PINE DALE MINE

ANNUAL REVIEW

2018

Prepared by: Enhance Place Pty Ltd
February 2019

Revision 1.0 – 25 February 2019

TITLE

Name of Operation:	Pine Dale Mine
Name of Operator:	Enhance Place Pty Limited
Project Approval Number:	10_0041
Project Approval Holder:	Enhance Place Pty Limited
Mining Lease Numbers:	ML1569, ML1578, ML1664, ML1637
Mining Lease Holder:	Enhance Place Pty Limited
Water Licence Number:	10WA118780
Water Licence Holder:	Enhance Place Pty Limited
MOP Commencement Date	15 April 2014
MOP Completion Date	12 April 2019
Annual Review Start Date:	1 January 2018
Annual Review End Date:	31 December 2018
Annual Review Report Author:	Carmen Rocher & Katy Shaw (RCA Australia)

I, Graham Goodwin, certify that this audit report is a true and accurate record of the compliance status of Pine Dale Mine, for the period 1 January 2018 to 31 December 2018 and that I am authorised to make this statement on behalf of Enhance Place Pty Ltd.

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

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

Authorised Reporting Officer:	Graham Goodwin
Title:	Mining Engineering Manager
Signature:	
Date	25.2.19

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1 STATEMENT OF COMPLIANCE

The Pine Dale Mine (PDM) Annual Review has been prepared to provide a summary of the performance of PDM operations over the period 1 January 2018 – 31 December 2018 (the reporting period).

This Annual Review has been prepared pursuant to Schedule 5, Condition 3 of the Project Approval 10_0041, and in accordance with the *Annual Review Guideline* developed by the NSW Department of Planning and Environment (October, 2015).

A summary of the PDM compliance status during this reporting period is provided in **Table 1**. There were two non-compliances relating to depositional dust monitoring during as detailed in EPL 4911 during the reporting period. A description of the non-compliance is provided in **Table 2**. The non-compliances recorded during the reporting period have been ranked according to the risk included in **Table 3**.

Table 1 Statement of Compliance

Approval No.	Were all conditions of the approval complied with?
PA 10_0041	Yes.
EPL 4911	No – Refer **Table 2.**
ML1569	Yes
ML1578	Yes
ML1664	Yes
ML1637	Yes
10WA118780	Yes

Table 2 Non-Compliances

Relevant Approval	Condition #	Summary of Condition.	Compliance Status (Refer Table 3)	Comment	Where addressed in Annual Review
EPL 4911	M2.2	Requirement to monitor on a monthly basis.	Non-Compliant	DD2 (Monitoring Point 7) located on private property was removed from the monitoring network at the request of the property owner.	**Section 6.2**
EPL 4911	M2.2	Requirement to monitor on a monthly basis.	Non-Compliant	No deposited dust data at DD3 for September2018 due to sampling error.	**Section 6.2**

Table 3 Compliance Status Key

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-compliance	Non-compliant	Only to be applied where the non-compliance does not result in any risk of environmental harm (e.g. submitting a report to government later than required under approval conditions).

An acceptable standard of environmental performance was achieved during the reporting period as evidenced by the following:

- Air quality monitoring results recorded during the reporting period for depositional dust, total suspended particulates (TSP) and fine particulate matter (PM_{10}) were below the NSW Environmental Protection Authority (EPA) assessment criteria and air quality criteria stipulated in the Project Approval 10_0041 at all monitoring locations with the exception of one PM_{10} twenty-four hour concentration. This concentration was considered to be impacted by a regional dust storm (refer **Section 6.2.2**).
- There were no noise exceedances from mining activities recorded at privately owned properties recorded during the reporting period;
- There were no surface water discharge events during the reporting period;
- Water monitoring results were compliant with Environment Protection Licence 4911.

During the reporting period, an assessment of rehabilitation areas was completed (refer **Appendix C**). Rehabilitation areas are generally stable in both the pasture and treed revegetation areas, whilst weed presence continues to be adequately controlled. It is recommended to continue weed management and the monitoring of performance indicators in the 2019 monitoring period.

2 INTRODUCTION

EnergyAustralia (EA) owns Enhance Place Pty Ltd (Enhance Place) which operates PDM near Lithgow in the Western Coalfields of New South Wales. EA acquired PDM in June 2012.

PDM is located at Blackmans Flat in NSW, 17km north of Lithgow off the Castlereagh Highway. The site is approximately 3km via the Castlereagh Highway from the Mt. Piper Power Station (MPPS) and immediately across the Highway from the Springvale Joint Venture Coal Preparation & Handling Facility. A locality plan is provided in **Plan 1**, **Appendix A**.

PDM operates under Project Approval (PA) 10_0041, dated 20 February 2011, granted by the Department of Planning and Infrastructure (DP&I) under section 75J of the Environmental Planning & Assessment Act 1979 (EP&A Act). The project approval provided for the extraction of up to 800,000 tonnes (t) of Run of Mine (ROM) from the Yarraboldy Extension at PDM up to 31 December 2014 at a maximum rate of 350,000 tonnes per annum (tpa). Approved mining resources at PDM were exhausted in March 2014. From April 2014 the mine was placed under care and maintenance, with only rehabilitation activities undertaken intermittently at the site from this time.

This Annual Review has been generated to meet:

- the Annual Review requirements of the Department of Planning and Environment under the conditions of a development consent or project approval:
- the Annual Environmental Management Report (AEMR) requirements of the Division of Resources & Energy under the conditions of a mining lease;
- the routine reporting expectations of DPI Lands & Water; and
- the Annual Reporting requirements of the Environmental Protection Authority under the conditions of the site Environmental Protection Licence.

This Annual Review is distributed to the following stakeholders:

- NSW Department of Planning & Environment (DPE);
- DPE – Resources Regulator (DPE-RR);
- NSW Department of Industry - Water (DPI Lands & Water);
- Environment Protection Authority (EPA);
- Lithgow City Council (LCC); and
- Pine Dale Mine Community Consultative Committee (CCC).

2.1 KEY PERSONNEL

The key personnel responsible for environmental management at the Pine Dale Mine are listed in **Table 4**.

Table 4 Key Contacts

Contact Person	Position	Telephone
Mr Graham Goodwin	Mining Engineering Manager	(02) 6355 7893
Mr Mark Frewin	Commercial Manager	(02) 6355 7893
Mr Ben Eastwood	NSW Environment Leader	(02) 6355 7893

3 APPROVALS, LEASES AND LICENCES

Pine Dale Mine operates in accordance with a number of relevant licenses and approvals which are summarised in Error! Reference source not found.. The mining and exploration lease boundaries are shown in **Plan 4**, **Appendix A**

Table 5 Pine Dale Mine Consents, Leases and Licences

Permit Type	Permit Number	Relevant Dates	Description
Project Approval	PA 10_0041	Granted 20 Feb 2012 Expired 31 Dec 2014	Granted by Minister of DP&I, Section 75J of the EP&A Act. A modification to PA 10_0041 was granted in March 2012.
Referral Decision	2011/6016	Date of Decision 20 October 2011	Issued by Department of Sustainability, Environment, Water, Population and Communities under section 75 & 77A of the EPBC Act 1999; to avoid impact on Purple Copper Butterfly & Austral toadflax (*Thesium austral*).
Environment Protection Licence	EPL 4911	Review Due Date 29 Aug 2018.	EPL held by Enhance Place Pty Ltd. Licence currently under review by NSW EPA. Licence variation submitted 21/01/2019
Mining Lease	ML1578	Granted 5 November 2013	ML 1578 incorporates 69.4ha of land within the boundary of the Pine Dale Mine site.
Mining Lease	ML1664	Grouped under ML1578, 5 Nov 2013	ML 1664 incorporates 4.1 Hectares of land within the boundary of the Pine Dale Mine site.
Mining Lease	ML 1569	Grouped under ML1578, 5 Nov 2013	ML1569 incorporates 161 hectares of land with which the Yarraboldy Extension and a portion of Pine Dale Coal Mine.
Mining Lease	ML1637	Grouped under ML1578, 5 Nov 2013	ML1637 covers an area to the south of Pine Dale Mine for the purpose of proposed rail infrastructure.
Exploration Mining Lease	EL7621	Granted 1 October 2010	EL 7621 incorporates 312 Hectares of land within the north western and central parts of the Wallerawang Colliery.
Bore Licence	10BL165933	Issued 22 December 2005	Issued by the Department of Natural Resources (DNR) under Part 5 of the Water Act 1912 for the use of six piezometers for monitoring groundwater levels and quality on the Pine Dale Mine site.
Bore Licence	10BL603588	Issued 17 December 2010	Issued by the Department of Natural Resources (DNR) under Part 5 of the Water Act 1912 for the use of eight piezometers for monitoring groundwater levels and quality on the Yarraboldy extension site.
Water Access Licence	WAL36480 (approval no 10WA118780)	Dated 1 July 2013 Expires 30 June 2026	This licence was issued by DECCW – NOW under Part 5 of the *Water Act 1912* for interception and use of up to 200ML of groundwater per year from The Bong.
Flood Control Works Licence	10CW801601 (approval no 10FW119292)	Dated 21 Sept 2015 Expires 21 Sep 2017	Issued by the DNR under Part 8 of the *Water Act 1912* for the construction of noise/flood bunding along the boundaries of Mining Areas A, B and C.

4 OPERATIONS SUMMARY

4.1 EXPLORATION

There were no exploration drilling activities carried out at PDM during the reporting period.

4.2 LAND PREPARATION

During the reporting period, there were no land preparation activities carried out at PDM.

4.3 CONSTRUCTION

No construction work was undertaken at the PDM during the reporting period.

4.4 MINING

During the reporting period there were no mining activities occurring at the PDM. The production and waste volumes during the reporting period are summarised in **Table 6**.

Table 6 Production and Waste Summary

	Approved Limit	Previous Reporting Period (actual)	This Reporting Period (actual)	Next Reporting Period (forecast)
Waste Rock / Overburden	NA	0	0	0
ROM Coal	800,000 t (over life of mine)	0	0	0
Coarse Reject	NA	0	0	0
Fine Reject (Tailings)	NA	0	0	0
Saleable product	350,000 t/year	0	0	0

4.5 COAL PROCESSING

At the completion of mining extraction in April 2014 the coal crushing plant was decommissioned.

4.6 COAL TRANSPORTING

Due to the care and maintenance status, no product coal was transported during the reporting period.

4.7 WASTE MANAGEMENT

Hydrocarbon based materials were stored or kept at the site in accordance with the currently approved Environmental Management Strategy and Waste Management Plan. Waste hydrocarbon materials were transported from the site by a licenced contractor.

General waste bins are kept at the site office for the collection of putrescible waste. These bins are inspected and emptied as part of the regular inspection and maintenance program for the site.

Sewage management facilities were maintained at the site during the reporting term with regular inspections and pump outs undertaken as required.

4.8 PRODUCT STOCKPILES

As the mine entered into care and maintenance in early 2014, the product stockpiles were decommissioned prior to the 2018 reporting period.

4.9 HAZARDOUS MATERIALS MANAGEMENT

There are no bulk oils stored on site. No oils were brought on site during the 2018 monitoring period. In the event hazardous materials are to be brought on site, they are to be accompanied by Material Safety Data Sheets (MSDS).

4.10 FORECAST OPERATIONS

There are no operations forecast for PDM during 2019. The mine will continue to remain under care and maintenance.

5 ACTIONS REQUIRED FROM PREVIOUS ANNUAL REVIEW

A letter from the compliance department of the DPE was received in relation to the 2017 Annual Review. The 2017 Annual Review was considered to generally satisfy the requirement of the approval in relation to the Annual Review. No actions were detailed to be undertaken by PDM.

6 ENVIRONMENTAL PERFORMANCE

The PDM regards sound environmental performance and community liaison as integral components of its operations.

Environmental monitoring and management at PDM is governed by the requirements of PA 10_0041 and supporting Environmental Assessment. The following management plans have been developed for the PDM to minimise the potential risk to the surrounding environment.

- Mining Operations Plan
- Aboriginal Heritage Management Plan
- Air Quality and Greenhouse Gas Management Plan
- Blast Management Plan
- Bushfire Management Plan
- Purple Copper Butterfly Monitoring & Management Plan
- Waste Management Plan
- Water Management Plan
- Noise Management Plan
- Pollution Incident Response Management Plan

These management plans are available on the EnergyAustralia website: https://www.energyaustralia.com.au/about-us/energy-generation/pine-dale-coal-mine/yarraboldy-stage-1

A summary of the environmental performance for noise monitoring and air quality monitoring is provided in **Table 7**. Detailed discussions of other key environmental performance indicators are presented further in this Section.

Table 7 Environmental Performance

Aspect	Approval Criteria	EA Prediction	Performance during 2018	Trends /Management Implications	Management Actions
Noise	NM1 – NM3 Daytime Criteria 42dB(A) $L_{Aeq(15minute)}$	NM1 41 NM2 32 NM3 39 dB(A) LAeq(15minute)	NM1 Nil detected NM2 Nil detected NM3 Nil detected dB(A) LAeq(15minute)	NA – no operational noise generated	Nil management actions required
	NM4 – NM6 Daytime Criteria 35dB(A) $L_{Aeq(15minute)}$	NM4 34 NM6 <30 dB(A) LAeq(15minute)	NM4 Nil detected NM5 Nil detected NM6 Nil detected dB(A) LAeq(15minute)	NA – no operational noise generated	Nil management actions required
Air Quality: Depositional Dust	Maximum total deposited dust 4g/m^2/month	Annual average of 3.2g/m^2/month deposited dust	Annual average range of 0.9 to 1.3g/m^2/month deposited dust	Annual average dust levels consistent with previous years	Maintain dust suppression measures as required
	Maximum increase in deposited dust 2g/m^2/month	Annual average increase of 1.2g/m^2/month deposited dust	Annual average *change* of 0.1 to 0.8g/m^2/month deposited dust	Annual average dust levels are slightly higher or similar to previous years however increases may be attributable to regional conditions.	Ensure dust suppression measures are efficiently utilised during extended dry periods, otherwise maintain current measures as required.
Air Quality: High Volume Air Sampling	TSP Annual Average 90 µg/m^3	TSP Annual Average 45 µg/m^3	TSP Annual Average 26.4 µg/m^3	Annual average TSP levels consistent with previous years	Maintain dust suppression measures as required
	PM_{10} Annual Average 25 µg/m^3	PM_{10} Annual Average 18 µg/m^3	PM_{10} Annual Average 12.2 µg/m^3	Annual average PM_{10} levels consistent with previous years	Maintain dust suppression measures as required
	PM_{10} 24hr Average Max 50 µg/m^3	PM_{10} 24hr Average Max 45.7 µg/m^3	Max PM_{10} 24hr average result 110 µg/m^3 (exceptional event). Second highest 24hr average result is 49 µg/m^3.	Max 24hr PM_{10} level is above the PM_{10} 24hr criterion, but is considered to be related to an exceptional event. Second highest 24hr PM_{10} concentration is slightly greater than the EA prediction, which may be attributable to regional conditions.	Ensure dust suppression measures are efficiently utilised during extended dry periods, otherwise maintain current measures as required.

6.1 NOISE

Mining related noise impacts at PDM are managed in accordance with Schedule 3, Condition 1 of PA 10_0041, EPL 4911 and the approved Noise Monitoring Program. Noise emissions from PDM operations were monitored on a quarterly basis at six (6) locations surrounding the site during the reporting period by RCA Australia (see **Plan 2 & 4**). These locations included:

- NM1 – the Green residence, Blackman's flat;
- NM2 – the Cherry residence, Blackman's flat;
- NM3 – front of Barnes residence, east of Blackman's flat;

- NM4 – the Rensen residence, north of View Street, Blackman's flat;
- NM5 – the Fraser residence, Wolgan Road, Lidsdale; and
- NM6 – the Turek residence, Wolgan Road, Lidsdale.

The operational noise assessment criteria is 42 dB LAeq (15 minute) at three (3) of the six (6) monitoring locations (NM1 to NM3); and a noise assessment criteria of 35dB LAeq (15 minute) applies at the remaining three (3) monitoring locations (NM4 to NM6).

Attended noise monitoring was undertaken routinely during the 2018 reporting period to assess any noise impacts from PDM against relevant criteria detailed within PA 10_0041 and EPL 4911. Quarterly monitoring was undertaken as follows:

- Quarter 1 – January to March; monitoring conducted 15 March 2018
- Quarter 2 – April to June; monitoring conducted 25-26 June 2018
- Quarter 3 – July to September; monitoring conducted 19 September 2018
- Quarter 4 – October to December monitoring conducted 16 October 2018

Although PDM is currently in care and maintenance, rehabilitation maintenance activities facilitating the use of mobile plant was conducted at the site during the 2018 reporting period. The measured LAeq 15min noise contribution from PDM was below the noise assessment criteria for all 15-minute surveys at all noise monitoring locations measured during the 2018 reporting period. Similarly, the measured noise contribution from PDM was also below the noise levels predicted in the Environmental Assessment. Audible noise emanating from the PDM has not been detected during noise monitoring surveys since the cessation of mining operations in April 2014.

Results for each noise survey during the 2018 reporting period are presented in full in **Appendix B**.

During the 2018 reporting period, no environmental performance or management measures were required to be implemented at the site in respect to noise generated by the site.

6.2 AIR QUALITY

Air quality management is a priority at PDM. During care and maintenance, water for dust suppression was sourced from the onsite sediment basins.

Air quality at PDM is managed in accordance with Schedule 3, Condition 18 of PA 10_0041, EPL 4911 and the approved Air Quality and Greenhouse Gas Management Plan (AQGGMP). The AQGGMP stipulates seven (7) air quality monitoring locations including six (6) depositional dust gauges (DDG) and one (1) high volume air sampling (HVAS) site which monitors total suspended particulates (TSP) and particulates less than 10µm (PM_{10}). Refer to **Plan 2a**, **Appendix A** for the location of these monitoring points.

Four (4) additional dust gauges associated with the Purple Copper Butterfly (PCB) Monitoring Program are located surrounding the Yarraboldy Extension. The PCB Monitoring Program was prepared to address concerns raised by the Commonwealth Department of Sustainability, Environment, Water, Populations and Communities (SEWPaC).

Monitoring is performed by RCA Australia; a summary report on data collected throughout the reporting period is available in **Appendix B**.

6.2.1 DEPOSITIONAL DUST

All depositional dust results have been compared to the nominated annual average assessment criteria of 4.0 g/m² per month, as stipulated in the project approval (PA 10_0041). Depositional dust results for the period January – December 2018 show an annual average insoluble solid range of 0.9 g/m² per month to 1.3 g/m² per month for all dust gauges. These results fall well below the nominated assessment criteria. It is noted that D2 was removed in February at the request of the landowner and therefore this result was based on only two (2) results as opposed to twelve (12) during the 2018 period. An EPL variation has been submitted to the EPA to remove this monitoring point from the licence in January 2019.

Comparative annual average depositional dust data for the previous five year period is presented in **Table 8**, with data presented graphically in **Figure 1**.

An examination of the historical data indicates a slight increase in the annual average depositional dust concentrations at the site during the period 2014 to 2018. Operations at the mine ceased during April 2014, with a reduction in depositional dust concentrations reflected between 2015 and 2017 inclusive, which was during the care and maintenance phase. Results observed in 2018 have generally increased at all locations with the exception of D5, which is similar to the 2015 annual average result, and D6 which is lower than the 2015 annual average. All of the 2018 depositional dust results are shown to be lower than the concentrations predicted in the site Environmental Assessment (predicted annual average of 3.2g/m^2/month deposited dust).

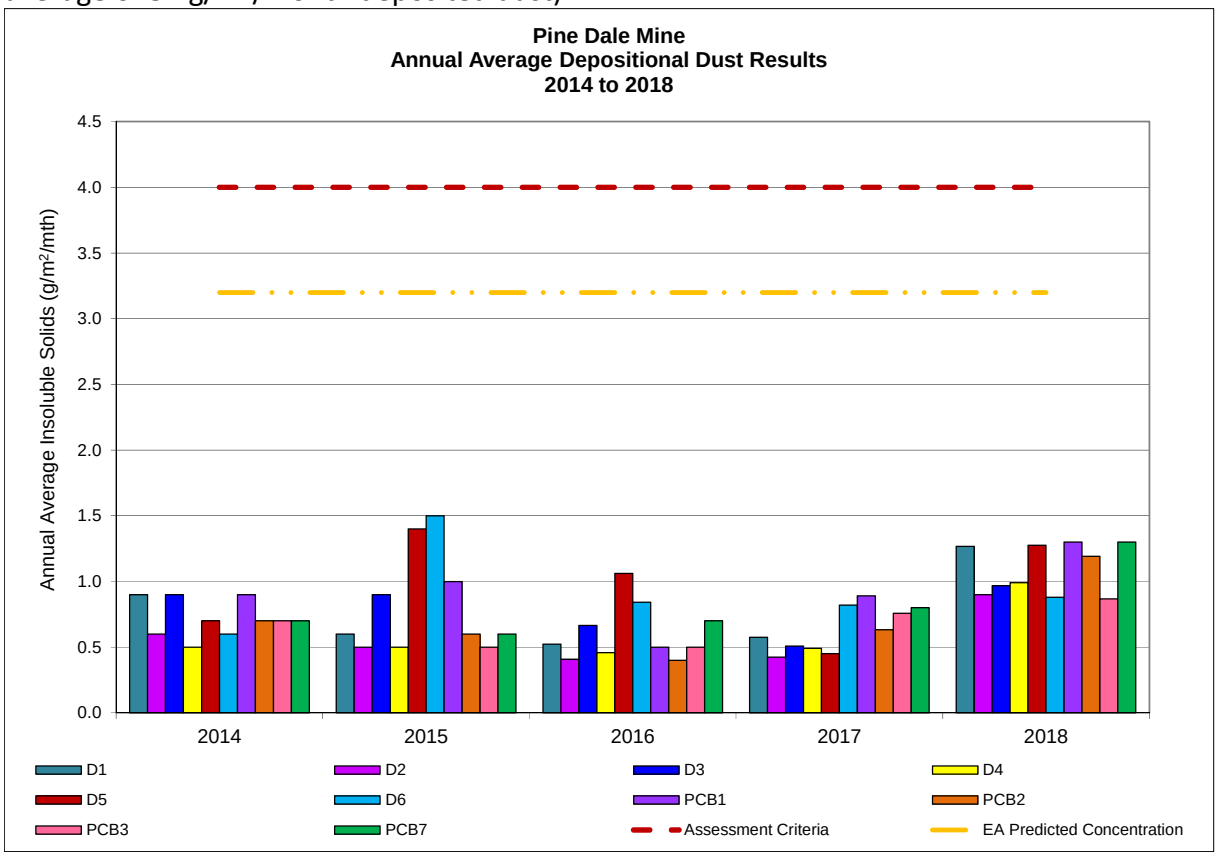


Figure 1 Historical Depositional Dust Data

Table 8 Depositional Dust Monitoring Results

Date	Total Insoluble Solids (g/m² per month)									
	Dust Gauge ID									
	D1	D2	D3	D4	D5	D6	PCB1	PCB2	PCB3	PCB7
Jan-18	1.9	1.1	0.9	1.1	3.7	0.8	1.1	1.5	1.5	2.0
Feb-18	1.2	0.7	0.9	1.0	0.6	1.0	1.5	1.4	1.1	2.1
Mar-18	0.9	Removed	0.6	0.3	0.8	0.7	0.8	0.8	0.8	1.5
Apr-18	1.5	Removed	0.4	1.0	0.4	0.6	0.9	0.9	0.6	1.7
May-18	0.7	Removed	0.6	0.8	0.6	0.6	0.6	0.9	0.5	1.2
Jun-18	1.0	Removed	0.7	0.5	0.5	0.6	0.4	0.5	0.6	0.6
Jul-18	0.3	Removed	*0.05*	0.3	0.6	*0.05*	0.4	0.2	*0.05*	0.4
Aug-18	0.5	Removed	0.6	0.6	2.1	0.6	2.7	0.9	0.7	0.2
Sep-18	0.4	Removed	ND	0.5	1.1	0.5	1.5	1.1	0.8	0.7
Oct-18	1.0	Removed	0.9	0.8	0.8	0.5	1.0	0.9	ND	0.8
Nov-18	2.8	Removed	2.1	2.2	1.3	2.1	1.6	1.6	1.3	1.8
Dec-18	3.0	Removed	2.9	2.8	2.8	2.5	3.1	3.6	1.6	3.0
Annual Averages										
2014	0.9	0.6	0.9	0.5	0.7	0.6	0.9	0.7	0.7	0.7
2015	0.6	0.5	0.9	0.5	1.4	1.5	1.0	0.6	0.5	0.6
2016	0.5	0.4	0.7	0.5	1.1	0.8	0.5	0.4	0.5	0.7
2017	0.6	0.4	0.5	0.5	0.5	0.8	0.9	0.6	0.8	0.8
2018	1.3	0.9	1.0	1.0	1.3	0.9	1.3	1.2	0.9	1.3
PA Annual Average Assessment Criteria	**4.0 g/m² per month**									

Notes: Results in *italics* indicate result is less than detection limits, and half the PQL has been reported.
Removed – The DDG has been removed at the request of the resident landowner.
ND – No data available due to a sampling error (incorrect bottle placed in the depositional dust gauge stand) at D3 in September and broken bottle at PCB3 in October 2018.

6.2.2 HIGH VOLUME AIR SAMPLING

Annual average PM_{10} and TSP monitoring results are summarised in **Table 9**. Detailed data analysis is presented in **Appendix B**. During the 2018 reporting period, all PM_{10} 24-hour average results recorded were below the 50 micrograms per cubic metre (µg/m³) assessment criteria nominated in PA 10_0041 with the exception of a concentration of 110µg/m³ on 15 December 2018. This concentration is considered to be attributable to an extraneous weather event, with PDM Mining Engineering Manager observing dust storms during mid-December 2018, and the NSW Office of Environment and Heritage (NSW OEH) Bathurst air monitoring location recording an average PM_{10} concentration of 274µg/m^3 on 15 December 2018.

The annual average PM_{10} result recorded in 2018 was 12 µg/m³, which is below the long term 25µg/m³ annual average assessment criteria. The highest TSP result recorded for 2018 was 175 µg/m³ on 15th December 2018. The annual average TSP result recorded during 2018 was 26 µg/m³, which is below the 90µg/m³ assessment criteria. Both the TSP and PM_{10} annual average concentrations continue to remain below the concentrations predicted in the Environmental Assessment. The long-term average annual PM_{10} and TSP levels are all within the nominated assessment criteria.

Table 9 PM_{10} and TSP Summary

	Particulate Matter <10µm (µg/m³)	TSP (µg/m³)
Maximum 24h Average result 2014	34	n/a
Maximum 24h Average result 2015	27	n/a
Maximum 24h Average result 2016	27	n/a
Maximum 24h Average result 2017	46	n/a
Maximum 24h Average result 2018	110*	n/a
PM_{10} 24h Assessment Criteria **	50	Not Required
Annual Average 2014	10	20
Annual Average 2015	8	18
Annual Average 2016	9	19
Annual Average 2017	10	20
Annual Average 2018	12	26
Annual Average Assessment Criteria**	30	90

* Result considered affected by external sources (dust storms) outside of the control of the project.
**Air Quality Assessment Criteria listed in project approval PA 10_0041.

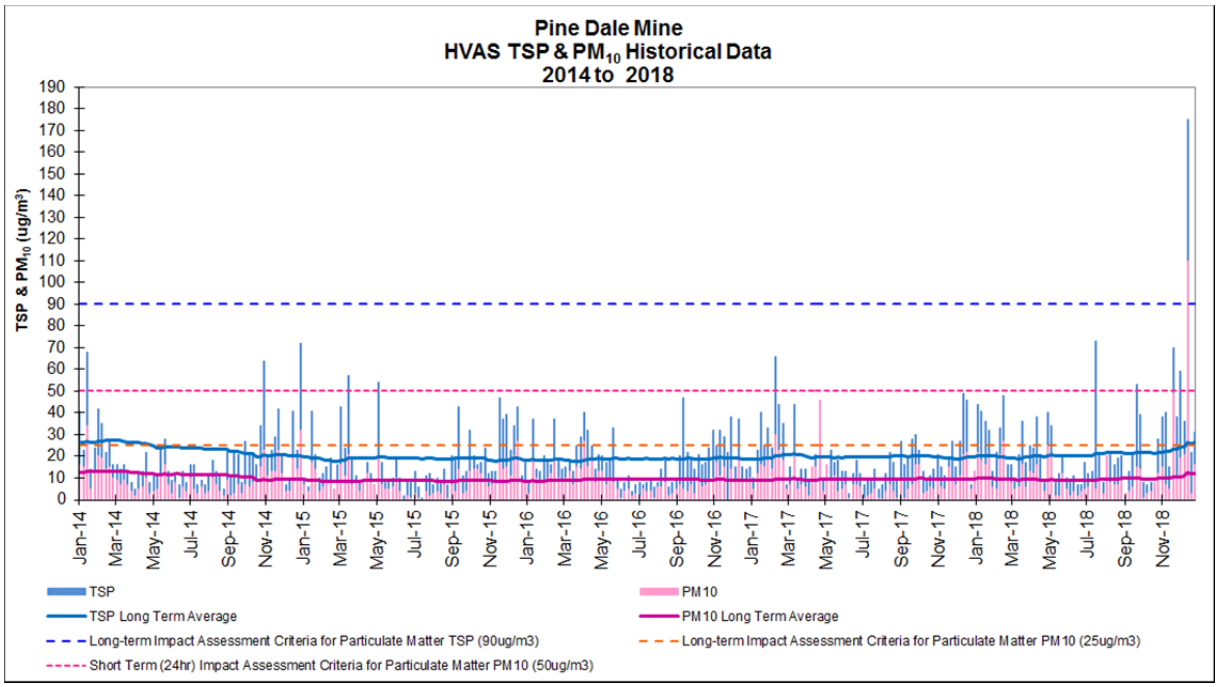


Figure 2 Historical HVAS Data

Results also demonstrate consistent PM_{10} and TSP levels were recorded at the site throughout the 2014 to 2018 monitoring period (see **Table 9** and **Figure 2**). The annual average PM_{10} and TSP particulate concentrations observed in 2018 are slightly higher than those recorded between 2014 and 2017 during which PDM has been under care and maintenance. It is considered that the slight increase in the concentrations in 2018 could be due to prolonged below average rainfall observed at the site, which is discussed in further detail in Section 6.3.1.

During the reporting period no additional environmental management measures were required to be implemented at the site in respect to depositional dust monitoring and high volume air sampling.

The existing air quality monitoring program and dust management practices will continue to be implemented throughout 2019. All air quality monitoring units will continue to be regularly calibrated and audited to ensure compliance with the appropriate Australian Standard.

6.3 METEOROLOGICAL MONITORING

In accordance with Schedule 3, Condition 22 of PA 10_0041 and EPL 4911, PDM operates a meteorological monitoring station which measures air temperature, wind direction, wind speed, solar radiation, sigma theta, rainfall, evapotranspiration and relative humidity. A summary of monthly meteorological conditions recorded during the 2018 reporting period are presented both in the following sections and **Appendix B**.

6.3.1 RAINFALL

PDM received 660 mm of rainfall and experienced 123 rainfall days during the 2018 reporting period. Rainfall during this reporting period was observed to be slightly more rainfall, although over fewer days that was recorded in 2017 (577 mm and 130 rainfall days).

The amount of rainfall during 2017 and 2018, are still considerably less than 2016 (1168mm over 147 days), and also less than the totals recorded in 2015 and 2014 (754 mm and 705 respectively).

The Bureau of Meteorology (BOM) station located at Lithgow (Birdwood St, approximately 20km from PDM) reported a long term median[1] rainfall, between 1889 and 2006 of 858.6mm. During the five years of data used within this report, only one (1) year has reported similar to, or above average rainfall; with 2018 reporting 77% of this amount. The monthly rainfall data for 2018 is summarised in **Table 10.** A graphical presentation of annual rainfall during the previous 5 years is presented in **Figure 3.**

6.3.2 TEMPERATURE

Temperature is monitored at two heights (2 metres and 10 metres) to account for temperature inversions. The maximum temperature recorded during the reporting period was 40.1°C at the 2m sensor and 38.4°C at the 10m sensor, during January. The lowest temperature occurred in July, with a recording of -8.9°C at both 2m and 10m. A summary of monthly temperatures for 2018 is included in **Table 10**. A graphical presentation of annual temperature variations during the previous 5 years is presented in **Figure 3.**

1 The use of the median (decile 5) value is specified as the preferred measure of 'typical' rainfall from a meteorological perspective as it reduces potential bias from extreme rainfall events.

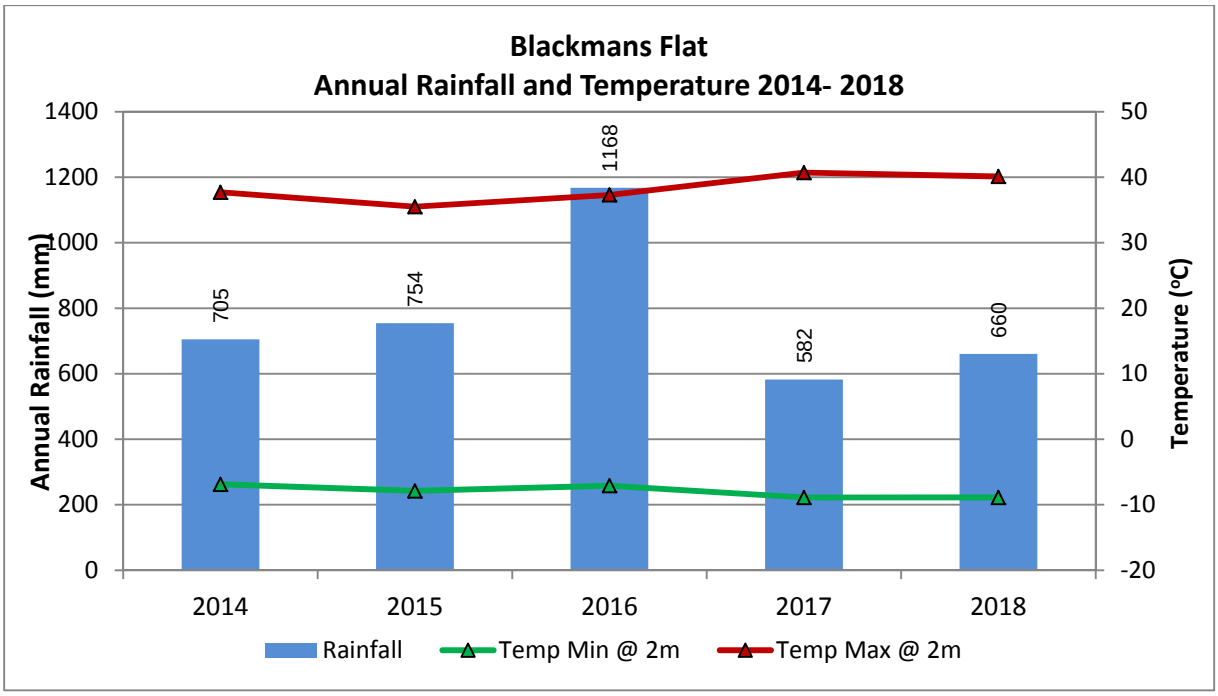


Figure 3 Annual Temperature & Rainfall Summary

6.3.3 WIND SPEED, DIRECTION & SIGMA THETA

Predominant wind directions at the site in 2018 were observed to be from the west to north-west, with southerly easterlies dominant January through to March. October reported an even percentage from the west north-west and south east.

The maximum wind speed measured at the site was 18.0m/s in July 2018 from a west-north-westerly direction. Sigma theta data was measured continuously throughout the entire 2018 monitoring period. A summary of monthly wind speed, predominant directions and sigma theta recordings in 2018 is included in **Table 10**.

6.3.4 RELATIVE HUMIDITY

Relative humidity was measured in the 2018 monitoring period. The minimum and maximum humidity recorded at the site were 3.3% recorded during January and 100.0% recorded during October. A summary of monthly humidity variations for 2018 is included in **Table 10**.

Table 10 Pine Dale Mine Meteorological Station Summary 2018

Month	Rainfall (mm)	Cumulative Rainfall (mm)	No of Rain Days/ Month	Air Temp. @ 2m (°C)			Air Temp. @ 10m (°C)			Sigma theta (º)			Relative Humidity (%)			Wind Speed (m/s)			Modal Wind Direction
				Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	
January	52	52	7	21.4	4.9	40.1	20.9	4.9	38.4	33.4	0.0	98.2	57.0	3.3	95.9	1.2	0.0	15.1	ESE
February	88.6	140.6	8	19.1	5.2	37.9	18.7	5.2	36.3	33.3	0.0	102.6	61.3	5.3	94.4	1.4	0.0	14.7	SE
March	59.4	200	7	17.2	-0.8	32.6	16.9	-0.8	31.3	32.7	0.0	103.6	68.6	14.4	95.6	1.3	0.0	14.2	SE
April	28.6	228.6	8	15.0	0.2	32.6	14.8	0	30.9	29.6	0.0	101.4	68.3	14.8	95.7	1.2	0.0	17.7	WNW
May	16	244.6	7	7.7	-4.1	23.5	7.8	-4.1	22.6	26.1	0.0	103.1	71.1	16.6	95.4	1.2	0.0	13.2	WNW
June	44.2	288.8	17	5.9	-8	16.6	5.9	-8.2	15.8	26.9	0.0	102.8	77.1	13.8	95.7	1.4	0.0	13.2	WNW
July	4.6	293.4	7	4.5	-8.9	18.3	4.7	-8.9	17.3	19.7	0.0	102.8	67.1	13.6	96	1.8	0.0	18.0	WNW
August	48.6	342	11	5.6	-7.9	18.3	5.7	-8.2	17.8	23.1	0.0	98.9	65.8	9.9	95.3	2.0	0.0	15.8	WNW
September	59.8	401.8	10	8.8	-4.9	25.1	8.8	-5	24.1	26.6	0.0	103.6	67.5	12.7	96.5	1.5	0.0	14.6	WNW
October	79.8	481.6	18	12.8	0	27.5	12.6	0	26.4	32.7	0.0	102.4	72.8	11.8	100	1.3	0.0	10.3	WNW/SE
November	117.4	599	15	15.2	1.7	30.5	15.0	1.7	29.7	28.0	0.0	101.5	64.6	14.5	96.8	1.4	0.0	15.2	WNW
December	61.4	660.4	8	19.4	4.3	37.3	19.2	4.5	36.8	31.3	0.0	99.8	62.1	10.3	96.6	0.8	0.0	16.8	WNW
TOTAL	**660.4**	-	**123**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Minimum	**4.6**	-	**7**	-	***-8.9***	-	-	***-8.9***	-	-	***0.0***	-	-	***3.3***	-	-	***0.0***	-	-
Maximum	**117.4**	-	**18**	-	-	***40.1***	-	-	***38.4***	-	-	***104***	-	-	***100***	-	-	***18.0***	-

6.4 EROSION AND SEDIMENT

The erosion and sediment controls for PDM have been implemented to safeguard against soil loss and minimise potential water quality impacts. Erosion control structures have been installed around the mine with the principle aim of containing sediment at its source. All runoff from disturbed areas is contained in temporary pollution control ponds within the open cut itself and surrounding hardstand areas.

Exposed areas which have been disturbed by previous mining operations are controlled though the use of windrows constructed by subsoil and/or clay material. Once vegetation has been cleared and topsoil removed, subsoil and clay material is pushed against the interface between the disturbed and undisturbed area creating a windrow where the potential for erosion impacts exist. Exposed areas are also managed through the use of temporary measures, such as silt fencing, to avoid sedimentation impacts on downstream waterways until the area has been rehabilitated. Additionally, temporary sediment ponds are constructed downslope of disturbed areas to ensure the capture of 'dirty' water and enable treatment prior to discharge into the underground workings. The management measures for the control of erosion described above is also put in place to increase batter and bench stability prior to establishment of permanent rehabilitation measures, where possible.

Erosion control structures at PDM are inspected on a monthly basis, particularly after significant rainfall events and repaired where necessary. Erosion and sediment control works which were undertaken during the 2018 reporting period included:

- The inspection and maintenance of windrows and silt fencing to prevent potential surface water impacts and sediment entering Neubeck's Creek;
- Repair of surface cracking from soil settling in Area B.

6.5 CONTAMINATED AND POLLUTED LAND

A voluntary per and poly-fluoro alkyl substances (PFAS) investigation was undertaken at PDM during the 2018 reporting period. The results of the investigation are discussed in **Section 6.5.1**. No other land was identified as being contaminated or polluted.

6.5.1 PFAS ASSESSMENT

During the 2018 reporting period, the NSW EPA requested NSW mine operators to undertake a PFAS investigation for potential PFAS contamination. An investigation was undertaken at PDM in July 2018.

Sediment and surface water samples were collected from five (5) locations at PDM. Samples were collected from the licence discharge point 13 (LDP13), upstream of LDP13, downstream of LDP13, surface water site S3 and the sediment dam by the workshop hardstand. One (1) groundwater sample was collected from The Old Ventilation Shaft which is located in the Old Wallerawang Underground mine workings. Sediment and water results were compared to the human health and ecological criteria as detailed in PFAS National Environmental Management Plan (HEPA, 2018). A summary of the investigation is detailed below:

- PFAS was not detected in the majority of sediment samples.

- PFAS concentrations in sediment in the Sediment Dam were in excess of the human health and ecological criteria. All other collected sediment samples were below the human health and ecological guideline.
- PFAS concentrations were detected in all water samples with the exception of the underground workings, in the sample collected from Old Ventilation Shaft which were below laboratory detection limits.
- PFAS concentrations in water samples in excess of the drinking water guidelines were limited to the sample taken at the Sediment Dam. There were no concentrations in excess of the ecological guideline.

Based on the drainage pathways within PDM, PFAS concentrations from the Sediment Dam have the potential to enter the old Wallerawang Underground workings; however, no detectable concentrations of PFAS were found within the sample taken from within the old Wallerawang underground workings (Old Shaft). This is considered likely due to dilution of PFAS concentrations as they enter the underground workings. As such, it is considered that the potential for PFAS concentrations to pose an ecological or health risk to off-site receptors to be low.

6.6 THREATENED FLORA & FAUNA

Measures for the management and mitigation of flora and fauna impacts at PDM and in the surrounding area are provided in the Care and Maintenance MOP and the Flora and Fauna Management Plan.

6.6.1 PURPLE COPPER BUTTERFLY

The Purple Copper Butterfly (PCB), also known as the Bathurst Copper Butterfly, is listed as an endangered species under the *Threatened Species Conservation Act 1995* and vulnerable under the *Environmental Protection and Biodiversity Conservation Act 1999.* The PCB and larvae has been identified adjacent to the eastern boundary of the PDM Yarraboldy Extension within an area of its habitat of native Blackthorn (*Bursaria spinosa* subsp. *Lasiophylla*). Native Blackthorn is found throughout the local area.

To minimise potential direct and indirect impacts of dust and vibration from the PDM on the PCB, the following mitigation measures were been implemented:

a) maintenance of fencing and earth bunds around known PCB habitat;
b) mining activity not occurring within 200m of the main habitat area between September through to the end February, when the flying season of the adult and larvae stages of the PCB were apparent as determined by an independent ecologist; and
c) implementation of further management and mitigation measures in accordance with PA 10_0041 and Particular Manner Decision 2011/6016.

A PCB monitoring program has been implemented to monitor potential indirect impacts from extractive mining activities (particularity blasting and vibration) on the known populations of the butterfly. As PDM has been in care and maintenance since April 2014, and mining activities have ceased there are no foreseen impacts upon the PCB. The field survey monitoring is conducted to coincide with the adult and larvae stages of the PCB with monitoring being undertaken by ecologists from Eco Logical Australia Pty Ltd. Monitoring is

undertaken in a 30m radius of the PCB dust gauge locations PCB1, PCB2 and PCB4. Locations are shown in **Plan 2a** in **Appendix A**.

Two field surveys were conducted during the 2018 reporting period in accordance with the Commonwealth Department of Environment (DoE) Notification of Referral Decision measure, as follows:

- 1 March 2018 - field survey of the Purple Copper Butterfly (PCB) within and adjacent to the locations identified in the Notification of Referral Decision to determine the completion of the larval stage.
- September 2018 - weekly survey for the PCB within monitoring locations identified in the Notification of Referral Decision, to determine whether the adult feeding stage of PCB lifecycle had commenced.

A review of the survey data recorded during the period 2013 to 2018 indicates PDM has had minimal impact upon the life cycles of the Purple Copper Butterfly.

Results of the ecologist field monitoring are provided in **Table 11**.

Data collected from dust gauges located within the butterfly habitat area is provided within **Appendix B.**

Table 11 Purple Copper Butterfly Field Survey Summary

Monitoring season	Purpose of field survey	Date of field surveys	Survey results	Conclusion	Response
2013-2014	To confirm commencement of PCB larval feeding season	5 September 2013	No larvae or evidence of larvae identified; eight adult PCB identified	Due to evidence of adult PCB, precautionary approach taken that PCB larval feeding season has commenced.	No mining activities to occur within 200m of PCB main habitat area.
		13 September 2013	No larvae or evidence of larvae identified; one adult PCB identified		
	To confirm completion of larval stage i.e. larvae not actively foraging above ground, within habitat area	Evening 11-12 March 2014	No larvae identified	The PCB in larvae form is no longer coming to the surface	Mining activities can recommence within 200m of PCB main habitat area.
2014-2015	To confirm commencement of PCB larval feeding season	5 September 2014	No larvae or evidence of larvae identified; no adult PCB identified	Lack of active larvae observed on the plants inspected suggests that the PCB breeding season had only recently commenced and the adult individuals observed had only recently emerged.	No mining activities to occur within 200m of PCB main habitat area.
		12 September 2014	No larvae or evidence of larvae identified; >36 adult PCB identified		
	To confirm completion of larval stage i.e. larvae not actively foraging above ground, within habitat area	Evening 5 - 6 March 2015	No larvae identified	Larvae have commenced pupation and are no longer active. Larvae stage is complete. The PCB is not expected to reappear above ground until Aug/Sept.	Mining activities can recommence within 200m of PCB main habitat area.
	To confirm commencement of PCB larval feeding season	4 September 2015	No larvae identified; five adult PCB identified	Lack of active larvae observed on the plants inspected suggests that the PCB breeding season had only recently commenced and the adult individuals observed had only recently emerged.	No mining activities to occur within 200m of PCB main habitat area.
2015-2016	To confirm completion of larval stage i.e. larvae not actively foraging above ground, within habitat area	Evening 22/23 February 2016	No larvae identified; no attendant ants observed near targeted plants.	No larvae detected indicate PCB larvae have commenced pupation and are no longer active. Larvae stage is complete. PCB not expected to re-appear until Aug / Sep.	Mining activities can recommence within 200m of PCB main habitat area.
	To confirm commencement of PCB larval feeding season	29 August 2016	Numerous adult PCB observed; no larvae observed.	Lack of active larvae observed indicates PCB breeding season had only recently commenced.	No mining activities to occur within 200m of PCB main habitat area.

Monitoring season	Purpose of field survey	Date of field surveys	Survey results	Conclusion	Response
2016-2017	To confirm completion of larval stage i.e. larvae not actively foraging above ground, within habitat area	Evening of 27 February 2017	No larvae identified on any plants; attendant ants were observed on two plants at site PCB1 and PCB2.	No larvae detected in survey area indicating PCB larvae have commenced pupation and are no longer active. Larvae stage is complete. PCB not expected to re-appear until late August / early September.	Mining activities can recommence within 200m of PCB main habitat area.
	To confirm commencement of PCB larval feeding season	31 August 2017	Abundant adult PCB observed; no larvae observed.	Absence of larvae observed indicates PCB breeding season had only recently commenced.	No mining activities to occur within 200m of PCB main habitat area.
2017-2018	To confirm completion of larval stage i.e. larvae not actively foraging above ground, within habitat area	Evening of 1 March 2018.	No larvae identified on any plants. No attendant ants observed.	Absence or larvae during seasonally mild conditions indicates that PCB larvae have commenced pupation and are no longer active. Larvae stage is complete.	Mining activities can recommence within 200m of PCB main habitat area.
	To confirm commencement of PCB larval feeding season	5 September 2018.	Six PCB (flying stage) identified at PCB1; no larvae observed.	Absence of larvae indicates PCB feeding season has commenced, no further monitoring required.	As PDM is in care and maintenance, no mining activities have ceased and no foreseeable impacts would be noted. No earthwork activities to occur within 200m of PCB main habitat area.

6.6.2 AUSTRAL TOADFLAX (THESIUM AUSTRALE)

Austral Toadflax is listed as vulnerable under the *Threatened Species Conservation Act 1995* (TSC Act) and the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). An erect to scrambling perennial herb, it occurs in small populations, parasitising a range of grass species, which at PDM is Kangaroo Grass. At subalpine and tableland climates the species dies back to rootstock during winter and re-sprouts in spring.

Surveys conducted by Eco Logical Australia in March 2011 identified a total of 260 individual Austral toadflax plants in three patches located beyond the north-west crest of the Yarraboldy Stage 1 Extension pit.

A Species Management Plan completed in consultation with the Department of Environment and Planning has been developed to mitigate the impact of open cut mining on the host habitat within the *Austral Toadflax buffer area*. This includes:

- Inclusion of a buffer zone from known specimens referred to as the *Austral Toadflax buffer area;*

- Installation and maintenance of fencing and signage between the open cut boundary and known location of specimens;
- Installation of additional signage and barriers (e.g. tape) when operating in close proximity to the Austral toadflax buffer area; and,
- Control of noxious weed infestations and feral animals.

During the reporting period, care and maintenance operations did not encroach within the habitat area (refer **Appendix C**). Control of noxious weeds within and surrounding the habitat area will continue to be undertaken in the next reporting period. There were no environmental performance or management issues in relation to impacts upon the Austral Toadflax.

6.7 WEEDS

Weed control activities at PDM are undertaken in accordance with the Care and Maintenance MOP. Weed control methods target four (4) noxious weeds previously identified within PDM and the Yarraboldy Extension area, namely:

- African lovegrass (*Eragrostis curvula*);
- Blackberry (*Rubus fruticosus aggregate species*);
- Briar Rose (*Rosa rubiginosa*); and
- St John's Wort (*Hypericum perforatum*).

Weed inspections were undertaken on a regular basis with a large portion of weed problems on PDM being sprayed during the reporting period. Active weed control for African Love Grass, Blackberry, Briar Rose and ST John's Wort was undertaken during summer (January 2018) and spring (November 2018).

The PDM Rehabilitation Monitoring Report (FirstField Environmental, 2018), attached in **Appendix C** indicated African lovegrass was present at the pasture rehabilitation areas (Area 8, Area B and Area C). The presence of African lovegrass comprised of <10% of the pasture area. These outbreaks were subjected to chemical control and were not observed to be growing or producing seeds. The report also found the method of African lovegrass control was consistent with legislative requirements.

The control of weeds will be undertaken on an ongoing basis consistent with the Care and Maintenance MOP as required to ensure noxious species are managed accordingly.

6.8 BLASTING

As PDM is currently in care and maintenance, there were no blasting activities undertaken at the site during the 2018 reporting period.

6.9 VISUAL, STRAY LIGHT

There were no adverse impacts associated with stray light or visual disturbance identified during the reporting period. There were no complaints received during the reporting period regarding visual and stray light impacts.

6.10 ABORIGINAL HERITAGE

There were no artefacts of Aboriginal Cultural Heritage found at PDM during the reporting period.

6.11 NATURAL HERITAGE

No items or areas of natural heritage significance were recorded or are considered to occur within the approved disturbance area at PDM.

6.12 SPONTANEOUS COMBUSTION

There were no incidences of spontaneous combustion in coal stockpiles or overburden material during the reporting period. The Lithgow Seam is known to have a low propensity for spontaneous combustion. All coal stockpiles have been decommissioned.

6.13 MINE SUBSIDENCE

There were no issues regarding mine subsidence during the reporting period.

6.14 HYDROCARBON CONTAMINATION

There were no reported incidents of hydrocarbon contamination at PDM during the reporting period. In the unlikely event that contaminated material is identified at the site, the remedial actions taken shall be those outlined in the MOP, whereby the affected material is either treated on-site or disposed of off-site by a licenced contractor.

6.15 BUSHFIRE

Bush fire control strategies for PDM are managed in accordance with Project Approval PA 10_0041 and the approved Bush Fire Management Plan. These strategies are employed for preventing the occurrence and spread of any fire events that may impact on the site or in surrounding lands (i.e. Ben Bullen State Forest). As such, measures are taken at PDM to prevent the occurrence and spread of fire through proper maintenance of machinery and equipment, and the maintenance of access roads.

During the reporting period there were no bush fire events at or in close proximity to PDM.

6.16 METHANE DRAINAGE/VENTILATION

The underground workings at this site were closed in 1986 and decommissioned over the period from 1987 to 1990. Methane levels are considered to be negligible at PDM.

6.17 PUBLIC SAFETY

No issues of public safety occurred during the reporting period. The entire perimeter of PDM is fenced, with “No Trespassing” signs displayed at various intervals. “Do Not Enter” and “Danger” signs are also displayed along the fence of the private sealed haul road. Continuation of the control of trespassing during the reporting period has occurred through routine inspection, monitoring, upgrades and repairs of fencing structures. During the care and maintenance term, the site has continued to be regularly monitored by mine personnel.

6.18 OTHER ISSUES AND RISKS

There are no other known issues or identified hazards at the operating PDM.

7 WATER MANAGEMENT

PDM lies within the Neubecks Creek catchment which is a sub-catchment of the Upper Coxs River catchment, which in turn is part of the Warragamba Catchment, administered by Water NSW.

The runoff from the surrounding area reports to the Coxs River via Neubecks Creek (a perennial tributary) which runs into Blue Lake, a former open cut mining void. Neubecks Creek is understood to flow intermittently (noting that many of its tributaries are temporary), with flows influenced by water discharges from other upstream industrial land uses.

Water resources at PDM are managed in accordance with the Water Management Plan (WMP) which was developed under the requirements of project approval PA 10_0041, Environmental Protection Licence (EPL 4911), respective groundwater bore licences, the water access licence (WAL 36480) and Water Supply Works Approval 10WA118780.

The water management system has been designed as a closed loop system, with all clean water diverted around the mining site where practicable. It is also designed not to discharge any water from the site into Neubecks Creek unless required to under an emergency. Drainage of surface water within the site's disturbed areas is generally to the south and southeast following the natural topography for treatment prior to free draining into the underground workings (see **Plan 4**). The runoff from the north is captured in temporary sumps and used as dust suppression when required.

7.1 STORED WATER

There are no permanent water storage structures at the PDM. Clean water diversion structures are utilised at the site in conjunction with temporary sediment ponds. Temporary sediment ponds are constructed downslope of disturbed areas to ensure the capture of 'dirty' water and enable treatment prior to draining into the underground workings.

7.2 SURFACE WATER

During the reporting period, all surface water monitoring at PDM was undertaken in accordance with the surface water monitoring program documented in the PDM WMP, and EPL 4911. Details of the locations, frequency and sampling methods for surface water monitoring are presented in **Table 12** and **13**. The parameters analysed were consistent with the requirements of the WMP and EPL 4911. Results of surface water monitoring are discussed in **Section 7.3.2** and also provided in **Appendix B**.

No discharge of waters via the licenced discharge point (LDP13) occurred during the reporting period.

Potable water for use in the offices and amenities is sourced from town water mains supply.

7.3 SURFACE WATER MONITORING

Surface water quality at PDM is managed in accordance with the WMP and the site EPL. Sampling is conducted at a total of eleven (11) locations within and surrounding the mine site. Surface water data is collected by RCA Australia and analysed at a NATA registered laboratory.

In accordance with EPL 4911 the following locations are required to be monitored at PDM on a quarterly basis for total suspended solids (TSS), sulfate and dissolved iron:

- Point 2 – Upstream of EnergyAustralia flow gauge;
- Point 3 – 100m downstream of bridge near site office; and
- Point 14 – Cox's River downstream of Blue Lake.

In accordance with EPL 4911, EPA Points 2, 3 and 14, and licenced discharge point LDP13 are required to be sampled for pH, EC and turbidity on a daily basis during when LDP13 is discharging. No discharge events occurred at LDP13 during the 2018 monitoring period.

Surface water locations Points 2, 3 and 14 are also required to be analysed for electrical conductivity (EC), pH, turbidity in accordance with the WMP.

The WMP also details monitoring of a further seven (7) locations, S1 to S7, which require monthly pH, temperature, EC and turbidity testing plus a quarterly analysis suite comprising major ions, anions and filtered metals. The locations of monitoring points are indicated on **Plan 2a** in **Appendix A**.

7.3.1 SURFACE WATER CONCENTRATION LIMITS AND TRIGGER LEVELS

Concentration limits are specified in EPL 4911 for the licenced discharge point LDP13, whilst the remaining water monitoring locations only have water quality trigger values stipulated in the site WMP – surface water section in accordance with Schedule 3, Condition 27(b) of the Project Approval (PA 10_0041). The current approved WMP trigger values are presented in **Table 12**.

EnergyAustralia commissioned an investigation of surface water quality at PDM to be undertaken which included identification of factors that influence surface water quality. This investigation was concluded in 2018 and as a result new surface water trigger values were proposed. These surface water trigger values were submitted to DPI – Water in late 2018. No response has been received at the time of writing.

The WMP details the protocol for the investigation, notification, and mitigation of any identified adverse impacts on surface water quality. The surface water component of the WMP also provides impact assessment criteria, including trigger levels for investigating any potentially adverse surface water impacts.

Table 12 WMP & EPL Surface Water Trigger Values & Limits

Surface Water Site	pH (range)	Electrical Conductivity (µS/cm)	Total Suspended Solids (mg/L)	Oil and Grease (mg/L)
S1	6.2 – 8.0	2325	30	10
S2	NA	NA	NA	NA
S3	6.4 – 8.0	2223	30	10
S4	7.3 – 8.0	957	30	10
S5	7.0 – 8.0	1013	30	10
S6	6.7 – 8.0	1941	30	10
S7	6.8 – 8.0	1007	30	10
EPA Point 2	7.1 – 8.0	2055	30	NA
EPA Point 3	6.4 – 8.0	2223	30	NA
EPA Point 13	6.5 – 8.0*	NA	30*	10*
EPA Point 14	7.5 – 8.0	1166	30	NA

* EPL Concentration Limit (daily during discharge)

7.3.2 SURFACE WATER QUALITY

7.3.2.1 EPL Surface Water Monitoring

During the monitoring period, four (4) quarterly EPL surface water monitoring events were conducted in February, May, August and November 2018. Monitoring Point 2 and Point 3 are ambient surface water monitoring points on Neubecks Creek; whilst monitoring Point 14 is an ambient surface water monitoring point located on the Coxs River which assesses the water quality downstream of the Pine Dale Mine. There are no EPL concentration limits for monitoring Points 2, 3 and 14. The EPL surface water monitoring points are shown in **Plan 2a**, **Appendix A**.

EPL surface water samples collected during the 2018 period are compared against the trigger values specified within the site WMP – surface water section. pH was within the respective site specific trigger value ranges with the exception of the following:

- EPA Point 2 was below the lower pH trigger value during three (3) of the four (4) water quality monitoring events. EPA Point 2 is located upstream of PDM, therefore these low pH values are not considered to be due to activities undertaken at PDM.
- EPA Point 14 was above the upper pH trigger level value during all four (4) water quality monitoring events. The pH at EPA Point 14 has historically shown to be greater than 8.0pH units (refer **Figure 4**). These elevated pH measurements are not considered to be due to activities undertaken at PDM during the 2018 monitoring period as the pH within Coxs River upstream of PDM (located S4, refer to **Section 7.3.22**) show levels that are generally greater than 8.0pH units.

EC was below the respective trigger values with the exception of the following:

- EPA Point 2 was above of the site specific trigger value during May 2018.
- EPA Point 3 was above of the site specific trigger value during May 2018.

- EPA Point 14 was above of the site specific trigger value during three (3) of the four (4) monitoring events. The greatest concentration was observed during the February 2018 monitoring event.

Electrical conductivity within Neubecks Creek and downstream water bodies, such as Coxs River are predominantly influenced by the electrical conductivity of discharges to Neubecks Creek, upstream of PDM. Electrical conductivity levels above the site specific trigger levels are not considered to be due to activities undertaken at PDM during the 2018 monitoring period.

All EPL locations were below the total suspended solids trigger value during all monitoring events.

The EC and pH for the period 2014 – 2018 is shown in **Figure 4**; EC and rainfall for this period is shown in **Figure 5**.

During the 2014 - 2018 monitoring period, pH has remained generally stable. A slight increasing trend in pH is evident at EPA Point 14. Electrical conductivity is shown to be increasing at EPA Point 2 and EPA Point 3 from January 2017 – December 2018. An investigation into water quality at PDM has indicated that increases in conductivity in Neubecks Creek (EPA Point 2 and EPA point 3) are attributable to increases in electrical conductivity upstream of PDM. These increases in electrical conductivity are also correlated with decreased rainfall.

The full suite of surface water monitoring results for Environmental Protection Licence 4911 for the 2018 period are presented in **Appendix B**.

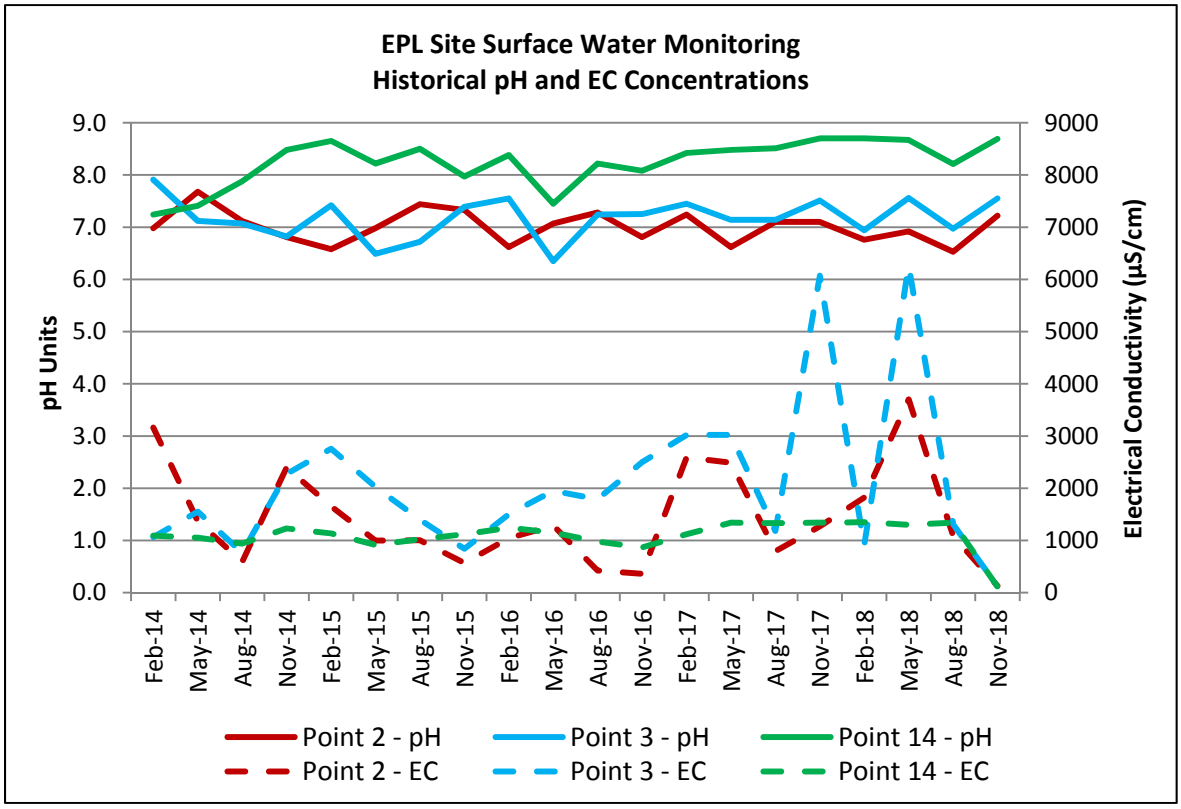


Figure 4 EPL Surface Water Historical Results

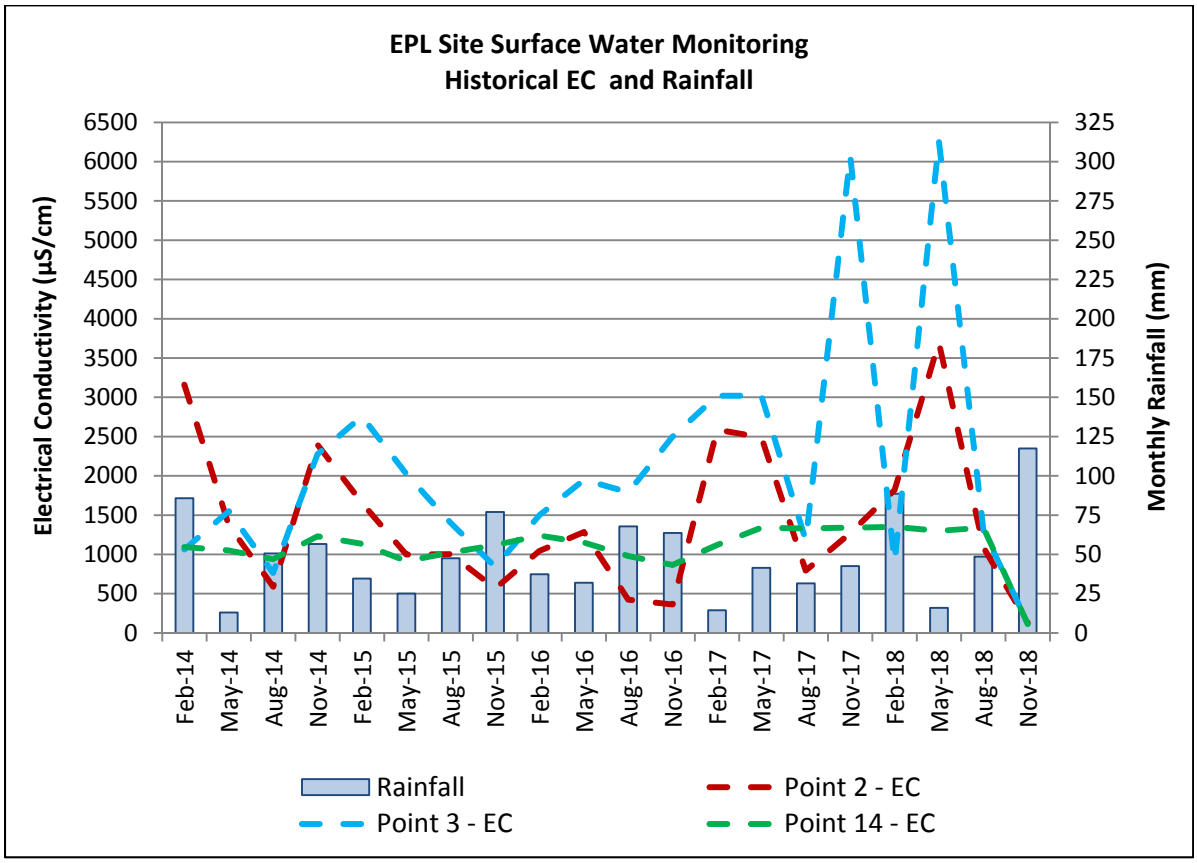


Figure 5 EPL Surface Water Historical Results and Rainfall

7.3.2.2 WMP Surface Water Monitoring

Seven (7) surface water samples associated with the WMP were collected monthly during the 2018 monitoring period. Site surface water samples S1 - S7 are generally shown to be consistent over the duration of the monitoring period. Results for pH and electrical conductivity for the 2014 – 2018 monitoring period is shown graphically in **Figure 6**, **Figure 7**, **Figure 8** and **Figure 9**. The full suite of surface water monitoring results for site S1 – S7 is shown in **Appendix B**.

Surface water sites S1, S3 and S6 are located within Neubecks Creek; S5 in Blue Lake; S4 and S7 are located in Coxs River. Monitoring locations are shown in **Plan 2a**, **Appendix A**.

