CULLEN VALLEY MINE ANNUAL REVIEW

1 January – 31 December 2018

March 2019

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FINAL

Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	**Date**	**Name**	**Date**
V1	Graham Goodwin	28 March 2019	Graham Goodwin	28 March 2019

Annual Review Title Block

Name of operation:	Cullen Valley Mine
Name of operator:	Shoalhaven Coal Pty Ltd
Development consent:	DA-200-5-2003
Name of holder of development consent:	Shoalhaven Coal Pty Ltd
Mining leases:	EL 5712, EL 6007, EL 8618, EL 8619, ML 1455, ML 1488, ML 1556, ML 1557
Name of holder of mining leases:	Shoalhaven Coal Pty Ltd
Water licence:	80WA706148
Name of holder of water licence:	Shoalhaven Coal Pty Ltd
MOP start date:	31 December 2015
MOP end date:	30 June 2020
Annual Review start date:	1 January 2018
Annual Review end date:	31 December 2018

I, Graham Goodwin, certify that this audit report is a true and accurate record of the compliance status of Cullen Valley Mine for the period 1 January 2018 to 31 December 2018, and that I am authorised to make this statement on behalf of Shoalhaven Coal Company Pty Limited.

Note.

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

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

Name of authorised report officer:	Graham Goodwin
Title of authorised report officer:	Mining Engineering Manager
Signature of authorised report officer:	
Date:	28 March 2019

Table of Contents

Figures

Tables

Appendices

1.0 Statement of Compliance

This Annual Review has been prepared to provide a summary of the performance of the Cullen Valley Mine (CVM) operations over the period 1 January 2018 to 31 December 2018 (referred to hereafter as the 2018 report period). The compliance of the operation with relevant approvals is summarised in **Table 1.1**.

It is noted that an Independent Environmental Audit (IEA) was undertaken during the 2016 report period. The IEA identified non-compliances with the EPL, Development Approval and the 2003 Environmental Impact Statement mitigation measure commitments. Further details regarding the status of the non-compliances identified by the IEA can be found in **Appendix 1.** A copy of the 2016 IEA is located on the CVM website.

Table 1.1 below provides a statement of compliance for the report period and has identified non-compliances with the Development Consent and EPL. It was determined that a total of 4 non-compliances occurred during the report period. There were three complaints received during 2018 related to odour and one non-compliance in relation to monitoring required to be undertaken by the High Volume Air Sampler (HVAS). The non-compliances recorded during the report period have been ranked according to the risk matrix included in **Table 1.2** and a brief description of each is provided in **Table 1.3**.

Table 1.1 Statement of Compliance

Relevant approval	All conditions complied with?
Development Approval DA-200-5-2003	No – refer to **Table 1.3**
Environment Protection Licence EPL 10341	No – refer to **Table 1.3**
Exploration Licence (EL) 5712	Yes
EL 6007	Yes
EL 8618	Yes
EL 8619	Yes
Mining lease(ML) 1455	Yes
ML 1488	Yes
ML 1556	Yes
ML 1557	Yes
WAL 27898	Yes
Water Supply Work Approval (80WA 706148)	Yes

Table 1.2 Compliance Status Key for Table 1.3

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

Source: Annual Review Guideline (NSW Government, 2015).

Table 1.3 Non compliances recorded during the 2018 Report Period

Relevant Approval	Condition #	Description (Summary)	Compliance Status	Comment and Proposed Action	Where addressed in Annual Review
Development Approval DA-200-5-2003	Condition 27 Schedule 4	Odour complaints associated with sub-surface heating areas at CVM.	**Non–compliant**	Non-compliant due to subsurface heating complaints received by CVM during the report period (refer to **Section 9.2**). Shoalhaven Coal has implemented a combination of inspection, management measures and remediation works during 2018 to manage and treat subsurface heating, refer to **Section 6.9**.	**Section 6.9**
EPL 10341	L6.1	Odour complaints associated with sub-surface heating areas at CVM.	**Non–compliant**	See comments for above non-compliance.	**Section 6.9**
Development Approval DA-200-5-2003	Condition 25 Schedule 4	Failure to monitor in accordance with Air Quality Monitoring Program	**Non–compliant**	On 21 December 2018, a power outage of the HVAS unit at Cullen Valley occurred due to a storm event. This resulted in a failure to monitor in accordance with the methods required in Schedule 4, Condition 25, of DA-200-5-2003). This was reported to DPE on 23 January 2019.	**Section 6.3**

2.0 Introduction

The CVM is located near the village of Cullen Bullen and approximately 30 kilometres (km) north-west of Lithgow in New South Wales (NSW) (refer to **Figure 2.1**).

Underground mining commenced at CVM formerly Tyldesley Colliery around 1904 and continued up until the 1960s when the workings were abandoned. Open cut operations were conducted on the site between 1948 and 1953. Modern open cut operations began at CVM after 19 August 1999 when the Lithgow Coal Company was granted Mining Lease (ML) 1455 by the then Minister for Mineral Resources. Mining commenced on site in May 2000 following a four month construction phase.

Following the identification of additional open cut coal reserves, a further Environmental Assessment and Development Application was lodged for an extension of the mine in April 2003 (i.e. DA-200-5-2003). The lease extension area lies along the western side of Tyldesley Hill adjacent to the main railway line. Approval of the Development Application was granted by the then Department of Planning and Infrastructure (DPI) on 19 August 2004.

CVM has previously supplied coal under contract to the Mount Piper Power Station. However, with the failure of the mine to secure a supply contract in 2007, it was proposed to place the operation on a care and maintenance program until such time as sufficient contracts were awarded that would make the operation of the mine viable once again. Coalpac Pty Ltd purchased the Lithgow Coal Company Pty Ltd, which owned the CVM, in January 2008 and the previous plans to place the mine on care and maintenance were discarded. Recommencement of the open cut mining operations occurred in February 2008. Mining of the available approved area at CVM was completed in early December 2012. Any remaining stockpiled ROM coal was transported to the Invincible Colliery during February 2013 and processed through the Invincible Coal Crushing Plant. The CVM was then placed under care and maintenance.

Shoalhaven Coal purchased the mine from Coalpac's administrators in May 2015 and continues to operate the mine under a care and maintenance arrangement.

2.1 Mine contacts

The Mining Engineering Manager is responsible to the regulatory authorities for all aspects of environmental management and compliance. The Mining Engineering Manager's contact details are included in **Table 2.1** below.

Table 2.1 Key Personnel Responsible for Environmental Management of CVM during Report Period

Name	Contact details
Graham Goodwin Mining Engineering Manager	Based at Invincible Colliery Castlereagh Highway Cullen Bullen, NSW 2790 0418 830 598 Graham.Goodwin@manildra.com.au
Cullen Valley Mine Website (Copies of approvals, licences, management plans, monitoring and other information relating to the operation)	http://www.castlereaghcoal.com.au/

2.2 Annual review requirements

Condition 5 of Schedule 6 of the CVM Extension Development Approval-200-5-2003 requires an Annual Review (AR) to be prepared and submitted to the Department of Planning and Environment (DPE) and relevant agencies. This report has been prepared in accordance with the *NSW Government Annual Review Guidelines* (NSW Government, 2015) and details the operational and environmental management activities at CVM during the report period. The reporting obligations contained in the Development Approval along with an explanation of where each requirement is addressed within this document are provided in **Table 2.2**.

Table 2.2 Development approval (200-5 2003) conditions for the Annual Review

Conditions		Addressed in Section
Schedule 4 – Specific Environmental Conditions Noise		
4.	The applicant shall: a) Investigate ways to reduce the noise generated by the development; b) Implement best practice noise mitigation measures at the development; and c) Report on these investigations and the implementation of any new noise mitigation measures at the development of the AEMR.	Noise management measures are discussed in **Section 6.5**
6.	**Noise Monitoring** Within 3 months of the date of this consent, unless otherwise approved by the DEC, the applicant shall establish a continuous noise monitoring system adjacent to the meteorological weather station required under this consent. This system must be capable of recording LAmax, LA1, LA90 and LAeq noise levels in 15-minute statistical intervals. Unless otherwise agreed, the results of this monitoring must be reported to the DEC on a monthly basis and included in the AEMR.	Results of noise monitoring are included in **Section 6.5**
Schedule 4 – Specific Environmental Conditions Waste Minimisation		
58.	**Waste Minimisation** The applicant shall: a) Monitor the amount of waste generated by the development; b) Investigate ways to minimise waste generated by the development; c) Implement reasonable and feasible actions to minimise waste generated by the development; and d) Report on waste monitoring and minimisation in the AEMR, to the satisfaction of the Director-General.	**Section 6.11**
Schedule 4 – Specific Environmental Conditions Greenhouse Gas		
60.	(e) report on greenhouse gas monitoring and minimisation in the AEMR	**Section 6.14**
Schedule 6 – Environmental Management, Monitoring, Auditing and Report Annual Report		
5.	The Proponent shall submit an AEMR to the Director- General and relevant agencies. This report must:	This document
	(a) identify the standards and performance measures that apply to the project;	Relevant sections throughout **Section 6.0**

Conditions		Addressed in Section
	(b) include a detailed summary of the complaints received during the past year, and compare this to the complaints received in the previous 5 years;	**Section 9.2**
	(c) include a detailed summary of the monitoring results for the project during the past year;	Relevant sections throughout **Section 6.0**
	(d) include a detailed analysis of these monitoring results against the relevant: • impact assessment criteria/limits; • monitoring results from previous years; and • predictions in the EA;	Relevant sections throughout **Section 6.0**
	(e) identify any trends in the monitoring results over the life of the development;	Relevant sections throughout **Section 6.0**
	(f) identify any non-compliance during the previous year;	**Section 11.0**
	(g) describe what actions were, or are being, taken to ensure compliance.	**Section 6.0**, **Section 11.0**

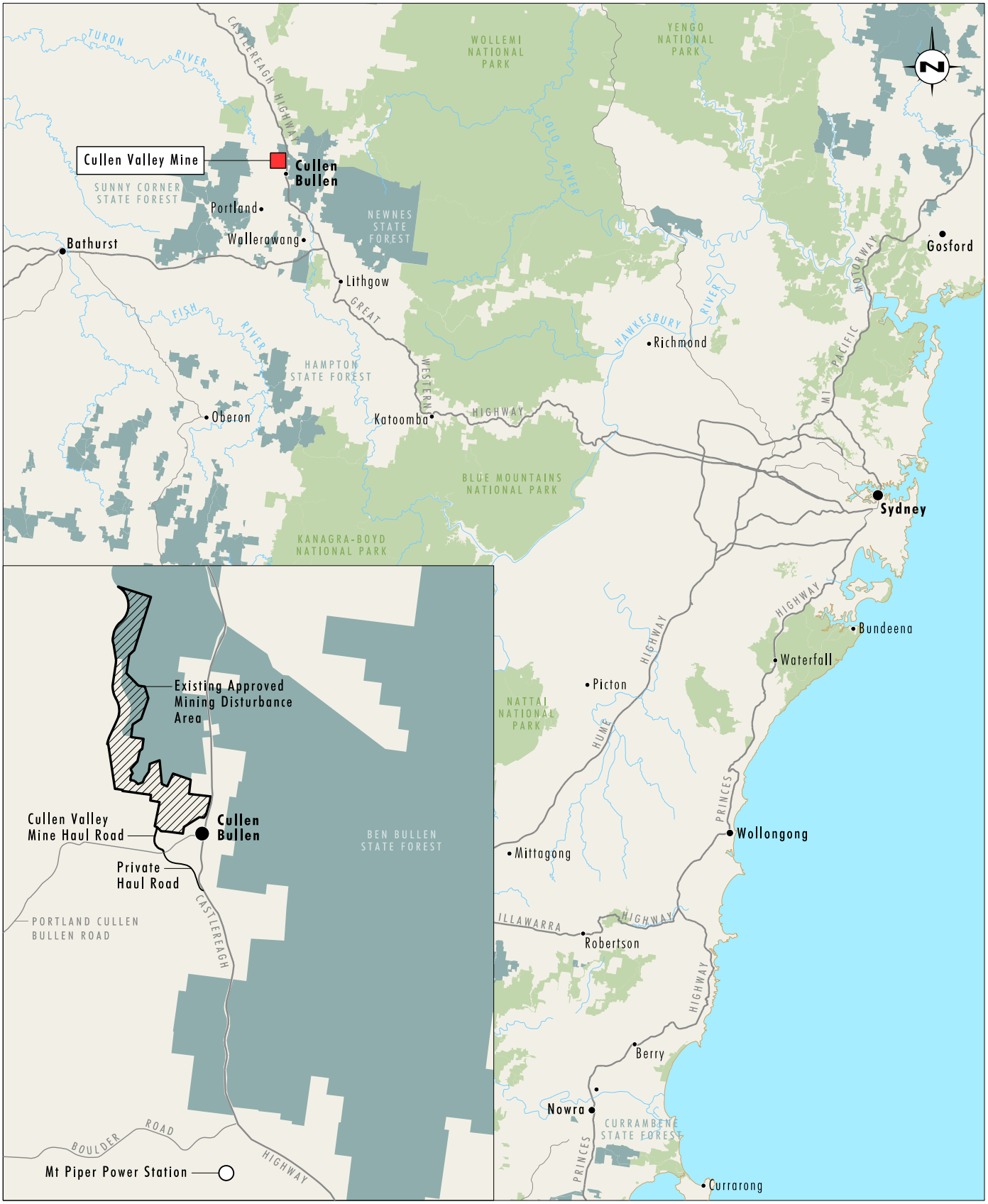


FIGURE 2.1

Locality Plan
Cullen Valley Mine

3.0 Approvals

The operations of CVM during 2018 were regulated by a range of leases, licences and approvals from both State and Local authorities. The current approvals, licences and leases associated with the CVM are listed in **Table 3.1**.

Table 3.1 Environmental approvals held by CVM

Approval	Date Granted	Expiry Date	Status
Development Approval (DA-200-5-2003)	19 August 2004	19 August 2025	Current
Environment Protection Licence (EPL) 10341	10 December (anniversary date)	Annually	Current
Authorisation 324	25 August 1983	9 April 2016	Tenement relinquished by NSW Resource Regulator 19 April 2018.
Authorisation 420	12 January 1990	9 April 2016	Tenement relinquished by NSW Resource Regulator 12 Oct 2017.
Exploration Licence (EL) 5712	10 April 2000	10 April 2019	Renewal report submitted – determination pending.
EL 6007	8 October 2002	7 October 2018	Renewal report submitted – determination pending.
EL 8618	12 July 2017	12 July 2023	Current
EL 8619	12 July 2017	12 July 2023	Current
ML 1455	19 August 1999	18 August 2020	Current
ML 1488	21 June 2001	20 June 2022	Current
ML 1556	20 September 2004	19 September 2025	Current
ML 1557	20 September 2004	19 September 2025	Current
Water Supply Work Approval 80WA706148	16 January 2012	5 July 2025	Current

Care and maintenance activities at CVM are undertaken in accordance with an approved Care and Maintenance (C&M) MOP (Sedgman, 2015) for the site. During late 2017, Shoalhaven Coal identified an opportunity to recommence the progressive rehabilitation of CVM using Virgin Excavated Natural Material (VENM) and Excavated Natural Material (ENM). This material was to be used to meet the rehabilitation obligations (i.e. the filling of the voids and the progression of the final landform). This activity was detailed in a revised Cullen Valley MOP (Shoalhaven Coal, 2018) which was approved by the NSW Trade and Investment – Division of Resources and Geoscience (DRG) on 6 March 2018. During the 2018 report period, CVM received a small volume of VENM / ENM at CVM. As a result of discussions between DPE and Shoalhaven Coal, the receipt of VENM / ENM at CVM ceased on 29 March 2018 and no further VENM / ENM has been received since this time. During 2019, Shoalhaven Coal will continue to liaise with DPE regarding the receipt of VENM / ENM at CVM.

The C&M MOP (Sedgman, 2015) was further reviewed during late 2018 to seek an extension of the approved MOP term, with a revised MOP being approved by DRG for activities up to 30 June 2020.

3.1 Status of management plans

In accordance with the DA-200-5-2003, CVM is required to implement a range of environmental management plans. **Table 3.2** identifies the environmental management plans and the approval status of each plan at the end of the report period. During 2019, Shoalhaven Coal will liaise with DPE regarding the review of the Flora and Fauna Management Plan and the Water Management Plan.

In accordance with the requirements of the Protection of the Environment Operations Act (1997), CVM also reviewed and updated the Pollution Incident Response Management Plan (PIRMP) during December 2018. The updated PIRMP has been placed on the Castlereagh Coal website.

Table 3.2 Status of DA-200-5-2003 Management Plans

Management Strategy / Plan	Approved	Modified Plan Submitted	Approved	Approval Agency
Environmental Management Plan (Coalpac, 2012c)	Yes	N/A	Yes	DPE
Flora and Fauna Management Plan (Coalpac, 2012a)	Yes	N/A	Yes	DPE
Flora and Fauna Management Plan (Umwelt, 2017a)	N/A	29 June 2017	Pending	DPE
Water Management Plan (Umwelt, 2017b)	N/A	31 August 2017	Pending	DPE
Species Management Plan (Clandulla Geebung) (Coalpac, 2012f)	Yes	N/A	Yes	DPE
Environmental Monitoring Program (Coalpac, 2009)	Yes	N/A	Yes	DPE
Blast Management Plan (Coalpac, 2012d)	Yes	N/A	Yes	DPE
Fire Management Plan (Coalpac, 2012e)	Yes	N/A	Yes	DPE
Cullen Valley C&M MOP (Sedgman, 2015)	Yes	2018	Yes	DRG
CVM and Invincible Colliery Pollution Incident Response Management Plan (PIRMP) (Umwelt, 2018c)	N/A	N/A	N/A	EPA

4.0 Operations Summary

4.1 Mining operations

No production occurred during the report period. A summary of the production figures and mining activity for 2018 and the forecast production for 2019 is summarised in Table **4.1**. It is noted that the CVM has been on care and maintenance since 2013 and therefore there has been minimal activity at the operations since this time. The production summary is included in **Table 4.1** below.

Table 4.1 Production summary

Material	Approved limit (specify source)	2017 Previous reporting period (actual)	2018 This reporting period (actual)	2019 Next report period (forecast)
Waste rock/overburden	Not specified	0	0	0
Coal works / Coal mining	0-2 Mtpa Coalworks (EPL) 0.5-2 Mtpa Mining for Coal (EPL) 1 Mtpa (DA)	0	0	0
Coarse reject	Not specified	0	0	0
Fine reject (tailings)	Not specified	0	0	0
Saleable coal	Not specified	0	0	0

4.1.1 Waste rock/overburden

As the site has been in care and maintenance since 2013, there were no mining activities undertaken during the report period. Therefore, no waste rock or overburden was produced.

4.1.2 ROM Coal

As the site has been in care and maintenance since 2013, there were no mining activities undertaken during the report period. Therefore, no coal was handled or produced.

4.1.3 Coarse reject

As the site has been in care and maintenance since 2013, there were no mining activities undertaken during the report period. Therefore, no coal reject material was produced.

4.1.4 Fine reject (tailings)

As the site has been in care and maintenance since 2013, there were no mining activities undertaken during the report period. Therefore, no tailings were produced.

4.1.5 Saleable coal

As the site has been in care and maintenance since 2013, there were no mining activities undertaken during the report period. Therefore, no coal was produced for sale.

4.2 Other operations

During the report period, the works undertaken included works to treat subsurface heating which included the excavation and compaction of surface material (refer to **Section 6.9**).

As discussed in **Section 3.0**, during the report period a small volume of VENM and ENM was received by CVM however as a result of discussions between DPE and Shoalhaven Coal, the receipt of VENM / ENM at CVM ceased on 29 March 2018 and no further VENM / ENM has been received since this time. During 2019, Shoalhaven Coal will continue to liaise with DPE regarding the ability of CVM to receive VENM / ENM,

There was no exploration undertaken during the report period.

4.3 Next report period

There are no coal mining operations proposed during the 2019 report period at CVM. To assist with the progressive rehabilitation of CVM, during the 2019 report period Shoalhaven Coal will continue to liaise with DPE regarding the ability of CVM to receive VENM and ENM to assist in developing the final landform for CVM.

5.0 Actions required from previous annual review

Following submission of the 2017 Annual review to DPE on 29 March 2018, DPE requested that future AEMRs provide trends over the life of the development for all parameters monitored, required clarification of VENM/ENM received on site and requested that the AEMR was to be made publically available on Castlereagh Coal's website. These requirements, works undertaken to address these actions and where they are addressed in this Annual Review are detailed in **Table 5.1** below.

Table 5.1 DPE Requirements following review of CVM 2017 annual review

DPE Requirement	Works Undertaken	Where addressed in this Document
Future AEMRs provide trends over the life of the development for all parameters monitored, including but not limited to PM_{10}/TSP and surface water.	Results and trends of all monitored parameters have been included in this AEMR.	**Section 6.3** and **6.4**
A response is to be provided by 11 May 2018 detailing under what approval VENM/ENM is planned to be transported to site for use in rehabilitation and when this activity is planned to occur.	A response was provided to DPE by Shoalhaven Coal on 11 May 2018. Further information on the status of the VENM / ENM in included in **Section 3.0** and **Section 4.2.**	**Section 3.0** and **Section 4.2**
The AEMR is to be uploaded to the website within one month of the date of this approval.	The AEMR was uploaded to the Castlereagh Coal website.	N/A

6.0 Environmental Performance

In accordance with the Annual Review Guidelines (DPE, 2015), this section describes the environmental monitoring and management measures undertaken at CVM during the report period. **Section 3.1** details the environmental management plans which have been prepared for the operation.

A range of environmental monitoring is required to be undertaken by the Development Consent, EPL and CVM management plans. **Figure 6.1** shows the CVM environmental monitoring locations.

6.1 Summary of performance against EIS predictions

CVM has been the subject of two Environmental Impact Statements (EIS) in the last 20 years of operations. The results of environmental monitoring conducted during the report period are compared to the predictions of these EIS's.

The Feldmast Coal Project for open cut and underground operations to the north-east and north-west of Cullen Bullen was assessed in the EIS dated February 1997 (International Environmental Consultants, 1997). The CVM Lease Extension Project involved expanded operations further to the north-west of the original mining area adjacent to the Wallerawang-Gwabegar Railway line and was assessed in the EIS dated April 2003 (International Environmental Consultants, 2003).

Environmental monitoring undertaken includes noise, air quality, water quality and biodiversity. Below is a summary of predictions from the two EIS's completed for the site. **Table 6.1** provides a summary of CVM environmental performance against the EIS predictions for the report period. It is noted that modelling undertaken for the respective EIS's assumed mining operations were being undertaken. As noted previously, CVM is in care and maintenance and there were no mining operations during the report period.

6.1.1 Noise predictions

The Feldmast EIS (1997) predicted that with construction of the noise bund, noise from open cut operations was expected to result in an increase in existing background levels measured at the Hillcroft property (Hillcroft) of no more than 5 dB(A). The construction of a private access road between the mine and Mudgee Road to bypass Cullen Bullen was completed during the construction phase and was expected to minimise truck noise. The bypass around Cullen Bullen and noise bund were constructed, significantly reducing traffic and noise impacts on the town and nearby properties.

In the 2003 EIS and approved extension to mining operations, noise exceedances of 2-4 dB(A) were predicted to occur at Red Springs during temperature inversion conditions. Noise exceedances of 4-7 dB(A) were also predicted at Hillcroft during temperature inversion conditions. At Forest Lodge, exceedances of 1 dB(A) (calm), 5dB(A) (south wind) and 5dB(A) (temperature inversion) were predicted in Years 9 and 10 of the extension operations. Exceedances of 3 dB(A) (calm), 10dB(A) (south wind) and 5dB(A) (temperature inversion) were also predicted during years 9 and 10 at the 25 acre allotments to the north of the mine. *NB: These are exceedances of the 35 dB(A) criteria.*

6.1.2 Air quality predictions

The Feldmast EIS (1997) predicted annual average TSP concentrations from background levels plus mine emissions to be 48 $\mu g/m^3$ at the closest residences to the mine, which is well below the 90 $\mu g/m^3$ annual average goal. Predicted PM_{10} concentrations were 24 $\mu g/m^3$ (background plus mine emissions) and this is well below the annual average goal of 30 $\mu g/m^3$. $PM_{2.5}$ concentrations from mine emissions were predicted to be 0.5 $\mu g/m^3$ at the closest residence.

Modelling of dust deposition in the worst case scenario predicted that no long-term adverse air quality impacts were expected at the closest residential area as a result of mine operations.

The 2003 EIS predicted that nearby residences and those in Cullen Bullen were unlikely to experience unacceptable long-term impacts on air quality from the mine extension operations. It was predicted that short-term impacts could occur if emissions from the mine extension operations were combined with elevated levels from other sources.

