# PINE DALE MINE

# ANNUAL REVIEW

# 2019

Prepared by: Enhance Place Pty Ltd
February 2020

Revision 1.0 – 19 February 2020

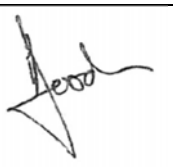
# TITLE

| | |
|---|---|
| **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** | 15 April 2021 |
| **Annual Review Start Date:** | 1 January 2019 |
| **Annual Review End Date:** | 31 December 2019 |
| **Annual Review Report Author:** | Carmen Rocher<br>(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 2019 to 31 December 2019 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** | 28.02.2020 |

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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 2019 – 31 December 2019 (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 no non-compliances during the 2019 reporting period.

**Table 1 Statement of Compliance**

| Approval No. | Were all conditions of the approval complied with? |
|---|---|
| PA 10_0041 | Yes. |
| EPL 4911 | Yes. |
| ML1569 | Yes |
| ML1578 | Yes |
| ML1664 | Yes |
| ML1637 | Yes |
| 10WA118780 | Yes |

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 air quality criteria stipulated in the Project Approval 10_0041 at all monitoring locations. Elevated concentrations occurred during November and December 2019; however, these concentrations were due to bushfire activity (refer **Section 6.2.2**).
- There were no noise exceedances from mining activities recorded at privately owned properties 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 2020 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 (AR) requirements of the NSW Department of Planning, Industry and Environment (formerly the NSW Department of Planning and Environment) under the conditions of a development consent or project approval:
- the annual reporting requirements of the DPIE Division of Resources & Energy under the conditions of a mining lease;
- the routine reporting expectations of DPIE – 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, Industry & Environment (DPIE);
- DPIE – Resources Regulator (DPIE-RR);
- DPIE - Water (DPIE Lands & Water);
- NSW 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 2**.

**Table 2 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 **Table 3**. The mining and exploration lease boundaries are shown in **Plan 4**, **Appendix A**

**Table 3 Pine Dale Mine Consents, Leases and Licences**

| Permit Type | Permit Number | Relevant Dates | Description |
|---|---|---|---|
| Project Approval | PA 10_0041 | Granted 20 Feb 2011<br>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<br>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<br>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<br>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<br>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<br>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<br>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<br>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<br>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 4**.

**Table 4 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 2019 reporting period.

## 4.9 HAZARDOUS MATERIALS MANAGEMENT

There are no bulk oils stored on site. No oils were brought on site during the 2019 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 2020. 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 (now DPIE) was received in relation to the 2018 Annual Review on the 26 March 2019. The 2018 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 5**. Detailed discussions of other key environmental performance indicators are presented further in this Section.

## Table 5 Environmental Performance

| Aspect | Approval Criteria | EA Prediction | Performance during 2019 | Trends /Management Implications | Management Actions |
|---|---|---|---|---|---|
| Noise | NM1 – NM3 Daytime Criteria 42dB(A) $L_{Aeq(15minute)}$ | NM1 41<br>NM2 32<br>NM3 39<br>dB(A) LAeq(15minute) | NM1 Nil detected<br>NM2 Nil detected<br>NM3 Nil detected<br>dB(A) LAeq(15minute) | NA – no operational noise generated | Nil management actions required |
| | NM4 – NM6 Daytime Criteria 35dB(A) $L_{Aeq(15minute)}$ | NM4 34<br>NM6 <30<br>dB(A) LAeq(15minute) | NM4 Nil detected<br>NM5 Nil detected<br>NM6 Nil detected<br>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 0.3 to 0.6g/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 50.1 µg/m$^3$ including bushfire impacted results. Annual average excluding bushfire impacted results 26.5 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 27.0 µg/m$^3$ including bushfire impacted results. $PM_{10}$ annual average 9.8 µg/m$^3$ excluding bushfire impacted results. | 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 355 µg/m$^3$ (bushfire impacted). Highest 24hr average result not impacted by bushfire is 44 µg/m$^3$. | Max 24hr $PM_{10}$ level above the $PM_{10}$ 24hr criterion; but is considered to be related to bushfire activity. Highest non-bushfire impacted concentration 44µg/m$^3$. | 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 2019 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 26 & 27 March 2019;
- Quarter 2 – April to June; monitoring conducted 27 & 28 June 2019;
- Quarter 3 – July to September; monitoring conducted 25 September 2019;
- Quarter 4 – October to December; monitoring conducted 15 October 2019.

Although PDM is currently in care and maintenance, rehabilitation maintenance activities facilitating the use of mobile plant was conducted at the site during the 2019 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 2019 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 2019 reporting period are presented in full in **Appendix B**.

During the 2019 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 six (6) air quality monitoring locations including five (5) depositional dust gauges (D1, D3, D4, D5 & D6) 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.

During the 2019 dust gauge D2 was removed from the Environment Protection Licence (EPL) during the 2019 reporting period and the AQGGMP. The dust gauge was requested to be removed by the property owner.

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 2019 show an annual average insoluble solid range of 1.1 g/m² per month to 1.6 g/m² per month for all dust gauges.

Comparative annual average depositional dust data for the previous five-year period is presented in **Table 6**, 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 2017 to 2019. Annual deposited dust concentrations shown in **Figure 1** reflect the operations that occurred within PDM in a care and maintenance state. Results observed in 2018 and 2019 have generally increased. These increases are considered to be due to below average rainfall (refer **Section 6.3** for rainfall totals) resulting in low soil moisture which makes the region more prone to dust storms, with dust storms observed during 2018 and 2019. All of the 2019 annual average 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) and the assessment criterion.

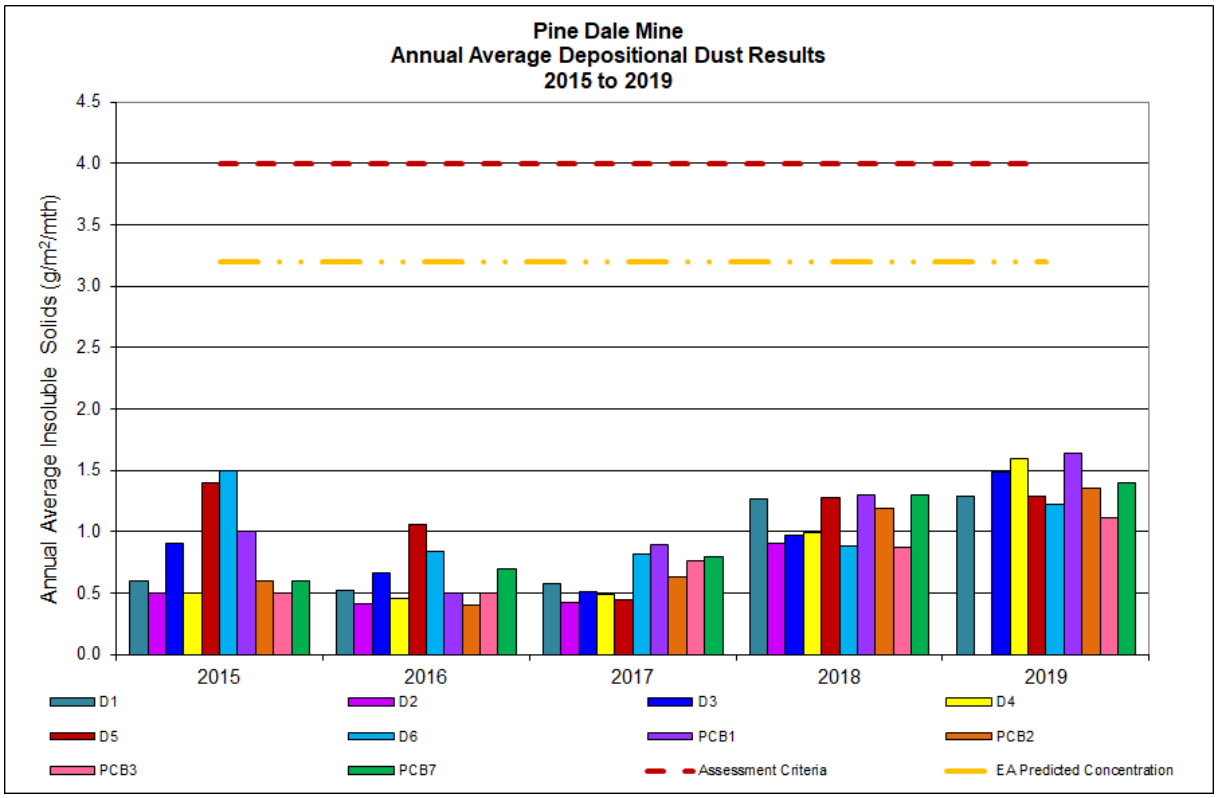



**Figure 1 Historical Depositional Dust Data**

## Table 6 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-19 | 3.3 | Removed | 3.4 | 4.2 | 4.3 | 3.0 | 3.4 | 2.9 | 1.9 | 3.4 |
| Feb-19 | 1.8 | Removed | 2.1 | 2.6 | 1.4 | 2.6 | 2.4 | 1.9 | 2.8 | 2.8 |
| Mar-19 | 1.7 | Removed | 1.9 | 2.6 | 1.2 | 1.0 | 2.0 | 2.1 | 1.2 | 1.4 |
| Apr-19 | 1.2 | Removed | 1.2 | 1.0 | 0.9 | 0.7 | 1.3 | 0.9 | 1.0 | 0.9 |
| May-19 | 0.6 | Removed | 0.8 | 0.7 | 0.2 | 0.5 | 0.9 | 0.5 | 0.7 | 0.8 |
| Jun-19 | 0.7 | Removed | 0.7 | 0.6 | 0.5 | 0.5 | 0.8 | 0.4 | 0.5 | 0.8 |
| Jul-19 | 0.3 | Removed | 0.4 | 0.2 | 0.1 | 0.2 | 0.5 | 0.3 | 0.2 | 0.1 |
| Aug-19 | 0.3 | Removed | 0.4 | 0.2 | 0.4 | 0.4 | 0.6 | 0.3 | 0.2 | 0.2 |
| Sep-19 | 1.1 | Removed | 1.0 | 0.7 | 0.9 | 0.6 | 1.3 | 1.0 | 0.7 | 0.6 |
| Oct-19 | 1.1 | Removed | 1.4 | 1.5 | 1.7 | 1.1 | 1.3 | 0.7 | 0.8 | 2.3 |
| Nov-19 | 1.8 | Removed | 1.8 | 2.1 | 1.8 | 2.3 | 2.5 | 2.7 | 1.4 | 1.9 |
| Dec-19 | 1.5 | Removed | 2.7 | 2.7 | 2.1 | 1.8 | 2.6 | 2.6 | 1.9 | 1.7 |
| **Annual Averages** | | | | | | | | | | |
| 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 |
| 2019 | 1.3 | Removed | 1.5 | 1.6 | 1.3 | 1.2 | 1.6 | 1.4 | 1.1 | 1.4 |
| **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 – Monitoring no longer undertaken at this location.

### 6.2.2 HIGH VOLUME AIR SAMPLING

Annual average $PM_{10}$ and TSP monitoring results are summarised in **Table 7**. Detailed data analysis is presented in **Appendix B**. During the 2019 reporting period, the $PM_{10}$ 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 the following concentrations:

- 22 November 2019: 110µg/m$^3$;
- 28 November 2019: 98µg/m$^3$;
- 10 December 2019: 98µg/m$^3$;
- 16 December 2019: 245µg/m$^3$;
- 12 December 2019: 355µg/m$^3$; and,
- 28 December 2019: 200µg/m$^3$;

These elevated concentrations are considered to be due to bushfire activity occurring predominantly within Wollemi National Park (known as the Gospers Mountain fire), which moved through Ben Bullen State Forest and Pine Dale Mine during December 2019. Air quality data from the DPIE Katoomba and Bathurst air quality monitoring station show elevated $PM_{10}$ concentrations during this period. Further detail regarding the DPIE $PM_{10}$ concentrations recorded at Katoomba and Bathurst is provided in **Appendix B**.

It is noted that PA 10_0041 stipulates that the $PM_{10}$ 24-hour assessment criterion, the TSP annual average assessment criterion and the $PM_{10}$ annual average assessment criterion excludes extraordinary events such as bushfires, prescribed burning, dust storms, fire incidents or any other activity agreed to by the Secretary (previously referred to as the Director-General) in consultation with the DPIE. As such, it is considered that the $PM_{10}$ concentrations in excess of the 24-hour assessment criterion are not in breach of the air quality acquisition criteria detailed in PA 10_0041.

The annual average $PM_{10}$ result recorded in 2019 was 27.0µg/m³, which is below the long term annual average assessment criterion (30µg/m³). The annual average $PM_{10}$ concentration excluding bushfire impacted $PM_{10}$ runs is 9.8µg/m³. Prior to the Wollemi National Park bushfire, the $PM_{10}$ annual average were significantly below the long term annual average assessment criterion, with the December 2018 – November 2019 rolling annual average shown to be 14.7µg/m$^3$, refer **Figure 2**. The highest TSP result recorded for 2019 was 450µg/m³ on 22 December 2019. The annual average TSP result recorded during 2019 was 50.1µg/m³, which is below the 90µg/m³ assessment criterion; whereas the annual average TSP concentration excluding bushfire impacted run events was 26.5µg/m³. Both the TSP and $PM_{10}$ annual average (excluding bushfire impacted run event) 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 7 $PM_{10}$ and TSP Summary**

| | Particulate Matter <10µm (µg/m³) | TSP (µg/m³) |
|---|---|---|
| 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[a] | n/a |
| Maximum 24h Average result 2019 | 355[a] | n/a |
| $PM_{10}$ 24h Assessment Criteria [b] | 50 | Not Required |
| Annual Average 2015 | 8 | 18 |
| Annual Average 2016 | 9 | 19 |
| Annual Average 2017 | 10 | 20 |
| Annual Average 2018 | 12 | 26 |
| Annual Average 2019[c] | 27.0 | 50.1 |
| Annual Average 2019[d] | 9.8 | 26.5 |
| Annual Average Assessment Criteria** | 30 | 90 |

[a] Result considered affected by external sources (dust storms or bushfire activity) outside of the control of the project.
[b] Air Quality Assessment Criteria listed in project approval PA 10_0041.
[c] Result includes bushfire impacted HVAS run events
[d] Excluding bushfire impacted HVAS run events

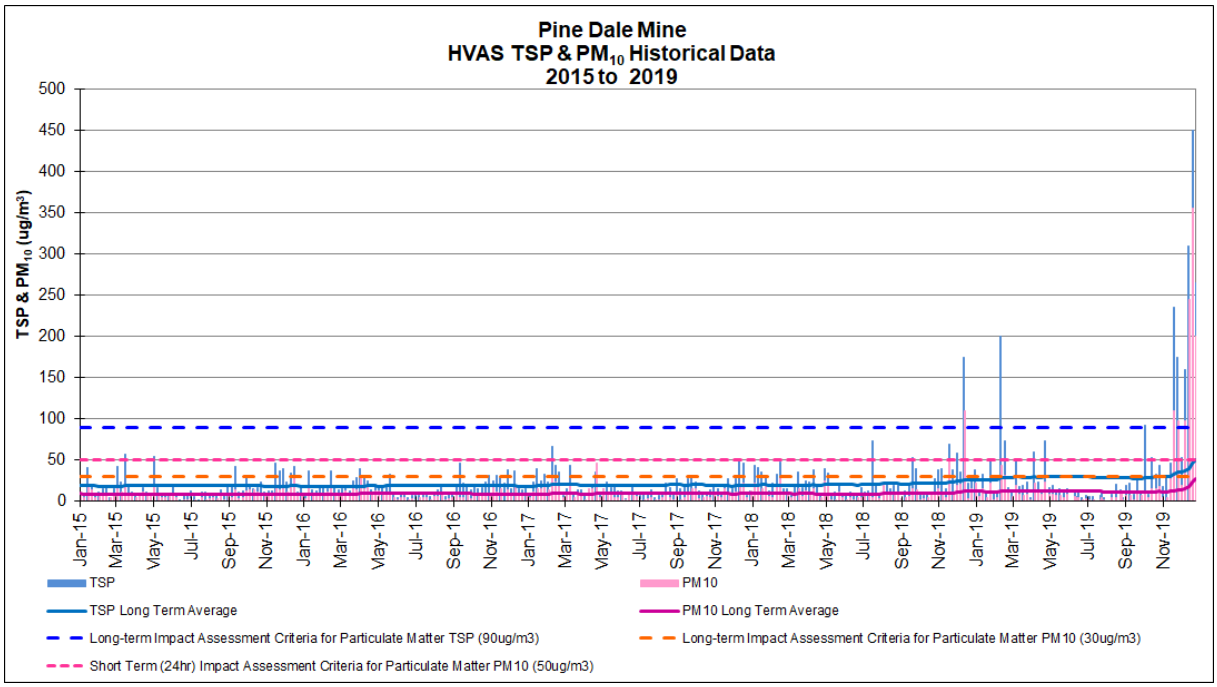



**Figure 2 Historical HVAS Data**

Results also show that the $PM_{10}$ and TSP concentrations recorded at the PDM throughout the 2015 to 2018 monitoring period have generally remained stable (see **Table 7** and **Figure 2**), the bushfire activity which occurred during November and December 2019 has resulted in a sharp increase in the TSP and $PM_{10}$ concentrations as well as the annual averages. The annual average $PM_{10}$ and TSP particulate concentrations observed during late 2018 and 2019 show a slight increasing trend. 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. The increase in annual average $PM_{10}$ and TSP concentrations during late 2019 are considered to be due to the Gospers Mountain bushfire.

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 2020. All air quality monitoring units will continue to be regularly calibrated and maintained 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 2019 reporting period are presented both in the following sections and **Appendix B**.

### 6.3.1 RAINFALL

PDM received 350.2mm of rainfall across 107 rainfall days during the 2019 reporting period. Rainfall during this reporting period was observed to be less than the annual rainfall recorded during 2018 (660mm) and 2017 (577mm). The amount of rainfall during 2017 and 2018, was still considerably less than 2016 (1168mm over 147 days), and also less than the totals recorded in 2015 and 2014 (754mm and 705mm respectively). A graphical presentation of annual rainfall during the previous 5 years is presented in **Figure 3.** The 2019 annual rainfall is shown to be considerably lower than that recorded during the previous four years.

The Bureau of Meteorology (BOM) station located at Lithgow (Cooerwull), approximately 14km from PDM) reported a long term median[1] rainfall, between 1889 and 2019 of 749.8mm. During the five years of data used within this report, only 2015 and 2016 has reported similar to, or above average rainfall; with 2019 reporting 47% of this amount. The monthly rainfall data for 2019 is summarised in **Table 8**.

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

### 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 39.5°C at the 10m sensor, during January. The lowest temperature occurred in August, with a recording of -8.9°C at both 2m and 10m. A summary of monthly temperatures for 2019 is included in **Table 8**. A graphical presentation of annual temperature variations during the previous 5 years is presented in **Figure 3.**

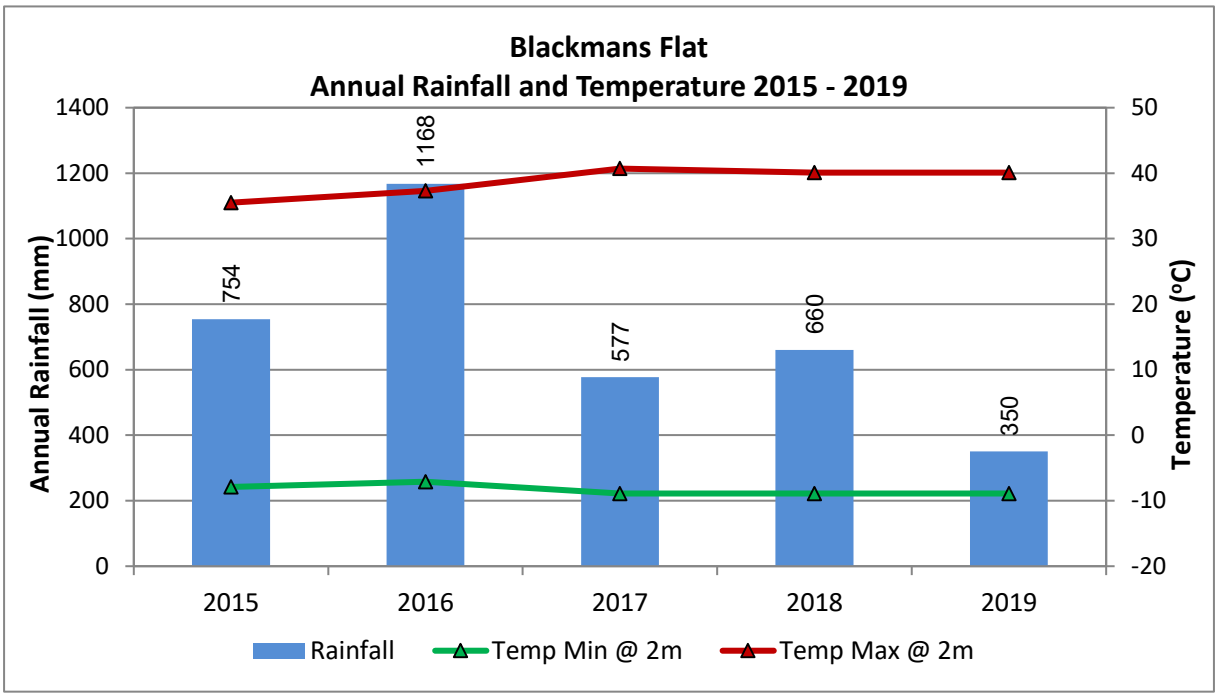



**Figure 3 Annual Temperature & Rainfall Summary**

### 6.3.3 WIND SPEED, DIRECTION & SIGMA THETA

Predominant wind direction at the site in 2019 was observed to be primarily from the north-western quadrant, with only February and June 2019 reporting the predominant wind direction from the south-east.

The maximum wind speed measured at the site was 21.0m/s in November 2019 from a west-north-westerly direction. Sigma theta data was measured continuously throughout the entire 2019 monitoring period. A summary of monthly wind speed, predominant directions and sigma theta recordings in 2019 is included in **Table 8**.

### 6.3.4 RELATIVE HUMIDITY

Relative humidity was measured in the 2019 monitoring period. The minimum humidity recorded at the site was 7.2% recorded during November. The maximum humidity recorded at the PDM meteorological monitoring was 100.0% during the period May - November. A summary of monthly humidity variations for 2019 is included in **Table 8**.

## Table 8 Pine Dale Mine Meteorological Station Summary 2019

| 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 | 136.2 | 136.2 | 15 | 23.1 | 12.6 | 40.1 | 22.9 | 12.4 | 39.5 | 31.7 | 0.0 | 103.6 | 67.3 | 10.2 | 96.4 | 0.5 | 0.0 | 9.0 | NW |
| February | 30.2 | 166.4 | 11 | 18.9 | 5.8 | 34.9 | 18.6 | 6 | 33.9 | 33.8 | 0.0 | 101.7 | 66.1 | 12.8 | 95.6 | 0.7 | 0.0 | 11.5 | SE |
| March | 12.4 | 178.8 | 9 | 17.2 | 4.7 | 34.9 | 17.0 | 4.7 | 34.4 | 31.8 | 0.0 | 101.2 | 71.0 | 15.0 | 96.5 | 0.7 | 0.0 | 11.2 | WNW |
| April | 0.4 | 179.2 | 2 | 13.0 | -0.9 | 27.5 | 13.0 | -0.8 | 26.4 | 31.9 | 0.0 | 102.6 | 72.4 | 14.9 | 96.0 | 0.5 | 0.0 | 10.0 | WNW |
| May | 35 | 214.2 | 13 | 8.0 | -2.5 | 21.1 | 8.1 | -2.7 | 20.8 | 33.7 | 4.3 | 101.8 | 82.4 | 22.6 | 100.0 | 1.7 | 0.0 | 15.5 | WNW |
| June | 21.4 | 235.6 | 17 | 5.5 | -6.8 | 19.1 | 5.7 | -6.8 | 18.9 | 37.3 | 3.4 | 102.2 | 87.3 | 34.2 | 100.0 | 1.3 | 0.0 | 11.4 | SE |
| July | 8.4 | 244 | 9 | 5.5 | -7.6 | 18.9 | 5.6 | -7.6 | 17.8 | 34.2 | 3.3 | 102.5 | 78.8 | 14.5 | 100.0 | 2.0 | 0.0 | 18.9 | WNW |
| August | 16.6 | 260.6 | 9 | 4.9 | -8.9 | 20.2 | 5.0 | -8.9 | 19.4 | 34.1 | 3.0 | 103.1 | 73.2 | 8.7 | 100.0 | 2.0 | 0.0 | 18.2 | W |
| September | 48 | 308.6 | 10 | 8.8 | -5.6 | 25.4 | 8.8 | -5.9 | 24.1 | 36.0 | 4.0 | 101.2 | 68.2 | 7.8 | 100.0 | 2.0 | 0.0 | 19.0 | W |
| October | 7 | 315.6 | 5 | 13.3 | -1.9 | 30.5 | 13.1 | -1.9 | 29.7 | 37.9 | 4.3 | 102.9 | 58.6 | 11.1 | 100.0 | 1.8 | 0.0 | 17.7 | W |
| November | 32.4 | 348 | 5 | 16.9 | 1.5 | 36.3 | 16.7 | 1.5 | 34.9 | 34.0 | 3.3 | 102.3 | 49.8 | 7.2 | 100.0 | 2.4 | 0.0 | 21.0 | W |
| December | 2.2 | 350.2 | 2 | 19.9 | 3.6 | 39.5 | 19.5 | 4.1 | 37.9 | 36.0 | 4.5 | 102.4 | 50.1 | 8.7 | 99.1 | 2.1 | 0.0 | 15.9 | W |
| **TOTAL** | **350.2** | - | **107** | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Minimum** | **0.4** | - | **2** | - | ***-8.9*** | - | - | ***-8.9*** | - | - | ***0.0*** | - | - | ***7.2*** | - | - | ***0.0*** | - | - |
| **Maximum** | **136.2** | - | **17** | - | - | ***40.1*** | - | - | ***39.5*** | - | - | ***103.6*** | - | - | ***100.0*** | - | - | ***21.0*** | - |

## 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 2019 reporting period included:

- The inspection and maintenance of windrows and silt fencing to prevent potential surface water impacts and sediment entering Neubeck's Creek;

## 6.5 CONTAMINATED AND POLLUTED LAND

There was no land identified as being contaminated or polluted during the reporting period.

## 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 have 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 2019 reporting period in accordance with the Commonwealth Department of Environment (DoE) Notification of Referral Decision measure, as follows:

- 28 February 2019 - 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.
- 5 September 2019 - 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 2019 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 9**.

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

## Table 9 Purple Copper Butterfly Field Survey Summary

| Monitoring season | Purpose of field survey | Date of field surveys | Survey results | Conclusion | Response |
|---|---|---|---|---|---|
| 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. |
| 2015-2016 | 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. |
| | 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. |
| 2016-2017 | 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. |
| | 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. |

| Monitoring season | Purpose of field survey | Date of field surveys | Survey results | Conclusion | Response |
|---|---|---|---|---|---|
| 2017-2018 | 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. |
| | 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 of 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. |
| 2018 – 2019 | To confirm commencement of PCB larval feeding season | 5 September 2018. | Seven (7) 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, mining activities have ceased and no foreseeable impacts would be noted. No earthwork activities to occur within 200m of PCB main habitat area. |
| | To confirm completion of larval stage i.e. larvae not actively foraging above ground, within habitat area. | 28 February 2019 | No larvae identified on any plants. No attendant ants observed. | Absence of larvae during seasonally mild conditions indicates that PCB larvae have commenced pupation and are no longer active. | Mining activities can recommence within 200m of PCB main habitat area. |
| 2019 – 2020 | To confirm commencement of PCB larval feeding season. | 5 September 2019 | Eight (8) adult PCB (flying stage) identified at PCB1. PCB feeding season has commenced. PCB survey to be undertaken March 2020 to confirm completion of larvae stage. | | As PDM is in care and maintenance, 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 Planning and Environment 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. 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 2019).

The PDM Rehabilitation Monitoring Report (FirstField Environmental, 2019), 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 2019 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 PDM 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.

The Pine Dale Mine Rehabilitation Monitoring 2019 (FirstField, 2019) determined that fuel loads within rehabilitation areas A, B, C and 8 were low. The internal access road within PDM provides a firebreak between Area A and the PDM office and infrastructure to the south. The haul road provides a firebreak between to the north of area A, and to the north and west of Areas B, C and 8. Fire-fighting access roads were also considered to be adequate, with all access roads within rehabilitated areas maintained in good condition and suitable for the passage of Category 1 tankers.

During the 2019 reporting period there were two instances where fire events impacted the surrounding lands and within the PDM site.

On the 6 September 2019, a grass fire ignited on the corner of View Street and Castlereagh Highway, Lidsdale and spread in an easterly and southerly direction. This fire did not spread into the PDM site; however, was located close to the south-eastern boundary.

A bushfire started at Gospers Mountain in October 2019 and moved through Wollemi National Park eventually spreading through Ben Bullen State Forest mid December 2019. The fire then entered PDM and impacted the Yarraboldy Extension area and Area A on the 19 December 2019. There was no damage to PDM infrastructure. An inspection of the environmental monitoring locations in January 2020 indicated no damage to monitoring locations or equipment; however, due to the potential safety risks of falling trees the off-site Yarraboldy groundwater monitoring bores within Ben Bullen State Forest could not be inspected, as such any damage to these bores and the vibrating wire piezometer groundwater level loggers could not be confirmed. The Gospers Mountain bushfire resulted in poor air quality recorded by the PDM TSP and $PM_{10}$ HVAS units (refer **Section 6.2.2**).

### 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 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. During the 2019 monitoring period, 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, electrical conductivity (EC) and turbidity on a daily basis when LDP13 is discharging. No discharge events occurred at LDP13 during the 2019 monitoring period.

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

The WMP also details monitoring of a further six (6) locations: S1, and S3 to S7, which require monthly pH, temperature, EC and turbidity testing plus a quarterly analysis suite comprising major ions, anions and filtered metals. Note, surface water location S3 is the same location as EPA Point 3. The locations of monitoring points are indicated on **Plan 2a** in **Appendix A**. The description of surface water monitoring sites S1 and S3 to S7 is as follows:

- S1 located within Neubecks Creek upstream of PDM operations;

- S3 and S6 are located within Neubecks Creek downstream of S1 and any PDM operations;
- S4 is located on Coxs River, upstream of the confluence of Neubecks Creek and does not receive water from PDM operations;
- S5 is located within Blue Lake which receives flow from Neubecks Creek and Cox River.
- S7 located within Coxs River, downstream of Neubecks Creek.

### 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 10**.

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 10 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 2019. 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 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 2019 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 one (1) 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 three (3) of the 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 2019 monitoring period as monitoring locations within Neubecks Creek upstream of EPL Point 14 (EPA Point 3 and surface water site S6, **Section 7.3.22**) show pH results below the upper pH trigger level. EPA Point 14 receives waters from Neubecks Creek (including sites EPA Point 3 and S6), Angus Place Colliery and Springvale Mine. There is potential for the pH to have been influenced by operations outside of PDM.

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

- EPA Point 2 was above the site specific trigger value during November 2019.
- EPA Point 3 was above the site specific trigger value during May and November 2019.
- EPA Point 14 was above the site specific trigger value during three (3) of the four (4) monitoring events (February, May and November 2019).

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 2019 monitoring period.

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

The EC and pH for the period 2015 – 2019 is shown in **Figure 4**; EC and rainfall for this period is shown in **Figure 5**.

During the 2015 - 2019 monitoring period, pH has remained generally stable. A slight increasing trend in pH is evident at EPA Point 3. Electrical conductivity is shown to be increasing at EPA Point 2 and EPA Point 3 from January 2017 – December 2018. Electrical conductivity concentrations were shown to decrease in November 2018 following significant rainfall (117mm) with conductivity showing an increasing trend throughout 2019 due to below

average rainfall. 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 2019 period are presented in **Appendix B**.

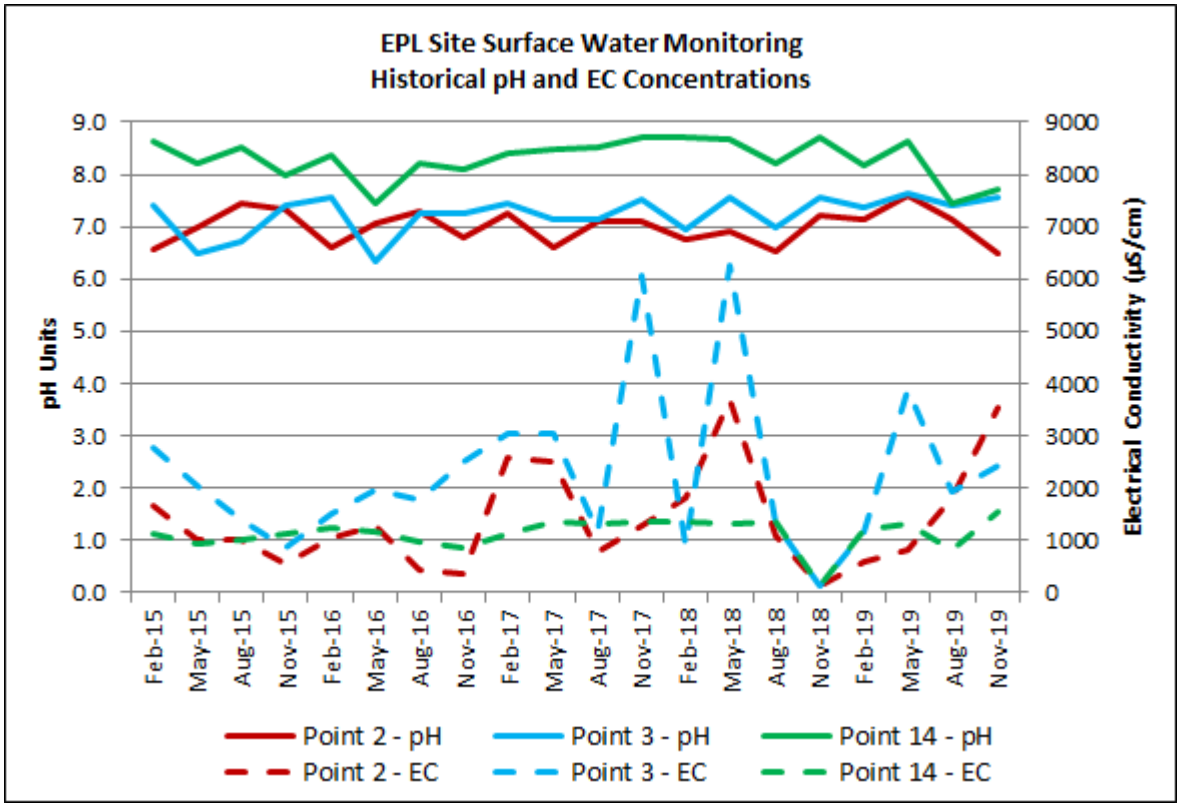



**Figure 4 EPL Surface Water Historical Results**

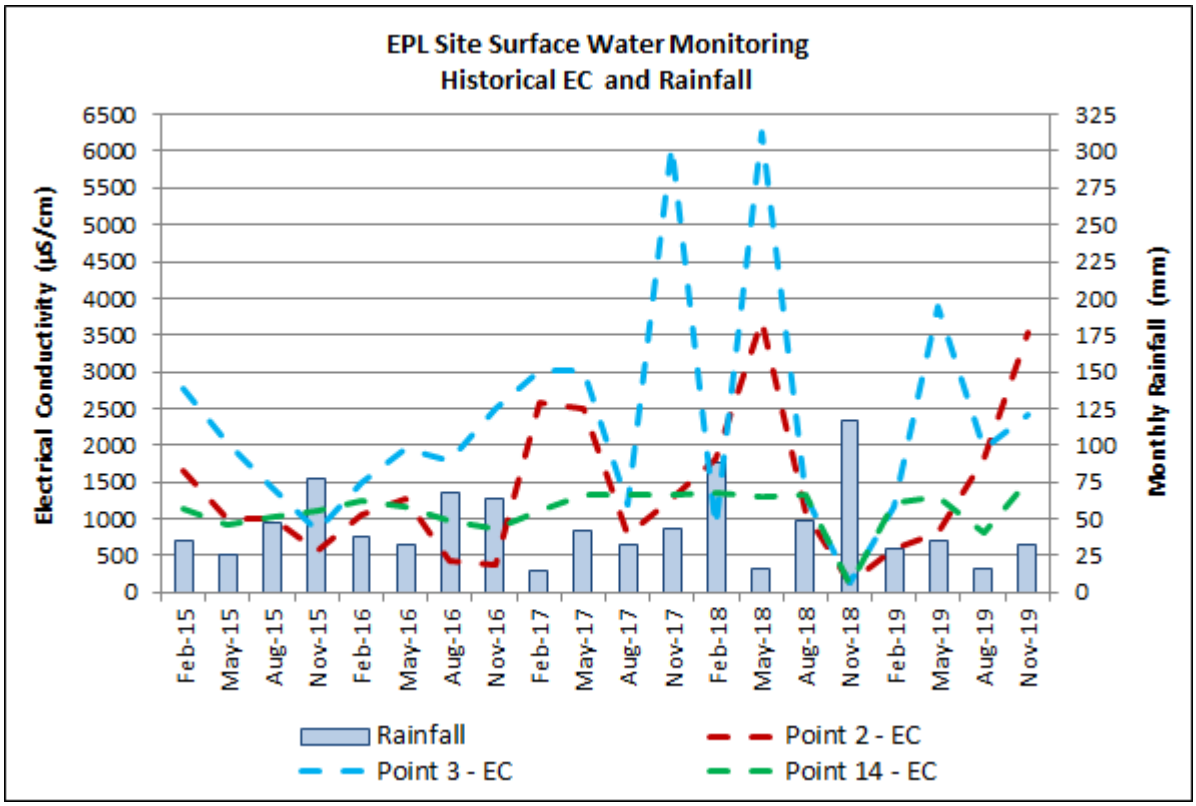



**Figure 5 EPL Surface Water Historical Results and Rainfall**

### 7.3.2.2 WMP Surface Water Monitoring

Six (6) surface water samples associated with the WMP were collected monthly during the 2019 monitoring period. Site surface water samples S1, and S3 - S7 are generally shown to be consistent over the duration of the monitoring period. Results for pH and electrical conductivity for the 2015 – 2019 monitoring period is shown graphically in **Figure 6**, **Figure 7**, **Figure 8** and **Figure 9**. The full suite of surface water monitoring results for sites S1 and S3 – S7 are shown in **Appendix B**.