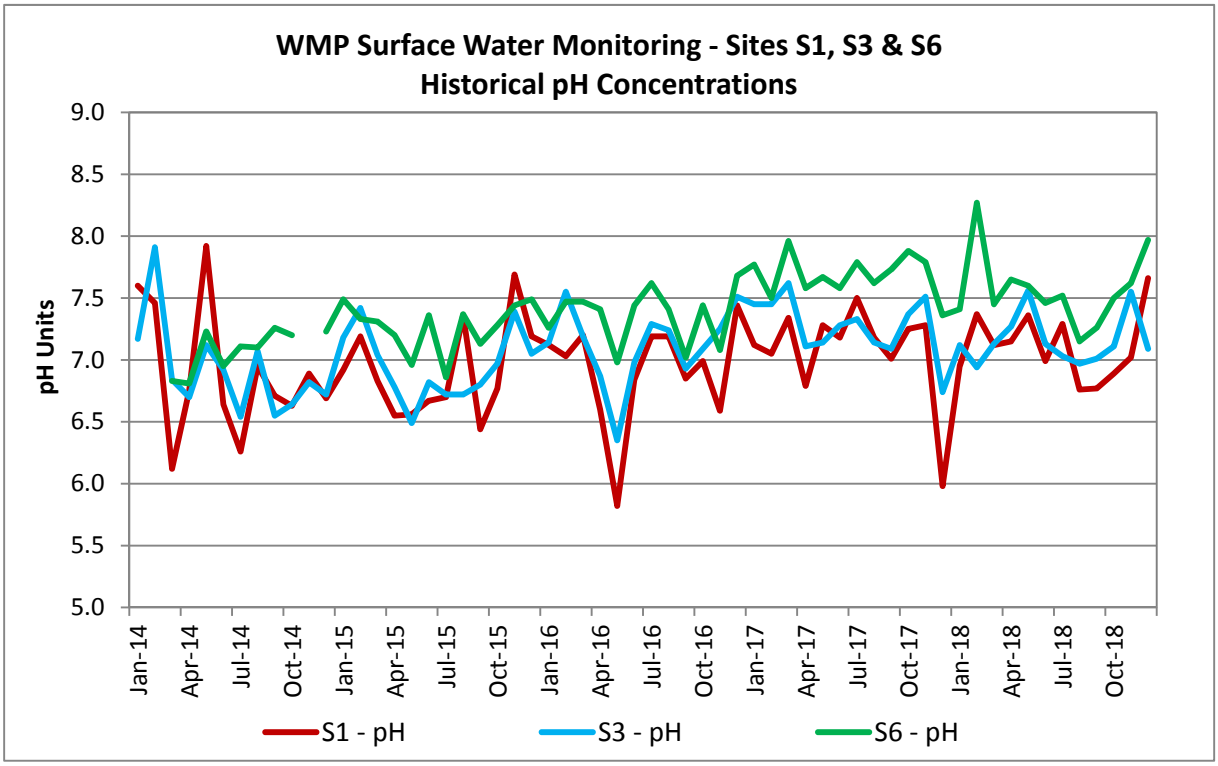


Figure 6 WMP S1, S3 & S6 Historical pH Results

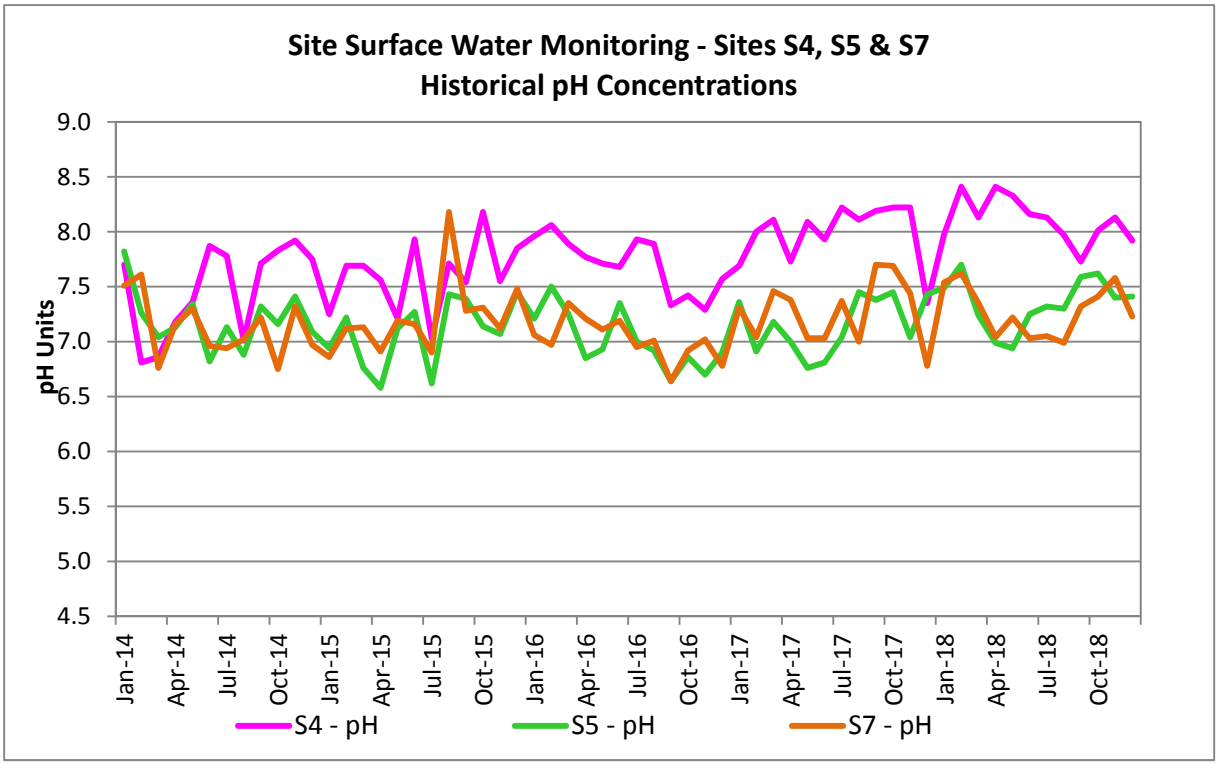


Figure 7 WMP S4, S5 & S6 Historical pH Results

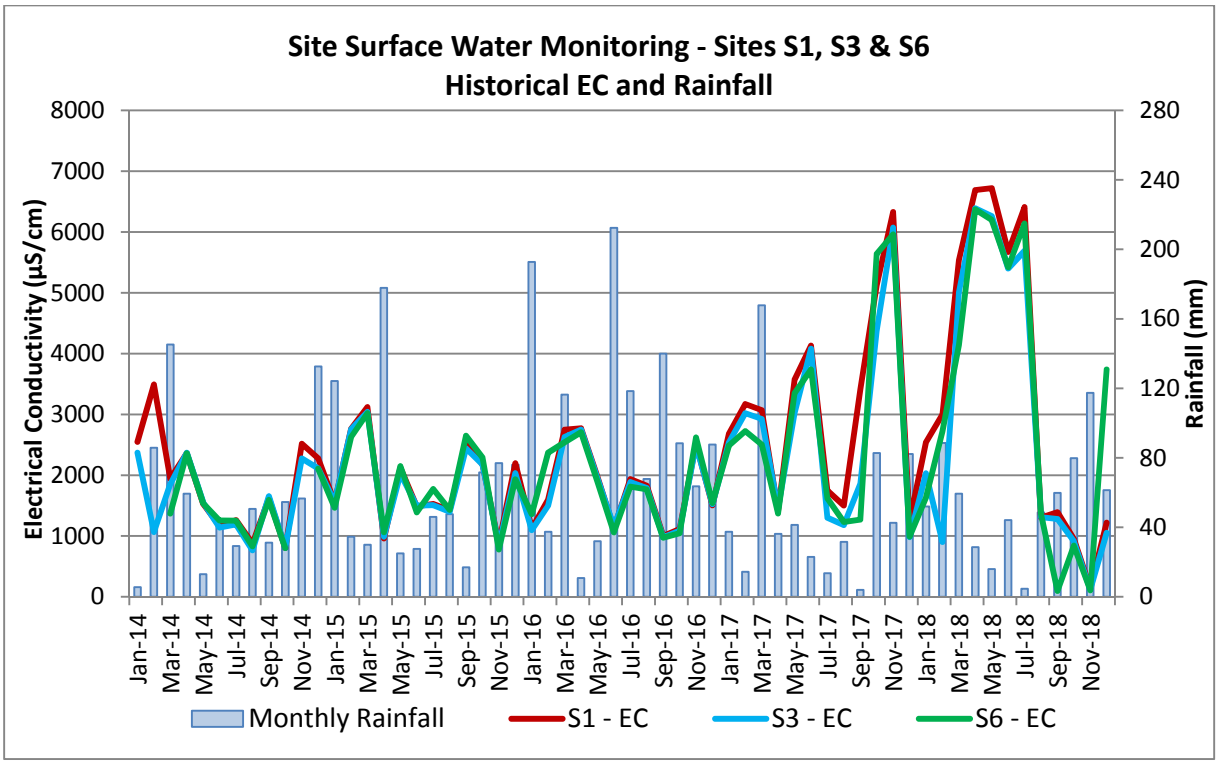


Figure 8 WMP S1, S3 & S6 Historical EC Results & Rainfall

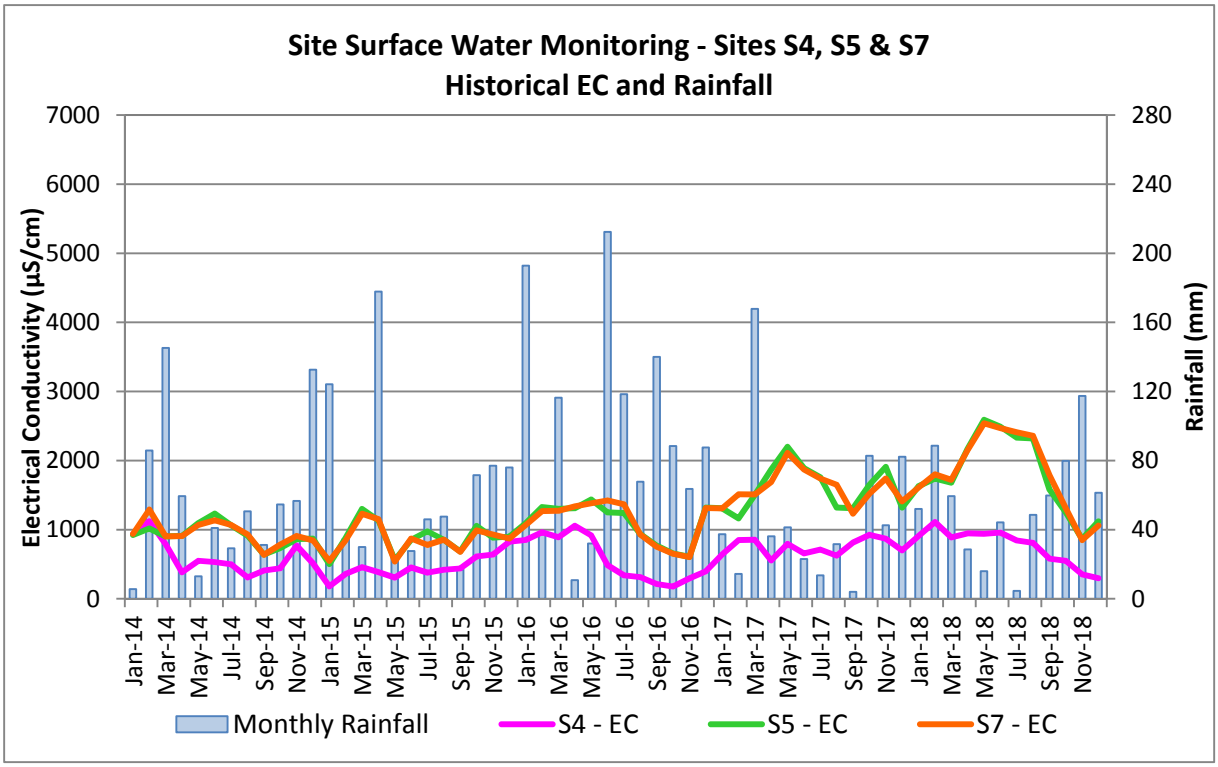


Figure 9 WMP S4, S5 & S6 Historical EC Results & Rainfall

During the 2018 monitoring period, pH was generally within the site specific trigger value ranges with the exception of the following surface water locations:

- S4 was above the upper pH trigger value during eight (8) of the (12) twelve monitoring events. This location is located upstream of the Neubecks Creek confluence and does not receive any water from PDM; therefore, the elevated pH readings are not considered to be due to activities undertaken at PDM.
- S5 was below the lower pH trigger value during two (2) of the twelve (12) monitoring events during April and May. This location receives water from Neubecks Creek and Coxs River; however, the pH within Neubecks Creek and Coxs River were greater than the pH reported at S5 during April and May. Therefore, it is considered that these pH readings below the lower trigger value may be due to other factors not associated with PDM.
- S6 was above the upper pH trigger value during February 2018 only; all other pH readings within Neubecks Creek upstream of S6 were within the site specific trigger level ranges during February 2018. There were no discharges into Neubecks Creek during the 2018 monitoring period. The cause of the elevated pH reading is unknown and considered to be localised within the area of S6 only, as such it is considered unlikely that PDM activities were the cause of the pH reading above the upper trigger value.

During the 2018 monitoring period, electrical conductivity was intermittently above the site specific trigger values, this occurred during the following instances:

- S1 was in excess of the site specific trigger value during seven (7) of the twelve (12) monitoring events.

- S3 was in excess of the site specific trigger value during five (5) of the twelve (12) monitoring events.
- S4 was in excess of the site specific trigger value during two (2) of the twelve (12) monitoring events. This location is upstream of PDM, therefore the electrical conductivity above the trigger value is not considered to be due to activities undertaken at PDM during the 2018 monitoring period.
- S5 was in excess of the site specific trigger value during eleven (11) of the twelve (12) monitoring events.
- S6 was in excess of the site specific trigger value during six (6) of the twelve (12) monitoring events.
- S7 was in excess of the site specific trigger value during eleven (11) of the twelve (12) monitoring events.

An examination of historical data collected over the previous five years indicates fluctuations in pH and electrical conductivity at all surface water locations. A slight overall increasing trend in pH however, is observable at the seven surface water monitoring locations. Electrical conductivity is shown in increase during the period January 2017 – June 2018, with a slight decreasing trend observed in the second half of 2018. Electrical conductivity trends are attributable to rainfall; however, an investigation has indicated that electrical conductivity within Neubecks Creek (S1, S3 and S6) is due to high conductivity discharges upstream of PDM. Locations S5, and S7 are located downstream of Neubecks Creek, as such are also considered to be impacted by discharges upstream of PDM. Electrical conductivity influences within Neubeck Creek are largely out of PDM control.

The complete 2018 surface water monitoring results are presented in **Appendix B**.

7.4 CHANNEL STABILITY & STREAM HEALTH MONITORING

Channel stability and stream health monitoring of Neubecks Creek is conducted on a six monthly basis in accordance with project approval PA 10_0041 and the WMP. Monitoring was conducted in March and October 2018.

Monitoring is conducted at three (3) monitoring points along Neubecks Creek (SH1, SH2 & SH3A) and one location at Coxs River (SH5), downstream of Blue Lake (refer **Plan 2**). Two (2) additional locations at Blue Lake (SH4) and the concrete lined section of Neubecks Creek (SH3A) are also included to allow for visual observation of the condition of the water bodies.

The monitoring involves an observational survey which provides a description of the locations and dimensions of erosive features. Indicators then produce a rating based on a scoring system. The combined total score of the indicators then rank each monitoring location from very actively eroding through to very stable. This assessment enables determinations to be made as to whether the section of creek has changed over time from the classification derived during the original baseline survey.

A Baseline Assessment of channel stability, stream health and vegetation health of Neubeck's Creek and Coxs River undertaken in 2013 indicated the drainage lines were classified as "potentially stabilising".

Follow-up (six-monthly) assessments were conducted at the same monitoring locations during 2014, 2015, 2016, 2017 and 2018. Results of the follow-up assessments undertaken

during 2014 to 2016 indicated there had been no major change to the Neubecks Creek and Coxs River drainage lines, with each monitoring location classified as "potentially stabilising". During 2017, the classification of Neubeck Creek did not change, however the particle size of the material on the Coxs river drainage line floor improved and the site was classified as 'stable'; these classifications have continued throughout 2018 (refer **Figure 10**). Detailed results are presented in **Appendix B**.

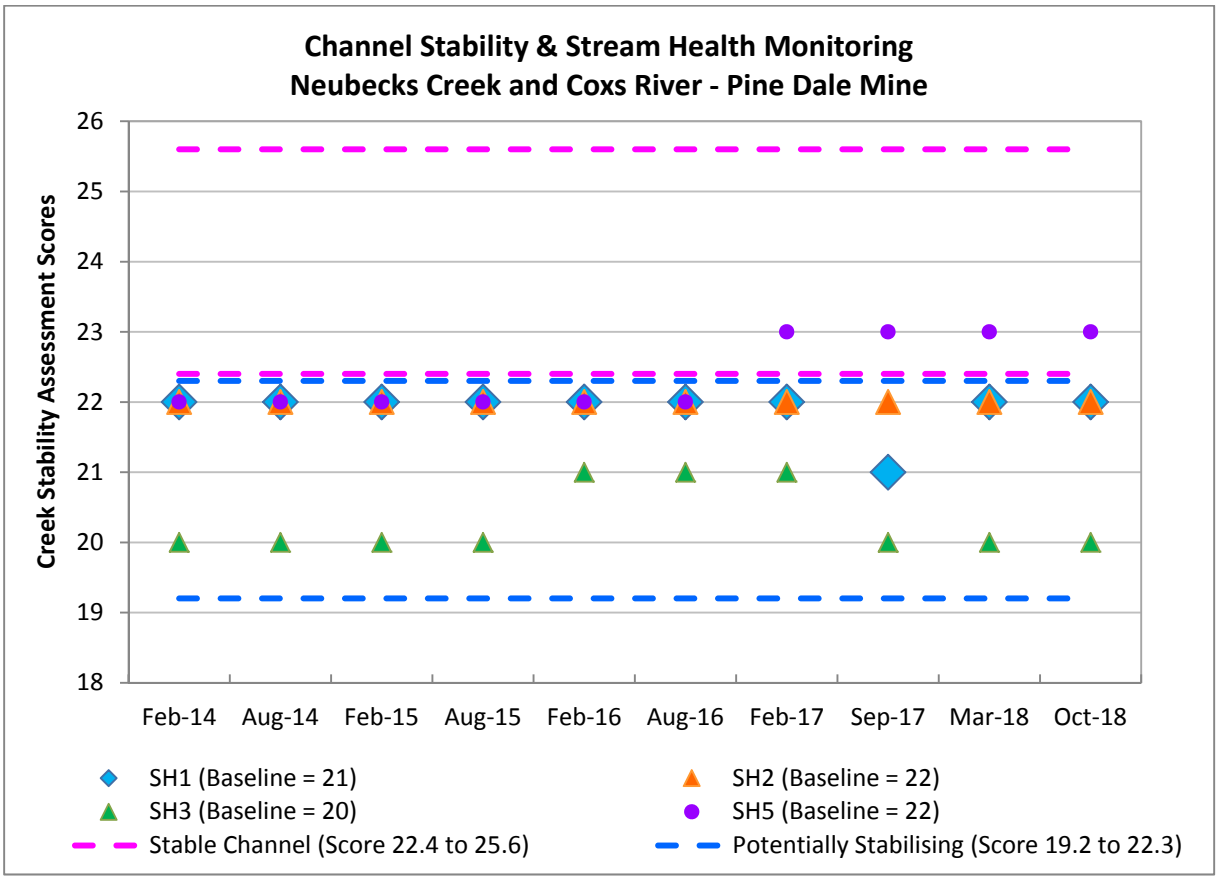


Figure 10 Channel Stability and Stream Health Results

7.5 GROUNDWATER

Management of groundwater at PDM is undertaken in accordance with project approval PA 10_0041 and with the WMP. Groundwater monitoring is not a requirement of EPL 4911. PDM also has approval for a water access licence (WAL36480) for the interception and use of groundwater from the underground workings; and Bore Licences (10BL165933 & 10BL603588) for the monitoring of groundwater levels and quality. Results of groundwater monitoring are discussed in **Section 7.6.2**, with a full dataset provided in **Appendix B**.

Review of groundwater extraction data by a qualified groundwater consultant to validate the recorded data against groundwater predictions is required to be undertaken in accordance with WAL36480. There was no measurable groundwater intercepted from the underground workings during the 2018 reporting period. As such, no review was required.

7.6 GROUNDWATER MONITORING

Groundwater monitoring for PDM is undertaken in accordance with the Groundwater Management Plan detailed within the WMP. Sampling is conducted at four (4) locations within PDM and seven (7) locations offsite. The offsite locations include five (5) monitoring locations surrounding the Yarraboldy Extension and two (2) locations at the former Enhance Place mine site. Monitoring locations are shown in **Appendix A**, **Plan 2a**.

Sampling is conducted monthly at the site bores (Old Shaft, P6, P7 and The Bong) for standing water level and physical water quality parameters, and on a quarterly basis for cations, anions and dissolved metals. Bores within the Yarraboldy extension (Bores A, B, C, D and E) are sampled on a monthly basis for standing water level and on a quarterly basis for an extended analysis suite. The Enhance Place bores (EP PDH3/GW and EP PDH4/GW) are sampled monthly for standing water level only. All parameters analysed are consistent with the requirements of the WMP. Groundwater sampling is undertaken by RCA Australia.

It should be noted that The Bong is an opening to the old underground workings. Water from The Bong is sampled from a surface water location denoted as Water Cart Dam on **Plan 2a** located in **Appendix A**. Water is pumped at The Bong on an as required basis.

7.6.1 GROUNDWATER CRITERIA AND TRIGGER VALUES

The site specific trigger values developed for PDM are detailed in the WMP in accordance with Schedule 3, Condition 27(c) of the Project Approval (PA 10_0041). The adopted trigger level values are detailed in **Table 13**.

The WMP details the protocol for the investigation, notification, and mitigation of any identified exceedances of the impacts on groundwater levels. It also details the groundwater impact assessment criteria, including trigger values for investigating any potentially adverse groundwater impacts.

Table 13 Groundwater Trigger Values & Levels

Groundwater Site	pH (range)	Electrical Conductivity (µS/cm)	SWL Trigger (m, AHD)
P6	6.2 - 8.0	1180	887.90
P7	6.3 - 8.0	852	883.28
EP DDH4/GW (Bore D)	6.8 - 8.0	608	940.61
EP DDH7/GW (Bore A)	6.5 - 8.0	326	954.40
EP PDH1/GW Bore C)	6.9 - 8.0	490	889.25
EP PDH3/GW (Enhance)	NA	NA	891.06
EP PDH4/GW (Enhance)	NA	NA	890.95
EP PDH7/GW (Bore E)	5.5 - 8.0	151	938.43
Old Ventilation Shaft	6.3 - 8.0	908	888.46
The Bong (at SW location)	5.8 - 8.0	1157	NA

NA – No trigger value required for these locations.

During the 2018 monitoring period, PDM commissioned an investigation to identify the cause of the intermittent trigger value exceedances during the 2017 monitoring period. As part of the investigation revised trigger values which take into account the causing factors of

the exceedances were also proposed. These values have been submitted to the Department of Primary Industries – Water in October 2018; however, PDM has not yet received a response. The approved site specific trigger values detailed in the PDM WMP are presented in **Table 13**.

7.6.2 GROUNDWATER WATER QUALITY

7.6.2.1 On-site Groundwater Monitoring

Groundwater bores P6, Old Shaft and The Bong are located within the old Wallerawang underground workings; whilst P7 is located within the Lithgow seam. A sample was not collected and analysed from The Bong during the June 2018 monitoring event, as the Water Cart Dam sampling location was dry. The full suite of groundwater results for the 2018 monitoring period are presented are located in **Appendix B**.

Groundwater samples collected from the on-site groundwater bores during 2018 have generally shown water quality to be consistent throughout the monitoring period. However some fluctuations were observed where key water monitoring parameters pH and electrical conductivity were intermittently recorded outside of the trigger level ranges. Monthly standing water level measurements and monthly total rainfall for the period January 2014 – December 2018 is shown in **Figure 11**. The monthly pH and electrical conductivity measurements for the period 2014 - 2018 are shown in **Figure 12** and **Figure 13**.

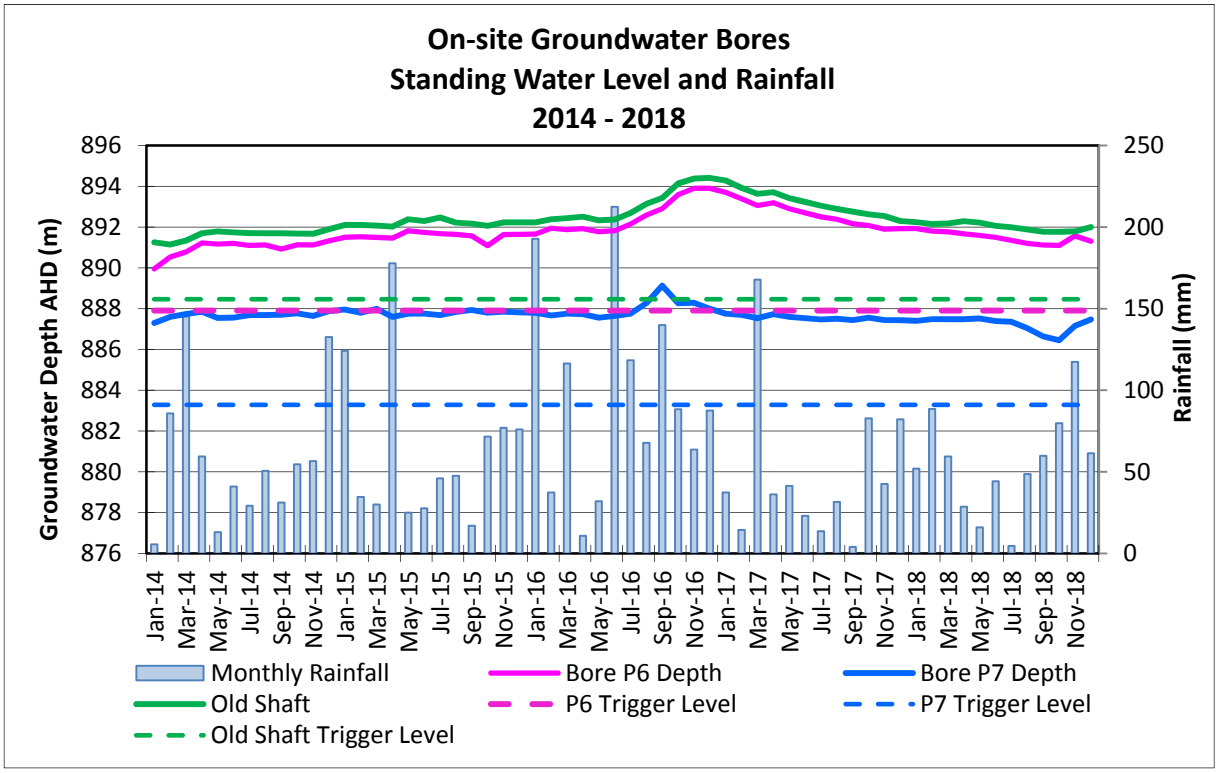


Figure 11 On-site Groundwater Bores Standing Water Level and Rainfall

During the 2018 monitoring period, there were no instances where the standing water level dropped below the respective trigger level values. During the second half of 2016 the groundwater level within the old Wallerawang underground workings (bores P6 and Old Shaft) was shown to increase likely due to increased rainfall. Standing water levels within the old Wallerawang underground area are shown to decrease from January 2017 – December 2018, likely due to decreased rainfall during this period. Refer to **Figure 3** for rainfall totals for the period 2014 – 2018.

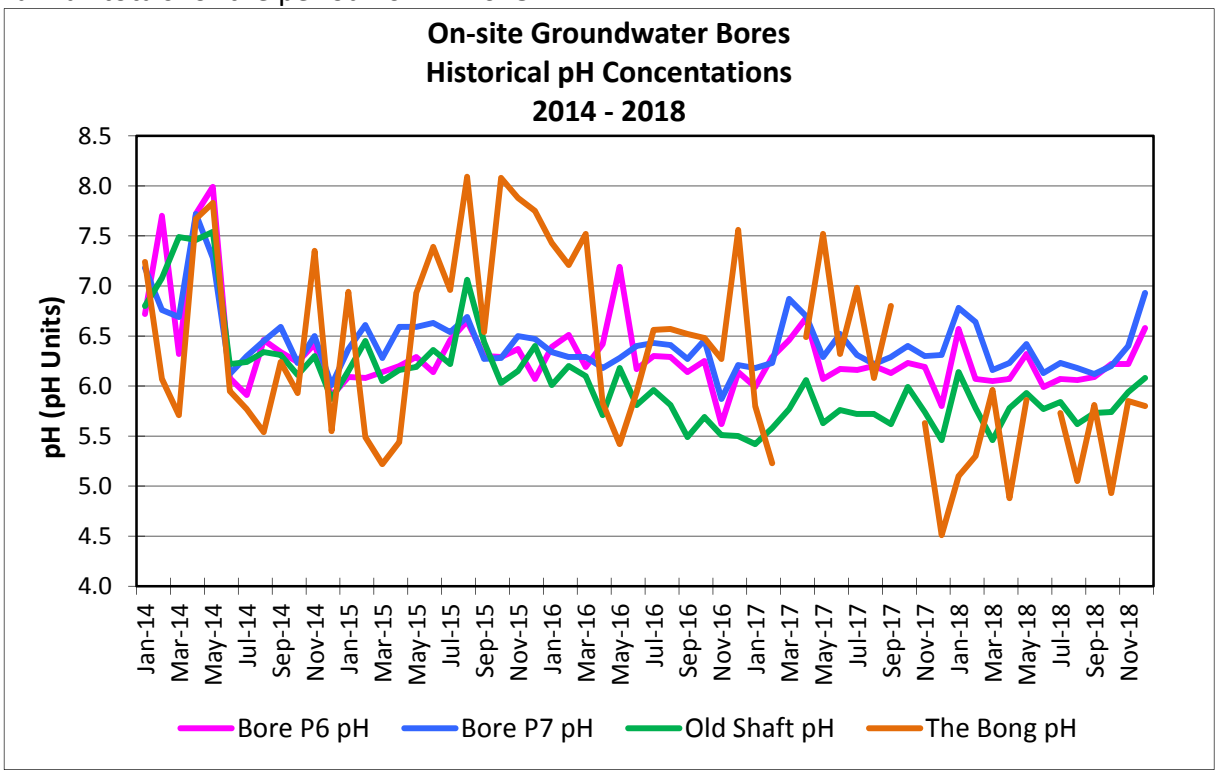


Figure 12 On-site Groundwater Bores pH Results

During the 2018 monitoring period, the pH within the site bores were shown to generally be below the site specific lower pH trigger value. The pH was shown to be below the site specific lower pH trigger value during:

- Seven (7) of the twelve (12) monitoring events at groundwater bores P6 and P7;
- All twelve monitoring events at groundwater bore Old Shaft; and
- Six (6) of the eleven monitoring events at The Bong.

During 2014 – 2018 (refer **Figure 12**), an overall decreasing trend is evident in pH across the four (4) on-site groundwater bores. The most pronounced decreases in pH are observed within Old Shaft and The Bong, which are located within the old Wallerawang Underground workings.

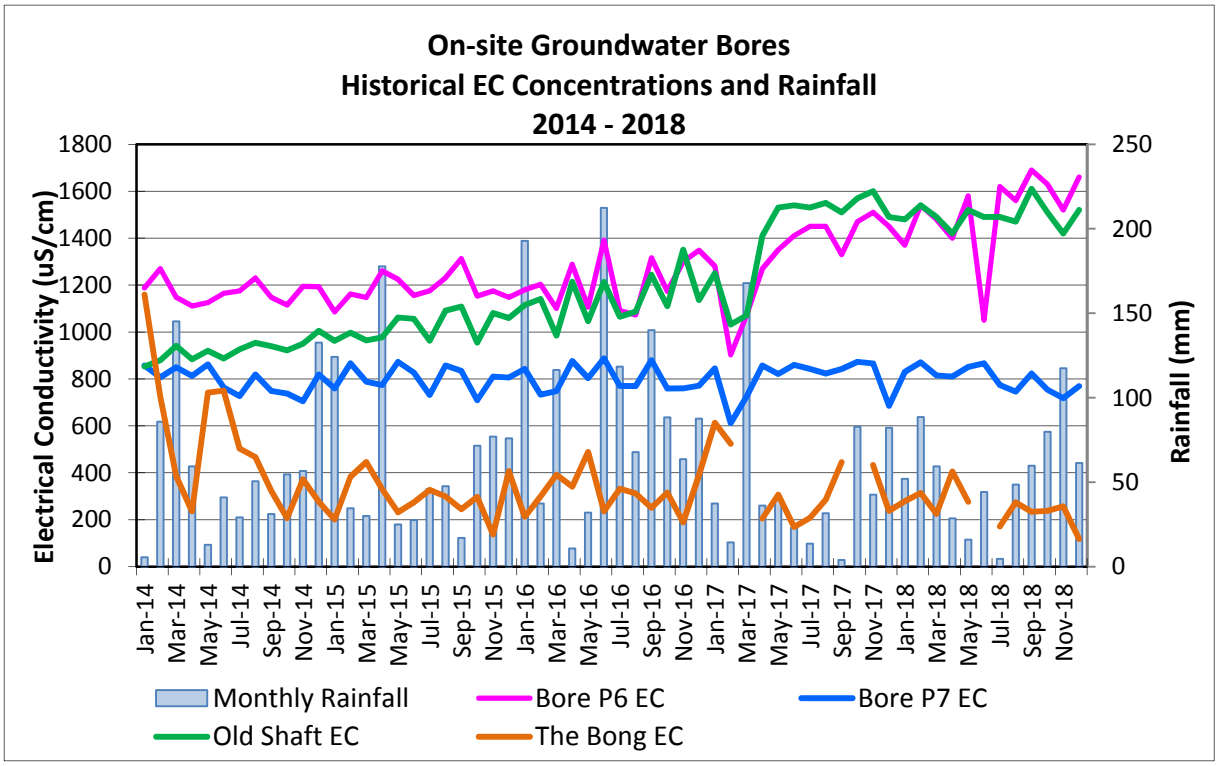


Figure 13 On-site Groundwater Bores Electrical Conductivity and Rainfall

During the 2018 monitoring period, electrical conductivity was intermittently above the respective trigger values, with the exception of The Bong. The electrical conductivity trigger values were in excess of the trigger values during:

- Eleven (11) of the twelve monitoring events at bore P6;
- Two (2) of the twelve monitoring events at bore P7; and
- All twelve monitoring events at Old Shaft.

The notable increasing trend in electrical conductivity at bore P6 and Old Shaft is due to increasing concentrations of sulfate, chloride, calcium and sodium and is correlated with the decrease in pH. The electrical conductivity concentrations at bore P7 that were in excess of the trigger values were less than 20µS/cm and considered minor.

The groundwater investigation undertaken in 2018 showed that a decrease in standing water level during early 2011 was noted within bores located in the old Wallerawang underground workings and the Lithgow seam. The decrease in standing water level exposed pyrite which interacted with water during the recovery of water levels during 2012. The interaction with pyrite caused a decrease in groundwater pH. This decrease in pH was accompanied by an increase in sulfate and dissolved iron causing the electrical conductivity to increase. The likelihood of future pH decreases is low as the dissolved oxygen trends indicate that pyrite has been completely oxidised.

Pyrite oxidisation is considered to be the primary influencing factor on groundwater quality. The trigger values devised by the 2018 investigation are considered appropriate for monitoring for risk of potential pyrite oxidisation due to decreasing groundwater levels as well as monitoring the potential spread of acid groundwater; however, these trigger values have not been approved by DPI – water at the time of writing.

7.6.2.2 Yarraboldy Groundwater Monitoring (Off-site Bores)

Groundwater bores located off-site and associated with the Yarraboldy Extension include Bores A, B, C, D and E. Bore B is not a groundwater quality monitoring location and consists of a vibrating piezometer for the purposes of monitoring groundwater levels only.

Groundwater quality monitoring is undertaken at the four (4) Yarraboldy off-site bores on a quarterly basis and measurement of standing water levels on a monthly basis in accordance with the PDM WMP. Water quality monitoring bores A, D and E are located within the Middle River seam and bore C within the Lithgow seam. Quarterly groundwater monitoring was scheduled to be undertaken during March, June, September and December 2018. The water level within Bore D was very low during the June, September and December monitoring events, and a sample was unable to be collected. This bore was attempted to be sampled monthly from July –December 2018. A sample was able to be collected during November 2018 only.

The monthly standing water level measurements compared with rainfall is shown in **Figure 14**. The quarterly pH and electrical conductivity measurements for the period 2014 - 2018 are shown in **Figure 15** and **Figure 16**. The results of quarterly water quality monitoring within the Yarraboldy (off-site) groundwater bores for pH, EC and standing water level are generally shown to be consistent throughout the 2018 monitoring period.

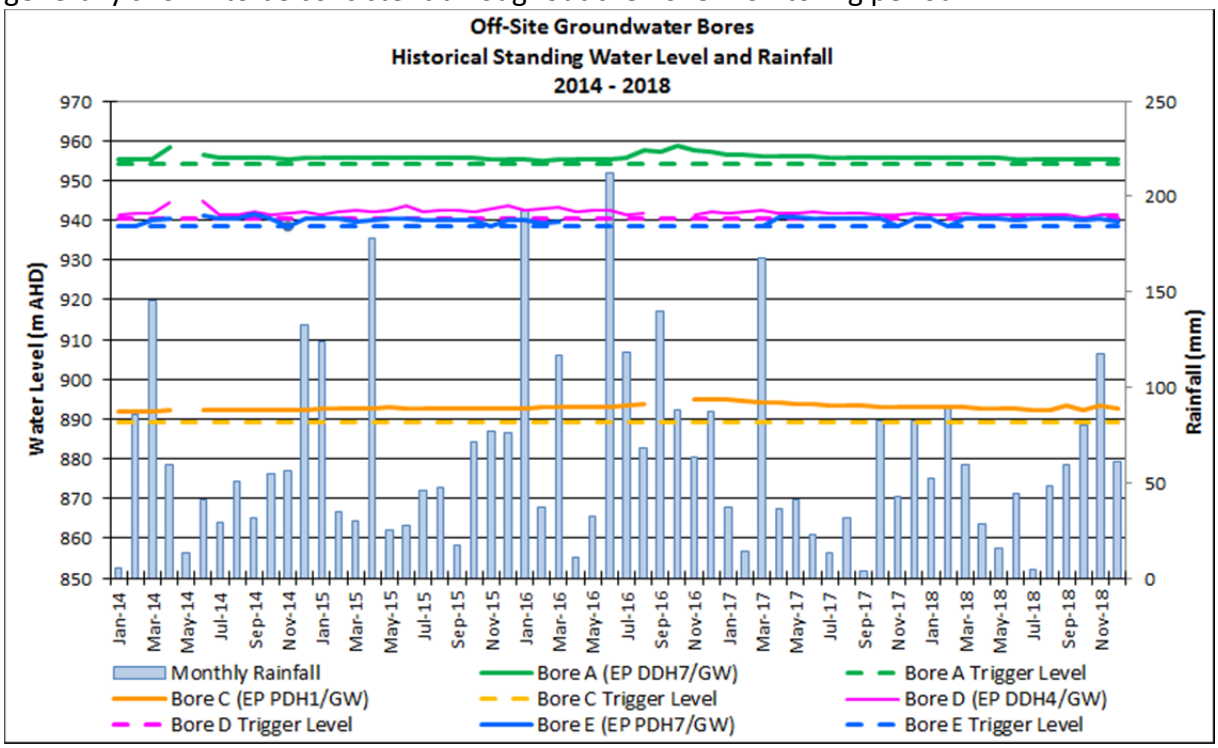


Figure 14 Off-Site Groundwater Bores Historical Standing Water Level

Note: Gaps in graph indicate no standing water level measurement was able to be taken.

During the 2014 – 2018 monitoring period, the Yarraboldy groundwater bores show varying levels of response to rainfall fluctuations, which a slight decreasing trend observed from November 2016 – December 2018.

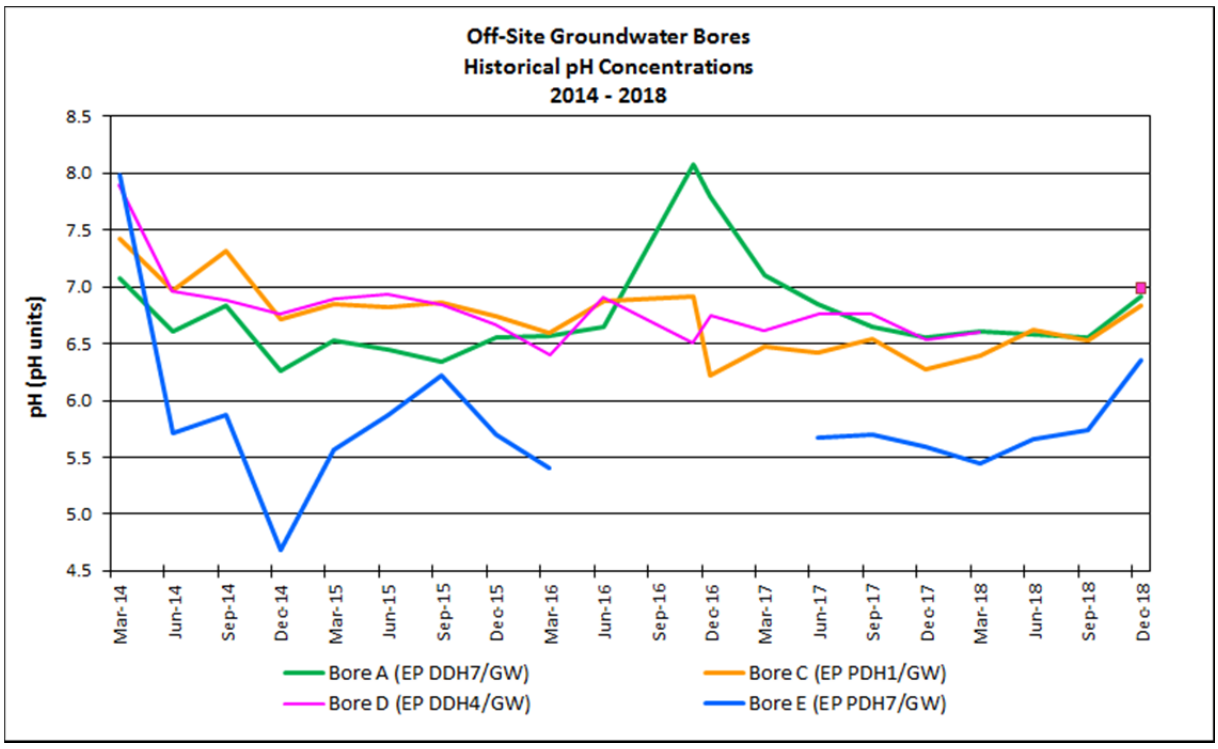


Figure 15 Off-Site Groundwater Bores Historical pH Results

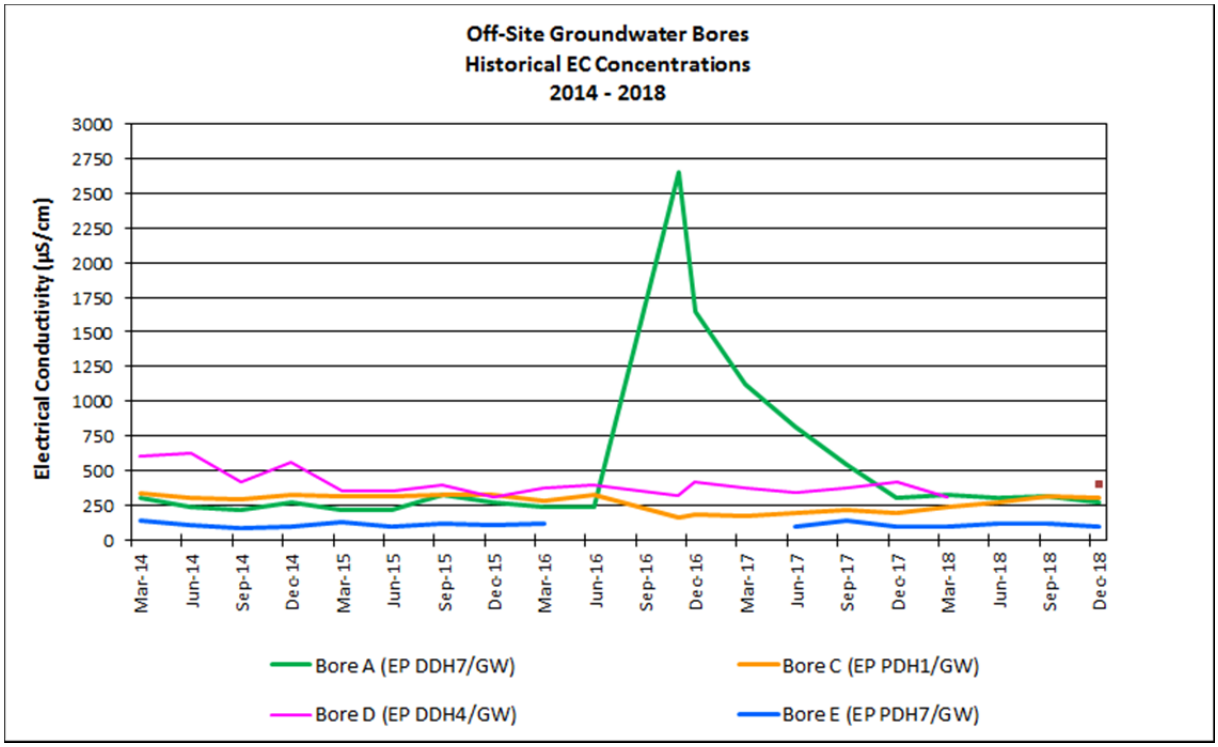


Figure 16 Off-Site Groundwater Bores Historical SWL & Rainfall

Groundwater samples collected from off-site bores were shown to be within pH trigger value

ranges with the exception of the following:

- Bore C was below the lower pH trigger value during the four (4) water quality monitoring events.
- Bore D was below the lower pH trigger value during one (1) of the two (2) water quality monitoring events, this occurred in March 2018.
- Bore E was below the lower pH trigger value during one (1) of the four (4) water quality monitoring events, this occurred in March 2018.

All electrical conductivity readings were below the respective site specific trigger values.

There were no standing water levels that fell below the water level trigger values.

During the 2014 – 2018 monitoring period, pH is generally shown to be stable in bores A, D and E. Bore C shows a decreasing trend in pH during March 2014 – December 2016. An increasing pH trend is evident during December 2017 – December 2018. An investigation conducted in 2018 indicates it is unlikely pyrite oxidation is occurring at bore C. The decrease in pH was not linked with any corresponding increases in sulfates or dissolved metals; as such, it is considered that the decreases in pH at this location may potentially be due to the spread of low pH groundwater from the old Wallerawang underground workings. The increases in pH during the previous twelve months suggest that the spread of low pH groundwater slowed or ceased. The pH readings at bores D and E, which are below the lower pH trigger values are likely due to the spread of acidic groundwater. Trigger values devised during the 2018 investigation, are designed to indicate if there is a risk of potential pyrite oxidation the Yarraboldy bores.

During the 2014 – 2018 monitoring period, electrical conductivity is generally shown to be stable with a slight decreasing trend with the exception of bore A. Bore A, shows a marked increase in electrical conductivity during June 2016 – September 2017. This marked increase also coincides with an increase in pH and water level. The cause of this anomalous pH and electrical conductivity is unknown; however, Bore A was vandalized in October 2016. It is unknown if the bore was tampered with, and the integrity of this data is unknown.

The complete groundwater results for the 2018 monitoring period are presented **Appendix B**.

Vibrating wire piezometers are installed within bores B, C, D and E at various target aquifers. A summary of the target aquifers and corresponding trigger values for each bore location is shown in **Table 14**. Groundwater level hydrographs graphs and rainfall for locations bore B, C and E are shown in **Figure 17**, **Figure 18** and **Figure 19**.

Table 14 Groundwater Level Trigger Values (Vibrating Piezometers)

Groundwater Site	Aquifer	SWL Trigger (m, AHD)
Bore B (EP DDH5)	Sandstone	921.23
	Irondale	NA*
	Lidsdale	899.23
	Lithgow	No trigger value
Bore C (EP HHD3)	Irondale	909.40
	Lithgow	No trigger value
	Lidsdale	891.78
	Marangaroo	889.76
Bore E (EP DDH6)	Irondale	884.67
	Litghow	No trigger value

NA – No data bore is depressurised (water level has dropped below sensor installation height.

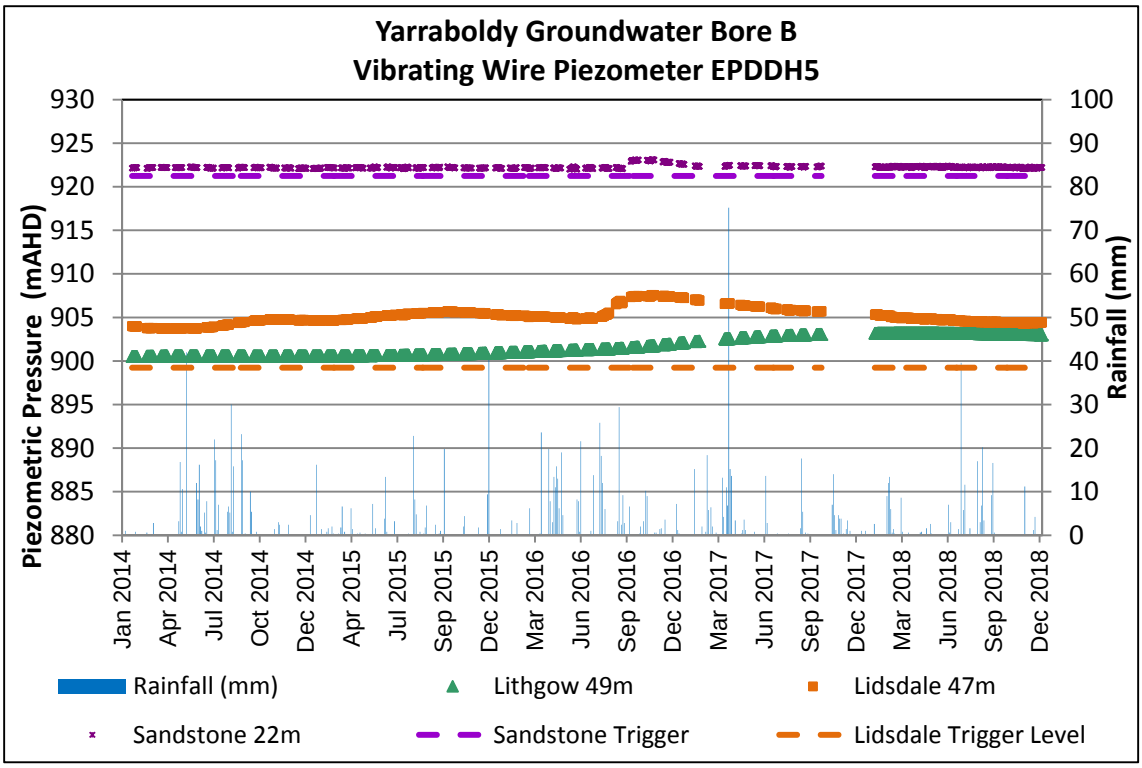


Figure 17 Yarraboldy Bore B VWP Hydrograph & Rainfall

Note: no data available 19/10/2017 – 1/2/2018, due to logger malfunction.

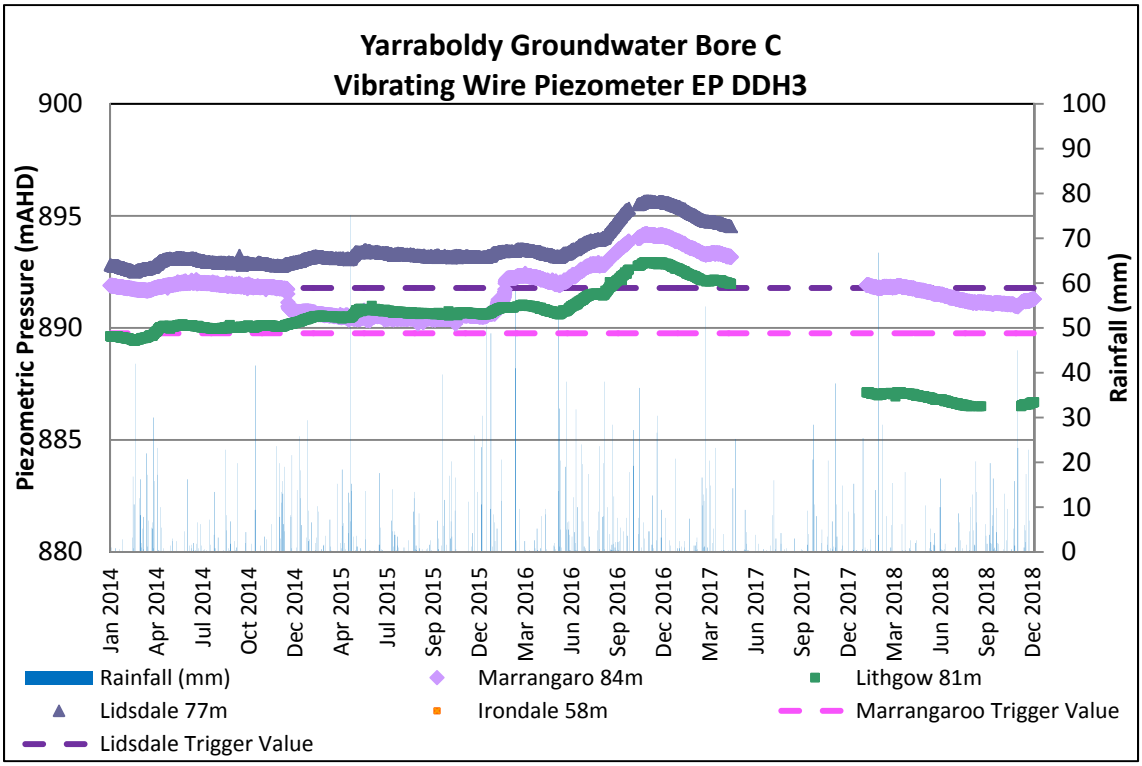


Figure 18 Yarraboldy Bore C-VWP Hydrograph & Rainfall

Note: no data available 11/05/2017 – 1/2/2018, due to logger malfunction.

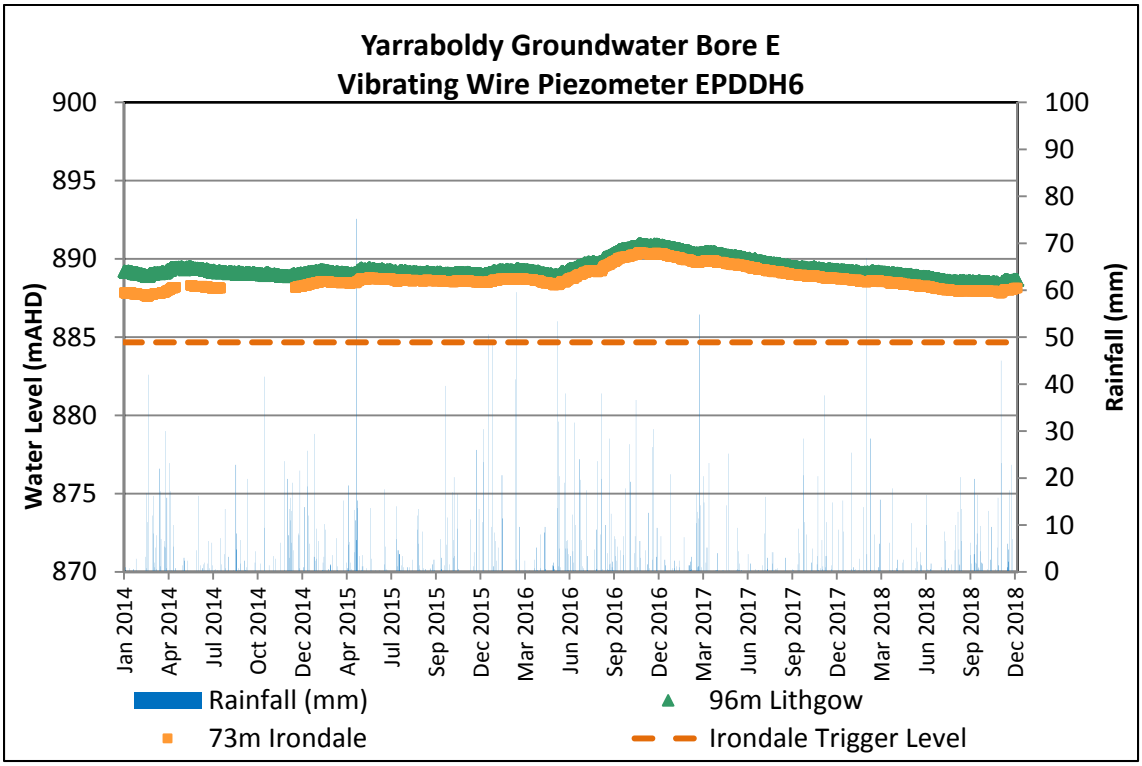


Figure 19 Yarraboldy Bore E-VWP Hydrograph & Rainfall

There was no data available at Bore B for the period 19/10/2017 – 1/2/2018 and Bore C for the period 11/5/2017 – 1/2/2018 due to connectivity issues with the vibrating wire piezometer loggers. The loggers were removed from site and new loggers installed. The

malfunctioning loggers were sent to the manufacturer for data retrieval, which was unsuccessful.

The groundwater levels at Bore B at the various aquifers have shown some variation in response to rainfall trends, however the response is minimal and the water levels have not fallen below the groundwater trigger levels. There is no data available for the Irondale seam as the water level has fallen below the sensor height.

The groundwater levels at Bore C show a general decreasing trend since January 2017 which is likely due to decreased rainfall during 2017 and 2018. There is no data available for the Lidsdale seam from February 2018 as the water level has fallen below the sensor height.

The groundwater levels at Bore E also show a general decreasing trend since January 2017 which is attributed to the decreased rainfall since early 2017.

The groundwater investigation indicates that the Yarraboldy bores show some variation in accordance with rainfall trends and it is likely that the levels will fluctuate in line with rainfall. Results of the investigation, predict there should be slight increases in regional groundwater levels. EnergyAustralia will continue to monitor the groundwater levels. Currently, groundwater levels are shown to be decreasing; however, this is considered to be due to decreased rainfall.

7.6.2.3 Enhance Place Groundwater Level Monitoring

Two (2) monitoring bores are located within the former Enhance Place Mine are required to be measured monthly for standing water level. The standing water level for the period January 2014 – December 2018 is shown in **Figure 20**.

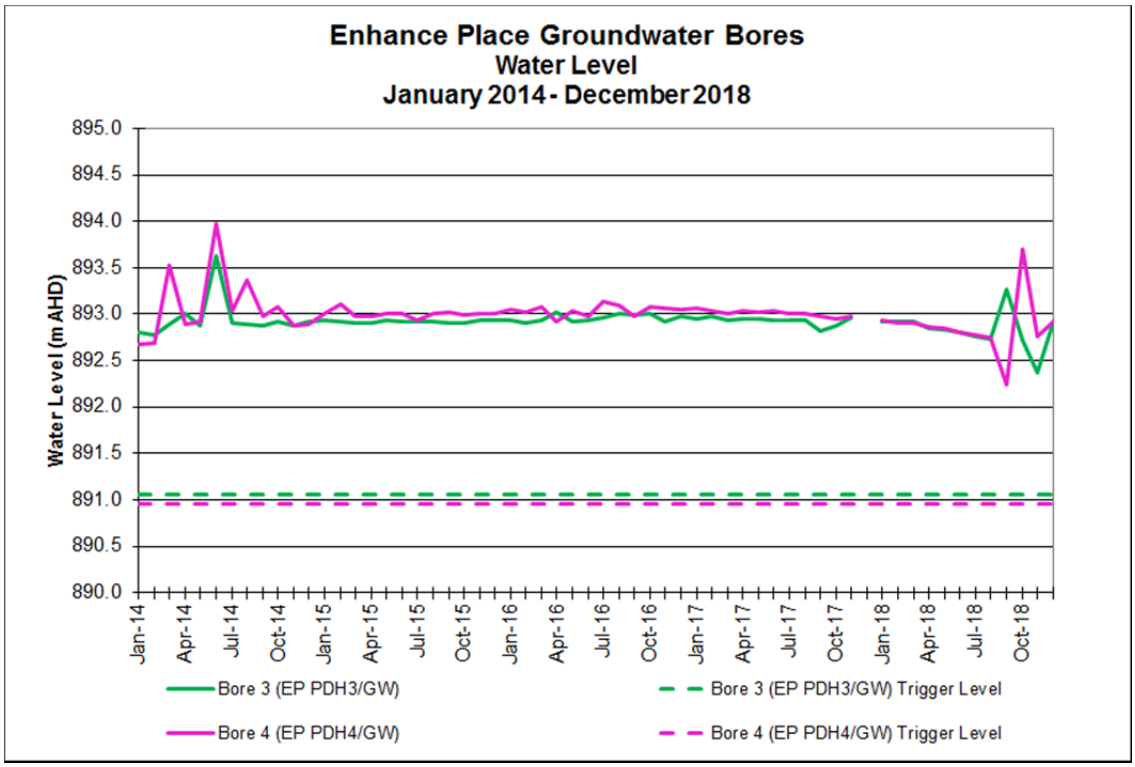


Figure 20 Enhance Place Standing Water Level 2014 - 2018

During the 2014 – 2018 monitoring period, there are some fluctuations in water level observed at the Enhance Place bores during 2014 and the end of 2018. Otherwise water levels are generally consistent and a slight decreasing trend is evident from January 2018, which is likely due to reduced rainfall. The groundwater level at both bores has not dropped below the water level trigger value for the 2014 – 2018 monitoring period.

A detailed summary of The Enhance Place groundwater bore standing water levels can be found in **Appendix B**.

8 REHABILITATION

Rehabilitation works at PDM are conducted in accordance with rehabilitation objectives in the approved Care and Maintenance MOP. Rehabilitation performance criteria documented in the MOP define the performance indicators, measuring criteria, status and progress of rehabilitation at the mine.

PDM is made up of a series of rehabilitation areas, comprising a series of parcels of land which are at various stages of being progressively rehabilitated back to a self-sustainable native ecosystem (acceptable post-mining land use and capability). This includes Areas A, B, C and 8. As the Yarraboldy Extension may form part of future mining operations (Stage 2

Project), only temporary maintenance activities have and will be undertaken within this area until such time the Stage 2 Project is determined. The location of each rehabilitation domain is depicted in **Plan 3**, **Appendix A**.

The principal re-vegetation technique currently employed is direct seeding using native tree and shrub species for woodland communities and pasture species for areas intended for agricultural activities.

The proposed final landform aims to emulate the pre-mining environment and to enhance local and regional ecological linkages across the site and surrounding areas.

8.1 REHABILITATION PERFORMANCE DURING THE REPORTING PERIOD

8.1.1 AGREED POST REHABILITATION LAND USE

Areas of privately owned land within PDM (Area B, C & 8) have been returned to pasture for agricultural purposes, including grazing, as per the approved rehabilitation strategy and landholder preferences.

The principal aim for the final land use of the Yarraboldy Extension rehabilitation area (including Area A) is for native vegetation conservation and for the use of Forests NSW. The Rehabilitation domains are shown in **Plan 3**, **Appendix A**.

8.1.2 REHABILITATION STATUS SUMMARY

A summary of the rehabilitation area status for the current and previous reporting period is presented in **Table 15** along with forecasts for the 2019 reporting period.

A rehabilitation monitoring report was prepared by FirstField Environmental (2018) which provides an overview of the rehabilitation status of PDM and recommendations for the improvement of rehabilitation outcomes in reference to the approved completion criteria. The 2018 rehabilitation monitoring report is attached in **Appendix C**. The rehabilitation report includes a survey of six (6) previously established monitoring transects; four (4) transects are located within rehabilitated pastures while two (2) transects are within treed rehabilitation areas. An additional two (2) transects exist as analogue sites in grazed pasture and undisturbed naturally vegetative areas to provide benchmarks against the pasture and treed rehabilitation areas (refer to Figure 1 of the FirstField Environmental located in **Appendix C**).

The 2018 rehabilitation status summary prepared by FirstField Environmental (2018) is reproduced in **Table 16**. The rehabilitation status is compared to the MOP performance indicators and completion criteria.

Table 15 Rehabilitation Area Summary

Mine Area Type	Area Affected/Rehabilitated (ha)		
	Previous Reporting Period (Actual) 2017	This Reporting Period (Actual) 2018	Next Reporting Period (Forecast) 2019
A. Total Mine Footprint	98.1	98.1	98.1
B. Total Active Disturbance	56.8	56.8	56.8
C. Land Being Prepared for Rehabilitation	0	0	0
D. Land Under Active Rehabilitation	32	32	7
E. Completed Rehabilitation	0	0	25.4

Table 16 Rehabilitation Status Summary

Performance indicator	Completion Criteria	Current Status (2018 Reporting Period)
Feral animal and noxious weed presence	• Feral animal and weed species presence and abundance is not considered to adversely impact the intended final land use.	**Satisfactory** – continue to monitor.
Feral animal and noxious weed control	• Feral animals and noxious weeds are controlled in accordance with legislation.	**Satisfactory** – continue to monitor
Fuel loads	• Fuel loads and fire breaks in and surrounding rehabilitation areas are assessed and maintained in accordance with the Bushfire Management Plan.	**Satisfactory** – continue to monitor
Access	• Adequate access for firefighting is maintained on rehabilitation areas.	**Satisfactory** – continue to monitor
Habitat features	• Habitat features are installed on native forest rehabilitation areas including: - Nesting boxes and salvaged hollows - Crushed timber spread over native forest rehab areas - Rock pile clusters.	**Ongoing** - nesting boxes to be installed once trees are established
Vegetation health	• More than 75% of native forest indicator species are assessed to be healthy and growing at year 5.	**Ongoing** – continue to monitor
	• Native forest indicator species tree height and girth is within the range of analogue sites.	**Ongoing** – continue to monitor
Soil loss	• Net annual soil loss is comparable to analogue sites at year 10.	**Ongoing** – continue to monitor
Erosion	• There are no significant erosion features that compromise landform stability or public safety (including gullying or tunnelling).	**Ongoing –** soil cracking has occurred at Transect 3 (Area B) – refer to **Appendix C**.
Woodland birds present	• Evidence of woodland birds utilising rehabilitation areas.	**Satisfactory** – continue to monitor.

Performance indicator	Completion Criteria	Current Status (2018 Reporting Period)
Evidence of mammals	• Evidence of target mammal species present in rehabilitation areas.	**Satisfactory** – continue to monitor.
Natural regeneration	• Evidence of second generation of native forest indicator species from desired vegetation community.	**Ongoing** – continue to monitor
	• Evidence of natural regeneration of at least four pasture species at year 5.	**Satisfactory** – continue to monitor
Structure	• Structural layers (canopy, mid-storey, understorey and ground cover) are comparable to analogue sites.	**Ongoing** – continue to monitor
Management inputs	• Management inputs (ameliorants, fertilisers, weed treatments) are within the range of analogue sites.	**Satisfactory** – continue to monitor
Rural land capability	• Pasture rehabilitation areas are assessed to have a Rural Land Capability Class VI or better (suitable for grazing).	**Satisfactory** – continue to monitor
Species composition	• Establishment of pasture comprising approximately 70% perennial grass and 20% annual legume, representative of species at analogue sites.	**Satisfactory** – continue to monitor
	• Vegetation within the treed rehabilitation areas is established in accordance with the approved species mix.	**Satisfactory** – continue to monitor
	• Approved pasture species mix is sown at the specified rate per hectare.	**Satisfactory** – continue to monitor
Weed presence	• Weeds including African Lovegrass to comprise <10% of the pasture sward.	**Satisfactory** – continue to monitor
Ground cover	• Ground cover (vegetation, leaf litter, mulch) >70% at year 5.	**Satisfactory** – continue to monitor

8.1.3 YARRABOLDY EXTENSION REHABILITATION PERFORMANCE

To minimise dust dispersion and soil erosion, overburden stockpiles located within the northern area of the Yarraboldy Extension have been re-contoured and seeded with pasture species.

The amenity bund located along the southern boundary of the Yarraboldy Extension was re-profiled in 2014, with the southern batter having a gradient of 18^{o} to minimise erosion and enhance establishment of seedlings. Following the application and tilling of topsoil, a native species grass and tree species seed mix has been applied followed by mulch (refer **Plate 1**).

During the reporting period, rehabilitation maintenance works were undertaken in the Yarraboldy Extension. These works were limited to drainage line repairs as hay bales were unable to be installed to reduce flow velocities due to the limited availability of hay during

drought conditions. Growth of vegetation on the bund (photo taken January 2019), which is representative of growth during the 2018 reporting period is shown in **Plate 2**. Growth during the 2017 reporting period is shown for comparison in **Plate 3**.

Plate 1 Amenity bund – application of mulch & native seed mix (2015)

Plate 2 Amenity Bund – Yarraboldy Extension Area, January 2019

Plate 3 Amenity Bund - Yarraboldy Extension area, December 2017

8.1.4 AREA A REHABILITATION PERFORMANCE

During 2008, seeding was commenced in Area A (8 ha) and 1500 trees were planted. In 2010, an additional 400 trees were planted. Further direct seeding and application of an organic mulch layer and lime occurred in October 2013; however, drought conditions late in 2013 limited the outcomes of this work.

A revised rehabilitation strategy was developed in 2014, incorporating recommendations from an agronomist (SLR, 2014) for input within the Care and Maintenance MOP. Annual rehabilitation monitoring reports (FirstField Environmental, 2014 - 2018) also provide recommendations for the improvement of rehabilitation within Area A. The recommendations included in these reports are summarised in **Table 17**. The rehabilitation activities undertaken in Area A during the reporting period are also presented in this table.

