CENTENNIAL

CENTENNIAL COAL
MYUNA COLLIERY
ANNUAL REVIEW

January 2019 to December 2019

March 2020

Table 1. Annual Review Title Block

Name of Operation	Myuna Colliery
Name of Operator	Centennial Myuna Pty. Ltd.
Development Consent/ Project Approval #	PA10_0080 MOD1 SH110-148
Name of holder of Development Consent / Project Approval	Centennial Myuna Pty. Ltd.
Mining Lease #	ML1632 ML1370 MPL334
Name of Holder of Mining Lease	Centennial Myuna Pty. Ltd.
Water License #	20BL172565 20BL173259
Name of Holder of Water License	Centennial Fassifern Pty. Ltd.
MOP/RMP Start Date	1st January 2016
MOP/RMP End Date	30th November 2022
Annual Review Start Date	1st January 2019
Annual Review End Date	31st December 2019

I, , certify that this audit report is a true and accurate record of the compliance status of Myuna Colliery for the period 1st January 2019 to 31st December 2019 and that I am authorized to make this statement on behalf of Centennial Myuna Pty Ltd.

Note:

a) *The Annual Review is an 'environmental audit' for the purposes of s122B(2) of the Environmental Planning and Assessment Act 1979. Section 122E provides that a person must not include false or misleading information (or provide information for inclusion) in an audit report produced to the Minister in connection with an environmental audit if the person knows that the information is false or misleading in a material respect. The maximum penalty is, in the case of a corporation, $1 million and for an individual, $250,000.*

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

Name of Authorised Reporting Officer	Michael Clark
Title of Authorised Reporting Officer	Director
Signature of Authorised Reporting Officer	M. Clark
Date	23-03-20

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Plans

Plan Reference No	Plan Name
MY11606	Annual Review Plan 2019
MY11301	Myuna Colliery Surface Layout

Appendices

Appendix No	Appendix Name
1	Myuna Colliery Weed Action Plan 2019
2	2019 Ecological Monitoring Report
3	Centennial Myuna Annual Groundwater Management Report

1. STATEMENT OF COMPLIANCE

Table 2 provides a statement of compliance with the relevant approvals during the reporting period.

Table 2. Statement of Compliance

Were all conditions of the relevant approval(s) complied with?	
Project Approval 10_0080 MOD1	NO
Development consent SH110/148	YES
Mining Operations Plan 2016-2022	YES
Mining Lease 1632	YES
Mining Lease 1370	YES
Mining Purposes Lease 334	YES
Exploration Lease 4444	YES
Exploration Lease 6640	YES
EPL 366	YES
Bore Licence 20BL172565	YES
Bore Licence 20BL173259	YES
Section 151 Point Wolstoncroft SCA	YES
Section 151 Pulbah Island SCA	YES
Section 151 Wangi Point SCA	YES

Table 3 provides a list of conditions that were not complied with during the reporting period.

Table 3. Non-Compliances

Relevant Approval/s	Condition #	Condition summary	Compliance Status	Comment	Where Addressed in Annual Review
PA 10_0080	Sch 3 Cond 17	Air Quality Criteria		Exceedance of 24 hr PM10 criteria	Section 11

Note: Compliance Status Key for Table 3

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

2. INTRODUCTION

Myuna Colliery is an underground coal mine owned and operated by Centennial Myuna Pty Limited. Myuna is located 25 km south west of Newcastle NSW in the Lake Macquarie and Wyong Local Government Areas. The Colliery lease lies within the Parishes of Awaba, Coorumbung, Morisset and Wallarah in the County of Northumberland subsidence district and is located within the Shire of Lake Macquarie.

Lake Macquarie City Council (LMCC) granted Development Consent SH110_148 for the development and operation of the Myuna and Cooranbong Collieries in 1977. The Development Consent was granted pursuant to the provisions of the now repealed Local Government Act 1919. The Development Consent remains in force and authorises the extraction of coal within the Development Consent Mining Area.

The Development of Myuna Colliery began in 1979 and underground mining using bord and pillar mining methods commenced in 1982. Centennial Coal Company Ltd acquired Myuna Colliery in 2002, and has operated the mine since this time.

On 18 January 2012, the then Minister of Planning and Infrastructure granted Project Approval (PA) 10_0080 to Centennial Myuna. A modification to PA10_0080 was approved 1st February 2015.

PA 10_0080 (MOD1) authorises the continued mining in areas outside the existing Development Consent SH110_148 mining area and within the boundary of existing mining leases held by Centennial Myuna. PA 10_0080 MOD1 authorises:

- the use of bord and pillar methods in the Wallarah, Great Northern and Fassifern coal seams;
- the continued use of ancillary infrastructure until 31st December 2032;
- the extraction of not more than 3 million tonnes of ROM coal from the site in any calendar year.

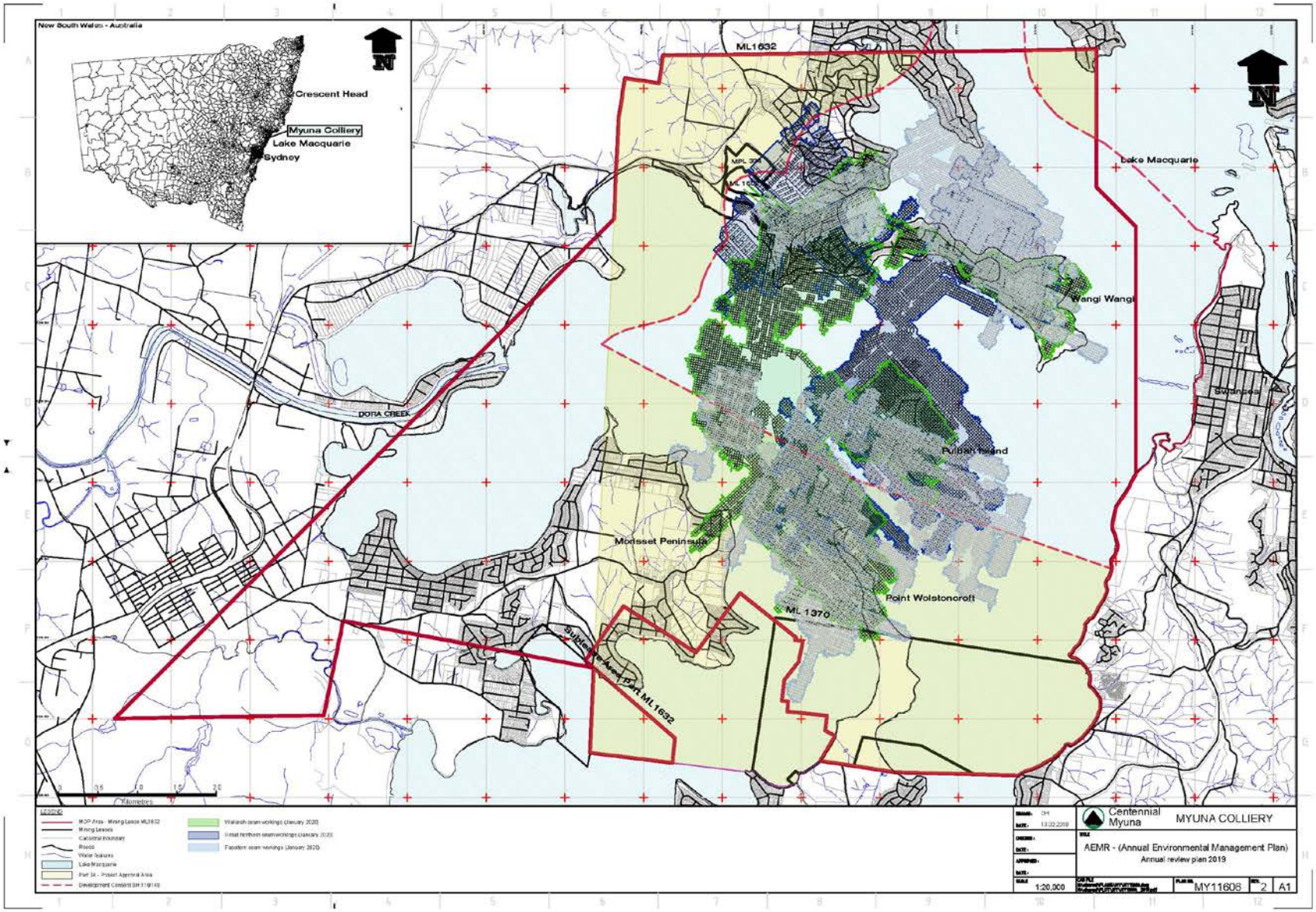
Plan MY11606, shows;

- the operation and its regional context,
- Development Consent SH110_148 and Project Approval 10_0080 boundaries,
- mining lease boundaries, and
- current operational disturbance footprint.

Table 4 provides the names and contact details of the key personnel who are responsible for the environmental management of the operation.

Table 4. Environmental Management Contact Details

Name	Position	Email	Phone
Mal Yule	Mine Manager	myunacolliery@centennialcoal.com.au	02 4970 0221
Angela van der Kroft	Environment & Community Coordinator		02 4970 0263
Pieter van Rooyen	Technical Services Manager		02 4970 0207


New South Wales - Australia
Crescent Head
Myuna Colliery
Lake Macquarie
Sydney
ML1632
Lake Macquarie
Wangi Wangi
Swansea
DORA CREEK
Pulbah Island
Morisset Peninsula
Point Wolstonoroft
ML 1370
Subject to Appl. for ML1632
Centennial Myuna
MYUNA COLLIERY
AEMR - (Annual Environmental Management Plan)
Annual review plan 2019
1:20,000
MY11606
2
A1

3. APPROVALS

The Myuna Colliery Holding is covered by Mining Lease No 1632. Mining Lease No 1632 includes a surface land area of 33 hectares for mine infrastructure (Mining Purposes Lease No. 334). The total lease area is 7426.5 hectares.

Centennial Myuna had subleased part of Consolidated Coal Lease No 762 held by Centennial Mandalong Pty Limited. The sublease area was then transferred to Centennial Myuna Pty Limited as ML1632. Effectively ML1632 replaced Part CCL762. The lease areas are shown on the Myuna Colliery Holding Plan PC14.

MPL334 was granted the 20th October 1994 for a period of 21 years. The renewal of the Mining Purposes Lease 334 took effect 20th October 2015 for a further period of 21 years to 20th October 2036. The lease conditions were amended upon renewal.

Myuna Colliery is classed a Level 1 mine. PA 10_0080 was granted by the Minister for Planning on 18th January 2012 under Section 75J of Part 3A of the EP&A Act 1979.

Table 5 includes a list of all of the environmental approvals held by Myuna Colliery under the EP&A Act, Mining Act, POEO Act, NPW Act, Water Act, Water Management Act, Radiation Act, and any changes made to these approvals during the reporting period.

Table 5. Approvals held by Centennial Myuna

Name	Description	Issued By	Expiry Date	Changed during reporting period?
SH. 110/148	Development Consent for Myuna Colliery	Lake Macquarie City Council	No expiration date specified in the consent. Subject to renewal of mining leases.	N
PA 10_0080	Myuna Colliery Mining Project	Department of Planning and Environment	31/12/2032	N
ML 1632	Mining Lease	Department of Planning and Environment – Division of Resources and Geosciences	13/10/2022	Y
MPL 334	Mining Purposes Lease		20/10/2036	Y
ML 1370	Mining Lease		07/03/2033	Y
EL 4444	Exploration Lease		23/10/2017**	N
EL 6640	Exploration Lease		23/10/2017**	N
Section 151 Licence	Mining Operations – Various Licence, Point	National Parks and Wildlife Services	10/09/2020	N

Name	Description	Issued By	Expiry Date	Changed during reporting period?
	Wolstoncroft			
Section 151 Licence	Mining Operations – Various Licence, Pulbah Island		31/10/2021	N
Section 151 Licence	Mining Operations – Various Licence, Wangi Wangi Point		15/02/2021	N
20BL172565	Bore Licence (Dewatering ground water 4380 ML)	Department of Primary Industries – Water	12/12/2015*	N
20BL173259	Bore Licence (Monitoring Bores)		Perpetuity	N
EPL 366	Environment Protection Licence (EPL)	Environmental Protection Agency	N/A	N

* DPI Water renewed Bore Licence 20BL172565 on 12/12/2015, awaiting copy of licence and expiry date.