Monitoring locations are shown in **Plan 2a**, **Appendix A**.

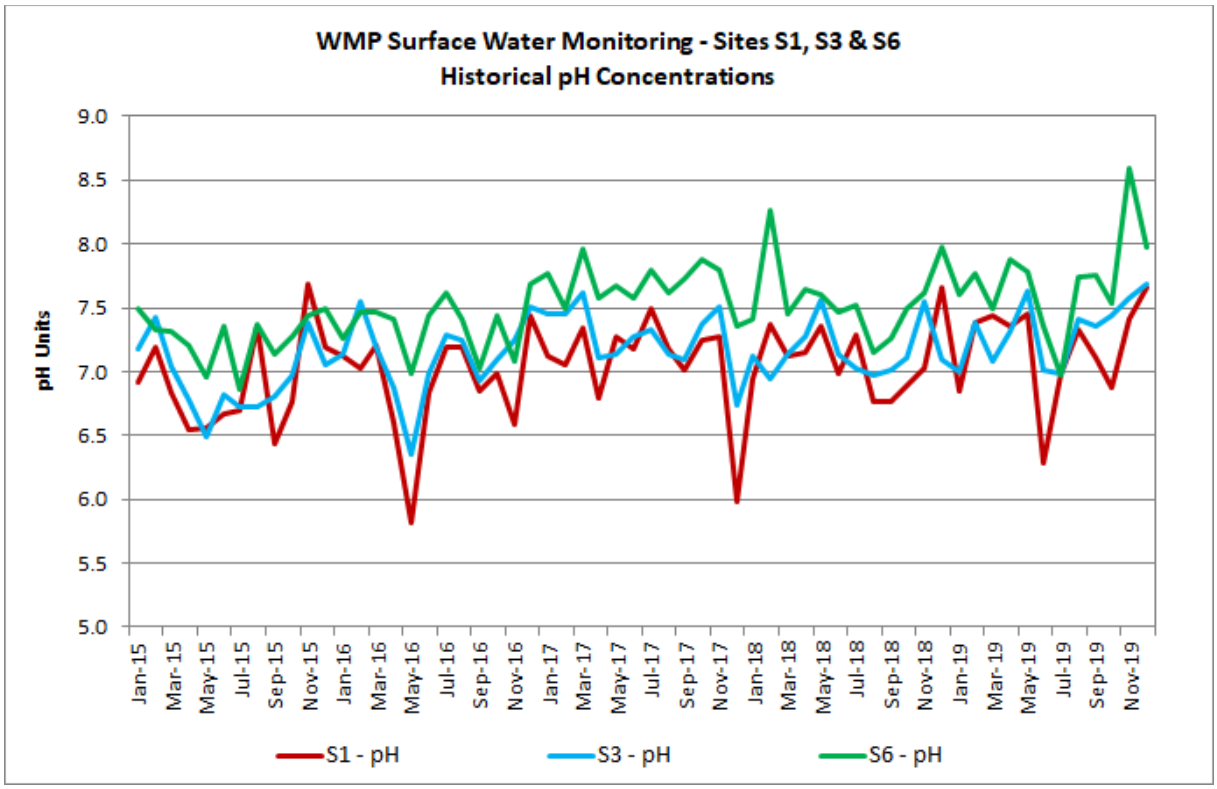



**Figure 6 WMP S1, S3 & S6 Historical pH Results**

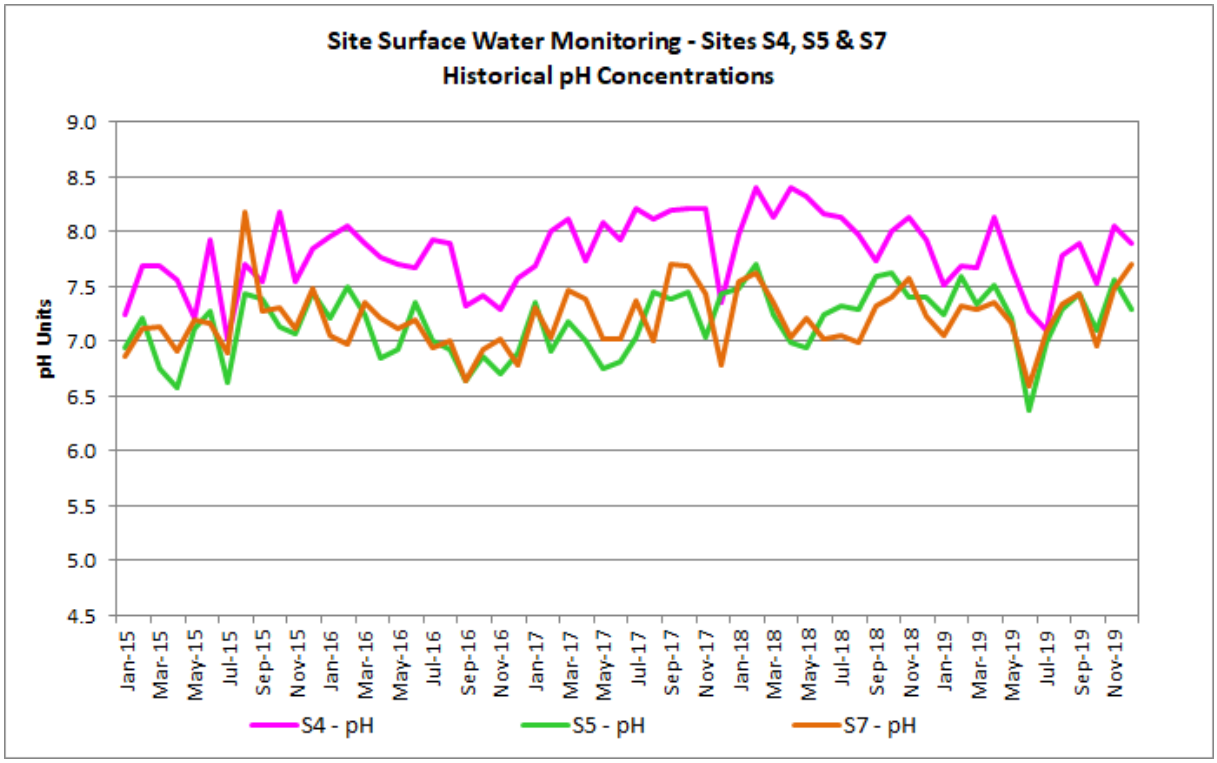



**Figure 7 WMP S4, S5 & S6 Historical pH Results**

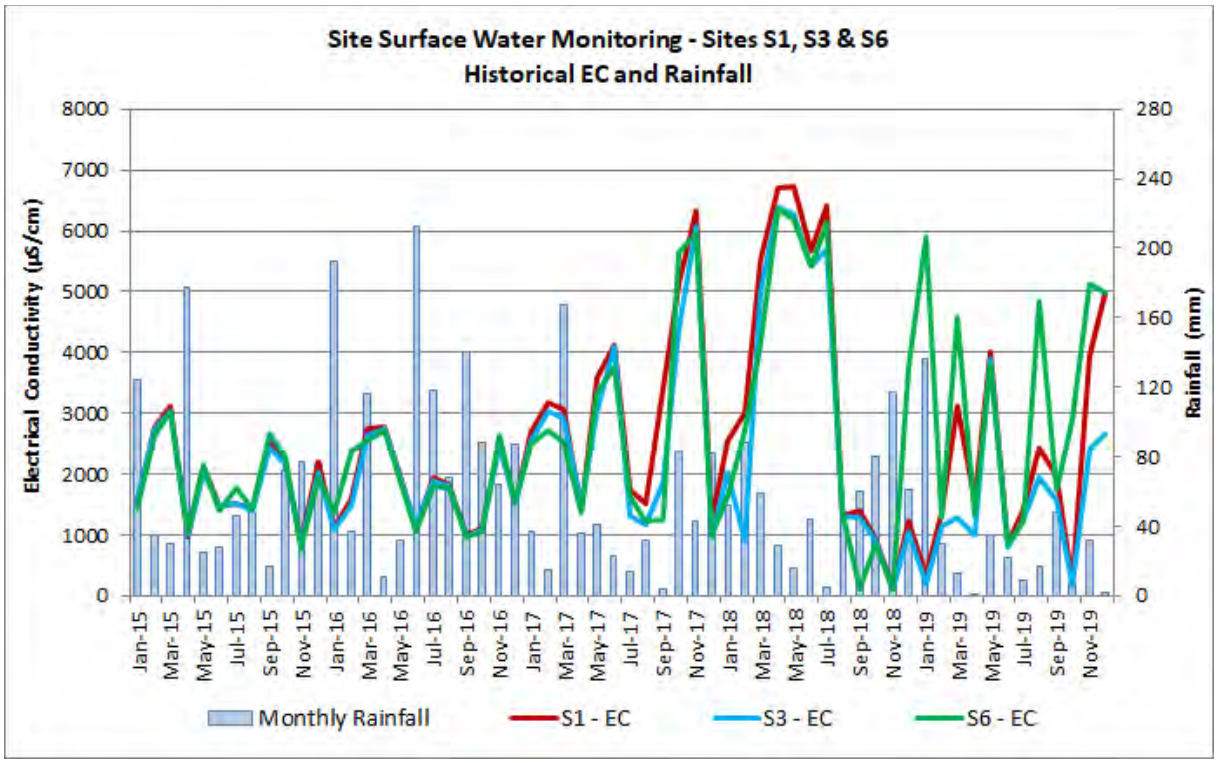



**Figure 8 WMP S1, S3 & S6 Historical EC Results & Rainfall**

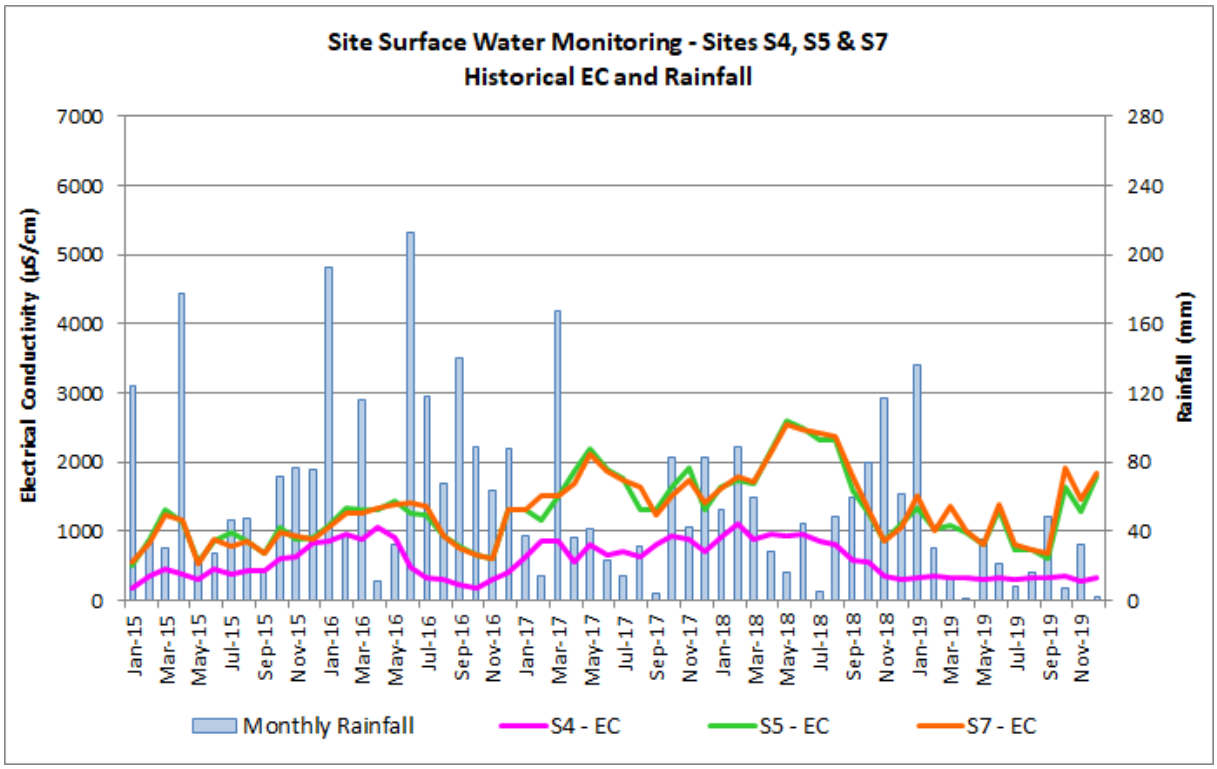



**Figure 9 WMP S4, S5 & S6 Historical EC Results & Rainfall**

During the 2019 monitoring period, pH was generally within the site specific trigger value ranges with the exception of the following surface water locations:

- S4 was below the lower pH trigger value during the July 2019 monitoring event and above the upper pH trigger value during the November 2019 monitoring event. S4 is located upstream of the Neubecks Creek confluence and does not receive any water from PDM; therefore, the pH results outside the trigger value range is not considered to be due to activities undertaken at PDM.
- S5 was below the lower pH trigger value during the June 2019 monitoring event. This location receives water from Neubecks Creek and Coxs River; however, the pH within Neubecks Creek directly upstream (location S6 and S3) and Coxs River (S4) reported pH results during June greater than the pH results reported at S5. Therefore, it is considered that these pH readings below the lower trigger value may be due to other factors not associated with PDM. The cause of the low pH is considered to be localised within the area of S5 only.
- S7 was below the lower pH trigger value during June 2019 only; the pH at S6 located within Neubecks Creek directly upstream of S7 reported a greater pH reading. There is potential for this low pH to be associated with the low pH reported at location S5 during June 2019.

During the 2019 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 four (4) of the twelve (12) monitoring events.
- S3 was in excess of the site specific trigger value during two (2) of the twelve (12) monitoring events.
- S5 was in excess of the site specific trigger value during seven (7) of the twelve (12) monitoring events.
- S6 was in excess of the site specific trigger value during seven (7) of the twelve (12) monitoring events.
- S7 was in excess of the site specific trigger value during eight (8) of the twelve (12) monitoring events.

An examination of historical data collected over the previous five years shows fluctuations in pH and electrical conductivity at all surface water locations. A slight overall increasing trend in pH however, is observable at the six (6) surface water monitoring locations.

Electrical conductivity is shown to increase during the period January 2017 – June 2018, with a sharp decrease during the period July – November 2018. Electrical conductivity within Neubecks Creek shows an overall increasing trend throughout 2019, particularly during November and December 2019. The electrical conductivity observed at S4 shows a stable trend throughout 2019, with conductivity measurements generally low when compared to the previous four years. Electrical conductivity within surface water sites S5 and S7, correlate strongly following a similar decreasing trend during January – September 2019, followed by an increasing trend for the remainder of 2019. 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 at a licence discharge point 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; however, impacts are diluted as water enters Blue Lake.

The complete 2019 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 2019.

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 2b**). An additional location at Blue Lake (SH4) is 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 - 2019. 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 continued throughout 2018 and March 2019 (refer **Figure 10**). During October 2019, there was a loss in vegetation in the drainage line walls which is considered to be due to below average rainfall (drought conditions), as such the classification was decreased to "potentially stabilising". Detailed results are presented in **Appendix B**.

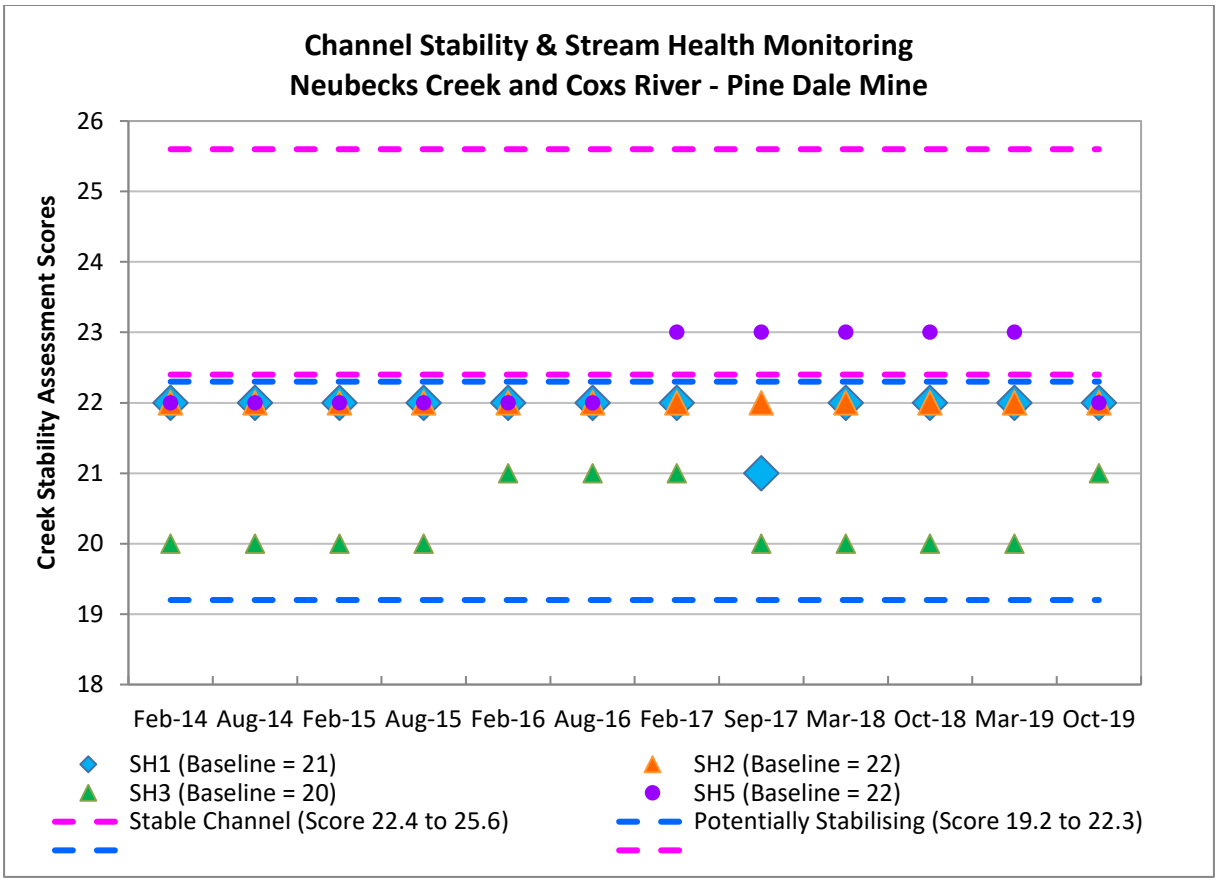



**Figure 10 Channel Stability and Stream Health Results**

## 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 2019 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.

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 11**.

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 11 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 2018, 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 11**.

### 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 March, August and September 2019 monitoring events, as the Water Cart Dam sampling location was dry. The full suite of groundwater results for the 2019 monitoring period are presented in **Appendix B**.

Groundwater samples collected from the on-site groundwater bores during 2019 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 2015 – December 2019 are shown in **Figure 11**. The monthly pH and electrical conductivity measurements for the period 2015 - 2019 are shown in **Figure 12** and **Figure 13**.

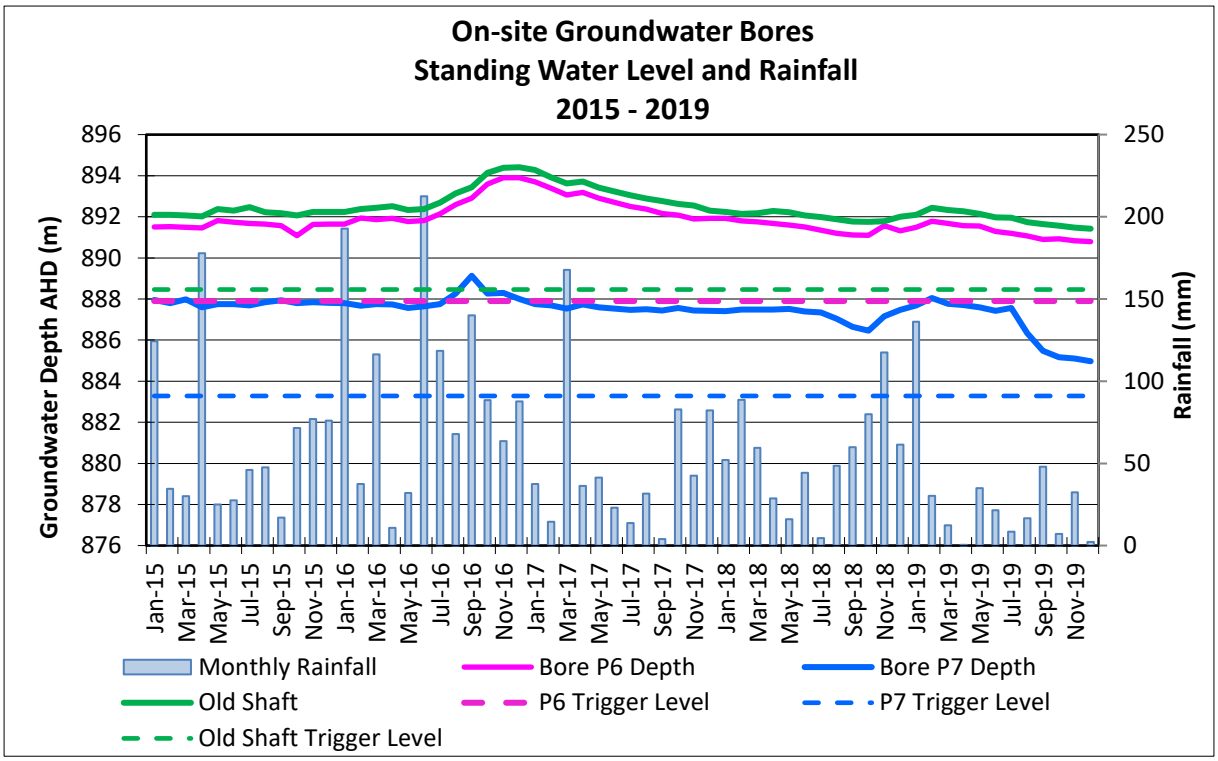



**Figure 11 On-site Groundwater Bores Standing Water Level and Rainfall**

During the 2019 monitoring period, there were no instances where the standing water level dropped below the respective trigger level values. Review of the previous five years of standing water level data shows the standing water level within the onsite bores are stable during the period January 2015 – June 2016. 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 (bore P6 and Old Shaft) are then shown to decrease from January 2017 – December 2018, likely due to decreased rainfall during this period (refer to **Figure 3**). The water level within bore P7, located within the Lithgow seam shows an overall decreasing trend for the previous five years. A notable decrease in water level is observable during July – December 2019.

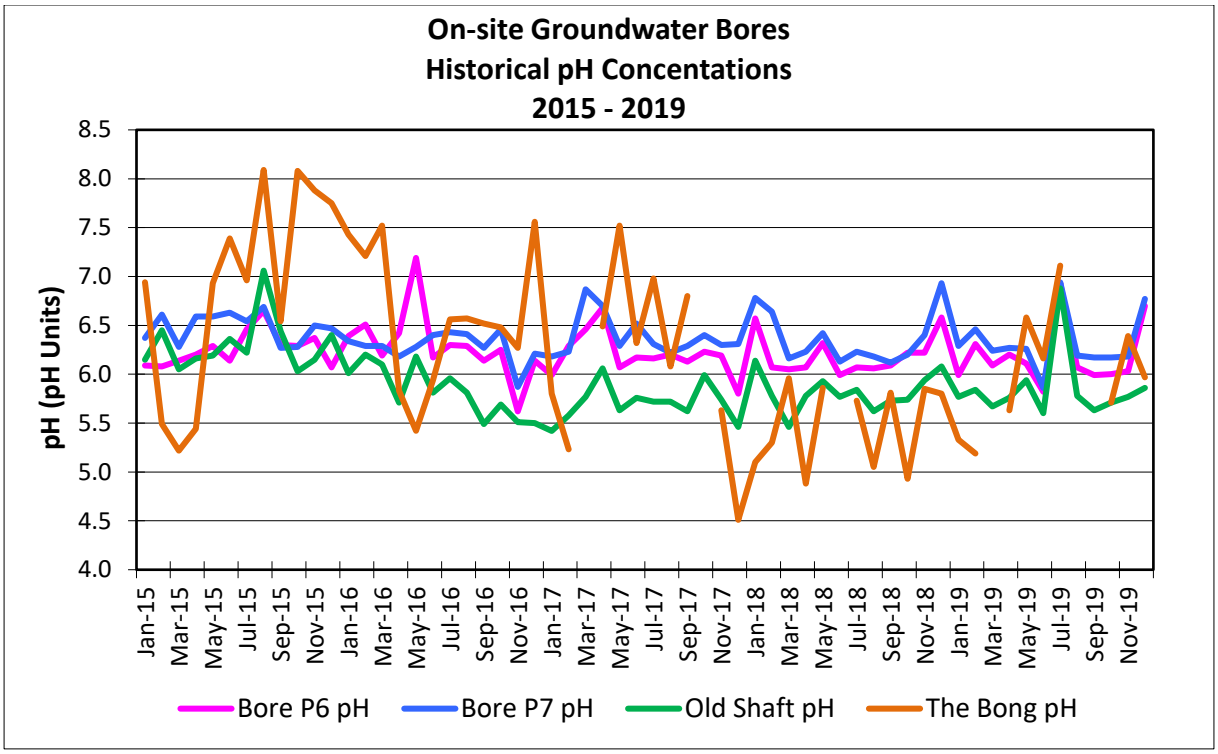



**Figure 12 On-site Groundwater Bores pH Results**

During the 2019 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:

- eight (8) of the twelve monitoring events at groundwater bore P6;
- five (5) of the twelve (12) monitoring events at groundwater bores P6 and P7;
- eleven (11) of the twelve (12) monitoring events at groundwater bore Old Shaft; and
- five (5) of the nine (9) monitoring events at The Bong.

During 2015 – 2019 (refer **Figure 12**), an overall decreasing trend is evident in pH across the four (4) on-site groundwater bores; however, the pH within bores P6, P7 and Old Shaft have stabilised from March 2018 onwards. The most pronounced decreases in pH are observed within Old Shaft and The Bong during January 2015 – March 2017. It is noted that Old Shaft and the Bong are located within the old Wallerawang underground workings. A slightly increasing pH trend is observable at the Bong during April – December 2019.

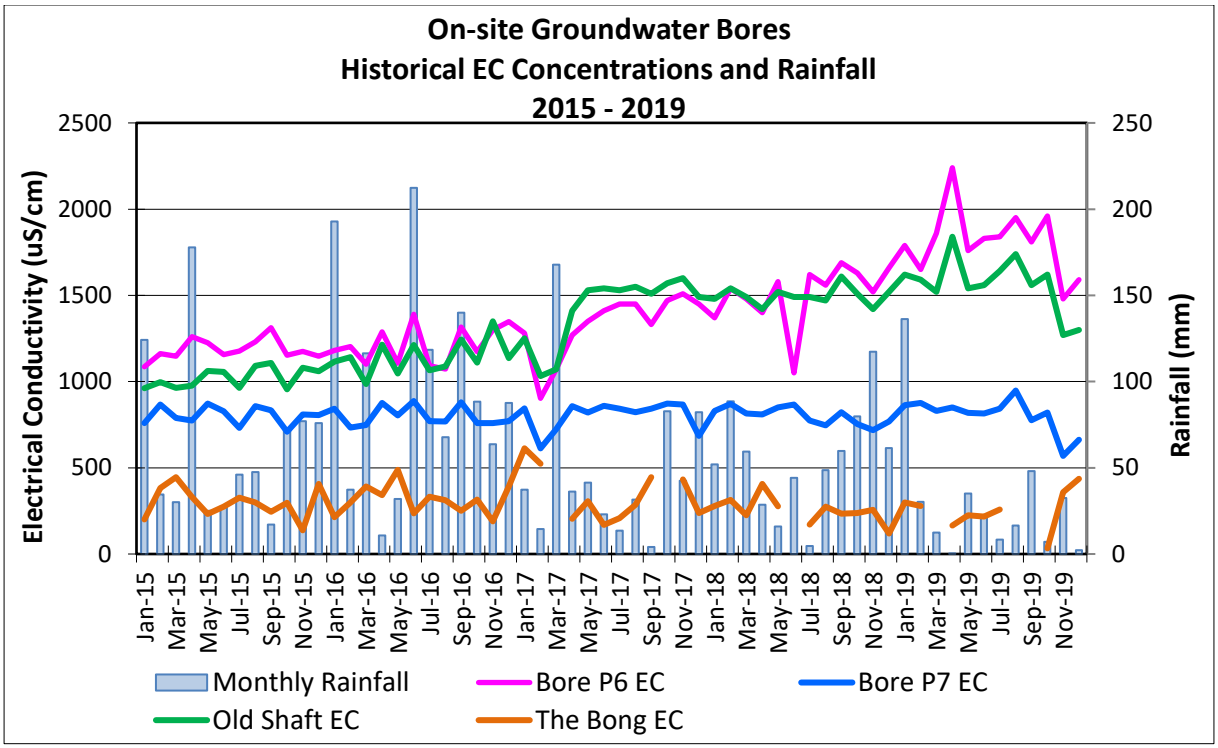



**Figure 13 On-site Groundwater Bores Electrical Conductivity and Rainfall**

During the 2019 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:

- all twelve monitoring events at bore P6 and Old Shaft; and
- three (3) of the twelve monitoring events at bore P7.

During 2015-2019 an increasing trend in electrical conductivity at bore P6 and Old Shaft was observed which correlates with the increasing of sulfate, chloride, calcium, iron and sodium (refer to **Appendix B** complete presentation of analytical results). The electrical conductivity concentrations at bore P7 that were in excess of the trigger values were less than 100µS/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. It is noted that during 2019 the pH has generally remained stable, although EC, chloride, sulfate, iron, calcium and sodium have increased.

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 2019. 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. During June 2019, sufficient water was able to be retrieved such that pH and EC measurements were able to be taken.

The monthly standing water level measurements compared with rainfall is shown in **Figure 14**. The quarterly pH and electrical conductivity measurements for the period 2015 - 2019 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 2019 monitoring period.

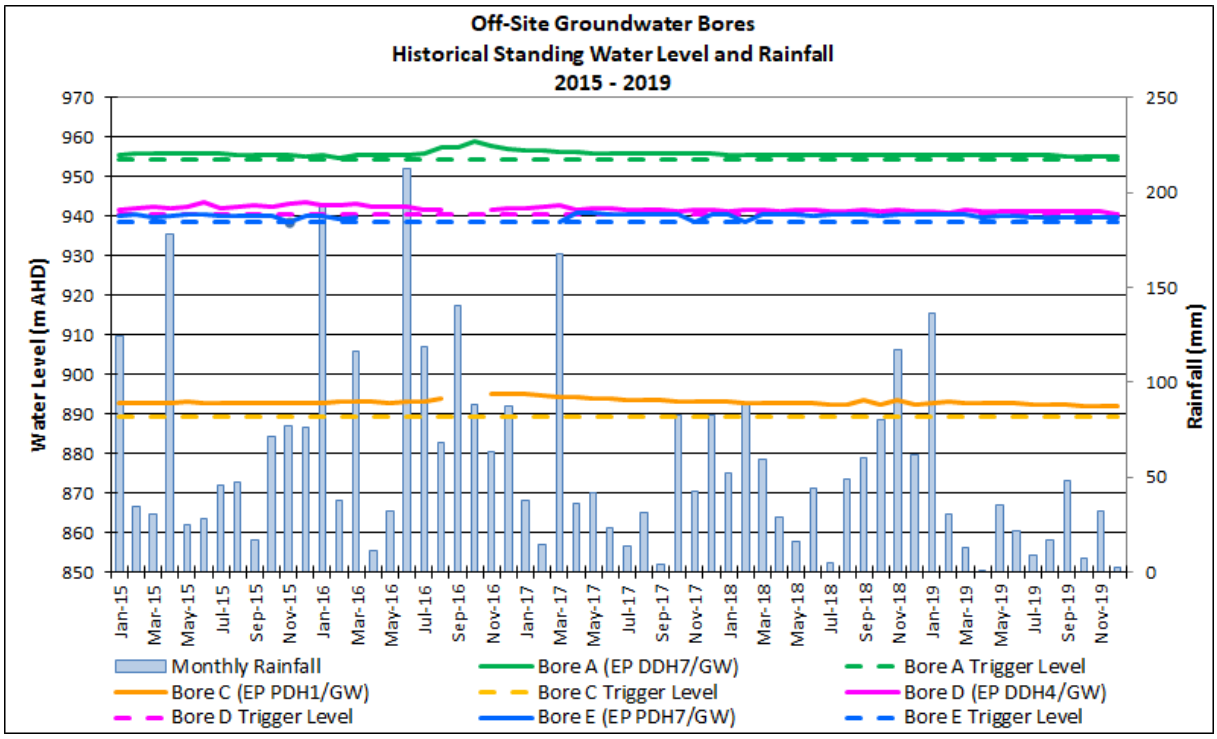



**Figure 14 Off-Site Groundwater Bores Historical Standing Water Level**

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

During the 2015 – 2019 monitoring period, the Yarraboldy groundwater bores standing water levels show varying levels of response to rainfall fluctuations, with a slight decreasing trend observed from November 2016 – December 2019. During the December 2019 monitoring round the standing water level fell below the nominated trigger level. No other

bores reported a standing water level below the nominated trigger level during the 2019 reporting period.

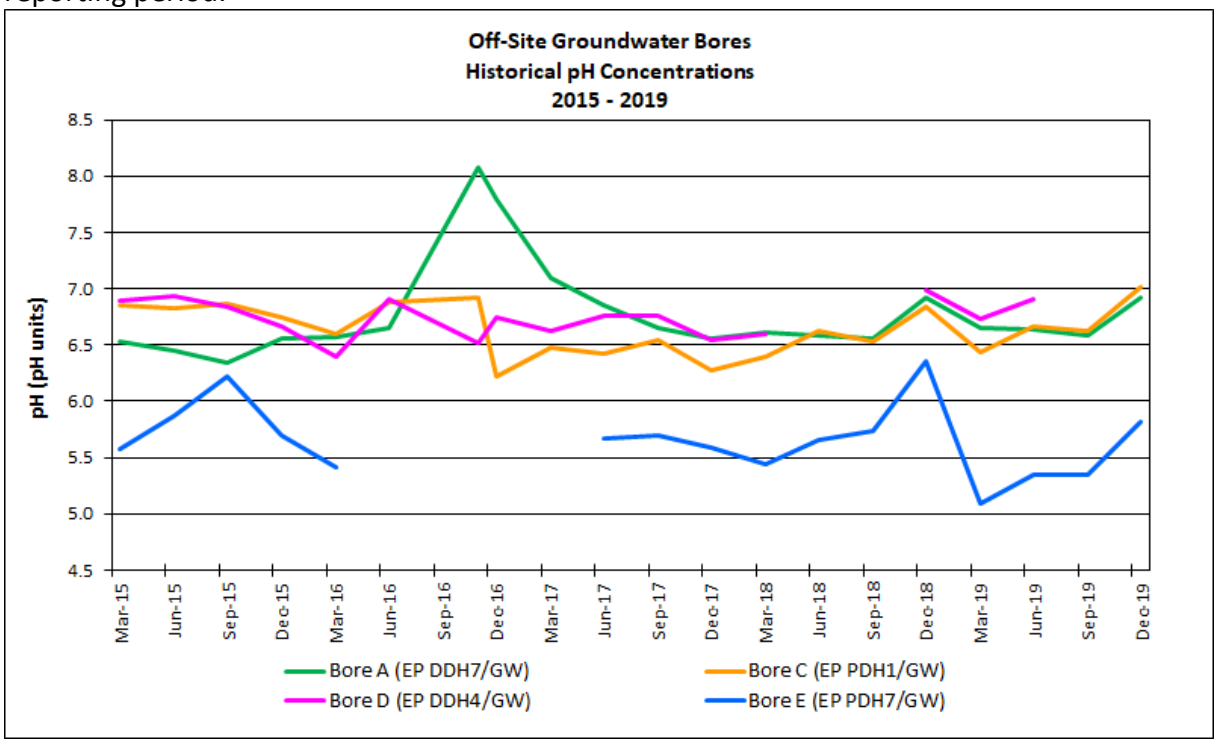



**Figure 15 Off-Site Groundwater Bores Historical pH Results**

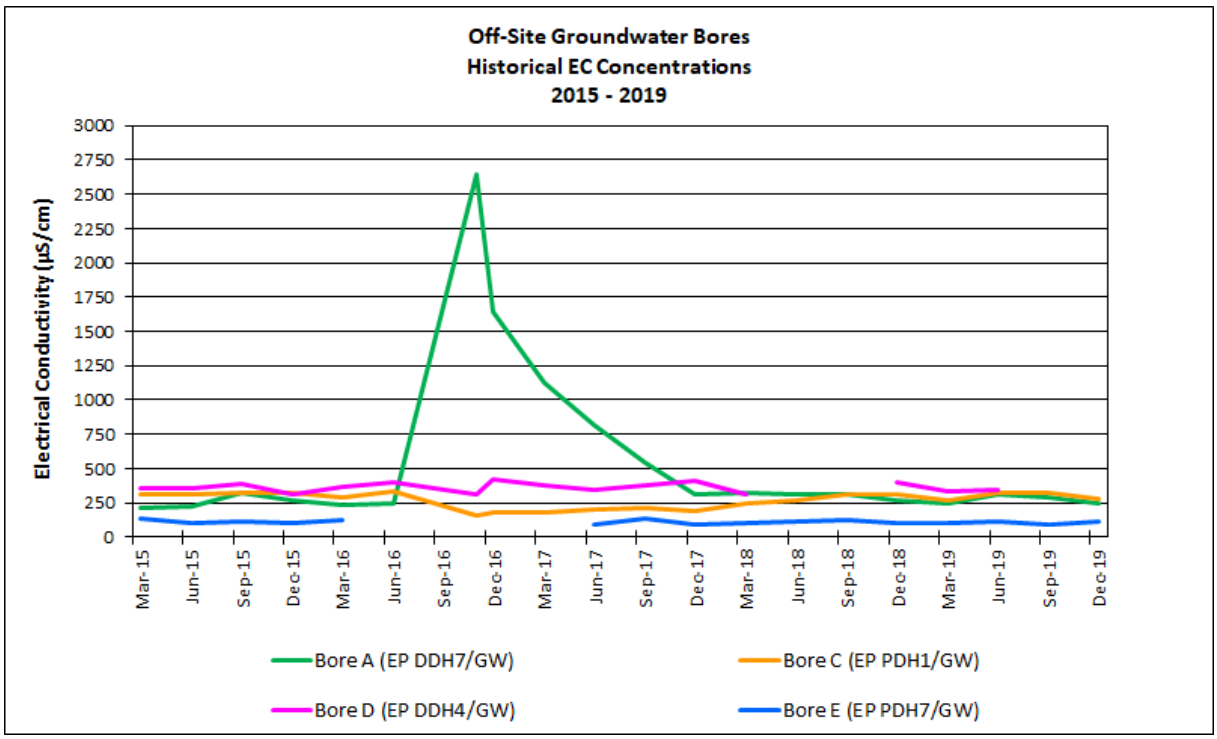



**Figure 16 Off-Site Groundwater Bores Historical SWL & Rainfall**

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 three (3) 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 2019.
- Bore E was below the lower pH trigger value during three (3) of the four (4) water quality monitoring events.