Table 17 Recommended and Completed Rehabilitation Actions in Area A

Recommended Rehabilitation Actions - Area A		Actions Completed (2014 to 2017)	Undertaken in 2018
Soil Assess. Report, 2014	Continue control of Biddy Bush with current spot spraying regime	Weed spraying as per Weed Man. Schedule (Section 6.7)	Yes
	Continue with further application of mushroom compost, lime & gypsum (10:3:2 tonnes/ha)	Fertilizer and compost applied at recommended rates.	No – not required.
	Increase potassium by application of Muriate of Potash or similar (0.25tonnes/ha)	Application of Muriate of Potash at recommended rate.	No – not required.
Rehabilitation Monitoring Report, 2014	Treat surface soil erosion on slopes via placement of cut vegetation or rocks in erosion channels	Coarse woody debris placed along contours above rills to reduce runoff rate and volume.	No – not required
	Re-sow exposed surfaces with fast-growing groundcover herbs and grasses	Exposed surfaces ripped and resewn with locally sourced seed mix.	No – not required
	Install nesting boxes in close proximity treed rehabilitation area	Installation will be undertaken when the native tree species are of a suitable size to support the nesting boxes.	No – trees unable to support boxes.
Rehabilitation Monitoring Report, 2015	Install nesting boxes in or adjacent to treed rehabilitation areas.	Installation will be undertaken when the native tree species are of a suitable size to support the nesting boxes.	No – trees unable to support boxes.
	Re-apply a mixture of mushroom compost, lime and gypsum to treed rehabilitation areas as per the recommendations of SLR (2014) report.	Application of fertilizer and compost at recommended rates.	Yes

Recommended Rehabilitation Actions - Area A		Actions Completed (2014 to 2017)	Undertaken in 2018
	Increase canopy cover of tall herbs and shrubs at treed rehabilitation Area A to 75% with 80% groundcover of grasses and broadleaf herbs.	Exposed surfaces ripped and resewn with fast growing herbs and grasses.	No – not required
	Concentrate tube stock planting in benches of treed rehabilitation areas to take advantage of run-on from banks.	Tree planting undertaken in addition to direct seeding.	No – not required
	Place additional coarse woody debris along contours above rills to reduce runoff rate and volume at treed rehabilitation areas.	Woody mulch placed along contours above rills to reduce runoff rate and volume	No – not required
Rehabilitation Monitoring Report, 2016	Continue to spot spray African Lovegrass outbreaks.	Weed spraying as per Weed Management Schedule (Section 6.7)	Yes
	Install nesting boxes in or adjacent to treed rehabilitation areas.	Installation will be undertaken when the native tree species are of a suitable size to support the nesting boxes.	No – trees unable to support boxes.
	Place additional coarse woody debris along contours above rills to reduce runoff rate and volume at treed rehabilitation areas.	Woody mulch placed along contours above rills to reduce runoff rate and volume	No – not required
Rehab Monitoring Report, 2017	Continue to spot spray African Lovegrass outbreaks.	Weed spraying as per Weed Management Schedule (Section 6.7)	Yes
	Install nesting boxes in or adjacent to treed rehabilitation areas.	Installation will be undertaken when the native tree species are of a suitable size to support the nesting boxes.	No – trees unable to support boxes.
Rehab Monitoring Report, 2018	Continue to spot spray African Lovegrass outbreaks.	Weed spraying as per Weed Management Schedule (Section 6.7)	Yes
	Install nesting boxes in or adjacent to treed rehabilitation areas.	Installation will be undertaken when the native tree species are of a suitable size to support the nesting boxes.	No – trees unable to support boxes.

The PDM Rehabilitation Monitoring Report for 2018 (attached in **Appendix C**) indicated the total living groundcover within the monitoring transects in Area A (transect 5 and transect 6) has remained stable when compared to 2017 results. The total living ground cover is 70% at transect 5 and 80% at transect 6. Fluctuations in total living ground cover were noted during the 2014 – 2018 monitoring period. Transect 5 has fluctuated from 90% in 2014, 50% in 2015 to 70% in 2018 and transect 6 has fluctuated from 90% in 2014, 70% in 2015 and 80% in 2018.

The total vegetation cover of Area A in January 2019 is shown in **Plate 4**. Vegetation cover of Area A in January 2019 is considered to be similar to vegetation cover during December 2018.

Plate 4 Area A – Vegetation cover, January 2019

8.1.5 AREA B AND C REHABILITATION PERFORMANCE

Rehabilitation Areas B and C cover an area of approximately 25 ha and have been rehabilitated as pasture. The final landform and water management structures have been completed and the areas seeded for pasture in accordance with Planning Approval 10_0041 and the requirements of the landowner.

The rehabilitation activities undertaken in Areas B and C during the reporting period are presented in **Table 18**, along with the actions recommended for improved rehabilitation, as presented in the *Soil Assessment and Recommendations for Rehabilitated Areas, Pine Dale Mine and Enhance Place* (SLR, 2014) and the *Pine Dale Mine Rehabilitation Monitoring Reports* (FirstField Environmental, 2014 - 2018).

Table 18 Recommended and Completed Rehabilitation Actions in Areas B & C

Recommended Rehabilitation Actions – Area B & C		Actions Completed (2014 to 2017)	Undertaken in 2018
Soil Assessment Report, 2014	Control of African Lovegrass prior to pasture establishment works.	Weed spraying as per Weed Management Schedule (Section 6.7)	Yes
	Ripping with a plough to create furrows, followed by application of pasture seed mix	Furrows created along pasture poor areas and contour banks, seed, fertiliser & compost applied	No – not required
	Application of Muriate of Potash (0.25tonnes/ha) and Di-ammonium phosphate 0.20 tonnes/ha)	MAP and DAP applied at recommended rates.	No – not required.
	Application of mushroom compost, lime & gypsum (10:4:1 tonnes/ha)	Fertilizer and compost applied at recommended rates.	No – not required.
Rehab. Monitoring Report, 2014	Continue to implement integrated weed management control methods for noxious weeds.	Weed spraying as per Weed Management Schedule (Section 6.7)	Yes
Rehabilitation Monitoring Report, 2015	Rip along contours of poorly established pasture rehabilitation areas and re-sow pasture mix and fertiliser. Cover with a mixture of mushroom compost, lime and gypsum as per the recommendations of SLR (2014) report.	Poorly established pasture areas and drainage lines mechanically ripped prior to re-sowing with pasture species	No – not required
	Increase and maintain groundcover in pasture rehabilitation Areas B and C and in Area 8 to at least 95%.	Application of fertilizer and compost at recommended rates.	No – not required.
Rehab. Monitoring Report, 2016	Continue to spot spray African Lovegrass outbreaks.	Weed spraying as per Weed Management Schedule (Section 6.7)	Yes
	Continue to monitor pest animal numbers.	Pest and animal monitoring not required to be undertaken.	No – not required
Rehab. Monitoring Report, 2017	Continue to spot spray African Lovegrass outbreaks.	Weed spraying as per Weed Management Schedule (Section 6.7)	Yes
Rehab. Monitoring Report, 2018	Continue to spot spray African Lovegrass outbreaks.	Weed spraying as per Weed Management Schedule (Section 6.7)	Yes
	Repair soil cracking along contours in Area B (transect 3).	Not applicable, cracking occurred in 2018.	Yes

During the reporting period, rehabilitation maintenance works were undertaken in Area B to repair the cracking identified at transect 3 (refer **Plate 5**).

Plate 5 Repair of cracking at Area B

The 2018 Rehabilitation Monitoring Report (FirstField) documented the following findings for rehabilitation Areas B & C:

- Total living groundcover in pasture rehabilitation areas is stable at 90% (**Plate 6**)
- African Lovegrass comprises <10% of pasture sward.
- Natural regeneration of pasture species is evident across Areas B & C.
- Rehabilitated pasture areas are considered satisfactory with Rural Land Capability Class VI are suitable for grazing.

The SLR (2018) Rehabilitation and Completion Assessment report indicates that rehabilitation has been successfully completed in Area B and C. The SLR (2018) Rehabilitation and Completion Assessment Report is located in **Appendix D**.

Plate 6 Area B Pasture Growth – January 2019

8.1.6 AREA 8 REHABILITATION PERFORMANCE

Seeding of Area 8 (10 ha) commenced in 2008, with a pasture mixture known as 'Cox's River Mix'. The vegetation communities prior to mining include a mixture of cleared land, pasture, pines and eucalyptus.

The rehabilitation activities undertaken in Area 8 during the reporting period are presented in **Table 19**, along with the actions recommended for improved rehabilitation, as presented in the *Soil Assessment and Recommendations for Rehabilitated Areas, Pine Dale Mine and Enhance Place* (SLR, 2014) and the *Pine Dale Mine Rehabilitation Monitoring Reports* (FirstField Environmental, 2014 - 2018).

Table 19 Recommended and Completed Rehabilitation Actions in Area 8

Recommended Rehabilitation Actions – Area 8		Actions Completed (2014 to 2017)	Undertaken in 2018
Soil Assessment Report, 2014	Control of African Lovegrass prior to pasture establishment works.	Weed spraying as per Weed Management Schedule	Yes
	Ripping with a plough to create furrows, followed by application of pasture seed mix	Furrows created along poorly vegetated areas followed by direct seeding	No – not required
	Application of Muriate of Potash (0.25tonnes/ha) and Di-ammonium phosphate 0.20 tonnes/ha)	MAP and DAP applied at recommended rates.	No – not required.
	Application of mushroom compost, lime & gypsum (10:4:1 tonnes/ha)	Fertilizer and compost applied at recommended rates.	No – not required.
Rehabilitation Monitoring Report, 2014	Treat surface soil erosion on slopes via placement of cut vegetation or rocks in erosion channels	Drainage lines re-shaped with rock placement in erosion channels	No, not required
	Re-sow exposed surfaces with fast-growing groundcover herbs and grasses	Exposed areas re-sown with pasture seed mix.	No – not required
	Install nesting boxes in close proximity treed rehabilitation area	Installation will be undertaken when the native tree species are of a suitable size to support the nesting boxes.	No – trees unable to support boxes.
Rehabilitation Monitoring Report, 2015	Rip along contours of poorly established pasture rehabilitation areas and re-sow pasture mix and fertiliser. Cover with a mixture of mushroom compost, lime and gypsum as per the recommendations of SLR (2014) report.	Furrows created over the land, pasture seed mix applied, followed by fertiliser and compost	No – not required.
	Increase and maintain groundcover in pasture rehabilitation Areas B and C and in Area 8 to at least 95%.	Application of fertilizer and compost at recommended rates.	No – not required
Rehabilitation Monitoring Report, 2016	Continue to spot spray African Lovegrass outbreaks.	Weed spraying as per Weed Management Schedule (Section 6.7)	Yes
	Continue to monitor pest animal numbers.	Pest and animal monitoring not required to be undertaken.	Yes, detailed in Annual Rehabilitation Monitoring Report (FirstField, 2018).
Rehab. Monitoring Report, 2017	Continue to spot spray African Lovegrass outbreaks.	Weed spraying as per Weed Management Schedule (Section 6.7)	Yes

Recommended Rehabilitation Actions – Area 8		Actions Completed (2014 to 2017)	Undertaken in 2018
Rehab. Monitoring Report, 2018	Continue to spot spray African Lovegrass outbreaks.	Weed spraying as per Weed Management Schedule (Section 6.7)	Yes

The 2018 Rehabilitation Monitoring Report (FirstField, refer **Appendix C**) indicated Transect 4, in the eastern portion of Area 8 had 90% total living ground groundcover, which is consistent with the previous reporting period (FirstField, 2017). African Lovegrass was reported as comprising <10% of the pasture sward.

The SLR (2018) Rehabilitation and Completion Assessment report indicates that rehabilitation has been successfully completed in Area 8 (refer **Appendix D**).

8.1.7 ADDITIONAL REHABILITATION MAINTENANCE WORKS

No other rehabilitation maintenance works were undertaken during the 2018 monitoring period.

8.1.8 RENOVATION / REMOVAL OF BUILDINGS

There were no buildings removed or constructed during the 2018 reporting period.

8.1.9 REHABILITATION FORMAL SIGN OFF

There were no areas of rehabilitation which acquired formal sign off from DPE-RR during the reporting period.

8.1.10 REHABILITATION TRIALS AND RESEARCH

There were no rehabilitation trials or research undertaken during the reporting period.

8.1.11 THREATS TO REHABILITATION SUCCESS

Significant threats to rehabilitation at the Pine Dale Mine have been identified in the Care and Maintenance MOP. These threats and the proposed mitigation and management measures are summarised in **Table 20**.

Table 20 Threats to Rehabilitation Success

Secondary Domains (Post Mining Land Use)	Potential Threat(s)	Mitigation & Management Measures
Infrastructure (A) Water Management Structure (B)	Engineering design failure	Any infrastructure remaining in place post mining would be inspected and approved by a suitably qualified person (if required) and agreed by relevant stakeholders.
	Water damage (erosion, flooding etc.)	Infrastructure and water management structures would be constructed in accordance with relevant guidelines and to ensure erosion and damage from floods is minimised.
Rehabilitation - Pasture (C) Rehabilitation - Native Forest (D) Rehabilitation – Pine Plantation (E)	Adverse soil chemistry	Soil testing and amelioration
	Erosion	Design to relevant guidelines, regular maintenance as required
	Seed germination failure	Seed treatment, soil amelioration, annual monitoring
	Species diversity and density	Annual monitoring and supplementary tree planting and seeding as required
	Weed presence	Inspections and weed control (herbicide application).
	Drought	Drought tolerant species selection, timing seeding to coincide with appropriate soil moisture.
	Grazing	Restrict grazing particularly in early years to rehabilitated areas
	Bushfire	Maintain low fuel loads, emergency preparedness and response

8.2 ACTIONS FOR THE NEXT REPORTING PERIOD

During the 2018 reporting period rehabilitation activities were undertaken on areas that will not be directly impacted by any future mining operations at the Pine Dale Mine. Maintenance and rehabilitation activities recommended in the Care and Maintenance MOP will continue on these areas throughout 2019 (sediment fences, fertilizing, re-seeding, weed control etc).

As per the recommendations made in the Rehabilitation Monitoring Report (**Appendix C**), further weed spraying is proposed in addition to the installation of nesting boxes once the treed area contains adequate structure to support nesting birds.

During the 2018 monitoring period, SLR Consulting (2018) has prepared a final rehabilitation and completion assessment report, attached in **Appendix D**. The report confirms that the rehabilitation objectives approved under the PDM MOP (2017) have been achieved for Areas B, C and 8. During the 2019 monitoring period, PDM will seek to relinquish rehabilitation Area B, C and 8.

9 COMMUNITY RELATIONS

9.1 ENVIRONMENTAL COMPLAINTS, ENQUIRIES & NOTIFICATIONS

All stakeholder and community complaints, enquiries and notifications regarding PDM are documented, with appropriate actions taken as soon as possible to determine the likely cause of the incident and all possible corrective actions to resolve the problem and prevent its recurrence. Complaints, enquiries and notifications are recorded and retained at the site office in addition to monthly publication on the EnergyAustralia website. Details of the complaints, enquiries and notifications received during the previous 5 years are presented in **Table 21**.

During the 2018 reporting period, there were no complaints received; one notification was made to PDM (shown in **Table 21**). The notifier (an adjacent landholder) advised PDM that a 'white residue' was observable within Neubecks Creek on PDM property on the 22 May 2018. PDM personnel inspected Neubecks Creek on the 22 May and engaged RCA to conduct an investigation on the composition and potential origin of the 'white residue'. The residue was considered to be an ionic compound comprising various cations and anions. Water quality testing was undertaken along Neubecks Creek and results indicated that high concentrations of cations and anions were discharging into Neubecks Creek, upstream and outside the PDM boundary (RCA, 2018).

Table 21 Community Complaints, Incidents & Notifications

Incident Type	Incidents Received 2018
Noise	0
Air Quality	0
Blasting	0
Traffic	0
Water	0
Other	0
Total Complaints Received	**0**
Enquiries/Notifications Received	**1**

Table 22 Historical Community Complaints, Incidents & Notifications

Complainant	Item No.	Date Received	Nature (Enquiry / Notification or Complaint)	Issue(s)	Comment on nature of complaint in relation to approved parametric limits	Corrective Action Required? Y/N	Response / Action	
							Y/N	Date Completed
7	001-18	22/05/18	Notification	White residue observed within Neubecks Creek	An inspection of Neubecks creek at Pine Dale Mine conducted on the 22nd May 2018. White residue was observed to have originated upstream outside of the Pine Dale Mine boundary. Investigation completed, white residue considered to be an ionic compound (salt).	Y	Y	22/06/18
7	002-17	26/05/17	Notification	Operations adjacent to Private Property	Notification from neighbouring resident that he did not want remediation activities occurring near his residential boundary.	Yes	Yes	10/11/17
6	001-17	28/02/17	Complaint	CCC Minutes on EA Website	Minutes of December 2015 CCC meeting were not able to be viewed on the website due to a problem with the link. The June and December 2016 minutes and the December 2015 minutes (when visible) were still shown in Draft format.	Yes	Yes	1/03/17
7	002-16	23/12/16	Complaint	Operations adjacent to Private Property	Energy Australia received an email from the office of the Member for Bathurst regarding a complaint they had received from a neighbouring PDM resident regarding rehabilitation activities undertaken at the mine during December within close proximity to the residential boundary without prior notification to the resident.	No	Yes	12/01/17
6	001-16	28/04/16	Complaint	Community Consultation	Email to DRE indicating lack of community consultation concerning renewal of Exploration Licence EL7621.	No	Yes	6/05/16
7	004-15	14/12/15	Enquiry / Notification	Trespassing	Notification regarding a trespasser entering the PDM property with the intention of going to Blue Lake. Complainant noticed the man and asked him to leave the site. Complainant also expressed concern over the potential impact of trespassers on their property.	Yes	Yes	15/12/15
7	003-15	28/10/15	Enquiry	Dust	Enquiry regarding dust generation during application of lime for PDM rehabilitation program	No	NA	NA
6	002-15	26/06/15	Enquiry	Noise	Letter regarding concerns of noise emissions from the proposed Pine Dale mine extension	No	Yes	3/07/15
7	001-15	9/04/15	Enquiry / Notification	Access	Enquiry regarding noise monitoring being undertaken within the Pine Dale Mine site (within 50m of Barnes' residential boundary) without prior notification to the resident.	Yes	Yes	9/04/15
6	002-14	28/02/14	Complaint	Various	Complaint received via DTRIS regarding rehabilitation and land use. Written response provided to DTRIS. Issue has been resolved.	No	Yes	5/03/14
7	001-14	5/02/14	Complaint	Noise	Complaint regarding noise which started around Christmas Eve from the security patrol company caused by reversing beeper. Issue has been resolved.	Yes	Yes	6/02/14

9.2 COMMUNITY LIAISON

9.2.1 COMMUNITY CONSULTATIVE COMMITTEE

PDM Community Consultative Committee (CCC) commenced in January 2012 and comprises representatives from the local community (LCC) and PDM. During 2017, the DPE approved an amalgamation of the PDM CCC and the regional EnergyAustralia CCC into one. The CCC meets on a biannual basis to discuss matters relating to the Pine Dale mine. The CCC meeting minutes are made publicly available via the EnergyAustralia website www.energyaustralia.com.au. During the reporting period the CCC meetings were held on the 30 July 2017 and 10 December 2018.

9.2.2 WEBSITE INFORMATION

A website has been established to keep the broader community up to date with recent activities at the Pine Dale Mine in accordance with Schedule 5, Condition 10 of the PA 10_0041; and EPL 4911. Copies of the following documents are made publicly available on the EnergyAustralia Website:

- EPL 4911;
- Environmental Assessment;
- Project Approval 10_0041;
- EPBC Act Referral Decision 2011/6016;
- The Care and Maintenance Mining Operation Plan;
- Environmental Management Plans for Pine Dale Mine;
- AEMR Reports / Annual Review;
- PIRMP;
- Independent Environmental Audits;
- Community Consultative Committee minutes;
- Community Complaints (Enquiries & Notifications);
- Blasting information; and
- Monthly Environmental Performance reports

9.2.3 SOCIAL/ ECONOMIC CONTRIBUTIONS

PDM has contributed to the economy of the district and NSW by providing direct employment, indirect employment through the purchase of services and materials from regional suppliers. Coal supplies to Mount Piper Power Station provide competitively priced energy for the NSW electricity market which ultimately flows through to provide economic benefit to electricity consumers.

10 INDEPENDENT ENVIRONMENTAL AUDIT

There was no requirement for an Independent Environmental Audit (IEA) to be conducted at PDM during the 2018 reporting period.

The last IEA was undertaken in August 2014. Copies of the audit report, the audit Action Plan and the auditor's recommendations and proposed actions by PDM are provided on the company website.

All of the non-compliances identified and recommendations made in the IEA Action Plan have been completed (refer **Table 23**).

As per the conditions of Project Approval 10_0041, no further IEA's are required at PDM.

Table 23 Independent Environmental Audit Action Plan

Condition	Summary of Condition / Requirement	Auditors Comment	Compliance Status and Auditors Recommendation	Enhance Place Comment (status as at 17 March 2016)	Timing
PA 10_0041, Condition 3.27 (c)	*c) a Groundwater Management Plan, which includes:* *i. groundwater assessment criteria, including trigger levels for investigating and potentially adverse groundwater impacts;* *ii. a program to monitor:* *i. groundwater inflows to the open cut mining operation* *ii. the impacts of the project on;* *- baseflows to Neubecks Creek;* *- any groundwater bores on privately owned land; and* *iii. a program to validate the groundwater model for the project, and calibrate it to site specific conditions; and* *iv. a plan to respond to any exceedances of the performance criteria, and offset the loss of any baseflow to Neubecks Creek caused by the project.*	*The previous IEA (URS, 2013, p.A-18) identified that this condition was non-compliant on the basis that the Bushfire Management Plan was not approved by State Forests by the end of April 2011. The Bushfire Management Plan has not been developed to the satisfaction of State Forests and has not been updated to reflect the Site response for a care and maintenance situation, as opposed to a mining operation.*	*Preparation – Compliant (2013)* *Implementation –* ***Non-compliant*** ***Repeat Recommendation 2013/IEA/009*** *Consult with NOW, OEH and DPE to review water quality trigger values and based on the consultation update and implement the WMP (incorporating the GWMP).*	Unforeseen delays in the progress of the Pine Dale Mine Stage 2 Extension Project application has caused delays in the review and updates of existing management plans. Enhance Place intends to review relevant Environmental Management plans in light of the site being held in care and maintenance for an extended period.	Completed in September 2015
PA 10_0041, Condition 3.52	*By the end of April 2011, the Proponent shall prepare and implement a* ***Bushfire Management Plan*** *for the site, to the satisfaction of the State Forest in consultation with the local Rural Fire Service.*	*The previous IEA (URS, 2013, p.A-18) identified that this condition was non-compliant on the basis that the Bushfire Management Plan was not approved by State Forests by the end of April 2011. The Bushfire Management Plan has not been developed to the satisfaction of State Forests and has not been updated to reflect the Site response for a care and maintenance situation, as opposed to a mining operation.*	**Non-compliant** **2014IEA/022 Recommendation** *Update the Bushfire Management Plan with respect to the Site being on care and maintenance. Ensure State Forests and the local RFS have involvement in the update of the Plan and confirm satisfaction of the plan from State Forests.*	Noted, relevant environmental management plans will be reviewed in light of site being held in care and maintenance for an extended period.	Completed in September 2015

Condition	Summary of Condition / Requirement	Auditors Comment	Compliance Status and Auditors Recommendation	Enhance Place Comment (status as at 17 March 2016)	Timing
PA 10_0041, Condition 5.1	**Environmental Management Strategy** *Refer to Appendix A for full Condition requirements.*	*Pine Dale has been found non-compliant with this Condition as a number of key revisions and updates have not occurred to the Environmental Management Strategy during the audit period.*	*Preparation – Compliant (2013) Implementation –* ***Non-compliant*** ***2014/IEA/011 Recommendation*** *Update the Environmental Management Strategy and relevant figures and plans to reflect current monitoring programs and reports as well as explain and reflect that the Site has moved from operational activities to a care and maintenance status and that controls as detailed in the strategy and plans will remain relevant.*	Noted, relevant environmental management plans will be reviewed in light of site being held in care and maintenance for an extended period.	Completed in September 2015
PA 10_0041, Condition 5.4	**Revision of Strategies, Plans and Programs** *Refer to Appendix A for full Condition requirements.*	*This Condition was found non-compliant in accordance with Condition 5.4(c) as strategies, plans and programs were not updated following submission of the previous IEA (URS, 2013).*	***Non-compliant*** ***2014/IEA/012 Recommendation*** *Strategies, plans, and programs should be reviewed and revised to reflect recommendations provided in the previous Independent Environmental Audit report and to reflect the care and maintenance status of the Site.*	Noted, relevant environmental management plans will be reviewed in light of site being held in care and maintenance for an extended period.	Completed in September 2015
PA 10_0041, Condition 5.8	**Independent Environmental Audit** *Refer to Appendix A for full Condition requirements.*	*Pine Dale was found non-compliant with this Condition due to timing of the 2014 independent environmental audit as the audit was not commenced until August 2014 as compared to the condition requirement of June 2014.*	***Non-compliant*** *(due to timing)*	Noted, no further action required.	Completed

Condition	Summary of Condition / Requirement	Auditors Comment	Compliance Status and Auditors Recommendation	Enhance Place Comment (status as at 17 March 2016)	Timing
ML 1569, Condition 2	***Mining,Rehabilitation,Environmental Management Process (MREMP) - Mining Operations Plan (MOP)*** *Refer to Appendix A for full Condition requirements.*	Refer to ML 1664, Condition 3(a). *This condition was found to be non-compliant given the MOP expired on 28 February 2014 whilst mining operations were continuing (the Site went into care and maintenance in April 2014) and the draft Care and Maintenance MOP was yet to be formally approved at the time of writing this report.*	*Refer to ML 1664, Condition 3(a).* ***Non-compliant*** *(due to expiration of previous MOP and no approval of draft C&M MOP)* ***2014/IEA/018 Recommendation*** *Prepare and implement a plan identifying detailed rehabilitation measures for the entire length of Neubecks Creek.*	A draft C&M MOP was submitted to DRE in March 2014. DRE responded in May 2014 seeking clarifications which rely on external advice. The required external expert assessment and advice has been received. Enhance Place has been actively working on the preparation of a robust rehabilitation strategy to meet DRE requirements. A revised C&M MOP has been submitted to DRE for approval A rehabilitation program for Neubecks Creek has been included in the C&M MOP submitted to DRE.	C&M MOP Completed in December 2014. C&MMOP revised in 2017.
ML 1569, Condition 3(a)	***Mining Operations Plan*** *Mining operations must not be carried out otherwise than in accordance with a Mining Operations Plan (MOP) which has been approved by the Director-General.*	*This condition was found to be non-compliant given the MOP expired on 28 February 2014 whilst mining operations were continuing (the Site went into care and maintenance in April 2014). Pine Dale has been consulting with DTRIS-DRE concerning the requirements for the draft Care and Maintenance Mining Operations Plan / Rehabilitation Management Plan since April 2014 and was in the process of actioning DTRIS-DRE requests for the draft MOP at the time of the audit with a view to approval by the end of 2014. Therefore DTRIS-DRE are aware of the situation with respect to the status of the MOP.*	***Non-compliant*** *(due to expiration of previous MOP and no approval of draft C&M MOP)*	See above comment	Completed December 2014.

Condition	Summary of Condition / Requirement	Auditors Comment	Compliance Status and Auditors Recommendation	Enhance Place Comment (status as at 17 March 2016)	Timing
ML 1569, Condition 3(e)	*A MOP ceases to have effect 7 years after date of approval or other such period as identified by the Director-General.*	*This condition was found to be non-compliant given the 2011 MOP expired in February 2014 and a replacement MOP was in the process of being prepared but had not formally been approved.*	***Non-compliant***	See above comment	Completed December 2014.

11 INCIDENTS AND NON COMPLIANCES

During the 2018 reporting period, there were two instances of non-compliance in relation to the project approval, mining leases, or the water access licence. Refer to **Section 1** for details of the non-compliances.

There were no reportable incidents, official cautions, warning letters, penalty notices or prosecution proceedings by any regulatory body during the reporting period.

There were several exceedances of the water quality triggers for groundwater during the reporting period. However, an investigation into water quality was commissioned by EnergyAustralia which identified pyrite oxidisation to be the primary influencing factor on groundwater quality. The investigation concluded that pyrite oxidisation has likely ceased. Revised trigger values to monitor for the risk of potential pyrite oxidisation and the spread of acid groundwater have been developed and submitted to DPI – Water. Exceedances of the surface water trigger values are generally attributed to influences upstream of PDM.

12 ACTIVITIES PROPOSED IN THE NEXT REPORTING PERIOD

The activities proposed for the 2019 reporting period are consistent with the Care & Maintenance MOP. General maintenance will be undertaken at the site in addition to rehabilitation activities including weed management and fertilizing if required.

12.1 MINING

All recoverable coal within the approved mining area was extracted during early 2014. No mining activities are proposed during the 2019 monitoring period.

12.2 FUTURE MINING DEVELOPMENT

Subject to market conditions, in order to maintain supply of commercial coal to Mount Piper Power Station, Enhance Place intends to lodge an application with the Department of Planning and Environment to extend the existing mining operations. A request to update the *Secretary's Environmental Assessment Requirements (SEARs)* was lodged by the Company in late 2016. Engagement with regulators and other key stakeholders will continue to be undertaken throughout 2019 as appropriate.

12.3 DOCUMENT REVIEWS

No document reviews were required to be undertaken in the 2018 reporting period.

13 REFERENCES

FirstField Environmental (2014), *Pine Dale Mine 2014 Rehabilitation Monitoring Report.*

FirstField Environmental (2015), *Pine Dale Mine 2015 Rehabilitation Monitoring Report*.

FirstField Environmental (2016), *Pine Dale Mine 2016 Rehabilitation Monitoring Report*.

FirstField Environmental (2017) *Pine Dale Mine 2017 Rehabilitation Monitoring Report*.

FirstField Environmental (2018) *Pine Dale Mine 2018 Rehabilitation Monitoring Report*.

HEPA (2018), *PFAS National Environmental Management Plan, January 2018.*

RCA (2019), *Annual Review Summary Report,* RCA Ref 6880-1785a/0.

RCA (2018), *Pine Dale Mine Complaint Investigation Neubecks Creek White Residue,* RCA Ref 6880e-401/0.

SLR (2014), *Soil Assessment and Recommendations for Rehabilitated Areas, Pine Dale Mine and Enhance Place.*

SLR (2018), *Pine Dale Mine Rehabilitation Completion Assessment*, SLR ref 630.12362-R01.

APPENDIX A

SITE PLANS 2018

228000
230000
6308000
6306000
6304000
6302000
226000
Castlereagh Highway
B55
Wolgan Road
Angus Place
Angus Place Colliery
Kangaroo Creek
Coxs River
Lamb's Creek
Crown Creek Trail
Ridgetop Trail
1664
1569
Wallerawang Colliery
Western Main Colliery
1578
Noon Street
Groves Road
View Street
Karawatha Drive
Beecroft Fire Trail
Maddox Lane
Ian Holt Drive
Lidsdale
Skelly Road
Duncan Street
Newcom Colliery

LEGEND

Pine Dale Mine

Mining Leases

Aerial Image Dated 3/10/2015
Coordinate System MGA Zone 56

0 180 360 720 1,080 1,440
metres

N

EnergyAustralia
LIGHT THE WAY

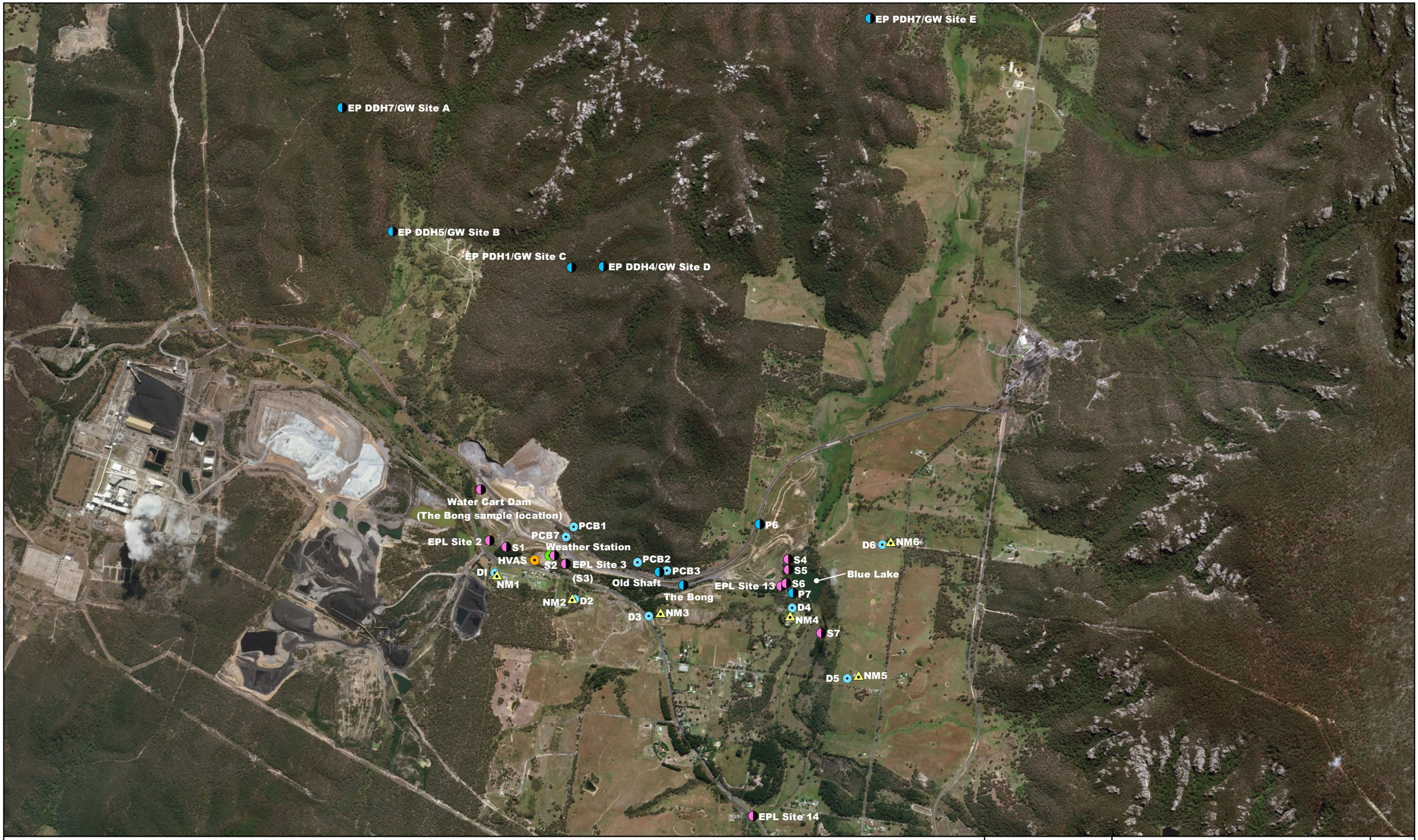
PINE DALE MINE
REGIONAL LOCALITY PLAN

PLAN: 1

DRAWN BY : C. Rocher

SCALE: 1:24,000 (A3)

DATE: 1/02/2019



LEGEND

- Noise monitoring location
- Depositional dust monitoring location
- Groundwater monitoring location
- High volume air sampling location
- Metorological monitoring location
- Surface water monitoring location

0 175 350 700 1,050 1,400
metres

N

EnergyAustralia
LIGHT THE WAY

PINE DALE MINE ENVIRONMENTAL MONITORING LOCATION PLAN

PLAN: 2a

DRAWN BY : C. Rocher

SCALE: 1:24,000 (A3)

DATE: 1/02/2019

LEGEND

- Monitoring location
- Licence discharge point location
- Clean water diversion location

0 37.5 75 150 225 300
metres

N

EnergyAustralia
LIGHT THE WAY

PINE DALE MINE
ENVIRONMENTAL MONITORING
CHANNEL STABILITY, STREAM AND
VEGETATIVE HEALTH
MONITORING SITES

PLAN: 2b

DRAWN BY : C. Rocher

SCALE: 1:5,000 (A3)

DATE: 1/02/2019

LEGEND

- Yarraboldy Extension Area (21.9ha)
- Rehabilitation Area - Native Forest (7.1ha)
- Rehabilitation Area - Pasture (25.4ha)
- Dams
- Bund Wall
- Road

NOTE: Drawing adapted from plan supplied by
Craven, Ellistion & Hayes (Lithgow) Pty Ltd
Drawing No. PINE AEMR13
Dated 31/12/2013

0 100 200 300 400 500
metres

N

EnergyAustralia
LIGHT THE WAY

PINE DALE MINE
REHABILITATION DOMAINS
DECEMBER 2018

PLAN: 3

DRAWN BY : C.Rocher

SCALE: 1 : 8000 (A3)

DATE: 1/02/2019

CDT-DWG-A3H-001/1

EP PDH7/GW (Site E)

EP DDH7/GW (Site A)

EL7621

EL7621

EP DDH5/GW (Site B)

EP PDH/GW (Site C)

EP DDH4/GW (Site D)

N

MT. PIPER

ANGUS PLACE

BEN BULLEN STATE FOREST

ML 1569

ML1664

ML 1578

ML1578

ML1637

ML 6

ML 5

ML 19

Pt Por.55

POR.53

POR. 15

LOT 1 D.P.597541

POR.41

POR.38

POR.39

Pt Por.291

POR.35

POR.29

POR.37

POR.38

POR.21

POR.27

Pt Por.20

Water Cart Dam

PCB1

PCB7

PCB2

PCB3

Weather Station

S1

S2

S3

S4

S5

S6

S7

P6

P7

ELP Point 2

ELP Point 3/S3

ELP point 13

EPL Point 14

CASTLEREAGH HIGHWAY

HAUL ROAD

Old Shaft

The Bong

WALLERAWANG COLLIERY RAILWAY

PML 11

D1

NM1

D2

NM2

D3

NM3

NM4

D5

NM5

D6

NM6

LEGEND

- Limit of underground workings
- Metorological monitoring location
- Air quality monitoring location
- Noise monitoring location
- Groundwater bore location
- Surface water location
- ML1569
- ML1578
- ML1637
- ML1664
- EL7621

NOTE: Drawing adapted from plan supplied by Craven, Ellistion & Hayes (Lithgow) Pty Ltd
Drawing No.3-1656
Dated 6/7/2011

0 200 300 400 500
metres

EnergyAustralia LIGHT THE WAY

PINE DALE MINE
MINING AND EXPLORATION LEASES

PLAN: 4

DRAWN BY : C.Rocher

SCALE : 1 : 2000 (A3)

DATE : 1/02/2019

CDT-DWG-A3H-001/1

APPENDIX B

ENVIRONMENTAL MONITORING SUMMARY REPORT

ANNUAL REVIEW ENVIRONMENTALSUMMARY 2018

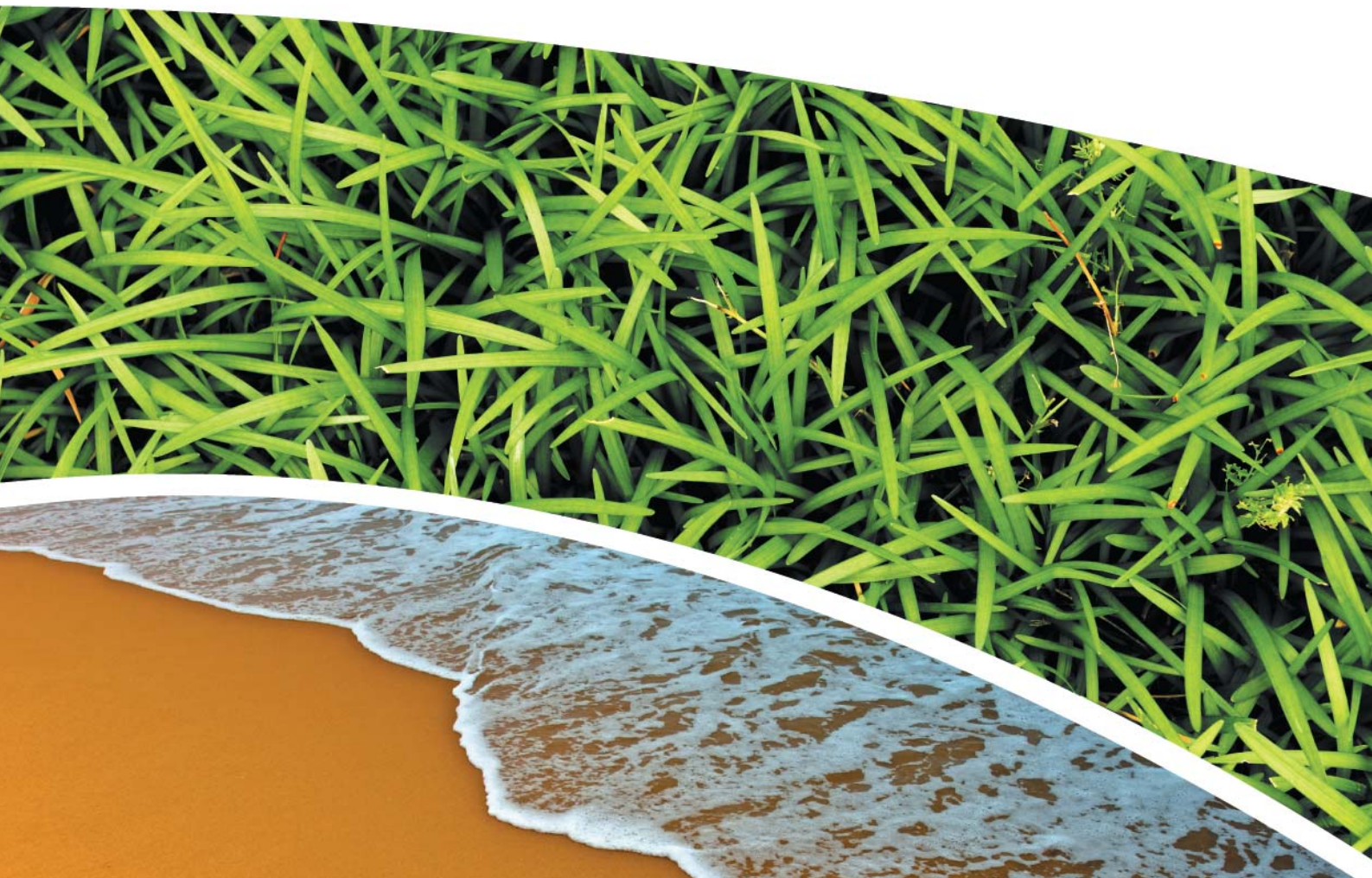
Prepared for Enhance Place Pty Ltd

Prepared by RCA Australia

RCA ref 6880-1785a/0

February 2019

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL



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/0	1	Electronic (email)	EnergyAustralia – Mark Frewin mark.frewin@energyaustralia.com.au	05.02.19
/0	1	Electronic report	RCA – job archive	05.02.19

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GEOTECHNICAL • ENVIRONMENTAL

Geotechnical Engineering
Engineering Geology
Environmental Engineering
Hydrogeology
Construction Materials Testing
Environmental Monitoring
Sound & Vibration
Occupational Hygiene

RCA ref 6880-1785a/0

5 February 2019

Enhance Place Pty Ltd
PO Box 202
WALLERAWANG NSW 2845

Attention: Mr Graham Goodwin

ANNUAL REVIEW ENVIRONMENTAL SUMMARY 2018
COMPILED FOR PINE DALE MINE
JANUARY – DECEMBER 2018

Robert Carr & Associates Pty Ltd
T/A RCA Australia ABN 53 063 515 711

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APPENDIX 1

ENVIRONMENTAL MONITORING LOCATIONS

STREAM HEALTH & CHANNNEL STABILITY MONITORING LOCATIONS

1 EXECUTIVE SUMMARY

Pine Dale Mine achieved an acceptable standard of environmental performance during the 2018 reporting period, as evidenced by the following:

- Air quality monitoring results recorded during the reporting period for depositional dust, total suspended particulate matter (TSP) and fine particulate matter (PM_{10}) were below the Project Approval (PA 10_0041) and Environmental Protection Authority assessment criteria in Blackmans Flat and other privately owned properties adjacent to the Mining Leases;
- There were no noise exceedances from mining activities recorded at privately owned properties recorded during the reporting period;
- There were no surface water discharge events during the reporting period; and monitoring was conducted in accordance with EPL 4911 and the site Water Management Plan.
- There was intermittent exceedance of surface water and groundwater, a review of surface water and groundwater data by GHD proposed revised trigger levels. These revised trigger levels have been forwarded to DPI – Water, however, no response has been received at the time of writing.

2 INTRODUCTION

The following report provides a summary of monthly environmental monitoring data for Pine Dale Mine (PDM) for the period January – December 2018. The 2018 environmental summary data includes:

- High Volume Air Samples: total suspended particulates (TSP) and (particulate matter less than or equal to 10 micrometres (PM_{10});
- Depositional dust;
- Surface Water;
- Groundwater;
- Channel stability and stream health monitoring; and
- Noise monitoring.

This report satisfies the requirements to monitor environmental parameters as presented in the PDM Environmental Protection Licence (EPL 4911) (Ref [1]) and Project Approval (PA 10_0041) (Ref [2]). Monitoring is undertaken in accordance with the PDM: Water Management Plan (Ref [3]); Air Quality and Greenhouse Gas Management Plan (Ref [4]; Purple Copper Butterfly Monitoring Program (Ref [5]); and Noise Management Plan (Ref [6]).

A compliance assessment of each environmental monitoring parameter is made in accordance with the relevant assessment criteria outlined in Project Approval (PA 10_0041), the PDM Management Plans and Environmental Protection Licence (EPL 4911).

3 AIR QUALITY MONITORING

3.1 DEPOSITIONAL DUST AND HVAS PARTICULATE MATTER ASSESSMENT CRITERIA

The Pine Dale Mine Project Approval (PA 10_0041, Schedule 3 Condition 18) (Ref [2]) and Air Quality and Greenhouse Gas Management Plan (Ref [4]) stipulates that dust emissions generated by the project must not cause additional exceedances of the long term impact assessment criteria listed in **Tables 1, 2** and **3**.

Table 1 *HVAS Particulate Matter: Long Term Assessment Criteria*

Pollutant	Average Period	[d]Criterion
Total suspended particulate (TSP) matter	Annual	[a]90µg/m^3
Particulate matter < 10µm (PM_{10})	Annual	[a]25µg/m^3

Table 2 *HVAS Particulate Matter: Short Term Assessment Criteria*

Pollutant	Average Period	[d]Criterion
Particulate matter < 10µm (PM_{10})	24 hours	[a]50µg/m^3

Table 3 *Depositional Dust: Long Term Assessment Criteria*

Pollutant	Average Period	Maximum increase in deposited dust level	Maximum total deposited dust level
[c] Deposited dust	Annual	[b]2 g/m^2.month	[a]4g/m^2.month

[a] Total impact (incremental increase in concentrations due to the project plus background concentrations due to other sources)

[b] Incremental impact (incremental increase in concentrations due to the project on its own);

[c] Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS3580.10.1 (Ref [7])

[d] Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents, illegal activities or any other activity agreed to by the Director-General in consultation with Office of Environment and Heritage (OEH) (formerly DECCW).

3.2 AIR MONITORING RESULTS – DEPOSITIONAL DUST GAUGE DATA SUMMARY

Depositional dust monitoring is undertaken at ten (10) locations across PDM.

A total of six (6) depositional dust gauges are monitored in accordance with the Air Quality and Green House Gas Management Plan (Ref 4]) and EPL 4911 (Ref [1]). Two (2) of these dust gauges are located within the settlement of Blackmans Flat (gauges D1 & D2). A third gauge is located to the east of Blackmans Flat along the Castlereagh Highway (gauge D3). The remaining three (3) gauges (D4, D5 & D6) were installed in November 2006 to coincide with the commencement of mining in Areas B & C. Gauge D4 is located to the north of View St, Blackmans Flat. Gauges D5 & D6 are located to the east of Mining Areas B & C, along Wolgan Road, Lidsdale (refer Drawing 1, **Appendix 1**).

The remaining four (4) depositional dust gauges are monitored in accordance with the Purple Copper Butterfly Monitoring Program (Ref [5]). These gauges are: PCB1, PCB2, PCB3 and PCB7. Three (3) of the dust gauges are located within the major butterfly population to the east of the mine workings in the Yarraboldy Extension (PCB1, PCB2 and PCB3); whilst the fourth dust gauge (PCB7) is located to the south west of the butterfly habitat area (refer Drawing 1, **Appendix 1**).

Depositional Dust summary results for the period January – December 2018 are shown in **Tables 4** to **13**. Graphical presentations are shown in **Figures 1** and **2**. A discussion of results is presented in **Section 2.3**.

Table 4 *Depositional Dust Data Summary Dust Gauge D1 Jan – Dec 2018*

Month	Gauge No.	Insoluble Solids (g/m^2.month)	Ash Residue (g/m^2.month)	Combustible Matter (g/m^2.month)
Jan-18	D1	1.9	1.0	0.9
Feb-18	D1	1.2	0.6	0.6
Mar-18	D1	0.9	0.3	0.6
Apr-18	D1	1.5	0.5	1.0
May-18	D1	0.7	0.4	0.3
Jun-18	D1	1.0	0.4	0.6
Jul-18	D1	0.3	<0.1*	0.3
Aug-18	D1	0.5	0.3	0.2
Sep-18	D1	0.4	0.3	0.1
Oct-18	D1	1.0	0.6	0.4
Nov-18	D1	2.8	1.7	1.1
Dec-18	D1	3.0	1.8	1.2
ANNUAL AVERAGE		***1.3***	***0.7***	***0.6***

*Where results are less than the detection limit, half of the detection limit has been used in statistical calculations.

Table 5 *Depositional Dust Data Summary Dust Gauge D2 Jan – Dec 2018*

Month	Gauge No.	Insoluble Solids (g/m^2.month)	Ash Residue (g/m^2.month)	Combustible Matter (g/m^2.month)
Jan-18	D2	1.1	0.6	0.5
Feb-18	D2	0.7	0.4	0.3
Mar-18	D2	D2 is situated on private property and was removed at the request of the property owner in March 2018		
Apr-18	D2			
May-18	D2			
Jun-18	D2			
Jul-18	D2			
Aug-18	D2			
Sep-18	D2			
Oct-18	D2			
Nov-18	D2			
Dec-18	D2			
ANNUAL AVERAGE		***0.9***	***0.1***	***0.1***

Table 6 *Depositional Dust Data Summary Dust Gauge D3 Jan – Dec 2018*

Month	Gauge No.	Insoluble Solids (g/m^2.month)	Ash Residue (g/m^2.month)	Combustible Matter (g/m^2.month)
Jan-18	D3	0.9	0.6	0.3
Feb-18	D3	0.9	0.6	0.3
Mar-18	D3	0.6	0.4	0.2
Apr-18	D3	0.4	0.2	0.2
May-18	D3	0.6	0.4	0.2
Jun-18	D3	0.7	0.5	0.2
Jul-18	D3	<0.1*	<0.1*	<0.1*
Aug-18	D3	0.6	0.4	0.2
Sep-18	D3	ND	ND	ND
Oct-18	D3	0.9	0.4	0.5
Nov-18	D3	2.1	1.3	0.8
Dec-18	D3	2.9	2.2	0.7
ANNUAL AVERAGE		***1.0***	***0.6***	***0.3***

* Where results are found to be less than the detection limit, values of half the detection limit are used for reporting purposes.

ND - No dust results are available for dust gauge D3 in September 2018 due to a sampling error (incorrect bottle placed in the depositional dust gauge stand).

Table 7 *Depositional Dust Data Summary Gauge D4 Jan – Dec 2018*

Month	Gauge No.	Insoluble Solids (g/m^2.month)	Ash Residue (g/m^2.month)	Combustible Matter (g/m^2.month)
Jan-18	D4	1.1	0.5	0.6
Feb-18	D4	1.0	0.4	0.6
Mar-18	D4	0.3	0.1	0.2
Apr-18	D4	1.0	0.4	0.6
May-18	D4	0.8	0.3	0.5
Jun-18	D4	0.5	0.2	0.3
Jul-18	D4	0.3	<0.1*	0.3
Aug-18	D4	0.6	0.4	0.2
Sep-18	D4	0.5	0.3	0.2
Oct-18	D4	0.8	0.3	0.5
Nov-18	D4	2.2	1.2	1.0
Dec-18	D4	2.8	1.9	0.9
ANNUAL AVERAGE		***1.0***	***0.5***	***0.5***

*Where results are less than the detection limit, half of the detection limit has been used in statistical calculations.

Table 8 *Depositional Dust Data Summary Gauge D5 Jan – Dec 2018*

Month	Gauge No.	Insoluble Solids (g/m^2.month)	Ash Residue (g/m^2.month)	Combustible Matter (g/m^2.month)
Jan-18	D5	3.7	1.0	2.7
Feb-18	D5	0.6	0.3	0.3
Mar-18	D5	0.8	0.5	0.3
Apr-18	D5	0.4	0.2	0.2
May-18	D5	0.6	0.3	0.3
Jun-18	D5	0.5	0.4	0.1
Jul-18	D5	0.6	0.3	0.3
Aug-18	D5	2.1	1.6	0.5
Sep-18	D5	1.1	0.6	0.5
Oct-18	D5	0.8	0.5	0.3
Nov-18	D5	1.3	0.8	0.5
Dec-18	D5	2.8	1.9	0.9
ANNUAL AVERAGE		***1.3***	***0.7***	***0.6***

Table 9 *Depositional Dust Data Summary Gauge D6 Jan – Dec 2018*

Month	Gauge No.	Insoluble Solids (g/m^2.month)	Ash Residue (g/m^2.month)	Combustible Matter (g/m^2.month)
Jan-18	D6	0.8	0.5	0.3
Feb-18	D6	1	0.5	0.5
Mar-18	D6	0.7	0.4	0.3
Apr-18	D6	0.6	0.4	0.2
May-18	D6	0.6	0.3	0.3
Jun-18	D6	0.6	0.3	0.3
Jul-18	D6	<0.1*	<0.1*	<0.1*
Aug-18	D6	0.6	<0.1*	0.6
Sep-18	D6	0.5	<0.1*	0.5
Oct-18	D6	0.5	0	0.5
Nov-18	D6	2.1	1.6	0.5
Dec-18	D6	2.5	1.8	0.7
ANNUAL AVERAGE		***0.9***	***0.5***	***0.4***

*Where results are less than the detection limit, half of the detection limit has been used in statistical calculations.

Table 10 *Depositional Dust Data Summary Gauge PCB1 Jan – Dec 2018*

Month	Gauge No.	Insoluble Solids (g/m^2.month)	Ash Residue (g/m^2.month)	Combustible Matter (g/m^2.month)
Jan-18	PCB1	1.1	0.4	0.7
Feb-18	PCB1	1.5	0.7	0.8
Mar-18	PCB1	0.8	0.2	0.6
Apr-18	PCB1	0.9	0.4	0.5
May-18	PCB1	0.6	0.2	0.4
Jun-18	PCB1	0.4	0.1	0.3
Jul-18	PCB1	0.4	<0.1*	0.4
Aug-18	PCB1	2.7	0.6	2.1
Sep-18	PCB1	1.5	0.7	0.8
Oct-18	PCB1	1	0.4	0.6
Nov-18	PCB1	1.6	0.6	1
Dec-18	PCB1	3.1	1.7	1.4
ANNUAL AVERAGE		***1.3***	***0.5***	***0.8***

*Where results are less than the detection limit, half of the detection limit has been used in statistical calculations.

Table 11 *Depositional Dust Data Summary Gauge PCB2 Jan – Dec 2018*

Month	Gauge No.	Insoluble Solids (g/m^2.month)	Ash Residue (g/m^2.month)	Combustible Matter (g/m^2.month)
Jan-18	PCB2	1.5	0.4	1.1
Feb-18	PCB2	1.4	0.5	0.9
Mar-18	PCB2	0.8	0.2	0.6
Apr-18	PCB2	0.9	0.3	0.6
May-18	PCB2	0.9	0.4	0.5
Jun-18	PCB2	0.5	0.2	0.3
Jul-18	PCB2	0.2	0.1	0.1
Aug-18	PCB2	0.9	0.4	0.5
Sep-18	PCB2	1.1	0.6	0.5
Oct-18	PCB2	0.9	1	0.8
Nov-18	PCB2	1.6	0.8	0.8
Dec-18	PCB2	3.6	1.8	1.8
ANNUAL AVERAGE		***1.2***	***0.6***	***0.7***

Table 12 *Depositional Dust Data Summary Gauge PCB3 Jan – Dec 2018*

Month	Gauge No.	Insoluble Solids (g/m^2.month)	Ash Residue (g/m^2.month)	Combustible Matter (g/m^2.month)
Jan-18	PCB3	1.5	0.4	1.1
Feb-18	PCB3	1.1	0.4	0.7
Mar-18	PCB3	0.8	0.2	0.6
Apr-18	PCB3	0.6	0.2	0.4
May-18	PCB3	0.5	0.2	0.3
Jun-18	PCB3	0.6	0.2	0.4
Jul-18	PCB3	<0.1*	<0.1*	<0.1*
Aug-18	PCB3	0.7	<0.1*	0.7
Sep-18	PCB3	0.8	<0.1*	0.8
Oct-18	PCB3	ND	ND	ND
Nov-18	PCB3	1.3	0.5	0.8
Dec-18	PCB3	1.6	0.6	1
ANNUAL AVERAGE		***0.8***	***0.2***	***0.6***

*Where results are less than the detection limit, half of the detection limit has been used in statistical calculations.

ND – No dust results are available for dust gauge PCB3 in October 2018 due to a broken bottle

Table 13 *Depositional Dust Data Summary Gauge PCB7 Jan – Dec 2018*

Month	Gauge No.	Insoluble Solids (g/m^2.month)	Ash Residue (g/m^2.month)	Combustible Matter (g/m^2.month)
Jan-18	PCB7	2.0	1.3	0.7
Feb-18	PCB7	2.1	0.8	1.3
Mar-18	PCB7	1.5	0.6	0.9
Apr-18	PCB7	1.7	1.1	0.6
May-18	PCB7	1.2	0.7	0.5
Jun-18	PCB7	0.6	0.3	0.3
Jul-18	PCB7	0.4	0.1	0.3
Aug-18	PCB7	0.2	<0.1*	0.2
Sep-18	PCB7	0.7	0.5	0.2
Oct-18	PCB7	0.8	0.3	0.5
Nov-18	PCB7	1.8	0.9	0.9
Dec-18	PCB7	3.0	1.7	1.3
ANNUAL AVERAGE		***1.3***	***0.8***	***0.6***

*Where results are less than the detection limit, half of the detection limit has been used in statistical calculations.

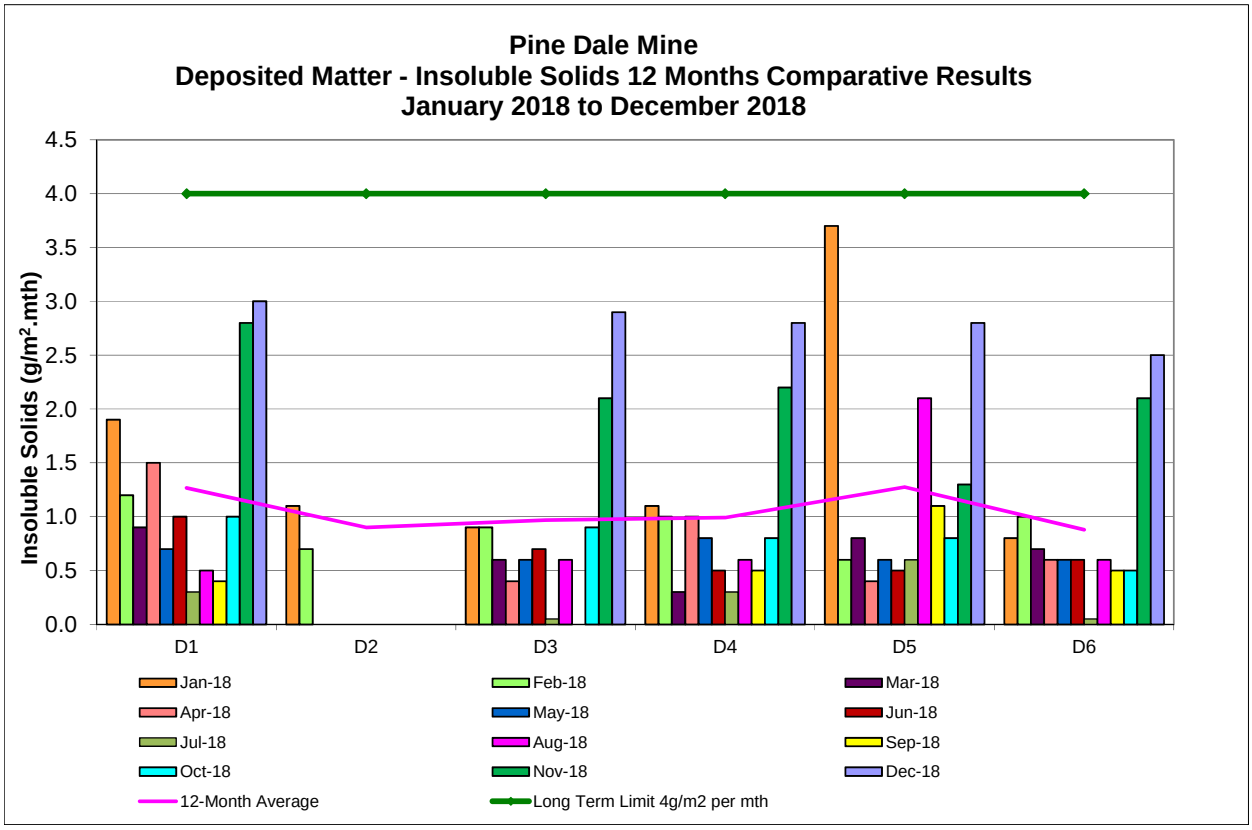

Figure 1 *Depositional Dust Results - Gauges D1 to D6*

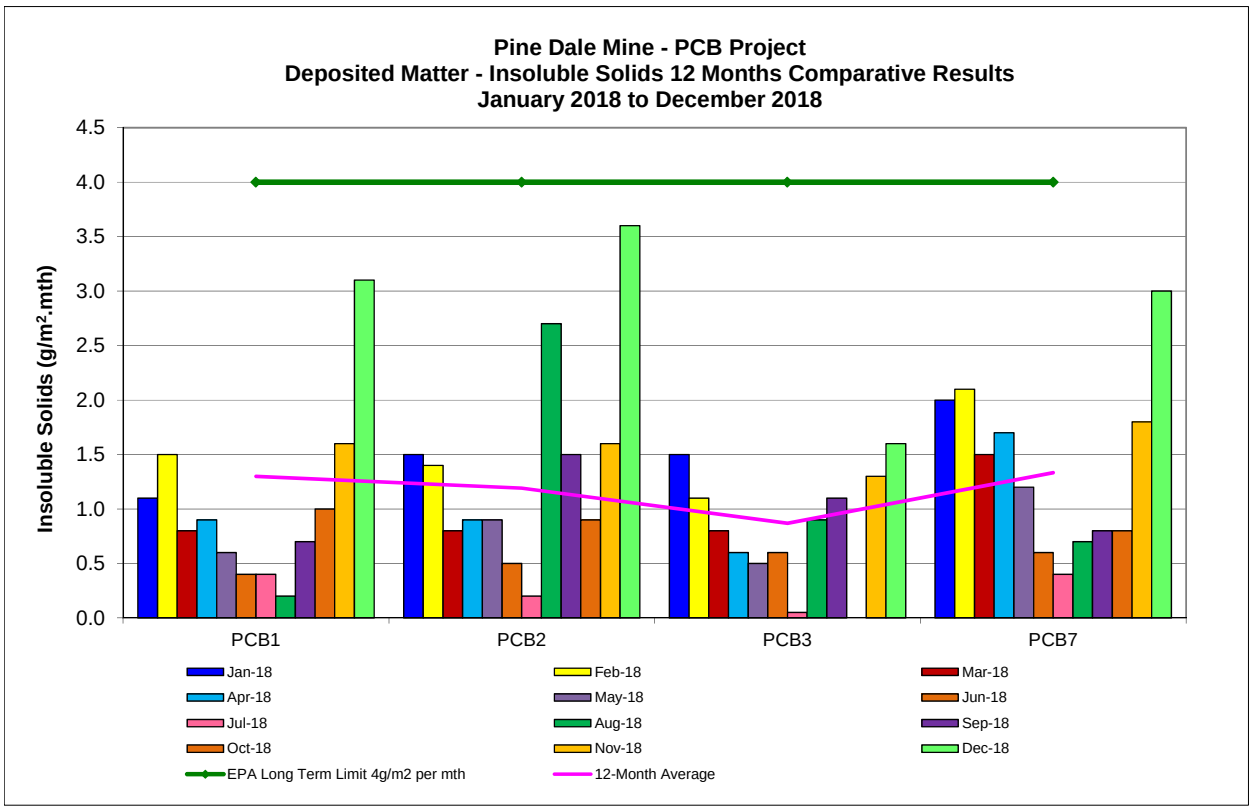

Figure 2 *Depositional Dust Results – Gauges PCB1-PCB3 & PCB7*

3.3 AIR MONITORING RESULTS – HVAS PARTICULATE MATTER DATA SUMMARY

PDM monitors TSP and PM_{10} concentrations using high volume air samplers (HVAS) on a 24-hour, one-in-six day sampling sequence. Monitoring is undertaken at one (1) location in accordance with Air Quality and Green House Gas Management Plan (Ref [4] and EPL 4911 (Ref [1]. The HVAS TSP and PM_{10} units are both located adjacent to the mine office at Blackmans Flat (refer Drawing 1, **Appendix 1**).

HVAS Particulate Matter summary results for the period January – December 2018 are shown in **Table 14**. Graphical presentations are shown in **Figure 3**.

Table 14 *HVAS Particulate Matter Summary Jan – Dec 2018*

Run Date	HVAS TSP ($\mu g/m^3$)	HVAS PM_{10} ($\mu g/m^3$)	Run Date	HVAS TSP ($\mu g/m^3$)	HVAS PM_{10} ($\mu g/m^3$)
1-Jan-18	13	13	6-Jul-18	12	6
7-Jan-18	44	22	12-Jul-18	13	9
13-Jan-18	41	18	18-Jul-18	73	5
19-Jan-18	36	16	24-Jul-18	20	10
25-Jan-18	32	20	30-Jul-18	8	3
31-Jan-18	13	6	5-Aug-18	15	20
6-Feb-18	22	5	11-Aug-18	21	8
12-Feb-18	33	21	17-Aug-18	16	7
18-Feb-18	48	27	23-Aug-18	19	7
24-Feb-18	16	9	29-Aug-18	20	9
2-Mar-18	16	8	4-Sep-18	3	3
8-Mar-18	9	5	10-Sep-18	13	4
14-Mar-18	21	6	16-Sep-18	22	6
20-Mar-18	36	16	22-Sep-18	53	15
26-Mar-18	17	6	28-Sep-18	39	14
1-Apr-18	25	13	4-Oct-18	8	1
7-Apr-18	24	12	10-Oct-18	7	3
13-Apr-18	38	16	16-Oct-18	8	4
19-Apr-18	20	9	22-Oct-18	3	8
25-Apr-18	8	4	28-Oct-18	28	12
1-May-18	40	25	3-Nov-18	38	15
7-May-18	34	20	9-Nov-18	40	7
13-May-18	8	2	15-Nov-18	15	5
19-May-18	12	2	21-Nov-18	70	49
25-May-18	19	12	27-Nov-18	38	11
31-May-18	10	5	3-Dec-18	59	19
6-Jun-18	8	2	9-Dec-18	36	21
12-Jun-18	11	4	15-Dec-18	175	110
18-Jun-18	7	2	21-Dec-18	22	3
24-Jun-18	7	4	27-Dec-18	31	16
30-Jun-18	17	5			
			Annual Average	***26.4***	***12.2***

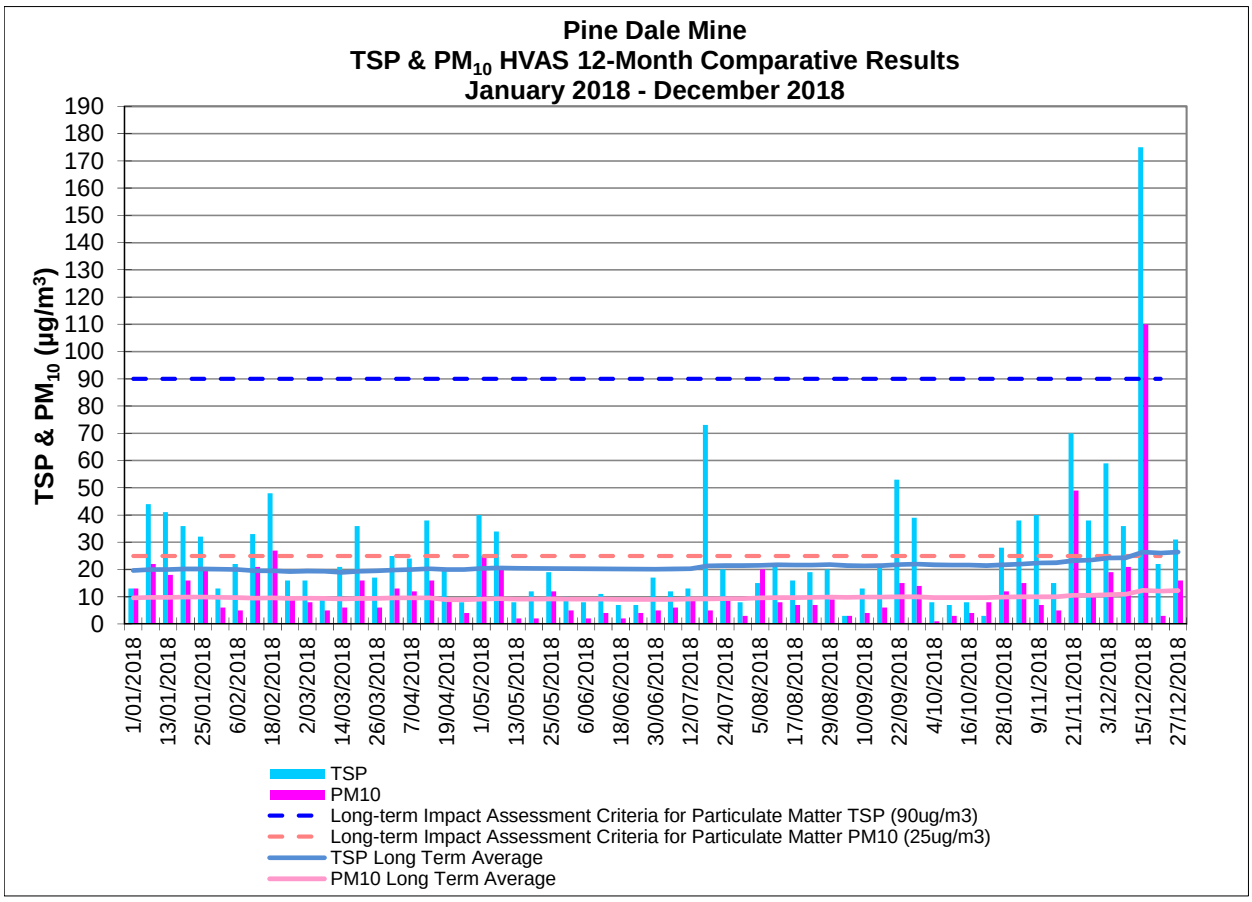

Figure 3 *HVAS TSP & PM_{10} Particulate Matter Summary Jan- Dec 2018*

3.4 REVIEW & INTERPRETATION OF AIR MONITORING RESULTS

3.4.1 DEPOSITIONAL DUST RESULTS

Depositional Dust results for the period January – December 2018 show an average insoluble solids range of 0.9g/m^2 per month to 1.3g/m^2 per month for dust gauges D1 to D6. These results are well below the long term assessment criteria detailed in **Table 3**.