** Renewal Applications for EL4444 and EL6640 were submitted to DRG via email on the 20/10/2017. No response has yet been received.

3.1. Changes made to Approvals during reporting period

There were no changes to any of the above approvals during the reporting period.

3.2. Annual Review Requirements

The Annual Review has been developed to satisfy the reporting requirements of the approvals listed in Table 6.

Table 6. Annual Review Requirements

Approval	Condition No.	Requirement	Where addressed in Annual Review
Project Approval 10_0080 MOD1	Schedule 5 Condition 4	By the end of March 2013, and annually thereafter, the Proponent shall review the environmental performance of the project to the satisfaction of the Secretary. This review must:	
		(a) describe the development (including any rehabilitation) that was carried out in the past calendar year, and the development that is proposed to be carried out over the next year;	Sections 8 & 8.1
		(b) include a comprehensive review of the monitoring results and complaints records of the project over the past calendar year, which includes a comparison of these results against the: • relevant statutory requirements, limits or performance measures/criteria; • requirements of any plan or program required under this approval; • monitoring results of previous years; and • predictions in the EA;	Sections 6 & 7
		(c) identify any non-compliance over the past year, and describe what actions were (or are being) taken to ensure compliance;	Section 11
		(d) identify any trends in the monitoring data over the life of the project;	Section 6 & 7
		(e) identify any discrepancies between the predicted and actual impacts of the project, and analyse the potential cause of any significant discrepancies; and	Section 6 & 7
		(f) describe what measures will be implemented over the next year to improve the environmental performance of the project.	Section 6 & 7

Approval	Condition No.	Requirement	Where addressed in Annual Review
ML1370 MPL334	Condition 3	Annual Rehabilitation Report (f) The lease holder must prepare a rehabilitation report to the satisfaction of the Minister. The report must: i. provide a detailed review of the progress of rehabilitation against performance measures and criteria established in the approved MOP; ii. be submitted annually on the grant anniversary date (or at such other times as agreed by the Minister); and iii. be prepared in accordance with any relevant annual reporting guidelines published on the Department's website at www.resources.nsw.gov.au/ environment. Note: the Rehabilitation Report replaces the Annual Environmental Management Report.	i. Section 8 ii. Section 5 iii. Section 5

4. OPERATIONS SUMMARY

Table 7. Production Summary

Material	Approved Limit (PA10_0080 MOD 1)	Previous Reporting Period (Actual)	This Reporting Period (Actual)	Next Reporting Period (Forecast)
Waste Rock/ Overburden	N/A	N/A	N/A	N/A
ROM Coal	3,000,000	2,166,743	1,561,793	2,282,879
Coarse reject	N/A	N/A	N/A	N/A
Fine reject (Tailings)	N/A	N/A	N/A	N/A
Saleable product	3,000,000	2,166,743	1,561,793	2,282,879

4.1. Other Operations

Table 8. Operations Summary

Limits	Approved Limit (PA10_0080 MOD 1)	Previous Reporting Period (Actual)	This Reporting Period (Actual)	Comment (if applicable)
Hours of operation	8760	8760	8760	Nil
Transport (rail)	N/A	N/A	N/A	Nil
Transport (road)	N/A	N/A	N/A	Nil

Note: Water Extraction under Water Licences is discussed in Section 7.

4.1. Exploration

No surface exploration occurred during the reporting period.

4.2. Next Reporting Period

During the 2020 reporting period, Myuna Colliery will undertake a survey program in the south-eastern portion of the combined Project Approval/Development Consent area. This work is required to ensure that a minimum of 40 m of rockhead is kept between the bottom of Lake Macquarie and the Mine's workings. The following survey methods will be used:

- Drone Aeromag trial.
- Sub-bottom Profiling (Sparker survey)
- Drilling program.

5. ACTIONS REQUIRED FROM PREVIOUS ANNUAL REVIEW

The 2018 Annual Review was submitted to the then Department of Planning and Environment (DPE), now Department of Planning, Industry and Environment (DPIE), on 13th March 2019 in accordance with Schedule 5, Condition 4 of the Project Approval 10_0080. It was also submitted to the Department of Planning and Environment – Resources Regulator (RR) on the 13th March 2019 in order to satisfy Condition 3 of ML1370 and MPL334 as well as Condition 4 of ML1632. On the 29 March 2019, an amended Myuna Colliery 2018 Annual Review and the 2018 Q1 Noise Compliance Report was also supplied to DPE. The Annual Review was prepared in accordance with DPE's *Annual Review Guideline – Post-approval Requirements for State significant mining developments (October 2015)* and any relevant annual reporting guidelines published on the DRG's website.

In correspondence dated 3rd May 2019, DPE note that they have reviewed the Annual review and consider it to satisfy the requirements of the Project Approval and request the following;

Table 9. Actions from previous Annual Review

Action Required	Requested By	Action Taken	Where Addressed in Annual Review
Any application of 'Emergency Day' noise limits is clearly identified in reporting of noise results.	DPE	Noted for future Annual Reviews.	Not applicable for 2019 reporting period

6. ENVIRONMENTAL PERFORMANCE

This section includes a summary of the environmental monitoring and management measures implemented at Myuna Colliery during the 2019 reporting period.

The monitoring locations are summarised in Table 10 below, and shown on Plan MY11301, which is appended to this document.

Table 10. Summary of Monitoring Requirements

Monitoring Type	Overview of Monitoring Requirements	Requirement of Approval / Management Plan	Where Addressed in Annual Review
Noise	Quarterly at 8 locations	Northern Region Noise Management Plan EPL 366	Section 6.1
Air quality	4 x DGs - Monthly 2 x HVAS – every 6 days	Northern Region Air Quality & Greenhouse Gas Management Plan EPL 366	Section 6.2
Biodiversity	Annual surveys at 3 locations	Biodiversity Management Plan	Section 6.3
Heritage	As required	Northern Region Aboriginal Cultural Heritage Management Plan. Northern Region Historic Heritage Management Plan	Section 6.4
Greenhouse Gas	Monthly gas bag sample.	Northern Region Air Quality & Greenhouse Gas Management Plan EPL 366	Section 6.5
Water	Surface Water Volume & Quality - Various Monthly Groundwater Depth	Water Management Plan EPL 366	Section 7
Rehabilitation	N/A	Mining Operations Plan / Rehabilitation Plan	Section 8

6.1. Noise

The control strategies were implemented as per the Northern Region Noise Management Plan and were adequate to manage the risks associated with the operation during the reporting period.

The Northern Region Noise Management Plan outlines potential sources and impacts of elevated noise levels. The Plan also identifies measures which must be in place to reduce noise levels. All contractors and employees undergo induction and regular refresher training that identifies individual responsibilities for noise management.

Result Summary

Attended noise monitoring is undertaken quarterly in accordance with the Myuna Colliery EPL 366 and the Project Approval. Noise monitoring is consistent with the OEH Industrial Noise Policy and Australian Standard AS 1055 Acoustics, Description and Management of Environmental Noise.

The attended monitoring is conducted at 8 locations around the Myuna Colliery pit top. The noise monitoring data is assessed against the Project Approval and EPL limit criteria.

Table 11. Noise Environmental Performance

Noise Receptor	Period		Approval criteria	EIS / EA Predictions	Performance during reporting period (actual)			
					Q1	Q2	Q3	Q4
R1	Day	L_{Aeq}(15 min)	35	40	I/A	I/A	I/A	I/A
	Evening	L_{Aeq}(15 min)	35	39	I/A	I/A	NM	I/A
	Night	L_{Aeq}(15 min)	35	35	I/A	30	I/A	I/A
		L_{A1}(1 min)	45	45	I/A	32	I/A	I/A
R2	Day	L_{Aeq}(15 min)	35	40	I/A	I/A	I/A	I/A
	Evening	L_{Aeq}(15 min)	35	39	NM	NM	I/A	I/A
	Night	L_{Aeq}(15 min)	35	35	I/A	33	30	I/A
		L_{A1}(1 min)	45	45	I/A	40	33	I/A
R3	Day	L_{Aeq}(15 min)	35	35	I/A	I/A	I/A	I/A
	Evening	L_{Aeq}(15 min)	35	35	30	I/A	I/A	I/A
	Night	L_{Aeq}(15	35	35	NM	30	NM	I/A

Noise Receptor	Period		Approval criteria	EIS / EA Predictions	Performance during reporting period (actual)			
					Q1	Q2	Q3	Q4
		min)						
		L_{A1}(1 min)	45	45	NM	32	NM	I/A
R4	Day	L_{Aeq}(15 min)	35	44	I/A	I/A	I/A	I/A
	Evening	L_{Aeq}(15 min)	40	42	I/A	I/A	I/A	I/A
	Night	L_{Aeq}(15 min)	38	39	33	32	28	I/A
		L_{A1}(1 min)	49	49	34	33	30	I/A
R5	Day	L_{Aeq}(15 min)	37	44	I/A	I/A	I/A	I/A
	Evening	L_{Aeq}(15 min)	42	42	I/A	I/A	I/A	I/A
	Night	L_{Aeq}(15 min)	39	39	33	29	30	I/A
		L_{A1}(1 min)	49	49	34	30	31	I/A
R6	Day	L_{Aeq}(15 min)	37	44	I/A	I/A	I/A	I/A
	Evening	L_{Aeq}(15 min)	42	42	I/A	I/A	I/A	I/A
	Night	L_{Aeq}(15 min)	39	39	32	31	30	I/A
		L_{A1}(1 min)	49	49	34	33	32	I/A
R7	Day	L_{Aeq}(15 min)	37	44	I/A	I/A	I/A	I/A
	Evening	L_{Aeq}(15 min)	42	42	I/A	I/A	I/A	I/A
	Night	L_{Aeq}(15 min)	39	39	31	34	36	I/A
		L_{A1}(1 min)	49	49	33	38	38	I/A
R8	Day	L_{Aeq}(15 min)	37	44	I/A	I/A	I/A	I/A
	Evening	L_{Aeq}(15 min)	42	42	I/A	I/A	I/A	I/A
	Night	L_{Aeq}(15	39	39	25	32	33	I/A

Noise Receptor	Period		Approval criteria	EIS / EA Predictions	Performance during reporting period (actual)			
					Q1	Q2	Q3	Q4
		min)						
		L_{A1}(1 min)	49	49	26	34	34	I/A

*I/A indicates that Myuna Colliery was inaudible at the time of monitoring.

**NM indicates that Myuna Colliery's noise contribution was Not Measureable at the time of monitoring.

6.1.1. Noise Monitoring Data Interpretation

There were no exceedances of the noise limit criteria for the reporting period.

Trend

Myuna Colliery has undertaken a program of attended noise monitoring from December 2012 to December 2019. The attended monitoring results have shown a consistency over the 7 year period. Colliery operations have been subjectively observed to contribute little to the measured L_{Aeq} noise levels during any period throughout the day, apart from exceedances in the 2016 and 2018 report periods. Extraneous noise sources, namely road traffic, contribute significantly to the noise levels.

EA Prediction

The Myuna Colliery Extension of Mining Project Noise Impact Assessment (Heggies 2010) predicted the operational noise levels and the noise emission levels of the Emergency Stockpile Area during operation would meet the project specific noise criteria at all assessed residential receivers under calm and prevailing weather conditions with the recommended noise mitigation and management strategies in place. The noise monitoring results for the report period have been consistent with the EA prediction.

6.2. Air Quality

Control strategies were implemented as per the Norther Region Air Quality and Greenhouse Gas Management Plan and were adequate to manage the risks associated with the operation during the report period.