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

During the 2015 – 2019 monitoring period, pH is generally shown to be stable in bores A, C and D. Bore C shows a decreasing trend in pH during January 2015 – December 2016. An increasing pH trend is evident during December 2017 – December 2019 at Bores A and C. Bore E shows a slight decreasing trend during the 2015 – 2019 period. Concentrations of sulfate and iron are generally low within Bores A, C and D as such it is considered unlikely that pyrite oxidation is impacting pH. There are some elevated levels of iron and low pH values within bore E; however, this is unaccompanied by sulfate concentrations. As such, it remains unclear if the impacts of acid mine drainage from the Wallerawang underground workings have spread to Bore E (Middle River seam).

During the 2015 – 2019 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 2019 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 12**. Groundwater level hydrographs and rainfall for locations Bore B, C and E are shown in **Figure 17**, **Figure 18** and **Figure 19**. Due to bushfire activity (refer **Section 6.15**), the last time the Yaraboldy bores were accessible was the 5 December 2019, as such this is the last date the vibrating wire piezometers were downloaded. Data presented in **Figure 17**, **Figure 18** and **Figure 19** is for the period 1 January 2015 – 5 December 2019.

**Table 12 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.

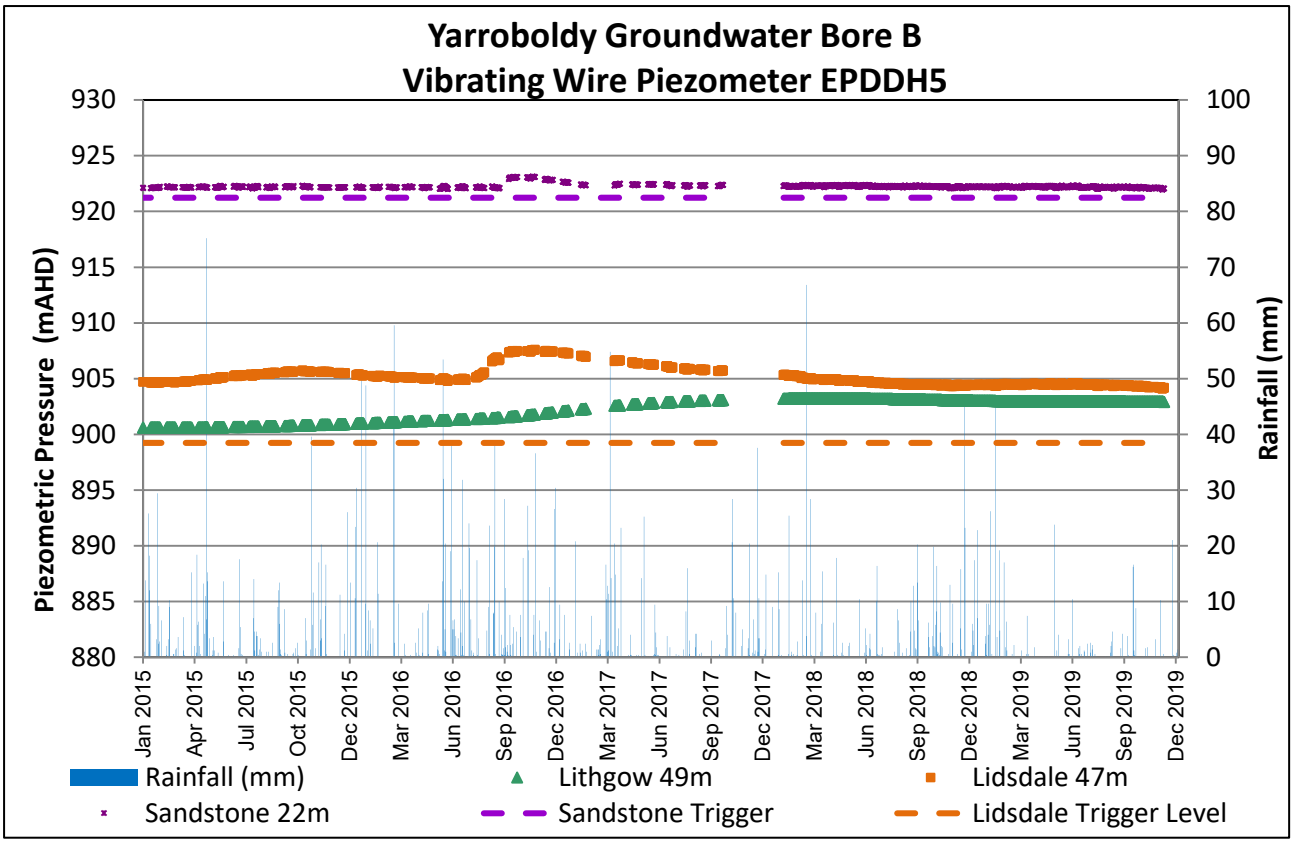



**Figure 17 Yarraboldy Bore B VWP Hydrograph & Rainfall**

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

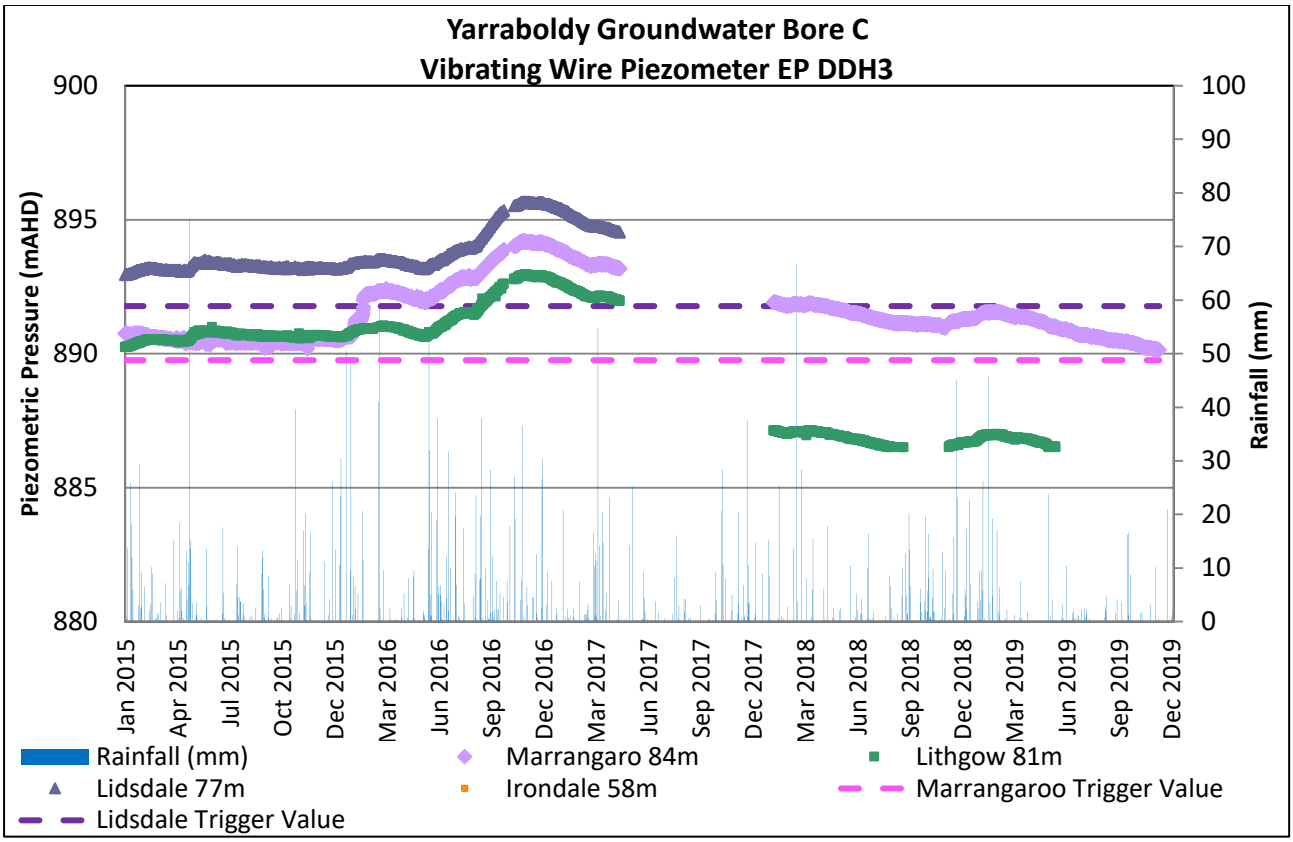



**Figure 18 Yarraboldy Bore C-VWP Hydrograph & Rainfall**

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

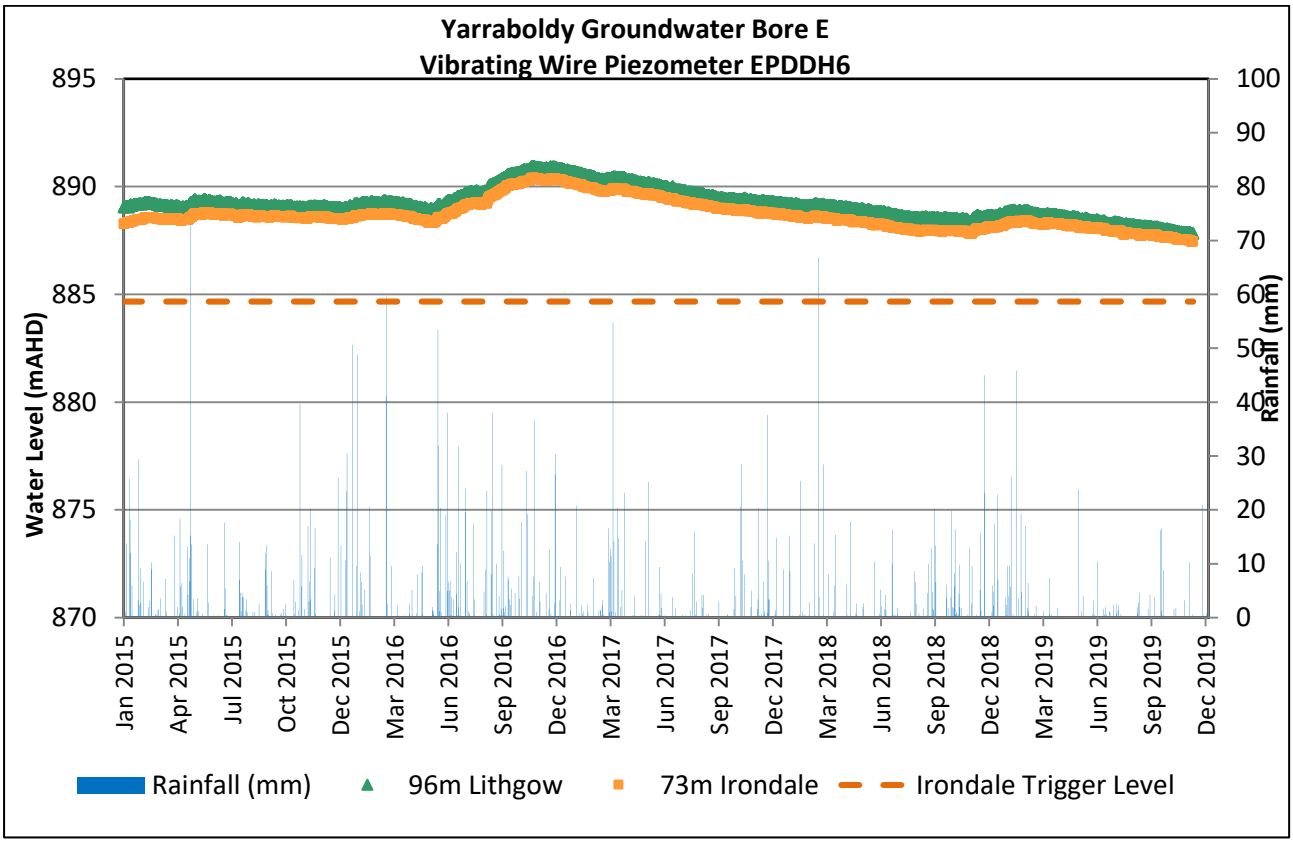



**Figure 19 Yarraboldy Bore E-VWP Hydrograph & Rainfall**

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 2019. There is no data available for the Lidsdale seam from February 2018 as the water level has fallen below the sensor height. Similarly, there is no data available for the Lithgow seam from June 2019 as the water level has fallen below the sensor height. The water level within the Marrangaroo aquifer has not fallen below the groundwater trigger level during the 2015 – 2019 period.

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 water level within the Irondale aquifer remains above the trigger level during the 2015 – 2019 period.

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. 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 2015 – December 2019 is shown in **Figure 20**.

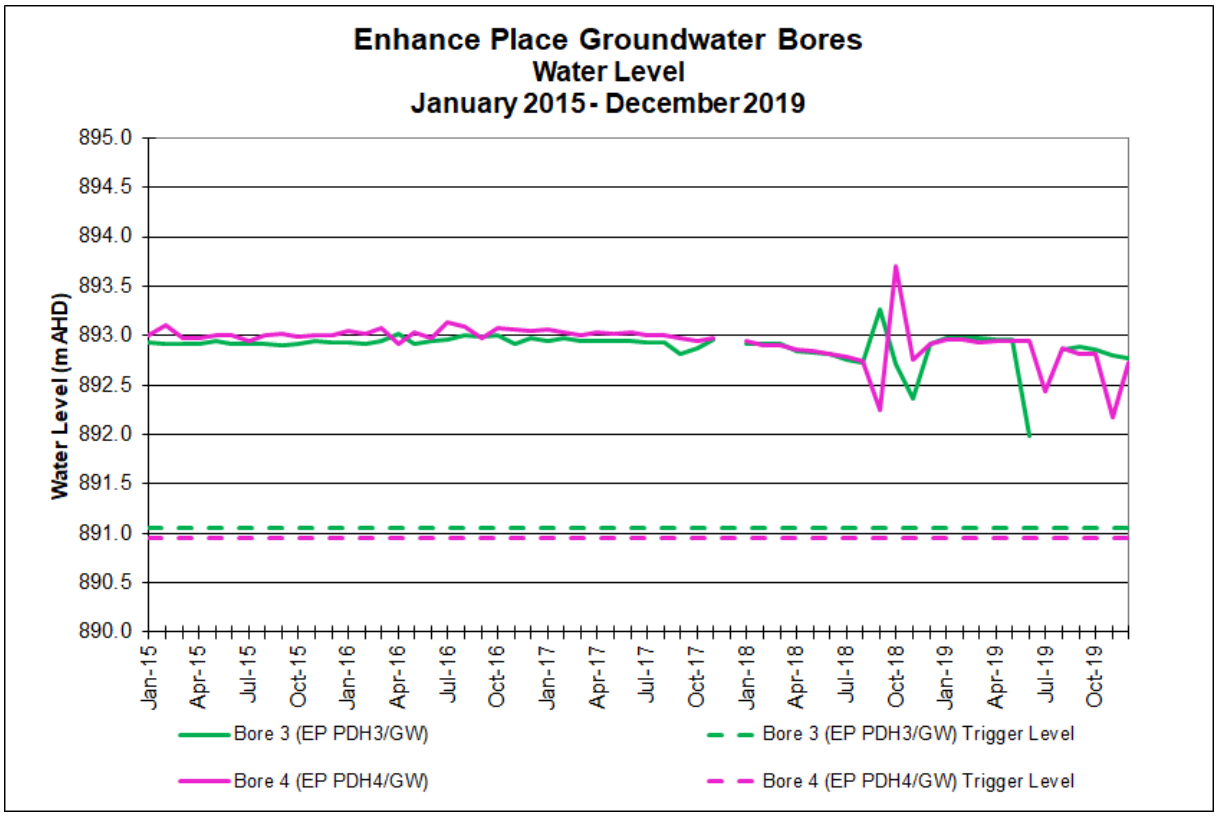



**Figure 20 Enhance Place Standing Water Level 2015 - 2019**

During the 2015 – 2019 monitoring period, there are some fluctuations in water level observed at the Enhance Place bores during 2014 and the end of 2019. 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 during the 2015 - 2019 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 the agreed post rehabilitation land use (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 as 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 2018 and 2019 reporting periods are presented in **Table 13** along with forecasts for the 2020 reporting period.

A rehabilitation monitoring report was prepared by FirstField Environmental (2019) 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 2019 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 2019 rehabilitation status summary prepared by FirstField Environmental (2019) is reproduced in **Table 14**. The rehabilitation status is compared to the MOP performance indicators and completion criteria.

## Table 13 Rehabilitation Area Summary

| Mine Area Type | Area Affected/Rehabilitated (ha) | | |
|---|---|---|---|
| | Previous Reporting Period (Actual) 2018 | This Reporting Period (Actual) 2019 | Next Reporting Period (Forecast) 2020 |
| 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 | 7 | 7 |
| E. Completed Rehabilitation | 0 | 25.4 | 25.4 |

## Table 14 Rehabilitation Status Summary

| Performance indicator | Completion Criteria | Current Status (2019 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:<br>- Nesting boxes and salvaged hollows<br>- Crushed timber spread over native forest rehab areas<br>- 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 tunnelling). | **Satisfactory –** continue to monitor. |
| Woodland birds present | • Evidence of woodland birds utilising rehabilitation areas. | **Satisfactory** – continue to monitor. |

| Performance indicator | Completion Criteria | Current Status (2019 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. | **Ongoing** – 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, maintenance works was not required to be undertaken in the Yarraboldy Extension. Rehabilitation work was limited to application of fertiliser due to the persistent dry conditions. Growth of vegetation on the bund (photo taken December 2019), which is representative of growth during the 2019 reporting period is shown in **Plate 2**.

Growth during the previous January 2019 and December 2017 are shown for comparison in **Plate 3** and **Plate 4**.

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

**Plate 2 Amenity Bund – December 2019**


**Plate 3 Amenity Bund – January 2019**

**Plate 4 Amenity Bund – 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 also provide recommendations for the improvement of rehabilitation within Area A. The recommendations included in the 2014 – 2019 reports are summarised in **Table 15**. The rehabilitation activities undertaken in Area A during the reporting period are also presented in this table.

## Table 15 Recommended and Completed Rehabilitation Actions in Area A

| Recommended Rehabilitation Actions - Area A | | Actions Completed (2014 to 2018) | Undertaken in 2019 |
|---|---|---|---|
| **Soil Assess. Report, 2014** | Continue control of Biddy Bush with current spot spraying regime. | Weed spraying as per Weed Management 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. | Yes |
| | 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 |
| | 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 Reports, 2017 - 2019** | 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 2019 (attached in **Appendix C**) indicated the total living groundcover within the monitoring transects in Area A (transect 5 and transect 6) has increased by 10% when compared to 2018 results. The total living cover during the 2019 assessment at transect 5 and transect 6 was 80%. Fluctuations in total living ground cover were noted during the 2015– 2019 period. Transect 5 has fluctuated from 50% in 2015 to 70% in 2018 and transect 6 has fluctuated from 70% in 2015 and 80% in 2018.

The total vegetation cover at Area A during December 2019 is shown in **Plate 5**.

**Plate 5 Area A – Vegetation cover – December 2019**

### 8.1.5 AREA B AND C REHABILITATION PERFORMANCE

Rehabilitation Areas B and C cover an area of approximately 25ha 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 16**, 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 - 2019). FirstField Environmental undertake an annual survey of Area B & C at transects 1, 2 and 3, as well as an analogue pasture transect, this was undertaken during 2019 and results of the survey are presented in the 2019 *Pine Dale Mine Rehabilitation Monitoring Report* (FirstField, 2019).

## Table 16 Recommended and Completed Rehabilitation Actions in Areas B & C

| Recommended Rehabilitation Actions – Area B & C | | Actions Completed (2014 to 2018) | Undertaken in 2019 |
|---|---|---|---|
| **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 |

| Recommended Rehabilitation Actions – Area B & C | | Actions Completed (2014 to 2018) | Undertaken in 2019 |
|---|---|---|---|
| **Rehab Monitoring Report, 2019** | Continue to spot spray African Lovegrass outbreaks. | Weed spraying as per Weed Management Schedule (Section 6.7). | Yes |

There were no rehabilitation maintenance works required to be undertaken during 2019.

The 2019 Rehabilitation Monitoring Report (FirstField) documented the following findings for rehabilitation Areas B & C (transects 1, 2 and 3):

- Total living groundcover in pasture rehabilitation areas is stable at 90%.
- 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 and are suitable for grazing.

Drought conditions prevailed throughout 2019, with significantly less rainfall than the previous year (refer **Section 6.3**), as such the grasses within Areas B & C were noted to be cured and not actively growing. Additionally, the pasture within Areas B & C were noted to have been grazed and shorter cropped than the analogue site. There was no significant change in total living groundcover; however, the species richness at the transects including the analogue site have decreased since the previous year, refer to **Plate 6** and **Plate 7** for a photograph of Area B and C during December 2019.

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 – December 2019**

**Plate 7 Area C Pasture Growth – December 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 17**, 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 - 2019). FirstField Environmental undertake an annual survey of Area 8 at transects 4 as well as an analogue pasture transect, this was undertaken during 2019 and results of the survey are presented in the 2019 *Pine Dale Mine Rehabilitation Monitoring Report* (FirstField, 2019).

## Table 17 Recommended and Completed Rehabilitation Actions in Area 8

| Recommended Rehabilitation Actions – Area 8 | | Actions Completed (2014 to 2018) | Undertaken in 2019 |
|---|---|---|---|
| **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 Reports, 2017 - 2019** | Continue to spot spray African Lovegrass outbreaks. | Weed spraying as per Weed Management Schedule (Section 6.7). | Yes |

The 2019 Rehabilitation Monitoring Report (FirstField, refer **Appendix C**) indicated Transect 4, in the eastern portion of Area 8 had 90% total living groundcover, which is consistent with the previous reporting period (FirstField, 2018). 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 2019 monitoring period.

### 8.1.8 RENOVATION / REMOVAL OF BUILDINGS

There were no buildings removed or constructed during the 2019 reporting period.

### 8.1.9 REHABILITATION FORMAL SIGN OFF

There were no areas of rehabilitation which acquired formal sign off from DPIE-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 18**.

**Table 18 Threats to Rehabilitation Success**

| Secondary Domains (Post Mining Land Use) | Potential Threat(s) | Mitigation & Management Measures |
|---|---|---|
| Infrastructure (A)<br><br>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)<br><br>Rehabilitation - Native Forest (D)<br><br>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 2019 reporting period rehabilitation activities were undertaken on areas that will not be directly impacted by any future mining operations at Pine Dale Mine. Maintenance and rehabilitation activities recommended in the Care and Maintenance MOP will continue on these areas throughout 2020 (sediment fences, fertilizing, re-seeding, weed control etc), where required and conditions allow.

As per the recommendations made in the Rehabilitation Monitoring Report (FirstField Environmental, 2019), located in **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.

In 2018, SLR Consulting (2018) prepared a final rehabilitation and completion assessment report, attached in **Appendix D**. The report confirms that the rehabilitation objectives approved under the PDM MOP (2019) have been achieved for Areas B, C and 8. During the 2020 onitoring 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. During the 2019 reporting period, there were no complaints received, enquiries or notifications received as summarised by **Table 19.**

Details of the complaints, enquiries and notifications received during the previous 5 years are presented in **Table 20**.

**Table 19 Community Complaints, Incidents & Notifications**

| Incident Type | Incidents Received 2019 |
|---|---|
| Noise | 0 |
| Air Quality | 0 |
| Blasting | 0 |
| Traffic | 0 |
| Water | 0 |
| Other | 0 |
| **Total Complaints Received** | **0** |
| **Enquiries/Notifications Received** | **0** |

## Table 20 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). | Yes | Yes | 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 |

## 9.2 COMMUNITY

### 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 DPIE (formerly DPE) approved an amalgamation of the PDM CCC and the regional EnergyAustralia CCC into one. The CCC meets on a quarterly 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 2019 reporting period the CCC meetings were held on the 25 February, 20 May, 19 August and 2 December.

### 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 and 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.

Additionally, EnergyAustralia undertakes a community grants program which provides funding for local initiatives that will deliver sustainable benefits for the Lithgow region. The two priority areas for funding are education and social inclusion. Details of the community grants program is provided on the EnergyAustralia website.

# 10 INDEPENDENT ENVIRONMENTAL AUDIT

There was no requirement for an Independent Environmental Audit (IEA) to be conducted at PDM during the 2019 reporting period and there is no requirement for an Independent Environmental Audit to be undertaken whilst Pine Dale Mine is in care and maintenance.

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.

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

# 11 INCIDENTS AND NON COMPLIANCES

During the 2019 reporting period, there was one instance of non-compliance in relation to the EPL. Refer to **Section 1** for details of the non-compliance.

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. Revised trigger values were developed to monitor for the risk of potential pyrite oxidisation and the spread of acid groundwater have been developed and submitted to DPIE – Water; however, DPIE have not provided a response at the time of writing. 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 2020 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 2020 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 2020 as appropriate.

## 12.3 DOCUMENT REVIEWS

The following documents were reviewed during the 2019 reporting period:

- Pine Dale Mine Care and Maintenance Mining Operations Plan.
- Air Quality and Greenhouse Gas Management Plan for the Pine Dale Coal Mine.

The Air Quality and Greenhouse Gas Management was reviewed and amended to remove the requirement to monitor at deposition dust gauge location D2 after removal from the EPL.

No documents are proposed to be reviewed during the 2020 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*.

FirstField Environmental (2019) *Pine Dale Mine 2019 Rehabilitation Monitoring Report*.

RCA (2019), *Annual Review Summary Report,* RCA Ref 6880-1815a/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 2019


228000
230000
6308000
6306000
6304000
6302000
226000

B55
Castlereagh Highway
Noon Street
Wolgan Road
Groves Road
Angus Place
Angus Place Colliery
Kangaroo Creek
Coxs River
Maddox Lane
Ian Hole Drive
Duncan Street
View Street
Karawatha Drive
Beecroft Fire Trail
Lidsdale
Stubbs Road

1661
1560
1578
Wallerawang Colliery
Western Main Colliery
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

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

0 37.5 75 150 225 300
metres

N

EnergyAustralia
LIGHT THE WAY

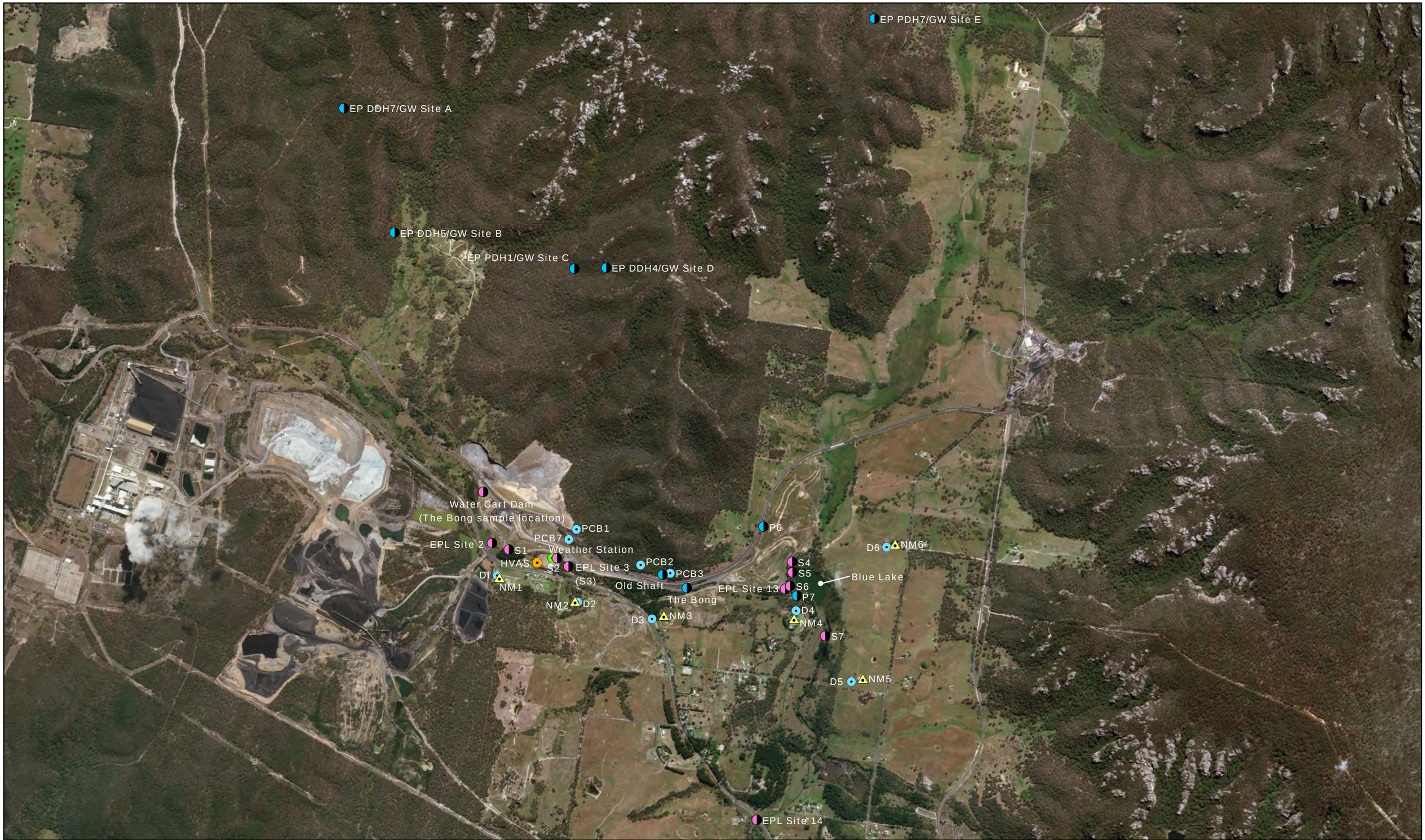
PINE DALE MINE
ENVIRONMENTAL MONITORING
CHANNEL STABILITY, STREAM AND
VEGETATIVE HEALTH
MONITORING SITES

PLAN: 2b

DRAWN BY : C. Rocher

SCALE: 1:5,000 (A3)

DATE: 1/02/2019




LEGEND

- 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

- 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

HAUL ROAD

CASTLEREAGH HIGHWAY

WALLERAWANG COLLIERY RAIL WAY

PML 11

D1

NM1

NM2

D2

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 2019

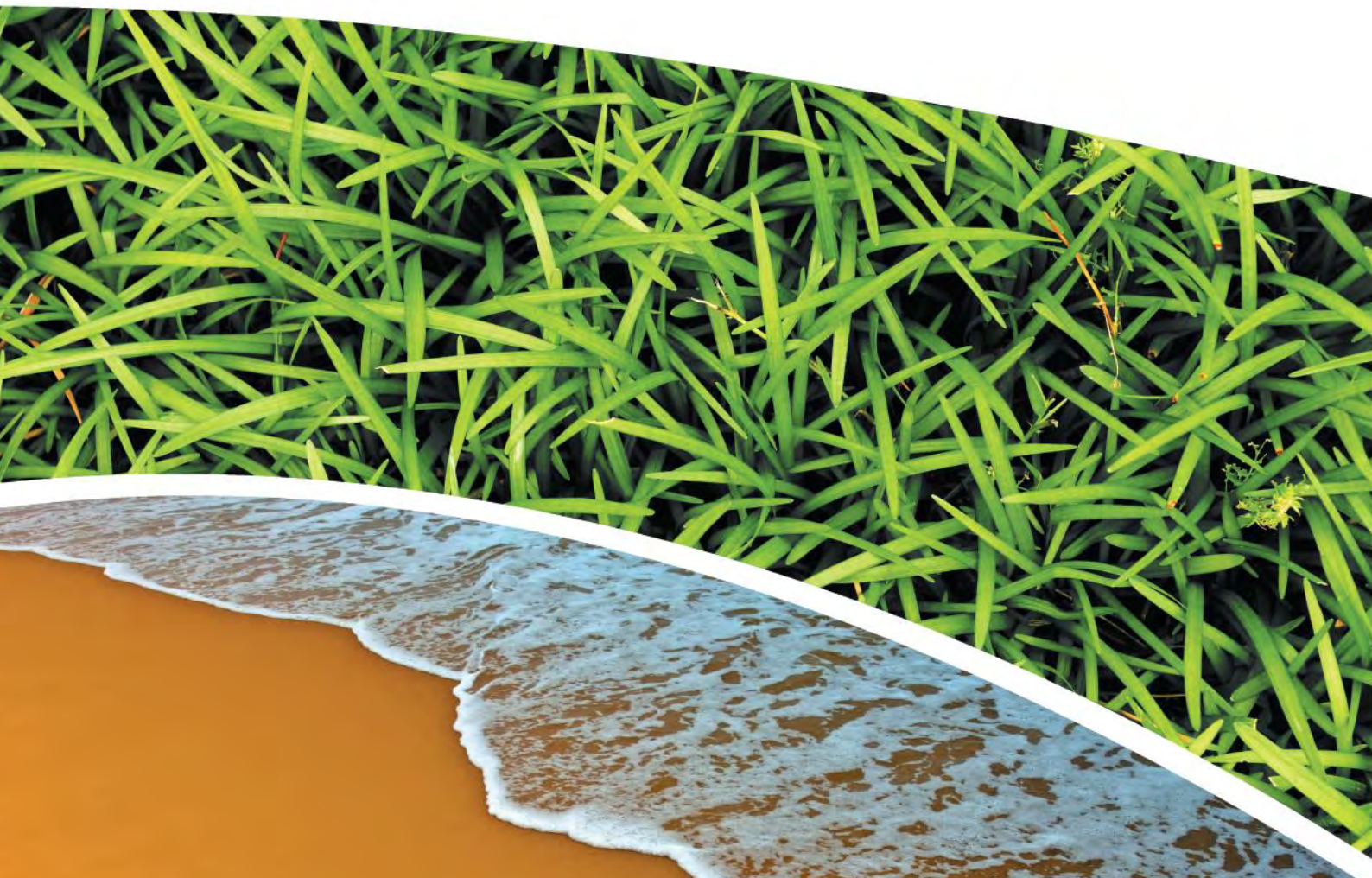
**Prepared for Enhance Place Pty Ltd**

**Prepared by RCA Australia**

**RCA ref 6880-1815a/0**

**January 2020**

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL



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| /0 | 1 | Electronic report | RCA – job archive | 21.01.2020 |

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RCA ref 6880-1815a/0

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

21 January 2020

Enhance Place Pty Ltd
PO Box 202
WALLERAWANG NSW 2845

Attention: Mr Graham Goodwin

# ANNUAL REVIEW ENVIRONMENTAL SUMMARY 2019
# COMPILED FOR PINE DALE MINE
# JANUARY – DECEMBER 2019

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

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## APPENDIX

## 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 2019 reporting period, as evidenced by the following:

- Air quality monitoring results recorded during the reporting period for depositional dust, total suspended particulate matter (TSP) 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;
- Concentrations of fine particulate matter ($PM_{10}$) were in excess of the 24-hour short term criteria during November and December 2019. These elevated concentrations are considered to be due to bushfire activity. The elevated $PM_{10}$ concentrations due to the bushfires have also increased the annual average concentration to above the annual average criteria.
- 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 2019. The 2019 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,e]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 Department of Planning, Industry and Environment (DPIE) (formerly OEH).