A review of historical data captured over the previous five years including the 2018 monitoring period indicate there were no instances where the dust gauges showed results which were greater than the maximum annual average increase of 2g/m^2 per month deposited matter, as detailed in **Table 3**.

It is noted that dust gauges PCB1, PCB2, PCB3 and PCB7 are located in a bushland setting under the canopy of tall trees and as such, these gauges do not conform to the siting requirements of AS/NZS 3580.1.1 (Ref [8]). The purpose of these gauges is to determine the level of dust present at each location to aid in the study of the Purple Copper Butterfly population.

3.4.2 HVAS PARTICULATE MATTER RESULTS

HVAS TSP results for the period January – December 2018 show an average result of 26.4µg/m^3, which is well below the long term assessment criterion of 90µg/m^3 (refer **Table 2**) for TSP. During the reporting period the TSP HVAS recorded 100% data capture, with sampling undertaken in accordance with AS/NZS 3580.9.3 (Ref [9]), with the following exceptions:

- On 6 February 2018 the TSP HVAS sampling was conducted for 19 hours.
- On 12 February 2018 the TSP HVAS sampling was conducted for 29.01 hours.
- On 30 June 2018 the TSP HVAS sampling was conducted for 15.06 hours.
- On 6 July 2018 the TSP HVAS sampling was conducted for 25.47 hours.
- On 18 July 2018 the TSP HVAS sampling was conducted for 15.41 hours.
- On 29 August 2018 the TSP HVAS sampling was conducted for 16 hours.

All the above TSP HVAS run times were outside of the 24 ±1 hour sampling period stipulated in AS/NZS 3580.9.3 (Ref [9]).

Similarly, the HVAS PM_{10} annual average result is below the long term assessment criterion of 25µg/m^3 (refer **Table 2**). The annual average PM_{10} result was 12.2µg/m^3. All HVAS results were below the short term 24 hour maximum assessment criterion of 50µg/m^3 with the exception of the run on 15 December 2018 which reported a concentration of 110µg/m^3. Comparison of the NSW OEH air quality network and observations by mining personnel indicates that this may be attributable to regional dust storm events.

During the reporting period the PM_{10} HVAS recorded 100% data capture. Sampling during 2018 was undertaken in accordance with AS/NZS 3580.9.6 (Ref [10]), with the exception of runs on the 6 July 2018, 5 August 2018 and 21 December 2018 where the PM_{10} sampler ran for 1.01 hours, 33.20 hours and 10.66 hours respectively; which were all outside of the 24±1 hour period stipulated in AS/NZS 3580.9.6 (Ref [10]).

4 GROUNDWATER QUALITY MONITORING

4.1 GROUNDWATER ASSESSMENT CRITERIA

Groundwater monitoring is undertaken at PDM to monitor for any potential impacts on local groundwater due to past mining operations. Site specific trigger values for standing water level (SWL) and water quality parameters pH and Electrical Conductivity were developed for the Pine Dale Mine, as stipulated in the Water Management Plan (Ref [3]) in accordance with Schedule 3, Condition 27(c) of the Project Approval (PA 10_0041). The groundwater trigger values are shown in **Table 15** (Ref [3]).

Table 15 *Groundwater Trigger Values*[e]

Bore	pH (range)	Electrical Conductivity (µS/cm)	SWL Trigger (m, AHD)
P6	6.2 - 8.0	1180	887.90
P7	6.3 - 8.0	852	883.28
EP DDH4/GW (Bore D)	6.8 - 8.0	608	940.61
EP DDH7/GW (Bore A)	6.5 - 8.0	326	954.40
EP PDH1/GW Bore C)	6.9 - 8.0	490	889.25
EP PDH3/GW (Enhance)	NA	NA	891.06
EP PDH4/GW (Enhance)	NA	NA	890.95
EP PDH7/GW (Bore E)	5.5 - 8.0	151	938.43
Old Ventilation Shaft	6.3 - 8.0	908	888.46
The Bong (at SW location)	5.8 - 8.0	1157	NA

NA – no trigger value required for these locations.

[e]GHD has undertaken a review of the trigger values and proposed revised values (Ref [11]). These values have been submitted to the Department of Primary Industries in October 2018; however, PDM has not yet received a response. The site specific trigger values detailed in the Water Management Plan (Ref [3]) have been utilised.

4.2 GROUNDWATER MONITORING DATA SUMMARY

Groundwater monitoring for the Pine Dale Mine is undertaken in accordance with the Water Management Plan (Ref [3]). Sampling is conducted at three (3) locations within the mine site; seven (7) locations surrounding the Yarraboldy Extension area (four (4) sampling wells and three (3) vibrating wire piezometer wells); and two (2) locations at the former Enhance Place Mine Site (refer **Drawing 1**, **Appendix 1**). Groundwater monitoring is not a requirement of EPL 4911.

Groundwater summary results for the period January – December 2018 are shown in **Tables 16** to **25**. Graphical presentations of standing water levels are shown in **Figures 4** to **6**.

Table 16 *Groundwater Monitoring Bore P6 Results January - December 2018*

Location	Site Bore P6												
Sample Number	01186880009	02186880011	03186880009	04186880009	05186880011	06186880009	07186880011	08186880011	09186880009	10186880009	11186880011	12186880009	
Sampling Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Date Sampled	12/01/18	12/02/18	14/03/18	11/04/18	10/05/18	07/06/18	05/07/18	07/08/18	07/09/18	09/10/18	08/11/18	06/12/18	
Time Sampled	9:58	14:36	8:12	16:33	14:50	10:50	10:54	9:50	9:58	7:10	15:15	17:04	**Trigger Values**
Standing Water Level (m)	25.92	26.10	26.14	26.18	26.26	26.35	26.50	26.65	26.73	26.75	26.28	26.54	
Standpipe Height (m)	0.90	0.95	0.95	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	
Relative Water Level (m)	25.02	25.15	25.19	25.28	25.36	25.45	25.60	25.75	25.83	25.85	25.38	25.64	
Water Level AHD (m)	891.93	891.80	891.76	891.67	891.59	891.50	891.35	891.20	891.12	891.10	891.57	891.31	**887.90 #**
Temperature (°C)	18.0	19.0	16.7	18.6	12.0	14.5	14.6	12.6	15.0	13.8	18.0	18.3	
pH	6.57	6.07	6.05	6.07	6.32	5.99	6.07	6.06	6.09	6.22	6.22	6.58	**6.2 to 8.0**
Conductivity (µS/cm)	1370	1540	1480	1400	1580	1050	1620	1560	1690	1630	1520	1660	**1180**
Turbidity (NTU)	62	59	63	91	46	55	44	68	91	118	67	34	
Dissolved Oxygen (mg/L)	<2	<2	3.0	2.0	3.8	<2	<2	2.0	3.00	2.90	2.00	<1	
TSS (mg/L)	52	60	43	83	37	52	47	48	62	63	71	43	
Oil & Grease (mg/L)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	
Bicarbonate Alkalinity (mg/L)	81	68	83	56	83	92	94	104	75	54	68	80	
Total Alkalinity (mg/L)	81	68	83	56	83	92	94	104	75	54	68	80	
Sulphate (mg/L)	629	590	564	645	608	588	777	722	674	654	722	774	
Chloride (mg/L)	36	36	39	40	46	46	62	38	46	43	45	48	
Calcium (mg/L)	133	136	134	132	141	158	149	156	137	145	145	150	
Magnesium (mg/L)	58	62	60	63	64	74	70	66	65	73	63	70	
Sodium (mg/L)	56	57	56	58	59	67	64	62	60	67	61	68	
Potassium (mg/L)	18	20	18	18	18	21	20	24	19	20	19	21	
Cobalt (dissolved) (mg/L)	0.074	0.073	0.076	0.072	0.073	0.065	0.037	0.054	0.044	0.055	0.054	0.062	
Manganese (dissolved) (mg/L)	2.62	2.76	2.58	2.48	2.69	2.73	2.92	2.74	3.4	2.91	2.59	3.33	
Nickel (dissolved) (mg/L)	0.122	0.125	0.13	0.118	0.124	0.09	0.034	0.078	0.062	0.082	0.086	0.107	
Zinc (dissolved) (mg/L)	0.068	0.056	0.021	0.09	0.022	0.006	0.012	0.01	0.031	0.028	0.03	0.019	
Iron (dissolved) (mg/L)	30.1	30.7	30.6	28.8	36.0	38.9	40.1	35.3	41.5	40.2	34	44.6	

Shaded Cells- Indicates results are outside of the nominated Trigger Level.

--- Indicates no sampling required

Water Level trigger is exceeded if the AHD water level drops below the nominated trigger level.

Table 17 *Groundwater Monitoring Bore P7 Results January - December 2018*

Location	Site Bore P7												
Sample Number	01186880010	02186880012	03186880010	04186880010	05186880012	06186880010	07186880012	08186880012	09186880010	10186880010	11186880012	121868800110	
Sampling Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Date Sampled	12/01/18	12/02/18	14/03/18	11/04/18	10/05/18	07/06/18	05/07/18	07/08/18	07/09/18	09/10/18	08/11/18	07/12/18	
Time Sampled	10:42	16:06	10:20	17:22	7:13	11:41	11:55	10:45	10:37	8:13	14:58	9:40	**Trigger Values**
Standing Water Level (m)	7.93	7.91	7.92	7.88	7.84	7.97	8.01	8.32	8.72	8.91	8.20	7.89	
Standpipe Height (m)	0.93	1.00	1.00	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	
Relative Water Level (m)	7.00	6.91	6.92	6.92	6.88	7.01	7.05	7.36	7.76	7.95	7.24	6.93	
Water Level AHD (m)	887.40	887.49	887.48	887.48	887.52	887.39	887.35	887.04	886.64	886.45	887.16	887.47	**883.28 #**
Temperature (°C)	17.5	17.8	16.1	17.9	13.0	14.4	15.5	12.7	14.4	13.8	18.0	16.2	
pH (pH units)	6.78	6.64	6.16	6.23	6.42	6.13	6.23	6.18	6.12	6.20	6.40	6.93	**6.3 to 8.0**
Conductivity (µS/cm)	830	871	815	810	851	867	774	746	823	754	718	769	**852**
Bicarbonate Alkalinity (mg/L)	---	228	---	---	231	---	---	218	---	---	174	---	
Total Alkalinity (mg/L)	---	228	---	---	231	---	---	218	---	---	174	---	
Sulphate (mg/L)	---	62	---	---	62	---	---	44	---	---	36	---	
Chloride (mg/L)	---	107	---	---	128	---	---	111	---	---	104	---	
Calcium (mg/L)	---	44	---	---	48	---	---	43	---	---	37	---	
Magnesium (mg/L)	---	47	---	---	51	---	---	41	---	---	35	---	
Sodium (mg/L)	---	50	---	---	50	---	---	47	---	---	43	---	
Potassium (mg/L)	---	7	---	---	10	---	---	9	---	---	7	---	
Iron (dissolved) (mg/L)	---	<0.05	---	---	0.34	---	---	<0.05	---	---	<0.05	---	

Shaded Cells - Indicates results are outside of the nominated Trigger Level.

--- Indicates no sampling required

Water Level trigger is exceeded if the AHD water level drops below the nominated trigger level.

Table 18 *Groundwater Monitoring Bore Old Shaft Results January - December 2018*

Location	Site Bore 'Old Shaft'												
Sample Number	01186880013	02186880015	03186880013	04186880013	05186880015	06186880013	07186880015	08186880015	09186880013	10186880013	11186880015	12186880013	
Sampling Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Date Sampled	11/01/18	12/02/18	13/03/18	11/04/18	10/05/18	7/06/18	5/07/18	7/08/18	7/09/18	8/10/18	8/11/18	6/12/18	
Time Sampled	8:13	13:45	17:57	15:57	15:55	13:35	13:40	9:30	9:20	17:52	13:55	17:30	**Trigger Values**
Standing Water Level (m)	12.30	12.39	12.37	12.47	12.54	12.70	12.77	12.88	12.99	13.00	12.97	12.76	
Standpipe Height (m)	1.5	1.5	1.5	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	1.72	
Relative Water Level (m)	10.80	10.89	10.87	10.75	10.82	10.98	11.05	11.16	11.27	11.28	11.25	11.04	
Water Level AHD (m)	892.24	892.15	892.17	892.29	892.22	892.06	891.99	891.88	891.77	891.76	891.79	892.00	**888.46 #**
Temperature (°C)	18.0	19.1	17.3	21.0	15.0	14.2	16.4	13.3	15.4	16.5	18.0	19.2	
pH	6.14	5.78	5.46	5.78	5.93	5.77	5.84	5.62	5.73	5.74	5.94	6.08	**6.3 to 8.0**
Conductivity (µS/cm)	1480	1540	1490	1420	1520	1490	1490	1470	1610	1510	1420	1520	**908**
Turbidity (NTU)	44	28	41	51	75	128	13	55	115	73	37	20	
Dissolved Oxygen (mg/L)	---	<2	---	---	3	---	---	4	---	---	3		
TSS (mg/L)	---	22	---	---	104	---	---	69	---	---	51		
Oil & Grease (mg/L)	---	<5	---	---	<5	---	---	<5	---	---	<5		
Bicarbonate Alkalinity (mg/L)	---	41	---	---	57	---	---	50	---	---	50		
Total Alkalinity (mg/L)	---	41	---	---	57	---	---	50	---	---	50		
Sulphate (mg/L)	---	665	---	---	654	---	---	728	---	---	792		
Chloride (mg/L)	---	26	---	---	30	---	---	24	---	---	28		
Calcium (mg/L)	---	152	---	---	145	---	---	168	---	---	159		
Magnesium (mg/L)	---	68	---	---	65	---	---	68	---	---	64		
Sodium (mg/L)	---	50	---	---	47	---	---	52	---	---	50		
Potassium (mg/L)	---	20	---	---	18	---	---	26	---	---	21		
Cobalt (dissolved) (mg/L)	---	0.142	---	---	0.143	---	---	0.13	---	---	0.118		
Manganese (dissolved) (mg/L)	---	3.5	---	---	3.26	---	---	2.67	---	---	3.1		
Nickel (dissolved) (mg/L)	---	0.23	---	---	0.217	---	---	0.219	---	---	0.204		
Zinc (dissolved) (mg/L)	---	0.392	---	---	0.39	---	---	0.364	---	---	0.319		
Iron (dissolved) (mg/L)	---	23.9	---	---	22.6	---	---	25.5	---	---	28.1		

Shaded Cells - Indicates results are outside of the nominated Trigger Level.

--- Indicates no sampling required

Water Level trigger is exceeded if the AHD water level drops below the nominated trigger level.

Table 19 *Groundwater Monitoring Location 'The Bong' Results January – December 2018*

Location	The Bong												
Sample Number	01186880001	02186880001	03186880001	04186880001	05186880001	06186880001	07186880001	08186880001	09186880001	10186880001	11186880001	12186880001	
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Trigger Values**
Date Sampled	12/01/18	12/02/18	14/03/18	11/04/18	10/05/18	7/06/18	5/07/18	7/08/18	7/09/18	8/10/18	8/11/18	7/12/18	
Time Sampled	8:25	12:46	7:57	16:00	14:03	13:47	9:56	8:01	7:48	17:57	11:30	8:27	
Temperature (°C)	23.0	29.88	17.5	25.7	13.00		6.7	5.20	11.7	18.6	17.0	16.8	
pH	5.10	5.30	5.96	4.88	5.86		5.73	5.05	5.81	4.93	5.85	5.80	**5.8 – 8.0**
Conductivity (µS/cm)	279	314	225	406	277		171	274	234	238	257	118	**1157**
Turbidity (NTU)	10	26	7	14	32		12	45	445	31	527	206	
Bicarbonate Alkalinity (mg/L)	---	<1	---	---	<1		---	<1	---	---	<1	---	
Total Alkalinity (mg/L)	---	<1	---	---	<1		---	<1	---	---	<1	---	
Sulphate (mg/L)	---	128	---	---	120		---	116	---	---	87	---	
Chloride (mg/L)	---	1	---	---	3		---	2	---	---	2	---	
Calcium (mg/L)	---	26	---	---	23		---	24	---	---	24	---	
Magnesium (mg/L)	---	10	---	---	9		---	10	---	---	8	---	
Sodium (mg/L)	---	4	---	---	3		---	4	---	---	3	---	
Potassium (mg/L)	---	5	---	---	4		---	6	---	---	3	---	
Arsenic (dissolved) (mg/L)	---	<0.001	---	---	<0.001		---	<0.001	---	---	<0.001	---	
Cadmium (dissolved) (mg/L)	---	0.0003	---	---	<0.0001		---	0.0002	---	---	0.0002	---	
Chromium (dissolved) (mg/L)	---	<0.001	---	---	<0.001		---	<0.001	---	---	<0.001	---	
Copper (dissolved) (mg/L)	---	<0.001	---	---	<0.001		---	<0.001	---	---	0.001	---	
Lead (dissolved) (mg/L)	---	<0.001	---	---	<0.001		---	<0.001	---	---	<0.001	---	
Nickel (dissolved) (mg/L)	---	0.034	---	---	0.02		---	0.025	---	---	0.034	---	
Zinc (dissolved) (mg/L)	---	0.044	---	---	0.025		---	0.055	---	---	0.05	---	
Iron (dissolved) (mg/L)	---	0.06	---	---	0.1		---	0.11	---	---	0.1	---	

Dry- no sample obtained

Shaded Cells - Indicates results are outside of the nominated Trigger Level.

--- Indicates no sampling required

Table 20 *Groundwater Monitoring Bore A (EP DDH7/GW) Results January - December 2018*

Location	Off-Site Bore A (EP DDH7/GW)												
Sample Number	01186880014	02186880016	03186880014	04186880014	05186880016	06186880014	07186880016	08186880018	09186880016	10186880016	11186880018	12186880016	
Sampling Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Date Sampled	11/01/18	12/02/18	13/03/18	11/04/18	10/05/18	7/06/18	4/07/18	6/08/18	7/09/18	8/10/18	8/11/18	6/12/18	**Trigger Values**
Standing Water Level (m)	68.90	68.92	68.96	69.00	69.00	69.06	69.08	69.10	69.14	69.16	69.21	69.18	
Standpipe Height (m)	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.77	
Relative Water Level (m)	68.15	68.17	68.21	68.25	68.25	68.31	68.33	68.35	68.39	68.41	68.46	68.41	
Water level AHD (m)#	955.65	955.63	955.59	955.55	955.55	955.49	955.47	955.45	955.41	955.39	955.34	955.39	**954.40**
pH	---	---	6.61	---	---	6.58	---	---	6.55	---	---	6.92	**6.5 to 8.0**
Conductivity (µS/cm)	---	---	321	---	---	308	---	---	313	---	---	267	**326**
Temperature (°C)	---	---	18.1	---	---	15.3	---	---	15.7	---	---	20.1	
TDS (mg/L)	---	---	147	---	---	133	---	---	129	---	---	134	
Bicarbonate Alkalinity (mg/L)	---	---	150	---	---	128	---	---	109	---	---	117	
Total Alkalinity (mg/L $CaCO_3$)	---	---	150	---	---	128	---	---	109	---	---	117	
Sulphate (mg/L)	---	---	4	---	---	7	---	---	6	---	---	2	
Chloride (mg/L)	---	---	9	---	---	9	---	---	6	---	---	6	
Calcium (mg/L)	---	---	18	---	---	17	---	---	17	---	---	17	
Magnesium (mg/L)	---	---	7	---	---	6	---	---	5	---	---	6	
Sodium (mg/L)	---	---	7	---	---	5	---	---	4	---	---	4	
Potassium (mg/L)	---	---	13	---	---	10	---	---	12	---	---	12	
Arsenic (dissolved) (mg/L)	---	---	<0.001	---	---	<0.001	---	---	<0.001	---	---	<0.001	
Cadmium (dissolved) (mg/L)	---	---	<0.0001	---	---	<0.0001	---	---	<0.0001	---	---	<0.0001	
Chromium (dissolved) (mg/L)	---	---	<0.001	---	---	<0.001	---	---	<0.001	---	---	<0.001	
Copper (dissolved) (mg/L)	---	---	<0.001	---	---	<0.001	---	---	<0.001	---	---	<0.001	
Lead (dissolved) (mg/L)	---	---	<0.001	---	---	<0.001	---	---	<0.001	---	---	<0.001	
Nickel (dissolved) (mg/L)	---	---	<0.001	---	---	<0.001	---	---	<0.001	---	---	<0.001	
Zinc (dissolved) (mg/L)	---	---	<0.005	---	---	0.01	---	---	0.014	---	---	0.012	
Iron (dissolved) (mg/L)	---	---	3.12	---	---	3.4	---	---	4.44	---	---	4.55	

Shaded Cells - Indicates results are outside of the nominated Trigger Level.

--- Indicates no sampling required

Water Level trigger is exceeded if the AHD water level drops below the nominated trigger level.

Table 21 *Groundwater Monitoring Bore C (EP PDH1/GW) Results January - December 2018*

Location	Off-Site Bore C (EP PDH1/GW)												
Sample Number	01186880016	02186880018	03186880016	04186880016	05186880019	06186880016	07186880018	08186880020	09186880018	10186880018	11186880020	12186880018	**Trigger Values**
Sampling Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Date Sampled	12/01/18	12/02/18	13/03/18	11/04/18	10/05/18	7/06/18	5/07/18	7/08/18	7/09/18	8/10/18	8/11/18	7/12/18	
Standing Water Level (m)	75.28	75.37	75.36	75.45	75.51	75.65	75.77	75.88	74.91	76.00	74.95	75.75	
Standpipe Height (m)	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	
Relative Water Level (m)	74.54	74.63	74.62	74.71	74.77	74.91	75.03	75.14	74.17	75.26	74.21	75.01	
Water level AHD (m)#	892.96	892.87	892.88	892.79	892.73	892.59	892.47	892.36	893.33	892.24	893.29	892.49	**889.25**
pH	---	---	6.39	---	---	6.62	---	---	6.53	---	---	6.84	**6.9 to 8.0**
Conductivity (µS/cm)	---	---	241	---	---	272	---	---	313	---	---	307	**490**
Temperature (°C)	---	---	19.1	---	---	17.7	---	---	17.1	---	---	16.7	
TDS (mg/L)	---	---	156	---	---	177	---	---	153	---	---	178	
Bicarbonate Alkalinity (mg/L)	---	---	125	---	---	131	---	---	122	---	---	139	
Total Alkalinity (mg/L $CaCO_3$)	---	---	125	---	---	131	---	---	122	---	---	139	
Sulphate (mg/L)	---	---	11	---	---	5	---	---	4	---	---	6	
Chloride (mg/L)	---	---	6	---	---	13	---	---	7	---	---	6	
Calcium (mg/L)	---	---	25	---	---	28	---	---	26	---	---	30	
Magnesium (mg/L)	---	---	8	---	---	10	---	---	8	---	---	10	
Sodium (mg/L)	---	---	6	---	---	7	---	---	6	---	---	6	
Potassium (mg/L)	---	---	9	---	---	10	---	---	8	---	---	10	
Arsenic (dissolved) (mg/L)	---	---	<0.001	---	---	<0.001	---	---	<0.001	---	---	<0.001	
Cadmium (dissolved) (mg/L)	---	---	<0.0001	---	---	<0.0001	---	---	<0.0001	---	---	<0.0001	
Chromium (dissolved) (mg/L)	---	---	<0.001	---	---	<0.001	---	---	<0.001	---	---	<0.001	
Copper (dissolved) (mg/L)	---	---	<0.001	---	---	<0.001	---	---	0.002	---	---	<0.001	
Lead (dissolved) (mg/L)	---	---	<0.001	---	---	<0.001	---	---	<0.001	---	---	<0.001	
Nickel (dissolved) (mg/L)	---	---	<0.001	---	---	<0.001	---	---	0.004	---	---	<0.001	
Zinc (dissolved) (mg/L)	---	---	0.03	---	---	0.016	---	---	0.042	---	---	0.029	
Iron (dissolved) (mg/L)	---	---	<0.05	---	---	<0.05	---	---	0.44	---	---	<0.05	

Shaded Cells - Indicates results are outside of the nominated Trigger Level.

--- Indicates no sampling required

Water Level trigger is exceeded if the AHD water level drops below the nominated trigger level.

Table 22 *Groundwater Monitoring Bore D (EP DDH4/GW) Results January - December 2018*

Location	Off-Site Bore D (EP DDH4/GW)												
Sample Number	01186880018	02186880019	03186880017	04186880017	05186880019	06186880017	07186880019	08186880021	09186880019	10186880019	11186880021	12186880019	
Sampling Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Date Sampled	11/01/18	12/02/18	13/03/18	11/04/18	10/05/18	7/06/18	5/07/18	7/08/18	7/09/18	8/10/18	8/11/18	7/12/18	**Trigger Values**
Standing Water Level (m)	37.81	37.65	37.51	37.86	37.76	37.65	37.91	37.79	37.64	37.84	37.76	38.10	
Standpipe Height (m)	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	
Relative Water Level (m)	37.10	36.94	36.80	37.15	37.05	36.94	37.20	37.08	36.93	37.84	37.13	37.05	
Water level AHD (m)#	941.40	941.56	941.70	941.35	941.45	941.56	941.30	941.42	941.57	940.66	941.37	941.45	**940.61**
pH	---	---	6.60	---	---	*Dry- no sample obtained*	---	---	*Insufficient water to sample.*	---	6.99	*Insufficient water to sample.*	**6.8 to 8.0**
Conductivity (µS/cm)	---	---	313	---	---		---	---		---	400		**608**
Temperature (°C)	---	---	17.5	---	---		---	---		---	19.0		
TDS (mg/L)	---	---	1581	---	---		---	---		---	273		
Bicarbonate Alkalinity (mg/L)	---	---	126	---	---		---	---		---	140		
Total Alkalinity (mg/L)	---	---	126	---	---		---	---		---	140		
Sulphate (mg/L)	---	---	23	---	---		---	---		---	29		
Chloride (mg/L)	---	---	11	---	---		---	---		---	15		
Calcium (mg/L)	---	---	4	---	---		---	---		---	6		
Magnesium (mg/L)	---	---	1	---	---		---	---		---	2		
Sodium (mg/L)	---	---	64	---	---		---	---		---	72		
Potassium (mg/L)	---	---	6	---	---		---	---		---	7		
Arsenic (dissolved) (mg/L)	---	---	<0.001	---	---		---	---		---	<0.001		
Cadmium (dissolved) (mg/L)	---	---	<0.0001	---	---		---	---		---	<0.0001		
Chromium (dissolved) (mg/L)	---	---	<0.001	---	---		---	---		---	<0.001		
Copper (dissolved) (mg/L)	---	---	<0.001	---	---		---	---		---	0.004		
Lead (dissolved) (mg/L)	---	---	<0.001	---	---		---	---		---	<0.001		
Nickel (dissolved) (mg/L)	---	---	0.003	---	---		---	---		---	0.007		
Zinc (dissolved) (mg/L)	---	---	0.018	---	---		---	---		---	0.08		
Iron (dissolved) (mg/L)	---	---	1.1	---	---		---	---		---	0.06		

Shaded Cells - Indicates results are outside of the nominated Trigger Level.

--- Indicates no sampling required

Water Level trigger is exceeded if the AHD water level drops below the nominated trigger level.

Table 23 *Groundwater Monitoring Bore E (EP PDH7/GW) Results January - December 2018*

Location	Off-Site Bore E (EP PDH7/GW)												
Sample Number	01186880018	02186880020	03186880018	04186880018	05196880020	06186880018	07196880020	08186880022	09186880020	10186880020	11186880022	12186880020	
Sampling Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Date Sampled	11/01/18	12/02/18	13/03/18	11/04/18	10/05/18	7/06/18	5/07/18	6/08/18	7/09/18	8/10/18	7/11/18	6/12/18	**Trigger Values**
Standing Water Level (m)	15.08	17.05	15.03	15.19	15.24	15.64	15.19	15.19	15.28	15.43	15.32	10:00	
Standpipe Height (m)	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	
Relative Water Level (m)	14.35	16.32	14.30	14.46	14.51	14.91	14.46	14.46	14.55	14.70	14.59	15.10	
Water level AHD (m)#	940.55	938.58	940.60	940.44	940.39	939.99	940.44	940.44	940.35	940.20	940.31	939.80	**938.43**
pH	---	---	5.44	---	---	5.66	---	---	5.74	---	---	6.35	**5.5 to 8.0**
Conductivity (µS/cm)	---	---	97	---	---	114	---	---	121	---	---	99	**151**
Temperature (°C)	---	---	16.8	---	---	14.0	---	---	14.6	---	---	17.1	
TDS (mg/L)	---	---	48	---	---	90	---	---	67	---	---	78	
Bicarbonate Alkalinity (mg/L)	---	---	22	---	---	24	---	---	17	---	---	22	
Total Alkalinity (mg/L)	---	---	22	---	---	24	---	---	17	---	---	22	
Sulphate (mg/L)	---	---	6	---	---	6	---	---	5	---	---	4	
Chloride (mg/L)	---	---	10	---	---	14	---	---	8	---	---	9	
Calcium (mg/L)	---	---	2	---	---	2	---	---	1	---	---	2	
Magnesium (mg/L)	---	---	2	---	---	2	---	---	2	---	---	2	
Sodium (mg/L)	---	---	7	---	---	7	---	---	7	---	---	6	
Potassium (mg/L)	---	---	5	---	---	5	---	---	4	---	---	5	
Arsenic (dissolved) (mg/L)	---	---	<0.001	---	---	<0.001	---	---	<0.001	---	---	<0.001	
Cadmium (dissolved) (mg/L)	---	---	<0.0001	---	---	<0.0001	---	---	<0.0001	---	---	<0.0001	
Chromium (dissolved) (mg/L)	---	---	<0.001	---	---	<0.001	---	---	<0.001	---	---	<0.001	
Copper (dissolved) (mg/L)	---	---	<0.001	---	---	<0.001	---	---	<0.001	---	---	<0.001	
Lead (dissolved) (mg/L)	---	---	<0.001	---	---	<0.001	---	---	<0.001	---	---	<0.001	
Nickel (dissolved) (mg/L)	---	---	0.002	---	---	0.002	---	---	0.002	---	---	0.002	
Zinc (dissolved) (mg/L)	---	---	0.022	---	---	0.043	---	---	0.026	---	---	0.041	
Iron (dissolved) (mg/L)	---	---	2.36	---	---	6.1	---	---	5.84	---	---	1.21	

Shaded Cells - Indicates results are outside of the nominated Trigger Level.

--- Indicates no sampling required

Water Level trigger is exceeded if the AHD water level drops below the nominated trigger level.

Table 24 *Groundwater Monitoring Bore - EP PDH3/GW Results January - December 2018*

Location	Enhance Place Bore EP PDH3/GW												
Sample Number	01186880011	02186880013	03186880011	04186880011	05186880013	06186880011	07186880011	08186880013	09186880011	10186880011	11186880013	12186880011	
Sampling Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Date Sampled	11/01/18	12/02/18	13/03/18	11/04/18	10/05/18	7/06/18	5/07/18	6/08/18	6/09/18	8/10/18	7/11/18	7/12/18	**Trigger Value**
Standing Water Level (m)	23.86	23.86	23.86	23.92	23.94	23.96	24.01	24.04	23.51	24.06	24.40	23.85	
Standpipe Height	0.78	0.78	0.78	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	
Relative Water Level (m)	23.08	23.08	23.08	23.15	23.17	23.19	23.24	23.27	22.74	23.29	23.63	23.08	
Water Level AHD (m)#	892.92	892.92	892.92	892.85	892.83	892.81	892.76	892.73	893.26	892.71	892.37	892.92	**891.06**

Shaded Cells - Indicates results are outside of the nominated Trigger Level.

Water Level trigger is exceeded if the AHD water level drops below the nominated trigger level.

Table 25 *Groundwater Monitoring Bore - EP PDH4/GW Results January – December 2018*

Location	Enhance Place Bore EP PDH4/GW												
Sample Number	01186880012	02186880014	03186880012	04186880012	05186880014	06186880012	07186880012	08186880014	09186880012	10186880012	11186880014	12186880012	
Sampling Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Date Sampled	11/01/18	12/02/18	13/03/18	11/04/18	10/05/18	7/06/18	5/07/18	6/08/18	6/09/18	08/10/18	7/11/18	07/12/18	**Trigger Value**
Standing Water Level (m)	23.31	23.35	23.35	23.38	23.4	23.43	23.46	23.5	24	22.54	23.48	23.32	
Standpipe Height	0.17	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	
Relative Water Level (m)	23.14	23.18	23.18	23.22	23.24	23.27	23.30	23.34	23.84	22.38	23.32	23.16	
Water Level AHD (m)#	892.94	892.90	892.90	892.86	892.84	892.81	892.78	892.74	892.24	893.70	892.76	892.92	**890.95**

Shaded Cells - Indicates results are outside of the nominated Trigger Level.

Water Level trigger is exceeded if the AHD water level drops below the nominated trigger level.

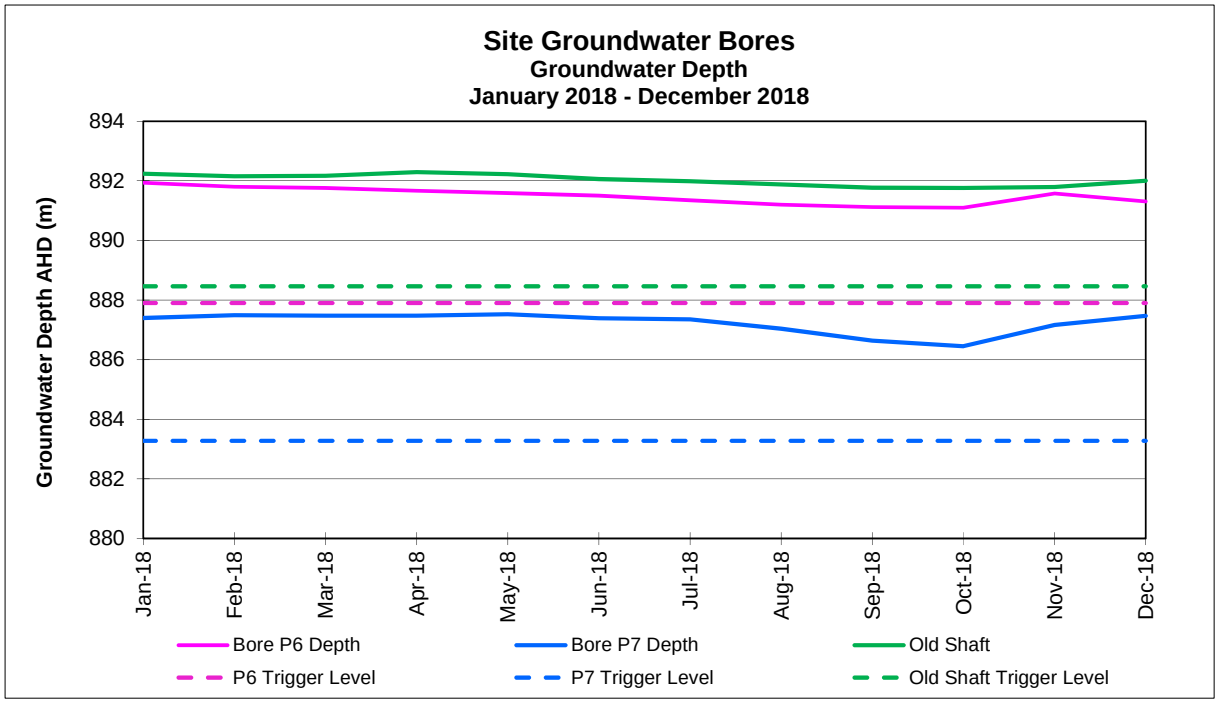

Figure 4 *Onsite Groundwater Standing Water Level 2018*

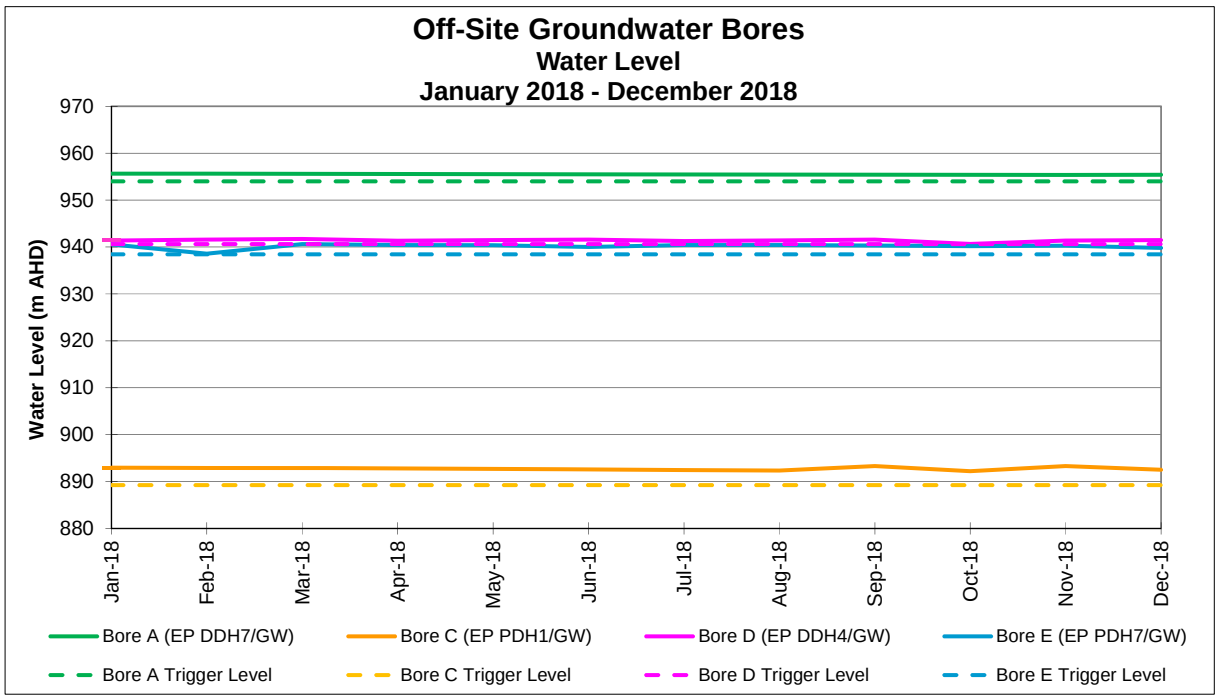

Figure 5 *Off-Site Groundwater Standing Water Level 2018*

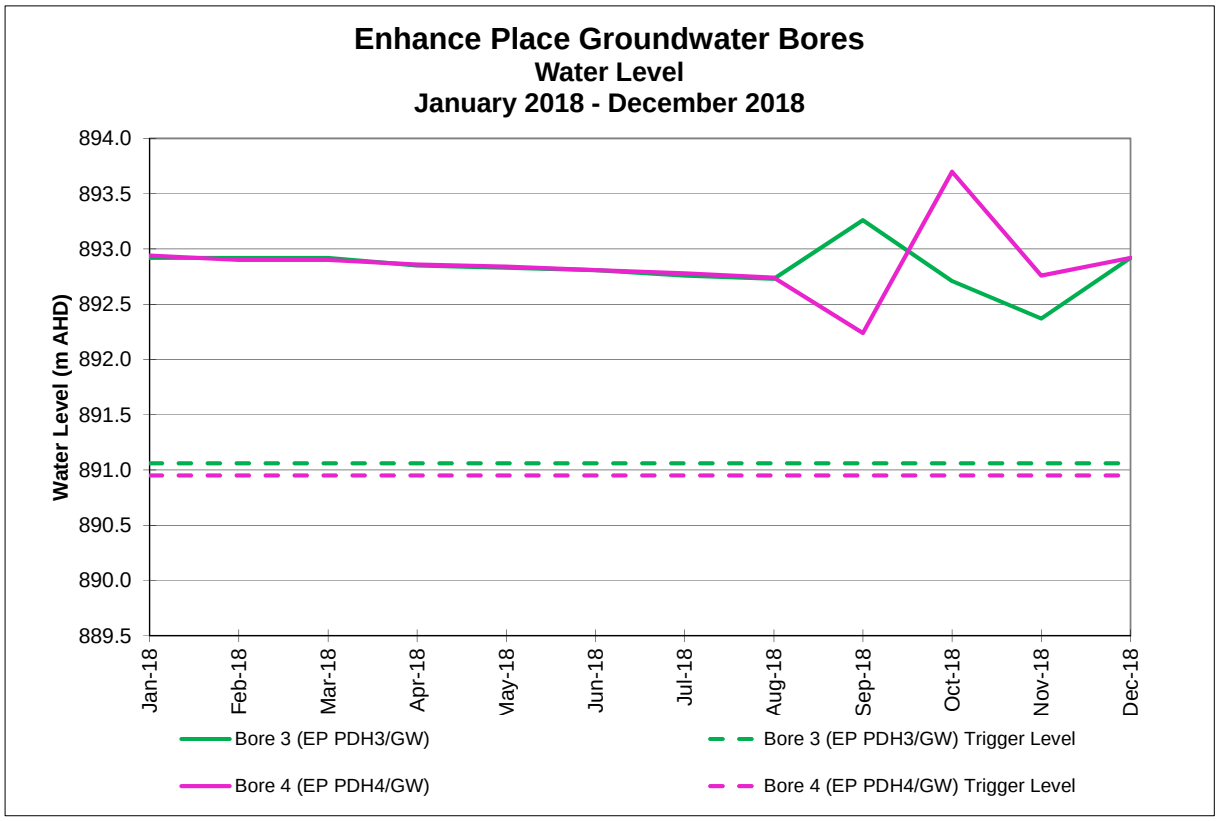

Figure 6 *Enhance Place Groundwater Standing Water Level 2018*

4.3 REVIEW & INTERPRETATION OF GROUND WATER MONITORING

4.3.1 SITE GROUNDWATER BORES

Groundwater monitoring is conducted on a monthly frequency at the on-site groundwater bores.

Groundwater samples collected from the on-site groundwater bores (P6, P7 and Old Shaft) during the January – December 2018 period generally show water quality results which are consistent throughout the monitoring period. There were no instances during the 2018 monitoring period where the standing water level dropped below their respective water level triggers. A slight decreasing trend in standing water level was observed at both P6 and Old Shaft during 2018. P7 also reported a slight decreasing trend in standing water level until October 2018 following which the subsequent two (2) monitoring events reported an increasing trend in standing water level.

The pH within the site bores were shown to generally be below the site specific lower pH trigger value. The pH was shown to be below the site specific lower pH trigger value during seven (7) of the twelve (12) monitoring events at groundwater bores P6 and P7; twelve (12) of the twelve (12) monitoring events at groundwater bore Old Shaft and six (6) of the eleven (11) monitoring events at The Bong. During 2018 there were no instances where the upper pH trigger levels (8.0 pH units) was exceeded at any of the on-site groundwater bores. No sample could be collected from The Bong during the June 2018 monitoring round as the sampling location was dry.

The electrical conductivity levels at the site bores have also intermittently exceeded their respective conductivity trigger values throughout the January – December 2018 monitoring period with the exception of the Bong which was compliant throughout the year. Bore P6

exceeded the conductivity trigger value during eleven (11) of the twelve (12) monitoring events; a maximum concentration of 1690μS/cm was recorded in September 2018. Bore P7 exceeded its site specific trigger value during two (2) of the twelve (12) monitoring events, with the greatest concentration (871μS/cm) observed in February 2018. The Old Shaft exceeded the trigger value during all instances of monitoring; the maximum concentration was 1610μS/cm during September 2018.

4.3.1.1 REVIEW OF SITE SPECIFIC TRIGGER VALUES

The current approved site specific trigger values detailed in the Water Management Plan (Ref [3]) and **Table 15** are derived from monitoring data collected in the period January 2011 – December 2014. Electrical conductivity and pH was shown to intermittently exceed the site specific trigger values during the 2017 monitoring period. It was considered that the exceedances may be attributed to the below average rainfall observed during 2017. In 2017, Enhance Place Pty Ltd undertook a scheduled review of the groundwater monitoring data in accordance with the Water Management Plan (Ref [3]). During the review it was noted that the approved trigger values are based on four years of data from 2011 – 2014. Enhance Place Pty Ltd proposed that the entire monitoring data set should be utilised in the derivation of the trigger values, which includes up to 12 years of data (2005 – 2017) for some monitoring locations. The rationale for including all available data was that it provided robust data sets which were more representative of site conditions including varying climatic influences. Revised trigger values based on all available monitoring data were derived and submitted to the Department of Industries (DPI) – Water for approval. In March 2018, DPI – Water rejected the request to revise the trigger values and recommended an investigation to be undertaken to determine the cause of the exceedances as a basis for the revision of the trigger values.

An investigation was undertaken by an external consultant (GHD). The findings of the investigation indicated that the likely cause of the decreasing pH trend observed in bore P6 and Old Shaft was likely to due to acid mine drainage. A decrease in groundwater levels at P6 and Old Shaft was observed from early 2010, with groundwater levels recovering in 2012. The increasing groundwater level interacted with exposed pyrite, generating acid. Increasing trends in dissolved cobalt, manganese, iron, nickel and zinc at Old Shaft and dissolved iron at P6 commenced in conjunction with recovering water levels in 2012 (Ref [11]). Revised site specified trigger values were also provided. The findings of the report and the revised trigger values have been submitted to DPI – Water for review. No response has been received at the time of writing this report; therefore, the accepted trigger values as detailed in the Water Management Plan (Ref [3]) have been used.

4.3.2 OFF-SITE GROUNDWATER BORES

Standing water level measurements are undertaken at a monthly frequency at the off-site groundwater bores and water quality monitoring at a quarterly frequency. Due to insufficient water within bore D, samples could only be collected on two (2) occasions during 2018. The results of water quality monitoring within the off-site groundwater bores are generally shown to be compliant with their respective water quality trigger values. Groundwater samples collected from off-site bores are shown to be compliant with the respective pH trigger values with the exception of the following:

- Bore C was below the lower pH trigger value during four (4) of the four (4) water quality monitoring events.

- Bore D was below the lower pH trigger value during one (1) of the two (2) water quality monitoring events, this occurred in March 2018.
- Bore E was below the lower pH trigger value during one (1) of the four (4) water quality monitoring events, this occurred in March 2018.

Electrical conductivity levels were below the respective conductivity trigger levels for all off-site bores during the 2018 monitoring period.

All off-site bores exhibited standing water levels which were consistent throughout the 2018 monitoring period and compliant with their respective trigger levels.

4.3.3 ENHANCE PLACE GROUNDWATER BORES

Standing water level measurements at the two (2) monitoring bores located at the former Enhance Place are required to be measured on a monthly frequency. During 2018, the standing water level was generally shown to be decreasing at both bore 3 (EP PDH3/GW) and bore 4 (EP PDH4/GW). Fluctuations in standing water level are observed during the period September – November 2018; however the water level remains above the water trigger level value at both bores.

5 SURFACE WATER QUALITY MONITORING

5.1 SURFACE WATER ASSESSMENT CRITERIA

The purpose of surface water monitoring is to ensure that any impact of the mining operations on the surface water bodies / streams can be identified, and to show compliance with relevant legislative requirements. Site specific trigger values for water quality parameters pH and electrical conductivity were developed for Pine Dale Mine as stipulated in the PDM Water Management Plan (Ref [3]) in accordance with Schedule 3, Condition 27(c) of the Project Approval (Pa 10_0041). Trigger values for oil and grease and total suspended solids are not site specific and are uniform across all surface water sites. Surface water assessment criteria are presented in **Table 26** (Ref [3])**.**

Table 26 *Surface Water Assessment Criteria*

Surface Water Site	pH (range)	Electrical Conductivity (µS/cm)	Total Suspended Solids (mg/L)	Oil and Grease (mg/L)
S1	6.2 – 8.0	2325	30	10
S2	NA	NA	NA	NA
S3	6.4 – 8.0	2223	30	10
S4	7.3 – 8.0	957	30	10
S5	7.0 – 8.0	1013	30	10
S6	6.7 – 8.0	1941	30	10
S7	6.8 – 8.0	1007	30	10
EPA Point 2	7.1 – 8.0	2055	30	NA
EPA Point 3	6.4 – 8.0	2223	30	NA
EPA Point 13	6.5 – 8.0^	NA	30^	10
EPA Point 14	7.5 – 8.0	1166	30	NA

NA – no trigger value required for these locations.

^refers to maximum concentration limits applicable during discharge events as detailed in EPL 4911 section L2.

5.2 SURFACE WATER MONITORING DATA SUMMARY

Surface water monitoring for the Pine Dale Mine is undertaken in accordance with the Water Management Plan (Ref [3]) and Environmental Protection Licence EPL 4911 (Ref [1]). Surface water sampling is undertaken at twelve monitoring locations within and surrounding the mine site (refer **Drawing 1**, **Appendix 1**.).

During the period January to December 2018, monitoring was undertaken on a monthly and quarterly basis for routine samples associated with the Water Management Plan (Ref [3]) and EPL.

No samples were collected at EPL Point 13 (discharge to concrete lined section of Neubeck's creek), as there was no discharge from the mine during the 2018 monitoring period.

Surface water summary results for the period January – December 2018 are shown in **Tables 27** to **37**. Graphical presentations are shown in **Figures 7** to **11**.

Table 27 *Surface Water Monitoring Location EPL Point 2 Results 2018*

Location	EPL Point 2				
Sample No	02186880009	05186880009	08186880009	11186880009	**Trigger Values**
Sampling Month	Feb	May	Aug	Nov	
Date Sampled	12/02/2018	10/05/2018	7/08/2018	8/11/2018	
Time Sampled	14:27	16:15	07:29	11:47	
pH (pH units)	6.76	6.92	6.53	7.22	**7.1 – 8.0**
Conductivity (µS/cm)	1820	3700	1090	130	**2055**
Sulphate (mg/L)	688	1140	373	482	
Iron filterable (mg/L)	0.15	0.63	0.06	0.07	
TSS (mg/L)	9	<5	<5	<5	**30**
Turbidity (NTU)	21	7	<1	<1	

Shaded Cells - Indicates results are outside of the nominated Trigger Value

Table 28 *Surface Water Monitoring Location EPL Point 3 Results 2018*

Location	EPL Point 3				
Sample No	02186880004	05186880004	08186880004	11186880004	**Trigger Values**
Sampling Month	Feb	May	Aug	Nov	
Date Sampled	12/02/2018	10/05/2018	7/08/2018	8/11/2018	
Time Sampled	12:13	14:50	07:48	11:15	
pH (pH units)	6.94	7.56	6.97	7.55	**6.4 – 8.0**
Conductivity (µS/cm)	902	6260	1310	121	**2223**
Sulphate (mg/L)	326	2700	526	465	
Iron filterable (mg/L)	0.73	0.26	0.34	0.14	
TSS (mg/L)	<5	<5	6	6	**30**
Turbidity (NTU)	3	4	2	<1	

Shaded Cells - Indicates results are outside of the nominated Trigger Value

Table 29 *Surface Water Monitoring Location EPL Point 14 Results 2018*

Location	EPL Point 14				
Sample No	02186880010	05186880010	08186880010	11186880010	**Trigger Values**
Sampling Month	Feb	May	Aug	Nov	
Date Sampled	12/02/2018	10/05/2018	6/08/2018	7/11/2018	
Time Sampled	10:52	09:35	16:20	13:30	
pH (pH units)	8.70	8.67	8.21	8.69	**7.5 – 8.0**
Conductivity (µS/cm)	1350	1300	1340	113	**1166**
Sulphate (mg/L)	44	105	144	57	
Iron filterable (mg/L)	<0.05	<0.05	<0.05	<0.05	
TSS (mg/L)	<5	12	5	7	**30**
Turbidity (NTU)	7	12	22	20	

Shaded Cells - Indicates results are outside of the nominated Trigger Value

Table 30 *Surface Water Monitoring Location S1 Results 2018*

Location	Surface Water S1												
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Trigger Values**
Sample Number	01186880002	02186880002	03186880002	04186880002	05186880002	06186880002	07186880002	08186880002	09186880002	10186880002	11186880002	12186880002	
Date Sampled	12/01/18	12/02/18	14/03/18	11/04/18	10/05/18	7/06/18	5/07/18	7/08/18	7/09/18	8/10/18	8/11/18	7/12/18	
Time Sampled	9:52	14:21	8:00	16:10	16:10	13:50	9:04	7:35	9:48	18:12	11:37	8:40	
Temperature (°C)	20.0	23.3	17.4	22.1	12.0	12.0	8.4	5.2	10.9	15.0	16.0	15.6	
pH	6.95	7.37	7.12	7.15	7.36	6.99	7.29	6.76	6.77	6.89	7.02	7.66	**6.2 – 8.0**
Conductivity (µS/cm)	2540	3000	5540	6690	6720	5670	6410	1300	1390	952	138	1220	**2325**
TSS (mg/L)	---	<5	---	---	<5	---	---	11	---	---	<5	---	**30**
Oil & Grease (mg/L)	---	<5	---	---	<5	---	---	<5	---	---	<5	---	**10**
Turbidity (NTU)	4	11	<1	<1	4	8	13	3	18	4	<1	11	
Dissolved Oxygen (mg/L)	---	7.9	---	---	8.0	---	---	8.0	---	---	6.0	---	
Bicarbonate Alkalinity (mg/L)	---	89	---	---	78	---	---	45	---	---	77	---	
Total Alkalinity (mg/L)	---	89	---	---	78	---	---	45	---	---	77	---	
Sulphate (mg/L)	---	1210	---	---	2940	---	---	527	---	---	555	---	
Chloride (mg/L)	---	204	---	---	540	---	---	70	---	---	87	---	
Calcium (mg/L)	---	151	---	---	276	---	---	79	---	---	84	---	
Magnesium (mg/L)	---	115	---	---	222	---	---	55	---	---	57	---	
Sodium (mg/L)	---	321	---	---	827	---	---	126	---	---	132	---	
Potassium (mg/L)	---	19	---	---	61	---	---	11	---	---	10	---	
Cobalt (dissolved) (mg/L)	---	0.01	---	---	0.029	---	---	0.002	---	---	0.002	---	
Manganese(dissolved) (mg/L)	---	3.75	---	---	1.89	---	---	0.754	---	---	0.861	---	
Nickel (dissolved) (mg/L)	---	0.105	---	---	0.345	---	---	0.037	---	---	0.046	---	
Zinc (dissolved) (mg/L)	---	0.027	---	---	0.077	---	---	0.014	---	---	0.008	---	
Iron (dissolved) (mg/L)	---	<0.05	---	---	0.10	---	---	0.11	---	---	0.09	---	

Shaded Cells - Indicates results are outside of the nominated Trigger Value.

--- Indicates no sampling required during particular period.

Table 31 *Surface Water Monitoring Location S2 Results 2018*

Location	Surface Water Site S2											
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Sample Number	01186880003	02186880003	03186880003	04186880003	05186880003	06186880003	07186880003	08186880003	09186880003	10186880003	11186880003	12186880003
Date Sampled	12/01/18	12/02/18	14/03/18	11/04/18	10/05/18	7/06/18	5/07/18	7/08/18	7/09/18	8/10/18	8/11/18	6/12/18
Time Sampled	9:46	12:19	7:55	14:54	14:55	10:30	13:55	7:50	7:30	11:20	11:20	16:49
Depth to Surface from Top of Rail Bridge (m)	3.75	3.77	3.76	3.73	3.74	3.73	3.71	3.75	3.65	3.73	3.74	3.74

Table 32 *Surface Water Monitoring Location S3 Results 2018*

Location	Surface Water S3												
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Trigger Values**
Sample Number	01186880004	02186880004	03186880004	04186880004	05186880004	06186880004	07186880004	08186880004	09186880004	10186880004	11186880004	12186880004	
Date Sampled	12/01/18	12/02/18	14/03/18	11/04/18	10/05/18	7/06/18	5/07/18	7/08/18	7/09/18	8/10/18	8/11/18	6/12/18	
Time Sampled	9:40	12:13	7:51	17:33	14:50	10:25	14:05	7:48	10:59	18:20	11:15	9:50	
Temperature (°C)	21.0	23.1	17.3	20.7	12.0	11.0	13.4	5.2	11.4	14.5	17.0	17.4	
pH	7.12	6.94	7.13	7.27	7.56	7.13	7.03	6.97	7.01	7.11	7.55	7.09	**6.4 – 8.0**
Conductivity (µS/cm)	2030	902	5010	6390	6260	5400	5690	1310	1280	916	121	1050	**2223**
TSS (mg/L)	---	<5	---	---	<5	---	---	6	---	---	6	---	**30**
Oil & Grease (mg/L)	---	<5	---	---	6	---	---	<5	---	---	<5	---	**10**
Turbidity (NTU)	4	3	1	1	4	3	5	2	35	21	<1	20	
Dissolved Oxygen (mg/L)	---	7.1	---	---	8.0	---	---	10.0	---	---	7.0		
Bicarbonate Alkalinity (mg/L)	---	12	---	---	67	---	---	77	---	---	69		
Total Alkalinity (mg/L)	---	12	---	---	67	---	---	77	---	---	69		
Sulphate (mg/L)	---	326	---	---	2700	---	---	526	---	---	465		
Chloride (mg/L)	---	48	---	---	502	---	---	70	---	---	71		
Calcium (mg/L)	---	48	---	---	253	---	---	76	---	---	74		
Magnesium (mg/L)	---	32	---	---	202	---	---	54	---	---	47		
Sodium (mg/L)	---	76	---	---	745	---	---	123	---	---	111		
Potassium (mg/L)	---	6	---	---	54	---	---	11	---	---	8		
Cobalt (dissolved) (mg/L)	---	0.014	---	---	0.026	---	---	0.004	---	---	0.005		
Manganese(dissolved) (mg/L)	---	2.51	---	---	1.74	---	---	0.962	---	---	1.18		
Nickel (dissolved) (mg/L)	---	0.046	---	---	0.313	---	---	0.045	---	---	0.041		
Zinc (dissolved) (mg/L)	---	0.059	---	---	0.066	---	---	0.026	---	---	0.016		
Iron (dissolved) (mg/L)	---	0.73	---	---	0.26	---	---	0.34	---	---	0.14		

Shaded Cells - Indicates results are outside of the nominated Trigger Value.

--- Indicates no sampling required during particular period.

Table 33 *Surface Water Monitoring Location S4 Results 2018*

Location	Surface Water S4												
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Trigger Values**
Sample Number	01186880005	02186880005	03186880005	04186880005	05186880005	06186880005	07186880005	08186880005	09186880005	10186880005	11186880005	12186880005	
Date Sampled	12/01/18	12/02/18	14/03/18	11/04/18	10/05/18	7/06/18	5/07/18	7/08/18	7/09/18	9/10/18	8/11/18	6/12/18	
Time Sampled	10:33	15:45	9:55	17:12	17:15	11:30	11:50	10:40	10:40	8:02	14:55	9:25	
Temperature (°C)	23.0	27.1	17.5	21.4	10.0	8.9	13.3	5.7	11.3	11.3	20.0	16.0	
pH	7.98	8.41	8.13	8.41	8.33	8.16	8.13	7.97	7.73	8.01	8.13	7.92	**7.3 – 8.0**
Conductivity (µS/cm)	909	1110	889	945	940	958	844	810	581	550	352	297	**957**
TSS (mg/L)	---	<5	---	---	<5	---	---	<5	---	---	6	---	**30**
Oil & Grease (mg/L)	---	<5	---	---	<5	---	---	<5	---	---	<5	---	**10**
Turbidity (NTU)	20	19	15	10	6	4	7	18	25	23	2	15	
Dissolved Oxygen (mg/L)	---	5.8	---	---	9.0	---	---	9.0	---	---	7.0	---	
Bicarbonate Alkalinity (mg/L)	---	580	---	---	532	---	---	466	---	---	160	---	
Total Alkalinity (mg/L)	---	600	---	---	551	---	---	466	---	---	160	---	
Sulphate (mg/L)	---	5	---	---	16	---	---	23	---	---	2	---	
Chloride (mg/L)	---	4	---	---	8	---	---	13	---	---	2	---	
Calcium (mg/L)	---	19	---	---	17	---	---	15	---	---	11	---	
Magnesium (mg/L)	---	18	---	---	16	---	---	16	---	---	6	---	
Sodium (mg/L)	---	193	---	---	181	---	---	151	---	---	54	---	
Potassium (mg/L)	---	35	---	---	31	---	---	29	---	---	11	---	
Cobalt (dissolved) (mg/L)	---	<0.001	---	---	<0.001	---	---	<0.001	---	---	<0.001	---	
Manganese(dissolved) (mg/L)	---	0.006	---	---	0.009	---	---	0.017	---	---	0.014	---	
Nickel (dissolved) (mg/L)	---	0.002	---	---	0.002	---	---	0.003	---	---	<0.001	---	
Zinc (dissolved) (mg/L)	---	<0.005	---	---	<0.005	---	---	0.006	---	---	<0.005	---	
Iron (dissolved) (mg/L)	---	0.25	---	---	0.15	---	---	0.36	---	---	0.68	---	

Shaded Cells - Indicates results are outside of the nominated Trigger Value.

--- Indicates no sampling required during particular period.

Table 34 *Surface Water Monitoring Location S5 Results 2018*

Location	Surface Water S5												
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Trigger Values**
Sample Number	01186880006	02186880006	03186880006	04186880006	05186880006	06186880006	07186880006	08186880006	09186880006	10186880006	11186880006	12186880006	
Date Sampled	12/01/18	12/02/18	14/03/18	11/04/18	10/05/18	7/06/18	5/07/18	7/08/18	7/09/18	9/10/18	8/11/18	6/12/18	
Time Sampled	10:30	15:50	9:50	17:16	17:10	11:35	12:05	10:35	10:38	8:08	14:50	9:30	
Temperature (°C)	26.0	27.1	19.2	22.6	11.5	11.4	14.4	7.6	12.8	12.9	20.0	19.5	
pH	7.49	7.70	7.24	6.99	6.94	7.25	7.32	7.30	7.59	7.62	7.40	7.41	**7.0 – 8.0**
Conductivity (µS/cm)	1630	1740	1680	2170	2590	2490	2330	2320	1580	1250	866	1120	**1013**
TSS (mg/L)	---	<5	---	---	<5	---	---	7	---	---	<5	---	**30**
Oil & Grease (mg/L)	---	<5	---	---	<5	---	---	<5	---	---	<5	---	**10**
Turbidity (NTU)	2	2	3	9	35	22	19	14	18	12	<1	10	
Dissolved Oxygen (mg/L)	---	6.6	---	---	6.0	---	---	9.0	---	---	7.0		
Bicarbonate Alkalinity (mg/L)	---	180	---	---	105	---	---	193	---	---	154		
Total Alkalinity (mg/L)	---	180	---	---	105	---	---	193	---	---	154		
Sulphate (mg/L)	---	516	---	---	832	---	---	891	---	---	262		
Chloride (mg/L)	---	66	---	---	160	---	---	150	---	---	35		
Calcium (mg/L)	---	90	---	---	126	---	---	118	---	---	41		
Magnesium (mg/L)	---	62	---	---	89	---	---	81	---	---	26		
Sodium (mg/L)	---	173	---	---	258	---	---	275	---	---	97		
Potassium (mg/L)	---	23	---	---	26	---	---	30	---	---	14		
Cobalt (dissolved) (mg/L)	---	0.012	---	---	0.038	---	---	0.023	---	---	0.006		
Manganese(dissolved) (mg/L)	---	1.32	---	---	2.26	---	---	1.42	---	---	0.477		
Nickel (dissolved) (mg/L)	---	0.088	---	---	0.163	---	---	0.137	---	---	0.036		
Zinc (dissolved) (mg/L)	---	0.05	---	---	0.102	---	---	0.058	---	---	0.018		
Iron (dissolved) (mg/L)	---	<0.05	---	---	<0.05	---	---	<0.05	---	---	0.45		

Shaded Cells - Indicates results are outside of the nominated Trigger Value.

--- Indicates no sampling required during particular period.

Table 35 *Surface Water Monitoring Location S6 Results 2018*

Location	Surface Water S6												
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Trigger Values**
Sample Number	01186880007	02186880007	03186880007	04186880007	05186880007	06186880007	07186880007	08186880007	09186880007	10186880007	11186880007	01186880007	
Date Sampled	12/01/18	12/02/18	14/03/18	11/04/18	10/05/18	7/06/18	5/07/18	7/08/18	7/09/18	9/10/18	8/11/18	12/01/18	
Time Sampled	10:30	16:00	9:45	17:04	17:05	7/06/2018	11:45	10:30	10:34	7:57	14:57	10:30	
Temperature (°C)	24.0	32.5	17.4	22.1	11.0	11.3	10.2	6.6	11.8	11.4	20.0	24.0	
pH	7.41	8.27	7.45	7.65	7.60	7.46	7.52	7.15	7.26	7.50	7.62	7.41	**6.7 – 8.0**
Conductivity (µS/cm)	1630	2720	4140	6370	6200	5420	6140	1360	95	841	106	1630	**1941**
TSS (mg/L)	---	<5	---	---	<5	---	---	6	---	---	<5	---	**30**
Oil & Grease (mg/L)	---	<5	---	---	<5	---	---	<5	---	---	<5	---	**10**
Turbidity (NTU)	18	22	<1	<1	2	2	3	2	38	5	<1	2	
Dissolved Oxygen (mg/L)	---	7.9	---	---	7.0	---	---	11.0	---	---	8.0	---	
Bicarbonate Alkalinity (mg/L)	---	66	---	---	69	---	---	37	---	---	52	---	
Total Alkalinity (mg/L)	---	66	---	---	69	---	---	37	---	---	52	---	
Sulphate (mg/L)	---	944	---	---	2700	---	---	574	---	---	435	---	
Chloride (mg/L)	---	174	---	---	498	---	---	108	---	---	64	---	
Calcium (mg/L)	---	133	---	---	253	---	---	79	---	---	66	---	
Magnesium (mg/L)	---	96	---	---	201	---	---	56	---	---	40	---	
Sodium (mg/L)	---	300	---	---	746	---	---	138	---	---	94	---	
Potassium (mg/L)	---	23	---	---	54	---	---	13	---	---	8	---	
Cobalt (dissolved) (mg/L)	---	<0.001	---	---	0.015	---	---	0.004	---	---	<0.001	---	
Manganese(dissolved) (mg/L)	---	0.128	---	---	1.11	---	---	0.661	---	---	0.098	---	
Nickel (dissolved) (mg/L)	---	0.073	---	---	0.285	---	---	0.054	---	---	0.027	---	
Zinc (dissolved) (mg/L)	---	<0.005	---	---	0.043	---	---	0.029	---	---	<0.005	---	
Iron (dissolved) (mg/L)	---	<0.05	---	---	<0.05	---	---	<0.05	---	---	<0.05	---	

Shaded Cells - Indicates results are outside of the nominated Trigger Value.

--- Indicates no sampling required during particular period.

Table 36 *Surface Water Monitoring Location S7 Results 2018*

Location	Surface Water S7												
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Trigger Values**
Sample Number	01186880008	02186880008	03186880008	04186880008	05186880008	06186880008	07186880008	08186880008	09186880008	10186880008	11186880008	12186880007	
Date Sampled	12/01/18	12/02/18	14/03/18	11/04/18	10/05/18	7/06/18	5/07/18	7/08/18	7/09/18	9/10/18	8/11/18	7/12/18	
Time Sampled	10:45	15:28	10:45	16:50	17:20	11:15	11:24	10:17	10:27	7:44	15:08	9:06	
Temperature (°C)	24.0	28.1	19.5	21.2	11.0	11.0	9.2	7.9	13.0	13.4	19.0	19.0	
pH	7.54	7.62	7.35	7.04	7.22	7.03	7.05	6.99	7.32	7.41	7.58	7.23	**6.8 – 8.0**
Conductivity (µS/cm)	1610	1800	1723	2150	2540	2470	2410	2360	1790	1310	848	1060	**1007**
TSS (mg/L)	---	<5	---	---	5	---	---	8	---	---	<5	---	**30**
Oil & Grease (mg/L)	---	<5	---	---	<5	---	---	<5	---	---	<5	---	**10**
Turbidity (NTU)	2	2	<1	2	7	9	9	9	2	10	<1	8	
Dissolved Oxygen (mg/L)	---	4.8	---	---	7.0	---	---	10.0	---	---	6.0	---	
Bicarbonate Alkalinity (mg/L)	---	183	---	---	111	---	---	182	---	---	162	---	
Total Alkalinity (mg/L)	---	183	---	---	111	---	---	182	---	---	162	---	
Sulphate (mg/L)	---	525	---	---	805	---	---	938	---	---	233	---	
Chloride (mg/L)	---	70	---	---	155	---	---	154	---	---	34	---	
Calcium (mg/L)	---	95	---	---	123	---	---	123	---	---	40	---	
Magnesium (mg/L)	---	65	---	---	87	---	---	83	---	---	25	---	
Sodium (mg/L)	---	182	---	---	248	---	---	277	---	---	97	---	
Potassium (mg/L)	---	24	---	---	25	---	---	30	---	---	15	---	
Cobalt (dissolved) (mg/L)	---	0.002	---	---	0.01	---	---	0.015	---	---	0.004	---	
Manganese(dissolved) (mg/L)	---	0.688	---	---	1.57	---	---	1.12	---	---	0.686	---	
Nickel (dissolved) (mg/L)	---	0.049	---	---	0.139	---	---	0.129	---	---	0.033	---	
Zinc (dissolved) (mg/L)	---	<0.005	---	---	0.029	---	---	0.026	---	---	0.006	---	
Iron (dissolved) (mg/L)	---	0.05	---	---	0.09	---	---	0.08	---	---	0.39	---	

Shaded Cells - Indicates results are outside of the nominated Trigger Value.