The Northern Region Air Quality and Greenhouse Gas Management Plan outlines potential sources and impacts of elevated dust levels. The Plan also identifies measures which must be in place to reduce dust and environmental activities conducted to minimise elevated dust levels. All contractors and employees undergo induction and refresher training that identifies individual responsibilities for air quality management.

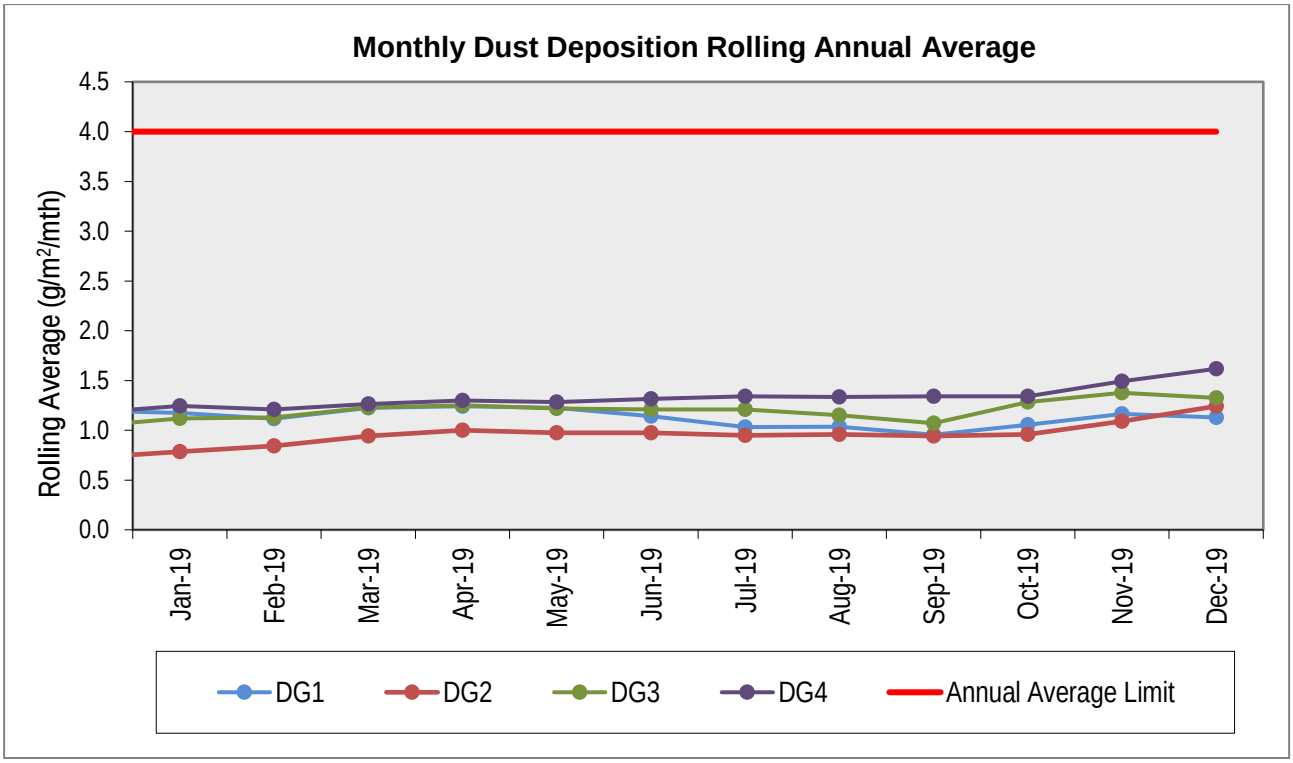


Figure 1. Dust Depositional Gauge – Rolling Annual Average

Table 12. Air Quality Environmental Performance

Dust Monitor	Approval criteria	EIS / EA Predictions	Performance during the reporting period	Long Term Average
DG1	2 g/m^2/month Max Annual Average Increase	<0.1	-0.07	0.04
	4 g/m^2/month Total Annual Average	1.9	1.1	0.9
DG2	2 g/m^2/month Max Annual Average Increase	<0.1	0.52	0.05
	4 g/m^2/month Total Annual Average	1.9	1.2	1.0

Dust Monitor	Approval criteria	EIS / EA Predictions	Performance during the reporting period	Long Term Average
DG3	2 g/m^2/month Max Annual Average Increase	<0.1	0.29	-0.03
	4 g/m^2/month Total Annual Average	1.9	1.3	1.4
DG4	2 g/m^2/month Max Annual Average Increase	<0.1	0.44	0.05
	4 g/m^2/month Total Annual Average	1.9	1.6	1.4
HVAS PM_{10}	30 µg/m^3 Annual Average	10.8	17.9	14.20
	50 µg/m^3 24 hr Average	10.5 to 51.7	73 (Max 24 hr result)	73 (Max 24 hr result)
HVAS TSP	90 µg/m^3 Annual Average	36.1	37.9	30.3

6.2.1. Dust Deposition

Result summary

The air quality monitoring data is assessed against the Project Approval and EPL limit criteria. There were no exceedances of the air quality limit criteria for the report period.

Depositional dust monitoring was performed at Myuna Colliery during 2019 on a monthly basis at four depositional dust gauges. The limit criterion for depositional dust is 4 g/m^2/month, applied as an annual average.

The current air quality controls include enclosed conveyor and coal handling plant, water sprays on the conveyor system and haul road, mobile water cannon, a road sweeper and a water cart operating on site during coal haulage activities. Further controls are being investigated specifically for the waste handling facility, which include sealing the area or treating the area with a commercially available dust suppressant.

Trend

Myuna Colliery has 16 years of dust monitoring data over the period from January 2003 to December 2019. Data for a 10 month period from February 2007 to November 2007 is not available. A trend analysis was undertaken using a linear trend line for the dust deposition monitoring from January 2003 to December 2019.