[e] PA 10_0041 stipulates the annual average $PM_{10}$ assessment criterion at 30µg/m$^3$; however, National Environment Protection (Ambient Air Quality) Measure was amended in 2016 and stipulates the $PM_{10}$ annual average assessment criterion at 25µg/m$^3$.

## 3.2 AIR MONITORING RESULTS – DEPOSITIONAL DUST GAUGE DATA SUMMARY

Depositional dust monitoring is undertaken at nine (9) locations across PDM.

A total of five (5) depositional dust gauges are monitored in accordance with the Air Quality and Green House Gas Management Plan (Ref [4]) and EPL 4911 (Ref [1]). One (1) dust gauge is located within the settlement of Blackmans Flat (gauge D1) and one (1) is located to the east of Blackmans Flat (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 2019 are shown in **Tables 4** to **12**. Graphical presentations are shown in **Figures 1** and **2**. A discussion of results is presented in **Section 2.3**.

Prior to May 2019, monitoring was required to be undertaken at dust gauge D2 located within the settlement of Blackmans Flat. Depositional dust gauge D2 was removed from EPL4911 (Ref [1]) in May 2019, as the property owner requested the gauge to be removed from his property. The Air Quality and Greenhouse Gas Management Plan was also updated to reflect the cessation of monitoring at location D2 (Ref [4]). No monitoring was undertaken at D2 during the period January – April 2019 as the owner had requested the dust gauge to be removed in March 2018.

**Table 4** *Depositional Dust Data Summary Dust Gauge D1 Jan – Dec 2019*

| Month | Gauge No. | Insoluble Solids (g/m².month) | Ash Residue (g/m².month) | Combustible Matter (g/m².month) |
|---|---|---|---|---|
| Jan-19 | D1 | 3.3 | 2.2 | 1.1 |
| Feb-19 | D1 | 1.8 | 1.3 | 0.5 |
| Mar-19 | D1 | 1.7 | 1.2 | 0.5 |
| Apr-19 | D1 | 1.2 | 0.8 | 0.4 |
| May-19 | D1 | 0.6 | 0.3 | 0.3 |
| Jun-19 | D1 | 0.7 | 0.4 | 0.3 |
| Jul-19 | D1 | 0.3 | 0.2 | 0.1 |
| Aug-19 | D1 | 0.3 | 0.2 | 0.1 |
| Sep-19 | D1 | 1.1 | 0.7 | 0.4 |
| Oct-19 | D1 | 1.1 | 0.7 | 0.4 |
| Nov-19 | D1 | 1.8 | 1.1 | 0.7 |
| Dec-19 | D1 | 1.5 | 1.0 | 0.5 |
| ***ANNUAL AVERAGE*** | | *1.3* | *0.8* | *0.4* |

**Table 5** *Depositional Dust Data Summary Dust Gauge D3 Jan – Dec 2019*

| Month | Gauge No. | Insoluble Solids (g/m².month) | Ash Residue (g/m².month) | Combustible Matter (g/m².month) |
|---|---|---|---|---|
| Jan-19 | D3 | 3.4 | 2.7 | 0.7 |
| Feb-19 | D3 | 2.1 | 1.5 | 0.6 |
| Mar-19 | D3 | 1.9 | 1.6 | 0.3 |
| Apr-19 | D3 | 1.2 | 0.8 | 0.4 |
| May-19 | D3 | 0.8 | 0.5 | 0.2 |
| Jun-19 | D3 | 0.7 | 0.4 | 0.3 |
| Jul-19 | D3 | 0.4 | 0.2 | 0.2 |
| Aug-19 | D3 | 0.4 | 0.2 | 0.2 |
| Sep-19 | D3 | 1.0 | 0.7 | 0.3 |
| Oct-19 | D3 | 1.4 | 0.8 | 0.6 |
| Nov-19 | D3 | 1.8 | 1.3 | 0.5 |
| Dec-19 | D3 | 2.7 | 2.1 | 0.6 |
| ***ANNUAL AVERAGE*** | | *1.5* | *1.1* | *0.4* |

**Table 6** *Depositional Dust Data Summary Gauge D4 Jan – Dec 2019*

| Month | Gauge No. | Insoluble Solids (g/m².month) | Ash Residue (g/m².month) | Combustible Matter (g/m².month) |
|---|---|---|---|---|
| Jan-19 | D4 | 4.2 | 3.0 | 1.2 |
| Feb-19 | D4 | 2.6 | 1.7 | 0.9 |
| Mar-19 | D4 | 2.6 | 1.6 | 1.0 |
| Apr-19 | D4 | 1.0 | 0.6 | 0.4 |
| May-19 | D4 | 0.7 | 0.3 | 0.3 |
| Jun-19 | D4 | 0.6 | 0.4 | 0.2 |
| Jul-19 | D4 | 0.2 | 0.1 | 0.1 |
| Aug-19 | D4 | 0.2 | <0.1* | 0.2 |
| Sep-19 | D4 | 0.7 | 0.5 | 0.2 |
| Oct-19 | D4 | 1.5 | 0.8 | 0.7 |
| Nov-19 | D4 | 2.1 | 1.6 | 0.5 |
| Dec-19 | D4 | 2.7 | 2.1 | 0.6 |
| ***ANNUAL AVERAGE*** | | *1.6* | *1.1* | *0.5* |

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

**Table 7** *Depositional Dust Data Summary Gauge D5 Jan – Dec 2019*

| Month | Gauge No. | Insoluble Solids (g/m².month) | Ash Residue (g/m².month) | Combustible Matter (g/m².month) |
|---|---|---|---|---|
| Jan-19 | D5 | 4.3 | 3.2 | 1.1 |
| Feb-19 | D5 | 1.4 | 1.0 | 0.4 |
| Mar-19 | D5 | 1.2 | 0.9 | 0.3 |
| Apr-19 | D5 | 0.9 | 0.6 | 0.3 |
| May-19 | D5 | 0.2 | <0.1* | 0.2 |
| Jun-19 | D5 | 0.5 | 0.2 | 0.3 |
| Jul-19 | D5 | 0.1 | <0.1* | 0.1 |
| Aug-19 | D5 | 0.4 | 0.2 | 0.2 |
| Sep-19 | D5 | 0.9 | 0.6 | 0.3 |
| Oct-19 | D5 | 1.7 | 0.6 | 1.1 |
| Nov-19 | D5 | 1.8 | 1.4 | 0.4 |
| Dec-19 | D5 | 2.1 | 1.6 | 0.5 |
| ***ANNUAL AVERAGE*** | | *1.3* | *0.9* | *0.4* |

*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 D6 Jan – Dec 2019*

| Month | Gauge No. | Insoluble Solids (g/m².month) | Ash Residue (g/m².month) | Combustible Matter (g/m².month) |
|---|---|---|---|---|
| Jan-19 | D6 | 3.0 | 2.3 | 0.7 |
| Feb-19 | D6 | 2.6 | 1.9 | 0.7 |
| Mar-19 | D6 | 1.0 | 0.8 | 0.2 |
| Apr-19 | D6 | 0.7 | 0.4 | 0.3 |
| May-19 | D6 | 0.5 | 0.3 | 0.2 |
| Jun-19 | D6 | 0.5 | 0.3 | 0.2 |
| Jul-19 | D6 | 0.2 | <0.1* | 0.2 |
| Aug-19 | D6 | 0.4 | 0.2 | 0.2 |
| Sep-19 | D6 | 0.6 | 0.4 | 0.2 |
| Oct-19 | D6 | 1.1 | 0.8 | 0.3 |
| Nov-19 | D6 | 2.3 | 1.9 | 0.4 |
| Dec-19 | D6 | 1.8 | 1.4 | 0.4 |
| ***ANNUAL AVERAGE*** | | *1.2* | *0.9* | *0.3* |

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

**Table 9** *Depositional Dust Data Summary Gauge PCB1 Jan – Dec 2019*

| Month | Gauge No. | Insoluble Solids (g/m².month) | Ash Residue (g/m².month) | Combustible Matter (g/m².month) |
|---|---|---|---|---|
| Jan-19 | PCB1 | 3.4 | 1.6 | 1.8 |
| Feb-19 | PCB1 | 2.4 | 1.3 | 1.1 |
| Mar-19 | PCB1 | 2.0 | 1.2 | 0.8 |
| Apr-19 | PCB1 | 1.3 | 0.7 | 0.6 |
| May-19 | PCB1 | 0.9 | 0.2 | 0.6 |
| Jun-19 | PCB1 | 0.8 | 0.2 | 0.6 |
| Jul-19 | PCB1 | 0.5 | 0.1 | 0.4 |
| Aug-19 | PCB1 | 0.6 | 0.2 | 0.4 |
| Sep-19 | PCB1 | 1.3 | 0.8 | 0.5 |
| Oct-19 | PCB1 | 1.3 | 0.7 | 0.6 |
| Nov-19 | PCB1 | 2.5 | 1.6 | 0.9 |
| Dec-19 | PCB1 | 2.6 | 1.8 | 0.8 |
| ***ANNUAL AVERAGE*** | | *1.6* | *0.9* | *0.8* |

**Table 10** *Depositional Dust Data Summary Gauge PCB2 Jan – Dec 2019*

| Month | Gauge No. | Insoluble Solids (g/m².month) | Ash Residue (g/m².month) | Combustible Matter (g/m².month) |
|---|---|---|---|---|
| Jan-19 | PCB2 | 2.9 | 1.8 | 1.1 |
| Feb-19 | PCB2 | 1.9 | 0.9 | 1.0 |
| Mar-19 | PCB2 | 2.1 | 1.2 | 0.9 |
| Apr-19 | PCB2 | 0.9 | 0.5 | 0.4 |
| May-19 | PCB2 | 0.5 | 0.1 | 0.4 |
| Jun-19 | PCB2 | 0.4 | 0.1 | 0.3 |
| Jul-19 | PCB2 | 0.3 | 0.1 | 0.2 |
| Aug-19 | PCB2 | 0.3 | 0.1 | 0.2 |
| Sep-19 | PCB2 | 1.0 | 0.6 | 0.4 |
| Oct-19 | PCB2 | 0.7 | 0.2 | 0.5 |
| Nov-19 | PCB2 | 2.7 | 1.7 | 1.0 |
| Dec-19 | PCB2 | 2.6 | 1.9 | 0.7 |
| ***ANNUAL AVERAGE*** | | *1.4* | *0.8* | *0.6* |

**Table 11** *Depositional Dust Data Summary Gauge PCB3 Jan – Dec 2019*

| Month | Gauge No. | Insoluble Solids (g/m².month) | Ash Residue (g/m².month) | Combustible Matter (g/m².month) |
|---|---|---|---|---|
| Jan-19 | PCB3 | 1.9 | 1.0 | 0.9 |
| Feb-19 | PCB3 | 2.8 | 1.2 | 1.6 |
| Mar-19 | PCB3 | 1.2 | 0.5 | 0.7 |
| Apr-19 | PCB3 | 1.0 | 0.3 | 0.7 |
| May-19 | PCB3 | 0.7 | 0.2 | 0.5 |
| Jun-19 | PCB3 | 0.5 | <0.1* | 0.5 |
| Jul-19 | PCB3 | 0.2 | <0.1* | 0.2 |
| Aug-19 | PCB3 | 0.2 | <0.1* | 0.2 |
| Sep-19 | PCB3 | 0.7 | 0.4 | 0.3 |
| Oct-19 | PCB3 | 0.8 | 0.4 | 0.4 |
| Nov-19 | PCB3 | 1.4 | 0.9 | 0.5 |
| Dec-19 | PCB3 | 1.9 | 1.3 | 0.6 |
| ***ANNUAL AVERAGE*** | | *1.1* | *0.5* | *0.6* |

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

**Table 12** *Depositional Dust Data Summary Gauge PCB7 Jan – Dec 2019*

| Month | Gauge No. | Insoluble Solids (g/m².month) | Ash Residue (g/m².month) | Combustible Matter (g/m².month) |
|---|---|---|---|---|
| Jan-19 | PCB7 | 3.4 | 2.0 | 1.4 |
| Feb-19 | PCB7 | 2.8 | 1.7 | 1.1 |
| Mar-19 | PCB7 | 1.4 | 0.9 | 0.5 |
| Apr-19 | PCB7 | 0.9 | 0.5 | 0.4 |
| May-19 | PCB7 | 0.8 | 0.3 | 0.4 |
| Jun-19 | PCB7 | 0.8 | 0.2 | 0.6 |
| Jul-19 | PCB7 | 0.1 | <0.1 | 0.1 |
| Aug-19 | PCB7 | 0.2 | <0.1 | 0.2 |
| Sep-19 | PCB7 | 0.6 | 0.4 | 0.3 |
| Oct-19 | PCB7 | 2.3 | 0.6 | 1.7 |
| Nov-19 | PCB7 | 1.9 | 1.4 | 0.5 |
| Dec-19 | PCB7 | 1.7 | 1.2 | 0.5 |
| ***ANNUAL AVERAGE*** | | *1.4* | *0.8* | *0.6* |

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

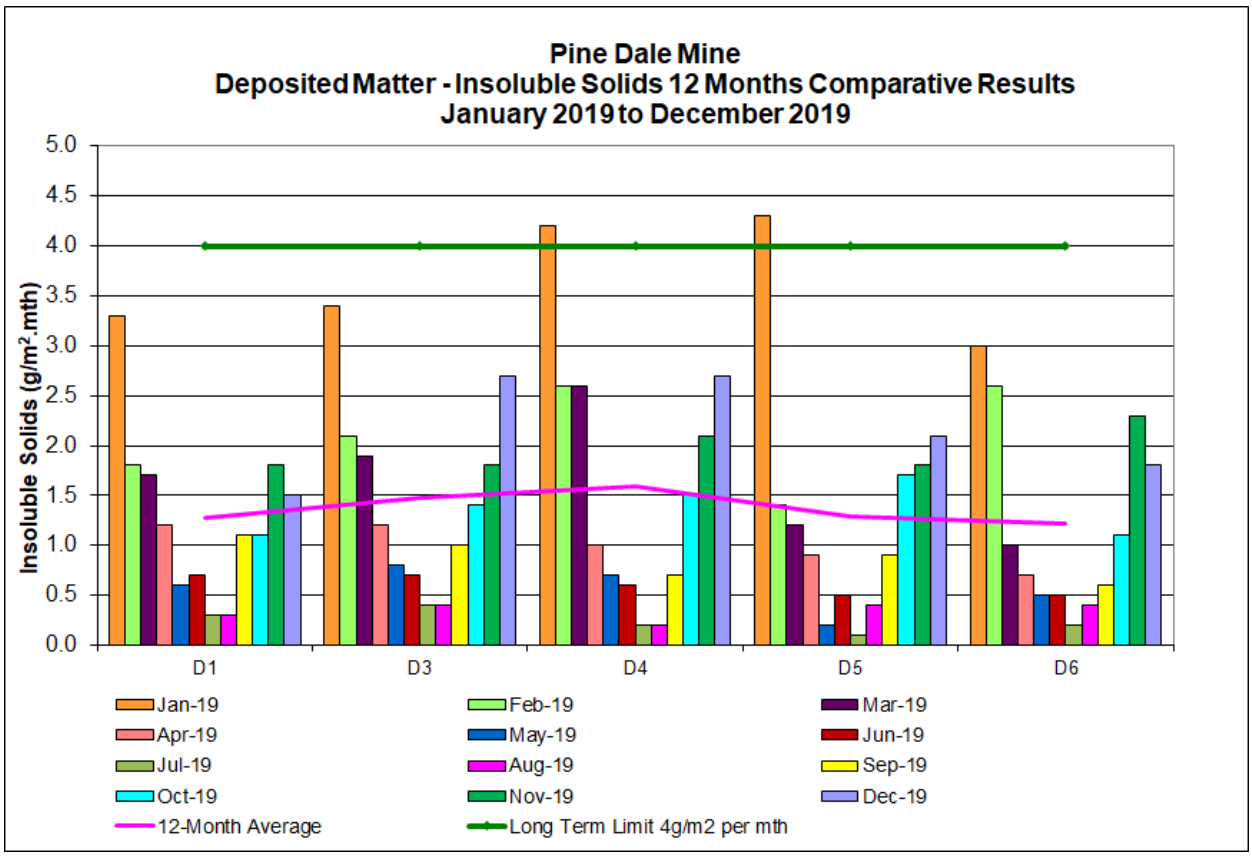


**Figure 1** *Depositional Dust Results - Gauges D1, D3 to D6*

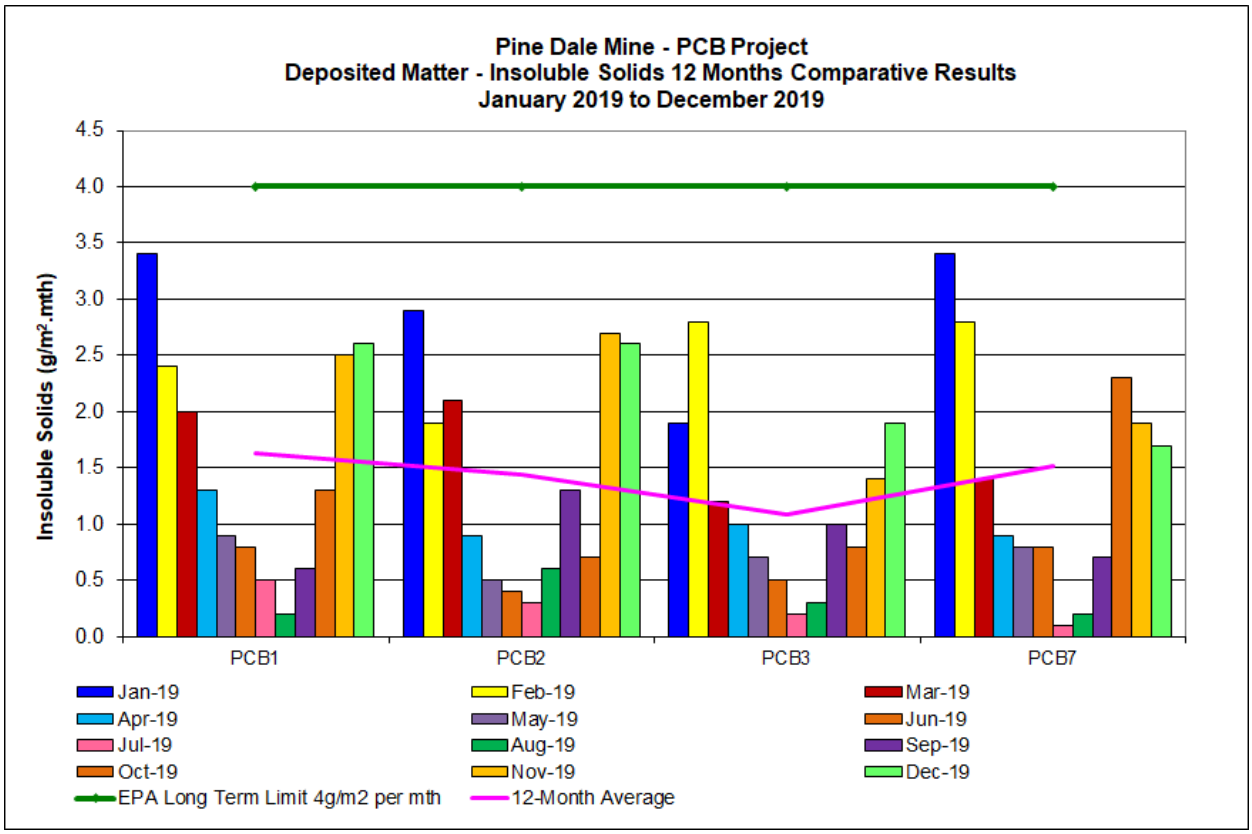


**Figure 2** *Depositional Dust Results – Gauges PCB1 to PCB3 & PCB7*

### 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 PDM, Blackmans Flat (refer Drawing 1, **Appendix 1**).

HVAS Particulate Matter summary results for the period January – December 2019 are shown in **Table 13**. Graphical presentations are shown in **Figure 3**.

During the 2019 monitoring period, intermittent issues associated with the TSP HVAS monitor resulted in the following HVAS run events outside the one-in-six day sampling sequence:

- 16 June 2019: scheduled run date was 7 June 2019;
- 27 July 2019: scheduled run date was 19 July 2019;
- 20 August 2019: scheduled run date was 6 August 2019;
- 26 August 2019: scheduled run date was 18 August 2019;
- 28 August 2019: scheduled run date was 24 August 2019.

During the 2019 monitoring period the power supply to the $PM_{10}$ monitor was interrupted resulting in the follow HVAS rune events undertaken outside the one-in-six day sampling sequence:

- 15 July 2019: Scheduled run date was 7 July 2019;
- 27 July 2019: Scheduled run date was 19 July 2019.

**Table 13** *HVAS Particulate Matter Summary Jan – Dec 2019*

| Run Date | HVAS TSP (µg/m$^3$) | HVAS $PM_{10}$ (µg/m$^3$) | Run Date | HVAS TSP (µg/m$^3$) | HVAS $PM_{10}$ (µg/m$^3$) |
|---|---|---|---|---|---|
| 02-Jan-19 | 38 | 22 | 7-Jul-19 | 6 | 1 |
| 08-Jan-19 | 14 | 6 | 13-Jul-19 | 6 | *0.5* |
| 14-Jan-19 | 33 | 15 | 25-Jul-19 | 7 | *0.5* |
| 20-Jan-19 | 12 | 4 | 27-Jul-19 | 13 | 5 |
| 26-Jan-19 | 51 | 22 | 31-Jul-19 | 5 | 1 |
| 01-Feb-19 | 11 | 2 | 12-Aug-19 | 8 | 4 |
| 07-Feb-19 | 11 | 5 | 20-Aug-19 | 21 | 4 |
| 13-Feb-19 | 200 | 44 | 26-Aug-19 | 14 | 9 |
| 19-Feb-19 | 73 | 32 | 28-Aug-19 | 13 | 13 |
| 25-Feb-19 | 17 | 10 | 30-Aug-19 | 5 | 1 |
| 3-Mar-19 | 13 | 6 | 5-Sep-19 | 20 | 7 |
| 9-Mar-19 | 49 | 20 | 11-Sep-19 | 22 | 7 |
| 15-Mar-19 | 18 | 8 | 17-Sep-19 | 8 | 1 |
| 21-Mar-19 | 19 | 7 | 23-Sep-19 | 28 | 8 |
| 27-Mar-19 | 24 | 9 | 29-Sep-19 | 12 | 7 |
| 02-Apr-19 | 5 | 1 | 5-Oct-19 | 92 | 10 |
| 08-Apr-19 | 60 | 22 | 11-Oct-19 | 9 | 5 |
| 14-Apr-19 | 24 | 14 | 17-Oct-19 | 53 | 16 |
| 20-Apr-19 | 13 | 9 | 23-Oct-19 | 33 | 16 |
| 26-Apr-19 | 73 | 24 | 29-Oct-19 | 44 | 18 |
| 02-May-19 | 17 | 8 | 4-Nov-19 | 18 | 5 |
| 08-May-19 | 20 | 9 | 10-Nov-19 | 29 | 5 |
| 14-May-19 | 13 | 7 | 16-Nov-19 | 46 | 27 |
| 20-May-19 | 16 | 7 | 22-Nov-19 | 235 | 110 |
| 26-May-19 | 14 | 5 | 28-Nov-19 | 175 | 98 |
| 01-Jun-19 | 15 | 9 | 04-Dec-19 | 53 | 20 |
| 13-Jun-19 | 12 | 6 | 10-Dec-19 | 160 | 98 |
| 16-Jun-19 | 6 | 5 | 16-Dec-19 | 310 | 245 |
| 19-Jun-19 | 11 | 4 | 22-Dec-19 | 450 | 355 |
| 25-Jun-19 | 5 | 2 | 28-Dec-19 | 265 | 200 |
| 1-Jul-19 | 7 | 3 | | | |
| | | | ***Annual Average*** | ***50.1*** | ***27.0*** |

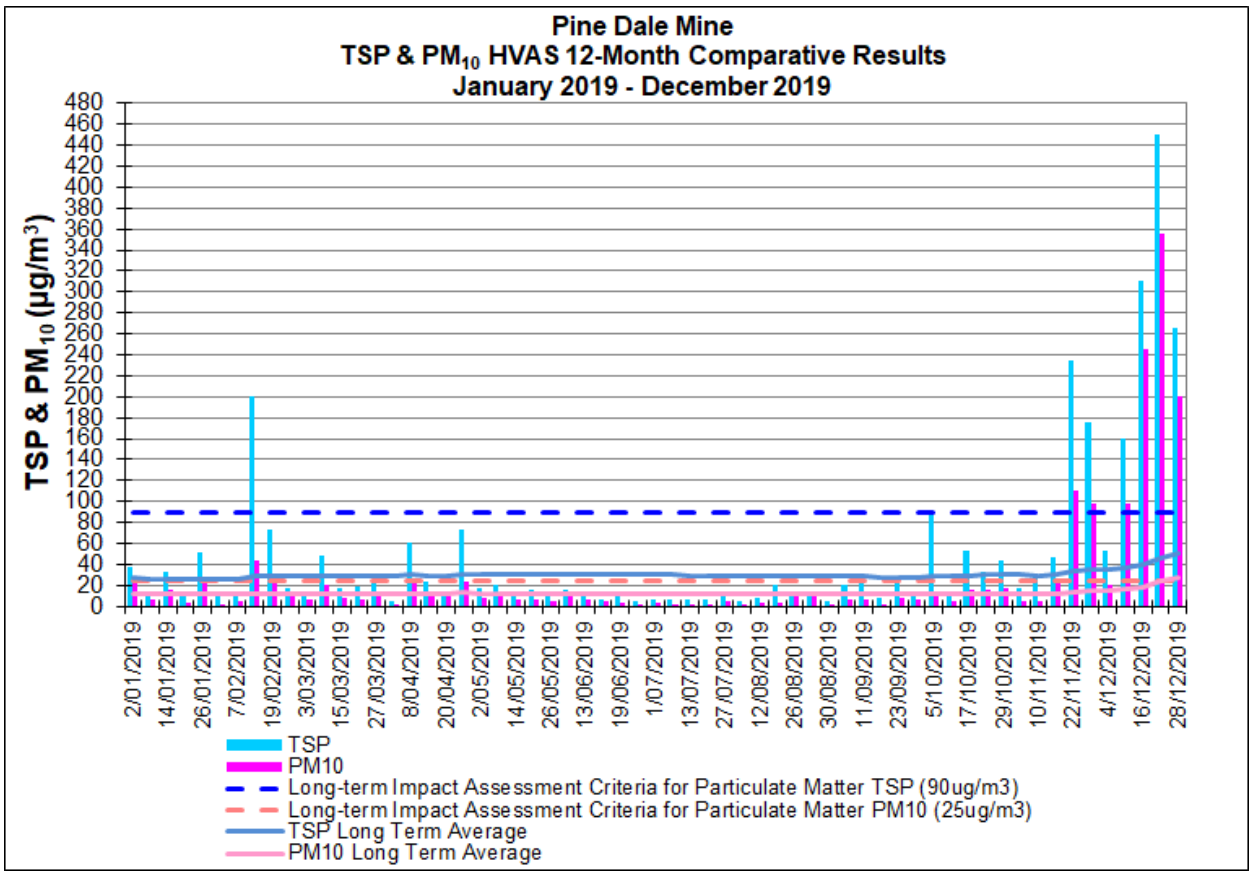


**Figure 3** *HVAS TSP & $PM_{10}$ Particulate Matter Summary Jan- Dec 2019*

## 3.4 REVIEW & INTERPRETATION OF AIR MONITORING RESULTS

### *3.4.1 DEPOSITIONAL DUST RESULTS*

Depositional dust results for the period January – December 2019 show an average insoluble solids range of 1.2g/m$^2$ per month to 1.6g/m$^2$ per month for dust gauges D1, and D3 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 2019 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. Depositional dust results for the period January – December 2019 show an average insoluble solids range of 1.1g/m$^2$ per month to 1.6g/m$^2$ per month for dust gauges within the Purple Copper Butterfly dust gages (PCB1, PCB2, PCB3 and PCB7). A review of historical data captured monitoring period indicates 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**.

### 3.4.2 HVAS PARTICULATE MATTER RESULTS

HVAS TSP results for the period January – December 2019 show an average result of 50.1µg/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]). There were instances where the one-in-six day sampling sequence were not adhered to, as detailed in **Section 3.3**.

The HVAS $PM_{10}$ annual average result is above the long-term assessment criterion of 25µg/m$^3$ (refer **Table 1**). The annual average $PM_{10}$ result was 27.0µg/m$^3$. During November and December 2019, the air quality in the Lithgow area was impacted by bushfires, predominantly the Gospers Mountain fire which occurred within Wollemi National Park, moving through to Ben Bullen State forest and Pine Dale Mine during December 2019. Air quality data from the Department of Planning and Industry Katoomba and Bathurst Air Quality monitoring station supports that air quality in the region was impacted by bushfire activity (refer **Table 14**).

All HVAS results were below the short term 24-hour maximum assessment criterion of 50µg/m$^3$ with the exception of the following HVAS runs:

- 22 November 2019: 110µg/m$^3$;
- 28 November 2019: 98µg/m$^3$;
- 10 December 2019: 98µg/m$^3$;
- 16 December 2019: 245µg/m$^3$;
- 12 December 2019: 355µg/m$^3$; and,
- 28 December 2019: 200µg/m$^3$;

The Department of Planning and Industry (DPIE) monitors air quality throughout NSW, the closet DPIE monitoring stations are located at Bathurst (46km south-west of PDM) and Katoomba (46km south-east of PDM). Twenty-four hour average $PM_{10}$ concentrations taken from the DPIE Bathurst and Katoomba air quality monitoring stations are shown in **Table 14**.

**Table 14** *DPIE Bathurst and Richmond 24-hour average $PM_{10}$ data*

| Run date | Katoomba (µg/m$^3$) | Bathurst $PM_{10}$ (µg/m$^3$) |
|---|---|---|
| 22 November 2019 | 58.2 | 200.0 |
| 28 November 2019 | 42.3 | 40.6 |
| 10 December 2019 | 84.9 | 77.3 |
| 16 December 2019 | 72.3 | 106.2 |
| 22 December 2019 | 34.4 | 355.0 |
| 28 December 2019 | ND | 200.0 |

ND – no data available.

The DPIE air quality data, as well as observations by mining personnel suggests that the elevated TSP and $PM_{10}$ concentrations recorded at PDM are considered to be impacted by bushfire activity in the region. The significantly elevated $PM_{10}$ concentrations due to bushfire activity recorded during November and December 2019 have caused the long-term annual average to exceed the criterion (refer **Table 1**). The $PM_{10}$ annual average for the period December 2018 – November 2019 was 14.7µg/m$^3$, which is well below the annual average criterion.

During the 2019 monitoring period the $PM_{10}$ HVAS recorded 100% data capture. Sampling during 2019 was undertaken in accordance with AS/NZS 3580.9.6 (Ref [10]); There were instances where the one-in-six day sampling sequence were not adhered to, as detailed in **Section 3.3**.

# 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 2019 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 2019*

| Location | Site Bore P6 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Number** | 01196880009 | 02196880011 | 03196880009 | 04196880009 | 05196880011 | 06196880001 | 07196880009 | 08196880011 | 09196880009 | 1019688009 | 11196880011 | 1219688009 | |
| **Sampling Month** | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
| **Date Sampled** | 07/01/19 | 08/02/19 | 12/03/19 | 10/04/19 | 07/05/19 | 05/06/19 | 04/07/19 | 01/08/19 | 03/09/19 | 04/10/19 | 05/11/19 | 06/12/19 | |
| **Time Sampled** | 15:14 | 8:42 | 8:40 | 7:45 | 12:13 | 8:26 | 9:50 | 12:21 | 9:35 | 7:24 | 13:35 | 7:35 | **Trigger Values** |
| **Standing Water Level (m)** | 26.36 | 26.06 | 26.17 | 26.29 | 26.30 | 26.56 | 26.66 | 26.78 | 26.95 | 26.93 | 27.02 | 27.06 | |
| **Standpipe Height (m)** | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | |
| **Relative Water Level (m)** | 25.46 | 25.16 | 25.27 | 25.39 | 25.40 | 25.66 | 25.76 | 25.88 | 26.05 | 26.03 | 26.12 | 26.16 | |
| **Water Level AHD (m)** | 891.49 | 891.79 | 891.68 | 891.56 | 891.55 | 891.29 | 891.19 | 891.07 | 890.90 | 890.92 | 890.83 | 890.79 | **887.90 #** |
| **Temperature (°C)** | 17.3 | 17.8 | 15.9 | 13.1 | 15.7 | 13.5 | 14.5 | 15.9 | 14.5 | 16.0 | 17.1 | 15.2 | |
| **pH** | 5.99 | 6.31 | 6.09 | 6.20 | 6.11 | 5.82 | 6.93 | 6.07 | 5.99 | 6.00 | 6.03 | 6.70 | **6.2 to 8.0** |
| **Conductivity (µS/cm)** | 1790 | 1650 | 1860 | 2240 | 1760 | 1831 | 1840 | 1950 | 1810 | 1960 | 1480 | 1590 | **1180** |
| **Turbidity (NTU)** | 63 | 113 | 97 | 62 | 44 | 87 | 30 | 21 | 47 | 88 | 48 | 78 | |
| **Dissolved Oxygen (mg/L)** | 2.0 | 4.6 | 1.2 | 1.9 | 3.0 | 3.0 | 2.2 | 1.0 | 3.0 | 3.0 | 2.1 | 3.0 | |
| **TSS (mg/L)** | 78 | 60 | 69 | 73 | 59 | 46 | 33 | 29 | 77 | 88 | 67 | 84 | |
| **Oil & Grease (mg/L)** | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | |
| **Bicarbonate Alkalinity (mg/L)** | 60 | 27 | 72 | 68 | 23 | 39 | 58 | 76 | 62 | 47 | 48 | 46 | |
| **Total Alkalinity (mg/L)** | 60 | 27 | 72 | 68 | 23 | 39 | 58 | 76 | 62 | 47 | 48 | 46 | |
| **Sulphate (mg/L)** | 740 | 606 | 913 | 760 | 768 | 864 | 794 | 774 | 910 | 799 | 771 | 830 | |
| **Chloride (mg/L)** | 48 | 47 | 53 | 53 | 74 | 52 | 47 | 51 | 57 | 59 | 57 | 59 | |
| **Calcium (mg/L)** | 158 | 158 | 156 | 155 | 148 | 149 | 159 | 174 | 146 | 160 | 160 | 159 | |
| **Magnesium (mg/L)** | 72 | 72 | 73 | 73 | 74 | 76 | 78 | 76 | 80 | 79 | 77 | 77 | |
| **Sodium (mg/L)** | 71 | 70 | 76 | 78 | 85 | 75 | 81 | 75 | 80 | 86 | 81 | 84 | |
| **Potassium (mg/L)** | 22 | 22 | 19 | 21 | 21 | 20 | 22 | 21 | 21 | 21 | 21 | 22 | |
| **Cobalt (dissolved) (mg/L)** | 0.064 | 0.063 | 0.059 | 0.059 | 0.059 | 0.063 | 0.065 | 0.065 | 0.064 | 0.065 | 0.065 | 0.064 | |
| **Manganese (dissolved) (mg/L)** | 3.03 | 3.01 | 3.18 | 3.21 | 3.14 | 3.31 | 3.24 | 3.17 | 3.1 | 3.06 | 3.52 | 3.58 | |
| **Nickel (dissolved) (mg/L)** | 0.106 | 0.109 | 0.104 | 0.105 | 0.106 | 0.115 | 0.113 | 0.121 | 0.12 | 0.119 | 0.125 | 0.124 | |
| **Zinc (dissolved) (mg/L)** | 0.036 | 0.131 | 0.063 | 0.07 | 0.194 | 0.028 | 0.045 | 0.013 | 0.019 | 0.089 | 0.083 | 0.124 | |
| **Iron (dissolved) (mg/L)** | 40.2 | 33.4 | 40.8 | 41.7 | 21 | 47.4 | 40.2 | 43.4 | 44.8 | 39.6 | 43.8 | 42.6 | |