--- Indicates no sampling required during particular period.

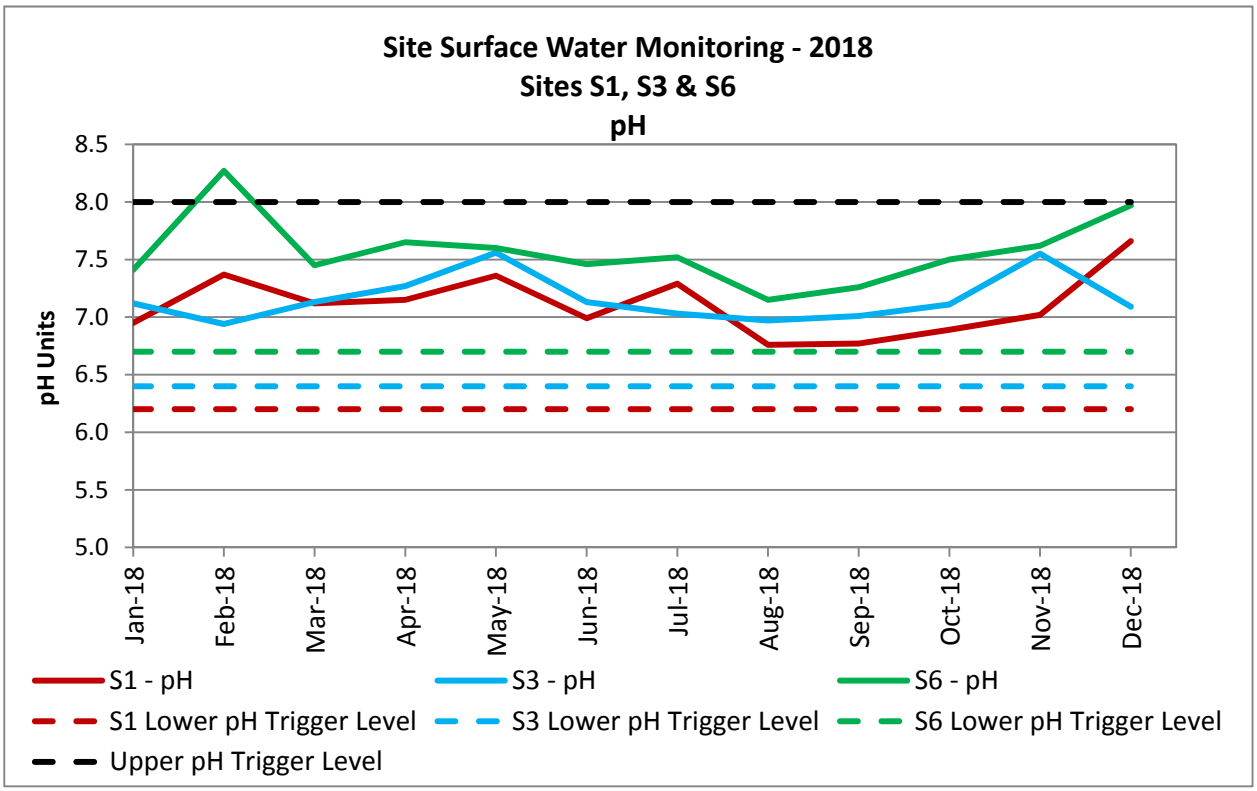

Figure 7 *Site Surface Water S1, S3 & S6 pH Results 2018*

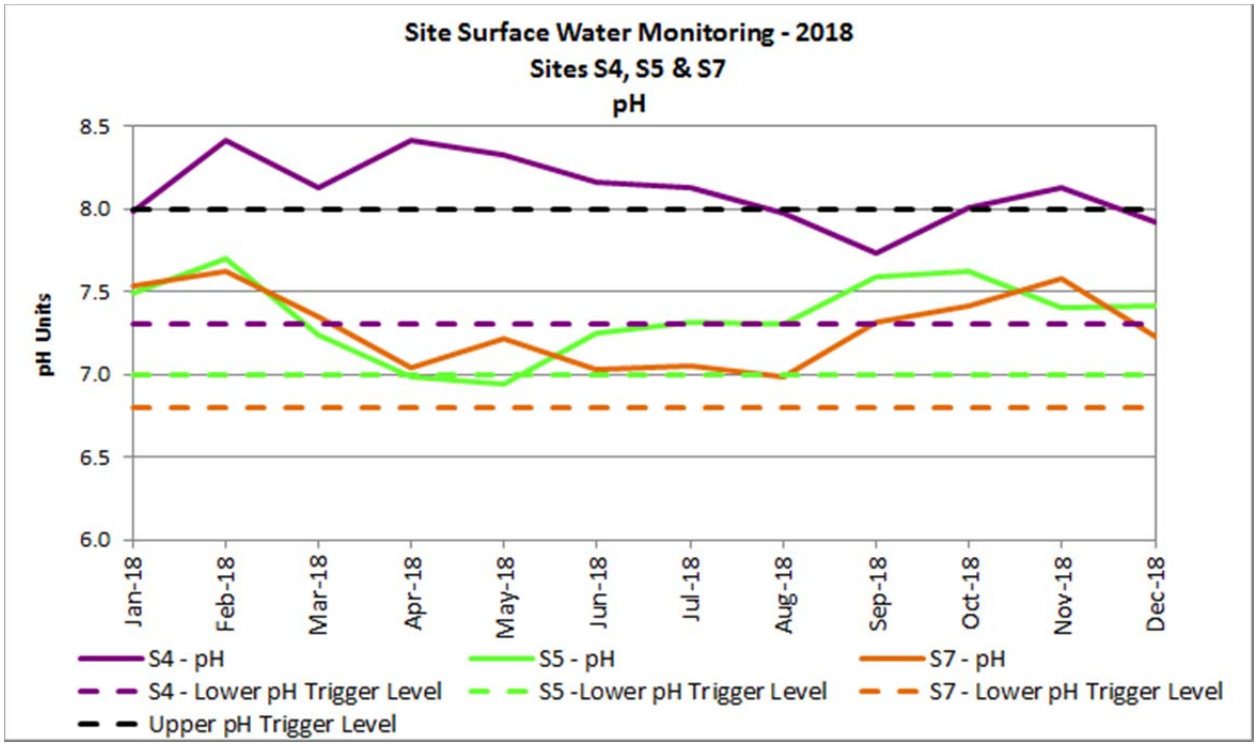

Figure 8 *Site Surface Water S4, S5 & S7 pH Results 2018*

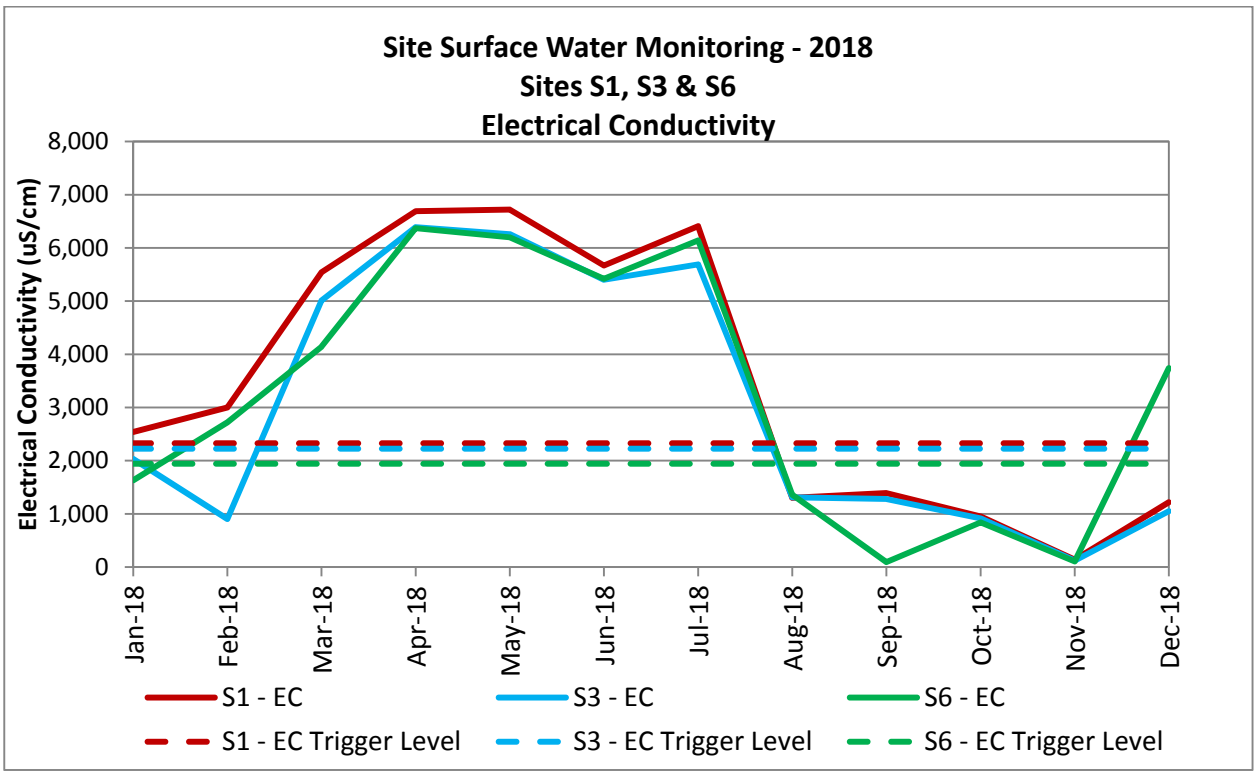

Figure 9 *Site Surface Water S1, S3 & S6 Electrical Conductivity Results 2018*

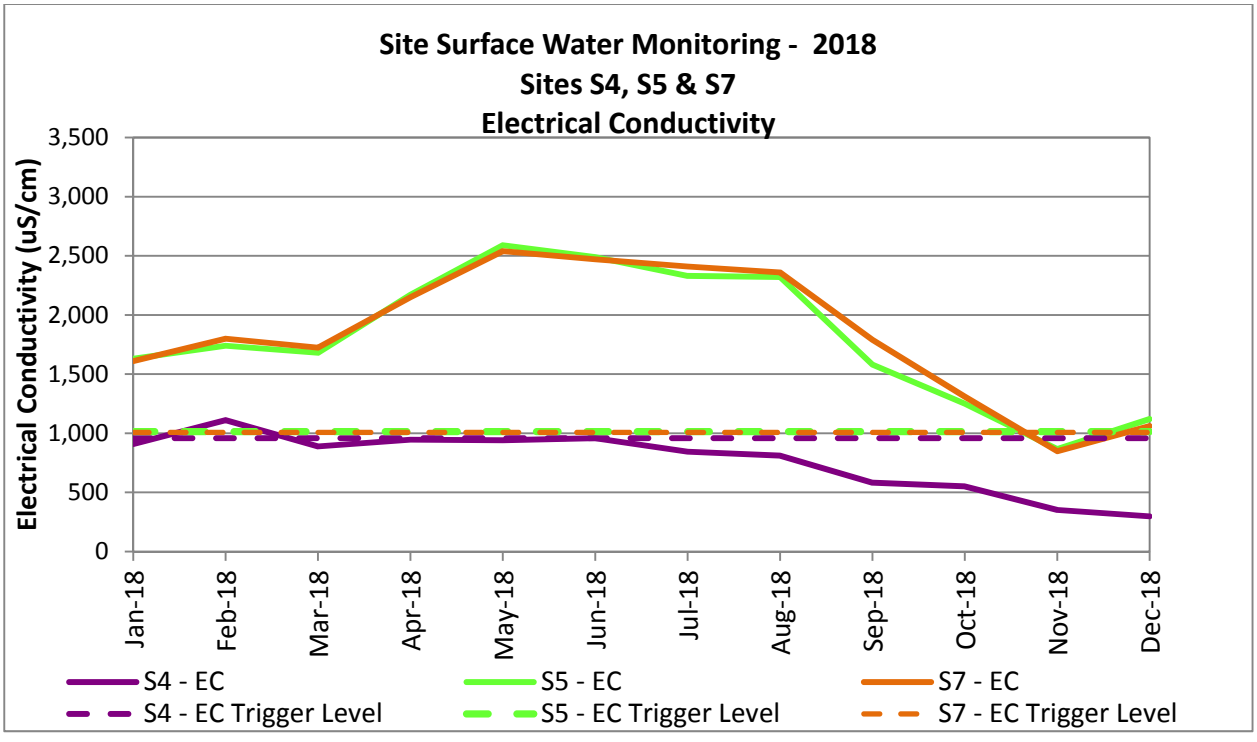

Figure 10 *Site Surface Water S4, S5 & S7 Electrical Conductivity Results 2018*

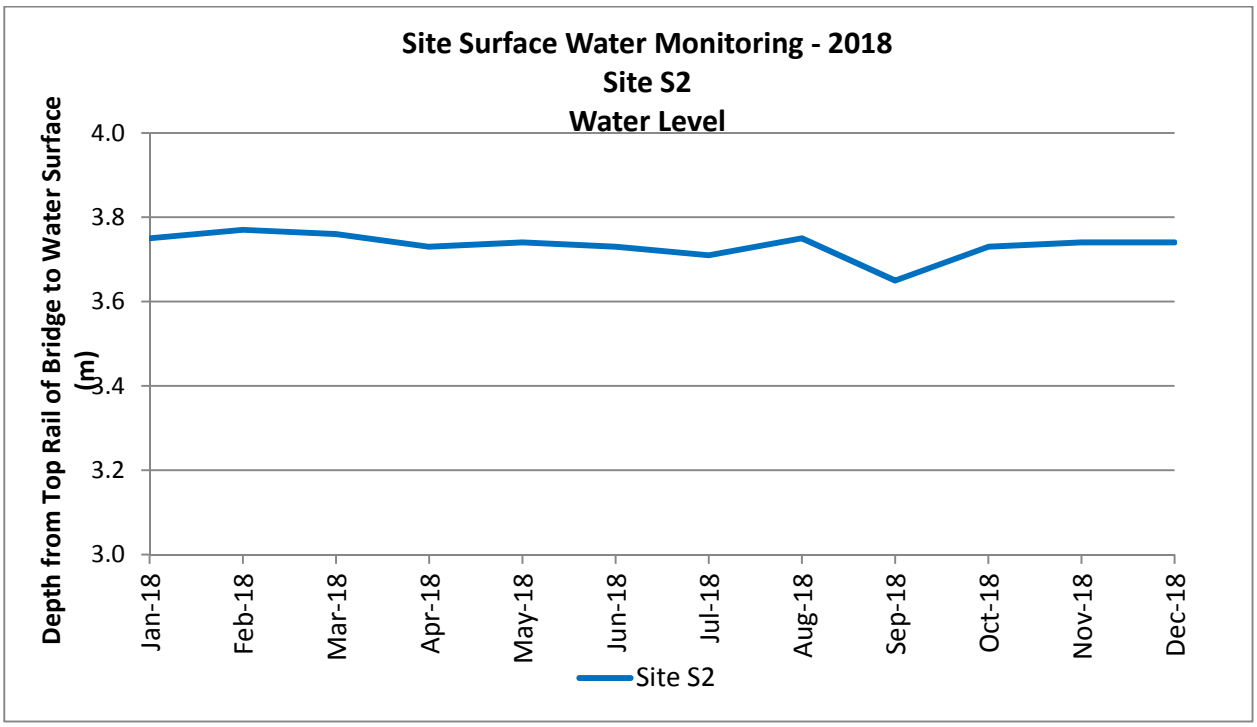

Figure 11 *Site Surface Water S2 – 2018 Water Level*

5.3 REVIEW & INTERPRETATION OF SURFACE WATER MONITORING RESULTS

5.3.1 EPL SURFACE WATER

Surface water monitoring is required to be undertaken at four (4) surface water monitoring locations as detailed in EPL 4911. These monitoring points are:

- EPA Point 2: ambient water monitoring point.
- EPA Point 3: ambient water monitoring point.
- EPA Point 14: ambient water monitoring point.
- EPA Point 13: discharge quality monitoring point.

Water quality monitoring is required to be undertaken at EPA Point 13 weekly during discharge, there were no discharge events during the 2018 monitoring period. No sampling or analysis was undertaken at EPA Point 13 during the 2018 monitoring period. Water quality monitoring is required to be undertaken at EPA Point 2, 3 and 14 for pH, electrical conductivity and turbidity, weekly during discharge events at EPA Point 13. EPL 4911 stipulates maximum concentrations limits applicable to EPA Point 13 discharge events as detailed in **Table 26**. No concentration limits are detailed in EPL 4911 for EPA Points 2, 3 and 14.

The PDM Water Management Plan (Ref [3]) stipulates monitoring of EPA Point 2, 3, 14 is to be undertaken on a quarterly basis for pH, electrical conductivity, turbidity, total suspended solids, sulfate and filterable (dissolved) iron. Trigger values for these quarterly monitoring events are detailed in the Water Management Plan (Ref [3]); however, compliance with these trigger values are not an EPL requirement.

During the 2018 monitoring period, four (4) quarterly surface water monitoring events were conducted at EPA Point 2, 3 and 14. These events were conducted during February, May, August and November 2018. The results of the water quality monitoring were generally compliant with respective water quality trigger levels. pH was compliant with the respective site specific trigger values with the exception of the following:

- EPA Point 2 was below the lower pH trigger value during three (3) of the four (4) water quality monitoring events.
- EPA Point 14 was above the upper pH trigger level value during four (4) of the four (4) water quality monitoring events.

Electrical conductivity was compliant with the respective trigger values with the exception of the following:

- EPA Point 2 was in excess of the site specific trigger value during May 2018.
- EPA Point 3 was in excess of the site specific trigger value during May 2018.
- EPA Point 14 was in excess of the site specific trigger value during three (3) of the four (4) monitoring events. The greatest concentration was observed during the February 2018 monitoring event (1350µS/cm).

All EPL locations were below the total suspended solids (TSS) trigger value during all monitoring events.

5.3.2 SITE SURFACE WATER

Site surface water samples were collected monthly during the January to December 2018 monitoring period.

During the 2018 monitoring period, pH was generally compliant with the site specific trigger values with the exception of the following surface water locations:

- S4 was above the upper pH trigger value during eight (8) of the twelve (12) monitoring events. The greatest pH was 8.41, which occurred during February and April.
- S5 was below the lower pH trigger value during two (2) of the twelve (12) monitoring events. The lowest pH was 6.94, which occurred during May.
- S6 was above the upper pH trigger value during one (1) of the twelve (12) monitoring events. This was during February 2018, a pH of 8.27 was recorded.

During the 2018 monitoring period, electrical conductivity was intermittently exceeded the site specific trigger values, this occurred during the following instances:

- S1 was in excess of the site specific trigger value during seven (7) of the twelve (12) monitoring events. The greatest electrical conductivity level was 6720 µS/cm, observed during May 2018.
- S3 was in excess of the site specific trigger value during five (5) of the twelve (12) monitoring events. The greatest electrical conductivity level was 6390µS/cm, observed during April 2018.
- S4 was in excess of the site specific trigger value during two (2) of the twelve (12) monitoring events. The greatest electrical conductivity level was 1110 µS/cm, observed during February 2018.

- S5 was in excess of the site specific trigger value during eleven (11) of the twelve (12) monitoring events. The greatest electrical conductivity level was 2590µS/cm, observed during May 2018.
- S6 was in excess of the site specific trigger value during six (6) of the twelve (12) monitoring events. The greatest electrical conductivity level was 6370µS/cm, observed during April 2018.
- S7 was in excess of the site specific trigger value during eleven (11) of the twelve (12) monitoring events. The greatest electrical conductivity level was 2540µS/cm, observed during May 2018.

During the 2018 monitoring period conductivity is generally shown to increase in response to decreased rainfall, as shown in **Figure 12.** The water monitoring locations in Neubeck's Creek (surface water sites S1, S3 and S6) show larger increases in electrical conductivity due to decreased rainfall than the surface water sites located at Blue Lake (S5) and Cox's River (S4, upstream of Blue Lake and S7, downstream of Blue Lake). A review of the surface water data undertaken by GHD indicated that increases in electrical conductivity at surface water sites S1, S3 and S6 is attributable to the increase in electrical conductivity upstream of Pine Dale Mine (Ref [11]). A licence discharge point (not associated with Pine Dale Mine or EPL 4911) is located at the confluence of EPL Point 2. Increases in electrical conductivity of discharge water at this location and decreases in rainfall are considered to be the contributing factors in observed increases in electrical conductivity within the Neubeck's Creek monitoring locations.

The GHD report (Ref [11]) also proposed revised trigger levels for surface water which have been forwarded to DPI – Water, no response has been received at the time of writing this report. Refer to **Section 4.3.3.1** for further detail.

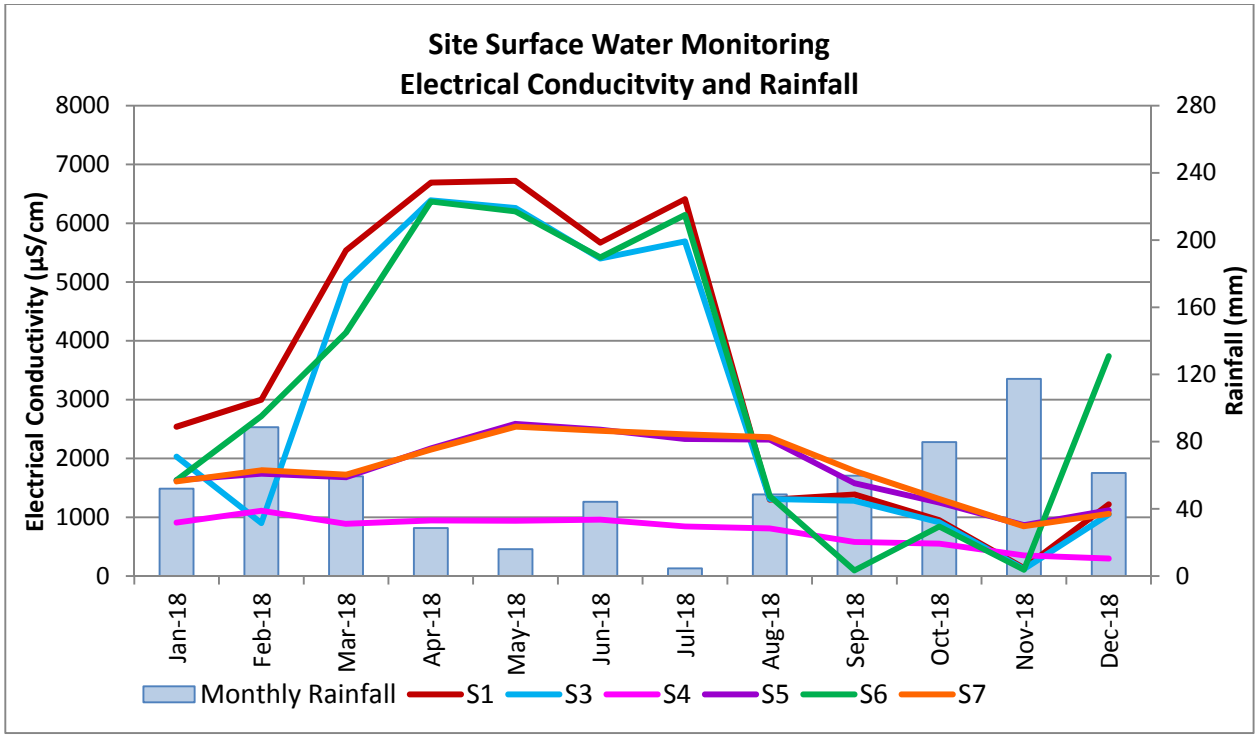

Figure 12 *Site Surface Water Electrical Conductivity and Monthly Rainfall*

6 METEOROLOGICAL MONITORING

6.1 METEOROLOGICAL MONITORING REQUIREMENTS

PDM records meteorological data continuously via an on-site meteorological monitoring station in accordance with the requirements of Environmental Protection License No. 4911. The meteorological monitoring requirements of EPL 4911 are presented in **Table 37**.

Table 37 *EPL Meteorological Monitoring Requirements*

Parameter	Units of Measure	Frequency	Averaging Period
Air temperature	°C	Continuous	1 hour
Wind direction	°	Continuous	15 minute
Wind speed	m/s	Continuous	15 minute
Sigma theta	°	Continuous	15 minute
Rainfall	mm	Continuous	15 minute
Relative humidity	%	Continuous	1 hour

6.2 METEOROLOGICAL MONITORING RESULTS

Meteorological monitoring Parameters recorded at the PDM Meteorological Monitoring Station include wind speed, wind direction, temperature at 10m height, temperature at 2m height, rainfall, humidity, solar radiation, sigma theta and evapotranspiration. Details of weather data recorded for the period January to December 2018 are summarised in **Table 38**. The windrose plot for the period January – December 2018 is presented in **Figure 13.** Quarterly windrose plots for 2018 are shown in **Figure 14**.

Table 38 *Meteorological Monitoring Summary Data 2018*

Month (2018)	Rainfall (mm)	Cumulative Rainfall (mm)	No. of Rain Days/ Month	Air Temp. @ 2m (°C)			Air Temp. @ 10m (°C)			Sigma theta (º)			Relative Humidity (%)			Wind Speed (m/s)			Modal Wind Direction
				Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	
January	52	52	7	21.4	4.9	40.1	20.9	4.9	38.4	33.4	0.0	98.2	57.0	3.3	95.9	1.2	0.0	15.1	ESE
February	88.6	140.6	8	19.1	5.2	37.9	18.7	5.2	36.3	33.3	0.0	102.6	61.3	5.3	94.4	1.4	0.0	14.7	SE
March	59.4	200	7	17.2	-0.8	32.6	16.9	-0.8	31.3	32.7	0.0	103.6	68.6	14.4	95.6	1.3	0.0	14.2	SE
April	28.6	228.6	8	15.0	0.2	32.6	14.8	0	30.9	29.6	0.0	101.4	68.3	14.8	95.7	1.2	0.0	17.7	WNW
May	16	244.6	7	7.7	-4.1	23.5	7.8	-4.1	22.6	26.1	0.0	103.1	71.1	16.6	95.4	1.2	0.0	13.2	WNW
June	44.2	288.8	17	5.9	-8	16.6	5.9	-8.2	15.8	26.9	0.0	102.8	77.1	13.8	95.7	1.4	0.0	13.2	WNW
July	4.6	293.4	7	4.5	-8.9	18.3	4.7	-8.9	17.3	19.7	0.0	102.8	67.1	13.6	96	1.8	0.0	18.0	WNW
August	48.6	342	11	5.6	-7.9	18.3	5.7	-8.2	17.8	23.1	0.0	98.9	65.8	9.9	95.3	2.0	0.0	15.8	WNW
September	59.8	401.8	10	8.8	-4.9	25.1	8.8	-5	24.1	26.6	0.0	103.6	67.5	12.7	96.5	1.5	0.0	14.6	WNW
October	79.8	481.6	18	12.8	0	27.5	12.6	0	26.4	32.7	0.0	102.4	72.8	11.8	100	1.3	0.0	10.3	WNW
November	117.4	599	15	15.2	1.7	30.5	15.0	1.7	29.7	28.0	0.0	101.5	64.6	14.5	96.8	1.4	0.0	15.2	WNW
December	61.4	660.4	8	19.4	4.3	37.3	19.2	4.5	36.8	31.3	0.0	99.8	62.1	10.3	96.6	0.8	0.0	16.8	WNW
TOTAL	660.4	-	123	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Minimum	4.6	-	7	-	*-8.9*	-	-	*-8.9*	-	-	*0.0*	-	-	*3.3*	-	-	*0.0*	-	-
Maximum	117.4	-	18	-	-	*40.1*	-	-	*38.4*	-	-	*103.6*	-	-	*100*	-	-	*18.0*	-

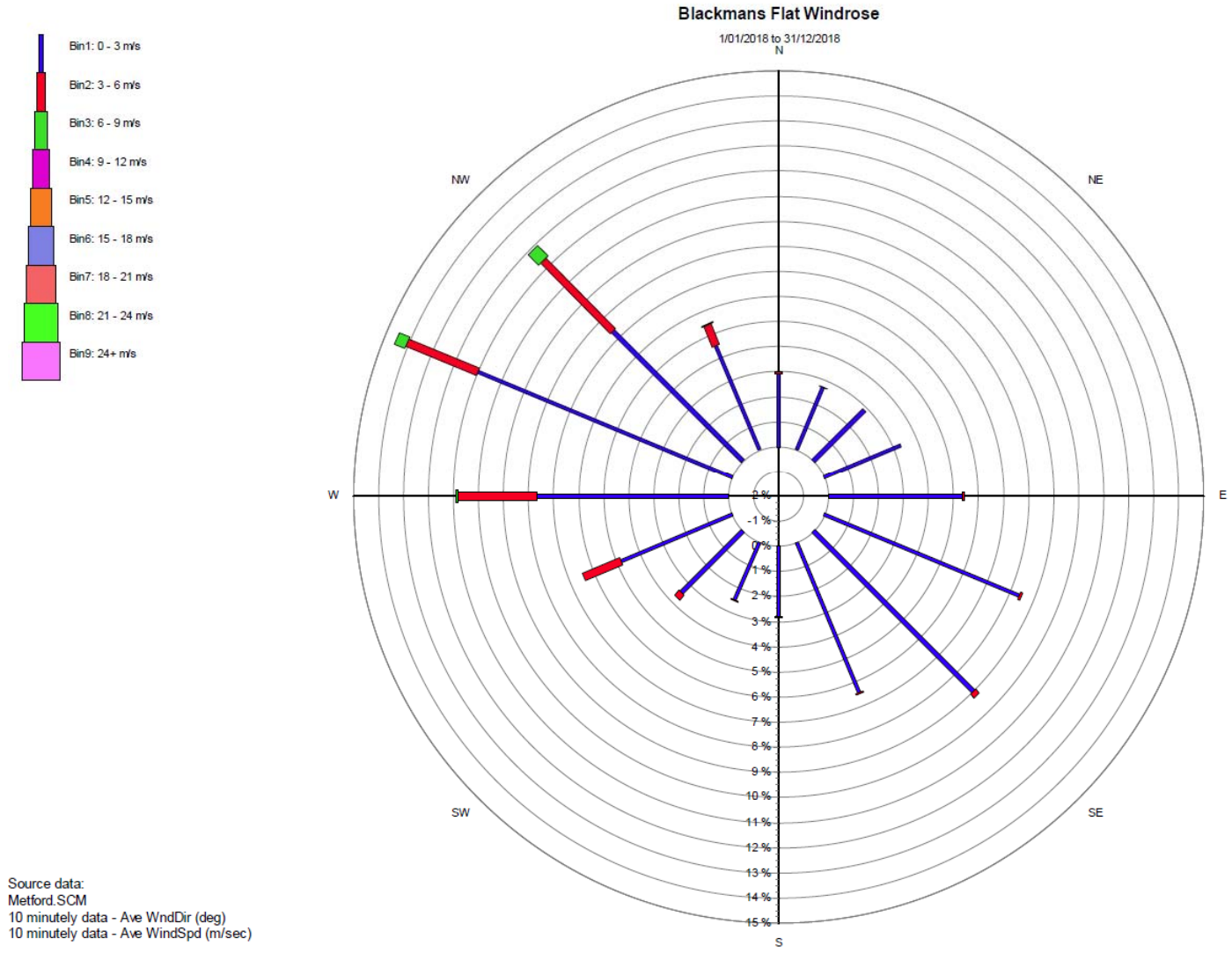

Figure 13 *Pine Dale Mine Windrose Plot - 2018*

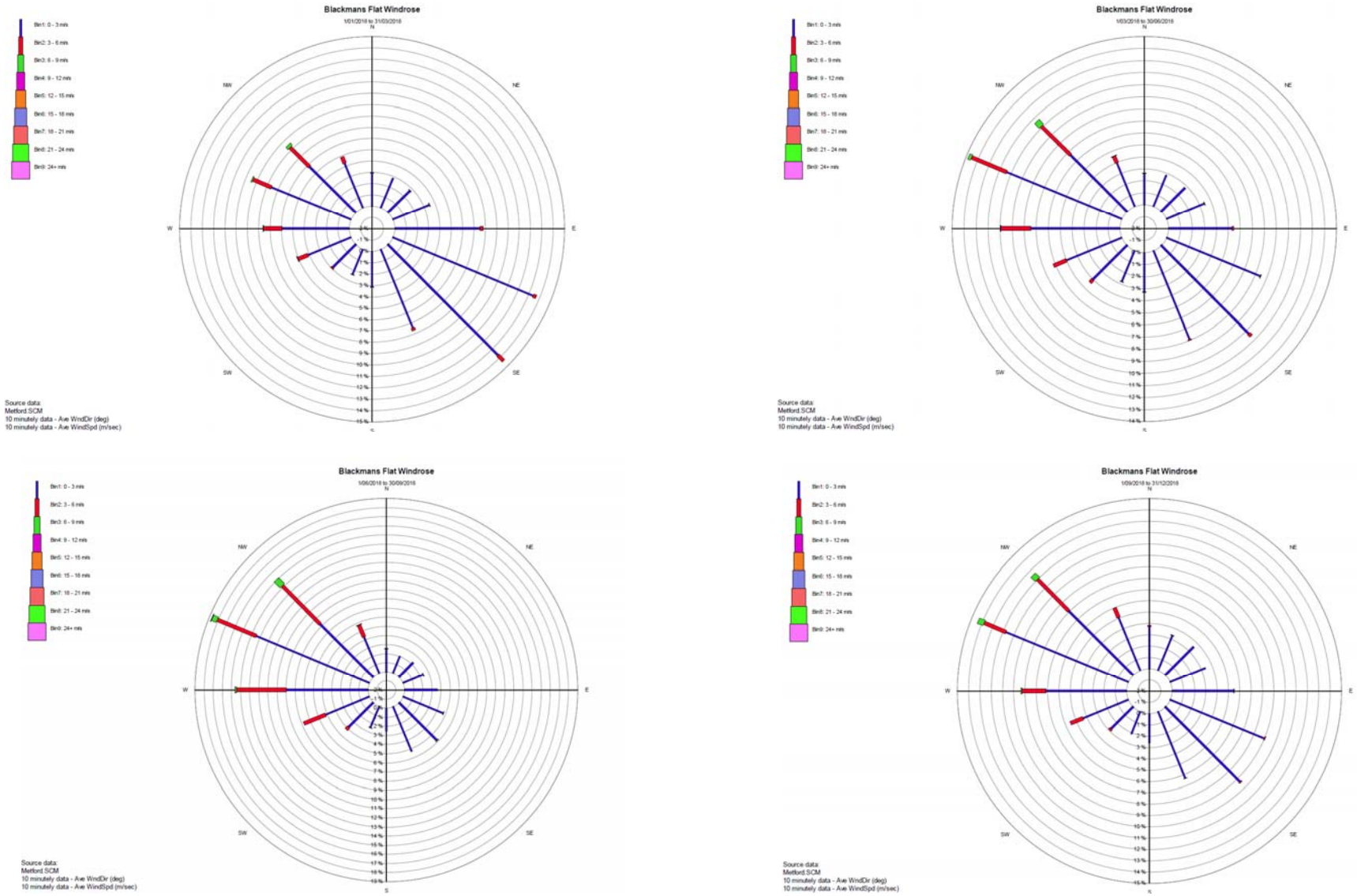

Figure 14 *Pine Dale Mine Quartery Windrose Plots - 2018*

6.3 REVIEW OF METEOROLOGICAL MONITORING RESULTS

PDM received 660.4mm of rainfall across 123 days during the 2018 monitoring period. Rainfall during this period was observed to slightly greater than 2017 (577.0mm), but less than 2016 (1167.6mm). The maximum 2m and 10m temperatures recorded during the reporting period was 40.1°C and 38.4°C respectively, both occurred in January 2018. The lowest temperature was observed during July with -8.9°C recorded at both 2m and 10m. Predominant wind directions at the PDM during 2018 were observed to be from the south east during January – March 2018 and the WNW for the remainder of the year. The maximum wind speed measured at the site was 18.0m/s on the 6 July from a west-north-westerly direction.

7 STREAM HEALTH & CHANNEL STABILITY MONITORING

7.1 STREAM HEALTH & CHANNEL STABILITY MONITORING SUMMARY

Schedule 3 Condition 27(b) of Project Approval PA 10_0041 requires performance criteria and a programme to monitor the stream health, riparian vegetation health and channel stability of creeks and other water bodies that could potentially be affected by the project (Pine Dale Mine). As defined in Schedule 3 Condition 27(b) of the Project Approval, the creeks and other water bodies that could potentially be affected by the project include Neubecks Creek, the Blue Lake and Coxs River.

A Channel Stability and Stream Health Monitoring programme is outlined in Section 4.6.5 of the *Pine Dale Mine Water Management Plan* (Ref [3]) for the purpose of monitoring channel stability and stream health and vegetation health of Neubecks Creek to ensure mining operations do not have an adverse effect upon the Neubecks Creek drainage line. In addition to the requirements of the Channel Stability and Stream Health Monitoring programme, the water bodies of Blue Lake and Coxs River have also been included in the monitoring programme, to satisfy the conditions outlined in the Project Approval (Ref [2]).

In accordance with the Channel Stability and Stream Health Monitoring programme, routine six-monthly assessments of Neubecks Creek, Blue Lake and Coxs River were undertaken in March and October 2018 (refer RCA Reports 6880-1778; and 6880-1786 respectively). The performance criteria utilized for the stream health assessment of each monitoring point is derived from the CSIRO *Ephemeral Stream Assessment* protocol (Ref [12]) which is reproduced in **Table 39**.

Visual assessments and photographic documentation of each site are also undertaken on a monthly basis detailing evidence of erosion, newly exposed soils, and vegetation disturbance (refer to monitoring field sheets presented in **Appendix 2**). Results of the routine six-monthly assessments are presented in **Tables 40** to **44**. The location of Stream Health monitoring sites are presented in **Drawing 2**, **Appendix 1**.

A stream health assessment of the Blue Lake site was not undertaken, as the site does not fit the requirements of the *Ephemeral Stream Assessment* protocol (Ref [12]), which has been developed for streams and drainage lines. Nevertheless, the Blue Lake is still included in monthly erosion and vegetation disturbance observation inspections.

Table 39 *Classification of Different Drainage Line States (CSIRO)*

Activity Rating (%)	Classification	Discussion of Classification
80 +	Very Stable	Drainage line is very stable and likely to be in original form. It is able to withstand all flow velocities that have previously occurred in this area and only minimal monitoring is required, predominantly after high flow events, to ensure condition does not deteriorate.
70-80	Stable	Drainage line is stable. It is important to assess this zone in relation to the other classifications and define whether this zone is moving from potentially stabilising to a more stable form, or if it is deteriorating from a very stable form. The nature of this relationship will identify the type of monitoring required.
60-69	Potentially Stabilising	Drainage line is potentially stabilising. Ongoing monitoring is required while rehabilitation works are not needed in the immediate future.
50-59	Active	Drainage line is actively eroding and remedial actions are required. It is important to classify if erosion is caused primarily by upstream flows, lateral flows or unstable wall materials so that appropriate rehabilitation can be carried out.
< 50	Very Active	Drainage line is very actively eroding and immediate remedial actions are required. It is important to classify if erosion is caused primarily by upstream flows, lateral flows or unstable wall materials so that appropriate rehabilitation can be carried out.

Table Source: CSIRO Ephemeral Stream Assessment (CSIRO, undated)

Table 40 *Classification of Different Drainage Line State – Site SH1*

Location:		**SH1**	
Assessment Date:		**14/03/18 & 09/10/18**	
Activity		**Rating**	**Explanation of Rating**
Vegetation	On Drainage Line Floor	1	Little or no vegetation growing on drainage line floor.
	On Drainage Line Walls	3	Dense perennial plant cover, similar to vegetation on floodplain/riparian zone. Characteristic wetland species composition. No observable plant burial by sediment.
Profile of D/L	Shape and Aspect of Drainage Line Section	3	Potentially stabilising. Side walls become rounded and crusted alluvial fan at foot of side walls. Width>depth.
	Longitudinal Morphology of Drainage Line	3	Flat with a cohesive fine textured 'soil-like' bed.
	Particle Size of Materials on Drainage Line Floor	3	Material on floor is much larger in particle size and/ or denser than material on walls. Surface armouring (e.g. cobbles, competent country rock).
Wall Materials	Nature of Drainage Line Materials	3	Materials that slake and/or disperse are exposed on less than 0.3m of wall height.
Bank Edge	Shape of Stream Bordering Slopes	2	Steep bank, 10-30^{o}, permitting moderate to high velocity flows.
	Nature of Lateral Flow Regulation	4	Dense grassland: low inflow rate, mostly diffuse.
2018 Overall Scores			
Classification of Drainage Line March 2018 survey		22/32 **69%**	Drainage line is potentially stabilizing. Ongoing monitoring is required while rehabilitation works are not needed in the immediate future.
Classification of Drainage Line October 2018 survey		22/32 **69%**	Drainage line is potentially stabilizing. Ongoing monitoring is required while rehabilitation works are not needed in the immediate future.

Table 41 *Classification of Different Drainage Line State – Site SH2*

Location:		SH2	
Assessment Date:		**14/03/18 & 09/10/18**	
Activity		**Rating**	**Explanation of Rating**
Vegetation	On Drainage Line Floor	1	Little or no vegetation growing on drainage line floor.
	On Drainage Line Walls	3	Dense perennial plant cover, similar to vegetation on floodplain/ riparian zone. Characteristic wetland species composition. No observable plant burial by sediment.
Profile of D/L	Shape and Aspect of Drainage Line Cross Section	3	Potentially stabilising. Side walls become rounded and crusted alluvial fan at foot of side walls. Width>depth.
	Longitudinal Morphology of Drainage Line	3	Flat with a cohesive fine textured 'soil-like' bed.
	Particle Size of Materials on Drainage Line Floor	3	Material on floor is much larger in particle size and/ or denser than material on walls. Surface armouring (e.g. cobbles, competent country rock).
Wall Materials	Nature of Drainage Line Materials	3	Materials that slake and/or disperse are exposed on less than 0.3m of wall height.
Bank Edge	Shape of Stream Bordering Slopes	2	Steep bank, 10-30^{o}, permitting moderate to high velocity flows.
	Nature of Lateral Flow Regulation	4	Dense grassland. Low inflow rate, mostly diffuse.
2018 Overall Scores			
Classification of Drainage Line March 2018 survey		22/32 **69%**	Drainage line is potentially stabilizing. Ongoing monitoring is required while rehabilitation works are not needed in the immediate future.
Classification of Drainage Line October 2018 survey		22/32 **69%**	Drainage line is potentially stabilizing. Ongoing monitoring is required while rehabilitation works are not needed in the immediate future.

Table 42 *Classification of Different Drainage Line State – Site SH3*

Location:		SH3	
Assessment Date:		**14/03/18 & 09/10/18**	
Activity		**Rating**	**Explanation of Rating**
Vegetation	On Drainage Line Floor	1	Little or no vegetation growing on drainage line floor.
	On Drainage Line Walls	3	Dense perennial plant cover, similar to vegetation on floodplain/ riparian zone. Characteristic wetland species composition. No observable plant burial by sediment.
Profile of D/L	Shape and Aspect of Drainage Line Cross Section	2	Actively eroding. Slight undercutting, near vertical walls, alluvial fans also eroding. Depth=width.
	Longitudinal Morphology of Drainage Line	2	Flat with a cohesive fine textured "soil like" bed
	Particle Size of Materials on Drainage Line Floor	2	Material on floor is slightly larger in particle size and/or denser (more consolidated) than material on walls (e.g. well sorted gravel).
Wall Materials	Nature of Drainage Line Materials	4	Materials that do not slake or disperse are exposed on the wall surface.
Bank Edge	Shape of Stream Bordering Slopes	2	Steep bank, 10-30^{o}, permitting moderate to high velocity flows.
	Nature of Lateral Flow Regulation	4	Dense grassland. Low inflow rate, mostly diffuse.
2018 Overall Scores			
Classification of Drainage Line March 2018 survey		20/32 **63%**	Drainage line is potentially stabilizing. Ongoing monitoring is required while rehabilitation works are not needed in the immediate future.
Classification of Drainage Line October 2018 survey		20/32 **63%**	Drainage line is potentially stabilizing. Ongoing monitoring is required while rehabilitation works are not needed in the immediate future.

Table 43 *Classification of Different Drainage Line State – Site SH3A*

Location:		SH3A	
Assessment Date:		**14/03/18 & 09/10/18**	
Activity		**Rating**	**Explanation of Rating**
Vegetation	On Drainage Line Floor	1	Little or no vegetation growing on drainage line floor.
	On Drainage Line Walls	1	Little or no vegetation growing on drainage line walls.
Profile of D/L	Shape and Aspect of Drainage Line Cross Section	NA	This section of drainage line coated with spray-concrete.
	Longitudinal Morphology of Drainage Line	NA	
	Particle Size of Materials on Drainage Line Floor	NA	
Wall Materials	Nature of Drainage Line Materials	NA	
Bank Edge	Shape of Stream Bordering Slopes	2	Steep bank, 10-30°, permitting moderate to high velocity flows.
	Nature of Lateral Flow Regulation	4	Dense grassland. Low inflow rate, mostly diffuse.
Classification of Drainage Line		NA	Drainage line is considered stabile due to spray-concrete lining.

Table 44 *Classification of Different Drainage Line State – Site SH5*

Location:		SH5	
Assessment Date:		**14/03/18 & 09/10/18**	
Activity		**Rating**	**Explanation of Rating**
Vegetation	On Drainage Line Floor	1	Little or no vegetation growing on drainage line floor.
	On Drainage Line Walls	3	Dense perennial plant cover, similar to vegetation on floodplain/ riparian zone. Characteristic wetland species composition. No observable plant burial by sediment.
Profile of D/L	Shape and Aspect of Drainage Line Cross Section	4	Stabilising: wall angle less than 65°, small inactive alluvial fan at foot of side walls: width> Depth.
	Longitudinal Morphology of Drainage Line	2	Flat with a cohesive fine textured “soil like” bed.
	Particle Size of Materials on Drainage Line Floor	3	Material on floor is much larger in particle size and/or denser than material on walls: surface armoring (e.g. cobbles, competent country rock).
Wall Materials	Nature of Drainage Line Materials	4	Materials that do not slake or disperse are exposed on wall surface.
Bank Edge	Shape of Stream Bordering Slopes	3	Moderately sloped bank, 5-10°
	Nature of Lateral Flow Regulation	3	Sparse grassland / woodland with bare soil bank lip. Moderate flow rate, some highly focused inflow locations.
2018 Overall Scores			
Classification of Drainage Line March 2018 survey		23/32 **72%**	Drainage line is stable. This site has remained stable.
Classification of Drainage Line October 2018 survey		23/32 **72%**	Drainage line is stable. This site SH5 has remained stable.

7.2 REVIEW & INTERPRETATION OF STREAM HEALTH MONITORING RESULTS

The routine six-monthly assessment of channel stability, stream health and vegetation health of the Neubecks Creek monitoring locations (SH1, SH2, SH3 and SH3A) at Pine Dale Mine indicates the drainage line is classified as potentially stabilising at locations SH1, SH2 and SH3. The drainage line at location SH3a is considered stable. An assessment of the Coxs River monitoring site (SH5) indicated the drainage line is also considered to be stable.

The CSIRO *Ephemeral Stream Assessment* protocol indicates ongoing monitoring of Neubecks Creek drainage line is required; however, rehabilitation works are not required in the immediate future. Coxs River drainage line is stable, however ongoing monitoring is still required to assess changes in the site's classification; either into a more stable form or deteriorating.

In accordance with the Pine Dale Mine *Water Management Plan*, monitoring of the six Stream Health assessment locations was conducted on a monthly basis throughout 2018. The ongoing monitoring encompasses monthly visual assessments and photographic documentation of each site over time. Results of this monthly monitoring indicate no evidence of erosion, newly exposed soils, or vegetation disturbance.

8 NOISE MONITORING

8.1 NOISE ASSESSMENT CRITERIA

The purpose of noise monitoring is to ensure that any impact of operations on the surrounding sensitive receivers can be identified; and to show compliance with relevant legislative requirements. The conditional requirements within Project Approval 10_0041 (Schedule 3, Condition 1) (Ref [2]) and EPL 4911 (Ref [1]) are presented in **Table 45**. As PDM is currently in care and maintenance, rehabilitation activities are considered to be the primary noise source.

Table 45 *Noise Assessment Criteria (Ref [1])*

Location		Noise Monitoring Location	Day LAeq (15 min) dBA	Evening LAeq (15 min) dBA
Residences 18, 32 and 33		NM1 - (EPL Ref No.33)	42	39
Residences 20-23, 25 and 27-29		N/A	42	36
Residences 8, 10-12 and14		NM2 - (EPL Ref No.14); NM3 - (EPL Ref No.10)	42	35
Residences 2, 5-7 and 35		NM4 - (EPL Ref No.5); NM6 - (EPL Ref No.2)	35	35
All other residences		NM5 - (EPL Ref No.4)	35	35
During construction and removal of the amenity bund	Residences 8, 10-12, 14, 18, 20-23, 25, 27-29 and 32 - 33	N/A	46	N/A

- *Noise generated by the project should not exceed the above criteria at any residence on privately-owned land or on more than 25% of any privately-owned land.*
- *Day: The period from 7:00am to 6:00pm Monday to Saturday and 8:00am to 6:00pm Sundays and Public Holidays*
- *Evening: The period from 6:00pm to 10:00pm Monday to Sunday*

8.2 NOISE MONITORING DATA SUMMARY

In accordance with the PDM Noise Management Plan (Ref [6]), EPL (Ref [1]) and Project Approval (Ref [2]) conditions attended noise surveys are undertaken on a quarterly basis.

Quarterly monitoring was undertaken at the following intervals during the 2018 period:

- Quarter 1 – January to March, monitoring conducted 15 March 2018
- Quarter 2 – April to June, monitoring conducted 25-26 June 2018.
- Quarter 3 – July to September, monitoring conducted on 19 September 2018.
- Quarter 4 – October to December, monitoring conducted on 16 October 2018.

The purpose of the attended noise survey is to record any impact of operational noise on the surrounding community. Two (2) consecutive 15-minute surveys are conducted at each of the six (6) monitoring locations. Results of attended noise surveys carried out during the 2018 monitoring period are presented in **Tables 46** to **49**. Meteorological conditions recorded during each noise survey are presented in **Table 50**; the 10m data has been sourced from PDM's on-site meteorological station subsequent to the completion of the noise surveys. Noise survey locations are presented in **Drawing 1**, **Appendix 1**.

Table 46 *Attended Noise Survey – Quarter 1, March 2018*

Survey Date	Survey Start Time	Location	Overall			Pine Dale Mine LAeq 15min Contribution	Pine Dale Mine LAeq 15min Limit	Road Traffic LAeq 15min Contribution	Birds & Other LAeq 15min Contribution	Noise Sources & Level Ranges (Min to Max) dB(A)	
			$L_{Aeq\ 15min}$	$L_{A10\ 15min}$	$L_{A90\ 15min}$						
15 March 2018	12:18	NM 1	53.5	56.7	45.3	NIL	42	53.0	44.1	Pine Dale Mine Road Traffic Birds & Other	NIL 43 to 68 41 to 56
15 March 2018	12:33	NM 1	53.9	57.3	44.7	NIL	42	53.2	45.7	Pine Dale Mine Road Traffic Birds & Other	NIL 46 to 68 38 to 60
15 March 2018	13:32	NM 2	62.0	66.8	44.1	NIL	42	61.7	50.8	Pine Dale Mine Road Traffic Birds & Other	NIL 46 to 76 39 to 80
15 March 2018	13:47	NM 2	59.7	63.9	43.1	NIL	42	59.6	44.1	Pine Dale Mine Road Traffic Birds & Other	NIL 46 to 76 38 to 57
15 March 2018	14:17	NM 3	60.2	64.0	48.7	NIL	42	59.9	48.0	Pine Dale Mine Road Traffic Birds & Other	NIL 49 to 73 42 to 65
15 March 2018	14:32	NM 3	60.8	63.4	42.8	NIL	42	60.7	44.8	Pine Dale Mine Road Traffic Birds & Other	NIL 45 to 80 38 to 58
15 March 2018	15:01	NM 4	45.0	47.8	39.7	NIL	35	35.6	44.4	Pine Dale Mine Road Traffic Birds & Other	NIL 38 to 46 36 to 60
15 March 2018	15:16	NM 4	41.9	44.1	38.0	NIL	35	33.7	41.2	Pine Dale Mine Road Traffic Birds & Other	NIL 36 to 45 33 to 51
15 March 2018	15:59	NM 5	40.6	41.4	38.6	NIL	35	29.4	40.2	Pine Dale Mine Road Traffic Birds & Other	NIL 37 to 53 37 to 61
15 March 2018	16:14	NM 5	40.8	42.2	38.3	NIL	35	33.8	39.8	Pine Dale Mine Road Traffic Birds & Other	NIL 37 to 52 35 to 48
15 March 2018	16:55	NM 6	39.5	43.3	32.8	NIL	35	30.8	38.9	Pine Dale Mine Road Traffic Birds & Other	NIL 31 to 51 30 to 55
15 March 2018	17:10	NM 6	50.9	48.0	35.6	NIL	35	31.9	50.8	Pine Dale Mine Road Traffic Birds & Other	NIL 35 to 57 32 to 69

Table 47 *Attended Noise Survey – Quarter 2, June 2018*

Survey Date	Survey Start Time	Location	Overall			Pine Dale Mine $L_{Aeq\ 15min}$ Contribution	Pine Dale Mine $L_{Aeq\ 15min}$ Limit	Road Traffic, birds and other $L_{Aeq\ 15min}$ Contribution	Noise Sources & Level Ranges (Min to Max) dB(A)	
			$L_{Aeq\ 15min}$	$L_{A10\ 15min}$	$L_{A90\ 15min}$					
25 June 2018	16:34	NM 1	57	61	39	NIL	42	57	Pine Dale Mine Road Traffic Birds & Other	NIL 33 to 70 31 to 53
25 June 2018	16:49	NM 1	57	60	45	NIL	42	57	Pine Dale Mine Road Traffic Birds & Other	NIL 40 to 68 38 to 47
25 June 2018	17:14	NM 2	61	66	42	NIL	42	61	Pine Dale Mine Road Traffic Birds & Other	NIL 33 to 77 34 to 54
25 June 2018	17:29	NM2	61	66	41	NIL	42	61	Pine Dale Mine Road Traffic Birds & Other	NIL 32 to 76 30 to 52
26 June 2018	07:24	NM 3	59	63	39	NIL	42	59	Pine Dale Mine Road Traffic Birds & Other	NIL 37 to 76 35 to 69
26 June 2018	07:39	NM 3	59	62	41	NIL	42	59	Pine Dale Mine Road Traffic Birds & Other	NIL 37 to 75 35 to 69
26 June 2018	08:04	NM 4	44	46	40	NIL	42	44	Pine Dale Mine Road Traffic Birds & Other	NIL 37 to 51 39 to 46
26 June 2018	08:19	NM 4	43	46	37	NIL	42	43	Pine Dale Mine Road Traffic Birds & Other	NIL 33 to 52 34 to 48
26 June 2018	08:49	NM 5	42	43	38	NIL	42	42	Pine Dale Mine Road Traffic Birds & Other	NI 35 to 62 36 to 48
26 June 2018	09:04	NM 5	43	43	37	NIL	42	43	Pine Dale Mine Road Traffic Birds & Other	NIL 32 to 65 33 to 47
26 June 2018	09:25	NM 6	41	44	35	NIL	42	41	Pine Dale Mine Road Traffic Birds & Other	NIL 32 to 60 30 to 61
26 June 2018	09:40	NM 6	46	50	35	NIL	42	46	Pine Dale Mine Road Traffic Birds & Other	NIL 31 to 60 30 to 61

Table 48 *Attended Noise Survey – Quarter 3, September 2018*

Survey Date	Survey Start Time	Location	Overall			Pine Dale Mine $L_{Aeq\ 15min}$ Contribution	Pine Dale Mine $L_{Aeq\ 15min}$ Limit	Road Traffic, birds and other $L_{Aeq\ 15min}$ Contribution	Noise Sources & Level Ranges (Min to Max) dB(A)	
			$L_{Aeq\ 15min}$	$L_{A10\ 15min}$	$L_{A90\ 15min}$					
19 September 2018	12:18	NM 1	54	58	45	NIL	42	54	Pine Dale Mine Road Traffic Birds & Other	NIL 44 to 75 40 to 70
19 September 2018	12:33	NM1	54	58	45	NIL	42	54	Pine Dale Mine Road Traffic Birds & Other	NIL 44 to 68 41 to 57
19 September 2018	13:10	NM 2	61	64	46	NIL	42	61	Pine Dale Mine Road Traffic Birds & Other	NIL 43 to 80 42 to 63
19 September 2018	13:25	NM 2	58	62	46	NIL	42	58	Pine Dale Mine Road Traffic Birds & Other	NIL 45 to 74 43 to 64
19 September 2018	13:50	NM 3	59	62	44	NIL	42	59	Pine Dale Mine Road Traffic Birds & Other	NIL 42 to 79 40 to 58
19 September 2018	14:05	NM 3	60	64	44	NIL	42	60	Pine Dale Mine Road Traffic Birds & Other	NIL 40 to 80 37 to 68
19 September 2018	14:31	NM 4	46	49	40	NIL	42	46	Pine Dale Mine Road Traffic Birds & Other	NIL 38 to 47 37 to 59
19 September 2018	14:46	NM 4	47	50	43	NIL	42	47	Pine Dale Mine Road Traffic Birds & Other	NIL 40 to 52 40 to 59
19 September 2018	15:16	NM 5	42	45	37	NIL	42	42	Pine Dale Mine Road Traffic Birds & Other	NIL 37 to 49 34 to 57
19 September 2018	15:31	NM 5	43	46	37	NIL	42	43	Pine Dale Mine Road Traffic Birds & Other	NIL 35 to 50 34 to 58
19 September 2018	16:13	NM 6	44	46	37	NIL	42	44	Pine Dale Mine Road Traffic Birds & Other	NIL 36 to 49 34 to 59
19 September 2018	16:28	NM 6	42	44	36	NIL	42	42	Pine Dale Mine Road Traffic Birds & Other	NIL 33 to 67 33 to 65

Table 49 *Attended Noise Survey – Quarter 4, October 2018*

Survey Date	Survey Start Time	Location	Overall			Pine Dale Mine $L_{Aeq\ 15min}$ Contribution	Pine Dale Mine $L_{Aeq\ 15min}$ Limit	Road Traffic, birds and other $L_{Aeq\ 15min}$ Contribution	Noise Sources & Level Ranges (Min to Max) dB(A)	
			$L_{Aeq\ 15min}$	$L_{A10\ 15min}$	$L_{A90\ 15min}$					
16 October 2018	16:18	NM 1	55	58	47	NIL	42	55	Pine Dale Mine Road Traffic Birds & Other	NIL 41 to 51 40 to 67
16 October 2018	16:33	NM 1	54	58	44	NIL	42	54	Pine Dale Mine Road Traffic Birds & Other	NIL 37 to 57 40 to 70
16 October 2018	15:34	NM 2	65	65	40	NIL	42	65	Pine Dale Mine Road Traffic Birds & Other	NIL 29 to 76 37 to 73
16 October 2018	15:49	NM2	60	65	42	NIL	42	60	Pine Dale Mine Road Traffic Birds & Other	NIL 36 to 55 33 to 73
16 October 2018	14:53	NM 3	64	61	36	NIL	42	64	Pine Dale Mine Road Traffic Birds & Other	NIL 28 to 63 35 to 80
16 October 2018	15:08	NM 3	57	60	33	NIL	42	57	Pine Dale Mine Road Traffic Birds & Other	NIL 28 to 77 35 to 80
16 October 2018	14:12	NM 4	39	42	30	NIL	42	39	Pine Dale Mine Road Traffic Birds & Other	NIL 28 to 63 28 to 58
16 October 2018	14:27	NM 4	36	39	29	NIL	42	36	Pine Dale Mine Road Traffic Birds & Other	NIL 26 to 52 27 to 52
16 October 2018	13:21	NM 5	42	30	42	NIL	42	42	Pine Dale Mine Road Traffic Birds & Other	NIL 25 to 50 33 to 51
16 October 2018	13:36	NM 5	38	41	31	NIL	42	38	Pine Dale Mine Road Traffic Birds & Other	NIL 26 to 51 29 to 62
16 October 2018	12:12	NM 6	37	41	30	NIL	42	37	Pine Dale Mine Road Traffic Birds & Other	NIL 27 to 53 30 to 49
16 October 2018	12:27	NM 6	42	41	32	NIL	42	42	Pine Dale Mine Road Traffic Birds & Other	NIL 28 to 70 30 to 70

Table 50 *Meteorological Conditions during Attended Noise Surveys*

Survey Date	Start Time	Location	Cloud (octa)	Temp at 10m (°C)	Wind Speed At Microphone Position	Wind Speed at Height of 10m (m/s)	Wind Direction
15 March 2018	12:18	NM 1	3	28.2	3.9	5.86	W
15 March 2018	13:32	NM 2	3	28.7	2.8	5.84	W
15 March 2018	14:17	NM 3	3	29.1	4.2	5.98	W
15 March 2018	15:01	NM 4	4	30.3	3.8	6.82	W-NW
15 March 2018	15:59	NM 5	4	28.7	2.2	5.64	W-NW
15 March 2018	16:55	NM 6	5	29.3	4.0	4.27	W
25 June 2018	16:34	NM 1	0	9.0	0	0.00	-
25 June 2018	17:14	NM 2	0	7.5	0	0.00	-
26 June 2018	07:24	NM 3	0	2.2	0	0.00	-
26 June 2018	08:04	NM 4	0	4.3	0	0.00	-
26 June 2018	08:49	NM 5	0	8.6	< 1	0.00	NW
26 June 2018	09:25	NM 6	0	8.3	< 1	0.55	NW
19 September 2018	12:18	NM 1	1	22	1 – 2.8	5.90	W
19 September 2018	13:10	NM 2	3	22	0 - 3	6.04	W
19 September 2018	13:50	NM 3	3	22	0	4.80	SW
19 September 2018	14:31	NM 4	2	24	0 – 2.2	5.55	-
19 September 2018	15:16	NM 5	1	21	0 – 2.9	4.12	-
19 September 2018	16:13	NM 6	0	20	1.5 – 2.5	3.14	NW
16 October 2018	16:18	NM 1	7	23	0 - 3	1.71	NW - NE
16 October 2018	15:34	NM 2	6	23	0 – 2.7	1.39	E
16 October 2018	14:53	NM 3	7	26	0 – 2.5	0.86	E
16 October 2018	14:12	NM 4	7	26	0 – 1	2.67	NE - E
16 October 2018	13:21	NM 5	6	26	1 - 2	2.88	N - NE
16 October 2018	12:12	NM 6	7	22	1.5 – 2.6	2.74	N - NW

Note: The Industrial Noise Policy states “Wind can also create extraneous noise on noise-monitoring equipment; an upper limit of 5 m/s at the microphone position is commonly applied during noise measurement to reduce this effect”

8.3 REVIEW & INTERPRETATION OF OPERATIONAL NOISE MONITORING RESULTS

Attended noise surveys of PDM for the 2018 monitoring period were undertaken during the care and maintenance period. The conditions and operations during noise surveys were considered to be representative of those undertaken on a normal daily basis during the care and maintenance period.

Time based source coding was used during the attended noise surveys to record the overall noise levels and identify the sound sources that contribute to the sound environment at each of the six (6) noise monitoring locations. Sound sources audible during the attended surveys were classified into three categories, mine noise (from PDM); birds; traffic and other noise sources. Contributions from these sources were determined by analysis of the time coded survey data using the sound level meter manufacturer's proprietary software. The software analysis determines the overall L_{Aeq} and L_n statistical values for the entire survey, as well as identifying the individual sound sources that were coded during the attended surveys and shows the energy average contribution and L_{min} and L_{max} values, for each source, for each of the 15 minute survey periods.

8.3.1 FIRST QUARTER 2018

Attended noise surveys for the January to March 2018 quarter were undertaken on the 15 March 2018 at the six (6) PDM noise monitoring locations. During each survey, PDM was observed to be non-operational. No traffic was observed to be using the privately-owned Angus Place haul road located within PDM.

The surveys conducted for this assessment period showed nil $L_{Aeq,\ 15min}$ noise contributions from PDM at the six (6) noise monitoring locations.

The surveys conducted at NM 1, NM2 and NM3 showed that road traffic was the dominant noise source with bird calls intermittently contributing to the acoustic climate. The surveys conducted at NM 4, NM 5 and NM 6 showed that bird calls & 'other' was the dominant noise source with road traffic intermittently contributing to the acoustic climate.

8.3.2 SECOND QUARTER 2018

Attended noise surveys for the April to June 2018 quarter were undertaken on the 25 and 26 June 2018. During each survey, PDM was observed to be non-operational. No traffic was observed to be using the privately-owned Angus Place haul road located within PDM.

The surveys conducted for this assessment period showed nil $L_{Aeq,\ 15min}$ noise contributions from PDM at the six (6) noise monitoring locations.

The surveys conducted at NM1, NM 2, NM3, NM4, and NM5 showed that road traffic was the dominant noise source with bird calls intermittently contributing to the acoustic climate. The surveys conducted at NM 6 showed that bird calls and 'other' was the dominant noise source with road traffic intermittently contributing to the acoustic climate.

8.3.3 THIRD QUARTER 2018

Attended noise surveys for the July to September 2018 quarter were undertaken on the 19 September 2018. During each survey, PDM was observed to be non-operational. No traffic observed to be using the privately owned Angus Place haul road located within PDM.

The surveys conducted for this assessment period showed nil $L_{Aeq,\ 15min}$ noise contributions from PDM at the six (6) noise monitoring locations.

The surveys conducted at NM1, NM2, and NM3 showed that road traffic was the dominant noise source with bird calls and wind gusts intermittently contributing to the acoustic climate. The

surveys conducted at NM4, NM5, and NM6 showed that bird calls & 'other' was the dominant noise source with road traffic intermittently contributing to the acoustic climate.

8.3.4 FOURTH QUARTER 2018

Attended noise surveys of the Pine Dale mine operations for the October to December 2018 quarter were undertaken on the 16 October 2018. During each survey, PDM was observed to be non-operational. No traffic observed to be using the privately owned Angus Place haul road located within PDM.

The surveys conducted for this assessment period showed nil $L_{Aeq,\ 15min}$ noise contributions from PDM at the six (6) noise monitoring locations.

The surveys conducted at NM1, NM2, NM3, NM4, and NM5 showed that road traffic was the dominant noise source with bird calls and wind gusts intermittently contributing to the acoustic climate. The survey conducted at NM6 showed that bird calls & 'other' was the dominant noise source with road traffic intermittently contributing to the acoustic climate.

8.3.5 OVERALL ASSESSMENT FOR 2018

The assessable sound levels from Pine Dale Mine were below the assessment criteria at the six (6) locations during the 2018 monitoring period.

It is a requirement under AS 1055 that the noise surveys also document levels of ambient sound resulting from non PDM sources. In the surveys conducted for PDM, traffic and natural sounds, which are represented by the "Overall" LAeq (15 minute) noise levels (refer **Tables 46** to **49**), were observed to be a significant contributor to the acoustic climate.

9 BLAST MONITORING

9.1 BLASTING OPERATIONS ASSESSMENT CRITERIA

The purpose of blast monitoring is to ensure that any impact of blasting operations on the surrounding land and nearby sensitive locations can be identified, and to show compliance with relevant legislative requirements. Conditional requirements within Project Approval 10_0041 (Schedule 3, Condition 8) and Environmental Protection License (EPL 4911) are presented in **Table 51**.

Table 51 *Blasting Operations: Compliance Requirements*

Location	*Airblast overpressure (dB(Lin Peak))*	*Ground vibration (mm/s)*	*Allowable exceedance*
Residence on privately-owned land	115	5	5% of the total number of blasts over a period of 12 months
	120	10	0%

9.2 BLASTING OPERATIONS MONITORING DATA SUMMARY

Throughout the 2018 monitoring period there were nil blast events conducted at the site as a result of the mine continuing to operate under Care and Maintenance.

10 LIMITATIONS

This report has been prepared for Enhance Place Pty Ltd in accordance with an agreement with RCA Australia (RCA). The services performed by RCA have been conducted in a manner consistent with that generally exercised by members of its profession and consulting practice.

This report has been prepared for the sole use of Enhance Place Pty Ltd. The report may not contain sufficient information for purposes of other uses or for parties other than Enhance Place Pty Ltd. This report shall only be presented in full and may not be used to support objectives other than those stated in the report without written permission from RCA Australia.