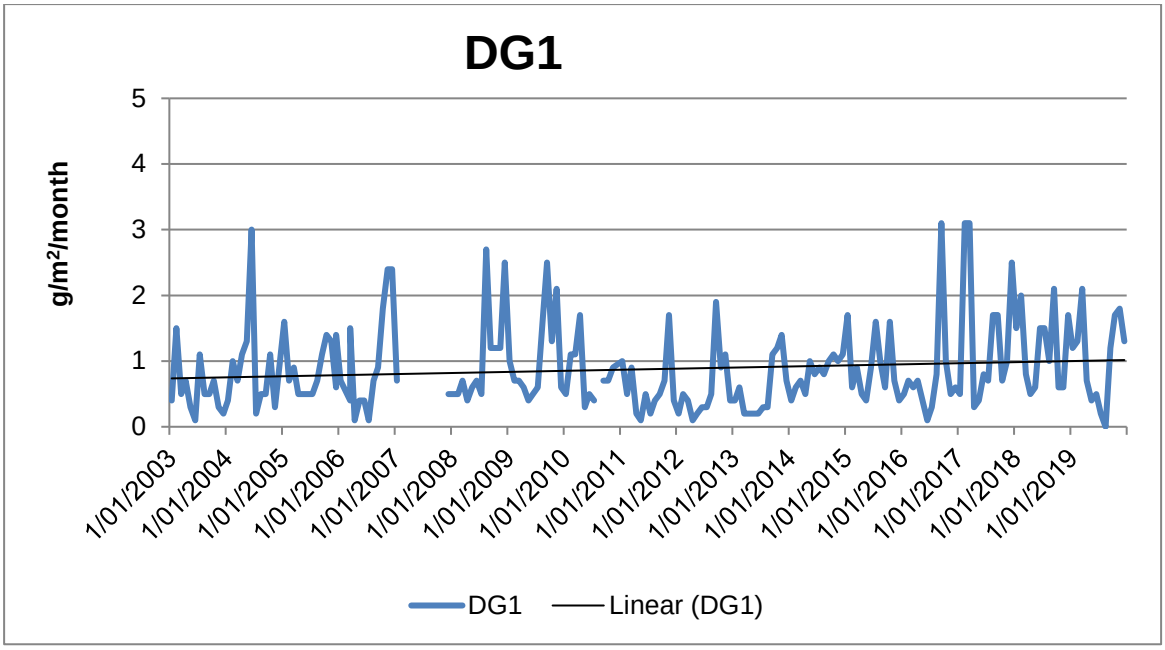


Figure 2. DG1 Trend Analysis Graph

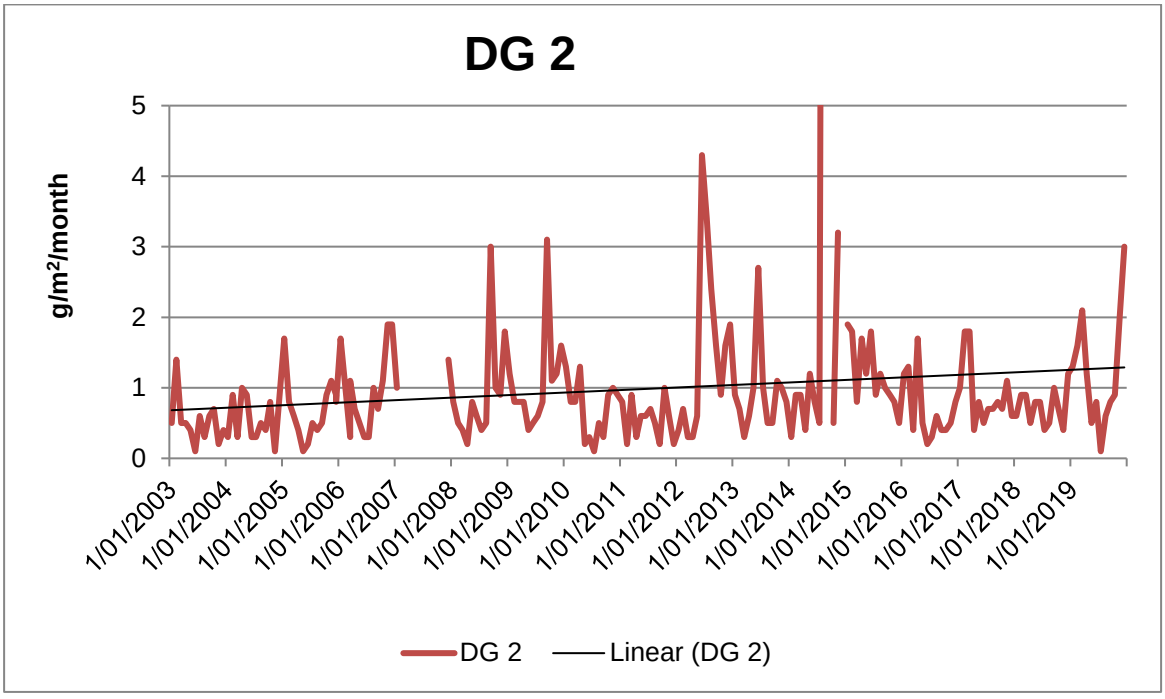


Figure 3. DG2 Trend Analysis Graph

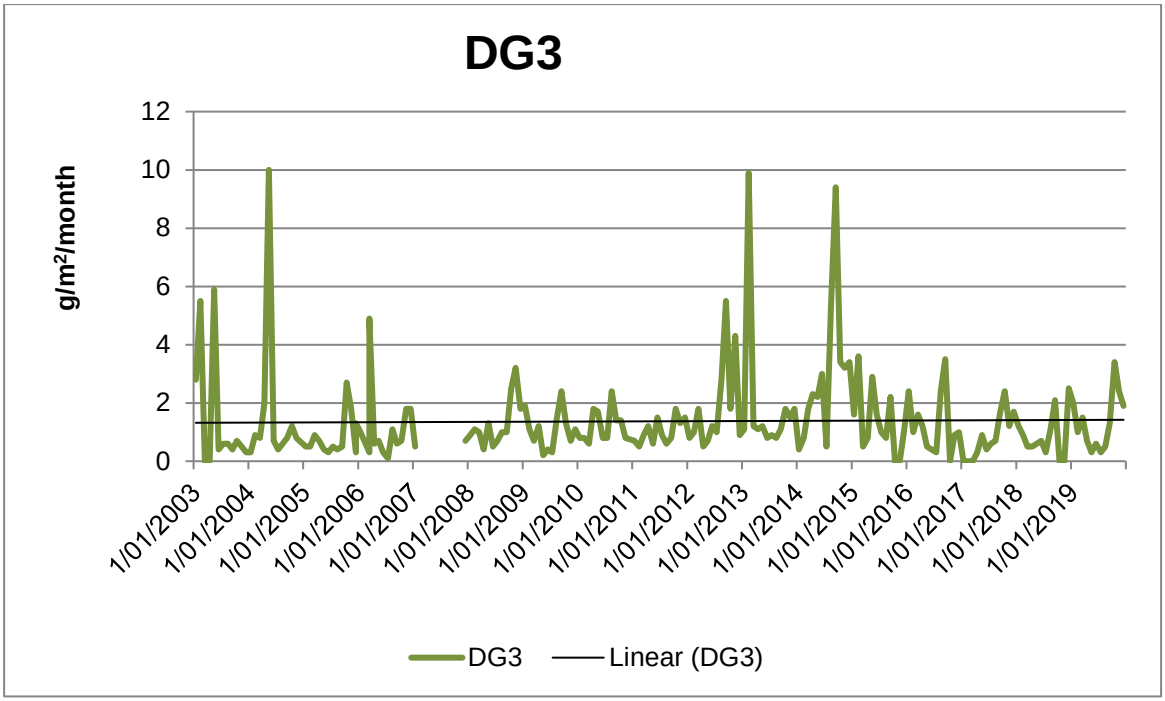


Figure 4. DG3 Trend Analysis Graph

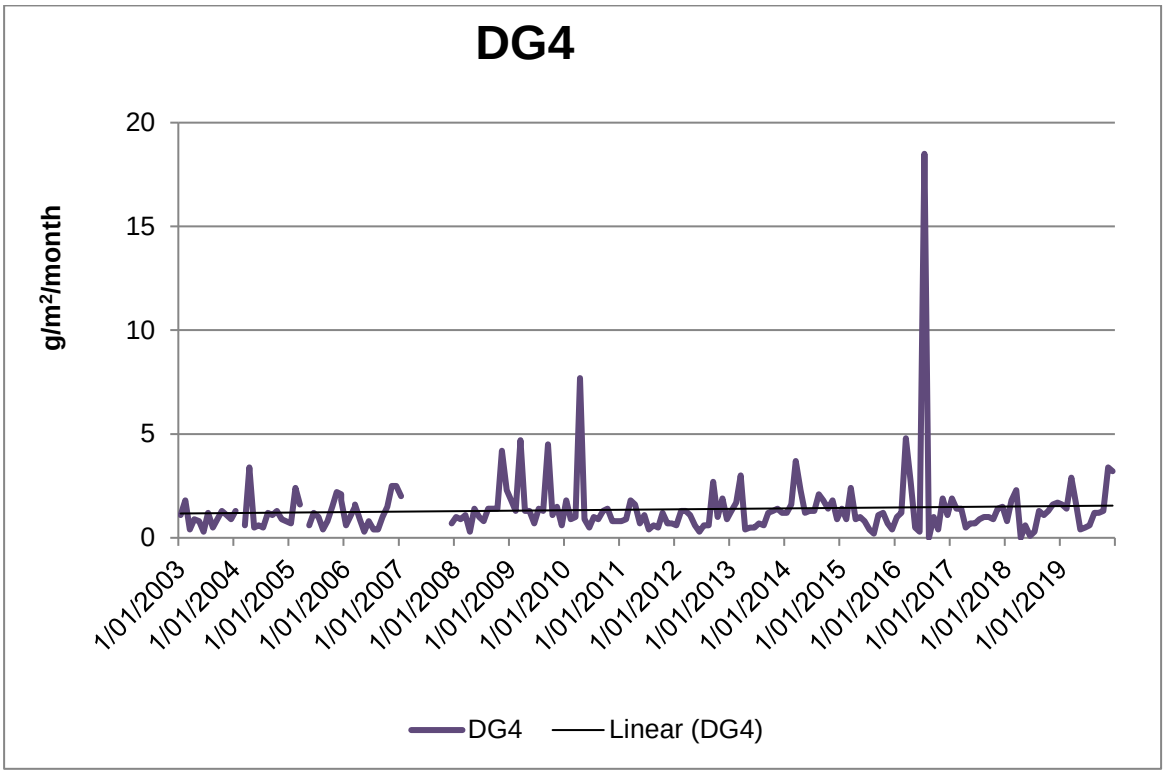


Figure 5. DG4 Trend Analysis Graph

The 2019 annual average and long term average for each dust gauge is provided in Table 12.

The 2019 annual averages for all dust gauges are consistent with the 16 year long term average. The 2019 averages for DG 3 is less than the long term average while the DG 1, 2 and 4 annual averages are higher than the respective long term averages.

The long term trend lines of DG 3 and 4 display a consistent trend for the monthly dust deposition while DG 1 and 2 display an increasing trend.

Dust Deposition Gauge DG1, for August 2019, was contaminated with material not associated with deposited dust. The visual analysis from the field staff indicated that the samples were primarily composed of bird droppings, insects and vegetation. The contaminated samples are excluded from the annual and long term average analysis above.

EA Prediction

The Myuna Colliery Extension of Mining Project Air Quality Impact Assessment (Heggies 2010) predicted the dust deposition levels would be below the Project air quality criteria at all receptors. The dust deposition results for the report period have been consistent with the EA prediction.

New Material

A revised version of the Northern Region Air Quality and Greenhouse Gas Management Plan, which encompasses the Centennial Coal operations, Mandalong, Myuna, Newstan and Northern Coal Services, was submitted to DPIE on the 30 October 2019 for review and approval. The plan was updated to take into consideration recommendations received during the Myuna Colliery Independent Environmental Audit.

6.2.2. HVAS

Result Summary

Air quality monitoring for PM10 and Total Suspended Particles (TSP) commenced in August 2013. The monitoring has been conducted in accordance with Schedule 3 Condition 17 of PA10_0080 and Condition M2 of and EPL 366.

The air quality monitoring data is assessed against the Project Approval and EPL limit criteria. The annual average limit criterion for TSP is 90 μg/m^3 and for PM10 is 30 μg/m^3. The 24 hour limit criterion for PM10 is 50 μg/m^3. There were five (5) exceedances of the 24 hour limit criteria for PM10 during the report period. These are detailed in Table 13 below.

Table 13. Air Quality Criteria Exceedances

Date	24 hr PM10 (μg/m^3)	Cause	Non-Compliance?
08/01/2019	73	Trucking on haul road	Yes
22/11/2019	75	Smoke from NSW Bushfires	No
28/11/2019	64	Smoke from NSW Bushfires	No
04/12/2019	79	Smoke from NSW Bushfires	No
10/12/2019	135	Smoke from NSW Bushfires	No

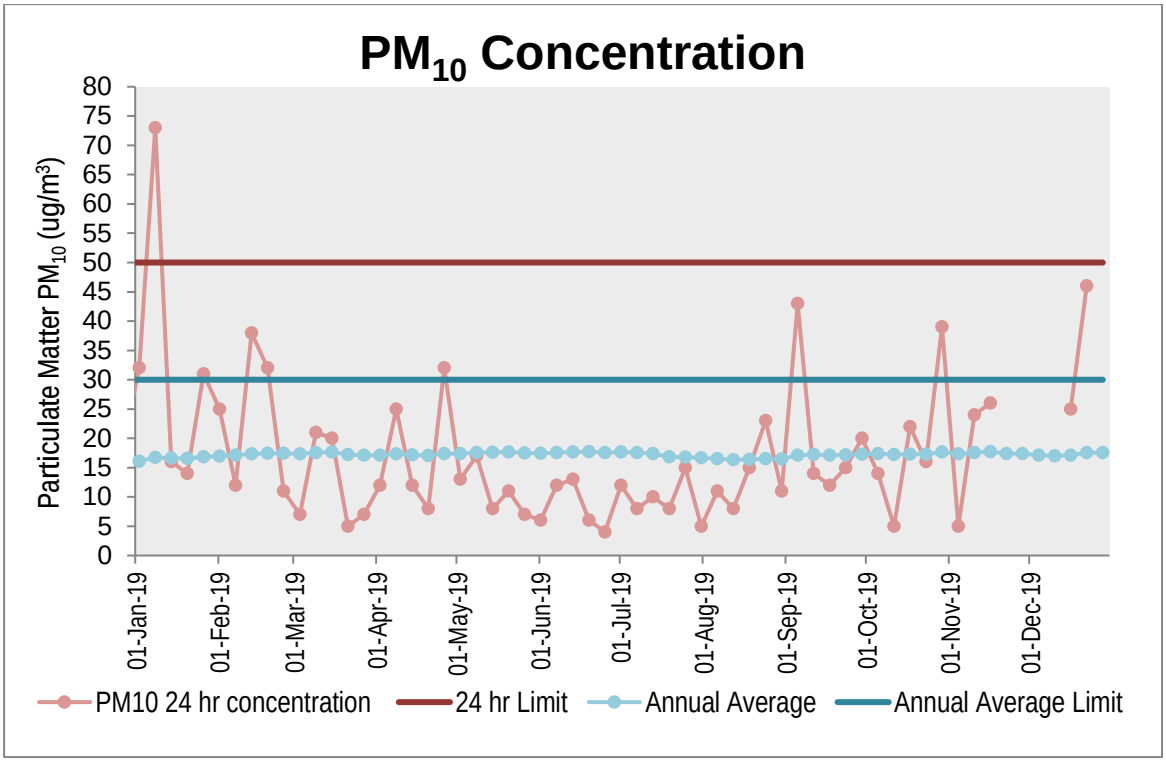


Figure 6. HVAS PM_{10} Rolling Annual Average & 24 hr Results

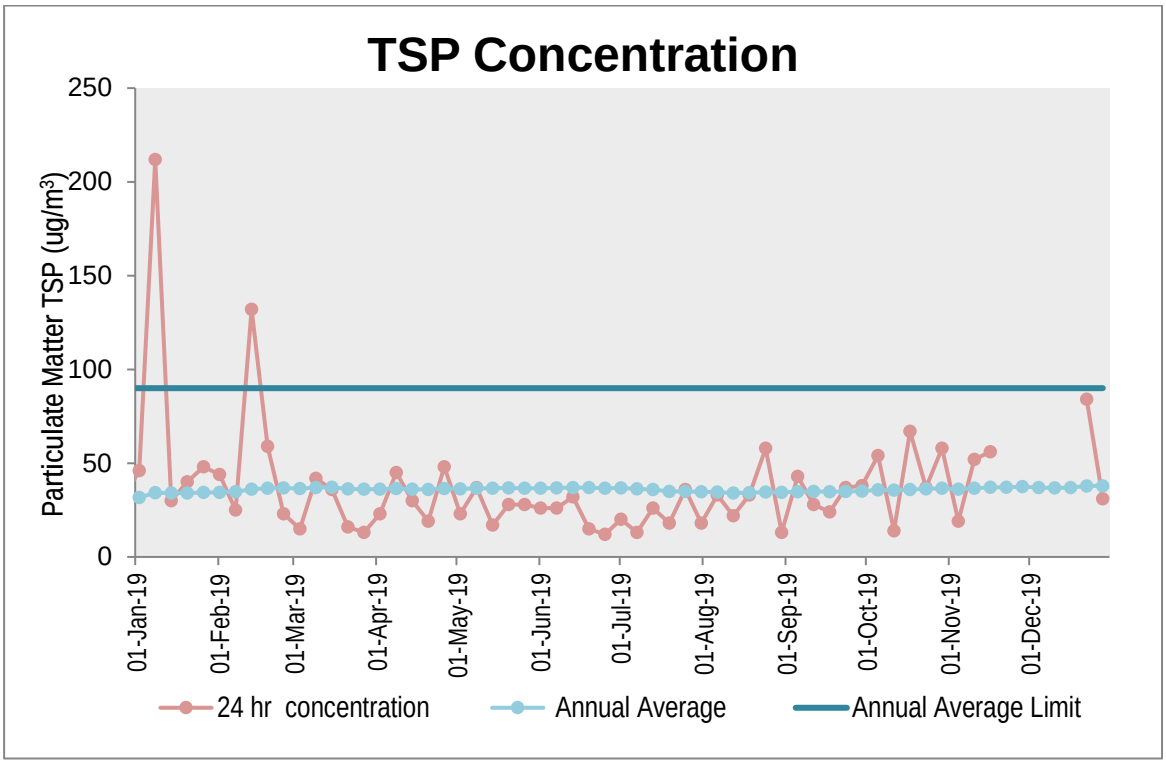


Figure 7. HVAS TSP Rolling Annual Average & 24 hr Results

Note that breaks in the 24 hr concentration lines in the graphs shown in Figures 6 and 7 occur due to the removal of results from contaminated samples. There is no way or approved method of separating the particulates generated by the operation from the

contamination. Also, the results for those sample runs are not representative of particulate concentrations at the site and are therefore excluded from annual averaging.