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 2019*

| Location | Site Bore P7 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Number** | 01196880011 | 02196880012 | 03196880010 | 04196880010 | 05196880012 | 06196880010 | 07196880010 | 08196880012 | 09196880010 | 10196880010 | 11196880012 | 12196880010 | |
| **Sampling Month** | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
| **Date Sampled** | 07/01/19 | 08/02/19 | 12/03/19 | 09/04/19 | 07/05/19 | 06/06/19 | 04/07/19 | 01/08/19 | 03/09/19 | 04/10/19 | 05/11/19 | 06/12/19 | |
| **Time Sampled** | 17:35 | 9:36 | 10:42 | 9:05 | 13:02 | 8:17 | 10:35 | 13:17 | 10:25 | 7:55 | 14:40 | 8:24 | **Trigger Values** |
| **Standing Water Level (m)** | 7.68 | 7.32 | 7.59 | 7.65 | 7.77 | 7.94 | 7.80 | 9.02 | 9.89 | 10.20 | 10.26 | 10.39 | |
| **Standpipe Height (m)** | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | |
| **Relative Water Level (m)** | 6.72 | 6.36 | 6.63 | 6.69 | 6.81 | 6.98 | 6.84 | 8.06 | 8.93 | 9.24 | 9.30 | 9.43 | |
| **Water Level AHD (m)** | 887.68 | 888.04 | 887.77 | 887.71 | 887.59 | 887.42 | 887.56 | 886.34 | 885.47 | 885.16 | 885.10 | 884.97 | **883.28 #** |
| **Temperature (°C)** | 16.7 | 18.2 | 17.0 | 14.7 | 15.5 | 12.4 | 14.5 | 15.4 | 15.0 | 14.9 | 17.8 | 15.4 | |
| **pH (pH units)** | 6.29 | 6.46 | 6.24 | 6.27 | 6.26 | 5.86 | 6.94 | 6.19 | 6.17 | 6.17 | 6.18 | 6.77 | **6.3 to 8.0** |
| **Conductivity (µS/cm)** | 863 | 877 | 830 | 850 | 818 | 815 | 843 | 948 | 775 | 821 | 569 | 663 | **852** |
| **Bicarbonate Alkalinity (mg/L)** | -- | 207 | -- | -- | 184 | -- | -- | 179 | -- | -- | 214 | | |
| **Total Alkalinity (mg/L)** | -- | 207 | -- | -- | 184 | -- | -- | 179 | -- | -- | 214 | | |
| **Sulphate (mg/L)** | -- | 39 | -- | -- | 44 | -- | -- | 42 | -- | -- | 37 | | |
| **Chloride (mg/L)** | -- | 116 | -- | -- | 121 | -- | -- | 126 | -- | -- | 116 | | |
| **Calcium (mg/L)** | -- | 46 | -- | -- | 39 | -- | -- | 45 | -- | -- | 42 | | |
| **Magnesium (mg/L)** | -- | 47 | -- | -- | 44 | -- | -- | 42 | -- | -- | 41 | | |
| **Sodium (mg/L)** | -- | 53 | -- | -- | 48 | -- | -- | 47 | -- | -- | 45 | | |
| **Potassium (mg/L)** | -- | 8 | -- | -- | 7 | -- | -- | 8 | -- | -- | 9 | | |
| **Iron (dissolved) (mg/L)** | -- | 0.96 | -- | -- | 1.68 | -- | -- | <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 2019*

| Location | Site Bore 'Old Shaft' | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Number** | 01196880013 | 02196880015 | 03196880013 | 04196880013 | 05196880015 | 06196880013 | 7196880013 | 08196880015 | 09196880013 | 10196880013 | 11196880015 | 12196880013 | |
| **Sampling Month** | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
| **Date Sampled** | 7/01/19 | 7/02/19 | 11/03/19 | 9/04/19 | 7/05/19 | 6/06/19 | 4/07/19 | 1/08/19 | 3/09/19 | 3/10/19 | 5/11/19 | 6/12/19 | |
| **Time Sampled** | 16:42 | 18:00 | 18:10 | 16:50 | 11:54 | 9:42 | 8:23 | 12:00 | 9:10 | 17:17 | 13:25 | 7:08 | **Trigger Values** |
| **Standing Water Level (m)** | 12.66 | 12.32 | 12.43 | 12.50 | 12.62 | 12.79 | 12.80 | 13.02 | 13.12 | 13.20 | 13.28 | 13.34 | |
| **Standpipe Height (m)** | 1.72 | 1.72 | 1.72 | 1.72 | 1.72 | 1.72 | 1.72 | 1.72 | 1.72 | 1.72 | 1.72 | 1.72 | |
| **Relative Water Level (m)** | 10.94 | 10.60 | 10.71 | 10.78 | 10.90 | 11.07 | 11.08 | 11.30 | 11.40 | 11.48 | 11.56 | 11.62 | |
| **Water Level AHD (m)** | 892.10 | 892.44 | 892.33 | 892.26 | 892.14 | 891.97 | 891.96 | 891.74 | 891.64 | 891.56 | 891.48 | 891.42 | **888.46 #** |
| **Temperature (°C)** | 18.4 | 21.4 | 19.0 | 17.6 | 16.3 | 14.0 | 14.9 | 15.5 | 14.8 | 14.9 | 17.9 | 18.6 | |
| **pH** | 5.77 | 5.84 | 5.67 | 5.76 | 5.94 | 5.60 | 6.88 | 5.78 | 5.63 | 5.71 | 5.77 | 5.86 | **6.3 to 8.0** |
| **Conductivity (µS/cm)** | 1620 | 1590 | 1520 | 1840 | 1540 | 1560 | 1640 | 1740 | 1560 | 1620 | 1270 | 1300 | **908** |
| **Turbidity (NTU)** | 53 | 12 | 182 | 99 | 46 | 64 | 159 | 123 | 141 | 125 | 36 | 31 | |
| **Dissolved Oxygen (mg/L)** | -- | 2.6 | -- | -- | 3 | -- | -- | 3 | -- | -- | 2.7 | -- | |
| **TSS (mg/L)** | -- | 41 | -- | -- | 42 | -- | -- | 193 | -- | -- | 373 | -- | |
| **Oil & Grease (mg/L)** | -- | <5 | -- | -- | <5 | -- | -- | <5 | -- | -- | <5 | -- | |
| **Bicarbonate Alkalinity (mg/L)** | -- | 43 | -- | -- | 36 | -- | -- | 38 | -- | -- | 45 | -- | |
| **Total Alkalinity (mg/L)** | -- | 43 | -- | -- | 36 | -- | -- | 38 | -- | -- | 45 | -- | |
| **Sulphate (mg/L)** | -- | 797 | -- | -- | 753 | -- | -- | 772 | -- | -- | 734 | -- | |
| **Chloride (mg/L)** | -- | 30 | -- | -- | 28 | -- | -- | 27 | -- | -- | 29 | -- | |
| **Calcium (mg/L)** | -- | 172 | -- | -- | 150 | -- | -- | 169 | -- | -- | 158 | -- | |
| **Magnesium (mg/L)** | -- | 76 | -- | -- | 70 | -- | -- | 69 | -- | -- | 70 | -- | |
| **Sodium (mg/L)** | -- | 56 | -- | -- | 48 | -- | -- | 47 | -- | -- | 50 | -- | |
| **Potassium (mg/L)** | -- | 26 | -- | -- | 19 | -- | -- | 20 | -- | -- | 21 | -- | |
| **Cobalt (dissolved) (mg/L)** | -- | 0.114 | -- | -- | 0.135 | -- | -- | 0.13 | -- | -- | 0.12 | -- | |
| **Manganese (dissolved) (mg/L)** | -- | 3.7 | -- | -- | 3.61 | -- | -- | 3.3 | -- | -- | 3.63 | -- | |
| **Nickel (dissolved) (mg/L)** | -- | 0.246 | -- | -- | 0.22 | -- | -- | 0.226 | -- | -- | 0.202 | -- | |
| **Zinc (dissolved) (mg/L)** | -- | 0.401 | -- | -- | 0.356 | -- | -- | 0.35 | -- | -- | 0.332 | -- | |
| **Iron (dissolved) (mg/L)** | -- | 33 | -- | -- | 28.2 | -- | -- | 27.9 | -- | -- | 34.8 | -- | |

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 2019*

| Location | The Bong | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Number** | 01196880001 | 02196880001 | 03196880001 | 04196880001 | 05196880001 | 06196880001 | 07196880001 | 08196880001 | 09196880001 | 10196880001 | 11196880001 | 12196880001 | |
| **Month** | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | **Trigger Values** |
| **Date Sampled** | 7/01/2019 | 8/02/2019 | 11/03/19 | 9/04/2019 | 7/05/2019 | 5/06/2019 | 04/07/19 | 1/08/19 | 3/09/19 | 3/10/19 | 5/11/19 | 6/12/19 | |
| **Time Sampled** | 15:14 | 8:09 | | 17:09 | 9:49 | 16:02 | 6:50 | | | 16:01 | 12:15 | 7:10 | |
| **Temperature (°C)** | 23.6 | 21.1 | | 17.9 | 10.9 | 10.4 | 9.6 | | | 21.1 | 21.7 | 15.3 | |
| **pH** | 5.33 | 5.19 | | 5.63 | 6.58 | 6.16 | 7.11 | | | 5.71 | 6.39 | 5.97 | **5.8 – 8.0** |
| **Conductivity (µS/cm)** | 298 | 279 | | 166 | 225 | 218 | 258 | | | 33 | 359 | 436 | **1157** |
| **Turbidity (NTU)** | 41 | 31 | | 15 | 76 | 21 | 32 | | | 4 | 36 | 21 | |
| **Bicarbonate Alkalinity (mg/L)** | | <1 | | | <1 | | | | | | 5 | | |
| **Total Alkalinity (mg/L)** | | <1 | | | <1 | | | | | | 5 | | |
| **Sulphate (mg/L)** | | 105 | | | 61 | | | | | | 206 | | |
| **Chloride (mg/L)** | | 2 | | | 5 | | | | | | 6.00 | | |
| **Calcium (mg/L)** | | 25 | | | 14 | | | | | | 41 | | |
| **Magnesium (mg/L)** | | 10 | Dry – no sample | | 5 | | | Dry – no sample | Dry – no sample | | 16 | | |
| **Sodium (mg/L)** | | 3 | | | 2 | | | | | | 8 | | |
| **Potassium (mg/L)** | | 4 | | | 6 | | | | | | 15 | | |
| **Arsenic (dissolved) (mg/L)** | | <0.001 | | | <0.001 | | | | | | <0.001 | | |
| **Cadmium (dissolved) (mg/L)** | | 0.0003 | | | 0.0001 | | | | | | <0.0001 | | |
| **Chromium (dissolved) (mg/L)** | | <0.001 | | | <0.001 | | | | | | <0.001 | | |
| **Copper (dissolved) (mg/L)** | | <0.001 | | | <0.001 | | | | | | <0.001 | | |
| **Lead (dissolved) (mg/L)** | | <0.001 | | | <0.001 | | | | | | <0.001 | | |
| **Nickel (dissolved) (mg/L)** | | 0.04 | | | 0.022 | | | | | | 0.026 | | |
| **Zinc (dissolved) (mg/L)** | | 0.055 | | | 0.047 | | | | | | 0.022 | | |
| **Iron (dissolved) (mg/L)** | | <0.05 | | | <0.05 | | | | | | 0.11 | | |

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 2019*

| Location | Off-Site Bore A (EP DDH7/GW) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Number** | 01196880016 | 02196880018 | 03196880016 | 04196880016 | 05196880018 | 06196880016 | 07196880016 | 08196880016 | 09196880016 | 10196880016 | 111196880018 | 12196880016 | |
| **Sampling Month** | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
| **Date Sampled** | 7/01/2019 | 7/02/2019 | 11/03/2019 | 9/04/2019 | 6/05/2019 | 5/06/2019 | 3/07/2019 | 1/08/2019 | 3/09/2019 | 4/10/2019 | 4/11/2019 | 5/12/2019 | **Trigger Values** |
| **Standing Water Level (m)** | 69.18 | 69.13 | 69.05 | 69.08 | 69.10 | 69.20 | 69.19 | 69.20 | 69.26 | 69.27 | 69.31 | 69.34 | |
| **Standpipe Height (m)** | 0.77 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | |
| **Relative Water Level (m)** | 68.41 | 68.38 | 68.30 | 68.33 | 68.35 | 68.45 | 68.44 | 68.45 | 68.51 | 68.52 | 68.56 | 68.59 | |
| **Water level AHD (m)#** | 955.39 | 955.42 | 955.50 | 955.47 | 955.45 | 955.35 | 955.36 | 955.35 | 955.29 | 955.28 | 955.25 | 955.21 | **954.40** |
| **pH** | -- | -- | 6.65 | -- | -- | 6.64 | -- | -- | 6.58 | -- | -- | 6.92 | **6.5 to 8.0** |
| **Conductivity (µS/cm)** | -- | -- | 245 | -- | -- | 312 | -- | -- | 294 | -- | -- | 240 | **326** |
| **Temperature (°C)** | -- | -- | 20.5 | -- | -- | 14.0 | -- | -- | 15.9 | -- | -- | 20.3 | |
| **TDS (mg/L)** | -- | -- | 133 | -- | -- | 125 | -- | -- | 94 | -- | -- | NS | |
| **Bicarbonate Alkalinity (mg/L)** | -- | -- | 117 | -- | -- | 118 | -- | -- | 105 | -- | -- | 106 | |
| **Total Alkalinity (mg/L $CaCO_3$)** | -- | -- | 117 | -- | -- | 118 | -- | -- | 105 | -- | -- | 106 | |
| **Sulphate (mg/L)** | -- | -- | 5 | -- | -- | 2 | -- | -- | 2 | -- | -- | 3 | |
| **Chloride (mg/L)** | -- | -- | 8 | -- | -- | 8 | -- | -- | 7 | -- | -- | 8 | |
| **Calcium (mg/L)** | -- | -- | 18 | -- | -- | 18 | -- | -- | 20 | -- | -- | 18 | |
| **Magnesium (mg/L)** | -- | -- | 6 | -- | -- | 7 | -- | -- | 8 | -- | -- | 7 | |
| **Sodium (mg/L)** | -- | -- | 6 | -- | -- | 6 | -- | -- | 6 | -- | -- | 5 | |
| **Potassium (mg/L)** | -- | -- | 12 | -- | -- | 14 | -- | -- | 14 | -- | -- | 14 | |
| **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)** | -- | -- | 0.01 | -- | -- | 0.025 | -- | -- | 0.018 | -- | -- | 0.023 | |
| **Iron (dissolved) (mg/L)** | -- | -- | 4.1 | -- | -- | 4.99 | -- | -- | 3.59 | -- | -- | 3.34 | |

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.

NS no sample analysis due to laboratory error.

**Table 21** *Groundwater Monitoring Bore C (EP PDH1/GW) Results January - December 2019*

| Location | Off-Site Bore C (EP PDH1/GW) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Number** | 01196880018 | 02196880020 | 03196880018 | 04196880018 | 05196880020 | 06196880018 | 07196880018 | 08196880018 | 09196880018 | 10196880018 | 11196880020 | 12196880018 | **Trigger Values** |
| **Sampling Month** | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
| **Date Sampled** | 7/01/19 | 8/02/19 | 11/03/19 | 9/04/19 | 7/05/19 | 5/06/19 | 4/07/19 | 1/08/19 | 3/09/19 | 3/10/19 | 4/11/19 | 5/12/19 | |
| **Standing Water Level (m)** | 75.64 | 75.30 | 75.39 | 75.50 | 75.60 | 75.60 | 75.85 | 76.00 | 76.09 | 76.19 | 76.20 | 76.27 | |
| **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)** | 74.90 | 74.56 | 74.65 | 74.76 | 74.86 | 74.86 | 75.11 | 75.26 | 75.35 | 75.45 | 75.46 | 75.53 | |
| **Water level AHD (m)#** | 892.60 | 892.94 | 892.85 | 892.74 | 892.64 | 892.64 | 892.39 | 892.24 | 892.15 | 892.05 | 892.04 | 891.97 | **889.25** |
| **pH** | -- | -- | 6.43 | -- | -- | 6.67 | -- | -- | 6.63 | -- | -- | 7.01 | **6.9 to 8.0** |
| **Conductivity (µS/cm)** | -- | -- | 268 | -- | -- | 317 | -- | -- | 321 | -- | -- | 275 | **490** |
| **Temperature (°C)** | -- | -- | 21.4 | -- | -- | 15.1 | -- | -- | 16.7 | -- | -- | 22.0 | |
| **TDS (mg/L)** | -- | -- | 192 | -- | -- | 156 | -- | -- | 159 | -- | -- | NS | |
| **Bicarbonate Alkalinity (mg/L)** | -- | -- | 146 | -- | -- | 145 | -- | -- | 127 | -- | -- | 137 | |
| **Total Alkalinity (mg/L $CaCO_3$)** | -- | -- | 146 | -- | -- | 145 | -- | -- | 127 | -- | -- | 137 | |
| **Sulphate (mg/L)** | -- | -- | 5 | -- | -- | 5 | -- | -- | 8 | -- | -- | 7 | |
| **Chloride (mg/L)** | -- | -- | 6 | -- | -- | 7 | -- | -- | 7 | -- | -- | 8 | |
| **Calcium (mg/L)** | -- | -- | 31 | -- | -- | 30 | -- | -- | 35 | -- | -- | 33 | |
| **Magnesium (mg/L)** | -- | -- | 10 | -- | -- | 11 | -- | -- | 12 | -- | -- | 12 | |
| **Sodium (mg/L)** | -- | -- | 6 | -- | -- | 6 | -- | -- | 6 | -- | -- | 6 | |
| **Potassium (mg/L)** | -- | -- | 10 | -- | -- | 10 | -- | -- | 11 | -- | -- | 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)** | -- | -- | 0.016 | -- | -- | 0.014 | -- | -- | 0.026 | -- | -- | 0.021 | |
| **Iron (dissolved) (mg/L)** | -- | -- | <0.05 | -- | -- | <0.05 | -- | -- | <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.

NS no sample analysis due to laboratory error.

**Table 22** *Groundwater Monitoring Bore D (EP DDH4/GW) Results January - December 2019*

| Location | Off-Site Bore D (EP DDH4/GW) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Number** | 01196880019 | 02196880021 | 03196880019 | 04196880019 | 05196880021 | 06196880019 | 07196880019 | 08196880019 | 09196880019 | 10196880019 | 11196880021 | 12196880019 | |
| **Sampling Month** | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
| **Date Sampled** | 7/01/19 | 8/02/19 | 11/03/19 | 9/04/19 | 7/05/19 | 5/06/19 | 4/07/19 | 1/08/19 | 3/09/19 | 4/10/19 | 4/11/19 | 5/12/19 | **Trigger Values** |
| **Standing Water Level (m)** | 37.92 | 38.38 | 37.76 | 38.10 | 38.02 | 37.88 | 38.04 | 38.05 | 38.00 | 38.02 | 37.96 | 38.92 | |
| **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)** | 37.21 | 37.67 | 37.05 | 37.39 | 37.31 | 37.17 | 37.33 | 37.34 | 37.29 | 37.31 | 37.25 | 38.21 | |
| **Water level AHD (m)#** | 941.29 | 940.83 | 941.45 | 941.11 | 941.19 | 941.33 | 941.17 | 941.16 | 941.21 | 941.19 | 941.25 | 940.29 | **940.61** |
| **pH** | -- | -- | 6.73 | -- | -- | 6.90 | -- | -- | Dry – no sample. | -- | -- | Dry – no sample. | **6.8 to 8.0** |
| **Conductivity (µS/cm)** | -- | -- | 336 | -- | -- | 343 | -- | -- | | -- | -- | | **608** |
| **Temperature (°C)** | -- | -- | 21.3 | -- | -- | 13.8 | -- | -- | | -- | -- | | |
| **TDS (mg/L)** | -- | -- | 285 | -- | -- | Insufficient sample for chemical analysis. | -- | -- | | -- | -- | | |
| **Bicarbonate Alkalinity (mg/L)** | -- | -- | 150 | -- | -- | | -- | -- | | -- | -- | | |
| **Total Alkalinity (mg/L)** | -- | -- | 150 | -- | -- | | -- | -- | | -- | -- | | |
| **Sulphate (mg/L)** | -- | -- | 21 | -- | -- | | -- | -- | | -- | -- | | |
| **Chloride (mg/L)** | -- | -- | 14 | -- | -- | | -- | -- | | -- | -- | | |
| **Calcium (mg/L)** | -- | -- | 5 | -- | -- | | -- | -- | | -- | -- | | |
| **Magnesium (mg/L)** | -- | -- | 2 | -- | -- | | -- | -- | | -- | -- | | |
| **Sodium (mg/L)** | -- | -- | 74 | -- | -- | | -- | -- | | -- | -- | | |
| **Potassium (mg/L)** | -- | -- | 6 | -- | -- | | -- | -- | | -- | -- | | |
| **Arsenic (dissolved) (mg/L)** | -- | -- | <0.001 | -- | -- | | -- | -- | | -- | -- | | |
| **Cadmium (dissolved) (mg/L)** | -- | -- | <0.0001 | -- | -- | | -- | -- | | -- | -- | | |
| **Chromium (dissolved) (mg/L)** | -- | -- | <0.001 | -- | -- | | -- | -- | | -- | -- | | |
| **Copper (dissolved) (mg/L)** | -- | -- | 0.004 | -- | -- | | -- | -- | | -- | -- | | |
| **Lead (dissolved) (mg/L)** | -- | -- | <0.001 | -- | -- | | -- | -- | | -- | -- | | |
| **Nickel (dissolved) (mg/L)** | -- | -- | 0.003 | -- | -- | | -- | -- | | -- | -- | | |
| **Zinc (dissolved) (mg/L)** | -- | -- | 0.02 | -- | -- | | -- | -- | | -- | -- | | |
| **Iron (dissolved) (mg/L)** | -- | -- | 0.08 | -- | -- | | -- | -- | | -- | -- | | |

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 2019*

| Location | Off-Site Bore E (EP PDH7/GW) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Number** | 01196880020 | 02196880022 | 03196880020 | 0419688020 | 05196880022 | 06196880020 | 07196880020 | 0819688020 | 09196880020 | 10196880020 | 1119688022 | 12196880020 | |
| **Sampling Month** | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
| **Date Sampled** | 8/01/2019 | 7/02/2019 | 11/03/2019 | 9/04/2019 | 7/05/2019 | 5/06/2019 | 3/07/2019 | 1/08/2019 | 3/09/2019 | 3/10/2019 | 4/11/2019 | 5/12/2019 | **Trigger Values** |
| **Standing Water Level (m)** | 15.14 | 14.97 | 15.06 | 16.00 | 15.52 | 14.91 | 15.21 | 15.85 | 15.85 | 15.87 | 15.85 | 15.83 | |
| **Standpipe Height (m)** | 0.73 | 0.73 | 0.73 | 0.73 | 0.73 | 0.21 | 0.16 | 0.73 | 0.73 | 0.73 | 0.73 | 0.73 | |
| **Relative Water Level (m)** | 14.41 | 14.24 | 14.33 | 15.27 | 14.79 | 14.70 | 15.05 | 15.12 | 15.12 | 15.14 | 15.12 | 15.10 | |
| **Water level AHD (m)#** | 940.49 | 940.66 | 940.57 | 939.63 | 940.11 | 940.20 | 939.85 | 939.78 | 939.78 | 939.76 | 939.78 | 939.80 | **938.43** |
| **pH** | -- | -- | 5.09 | -- | -- | 5.35 | -- | -- | 5.35 | | | 5.81 | **5.5 to 8.0** |
| **Conductivity (µS/cm)** | -- | -- | 101 | -- | -- | 117 | -- | -- | 95 | -- | | 111 | **151** |
| **Temperature (°C)** | -- | -- | 17.1 | -- | -- | 13.9 | -- | -- | 16.2 | -- | | 16.7 | |
| **TDS (mg/L)** | -- | -- | 122 | -- | -- | 103 | -- | -- | 30 | -- | | NS | |
| **Bicarbonate Alkalinity (mg/L)** | -- | -- | 22 | -- | -- | 13 | -- | -- | 24 | -- | | 22 | |
| **Total Alkalinity (mg/L)** | -- | -- | 22 | -- | -- | 13 | -- | -- | 24 | -- | | 22 | |
| **Sulphate (mg/L)** | -- | -- | 6 | -- | -- | 2 | -- | -- | 7 | -- | | 9 | |
| **Chloride (mg/L)** | -- | -- | 10 | -- | -- | 10 | -- | -- | 9 | -- | | 12 | |
| **Calcium (mg/L)** | -- | -- | 1 | -- | -- | 1 | -- | -- | 2 | -- | | 2 | |
| **Magnesium (mg/L)** | -- | -- | 2 | -- | -- | 2 | -- | -- | 3 | -- | | 2 | |
| **Sodium (mg/L)** | -- | -- | 7 | -- | -- | 6 | -- | -- | 7 | -- | | 8 | |
| **Potassium (mg/L)** | -- | -- | 5 | -- | -- | 4 | -- | -- | 5 | -- | | 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)** | -- | -- | <0.001 | -- | -- | <0.001 | -- | -- | 0.002 | -- | | 0.002 | |
| **Zinc (dissolved) (mg/L)** | -- | -- | 0.012 | -- | -- | 0.024 | -- | -- | 0.028 | -- | | 0.034 | |
| **Iron (dissolved) (mg/L)** | -- | -- | 1.21 | -- | -- | 10.2 | -- | -- | 1.98 | -- | | 2.14 | |

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.

NS no sample analysis due to laboratory error.

**Table 24** *Groundwater Monitoring Bore - EP PDH3/GW Results January - December 2019*

| Location | Enhance Place Bore EP PDH3/GW | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Number** | 01196880011 | 02196880013 | 03196880011 | 04196880011 | 05196880011 | 06196880011 | 07196880011 | 08196880013 | 09196880011 | 10196880011 | 11196880011 | 12196880009 | |
| **Sampling Month** | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
| **Date Sampled** | 8/01/2019 | 7/02/2019 | 11/03/2019 | 9/04/2019 | 7/05/2019 | 6/06/2019 | 3/07/2019 | 1/08/2019 | 2/09/2019 | 4/10/2019 | 5/11/2019 | 5/12/2019 | **Trigger Value** |
| **Standing Water Level (m)** | 23.8 | 23.8 | 23.79 | 23.81 | 23.81 | 24.78 | NR | 23.91 | 23.88 | 23.91 | 23.97 | 24.00 | |
| **Standpipe Height** | 0.77 | 0.77 | 0.77 | 0.77 | 0.77 | 0.77 | NR | 0.77 | 0.77 | 0.77 | 0.77 | 0.77 | |
| **Relative Water Level (m)** | 23.03 | 23.03 | 23.02 | 23.04 | 23.04 | 24.01 | NR | 23.14 | 23.11 | 23.14 | 23.20 | 23.23 | |
| **Water Level AHD (m)#** | 892.97 | 892.97 | 892.98 | 892.96 | 892.96 | 891.99 | NR | 892.86 | 892.89 | 892.86 | 892.80 | 892.77 | **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.
NR no reading taken due to safety issues associated with livestock.

**Table 25** *Groundwater Monitoring Bore - EP PDH4/GW Results January – December 2019*

| Location | Enhance Place Bore EP PDH4/GW | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Number** | 01196880012 | 02196880014 | 03166880012 | 04136880012 | 05196880012 | 06196880012 | 07196880012 | 08196880014 | 09196880012 | 10196880012 | 11196880011 | 12196880012 | |
| **Sampling Month** | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
| **Date Sampled** | 08/01/2019 | 7/02/2019 | 11/03/2019 | 9/04/2019 | 07/05/2019 | 6/06/2019 | 03/07/2019 | 1/08/2019 | 02/09/2019 | 4/10/2019 | 5/11/2019 | 5/12/2019 | **Trigger Value** |
| **Standing Water Level (m)** | 23.28 | 23.28 | 23.31 | 23.30 | 23.30 | 23.30 | 23.80 | 23.37 | 23.43 | 23.43 | 24.07 | 23.52 | |
| **Standpipe Height** | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | |
| **Relative Water Level (m)** | 23.12 | 23.12 | 23.15 | 23.14 | 23.14 | 23.14 | 23.64 | 23.21 | 23.27 | 23.27 | 23.91 | 23.36 | |
| **Water Level AHD (m)#** | 892.96 | 892.96 | 892.93 | 892.94 | 892.94 | 892.94 | 892.44 | 892.87 | 892.81 | 892.81 | 892.17 | 892.72 | **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.

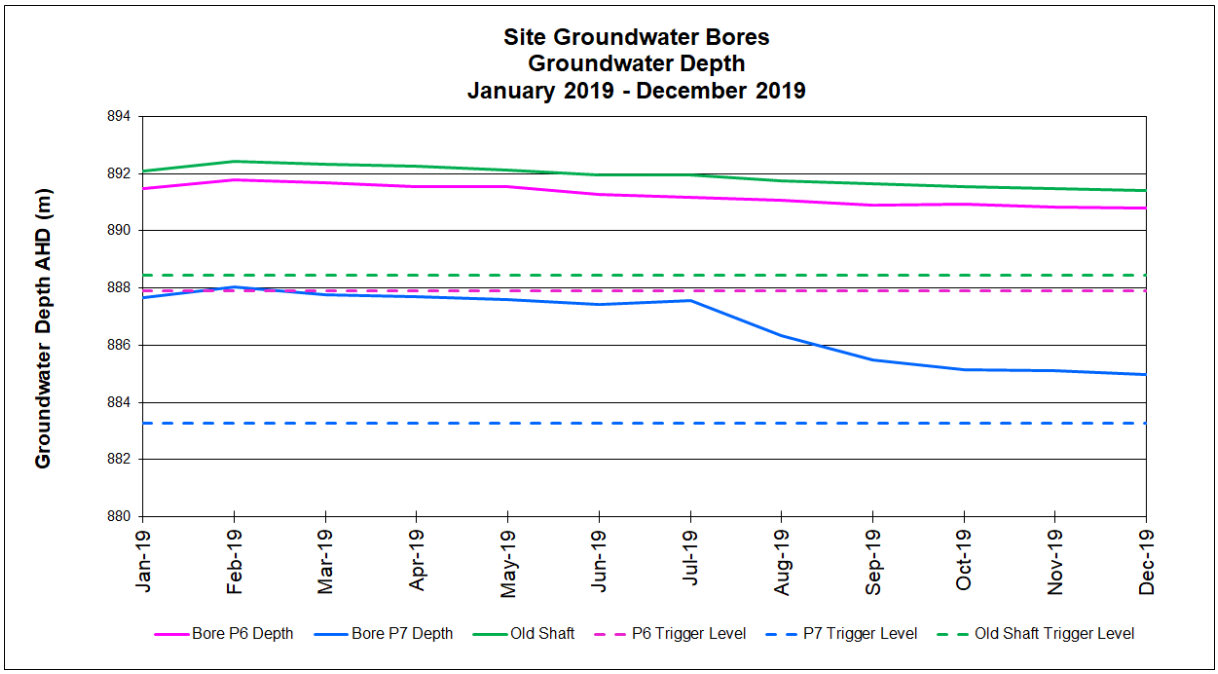


**Figure 4** *Onsite Groundwater Standing Water Level 2019*

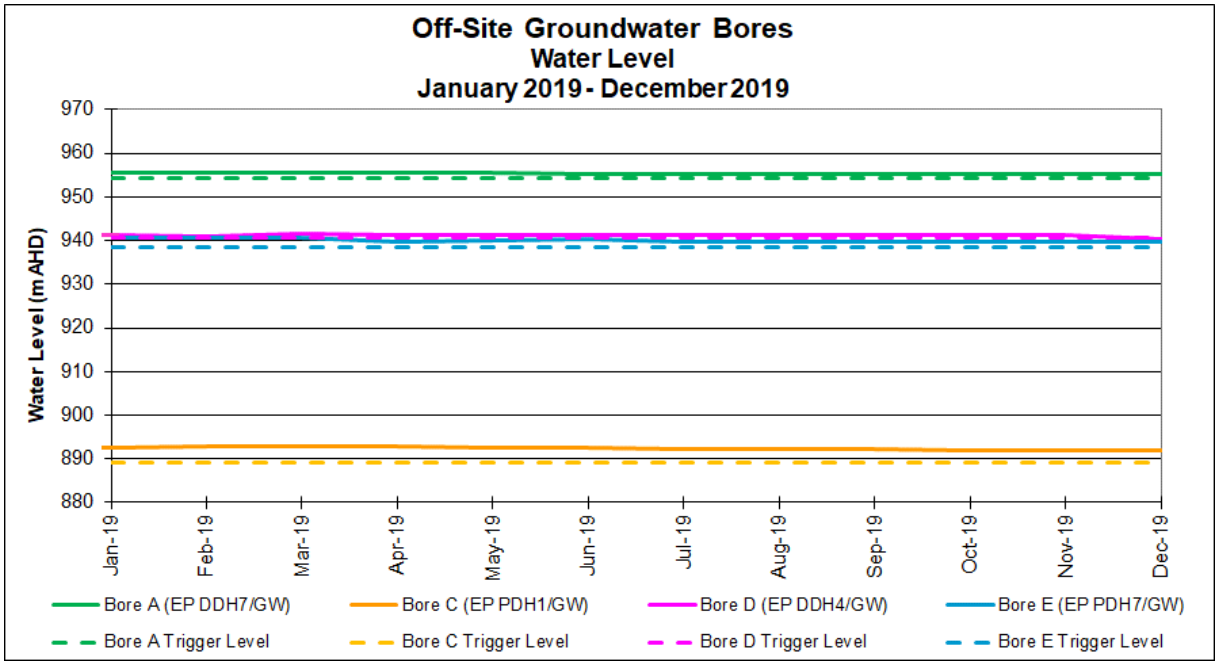


**Figure 5** *Off-Site Groundwater Standing Water Level 2019*

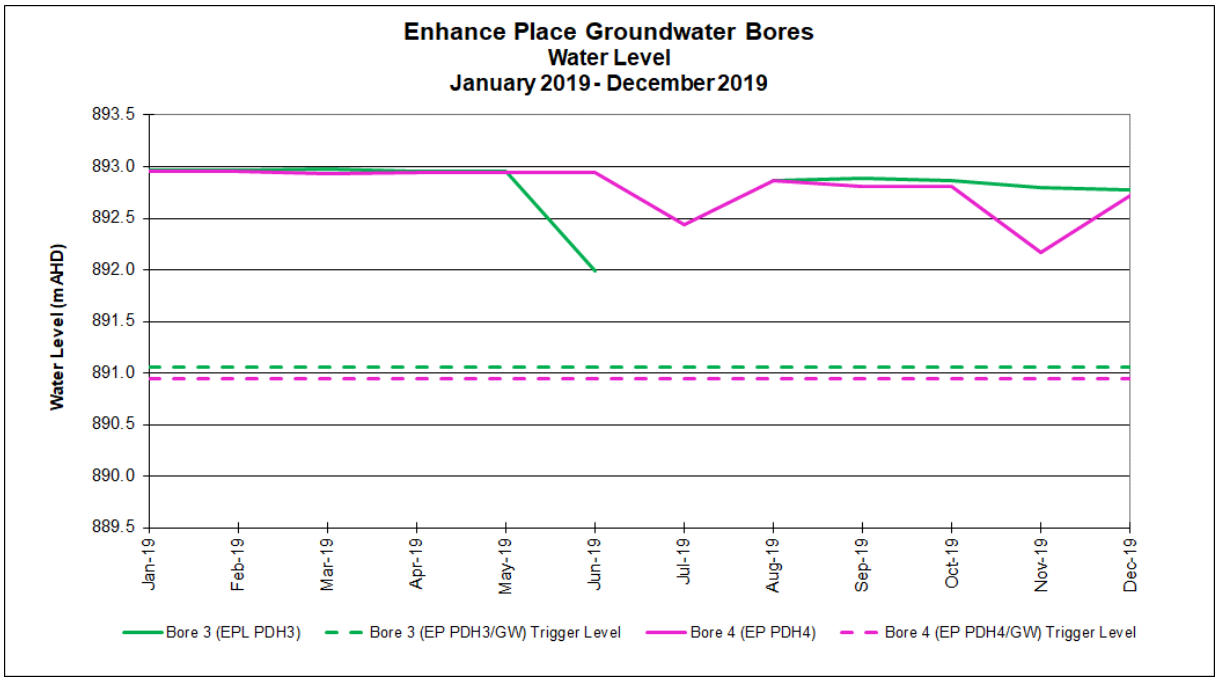


**Figure 6** *Enhance Place Groundwater Standing Water Level 2019*

## 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 2019 period generally show water quality results which are consistent throughout the monitoring period. There were no instances during the 2019 monitoring period where the standing water level dropped below their respective water level triggers. A decreasing trend in standing water level was observed at P6, P7 and Old Shaft during 2019. Bore P7 shows a marked decreased trend during the period July – December 2019.

The pH within the on-site bores were generally shown to be below the site specific lower pH trigger values. The pH was below the site specific lower pH trigger value during eight (8) of the twelve (12) monitoring events at groundwater bore P6; five (5) of the twelve monitoring events at bore P7; eleven (11) of the twelve (12) monitoring events at Old Shaft and five (5) of the nine (9) monitoring events undertaken at The Bong. During 2019, 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 March, August and September 2019 monitoring events as the sampling location was dry.

The electrical conductivity at the site bores have also intermittently exceeded their respective conductivity trigger values throughout the January – December 2019 monitoring period with the exception of the Bong which was compliant throughout the year. Bore P6 exceeded the conductivity trigger value during twelve (12) of the twelve (12) monitoring events; a maximum concentration of 2240µS/cm was recorded in April 2019. Bore P7 exceeded its site-specific trigger value during three (3) of the twelve (12) monitoring events, with the greatest concentration (948µS/cm) observed in August 2019. The Old Shaft exceeded the trigger

value during all instances of monitoring; the maximum concentration was 1840µS/cm during April 2019.

#### *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 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 one (1) occasion (March 2019). During June 2019, sufficient sample was retrieved to undertake a pH and electrical conductivity measurement only. 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 three (3) 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 where pH was analysed.
- Bore E was below the lower pH trigger value during three (3) of the four (4) water quality monitoring events.

- The standing water level within Bore D dropped below the water level trigger level during June 2019.

Electrical conductivity levels were below the respective conductivity trigger levels for all off-site bores during the 2019 monitoring period.

All off-site bores exhibited standing water levels which were consistent throughout the 2019 monitoring period and compliant with their respective trigger levels with the exception of Bore D during the December 2019 monitoring event.

#### *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 2019, the standing water level was generally shown to be slightly decreasing at both bore 3 (EP PDH3/GW) and bore 4 (EP PDH4/GW). 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 surface water bodies and 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 2019, 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 2019 monitoring period.