The information in this report is considered accurate at the date of issue with regard to the current conditions of the site. Conditions can vary across any site that cannot be explicitly defined by investigation.

Environmental conditions including analyte concentrations can change in a limited period of time. This should be considered if the report is used following a significant period of time after the date of issue.

Yours faithfully

RCA AUSTRALIA

Carmen Rocher
Environmental Engineer

Katy Shaw
Senior Environmental Scientist

Kirsty Nealon
Senior Environmental Scientist

REFERENCES

[1] NSW EPA, *Environmental Protection Licence 4911,* 22 March 2013.

[2] NSW Department of Planning, *Project Approval Application Number 10_0041.*

[3] Enhance Place Pty Ltd, *Water Management Plan for the Pine Dale Coal Mine,* August 2015.

[4] Enhance Place Pty Ltd, *Air Quality and Greenhouse Gas Management Plan for the Pine Dale Coal Mine,* August 2015.

[5] Enhance Place Pty Ltd, *Purple Copper Butterfly Monitoring Program for the Pine Dale Coal Mine,* August 2015.

[6] Enhance Place Pty Ltd, *Noise Management Plan for the Pine Dale Coal Mine,* August 2015.

[7] Standards Australia, *AS/NZS 3580.10.1:2016: Methods for sampling and analysis of ambient air: Determination of particulate matter – Deposited matter – Gravimetric Method*, 2016.

[8] Standards Australia, *AS/NZS 3580.1.1:2007: Methods for sampling and analysis of ambient air: Guide to siting air monitoring equipment*, 2007.

[9] Standards Australia, *AS/NZS 3580.9.3:2015: Methods for sampling and analysis of ambient air: Determination of suspended particulate matter (TSP) – High volume sampler gravimetric method,* 2015.

[10] Standards Australia, *AS/NZS 3580.9.6:2015: Methods for sampling and analysis of ambient air: Determination of suspended particulate matter (PM10) – High volume sampler air sampler with size selective inlet – gravimetric method,* 2015.

[11] GHD, *Pine Dale Groundwater and Surface Water Investigation Trigger Value Review Report,* September 2018.

[12] CSIRO, *Ecosystem Function Analysis – Ephemeral Stream Assessment*.

Appendix 1

Drawing 1 - Environmental Monitoring Locations

Drawing 2 - Stream Health & Channel Stability Monitoring Locations

EP PDH7/GW Site E

EP DDH7/GW Site A

EP DDH5/GW Site B

EP PDH1/GW Site C

EP DDH4/GW Site D

Water Cart Dam
(The Bong sample location)

PCB1

PCB7

Weather Station

EPL Site 2

S1

HVAS

S2

EPL Site 3
(S3)

PCB2

PCB3

DI

NM1

Old Shaft

The Bong

NM2

D2

D3

NM3

P6

D6

NM6

S4

S5

S6

P7

D4

NM4

S7

EPL Site 13

Blue Lake

D5

NM5

EPL Site 14

Locality Plan
N.T.S.

LEGEND

- Noise monitoring location
- Depositional dust monitoring location
- Groundwater monitoring location
- High volume air sampling location
- Metorological monitoring location
- Surface water monitoring location

0 175 350 700 1,050 1,400
metres

N

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PINE DALE MINE
ENVIRONMENTAL MONITORING LOCATION PLAN

CLIENT	Pine Dale Mine			RCA Ref	6880-1785a
DRAWN BY	CR	SCALE	1:24,000 (A3)	DRAWING 1	REV 0
APPROVED BY	KS	DATE	25/01/2019	OFFICE	NEWCASTLE

LEGEND

- Monitoring location
- Licence discharge point location
- Clean water diversion location

0 37.5 75 150 225 300
metres

N

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PINE DALE MINE
CHANNEL STABILITY, STREAM AND VEGETATIVE HEALTH MONITORING SITES

CLIENT	Pine Dale Mine			RCA Ref	6880-1785a
DRAWN BY	CR	SCALE	1:5,000 (A3)	DRAWING 2	REV 0
APPROVED BY	KS	DATE	25/01/2019	OFFICE	NEWCASTLE

APPENDIX C

2018 REHABILITATION MONITORING REPORT

Pine Dale Mine

Rehabilitation Monitoring Report 2018

Report prepared by First Field Environmental
on behalf of EnergyAustralia

23 October 2018

Revision history		
Version	Date	Author
Draft	8 October 2018	Michelle Evans
Final	23 October 2018	Michelle Evans

Cover image: Transect 6

This report has been prepared by First Field Environmental for EnergyAustralia. The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report.

First Field Environmental

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Contents

Appendices

Figures

Tables

1. Introduction

Pine Dale Mine is located in the Western Coalfields of NSW at Blackmans Flat, 15km north of Lithgow on the northern side of Castlereagh Highway. The property is approximately 3km east of Mount Piper Power Station.

Pine Dale Mine is managed in accordance with Project Approval 10_0041 and relevant subsidiary licenses and approvals. The *Care and Maintenance Mining Operations Plan* (Enhance Place Pty Ltd, 2014) has been prepared in accordance with the above approval documentation and describes the following rehabilitation objectives:

- *"The rehabilitated landform is safe, stable, non-polluting and sustainable;*
- *Rehabilitation maintains or improves species diversity and habitat values of the Yarraboldy Extension Area, particularly the former Yarraboldy Open Cut Mine; and*
- *The agreed post mining land use is compatible with the surrounding land fabric and land use requirements."*

The preparation of this Rehabilitation Monitoring Report has been prepared to satisfy Schedule 3, Condition 55 of Project Approval 10_0041.

This report aims to identify successes and failures in rehabilitation in regard to agreed performance indicators and completion criteria. Recommendations are made in areas that could be improved.

2. Performance indicators

Table 1 identifies the performance indicators and completion criteria for Pine Dale Mine as determined by the *Care and Maintenance Mining Operations Plan* (Enhance Place Pty Ltd, 2014).

Table 1 Performance indicators and completion criteria

Performance indicator	Completion criteria
Feral animal and priority weed presence	• Feral animal and weed species presence and abundance is not considered to adversely impact the intended final land use.
Feral animal and priority weed control	• Feral animals and priority weeds are controlled in accordance with legislation.
Fuel loads	• Fuel loads and fire breaks in and surrounding rehabilitation areas are assessed and maintained in accordance with the Bushfire Management Plan.
Access	• Adequate access for fire-fighting is maintained on rehabilitation areas.
Habitat features	• Habitat features are installed on native forest rehabilitation areas including: - Nesting boxes and salvaged hollows - Crushed timber spread over native forest rehabilitation areas - Rock pile clusters.
Vegetation health	• More than 75% of native forest indicator species are assessed to be healthy and growing at year 5.

Performance indicator	Completion criteria
	• Native forest indicator species tree height and girth is within the range of analogue sites.
Soil loss	• Net annual soil loss is comparable to analogue sites at year 10.
Erosion	• There are no significant erosion features that compromise landform stability or public safety (including gullying or tunneling).
Woodland birds present	• Evidence of woodland birds utilising rehabilitation areas.
Evidence of mammals	• Evidence of target mammal species presence in rehabilitation areas.
Natural regeneration	• Evidence of second generation of native forest indicator species from desired vegetation community. • Evidence of natural regeneration of at least four pasture species at year 5.
Structure	• Structural layers (canopy, mid-storey, understorey and ground cover) are comparable to analogue sites.
Management inputs	• Management inputs (ameliorants, fertilisers, weed treatments) are within the range of analogue sites.
Rural land capability	• Pasture rehabilitation areas are assessed to have a Rural Land Capability Class VI or better (suitable for grazing).
Species composition	• Establishment of pasture comprising approximately 70% perennial grass and 20% annual legume, representative of species at analogue sites. • Vegetation within the treed rehabilitation areas are established in accordance with the approved species mix. • Approved pasture species mix is sown at the specified rate per hectare.
Weed presence	• Weeds including African Lovegrass to comprise <10% of the pasture sward.
Ground cover	• Ground cover (vegetation, leaf litter, mulch) >70% at year 5.

Source: *Care and Maintenance Mining Operations Plan for Pine Dale Mine* (Enhance Place Pty Ltd, 2014)

3. Weather conditions

The months leading up to the survey were warmer than average (over a 30 year period of observations). The area received lower than average rainfall in the months leading up to the survey (Bureau of Meteorology 2018). Table 2 presents regional rainfall data for the period commencing 2013.

Table 2 Rainfall (in mm) recorded January 2013 - August 2018

Year	Average	2013	2014	2015	2016	2017	2018
January	80.2	87.4	9.2	156.2	142.0	37.2	49.0
February	60.2	149	85	21.2	28.8	12.2	65.2
March	84.2	43.2	155	39.4	69.6	141.4	56.6
April	48.2	26.8	63	158.2	6.2	21.2	13.6

Year	Average	2013	2014	2015	2016	2017	2018
May	22.3	23.6	14	25.2	26.0	32.6	12.6
June	63.8	87	43.2	24.8	173.4	19.6	34.6
July	32.2	19.6	25.6	44.6	91.4	6.6	5.4
August	42.4	22.4	56.4	43.8	52.2	41.8	38.0
September	42.4	44	35.2	9.8	118.6	4.2	-
October	61.6	20.8	51.6	58.0	71.4	106.0	-
November	51.2	68.6	36.8	63.6	58.4	28.8	-
December	83.8	38.4	160.4	58.6	86.4	75.2	-
Annual	**762.1**	**630.8**	**735.4**	**703.4**	**924.4**	**526.8**	-

Source: Bureau of Meteorology (2018)

4. Survey methodology

4.1 Rehabilitation monitoring

Monitoring locations - Previous studies have seen the establishment of six monitoring transects; four transects are located within rehabilitated pastures while the remaining two transects are within treed rehabilitation areas. Additional transects exist as analogue sites in grazed pasture and an undisturbed naturally vegetated area of the property to provide benchmarks against which the pasture and treed rehabilitation areas are assessed. Monitoring locations are shown in Figure 1.

Photopoint monitoring - Coordinates for each transect and analogue site are provided in Appendix A. Each transect area contains previously established photo monitoring points. Photos taken from these points enable a visual comparison to photos from previous surveys and are provided in Appendix E.

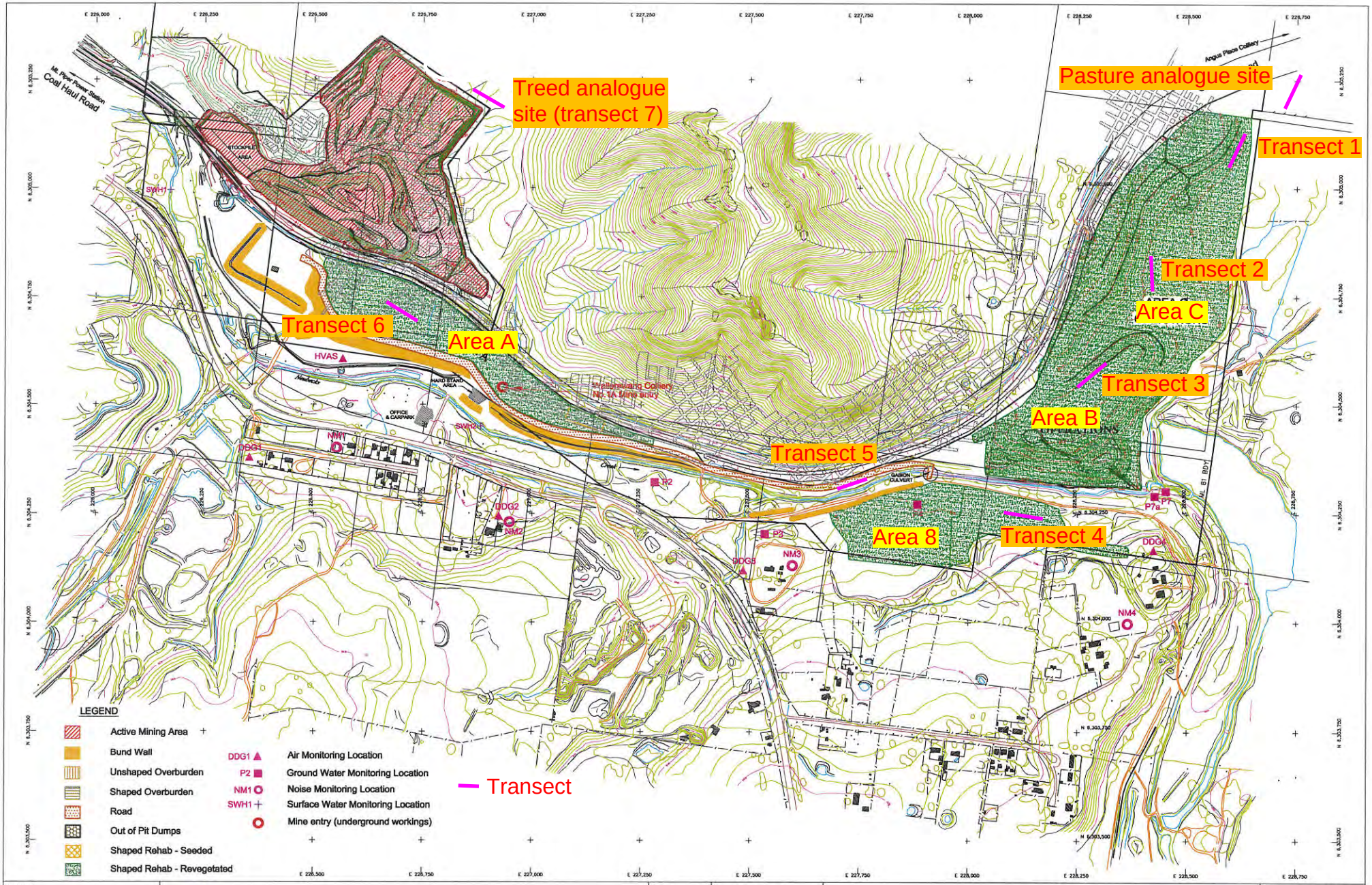
4.2 Erosion and sedimentation

Evidence of erosion and sedimentation along and within the vicinity of each transect has been determined in accordance with *Best Practice Erosion and Sediment Control* (IECA 2006).

4.3 Soil loss

The *Pine Dale Mine Care and Maintenance Mining Operations Plan* (Enhance Place Pty Ltd 2014) recommends that net soil loss be determined in accordance with the *Ecosystem Function Analysis* (CSIRO 2008). This method has been found to be inadequate for determining soil loss in comparison with the widely used *RUSLE* (IEAC Australasia 2012).

An estimation of soil loss at each transect site has been calculated using the *Revised Universal Soil Loss Equation* (RUSLE) (IEAC Australasia 2012). Values used for these calculations are presented in Appendix C.



NOTES:

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DATE	31-12-12
AMENDED	
SURVEYOR	AERIAL PHOTO/TE/TH
DRAWN	K.L.F.
CHECKED	

PINEDALE MINE
AEMR PLAN
END DECEMBER 2012

SCALE - 1 : 4000 (A1 Sheet)

DWG No
PINE-AEMR12

4.4 Vegetation assessment

Pasture rehabilitation areas – Cox's River seed mix was sown in 2010-2011 at Areas B, C and Area 8 at the following rates:

- 40% Fescue *(Festuca spp.)*
- 25% Cocksfoot *(Dactylis glomerata)*
- 20% Subterranean clover *(Trifolium subterranean)*
- 6% Perennial rye grass *(Lolium perene)*
- 5% White clover *(Trifolium repens)*
- 4% Phalaris *(Phalaris aquatica)*

The proportion of perennial grasses and annual legumes currently in evidence at pasture transects has been recorded and compared with the proportion at which these species were initially sown.

Tree rehabilitation areas – The *Pine Dale Mine Care and Maintenance Mining Operations Plan* (Enhance Place Pty Ltd 2014) recommends that vegetation structure be determined in accordance with the *Ecosystem Function Analysis* (CSIRO 2008). This method does not adequately enable the identification of all completion criteria as required by the *Pine Dale Mine Care and Maintenance Mining Operations Plan* (Enhance Place Pty Ltd 2014). Vegetation health, natural regeneration, structure and species composition have instead been determined in accordance with the *Australian Soil and Land Survey Field Handbook* (CSIRO 2009).

4.5 Evidence of fauna and habitat features

Fauna - Evidence of woodland birds and native fauna utilising rehabilitated areas has been recorded through the observation of scats and tracks and sightings.

Habitat features - The presence of nesting boxes, crushed timber piles and rock pile clusters within the rehabilitation areas is noted.

4.6 Pest animal and weed survey

Pest animal presence - Evidence of feral animal presence across the rehabilitation areas has been determined through scat and trail identification.

Priority weeds - The location and extent of priority weeds as declared for the Central Tablelands Region (Central Tablelands Local Land Services, 2017) have been recorded. Target weed species, particularly African Lovegrass were identified in accordance with field guides and botanical keys.

4.7 Fuel loads and fire-fighting access

Fuel loads - Fuel loads within and adjacent to rehabilitation areas have been assessed in accordance with the *Overall Fuel Hazard Assessment Guide* (Department of Sustainability 2010).

Fire-fighting access - Access trails within rehabilitated areas have been assessed in accordance with *Policy No. 2/2007 Fire Trails* (Bush Fire Coordinating Committee 2007).

4.8 Rural land capability assessment

Pasture rehabilitation areas have been assessed in accordance with the *Land and Soil Capability Assessment* (OEH 2007).

4.9 Management input assessment

Land management activities - Land management and soil amelioration activities conducted in the past year have been identified through discussions with the land manager.

Feral animal and weed management - Evidence of feral animal and priority weed control activities have been sought from the land manager and audited against relevant legislative requirements.

5. Field survey results

Field survey was conducted on 10th September 2018 by a qualified ecologist. The survey revisited six transects representing rehabilitated pasture and treed areas as well as pasture and treed analogue sites.

5.1 Erosion and sedimentation

There are no significant erosion features that compromise landform stability or public safety (including gullying or tunneling) within the rehabilitation areas. The presence and extent of active surface erosion within transect areas is recorded in Appendix A.

Pasture rehabilitation areas - The pasture rehabilitation areas support evidence of minor wind erosion where groundcover is poorly established or absent. Isolated occurrences of soil cracking were observed along contours in Transect 3 (see Figures 2 and 3).

Figure 2 Extent of cracking along contour

Figure 3 Soil cracking

Treed rehabilitation areas - Minor wind and rill erosion is occurring at treed rehabilitation areas.

Analogue sites - No active erosion is evident at the pasture and treed analogue sites.

5.2 Soil loss

Rehabilitation activities commenced less than 10 years ago, and it is not yet possible to determine whether net soil loss is comparable to analogue sites at year 10. Estimated annual soil loss at rehabilitated transects is summarised in Table 3. Full calculations are provided in Appendix C.

Table 3 Estimated soil loss due to erosion

Estimated annual soil loss t/ha	Pasture analogue site	Transect 1 (pasture)	Transect 2 (pasture)	Transect 3 (pasture)	Transect 4 (pasture)	Transect 5 (treed)	Transect 6 (treed)	Treed analogue site (transect 7)
	0.09 t/ha	0.09 t/ha	0.09 t/ha	0.18 t/ha	0.03 t/ha	1.46 t/ha	0.36 t/ha	0.0 t/ha

5.3 Vegetation assessment

Flora species identified along and within the vicinity of transects are listed in Appendix D.

Species composition at pasture rehabilitation areas – Pasture rehabilitation areas are established with a mix of 70% perennial grasses and 20% annual legumes and are representative of species composition at the analogue pasture site. Examples of transect 1, 2 and 3 pasture are shown in Figure 4 and Figure 3.

Figure 4 Typical pasture composition of transect 1

Figure 5 Pasture composition representative of transects 2 and 3

Groundcover at pasture rehabilitation areas – Rehabilitated pasture surfaces in each of the transect areas support living groundcover of approximately 90%.

Areas currently exist within each pasture rehabilitation area where groundcover is sparse or absent. It is estimated that these areas account for less than 10% of each pasture area.

Natural regeneration at pasture rehabilitation areas – Natural regeneration of groundcover species is evident across all the pasture rehabilitation areas.

Species composition at treed rehabilitation areas – Treed rehabilitation areas are established in accordance with an approved species mix representing local native species.

Structure of vegetation at treed rehabilitation areas – Structural layers of vegetation at treed rehabilitation areas are not comparable to those of the treed analogue site.

The treed analogue site is characterised by a canopy to 14m height with 20% canopy cover over a sparse shrubby mid-storey to 3m height and isolated shrubs to 1.5m height in the understorey. Groundcover consists of grasses and herbs with a cover of >95% (Figure 6).

Figure 6 Vegetation structure of treed analogue site (transect 7)

Figure 7 Transect 6 vegetation structure

Canopy cover is sparse in treed rehabilitation areas. A sparse mid-storey of isolated juvenile trees and shrubs exists over a sparse, low, shrubby understorey (seen in Figure 6). Groundcover is a mix of broadleaf herbs and grasses. Changes in vegetation structure over time (as shown in Appendix B) are not considered significant.

Groundcover at treed rehabilitation areas – Total living cover within the transect 5 area has fluctuated from 90% in 2014, 50% in 2015, to 70% cover in 2018. Annual cover has decreased from 20% in 2015 to 10% in 2018, while perennial living cover has increased from 30% to 60% in the same period. Litter cover appears to be stable at 10% and the area of bare surface along the transect has decreased from 40% in 2015 to 20% in 2018.

Total living cover at transect 6 has fluctuated between 90% in 2014 to 70% in 2018. Annual living cover is generally stable at around 10%. Perennial cover is at 60% in 2018 and remains within range of fluctuations from 60% in 2015 and 70% in 2017. Litter cover has been stable at 10% from 2015 to 2018 and bare surface has increased from 10% in 2016 to 20% in 2018. See Appendix E for a visual comparison of cover at 2014 and 2018.

Vegetation health at treed rehabilitation areas – Native forest indicator species are those that occur both in treed rehabilitation areas and the treed analogue site and provide an opportunity for comparison of growth between natural and rehabilitation conditions. Indicator species include native trees, shrubs and groundcovers.

More than 20% of native species recorded within the treed analogue site are actively growing in the treed rehabilitation areas. These species are dominated by trees and shrubs and it is expected that groundcovers and herbaceous species will be able to colonise the treed rehabilitation areas once sufficient canopy cover is established.

It is difficult to determine whether native forest indicator tree species on treed rehabilitation areas are within the height and girth measurements of trees on the treed analogue site. While there is evidence of recruitment on the treed analogue site it is not possible to determine the whether the age of juvenile trees is comparable to those establishing on the treed rehabilitation areas.

Natural regeneration of treed rehabilitation areas - There is no evidence of second generation native forest indicator tree or shrub species on treed rehabilitation areas; however natural regeneration of groundcover species is evident.

5.4 Evidence of fauna and habitat features

Field surveys recorded evidence of woodland birds utilising rehabilitation areas. Habitat features are installed on native forest rehabilitation areas including crushed timber rock pile clusters. Nesting boxes have not been installed in treed rehabilitation areas.

Fauna – Macropod, wombat, fox and rabbit scats and tracks were evident throughout the property. Evidence of foraging was observed as shallow diggings in both pasture and treed rehabilitation areas. Logs within the treed analogue and rehabilitation areas showed evidence of scratching.

Native woodland birds were observed landing on trees and foraging within mulch in each of the treed vegetation areas and in the treed analogue site. Generalist birds including Currawong, Magpie and Noisy Miner were observed on the ground within pasture areas A and B and Area 8.

Habitat features – Crushed timber piles and rock pile clusters were observed within the treed rehabilitation areas of transects 5 and 6. Habitat features at the treed analogue site include fallen trees and scattered piles of fallen vegetation.

5.5 Feral animals and weeds

Feral animal and weed species presence and abundance is not considered to adversely impact the intended final land use. Feral animals and priority weeds are controlled in accordance with legislation. Weeds including African Lovegrass comprise <10% of the pasture sward. The presence or evidence of pests and weeds within and in the vicinity of each transect is recorded in Appendix A.

Pest animal presence – Rabbit and fox scats were observed across the property. The European rabbit and European red fox are declared pests under the *Local Land Services Act* 2013. Rabbit and fox density is considered low, with some evidence of shallow soil scraping and scats across each of the monitoring locations. No holes, burrows or dens were observed.

Priority and targeted weed species – Priority weeds observed during field survey are listed in Table 4.

Table 4 Feral animal and priority weed presence

Common name *Species name*	Location	Treatment
European Red Fox *Vulpes vulpes*	All locations	Landholders are obliged to control populations on their land.
European rabbit *Oryctolagus cuniculus*		

Common name *Species name*	Location	Treatment
African lovegrass *Eragrostis curvula*	All locations	All plants are regulated with a general biosecurity duty to prevent, eliminate or minimise any biosecurity risk they may pose. Any person who deals with any plant, who knows (or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable.

The presence of African lovegrass was noted at all locations and occurred across less than 10% of the pasture area. These outbreaks have been subjected to ongoing chemical control and were not observed to be growing or producing seed.

5.6 Fuel loads and fire-fighting access

Fuel loads and fire breaks in and surrounding rehabilitation areas are assessed and maintained in accordance with the Bushfire Management Plan, and adequate access for firefighting is maintained on rehabilitation areas.

Fuel loads – Fuel loads within Areas A, B and C and Area 8 are low and fuel hazard mitigation activities are not required at this time.

Firebreaks - The internal road provides a mineral earth firebreak between Area A and Pine Dale Mine infrastructure to the south, while the Coal Haul Road provides a mineral earth firebreak immediately to the north of Area A. The Coal Haul Road and internal road provide a mineral earth firebreak to the north and west of Areas B and C and Area 8. Private grazing land is located immediately adjacent to the east and south of Areas B and C and Area 8. The majority of this interface supports mature Pine and Eucalypt trees which would provide a barrier to wind-borne embers spreading to private grazing land during a fire event.

Fire-fighting access - Access to each of the rehabilitation areas is considered to be adequate. The Coal Haul Road is a private road located immediately to the north of Areas A, B and C and Area 8 and allows movement from within Wallerawang Power Station, through Pine Dale Mine and to Mount Piper Power Station. An internal road is located immediately to the south of Areas A and B and to the north of Area 8. This road connects to Castlereagh Highway through the administration area of Pine Dale Mine. Area C is accessible by following the internal road through Area B. All access roads within rehabilitated areas are maintained in good condition and are suitable for the passage of Category 1 tankers, having a vertical clearance of >4m and a width of >2.8m (*Policy No. 2/2007 Fire Trails* (Bush Fire Coordinating Committee 2007)).

5.7 Rural land capability assessment

Pasture rehabilitation areas are assessed to have a Rural Land Capability Class VI or better (suitable for grazing).

Pasture rehabilitation areas are assessed as being Land and Soil Capability Class V and are suitable for grazing. The limiting factors for land use are generally related to wind erosion hazard. Note that the area of transect 4 is also subject to soil acidification hazard due to soil texture (Table 5).

Table 5 Rural land capability assessment of pasture areas

Class	Transect 1	Transect 2	Transect 3	Transect 4
Water erosion hazard class	2 1 - <3% slope	3 3 - <10% slope	4 10 - <20% slope, no gully erosion present	2 1 - <3% slope
Wind erosion hazard class	5 Moderate wind erodibility class of surface soil, high winds erosive power, high exposure to wind, average annual rainfall >500mm			
Soil structural decline class	4 Fragile light textured soil - hardsetting			
Soil acidification hazard class	4 Very low texture /buffering capacity, pH 6.7 – 7.5 ($CaCl_2$)			5 Very low texture /buffering capacity, pH 4.0 – 4.7 ($CaCl_2$)
Salinity hazard class	1 Moderate to high recharge potential, low discharge potential, low salt store			
Waterlogging hazard class	2 0 – 0.25 months typical waterlogging duration, moderately well drained soils			
Shallow soils and rockiness hazard class	1 Nil rocky outcrop, soil depth >100cm			
Mass movement hazard class	1 No mass movement present			

5.8 Management input assessment

Management inputs (ameliorants, fertilisers, weed treatments) are within the range of analogue sites.

Control of priority and targeted weed species has been undertaken across all rehabilitation areas as required and in accordance with the recommendations of the *Pine Dale Mine Rehabilitation Monitoring Report 2014* (First Field Environmental 2014).

6. Rehabilitation status

The status of performance indicators and completion criteria are summarised in Table 6.

Table 6 Status of completion criteria

Performance indicator	Completion criteria	Status
Feral animal and priority weed presence	• Feral animal and weed species presence and abundance is not considered to adversely impact the intended final land use.	• **Satisfactory** – continue to monitor
Feral animal and priority weed control	• Feral animals and priority weeds are controlled in accordance with legislation.	• **Satisfactory** – continue to monitor

Performance indicator	Completion criteria	Status
Fuel loads	• Fuel loads and fire breaks in and surrounding rehabilitation areas are assessed and maintained in accordance with the Bushfire Management Plan.	• **Satisfactory** – continue to monitor
Access	• Adequate access for firefighting is maintained on rehabilitation areas.	• **Satisfactory** – continue to monitor
Habitat features	• Habitat features are installed on native forest rehabilitation areas including: - Nesting boxes and salvaged hollows - Crushed timber spread over native forest rehabilitation areas - Rock pile clusters.	• **Ongoing** - nesting boxes to be installed once trees are established
Vegetation health	• More than 75% of native forest indicator species are assessed to be healthy and growing at year 5.	• **Satisfactory** – continue to monitor
	• Native forest indicator species tree height and girth is within the range of analogue sites.	• **Ongoing** – continue to monitor
Soil loss	• Net annual soil loss is comparable to analogue sites at year 10.	• **Ongoing** – continue to monitor
Erosion	• There are no significant erosion features that compromise landform stability or public safety (including gullying or tunneling).	• **Ongoing** – soil cracking has occurred at transect 3
Woodland birds present	• Evidence of woodland birds utilising rehabilitation areas.	• **Satisfactory** – continue to monitor
Evidence of mammals	• Evidence of target mammal species presence in rehabilitation areas.	• **Satisfactory** – continue to monitor
Natural regeneration	• Evidence of second generation of native forest indicator species from desired vegetation community.	• **Ongoing** – continue to monitor
	• Evidence of natural regeneration of at least four pasture species at year 5.	• **Satisfactory** – continue to monitor
Structure	• Structural layers (canopy, mid-storey, understorey and ground cover) are comparable to analogue sites.	• **Ongoing** – continue to monitor
Management inputs	• Management inputs (ameliorants, fertilisers, weed treatments) are within the range of analogue sites.	• **Satisfactory** – continue to monitor
Rural land capability	• Pasture rehabilitation areas are assessed to have a Rural Land Capability Class VI or better (suitable for grazing).	• **Satisfactory** – continue to monitor

Performance indicator	Completion criteria	Status
Species composition	• Establishment of pasture comprising approximately 70% perennial grass and 20% annual legume, representative of species at analogue sites. • Vegetation within the treed rehabilitation areas is established in accordance with the approved species mix. • Approved pasture species mix is sown at the specified rate per hectare.	• **Satisfactory** – continue to monitor • **Satisfactory** – continue to monitor • **Satisfactory** – continue to monitor
Weed presence	• Weeds including African lovegrass to comprise <10% of the pasture sward.	• **Satisfactory** – continue to monitor
Ground cover	• Ground cover (vegetation, leaf litter, mulch) >70% at year 5.	• **Satisfactory** – continue to monitor

7. Key findings

- No significant change in total living ground cover has occurred in the last 12 months at pasture transects.
- Rehabilitated pastures are consistent with the structure and complexity of pasture at the analogue site.
- Soil cracking has occurred along contours in Transect 3.
- Total living cover at the treed rehabilitation area of transect 5 has fluctuated from 90% in 2014 to 70% in 2018.
- Annual cover at transect 5 has decreased from 20% in 2015 to 10% in 2018, while perennial living cover has increased from 30% to 60% over the same period; indicating that the vegetation community is maturing.
- Bare surface at transect 5 has increased from 10% in 2016 to 20% in 2018 and is likely a response to decreasing annual species.
- Total living ground cover at transect 6 has decreased from 90% in 2014 to 70% in 2018.
- Perennial ground cover has decreased at transect 6 from 70% in 2016 to 60% in 2018.
- There is no evidence of second generation establishment at treed rehabilitation areas.
- Nesting boxes are not installed in or adjacent to the treed rehabilitation areas.
- The increased height and structural complexity at the treed analogue site (transect 7) is consistent with a maturing vegetation community.
- Fuel loads across the property do not pose a hazard to assets or access.

8. Recommendations

The following recommendations for mitigation and management are consistent with intervention and adaptive management measures contained within the *Pine Dale Mine Care and Maintenance Mining Operations Plan* (Enhance Place Pty Ltd 2014).

- Continue to monitor performance indicators;
- Continue to spot-spray outbreaks of African lovegrass;
- Fill surface cracks along contours of transect 3; and
- Install nesting boxes once the treed rehabilitation areas contain adequate structure to support nesting woodland birds.

9. References

BFCC (2007) *Policy No. 2/2007 Fire Trails*, Bush Fire Coordinating Committee, Australia

Bureau of Meteorology (2018) *Weather data Lidsdale (Maddox Lane) NSW*, http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=063132

Central Tablelands Local Land Services (2017) *Central Tablelands Regional Strategic Weed Management Plan 2017-2022*

CSIRO (2008) *Ecosystem Function Analysis,* CSIRO, Australia

CSIRO (2009) *Australian Soil and Land Survey Field Handbook*, CSIRO, Australia

Cunningham, G (2012) *Flora Monitoring Report: Pine Dale Mine – February 2010 to November 2010*, Geoff Cunningham Natural Resource Consultants Pty Ltd, Killara NSW

DSE (2010) Overall Fuel Hazard Assessment Guide, Department of Sustainability and Environment, VIC

Enhance Place Pty Ltd (2014) *Pine Dale Mine Care and Maintenance Mining Operations Plan*, Enhance Place Pty Ltd, NSW

First Field Environmental (2017) *Pine Dale Mine Rehabilitation Monitoring Report*, First Field Environmental, NSW

IECA (2008) *Best Practice Erosion and Sediment Control,* International Erosion Control Association (Australasia)

NSW DPI (2016) *Rabbit Control*, New South Wales Department of Primary Industries, http://www.dpi.nsw.gov.au/content/agriculture/pests-weeds/vertebrate-pests/pest-animals-in-nsw/rabbit-control

OEH (2007) *Land and Soil Capability Assessment*, Office of Environment and Heritage, NSW

SLR (2014) *Soil Assessment and Recommendations for Rehabilitation Areas*, NSW

Appendix A
Survey data 2018

Pasture analogue site (Pine Dale Mine)	
Easting	Northing
228300	6304880
228317	6304925
Landform and soils	
Slope	1 - <3% slope inclining to the northwest.
Erosion	Not observed.
Cracking soils	Not observed.
Surface drainage impediments	No significant drainage impediments.
Vegetation	
Vegetation structure	Groundcover of mixed native and exotic grasses and broadleaf herbs.
Species richness	>30 herb and 15 grass species identified.
Cover classification 2015	
Total living cover	>90%
Annual living cover	40%
Perennial living cover	50%
Litter cover	<10%
Bare surface	-

Transect 1 Pasture rehabilitation area					
Easting			Northing		
228621			6305093		
228594			6305048		
Landform and soils					
Slope	Transect located along a contour. 1 - <3% slope inclining to the northwest.				
Erosion	Minor wind erosion observed on exposed soils.				
Cracking soils	Not observed.				
Surface drainage impediments	No significant drainage impediments.				
Vegetation					
Vegetation structure	Groundcover of mixed native exotic grasses and broadleaf herbs.				
Species richness	>30 herbs and grasses identified, dominated by exotic species.				
Cover classification	% cover at each observation				
	April 2014	September 2015	September 2016	September 2017	September 2018
Total living cover	90%	80%	95%	90%	90%
Annual living cover	-	40%	47.5%	40%	40%
Perennial living cover	-	50%	47.5%	50%	50%
Litter cover	10%	-	-	<10%	10%
Bare surface	-	20%	5%	<10%	10%
Target weed presence					
African Lovegrass (*Eragrostis curvula)*	<10%				

Transect 2 Pasture rehabilitation area					
Easting			Northing		
228454			6304718		
228400			6304744		
Landform and soils					
Slope	Transect located along a contour. 3 - <10% slope inclining to the west.				
Erosion	Minor wind erosion observed on exposed soils.				
Cracking soils	Not observed.				
Surface drainage impediments	No significant drainage impediments.				
Vegetation					
Vegetation structure	Groundcover of mixed native exotic grasses and broadleaf herbs.				
Species richness	>30 herbs and grasses identified, dominated by exotic species.				
Cover classification	% cover at each observation				
	April 2014	September 2015	September 2016	September 2017	September 2018
Total living cover	90%	80%	90%	90%	90%
Annual living cover	-	40%	42%	40%	40%
Perennial living cover	-	50%	48%	50%	50%
Litter cover	10%	-	-	<10%	10%
Bare surface	-	20%	10%	<10%	10%
Target weed presence					
African Lovegrass (*Eragrostis curvula)*	<10%				

Transect 3 Pasture rehabilitation area					
Easting			Northing		
228267			6304532		
228306			6304560		
Landform and soils					
Slope	Transect located along a contour. 10 - <20% slope declining to the northwest.				
Erosion	Minor wind erosion observed on exposed soils.				
Cracking soils	Minor cracking observed along contours.				
Surface drainage impediments	No significant drainage impediments.				
Vegetation					
Vegetation structure	Groundcover of mixed native and exotic grasses and broadleaf herbs.				
Species richness	>30 herbs and grasses recorded, dominated by exotic species.				
Cover classification	% cover at each observation				
	April 2014	September 2015	September 2016	September 2017	September 2018
Total living cover	90%	80%	90%	90%	90%
Annual living cover	-	40%	46%	40%	40%
Perennial living cover	-	50%	44%	50%	50%
Litter cover	10%	-	-	<10%	10%
Bare surface	-	20%	10%	<10%	10%
Target weed presence					
African Lovegrass (*Eragrostis curvula)*	<10%				

Transect 4 Pasture rehabilitation area					
Easting			Northing		
228318			6304224		
228249			6304227		
Landform and soils					
Slope	Transect located along a contour. 1 - <3% slope declining to the west.				
Erosion	Minor wind erosion observed on exposed soils.				
Cracking soils	Not observed.				
Surface drainage impediments	No significant drainage impediments.				
Vegetation					
Vegetation structure	Groundcover of mixed native exotic grasses and broadleaf herbs.				
Species richness	Diverse groundcover with >30 exotic herb and grass species recorded.				
Cover classification	% cover at each observation				
	April 2014	September 2015	September 2016	September 2017	September 2018
Total living cover	90%	80%	90%	90%	90%
Annual living cover	-	40%	42%	30%	30%
Perennial living cover	-	50%	48%	60%	60%
Litter cover	10%	-	-	<10%	10%
Bare surface	-	20%	10%	<10%	10%
Target weed presence					
African Lovegrass (*Eragrostis curvula)*	<10%				

Transect 5 Treed rehabilitation area					
Easting	Northing				
227846	6304272				
227787	6304251				
Landform and soils					
Slope	Transect located along contour of mid slope inclining 10-20% to the north.				
Erosion	Minor wind and rill erosion observed on exposed soils.				
Cracking soils	Not present.				
Surface drainage impediments	No significant drainage impediments.				
Vegetation					
Vegetation structure	Sparse tree layer to 3m height with scattered juvenile trees and sparse mixed native shrub species. Dense groundcover dominated by native and exotic grasses with scattered mixed native and exotic herbs.				
Species richness	Shrub layer is dominated by native species and juvenile trees. Groundcover dominated by exotic broadleaf herbs and grasses. >15 species recorded.				
Cover classification	% cover at each observation				
	April 2014	September 2015	September 2016	September 2017	September 2018
Total living cover	90%	50%	75%	70%	70%
Annual living cover	-	20%	12%	10%	10%
Perennial living cover	-	30%	63%	60%	60%
Litter cover	10%	10%	10%	10%	10%
Bare surface	-	40%	15%	20%	20%
Target weed presence					
None observed.					

Transect 6 Treed rehabilitation area					
Easting	Northing				
226604	6304724				
226647	6304706				
Landform and soils					
Slope	Transect located along contour of mid slope inclining 10-20% to the northeast.				
Erosion	Minor wind and rill erosion observed on exposed soils.				
Cracking soils	Not observed.				
Surface drainage impediments	No significant drainage impediments.				
Vegetation					
Vegetation structure	Sparse tree layer to 3m height with scattered juvenile trees and sparse mixed native shrub species. Moderately dense groundcover dominated by native and exotic grasses with scattered mixed native and exotic herbs.				
Species richness	Shrub layer is dominated by native species and juvenile trees. Groundcover dominated by exotic broadleaf herbs and grasses. >15 species recorded.				
Cover classification	% cover at each observation				
	April 2014	September 2015	September 2016	September 2017	September 2018
Total living cover	90%	70%	80%	80%	70%
Annual living cover	-	10%	12%	10%	10%
Perennial living cover	-	60%	68%	70%	60%
Litter cover	10%	10%	10%	10%	10%
Bare surface	-	20%	10%	10%	20%
Target weed presence					
None observed.					

Treed analogue site (transect 7)	
Easting	Northing
226801	6305097
226838	6305039
Landform and soils	
Slope	Transect located along contour of mid slope gently inclining to the north.
Erosion	No erosion observed.
Cracking soils	Not observed.
Surface drainage impediments	No drainage impediments.
Vegetation	
Vegetation structure	Eucalyptus dominated canopy to 14m high with a canopy cover of 20%. Sparser shrub layer to 3m height. >95% groundcover to 0.5m height, dominated by native grasses with mixed native herbs.
Species richness	More than 10 tree species, dominated by *Eucalyptus* spp. Shrub layer of >14 native species. Diverse groundcover dominated by *Poa* spp. with mixed native herbs.
Cover classification	
Total living cover	95%
Annual living cover	10%
Perennial living cover	80%
Litter cover	5%
Bare surface	-
Target weed presence	
None observed.	

Appendix B
Vegetation assessment of treed areas

Vegetation assessment treed areas 2018

Transect	Treed rehabilitation area (transect 5)	Treed rehabilitation area (transect 6)	Treed analogue site (transect 7)
Vegetation type	Rehabilitated	Rehabilitated	Dry Sclerophyll Forest (grassy)
Native plant species richness	>30	>30	>50
Trees	Sparse. To 3 m height.	Sparse. To 3 m height.	>10 species, 12-14 m height. 20% canopy cover.
Understorey	Sparse, to 2 m height. Includes juvenile Eucalyptus and Acacia species.	Sparse, to 3 m height. Includes juvenile Eucalyptus and Acacia species.	>14 species, 1-3 m height, 10% cover
Groundcover	70% cover. Mix of exotic grasses, native and exotic herbs.	Dominated by exotic grasses and herbs. Some native herbs present. 80% cover.	Dominated by *Poa* spp. >95% cover. Mixed herbs and grasses also present.
Non-native species	>10	>10	<5
Recruitment	Not observed.	Not observed.	Observed.
Organic litter	Very sparse layer of mulch remaining.	Very sparse layer of mulch remaining.	Well-developed to 2 cm depth.
Logs	Large logs placed along contours on upper slope.	Large logs placed along contours on upper slope.	>10 fallen logs of >20 cm diameter present along transect.

Vegetation assessment treed areas 2017

Transect	Treed rehabilitation area (transect 5)	Treed rehabilitation area (transect 6)	Treed analogue site (transect 7)
Vegetation type	Rehabilitated	Rehabilitated	Dry Sclerophyll Forest (grassy)
Native plant species richness	>30	>30	>50
Trees	Sparse. To 3 m height.	Sparse. To 3 m height.	>10 species, 12-14 m height. 20% canopy cover.
Understorey	Sparse, to 2 m height. Includes juvenile Eucalyptus and Acacia species.	Sparse, to 3 m height. Includes juvenile Eucalyptus and Acacia species.	>9 species, 1-2 m height, 10% cover
Groundcover	70% cover. Mix of exotic grasses, native and exotic herbs.	Dominated by exotic grasses and herbs. Some native herbs present. 80% cover.	Dominated by *Poa* spp. >95% cover. Mixed herbs and grasses also present.
Non-native species	>10	>10	<5
Recruitment	Not observed.	Not observed.	Observed.
Organic litter	Very sparse layer of mulch remaining.	Very sparse layer of mulch remaining.	Well-developed to 2 cm depth.
Logs	Large logs placed along contours on upper slope.	Large logs placed along contours on upper slope.	8 fallen logs of >20 cm diameter present along transect.

Vegetation assessment treed areas 2016

Transect	Treed rehabilitation area (transect 5)	Treed rehabilitation area (transect 6)	Treed analogue site (transect 7)
Vegetation type	Rehabilitated	Rehabilitated	Dry Sclerophyll Forest (grassy)
Native plant species richness	>30	>30	>50
Trees	Sparse. To 3 m height.	Sparse. To 3 m height.	>10 species, 12-14 m height. 20% canopy cover.
Understorey	Sparse, to 2 m height. Juvenile Eucalyptus and Acacia species.	Sparse, to 3 m height. Juvenile Eucalyptus and Acacia species.	>9 species, 1-2 m height, 10% cover
Groundcover	75% cover. Mix of exotic grasses, native and exotic herbs.	Dominated by exotic grasses and herbs. Some native herbs present. 80% cover.	Dominated by *Poa* spp. >95% cover. Mixed herbs and grasses also present.
Non-native species	>15	>13, including *Senecio madagascariensis.*	<10
Recruitment	Not observed.	Not observed.	Present
Organic litter	Very sparse layer of mulch remaining.	Very sparse layer of mulch remaining.	Well-developed to 2 cm depth.
Logs	Large logs placed along contours on upper slope.	Large logs placed along contours on upper slope.	8 fallen logs of >20 cm diameter present along transect.

Vegetation assessment treed areas 2015

Transect	Treed rehabilitation area (transect 5)	Treed rehabilitation area (transect 6)	Treed analogue site (transect 7)
Vegetation type	Rehabilitated	Rehabilitated	Dry Sclerophyll Forest (grassy)
Native plant species richness	>30	>30	>50
Trees	Sparse. To 3 m height.	Sparse. To 3 m height.	>5 species, 12-14 m height. 20% canopy cover.
Understorey	Sparse, to 2 m height. Juvenile Eucalyptus and Acacia species. *Cassinia arcuata.*	Sparse, to 2 m height. Juvenile Eucalyptus and Acacia species. *Cassinia arcuata.*	>7 species, 1-2 m height, 10% cover
Groundcover	<40%. Mix of exotic grasses, native and exotic herbs.	Dominated by exotic grasses and herbs. Some native herbs present. 20% cover.	Dominated by *Poa* spp. >95% cover. Mixed herbs and grasses also present.
Non-native species	>10, including *Rubus fruticosus.*	>10	<10
Recruitment	Not observed.	Not observed.	Present
Organic litter	Thin mulch present.	Thin mulch present.	Well-developed to 2 cm depth.
Logs	Large logs placed along contours on upper slope.	Large logs placed along contours on upper slope.	8 fallen logs of >20 cm diameter present along transect.

Vegetation assessment treed areas 2014

Transect	Treed rehabilitation area (transect 5)	Treed rehabilitation area (transect 6)	Treed analogue site (transect 7)
Vegetation type	Rehabilitated	Rehabilitated	Dry Sclerophyll Forest (grassy)
Native plant species richness	>30	>30	>50
Trees	Sparse. To 3m height.	Sparse. To 3m height.	>5 species, 12-14 m height. 40% canopy cover.
Understorey	Sparse. Juvenile Eucalyptus spp. present with Acacia shrubs.	Sparse. Juvenile Eucalyptus spp. present with Acacia shrubs.	>7 species, 1.5 - 3 m height, 35% cover
Groundcover	Sparse. Mix of exotic grasses, native and exotic herbs.	Sparse. Mix of exotic grasses, native and exotic herbs.	70% cover. Dominated by *Poa* spp. with mixed native herbs.
Non-native species	>10	>10	<10
Recruitment	Not observed.	Not observed.	Present
Organic litter	Thin mulch present.	Thin mulch present.	Well-developed to >2cm depth.
Logs	Large logs placed along contours on upper slope.	Large logs placed along contours on upper slope.	8 fallen logs of >20 cm diameter present along transect.

Appendix C
Estimation of annual soil loss in pastures

Annual soil loss factors	Pasture analogue site	Transect 1 (pasture)	Transect 2 (pasture)	Transect 3 (pasture)	Transect 4 (pasture)	Transect 5 (treed)	Transect 6 (treed)	Treed analogue site (transect 7)
Annual rainfall erosivity factor **(R)**	**1365** Bathurst							
Soil erodibility factor **(K)**	**0.03** Sandy loam /fine sandy loam				**0.025** Sandy clay-loam			**0.03** Sandy loam /fine sandy loam
Topographic factor **(LS)**	**0.17** 3% gradient, 5m slope length			**0.34** 8% gradient, 5m slope length	**0.09** 1% gradient, 5m slope length	**0.89** 20% gradient, 5m slope length		**0.52** 12% gradient, 5m slope length
Cover and management factor **(C)**	**0.01** No appreciable canopy cover, 80-95% grassy groundcover					**0.04** 25% canopy cover of tall weeds or short brush, 60-80% grassy groundcover	**0.01** 25% canopy cover of tall weeds or short brush, 80-95% grassy groundcover	**0.00** Consistent with 40% canopy cover of trees and 95% grassy groundcover
Erosion control practice factor **(P)**	**1.3** Compacted					**1.2** Consistent with trackwalking along contour		**1.3** Compacted
Annual soil loss due to erosion **(A)**	**0.09 t/ha**	**0.09 t/ha**	**0.09 t/ha**	**0.18 t/ha**	**0.03 t/ha**	**1.46 t/ha**	**0.36 t/ha**	**0.0 t/ha**

Appendix D
Species list

Scientific name	Transect 1	Transect 2	Transect 3	Transect 4	Transect 5	Transect 6	Treed analogue site (Pine Dale Mine transect 7)
Acacia dealbata subsp. *dealbata*					X	X	X
Acacia nana					X	X	
Acacia parramattensis						X	
Acacia rubida					X	X	X
Acacia sp.					X	X	X
Acacia spectabilis						X	
Acacia ulcifolia							X
Ajuga australis							X
Amaranthus sp.	X	X	X	X	X	X	
Brassica juncea	X	X	X	X	X	X	
Bursaria spinosa subsp. *lasiophylla*					X	X	X
Calandrinia calyptrata							X
Cassinia arcuata						X	
Cirsium vulgare	X	X	X	X			
Conyza bonariensis	X	X	X	X	X	X	
Crassula sp.					X		
Dactylis glomerata	X	X	X	X			
Desmodium varians							X
Dillwynia phylicoides							X
Eragrostis sp.	X	X	X	X			
Eucalyptus cypellocarpa						X	
Eucalyptus dalrympleana subsp. *dalrympleana*							X

Scientific name	Transect 1	Transect 2	Transect 3	Transect 4	Transect 5	Transect 6	Treed analogue site (Pine Dale Mine transect 7)
Eucalyptus dealbata						X	
Eucalyptus dives					X	X	X
Eucalyptus mannifera subsp. *mannifera*							X
Eucalyptus pulverulenta						X	
Eucalyptus radiata subsp. *radiata*						X	
Eucalyptus rubida subsp. *rubida*							X
Festuca arundinacea	X	X	X	X			
Festuca sp.	X	X	X	X			
Gamochaeta sp.	X	X	X	X			
Geranium sp.				X			X
Gompholobium huegelii							X
Goodenia hederacea							X
Hibbertia aspera subsp. *aspera*							X
Hibbertia obtusifolia							X
Hypochaeris radicata	X	X	X	X	X	X	
Juncus spp.		X					
Leucopogon sp.							X
Lissanthe strigose subsp. *subulata*							X
Lomandra filiformis							X
Medicago sp.	X	X	X	X			
Oxalis corniculata	X	X	X				
Paspalum sp.				X	X		
Persoonia laurina							X

Scientific name	Transect 1	Transect 2	Transect 3	Transect 4	Transect 5	Transect 6	Treed analogue site (Pine Dale Mine transect 7)
Phalaris aquatica	X	X	X	X			
Pinus sp.							X
Plantago lanceolata	X	X	X	X	X	X	
Poa annua	X	X	X	X			X
Poa labillardierei							X
Poa spp.	X	X	X	X	X	X	X
Ranunculus lappaceus							X
Ranunculus sp.	X	X	X	X	X	X	
Rumex acetosella	X	X			X	X	
Sonchus oleraceus	X	X	X	X			
Taraxacum officinale				X			
Themeda australis							X
Trifolium arvense	X	X	X	X			
Trifolium repens	X	X	X	X			
Trifolium subterraneum	X	X	X	X			
Veronica calycina							X
Vicia sp.					X	X	
Vulpia sp.	X	X	X	X			

Appendix E
Photopoint monitoring to 2018

Transect 1 looking south 2014

Transect 1 looking south 2015

Transect 1 looking south 2016

Transect 1 looking south 2017

Transect 1 looking south 2018

Transect 2 looking southeast 2014

Transect 2 looking southeast 2015

Transect 2 looking southeast 2016

Transect 2 looking southeast 2017

Transect 2 looking southeast 2018

Transect 3 looking southwest 2014

Transect 3 looking southwest 2015

Transect 3 looking southwest 2016

Transect 3 looking southwest 2017

Transect 3 looking southwest 2018

Transect 4 looking west 2014

Transect 4 looking west 2015

Transect 4 looking west 2016

Transect 4 looking west 2017

Transect 4 looking west 2018

Transect 5 looking west 2014

Transect 5 looking west 2015

Transect 5 looking west 2016

Transect 5 looking west 2017

Transect 5 looking west 2018

Transect 6 looking east 2014

Transect 6 looking east 2015

Transect 6 looking east 2016

Transect 6 looking east 2017

Transect 6 looking east 2018

Transect 7 looking east 2014

Transect 7 looking east 2015

Transect 7 looking east 2016

Transect 7 looking east 2017

Transect 7 looking east 2018

Quadrat 1 February 2010 (Cunningham 2012)

Quadrat 1 September 2011 (Cunningham 2012)

Quadrat 1 November 2012 (Cunningham 2012)

Quadrat 1 April 2014

Quadrat 1 September 2015

Quadrat 1 September 2016

Quadrat 1 September 2017

Quadrat 1 September 2018

APPENDIX D

PINE DALE MINE REHABILITATION AND COMPLETION ASSESSMENT REPORT

PINE DALE MINE

Rehabilitation and Completion Assessment

Prepared for:

Enhance Place Pty Ltd
PO Box 202
Wallerawang NSW 2790

SLR Ref: 630.12362-R01
Version No: -v1.0
December 2018

PREPARED BY

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Enhance Place 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.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
630.12362-R01-v1.0	20 December 2018	Nathan Archer	Murray Fraser	Nathan Archer

EXECUTIVE SUMMARY

Energy Australia (EA) owns Enhance Place Pty Limited (Enhance Place) which owns and operates the Pine Dale Mine and Enhance Place Mine near Lithgow in the Western Coalfields of New South Wales (NSW).

The Pine Dale Mine has been under care and maintenance since approved mining resources were exhausted in 2014. Since that time, extensive work has been undertaken to rehabilitate the degraded former mining areas back to an approved final land use which is commensurate with the surrounding area. Enhance Place has rehabilitated Areas C and 8 at the Pine Dale Mine back to pasture for agricultural purposes, including grazing. Enhance Place has undertaken a strategic approach to the rehabilitation of the Pine Dale Mine, consistent with NSW Government recommendations and best practice environmental management.

In 2014, Enhance Place engaged SLR to undertake an assessment of the status of rehabilitated pasture areas to identify measures required to improve the productivity of pasture areas. The assessment identified appropriate soil amelioration and management measures would improve soil quality and rehabilitation performance over the long term. Based on the findings and recommendations of the assessment Enhance Place developed and implemented a targeted rehabilitation works and monitoring program which was incorporated into the *Pine Dale Care and Maintenance Mining Operations Plan* (MOP) (Enhance Place, 2017).

In addition, Enhance Place has engaged FirstField Environmental to undertake annual rehabilitation monitoring and to make further recommendations for improving rehabilitation performance. The results of the rehabilitation monitoring have been reported in the Annual Review for the site with an ongoing works program being implemented by Enhance Place to incorporate the additional recommendations.

Rehabilitation works undertaken at the Pine Dale Mine have included:

- Construction of final landform and water management / erosion and sediment control structures;
- Seeding with approved pasture mixture known as '*Cox's River Mix*':
- Lime amelioration to raise soil pH and provide improved soil conditions to promote pasture growth;
- Application of Muriate of Potash (MOP) at 0.25 tonnes/ha and di-ammonium phosphate (DAP) at 0.20 tonnes/ha;
- Weed spraying to control noxious weeds including African Lovegrass;
- Ripping of furrows along poorly vegetated areas followed by direct reseeding;
- Reseeding of exposed areas with pasture seed mix; and
- Application of additional seed, fertiliser and compost at recommended rates, where required;

These works have improved soil nutrient parameters, ground cover and pasture composition within the rehabilitation areas whilst also reducing erosion and weed presence. Rehabilitation monitoring results and soil nutrient analysis have shown that the rehabilitation within all the areas has now been completed to a standard where the approved rehabilitation objectives and completion criteria specified in the MOP have been achieved. As such, Enhance Place is seeking to partially relinquish the relevant mining leases covering these areas and seeks confirmation that rehabilitation has been successfully completed to the satisfaction of the Department.

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1 Introduction

Energy Australia (EA) owns Enhance Place Pty Limited (Enhance Place) which owns and operates the Pine Dale Mine and Enhance Place Mine near Lithgow in the Western Coalfields of New South Wales (NSW).

The Pine Dale Mine has been under care and maintenance since approved mining resources were exhausted in 2014. Since that time, extensive work has been undertaken to rehabilitate the degraded former mining areas back to an approved final land use which is commensurate with the surrounding area. Works undertaken by Pine Dale Mine have improved soil nutrient parameters, ground cover and pasture composition within the rehabilitation areas whilst also reducing erosion and weed presence. Rehabilitation has been completed to a standard where the completion criteria approved within the *Pine Dale Care and Maintenance Mining Operations Plan* (MOP) (Enhance Place, 2017) have been met and rehabilitation is considered complete. As such Enhance Place is seeking to partially relinquish the mining lease covering these areas.

This report has been prepared to support an application to the Department of Planning and Environment – Resource Regulator (DPE-RR) for the partial relinquishment of Mining Lease 1578. This report confirms that the rehabilitation objectives approved under the MOP have been achieved. Pine Dale Mine therefore seek confirmation that rehabilitation has been successfully completed to the satisfaction of the Department.

The report has been prepared in accordance with the requirements of *Form ESF2: Rehabilitation Completion and/or Review of Rehabilitation Cost Estimate* (DRE 2017). It includes a description of the rehabilitation activities undertaken and evidence of meeting the approved rehabilitation objectives and completion criteria specified in the MOP.

2 Background and Justification for Relinquishment

Pine Dale Mine operates under Project Approval (PA) 10_0041, dated 20 February 2011 granted by the then Department of Planning and Infrastructure (DP&I) under Section 75J of the Environmental Planning and Assessment Act 1979 (EP&A Act). The PA provided for the extraction of up to 800,000 tonnes (t) of Run-of-Mine (ROM) coal from the Yarraboldy Extension at Pine Dale Mine through to 31 December 2014 at a maximum rate of 350,000 tonnes per annum (tpa).

Approved mining resources at the Pine Dale Mine were exhausted in March 2014. The mine has been under care and maintenance since April 2014 with only rehabilitation activities undertaken at the site. Rehabilitation activities have been undertaken with the intention of improving rehabilitation areas to an appropriate standard to be relinquished. Enhance Place has undertaken a strategic approach to the rehabilitation of the Pine Dale Mine, consistent with NSW Government recommendations and best practice environmental management.

In 2014, an assessment of the status of rehabilitation was undertaken by SLR to identify measures improve the productivity of pasture areas and to progress towards the desired objective of establishing sustainable grazing to a standard appropriate to relinquish the mining lease. The assessment identified appropriate soil amelioration and management measures would improve soil quality and rehabilitation performance over the long term. Additionally the assessment established soil performance indicators using site specific characteristics and baseline data from undisturbed analogue sites.

The results and recommendations of the assessment were presented in the *Soil Assessment and Recommendations for Rehabilitated Areas – Pine Dale Mine and Enhance Place Mine* (SLR, 2014). Based on the findings and recommendations of the assessment Enhance Place developed and implemented a targeted rehabilitation works and monitoring program which was incorporated into the MOP (Enhance Place, 2017).

Enhance Place engaged FirstField Environmental to undertake annual monitoring of the progress of rehabilitation and to make further recommendations for improving rehabilitation performance. The results of the rehabilitation monitoring have been reported in the Annual Review for the site with an ongoing works program being implemented by Enhance Place to incorporate any additional recommendations. The findings of the 2017 Annual Rehabilitation Monitoring Report (FirstField Environmental, 2017) are included as **Appendix A** and are summarised in **Section 8.1** of this report.

A further rehabilitation assessment and soil sampling program was undertaken by SLR in March 2018 to determine if the site had progressed to a relinquishable standard. The findings of the inspection are presented in *Assessment of Rehabilitated Areas – Pine Dale and Enhance Place Mine,* (SLR 2018) (**Appendix B**) and are summarised in **Section 8.2** of this report. The inspection showed that works undertaken have improved soil nutrient parameters, ground cover and pasture composition within the rehabilitation areas whilst also reducing erosion and weed presence.

As presented in this report, through the implementation of all appropriate recommendations, Enhance Place has rehabilitated Areas C and 8 at the Pine Dale Mine back to pasture for agricultural purposes, including grazing. Rehabilitation monitoring results and soil nutrient analysis has shown that the rehabilitation within all the areas has met or exceeded the approved rehabilitation objectives and completion criteria specified in the MOP.

3 Reference Documents

The following documents have been referred to in the preparation of this report:

- Pine Dale Care and Maintenance MOP (Enhance Place 2017);
- Pine Dale Mine Annual Reviews (2011 to 2017);
- Rehabilitation Monitoring Reports (FirstField Environmental 2014 to 2017);
- Soil Assessment and Recommendations for Rehabilitated Areas – Pine Dale Mine and Enhance Place Mine (SLR, 2014); and
- Assessment of Rehabilitated Areas – Pine Dale Mine and Enhance Place Mine (SLR, 2018).

4 Regulatory Requirements and Rehabilitation Objectives

Pine Dale is managed in accordance with Project Approval 10_0041 and relevant licences and mining leases. The MOP has been prepared in accordance with the relevant regulatory requirements with the approved rehabilitation objectives for the site as follows:

- The rehabilitated landform is safe, stable, non-polluting and sustainable;
- Rehabilitation maintains or improves species diversity and habitat values of the Yarraboldy Extension Area, particularly the former Yarraboldy Open Cut Mine; and

- The agreed post mining land use is compatible with the surrounding land fabric and land use requirements.

The approved rehabilitation objectives specific to the pasture rehabilitation areas at the Pine Dale Mine are:

- Establish approximately 21 ha of sustainable pasture on areas disturbed by mining;
- Pasture areas to be compatible with surrounding undisturbed land;
- Appropriate topsoil or topsoil substitutes will be spread and ameliorated (as required) to produce a growth media capable of sustaining pasture growth;
- Pasture areas are revegetated with a mix of native and exotic perennial pasture species; and

Maintenance needs / management inputs to be no greater than those of surrounding land.

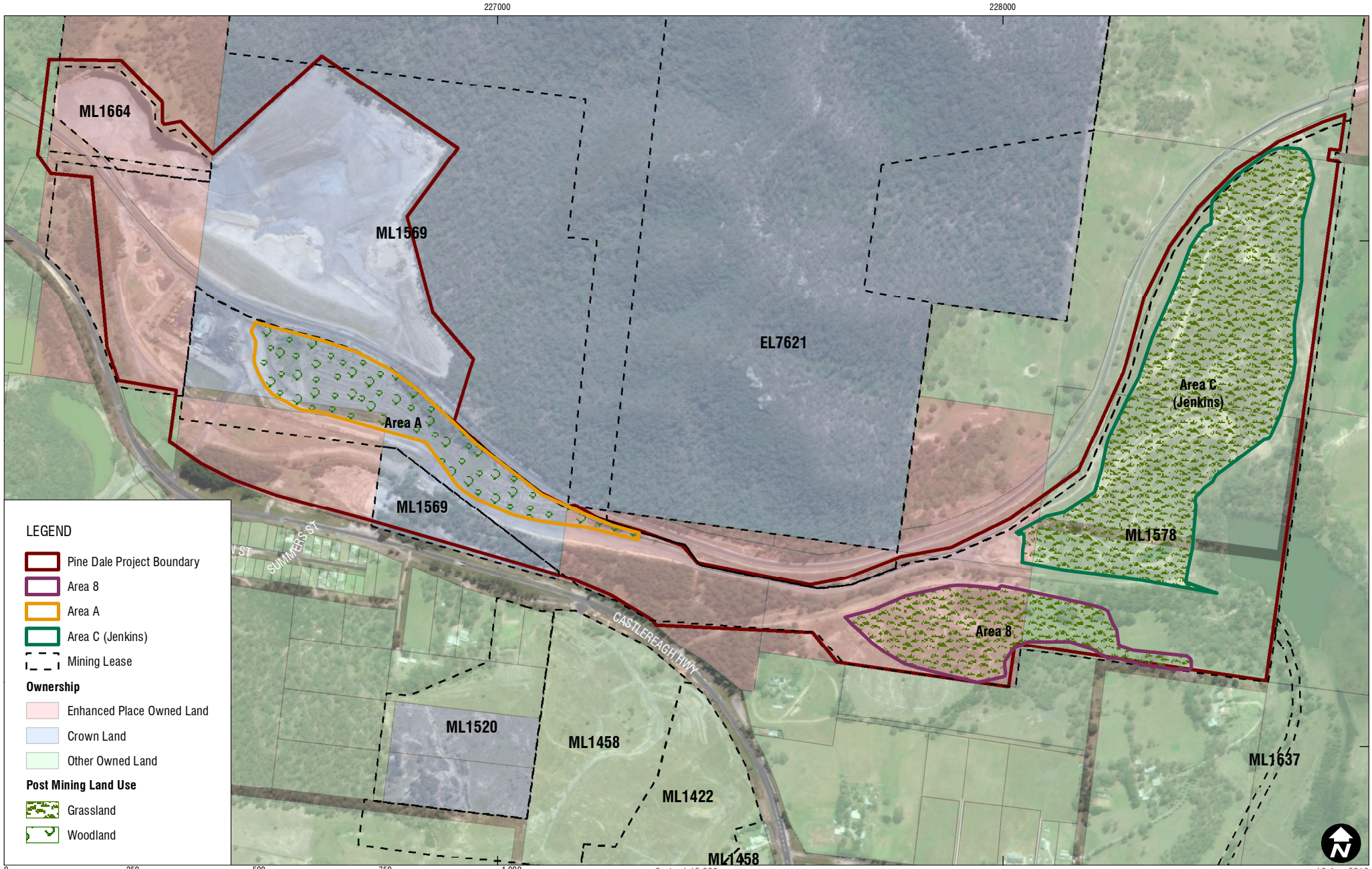
5 Rehabilitation Areas and Post Mining Land Use

Rehabilitation at Pine Dale Mine has been undertaken in a series of rehabilitation areas, comprising parcels of land which are at various stages of being progressively rehabilitated back to a self-sustaining post mining land use.

The locations of the rehabilitation areas at Pine Dale Mine are shown in **Figure 1** along with the final land use and the applicable land ownership. The rehabilitation areas comprise:

- **Area A** - Area A has been reseeded to rehabilitate the area to a native woodland vegetation community. Enhance Place are not seeking to relinquish Area A at this time and therefore it is not mentioned further in this report;
- **Area C** – Area C is located entirely on privately owned land and has been returned to pasture for agricultural purposed, including grazing, as per the approved rehabilitation strategy and landholder preferences; and
- **Area 8** – Area 8 is predominantly owned by Enhance Place with the eastern portion privately owned. Area 8 has also been returned to pasture for agricultural purposed, including grazing, as per the approved rehabilitation strategy and landholder preferences.

Enhance Place seeks to relinquish rehabilitation Area C and Area 8 at the Pine Dale Mine as they are considered to have met the nominated rehabilitation objectives. The following sections presents a summary of the rehabilitation completed at Pine Dale Mine along with rehabilitation monitoring results which demonstrates the successful achievement of the approved rehabilitation completion criteria specified in the MOPs.



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16-Aug-2018
630.12362

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Pine Dale
Rehabilitation Areas

Figure 1

6 Rehabilitation Activities Completed

Rehabilitation works at Pine Dale Mine within Area C and 8 have been conducted in accordance with rehabilitation objectives in the approved MOP (Enhance Place, 2017). Enhance Place has undertaken works to improve pasture rehabilitation outcomes in accordance with recommendations documented in the *Soil Assessment and Recommendations for Rehabilitated Areas – Pine Dale Mine and Enhance Place Mine* (SLR, 2014)). Additional rehabilitation and maintenance activities have been conducted, as required, to action any recommendations of annual rehabilitation monitoring undertaken as part of the annual review process.

The specific rehabilitation activities undertaken at the Pine Dale Mine are summarised in the following sections.

6.1 Area C

Rehabilitation Area C covers an area of approximately 25 ha and has been rehabilitated to pasture. The final landform and water management structures have been completed and the areas seeded with pasture in accordance with Project Approval 10_0041 and the requirements of the landowner.

Shaping and seeding of Area C commenced in 2010 and was completed in 2011. The area was seeded with a pasture mixture known as '*Cox's River Mix*' and comprised:

- 40% Fescue (*Festuca spp.*);
- 25% Cocksfoot (*Dactylis glomerata*);
- 20% Subterranean Clover (*Trifolium subterranean*);
- 6% Perennial Ryegrass (*Lolium perene*);
- 5% White Clover (*Trifolium repens*); and
- 4% Phalaris (*Phalaris aquatica*).