6.1.3 Water quality predictions

Given the water management system contains and treats water within storage ponds prior to discharge, the Feldmast EIS (1997) predicted that EPA discharge criteria would be met. All water within the Lithgow Seam was proposed to be drained within the mining area. Groundwater systems below the Lithgow Seam were expected to be unaffected by the project.

The 2003 EIS predicted that the water management system for containment and reuse of all runoff from disturbed areas would ensure that EPA licence criteria for surface water quality would be met. The project was expected to use underground water within the old Tyldesley underground workings which collects subsurface water contained within the coal measures. Groundwater systems below the Lithgow Seam were expected to be unaffected by the project.

6.1.4 Groundwater predictions

During the 2017 report period, a review of the groundwater regime in the vicinity of CVM was undertaken which resulted in the development of a standalone CVM Water Management Plan (Umwelt, 2017b).
For the purposes of this report, the results of the 2018 groundwater monitoring have been compared to the groundwater trigger levels contained in the CVM Water Management Plan (Umwelt, 2017b).

6.1.5 Biodiversity predictions

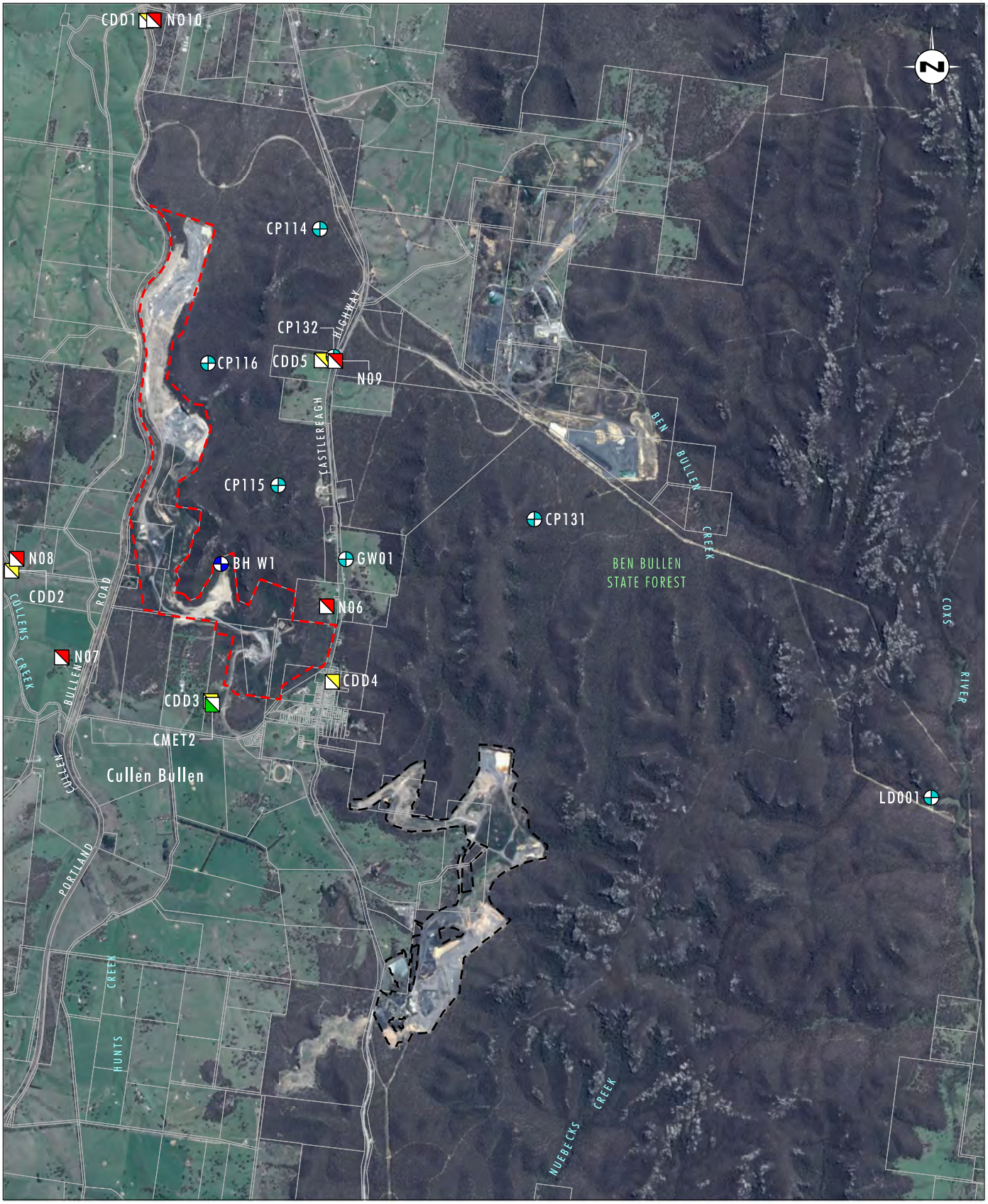
Only one threatened plant species, Capertee Stringybark, was found to occur in the study area during the Feldmast EIS (1997). The EIS predicted that no local population of Capertee Stringybark would be placed at risk of extinction as a result of the proposed mining operations. The 2003 EIS made similar predictions and concluded that there would not be a significant effect on Capertee Stringybark as a result of the expansion.

The 1997 EIS predicted that the mining operations were unlikely to cause a significant impact on threatened fauna species found in the study area. Similarly, the 2003 EIS predicted that the expansion was unlikely to have a significant impact on threatened fauna.

A summary of the environmental performance of CVM during the report period as compared to predictions made in the EIS's is provided in **Table 6.1**.

Table 6.1 Summary of environmental performance during 2018

Aspect	Development Approval criteria / EA prediction	Performance during the report period	Trend / key management implications	Proposed additional management actions
Noise	Refer to **Section 6.1.1**	**Compliant** Noise performance is compliant with Development Approval criteria and conforms to EIS predictions. Refer to **Section 6.5**	No noise exceedance recorded during 2018. Historic trends are shown In **Section 6.5**	No further action required. The NMP will be reviewed should mining operations recommence.
Air Quality	Refer to **Section 6.1.2**	**Non-compliant** Air Quality monitoring conforms to EIS predictions. Non-compliance relates to failure of air quality monitoring equipment. Refer to **Section 6.3**	A comparison to historic trends for air quality are shown in **Section 6.3** and **Appendix 2**	No further action required. Dust emissions on site to continue to be managed in accordance with approved management plan.
Water Quality	Refer to **Sections 6.1.3** and **6.1.4**	**Compliant** Surface water quality performance is compliant with Development Approval criteria and conforms to EIS predictions. Refer to **Section 6.4.1**. Groundwater monitoring has been compared to trigger levels developed during 2017 in **Section 6.4.2**.	A comparison of Surface Water Quality results to historic trends are shown in **Section 6.4.2** and **Appendix 3.** Groundwater monitoring was undertaken and is discussed in **Section 6.4.2** and **Appendix 4**.	Groundwater monitoring will continue to occur during the 2019 report period.
Biodiversity	Refer to **Section 6.1.5**	**Compliant** Rehabilitation areas are progressing towards satisfactory completion.	The revised Biodiversity Monitoring Program commenced in 2016 and will be continued in 2019.	Biodiversity monitoring will continue to be undertaken during 2019.



Legend

- Existing Approved Mining Disturbance Area - Cullen Valley
- Existing Approved Mining Disturbance Area - Invincible
- Depositional Dust Monitoring Point
- Meteorological Station
- Noise Monitoring Point
- Surface Water Monitoring Point
- Groundwater Monitoring Point

FIGURE 6.1

Environmental Monitoring Locations
Cullen Valley Mine

6.2 Meteorological monitoring

Meteorological monitoring is undertaken at CVM. The CVM weather station (CMET2) is located at the training centre adjacent to the compensatory habitat area (see **Figure 6.1**). A summary of monthly meteorological monitoring results is provided in **Table 6.3.**

6.2.1 Rainfall

CVM received 531 mm of rainfall over 122 rain days during the report period. The highest rainfall occurred during November (99.4 mm), while July had the lowest rainfall (3.6 mm). A summary of monthly rainfall data is provided in **Table 6.3**.

6.2.2 Temperature

Air temperature is measured at 2 m and 10 m above ground level. The maximum temperature recorded during the report period was in January (39.3°C @ 2m, 37.9°C @10m) and the lowest temperature occurred in July (-10.8°C @ 2m, -9.4°C @10m). The minimum and maximum monthly temperature data is provided in **Table 6.3**

6.2.3 Humidity

The highest humidity recorded during the report period at CVM occurred during December (99.0%) and the lowest was during January (5.7%) as shown in **Table 6.3**.

6.3 Air quality

6.3.1 Environmental management measures

CVM's Environmental Management Plan (Coalpac, 2012c), includes an Air Quality Management Plan (AQMP), which defines mitigation measures and monitoring procedures for the management of dust.

The air quality monitoring network at CVM consists of five dust deposition gauges (i.e. CDD1 to CDD5) and one High Volume Air Sampler (HVAS) measuring particulate matter <10 µm (PM_{10}) (see **Figure 6.1**).

6.3.2 Performance criteria

The air quality impact assessment criteria specified in DA 200-5-2003 are provided in **Table 6.2**

Table 6.2 Air quality impact assessment criteria

Pollutant	Averaging Period	Criterion
Total suspended particulate (TSP) matter	Annual average	90 µg/m^3
Particulate matter <10µm (PM_{10})	Annual average	30 µg/m^3
	24 hour average	50 µg/m^3
Deposited dust	Annual average (maximum total)	4 g/m^2/month
	Annual average (maximum increase)	2 g/m^2/month

Table 6.3 CVM weather station summary

Month	Rainfall (mm)	Cumulative Rainfall (mm)	No of rain days	Air temp @ 2m (°C)		Air temp @ 10m (°C)		Humidity (%)	
				Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
January 2018	36.4	36.4	9	4.0	39.3	5.2	37.9	5.7	96.1
February 2018	59.6	96	7	4.7	36.9	5.7	35.7	6.0	95.3
March 2018	40.0	136	6	-0.6	33.1	0.6	31.8	13.3	96.0
April 2018	30.8	166.8	8	-0.6	31.2	1.1	29.9	14.1	96.3
May 2018	11.0	177.8	8	-4.3	22.1	-3.6	21.3	14.1	94.9
June 2018	35.2	213	18	-7.4	16.1	-5.7	15.6	13.4	95.5
July 2018	3.6	216.6	8	-10.8	18.5	-9.4	17.6	12.3	94.7
August 2018	43.6	260.2	9	-6.9	19.2	-6.0	18.7	9.2	94.7
September 2018	52.4	312.6	11	-4.7	25.0	-3.6	24.0	13.9	94.8
October 2018	71.2	383.8	18	-0.5	29.1	1.0	28.0	13.3	97.3
November 2018	99.4	483.2	12	1.5	30.6	2.6	29.1	15.3	96.2
December 2018	47.8	531.0	8	0.1	36.9	0.3	36.1	11.3	99.0
Total	531.0	-	122	-	-	-	-	-	-

6.3.3 Environmental outcomes

Deposited dust is monitored on a monthly basis at 5 representative locations around the mine site (dust deposition gauges CDD1 to CDD5). The annual average criterion for deposited dust (4 g/m^2/month) was not exceeded at any of the dust deposition gauges during the report period. The increase in annual average dust levels was less than the criterion of 2 g/m^2/month at all gauges. The deposited dust monitoring results for 2018 are shown in **Table 6.4** and is compared with historical results in **Appendix 2**.

Table 6.4 Deposited dust monitoring results

	Total Insoluble Solids (g/m^2/month)				
Date	**CDD1**	**CDD2**	**CDD3**	**CDD4**	**CDD5**
January 2018	1.0	0.7	1.0	1.5	1.4
February 2018	0.5	0.8	1.4	0.5	0.9
March 2018	0.3	0.7	0.9	1.0	1.1
April 2018	0.4	0.7	0.7	0.8	0.4
May 2018	1	<0.1	0.4	0.8	0.6
June 2018	0.2	0.3	0.4	0.4	1.0
July 2018	0.3	0.7	0.5	0.8	1.8
August 2018	0.8	0.5	0.6	0.5	1.2
September 2018	0.6	0.7	1.1	0.4	1.5
October 2018	0.7	0.9	0.9	1.2	3.8
November 2018	1.1	9.0*	1.0	3.6	2.1
December 2018	2.9	4.2	2.9	2.5	1.8
Annual Average 2018	**0.8**	**0.9**	**1.0**	**1.2**	**1.5**

Note*: These results have been excluded from the annual average calculations as the dust gauge was contaminated.

Monitoring of particulate matter was conducted during 2018. Total suspended particulates are estimated from the PM_{10} concentrations. The annual average criteria for PM_{10} (30 µg/m^3) and TSP (90 µg/m^3) were not exceeded during the report period. Results in excess of the 24 hour maximum allowable limit for PM_{10} (50µg/m^3) were recorded on two occasions during the report period, however these results were attributed to regional weather events. On 21 November 2018 and 15 December 2018, the HVAS unit at Cullen Valley recorded results in excess of the 24 hour PM10 criteria limit of 50µg/m^3 as specified in DA-200-5-2003. These elevated concentrations were influenced by an "extraordinary event" and were impacted by regional dust events observed by mining personnel, and demonstrated by monitors in OEH's air quality monitoring network in the vicinity of Cullen Valley which also recording elevated results. There were no operations undertaken at CVM on these days that would have led to the generation of dust as the mine was on care and maintenance. DPE was notified of these elevated readings in relation to the extraordinary event on 23 January 2019.

The PM_{10} monitoring results for the reporting period are shown in **Table 6.5**.

Table 6.5 Particulate matter (PM_{10}) and Total Suspended Particulates (TSP) results

	PM_{10} (µg/m^3)	TSP (µg/m^3)
Annual Average 2018	13.7	34.3

Note*: Total suspended particulates are estimated from the PM_{10} concentrations

On 21 December 2018, a power outage of the HVAS unit at Cullen Valley occurred due to a storm event. This resulted in a failure to monitor in accordance with the methods required in Schedule 4, Condition 25, of DA-200-5-2003. This was reported to DPE on 23 January 2019.

6.3.4 Trends in data

Annual averages for dust deposition during 2018 are compared with monitoring data from the previous five years in **Table 6.6** below. Graphs of the long term dust deposition results are included in **Appendix 2**. The annual averages for particulate matter recorded at CVM during 2018 are within the range of results recorded in the previous five years and are well below criteria limits.

Table 6.6 Annual averages for dust deposition 2013 -2018

	Total Insoluble Solids (g/m2/month)				
Year	CDD1	CDD2	CDD3	CDD4	CDD5
2013	0.7	0.6	0.7	0.6	1.2
2014	0.6	0.6	0.6	0.7	2.9
2015	0.2	2.7	0.4	0.8	0.6
2016	0.2	0.6	0.4	0.6	0.8
2017	0.5	1.3	0.5	0.6	1.3
2018	0.8	0.9	1.0	1.2	1.5

A graph of the PM_{10} and TSP monitoring data for 2018, as well as historical data trends, is shown in **Appendix 2**.

6.3.5 Proposed improvements

No additional mitigation measures or monitoring procedures are proposed to be implemented which are outside that detailed in the CVM EMP (Coalpac, 2012c).

6.4 Water management

During 2017 a standalone Water Management Plan (Umwelt, 2017b) was prepared for the CVM was submitted to DPE for approval (refer to **Section 3.1**). The WMP sets out water quality criteria, mitigation measures and monitoring procedures for the management of surface water and groundwater.

6.4.1 Surface water quality

6.4.1.1 Environmental management measures

The surface water management system at CVM utilises a series of settlement dams. The system is primarily operated as a closed loop system. The CVM Water Management System (WMS) incorporates a range of infrastructure to manage clean water runoff from upslope undisturbed catchments, dirty water runoff from disturbed catchments and mine water (i.e. groundwater extracted from former underground workings or water that has come into contact with coal). Whilst CVM is on care and maintenance, mine water is only utilised for dust suppression. Where mine water is utilised for dust suppression it is captured and managed within the dirty water management system. The fundamental principle of the WMS is to minimise

interaction of clean, dirty and mine waters and to capture dirty water for re-use and provide controls to treat captured dirty water to a standard suitable for discharge off-site.

The Tyldesley Mine underground workings are also used to store excess water from the WMS. The primary source of water for site use (when required) is from the abandoned and flooded Tyldesley Mine underground workings via the Tilley's Bore (GW01) in accordance with Water Access Licence WAL27898. When required, water is pumped from the workings via the Tilley's Bore to two 500,000 L tanks at CVM. Site water is transferred between site dams through gravity fed water mains.

CVM operates under EPL 10341. The EPL provides water quality criteria and water quality monitoring requirements for water discharges from the two CVM Licensed Discharge Points (LDP's) being LDP 001 and LDP 004, refer to **Figure 6.1**. Further discussion regarding water management and erosion and sediment control measures is included in **Section 7.0**.

6.4.1.2 Performance criteria

Water may be discharged from LDP 001 and LDP 004 at CVM in accordance with EPL and Development Approval requirements. **Table 6.7** presents the EPL discharge criteria for these discharge points.

Table 6.7 Water quality concentration limits for LDP 001 and LDP 004 during discharge

Pollutant	Concentration limit
Oil & Grease	10 mg/L
pH	6.5 – 8.5
Total suspended solids (TSS)	30 mg/L

6.4.1.3 Environmental outcomes

Water quality monitoring is conducted monthly at settlement dams associated with LDP 001 and LDP 004 regardless of the discharge status. This is undertaken for due diligence purposes to monitor the water quality within the respective dams. There were no discharge events from LDP 001 and LDP 004 during the 2018 report period. The results of the monthly due diligence monitoring at Dam 1 and Dam 4 are included in **Appendix 3**.

6.4.1.4 Trends in data

As noted above, during the 2018 report period there was no discharge from EPL Points LDP001 and LDP004. The monthly water quality results in Dam 1 and Dam 4 during 2018 are therefore for due diligence purposes only, refer to **Appendix 3.**

Due Diligence Monitoring

The pH results for Dams 1 and 4 during the report period ranges between 6.4 and 8.1, as shown in **Appendix 3**. This range is generally consistent with those recorded during the previous 2017 report period (i.e. 6.5 and 8.0).These levels are within the EPL discharge criteria however there were no discharges during the report period.

Oil and grease was below detection limits in Dam 1 and Dam 4 during the report period.

Results of TSS monitoring were elevated in Dam 1 during December 2018 and in Dam 4 during July 2018, but were below the EPL discharge criteria for remaining months. As noted previously, these water quality

results are for due diligence/site management purposes as there was no discharge from EPL Points LDP 001 and LDP 004 during the report period.

6.4.1.5 Proposed improvements

No additional mitigation measures or monitoring procedures are proposed to be implemented which are outside that detailed in the WMP (Umwelt, 2017b).

6.4.2 Groundwater quality

6.4.2.1 Environmental management measures

CVM is located on the western escarpment of the Sydney Basin. Aquifers in this area are typically limited to the Lithgow Seam and the Marangaroo Sandstone which underlies the Lithgow Seam. Despite their proximity, there is little observed horizontal movement between these aquifers in the Marangaroo Sandstone and the Lithgow Seam (AGE, 2012).

Past open cut and highwall mining at CVM has targeted the Irondale, Lidsdale and Lithgow seams. Underground mining in the area has been largely limited to the Lithgow seam. The Lithgow Seam can be seen in the highwalls faces at CVM (some of which are now covered by emplaced overburden). Outcrop areas north of the open cut workings represent local recharge points for the Lithgow seam.

Figure 6.2 shows the general dip in the strata of the Lithgow seam to the east - northeast and the location of underground workings in the Lithgow seam in the area. The open cut workings in the southern parts of the CVM are hydraulically connected to the former Tyldesley Colliery workings which extend to the east of the southern part of CVM (refer to **Figure 6.2**). The water in the Tyldesley Colliery workings is sourced from groundwater inflows (i.e. recharge areas) located up-dip, ingress from areas at CVM where the open cut operations are hydraulically connected to the Tyldesley workings, and infiltration through subsidence cracking associated with pillar extraction and pillar failure in the former workings. Water quality in these workings is monitored at GW01 (East Tyldesley Bore) (refer to **Figure 6.2**).

As can be seen from **Figure 6.2**, the CVM pit is located up-dip of the Lithgow seam groundwater monitoring bores of CP 116, CP 115 and CP 132 and operates as a recharge point for the Lithgow seam in this area. As mining at CVM extended to the base of the Lithgow Seam and as CVM represents an up-dip recharge point of this aquifer, the open cut at CVM do not intercept any natural groundwater aquifers. Therefore, there are limited depressurisation impacts associated with the CVM open cut pits and any impacts would be associated with interactions with the recharge regime; these impacts are expected to be limited due to the low recharge rates and the generally benign nature of the overburden emplaced adjacent to the outcropping coal seams (Umwelt, 2017b).

6.4.2.2 Performance criteria

There are no pollutant concentration limits for groundwater specified in the Development Approval or EPL for CVM. The CVM WMP (Umwelt, 2017b) includes trigger values against which groundwater monitoring results are compared. For the purposes of this Annual Review, the groundwater results obtained during the report period have been compared to these trigger values.

The CVM WMP (Umwelt, 2017b) has reviewed the location and target seam for each groundwater monitoring bore and considers the CP115, CP116 and GW01 groundwater monitoring bores are suitable to assess any potential offsite groundwater impacts associated with the operation of CVM. These bores are located down dip of CVM and are also located within appropriate seams. **Table 6.8** shows the trigger level/range for key groundwater monitoring parameters that are specific to bores CP115, CP116 and GW01. Results outside of these ranges are triggers for further investigation. The results of CP115, CP116 and

GW01 are also compared to reference bores which are bores that are considered to be representative of background groundwater quality (refer to **Section 6.4.2.4**).

Table 6.8 Groundwater quality and level triggers as defined in CVM WMP (Umwelt, 2017b)

Bore	Groundwater Level (mAHD) Trigger Range	Analyte			
		pH	EC (us/cm)	Sulphate (mg/L)	Hardness (mg of $CaCO_3$/L)
CP116	890 - 894	Range 5.82 - 7.2	Upper limit 840	Upper limit 140	Upper limit 210
CP115	892 - 896	Range 6.26 - 7.3	Upper limit 970	Upper limit 380	Upper limit 376
GW01[1]	N/A as bore is located in workings	Range 6.14 - 6.82	Upper limit 939	Upper limit 338	Total Alkalinity[2] Upper limit 100 mg of $CaCO_3$

[1] Baseline data for GW01 has been obtained from 11 groundwater monitoring events over an 11 month period from 2016-2017 for the trigger levels. The trigger levels will be refined in 2019 to consider the data included from the 2018 monitoring period.

[2] GW01 has not been monitored for Hardness as part of groundwater quality baseline monitoring. Total Alkalinity has been used as a proxy for Hardness, and will be utilised as a trigger for this bore until sufficient baseline data for hardness has been obtained for this bore to develop a trigger value.

Baseline groundwater monitoring programs and associated trigger levels when developed in accordance with ANZECC recommendations require the utilisation of 24 contiguous monthly samples (ANZECC, 2000). The trigger levels for groundwater monitoring at CVM have been developed utilising the groundwater data set which is a limited data set of between nine and eleven annual groundwater samples at each location between the period 2011 – 2017. It is therefore intended that the groundwater trigger levels for the CVM groundwater bores will be refined during 2019 to incorporate the additional monitoring data obtained during the 2018 report period. The trigger action response plan, as detailed in the CVM WMP (Umwelt, 2017b) defines a process for reviewing results which are outside of the groundwater trigger levels as detailed in **Table 6.8**. Section 5.7.1 of the CVM WMP (Umwelt, 2017b) states:

> *'Monitoring results observed outside groundwater quality and level triggers identified in Table 5.3 do not necessarily reflect an environmental impact associated with CVM, as variances within the CVM bores may be influenced by natural environmental variations and /or localised land use activities (not associated with CVM activities).'*

6.4.2.3 Environmental outcomes

During the report period, groundwater monitoring was conducted on two occasions (refer to **Table 6.9**). A discussion of the 2018 groundwater monitoring results is included in **Section 6.4.2.4**.