Surface water summary results for the period January – December 2019 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 2019*

| Location | EPL Point 2 | | | | |
|---|---|---|---|---|---|
| **Sample No** | 02196880009 | 05196880009 | 08196880009 | 11196880009 | **Trigger Values** |
| **Sampling Month** | Feb | May | Aug | Nov | |
| **Date Sampled** | 8/02/2019 | 7/05/2019 | 1/08/2019 | 5/11/2019 | |
| **Time Sampled** | 08:18 | 10:15 | 10:35 | 12:10 | |
| **pH (pH units)** | 7.14 | 7.60 | 7.15 | 6.47 | **7.1 – 8.0** |
| **Conductivity (µS/cm)** | 588 | 809 | 1830 | 3520 | **2055** |
| **Sulphate (mg/L)** | 147 | 196 | 599 | 1520 | |
| **Iron filterable (mg/L)** | 0.07 | <0.05 | <0.05 | 0.21 | |
| **TSS (mg/L)** | <5 | <5 | <5 | 10 | **30** |
| **Turbidity (NTU)** | 3 | <1 | <1 | 5 | |

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

**Table 28** *Surface Water Monitoring Location EPL Point 3 Results 2019*

| Location | EPL Point 3 | | | | |
|---|---|---|---|---|---|
| **Sample No** | 2196880004 | 05196880004 | 08196880004 | 11196880004 | **Trigger Values** |
| **Sampling Month** | Feb | May | Aug | Nov | |
| **Date Sampled** | 8/02/2019 | 7/05/2019 | 1/08/2019 | 5/11/2019 | |
| **Time Sampled** | 09:57 | 10:25 | 13:36 | 15:10 | |
| **pH (pH units)** | 7.38 | 7.63 | 7.41 | 7.57 | **6.4 – 8.0** |
| **Conductivity (µS/cm)** | 1150 | 3900 | 1940 | 2410 | **2223** |
| **Sulphate (mg/L)** | 326 | 1510 | 715 | 997 | |
| **Iron filterable (mg/L)** | 0.56 | 0.13 | 0.58 | 0.09 | |
| **TSS (mg/L)** | 6 | <5 | 7 | 12 | **30** |
| **Turbidity (NTU)** | 2 | <1 | <1 | 1 | |

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

**Table 29** *Surface Water Monitoring Location EPL Point 14 Results 2019*

| Location | EPL Point 14 | | | | |
|---|---|---|---|---|---|
| **Sample No** | 02196880010 | 05196880010 | 08196880010 | 11196880010 | **Trigger Values** |
| **Sampling Month** | Feb | May | Aug | Nov | |
| **Date Sampled** | 8/02/2019 | 7/05/2019 | 1/08/2019 | 5/11/2019 | |
| **Time Sampled** | 06:40 | 09:20 | 09:50 | 08:20 | |
| **pH (pH units)** | 8.17 | 8.64 | 7.44 | 7.72 | **7.5 – 8.0** |
| **Conductivity (µS/cm)** | 1210 | 1310 | 807 | 1530 | **1166** |
| **Sulphate (mg/L)** | 92 | 78 | 147 | 578 | |
| **Iron filterable (mg/L)** | 0.21 | <0.05 | 0.07 | <0.05 | |
| **TSS (mg/L)** | 12 | 6 | <5 | <5 | **30** |
| **Turbidity (NTU)** | 47 | 17 | <1 | 8 | |

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

**Table 30** *Surface Water Monitoring Location S1 Results 2019*

| Location | Surface Water S1 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Month** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** | **Trigger Values** |
| **Sample Number** | 01196880002 | 02196880002 | 03196880002 | 04196880002 | 05196880002 | 06196880002 | 07196880002 | 08196880002 | 09196880002 | 10196880004 | 11196880002 | 12196880002 | |
| **Date Sampled** | 7/01/19 | 8/02/19 | 12/03/19 | 9/04/19 | 7/05/19 | 5/06/19 | 4/07/19 | 1/08/19 | 3/09/19 | 3/10/19 | 5/11/19 | 6/12/19 | |
| **Time Sampled** | 15:21 | 8:30 | 8:24 | 17:21 | 10:02 | 8:05 | 8:47 | 10:18 | 9:23 | 16:06 | 11:55 | 7:25 | |
| **Temperature (°C)** | 20.5 | 20.0 | 15.7 | 15.3 | 13.5 | 7.4 | 7.8 | 6.4 | 8.9 | 16.5 | 14.1 | 14.9 | |
| **pH** | 6.85 | 7.39 | 7.44 | 7.35 | 7.45 | 6.29 | 6.98 | 7.33 | 7.11 | 6.88 | 7.41 | 7.66 | **6.2 – 8.0** |
| **Conductivity (µS/cm)** | 339 | 1370 | 3110 | 1580 | 4000 | 841 | 1440 | 2430 | 1970 | 219 | 3950 | 4990 | **2325** |
| **Turbidity (NTU)** | 8 | <1 | 24 | 1 | 25 | 14 | <1 | <1 | 5 | 3 | <1 | 2 | |
| **Dissolved Oxygen (mg/L)** | -- | 6.9 | -- | -- | 6.0 | -- | -- | 7.0 | -- | -- | 7.1 | -- | |
| **TSS (mg/L)** | -- | <5 | -- | -- | <5 | -- | -- | 8 | -- | -- | 24 | -- | **30** |
| **Oil & Grease (mg/L)** | -- | <5 | -- | -- | <5 | -- | -- | <5 | -- | -- | <5 | -- | **10** |
| **Bicarbonate Alkalinity (mg/L)** | -- | 100 | -- | -- | 81 | -- | -- | 70 | -- | -- | 79 | -- | |
| **Total Alkalinity (mg/L)** | -- | 100 | -- | -- | 81 | -- | -- | 70 | -- | -- | 79 | -- | |
| **Sulphate (mg/L)** | -- | 417 | -- | -- | 1610 | -- | -- | 842 | -- | -- | 2070 | -- | |
| **Chloride (mg/L)** | -- | 70 | -- | -- | 345 | -- | -- | 167 | -- | -- | 363 | -- | |
| **Calcium (mg/L)** | -- | 68 | -- | -- | 172 | -- | -- | 118 | -- | -- | 192 | -- | |
| **Magnesium (mg/L)** | -- | 42 | -- | -- | 142 | -- | -- | 83 | -- | -- | 153 | -- | |
| **Sodium (mg/L)** | -- | 126 | -- | -- | 537 | -- | -- | 224 | -- | -- | 508 | -- | |
| **Potassium (mg/L)** | -- | 12 | -- | -- | 47 | -- | -- | 15 | -- | -- | 34 | -- | |
| **Cobalt (dissolved) (mg/L)** | -- | 0.002 | -- | -- | 0.022 | -- | -- | 0.004 | -- | -- | 0.005 | -- | |
| **Manganese(dissolved) (mg/L)** | -- | 0.638 | -- | -- | 1.42 | -- | -- | 0.727 | -- | -- | 0.954 | -- | |
| **Nickel (dissolved) (mg/L)** | -- | 0.04 | -- | -- | 0.212 | -- | -- | 0.078 | -- | -- | 0.151 | -- | |
| **Zinc (dissolved) (mg/L)** | -- | 0.012 | -- | -- | 0.057 | -- | -- | 0.018 | -- | -- | 0.023 | -- | |
| **Iron (dissolved) (mg/L)** | -- | 0.10 | -- | -- | 0.06 | -- | -- | 0.21 | -- | -- | 0.26 | -- | |

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 2019*

| Location | Surface Water Site S2 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Month** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| **Sample Number** | 01196880003 | 02196880003 | 03196880004 | 04196880003 | 05196880003 | 06196880003 | 07196880003 | 08196880003 | 0919688003 | 1019688003 | 11196880003 | 12196880003 |
| **Date Sampled** | 7/01/19 | 7/02/19 | 11/03/19 | 9/04/19 | 7/05/19 | 5/06/19 | 4/07/19 | 1/08/19 | 3/09/19 | 3/10/19 | 5/11/19 | 6/12/19 |
| **Time Sampled** | 15:03 | 17:23 | 18:30 | 17:27 | 10:18 | 16:00 | 9:05 | 10:12 | 7:40 | 15:57 | 11:30 | 6:59 |
| **Depth to Surface from Top of Rail Bridge (m)** | 3.78 | 3.76 | 3.77 | 3.77 | 3.72 | 3.75 | 3.76 | 3.77 | 3.77 | 3.57 | 3.74 | 3.77 |

**Table 32** *Surface Water Monitoring Location S3 Results 2019*

| Location | Surface Water S3 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Month** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** | **Trigger Values** |
| **Sample Number** | 01196880004 | 02196880004 | 03196880004 | 04196880004 | 05196880004 | 06196880004 | 07196880004 | 08196880004 | 09196880004 | 10196880004 | 11196880004 | 12196880004 | |
| **Date Sampled** | **7/01/19** | **8/02/19** | **12/03/19** | **9/04/19** | **7/05/19** | **6/06/19** | **4/07/19** | **1/08/19** | **3/09/19** | **3/10/19** | **5/11/19** | **6/12/19** | |
| **Time Sampled** | 14:58 | 9:57 | 10:58 | 17:30 | 10:25 | 9:50 | 9:07 | 13:37 | 10:40 | 15:53 | 15:10 | 8:39 | |
| **Temperature (°C)** | 22.2 | 20.9 | 19.2 | 16.6 | 13.3 | 7.3 | 8.2 | 12.4 | 11.6 | 20.9 | 20.3 | 14.7 | |
| **pH** | 7.00 | 7.38 | 7.08 | 7.31 | 7.63 | 7.01 | 6.98 | 7.41 | 7.36 | 7.44 | 7.57 | 7.69 | **6.4 – 8.0** |
| **Conductivity (µS/cm)** | 193 | 1150 | 1290 | 1010 | 3900 | 811 | 1260 | 1940 | 1580 | 162 | 2410 | 2660 | **2223** |
| **Turbidity (NTU)** | 5 | 2 | 4 | 4 | <1 | 32 | <1 | <1 | 7 | 4 | 1 | 5 | |
| **Dissolved Oxygen (mg/L)** | -- | 7.7 | -- | -- | 7.0 | -- | -- | 7.0 | -- | -- | 7.1 | -- | |
| **TSS (mg/L)** | -- | 6 | -- | -- | <5 | -- | -- | 9 | -- | -- | 12 | -- | **30** |
| **Oil & Grease (mg/L)** | -- | <5 | -- | -- | <5 | -- | -- | <5 | -- | -- | <5 | -- | **10** |
| **Bicarbonate Alkalinity (mg/L)** | -- | 70 | -- | -- | 80 | -- | -- | 55 | -- | -- | 59 | -- | |
| **Total Alkalinity (mg/L)** | -- | 70 | -- | -- | 80 | -- | -- | 55 | -- | -- | 59 | -- | |
| **Sulphate (mg/L)** | -- | 326 | -- | -- | 1510 | -- | -- | 715 | -- | -- | 997 | -- | |
| **Chloride (mg/L)** | -- | 58 | -- | -- | 277 | -- | -- | 135 | -- | -- | 210 | -- | |
| **Calcium (mg/L)** | -- | 62 | -- | -- | 164 | -- | -- | 96 | -- | -- | 125 | -- | |
| **Magnesium (mg/L)** | -- | 36 | -- | -- | 134 | -- | -- | 68 | -- | -- | 96 | -- | |
| **Sodium (mg/L)** | -- | 100 | -- | -- | 504 | -- | -- | 184 | -- | -- | 334 | -- | |
| **Potassium (mg/L)** | -- | 10 | -- | -- | 44 | -- | -- | 13 | -- | -- | 25 | -- | |
| **Cobalt (dissolved) (mg/L)** | -- | 0.013 | -- | -- | 0.021 | -- | -- | 0.008 | -- | -- | 0.011 | -- | |
| **Manganese(dissolved) (mg/L)** | -- | 1.66 | -- | -- | 1.44 | -- | -- | 1.04 | -- | -- | 1.49 | -- | |
| **Nickel (dissolved) (mg/L)** | -- | 0.049 | -- | -- | 0.198 | -- | -- | 0.073 | -- | -- | 0.116 | -- | |
| **Zinc (dissolved) (mg/L)** | -- | 0.04 | -- | -- | 0.053 | -- | -- | 0.028 | -- | -- | 0.03 | -- | |
| **Iron (dissolved) (mg/L)** | -- | 0.56 | -- | -- | 0.13 | -- | -- | 0.58 | -- | -- | 0.09 | -- | |

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 2019*

| Location | Surface Water S4 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Month** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** | **Trigger Values** |
| **Sample Number** | 1196880005 | 02196880005 | 03196880005 | 04196880005 | 05196880005 | 06196880005 | 07196880005 | 08196880005 | 09196880005 | 10196880005 | 11196880005 | 12196880005 | |
| **Date Sampled** | 7/01/19 | **8/02/19** | 12/03/19 | 10/04/19 | **7/05/19** | 6/06/19 | **4/07/19** | **1/08/19** | 3/09/19 | **4/10/19** | **5/11/19** | 6/12/19 | |
| **Time Sampled** | 17:37 | 9:35 | 10:40 | 8:50 | 12:55 | 8:46 | 10:35 | 13:12 | 10:20 | 7:48 | 14:30 | 8:14 | |
| **Temperature (°C)** | 20.2 | 20.0 | 17.5 | 10.3 | 10.8 | 6.0 | 9.2 | 10.3 | 8.4 | 12.0 | 17.5 | 14.6 | |
| **pH** | 7.51 | 7.69 | 7.68 | 8.13 | 7.67 | 7.28 | 7.10 | 7.78 | 7.90 | 7.53 | 8.06 | 7.90 | **7.3 – 8.0** |
| **Conductivity (µS/cm)** | 328 | 346 | 316 | 320 | 298 | 329 | 298 | 324 | 321 | 340 | 278 | 317 | **957** |
| **Turbidity (NTU)** | 16 | 6 | 27 | 3 | <1 | 55 | <1 | <1 | 8 | 16 | 5 | 19 | |
| **Dissolved Oxygen (mg/L)** | -- | 5.9 | -- | -- | 7.0 | -- | -- | <5 | -- | -- | 6.6 | -- | |
| **TSS (mg/L)** | -- | <5 | -- | -- | <5 | -- | -- | 9 | -- | -- | <5 | -- | **30** |
| **Oil & Grease (mg/L)** | -- | <5 | -- | -- | <5 | -- | -- | <5 | -- | -- | <5 | -- | **10** |
| **Bicarbonate Alkalinity (mg/L)** | -- | 156 | -- | -- | 133 | -- | -- | 135 | -- | -- | 187 | -- | |
| **Total Alkalinity (mg/L)** | -- | 156 | -- | -- | 133 | -- | -- | 135 | -- | -- | 187 | -- | |
| **Sulphate (mg/L)** | -- | 2 | -- | -- | 9 | -- | -- | 7 | -- | -- | 3 | -- | |
| **Chloride (mg/L)** | -- | 2 | -- | -- | 6 | -- | -- | 5 | -- | -- | 4 | -- | |
| **Calcium (mg/L)** | -- | 10 | -- | -- | 7 | -- | -- | 7 | -- | -- | 9 | -- | |
| **Magnesium (mg/L)** | -- | 4 | -- | -- | 4 | -- | -- | 4 | -- | -- | 4 | -- | |
| **Sodium (mg/L)** | -- | 50 | -- | -- | 56 | -- | -- | 53 | -- | -- | 61 | -- | |
| **Potassium (mg/L)** | -- | 7 | -- | -- | 8 | -- | -- | 8 | -- | -- | 9 | -- | |
| **Cobalt (dissolved) (mg/L)** | -- | <0.001 | -- | -- | <0.001 | -- | -- | <0.001 | -- | -- | <0.001 | -- | |
| **Manganese(dissolved) (mg/L)** | -- | 0.037 | -- | -- | 0.008 | -- | -- | 0.004 | -- | -- | 0.02 | -- | |
| **Nickel (dissolved) (mg/L)** | -- | <0.001 | -- | -- | <0.001 | -- | -- | <0.001 | -- | -- | 0.001 | -- | |
| **Zinc (dissolved) (mg/L)** | -- | 0.005 | -- | -- | <0.005 | -- | -- | <0.005 | -- | -- | 0.005 | -- | |
| **Iron (dissolved) (mg/L)** | -- | 0.76 | -- | -- | 0.16 | -- | -- | 0.07 | -- | -- | 0.56 | -- | |

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 2019*

| Location | Surface Water S5 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Month** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** | **Trigger Values** |
| **Sample Number** | 01196880006 | 02196880006 | 03196880006 | 04196880006 | 05196880006 | 06196880006 | 07196880006 | 08196880006 | 09196880006 | 10196880006 | 11196880006 | 12196880006 | |
| **Date Sampled** | 7/01/19 | **8/02/19** | 12/03/19 | 10/04/19 | 7/05/19 | 6/06/19 | **4/07/19** | 1/08/19 | 3/09/19 | 4/10/19 | 5/11/19 | 6/12/19 | |
| **Time Sampled** | 17:32 | 9:37 | 10:44 | 8:55 | 12:58 | 8:50 | 10:33 | 13:16 | 10:15 | 7:52 | 14:35 | 8:16 | |
| **Temperature (°C)** | 20.8 | 23.0 | 20.2 | 14.2 | 12.9 | 8.4 | 10.6 | 11.9 | 13.2 | 14.3 | 19.8 | 17.8 | |
| **pH** | 7.25 | 7.60 | 7.34 | 7.52 | 7.22 | 6.37 | 6.99 | 7.29 | 7.43 | 7.10 | 7.56 | 7.30 | **7.0 – 8.0** |
| **Conductivity (µS/cm)** | 1330 | 1040 | 1090 | 987 | 800 | 1310 | 727 | 733 | 612 | 1650 | 1280 | 1790 | **1013** |
| **Turbidity (NTU)** | 10 | 7 | 4 | 4 | <1 | 48 | 17 | <1 | 10 | 70 | 4 | 13 | |
| **Dissolved Oxygen (mg/L)** | -- | 4.2 | -- | -- | 6.0 | -- | -- | 6.0 | -- | -- | 6.2 | -- | |
| **TSS (mg/L)** | -- | <5 | -- | -- | <5 | -- | -- | 8 | -- | -- | <5 | -- | **30** |
| **Oil & Grease (mg/L)** | -- | <5 | -- | -- | <5 | -- | -- | <5 | -- | -- | <5 | -- | **10** |
| **Bicarbonate Alkalinity (mg/L)** | -- | 123 | -- | -- | 113 | -- | -- | 116 | -- | -- | 148 | -- | |
| **Total Alkalinity (mg/L)** | -- | 123 | -- | -- | 113 | -- | -- | 116 | -- | -- | 148 | -- | |
| **Sulphate (mg/L)** | -- | 257 | -- | -- | 214 | -- | -- | 182 | -- | -- | 500 | -- | |
| **Chloride (mg/L)** | -- | 45 | -- | -- | 47 | -- | -- | 27 | -- | -- | 72 | -- | |
| **Calcium (mg/L)** | -- | 46 | -- | -- | 35 | -- | -- | 33 | -- | -- | 61 | -- | |
| **Magnesium (mg/L)** | -- | 27 | -- | -- | 25 | -- | -- | 20 | -- | -- | 44 | -- | |
| **Sodium (mg/L)** | -- | 108 | -- | -- | 88 | -- | -- | 82 | -- | -- | 178 | -- | |
| **Potassium (mg/L)** | -- | 14 | -- | -- | 12 | -- | -- | 11 | -- | -- | 18 | -- | |
| **Cobalt (dissolved) (mg/L)** | -- | 0.005 | -- | -- | 0.011 | -- | -- | 0.01 | -- | -- | 0.008 | -- | |
| **Manganese(dissolved) (mg/L)** | -- | 0.634 | -- | -- | 0.644 | -- | -- | 0.573 | -- | -- | 0.679 | -- | |
| **Nickel (dissolved) (mg/L)** | -- | 0.041 | -- | -- | 0.038 | -- | -- | 0.036 | -- | -- | 0.066 | -- | |
| **Zinc (dissolved) (mg/L)** | -- | 0.017 | -- | -- | 0.031 | -- | -- | 0.029 | -- | -- | 0.038 | -- | |
| **Iron (dissolved) (mg/L)** | -- | 0.6 | -- | -- | 0.17 | -- | -- | 0.11 | -- | -- | 0.2 | -- | |

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 2019*

| Location | Surface Water S6 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Month** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** | **Trigger Values** |
| **Sample Number** | 01196880007 | 02196880007 | 03196880007 | 04196880007 | 05196880007 | 06196880007 | 07196880007 | 08196880007 | 09196880007 | 10196880007 | 11196880007 | 12196880007 | |
| **Date Sampled** | 7/01/19 | 8/02/19 | 12/03/19 | 10/04/19 | 7/05/19 | 6/06/19 | 4/07/19 | 1/08/19 | 3/09/19 | 4/10/19 | 5/11/19 | 6/12/19 | |
| **Time Sampled** | 17:28 | 9:25 | 10:33 | 8:45 | 12:52 | 8:51 | 10:29 | 13:06 | 10:15 | 7:45 | 14:20 | 8:10 | |
| **Temperature (°C)** | 21.5 | 21.4 | 19.7 | 11.9 | 13.0 | 5.7 | 8.9 | 12.2 | 12.6 | 13.8 | 26.5 | 15.3 | |
| **pH** | 7.60 | 7.77 | 7.49 | 7.88 | 7.78 | 7.36 | 6.97 | 7.74 | 7.76 | 7.54 | 8.59 | 7.98 | **6.7 – 8.0** |
| **Conductivity (µS/cm)** | 5900 | 1280 | 4590 | 1300 | 3820 | 842 | 1240 | 4830 | 1740 | 2880 | 5140 | 4970 | **1941** |
| **Turbidity (NTU)** | 14 | 5 | 7 | 1 | <1 | 16 | <1 | <1 | 6 | 9 | 12 | 3 | |
| **Dissolved Oxygen (mg/L)** | -- | 6.0 | -- | -- | 7.0 | -- | -- | 11.0 | -- | -- | 8.6 | -- | |
| **TSS (mg/L)** | -- | <5 | -- | -- | <5 | -- | -- | 8 | -- | -- | 11 | -- | **30** |
| **Oil & Grease (mg/L)** | -- | <5 | -- | -- | <5 | -- | -- | <5 | -- | -- | <5 | -- | **10** |
| **Bicarbonate Alkalinity (mg/L)** | -- | 76 | -- | -- | 75 | -- | -- | 96 | -- | -- | 80 | -- | |
| **Total Alkalinity (mg/L)** | -- | 76 | -- | -- | 75 | -- | -- | 96 | -- | -- | 80 | -- | |
| **Sulphate (mg/L)** | -- | 353 | -- | -- | 1300 | -- | -- | 2060 | -- | -- | 2650 | -- | |
| **Chloride (mg/L)** | -- | 64 | -- | -- | 264 | -- | -- | 343 | -- | -- | 439 | -- | |
| **Calcium (mg/L)** | -- | 64 | -- | -- | 164 | -- | -- | 224 | -- | -- | 239 | -- | |
| **Magnesium (mg/L)** | -- | 44 | -- | -- | 132 | -- | -- | 163 | -- | -- | 188 | -- | |
| **Sodium (mg/L)** | -- | 130 | -- | -- | 489 | -- | -- | 605 | -- | -- | 785 | -- | |
| **Potassium (mg/L)** | -- | 12 | -- | -- | 42 | -- | -- | 51 | -- | -- | 64 | -- | |
| **Cobalt (dissolved) (mg/L)** | -- | 0.001 | -- | -- | 0.009 | -- | -- | 0.023 | -- | -- | 0.003 | -- | |
| **Manganese(dissolved) (mg/L)** | -- | 0.274 | -- | -- | 0.878 | -- | -- | 1.69 | -- | -- | 0.189 | -- | |
| **Nickel (dissolved) (mg/L)** | -- | 0.04 | -- | -- | 0.172 | -- | -- | 0.253 | -- | -- | 0.244 | -- | |
| **Zinc (dissolved) (mg/L)** | -- | 0.012 | -- | -- | 0.024 | -- | -- | 0.04 | -- | -- | <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 2019*

| Location | Surface Water S7 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Month** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** | **Trigger Values** |
| **Sample Number** | 01196880008 | 02196880008 | 03196880008 | 04196880008 | 05196880008 | 06196880008 | 07196880008 | 08196880008 | 09196880008 | 10196880008 | 11196880008 | 12196880008 | |
| **Date Sampled** | 7/01/19 | 8/02/19 | 12/03/19 | 10/04/19 | 7/05/19 | 6/06/19 | 4/07/19 | 1/08/19 | 3/09/19 | 4/10/19 | 5/11/19 | 6/12/19 | |
| **Time Sampled** | 17:18 | 9:12 | 10:25 | 8:30 | 12:40 | 8:42 | 10:20 | 12:54 | 10:00 | 7:37 | 14:08 | 8:02 | |
| **Temperature (°C)** | 22.7 | 22.8 | 19.7 | 13.9 | 12.9 | 7.9 | 9.4 | 11.2 | 11.6 | 13.9 | 19.1 | 17.6 | |
| **pH** | 7.06 | 7.32 | 7.29 | 7.36 | 7.16 | 6.60 | 7.08 | 7.34 | 7.44 | 6.96 | 7.49 | 7.70 | **6.8 – 8.0** |
| **Conductivity (µS/cm)** | 1520 | 1010 | 1360 | 1020 | 798 | 1390 | 801 | 725 | 678 | 1920 | 1450 | 1830 | **1007** |
| **Turbidity (NTU)** | 15 | 8 | 8 | 5 | <1 | 39 | <1 | <1 | 11 | 11 | 3 | 5 | |
| **Dissolved Oxygen (mg/L)** | -- | 4.0 | -- | -- | 7.0 | -- | -- | 9.0 | -- | -- | 5.7 | -- | **10** |
| **TSS (mg/L)** | -- | <5 | -- | -- | <5 | -- | -- | <5 | -- | -- | <5 | -- | **30** |
| **Oil & Grease (mg/L)** | -- | <5 | -- | -- | <5 | -- | -- | <5 | -- | -- | <5 | -- | |
| **Bicarbonate Alkalinity (mg/L)** | -- | 120 | -- | -- | 114 | -- | -- | 116 | -- | -- | 142 | -- | |
| **Total Alkalinity (mg/L)** | -- | 120 | -- | -- | 114 | -- | -- | 116 | -- | -- | 142 | -- | |
| **Sulphate (mg/L)** | -- | 251 | -- | -- | 220 | -- | -- | 159 | -- | -- | 584 | -- | |
| **Chloride (mg/L)** | -- | 42 | -- | -- | 42 | -- | -- | 26 | -- | -- | 82 | -- | |
| **Calcium (mg/L)** | -- | 44 | -- | -- | 37 | -- | -- | 33 | -- | -- | 74 | -- | |
| **Magnesium (mg/L)** | -- | 28 | -- | -- | 26 | -- | -- | 20 | -- | -- | 53 | -- | |
| **Sodium (mg/L)** | -- | 108 | -- | -- | 90 | -- | -- | 81 | -- | -- | 201 | -- | |
| **Potassium (mg/L)** | -- | 13 | -- | -- | 12 | -- | -- | 11 | -- | -- | 20 | -- | |
| **Cobalt (dissolved) (mg/L)** | -- | 0.003 | -- | -- | 0.003 | -- | -- | 0.003 | -- | -- | 0.002 | -- | |
| **Manganese(dissolved) (mg/L)** | -- | 0.544 | -- | -- | 0.313 | -- | -- | 0.314 | -- | -- | 0.622 | -- | |
| **Nickel (dissolved) (mg/L)** | -- | 0.037 | -- | -- | 0.032 | -- | -- | 0.028 | -- | -- | 0.06 | -- | |
| **Zinc (dissolved) (mg/L)** | -- | 0.013 | -- | -- | 0.018 | -- | -- | 0.02 | -- | -- | 0.299 | -- | |
| **Iron (dissolved) (mg/L)** | -- | 0.52 | -- | -- | 0.2 | -- | -- | 0.14 | -- | -- | 0.08 | -- | |

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

--- Indicates no sampling required during particular period.