Contour drains and catchment dams were constructed in 2012 within the rehabilitated Area C as reported in the 2012 Annual Review (Enhance Place 2013). In addition, erosion and sediment controls (including sediment fences and rock lined drains) have been installed and maintained, as required, throughout the rehabilitation of Area C.

Area C had lime applied in October 2013 to raise soil pH and provide improved soil conditions to promote pasture growth (refer 2013 Annual Review (Enhance Place 2014)).

As reported in the 2015 Annual Review (Enhance Place 2016), the following rehabilitation works were undertaken at Area C during 2015:

- Tilling of the drainage lines;
- Application of hydro-mulch containing a seed mix comprising Kasbah Cocksfoot, Atlas Phalaris, Zulu Arrowleaf Clover and Goulburn Sub Clover; with follow-up watering;
- Application of a lime, gypsum and mushroom compost mixture (10:4:1 tonnes/ha);
- Application of Muriate of Potash (MOP) at 0.25 tonnes/ha and di-ammonium phosphate (DAP) at 0.20 tonnes/ha; and

- Intensive weed spraying.

In 2016 and 2017, continued rehabilitation maintenance and improvement activities were undertaken within Area C, as reported in the 2016 and 2017 Annual Reviews (Enhance Place 2017, 2018). Activities included:

- Weed spraying to control noxious weeds including African Lovegrass;
- Removal of rocks and fallen trees from pasture;
- Ripping of furrows along poor pasture establishment areas and contour banks/drainage lines prior to reseeding; and
- Application of additional seed, fertiliser and compost at recommended rates, where required.

6.2 Area 8

Rehabilitation Area 8 is approximately 10 ha and has been rehabilitated with the same pasture mixture used in Area C known as '*Cox's River Mix*'. Seeding of Area 8 commenced in 2008 after the final landform was established. The vegetation communities prior to mining include a mixture of cleared land, pasture, pines and eucalyptus.

Following seeding, rehabilitation activities at Area 8 generally comprised of additional maintenance activities in the form of erosion control, fertilizing and weed management.

As reported in the 2015 Annual Review (Enhance Place 2016), the following rehabilitation works were undertaken at Area 8 during 2015:

- the application of a lime, gypsum and mushroom compost mixture a rate of 10:1:3 tonnes/ha;
- re-shaping of drainage lines within the area and rock placement in erosion channels.
- intensive weed spraying was undertaken;
- application of pasture seed mix along with MOP at 0.25 tonnes/ha and DAP at 0.20 tonnes/ha.

In 2016 and 2017, continued rehabilitation maintenance and improvement activities were undertaken within Area 8, as reported in the 2016 and 2017 Annual Reviews (Enhance Place 2017, 2018). Activities included:

- Weed spraying to control noxious weeds including African Lovegrass;
- Ripping of furrows along poorly vegetated areas followed by direct reseeding;
- Reseeding of exposed areas with pasture seed mix; and
- Application of additional seed, fertiliser and compost at recommended rates, where required.

7 Completion Criteria

Table 1 presents the approved rehabilitation completion criteria relevant to the pasture rehabilitation areas in Areas C and 8 at Pine Dale Mine. The rehabilitation completion criteria were developed in accordance with the requirements of PA 10_0041, relevant mining leases and *ESG3: Mining Operations Plan (MOP) Guidelines* dated September 2013 and were approved by the DPE on 12 April 2017. **Table 1** also presents the completion status of each of the criteria as well as the section of this report where further evidence is provided.

Table 2 presents the specific soil nutrient completion targets required to meet the desired objective of establishing sustainable grazing pasture that will require ongoing management inputs that are consistent with comparable pasture and grazing practices.

Table 1 Pine Dale Mine Performance Indicators and Completion / Relinquishment Criteria

Objective	Performance Indicator	Completion Criteria	Justification / Source	Complete (Yes / No)	Evidence / Section of report addressed
Phase – Growth media development					
Domain – Rehabilitation Area Pasture					
Growth media is suitable for establishing the desired vegetation community	Soil characterisation	Topsoil and subsoil has been tested to assess suitability for intended post mining land use.	Soil Assessment Results and Rehabilitation Monitoring Reports	Yes	Table 2 and *Soil Assessment and Recommendations for Rehabilitated Areas – Pine Dale Mine and Enhance Place Mine* (SLR, 2014)
	Topsoil and subsoil depth	≥ 250 mm of subsoil material e.g. clay ≥ 50mm of topsoil	Soil Assessment Results and Rehabilitation Monitoring Reports	Yes	Available soil materials have been spread where available. Where limited topsoil resources have been available, appropriate ameliorants have been applied to assist in microbial activity and the "making" of topsoil.
	Amelioration	Topsoils and subsoils are ameliorated in accordance with the recommendations of the soil characterisation (including application of boiler ash, fertilisers and organics as required).	Soil Assessment Results and Rehabilitation Monitoring Reports	Yes	Section 6; and *Assessment of Rehabilitated Areas – Pine Dale Mine and Enhance Place Mine* (SLR, 2018) (**Appendix B**)
	Deep ripping	Rehabilitation area deep ripped on contour.	Rehabilitation Monitoring Reports	Yes	Section 6; and 2015-2017 Annual Reviews

Objective	Performance Indicator	Completion Criteria	Justification / Source	Complete (Yes / No)	Evidence / Section of report addressed
Erosion hazards are minimised	Temporary ESC	Erosion and sediment controls are installed prior to topsoil respreading.	From Managing Urban Stormwater: Soils & Construction	Yes	Section 6; and 2015-2017 Annual Reviews
Phase – Ecosystem and land use establishment					
Domain – All Domains					
Weed species and feral animals are controlled and do not significantly impact the desired final land use	Feral animal and noxious weed presence	Feral animal and weed species presence and abundance is not considered to adversely impact the intended final land use	Rehabilitation Monitoring Reports	Yes	Section 8.1; and 2017 Annual Rehabilitation Monitoring Report (**Appendix A**)
	Feral animal and noxious weed control	Feral animals and noxious weeds are controlled in accordance with legislation	Rehabilitation Monitoring Reports	Yes	Section 8.1; and 2017 Annual Rehabilitation Monitoring Report (**Appendix A**)
Bushfire risk is managed on rehabilitation areas.	Fuel loads	Fuel loads and fire breaks in and surrounding rehabilitation areas are assessed and maintained in accordance with the Bushfire Management Plan.	Bushfire Management Plan	Yes	Section 8.1; and 2017 Annual Rehabilitation Monitoring Report (**Appendix A**)
	Access	Adequate access for firefighting is maintained on rehabilitation areas.	Bushfire Management Plan	Yes	Section 8.1; and 2017 Annual Rehabilitation Monitoring Report (**Appendix A**)
Erosion does not compromise public safety or the post mining land capability	Erosion	No evidence of significant erosion.	Rehabilitation Monitoring Reports	Yes	Section 8.1; and Annual Rehabilitation Monitoring Reports

Objective	Performance Indicator	Completion Criteria	Justification / Source	Complete (Yes / No)	Evidence / Section of report addressed
Soil profile is developing appropriate for the intended post mining land use.	Soil quality	Soil chemical characteristics including: pH, EC, major cations (K, Na, Al, Ca, Zn), sulfur and nitrate are comparable with analogue site (PD3) (refer **Table 2**).	Soil Assessment Results / MOP Appendix D	Yes	Section 8.2; and *Assessment of Rehabilitated Areas – Pine Dale Mine and Enhance Place Mine* (SLR, 2018) (**Appendix B**)
	Ground cover	Ground cover (vegetation, leaf litter, mulch) greater than 70% at Year 5.	Ecosystem Function Analysis. (CSIRO 2008)	Yes	Section 8.1; and 2017 Annual Rehabilitation Monitoring Report (**Appendix A**)
Domain – Rehabilitated area (pasture)					
Pasture rehabilitation areas will be established comparable to surrounding undisturbed pasture lands.	Pasture species	Approved pasture species mix is sown at the specified rate per hectare.	Rehabilitation Monitoring Reports / MOP Appendix D	Yes	Section 6; and 2015-2017 Annual reviews.
	Species composition	Established pasture mix comprises approximately 70% perennial grasses and 20% annual legumes, representative of species at analogue sites.	Rehabilitation Monitoring Reports/MOP Appendix D	Yes	Section 8.1; and 2017 Annual Rehabilitation Monitoring Report (**Appendix A**)
	Weed presence	Weeds including African Lovegrass comprise less than 10% of the total pasture sward.	Rehabilitation Monitoring Reports / MOP Appendix D	Yes	Section 8.1; and 2017 Annual Rehabilitation Monitoring Report (**Appendix A**)
Phase – Ecosystem and land use sustainability					
Domain – All Domains					
Erosion does not present a safety hazard or compromise the post mining land capability.	Soil loss	Net annual soil loss is comparable to analogue sites at Year 10.	Ecosystem Function Analysis. (CSIRO 2008)	Yes	Section 8.1; and 2017 Annual Rehabilitation Monitoring Report (**Appendix A**)

Objective	Performance Indicator	Completion Criteria	Justification / Source	Complete (Yes / No)	Evidence / Section of report addressed
	Erosion features	There are no significant erosion features that compromise landform stability or public safety (including gullying or tunnelling)	From Managing Urban Stormwater: Soils & Construction	Yes	Section 8.1; and 2017 Annual Rehabilitation Monitoring Report (**Appendix A**)
Soil profile is developing appropriate for the intended post mining land use.	Soil quality	Soil chemical characteristics including: pH, EC, major cations (K, Na, Al, Ca, Zn), sulfur and nitrate are comparable with analogue site (PD3) (refer **Table 2**).	Soil Assessment Results / MOP Appendix D	Yes	Section 8.2; and *Assessment of Rehabilitated Areas – Pine Dale Mine and Enhance Place Mine* (SLR, 2018) (**Appendix B**)
	Ground cover	Ground cover (vegetation, leaf litter, mulch) greater than 70% at Year 5.	Ecosystem Function Analysis. (CSIRO 2008)	Yes	Section 8.1; and 2017 Annual Rehabilitation Monitoring Report (**Appendix A**)
Domain – Rehabilitated area (pasture)					
Pasture rehabilitation areas are self-sustaining.	Natural regeneration	Evidence of natural regeneration of at least four pasture species at Year 5.	*Ecosystem Function Analysis.* (CSIRO 2008)	Yes	Section 8.1; and 2017 Annual Rehabilitation Monitoring Report (**Appendix A**)
	Rural land capability	Pasture Rehabilitation Areas are assessed to have a Rural Land Capability Class VI or better (suitable for grazing).	*Ecosystem Function Analysis.* (CSIRO 2008)	Yes	Section 8.1; and 2017 Annual Rehabilitation Monitoring Report (**Appendix A**)
	Management inputs	Management inputs (ameliorants, fertilisers, weed treatments) are within the range of analogue sites.	Rehabilitation Monitoring Reports & MOP Appendix D	Yes	Section 8.1; and 2017 Annual Rehabilitation Monitoring Report (**Appendix A**)

Table 2 Soil Nutrient Level Completion Targets

Soil Element	Measure & Test	Site PD3 Soil Test	Ideal Soil Element Range[1]	Completion Target Measure
pH	1:5 $CaCl_2$	4.94	Between 5.2 – 8.0	Greater than 4.9
Potassium	% of Total CEC	3.17	Greater than 2%	Greater than 2%
Sodium	% of Total CEC	1.90	Less than 3%	Less than 3%
Aluminium	% of Total CEC	0.53	Less than 5%	Less than 5%
Sulfur	mg/kg KCl 40 S	6.8	Greater than 8	Greater than 5.4[2]
Nitrogen	mg/kg Water Extract	4.6	Greater than 10	Greater than 4.6
Zinc	mg/kg DTPA	0.7	Greater than 1	Greater than 0.7
Calcium	Calcium to Magnesium Ratio	2.14	Greater than 3	Greater than 2.1

1 - Ideal soil element ranges were derived from Lines-Kelly R (1994) *Soil Sense: Soil Management for North Coast Farmers* and Peverill K.I. Sparrow L.A. Reuter D.J. (1999) *Soil Analysis: An Interpretation Manual*

2 - Upon analysis of soil samples taken from analogue sites in March 2018, the sulfur levels at PD3 in September 2014 appear to be unusually high, with all analogue sites (including PD3) having sulfur levels significantly lower than 6.8, with an average across the five analogue sites of 5.4,. Considering these results a sulfur completion target measure of greater than 5.4 is considered a more realistic representation of baseline conditions.

8 Assessment of Rehabilitation Areas

8.1 Rehabilitation Monitoring Results

Annual rehabilitation monitoring is undertaken by FirstField Environmental and is reported in the Pine Dale Mine Annual Review, available on the Enhance Place website. Rehabilitation monitoring has assessed the status of the rehabilitation against the *ecosystem and land use establishment* and *ecosystem and land use sustainability* completion criteria presented in **Table 1**.

The findings of the *2017 Annual Rehabilitation Monitoring Report* (FirstField Environmental, 2017) (**Appendix A**) showing the assessed status of the rehabilitation in the pasture rehabilitation areas at Pine Dale Mine are summarised in **Table 3**.

Table 3 2017 Rehabilitation Monitoring Results

Performance Indicator	Completion Criteria	2017 Annual Rehabilitation Monitoring Findings	Status of Completion Criteria
Phase – Ecosystem and land use establishment			
Feral animal and noxious weed presence	Feral animal and weed species presence and abundance is not considered to adversely impact the intended final land use	Feral animal and noxious weed species are controlled in accordance with legislation and are not considered to adversely impact the intended final land use. Weeds including African lovegrass comprise <10% of the pasture sward. African lovegrass has been subjected to ongoing chemical treatment and were not observed to be growing or producing seed. Rabbit and fox numbers are considered low and do not require population reduction measures. Some scats were observed across the property but no holes, burrows or dens were observed.	**Satisfactory**
Feral animal and noxious weed control	Feral animals and noxious weeds are controlled in accordance with legislation		
Fuel loads	Fuel loads and fire breaks in and surrounding rehabilitation areas are assessed and maintained in accordance with the Bushfire Management Plan.	Fuel loads are low and fuel hazard mitigation is not required at this time. Fire breaks are maintained in accordance with the Bushfire Management Plan.	**Satisfactory**
Access	Adequate access for firefighting is maintained on rehabilitation areas.	Access to each of the rehabilitation areas is considered adequate. All access roads within rehabilitated areas are maintained in good condition and are suitable for the passage of Category 1 tankers having a vertical clearance of >4m and width >2.8m.	**Satisfactory**
Erosion	No evidence of significant erosion.	There are no significant erosion features that compromise landform stability or public safety. Pasture areas support evidence of minor wind erosion where groundcover is poorly established or absent.	**Satisfactory**
Soil quality	Soil chemical characteristics including: pH, EC, major cations (K, Na, Al, Ca, Zn), sulfur and nitrate are comparable with analogue site (PD3) (refer **Table 2**).	Not assessed by FirstField Environmental (refer **Section 8.2**)	Refer **Section87.2**

Performance Indicator	Completion Criteria	2017 Annual Rehabilitation Monitoring Findings	Status of Completion Criteria
Ground cover	Ground cover (vegetation, leaf litter, mulch) greater than 70% at Year 5.	Rehabilitated pasture surfaces in each of the transect areas support living groundcover of approximately 90%. Areas where groundcover is sparse or absent is estimated to account for <10% of each rehabilitation pasture area.	**Satisfactory**
Pasture species	Approved pasture species mix is sown at the specified rate per hectare.	Cox's River Mix was sown in 2010-2011 (refer **Section 6**).	**Satisfactory**
Species composition	Established pasture mix comprises approximately 70% perennial grasses and 20% annual legumes, representative of species at analogue sites.	Pasture rehabilitation areas are established with a mixture of 70% perennial grasses and 20% annual legumes and are representative of the species composition at the analogue pasture site.	**Satisfactory**
Weed presence	Weeds including African Lovegrass comprise less than 10% of the total pasture sward.	Weeds including African lovegrass comprise <10% of the pasture sward. African lovegrass has been subjected to ongoing chemical treatment and were not observed to be growing or producing seed.	**Satisfactory**
Phase - Ecosystem and Land Use Sustainability			
Soil loss	Net annual soil loss is comparable to analogue sites at Year 10.	Given that rehabilitation commenced <10 years ago it is not yet possible to determine whether net soil loss is comparable to analogue sites at Year 10. Estimated soil loss in pasture rehabilitation areas is estimated to be between 0.03 and 0.18 t/ha, whilst estimated soil loss at the pasture analogue site is estimated to be 0.09 t/ha. Estimated soil loss in each transect is considered adequate and is comparable to the analogue site.	**Ongoing**
Erosion features	There are no significant erosion features that compromise landform stability or public safety (including gullying or tunnelling)	There are no significant erosion features that compromise landform stability or public safety. Pasture areas support evidence of minor wind erosion where groundcover is poorly established or absent.	**Satisfactory**

Performance Indicator	Completion Criteria	2017 Annual Rehabilitation Monitoring Findings	Status of Completion Criteria
Soil quality	Soil chemical characteristics including: pH, EC, major cations (K, Na, Al, Ca, Zn), sulfur and nitrate are comparable with analogue site (PD3) (refer **Table 2**).	Not assessed by FirstField Environmental (refer **Section 8.2**)	Refer **Section 8.2**
Ground cover	Ground cover (vegetation, leaf litter, mulch) greater than 70% at Year 5.	Rehabilitated pasture surfaces in each of the transect areas support living groundcover of approximately 90%. Areas where groundcover is sparse or absent is estimated to account for <10% of each rehabilitation pasture area.	**Satisfactory**
Natural regeneration	Evidence of natural regeneration of at least four pasture species at Year 5.	Natural regeneration of groundcover species is evident across all the pasture rehabilitation areas.	**Satisfactory**
Rural land capability	Pasture Rehabilitation Areas are assessed to have a Rural Land Capability Class VI or better (suitable for grazing).	Pasture rehabilitation areas are assessed as being Land and Soil Capability Class V and are suitable for grazing.	**Satisfactory**
Management inputs	Management inputs (ameliorants, fertilisers, weed treatments) are within the range of analogue sites.	Management inputs are within the range of analogue sites. Control of noxious and targeted weeds has been undertaken across all areas as required.	**Satisfactory**

As presented in **Table 2**, the status of all completion criteria was determined to be satisfactory during the 2017 Annual Rehabilitation Monitoring with the exception of estimated soil loss. Estimated soil loss is considered to be in the range of the analogue site; however given that the rehabilitation is less than 10 years old an assessment of the soil loss at year 10 could not be made. Given pasture groundcover is greater than 70% along with the application of mushroom compost it is unlikely that net soil loss would be occurring in the rehabilitated areas.

8.2 Rehabilitation Inspection and Soil Nutrient Sampling Results

In March 2018 SLR completed a detailed walk through inspection to assess the current status of the mining lease and to determine whether rehabilitation objectives had been met in Area C and Area 8. During the inspection soil samples were taken from the topsoil (0-10 cm) at each inspection site and analysed for soil chemical characteristics including pH, EC, major cations (K, Na, Al, Ca, Zn), sulfur and nitrate for comparison with the analogue site and the completion criteria presented in **Table 2**.

The findings of the inspection are presented in *Assessment of Rehabilitated Areas – Pine Dale and Enhance Place Mine,* (SLR 2018) (**Appendix B**) and are summarised below.

Results are summarised for each of the sites inspected at Pine Dale Mine in 2018 alongside comparisons made with 2014 inspection results. It is intended to show the general condition of each site at the time of the inspection as well as document any further identified constraints which may be limiting desirable plant establishment and growth. A traffic light risk rating was used to describe any soil nutrient deficiencies/toxicities which may be limiting plant establishment and production as outlined in **Table 4**.

Table 4 Soil Nutrient Descriptors

Rating	Descriptor
	Soil nutrient is present in levels that are deficient /toxic and are highly likely to be impacting optimum plant growth.
	Soil nutrient is present in levels that are marginally deficient /toxic and may be impacting optimum plant growth.
	Soil nutrient is present in levels which are ideal for optimum plant growth.

The location of each inspection site is shown in **Figure 2** along with the location and aspect of all photographs provided in the discussion below.

Scale: 1:10,000
GDA 1994 MGA Zone 56

16-Aug-2018
630.12362

Sheet Size : A4

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Pine Dale
Inspection Points and Photo Locations

Figure 2

8.2.1 Area C

8.2.1.1.1 Analogue Sites

Analogue sites PD3 and PD6 have not been disturbed by mining activity and have not been rehabilitated. These sites are considered to be representative of pre-mining grazing land use conditions in regards to soil profile and vegetation cover for this area. They are considered appropriate analogue sites for Area C for comparison with rehabilitated areas.

Analogue Site PD3

Table 5 below shows a comparison of soil nutrient levels at Site PD3 from the 2014 and 2018 inspections. Grazing completion targets were developed from the 2014 results at Site PD3. Sulfur has dropped from 6.8 mg/kg to 5.3 mg/kg, an unexpected change which also occurred at several of the analogue sites.

Site PD3 underwent the same treatments as other rehabilitated sites within Area C.

Table 5 Soil Nutrient Levels Site PD3 (Analogue Site)

Soil Element	Measure & Test	Site PD3 2014	Completion Target	Site PD3 2018
pH	1:5 $CaCl_2$	4.9	Greater than 4.9	6.6
Potassium	% of Total CEC	3.8	Greater than 2%	4.4
Sodium	% of Total CEC	1.9	Less than 3%	0.2
Aluminium	% of Total CEC	0.5	Less than 5%	0.0
Sulfur	mg/kg KCl 40 S	6.8	Greater than 5.4	5.3
Nitrogen	mg/kg Water Extract	4.6	Greater than 4.6	9.2
Zinc	mg/kg DTPA	0.7	Greater than 0.7	0.7
Calcium	Calcium:Magnesium Ratio	2.1	Greater than 2.1	2.8

Photo 1 and **Photo 2** show the general landscape setting for site PD3 within Area C at Pine Dale Mine during the 2014 and 2018 inspections.

Topsoil consists of a sandy clay loam over a medium clay subsoil. This area supports a perennial grass and clover pasture, including cocksfoot, tall fescue, phalaris, sub clover, with some annual ryegrass. These pasture species have a winter and spring growth habit, with the difference in pasture mass clearly evident between the 2014 (September) and 2018 (March) inspections.

Photo 1 Analogue Site PD3 – September 2014

Photo 2 Analogue Site PD3 March 2018

Analogue Site PD6

Table 6 below shows soil nutrient levels at Site PD6 from the 2018 inspection. Site PD6 was chosen as an additional analogue site for Area C.

Table 6 Soil Nutrient Levels Site PD6 (Analogue Site)

Soil Element	Measure & Test	Site PD6 2014	Completion Target	Site PD6 2018
pH	1:5 $CaCl_2$	New Site Not Tested 2014	Greater than 4.9	5.2
Potassium	% of Total CEC		Greater than 2%	3.2
Sodium	% of Total CEC		Less than 3%	0.2
Aluminium	% of Total CEC		Less than 5%	0.0
Sulfur	mg/kg KCl 40 S		Greater than 5.4	5.2
Nitrogen	mg/kg Water Extract		Greater than 4.6	18.4
Zinc	mg/kg DTPA		Greater than 0.7	1.0
Calcium	Calcium:Magnesium Ratio		Greater than 2.1	2.5

Photo 3 shows the general landscape setting for Site PD6 within Area C at Pine Dale Mine during the 2018 inspection. Pasture at Site PD6 is dominated by the perennial grasses phalaris and fescue.

Photo 3 Analogue Site PD6 March 2018

8.2.1.1.2 Rehabilitated Sites

Rehabilitated Site PD1

Table 7 shows a comparison of soil nutrient levels at Site PD1 from the 2014 and 2018 inspections. Grazing completion targets were met for all soil elements and were comparable to or exceeded those at the analogue sites PD3 and PD6.

Table 7 Soil Nutrient Levels Site PD1 (Rehabilitated Site)

Soil Element	Measure & Test	Site PD1 2014	Completion Target	Site PD1 2018
pH	1:5 $CaCl_2$	6.6	Greater than 4.9	6.5
Potassium	% of Total CEC	1.7	Greater than 2%	3.5
Sodium	% of Total CEC	2.5	Less than 3%	0.2
Aluminium	% of Total CEC	0.0	Less than 5%	0.0
Sulfur	mg/kg KCl 40 S	5.4	Greater than 5.4	6.3
Nitrogen	mg/kg Water Extract	6.9	Greater than 4.6	27.6
Zinc	mg/kg DTPA	0.7	Greater than 0.7	1.0
Calcium	Calcium:Magnesium Ratio	1.6	Greater than 2.1	2.7

Photo 4 and **Photo 5** show the general landscape setting for Site PD1 within Area C at Pine Dale Mine during the 2014 and 2018 inspections.

Pasture at Site PD1 is dominated by perennial cocksfoot and paspalum grass pasture with some sub clover and arrowleaf clover present in the sward, with greater than 90% groundcover. There is no African lovegrass present. The difference in pasture growth between autumn and spring can clearly be seen.

Photo 4 Rehabilitated Site PD1 September 2014

Photo 5 Rehabilitated Site PD1 March 2018

Rehabilitated Site PD2

Table 8 below shows a comparison of soil nutrient levels at Site PD2 from the 2014 and 2018 inspections. Grazing completion targets were met for all soil elements and were comparable to or exceeded those at analogue sites PD3 and PD6.

Table 8 Soil Nutrient Levels Site PD2 (Rehabilitated Site)

Soil Element	Measure & Test	Site PD2 2014	Completion Target	Site PD2 2018
pH	1:5 $CaCl_2$	4.6	Greater than 4.9	5.9
Potassium	% of Total CEC	1.7	Greater than 2%	4.4
Sodium	% of Total CEC	2.3	Less than 3%	0.3
Aluminium	% of Total CEC	4.5	Less than 5%	0.0
Sulfur	mg/kg KCl 40 S	6.0	Greater than 5.4	7.7
Nitrogen	mg/kg Water Extract	4.6	Greater than 4.6	46.0
Zinc	mg/kg DTPA	0.8	Greater than 0.7	0.8
Calcium	Calcium:Magnesium Ratio	1.8	Greater than 2.1	2.3

Photo 5 and **Photo 6** show the general landscape setting for Site PD2 within Area C at Pine Dale Mine during the 2014 and 2018 inspections.

Pasture at Site PD2 is dominated by perennial cocksfoot and paspalum grass pasture with the herb plantain and some arrowleaf clover present in the sward, with greater than 80% groundcover. There are isolated African lovegrass tussocks present which comprise less than 5% of the pasture sward. Significant increase in perennial grass groundcover can be seen between the two inspection periods.

Photo 6 Rehabilitated Site PD2 September 2014

Photo 7 Rehabilitated Site PD2 March 2018

Rehabilitated Site PD7

Table 9 below shows nutrient levels at Site PD7 from the 2018 inspection. Site PD7 was chosen as an additional rehabilitation site for Area C. Grazing completion targets were met for all soil elements and were comparable to or exceeded those at analogue sites PD3 and PD6

Table 9 Soil Nutrient Levels Site PD7 (Rehabilitated)

Soil Element	Measure & Test	Site PD7 2014	Completion Target	Site PD7 2018
pH	1:5 $CaCl_2$	New Site Not Tested 2014	Greater than 4.9	5.3
Potassium	% of Total CEC		Greater than 2%	5.2
Sodium	% of Total CEC		Less than 3%	0.3
Aluminium	% of Total CEC		Less than 5%	0.0
Sulfur	mg/kg KCl 40 S		Greater than 5.4	5.5
Nitrogen	mg/kg Water Extract		Greater than 4.6	9.2
Zinc	mg/kg DTPA		Greater than 0.7	0.7
Calcium	Calcium:Magnesium Ratio		Greater than 2.1	2.7

Photo 8 shows the general landscape setting for Site PD7 within Area C at Pine Dale Mine during the 2018 inspection. Pasture at Site PD6 is dominated by perennial grasses phalaris, fescue and paspalum along with the herb plantain and arrowleaf clover. There is greater than 90% groundcover with only isolated tussocks of African lovegrass, which comprises less than 5% of the pasture sward.

Photo 8 Rehabilitated Site PD7 March 2018

8.2.2 Area 8

8.2.2.1.1 Analogue Site PD8

Table 10 below shows soil nutrient levels at Site PD8 from the 2018 inspection. Site PD8 was chosen as an analogue site for Area 8 as it is undisturbed by mining and did not receive any of the Area 8 treatment, being located between pine trees and not accessed by fertiliser spreading equipment.

Table 10 Soil Nutrient Levels Site PD8 (Analogue Site)

Soil Element	Measure & Test	Site PD8 2014	Completion Target	Site PD8 2018
pH	1:5 $CaCl_2$	New Analogue Site Not Tested 2014	Greater than 4.9	5.0
Potassium	% of Total CEC		Greater than 2%	2.5
Sodium	% of Total CEC		Less than 3%	0.9
Aluminium	% of Total CEC		Less than 5%	2.0
Sulfur	mg/kg KCl 40 S		Greater than 5.4	5.0
Nitrogen	mg/kg Water Extract		Greater than 4.6	2.3
Zinc	mg/kg DTPA		Greater than 0.7	0.8
Calcium	Calcium:Magnesium Ratio		Greater than 2.1	1.7

Photo 9 shows the general landscape setting for Site PD8 within Area 8 at Pine Dale Mine during the 2018 inspection. Pasture at Site PD8 is dominated by perennial phalaris and fescue with some arrowleaf clover present in the sward, with greater than 90% groundcover. There are isolated African lovegrass tussocks present which comprise less than 5% of the pasture sward.

Photo 9 Analogue Site PD8 March 2018

8.2.2.1.2 Rehabilitated Site PD4

Table 11 below shows a comparison of soil nutrient levels at Site PD4 from the 2014 and 2018 inspections. Grazing completion targets were met for all soil elements. Soil nutrient levels are comparable to or exceed those at analogue site PD8.

Table 11 Soil Nutrient Levels Site PD4 (Rehabilitated Site)

Soil Element	Measure & Test	Site PD4 2014	Completion Target	Site PD4 2018
pH	1:5 $CaCl_2$	5.7	Greater than 4.9	6.1
Potassium	% of Total CEC	3.5	Greater than 2%	4.4
Sodium	% of Total CEC	1.4	Less than 3%	0.3
Aluminium	% of Total CEC	0.0	Less than 5%	0.0
Sulfur	mg/kg KCl 40 S	7.4	Greater than 5.4	8.9
Nitrogen	mg/kg Water Extract	4.6	Greater than 4.6	36.8
Zinc	mg/kg DTPA	0.8	Greater than 0.7	0.7
Calcium	Calcium:Magnesium Ratio	2.7	Greater than 2.1	3.7

Photo 10 and **Photo 11** show the general landscape setting for Site PD4 within Area 8 at Pine Dale Mine during the 2014 and 2018 inspections.

Pasture at Site PD4 is dominated by perennial grasses cocksfoot, fescue and paspalum with some arrowleaf clover present in the sward, and greater than 90% groundcover. There are isolated African lovegrass tussocks present which comprise less than 5% of the pasture sward. Significant increase in perennial grass groundcover can be seen between the two inspection periods.

Photo 10 Rehabilitated Site PD4 September 2014

Photo 11 Rehabilitated Site PD 4 March 2018

APPENDIX A

2017 Annual Rehabilitation Monitoring Report

Pine Dale Mine

Rehabilitation Monitoring Report 2017

Report prepared by First Field Environmental
on behalf of EnergyAustralia

6 October 2017

Revision history		
Version	Date	Author
Draft	22 September 2017	Michelle Evans
Final	6 October 2017	Michelle Evans

This report has been prepared by First Field Environmental for EnergyAustralia. The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report.

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1. Introduction

Pine Dale Mine is located in the Western Coalfields of NSW at Blackmans Flat, 15km north of Lithgow on the northern side of Castlereagh Highway. The property is approximately 3km east of Mount Piper Power Station.

Pine Dale Mine is managed in accordance with Project Approval 10_0041 and relevant subsidiary licenses and approvals. The *Care and Maintenance Mining Operations Plan* (Enhance Place Pty Ltd, 2014) has been prepared in accordance with the above approval documentation and describes the following rehabilitation objectives:

- *"The rehabilitated landform is safe, stable, non-polluting and sustainable;*
- *Rehabilitation maintains or improves species diversity and habitat values of the Yarraboldy Extension Area, particularly the former Yarraboldy Open Cut Mine; and*
- *The agreed post mining land use is compatible with the surrounding land fabric and land use requirements."*

The preparation of this Rehabilitation Monitoring Report has been prepared to satisfy Schedule 3, Condition 55 of Project Approval 10_0041.

This report aims to identify successes and failures in rehabilitation in regard to agreed performance indicators and completion criteria. Recommendations are made in areas that could be improved.

2. Performance indicators

Table 1 identifies the performance indicators and completion criteria for Pine Dale Mine as determined by the *Care and Maintenance Mining Operations Plan* (Enhance Place Pty Ltd, 2014).

Table 1 Performance indicators and completion criteria

Performance indicator	Completion criteria
Feral animal and noxious weed presence	• Feral animal and weed species presence and abundance is not considered to adversely impact the intended final land use.
Feral animal and noxious weed control	• Feral animals and noxious weeds are controlled in accordance with legislation.
Fuel loads	• Fuel loads and fire breaks in and surrounding rehabilitation areas are assessed and maintained in accordance with the Bushfire Management Plan.
Access	• Adequate access for fire-fighting is maintained on rehabilitation areas.
Habitat features	• Habitat features are installed on native forest rehabilitation areas including: - Nesting boxes and salvaged hollows - Crushed timber spread over native forest rehabilitation areas - Rock pile clusters.
Vegetation health	• More than 75% of native forest indicator species are assessed to be healthy and growing at year 5.

Performance indicator	Completion criteria
	• Native forest indicator species tree height and girth is within the range of analogue sites.
Soil loss	• Net annual soil loss is comparable to analogue sites at year 10.
Erosion	• There are no significant erosion features that compromise landform stability or public safety (including gullying or tunneling).
Woodland birds present	• Evidence of woodland birds utilising rehabilitation areas.
Evidence of mammals	• Evidence of target mammal species presence in rehabilitation areas.
Natural regeneration	• Evidence of second generation of native forest indicator species from desired vegetation community. • Evidence of natural regeneration of at least four pasture species at year 5.
Structure	• Structural layers (canopy, mid-storey, understorey and ground cover) are comparable to analogue sites.
Management inputs	• Management inputs (ameliorants, fertilisers, weed treatments) are within the range of analogue sites.
Rural land capability	• Pasture rehabilitation areas are assessed to have a Rural Land Capability Class VI or better (suitable for grazing).
Species composition	• Establishment of pasture comprising approximately 70% perennial grass and 20% annual legume, representative of species at analogue sites. • Vegetation within the treed rehabilitation areas are established in accordance with the approved species mix. • Approved pasture species mix is sown at the specified rate per hectare.
Weed presence	• Weeds including African Lovegrass to comprise <10% of the pasture sward.
Ground cover	• Ground cover (vegetation, leaf litter, mulch) >70% at year 5.

Source: *Care and Maintenance Mining Operations Plan for Pine Dale Mine* (Enhance Place Pty Ltd, 2014)

3. Weather conditions

Winter of 2017 was characterised by sustained warmer weather. Average monthly rainfall leading up to the survey was variable, with June and July being unusually dry receiving significantly lower rainfall than the statistical average for that month.

The area received light rain (between 2 and 6 mm per day) during the week leading up to the survey work on the 25th of August (Bureau of Meteorology 2017).

Table 2 presents regional rainfall data for the period commencing 2010.

The area received light rain (between 2 and 6 mm per day) during the week leading up to the survey work on the 25th of August (Bureau of Meteorology 2017).

Table 2 Rainfall (in mm) recorded at Lidsdale (Maddox Lane) January 2011 - August 2017

Year	Average	2011	2012	2013	2014	2015	2016	2017
Month								
January	77.6	63	48.2	87.4	9.2	156.2	142.0	37.2
February	76.8	68.2	173.8	149	85	21.2	28.8	12.2
March	101.9	78	187	43.2	155	39.4	69.6	141.4
April	47.2	23.8	31.6	26.8	63	158.2	6.2	21.2
May	29.2	42.4	40.6	23.6	14	25.2	26.0	32.6
June	65.6	41.2	70.6	87	43.2	24.8	173.4	19.6
July	36.4	18.2	48.8	19.6	25.6	44.6	91.4	6.6
August	42.0	54.8	23.2	22.4	56.4	43.8	52.2	41.8
September	52.2	65.4	40.4	44	35.2	9.8	118.6	-
October	42.5	36.8	16.6	20.8	51.6	58.0	71.4	-
November	70.7	158	39	68.6	36.8	63.6	58.4	-
December	81.8	86	61.2	38.4	160.4	58.6	86.4	-
Annual	**762.1**	**735.8**	**781**	**630.8**	**735.4**	**703.4**	**924.4**	**-**

Source: Bureau of Meteorology (2017)

4. Survey methodology

4.1 Rehabilitation monitoring

Monitoring locations - Previous studies have seen the establishment of six monitoring transects; four transects are located within rehabilitated pastures while the remaining two transects are within treed rehabilitation areas. Additional transects exist as analogue sites in grazed pasture and an undisturbed naturally vegetated area of the property to provide benchmarks against which the pasture and treed rehabilitation areas are assessed. Monitoring locations are shown in Figure 1.

Photopoint monitoring - Coordinates for each transect and analogue site are provided in Appendix A. Each transect area contains previously established photo monitoring points. Photos taken from these points enable a visual comparison to photos from previous surveys and are provided in Appendix E.

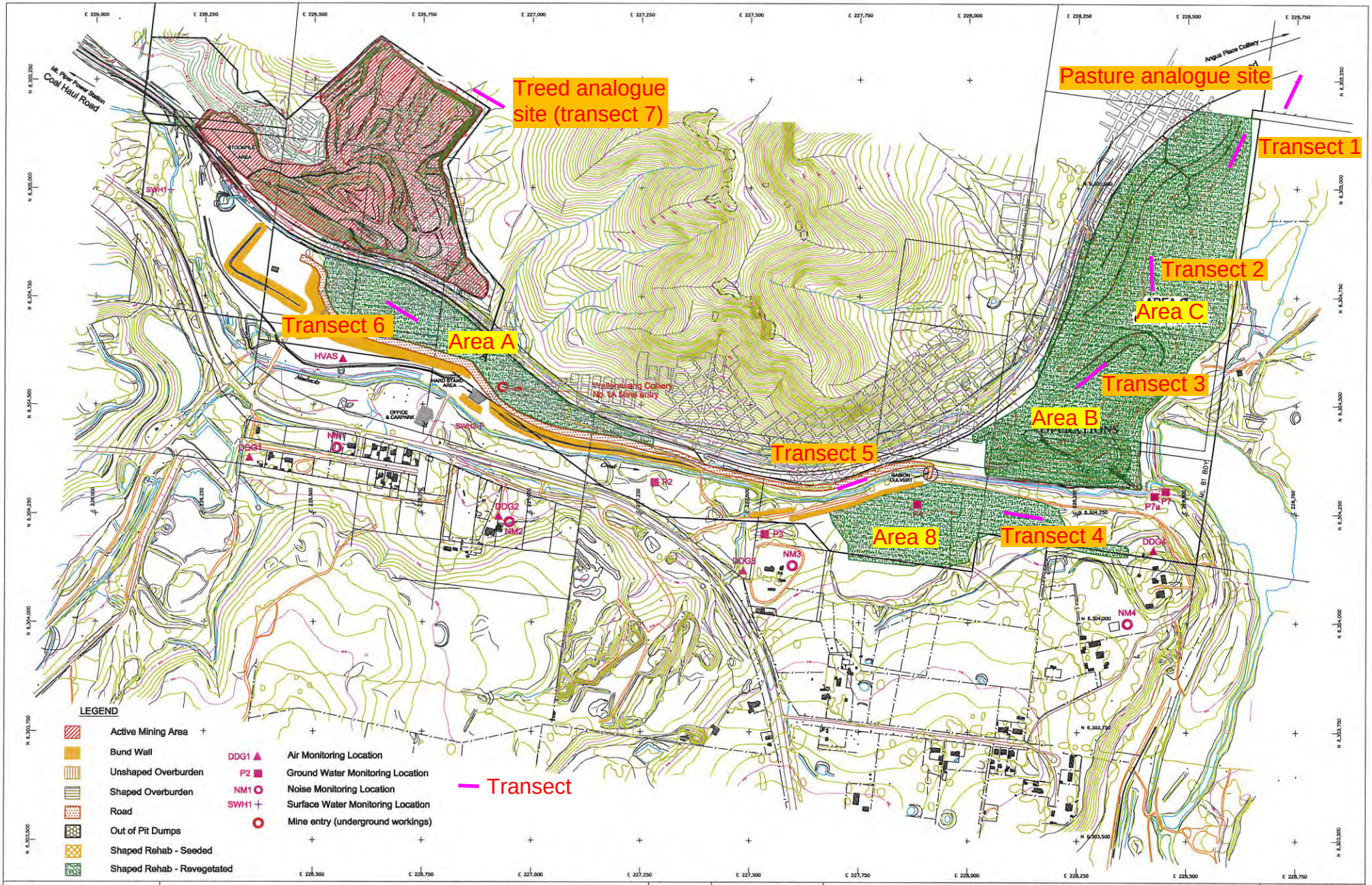
4.2 Erosion and sedimentation

Evidence of erosion and sedimentation along and within the vicinity of each transect has been determined in accordance with *Best Practice Erosion and Sediment Control* (IECA 2006).

4.3 Soil loss

The *Pine Dale Mine Care and Maintenance Mining Operations Plan* (Enhance Place Pty Ltd 2014) recommends that net soil loss be determined in accordance with the *Ecosystem Function Analysis* (CSIRO 2008). This method has been found to be inadequate for determining soil loss in comparison with the widely used *RUSLE* (IEAC Australasia 2012).

An estimation of soil loss at each transect site has been calculated using the *Revised Universal Soil Loss Equation* (RUSLE) (IEAC Australasia 2012). Values used for these calculations are presented in Appendix C.



NOTES:

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DATE	31-12-12
AMENDED	
SURVEYOR	AERIAL PHOTO/TE/TH
DRAWN	K.L.F.
CHECKED	

PINEDALE MINE
AEMR PLAN
END DECEMBER 2012
SCALE - 1 : 4000 (A1 Sheet)

DWG No
PINE-AEMR12

4.4 Vegetation assessment

Pasture rehabilitation areas – Cox's River seed mix was sown in 2010-2011 at Areas B, C and Area 8 at the following rates:

- 40% Fescue *(Festuca spp.)*
- 25% Cocksfoot *(Dactylis glomerata)*
- 20% Subterranean clover *(Trifolium subterranean)*
- 6% Perennial rye grass *(Lolium perene)*
- 5% White clover *(Trifolium repens)*
- 4% Phalaris *(Phalaris aquatica)*

The proportion of perennial grasses and annual legumes currently in evidence at pasture transects has been recorded and compared with the proportion at which these species were initially sown.

Tree rehabilitation areas – The *Pine Dale Mine Care and Maintenance Mining Operations Plan* (Enhance Place Pty Ltd 2014) recommends that vegetation structure be determined in accordance with the *Ecosystem Function Analysis* (CSIRO 2008). This method does not adequately enable the identification of all completion criteria as required by the *Pine Dale Mine Care and Maintenance Mining Operations Plan* (Enhance Place Pty Ltd 2014). Vegetation health, natural regeneration, structure and species composition have instead been determined in accordance with the *Australian Soil and Land Survey Field Handbook* (CSIRO 2009).

4.5 Evidence of fauna and habitat features

Fauna - Evidence of woodland birds and native fauna utilising rehabilitated areas has been recorded through the observation of scats and tracks and sightings.

Habitat features - The presence of nesting boxes, crushed timber piles and rock pile clusters within the rehabilitation areas is noted.

4.6 Pest animal and weed survey

Pest animal presence - Evidence of feral animal presence across the rehabilitation areas has been determined through scat and trail identification.

Noxious weeds - The location and extent of noxious weeds (as declared for the Upper Macquarie County Council area (NSW DPI, 2017) have been recorded. Target weed species, particularly African Lovegrass were identified in accordance with field guides and botanical keys.

4.7 Fuel loads and fire-fighting access

Fuel loads - Fuel loads within and adjacent to rehabilitation areas have been assessed in accordance with the *Overall Fuel Hazard Assessment Guide* (Department of Sustainability 2010).

Fire-fighting access - Access trails within rehabilitated areas have been assessed in accordance with *Policy No. 2/2007 Fire Trails* (Bush Fire Coordinating Committee 2007).

4.8 Rural land capability assessment

Pasture rehabilitation areas have been assessed in accordance with the *Land and Soil Capability Assessment* (OEH 2007).

4.9 Management input assessment

Land management activities - Land management and soil amelioration activities conducted in the past year have been identified through discussions with the land manager.

Feral animal and weed management - Evidence of feral animal and noxious weed control activities have been sought from the land manager and audited against relevant legislative requirements.

5. Field survey results

Field survey was conducted on 25th August 2017 by a qualified ecologist. The survey revisited six transects representing rehabilitated pasture and treed areas as well as pasture and treed analogue sites.

5.1 Erosion and sedimentation

There are no significant erosion features that compromise landform stability or public safety (including gullying or tunneling) within the rehabilitation areas. The presence and extent of active surface erosion within transect areas is recorded in Appendix A.

Pasture rehabilitation areas - The pasture rehabilitation areas support evidence of minor wind erosion where groundcover is poorly established or absent.

Treed rehabilitation areas - Minor wind and rill erosion is occurring at treed rehabilitation areas.

Analogue sites - No active erosion is evident at the pasture and treed analogue sites.

5.2 Soil loss

Rehabilitation activities commenced less than 10 years ago, and it is not yet possible to determine whether net soil loss is comparable to analogue sites at year 10. Estimated annual soil loss at rehabilitated transects is summarised in Table 3. Full calculations are provided in Appendix C.

Table 3 Estimated soil loss due to erosion

Estimated annual soil loss t/ha	Pasture analogue site	Transect 1 (pasture)	Transect 2 (pasture)	Transect 3 (pasture)	Transect 4 (pasture)	Transect 5 (treed)	Transect 6 (treed)	Treed analogue site (transect 7)
	0.09 t/ha	0.09 t/ha	0.09 t/ha	0.18 t/ha	0.03 t/ha	1.46 t/ha	0.36 t/ha	0.0 t/ha

5.3 Vegetation assessment

Flora species identified along and within the vicinity of transects are listed in Appendix D.

Species composition at pasture rehabilitation areas – Pasture rehabilitation areas are established with a mix of 70% perennial grasses and 20% annual legumes and are representative of species composition at the analogue pasture site. An example of transect 1, 2 and 3 pasture is shown in Figure 2 and Figure 3.

Figure 2 Typical pasture composition of transects 1, 2 and 3

Figure 3 Pasture composition representative of transect 4

Groundcover at pasture rehabilitation areas – Rehabilitated pasture surfaces in each of the transect areas support living groundcover of approximately 90%.

Areas currently exist within each pasture rehabilitation area where groundcover is sparse or absent. It is estimated that these areas account for less than 10% of each pasture area.

Natural regeneration at pasture rehabilitation areas – Natural regeneration of groundcover species is evident across all the pasture rehabilitation areas.

Species composition at treed rehabilitation areas – Treed rehabilitation areas are established in accordance with an approved species mix representing local native species.

Structure of vegetation at treed rehabilitation areas – Structural layers of vegetation at treed rehabilitation areas are not comparable to those of the treed analogue site.

The treed analogue site is characterised by a canopy to 12m height with 40% canopy cover over a sparse shrubby mid-storey to 3m height and isolated shrubs to 1.5m height in the understorey. Groundcover consists of grasses and herbs with a cover of >95% (Figure 4).

Figure 4 Vegetation structure of treed analogue site (transect 7)

Figure 5 Transect 6 vegetation structure

Canopy cover is absent in treed rehabilitation areas. A sparse mid-storey of isolated juvenile trees and shrubs exists over a sparse, low, shrubby understorey (seen in Figure 6). Groundcover is a sparse mix of broadleaf herbs and grasses. Changes in vegetation structure over time (as shown in Appendix B) are not considered significant.

Groundcover at treed rehabilitation areas – Transect 5 supports a total living groundcover of 70%. Total living cover within the transect 5 area has fluctuated from 90% in 2014, 50% in 2015 and 75% cover in 2017. Annual cover has decreased slowly from 20% in 2015 to 10% in 2017, while perennial living cover has increased from 30% to 60% in the same period. Litter cover appears to be stable at 10% and the area of bare surface along the transect has decreased from 40% in 2015 to 20% in 2017.

Groundcover at transect 6 is 80%. Total living cover has fluctuated from 90% in 2014 to 70% in 2015 and 80% in 2016 and 2017. Annual and perennial living cover is generally stable at around 10% for annual cover and 70% for perennial cover. Litter cover has been stable at 10% from 2015 to 2017 and bare surface has decreased from 20% in 2015 to 10% in 2016 and 2017.

See Appendix E for a visual comparison of cover at 2014 and 2017.

Vegetation health at treed rehabilitation areas – Native forest indicator species are those that occur both in treed rehabilitation areas and the treed analogue site and provide an opportunity for comparison of growth between natural and rehabilitation conditions. Indicator species include native trees, shrubs and groundcovers.

More than 20% of native species recorded within the treed analogue site are actively growing in the treed rehabilitation areas. These species are dominated by trees and shrubs and it is expected that groundcovers and herbaceous species will be able to colonise the treed rehabilitation areas once sufficient canopy cover is established.

It is difficult to determine whether native forest indicator tree species on treed rehabilitation areas are within the height and girth measurements of trees on the treed analogue site. While there is evidence of recruitment on the treed analogue site it is not possible to determine the whether the age of juvenile trees is comparable to those establishing on the treed rehabilitation areas.

Natural regeneration of treed rehabilitation areas - There is no evidence of second generation native forest indicator tree or shrub species on treed rehabilitation areas; however natural regeneration of groundcover species is evident.

5.4 Evidence of fauna and habitat features

Field surveys recorded evidence of woodland birds utilising rehabilitation areas. Habitat features are installed on native forest rehabilitation areas including crushed timber rock pile clusters. Nesting boxes have not been installed in treed rehabilitation areas.

Fauna – Macropod, wombat, fox and rabbit scats and tracks were evident throughout the property. Evidence of foraging was observed as shallow diggings in both pasture and treed rehabilitation areas. Logs within the treed analogue and rehabilitation areas showed evidence of scratching. The remains of a rabbit kill were observed within Transect 6.

Native woodland birds were observed landing on trees and foraging within mulch in each of the treed vegetation areas and in the treed analogue site. Generalist birds including Currawong, Magpie and Noisy Miner were observed on the ground within pasture areas A and B and Area 8.

Habitat features – Crushed timber piles and rock pile clusters were observed within the treed rehabilitation areas of transects 5 and 6. Habitat features at the treed analogue site include fallen trees and scattered piles of fallen vegetation (visible in Figure 6).

Figure 6 An active burrow in an equipment storage area

5.5 Feral animals and weeds

Feral animal and weed species presence and abundance is not considered to adversely impact the intended final land use. Feral animals and noxious weeds are controlled in accordance with legislation. Weeds including African Lovegrass comprise <10% of the pasture sward. The presence or evidence of pests and weeds within and in the vicinity of each transect is recorded in Appendix A.

Pest animal presence – Rabbit and fox scats were observed across the property. Rabbit and fox numbers are considered low and do not require population reduction measures.

The European rabbit and European red fox are declared pests under the Local Land Services Act 2013. Rabbit and fox density is considered low, with some evidence of shallow soil scraping and scats across each of the monitoring locations. No holes, burrows or dens were observed.

Noxious and targeted weed species – Noxious weeds observed during field survey are listed in Table 4.

Table 4 Feral animal and noxious weed presence

Common name *Species name*	Location	Treatment
European Red Fox *Vulpes vulpes*	All locations	Landholders are obliged to control populations on their land.
European rabbit Oryctolagus cuniculus		
African Lovegrass *Eragrostis curvula*	Transects 1, 2, 3 and 4	The growth of the plant must be managed in a manner that reduces its numbers, spread and incidence and continually inhibits its reproduction. Not notifiable.

The presence of African Lovegrass was noted at transects 1, 2, 3 and 4 and occurred across less than 10% of the pasture area. These outbreaks have been subjected to ongoing chemical control and were not observed to be growing or producing seed.

5.6 Fuel loads and fire-fighting access

Fuel loads and fire breaks in and surrounding rehabilitation areas are assessed and maintained in accordance with the Bushfire Management Plan, and adequate access for firefighting is maintained on rehabilitation areas.

Fuel loads – Fuel loads within Areas A, B and C and Area 8 are low and fuel hazard mitigation activities are not required at this time.

Firebreaks - The internal road provides a mineral earth firebreak between Area A and Pine Dale Mine infrastructure to the south, while the Coal Haul Road provides a mineral earth firebreak immediately to the north of Area A. The Coal Haul Road and internal road provide a mineral earth firebreak to the north and west of Areas B and C and Area 8. Private grazing land is located immediately adjacent to the east and south of Areas B and C and Area 8. The majority of this interface supports mature Pine and Eucalypt trees which would provide a barrier to wind-borne embers spreading to private grazing land during a fire event.

Fire-fighting access - Access to each of the rehabilitation areas is considered to be adequate. The Coal Haul Road is a private road located immediately to the north of Areas A, B and C and Area 8 and allows movement from within Wallerawang Power Station, through Pine Dale Mine and to Mount Piper Power Station. An internal road is located immediately to the south of Areas A and B and to the north of Area 8. This road connects to Castlereagh Highway through the administration area of Pine Dale Mine. Area C is accessible by following the internal road through Area B. All access roads within rehabilitated areas are maintained in good condition and are suitable for the passage of Category 1 tankers, having a vertical clearance of >4m and a width of >2.8m (*Policy No. 2/2007 Fire Trails* (Bush Fire Coordinating Committee 2007)).

5.7 Rural land capability assessment

Pasture rehabilitation areas are assessed to have a Rural Land Capability Class VI or better (suitable for grazing).

Pasture rehabilitation areas are assessed as being Land and Soil Capability Class V and are suitable for grazing. The limiting factors for land use are generally related to wind erosion hazard. Note that the area of transect 4 is also subject to soil acidification hazard due to soil texture (Table 5).

Table 5 Rural land capability assessment of pasture areas

Class	Transect 1	Transect 2	Transect 3	Transect 4
Water erosion hazard class	2 1 - <3% slope	3 3 - <10% slope	4 10 - <20% slope, no gully erosion present	2 1 - <3% slope
Wind erosion hazard class	5 Moderate wind erodibility class of surface soil, high winds erosive power, high exposure to wind, average annual rainfall >500mm			
Soil structural decline class	4 Fragile light textured soil - hardsetting			
Soil acidification hazard class	4 Very low texture /buffering capacity, pH 6.7 – 7.5 ($CaCl_2$)			5

Class	Transect 1	Transect 2	Transect 3	Transect 4
				Very low texture /buffering capacity, pH 4.0 – 4.7 ($CaCl_2$)
Salinity hazard class	1 Moderate to high recharge potential, low discharge potential, low salt store			
Waterlogging hazard class	2 0 – 0.25 months typical waterlogging duration, moderately well drained soils			
Shallow soils and rockiness hazard class	1 Nil rocky outcrop, soil depth >100cm			
Mass movement hazard class	1 No mass movement present			

5.8 Management input assessment

Management inputs (ameliorants, fertilisers, weed treatments) are within the range of analogue sites.

Control of noxious and targeted weed species has been undertaken across all rehabilitation areas as required and in accordance with the recommendations of the *Pine Dale Mine Rehabilitation Monitoring Report 2014* (First Field Environmental 2014).

6. Rehabilitation status

The status of performance indicators and completion criteria are summarised in Table 6.

Table 6 Status of completion criteria

Performance indicator	Completion criteria	Status
Feral animal and noxious weed presence	• Feral animal and weed species presence and abundance is not considered to adversely impact the intended final land use.	• **Satisfactory** – continue to monitor
Feral animal and noxious weed control	• Feral animals and noxious weeds are controlled in accordance with legislation.	• **Satisfactory** – continue to monitor
Fuel loads	• Fuel loads and fire breaks in and surrounding rehabilitation areas are assessed and maintained in accordance with the Bushfire Management Plan.	• **Satisfactory** – continue to monitor
Access	• Adequate access for firefighting is maintained on rehabilitation areas.	• **Satisfactory** – continue to monitor
Habitat features	• Habitat features are installed on native forest rehabilitation areas including: - Nesting boxes and salvaged hollows - Crushed timber spread over native forest rehabilitation areas - Rock pile clusters.	• **Ongoing** - nesting boxes to be installed once trees are established

Performance indicator	Completion criteria	Status
Vegetation health	• More than 75% of native forest indicator species are assessed to be healthy and growing at year 5.	• **Ongoing** – continue to monitor
	• Native forest indicator species tree height and girth is within the range of analogue sites.	• **Ongoing** – continue to monitor
Soil loss	• Net annual soil loss is comparable to analogue sites at year 10.	• **Ongoing** – continue to monitor
Erosion	• There are no significant erosion features that compromise landform stability or public safety (including gullying or tunneling).	• **Satisfactory** – continue to monitor
Woodland birds present	• Evidence of woodland birds utilising rehabilitation areas.	• **Satisfactory** – continue to monitor
Evidence of mammals	• Evidence of target mammal species presence in rehabilitation areas.	• **Satisfactory** – continue to monitor
Natural regeneration	• Evidence of second generation of native forest indicator species from desired vegetation community.	• **Ongoing** – continue to monitor
	• Evidence of natural regeneration of at least four pasture species at year 5.	• **Satisfactory** – continue to monitor
Structure	• Structural layers (canopy, mid-storey, understorey and ground cover) are comparable to analogue sites.	• **Ongoing** – continue to monitor
Management inputs	• Management inputs (ameliorants, fertilisers, weed treatments) are within the range of analogue sites.	• **Satisfactory** – continue to monitor
Rural land capability	• Pasture rehabilitation areas are assessed to have a Rural Land Capability Class VI or better (suitable for grazing).	• **Satisfactory** – continue to monitor
Species composition	• Establishment of pasture comprising approximately 70% perennial grass and 20% annual legume, representative of species at analogue sites. • Vegetation within the treed rehabilitation areas is established in accordance with the approved species mix. • Approved pasture species mix is sown at the specified rate per hectare.	• **Satisfactory** – continue to monitor
Weed presence	• Weeds including African Lovegrass to comprise <10% of the pasture sward.	• **Satisfactory** – continue to monitor
Ground cover	• Ground cover (vegetation, leaf litter, mulch) >70% at year 5.	• **Satisfactory** – continue to monitor

7. Key findings

General

- Estimated soil loss in each of the transect areas is considered acceptable. Heightened soil loss calculated for the treed rehabilitation areas is consistent with the structural complexity differences between the rehabilitation and analogue sites.

Treed rehabilitation areas

- Nesting boxes are not installed in or adjacent to the treed rehabilitation areas.
- There is no evidence of second generation establishment at treed rehabilitation areas.
- Structural vegetation layers at treed rehabilitation areas are not comparable to the vegetation structure at the treed analogue site.

8. Recommendations

The following recommendations for mitigation and management are consistent with intervention and adaptive management measures contained within the *Pine Dale Mine Care and Maintenance Mining Operations Plan* (Enhance Place Pty Ltd 2014).

- Continue to monitor performance indicators, in particular:
- Continue to spot-spray outbreaks of African Lovegrass; and
- Install nesting boxes once the treed rehabilitation areas contain adequate structure to support nesting woodland birds.

9. References

BFCC (2007) *Policy No. 2/2007 Fire Trails*, Bush Fire Coordinating Committee, Australia

Bureau of Meteorology (2017) *Weather data Lidsdale NSW*, http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=063132

CSIRO (2008) *Ecosystem Function Analysis,* CSIRO, Australia

CSIRO (2009) *Australian Soil and Land Survey Field Handbook*, CSIRO, Australia

Cunningham, G (2012) *Flora Monitoring Report: Pine Dale Mine – February 2010 to November 2010*, Geoff Cunningham Natural Resource Consultants Pty Ltd, Killara NSW

DSE (2010) Overall Fuel Hazard Assessment Guide, Department of Sustainability and Environment, VIC

Enhance Place Pty Ltd (2014) *Pine Dale Mine Care and Maintenance Mining Operations Plan*, Enhance Place Pty Ltd, NSW

First Field Environmental (2014) *Pine Dale Mine Rehabilitation Monitoring Report*, First Field Environmental, NSW

First Field Environmental (2015) *Pine Dale Mine Rehabilitation Monitoring Report*, First Field Environmental, NSW

First Field Environmental (2016) *Pine Dale Mine Rehabilitation Monitoring Report*, First Field Environmental, NSW

IECA (2008) *Best Practice Erosion and Sediment Control,* International Erosion Control Association (Australasia)

NSW DPI (2017) *Noxious Weed Declarations for Upper Macquarie County Council*, New South Wales Department of Primary Industries, http://www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds/noxweed/

NSW DPI (2016) *Rabbit Control*, New South Wales Department of Primary Industries, http://www.dpi.nsw.gov.au/content/agriculture/pests-weeds/vertebrate-pests/pest-animals-in-nsw/rabbit-control

OEH (2007) *Land and Soil Capability Assessment*, Office of Environment and Heritage, NSW

SLR (2014) *Soil Assessment and Recommendations for Rehabilitation Areas*, NSW

Appendix A
Survey data 2017

Pasture analogue site	
Easting	Northing
228300	6304880
228317	6304925
Landform and soils	
Slope	1 - <3% slope inclining to the northwest.
Erosion	Not observed.
Cracking soils	Not observed.
Surface drainage impediments	No significant drainage impediments.
Vegetation	
Vegetation structure	Groundcover of mixed native and exotic grasses and broadleaf herbs.
Species richness	>30 herb and 15 grass species identified.
Cover classification 2015	
Total living cover	>90%
Annual living cover	40%
Perennial living cover	50%
Litter cover	<10%
Bare surface	-

Transect 1 Pasture rehabilitation area				
Easting	Northing			
228621	6305093			
228594	6305048			
Landform and soils				
Slope	Transect located along a contour. 1 - <3% slope inclining to the northwest.			
Erosion	Minor wind erosion observed on exposed soils.			
Cracking soils	Not observed.			
Surface drainage impediments	No significant drainage impediments.			
Vegetation				
Vegetation structure	Groundcover of mixed native exotic grasses and broadleaf herbs.			
Species richness	>30 herbs and grasses identified, dominated by exotic species.			
Cover classification	% cover at each observation			
	April 2014	September 2015	September 2016	September 2017
Total living cover	90%	80%	95%	90%
Annual living cover	-	40%	47.5%	40%
Perennial living cover	-	50%	47.5%	50%
Litter cover	10%	-	-	<10%
Bare surface	-	20%	5%	<10%
Target weed presence				
African Lovegrass (*Eragrostis curvula)*	<10%			

Transect 2 Pasture rehabilitation area				
Easting	Northing			
228454	6304718			
228400	6304744			
Landform and soils				
Slope	Transect located along a contour. 3 - <10% slope inclining to the west.			
Erosion	Minor wind erosion observed on exposed soils.			
Cracking soils	Not observed.			
Surface drainage impediments	No significant drainage impediments.			
Vegetation				
Vegetation structure	Groundcover of mixed native exotic grasses and broadleaf herbs.			
Species richness	>30 herbs and grasses identified, dominated by exotic species.			
Cover classification	% cover at each observation			
	April 2014	September 2015	September 2016	September 2017
Total living cover	90%	80%	90%	90%
Annual living cover	-	40%	42%	40%
Perennial living cover	-	50%	48%	50%
Litter cover	10%	-	-	<10%
Bare surface	-	20%	10%	<10%
Target weed presence				
African Lovegrass (*Eragrostis curvula)*	<10%			

Transect 3 Pasture rehabilitation area				
Easting	Northing			
228267	6304532			
228306	6304560			
Landform and soils				
Slope	Transect located along a contour. 10 - <20% slope declining to the northwest.			
Erosion	Minor wind erosion observed on exposed soils.			
Cracking soils	Not observed.			
Surface drainage impediments	No significant drainage impediments.			
Vegetation				
Vegetation structure	Groundcover of mixed native and exotic grasses and broadleaf herbs.			
Species richness	>30 herbs and grasses recorded, dominated by exotic species.			
Cover classification	% cover at each observation			
	April 2014	September 2015	September 2016	September 2017
Total living cover	90%	80%	90%	90%
Annual living cover	-	40%	46%	40%
Perennial living cover	-	50%	44%	50%
Litter cover	10%	-	-	<10%
Bare surface	-	20%	10%	<10%
Target weed presence				
African Lovegrass (*Eragrostis curvula)*	<10%			

Transect 4 Pasture rehabilitation area				
Easting		Northing		
228318		6304224		
228249		6304227		
Landform and soils				
Slope	Transect located along a contour. 1 - <3% slope declining to the west.			
Erosion	Minor wind erosion observed on exposed soils.			
Cracking soils	Not observed.			
Surface drainage impediments	No significant drainage impediments.			
Vegetation				
Vegetation structure	Groundcover of mixed native exotic grasses and broadleaf herbs.			
Species richness	Diverse groundcover with >30 exotic herb and grass species recorded.			
Cover classification	% cover at each observation			
	April 2014	September 2015	September 2016	September 2017
Total living cover	90%	80%	90%	90%
Annual living cover	-	40%	42%	30%
Perennial living cover	-	50%	48%	60%
Litter cover	10%	-	-	<10%
Bare surface	-	20%	10%	<10%
Target weed presence				
African Lovegrass (*Eragrostis curvula)*	<10%			

Transect 5 Treed rehabilitation area				
Easting	Northing			
227846	6304272			
227787	6304251			
Landform and soils				
Slope	Transect located along contour of mid slope inclining 10-20% to the north.			
Erosion	Minor wind and rill erosion observed on exposed soils.			
Cracking soils	Not present.			
Surface drainage impediments	No significant drainage impediments.			
Vegetation				
Vegetation structure	Sparse tree layer to 3m height with scattered juvenile trees and sparse mixed native shrub species. Dense groundcover dominated by native and exotic grasses with scattered mixed native and exotic herbs.			
Species richness	Shrub layer is dominated by native species and juvenile trees. Groundcover dominated by exotic broadleaf herbs and grasses. >15 species recorded.			
Cover classification	% cover at each observation			
	April 2014	September 2015	September 2016	September 2017
Total living cover	90%	50%	75%	70%
Annual living cover	-	20%	12%	10%
Perennial living cover	-	30%	63%	60%
Litter cover	10%	10%	10%	10%
Bare surface	-	40%	15%	20%
Target weed presence				
None observed.				

Transect 6 Treed rehabilitation area				
Easting	Northing			
226604	6304724			
226647	6304706			
Landform and soils				
Slope	Transect located along contour of mid slope inclining 10-20% to the northeast.			
Erosion	Minor wind and rill erosion observed on exposed soils.			
Cracking soils	Not observed.			
Surface drainage impediments	No significant drainage impediments.			
Vegetation				
Vegetation structure	Sparse tree layer to 3m height with scattered juvenile trees and sparse mixed native shrub species. Moderately dense groundcover dominated by native and exotic grasses with scattered mixed native and exotic herbs.			
Species richness	Shrub layer is dominated by native species and juvenile trees. Groundcover dominated by exotic broadleaf herbs and grasses. >15 species recorded.			
Cover classification	% cover at each observation			
	April 2014	September 2015	September 2016	September 2017
Total living cover	90%	70%	80%	80%
Annual living cover	-	10%	12%	10%
Perennial living cover	-	60%	68%	70%
Litter cover	10%	10%	10%	10%
Bare surface	-	20%	10%	10%
Target weed presence				
None observed.				

Treed analogue site (transect 7)	
Easting	Northing
226801	6305097
226838	6305039
Landform and soils	
Slope	Transect located along contour of mid slope gently inclining to the north.
Erosion	No erosion observed.
Cracking soils	Not observed.
Surface drainage impediments	No drainage impediments.
Vegetation	
Vegetation structure	Eucalyptus dominated canopy to 12m high with a canopy cover of 40%. Sparser shrub layer to 3m height with isolated shrubs to 1.5m height. >90% groundcover to 0.5m height, dominated by native grasses with mixed native herbs.
Species richness	More than 10 tree species, dominated by *Eucalyptus* spp. Shrub layer of >9 native species. Diverse groundcover dominated by *Poa* spp. with mixed native herbs.
Cover classification	
Total living cover	90%
Annual living cover	10%
Perennial living cover	80%
Litter cover	10%
Bare surface	-
Target weed presence	
None observed.	

Appendix B
Vegetation assessment of treed areas

Vegetation assessment treed areas 2017

Transect	Treed rehabilitation area (transect 5)	Treed rehabilitation area (transect 6)	Treed analogue site (transect 7)
Vegetation type	Rehabilitated	Rehabilitated	Dry Sclerophyll Forest (grassy)
Native plant species richness	>30	>30	>50
Trees	Sparse. To 3 m height.	Sparse. To 3 m height.	>10 species, 12-14 m height. 20% canopy cover.
Understorey	Sparse, to 2 m height. Includes juvenile Eucalyptus and Acacia species.	Sparse, to 3 m height. Includes juvenile Eucalyptus and Acacia species.	>9 species, 1-2 m height, 10% cover
Groundcover	70% cover. Mix of exotic grasses, native and exotic herbs.	Dominated by exotic grasses and herbs. Some native herbs present. 80% cover.	Dominated by *Poa* spp. >95% cover. Mixed herbs and grasses also present.
Non-native species	>10	>10	<5
Recruitment	Not observed.	Not observed.	Observed.
Organic litter	Very sparse layer of mulch remaining.	Very sparse layer of mulch remaining.	Well-developed to 2 cm depth.
Logs	Large logs placed along contours on upper slope.	Large logs placed along contours on upper slope.	8 fallen logs of >20 cm diameter present along transect.