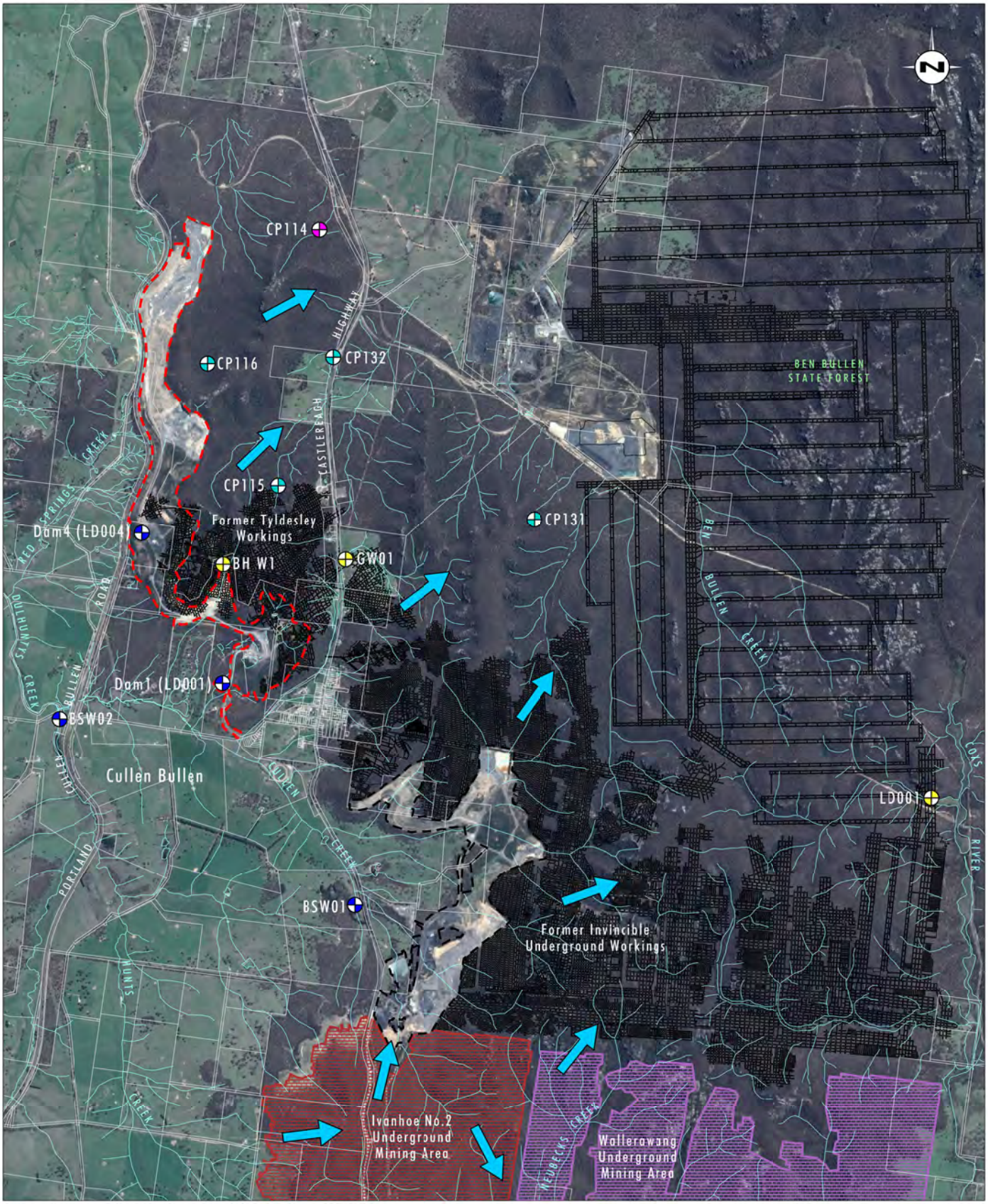


Image Source: Google Earth - CNES/Astrim (2016)
Data Source: LPI (2016), Sedgman (2014)

0 0.5 1.0 2.0km
1:50 000

Legend

- Open Cut Mining Disturbance Area - Cullen Valley
- Existing Mining Disturbance Area - Invincible
- Direction of Coal Seam Dip
- Former Invincible Underground Workings
- Invincible Project Approval Boundary
- Wallerawang Underground Mining Area
- Groundwater Monitoring Point (Lithgow Seam)
- Groundwater Monitoring Point (Marangaroo Sandstone)
- Groundwater Monitoring Point (Underground Workings)
- Surface Water Monitoring Point (Invincible)

FIGURE 6.2

Hydrology Context
Cullen Valley Mine

File Name (A4): R82/3968_134.dgn
20190312 13.27

Table 6.9 2018 groundwater monitoring

Sampling Date	Overview of Sampling
April 2018	Monitoring undertaken during 2018 was applicable only to selected bores and parameters, based on results from the previous round of monitoring in December 2017 to monitor potential trends. Bore CP115 is monitored every 6 months (Umwelt, 2017b).
November 2018	Groundwater sampling undertaken in November 2018 was undertaken in accordance with the Annual Groundwater sampling program required by the CVM WMP (Umwelt, 2017b).

6.4.2.4 Trends in Data

The groundwater monitoring program at CVM consists of:

- impact bores – bores with the potential to identify potential groundwater impact from CVM, specifically CP115, CP116 and GW01; and
- reference bores - bores that are considered to be representative of background groundwater quality (i.e. are unlikely to be impacted by CVM operations), specifically CP114, CP131, CP132 and LD001. These bores provide a baseline for comparison with bores CP115, CP116 and GW01.

Standing Water Level

The standing water level in the impact bores during the report period are within the trigger level range, as shown in **Table 6.10**.

Table 6.10 Impact bores standing water levels and triggers

Bore	Groundwater Level (mAHD) Trigger Range	April 2018 Groundwater Level (mAHD)	November 2018 Groundwater Level (mAHD)	Complied with Trigger Level
CP116	890 - 894	892.82	892.76	Yes
CP115	892 - 896	894.02	893.98	Yes
GW01	N/A as bore is located in workings	N/A	N/A	N/A

The long term standing water level trend in both impact bores (CP116 and CP 115) has been almost identical since monitoring commenced in February 2012. Since February 2012, the standing water level has gradually increased until November 2016 after which time it has gradually declined, as shown graphically in **Appendix 4**. The reference bores however show greater variability in the long term standing water level trends, as shown graphically in **Appendix 4.**

pH

The pH results for the impact bores during the report period were within the trigger level range, with the exception being the April 2018 results for CP115 and November 2018 for CP116, as shown in **Table 6.11** CP115 had a pH reading 0.21 pH units below the trigger level of 6.26, while CP116 had a pH reading 0.1 pH units above the upper trigger value range of 7.2. The increase in pH values appears to be consistent with the trends observed across both impact and reference bores. As such, these results are considered to be

reflective of a wide regional trend and not the results of CVM activities, as shown as shown graphically in **Appendix 4**.

Table 6.11 Impact bore pH levels and triggers

Bore	pH Trigger Range	April 2018 pH Level	November 2018 pH Level	Complied with Trigger Level
CP116	5.82 – 7.2	6.10	7.21	No
CP115	6.26 – 7.3	6.05	7.04	No
GW01	6.14 – 6.82	No sample required*	6.68	Yes

* sampled annually – this note also applies to **Tables 6.12 – 6.14**.

The impact and reference bores typically display an increase in pH from the 2017 and 2018 monitoring rounds. pH monitoring results from impact bores generally mirrored results from reference bores during the 2018 report period. The long term pH trend across both impact and reference bores is typically one of increasing pH value, with occasional isolated spikes and drops depending on the bore in question, as shown graphically in **Appendix 4**.

Given the restricted dataset of baseline monitoring completed, the April and November 2018 CP115 and CP116 results are possibly within the range of likely expected values for the bore and are not necessarily indicative of groundwater impact. As the results are slightly outside the trigger range, no further action is proposed at this time. An analysis of water licenses in the region completed during May 2017 identified that there were no registered bore users in the area down-dip of CVM and thus there are no users which would be impacted by these results.

Electrical Conductivity

The Electrical Conductivity (EC) in the impact bores during the report period are below the trigger level, as shown in **Table 6.12**.

Table 6.12 Impact bores electrical conductivity levels and triggers

Bore	Electrical Conductivity (µS/cm) Trigger Level	April 2018 Electrical Conductivity Level (µS/cm)	November 2018 Electrical Conductivity Level (µS/cm)	Complied with Trigger Level
CP116	Upper limit 840	391	355	Yes
CP115	Upper limit 970	398	757	Yes
GW01	Upper limit 939	No sample required	779	Yes

The long term trend in EC values across the reference bores is mixed. LD001 has shown minor variability (±20 µS/cm) around 130 µS/cm. CP114 exhibits a decline in 2018 monitoring from 300 µS/cm to 285 µS/cm, with historical results showing occasional small spikes and stable periods before returning to a steady decline. Results of monitoring at CP132 increased initially, declined during 2017, and have risen in 2018, as shown graphically in **Appendix 4**.

The long term trend in EC values in the impact bores however shows greater variability than the reference bores. There also does not appear to be a consistent trend for the impact bores, as shown graphically in **Appendix 4**.

Sulphate

The sulphate levels in the impact bores during the report period are below the trigger level, as shown in **Table 6.13**

Table 6.13 Impact bores sulphate levels and triggers

Bore	Sulphate (mg/L) Trigger Level	April 2018 Sulphate Level (mg/L)	November 2018 Sulphate Level (mg/L)	Complied with Trigger Level
CP116	Upper limit 140	54	44	Yes
CP115	Upper limit 380	354	299	Yes
GW01	Upper limit 338	No sample required	276	Yes

The long term trend in sulphate values for the reference bores LD001 and CP114 is consistently 17 mg/L ±5 mg/L. CP132 shows greater variability with results ranging between 17 mg/L at February 2011 and 103 mg/L at May 2017 with up to 70 mg/L of variation between consecutive samples, as shown graphically in **Appendix 4**.

The results for the impact bores show very different trends. CP116 initially declined, before spiking in November 2015, after which it dropped back to levels comparable to pre November 2015 (i.e. approximately 25 mg/L) and has since increased slightly and has dropped slightly in November 2018. While CP115 typically increased from 100 mg/L in February 2011 to 380 mg/L in April 2014, after which it has remained relatively stable around a value of 350 mg/L, until November 2018 where it has declined to 299 mg/L, as shown graphically in **Appendix 4**.

As discussed within the groundwater study completed for CVM in 2017 (Umwelt, 2017e), the recorded sulphate levels are all well within the ANZECC criteria for drinking water for domestic stock which provide:

> *No adverse effects to stock are expected if the concentration of sulphate in drinking water does not exceed 1000 mg/L. Adverse effects may occur at sulphate concentrations between 1000 and 2000 mg/L, especially in young or lactating animals or in dry, hot weather when water intake is high. These effects may be temporary and may cease once stock become accustomed to the water. Levels of sulphate greater than 2000 mg/L may cause chronic or acute health problems in stock.*

As the sulphate results from CP115 are stable and within ANZECC guidelines, there is no indication of any environmental harm associated with these results. In accordance with the CVM WMP (Umwelt, 2017b) Shoalhaven Coal will continue to monitor sulphate levels however no specific investigation of sulphate levels is required to be undertaken.

Hardness

The hardness levels in the impact bores during the report period are below the trigger level, as shown in **Table 6.14**. An analysis of water licenses in the region completed during May 2017 identified that there were no bore users in the area down-dip of CVM and therefore there are no groundwater bores which would be impacted by increased hardness levels if it were to occur.

Table 6.14 Impact bores hardness levels and triggers

Bore	Hardness (mg/L) Trigger Level	April 2018 Hardness Level (mg/L)	November 2018 Hardness Level (mg/L)	Complied with Trigger Level
CP116	Upper limit 210	123	134	Yes
CP115	Upper limit 376	356	338	Yes
GW01	Total Alkalinity Upper limit 100 mg of $CaCO_3$	No sample required	68	Yes

The long term trend in hardness values for the reference bores is mixed. LD001 shows little change throughout. CP114 shows small variability around 100 mg/L before a result of 350 mg/L in December 2017, and decreasing to around 100 mg/L during the report period. CP 114 is a reference bore as defined in the CVM WMP (Umwelt, 2017). Sampling of CP114 was undertaken in 2018 and confirmed the hardness values had returned to the historic range. Sampling of EC was also undertaken and results were consistent with historical values. The resampling of this bore during 2018 was undertaken as per the requirements of the CVM WMP (Umwelt, 2017) which requires resampling of impact bores when a result spike cannot be attributed to non-compliance with sampling procedures, or similar trends are observed in surrounding bores even though the bore is a 'reference' bore and not an 'impact' bore.

CP132 initially was consistent around a level of 150 mg/L (April 14 to Nov 15), before spiking at 200 mg/L on November 2016 and declining to 50 mg/L in December 2017, and has increased during 2018, as shown graphically in **Appendix 4**. In April 2018, CP132 increased to 174 mg/L and to 210 mg/L in November 2018. Sampling of CP132 will be undertaken in 2019 to confirm whether the hardness values have returned to the historic range.

The impact bores also show different long term trends in hardness. CP116 has declined from an initial level of 210 mg/L before stabilising in April 2014 around a level of 100-125 mg/L, and have increased during 2018 to 134 mg/L in November 2018. The 2011 to 2017 trend for CP115 shows an overall increasing trend, from 210 mg/L in February 2011, increasing to a range of 350-387 mg/L and peaking in December 2017, as shown graphically in **Appendix 4**. During 2018, CP115 decreased in hardness to 338 mg/L in November.

Given the restricted dataset of baseline monitoring completed, the December 2017 CP115 value was possibly within the range of likely expected values for the bore and are not necessarily indicative of groundwater impact. In accordance with Table 5.1 of the CVM WMP (Umwelt 2017b), CP115 was sampled during 2018, the results of which confirmed a decline in hardness values. An analysis of water licenses in the region completed during May 2017 identified that there were no registered bore users in the area down-dip of CVM and thus there are no users which would be impacted by this result.

Other Analytes (not required for trigger level assessment as described in the WMP)

Nitrate

Results for 2018 monitoring together with the long terms trend show that both impact and reference bores have very low levels of nitrate, the majority of which are less than the laboratory detection limit (shown graphically in **Appendix 4**), with the exception of the April 2018 result at CP116 of 0.16 mg/L. The November 2018 result returned 0.02 mg/L, consistent with historical results. Monitoring will continue during 2019, in accordance with the requirements of the CVM WMP (Umwelt, 2017b).

Metals

Results of monitoring undertaken during 2018 for dissolved metals within the Impact bores are highly variable. Metals are usually analysed for trends as a group (or groups of metals) rather than on an individual metal basis. This is usually completed where sufficient baseline information is available to analyse potential trends. Given the restricted available dataset, the ability to meaningfully analyse metals results obtained during 2018 and trends in data is therefore limited. It is noted that bore CP115 is monitored every 6 months with the remaining bores monitored annually during November. Results are discussed below:

Monitored every 6 months

- Impact bore CP115 – Monitoring undertaken during April 2018 did not identify any metals above the previous maximum levels. The results of monitoring completed in November 2018 indicate that levels of Molybdenum and Nickel were greater than those measured in April 2018, but within the previous range of results. The remaining metal analytes (Aluminium, Arsenic, Cadmium, Chromium, Copper, Iron, Lead, Manganese, Selenium, Zinc and Mercury) levels recorded in April and November 2018 were within the range of previous results. Insufficient data is available to set meaningful trigger levels for metals at this stage, based on ANZECC guidelines.

Monitored Annually

- Impact bore CP116 – Iron and aluminium levels recorded during April 2018 were within previous levels, however the November 2018 levels exceeded the previous maximum levels for dissolved iron and aluminium. The remaining metal analytes levels recorded in April and November 2018 were within the range of previous results. A trend of increasing dissolved Iron can be seen within bore CP116. Results were shown to have fluctuated down in April 2018 and then increased in November 2018, this trend will continue to be monitored during 2019. However, with the limited available dataset, it is difficult to determine whether these results are within the historical range of expected results from this bore. There is no ANZECC level for Iron and there are no registered bore users in the area down-dip of CVM, therefore there are no users which would be impacted by this result. CP116 will be sampled in April 2019 to monitor these trends.

- Impact bore GW01 –No sample was required during April 2018 as sampling was required for selected bores and parameters only. In November 2018, Aluminium, Arsenic, Chromium, Copper, Lead, Molybdenum and Selenium all returned results which were below the limit of detection. Cadmium, Iron, Manganese, Nickel and Zinc returned levels above the limit of detection, but within the previous range of results. Results for Manganese and Cadmium were slightly higher than the previous maximum levels. As monitoring of GW01 only commenced in December 2017, it is difficult to determine whether these results are within historical range of expected results as the dataset is limited.

- Reference bore CP132 – During November 2018 levels of dissolved iron and manganese which were higher than previous maximum levels were recorded, while Nickel and Zinc were above the laboratory limit of detection but within the range of previous results. All remaining metals were lower than the laboratory detection limit. Monitoring will continue at this location in 2019.

- Reference bore LD001 – During November 2018, Aluminium, Arsenic, Cadmium, Chromium, Iron, Lead, Manganese, Molybdenum and Selenium all returned results which were below the limit of detection. The levels for Copper and Nickel were above the limit of detection, however within the range of previous results. The level of Zinc recorded was above the previous maximum levels, however the November 2018 zinc result is still within the levels recorded within the adjacent CP116, CP115 and is generally consistent with zinc levels recorded in CP114. Monitoring at this bore will continue in 2019 to monitor this trend.

- Reference bore CP114 - results of monitoring completed during April and November 2018 recorded levels below the previous maximum for all metals which were above the laboratory detection limit. Results for Aluminium, Iron, Manganese and Nickel recorded in November 2018 were higher than April 2018 results, however remained within the previous range of results.

The CVM WMP (Umwelt, 2017b) does not include trigger values for metals, due to the limited data set and variable nature of the dissolved metals in groundwater samples taken to date. In order to develop trigger levels for the metals results obtained from the CVM bores, 24 contiguous monthly samples would be required, as per ANZECC guidelines (ANZECC, 2000). Given the phase of operations at the site (i.e. care and maintenance), there are no proposed changes to the groundwater monitoring regime, however the CVM WMP and trigger levels will be updated during 2019 to include revised groundwater monitoring data obtained during 2018.

6.4.2.5 Proposed improvements

No additional mitigation measures or monitoring procedures are proposed to be implemented which are outside that detailed in the CVM WMP (Umwelt, 2017b).

6.5 Noise

6.5.1 Environmental management measures

CVM's Environmental Management Plan (Coalpac, 2012c) includes a Noise Management Plan (NMP), which details mitigation measures and monitoring procedures for noise management. There were no mining operations during the report period; however, quarterly attended monitoring was conducted at five locations around CVM in accordance with the CVM Environmental Management Plan (Coalpac, 2012c). Noise controls and mitigation measures are implemented to ensure compliance with noise impact assessment criteria.

6.5.2 Performance criteria

Noise criteria is specified in the Development Approval and EPL 10341. **Table 6.15** and **Table 6.16** summarises the criteria across the Development Approval and EPL 10341.

Table 6.15 Noise criteria in DA-200-5-2003

Location	Day – L_{Aeq} (15 minute) (dB)	Evening – L_{Aeq} (15 minute) (dB)	Night – L_{Aeq} (15 minute) (dB)	Night - L_{A1} (1 minute) (dB)
Red Springs (east of rail line)	37	35	35	45
Red Springs (west of rail line)	43	38	35	45
Hillcroft (east of rail line)	35	35	35	45
Hillcroft (west of rail line)	43	38	35	45
Forest Lodge	40	40	38	45
Doble Gate	43	38	35	45
Tilley	43	38	35	45

Table 6.16 Noise criteria in EPL 10341

Location	Day – L_{Aeq} (15 minute) (dB)	Evening – L_{Aeq} (15 minute) (dB)	Night – L_{Aeq} (15 minute) (dB)	Night - L_{A1} (1 minute) (dB)
Red Springs (east of rail line)	35	35	35	45
Red Springs (west of rail line)	43	38	35	45
Hillcroft (east of rail line)	35	35	35	45
Hillcroft (west of rail line)	43	38	35	45
Forest Lodge	40	40	40	45
Doble Gate	43	38	35	45
Tilley	43	38	35	45

6.5.3 Environmental outcomes

There were no exceedances of the Development Approval or EPL criteria during the report period as shown in **Table 6.17**. CVM was inaudible during Quarter 2 to Quarter 4 however was audible during Quarter 1 During Quarter 1 monitoring at Hillcroft, CVM was audible during the measurement as low-level exhaust. Despite CVM being audible during the Quarter 1 monitoring, the site noise levels were observed to be well below (more than 5dB lower than) any relevant criterion. As a result, noise at this location was assigned a maximum estimate of the potential contribution of the site, based on other measured site-only noise levels (expressed as a 'less than' quantity). Quarter 1 noise monitoring occurred on 28 March 2018, with a small number of truck movements occurring at the site on this day for the receipt of VENM / ENM (refer to **Section 3.0** and **Section 4.2**). There were no complaints received in regards to noise during the report period and CVM ceased receipt of VENM / ENM during late March 2018. Birds and insects also contributed to noise levels during Quarter 1 monitoring at the Hillcroft location. During all other noise monitoring events, CVM was inaudible.

Table 6.17 2018 Quarterly noise monitoring results

Location	Consent Criterion (dB)	EPL Criterion (dB)	Quarter 1 ($L_{Aeq\ 15min}$) (dB)	Quarter 2 ($L_{Aeq\ 15min}$) (dB)	Quarter 3 ($L_{Aeq\ 15min}$) (dB)	Quarter 4 ($L_{Aeq\ 15min}$) (dB)
Red Springs (N07)	37	35	IA	IA	IA	IA
Hillcroft (N08)	35	35	<20	IA	IA	IA
Forest Lodge (N10)	40	40	IA	IA	IA	IA
Doble Gate (N09)	43	43	IA	IA	IA	IA
Tilley (N06)	43	43	IA	IA	IA	IA

IA – noise from CVM was inaudible

< - contributions from CVM were audible and directly measurable, such that the site-only LAeq was not "Not Measurable" or less than a maximum cut of value (e.g. "<20 dB" or "<30dB")

6.5.4 Trends in data

The quarterly noise monitoring results for the period 2011 – 2018 are summarised in **Appendix 5**. The results show CVM has largely been inaudible at each noise monitoring location since CVM entered care and maintenance.

6.5.5 Proposed improvements

No additional mitigation measures or monitoring procedures are proposed to be implemented which are outside that detailed in the CVM EMP (Coalpac, 2012c) in relation to noise management.

6.6 Biodiversity

6.6.1 Environmental management measures

CVM's Environmental Monitoring Program (Coalpac, 2009) and Flora and Fauna Management Plan (Coalpac, 2012a) have been prepared in accordance with the Development Approval, outlining the required monitoring of rehabilitation and compensatory habitat sites.

Biodiversity monitoring has been undertaken at CVM since the base line survey in 2012 (Kleinfelder, 2012-2015) and has been undertaken by Umwelt since 2016 (refer to **Figures 6.3** and **6.4**). Existing vegetation communities and fauna habitat have been previously characterised during the Ecological Impact Assessment (Cumberland Ecology, 2014). As noted in **Section 3.1**, CVM submitted a revised Flora and Fauna Management Plan (Umwelt, 2017) to DPE during 2017 however consultation is required to be undertaken with OEH prior to DPE review of the plan. This is expected to occur in 2019.

6.6.2 Performance criteria

In 2018 biodiversity monitoring was undertaken for the CVM Compensatory Habitat Area (CHA) and within Rehabilitation Areas as shown on **Figure 6.3**. The biodiversity monitoring program for CVM was based on the monitoring requirements documented in the following plans:

- Cullen Valley Mine Flora and Fauna Management Plan (Coalpac, 2012a); and
- Cullen Valley Mine Environmental Monitoring Program (Hansen Bailey, 2009).

In addition to the monitoring requirements stated in the above documents, monitoring undertaken of the CHA and Rehabilitation Areas in 2018 included the following:

- floristic monitoring within fixed plots (20m x 10m) every 10 ha;
- fauna surveys to identify the fauna species and habitats quality;
- Clandulla geebung and Capertee stringybark monitoring (biodiversity conservation area);
- vegetation dieback surveys in areas of subsurface heating (further discussed in **Section 6.9**) and
- an assessment against the performance/completion criteria with the CVM C&M MOP (Sedgman, 2015).

An assessment of compliance against the relevant biodiversity and rehabilitation performance and completion criteria for CVM is summarised in **Table 8.2**.

6.6.3 Environmental outcomes/trends in Data

6.6.3.1 Environmental Conditions

The results of the Annual Biodiversity Monitoring were influenced by seasonal environmental conditions experienced in the months preceding the field surveys. In 2018, a period of extremely dry conditions was experienced between March and August, followed by short periods of rainfall throughout October and November leading into the monitoring event in December 2018. The monthly rainfall and weather conditions leading up to the survey are provided in **Section 6.2.**

6.6.3.2 CVM compensatory habitat areas

Native vegetation within the CHA is considered to be in good condition, with a low abundance of weeds. The three vegetation communities monitored in 2018 (i.e. the Tablelands Dry Woodland type, Tablelands Sheltered Valley Forest type and the Sandstone Ridgetop Woodland type) were floristically and structurally similar to that observed in previous monitoring events. This is expected as the CHA consists of intact woodland situated adjacent to Ben Bullen State Forest forming a corridor facilitating native species recruitment.