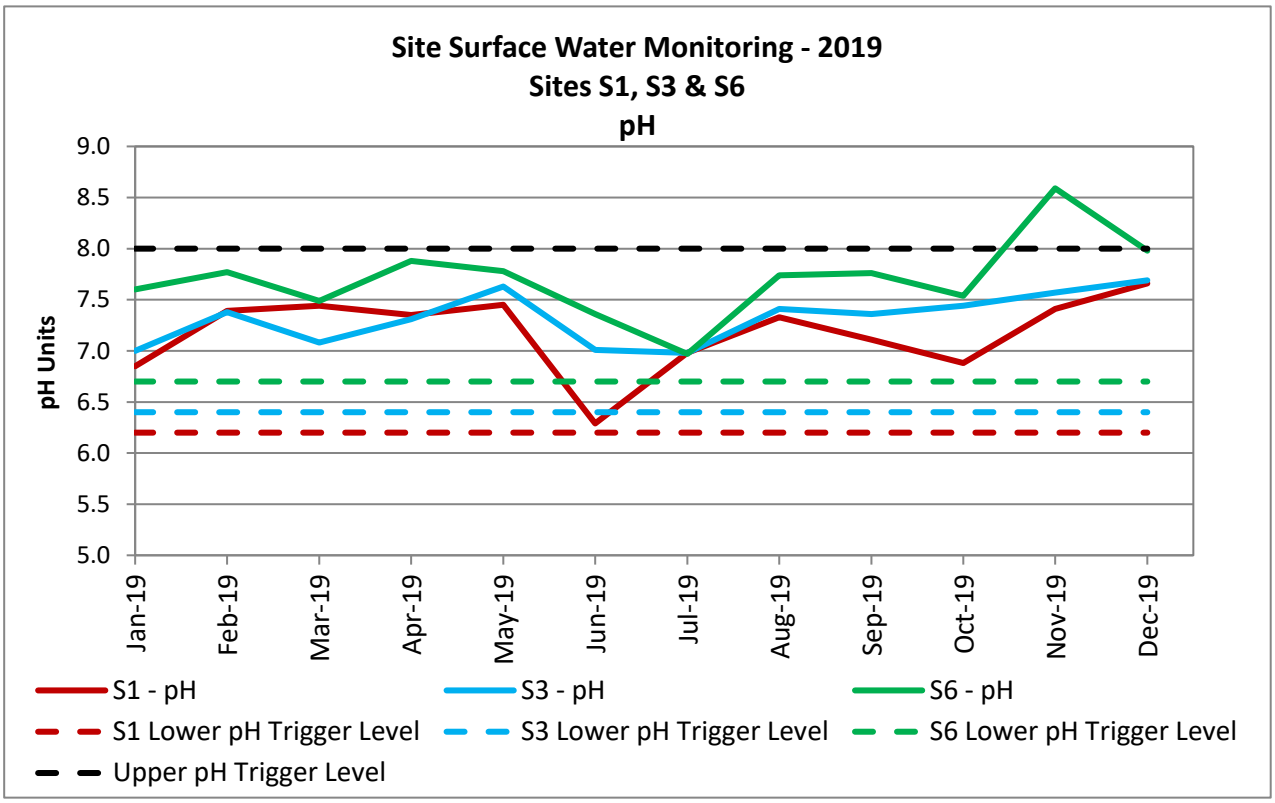


**Figure 7** *Site Surface Water S1, S3 & S6 pH Results 2019*

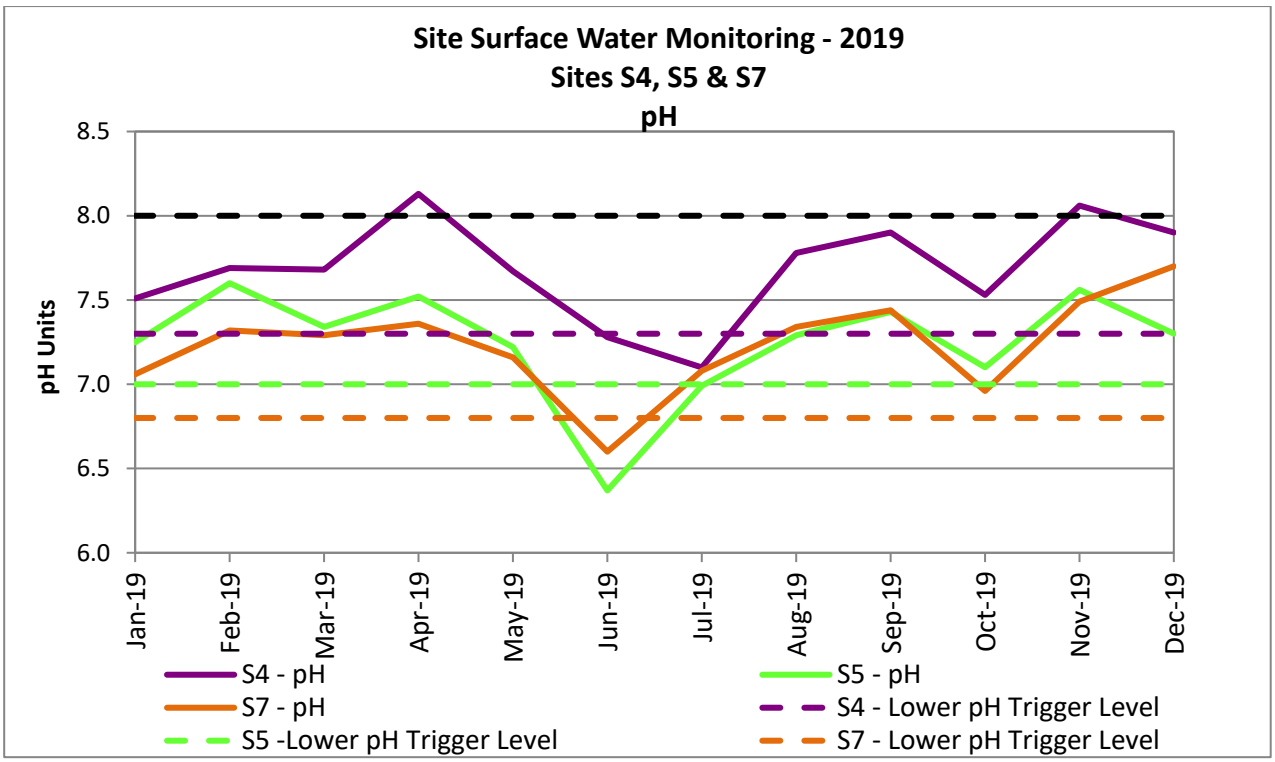


**Figure 8** *Site Surface Water S4, S5 & S7 pH Results 2019*

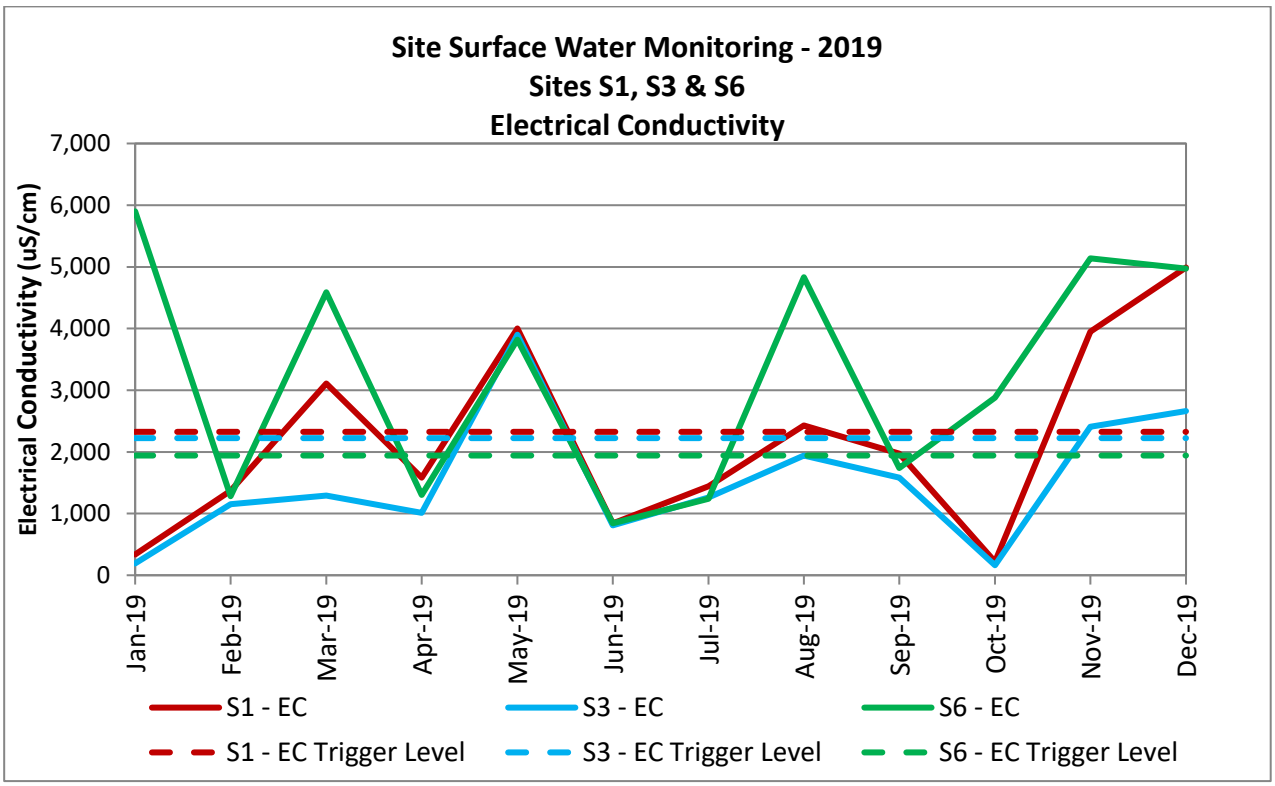


**Figure 9** *Site Surface Water S1, S3 & S6 Electrical Conductivity Results 2019*

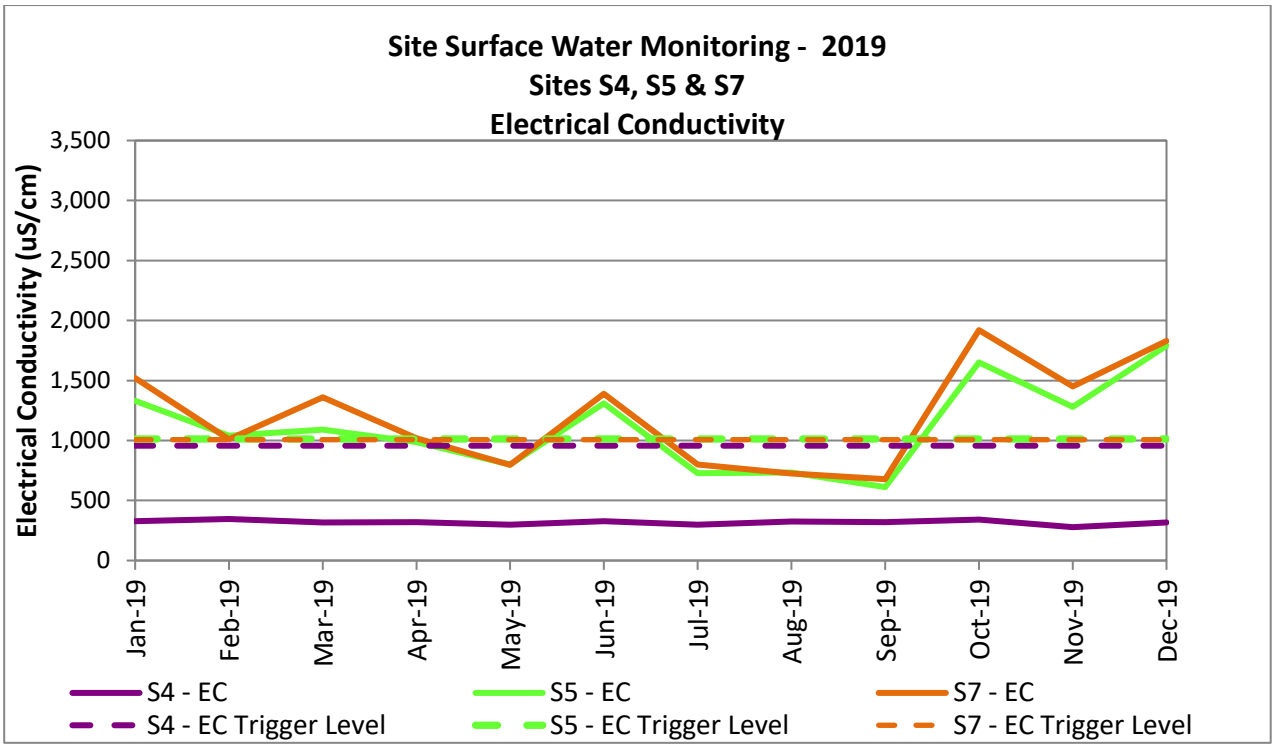


**Figure 10** *Site Surface Water S4, S5 & S7 Electrical Conductivity Results 2019*

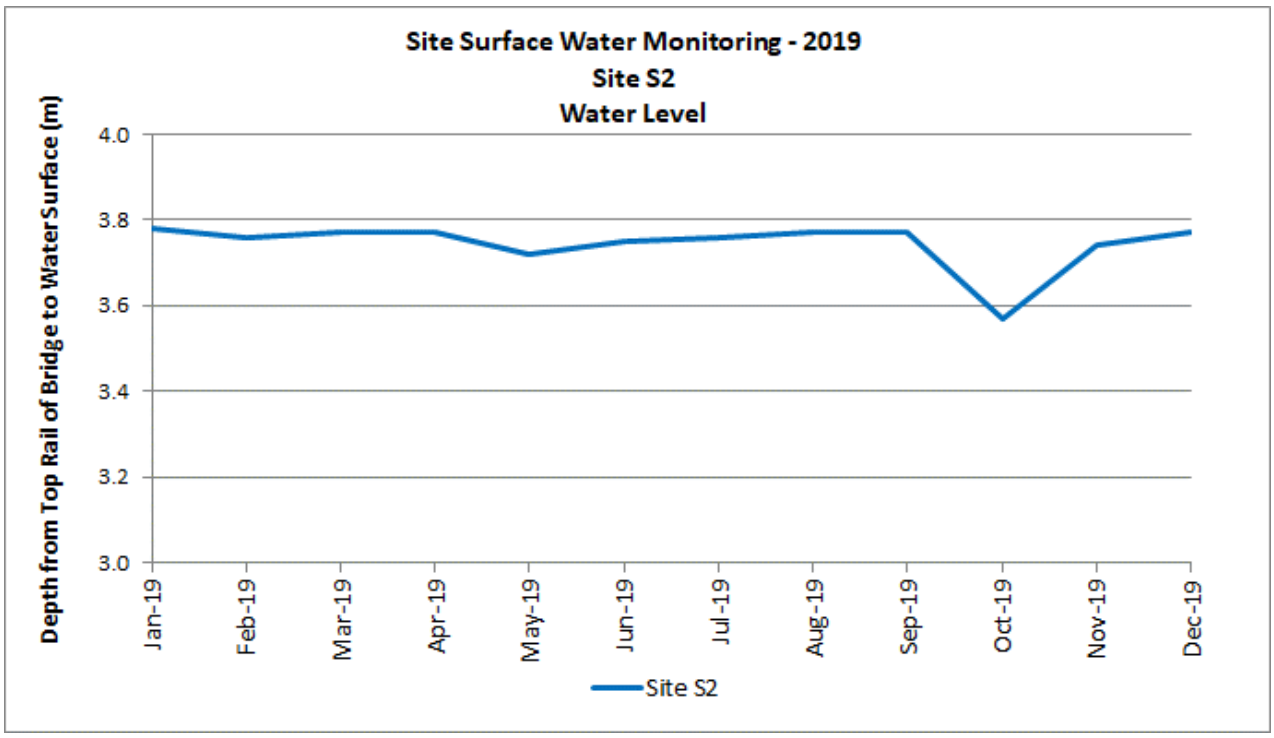


**Figure 11** *Site Surface Water S2 – 2019 Water Level*

## 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 2019 monitoring period, therefore, no sampling or analysis was undertaken at EPA Point 13 during the 2019 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 2019 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 2019. 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 one (1) of the four (4) water quality monitoring events (November 2019).
- EPA Point 14 was above the upper pH trigger level value during three (3) of the four (4) water quality monitoring events and below the lower pH trigger value during August 2019.

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 the November 2019 monitoring event.
- EPA Point 3 was in excess of the site-specific trigger value during the May and November 2019 monitoring event.
- EPA Point 14 was in excess of the site-specific trigger value during three (3) of the four (4) monitoring events. The greatest concentration occurred during the November 2019 monitoring event (1530µS/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 2019 monitoring period.

During the 2019 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 one (1) of the twelve (12) monitoring events (November 2019) and below the lower pH trigger value during July 2019.
- S5 was below the lower pH trigger value during one (1) of the twelve (12) monitoring events (June 2019).
- S7 was below the lower pH trigger value during June 2019 only, there were a total of twelve monitoring events at this location.

During the 2019 monitoring period, electrical conductivity intermittently exceeded the site specific trigger values, this occurred during the following instances:

- S1 was in excess of the site-specific trigger value during four (4) of the twelve (12) monitoring events. The greatest electrical conductivity level was 4990 µS/cm, observed during December 2019.
- S3 was in excess of the site-specific trigger value during two (2) of the twelve (12) monitoring events. The greatest electrical conductivity level was 3900 µS/cm, observed during May 2019.

- S5 was in excess of the site-specific trigger value during seven (7) of the twelve (12) monitoring events. The greatest electrical conductivity level was 1790µS/cm, observed during December 2019.
- S6 was in excess of the site-specific trigger value during seven (7) of the twelve (12) monitoring events. The greatest electrical conductivity level was 5900µS/cm, observed during January 2019.
- S7 was in excess of the site-specific trigger value during eight (8) of the twelve (12) monitoring events. The greatest electrical conductivity level was 1920µS/cm, observed during October 2019.

Historically, conductivity is generally shown to increase in response to decreased rainfall. This trend was not observable during 2019 as shown in **Figure 12**. Historically, 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. Total rainfall during 2019 was significantly lower than previous years (refer to **Section 6**), as such it is possible this has influenced the discharge volumes located upstream of Pine Dale Mine, such that minimal discharges have occurred.

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.

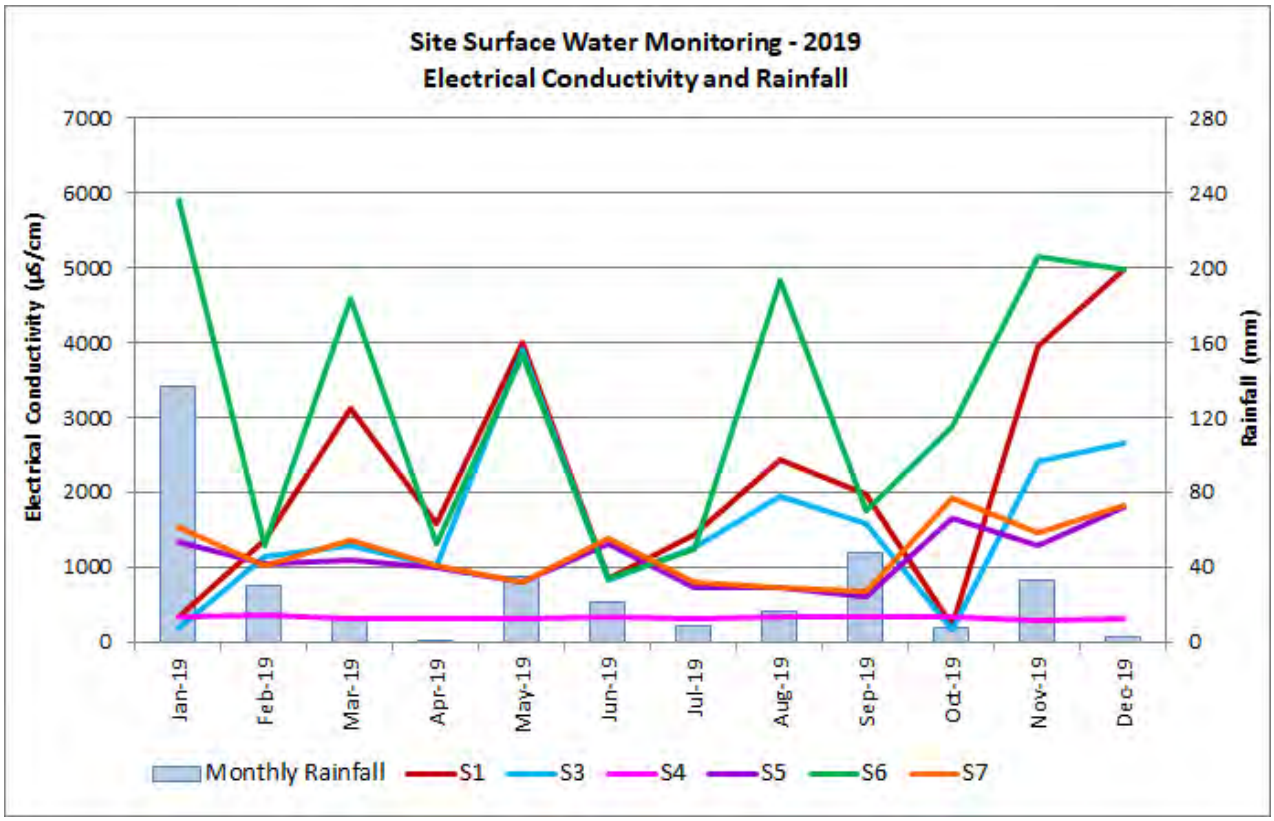


**Figure 12** *Site Surface Water Electrical Conductivity and Monthly Rainfall*

# 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 2019 are summarised in **Table 38**.

**Table 38** *Meteorological Monitoring Summary Data 2019*

| Month (2019) | 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 | 136.2 | 136.2 | 15 | 23.1 | 12.6 | 40.1 | 22.9 | 12.4 | 39.5 | 31.7 | 0.0 | 103.6 | 67.3 | 10.2 | 96.4 | 0.5 | 0.0 | 9.0 | NW |
| February | 30.2 | 166.4 | 11 | 18.9 | 5.8 | 34.9 | 18.6 | 6 | 33.9 | 33.8 | 0.0 | 101.7 | 66.1 | 12.8 | 95.6 | 0.7 | 0.0 | 11.5 | SE |
| March | 12.4 | 178.8 | 9 | 17.2 | 4.7 | 34.9 | 17.0 | 4.7 | 34.4 | 31.8 | 0.0 | 101.2 | 71.0 | 15.0 | 96.5 | 0.7 | 0.0 | 11.2 | WNW |
| April | 0.4 | 179.2 | 2 | 13.0 | -0.9 | 27.5 | 13.0 | -0.8 | 26.4 | 31.9 | 0.0 | 102.6 | 72.4 | 14.9 | 96.0 | 0.5 | 0.0 | 10.0 | WNW |
| May | 35 | 214.2 | 13 | 8.0 | -2.5 | 21.1 | 8.1 | -2.7 | 20.8 | 33.7 | 4.3 | 101.8 | 82.4 | 22.6 | 100.0 | 1.7 | 0.0 | 15.5 | WNW |
| June | 21.4 | 235.6 | 17 | 5.5 | -6.8 | 19.1 | 5.7 | -6.8 | 18.9 | 37.3 | 3.4 | 102.2 | 87.3 | 34.2 | 100.0 | 1.3 | 0.0 | 11.4 | SE |
| July | 8.4 | 244 | 9 | 5.5 | -7.6 | 18.9 | 5.6 | -7.6 | 17.8 | 34.2 | 3.3 | 102.5 | 78.8 | 14.5 | 100.0 | 2.0 | 0.0 | 18.9 | WNW |
| August | 16.6 | 260.6 | 9 | 4.9 | -8.9 | 20.2 | 5.0 | -8.9 | 19.4 | 34.1 | 3.0 | 103.1 | 73.2 | 8.7 | 100.0 | 2.0 | 0.0 | 18.2 | W |
| September | 48 | 308.6 | 10 | 8.8 | -5.6 | 25.4 | 8.8 | -5.9 | 24.1 | 36.0 | 4.0 | 101.2 | 68.2 | 7.8 | 100.0 | 2.0 | 0.0 | 19.0 | W |
| October | 7 | 315.6 | 5 | 13.3 | -1.9 | 30.5 | 13.1 | -1.9 | 29.7 | 37.9 | 4.3 | 102.9 | 58.6 | 11.1 | 100.0 | 1.8 | 0.0 | 17.7 | W |
| November | 32.4 | 348 | 5 | 16.9 | 1.5 | 36.3 | 16.7 | 1.5 | 34.9 | 34.0 | 3.3 | 102.3 | 49.8 | 7.2 | 100.0 | 2.4 | 0.0 | 21.0 | W |
| December | 2.2 | 350.2 | 2 | 19.9 | 3.6 | 39.5 | 19.5 | 4.1 | 37.9 | 36.0 | 4.5 | 102.4 | 50.1 | 8.7 | 99.1 | 2.1 | 0.0 | 15.9 | W |
| **TOTAL** | **350.2** | **-** | **107** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | - |
| **Minimum** | **0.4** | **-** | **2** | **-** | ***-8.9*** | **-** | **-** | ***-8.9*** | **-** | **-** | ***0.0*** | **-** | **-** | ***7.2*** | **-** | **-** | ***0.0*** | **-** | - |
| **Maximum** | **136.2** | **-** | **17** | **-** | **-** | ***40.1*** | **-** | **-** | ***39.5*** | **-** | **-** | ***103.6*** | **-** | **-** | ***100.0*** | **-** | **-** | ***21.0*** | - |

### 6.3 REVIEW OF METEOROLOGICAL MONITORING RESULTS

PDM received 350.2mm of rainfall across 107 days during the 2019 monitoring period. Rainfall during this period was observed to be less than the 2018 (660.4mm) and 2017 (577.0mm) annual rainfall amounts. The maximum 2m and 10m temperatures recorded during the reporting period was 40.1°C and 39.5°C respectively, both occurred in January 2019. The lowest temperature was observed during August with -8.9°C recorded at both 2m and 10m. Predominant wind directions at the PDM during 2019 were observed to generally be from a westerly or 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 2019 (refer RCA Reports 6880-1797 and 6880-1812, 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 **46**. 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:** | | **12/03/2019 & 4/10/2019** | |
| **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. |
| **2019 Overall Scores** | | | |
| **Classification of Drainage Line March 2019 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 2019 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: | | 12/03/2019 & 4/10/2019 | |
| 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.<br>Characteristic wetland species composition.<br>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.<br>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°, permitting moderate to high velocity flows. |
| | Nature of Lateral Flow Regulation | 4 | Dense grassland.<br>Low inflow rate, mostly diffuse. |
| 2019 Overall Scores | | | |
| Classification of Drainage Line March 2019 survey | | 22/32<br>**69%** | Drainage line is potentially stabilizing.<br>Ongoing monitoring is required while rehabilitation works are not needed in the immediate future. |
| Classification of Drainage Line October 2019 survey | | 22/32<br>**69%** | Drainage line is potentially stabilizing.<br>Ongoing monitoring is required while rehabilitation works are not needed in the immediate future. |

**Table 42** *Classification of Different Drainage Line State – Site SH3 March 2019*

| Location: | | SH3 | |
|---|---|---|---|
| Assessment Date: | | 12/03/2019 | |
| 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.<br>Characteristic wetland species composition.<br>No observable plant burial by sediment. |
| Profile of D/L | Shape and Aspect of Drainage Line Cross Section | 2 | Actively eroding: slight undercutting near, near vertical walls, alluvial fans also eroding. |
| | Longitudinal Morphology of Drainage Line | 2 | Flat, continuous, loose sediment with signs of recent/frequent movement. |
| | 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.<br>Surface armoring (eg. cobbles, competent country rock). |
| Wall Materials | Nature of Drainage Line Materials | 3 | Materials that slake or disperse are exposed on greater than 0.3metres and less than 1 metre of vertical height (the sum of multiple layers if present). |
| 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.<br>Low inflow rate, mostly diffuse. |

| 2019 Overall Scores | | |
|---|---|---|
| **Classification of Drainage Line March 2019 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 2019 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 SH3 October 2019*

| **Location:** | | **SH3** | |
|---|---|---|---|
| **Assessment Date:** | | **4/10/2019** | |
| **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 | 2 | Flat, continuous, loose sediment with signs of recent/frequent movement. |
| | 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 (eg, cobbles, competent country rock). |
| **Wall Materials** | Nature of Drainage Line Materials | 3 | Materials that slake or disperse are exposed on greater than 0.3metres and less than 1 metre of vertical height (the sum of multiple layers if present). |
| **Bank Edge** | Shape of Stream Bordering Slopes | 2 | Steep bank, 10-30º, permitting moderate to high velocity flows. |
| | Nature of Lateral Flow Regulation | 4 | Dense grassland. Low inflow rate, mostly diffuse. |
| **2019 Overall Scores** | | | |
| **Classification of Drainage Line October 2019 survey** | | 21/32 **63%** | Drainage line is potentially stabilizing. Ongoing monitoring is required while rehabilitation works are not needed in the immediate future. |

**Table 44** *Classification of Different Drainage Line State – Site SH3A*

| **Location:** | | **SH3A** | |
|---|---|---|---|
| **Assessment Date:** | | **12/3/2019 & 4/10/2019** | |
| **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.<br>Low inflow rate, mostly diffuse. |
| **Classification of Drainage Line** | | NA | Drainage line is considered stabile due to spray-concrete lining. |

**Table 45** *Classification of Different Drainage Line State – Site SH5*

| **Location:** | | **SH5** | |
|---|---|---|---|
| **Assessment Date:** | | **12/03/2019 &** | |
| **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.<br>Characteristic wetland species composition.<br>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.<br>Moderate flow rate, some highly focused inflow locations. |
| **2019 Overall Scores** | | | |
| **Classification of Drainage Line March 2019 survey** | | 23/32<br>**72%** | Drainage line is stable. This site has remained stable. |

**Table 46** *Classification of Different Drainage Line State – Site SH5*

| **Location:** | | **SH5** | |
|---|---|---|---|
| **Assessment Date:** | | **12/03/2019 &** | |
| **Activity** | | **Rating** | **Explanation of Rating** |
| **Vegetation** | On Drainage Line Floor | 1 | Little or no vegetation growing on drainage line floor. |
| | On Drainage Line Walls | 2 | Any vegetation present is annual or short-lived: partial burial of plants by recently deposited sediment is evident. |
| **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, continuous loose sediment with signs of frequent movement. |
| | 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. |
| **2019 Overall Scores** | | | |
| **Classification of Drainage Line October 2019 survey** | | 22/32 **69%** | Drainage line is potentially stabilising. Ongoing monitoring is required while rehabilitation works are not needed in the immediate future. |

### 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 2019. 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 47**. As PDM is currently in care and maintenance, rehabilitation activities are considered to be the primary noise source.

**Table 47** *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 2019 period:

- Quarter 1 – January to March, monitoring conducted 26 & 27 March 2019.
- Quarter 2 – April to June, monitoring conducted 27 & 28 June 2019.
- Quarter 3 – July to September, monitoring conducted on 25 September 2019.
- Quarter 4 – October to December, monitoring conducted on 15 October 2019.

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 2019 monitoring period are presented in **Tables 48** to **51**. Meteorological conditions recorded during each noise survey are presented in **Table 52**; the 10m data has been sourced from the PDM on-site meteorological station subsequent to the completion of the noise surveys. Noise survey locations are presented in **Drawing 1**, **Appendix 1**.

**Table 48** *Attended Noise Survey – Quarter 1, March 2019*

| Survey Date | Survey Start Time | Location | Overall | | | Pine Dale Mine LAeq 15min Contribution | Pine Dale Mine LAeq 15min Limit | Road Traffic, birds and other LAeq 15min Contribution | Noise Sources & Level Ranges (Min to Max) dB(A) |
|---|---|---|---|---|---|---|---|---|---|
| | | | $L_{Aeq}$ 15min | $L_{A10}$ 15min | $L_{A90}$ 15min | | | | |
| 26/03/2019 | 13:45 | NM 1 | 53 | 56 | 48 | NIL | 42 | 53 | Pine Dale Mine NIL*<br>Road Traffic 40 to 62<br>Birds & Other <41<br>Grader (not Pinedale) 42 to 48 |
| 26/03/2019 | 14:00 | NM 1 | 52 | 56 | 45 | NIL | 42 | 52 | Pine Dale Mine NIL*<br>Road Traffic 37 to 58<br>Birds & Other <40<br>Grader (not Pinedale) 43 to 48 |
| 26/03/2019 | 14:45 | NM 2 | 52 | 52 | 41 | NIL | 42 | 52 | Pine Dale Mine NIL*<br>Road Traffic 37 to 62<br>Birds & Other <38<br>Grader (not Pinedale) <47 |
| 26/03/2019 | 15:00 | NM2 | 45 | 48 | 38 | NIL | 42 | 45 | Pine Dale Mine NIL*<br>Road Traffic 37 to 58<br>Birds & Other <36 |
| 26/03/2019 | 15:30 | NM 3 | 57 | 60 | 46 | NIL | 42 | 57 | Pine Dale Mine NIL*<br>Road Traffic 45 to 66<br>Birds & Other <43 |
| 26/03/2019 | 15:45 | NM 3 | 57 | 60 | 46 | NIL | 42 | 57 | Pine Dale Mine NIL*<br>Road Traffic 40 to 76<br>Birds & Other 40 to 52 |
| 26/03/2019 | 16:35 | NM 4 | 41 | 38 | 32 | NIL | 42 | 41 | Pine Dale Mine NIL*<br>Road Traffic 30 to 35<br>Birds & Other 31 to 57 |
| 26/03/2019 | 16:52 | NM 4 | 37 | 39 | 33 | NIL | 42 | 37 | Pine Dale Mine NIL*<br>Road Traffic 30 to 48<br>Birds & Other 31 to 44 |
| 27/03/2019 | 09:15 | NM 5 | 58 | 50 | 32 | NIL | 42 | 58 | Pine Dale Mine NIL*<br>Road Traffic 30 to 81<br>Birds & Other <30 |
| 27/03/2019 | 09:30 | NM 5 | 59 | 50 | 33 | NIL | 42 | 59 | Pine Dale Mine NIL*<br>Road Traffic 26 to 79<br>Birds & Other 31 to 57 |
| 27/03/2019 | 08:30 | NM 6 | 53 | 54 | 32 | NIL | 42 | 53 | Pine Dale Mine NIL*<br>Road Traffic 27 to 72<br>Birds & Other 28 to 72 |
| 27/03/2019 | 08:45 | NM 6 | 57 | 54 | 30 | NIL | 42 | 57 | Pine Dale Mine NIL*<br>Road Traffic 28 to 70<br>Birds & Other 27 to 57 |

**Table 49** *Attended Noise Survey – Quarter 2, June 2019*

| Survey Date | Survey Start Time | Location | Overall | | | Pine Dale Mine LAeq 15min Contribution | Pine Dale Mine LAeq 15min Limit | Road Traffic, birds and other LAeq 15min Contribution | Noise Sources & Level Ranges (Min to Max) dB(A) |
|---|---|---|---|---|---|---|---|---|---|
| | | | $L_{Aeq}$ 15min | $L_{A10}$ 15min | $L_{A90}$ 15min | | | | |
| 27/06/2019 | 13:30 | NM 1 | 60 | 64 | 44 | NIL | 42 | 60 | Pine Dale Mine NIL*<br>Road Traffic 40 to 75<br>Birds & Other 36 to 53 |
| 27/06/2019 | 13:45 | NM 1 | 60 | 65 | 42 | NIL | 42 | 60 | Pine Dale Mine NIL*<br>Road Traffic 39 to 72<br>Birds & Other 35 to 52<br>Grader (not Pinedale) 43 to 51 |
| 27/06/2019 | 14:15 | NM 2 | 50 | 55 | 38 | NIL | 42 | 50 | Pine Dale Mine NIL*<br>Road Traffic 37 to 61<br>Birds & Other 32 to 52 |
| 27/06/2019 | 14:30 | NM2 | 51 | 55 | 39 | NIL | 42 | 51 | Pine Dale Mine NIL*<br>Road Traffic 40 to 62<br>Birds & Other 33 to 50 |
| 27/06/2019 | 15:00 | NM 3 | 57 | 61 | 42 | NIL | 42 | 57 | Pine Dale Mine NIL*<br>Road Traffic 45 to 68<br>Birds & Other 30 to 62 |
| 27/06/2019 | 15:15 | NM 3 | 59 | 63 | 49 | NIL | 42 | 59 | Pine Dale Mine NIL*<br>Road Traffic 40 to 72<br>Birds & Other 37 to 62 |
| 27/06/2019 | 15:45 | NM 4 | 33 | 35 | 27 | NIL | 42 | 33 | Pine Dale Mine NIL*<br>Road Traffic 35 to 44<br>Birds & Other 30 to 52 |
| 27/06/2019 | 16:00 | NM 4 | 33 | 37 | 26 | NIL | 42 | 33 | Pine Dale Mine NIL*<br>Road Traffic 33 to 44<br>Birds & Other 26 to 46 |
| 28/06/2019 | 09:15 | NM 5 | 57 | 47 | 30 | NIL | 42 | 57 | Pine Dale Mine NIL*<br>Road Traffic 38 to 81<br>Birds & Other 27 to 52 |
| 28/06/2019 | 09:30 | NM 5 | 63 | 57 | 31 | NIL | 42 | 63 | Pine Dale Mine NIL*<br>Road Traffic 38 to 83<br>Birds & Other 29 to 55 |
| 28/06/2019 | 08:30 | NM 6 | 58 | 50 | 28 | NIL | 42 | 58 | Pine Dale Mine NIL*<br>Road Traffic 38 to 83<br>Birds & Other 26 to 52 |
| 28/06/2019 | 08:45 | NM 6 | 58 | 49 | 26 | NIL | 42 | 58 | Pine Dale Mine NIL*<br>Road Traffic 38 to 83<br>Birds & Other 24 to 53 |

**Table 50** *Attended Noise Survey – Quarter 3, September 2019*

| Survey Date | Survey Start Time | Location | Overall | | | Pine Dale Mine LAeq 15min Contribution | Pine Dale Mine LAeq 15min Limit | Road Traffic, birds and other LAeq 15min Contribution | Noise Sources & Level Ranges (Min to Max) dB(A) |
|---|---|---|---|---|---|---|---|---|---|
| | | | $L_{Aeq\ 15min}$ | $L_{A10\ 15min}$ | $L_{A90\ 15min}$ | | | | |
| 25/09/2019 | 08:05 | NM 1 | 53 | 57 | 32 | NIL | 42 | 53 | Pine Dale Mine NIL*<br>Road Traffic 35 to 68<br>Birds & Other 36 to 52 |
| 25/09/2019 | 08:20 | NM 1 | 53 | 57 | 40 | NIL | 42 | 53 | Pine Dale Mine NIL*<br>Road Traffic 36 to 65<br>Birds & Other 42 to 56 |
| 25/09/2019 | 08:42 | NM 2 | 53 | 56 | 36 | NIL | 42 | 53 | Pine Dale Mine NIL*<br>Road Traffic 34 to 68<br>Birds & Other 33 to 45 |
| 25/09/2019 | 08:59 | NM2 | 49 | 53 | 32 | NIL | 42 | 49 | Pine Dale Mine NIL*<br>Road Traffic 32 to 68<br>Birds & Other 32 to 46 |
| 25/09/2019 | 09:24 | NM 3 | 60 | 64 | 34 | NIL | 42 | 60 | Pine Dale Mine NIL*<br>Road Traffic 33 to 76<br>Birds & Other 32 to 45 |
| 25/09/2019 | 09:39 | NM 3 | 60 | 63 | 33 | NIL | 42 | 60 | Pine Dale Mine NIL*<br>Road Traffic 33 to 77<br>Birds & Other 31 to 50 |
| 25/09/2019 | 10:01 | NM 4 | 39 | 39 | 28 | NIL | 42 | 39 | Pine Dale Mine NIL*<br>Road Traffic 38 to 57<br>Birds & Other 34 to 55 |
| 25/09/2019 | 10:16 | NM 4 | 40 | 38 | 28 | NIL | 42 | 40 | Pine Dale Mine NIL*<br>Road Traffic 31 to 49<br>Birds & Other 31 to 55 |
| 25/09/2019 | 11:26 | NM 5 | 57 | 46 | 31 | NIL | 42 | 57 | Pine Dale Mine NIL*<br>Road Traffic 38 to 79<br>Birds & Other 33 to 47 |
| 25/09/2019 | 11:41 | NM 5 | 61 | 50 | 32 | NIL | 42 | 61 | Pine Dale Mine NIL*<br>Road Traffic 34 to 84<br>Birds & Other 33 to 57 |
| 25/09/2019 | 10:47 | NM 6 | 60 | 53 | 26 | NIL | 42 | 60 | Pine Dale Mine NIL*<br>Road Traffic 32 to 81<br>Birds & Other 26 to 52 |
| 25/09/2019 | 11:02 | NM 6 | 57 | 47 | 28 | NIL | 42 | 57 | Pine Dale Mine NIL*<br>Road Traffic 34 to 79<br>Birds & Other 28 to 46 |

**Table 51** *Attended Noise Survey – Quarter 4, October 2019*

| Survey Date | Survey Start Time | Location | Overall | | | Pine Dale Mine LAeq 15min Contribution | Pine Dale Mine LAeq 15min Limit | Road Traffic, birds and other LAeq 15min Contribution | Noise Sources & Level Ranges (Min to Max) dB(A) |
|---|---|---|---|---|---|---|---|---|---|
| | | | $L_{Aeq}$ 15min | $L_{A10}$ 15min | $L_{A90}$ 15min | | | | |
| 15/10/2019 | 13:17 | NM 1 | 59 | 63 | 45 | NIL | 42 | 59 | Pine Dale Mine NIL*<br>Road Traffic 45 to 73<br>Birds & Other 55 to 62 |
| 15/10/2019 | 13:32 | NM 1 | 57 | 62 | 41 | NIL | 42 | 57 | Pine Dale Mine NIL*<br>Road Traffic 40 to 71<br>Birds & Other 38 to 44 |
| 15/10/2019 | 13:52 | NM 2 | 55 | 58 | 44 | NIL | 42 | 55 | Pine Dale Mine NIL*<br>Road Traffic 45 to 69<br>Birds & Other 37 to 55 |
| 15/10/2019 | 14:07 | NM2 | 56 | 60 | 45 | NIL | 42 | 56 | Pine Dale Mine NIL*<br>Road Traffic 40 to 71<br>Birds & Other 40 to 53 |
| 15/10/2019 | 14:27 | NM 3 | 61 | 64 | 44 | NIL | 42 | 61 | Pine Dale Mine NIL*<br>Road Traffic 41 to 77<br>Birds & Other 37 to 47 |
| 15/10/2019 | 14:42 | NM 3 | 60 | 65 | 46 | NIL | 42 | 60 | Pine Dale Mine NIL*<br>Road Traffic 44 to 75<br>Birds & Other 40 to 48 |
| 15/10/2019 | 15:03 | NM 4 | 45 | 48 | 38 | NIL | 42 | 45 | Pine Dale Mine NIL*<br>Road Traffic 35 to 39<br>Birds & Other 36 to 52 |
| 15/10/2019 | 15:18 | NM 4 | 52 | 48 | 38 | NIL | 42 | 48 | Pine Dale Mine NIL*<br>Road Traffic 44 to 75<br>Birds & Other 39 to 54 |
| 15/10/2019 | 16:19 | NM 5 | 56 | 55 | 34 | NIL | 42 | 56 | Pine Dale Mine NIL*<br>Road Traffic 36 to 73<br>Birds & Other 31 to 64 |
| 15/10/2019 | 16:34 | NM 5 | 56 | 52 | 34 | NIL | 42 | 56 | Pine Dale Mine NIL*<br>Road Traffic 37 to 79<br>Birds & Other 29 to 67 |
| 15/10/2019 | 15:43 | NM 6 | 66 | 57 | 34 | NIL | 42 | 57 | Pine Dale Mine NIL*<br>Road Traffic 34 to 91<br>Birds & Other 33 to 47 |
| 15/10/2019 | 15:59 | NM 6 | 56 | 50 | 34 | NIL | 42 | 56 | Pine Dale Mine NIL*<br>Road Traffic 36 to 79<br>Birds & Other 34 to 56 |

**Table 52** *Meteorological Conditions during Attended Noise Surveys*

| Survey Date | Start Time | Location | Temp at 10m (°C) | Average Wind Speed (m/s) | Average Wind Direction |
|---|---|---|---|---|---|
| 26/03/2019 | 13:45 | NM 1 | 17 | 2.7 | W |
| 26/03/2019 | 14:00 | NM 1 | 18 | 1.2 | SW |
| 26/03/2019 | 14:45 | NM 2 | 18 | 1.8 | S |
| 26/03/2019 | 15:00 | NM 2 | 18 | 2.1 | W |
| 26/03/2019 | 15:30 | NM 3 | 18 | 1.0 | SW |
| 26/03/2019 | 15:45 | NM 3 | 18 | 1.3 | SW |
| 26/03/2019 | 16:35 | NM 4 | 19 | 0.6 | SW |
| 26/03/2019 | 16:52 | NM 4 | 19 | 0.4 | W |
| 27/03/2019 | 09:15 | NM 5 | 14 | 1.5 | E |
| 27/03/2019 | 09:30 | NM 5 | 15 | 0.3 | N |
| 27/03/2019 | 08:30 | NM 6 | 14 | 1.6 | E |
| 27/03/2019 | 08:45 | NM 6 | 14 | 0.7 | E |
| 27/06/2019 | 13:30 | NM 1 | 14 | 2.5 | NE |
| 27/06/2019 | 13:45 | NM 1 | 14 | 2.4 | N |
| 27/06/2019 | 14:15 | NM 2 | 12 | 1.4 | NE |
| 27/06/2019 | 14:30 | NM 2 | 14 | 2.1 | NE |
| 27/06/2019 | 15:00 | NM 3 | 12 | 1.5 | NE |
| 27/06/2019 | 15:15 | NM 3 | 11 | 1.9 | E |
| 27/06/2019 | 15:45 | NM 4 | 12 | 0.9 | NE |
| 27/06/2019 | 16:00 | NM 4 | 12 | 0.9 | NE |
| 28/06/2019 | 09:15 | NM 5 | 9 | 1.9 | N |
| 28/06/2019 | 09:30 | NM 5 | 11 | 2.1 | NW |
| 28/06/2019 | 08:30 | NM 6 | 6 | 0.6 | NW |
| 28/06/2019 | 08:45 | NM 6 | 8 | 2 | NW |

| Survey Date | Start Time | Location | Temp at 10m (°C) | Average Wind Speed (m/s) | Average Wind Direction |
|---|---|---|---|---|---|
| 25/09/2019 | 08:05 | NM 1 | 6.8 | 0.8 | E |
| 25/09/2019 | 08:20 | NM 1 | 8.6 | 1.3 | E |
| 25/09/2019 | 08:42 | NM 2 | 9.4 | 1.9 | E |
| 25/09/2019 | 08:59 | NM 2 | 10.5 | 1.4 | SE |
| 25/09/2019 | 09:24 | NM 3 | 11.1 | 1.8 | E |
| 25/09/2019 | 09:39 | NM 3 | 12.6 | 1.3 | E |
| 25/09/2019 | 10:01 | NM 4 | 12.9 | 1.3 | NE |
| 25/09/2019 | 10:16 | NM 4 | 14.0 | 1.0 | E |
| 25/09/2019 | 11:26 | NM 5 | 15.6 | 1.6 | E |
| 25/09/2019 | 11:41 | NM 5 | 15.8 | 1.6 | SE |
| 25/09/2019 | 10:47 | NM 6 | 14.9 | 1.4 | NE |
| 25/09/2019 | 11:02 | NM 6 | 14.8 | 1.3 | E |
| 15/10/2019 | 13:17 | NM 1 | 26 | 4.1 | W |
| 15/10/2019 | 13:32 | NM 1 | 26 | 4.3 | W |
| 15/10/2019 | 13:52 | NM 2 | 27 | 3.3 | W |
| 15/10/2019 | 14:07 | NM 2 | 28 | 4.2 | W |
| 15/10/2019 | 14:27 | NM 3 | 27 | 4.0 | W |
| 15/10/2019 | 14:42 | NM 3 | 26 | 4.0 | W |
| 15/10/2019 | 15:03 | NM 4 | 26 | 3.8 | W |
| 15/10/2019 | 15:18 | NM 4 | 26 | 4.3 | W |
| 15/10/2019 | 16:19 | NM 5 | 27 | 3.5 | W |
| 15/10/2019 | 16:34 | NM 5 | 27 | 3.5 | SW |
| 15/10/2019 | 15:43 | NM 6 | 27 | 4.4 | W |
| 15/10/2019 | 15:59 | NM 6 | 27 | 4.0 | SW |

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 2019 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 2019*

Attended noise surveys for the January to March 2019 quarter were undertaken on the 26 and 27 March 2019 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 NM1, NM2, NM3, NM5, and NM6 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 NM4 showed that bird calls & other was the dominant noise source with road traffic intermittently contributing to the acoustic climate.