Vegetation assessment treed areas 2016

Transect	Treed rehabilitation area (transect 5)	Treed rehabilitation area (transect 6)	Treed analogue site (transect 7)
Vegetation type	Rehabilitated	Rehabilitated	Dry Sclerophyll Forest (grassy)
Native plant species richness	>30	>30	>50
Trees	Sparse. To 3 m height.	Sparse. To 3 m height.	>10 species, 12-14 m height. 20% canopy cover.
Understorey	Sparse, to 2 m height. Juvenile Eucalyptus and Acacia species.	Sparse, to 3 m height. Juvenile Eucalyptus and Acacia species.	>9 species, 1-2 m height, 10% cover
Groundcover	75% cover. Mix of exotic grasses, native and exotic herbs.	Dominated by exotic grasses and herbs. Some native herbs present. 80% cover.	Dominated by *Poa* spp. >95% cover. Mixed herbs and grasses also present.
Non-native species	>15	>13, including *Senecio madagascariensis.*	<10
Recruitment	Not observed.	Not observed.	Present
Organic litter	Very sparse layer of mulch remaining.	Very sparse layer of mulch remaining.	Well-developed to 2 cm depth.
Logs	Large logs placed along contours on upper slope.	Large logs placed along contours on upper slope.	8 fallen logs of >20 cm diameter present along transect.

Vegetation assessment treed areas 2015

Transect	Treed rehabilitation area (transect 5)	Treed rehabilitation area (transect 6)	Treed analogue site (transect 7)
Vegetation type	Rehabilitated	Rehabilitated	Dry Sclerophyll Forest (grassy)
Native plant species richness	>30	>30	>50
Trees	Sparse. To 3 m height.	Sparse. To 3 m height.	>5 species, 12-14 m height. 20% canopy cover.
Understorey	Sparse, to 2 m height. Juvenile Eucalyptus and Acacia species. *Cassinia arcuata.*	Sparse, to 2 m height. Juvenile Eucalyptus and Acacia species. *Cassinia arcuata.*	>7 species, 1-2 m height, 10% cover
Groundcover	<40%. Mix of exotic grasses, native and exotic herbs.	Dominated by exotic grasses and herbs. Some native herbs present. 20% cover.	Dominated by *Poa* spp. >95% cover. Mixed herbs and grasses also present.
Non-native species	>10, including *Rubus fruticosus.*	>10	<10
Recruitment	Not observed.	Not observed.	Present
Organic litter	Thin mulch present.	Thin mulch present.	Well-developed to 2 cm depth.
Logs	Large logs placed along contours on upper slope.	Large logs placed along contours on upper slope.	8 fallen logs of >20 cm diameter present along transect.

Vegetation assessment treed areas 2014

Transect	Treed rehabilitation area (transect 5)	Treed rehabilitation area (transect 6)	Treed analogue site (transect 7)
Vegetation type	Rehabilitated	Rehabilitated	Dry Sclerophyll Forest (grassy)
Native plant species richness	>30	>30	>50
Trees	Sparse. To 3m height.	Sparse. To 3m height.	>5 species, 12-14 m height. 40% canopy cover.
Understorey	Sparse. Juvenile Eucalyptus spp. present with Acacia shrubs.	Sparse. Juvenile Eucalyptus spp. present with Acacia shrubs.	>7 species, 1.5 - 3 m height, 35% cover
Groundcover	Sparse. Mix of exotic grasses, native and exotic herbs.	Sparse. Mix of exotic grasses, native and exotic herbs.	70% cover. Dominated by *Poa* spp. with mixed native herbs.
Non-native species	>10	>10	<10
Recruitment	Not observed.	Not observed.	Present
Organic litter	Thin mulch present.	Thin mulch present.	Well-developed to >2cm depth.
Logs	Large logs placed along contours on upper slope.	Large logs placed along contours on upper slope.	8 fallen logs of >20 cm diameter present along transect.

Appendix C
Estimation of annual soil loss in pastures

Annual soil loss factors	Pasture analogue site	Transect 1 (pasture)	Transect 2 (pasture)	Transect 3 (pasture)	Transect 4 (pasture)	Transect 5 (treed)	Transect 6 (treed)	Treed analogue site (transect 7)
Annual rainfall erosivity factor **(R)**	**1365** Bathurst							
Soil erodibility factor **(K)**	**0.03** Sandy loam /fine sandy loam				**0.025** Sandy clay-loam			**0.03** Sandy loam /fine sandy loam
Topographic factor **(LS)**	**0.17** 3% gradient, 5m slope length			**0.34** 8% gradient, 5m slope length	**0.09** 1% gradient, 5m slope length	**0.89** 20% gradient, 5m slope length		**0.52** 12% gradient, 5m slope length
Cover and management factor **(C)**	**0.01** No appreciable canopy cover, 80-95% grassy groundcover					**0.04** 25% canopy cover of tall weeds or short brush, 60-80% grassy groundcover	**0.01** 25% canopy cover of tall weeds or short brush, 80-95% grassy groundcover	**0.00** Consistent with 75% canopy cover of trees and 95% grassy groundcover
Erosion control practice factor **(P)**	**1.3** Compacted					**1.2** Consistent with trackwalking along contour		**1.3** Compacted
Annual soil loss due to erosion **(A)**	**0.09 t/ha**	**0.09 t/ha**	**0.09 t/ha**	**0.18 t/ha**	**0.03 t/ha**	**1.46 t/ha**	**0.36 t/ha**	**0.0 t/ha**

Appendix D
Species list

Scientific name	Transect 1	Transect 2	Transect 3	Transect 4	Transect 5	Transect 6	Treed analogue site (Pine Dale Mine transect 7)
Acacia dealbata subsp. *dealbata*					X	X	X
Acacia nana					X	X	
Acacia rubida					X	X	X
Acacia sp.					X	X	X
Acacia ulcifolia							X
Ajuga australis							X
Amaranthus sp.	X	X	X	X	X	X	
Brassica juncea	X	X	X	X	X	X	
Bursaria spinosa subsp. *lasiophylla*					X	X	X
Calandrinia calyptrata							X
Cirsium vulgare	X	X	X	X			
Conyza bonariensis	X	X	X	X	X	X	
Crassula sp.					X		
Dactylis glomerata	X	X	X	X			
Desmodium varians							X
Dillwynia phylicoides							X
Eragrostis sp.	X	X	X	X			
Eucalyptus dalrympleana subsp. *dalrympleana*							X
Eucalyptus dives					X	X	X
Eucalyptus mannifera subsp. *mannifera*							X
Eucalyptus radiata subsp. *radiata*						X	
Eucalyptus rubida subsp. *rubida*							X

Scientific name	Transect 1	Transect 2	Transect 3	Transect 4	Transect 5	Transect 6	Treed analogue site (Pine Dale Mine transect 7)
Festuca arundinacea	X	X	X	X			
Festuca sp.	X	X	X	X			
Gamochaeta sp.	X	X	X	X			
Geranium sp.				X			X
Gompholobium huegelii							X
Goodenia hederacea							X
Hibbertia aspera subsp. *aspera*							X
Hibbertia obtusifolia							X
Hypochaeris radicata	X	X	X	X	X	X	
Juncus spp.		X					
Leucopogon sp.							X
Lissanthe strigose subsp. *subulata*							X
Lomandra filiformis							X
Medicago sp.	X	X	X	X			
Oxalis corniculata	X	X	X				
Paspalum sp.				X	X		
Persoonia laurina							X
Phalaris aquatica	X	X	X	X			
Pinus sp.							X
Plantago lanceolata	X	X	X	X	X	X	
Poa annua	X	X	X	X			X
Poa labillardierei							X
Poa spp.	X	X	X	X	X	X	X
Ranunculus lappaceus							X

Scientific name	Transect 1	Transect 2	Transect 3	Transect 4	Transect 5	Transect 6	Treed analogue site (Pine Dale Mine transect 7)
Ranunculus sp.	X	X	X	X	X	X	
Rumex acetosella	X	X			X	X	
Sonchus oleraceus	X	X	X	X			
Taraxacum officinale				X			
Themeda australis							X
Trifolium arvense	X	X	X	X			
Trifolium repens	X	X	X	X			
Trifolium subterraneum	X	X	X	X			
Veronica calycina							X
Vicia sp.					X	X	
Vulpia sp.	X	X	X	X			

Appendix E
Photopoint monitoring to 2017

Transect 1 looking south 2014

Transect 1 looking south 2015

Transect 1 looking south 2016

Transect 1 looking south 2017

Transect 2 looking southeast 2014

Transect 2 looking southeast 2015

Transect 2 looking southeast 2016

Transect 2 looking southeast 2017

Transect 3 looking southwest 2014

Transect 3 looking southwest 2015

Transect 3 looking southwest 2016

Transect 3 looking southwest 2017

Transect 4 looking west 2014

Transect 4 looking west 2015

Transect 4 looking west 2016

Transect 4 looking west 2017

Transect 5 looking west 2014

Transect 5 looking west 2015

Transect 5 looking west 2016

Transect 5 looking west 2017

Transect 6 looking east 2014

Transect 6 looking east 2015

Transect 6 looking east 2016

Transect 6 looking east 2017

Transect 7 looking east 2014

Transect 7 looking east 2015

Transect 7 looking east 2016

Transect 7 looking east 2017

Quadrat 1 February 2010 (Cunningham 2012)

Quadrat 1 September 2011 (Cunningham 2012)

Quadrat 1 November 2012 (Cunningham 2012)

Quadrat 1 April 2014

Quadrat 1 September 2015

Quadrat 1 September 2016

Quadrat 1 September 2017

APPENDIX B

Assessment of Rehabilitated Areas – Pine Dale Mine and Enhance Place Mine

global environmental solutions

Assessment of Rehabilitated Areas

Pine Dale Mine and Enhance Place Mine

Report Number 630.12362

July 2018

for Enhance Place Pty Ltd

Version: Final Draft

Assessment of Rehabilitated Areas

Pine Dale Mine and Enhance Place Mine

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Reference	Status	Date	Prepared	Checked	Authorised
630.12362	Final Draft	July 2018	Murray Fraser	Andrew Hutton	Andrew Hutton

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TABLES

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1 INTRODUCTION

Enhance Place Pty Ltd (Enhance Place) owns and operates the Pine Dale Mine and Enhance Place Mine in accordance with Project Approval (PA) 10_0041 and PA 451_01 respectively, granted by the Minister for the Department of Planning and Environment.

SLR was engaged by Enhance Place to conduct an assessment of rehabilitated areas of Pine Dale Mine and Enhance Place for possible relinquishment of the mining lease, having met rehabilitation commitments and completion criteria.

Previously (September, 2014) SLR was engaged by Enhance Place to:

- Undertake soil analysis and any other assessment as required, to inform development of quantitative rehabilitation completion criteria for Growth Media Development phase of rehabilitation; and
- Provide advice and recommendations for pasture improvement strategies required to achieve the agreed rehabilitation completion criteria as described in the relevant Mining Operations Plan.

In total, five sites have been rehabilitated between Pine Dale Mine and Enhance Place Mine. These sites are shown in **Figure 1** and **Figure 2** and are identified as the following:

Pine Dale Mine

- Area A;
- Area C (Jenkins Property); and
- Area 8.

Enhance Place

- Morris Property; and
- Crown Land block.

2 METHODOLOGY

A detailed walk-through inspection of these five areas was undertaken by Murray Fraser (SLR Associate Agronomist) and Graham Goodwin (Manager Mining Engineering) on 12th March 2018. The objective of this inspection was to assess the current condition of these rehabilitated areas, particularly the extent African lovegrass (*Eragrostis curvula*), to determine whether rehabilitation objectives have been met.

Soil samples were taken from the topsoil (0-10 cm) at each inspection site and sent to Soiltec Laboratories for nutrient testing and further analysis.

A traffic light risk rating has been used to describe any soil nutrient deficiencies/toxicities which may be limiting plant establishment and production in the rehabilitation areas at each of the sites. **Table 1** below outlines the meaning of each rating as per the traffic light methodology. Detailed soil test results are contained in **Appendix A**.

Table 2 Soil Nutrient Descriptors

Rating	Descriptor
	Soil nutrient is present in levels that are deficient /toxic and are highly likely to be impacting optimum plant growth.
	Soil nutrient is present in levels that are marginally deficient /toxic and may be impacting optimum plant growth.
	Soil nutrient is present in levels which are ideal for optimum plant growth.

2.1 Grazing Pasture Completion Criteria

Enhance Place proposed the following completion criteria for the grazing areas at Enhance Place Mine and Pine Dale Mine to be achieved within five years:

- Establishment of a vigorous perennial grass and annual legume pasture, comprising approximately 70% perennial grass and 20% annual legume.
- Obtain a year round pasture groundcover of greater than 70%.
- African lovegrass to comprise less than 10% of the pasture sward.
- Soil nutrient levels tested to meet the minimum completion targets shown in **Table 2**.

Soil element completion target measures were developed using a combination of the ideal range for soil elements and those measured at the undisturbed (analogue) Site PD3 in Area C (**Appendix B**) during the 2014 inspections, where there was a vigorous perennial grass and annual clover based pasture established.

Rainfall data obtained from the Lidsdale Bureau of Meteorology Station (063132) show that for the three months preceding the 2014 (153.2 millimetres) and the 2018 (210.8 millimetres) inspections cumulative rainfall was 30% less than the long term average, giving similar climatic conditions to make a comparable comparison in nutrient levels and pasture groundcover between these years.

Table 2 Soil Nutrient Level Completion Targets

Soil Element	Measure & Test	Site PD3 Soil Test	Ideal Soil Element Range	Completion Target Measure
pH	1:5 $CaCl_2$	4.94	Between 5.2 – 8.0	Greater than 4.9
Potassium	% of Total CEC	3.17	Greater than 2%	Greater than 2%
Sodium	% of Total CEC	1.90	Less than 3%	Less than 3%
Aluminium	% of Total CEC	0.53	Less than 5%	Less than 5%
Sulfur	mg/kg KCl 40 S	6.8	Greater than 8	Greater than 6.8
Nitrogen	mg/kg Water Extract	4.6	Greater than 10	Greater than 4.6
Zinc	mg/kg DTPA	0.7	Greater than 1	Greater than 0.7
Calcium	Calcium to Magnesium Ratio	2.14	Greater than 3	Greater than 2.1

Upon analysis of soil samples taken from analogue sites in March 2018, the sulfur levels at PD3 in September 2014 appear to be unusually high, with all analogue sites (including PD3) having sulfur levels significantly lower than 6.8, with an average across the five analogue sites of 5.4, as shown in **Table 3** below. Considering these results, a sulfur completion target measure of greater than 5.4 is considered a more realistic representation of baseline conditions.

Table 3 Analogue Site 2018 Sulfur Levels

Soil Element	PD3	PD6	PD8	EP4	EP6	Average
Sulfur	5.3	5.2	5.0	6.0	5.7	**5.4**

2.2 Recommended Agronomic Treatments 2014

The following agronomic recommendations were made by SLR in November 2014 in order for Pine Dale Mine and Enhance Place Mine to achieve the nominated rehabilitation criteria.

Pine Dale Mine – Area A

Table 4 Area A Fertiliser Application

Site	Fertiliser Requirement	Tonnes/ha	Total tonnes
Area A Approx. 7 hectares	MOP	0.25	1.75
	Mushroom compost	10	70
	Lime	3	21
	Gypsum	2	14

Pine Dale Mine – Area C (Jenkins Property)

Area C requires a boom spray application of *Taskforce* for the control of African Lovegrass prior to any pasture establishment works being undertaken.

Table 5 Area C Fertiliser Application

Site	Fertiliser Requirement	Tonnes/ha	Total tonnes
Area C Approx. 14 hectares	MOP	0.25	3.5
	DAP	0.20	2.8
	Mushroom compost	10	140
	Lime	4	56
	Gypsum	1	14

Pine Dale Mine – Area 8

Area 8 requires a boom spray application of *Taskforce* for the control of African Lovegrass prior to any pasture establishment works being undertaken.

Table 6 Area 8 Fertiliser Application

Site	Fertiliser Requirement	Tonnes/ha	Total tonnes
Area 8 Approx. 7 hectares	DAP	0.20	1.4
	Mushroom compost	10	70
	Lime	1	7
	Gypsum	3	21

Enhance Place Mine – Morris Property

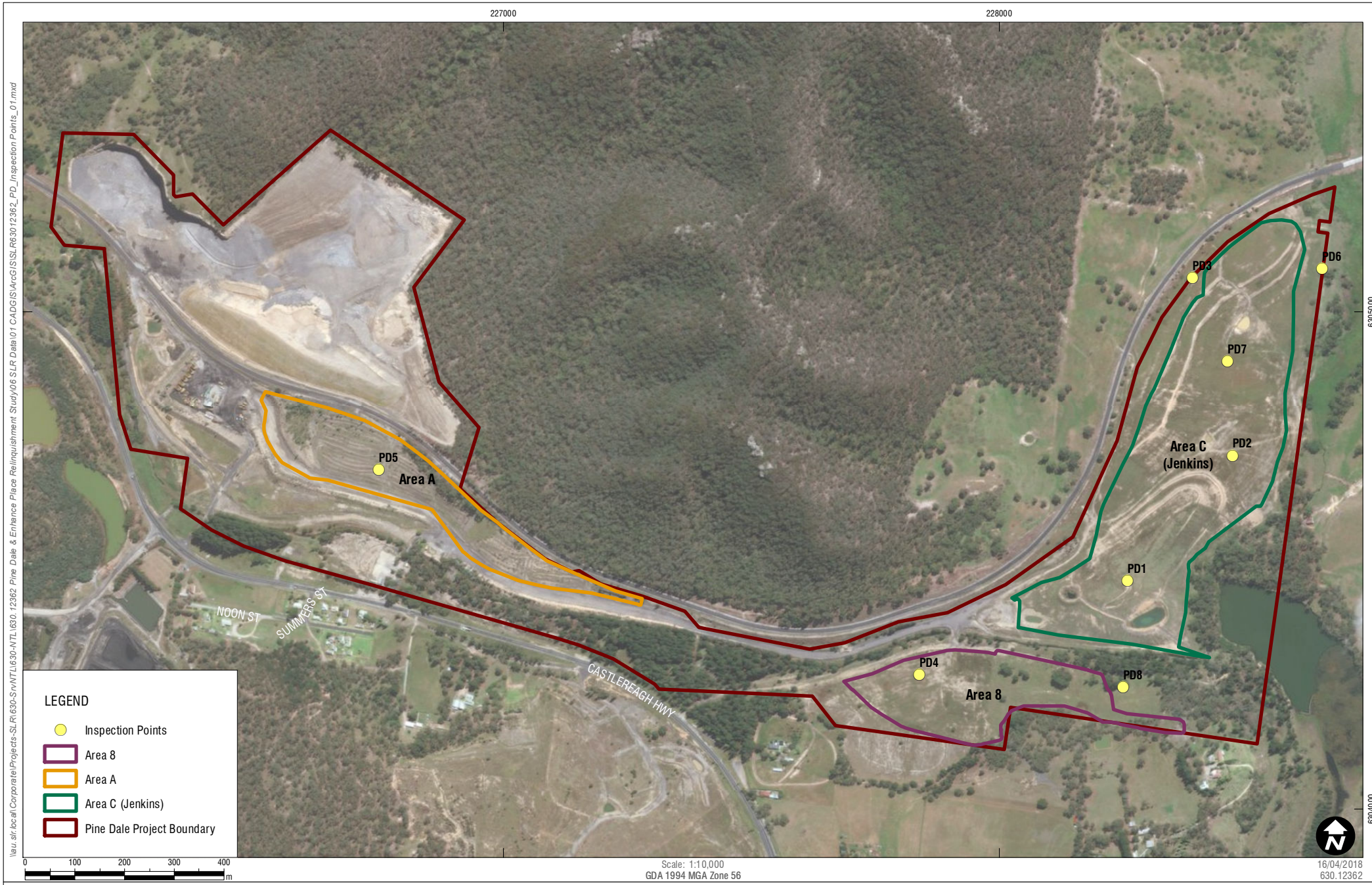
The Morris property requires a boom spray application of *Taskforce* to control African lovegrass and also broadleaf weed control prior to any pasture renovation being undertaken.

Table 7 Morris Property Fertiliser Application

Site	Fertiliser Requirement	Tonnes/ha	Total tonnes
Morris Property Approx. 23 hectares	DAP	0.20	4.6
	MOP	0.25	5.75
	Gypsum	3	69

Enhance Place Mine – Crown Land

The Crown Land (EP 2) Block does not require any remedial action as it has satisfactory pasture groundcover and appears to be only grazed by kangaroos. It is recommended that this area continues to be monitored against agreed rehabilitation completion criteria



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Pine Dale
Inspection Points

FIGURE 1

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Enhance Place
Inspection Points

FIGURE 2

3 INSPECTION RESULTS

The following section summarises the results for each of the sites inspected at both Pine Dale Mine and Enhance Place Mine in 2018 alongside comparisons made with 2014 inspection results. It is intended to show the general condition of each site at the time of the inspection as well as document any further identified constraints which may be limiting desirable plant establishment and growth.

3.1 Pine Dale Mine

3.1.1 Area A

Rehabilitated Site PD5

The rehabilitation objective for Area A, incorporating Site PD5 is return to a native woodland vegetation community. **Table 8** below shows a comparison of soil nutrient levels between the 2014 and 2018 inspections. All completion targets have been achieved at Site PD5.

Table 8 Soil Nutrient Levels Site PD5 (Rehabilitated Site)

Soil Element	Measure & Test	Site PD5 2014	Completion Target	Site PD5 2018
pH	1:5 $CaCl_2$	4.1	Greater than 4.9	6.6
Potassium	% of Total CEC	2.7	Greater than 2%	3.1
Sodium	% of Total CEC	7.1	Less than 3%	0.1
Aluminium	% of Total CEC	6.2	Less than 5%	0.0
Sulfur	mg/kg KCl 40 S	6.3	Greater than 5.4	9.0
Nitrogen	mg/kg Water Extract	6.9	Greater than 4.6	13.8
Zinc	mg/kg DTPA	0.9	Greater than 0.7	1.0
Calcium	Calcium:Magnesium Ratio	1.6	Greater than 2.1	2.3

Plate 1 and **Plate 2** show the general landscape setting for site PD5 within Area A at Pine Dale Mine during the 2014 and 2018 inspections. The rehabilitation objective for PD5 is a native woodland vegetation community.

Increased growth of eucalypts can clearly be seen while groundcover consists of couch, phalaris and fescue perennial grasses with greater than 80% groundcover.

Plate 1: Rehabilitated Site PD5 September 2014

Plate 2: Rehabilitated Site PD5 March 2018

3.1.2 Area C (Jenkins Property)

Analogue Site PD3

Table 9 below shows a comparison of soil nutrient levels at Site PD3 from the 2014 and 2018 inspections. Grazing completion targets were developed from the 2014 results at Site PD3. Sulfur has dropped from 6.8 mg/kg to 5.3 mg/kg, an unexpected change which also occurred at several of the analogue sites.

Site PD3 underwent the same treatments as other rehabilitated sites within Area C.

Table 9 Soil Nutrient Levels Site PD3 (Analogue Site)

Soil Element	Measure & Test	Site PD3 2014	Completion Target	Site PD3 2018
pH	1:5 $CaCl_2$	4.9	Greater than 4.9	6.6
Potassium	% of Total CEC	3.8	Greater than 2%	4.4
Sodium	% of Total CEC	1.9	Less than 3%	0.2
Aluminium	% of Total CEC	0.5	Less than 5%	0.0
Sulfur	mg/kg KCl 40 S	6.8	Greater than 5.4	5.3
Nitrogen	mg/kg Water Extract	4.6	Greater than 4.6	9.2
Zinc	mg/kg DTPA	0.7	Greater than 0.7	0.7
Calcium	Calcium:Magnesium Ratio	2.1	Greater than 2.1	2.8

Plate 3 and **Plate 4** show the general landscape setting for site PD3 within Area C at Pine Dale Mine during the 2014 and 2018 inspections.

Site PD3 has not been disturbed by mining activity and has not been rehabilitated. Site PD3 is considered to be representative of pre-mining grazing land use conditions in regards to soil profile and vegetation cover for this area. It is considered an analogue site for Area C.

Topsoil consists of a sandy clay loam over a medium clay subsoil. This area supports a perennial grass and clover pasture, including cocksfoot, tall fescue, phalaris, sub clover, with some annual ryegrass. These pasture species have a winter and spring growth habit, with the difference in pasture mass clearly evident between the 2014 (September) and 2018 (March) inspections.

Plate 3: Analogue Site PD3 September 2014

Plate 4: Analogue Site PD3 March 2018

Rehabilitated Site PD1

Table 10 below shows a comparison of soil nutrient levels at Site PD1 from the 2014 and 2018 inspections. Grazing completion targets were met for all soil elements.

Table 10 Soil Nutrient Levels Site PD1 (Rehabilitated Site)

Soil Element	Measure & Test	Site PD1 2014	Completion Target	Site PD1 2018
pH	1:5 $CaCl_2$	6.6	Greater than 4.9	6.5
Potassium	% of Total CEC	1.7	Greater than 2%	3.5
Sodium	% of Total CEC	2.5	Less than 3%	0.2
Aluminium	% of Total CEC	0.0	Less than 5%	0.0
Sulfur	mg/kg KCl 40 S	5.4	Greater than 5.4	6.3
Nitrogen	mg/kg Water Extract	6.9	Greater than 4.6	27.6
Zinc	mg/kg DTPA	0.7	Greater than 0.7	1.0
Calcium	Calcium:Magnesium Ratio	1.6	Greater than 2.1	2.7

Plate 5 and **Plate 6** show the general landscape setting for Site PD1 within Area C at Pine Dale Mine during the 2014 and 2018 inspections.

Pasture at Site PD1 is dominated by perennial cocksfoot and paspalum grass pasture with some sub clover and arrowleaf clover present in the sward, with greater than 90% groundcover. There is no African lovegrass present. Again the difference in pasture growth between autumn and spring can clearly be seen.

Plate 5: Rehabilitated Site PD1 September 2014

Plate 6: Rehabilitated Site PD1 March 2018

Rehabilitated Site PD2

Table 11 below shows a comparison of soil nutrient levels at Site PD2 from the 2014 and 2018 inspections. Grazing completion targets were met for all soil elements.

Table 11 Soil Nutrient Levels Site PD2 (Rehabilitated Site)

Soil Element	Measure & Test	Site PD2 2014	Completion Target	Site PD2 2018
pH	1:5 $CaCl_2$	4.6	Greater than 4.9	5.9
Potassium	% of Total CEC	1.7	Greater than 2%	4.4
Sodium	% of Total CEC	2.3	Less than 3%	0.3
Aluminium	% of Total CEC	4.5	Less than 5%	0.0
Sulfur	mg/kg KCl 40 S	6.0	Greater than 5.4	7.7
Nitrogen	mg/kg Water Extract	4.6	Greater than 4.6	46.0
Zinc	mg/kg DTPA	0.8	Greater than 0.7	0.8
Calcium	Calcium:Magnesium Ratio	1.8	Greater than 2.1	2.3

Plate 7 and **Plate 8** show the general landscape setting for Site PD2 within Area C at Pine Dale Mine during the 2014 and 2018 inspections.

Pasture at Site PD2 is dominated by perennial cocksfoot and paspalum grass pasture with the herb plantain and some arrowleaf clover present in the sward, with greater than 80% groundcover. There are isolated African lovegrass tussocks present which comprise less than 5% of the pasture sward. Significant increase in perennial grass groundcover can be seen between the two inspection periods.

Plate 7: Rehabilitated Site PD2 September 2014

Plate 8: Rehabilitated Site PD2 March 2018

Analogue Site PD6

Table 12 below shows soil nutrient levels at Site PD6 from the 2018 inspection. Site PD6 was chosen as an additional analogue site for Area C.

Table 12 Soil Nutrient Levels Site PD6 (Analogue Site)

Soil Element	Measure & Test	Site PD6 2014	Completion Target	Site PD6 2018
pH	1:5 $CaCl_2$	New Site Not Tested 2014	Greater than 4.9	5.2
Potassium	% of Total CEC		Greater than 2%	3.2
Sodium	% of Total CEC		Less than 3%	0.2
Aluminium	% of Total CEC		Less than 5%	0.0
Sulfur	mg/kg KCl 40 S		Greater than 5.4	5.2
Nitrogen	mg/kg Water Extract		Greater than 4.6	18.4
Zinc	mg/kg DTPA		Greater than 0.7	1.0
Calcium	Calcium:Magnesium Ratio		Greater than 2.1	2.5

Plate 9 shows the general landscape setting for Site PD6 within Area C at Pine Dale Mine during the 2018 inspection. Pasture at Site PD6 is dominated by the perennial grasses phalaris and fescue

Rehabilitated Site PD7

Table 13 below shows nutrient levels at Site PD7 from the 2018 inspection. Site PD7 was chosen as an additional rehabilitation site for Area C. Grazing completion targets were met for all soil elements.

Table 13 Soil Nutrient Levels Site PD7 (Rehabilitated Site)

Soil Element	Measure & Test	Site PD7 2014	Completion Target	Site PD7 2018
pH	1:5 $CaCl_2$	New Site Not Tested 2014	Greater than 4.9	5.3
Potassium	% of Total CEC		Greater than 2%	5.2
Sodium	% of Total CEC		Less than 3%	0.3
Aluminium	% of Total CEC		Less than 5%	0.0
Sulfur	mg/kg KCl 40 S		Greater than 5.4	5.5
Nitrogen	mg/kg Water Extract		Greater than 4.6	9.2
Zinc	mg/kg DTPA		Greater than 0.7	0.7
Calcium	Calcium:Magnesium Ratio		Greater than 2.1	2.7

Plate 10 shows the general landscape setting for Site PD7 within Area C at Pine Dale Mine during the 2018 inspection. Pasture at Site PD6 is dominated by perennial grasses phalaris, fescue and paspalum along with the herb plantain and arrowleaf clover. There is greater than 90% groundcover with only isolated tussocks of African lovegrass, which comprises less than 5% of the pasture sward.

Plate 9: Analogue Site PD6 March 2018

Plate 10: Rehabilitated Site PD7 March 2018

3.1.3 Area 8

Rehabilitated Site PD4

Table 14 below shows a comparison of soil nutrient levels at Site PD4 from the 2014 and 2018 inspections. Grazing completion targets were met for all soil elements.

Table 14 Soil Nutrient Levels Site PD4 (Rehabilitated Site)

Soil Element	Measure & Test	Site PD4 2014	Completion Target	Site PD4 2018
pH	1:5 $CaCl_2$	5.7	Greater than 4.9	6.1
Potassium	% of Total CEC	3.5	Greater than 2%	4.4
Sodium	% of Total CEC	1.4	Less than 3%	0.3
Aluminium	% of Total CEC	0.0	Less than 5%	0.0
Sulfur	mg/kg KCl 40 S	7.4	Greater than 5.4	8.9
Nitrogen	mg/kg Water Extract	4.6	Greater than 4.6	36.8
Zinc	mg/kg DTPA	0.8	Greater than 0.7	0.7
Calcium	Calcium:Magnesium Ratio	2.7	Greater than 2.1	3.7

Plate 11 and **Plate 12** show the general landscape setting for Site PD4 within Area 8 at Pine Dale Mine during the 2014 and 2018 inspections.

Pasture at Site PD4 is dominated by perennial grasses cocksfoot, fescue and paspalum with some arrowleaf clover present in the sward, and greater than 90% groundcover. There are isolated African lovegrass tussocks present which comprise less than 5% of the pasture sward. Significant increase in perennial grass groundcover can be seen between the two inspection periods.

Plate 11: Rehabilitated Site PD4 September 2014

Plate 12: Rehabilitated Site PD4 March 2018

Analogue Site PD8

Table 15 below shows soil nutrient levels at Site PD8 from the 2018 inspection. Site PD8 was chosen as an analogue site for Area 8 as it is undisturbed by mining and did not receive any of the Area 8 treatment, being located between pine trees and not accessed by fertiliser spreading equipment.

Table 15 Soil Nutrient Levels Site PD8 (Analogue Site)

Soil Element	Measure & Test	Site PD8 2014	Completion Target	Site PD8 2018
pH	1:5 $CaCl_2$	New Analogue Site Not Tested 2014	Greater than 4.9	5.0
Potassium	% of Total CEC		Greater than 2%	2.5
Sodium	% of Total CEC		Less than 3%	0.9
Aluminium	% of Total CEC		Less than 5%	2.0
Sulfur	mg/kg KCl 40 S		Greater than 5.4	5.0
Nitrogen	mg/kg Water Extract		Greater than 4.6	2.3
Zinc	mg/kg DTPA		Greater than 0.7	0.8
Calcium	Calcium:Magnesium Ratio		Greater than 2.1	1.7

Plate 13 shows the general landscape setting for Site PD8 within Area 8 at Pine Dale Mine during the 2018 inspection. Pasture at Site PD8 is dominated by perennial phalaris and fescue with some arrowleaf clover present in the sward, with greater than 90% groundcover. There are isolated African lovegrass tussocks present which comprise less than 5% of the pasture sward.

Plate 13: Analogue Site PD8 March 2018

3.2 Enhance Place Mine

3.2.1 Morris Property

Analogue Site EP4

Table 16 below shows soil nutrient levels at Site EP4 from the 2018 inspection. Site EP4 was chosen as an analogue site for the Morris Property as it is undisturbed by mining did not receive any of the Morris Property treatment, being located between eucalypt trees and not accessed by fertiliser spreading equipment. **Plate 14** shows the general landscape setting for analogue Site EP4

Table 16 Soil Nutrient Levels Site EP4 (Analogue Site)

Soil Element	Measure & Test	Site EP4 2014	Completion Target	Site EP4 2018
pH	1:5 $CaCl_2$	New Analogue Site Not Tested 2014	Greater than 4.9	4.8
Potassium	% of Total CEC		Greater than 2%	3.7
Sodium	% of Total CEC		Less than 3%	0.2
Aluminium	% of Total CEC		Less than 5%	2.0
Sulfur	mg/kg KCl 40 S		Greater than 5.4	6.0
Nitrogen	mg/kg Water Extract		Greater than 4.6	4.6
Zinc	mg/kg DTPA		Greater than 0.7	0.8
Calcium	Calcium:Magnesium Ratio		Greater than 2.1	2.6

Analogue Site EP6

Table 17 below shows soil nutrient levels at Site EP6 from the 2018 inspection. Site EP6 was chosen as an analogue site for the Morris Property as it is undisturbed by mining and also located in a roadside reserve and not accessed by fertiliser spreading equipment. **Plate 15** shows the general landscape setting for analogue Site EP6.

Table 17 Soil Nutrient Levels Site EP6 (Analogue Site)

Soil Element	Measure & Test	Site EP6 2014	Completion Target	Site EP6 2018
pH	1:5 $CaCl_2$	New Analogue Site Not Tested 2014	Greater than 4.9	4.6
Potassium	% of Total CEC		Greater than 2%	4.0
Sodium	% of Total CEC		Less than 3%	1.3
Aluminium	% of Total CEC		Less than 5%	6.2
Sulfur	mg/kg KCl 40 S		Greater than 5.4	5.7
Nitrogen	mg/kg Water Extract		Greater than 4.6	4.6
Zinc	mg/kg DTPA		Greater than 0.7	0.7
Calcium	Calcium:Magnesium Ratio		Greater than 2.1	1.8

Plate 14: Analogue Site EP4 March 2018

Plate 15: Analogue Site EP6 March 2018

Rehabilitated Site EP1

Table 18 below shows a comparison of soil nutrient levels at Site EP1 from the 2014 and 2018 inspections. Grazing completion targets were met for all soil elements.

Table 18 Soil Nutrient Levels Site EP1 (Rehabilitated Site)

Soil Element	Measure & Test	Site EP1 2014	Completion Target	Site EP1 2018
pH	1:5 $CaCl_2$	7.2	Greater than 4.9	5.1
Potassium	% of Total CEC	3.0	Greater than 2%	5.2
Sodium	% of Total CEC	1.8	Less than 3%	0.4
Aluminium	% of Total CEC	0.0	Less than 5%	0.0
Sulfur	mg/kg KCl 40 S	7.0	Greater than 5.4	6.2
Nitrogen	mg/kg Water Extract	2.3	Greater than 4.6	46.0
Zinc	mg/kg DTPA	0.8	Greater than 0.7	0.8
Calcium	Calcium:Magnesium Ratio	2.7	Greater than 2.1	3.3

Plate 16 and **Plate 17** show the general landscape setting for Site EP1 within the Morris Property at Enhance Place Mine during the 2014 and 2018 inspections.

Pasture at Site EP1 is dominated by perennial grasses phalaris and cocksfoot, the herb plantain with some medic present in the sward, and greater than 80% groundcover. Significant increase in perennial grass groundcover can be seen between the two inspection periods.

Overgrazing is still a major land management issue here, however increase in perennial grass pasture density have been achieved nonetheless.

Plate 16: Rehabilitated Site EP1 September 2014

Plate 17: Rehabilitated Site EP1 March 2018

Rehabilitated Site EP3

Table 19 below shows a comparison of soil nutrient levels at Site EP3 from the 2014 and 2018 inspections. Grazing completion targets were met for all soil elements.

Table 19 Soil Nutrient Levels Site EP3 (Rehabilitated Site)

Soil Element	Measure & Test	Site EP3 2014	Completion Target	Site EP3 2018
pH	1:5 $CaCl_2$	6.8	Greater than 4.9	5.3
Potassium	% of Total CEC	2.4	Greater than 2%	3.5
Sodium	% of Total CEC	3.7	Less than 3%	0.3
Aluminium	% of Total CEC	0.0	Less than 5%	0.0
Sulfur	mg/kg KCl 40 S	5.9	Greater than 5.4	7.8
Nitrogen	mg/kg Water Extract	2.3	Greater than 4.6	115.0
Zinc	mg/kg DTPA	0.8	Greater than 0.7	0.9
Calcium	Calcium:Magnesium Ratio	1.6	Greater than 2.1	2.3

Plate 18 and **Plate 19** show the general landscape setting for Site EP3 within the Morris Property at Enhance Place Mine during the 2014 and 2018 inspections.

Pasture at Site EP3 is dominated by perennial grasses fescue and cocksfoot, the herb plantain with some medic present in the sward, and greater than 80% groundcover. Significant increase in perennial grass groundcover can be seen between the two inspection periods. There are areas of *Brassica* weed species which are being grazed by horses and cattle.

Overgrazing is still a major land management issue here, however increase in perennial grass pasture density have been achieved nonetheless.

Plate 18: Rehabilitated Site EP3 September 2014

Plate 19: Rehabilitated Site EP3 March 2018

Rehabilitated Site EP5

Table 20 below shows soil nutrient levels at Site EP5 from the 2018 inspection. Grazing completion targets were met for all soil elements.

Table 20 Soil Nutrient Levels Site EP5 (Rehabilitated Site)

Soil Element	Measure & Test	Site EP5 2014	Completion Target	Site EP5 2018
pH	1:5 $CaCl_2$	New Site Not Tested 2014	Greater than 4.9	6.1
Potassium	% of Total CEC		Greater than 2%	4.3
Sodium	% of Total CEC		Less than 3%	0.3
Aluminium	% of Total CEC		Less than 5%	0.0
Sulfur	mg/kg KCl 40 S		Greater than 5.4	7.5
Nitrogen	mg/kg Water Extract		Greater than 4.6	73.6
Zinc	mg/kg DTPA		Greater than 0.7	0.8
Calcium	Calcium:Magnesium Ratio		Greater than 2.1	3.1

Plate 20 shows the general landscape setting for Site EP5 within the Morris Property at Enhance Place Mine during the 2018 inspections. Pasture at Site EP5 is dominated by perennial grasses fescue and phalaris, the herb plantain with some medic present in the sward, and greater than 90% groundcover.

Plate 20: Rehabilitated Site EP5 March 2018

3.2.2 Crown Land Block

Rehabilitated Site EP2

Table 21 below shows a comparison of soil nutrient levels at Site EP3 from the 2014 and 2018 inspections. Grazing completion targets were met for all soil elements.

Table 21 Soil Nutrient Levels Site EP2 (Rehabilitated Site)

Soil Element	Measure & Test	Site EP2 2014	Completion Target	Site EP2 2018
pH	1:5 $CaCl_2$	7.1	Greater than 4.9	6.3
Potassium	% of Total CEC	4.0	Greater than 2%	4.1
Sodium	% of Total CEC	2.1	Less than 3%	0.4
Aluminium	% of Total CEC	0.0	Less than 5%	0.0
Sulfur	mg/kg KCl 40 S	6.5	Greater than 5.4	5.4
Nitrogen	mg/kg Water Extract	4.6	Greater than 4.6	13.8
Zinc	mg/kg DTPA	0.7	Greater than 0.7	0.7
Calcium	Calcium:Magnesium Ratio	2.1	Greater than 2.1	2.9

The Crown Land Block adjacent to the Morris property is grazed only by kangaroos with domestic stock being excluded. In 2014 EP2 had sufficient groundcover and a desirable pasture species composition with no further remediation work recommended.

Plate 21 and **Plate 22** show the general landscape setting for Site EP2 within the Morris Property at Enhance Place Mine during the 2014 and 2018 inspections, with greater than 80% groundcover.

Plate 21: Rehabilitated Site EP2 September 2014

Plate 22: Rehabilitated Site EP2 March 2018

4 SUMMARY

All rehabilitated sites at Pine Dale Mine and Enhance Place Mine showed improved levels of soil fertility from 2014. Additionally, desirable perennial pasture content had increased and African lovegrass populations had significantly decreased.

SLR is of the opinion that Enhance Place Pty Ltd. has met (and exceeded) the Grazing Pasture Completion Criteria stated in **Section 2.1** at the Pine Dale Mine and Enhance Place sites.

Appendix A

2018 All Sites Laboratory Soil Test Results

SOILTEC

SOIL AND PLANT ANALYSIS

2/37 OWENS CR (PO BOX 374) ALSTONVILLE NSW 2477
PHONE 02 66281411 FAX 02 66285868 EMAIL : chemist@soiltec.com.au

Soil Test Report #s18-0307 (8)

Client: ***SLR***
Account: **PD1**
10 Kings rd
New lambton NSW

Sample Received: 16.4.2018 Report Reply: 24.4.2018
SAMPLE I.D: 0-10cm **INTENDED USE:**

			RESULT	***OPTIMAL***
Conductivity (dS/m)(1:5 water)			0.12	<0.15
pH	(1:5 $CaCl_2$)		6.50	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	11.27	See Percentage
Magnesium:		(Mg)(meq/100g)	4.11	See Percentage
Potassium:		(K)(meq/100g)	0.56	0.5-1.0
Sodium:		(Na)(meq/100g)	0.03	Zero
Aluminium:		(Al)(meq/100g)	0.00	Zero
Total Cation Exchange Capacity (CEC):			**15.97**	
Exchangeable Cations (as a % of Total)				
Calcium:			70.57	65-80%
Magnesium:			25.74	15-20%
Potassium:			3.51	2-5%
Sodium:			0.19	<3%
Aluminium:			0.00	<5%
Phosphorus:	(mg/kg)	(Bray-1)	15.7	
Sulphur	(mg/kg)	(KCl 40 S)	6.3	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	27.6	At least 10
Organic Carbon	(%)	(Walkely & Black)	4.0	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	1.3	
Zinc		(mg/kg) (DTPA)	1.0	
Manganese		(mg/kg) (DTPA)	56.3	
Iron		(mg/kg) (DTPA)	60.3	
Boron		(mg/kg) (Hot CaCl)	1.0	
Calculations:				
Lime Requirement (Cregan)			0.00	(see notes on page 2)
Calcium/Magnesium Ratio:			2.74	3-5

~ASPAC~

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SOILTEC *SOIL AND PLANT ANALYSIS*

2/37 OWENS CR (PO BOX 374) ALSTONVILLE NSW 2477
PHONE 02 66281411 FAX 02 66285868 EMAIL : chemist@soiltec.com.au

Soil Test Report #s18-0307 (9)

Client: ***SLR***
Account: **PD2**
10 Kings rd
New lambton NSW

Sample Received: 16.4.2018 Report Reply: 24.4.2018
SAMPLE I.D: 0-10cm **INTENDED USE:**

			RESULT	***OPTIMAL***
Conductivity (dS/m)(1:5 water)			0.10	<0.15
pH	(1:5 $CaCl_2$)		5.85	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	6.59	See Percentage
Magnesium:		(Mg)(meq/100g)	2.93	See Percentage
Potassium:		(K)(meq/100g)	0.44	0.5-1.0
Sodium:		(Na)(meq/100g)	0.03	Zero
Aluminium:		(Al)(meq/100g)	0.00	Zero
Total Cation Exchange Capacity (CEC):			**9.99**	
Exchangeable Cations (as a % of Total)				
Calcium:			65.97	65-80%
Magnesium:			29.33	15-20%
Potassium:			4.40	2-5%
Sodium:			0.30	<3%
Aluminium:			0.00	<5%
Phosphorus:	(mg/kg)	(Bray-1)	35.9	
Sulphur	(mg/kg)	(KCl 40 S)	7.7	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	46.0	At least 10
Organic Carbon	(%)	(Walkely & Black)	3.9	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	1.0	
Zinc		(mg/kg) (DTPA)	0.8	
Manganese		(mg/kg) (DTPA)	40.3	
Iron		(mg/kg) (DTPA)	46.9	
Boron		(mg/kg) (Hot CaCl)	0.7	
Calculations:				
Lime Requirement (Cregan)			0.00	(see notes on page 2)
Calcium/Magnesium Ratio:			2.25	3-5

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2/37 OWENS CR (PO BOX 374) ALSTONVILLE NSW 2477
PHONE 02 66281411 FAX 02 66285868 EMAIL : chemist@soiltec.com.au

Soil Test Report #s18-0307 (10)

Client: ***SLR***
Account: **PD3**
10 Kings rd
New lambton NSW

Sample Received: 16.4.2018 Report Reply: 24.4.2018
SAMPLE I.D: 0-10cm **INTENDED USE:**

			RESULT	OPTIMAL
Conductivity (dS/m)(1:5 water)			0.08	<0.15
pH	(1:5 $CaCl_2$)		6.60	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	7.54	See Percentage
Magnesium:		(Mg)(meq/100g)	2.67	See Percentage
Potassium:		(K)(meq/100g)	0.47	0.5-1.0
Sodium:		(Na)(meq/100g)	0.02	Zero
Aluminium:		(Al)(meq/100g)	0.00	Zero
Total Cation Exchange Capacity (CEC):			**10.70**	
Exchangeable Cations (as a % of Total)				
Calcium:			70.47	65-80%
Magnesium:			24.95	15-20%
Potassium:			4.39	2-5%
Sodium:			0.19	<3%
Aluminium:			0.00	<5%
Phosphorus:	(mg/kg)	(Bray-1)	13.6	
Sulphur	(mg/kg)	(KCl 40 S)	5.3	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	9.2	At least 10
Organic Carbon	(%)	(Walkely & Black)	3.4	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	1.2	
Zinc		(mg/kg) (DTPA)	0.7	
Manganese		(mg/kg) (DTPA)	44.3	
Iron		(mg/kg) (DTPA)	48.2	
Boron		(mg/kg) (Hot CaCl)	0.8	
Calculations:				
Lime Requirement (Cregan)			0.00	(see notes on page 2)
Calcium/Magnesium Ratio:			2.82	3-5

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SOIL AND PLANT ANALYSIS

2/37 OWENS CR (PO BOX 374) ALSTONVILLE NSW 2477
PHONE 02 66281411 FAX 02 66285868 EMAIL : chemist@soiltec.com.au

Soil Test Report #s18-0307 (11)

Client: ***SLR***
Account: **PD4**
10 Kings rd
New lambton NSW

Sample Received: 16.4.2018 Report Reply: 24.4.2018
SAMPLE I.D: 0-10cm **INTENDED USE:**

			RESULT	***OPTIMAL***
Conductivity (dS/m)(1:5 water)			0.29	<0.15
pH	(1:5 $CaCl_2$)		6.11	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	6.53	See Percentage
Magnesium:		(Mg)(meq/100g)	1.79	See Percentage
Potassium:		(K)(meq/100g)	0.38	0.5-1.0
Sodium:		(Na)(meq/100g)	0.03	Zero
Aluminium:		(Al)(meq/100g)	0.00	Zero
Total Cation Exchange Capacity (CEC):			**8.73**	
Exchangeable Cations (as a % of Total)				
Calcium:			74.80	65-80%
Magnesium:			20.50	15-20%
Potassium:			4.35	2-5%
Sodium:			0.34	<3%
Aluminium:			0.00	<5%
Phosphorus:	(mg/kg)	(Bray-1)	46.0	
Sulphur	(mg/kg)	(KCl 40 S)	8.9	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	36.8	At least 10
Organic Carbon	(%)	(Walkely & Black)	3.6	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	1.0	
Zinc		(mg/kg) (DTPA)	0.7	
Manganese		(mg/kg) (DTPA)	43.7	
Iron		(mg/kg) (DTPA)	40.3	
Boron		(mg/kg) (Hot CaCl)	0.7	
Calculations:				
Lime Requirement (Cregan)			0.00	(see notes on page 2)
Calcium/Magnesium Ratio:			3.65	3-5

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PHONE 02 66281411 FAX 02 66285868 EMAIL : chemist@soiltec.com.au

Soil Test Report #s18-0307 (12)

Client: ***SLR***
Account: **PD5**
10 Kings rd
New lambton NSW

Sample Received: 16.4.2018 Report Reply: 24.4.2018
SAMPLE I.D: 0-10cm **INTENDED USE:**

			RESULT	***OPTIMAL***
Conductivity (dS/m)(1:5 water)			0.21	<0.15
pH	(1:5 $CaCl_2$)		6.55	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	12.21	See Percentage
Magnesium:		(Mg)(meq/100g)	5.26	See Percentage
Potassium:		(K)(meq/100g)	0.56	0.5-1.0
Sodium:		(Na)(meq/100g)	0.02	Zero
Aluminium:		(Al)(meq/100g)	0.00	Zero
Total Cation Exchange Capacity (CEC):			**18.05**	
Exchangeable Cations (as a % of Total)				
Calcium:			67.65	65-80%
Magnesium:			29.14	15-20%
Potassium:			3.10	2-5%
Sodium:			0.11	<3%
Aluminium:			0.00	<5%
Phosphorus:	(mg/kg)	(Bray-1)	45.2	
Sulphur	(mg/kg)	(KCl 40 S)	9.0	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	13.8	At least 10
Organic Carbon	(%)	(Walkely & Black)	6.1	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	1.2	
Zinc		(mg/kg) (DTPA)	1.0	
Manganese		(mg/kg) (DTPA)	58.8	
Iron		(mg/kg) (DTPA)	72.4	
Boron		(mg/kg) (Hot CaCl)	1.1	
Calculations:				
Lime Requirement (Cregan)			0.00	(see notes on page 2)
Calcium/Magnesium Ratio:			2.32	3-5

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PHONE 02 66281411 FAX 02 66285868 EMAIL : chemist@soiltec.com.au

Soil Test Report #s18-0307 (13)

Client: ***SLR***
Account: **PD6**
10 Kings rd
New lambton NSW

Sample Received: 16.4.2018 Report Reply: 24.4.2018
SAMPLE I.D: 0-10cm **INTENDED USE:**

			RESULT	***OPTIMAL***
Conductivity (dS/m)(1:5 water)			0.08	<0.15
pH	(1:5 $CaCl_2$)		5.16	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	8.53	See Percentage
Magnesium:		(Mg)(meq/100g)	3.37	See Percentage
Potassium:		(K)(meq/100g)	0.40	0.5-1.0
Sodium:		(Na)(meq/100g)	0.03	Zero
Aluminium:		(Al)(meq/100g)	0.00	Zero
Total Cation Exchange Capacity (CEC):			**12.33**	
Exchangeable Cations (as a % of Total)				
Calcium:			69.18	65-80%
Magnesium:			27.33	15-20%
Potassium:			3.24	2-5%
Sodium:			0.24	<3%
Aluminium:			0.00	<5%
Phosphorus:	(mg/kg)	(Bray-1)	10.0	
Sulphur	(mg/kg)	(KCl 40 S)	5.2	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	18.4	At least 10
Organic Carbon	(%)	(Walkely & Black)	3.7	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	1.1	
Zinc		(mg/kg) (DTPA)	1.0	
Manganese		(mg/kg) (DTPA)	43.9	
Iron		(mg/kg) (DTPA)	63.1	
Boron		(mg/kg) (Hot CaCl)	0.7	
Calculations:				
Lime Requirement (Cregan)			0.00	(see notes on page 2)
Calcium/Magnesium Ratio:			2.53	3-5

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SOIL AND PLANT ANALYSIS

2/37 OWENS CR (PO BOX 374) ALSTONVILLE NSW 2477
PHONE 02 66281411 FAX 02 66285868 EMAIL : chemist@soiltec.com.au

Soil Test Report #s18-0307 (14)

Client: ***SLR***
Account: **PD7**
10 Kings rd
New lambton NSW

Sample Received: 16.4.2018 Report Reply: 24.4.2018
SAMPLE I.D: 0-10cm **INTENDED USE:**

			RESULT	*OPTIMAL*
Conductivity (dS/m)(1:5 water)			0.03	<0.15
pH	(1:5 $CaCl_2$)		5.29	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	4.67	See Percentage
Magnesium:		(Mg)(meq/100g)	1.74	See Percentage
Potassium:		(K)(meq/100g)	0.35	0.5-1.0
Sodium:		(Na)(meq/100g)	0.02	Zero
Aluminium:		(Al)(meq/100g)	0.00	Zero
Total Cation Exchange Capacity (CEC):			**6.78**	
Exchangeable Cations (as a % of Total)				
Calcium:			68.88	65-80%
Magnesium:			25.66	15-20%
Potassium:			5.16	2-5%
Sodium:			0.29	<3%
Aluminium:			0.00	<5%
Phosphorus:	(mg/kg)	(Bray-1)	11.2	
Sulphur	(mg/kg)	(KCl 40 S)	5.5	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	9.2	At least 10
Organic Carbon	(%)	(Walkely & Black)	2.3	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	0.9	
Zinc		(mg/kg) (DTPA)	0.7	
Manganese		(mg/kg) (DTPA)	36.2	
Iron		(mg/kg) (DTPA)	45.8	
Boron		(mg/kg) (Hot CaCl)	0.6	
Calculations:				
Lime Requirement (Cregan)			0.00	(see notes on page 2)
Calcium/Magnesium Ratio:			2.68	3-5

SOILTEC *SOIL AND PLANT ANALYSIS*

2/37 OWENS CR (PO BOX 374) ALSTONVILLE NSW 2477
PHONE 02 66281411 FAX 02 66285868 EMAIL : chemist@soiltec.com.au

Soil Test Report #s18-0307 (15)

Client: ***SLR***
Account: **PD8**
10 Kings rd
New lambton NSW

Sample Received: 16.4.2018 Report Reply: 24.4.2018
SAMPLE I.D: 0-10cm **INTENDED USE:**

			RESULT	OPTIMAL
Conductivity (dS/m)(1:5 water)			0.03	<0.15
pH	(1:5 $CaCl_2$)		4.95	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	7.05	See Percentage
Magnesium:		(Mg)(meq/100g)	4.21	See Percentage
Potassium:		(K)(meq/100g)	0.30	0.5-1.0
Sodium:		(Na)(meq/100g)	0.11	Zero
Aluminium:		(Al)(meq/100g)	0.24	Zero
Total Cation Exchange Capacity (CEC):			**11.91**	
Exchangeable Cations (as a % of Total)				
Calcium:			59.19	65-80%
Magnesium:			35.35	15-20%
Potassium:			2.52	2-5%
Sodium:			0.92	<3%
Aluminium:			2.02	<5%
Phosphorus:	(mg/kg)	(Bray-1)	6.9	
Sulphur	(mg/kg)	(KCl 40 S)	5.0	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	2.3	At least 10
Organic Carbon	(%)	(Walkely & Black)	1.9	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	1.0	
Zinc		(mg/kg) (DTPA)	0.8	
Manganese		(mg/kg) (DTPA)	46.6	
Iron		(mg/kg) (DTPA)	49.7	
Boron		(mg/kg) (Hot CaCl)	0.7	
Calculations:				
Lime Requirement (Cregan)			0.31	(see notes on page 2)
Calcium/Magnesium Ratio:			1.67	3-5

SOILTEC SOIL AND PLANT ANALYSIS

2/37 OWENS CR (PO BOX 374) ALSTONVILLE NSW 2477
PHONE 02 66281411 FAX 02 66285868 EMAIL : chemist@soiltec.com.au

Soil Test Report #s18-0307 (1)

Client: ***SLR***
Account: **EP1**
10 Kings rd
New lambton NSW

Sample Received: 16.4.2018 Report Reply: 24.4.2018
SAMPLE I.D: 0-10cm **INTENDED USE:**

			RESULT	***OPTIMAL***
Conductivity (dS/m)(1:5 water)			0.14	<0.15
pH	(1:5 $CaCl_2$)		5.11	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	5.93	See Percentage
Magnesium:		(Mg)(meq/100g)	1.78	See Percentage
Potassium:		(K)(meq/100g)	0.42	0.5-1.0
Sodium:		(Na)(meq/100g)	0.03	Zero
Aluminium:		(Al)(meq/100g)	0.00	Zero
Total Cation Exchange Capacity (CEC):			**8.16**	
Exchangeable Cations (as a % of Total)				
Calcium:			72.67	65-80%
Magnesium:			21.81	15-20%
Potassium:			5.15	2-5%
Sodium:			0.37	<3%
Aluminium:			0.00	<5%
Phosphorus:	(mg/kg)	(Bray-1)	15.8	
Sulphur	(mg/kg)	(KCl 40 S)	6.2	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	46.0	At least 10
Organic Carbon	(%)	(Walkely & Black)	3.4	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	0.8	
Zinc		(mg/kg) (DTPA)	0.8	
Manganese		(mg/kg) (DTPA)	35.6	
Iron		(mg/kg) (DTPA)	51.2	
Boron		(mg/kg) (Hot CaCl)	0.7	

Calculations:

Lime Requirement (Cregan)	0.00	(see notes on page 2)
Calcium/Magnesium Ratio:	3.33	3-5

SOILTEC SOIL AND PLANT ANALYSIS

2/37 OWENS CR (PO BOX 374) ALSTONVILLE NSW 2477
PHONE 02 66281411 FAX 02 66285868 EMAIL : chemist@soiltec.com.au

Soil Test Report #s18-0307 (2)

Client: ***SLR***
Account: **EP2**
10 Kings rd
New lambton NSW

Sample Received: 16.4.2018 Report Reply: 24.4.2018
SAMPLE I.D: 0-10cm **INTENDED USE:**

			RESULT	***OPTIMAL***
Conductivity (dS/m)(1:5 water)			0.06	<0.15
pH	(1:5 $CaCl_2$)		6.34	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	6.68	See Percentage
Magnesium:		(Mg)(meq/100g)	2.34	See Percentage
Potassium:		(K)(meq/100g)	0.39	0.5-1.0
Sodium:		(Na)(meq/100g)	0.04	Zero
Aluminium:		(Al)(meq/100g)	0.00	Zero
Total Cation Exchange Capacity (CEC):			**9.45**	
Exchangeable Cations (as a % of Total)				
Calcium:			70.69	65-80%
Magnesium:			24.76	15-20%
Potassium:			4.13	2-5%
Sodium:			0.42	<3%
Aluminium:			0.00	<5%
Phosphorus:	(mg/kg)	(Bray-1)	6.8	
Sulphur	(mg/kg)	(KCl 40 S)	5.4	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	13.8	At least 10
Organic Carbon	(%)	(Walkely & Black)	3.1	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	0.9	
Zinc		(mg/kg) (DTPA)	0.7	
Manganese		(mg/kg) (DTPA)	39.3	
Iron		(mg/kg) (DTPA)	53.8	
Boron		(mg/kg) (Hot CaCl)	0.72	
Calculations:				
Lime Requirement (Cregan)			0.00	(see notes on page 2)
Calcium/Magnesium Ratio:			2.85	3-5

SOILTEC *SOIL AND PLANT ANALYSIS*

2/37 OWENS CR (PO BOX 374) ALSTONVILLE NSW 2477
PHONE 02 66281411 FAX 02 66285868 EMAIL : chemist@soiltec.com.au

Soil Test Report #s18-0307 (3)

Client: ***SLR***
Account: **EP3**
10 Kings rd
New lambton NSW

Sample Received: 16.4.2018 Report Reply: 24.4.2018
SAMPLE I.D: 0-10cm **INTENDED USE:**

			RESULT	***OPTIMAL***
Conductivity (dS/m)(1:5 water)			0.32	<0.15
pH	(1:5 $CaCl_2$)		5.32	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	8.92	See Percentage
Magnesium:		(Mg)(meq/100g)	3.88	See Percentage
Potassium:		(K)(meq/100g)	0.47	0.5-1.0
Sodium:		(Na)(meq/100g)	0.04	Zero
Aluminium:		(Al)(meq/100g)	0.00	Zero
Total Cation Exchange Capacity (CEC):			**13.31**	
Exchangeable Cations (as a % of Total)				
Calcium:			67.02	65-80%
Magnesium:			29.15	15-20%
Potassium:			3.53	2-5%
Sodium:			0.30	<3%
Aluminium:			0.00	<5%
Phosphorus:	(mg/kg)	(Bray-1)	50.0	
Sulphur	(mg/kg)	(KCl 40 S)	7.8	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	115.0	At least 10
Organic Carbon	(%)	(Walkely & Black)	3.8	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	1.1	
Zinc		(mg/kg) (DTPA)	0.9	
Manganese		(mg/kg) (DTPA)	45.4	
Iron		(mg/kg) (DTPA)	63.2	
Boron		(mg/kg) (Hot CaCl)	0.79	

Calculations:

Lime Requirement (Cregan)	0.00	(see notes on page 2)
Calcium/Magnesium Ratio:	2.30	3-5

SOILTEC SOIL AND PLANT ANALYSIS

2/37 OWENS CR (PO BOX 374) ALSTONVILLE NSW 2477
PHONE 02 66281411 FAX 02 66285868 EMAIL : chemist@soiltec.com.au

Soil Test Report #s18-0307 (4)

Client: ***SLR***
Account: **EP4**
10 Kings rd
New lambton NSW

Sample Received: 16.4.2018 Report Reply: 24.4.2018
SAMPLE I.D: 0-10cm **INTENDED USE:**

			RESULT	***OPTIMAL***
Conductivity (dS/m)(1:5 water)			0.06	<0.15
pH	(1:5 $CaCl_2$)		4.84	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	7.54	See Percentage
Magnesium:		(Mg)(meq/100g)	2.86	See Percentage
Potassium:		(K)(meq/100g)	0.41	0.5-1.0
Sodium:		(Na)(meq/100g)	0.02	Zero
Aluminium:		(Al)(meq/100g)	0.22	Zero
Total Cation Exchange Capacity (CEC):			**11.05**	
Exchangeable Cations (as a % of Total)				
Calcium:			68.24	65-80%
Magnesium:			25.88	15-20%
Potassium:			3.71	2-5%
Sodium:			0.18	<3%
Aluminium:			1.99	<5%
Phosphorus:	(mg/kg)	(Bray-1)	15.0	
Sulphur	(mg/kg)	(KCl 40 S)	6.0	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	4.6	At least 10
Organic Carbon	(%)	(Walkely & Black)	3.6	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	1.0	
Zinc		(mg/kg) (DTPA)	0.8	
Manganese		(mg/kg) (DTPA)	42.1	
Iron		(mg/kg) (DTPA)	60.8	
Boron		(mg/kg) (Hot CaCl)	0.74	
Calculations:				
Lime Requirement (Cregan)			0.29	(see notes on page 2)
Calcium/Magnesium Ratio:			2.64	3-5

SOILTEC SOIL AND PLANT ANALYSIS

2/37 OWENS CR (PO BOX 374) ALSTONVILLE NSW 2477
PHONE 02 66281411 FAX 02 66285868 EMAIL : chemist@soiltec.com.au

Soil Test Report #s18-0307 (5)

Client: ***SLR***
Account: **EP5**
10 Kings rd
New lambton NSW

Sample Received: 16.4.2018 Report Reply: 24.4.2018
SAMPLE I.D: 0-10cm **INTENDED USE:**

			RESULT	***OPTIMAL***
Conductivity (dS/m)(1:5 water)			0.26	<0.15
pH	(1:5 $CaCl_2$)		6.11	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	6.37	See Percentage
Magnesium:		(Mg)(meq/100g)	2.04	See Percentage
Potassium:		(K)(meq/100g)	0.38	0.5-1.0
Sodium:		(Na)(meq/100g)	0.03	Zero
Aluminium:		(Al)(meq/100g)	0.00	Zero
Total Cation Exchange Capacity (CEC):			**8.82**	
Exchangeable Cations (as a % of Total)				
Calcium:			72.22	65-80%
Magnesium:			23.13	15-20%
Potassium:			4.31	2-5%
Sodium:			0.34	<3%
Aluminium:			0.00	<5%
Phosphorus:	(mg/kg)	(Bray-1)	47.2	
Sulphur	(mg/kg)	(KCl 40 S)	7.5	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	73.6	At least 10
Organic Carbon	(%)	(Walkely & Black)	5.1	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	0.9	
Zinc		(mg/kg) (DTPA)	0.8	
Manganese		(mg/kg) (DTPA)	38.7	
Iron		(mg/kg) (DTPA)	54.6	
Boron		(mg/kg) (Hot CaCl)	0.77	
Calculations:				
Lime Requirement (Cregan)			0.00	(see notes on page 2)
Calcium/Magnesium Ratio:			3.12	3-5

SOILTEC *SOIL AND PLANT ANALYSIS*

2/37 OWENS CR (PO BOX 374) ALSTONVILLE NSW 2477
PHONE 02 66281411 FAX 02 66285868 EMAIL : chemist@soiltec.com.au

Soil Test Report #s18-0307 (6)

Client: ***SLR***
Account: **EP6**
10 Kings rd
New lambton NSW

Sample Received: 16.4.2018 Report Reply: 24.4.2018
SAMPLE I.D: 0-10cm **INTENDED USE:**

			RESULT	***OPTIMAL***
Conductivity (dS/m)(1:5 water)			0.04	<0.15
pH	(1:5 $CaCl_2$)		4.56	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	3.96	See Percentage
Magnesium:		(Mg)(meq/100g)	2.17	See Percentage
Potassium:		(K)(meq/100g)	0.28	0.5-1.0
Sodium:		(Na)(meq/100g)	0.09	Zero
Aluminium:		(Al)(meq/100g)	0.43	Zero
Total Cation Exchange Capacity (CEC):			**6.93**	
Exchangeable Cations (as a % of Total)				
Calcium:			57.14	65-80%
Magnesium:			31.31	15-20%
Potassium:			4.04	2-5%
Sodium:			1.30	<3%
Aluminium:			6.20	<5%
Phosphorus:	(mg/kg)	(Bray-1)	14.1	
Sulphur	(mg/kg)	(KCl 40 S)	5.7	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	4.6	At least 10
Organic Carbon	(%)	(Walkely & Black)	2.0	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	0.9	
Zinc		(mg/kg) (DTPA)	0.7	
Manganese		(mg/kg) (DTPA)	33.6	
Iron		(mg/kg) (DTPA)	40.3	
Boron		(mg/kg) (Hot CaCl)	0.6	
Calculations:				
Lime Requirement (Cregan)			0.56	(see notes on page 2)
Calcium/Magnesium Ratio:			1.82	3-5

Appendix B

2014 EP3 Analogue Laboratory Soil Test Results

SOILTEC

SOIL AND PLANT ANALYSIS

2/37 OWENS CR (PO BOX 374) ALSTONVILLE NSW 2477
PHONE 02 66281411 FAX 02 66285868 EMAIL : chemist@soiltec.com.au

Soil Test Report #s14-0897 (6)

Client: ***SLR***
Account: **Pdk 3**

Sample Received: 3.10.2014 Report Reply: 9.10.2014
SAMPLE I.D: 0-10cm **INTENDED USE:**
TEXTURE

			RESULT	*OPTIMAL*
Conductivity (dS/m)(1:5 water)			0.06	<0.15
pH	(1:5 $CaCl_2$)		4.94	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	6.08	See Percentage
Magnesium:		(Mg)(meq/100g)	2.84	See Percentage
Potassium:		(K)(meq/100g)	0.30	0.5-1.0
Sodium:		(Na)(meq/100g)	0.18	Zero
Aluminium:		(Al)(meq/100g)	0.05	Zero
Total Cation Exchange Capacity (CEC):			**9.45**	
Exchangeable Cations (as a % of Total)				
Calcium:			64.34	65-80%
Magnesium:			30.05	15-20%
Potassium:			3.17	2-5%
Sodium:			1.90	<3%
Aluminium:			0.53	<5%
Phosphorus:	(mg/kg)	(Bray-1)	14.7	
Sulphur	(mg/kg)	(KCl 40 S)	6.8	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	4.6	At least 10
Organic Carbon	(%)	(Walkely & Black)	1.5	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	0.8	
Zinc		(mg/kg) (DTPA)	0.7	
Manganese		(mg/kg) (DTPA)	19.3	
Iron		(mg/kg) (DTPA)	30.8	
Boron		(mg/kg) (Hot CaCl)	0.8	
Calculations:				
Lime Requirement (Cregan)			0.07	(see notes on page 2)
Calcium/Magnesium Ratio:			2.14	3-5

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