The vegetation of the CHA demonstrates minimal degradation due to human influences with the exception of vehicle tracks and rubbish dumping by others. Vegetation within the CHA is generally healthy with minimal degradation from disease or herbivory, while large proportion of the canopy demonstrates minor signs of dieback. This may be attributed to the dry weather that has been experienced for the last two monitoring events, since 2016. Given the above no flora management activities are recommended at the present time.

The CHA exhibits good fauna habitat characteristics, with well-established woodland and forest communities providing a stable range of habitat features. An abundance of fauna habitat features were recorded during the survey (e.g. woody debris, hollow bearing trees, fallen timber, permanent dams, escarpment and large rocky outcrops). The occurrence and abundance of such features highlight the importance of retaining a diversity of complex habitat structures to support a wide range of fauna groups.

The CHA supports substantial species diversity with 69 fauna species recorded during fauna survey. This result is consistent with previous monitoring events. A large proportion of the fauna are birds with 48 species recorded across all CHA sites. While this may be due to diversity of complex habitat structures in the CHA, the proximity of the CHA to Ben Bullen State Forest is also likely to influence the diversity of fauna species and the occurrence of threatened species.

A total of three threatened species were recorded in the CHA's at Cullen Valley Mine. These were the gang-gang cockatoo (*Callocephalon fimbriatum*), dusky woodswallow (*Artamus cyanopterus cyanopterus*) and Clandulla geebung (*Persoonia marginata*). All three species are listed as vulnerable under the Biodiversity Conservation Act 2016 (BC Act) and have been recorded in previous survey events.

6.6.3.3 Rehabilitation areas

The Cullen Valley Rehabilitation Areas are identified by the year each area was established, these being nine Rehabilitation Areas established in 2002, 2003, 2004, 2005, 2006, 2009, 2010, 2012 and 2014.

Rehabilitation at CVM is considered successful across all years, as the vegetation condition is considered to be generally in good condition with a low abundance of weed species. Floristic composition and habitat function of Rehabilitation Areas have overall remained consistent with previous monitoring events excluding the areas of subsurface heating (refer to **Section 6.9**).

The formation of habitat features and ecosystem function was found to improve within the younger Rehabilitation Areas. A gradual improvement in the seeding mixes and seeding rates along with the introduction of organic material has assisted vegetation establishment. Woody debris and large timber logs were more frequently recorded in younger areas of rehabilitation. These features aid habitat stability by forming sediment traps and increase ground cover to reduce effects of erosion. Ecosystem functionality can be enhanced by implementing some additional management actions including increasing the amount of woody debris to develop and improve soil structure and facilitate organic matter deposition, enhancing the available compensatory habitat through installing nest boxes and hollow logs, and targeted plantings of native ground cover and tubestock where required.

The results of the 2018 biodiversity monitoring survey identified high fauna diversity with 60 species recorded. This is lower than the 70 species recorded during surveys of the rehabilitation area in 2017 and is only slightly lower than the CHA (refer to **Section 6.6.3.2**). This is still an excellent result given they are from the Rehabilitated Areas. This high diversity is likely due to the proximity of the Rehabilitation Areas to the established remnant habitat of the CHA and Ben Bullen State Forest. This is particularly the case for highly mobile fauna such as birds that move between habitat patches while foraging. Additionally, the range of ages of vegetation within the Rehabilitation Areas provides an increased level of habitat complexity, providing a variety of habitat for different species. Compensatory habitat features such as nest boxes provide an artificial substitute for species including a variety of gliders, birds and microbats, which have been shown to consistently use the boxes based on monitoring undertaken 2016 – 2018.

A total of two threatened species were recorded in the CHA at CVM. These were the gang-gang cockatoo (*Callocephalon fimbriatum*), and glossy black-cockatoo (*Calyptorhynchus lathami).* Both species are listed as vulnerable under the BC Act and have been recorded in previous survey events.

6.6.3.4 Clandulla geebung monitoring

In the 2018 biodiversity monitoring surveys, 94 Clandulla geebung plants were recorded within the established Clandulla geebung monitoring site. This is a decrease from the results of the previous year (2017), which recorded 100 plants but is similar to the baseline survey in 2012 where 92 plants were recorded. Of the 94 plants identified in 2018, 15 specimens were flowering, 11 specimen were recorded with buds and none were found bearing fruit. These observations indicate that this population is healthy and reproducing notwithstanding the prevailing dry conditions. Overall, there has been no discernible change in this population which suggests that the population is stable and currently not affected by the previous mining activities.

6.6.4 Proposed improvements

Monitoring of rehabilitation and compensatory habitat areas will continue in 2019.

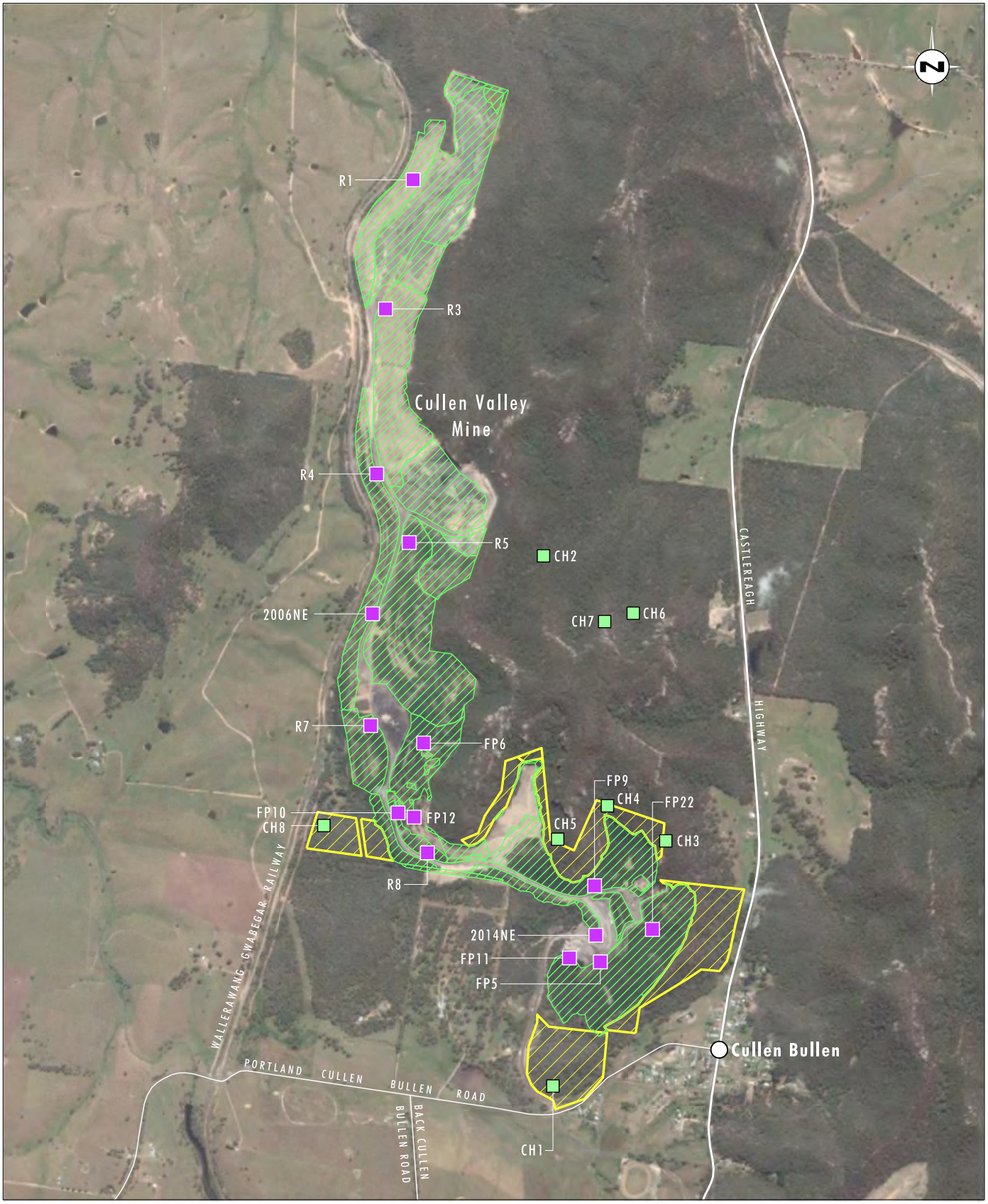


Image Source: Google Earth (MAR 2015)
Data Source: Kleinfelder (2017)

Legend

- Compensatory Habitat Area
- Rehabilitation Zones
- Rehabilitation Monitoring Sites
- Compensatory Habitat Monitoring Sites

FIGURE 6.3

Cullen Valley Environmental Monitoring Sites

6.7 Weeds and feral animals

6.7.1 Weeds

Weeds within both the CHA and Rehabilitation Areas were typically found to be cosmopolitan weed species such as catsear (*Hypochaeris radicata*) or St John's wort (*Hypericum perforatum*) and are not likely to cause a significant impact to vegetation condition at this stage. While studies have shown that bare ground favours the establishment of some weed species via colonisation from surrounding areas, this does not appear to be the case considering Rehabilitation Areas have been established for up to 16 years (2002). The likelihood of exotic species further colonising Rehabilitation Areas is low, given the soil structure and the density of tree and shrub species currently in established in the rehabilitation areas.

Weed management is conducted in accordance with the Cullen Valley Mine Flora and Fauna Management Plan (Coalpac, 2012a) and spraying is targeted towards known weed species occurrences.

6.7.2 Feral animals

6.7.2.1 Compensatory habitat area

One introduced species, the red fox (*Vulpes vulpes*) was recorded within the CHA during 2018 monitoring surveys.

6.7.2.2 Rehabilitation area

One introduced species, the red fox (*Vulpes vulpes*), was recorded within the Rehabilitation Areas during the 2018 monitoring surveys. Previously, the brown hare (*Lepus capensis*) and rabbit (*Oryctolagus cuniculus*) have been also recorded occurring within Rehabilitation Areas. Feral animal management will be undertaken as required during 2019.

6.8 Erosion and sediment control

6.8.1 Environmental management measures

The intent of the CVM water management system is to separate clean water and dirty/mine water at CVM. Erosion and sediment control is focused on the management of 'dirty' water which is runoff from disturbed areas. The erosion and sediment controls (ESC's) previously implemented for CVM during mining are currently, and will remain, in place for water management whilst the operation is under care and maintenance. These ESC's include dirty water sediment dams, open drainage channels with established vegetation and/or rock armouring and drop structures where required.

6.8.2 Performance criteria

There are no performance criteria for erosion and sediment control specified in either the Development Approval or the EPL.

6.8.3 Environmental outcomes

Visual inspections of the erosion control repairs undertaken during the previous 2017 report period has indicated that the repaired structures are operating as intended during the 2018 report period.

6.8.4 Trends in data and proposed improvements

As detailed in **Section 6.8.3**, visual inspections of the erosion control repairs undertaken during the 2017 report period has indicated that the repaired structures are operating as intended. No additional mitigation measures or monitoring procedures are proposed to be implemented which are outside that detailed in the WMP, in relation to ESC management.

6.9 Subsurface heating

In 2011, the former Department of Resources and Energy (DRE) issued the previous mine owner/ operator (Coalpac) with a Section 240 direction requiring a concentrated effort to manage and extinguish subsurface heating in a noise bund and in other areas within ML 1488. The direction also required rehabilitation of heating affected areas. Subsequently, a plan of work was developed and included within the Plan of Works MOP Variation (dated 30 January 2013) and the 2011 to 2015 CVM Care and Maintenance (C&M) MOP. During the report period, CVM sought an extension to the CVM C&M MOP (Sedgman, 2015) to extend the duration of the MOP. DRG approved the extension on 29 November 2018 with the MOP now approved until 30 June 2020.

Subsurface heating at CVM has been observed to occur in five main areas on site being area R1, F1, F2, F3 and F4 (refer to **Figure 6.4**). Areas R1, F1 and F2 have been mapped since 2016 with Area F3 with Area F4, being observed in the 2017 round of biodiversity monitoring.

Mapping of the extent of subsurface heating has occurred since 2015 and it is noted that the methodology utilised to map the extent of heating impacts has been refined since 2015. In regards to the physical extent of heating areas as shown on **Figure 6.4** it is important to note the following:

- 2015 – showed the extent of heating and ground disturbance which occurred to remediate heating and predominantly focussed on Area R1
- 2016 – showed the extent of area which had previously been impacted by sub-surface heating, noting that the area was not necessarily showing active signs of being impacted by heating at that point in time (i.e. the presence of active subsurface heating smell, smoke and /or surface cracking)
- 2017 (revised mapping methodology commenced) – areas shown are those which were observed to be showing signs of active heating (the presence of active subsurface heating smell, smoke and /or surface cracking). These areas were observed in F1, F2, F3, R1 and a new area F4)
- 2018 – Areas shown are those showing signs of active heating. During the 2018 report period, area F4 was also cleared of vegetation, excavated and compacted as a treatment measure.

Table 6.18 shows the progression of the subsurface heating areas mapped during Annual Biodiversity Monitoring from 2015 to 2018. The extent of 2018 active subsurface heating was delineated by recent vegetation die back/stress and observations of subsurface heating characteristics (e.g. smell, smoke and /or surface cracking).

Table 6.18 Summary of subsurface heating impact extent (2016 – 2018)

Subsurface Heating Area Name	2016 Approximate Size (ha)	2017 Approximate Size Active Heating (ha)	2018 Approximate Size Active Heating (ha)	2018 Comment
F1	1.05	0.26	0.031	Active hearting area reduced during 2018.

Subsurface Heating Area Name	2016 Approximate Size (ha)	2017 Approximate Size Active Heating (ha)	2018 Approximate Size Active Heating (ha)	2018 Comment
F2	0.28	0.28	0.28	Active heating observed in 2018.
F3	-	0.07	0.19	Active heating observed in 2018 with an increase in area observed.
F4	-	0.1	0.12	Area cleared of vegetation during 2018 report period to allow earthworks and compaction. Small area observed to be impacted by subsurface heating which was not impacted in 2017.
R1	1.97	0.05	0.46	Area of subsurface heating increased in 2018 report period.

*Note: **Section 6.9** explains how these mapping areas have been calculated.*

Active subsurface heating impacts were recorded across all areas during the 2018 biodiversity monitoring. Subsurface heating areas F3, F4, and R1 demonstrated increases to the areas previously mapped in 2017. Area F4 was cleared of vegetation during the report period to allow excavation and compaction of the area to treat subsurface heating. Site R1 demonstrated vegetation dieback extending to the south and west from the area mapped in 2017. Small localised patches of hot earth were observed in the western proportion of Site R1. Site R1 demonstrated vegetation dieback extending west from previously cleared and remediated areas. A proportion of active heating occurs within Site F2 with a small amount of regenerating vegetation (shrubs and small forbs) recorded down slope from the active heating. Site F3 demonstrated little change in condition to monitoring undertaken in 2017 a small increase to the overall extent of vegetation showing signs of being impacted by subsurface heating.

Evidence of regenerating vegetation was recorded at Site R1 with canopy and shrub species of adjacent rehabilitated area colonising the bare ground. Continued growth of existing established vegetation and natural regeneration was evident along edges of areas that were previously experiencing dieback to the north-west and east of Site R1. Subsequent monitoring surveys will provide further information regarding how rehabilitation responds after subsurface heating has passed through the area. The ongoing management of these areas will be undertaken with the management measures as detailed in the CVM C&M MOP (Sedgman, 2015). Rapid floristic assessments of the recovering subsurface heating impacted areas will continue as part of future monitoring programs.

6.9.1 Environmental management measures

Management measures utilised at CVM to treat sub surface heating are detailed in the CVM Care and Maintenance MOP (Sedgman, 2015) with the management measures developed in consultation with DRG. Environmental management controls implemented by CVM to monitor and treat subsurface heating include:

- Weekly monitoring of heating areas;
- Capping of surface cracking using cement; and
- Excavation and compaction of material as required.

During the report period CVM has observed a variation in the level of vegetation regeneration between the different treatment techniques. Recording of this information will in part be used to guide what treatment techniques will be implemented in the future. Aggressive/active treatment techniques (e.g. large scale excavation of heating areas) will only be undertaken should the amenity of off-site receivers be impacted.

6.9.2 Environmental outcomes and further improvements

During 2018, minor works (i.e. localised earthworks – excavation of cracks and backfilling with inert material and compacting and filling cracks with concrete) was undertaken in subsurface heating areas with the exception of Area F3. Monitoring and treatment of heating areas will continue during 2019.

6.10 Blasting

There was no blasting conducted at CVM during the report period.

6.11 Waste management

As no mining activities were undertaken during the report period and as there is only one staff member on site, minimal quantities of waste, typically office waste, was generated. Sewage from the workshop areas are directed to a septic system which is pumped out by a licensed waste collection and disposal contractor on an as-needs basis.

During the report period only minimal oil and greases were stored on site. Any maintenance works required on machinery and equipment is undertaken within existing bunded areas. Waste oils and grease are collected by a licensed waste recycling contractor on an as needs basis.

All paper and general wastes from workshop areas is disposed of in garbage bins located adjacent to the workshop areas, which are collected by a licensed contractor on an as needs basis.

6.12 Hazardous material management

Hazardous material storage tanks containing oils, grease and degreasers have been emptied, isolated and secured. Any excess storage tanks have been removed from the site. Storage tanks remaining onsite have been kept empty during the care and maintenance period.

The above ground self bunded diesel tank (Transtank) is not currently operational during the care and maintenance period. Up to 35,000L of diesel may be stored in the facility if diesel is required for environmental works on site. Two EPA registered radionuclide fixed radiation gauges (No.s RR20215 and RR21832) have been decommissioned and are stored onsite.

6.13 Heritage

6.13.1 Indigenous heritage

Previous archaeological surveys did not locate any Aboriginal artefacts or sites within the approved open cut mining area. However, two sites of significance were recorded in close proximity to the approved mining area. A campsite-stone artefact scatter (C-OS-1) and a rock shelter site (C-S-1). A further two sites where identified in surveys undertaken during 2011 and include 45-1-2542 and RSC-OS-1. These sites are located outside of the existing mining area.

6.13.2 Non-indigenous heritage

No mining activities or exploration works were undertaken in proximity of locations of European heritage significance during the report period.

6.14 Greenhouse gas emissions

As the site was in care and maintenance during the report period, greenhouse gas emissions were minimal. Emissions are limited to a small fleet of vehicles/equipment which are utilised for care and maintenance works as well as minor works undertaken to handle VENM / ENM received on site. CVM is below the trigger thresholds for National Greenhouse and Energy Report System (NGERS) report as a single facility, however a consolidated greenhouse gas emissions report is completed by the ownership group which takes into account other business interests, in accordance with NGERS requirements. NGERs reporting was undertaken during the 2018 report period.

6.15 Bushfire

A CVM Fire Management Plan (Coalpac, 2012e) has been developed and includes a number of measures to minimise bushfire risk. These measures include:

- fitting fire extinguishers to all earthmoving and mining equipment;
- fitting and maintaining efficient exhaust systems and spark arresters to mobile equipment;
- advising NSW Rural Fire Service, regulatory authorities and neighbours of any burning-off operations;
- facilitating that vehicles with low level exhaust systems do not leave defined tracks in locations and conditions likely to lead to ignition of combustible plant material; and
- maintaining, at the request of Forestry Corporation NSW, existing fire trails or access roads at the extremities of the lease area, which serve as access for firefighting services as well as establishing a fire break to the limits of operations at the open cut.

6.16 Mine subsidence

Mining operations at CVM ceased in 2012. There have been no subsidence management measures required to be implemented by CVM during the report period.

6.17 Public safety

Access to working areas of the CVM open cut are controlled by locked gates. Access to CVM by members of the public is via contact at the mine office where visitors or contractors can only be escorted by site personnel around the site.

Image Source: Google Earth (MAR 2015)
Data Source: Kleinfelder (2017)

0 100 200 400m
1:7 500

Legend

- Sub-surface Heating Impact Areas 2018
- Sub-surface Heating Impact Areas 2017
- Sub-surface Heating Impact Areas 2016
- Sub-surface Heating Impact Area - SE Boundary (Kleinfelder 2015)

FIGURE 6.4

Sub-surface Heating Impact Areas
Cullen Valley Mine

7.0 Water Usage

7.1 Water management system

The water management system at CVM is described within the CVM WMP (Umwelt, 2017b) and also within **Section 6.4** of this document.

7.2 Water take

Licence and water take information is summarised in **Table 7.1**. During the report period, there were 5 ML water extracted for utilisation as dust suppression whilst VENM / ENM was being received.

Table 7.1 Water take during 2018 report period

Water Licence #	Water sharing plan, source and management zone (as applicable)	Entitlement	Passive take/ inflows	Active pumping	Total (ML)
80WA706148	Sydney Basin MDB Groundwater Source Water Sharing Plan – NSW Murray Darling Basin porous rock groundwater sources	80 units	0	5	5

8.0 Rehabilitation

8.1 Status of mining and rehabilitation

CVM has operated on a care and maintenance basis since coal mining ceased in December 2012. Previously established rehabilitation areas include 132.8 ha of land mined since the commencement of open cut mining operations at CVM. As noted in **Section 6.8.3** and **Section 6.9**, rehabilitation works undertaken during the report period largely included works to treat subsurface heating. As detailed in **Section 4.2**, CVM received a small amount of VENM / ENM during the report period to assist with the rehabilitation of CVM however as a result of discussions between DPE and Shoalhaven Coal, the receipt of VENM / ENM at CVM ceased on 29 March 2018 and no further VENM / ENM has been received since this time. During 2019, Shoalhaven Coal will continue to liaise with DPE regarding the receipt of VENM / ENM at CVM to assist with the rehabilitation of the site.

There was no tree planting or tree seeding undertaken during the report period. An assessment of the status of the existing CVM rehabilitation against the performance indicators and completion criteria as detailed within the CVM CM MOP (Sedgman, 2015) is detailed in **Section 8.3**.

The status of rehabilitation at CVM is detailed in **Table 8.1**.

Table 8.1 CVM rehabilitation status

Mine Area Type	Previous Report Period (actual) 2017 (ha)	This Report Period (actual) 2018 (ha)	Next Report Period (forecast) 2019 (ha)
A. Total mine footprint (all areas including active disturbance areas and rehabilitation areas)	193.9	193.9	193.9
B. Total active disturbance (areas within the footprint still requiring rehabilitation)	56.7	56.7	56.7
C. Land being prepared for rehabilitation	4.4	4.4	4.4
D. Land under active rehabilitation	132.8	132.8	132.8
E. Completed rehabilitation (areas that have achieved completion criteria and been signed-off by DRE)	0	0	0

8.2 Post rehabilitation land uses

The proposed final land use aims to emulate the pre-mining environment and will enhance local and regional ecological linkages across the site and adjacent areas. The primary objective of site revegetation and regeneration is to create a stable final landform with acceptable post-mining land use and suitability. In the long term, rehabilitation areas will become integrated with adjacent native vegetation communities. Rehabilitation areas will continue to be monitored on an annual basis and will be managed until self-sustaining. Final rehabilitation areas will achieve the rehabilitation completion criteria specified in the approved CVM C&M MOP (Sedgman, 2015) prior to relinquishment.

8.3 Completion criteria assessment

The results of the 2018 biodiversity monitoring program have been compared against the objectives as defined in the CVM C&M MOP (Sedgman, 2015). Monitoring undertaken during 2018 has indicated that the CHA's within CVM are providing consistent native flora and fauna habitat compared to baseline information and previous annual monitoring results.

An assessment of the rehabilitation of CVM against the performance indicators and completion criteria as detailed in the CVM C&M MOP (Sedgman, 2015) is provided in **Table 8.2**. It is noted that not all criteria from the MOP were assessed during the 2018 biodiversity monitoring surveys as some criteria had not yet been triggered e.g. criteria related to the decommissioning of infrastructure. Criteria relevant to rehabilitation works undertaken to date on site are shown in **Table 8.2**. Actions recommended from the Biodiversity monitoring are discussed in **Section 6.6**.

8.4 Rehabilitation activities

Although the mine is in care and maintenance, management and monitoring of rehabilitation areas is undertaken in accordance with the approved CVM Flora and Fauna Management Plan (Coalpac, 2012a).

There has been no removal of buildings or other infrastructure and no new rehabilitation areas were established during the 2018 report period as the mine is currently in care and maintenance. Subsurface heating treatment is discussed in **Section 6.9**.