There was a grader operating near NM1 which contributed to the noise levels measured at this location. This grader was not part of Pine Dale Mine operations and has not been allocated to the Pine Dale Mine noise contributions.

### 8.3.2 SECOND QUARTER 2019

Attended noise surveys for the April to June 2019 quarter were undertaken on the 27 and 28 June 2019. 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 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 survey 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.

There was a grader operating near NM1 which contributed to the noise levels measured at this location. This grader was not part of Pine Dale Mine operations and has not been allocated to the Pine Dale Mine noise contributions.

### 8.3.3 THIRD QUARTER 2019

Attended noise surveys for the July to September 2019 quarter were undertaken on the 25 September 2019. 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, NM5, and NM6 showed that road traffic along Castlereagh Hwy was the dominant noise source with bird calls, dog barks, and aircraft intermittently contributing to the acoustic climate. The survey conducted at NM4 showed that bird calls & other was the dominant noise source with road traffic intermittently contributing to the acoustic climate.

### 8.3.4 FOURTH QUARTER 2019

Attended noise surveys of the Pine Dale mine operations for the October to December 2019 quarter were undertaken on the 15 October 2019. 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, NM5, and NM6 showed that road traffic along Castlereagh Highway was the dominant noise source with bird calls, dog barks, wind, and aircraft intermittently contributing to the acoustic climate. The survey conducted at NM4 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 2019

The assessable sound levels from Pine Dale Mine were below the assessment criteria at the six (6) locations during the 2019 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 48** to **52**), 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 53** *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 2019 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

## 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

EPL Site 2

S1

Weather Station

HVAS

S2

EPL Site 3
(S3)

PCB2

PCB3

DI

NM1

Old Shaft

The Bong

NM2

D2

D3

NM3

P6

D6

NM6

S4

S5

Blue Lake

EPL Site 13

S6

P7

D4

NM4

S7

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 | 6880-1815a |
| DRAWN BY | CR | SCALE | 1:24,000 (A3) | DRAWING 1 | REV 0 |
| APPROVED BY | CR | DATE | 22/01/2019 | 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 | 6880-1815a |
| DRAWN BY | CR | SCALE | 1:5,000 (A3) | DRAWING 2 | REV 0 |
| APPROVED BY | CR | DATE | 22/01/2020 | OFFICE | NEWCASTLE |

# APPENDIX C

# 2019 REHABILITATION MONITORING REPORT

# Pine Dale Mine

# Rehabilitation Monitoring Report 2019

Report prepared by First Field Environmental
on behalf of EnergyAustralia

28 October 2019

| Revision history | | |
|---|---|---|
| Version | Date | Author |
| Draft | 28 October 2019 | Michelle Evans |
| Final | 14 December 2019 | Michelle Evans |

Cover image: Tree rehabilitation area at Transect 5

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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# Contents

# Appendices



# Figures



# Tables

# 1. Introduction

Pine Dale Mine is located in the Western Coalfields of NSW at Blackmans Flat, 15 km north of Lithgow on the northern side of Castlereagh Highway. The property is approximately 3 km 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:<br>- Nesting boxes and salvaged hollows<br>- Crushed timber spread over native forest rehabilitation areas<br>- 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.<br>• 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.<br>• Vegetation within the treed rehabilitation areas are established in accordance with the approved species mix.<br>• 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 with winter rainfall of 45 mm compared with the average of 138.4 mm in the months of June – August (Bureau of Meteorology 2019). Table 2 presents regional rainfall data for the period commencing 2013.

Table 2 Rainfall (in mm) recorded January 2013 – September 2019

| Year | Average | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|
| January | 80.2 | 87.4 | 9.2 | 156.2 | 142.0 | 37.2 | 49.0 | 154.6 |
| February | 60.2 | 149 | 85 | 21.2 | 28.8 | 12.2 | 65.2 | 21.4 |
| March | 84.2 | 43.2 | 155 | 39.4 | 69.6 | 141.4 | 56.6 | 84.2 |
| April | 48.2 | 26.8 | 63 | 158.2 | 6.2 | 21.2 | 13.6 | 1.0 |
| May | 22.3 | 23.6 | 14 | 25.2 | 26.0 | 32.6 | 12.6 | 37.2 |
| June | 63.8 | 87 | 43.2 | 24.8 | 173.4 | 19.6 | 34.6 | 16.2 |
| July | 32.2 | 19.6 | 25.6 | 44.6 | 91.4 | 6.6 | 5.4 | 10.8 |
| August | 42.4 | 22.4 | 56.4 | 43.8 | 52.2 | 41.8 | 38.0 | 18.0 |
| September | 42.4 | 44 | 35.2 | 9.8 | 118.6 | 4.2 | 67.6 | 52.0 |
| October | 61.6 | 20.8 | 51.6 | 58.0 | 71.4 | 106.0 | 79.8 | - |
| November | 51.2 | 68.6 | 36.8 | 63.6 | 58.4 | 28.8 | 124.6 | - |
| December | 83.8 | 38.4 | 160.4 | 58.6 | 86.4 | 75.2 | 80.6 | - |
| **Annual** | **762.1** | **630.8** | **735.4** | **703.4** | **924.4** | **526.8** | 627.6 | - |

Source: Bureau of Meteorology (2019)

# 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.


Legend

- Transect lines
- Treed rehabilitation site
- Pine Dale Mine

0 250 500 m

firstfield ENVIRONMENTAL

**Pindale Mine Rehabilitation Monitoring Report**

| | |
|---|---|
| Drawing No: A1 | Prepared for Enhanced Place Mine |
| Date: 26/9/2019 / Drawing Size: A4 | This figure may be based on third party data or data which has not been verified by First Field Environmental and it may not be to scale. Unless expressly agreed otherwise this figure is intended as a guide only and First Field Environmental does not warrant its accuracy. |
| Drawn By: Andrew Evans / Reviewed By: Michelle Evans | |
| Coordinate System: GDA2020 MGA Zone 56 EPSG:28356 | |

## 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 2019) 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 6 September 2019 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 consistent with species composition at the analogue pasture site. Examples of analogue pasture and Transect 1 pasture are shown in Figure 2 and Figure 3.

Figure 1 Pasture composition at the Pasture Analogue site

Figure 2 Typical pasture composition at Transect 1

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.

The proportion of living groundcover at all pasture transects is approximately 33% annual and 55% perennial species. This proportion is consistent with the composition of the Analogue Pasture.

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 4).

Figure 3 Vegetation structure of Treed Analogue site (Transect 7)

Figure 4 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, 70% in 2018 to ~80% cover in 2019. Annual cover has decreased from 20% in 2015 to 10% in 2019, 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 2019.

Total living cover at Transect 6 has fluctuated between 90% in 2014 to 80% in 2019. Annual living cover is generally stable at around 10%. Perennial cover is at 60% in 2019. Litter cover has been stable at 10% from 2015 to 2019 and bare surface has increased from 10% in 2016 to 20% in 2019. See Appendix E for a visual comparison of cover at 2014 and 2019.

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. Shrubs at Transect 5 are increasing ion height and spread. Juvenile trees and shrubs at Transect 6 are increasing in height and spread. It is noted that many Eucalypt species at Transect 6 are producing mature leaves and flowers.

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.

## 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.

Native woodland birds were observed landing within the treed vegetation areas and in the treed analogue site. Magpies and Currawongs were observed on the ground within pasture areas A, B and C and within 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. 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<br>*Species name* | Location | Treatment |
|---|---|---|
| European Red Fox<br>*Vulpes vulpes* | All locations | Landholders are obliged to control populations on their land. |
| European rabbit<br>*Oryctolagus cuniculus* | | |
| African lovegrass<br>*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 the former Wallerawang Power Station site, 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 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<br>1 - <3% slope | 3<br>3 - <10% slope | 4<br>10 - <20% slope, no gully erosion present | 2<br>1 - <3% slope |
| Wind erosion hazard class | 5<br>Moderate wind erodibility class of surface soil, high winds erosive power, high exposure to wind, average annual rainfall >500mm | | | |
| Soil structural decline class | 4<br>Fragile light textured soil - hardsetting | | | |
| Soil acidification hazard class | 4<br>Very low texture /buffering capacity, pH 6.7 – 7.5 ($CaCl_2$) | | | 5<br>Very low texture /buffering capacity, pH 4.0 – 4.7 ($CaCl_2$) |
| Salinity hazard class | 1<br>Moderate to high recharge potential, low discharge potential, low salt store | | | |
| Waterlogging hazard class | 2<br>0 – 0.25 months typical waterlogging duration, moderately well drained soils | | | |
| Shallow soils and rockiness hazard class | 1<br>Nil rocky outcrop, soil depth >100cm | | | |
| Mass movement hazard class | 1<br>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 |
| 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:<br>- Nesting boxes and salvaged hollows<br>- Crushed timber spread over native forest rehabilitation areas<br>- 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). | • **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 |

| Performance indicator | Completion criteria | Status |
|---|---|---|
| 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. | • **Ongoing** – 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 |

# 7. Key findings

- The study area is notably dry, having experienced reduced effective rainfall throughout the study period.
- Grasses are generally cured and not actively growing.
- Pasture in Areas B and C have been grazed and appear to be shorter cropped than pasture in the Analogue Site.
- No significant change in total living ground cover has occurred in the last 12 months at pasture transects.
- Species richness at all pasture transects and the analogue site has decreased.
- The composition of species in all pasture transects and the analogue pasture are at approximately 55% perennial and 33% annual per total living groundcover.
- Total living cover at the treed rehabilitation area of Transect 5 has increased from 70% in 2018 to 80% in 2019.
- Annual cover at Transect 5 has decreased from 20% in 2015 to 10% in 2019, 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 2019 and is likely a response to decreasing annual species and the effects of decreased effective rainfall.

- Total living ground cover at Transect 6 has increased from 70% in 2018 to 80% in 2019.
- There is no evidence of second-generation establishment at treed rehabilitation areas.
- Shrubs within Transects 5 and 6 are increasing in height and spread.
- Juvenile trees within Transect 6 are producing mature leaf forms, increasing in height and spread and are beginning to flower.
- Species richness has decreased at both the treed rehabilitation areas and the analogue site.
- Nesting boxes are not installed in or adjacent to the treed rehabilitation areas.
- 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; and
- Install nesting boxes once the treed rehabilitation areas contain adequate structure to support nesting woodland birds.

# 9. References


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

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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

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

# Appendix A
# Survey data 2019

| 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 | |
| Total living cover | 90% |
| Annual living cover | 40% |
| Perennial living cover | 50% |
| Litter cover | - |
| Bare surface | 10% |

| 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 | >25 herbs and grasses identified, dominated by exotic species. | | | | | |
| Cover classification | % cover at each observation | | | | | |
| | April 2014 | September 2015 | September 2016 | September 2017 | September 2018 | September 2019 |
| Total living cover | 90% | 80% | 95% | 90% | 90% | 90% |
| Annual living cover | - | 40% | 47.5% | 40% | 40% | 40% |
| Perennial living cover | - | 50% | 47.5% | 50% | 50% | 50% |
| Litter cover | 10% | - | - | <10% | 10% | - |
| Bare surface | - | 20% | 5% | <10% | 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 | >25 herbs and grasses identified, dominated by exotic species. | | | | | |
| Cover classification | % cover at each observation | | | | | |
| | April 2014 | September 2015 | September 2016 | September 2017 | September 2018 | September 2019 |
| Total living cover | 90% | 80% | 90% | 90% | 90% | 90% |
| Annual living cover | - | 40% | 42% | 40% | 40% | 40% |
| Perennial living cover | - | 50% | 48% | 50% | 50% | 50% |
| Litter cover | 10% | - | - | <10% | 10% | - |
| Bare surface | - | 20% | 10% | <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 | Not observed. | | | | | |
| Surface drainage impediments | No significant drainage impediments. | | | | | |
| Vegetation | | | | | | |
| Vegetation structure | Groundcover of mixed native and exotic grasses and broadleaf herbs. | | | | | |
| Species richness | >25 herbs and grasses recorded, dominated by exotic species. | | | | | |
| Cover classification | % cover at each observation | | | | | |
| | April 2014 | September 2015 | September 2016 | September 2017 | September 2018 | September 2019 |
| Total living cover | 90% | 80% | 90% | 90% | 90% | 90% |
| Annual living cover | - | 40% | 46% | 40% | 40% | 40% |
| Perennial living cover | - | 50% | 44% | 50% | 50% | 50% |
| Litter cover | 10% | - | - | <10% | 10% | - |
| Bare surface | - | 20% | 10% | <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 >25 exotic herb and grass species recorded. | | | | | |
| Cover classification | % cover at each observation | | | | | |
| | April 2014 | September 2015 | September 2016 | September 2017 | September 2018 | September 2019 |
| Total living cover | 90% | 80% | 90% | 90% | 90% | 90% |
| Annual living cover | - | 40% | 42% | 30% | 30% | 40% |
| Perennial living cover | - | 50% | 48% | 60% | 60% | 50% |
| Litter cover | 10% | - | - | <10% | 10% | - |
| Bare surface | - | 20% | 10% | <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 observed. | | | | | |
| Surface drainage impediments | No significant drainage impediments. | | | | | |
| Vegetation | | | | | | |
| Vegetation structure | Sparse tree layer to 3m height with isolated 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 consists of native species and juvenile trees.<br>Groundcover dominated by exotic broadleaf herbs and grasses.<br>>15 species recorded. | | | | | |
| Cover classification | % cover at each observation | | | | | |
| | April 2014 | September 2015 | September 2016 | September 2017 | September 2018 | September 2019 |
| Total living cover | 90% | 50% | 75% | 70% | 70% | 70% |
| Annual living cover | - | 20% | 12% | 10% | 10% | 10% |
| Perennial living cover | - | 30% | 63% | 60% | 60% | 60% |
| Litter cover | 10% | 10% | 10% | 10% | 10% | 15% |
| Bare surface | - | 40% | 15% | 20% | 20% | 15% |
| 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 3 m height with isolated 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 consists of native species and juvenile trees.<br>Groundcover dominated by exotic broadleaf herbs and grasses.<br>>15 species recorded. | | | | | |
| Cover classification | % cover at each observation | | | | | |
| | April 2014 | September 2015 | September 2016 | September 2017 | September 2018 | September 2019 |
| Total living cover | 90% | 70% | 80% | 80% | 70% | 70% |
| Annual living cover | - | 10% | 12% | 10% | 10% | 10% |
| Perennial living cover | - | 60% | 68% | 70% | 60% | 60% |
| Litter cover | 10% | 10% | 10% | 10% | 10% | 15% |
| Bare surface | - | 20% | 10% | 10% | 20% | 15% |
| 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 14 m high with a canopy cover of 20%. Sparser shrub layer to 3 m height. >95% groundcover to 0.5 m height, dominated by native grasses with mixed native herbs. |
| Species richness | More than 10 tree species, dominated by *Eucalyptus* spp.<br>Shrub layer of >14 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 2019

| 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 | >10 | >15 | >25 |
| 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 | 80% 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 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**<br>Bathurst | | | | | | | |
| Soil erodibility factor **(K)** | **0.03**<br>Sandy loam /fine sandy loam | | | | **0.025**<br>Sandy clay-loam | | | **0.03**<br>Sandy loam /fine sandy loam |
| Topographic factor **(LS)** | **0.17**<br>3% gradient, 5m slope length | | | **0.34**<br>8% gradient, 5m slope length | **0.09**<br>1% gradient, 5m slope length | **0.89**<br>20% gradient, 5m slope length | | **0.52**<br>12% gradient, 5m slope length |
| Cover and management factor **(C)** | **0.01**<br>No appreciable canopy cover, 80-95% grassy groundcover | | | | | **0.04**<br>25% canopy cover of tall weeds or short brush, 60-80% grassy groundcover | **0.01**<br>25% canopy cover of tall weeds or short brush, 80-95% grassy groundcover | **0.00**<br>Consistent with 40% canopy cover of trees and 95% grassy groundcover |
| Erosion control practice factor **(P)** | **1.3**<br>Compacted | | | | | **1.2**<br>Consistent with trackwalking along contour | | **1.3**<br>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 | | | |
| *Anagalis arvensis* | X | X | X | X | | | |
| *Brassica spp.* | 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 | | | |
| *Erodium* sp. | | | | X | | | |
| *Eucalyptus bensonii* | | | | | | | X |

| Scientific name | Transect 1 | Transect 2 | Transect 3 | Transect 4 | Transect 5 | Transect 6 | Treed analogue site (Pine Dale Mine transect 7) |
|---|---|---|---|---|---|---|---|
| *Eucalyptus cypellocarpa* | | | | | | X | |
| *Eucalyptus dalrympleana* subsp. *dalrympleana* | | | | | | | X |
| *Eucalyptus dealbata* | | | | | | X | |
| *Eucalyptus dives* | | | | | X | X | X |
| *Eucalyptus machrorhyncha* subsp. *cannonii* | | | | | | | X |
| *Eucalyptus mannifera* subsp. *Mannifera* | | | | | | | X |
| *Eucalyptus pulverulenta* | | | | | | X | |
| *Eucalyptus radiata* subsp. *radiata* | | | | | | X | X |
| *Eucalyptus rubida* subsp. *rubida* | | | | | | | X |
| *Euphorbia sp.* | X | X | X | X | | | |
| *Exocarpos cuppressiformis* | | | | | | | 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 |

| Scientific name | Transect 1 | Transect 2 | Transect 3 | Transect 4 | Transect 5 | Transect 6 | Treed analogue site (Pine Dale Mine transect 7) |
|---|---|---|---|---|---|---|---|
| *Medicago* sp. | X | X | X | X | | | |
| *Oxalis corniculata* | X | X | X | | | | |
| *Paspalum* sp. | | | | X | | | |
| *Persoonia laurina* | | | | | | | |
| *Perssonia mollis subsp. mollis* | | | | | | | X |
| *Persoonia spp.* | | | | | | | X |
| *Phalaris aquatica* | X | X | X | X | | | |
| *Pinus* sp. | | | | | | | X |
| *Plantago lanceolata* | X | X | X | X | X | X | |
| *Poa labillardierei* | | | | | | | X |
| *Poa* spp. | X | X | X | X | | | X |
| *Ranunculus lappaceus* | | | | | | | X |
| *Ranunculus* sp. | X | X | X | X | | | |
| *Rumex acetosella* | 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 |
| *Vulpia* sp. | X | X | X | X | | | |

# Appendix E
# Photopoint monitoring to 2019

**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 1 looking south 2019**

**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 2 looking southeast 2019**

**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 3 looking southwest 2019**

**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 4 looking west 2019**

**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 5 looking west 2019**

**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 6 looking east 2019**

**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**

**Transect 7 looking east 2019**

**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**

**Quadrat 1 September 2019**

# 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**

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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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# DOCUMENT REFERENCES

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## FIGURES

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## PHOTOS



## APPENDICES

# 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.

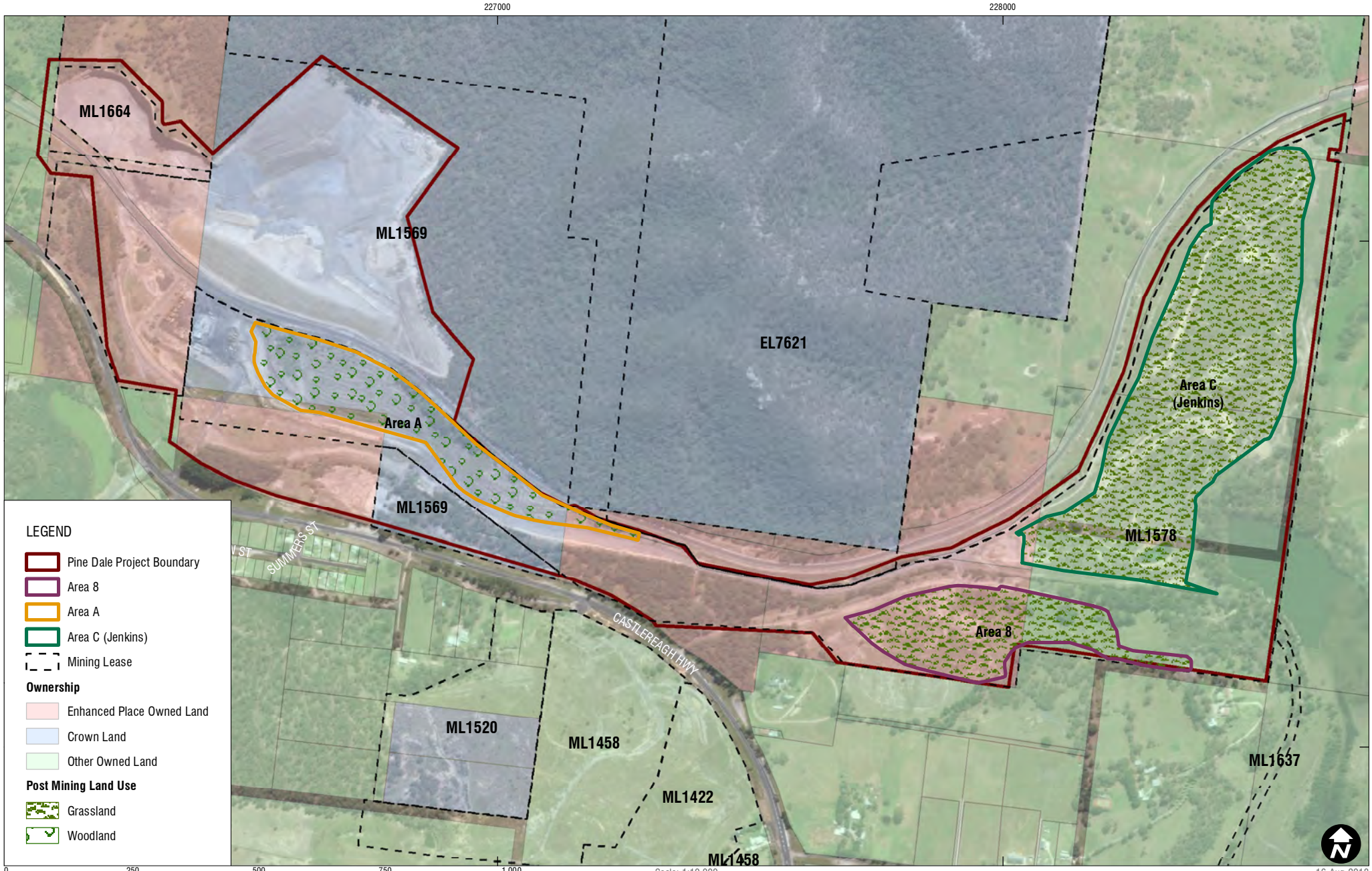
# 5 Rehabilitation Areas and Post Mining Land Use

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

Sheet Size : A4

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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<br>≥ 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<br>*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<br>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<br>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<br>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<br>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<br>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<br>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<br>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<br>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<br>*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<br>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.*<br>(CSIRO 2008) | Yes | Section 8.1; and<br>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.*<br>(CSIRO 2008) | Yes | Section 8.1; and<br>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<br>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.<br>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.<br>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.<br>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%.<br>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.<br>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%.<br>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
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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<br>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<br>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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# 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 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:<br>- Nesting boxes and salvaged hollows<br>- Crushed timber spread over native forest rehabilitation areas<br>- 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.<br>• 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.<br>• Vegetation within the treed rehabilitation areas are established in accordance with the approved species mix.<br>• 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.

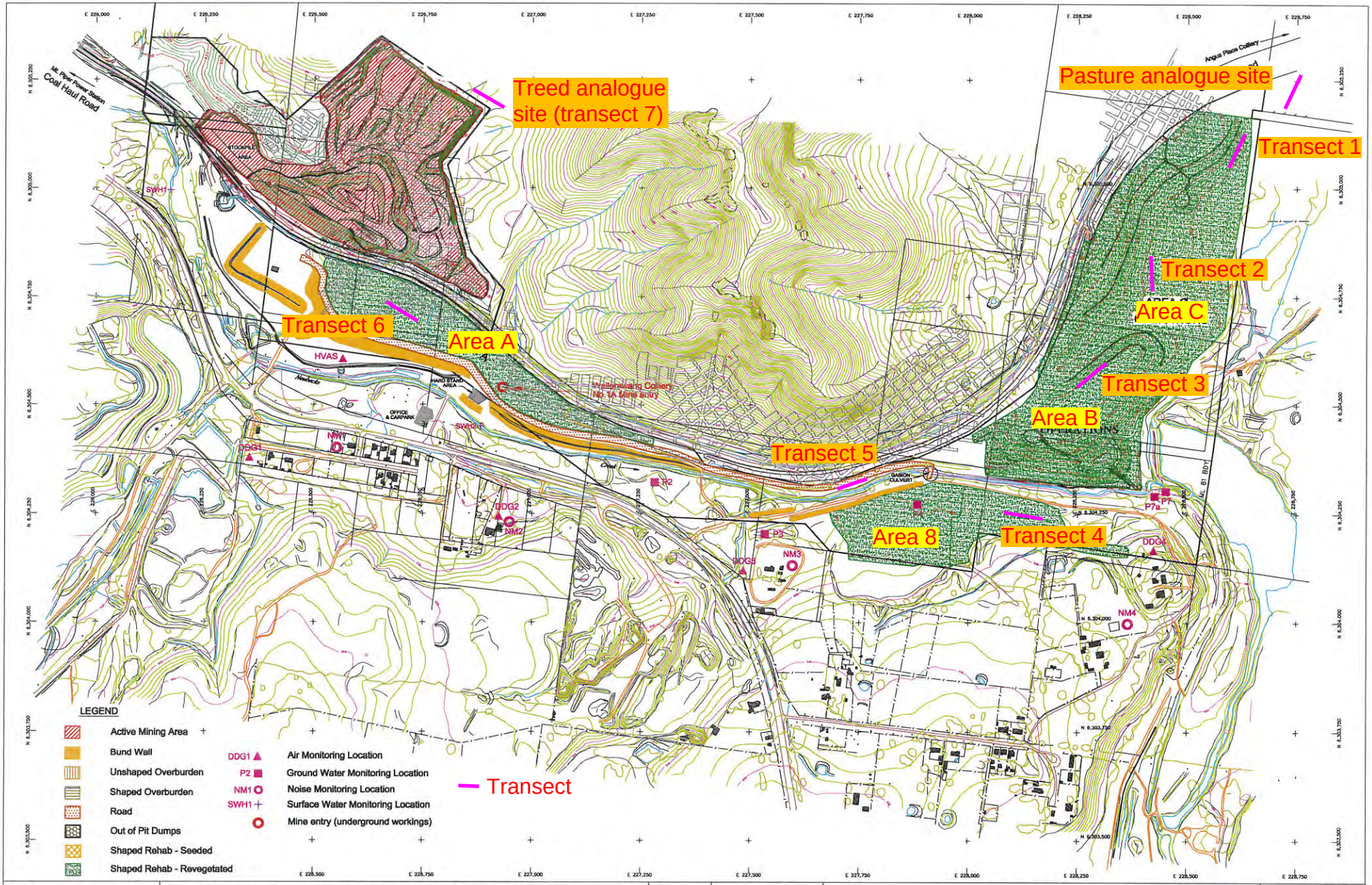
## 4.2 Erosion and sedimentation

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<br>*Species name* | Location | Treatment |
|---|---|---|
| European Red Fox<br>*Vulpes vulpes* | All locations | Landholders are obliged to control populations on their land. |
| European rabbit<br>Oryctolagus cuniculus | | |
| African Lovegrass<br>*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.<br>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<br>1 - <3% slope | 3<br>3 - <10% slope | 4<br>10 - <20% slope, no gully erosion present | 2<br>1 - <3% slope |
| Wind erosion hazard class | 5<br>Moderate wind erodibility class of surface soil, high winds erosive power, high exposure to wind, average annual rainfall >500mm | | | |
| Soil structural decline class | 4<br>Fragile light textured soil - hardsetting | | | |
| Soil acidification hazard class | 4<br>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<br>Moderate to high recharge potential, low discharge potential, low salt store | | | |
| Waterlogging hazard class | 2<br>0 – 0.25 months typical waterlogging duration, moderately well drained soils | | | |
| Shallow soils and rockiness hazard class | 1<br>Nil rocky outcrop, soil depth >100cm | | | |
| Mass movement hazard class | 1<br>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:<br>- Nesting boxes and salvaged hollows<br>- Crushed timber spread over native forest rehabilitation areas<br>- 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.<br>• Vegetation within the treed rehabilitation areas is established in accordance with the approved species mix.<br>• 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


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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.<br>Groundcover dominated by exotic broadleaf herbs and grasses.<br>>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.<br>Groundcover dominated by exotic broadleaf herbs and grasses.<br>>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.<br>Shrub layer of >9 native species.<br>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**<br>Bathurst | | | | | | | |
| Soil erodibility factor **(K)** | **0.03**<br>Sandy loam /fine sandy loam | | | | **0.025**<br>Sandy clay-loam | | | **0.03**<br>Sandy loam /fine sandy loam |
| Topographic factor **(LS)** | **0.17**<br>3% gradient, 5m slope length | | | **0.34**<br>8% gradient, 5m slope length | **0.09**<br>1% gradient, 5m slope length | **0.89**<br>20% gradient, 5m slope length | | **0.52**<br>12% gradient, 5m slope length |
| Cover and management factor **(C)** | **0.01**<br>No appreciable canopy cover, 80-95% grassy groundcover | | | | | **0.04**<br>25% canopy cover of tall weeds or short brush, 60-80% grassy groundcover | **0.01**<br>25% canopy cover of tall weeds or short brush, 80-95% grassy groundcover | **0.00**<br>Consistent with 75% canopy cover of trees and 95% grassy groundcover |
| Erosion control practice factor **(P)** | **1.3**<br>Compacted | | | | | **1.2**<br>Consistent with trackwalking along contour | | **1.3**<br>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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**DOCUMENT CONTROL**

| Reference | Status | Date | Prepared | Checked | Authorised |
|---|---|---|---|---|---|
| 630.12362 | Final Draft | July 2018 | Murray Fraser | Andrew Hutton | Andrew Hutton |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
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**TABLES**

# Table of Contents

# 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<br>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<br>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<br>Approx. 7 hectares | DAP | 0.20 | 1.4 |
| | Mushroom compost | 10 | 70 |
| | Lime | 1 | 7 |
| | Gypsum | 3 | 21 |
| | | | |

**Enhance Place Mine – Morris Property**

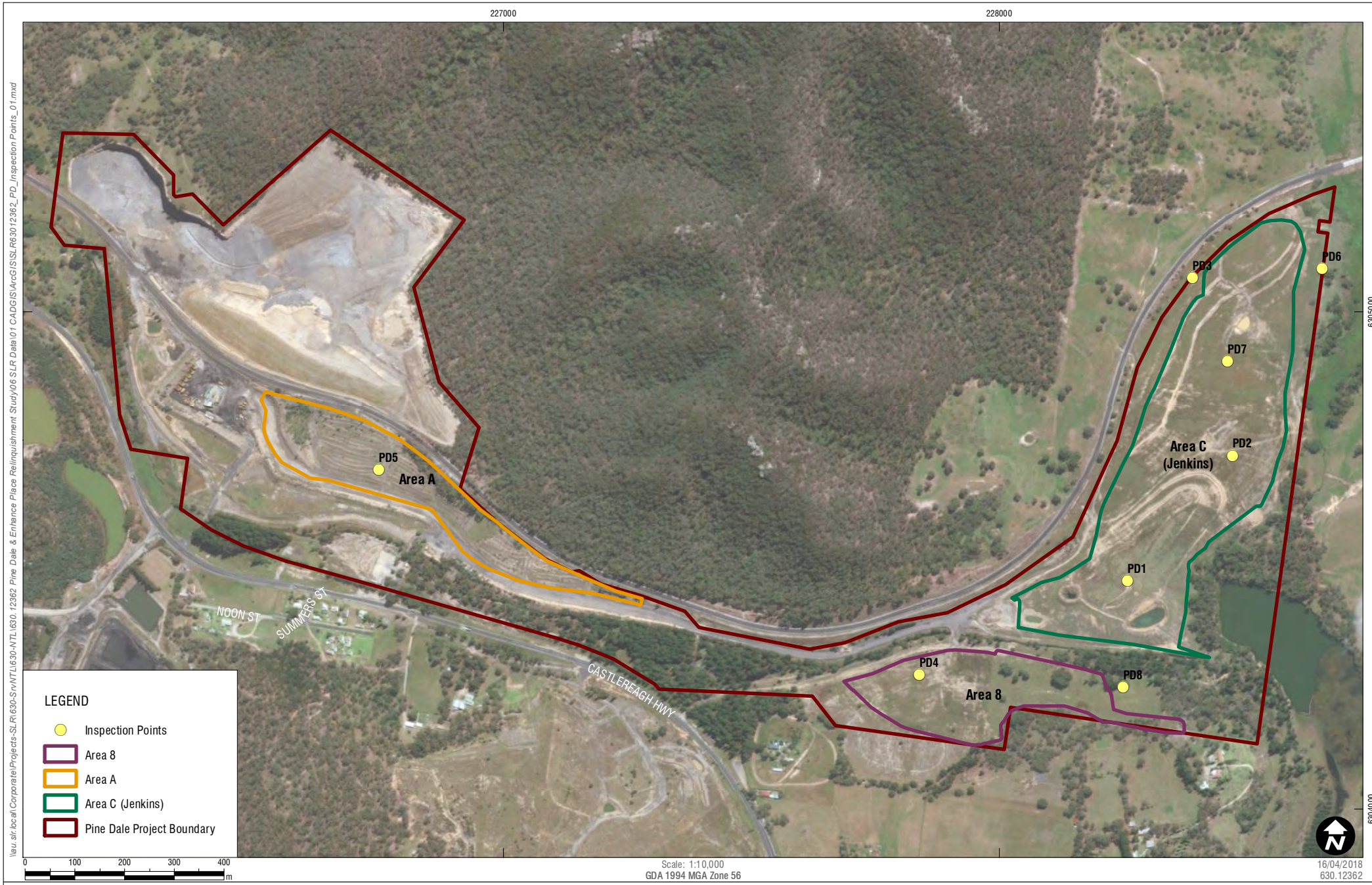
The Morris property requires a boom spray application of *Taskforce* to control African lovegrass and also broadleaf weed control prior to any pasture renovation being undertaken.

**Table 7 Morris Property Fertiliser** Application

| Site | Fertiliser Requirement | Tonnes/ha | Total tonnes |
|---|---|---|---|
| Morris Property<br>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




\\au.slr.local\Corporate\Projects-SLR\630-SrvNTL\630-NTL\630.12362 Pine Dale & Entrance Place Relinquishment Study\06 SLR Data\01 CADGIS\ArcGIS\SLR630123 62_PD_Inspection Points_01.mxd

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

16/04/2018
630.12362

Sheet Size : A4

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**Pine Dale**
**Inspection Points**

**FIGURE 1**


Sheet Size : A4

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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<br>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<br>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<br>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 |

# 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 |

# 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 (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 |

# 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 (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 |

# SOILTEC *SOIL AND PLANT ANALYSIS*

2/37 OWENS CR (PO BOX 374) ALSTONVILLE NSW 2477
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## *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 |

# SOILTEC SOIL AND PLANT ANALYSIS

2/37 OWENS CR (PO BOX 374) ALSTONVILLE NSW 2477
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## *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 |

# SOILTEC SOIL AND PLANT ANALYSIS

2/37 OWENS CR (PO BOX 374) ALSTONVILLE NSW 2477
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## *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

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## *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
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## *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
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## *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
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## ***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
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## *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
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## *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
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## *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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