The maximum recorded 24 hour PM10 concentration, which was not impacted by bushfire smoke, for the report period was 73 µg/m^3 and the maximum recorded 24 hour TSP concentration, which was not impacted by bushfire smoke, for the report period was 212 µg/m^3.

Trend

The 2019 annual averages for TSP and PM10 are greater than the long term average.

The trend analysis was undertaken using a linear trend line for the TSP and PM_{10} monitoring data from August 2013 to December 2019. The trend lines indicate slightly decreasing trends for the TSP and PM_{10} over the long term monitoring period.

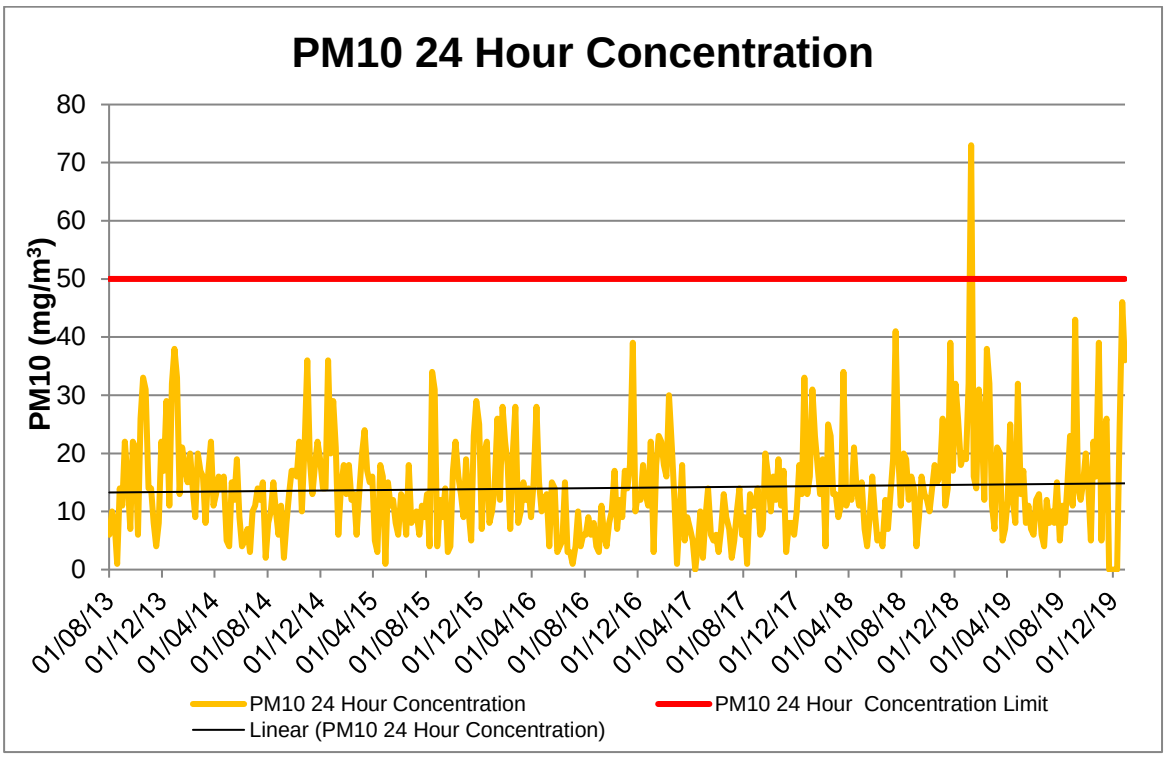


Figure 8. HVAS PM_{10} Trend Analysis Graph

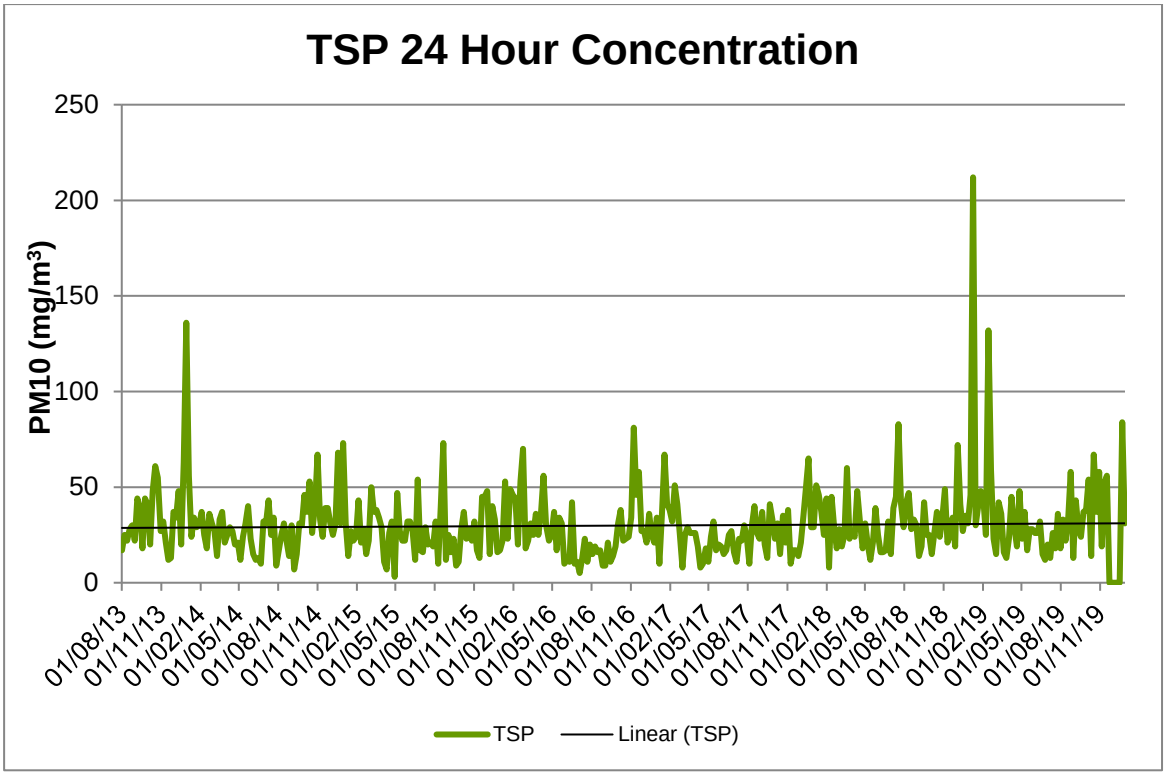


Figure 9. HVAS TSP Trend Analysis Graph

EA Prediction

The Myuna Colliery Extension of Mining Project Air Quality Impact Assessment (Heggies 2010) predicted the cumulative annual average TSP and PM_{10} concentrations would be below the project air quality goal at all private receptors. Cumulative maximum 24-hour PM_{10} concentrations attributable to the Project were predicted to be below the project air quality goals at all surrounding dwellings excluding periods of regional pollution events. The TSP and PM_{10} results for the report period have been consistent with the EA prediction.

6.3. Biodiversity

Control strategies were implemented as per the Biodiversity Management Plan and were adequate to manage the risks associated with the operation during the report period.

The Biodiversity Management Plan for the site outlines measures in place to protect and enhance the Swamp Sclerophyll Forest on Coastal Floodplains Endangered Ecological Community (EEC) on Wangi Creek. All contractors and employees undergo induction and refresher training that identifies individual responsibilities.

Myuna Colliery engaged a consultant to conduct monitoring of the EEC near Wangi Creek. The 2019 Ecological Monitoring Report (Umwelt 2019) is provided in Appendix 3.

Result Summary

The EEC Monitoring Report (Umwelt 2019) provides a qualitative comparison with the baseline assessment of 2016 and the follow up monitoring of 2017 and 2018. A direct quantitative comparison was not possible as, although the objectives of the monitoring have not changed, in 2018, the monitoring program has been updated to collect data in accordance with the Biodiversity Assessment Method (BAM) rather than the BioBanking

Assessment Methodology (BBAM). In addition, from 2018, monitoring occurs in spring rather than autumn.

The results of the 2019 EEC monitoring suggest that current mining operations are not having a substantial impact on the *Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* EEC. The floristic sampling and photos suggest that each sampling site is relatively consistent with the previous years and the analysis of the BAM data to the PCT benchmark data suggests that VMA 1 (Plots 1 and 2) are generally within benchmark condition however VMA 2 (Plot 3) generally does not meet benchmark condition.

Despite VMA 2 not meeting benchmark, a comparison of the condition from 2016 and 2017 against the BBAM benchmark data, as well as the results from 2018 and 2019, suggest that the condition of VMA 2 is relatively stable from year to year. Notwithstanding this, some recommended management actions were provided for consideration to provide better data quality and to improve the condition of VMA 2 in 2019.

The number of weed species in VMA 1 has risen substantially since monitoring began, particularly in Plot 1 where one weed species was present in 2016 and 2017, however nine were present in 2018 and 2019. Despite this, during the 2019 monitoring event, weed species coverage was still low. This substantial change in weed species number is likely as a result of a combination of factors including minor changes in plot location, changes in ecologists conducting the surveys, weather conditions and the tendency of the creekline to bring in and flush weedy material through the plots.

During 2019 HLM spent approximately 100 labour hours on ground at the site actively controlling high priority target weeds. This equates to 5 days with a crew of two carrying out primarily cut and paint bush regeneration methods, supported by foliar spraying for dense lantana, Cassia and Crofton weed infestations. Where suitable, (i.e. away from waterways) selective herbicides were used to spray lantana to limit the off-target damage to grasses and other non-susceptible species. This in turn helps to maintain active groundcover. This was primarily used on plants growing up to and through boundary fences in hard to reach locations for time efficient control.

Trend

From 2012 to the end 2019 there have been eight Annual Weed Action Plans conducted at Myuna Colliery, including an annual weed survey and on ground works. This has resulted in the ongoing suppression and removal of Lantana, Bitou Bush, Pampas Grass, Pine Trees and Castor Oil Plant among others.

EA Prediction

The Myuna Colliery Extension of Mining Project Terrestrial Flora and Fauna Assessment (RPS 2011) predicted due to negligible surface impacts the project was unlikely to impact on any threatened species, endangered populations or threatened ecological communities.

New Material

A Northern Region Biodiversity Management Plan, which encompasses the Centennial Coal operations, Mandalong, Myuna, Newstan and Northern Coal Services, was approved by DPE on the 23 April 2019. This Plan replaces Myuna's Biodiversity Management Plan.