Table 8.2 Assessment of CVM rehabilitation against MOP Performance Indicators and completion criteria

Domain Objectives	Performance indicators	Completion criteria	2018 Status Against Completion Criteria
Revegetation works are undertaken in accordance with the Flora and Fauna Management Plan.	Plant establishment	Planting/seeding is assessed during annual monitoring as becoming successfully established.	Progressing towards satisfactory completion No further works required
Established rehabilitation areas to be monitored on an annual basis and managed until self-sustaining.	Species composition	A range of native shrubs, grasses and other understorey species have established through topsoil, seeding or recolonization.	Progressing towards satisfactory completion No further works required at this stage.
	Plant health	More than 75% of trees are healthy and growing as indicated by monitoring.	Progressing towards satisfactory completion Only the 2010 areas were found not to have 75% or more healthy trees. It is expected that the 2010 Rehabilitation Areas will passively regenerate over time. All other Rehabilitation Areas inspected were considered to meet this criteria milestone.
	Weed establishment	A spraying program for the control of declared plants and other weeds has been implemented on the site.	Satisfied A spraying program for the control of declared plants and other weeds has been implemented on the site where required.
	Soil conditions	Soil salinity is sufficiently low to allow survival and growth of plant species, soil pH levels are within the range to allow plant growth.	Not monitored as part of the 2018 monitoring report.

Domain Objectives	Performance indicators	Completion criteria	2018 Status Against Completion Criteria
	Fauna habitat structure	Fauna habitat includes a range of vegetation structural habitats, e.g. eucalypts, shrubs, ground cover and a developing litter layer.	Progressing towards satisfactory completion. Rehabilitated Areas are not old enough to support the range of naturally forming habitats and rely on habitat features established during the planting phase of rehabilitation (such as woody debris, log piles etc.). The Rehabilitated Areas are progressing towards the pre-existing or surrounding landforms.
	Presence of fauna species	Vertebrate surveys demonstrate that bird, mammal, reptile and frog communities are becoming established in rehabilitated sites.	Progressing towards satisfactory completion. Results suggest that habitats of Rehabilitated Areas are improving the connectivity to surrounding remnant habitats. Evidence suggests that the progress of established vegetation has encouraged fauna activity and utilisation of these areas for foraging and temporary refuge. Further evidence will be drawn from future monitoring events.
	Biodiversity monitoring	Annual biodiversity monitoring indicates that rehabilitation areas are becoming integrated with adjacent vegetation communities	Progressing towards satisfactory completion. Rehabilitated Areas are not old enough to support the range of habitats provided by the surrounding un-mined forests and woodlands. The Rehabilitated Areas are progressing towards the pre-existing or surrounding landforms.
Final rehabilitation areas to achieve rehabilitation completion criteria	Vegetation cover	No bare areas that have obviously failed and are greater than 0.5 ha in total area.	Progressing towards satisfactory completion. All Rehabilitation Areas inspected were considered to meet this criteria milestone, with exception of areas affected by subsurface heating. Previous monitoring noted bare areas within the 2014 Rehabilitation Area, however this is likely due to the age of vegetation.
	Tree cover	No treeless areas greater than 0.5 ha are present.	Progressing towards satisfactory completion. No treeless area greater than 0.5 hectares were observed during the 2018 monitoring.

Domain Objectives	Performance indicators	Completion criteria	2018 Status Against Completion Criteria
	Shrub/grass cover	Monitoring and visual estimation show grass or shrub cover to be >50%.	Progressing towards satisfactory completion. Monitoring and visual estimation show grass or shrub cover to be >50% on the Rehabilitation areas in 2018. It is noted that these are mainly exotic cover crop species.
Water management system to be maintained and monitored in accordance with the Water Management Plan	Mine affected water	Clean water is diverted around unsealed areas and directed through the water management system.	Progressing towards satisfactory completion. Repairs to erosion control structures on site were undertaken during the 2017 report period (refer to **Section 6.8**). No further works were required during the 2018 report period.
Disturbed landform is graded and shaped to reflect natural landforms and is free-draining.	Sediment and erosion control	Monitoring by the Mining Engineering Manager and annual monitoring of rehabilitation areas does not detect any major erosion/washouts that will compromise vegetation establishment or safety of final surfaces.	Progressing towards satisfactory completion. Repairs to erosion control structures on site were undertaken during the 2017 report period (refer to **Section 6.8**). No further works were required during the 2018 report period.
Water management system to be maintained and monitored in accordance with the Water Management Plan.	Water management system	Clean water to be diverted around operational mining areas and directed through the water management system.	Progressing towards satisfactory completion. Repairs to erosion control structures on site were undertaken during the 2017 report period (refer to **Section 6.8**). No further works were required during the 2018 report period.
		Mine affected water and sediment laden water from bare ground surfaces is captured and diverted to sediment ponds and dams for treatment prior to discharge from the site.	Progressing towards satisfactory completion. Repairs to erosion control structures on site were undertaken during the 2017 report period (refer to **Section 6.8**). No further works were required during the 2018 report period.

Domain Objectives	Performance indicators	Completion criteria	2018 Status Against Completion Criteria
Water management structures to be retained in place until rehabilitation is complete and post-mining landforms achieve stability and land use suitability.	Discharge water quality	Water quality at the licenced discharge point is assessed as being within EPL licence release limits prior to discharge	Progressing towards satisfactory completion. There were no discharges from EPL Points during the 2018 report period, refer to **Section 6.4.1**.

8.5 Actions for the next report period

During 2019, rehabilitation works will involve:

- further subsurface heating capping works as described in **Section 6.9**; and
- the receipt of the VENM/ENM to fill voids, establish the final landform and undertake progressive rehabilitation at CVM, if approved to recommence by DPE.

9.0 Community

9.1 CCC meetings

Two meetings were held in 2018 with CCC meetings on 29 August 2018 and 12 December 2018. During these meetings, information was presented on environmental monitoring and performance, complaints received, statutory reporting, rehabilitation and land management works undertaken on site. The outcomes of the CCC meetings are detailed in the meeting minutes available on the Castlereagh Coal website.

9.2 Complaints

In accordance with Condition M5 of the EPL, Shoalhaven Coal maintains a complaints register to record and respond to complaints received from the community. The register is included in the Castlereagh Coal website. Three complaints were received from the local community during the report period. These were received on 23 February 2018, 29 May 2018 and 7 September 2018. The complaints were in relation to odour from a subsurface heating area on site. Following the receipt of the complaints, Shoalhaven Coal undertook prompt repair works to manage the subsurface heating odour. A comparison of complaints received between 2011 and 2018 is outlined in **Table 9.1** below.

Table 9.1 Comparison of complaints

Complaint type	2011	2012	2013*	2014	2015	2016	2017	2018
Noise	9	9	1	0	1	0	0	0
Air quality	5	5	2	0	1	0	0	0
Blasting	3	5	0	0	0	0	0	0
Traffic	4	13	0	0	0	0	0	0
Water	0	0	0	2	0	0	0	0
Subsurface Heating	2	0	0	0	0	4	2	3
Other	2	4	2	1	0	0	0	0
Total	**25**	**36**	**5**	**3**	**2**	**4**	**2**	**3**

** CVM was placed in care and maintenance in December 2012*

10.0 Audit information

10.1 DPE independent environmental audit

An Independent Environmental Audit (IEA) was conducted during 2016 in accordance with Schedule 6, Condition 6 of the Development Approval DA-200-5-2003. The audit timeframe covered the period from November 2010 to September 2016. The mine was operated by the previous mine owner Coalpac up until May 2015. The current owner, Shoalhaven Coal, was only responsible for operations from May 2015 onwards and therefore many of the non-compliances detected by the audit were outside the control of Shoalhaven Coal. In addition, a large number of the non-compliances that have occurred during Shoalhaven Coal's ownership are as a direct result of historical practices conducted by Coalpac.

An action plan was developed as an outcome of the audit findings and follow up actions have been implemented as required in consultation with DPE. The updated audit action plan is included on the Castlereagh Coal website. In accordance with the Development Approval the next IEA to be undertaken at CVM is required to be conducted by June 2021.

Key actions required to be implemented by Shoalhaven Coal following the 2016 IEA and where these items are discussed in the Annual Review is presented below. Further detail on the status of each action can be found in **Appendix 1**.

- Continued treatment of subsurface heating and repair of erosion control structures (refer to **Section 6.8** and **6.9**)
- completion of annual biodiversity monitoring (refer to **Sections 6.6** and **8.3**)
- revision and submission of updated Flora and Fauna and Water Management Plans to DPE (refer to **Section 3.1**)
- continued progression of rehabilitation of CVM (refer to **Section 8.0**).

11.0 Incidents and non-compliances during the report period

The CVM PIRMP (Umwelt, 2018c) was not activated during the report period. Non-compliances noted during the report period are detailed in **Section 1.0**.

12.0 Activities to be undertaken in the next report period

There are no mining activities proposed at CVM in the next report period (1 Jan 2019 – 31 Dec 2019) as the site is currently managed under a care and maintenance arrangement. During the 2019 report period, Shoalhaven Coal will continue to implement the various approved environmental management plans and update the Water Management Plan to consider the additional groundwater monitoring data obtained in 2018 as part of the groundwater monitoring triggers.

During 2019, rehabilitation works will involve further subsurface heating capping works as described in **Section 6.9**. Rehabilitation activities proposed in the 2019 report period are detailed in **Section 8.5**.

13.0 References

Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2000. (ANZECC, 2000) An Introduction to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Commonwealth Government.

Castlereagh Coal (2018). Care and Maintenance Mining Operations Plan Cullen Valley Mine.

Coalpac (2009). Environmental Monitoring Program.

Coalpac (2012a). Cullen Valley Mine Flora and Fauna Management Plan.

Coalpac (2012b). Cullen Valley Mine Species Management Plan (Clandulla Geebung).

Coalpac (2012c). Environmental Management Plan.

Coalpac (2012d). Blast Management Plan.

Coalpac (2012e) Fire Management Plan.

Castlereagh Coal (2018). Cullen Valley Mine Care and Maintenance Mining Operations Plan

Global Acoustics Pty Ltd (2017a). Cullen Valley Mine Environmental Noise Monitoring Quarter 1, 2018. Prepared for Shoalhaven Coal.

Global Acoustics Pty Ltd (2017b). Cullen Valley Mine Environmental Noise Monitoring Quarter 2, 2018. Prepared for Shoalhaven Coal.

Global Acoustics Pty Ltd (2017c). Cullen Valley Mine Environmental Noise Monitoring Quarter 3, 2018. Prepared for Shoalhaven Coal.

Global Acoustics Pty Ltd (2017d). Cullen Valley Mine Environmental Noise Monitoring Quarter 4, 2018. Prepared for Shoalhaven Coal.

International Environmental Consultants, 1997. Feldmast Coal Project Environmental Impact Statement.

International Environmental Consultants, 2004. Cullen Valley Mine Open Cut Extension Environmental Impact Statement

NSW Government (2015). Annual Review Guideline.

Sedgman (2015) Cullen Valley Mine Care and Maintenance MOP.

SLR Consulting (2016). Cullen Valley Mine Independent Environmental Audit. Prepared for Shoalhaven Coal Pty LimiteU

Umwelt (2017a). Flora and Fauna Management Plan.

Umwelt (2017b). Water Management Plan Cullen Valley Mine.

Umwelt (2017c). Cullen Valley Mine & Invincible Colliery Pollution Incident Response Management Plan. Prepared for Shoalhaven Coal.

Umwelt (2017d). 2017 Biodiversity Monitoring Report. Cullen Valley Mine and Invincible Colliery, Castlereagh Highway Draft.

Umwelt (2017e). Cullen Valley Mine Groundwater Quality Investigation.

APPENDIX 1

Status of 2016 audit actions

Appendix 1 2018 Annual Review IEA Action Plan Update

Consent Condition	Audit Finding	Compliance identified during audit	Audit Recommendation	Proposed Action and Timing
DA Sch 4, Condition 2	2010 AEMR - During the report period, CVM complied with the criteria LAeq(15 minute) noise limits at all locations with the exception of Hillcroft in Q1 and Q3. The noise levels at Hillcroft exceeded the criteria by 5 and 2 dB(A) respectively. This was outside the audit period. 2011 AEMR - CVM complied with the daytime LAeq (15 minute) noise criteria at all locations during the report period, with the exception of the Hillcroft property (N08) during Q2. 2012 AEMR - CVM complied with the daytime LAeq (15 minute) noise criteria at all locations during the report period, with the exception of the Hillcroft property (N08) which exceeded the noise criteria on one occasion during Q2. 2013, 14 and 15 AEMR's - Nil exceedances These noise non - compliances related to when the site was operating and under previous ownership. Noise is a minor issue during care and maintenance, however if mining activities were to recommence there would be a requirement for additional noise controls.	Non-compliant	Noise is a minor issue during care and maintenance, however if mining activities were to recommence there should be a full review of noise mitigation measures to reduce the chance of non - compliances relating to noise. The Noise Management Plan would require to be updated.	Noise exceedances occurred during Coalpac ownership of the mine. The noise management plan would only be updated if and when mining operations recommence at CVM. Noise mitigation measures for mining operations would be reviewed at that time. **2017 Annual Review Update** No further action required. As noted above, if mining operations recommence the Noise Management Plan will be updated. **2018 Annual Review Update** No further action required. As noted above, if mining operations recommence the Noise Management Plan will be updated.
DA Sch 4, Condition 27	There have been odour complaints in every year of the audit period with this relating to the area of sub surface heating. These have been outlined in the AEMR/Annual Reviews. There has been some works at site (movement of material) to control the fire/odour issue with investigations still continuing. Based on discussions with site this is an ongoing issue that is being managed by Shoalhaven Coal in consultation with experts and the Departments. Shoalhaven Coal are also resolving drainage issues that are directly linked to 2017 heating issues particularly venting, smoke and odour prior to capping.	Non-compliant	Continue to investigate issue and develop a strategy to remediate. Continue to monitor and report on the odour issue. Implement actions where possible.	Sub-surface heating is being managed by Shoalhaven Coal in consultation with specialist consultants and the Departments. Shoalhaven are also undertaking reconstruction of contour and flume drains to direct water away from areas to reduce the incidence of venting, smoke and odour. Stage 1 works will be monitored during Q2 and Q3 2017. **2016 Annual Review Update** In accordance with Section 12.0 of the Annual Review and DRE requirements, during 2017 Shoalhaven Coal will review and manage subsurface heating across the site, and an updated Plan of Works (PoW) for management of subsurface heatings will be developed as part of the updated C&M MOP. **2017 Annual Review Update** During 2017, Shoalhaven Coal undertook repairs to a number of erosion control structures and these are discussed in the 2017 CVM Annual Review. Shoalhaven Coal has continued to implement the PoW as detailed in the approved MOP and liaise with the Division of Resources and Geoscience, during the reporting period. **2018 Annual Review Update** During 2018, Shoalhaven Coal has continued to implement the PoW as detailed in the approved MOP. Subsurface heating management is detailed in Section 6.9 of the Annual Review.
DA Sch 4, Condition 31	a) Partially covered under Section 2.2 of the Compensatory Habitat Plan. No differentiation between short term and long term management. There should be goals developed for short term e.g. Year 1, medium term Year 5 and long-term Year 10. b) Covered under Section 2.2.3.1 of the Compensatory Habitat Plan. This section outlines fencing and prohibiting access. Minimal signage was identified at the site illustrating the compensatory habitat area. There has been no evidence of disturbance (from the site inspection) associated with the Cullen Valley project within the compensatory habitat area. A detailed plan within the Flora and Fauna Management Plan outlines the boundaries of these areas. c) Covered under Section 2.2.3.1 including fencing and signage.	Administrative non-compliance	There is no differentiation between short term and long term management of compensatory habitat area. To be included in future updates. Completion criteria for the compensatory habitat area should be included in this Management Plan. All management plans would be required to be updated prior to recommencement of operations as agreed with DP&E. The ecological monitoring has been prepared to a high standard, however there are no definitive goals for the compensatory habitat area or other rehabilitation areas. These criteria and goals should be developed as well as	Annual Biodiversity Monitoring was undertaken in December 2016 and was broadened from the scope of previous biodiversity monitoring. This monitoring included assessment of the compensatory habitat areas. As requested by DPE, the Flora and Fauna Management Plan will be updated by 30 June 2017. **2017 Annual Review Update** The CVM Flora and Fauna management plan was updated and submitted to DPE for review on 29 June 2017. DPE have not provided any comments on the draft management plan to date.

Consent Condition	Audit Finding	Compliance identified during audit	Audit Recommendation	Proposed Action and Timing
	d) Baseline vegetation communities are shown in Figure 2 of the audit report. Description of existing vegetation within Section 2.2.2. e) Implementation within Section 2.2.3 of the Compensatory Habitat Plan. Details of monitoring are outlined in the Annual Flora, Fauna and Rehabilitation Monitoring Program which is undertaken by Kleinfelder. This monitoring program includes eight survey sites across the compensatory habitat area. A brief methodology relating to the monitoring within the compensatory habitat area is outlined within Section 3.2 of the 2015 Annual Flora, Fauna and Rehabilitation Monitoring Program. f) There is no criteria for the compensatory habitat area within the Compensatory Habitat Plan. SLR recognises that this management plan was completed prior to the site being managed by Shoalhaven Coal.		being included within the management plan and monitoring reports. Where possible this criteria should be linked with MOP criteria. There should be a more detailed analysis of monitoring results relating to the compensatory habitat area within the Annual Review. Currently there is little detail in the Annual Review regarding the performance and management of the compensatory habitat area, with reference to the very detailed ecological monitoring report. Although the Kleinfelder report is very detailed, a summary section or table within the report would be useful in determining key changes within monitoring locations and proposed actions within specific sections of the compensatory habitat area. The recommendations from the Annual Flora, Fauna and Rehabilitation Monitoring Program should be implemented by Shoalhaven Coal. This includes: • Development of a feral animal control strategy. It should be noted the feral animals identified within the compensatory habitat area are consistent with the surrounding landscape. • Dumping has occurred to a minor extent within the compensatory habitat area. During the inspection SLR did not view these areas, but the Ecological Report recommends rubbish is removed.	**2018 Annual Review Update** The CVM Flora and Fauna management plan was updated and submitted to DPE for review on 29 June 2017. During 2019, Shoalhaven Coal will liaise with DPE regarding the status of the management plan.
DA Sch 4, Condition 47	(a) minimal infrastructure visible from offsite (b) noise bunds act as visual screens c) revegetating underway on noise bunds, was rehabilitated previously but had to be re-turned and shaped due to sub - surface heating (d) lots of areas still required for rehabilitation. Pre 2012 rehabilitation appears to be of a good quality with low degree slopes, topsoil used and a mix of grasses, acacias and eucalypts. Poor results in large sections of the post 2012 rehabilitation was observed with erosion in some areas. This is possibly due to steep slopes and lack of topsoil. No rehabilitation has been completed (apart from rehabilitation maintenance) since Shoalhaven Coal commenced managing the site. In 2016 the focus has been to improve existing rehabilitation. Biodiversity monitoring is conducted annually in rehabilitation areas and will be conducted again in December 2016. Based on discussions with Shoalhaven Coal the scope of works for this monitoring has been broadened from the monitoring conducted between 2011-2015	Non-compliant	SLR recommends engaging a specialist to review the reasons for poor rehabilitation (post 2012 rehabilitation) to improve existing rehabilitation as well as future rehabilitation. Some possible options to improve future rehabilitation include: * soil and material testing. * reducing slope angle and landform design; * application of ameliorates such as gypsum, biosolids; and * review of seed mix (including grass within seed mix). It is acknowledged there is little topsoil available for future rehabilitation. Further rehabilitation/biodiversity monitoring should be compared against completion criteria from the MOP. Local seed should be collected for rehabilitation in accordance with the Flora and Fauna Management Plan.	Biodiversity monitoring is conducted annually in rehabilitation areas by a specialist ecological consultant and was conducted again in December 2016. The scope of works for this monitoring was broadened from the monitoring conducted between 2011-2015. Annual Biodiversity Monitoring was completed during December 2016. **2016 Annual Review Update** Results of 2016 Biodiversity Monitoring are included in the 2016 Annual Review **2017 Annual Review Update** Biodiversity monitoring was undertaken in 2017 with the results included in the CVM 2017 Annual Review. **2018 Annual Review Update** Biodiversity monitoring was undertaken in 2018 with the results included in the CVM 2017 Annual Review.
DA Sch 6, Condition 5	AEMRs/Annual Reviews sighted for 2011 to 2015. A comparison against the EIS predictions was not been completed in the recent C&M AEMRs/Annual Reviews. SLR understands that most EIS commitments are not relevant to the site as it is under care and maintenance; however some predictions for water should be reviewed and reported against. Monitoring results are compared against monitoring limits/criteria. There was a comparison of dust data across five years with this outlining the long-term trend. Details of complaints are included however there is no comparison over five	Administrative non-compliance	Ensure key EIS predictions are reviewed in future Annual Reviews. Provide details of complaints across five years.	This Annual Review provides a comparison of EIS predictions in **Section 6.1**. A review of complaints is provided in **Section 9.0**. **2017 Annual Review Update** The CVM reporting period monitoring results and environmental performance have been included in the 2016 and 2017 CVM Annual Reviews.

Consent Condition	Audit Finding	Compliance identified during audit	Audit Recommendation	Proposed Action and Timing
	years which means this is an administrative non-compliance. Details of complainants (names) should not be included in the AEMR/Annual Reviews.			**2018 Annual Review Update** The CVM reporting period monitoring results and environmental performance have been included in the 2018 CVM Annual Review.