6.4. Greenhouse Gas

The control strategies were implemented as per the Northern Region Air Quality and Greenhouse Gas Management Plan and were adequate to manage the risks associated with the operation during the reporting period.

Environmental Performance

Estimation of the GHG emissions associated with the Myuna was undertaken using the emission factors and methods outlined in the National Greenhouse and Energy Reporting (Measurement) Determination 2008.

Table 14 provides the total emissions by source in carbon dioxide equivalent tonnes for the reporting period.

Table 14. Total GHG Emissions from Site

Emissions Summary - July 2017 to June 2018	Total (t_{CO2-e})
Electricity	29 827
Diesel	1 232
Petroleum Based Oils and Greases	199
SF6	4
Fugitives - CH_4	551 636
Fugitives - CO_2	4 893
TOTAL	**587 791**

6.5. Heritage

Control strategies implemented as per the Northern Region Aboriginal Cultural Heritage Management Plan (ACHMP) and the Northern Region Historic Heritage Management Plan were adequate to manage the risks associated with the operation during the reporting period.

Result Summary

No monitoring was required under the Northern Region Historic Heritage Management Plan (HHMP) for the 2019 reporting period.

RPS was engaged to prepare the Phase 3 post-mining condition report for middens and a rock formation at Pulbah Island in Lake Macquarie in accordance with Centennial's Northern Region Aboriginal Cultural Heritage Management Plan (ACHMP). The purpose of the Phase 3 post mining condition monitoring is to reinspect the sites and compare their condition to the last documented results, as well as to provide representatives of the Registered Aboriginal Parties with an opportunity to share additional information on the ceremonial significance of the island.

The survey of Pulbah Island was undertaken on Wednesday the 21st of August 2019 involving representatives from the Aboriginal parties who registered an interest in the Centennial Myuna Extension of Mining Cultural Heritage Assessment 2012.

RPS made the following observations, "*Midden sites 45-7-0087, 38-4-1823, 45-7-0191*

and 45-7-0086 are in relatively good condition being stabilised by vegetation growth. Midden site 45-7-0188 continues to suffer from natural erosion and has largely collapsed into the lake. Condition reports for 45-7-0088 and 45-7-0219 are largely non applicable given they are Aboriginal Place recordings for the whole of the island itself."

EA Prediction

The Myuna Colliery Extension of Mining Project Cultural Heritage Assessment (RPS 2011) considered there was minimal potential for impact from the Project on sensitive Aboriginal cultural places or objects or on European cultural heritage items.

7. WATER MANAGEMENT

Centennial Myuna was granted Bore Licence 20BL172565 in December 2010 for the purpose of dewatering up to 4380 ML/ year of ground water from mine workings at Myuna Colliery. Ground water extracted from the underground mine workings is currently discharged from site via LDP 9. Volumetric and water quality monitoring data at LDP 9 is therefore representative of ground water volumes and ground water quality extracted from the mine workings.

The volume of ground water extracted from the works authorized by the licence shall not exceed 4380 ML in any twelve month period commencing the 1st July. The total volume of water discharged through LDP 9 for the 2018 / 2019 period is 1877 ML. There was no exceedance of the Bore Licence criteria during the reporting period.

Table 15 identifies the water take under the water licences. It is important to note that Table 15 reports on the water year, which is from 1 July 2018 to 30 June 2019, not the calendar year.

Table 15. Water Take

License #	Water Sharing Plan, source and management zone (as applicable)	Entitlement	Passive take / inflows	Active pumping	TOTAL TAKE
20BL172565	North Coast Fractured and Porous Rock Ground Water Sources	4380	1563	118	1681

Note: Volume is reported in megalitres per year (ML/y)

The Wallarah, Great Northern and Fassifern seams contain reservoirs which are used for the retention and settlement of mine water and surface water prior to pumping to the surface settlement ponds. Significant improvements in the water management system have been achieved by increasing the rate of transfer (approximately 10 L/sec to 50 L/sec) from the CHP dam to the underground settlement reservoir. This has been achieved by the addition of a larger diameter pipe line to the automated pumping system and the implementation of a syphon line from the CHP dam to an underground reservoir via a surface to seam borehole. The pump line and syphon line are metered for the purpose of measuring the volume pumped to the underground. The volume of surface water pumped to the underground reservoir during the 2019 reporting period was approximately 35 ML.

The underground water storages in the Wallarah Seam, the Great Northern Seam and the Fassifern Seam are based on an average seam height of 3 m and a recovery ratio of

0.333, Centennial Myuna has estimated the volume of water storages in each of the seams. The underground water storage volumes are shown below in the table below.

The hydrogeological model developed for Myuna Colliery assumes that the volumes of each of these storages are constant. An annual survey of the water storage areas will be conducted when possible for the Annual Groundwater Management Report to determine whether storage volumes have changed and the hydrogeological model is recalibrated as required.

Table 16. Water Storage

Seam	Water Storage Volume (ML)
Wallarah	740
Great Northern	929
Fassifern	1504

Myuna Colliery used 64 ML of potable water for the 2019 reporting period of which approximately 95% (or 61 ML) was used for mining operations.

In accordance with the requirements of the Water Management Plan, the transfer of water from the underground workings to the surface has been monitored daily. The transfer volume for the 2019 report period was approximately 1752 ML.

Visual inspection of the flow volume trend, in the Centennial Myuna Annual Groundwater Management Report Figure 4–1(GHD March 2020), indicates that extraction from the underground workings was decreasing between mid-2013 and 2014. Extraction rates began to increase in 2015. Since 2015 extraction rates have remained relatively constant until the end of 2019. The historical observed trends in extraction rate are most likely attributable to the storage of groundwater inflows within old workings and/or underground dams rather than the immediate extraction of groundwater inflows.

7.1. Surface Water Monitoring

Control strategies were implemented as per the Water Management Plan and were adequate to manage the risks associated with the operation during the report period.

Myuna Colliery has a Water Management Plan which discusses responsibilities, pollution sources, hazards, risks and mitigation strategies of water management. Regular refresher training and site inductions discuss water management to make personnel aware of the site issues.

The surface water monitoring has been conducted in accordance with the conditions of EPL366. This Licence specifies monitoring and reporting requirements along with concentration limits for water discharged through LDP 9 and LDP 10. Other EPL monitoring requirements included E1 Manganese monitoring in Wangi Bay.

There was no discharge of water through LDP 10 during 2019 so this section will focus on LDP 9.

Table 17. Summary of Surface Water Monitoring Locations

Monitoring Point Reference	Description / Creek Catchment
LDP 9	Discharge Location 1 into Wangi Creek. EPL Monitoring Location 9, formerly referred to as LDP B.
LDP 10	Discharge Location 2 into Wangi Creek. EPL Monitoring Location 10, , formerly referred to as LDP A.

7.1.1. Surface Water Monitoring Results

Mine water discharged from LDP 9 is required to be monitored daily during discharge for the following parameters;

- Volume;
- pH;
- Total Suspended Solids (TSS); and
- Oil and Grease

Discharge of mine water occurred on every day in the report period. A sample was collected and analysed for the parameters on every day of discharge (Table 19 and 20).

The flow volumes through LDP 9 are monitored continuously in accordance with EPL366. The daily volume discharge limit for LDP 9 is 13000 kL. The maximum daily volume discharged was 9 682 kL during the reporting period. The average daily volume discharged for 2018 was 5 126 kL. There were no exceedances of the LDP 9 volume limit criteria during the reporting period.

The pH of the mine water discharged through LDP 9 was consistent throughout 2019 with a minimum pH level of 7.2 and a maximum of 7.9. The limit criterion for pH is a range between 6.5 and 8.5. There were no exceedances of this limit during the reporting period.

The concentration of total suspended solids analysed in the mine water discharged through LDP 9 was consistently low with an average concentration of 6 mg/L and a maximum concentration of 24 mg/L during 2019. The concentration limit for TSS is 50 mg/L. There were no exceedances of this limit during the reporting period.

The concentration of oil and grease analysed in the mine water discharged through LDP 9 was consistently low with a maximum below the limit of reporting. The concentration limit for oil and grease is 10 mg/L. There were no exceedances of this limit during the reporting period.

Graphs of the main water quality analytes for LDP 9 for the reporting period are provided in Figure 10 and 11 below.

Table 18. Average Surface Water Quality for the 12 month period from January 2018 to December 2018 and the Long-term Average (LTA)

Monitoring Point Reference	Catchment	pH		TSS		Oil & Grease	
		Average	LTA	Average	LTA	Average	LTA
LDP 9 (EPL Point 9)	Wangi Creek	7.62	7.63	6	7	0	0

Table 19. LDP 9 Water Quality

Pollutant	Unit of Measure	No. of Samples required by licence	No. of Samples collected and analysed	Lowest sample value	Mean of samples	Highest sample value	EPL Limit	Recommended Trigger Value (EA)
pH	pH	365	365	7.20	7.62	7.90	6.5 – 8.5	6.5 – 8.5
Total Suspended Solids	mg/L	365	365	0	6	24	50	<50
Oil & Grease	mg/L	365	365	0	0	0	10	-

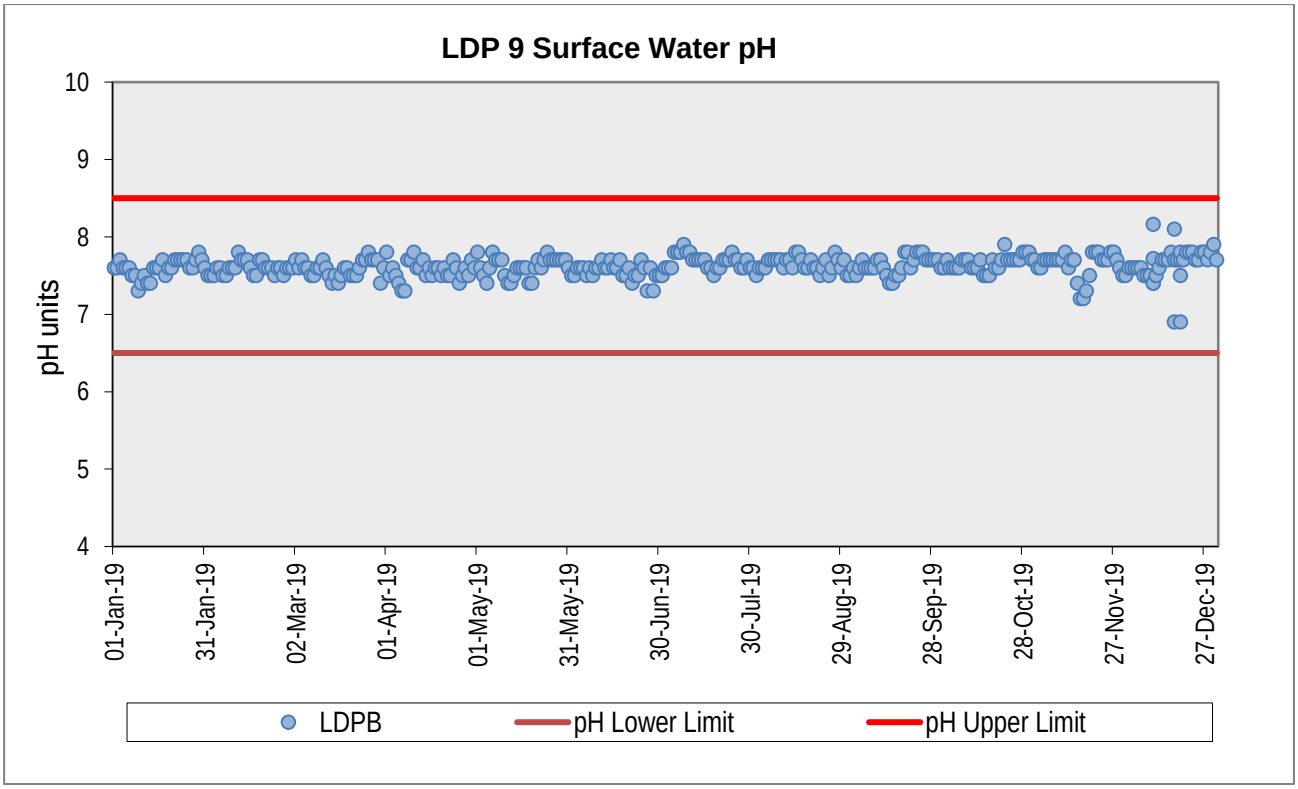


Figure 10. LDP 9 Water Quality Monitoring Results - pH

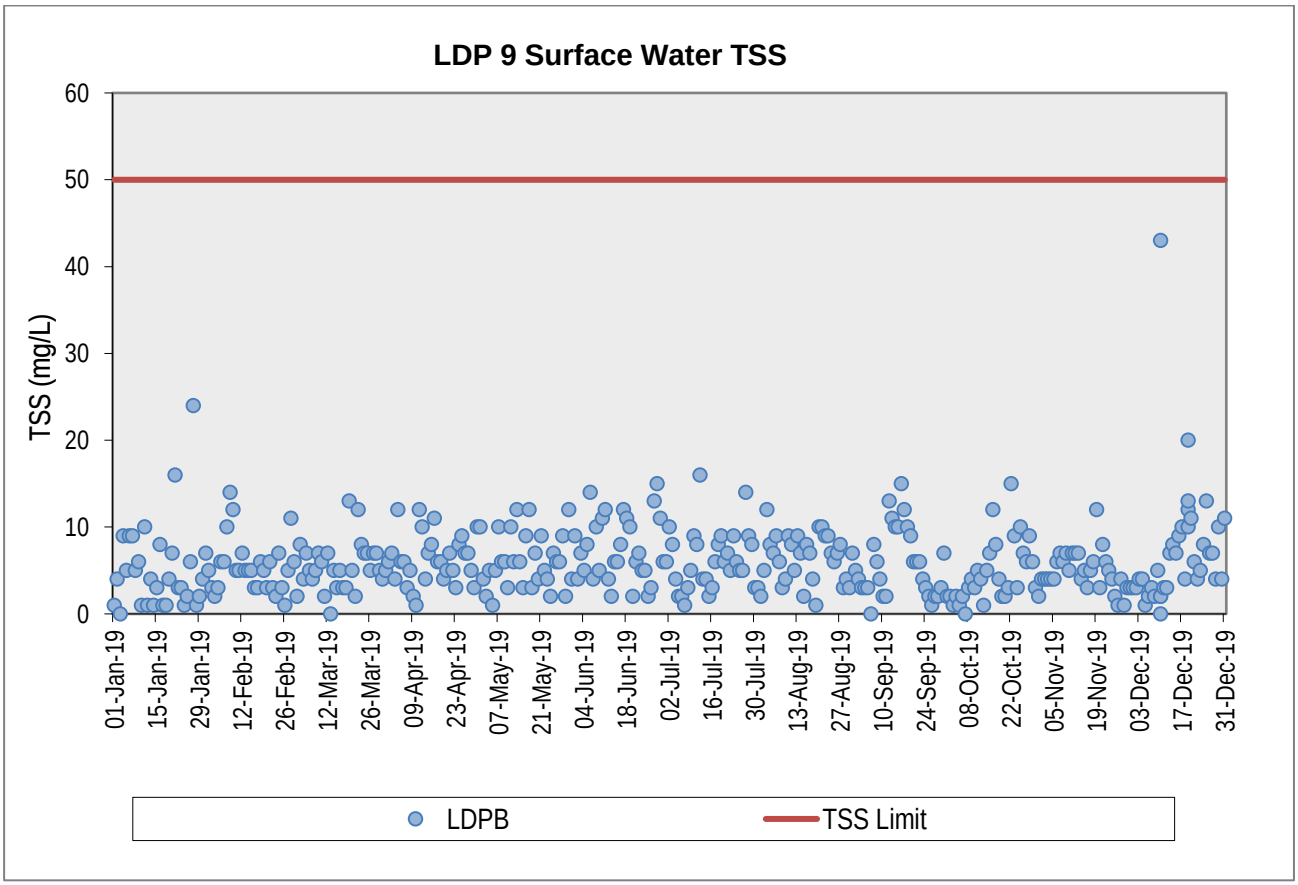


Figure 11. LDP 9 Water Quality Monitoring Results - TSS

Water Volume is required to be monitored daily during discharge at the licenced discharge points in accordance with EPL 366. Table 20 provides the discharge volume results for LDP 9 for the Annual Review period. There was no discharge from LDP 10 during the period

Table 20. LDP Discharge Volumes

Monitoring Point Reference	Frequency	No. of Measurements made	Lowest Result (kL)	Mean Result (kL)	Highest Result (kL)	EPL Limit
LDP 9 (EPL Point 9)	Daily During Discharge	365	1918	5140	9682	13000

7.1.2. Data interpretation

As shown in the figures below, linear trend lines were applied to the monitoring data from 2011 to 2019 for pH, TSS and Oil & Grease. The trend lines displayed decreasing trends over the eight year period for TSS and Oil & Grease with pH tending to remain relatively constant.