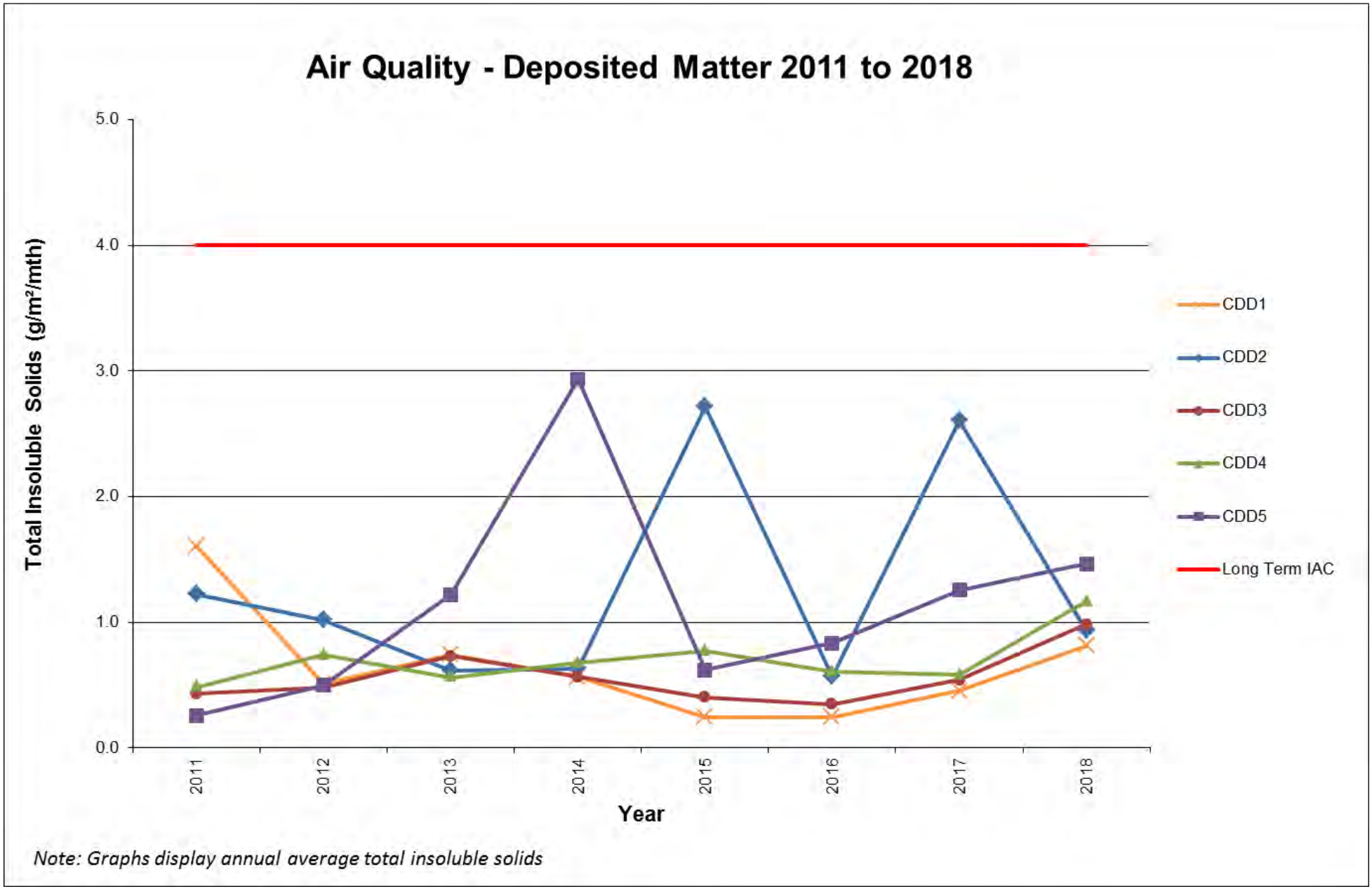
Licence Condition	Audit Finding	Compliance	Audit Recommendation	Proposed Action and Timing
EPL L4.5	Quarterly noise monitoring reports state the source of the meteorological data utilised for determining meteorological conditions. The data is generally sourced from the Cullen Valley weather station however, it is noted that the noise monitoring reports prepared for 2015 state that meteorological data has been sourced from the Bureau of Meteorology Met station in Bathurst. This is located approximately 45 km from the site and is unlikely to be representative of onsite weather conditions. Temperature inversion conditions are reported in the quarterly noise monitoring reports and are calculated from sigma theta data. Where met data is obtained from Bathurst, standard stability class is assumed. Shoalhaven Coal informed SLR that the weather station at CVM had been shut down and was inoperable prior to Shoalhaven Coal ownership. Shoalhaven Coal has reinstated and serviced the weather station to allow recording and download of meteorological data during care and maintenance. Prior to recommencement of operations, the weather station will be calibrated according to the Australian Standard to allow data to be used for noise monitoring purposes.	Administrative non-compliance	Ensure that meteorological data is sourced from the onsite meteorological station. If this is not possible due to equipment failure etc., justification for the use of alternative meteorological data and its relevance should be provided.	The noise monitoring requires weather data from an accredited source. The weather station at CVM had been shut down and was inoperable prior to Shoalhaven Coal ownership. Shoalhaven Coal has now reinstated and serviced the weather station to allow recording and download of meteorological data during care and maintenance. Prior to recommencement of operations, the weather station will be calibrated according to the Australian Standard to allow data to be used for noise monitoring purposes. This action will only be required if and when mining operations recommence at CVM. **2017 Annual Review Update** As noted above, prior to the commencement of any mining operations the weather station will be calibrated to enable its use for noise monitoring purposes. **2018 Annual Review Update** During the report period the meteorological station was calibrated and has been utilised for noise monitoring purposes as required by this recommendation.
EPL L6.1	There have been odour complaints in every year of the audit period with relating to the area of sub surface heating. These have been outlined in the AEMR/Annual Reviews. There has been some works at site (movement of material) to control the fire/odour issue with investigations still continuing. Based on discussions with site this is an ongoing issue that is being managed by Shoalhaven Coal in consultation with experts and the Departments. Shoalhaven Coal are also resolving drainage issues that are directly linked to sub surface heating issues particularly venting, smoke and odour prior to capping.	Non-compliant	Continue to investigate issue and develop a strategy to remediate. Continue to monitor and report on the odour issue.	Sub-surface heating is being managed by Shoalhaven Coal in consultation with specialist consultants and the Departments. Shoalhaven Coal are also undertaking reconstruction of contour and flume drains to direct water away from areas to reduce the incidence of venting, smoke and odour. Stage 1 works will be monitored during Q2 and Q3 2017. **2016 Annual Review Update** In accordance with Section 12.0 of the Annual Review and DRE requirements, during 2017 Shoalhaven Coal will review and manage subsurface heating across the site, and an updated PoW for management of subsurface heatings will be developed as part of the updated C&M MOP. **2017 Annual Review Update** During 2017, Shoalhaven Coal undertook repairs to a number of erosion control structures and these are discussed in the 2017 CVM Annual Review. Management measures utilised at CVM to treat sub surface heating are detailed in the CVM C&M MOP (Sedgman, 2015) with the management measures developed in consultation with DRG. Environmental management controls implemented by CVM to monitor

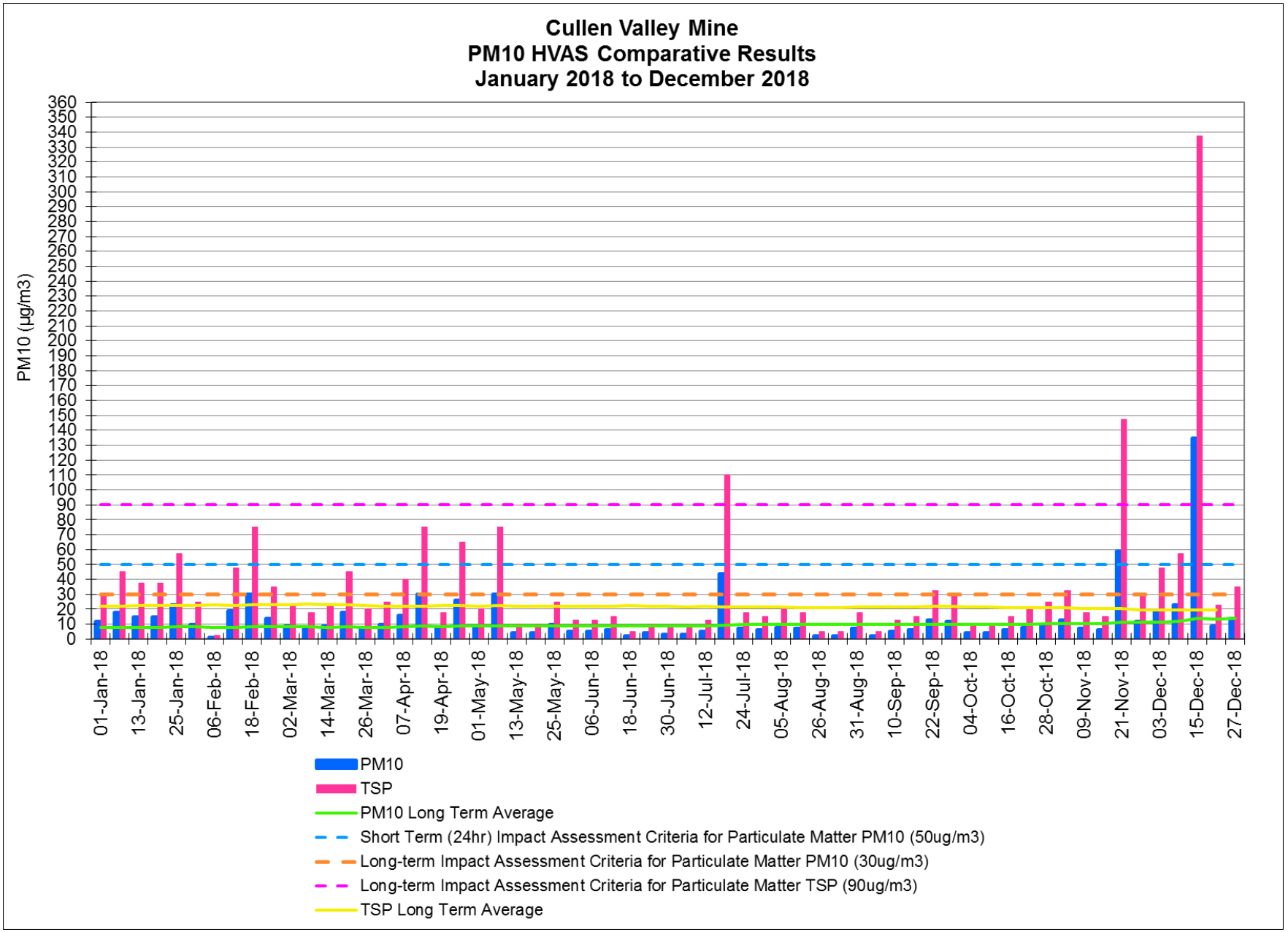
Licence Condition	Audit Finding	Compliance	Audit Recommendation	Proposed Action and Timing
				and treat subsurface heating include: • Weekly hearing monitoring of heating areas; • Capping of surface cracking using cement; • Excavation and compaction of material as required **2018 Annual Review Update** Odour complaints have been recorded during the 2018 report period and these complaints are detailed in Section 9 of the Annual Review. Subsurface heating management measures implemented during the report period are consistent with actions identified in the 2017 Annual Review update and are also detailed in Section 6.9 of the Annual Review.

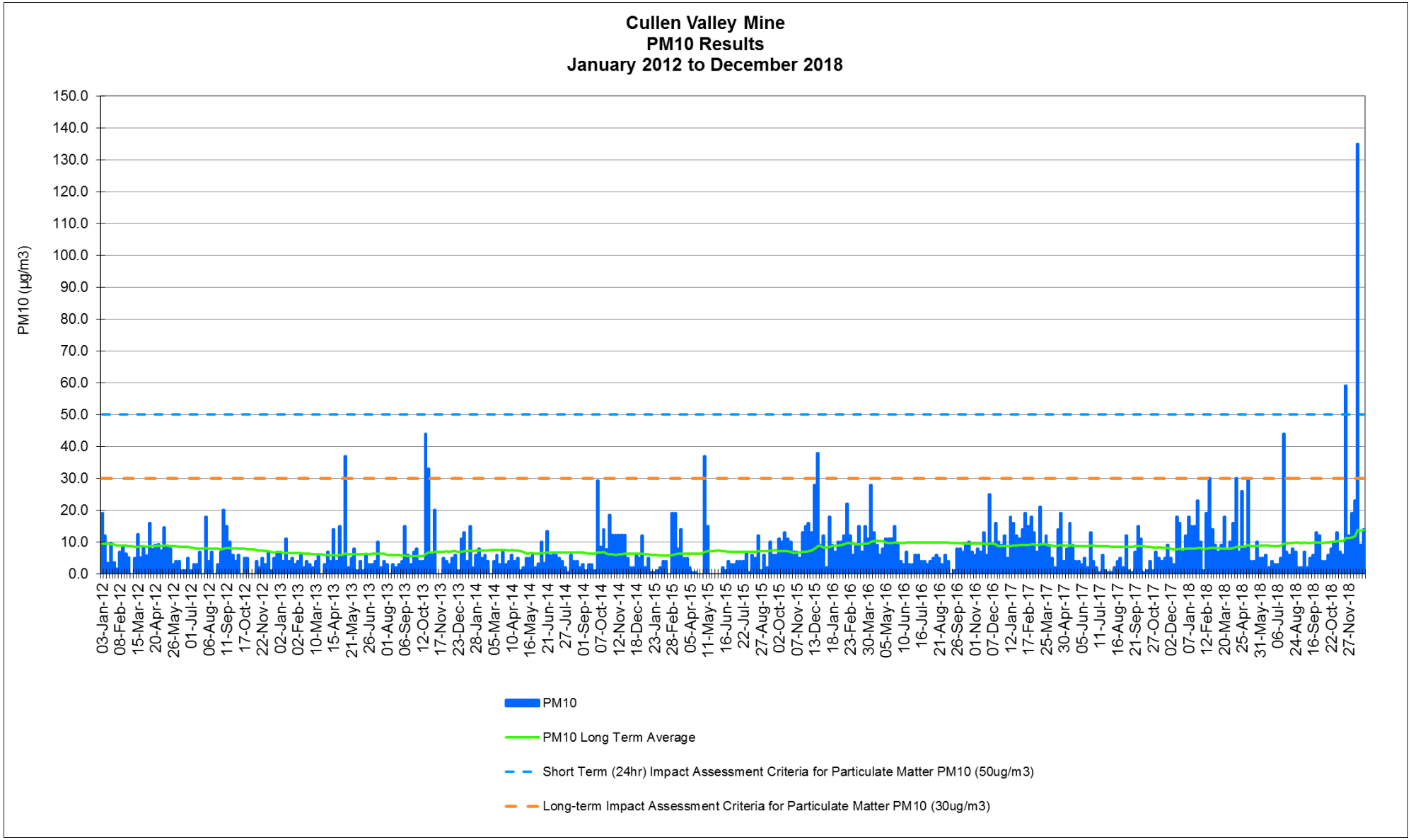
EIS Commitments	Audit Finding	Compliance	Audit Recommendation	Proposed Action and Timing
2003 EIS Section: Flora	Rehabilitation works have attempted to replicate a woodland/forest community. Results have been variable with good results prior to 2012, and average since. No Capertee Stringybark seed has been collected for rehabilitation.	Non-compliant	Recommend engaging a specialist to review reasons for poor rehabilitation (post 2012 rehabilitation) to improve existing rehabilitation as well as future rehabilitation. Some possible options to improve future rehabilitation include: * soil and material testing. * reducing slope angle and landform design; * application of ameliorates such as gypsum, biosolids; * review of seed mix (including grass within seed mix); It is acknowledged there is little topsoil available for future rehabilitation. Further rehabilitation/biodiversity monitoring should be compared against completion criteria from the MOP. Local seed should be collected for rehabilitation in accordance with the Flora and Fauna Management Plan.	Biodiversity monitoring is conducted annually in rehabilitation areas by a specialist ecological consultant and was conducted again in December 2016. The scope of works for this monitoring was broadened from the previous monitoring conducted between 2011-2015. The Annual Biodiversity Monitoring was completed during December 2016. **2016 Annual Review Update** Results of 2016 Biodiversity Monitoring are included in the 2016 Annual Review **2017 Annual Review Update** Results of 2017 Biodiversity Monitoring are included in the 2017 Annual Review. The biodiversity monitoring includes a comparison of CVM rehabilitation to the performance indicators / completion criteria included in the CVM C&M MOP (Sedgman, 2015). **2018 Annual Review Update** Results of 2018 Biodiversity Monitoring are included in the 2018 Annual Review.
2003 EIS Section: Rehabilitation	There are still large sections of disturbed areas that have not been rehabilitated.	Non-compliant	Same as 'Flora' recommendation to improve rehabilitation.	Biodiversity monitoring is conducted annually in rehabilitation areas by a specialist ecological consultant and was conducted again in December 2016. The scope of works for this monitoring was broadened from the previous monitoring conducted between 2011-2015. The Annual Biodiversity Monitoring was completed during December 2016. **2017 Annual Review Update** As detailed within the 2017 CVM Annual Review, during the 2018 Report Period CVM propose to utilise VENM / ENM to fill site voids and progress with the rehabilitation of the mine. **2018 Annual Review Update** As discussed in Section 3.0 of the Annual Review, during the 2018 report period a small volume of VENM and ENM was received by CVM however as a result of discussions between DPE and Shoalhaven Coal, the receipt of VENM / ENM at CVM ceased on 29 March 2018 and no further VENM / ENM has been received since this time. During 2019, Shoalhaven Coal will seek to continue to liaise with DPE regarding the receipt of VENM / ENM at CVM.
2003 EIS Section: Soil Resources	Topsoil was used in most of the rehabilitation prior to 2012, however does not appear to be used in post 2012 rehabilitation.	Non-compliant	Same as 'Flora' recommendation to improve rehabilitation.	Biodiversity monitoring is conducted annually in rehabilitation areas by a specialist ecological consultant and was conducted again in December 2016. The scope of works for this monitoring was broadened from the previous monitoring conducted between 2011-2015. The Annual Biodiversity Monitoring was completed during December 2016. **2017 Annual Review Update** Results of 2017 Biodiversity Monitoring are included in the 2017 Annual Review. The biodiversity monitoring includes a comparison of CVM rehabilitation to the performance indicators / completion criteria included in the CVM C&M MOP (Sedgman, 2015). **2018 Annual Review Update** Results of 2018 Biodiversity Monitoring are included in the 2018 Annual Review. The biodiversity monitoring includes a comparison of CVM rehabilitation to the performance indicators / completion criteria included in the CVM C&M MOP (Sedgman, 2015).

APPENDIX 2

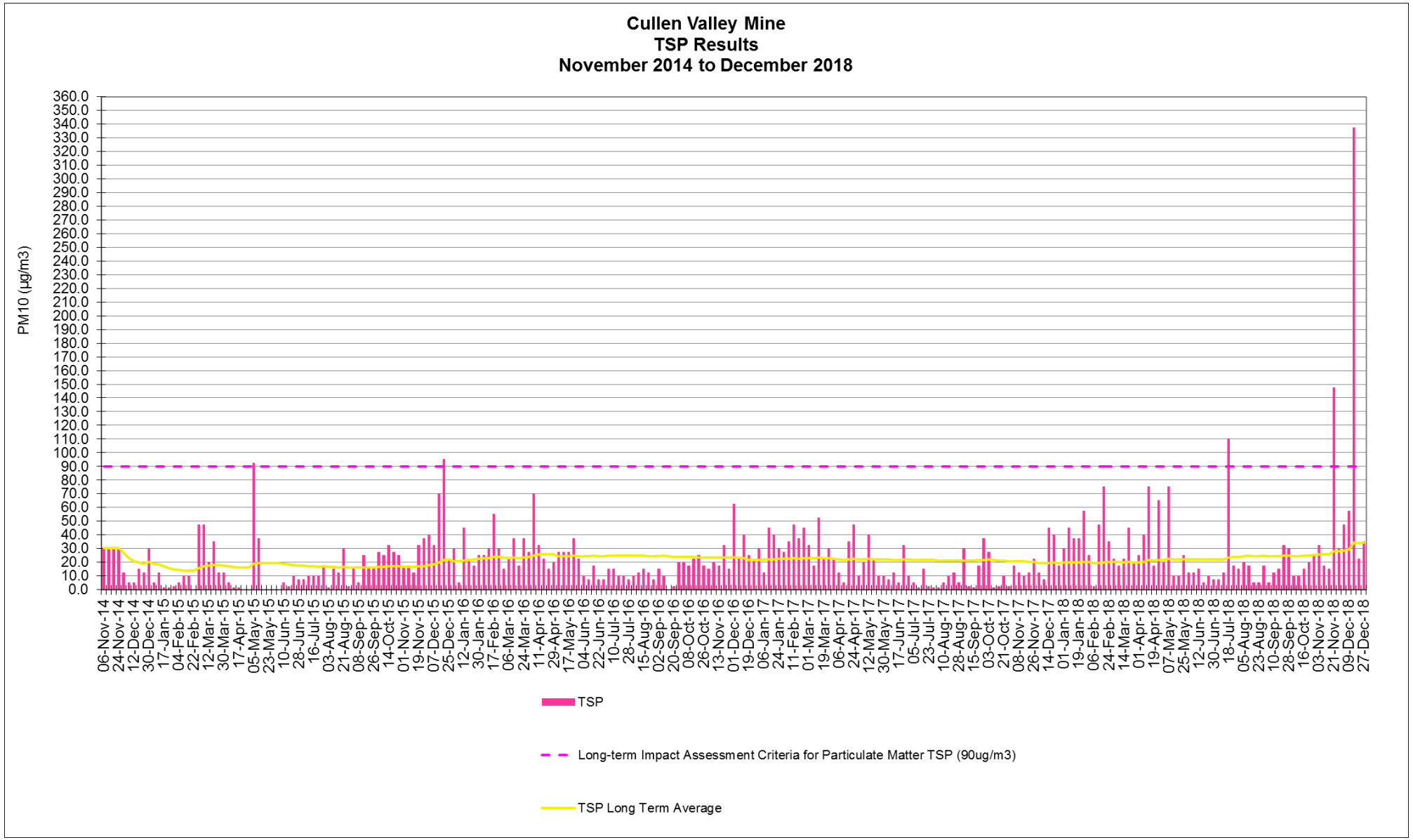
Air quality monitoring graphs


Air Quality - Deposited Matter 2011 to 2018
Total Insoluble Solids (g/m²/mth)
5.0
4.0
3.0
2.0
1.0
0.0
2011
2012
2013
2014
2015
2016
2017
2018
Year
CDD1
CDD2
CDD3
CDD4
CDD5
Long Term IAC
Note: Graphs display annual average total insoluble solids


Cullen Valley Mine
PM10 HVAS Comparative Results
January 2018 to December 2018
PM10 (µg/m3)
360
350
340
330
320
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
01-Jan-18
13-Jan-18
25-Jan-18
06-Feb-18
18-Feb-18
02-Mar-18
14-Mar-18
26-Mar-18
07-Apr-18
19-Apr-18
01-May-18
13-May-18
25-May-18
06-Jun-18
18-Jun-18
30-Jun-18
12-Jul-18
24-Jul-18
05-Aug-18
26-Aug-18
31-Aug-18
10-Sep-18
22-Sep-18
04-Oct-18
16-Oct-18
28-Oct-18
09-Nov-18
21-Nov-18
03-Dec-18
15-Dec-18
27-Dec-18
PM10
TSP
PM10 Long Term Average
Short Term (24hr) Impact Assessment Criteria for Particulate Matter PM10 (50ug/m3)
Long-term Impact Assessment Criteria for Particulate Matter PM10 (30ug/m3)
Long-term Impact Assessment Criteria for Particulate Matter TSP (90ug/m3)
TSP Long Term Average



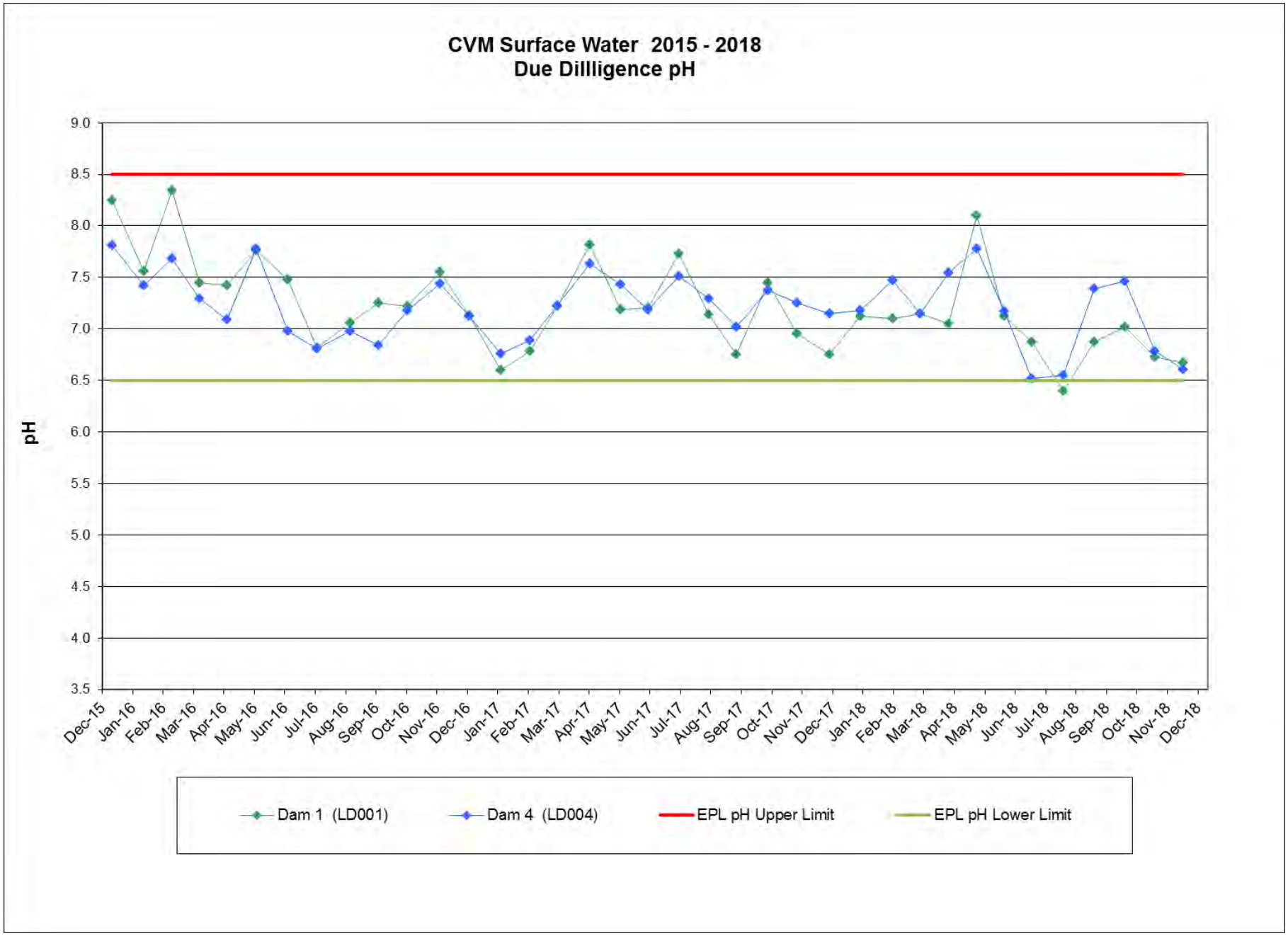
Appendix 2 CVM Air Quality Monitoring Graphs

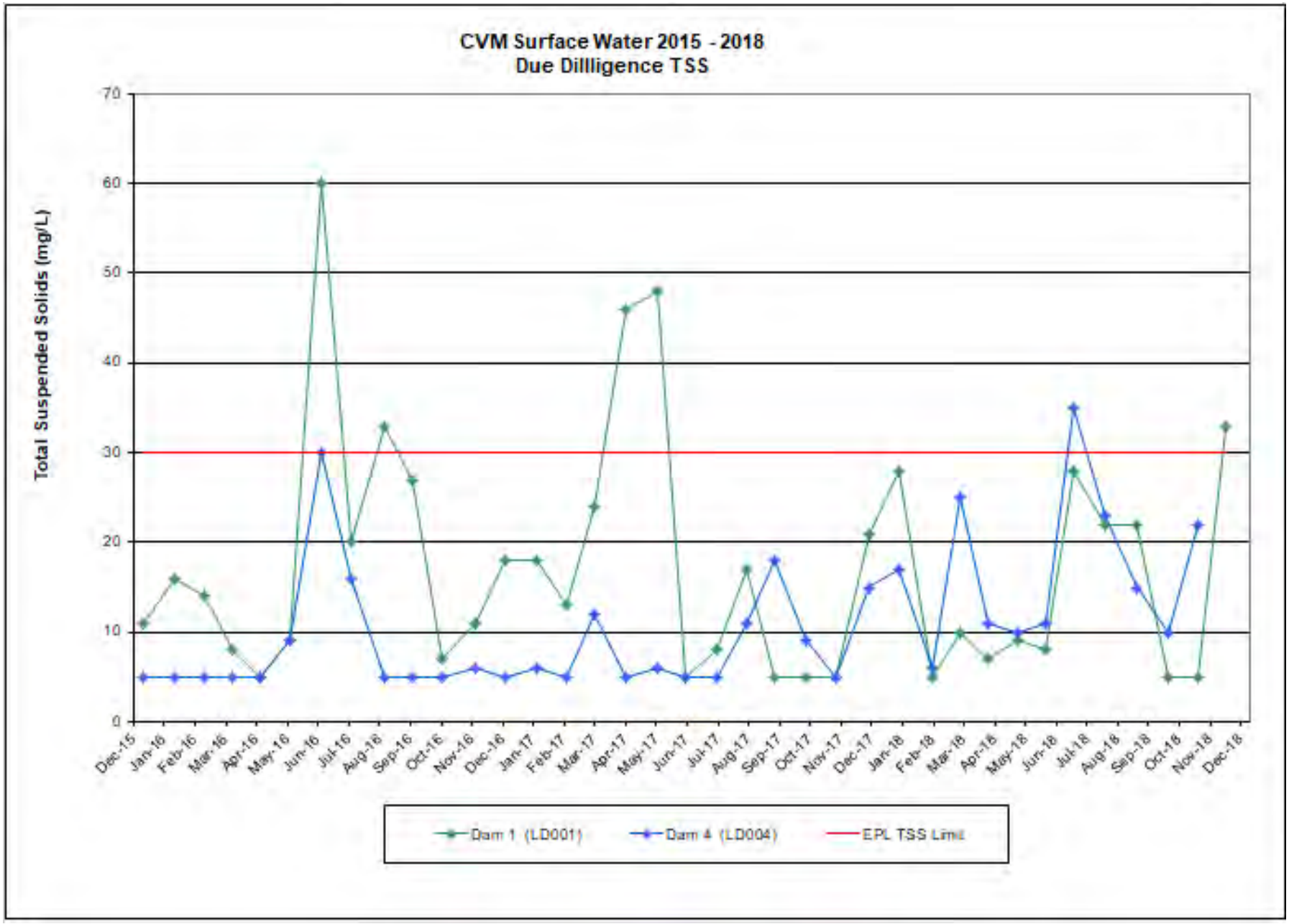


Appendix 2 CVM Air Quality Monitoring Graphs

APPENDIX 3

Surface water monitoring graphs and tables


CVM Surface Water 2015 - 2018
Due Dillligence pH
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
Dec-15
Jan-16
Feb-16
Mar-16
Apr-16
May-16
Jun-16
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17
Jan-18
Feb-18
Mar-18
Apr-18
May-18
Jun-18
Jul-18
Aug-18
Sep-18
Oct-18
Nov-18
Dec-18
Dam 1 (LD001)
Dam 4 (LD004)
EPL pH Upper Limit
EPL pH Lower Limit


CVM Surface Water 2015 - 2018
Due Dillligence TSS
Total Suspended Solids (mg/L)
70
60
50
40
30
20
10
0
Dec-15
Jan-16
Feb-16
Mar-16
Apr-16
May-16
Jun-16
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17
Jan-18
Feb-18
Mar-18
Apr-18
May-18
Jun-18
Jul-18
Aug-18
Sep-18
Oct-18
Nov-18
Dec-18
Dam 1 (LD001)
Dam 4 (LD004)
EPL TSS Limit

The water quality monitoring results for CVM are shown in **Table A**. It is noted that there was no discharge from CVM EPL points during the 2018 report period and the below sampling is undertaken monthly for due diligence purposes only.

Table A Water quality monitoring results in site dams and receiving environments

Sampling date	pH	Oil and grease	TSS
Dam 1			
11/1/2018	7.12	<5	28
13/2/2018	7.10	<5	<5
13/3/2018	7.15	<5	10
11/4/2018	7.05	<5	7
10/5/2018	8.10	<5	9
7/6/2018	7.12	<5	8
5/7/2018	6.87	<5	28
6/8/2018	6.40	<5	22
6/9/2018	6.87	<5	22
8/10/2018	7.02	<5	<5
7/11/2018	6.73	<5	<5
6/12/2018	6.67	<5	33
Dam 4			
11/1/2018	7.18	<5	17
13/2/2018	7.47	<5	6
13/3/2018	7.15	<5	25
11/4/2018	7.54	<5	11
10/5/2018	7.78	<5	10
7/6/2018	7.17	<5	11
5/7/2018	6.52	<5	35
6/8/2018	6.55	<5	23
6/9/2018	7.39	<5	15
8/10/2018	7.46	<5	10

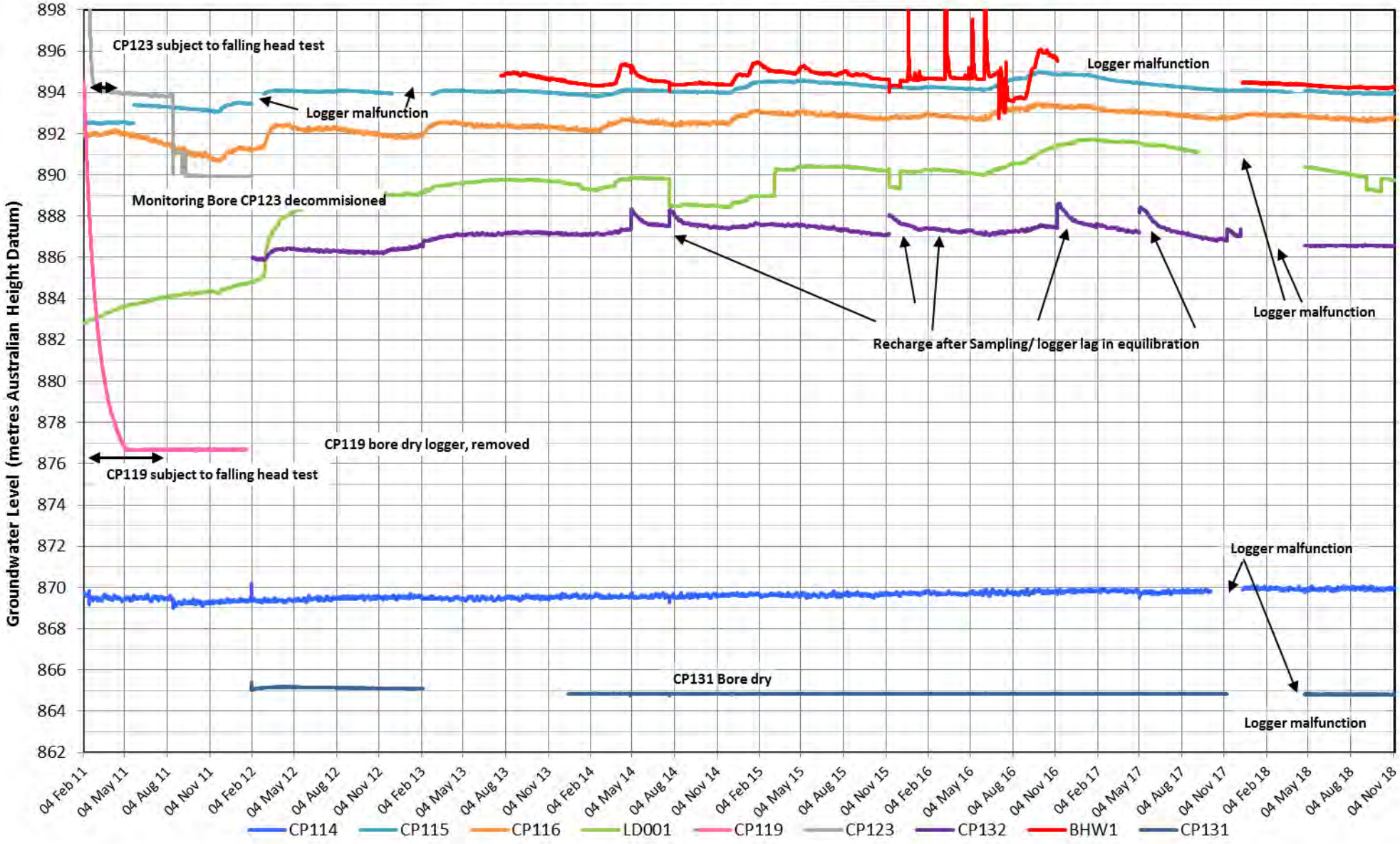
Sampling date	pH	Oil and grease	TSS
7/11/2018	6.78	<5	22
6/12/2018	6.61	<5	NS*
BSW03			
11/1/2018	7.13	<5	29
12/2/2018	7.79	<5	17
13/3/2018	7.29	<5	11
11/4/2018	7.78	<5	37
10/5/2018	7.46	<5	70
7/6/2018	7.86	<5	29
5/7/2018	7.14	<5	19
6/8/2018	7.71	<5	21
6/9/2018	8.04	<5	28
8/10/2018	7.43	<5	13
7/11/2018	7.07	<5	8
6/12/2018	6.56	<5	53

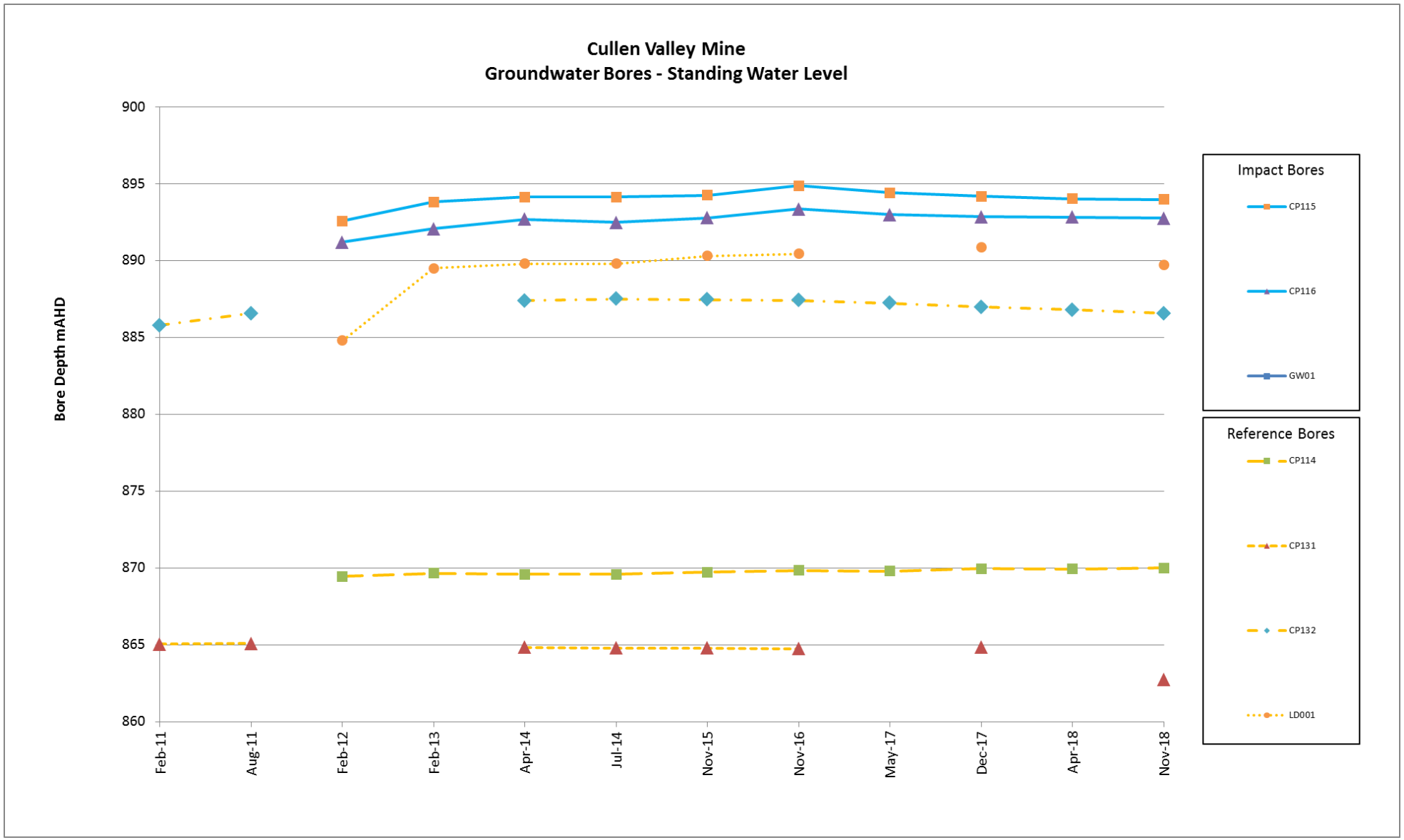
Note: Sample in Dam 4 during December 2018 was undertaken for due diligence purposes and has been removed from the data set as the result of 171 is not considered to reflective of water quality in the basin. Field sampling notes state the water sampled was pooled and stagnant.

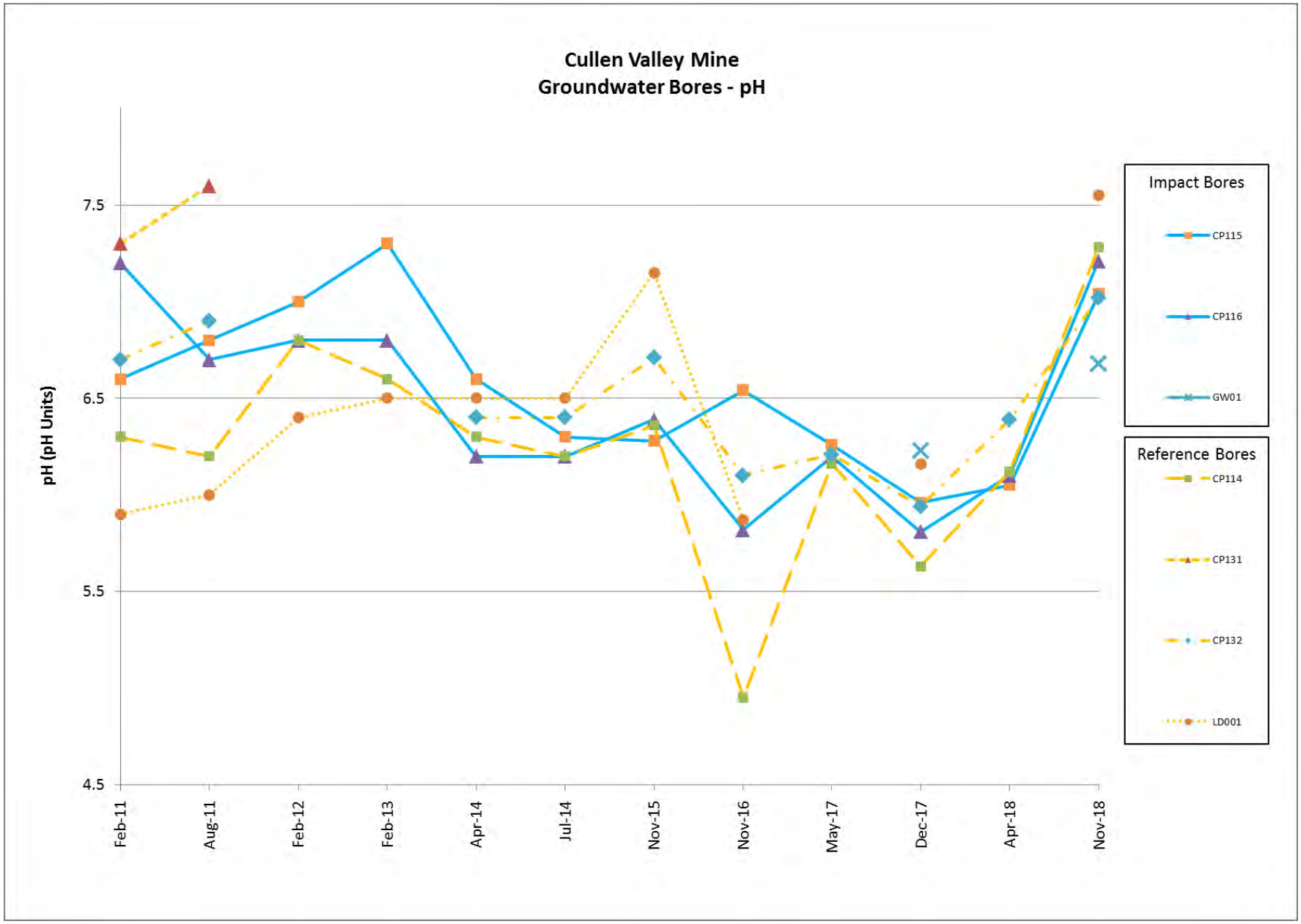
APPENDIX 4

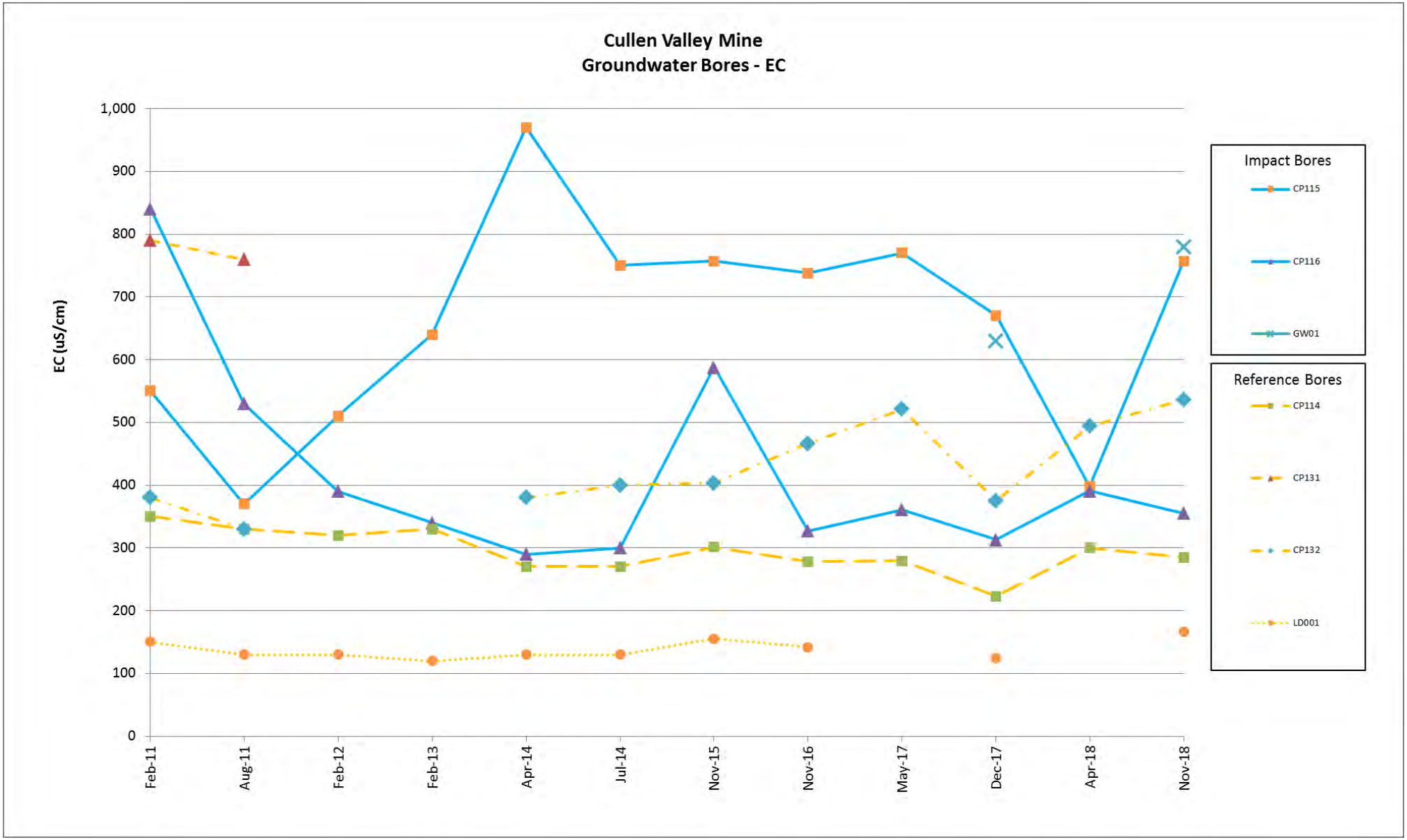
Groundwater monitoring graphs and tables

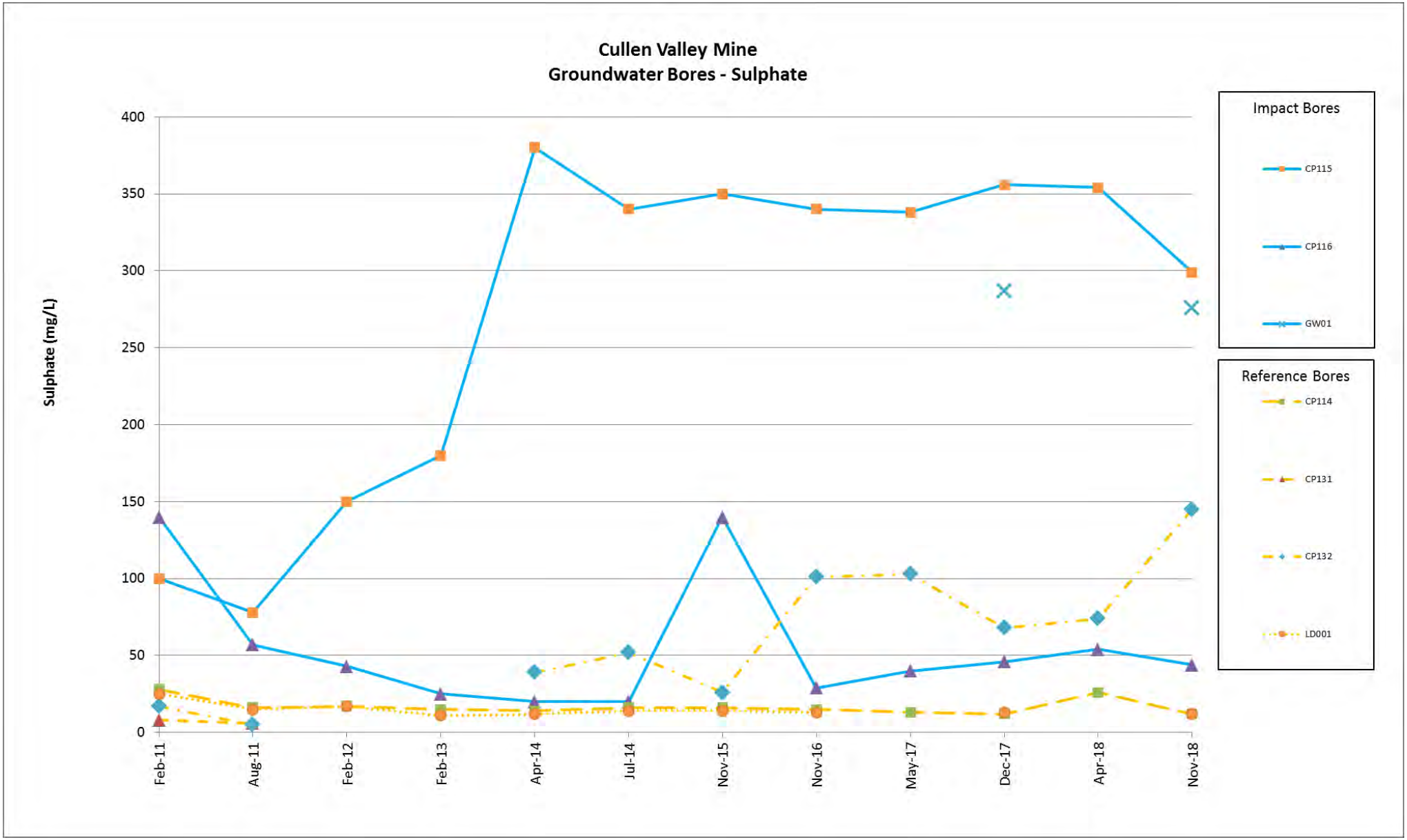
Groundwater Hydrographs - Cullen Valley (2011-2018)

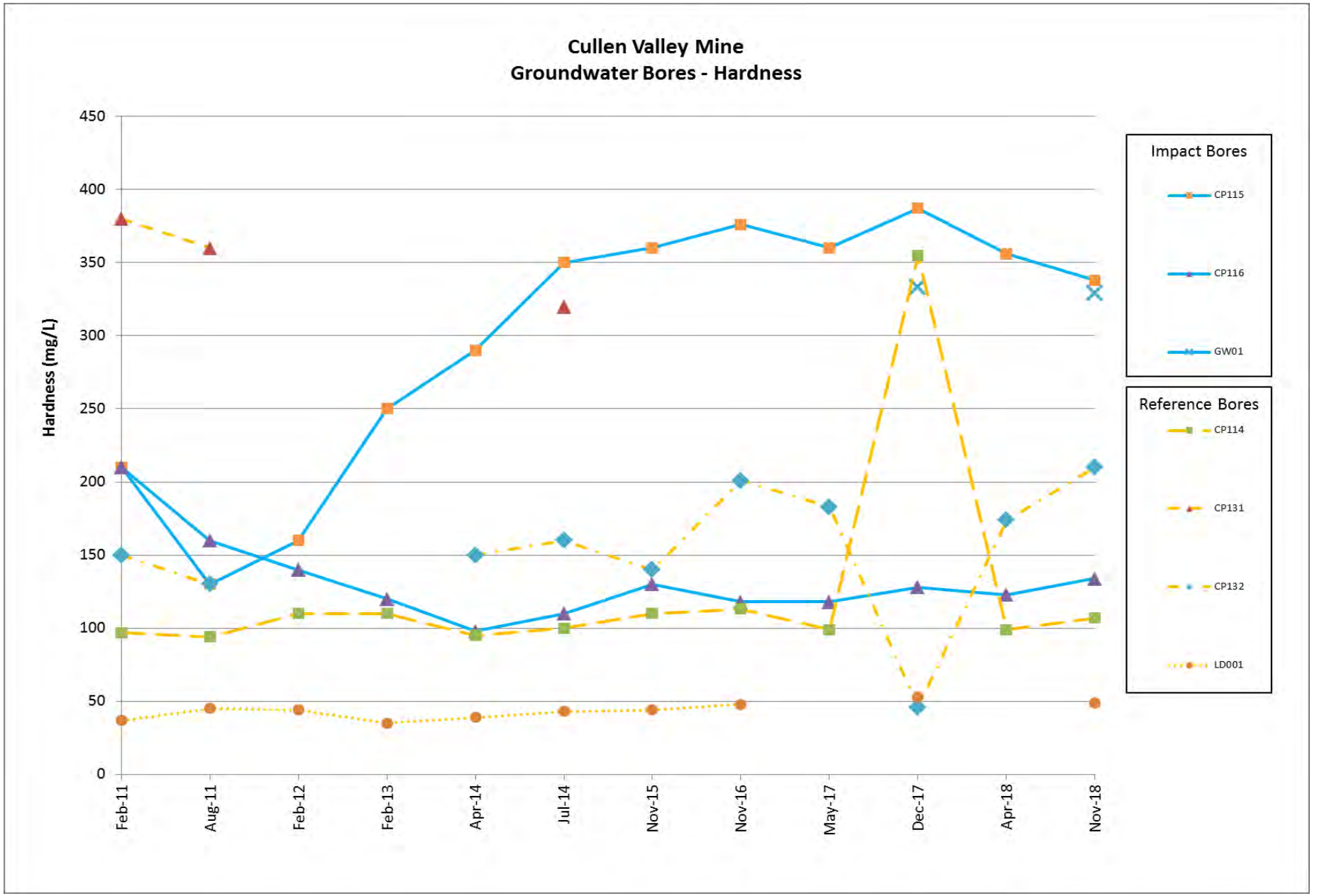


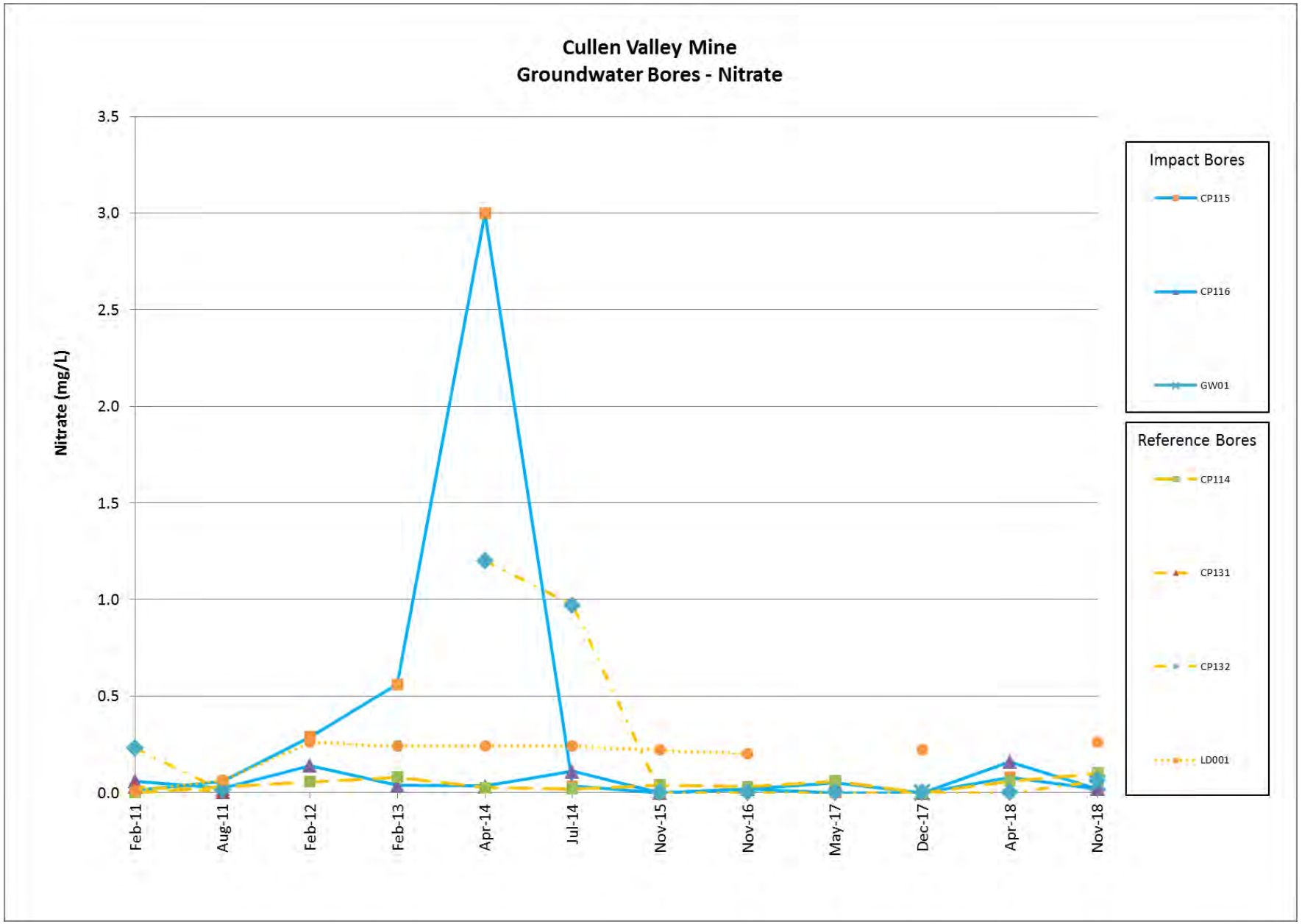

Cullen Valley Mine
Groundwater Bores - Standing Water Level
Bore Depth mAHD
900
895
890
885
880
875
870
865
860
Feb-11
Aug-11
Feb-12
Feb-13
Apr-14
Jul-14
Nov-15
Nov-16
May-17
Dec-17
Apr-18
Nov-18
Impact Bores
CP115
CP116
GW01
Reference Bores
CP114
CP131
CP132
LD001


Cullen Valley Mine
Groundwater Bores - pH
pH (pH Units)
7.5
6.5
5.5
4.5
Feb-11
Aug-11
Feb-12
Feb-13
Apr-14
Jul-14
Nov-15
Nov-16
May-17
Dec-17
Apr-18
Nov-18
Impact Bores
CP115
CP116
GW01
Reference Bores
CP114
CP131
CP132
LD001


Cullen Valley Mine
Groundwater Bores - EC
EC (uS/cm)
1,000
900
800
700
600
500
400
300
200
100
0
Feb-11
Aug-11
Feb-12
Feb-13
Apr-14
Jul-14
Nov-15
Nov-16
May-17
Dec-17
Apr-18
Nov-18
Impact Bores
CP115
CP116
GW01
Reference Bores
CP114
CP131
CP132
LD001


Cullen Valley Mine
Groundwater Bores - Sulphate
Sulphate (mg/L)
400
350
300
250
200
150
100
50
0
Feb-11
Aug-11
Feb-12
Feb-13
Apr-14
Jul-14
Nov-15
Nov-16
May-17
Dec-17
Apr-18
Nov-18
Impact Bores
CP115
CP116
GW01
Reference Bores
CP114
CP131
CP132
LD001


Cullen Valley Mine
Groundwater Bores - Hardness
Hardness (mg/L)
450
400
350
300
250
200
150
100
50
0
Feb-11
Aug-11
Feb-12
Feb-13
Apr-14
Jul-14
Nov-15
Nov-16
May-17
Dec-17
Apr-18
Nov-18
Impact Bores
CP115
CP116
GW01
Reference Bores
CP114
CP131
CP132
LD001


Cullen Valley Mine
Groundwater Bores - Nitrate
Nitrate (mg/L)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Feb-11
Aug-11
Feb-12
Feb-13
Apr-14
Jul-14
Nov-15
Nov-16
May-17
Dec-17
Apr-18
Nov-18
Impact Bores
CP115
CP116
GW01
Reference Bores
CP114
CP131
CP132
LD001

The results of groundwater monitoring conducted during the 2017 and 2018 reporting periods are provided in **Tables B - E.**

Table B CP114 and CP115 Groundwater monitoring results

Sample site	CP114				CP115			
Sample date	5/5/2017	13/12/2017	26/4/2018	6/11/2018	5/05/2017	13/12/2017	27/4/2018	6/11/2018
AHD (RL) (m)	869.78	869.96	869.94	869.99	894.41	894.19	894.02	893.98
Depth to aquifer (m)	36.18	36.00	36.02	35.97	56.87	57.09	57.21	57.30
pH	6.16	5.63	6.12	7.28	6.26	5.96	6.05	7.04
Electrical Conductivity (µS/cm	279	223	300	285	770	670	398	757
Nitrite (mg/L)	<0.05	<0.05	0.06	<0.01	<0.05	<0.05	0.05	<0.01
Total Oxidised Nitrogen (mg/L)	0.060	<0.05	0.12	0.1	<0.05	<0.05	0.13	0.02
Chloride (mg/L)	5	22	8	15	5	4	4	3
Nitrate (mg/L)	0.060	<0.05	0.06	0.1	<0.05	<0.05	0.08	0.02
Sulphate (mg/L)	13	12	26	12	338	356	354	299
Alkalinity (mg/L)	110	100	100	104	62	62	64	46
Calcium (mg/L)	23	86	23	23	85	94	85	81
Magnesium (mg/L)	10	34	10	12	36	37	35	33
Sodium (mg/L)	8	12	13	12	11	13	13	16
Potassium (mg/L)	5	10	6	6	10	11	10	10
Total Hardness (mg $CaCO_3$/L)	99	355	99	107	360	387	356	338
Aluminium (µg/L)	<10	280	20	60	<10	490	10	<10

Sample site	CP114				CP115			
Arsenic (µg/L)	<1	<1	<1	<1	<1	<1	<1	<1
Cadmium (µg/L)	<0.1	<0.1	<0.1	<0.1	0.2	0.1	<0.1	<0.1
Chromium (µg/L)	<1	1	<1	<1	2	2	<1	<1
Copper (µg/L)	1	9	3	2	<1	10	<1	<1
Iron (µg/L)	2240	12800	<50	1350	9450	12300	7880	7840
Lead (µg/L)	<1	15	<1	<1	<1	17	<1	<1
Manganese (µg/L)	964	414	535	635	424	461	448	388
Molybdenum (µg/L)	8	<1	1	1	2	<1	<1	5
Nickel (µg/L)	6	3	4	27	16	3	3	49
Selenium (µg/L)	<10	<10	<10	<10	<10	<10	<10	<10
Zinc (µg/L)	48	86	21	16	317	86	115	78
Mercury (mg/L)	<0.0001	<0.0001	<0.0001	Removed from monitoring program	<0.0001	<0.0001	<0.0001	Removed from monitoring program

Table C CP116 and CP131 Groundwater monitoring results

Sample site	CP116				CP131			
Sample date	5/05/2017	13/12/2017	27/4/2018	6/11/2018	5/5/2017	13/12/2017	27/4/2018	6/11/2019
AHD (RL) (m)	892.98	892.86	892.82	892.76	NS	864.85	NS	862.75
Depth to aquifer (m)	49.62	49.74	49.75	49.81		74.37		76.35
pH	6.20	5.81	6.10	7.21		*		*
Electrical Conductivity (µS/cm	361	313	391	355				
Nitrite (mg/L)	<0.05	<0.05	<0.05	<0.01				
Total Oxidised Nitrogen (mg/L)	0.05	<0.05	0.16	0.02				
Chloride (mg/L)	16	20	16	16				
Nitrate (mg/L)	0.05	<0.05	0.16	0.02				
Sulphate (mg/L)	40	46	54	44				
Alkalinity (mg/L)	110	104	124	104				
Calcium (mg/L)	26	28	28	29				
Magnesium (mg/L)	13	14	13	15				
Sodium (mg/L)	12	14	14	15				
Potassium (mg/L)	6	7	6	6				
Total Hardness (mg $CaCO_3$/L)	118	128	123	134				
Aluminium (µg/L)	10	<10	<0.01	80				
Arsenic (µg/L)	<1	<1	<1	<1				
Cadmium (µg/L)	<0.1	<0.1	<0.1	<0.1				

Sample site	CP116				CP131			
Chromium (µg/L)	1	<1	<1	1				
Copper (µg/L)	<1	<1	<1	<1				
Iron (µg/L)	11800	12000	10200	14500				
Lead (µg/L)	<1	<1	<1	<1				
Manganese (µg/L)	561	562	551	553				
Molybdenum (µg/L)	2	<1	<1	<1				
Nickel (µg/L)	2	1	1	2				
Selenium (µg/L)	<10	<10	<10	<10				
Zinc (µg/L)	105	19	56	5				
Mercury (mg/L)	<0.0001	<0.0001	<0.0001	Removed from monitoring program				

NS – No sample required (Annual Monitoring only)

** Insufficient water available to sample or Bore dry.*

Table D CP132 and LD001 Groundwater monitoring results

Sample site	CP132				LD001			
Sample date	5/05/2017	12/12/2017	26/4/2018	6/11/2018	5/5/2017	12/12/2017	26/4/2018	7/11/2018
AHD (RL) (m)	887.23	886.981	886.79	886.56	NS	890.88	NS	889.73
Depth to aquifer (m)	18.53	18.78	18.97	19.20		49.25		50.40
pH	6.21	5.94	6.39	7.02		6.16		7.55
Electrical Conductivity (µS/cm	521	375	494	536		125		166
Nitrite (mg/L)	<0.05	<0.05	-	<0.1		<0.05		<0.01
Total Oxidised Nitrogen (mg/L)	<0.05	<0.05	-	0.06		0.22		0.26
Chloride (mg/L)	32	36	32	26		6		5
Nitrate (mg/L)	<0.05	<0.05	-	0.06		0.22		0.26
Sulphate (mg/L)	103	68	74	145		13		12
Alkalinity (mg/L)	104	108	140	86		56		63
Calcium (mg/L)	42	12	401	48		13		13
Magnesium (mg/L)	19	4	18	22		5		4
Sodium (mg/L)	13	6	14	19		6		8
Potassium (mg/L)	9	7	9	10		8		8
Total Hardness (mg $CaCO_3$/L)	183	46	174	210		53		49
Aluminium (µg/L)	<10	<10	-	<10		<10		<10
Arsenic (µg/L)	<1	<1	-	<1		<1		<1
Cadmium (µg/L)	<0.1	<0.1	-	<0.1		<0.1		<0.1

Sample site	CP132				LD001			
Chromium (µg/L)	<1	<1	-	<1		<1		<1
Copper (µg/L)	<1	<1	-	<1		10		6
Iron (µg/L)	8430	7250	-	9820		<50		<50
Lead (µg/L)	<1	<1	-	<1		<1		<1
Manganese (µg/L)	267	222	-	303		4		<1
Molybdenum (µg/L)	1	<1	-	<1		<1		<1
Nickel (µg/L)	<1	<1	-	1		8		8
Selenium (µg/L)	<10	<10	-	<10		<10		10
Zinc (µg/L)	14	<5	-	5		138		150
Mercury (mg/L)	<0.0001	<0.0001	-	Removed from monitoring program		<0.0001		Removed from monitoring program

NS – No sample required (Annual Monitoring only)

Table E GW01 and BHW1 Groundwater monitoring results

Sample site	GW01			BHW1			
Sample date	13/12/2017	27/4/2018	6/11/2018	4/05/2017	13/12/2017	27/4/2018	8/11/2018
AHD (RL) (m)	N/A (Tap)	NS	N/A (Tap)	895.00	894.52	NS	894.29
Depth to aquifer (m)	N/A (Tap)		N/A (Tap)	43.8	44.28		44.51
pH	6.23		6.68	6.42	WL		WL
Electrical Conductivity (µS/cm	629		779	485			
Nitrite (mg/L)	<0.05		<0.01	<0.05			
Total Oxidised Nitrogen (mg/L)	<0.05		0.5	<0.05			
Chloride (mg/L)	22		18	22			
Nitrate (mg/L)	<0.05		0.05	<0.05			
Sulphate (mg/L)	287		276	67			
Alkalinity (mg/L)	84		68	190			
Calcium (mg/L)	64		64	46			
Magnesium (mg/L)	42		41	19			
Sodium (mg/L)	19		22	10			
Potassium (mg/L)	13		13	8			
Total Hardness (mg $CaCO_3$/L)	333		329	193			
Aluminium (µg/L)	<10		<10	<10			
Arsenic (µg/L)	<1		<1	3.00			
Cadmium (µg/L)	<0.1		0.1	0.1			

Sample site	GW01			BHW1			
Chromium (µg/L)	<1		<1	<1			
Copper (µg/L)	<1		<1	<1			
Iron (µg/L)	7780		310	3580			
Lead (µg/L)	<1		<1	<1			
Manganese (µg/L)	1960		2060	366			
Molybdenum (µg/L)	<1		<1	<1			
Nickel (µg/L)	24		16	22			
Selenium (µg/L)	<10		<10	<10			
Zinc (µg/L)	38		29	17100			
Mercury (mg/L)	<0.0001		-	<0.0001			

NS – No sample required (Annual Monitoring only)
WL Water Level only

APPENDIX 5

Noise monitoring results

Historical Noise monitoring results for years 2018, 2017, 2016, 2015, 2012 and 2011 are shown in **Tables A to F**. Contribution from CVM was inaudible for all monitoring undertaken for 2013, and 2014.

Table A 2018 Quarterly Monitoring Results

Location	Criterion (dB)	Quarter 1 (L_{Aeq})	Quarter 2 (L_{Aeq})	Quarter 3 (L_{Aeq})	Quarter 4 (L_{Aeq})
Red Springs (N07)	37	34 (IA)	38 (IA)	33 (IA)	40 (IA)
Hillcroft (N08)	35	35 (<20)	39 (IA)	40 (IA)	33 (IA)
Forest Lodge (N10)	40	50 (IA)	27 (IA)	43 (IA)	33 (IA)
Doble Gate (N09)	43	47 (IA)	49 (IA)	50 (IA)	49 (IA)
Tilley (N06)	43	66 (IA)	62 (IA)	68 (IA)	67 (IA)

Table B 2017 Quarterly Noise Monitoring Results

Location	Criterion (dB)	Quarter 1 (L_{Aeq})	Quarter 2 (L_{Aeq})	Quarter 3 (L_{Aeq})	Quarter 4 (L_{Aeq})
Red Springs (N07)	37	44 (IA)	33 (IA)	34 (IA)	34 (IA)
Hillcroft (N08)	35	42 (IA)	37 (IA)	29 (IA)	29 (IA)
Forest Lodge (N10)	40	33 (IA)	34 (IA)	31 (IA)	31 (IA)
Doble Gate (N09)	43	47 (IA)	50 (IA)	45 (IA)	45 (IA)
Tilley (N06)	43	65 (IA)	68 (IA)	67 (IA)	67 (IA)

Table C 2016 Quarterly Noise Monitoring Results*

Location	Criterion (dB)	Quarter 1 (L_{Aeq})	Quarter 2 (L_{Aeq})	Quarter 3 (L_{Aeq})	Quarter 4 (L_{Aeq})
Red Springs (N07)	37	32 (IA)	37 (IA)	36 (IA)	36 (IA)
Hillcroft (N08)	35	40 (IA)	37 (IA)	35 (IA)	35 (IA)
Forest Lodge (N10)	40	32 (IA)	33 (IA)	30 (IA)	36 (IA)
Doble Gate (N09)	43	46 (IA)	52 (IA)	49 (IA)	48 (IA)
Tilley (N06)	43	67 (IA)	66 (IA)	67 (IA)	66 (IA)

Table D 2015 Quarterly Noise Monitoring Results*

Location	Criterion (dB)	Quarter 1 (L_{Aeq})	Quarter 2 (L_{Aeq})	Quarter 3 (L_{Aeq})	Quarter 4 (L_{Aeq})
Red Springs (N07)	37	42 (IA)	32	43 (IA)	41 (IA)
Hillcroft (N08)	35	34	39 (IA) #	35	38 (IA)
Forest Lodge (N10)	40	40	28	40	42 (IA)
Doble Gate (N09)	43	64 (IA)	49 (IA) #	51 (IA) #	49 (IA)
Tilley (N06)	43	66 (IA)	69 (IA) #	66 (IA) #	69 (IA)

IA – noise from the mine was inaudible therefore criteria do not apply

 # – these measurements were affected by wind speeds > 3m/s2 therefore criteria do not apply

Table E 2012 Quarterly Noise Monitoring Results

Location	Criterion (dB)	Quarter 1 ($L_{Aeq\ 15min}$)	Quarter 2 ($L_{Aeq\ 15min}$)	Quarter 3 ($L_{Aeq\ 15min}$)	Quarter 4 ($L_{Aeq\ 15min}$)
Red Springs (N07)	37	33	35	30	32
Hillcroft (N08)	35	35	39	32	33
Forest Lodge (N10)	40	<25	30	<25	NM
Doble Gate (N09)	43	IA	IA	IA	IA
Tilley (N06)	43	IA	IA	IA	IA

IA – noise from the mine was inaudible therefore criteria do not apply
NM – noise was not measurable

Table F 2011 Quarterly Noise Monitoring Results

Location	Criterion (dB)	Quarter 1 ($L_{Aeq\ 15min}$)	Quarter 2 ($L_{Aeq\ 15min}$)	Quarter 3 ($L_{Aeq\ 15min}$)	Quarter 4 ($L_{Aeq\ 15min}$)
Red Springs (N07)	37	IA	33	<20	IA
Hillcroft (N08)	35	31	37	30	<20
Forest Lodge (N10)	40	26	<30	<25	<25
Doble Gate (N09)	43	IA	IA	IA	IA
Tilley (N06)	43	IA	IA	IA	IA

IA – noise from the mine was inaudible therefore criteria do not apply