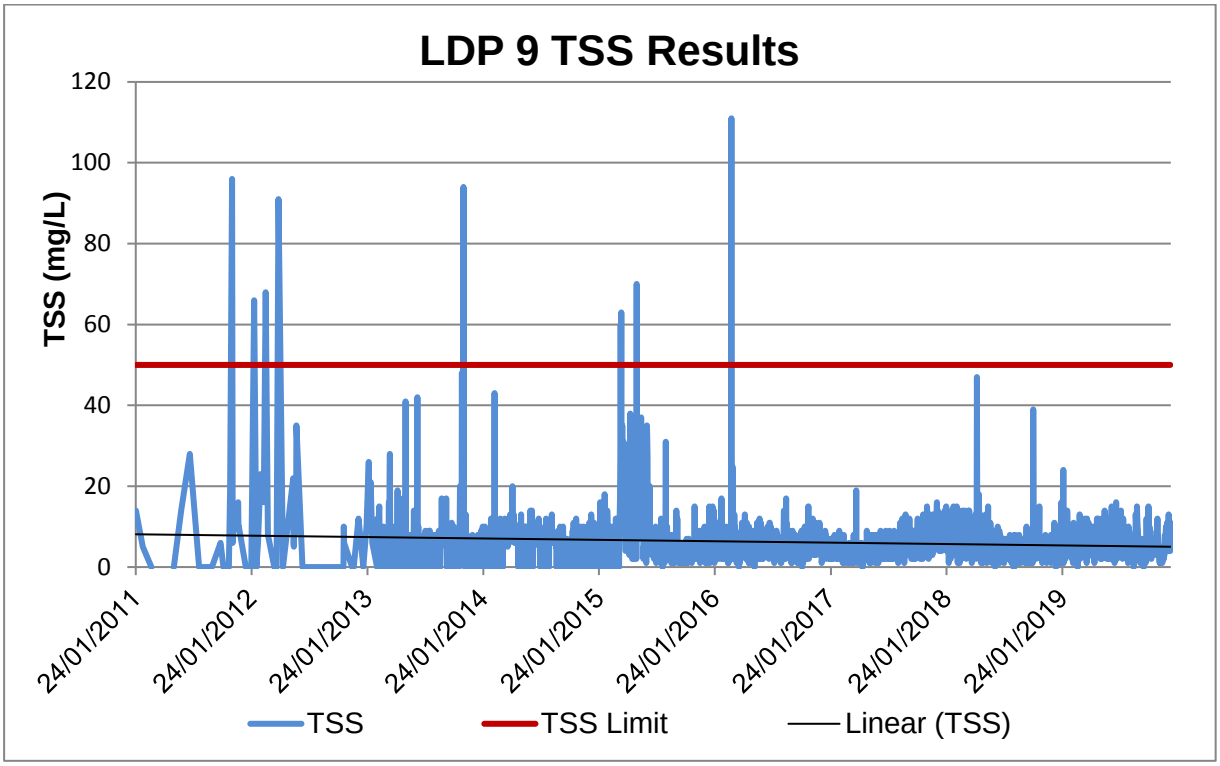


Figure 12. LDP 9 TSS Monitoring Results and Linear Trend Line

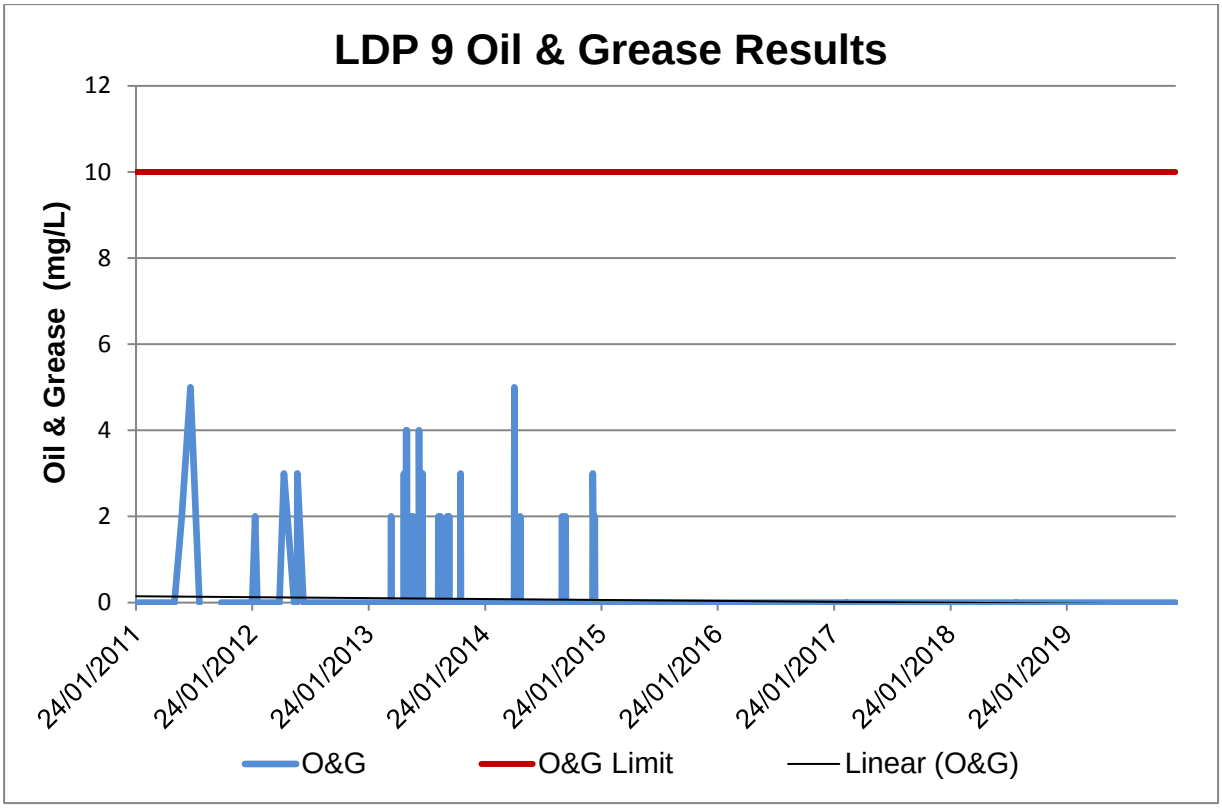


Figure 13. LDP 9 TSS Monitoring Results and Linear Trend Line

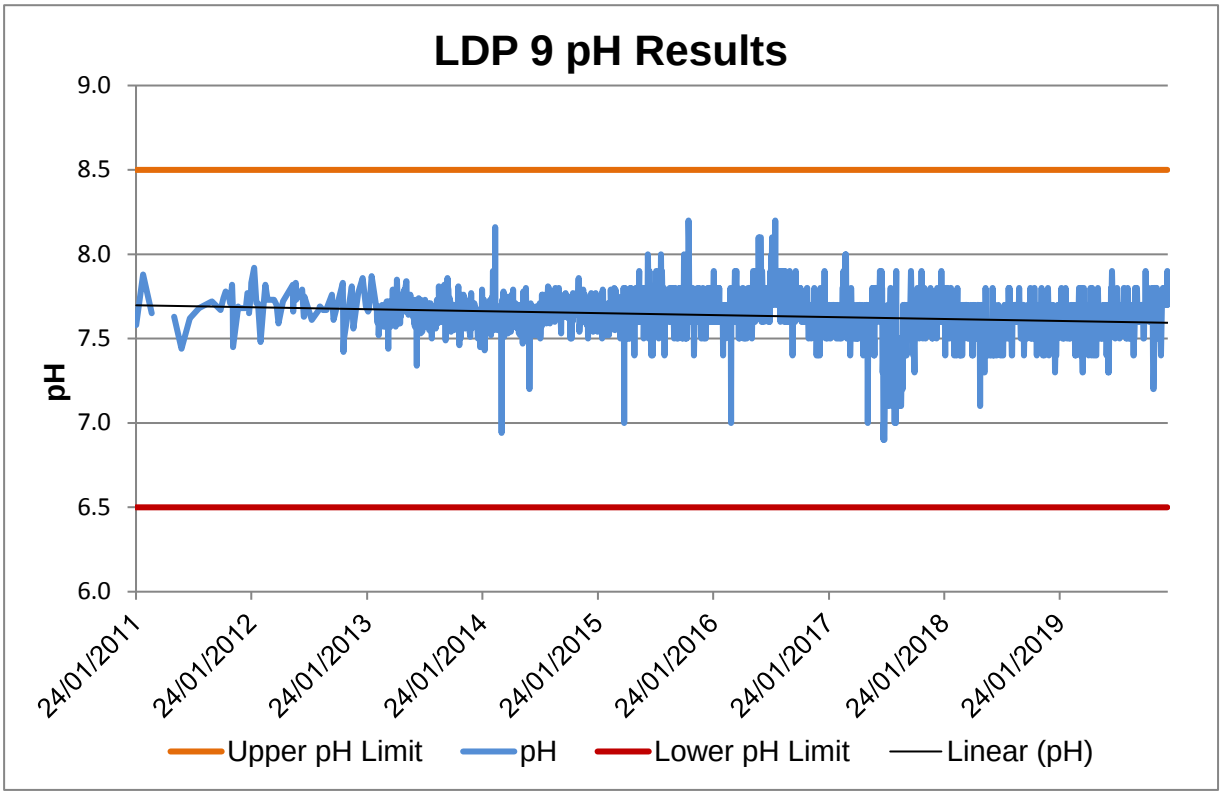
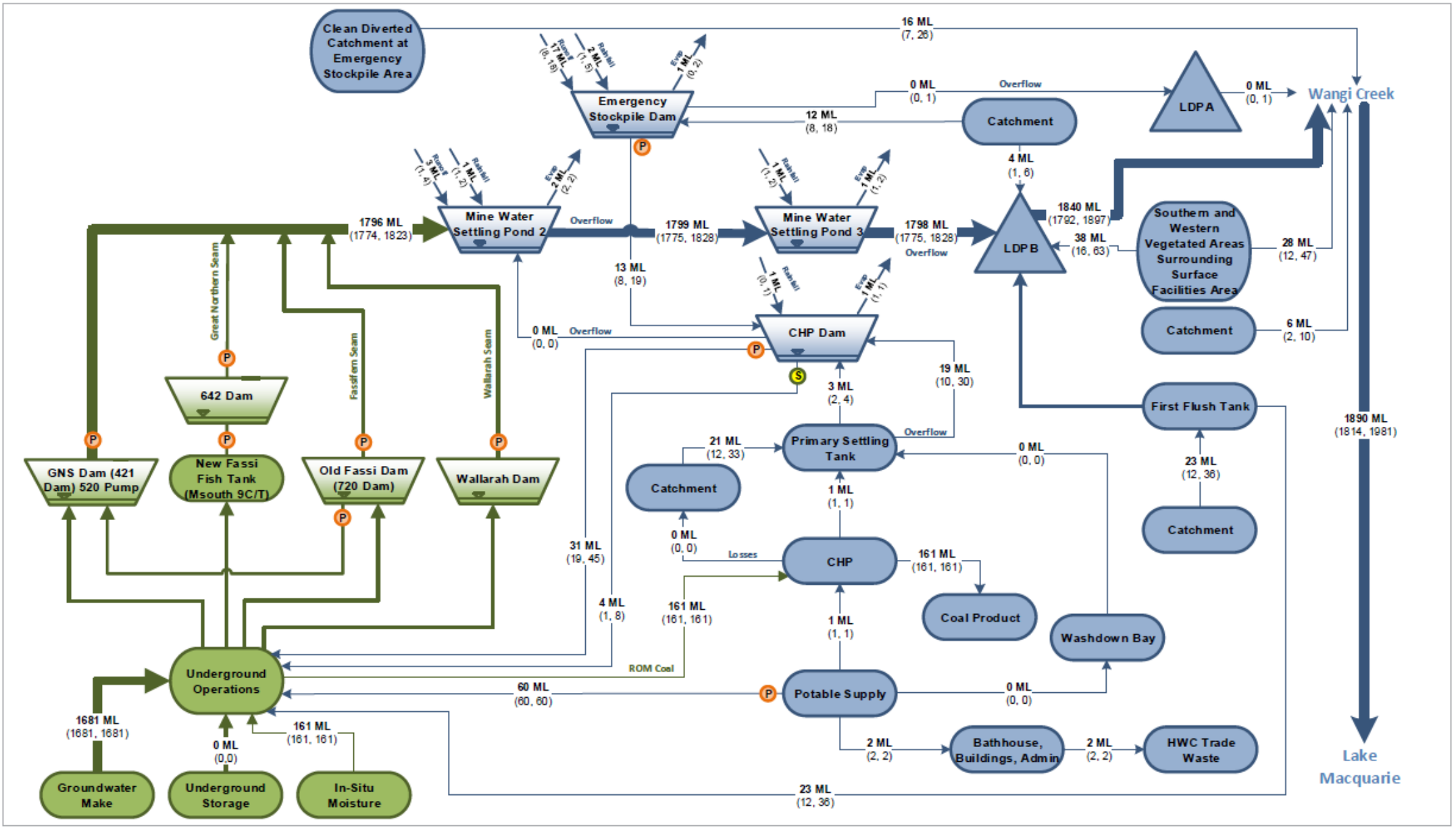


Figure 14. LDP 9 pH Monitoring Results and Linear Trend Line

7.2. Water Balance

The overall water balance for 2019 is shown as a water cycle schematic on the next page. The results shown are the modelled outputs from the water balance model and include modelled estimates of water volumes that are not able to be directly measured.



Legend

- Underground storage
- Underground process
- Surface storage
- Surface process
- Licensed discharge point
- Surface water flow
- Groundwater flow
- X (X,X) Mean (10th percentile, 90th percentile)

GHD

Centennial Coal Company Limited
Myuna Colliery
Site water balance assessment

Water management schematic
Future conditions (2020)

Project No. 12516285
Revision No. A
Date 20/02/2020

FIGURE 4-2

Created by: Tyler Tinkler

7.3. Groundwater Management

In November 2017, Myuna commenced monitoring of groundwater levels around the pit top area. The groundwater monitoring network includes ten shallow alluvial monitoring bores which were installed in August 2012. Details of the groundwater monitoring bores are provided below in Table 21.

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Table 21. Groundwater Monitoring Bore Details

Bore	Monitoring Period	Lithology	Bore Depth (m)	Monitoring Parameters
MW01	Nov 2017 – Ongoing	Alluvium	6	Groundwater Level
MW05	Nov 2017 – Ongoing	Alluvium	18.5	Groundwater Level
MW06	Nov 2017 – Ongoing	Alluvium	13	Groundwater Level
MW07	Nov 2017 – Ongoing	Alluvium	8.5	Groundwater Level
MW08	Nov 2017 – Ongoing	Alluvium	9	Groundwater Level
MW09	Nov 2017 – Ongoing	Alluvium	7	Groundwater Level
MW10	Nov 2017 – Ongoing	Alluvium	10	Groundwater Level
MW11	Nov 2017 – Ongoing	Alluvium	7	Groundwater Level
MW12	Nov 2017 – Ongoing	Alluvium	8	Groundwater Level
MW13	Nov 2017 – Ongoing	Alluvium	11	Groundwater Level

7.3.1. Groundwater Monitoring Results

As discussed in Section 7.3, the groundwater monitoring network at Myuna Colliery includes ten alluvial monitoring bores. Observed groundwater levels at these monitoring bores for 2019 are shown below in Table 22.

Table 22. Groundwater Levels for Myuna Colliery

Bore	Groundwater Level (m AHD)												
	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019	Aug 2019	Sep 2019	Oct 2019	Nov 2019	Dec 2019	EIS Prediction
MW01	18.8	19.1	19.1	19.1	19.0	19.0	18.8	18.7	18.7	18.8	18.9	18.5	Minimal Impact
MW05	12.8	13.2	12.9	13.0	13.3	13.3	13.2	12.6	12.6	12.7	12.6	12.6	Minimal Impact
MW06	12.8	12.8	12.8	12.1	12.8	12.8	12.7	12.7	12.7	12.7	12.9	12.7	Minimal Impact
MW07	21.6	21.6	21.7	21.7	21.6	21.5	21.3	21.2	21.1	21.3	21.4	21.4	Minimal Impact
MW08	20.2	19.8	20.1	19.2	20.0	19.9	19.6	20.0	20.2	20.2	20.1	20.0	Minimal Impact
MW09	16.1	14.8	15.6	16.1	15.4	15.4	15.8	15.4	16.8	16.8	15.6	14.9	Minimal Impact
MW10	23.7	23.3	23.2	23.6	23.2	23.3	23.3	23.1	23.5	23.5	23.3	23.0	Minimal Impact
MW11	9.3	9.2	9.7	9.4	9.2	9.2	9.3	9.3	9.6	9.5	9.4	9.3	Minimal Impact
MW12	6.4	6.2	6.4	6.5	6.2	6.1	6.4	6.3	7.0	7.0	6.0	5.7	Minimal Impact
MW13	2.0	1.7	1.8	2.0	1.8	1.8	2.0	1.8	2.3	2.4	1.8	1.6	Minimal Impact

7.3.2. Data Interpretation

Groundwater levels at all monitoring locations remained relatively stable during the reporting period. Since November 2016, MW09 displays a trend of increasing groundwater level. It is unlikely that the increasing level is related to mining as this trend has not been replicated at surrounding monitoring bores. Groundwater levels have been relatively stable at all other groundwater monitoring locations since November 2016.

7.4. Manganese Monitoring

The monitoring of filterable Manganese is undertaken as per special condition E1 Additional Monitoring of EPL366, in Wangi Bay on a quarterly schedule. There is no limit criteria applied to the Manganese monitoring. The monitoring results are submitted to the EPA quarterly.

Result Summary

Four samples are collected quarterly from Wangi Bay at the outlet of Wangi Creek. The average of the samples for each quarter is provided in Table 23.

Table 23. Manganese Monitoring Results

Date	March 2019	June 2019	September 2019	December 2019
Unit - µg/L	73	21	209	161

Trends

The Manganese monitoring has been conducted over a period of nine years from 2011. Manganese concentrations recorded in Wangi Bay over the nine year period of monitoring display a relatively constant trend at T1 and a downward trend at T2. The results decreased in consecutive years from 2013 to 2015. The results for 2016 showed a slight increase before decreasing again in the 2017 reporting period, with the exception of one high result in March, and increasing again in 2018 probably influenced by another high result in March and in 2019, influenced by a high result in September.

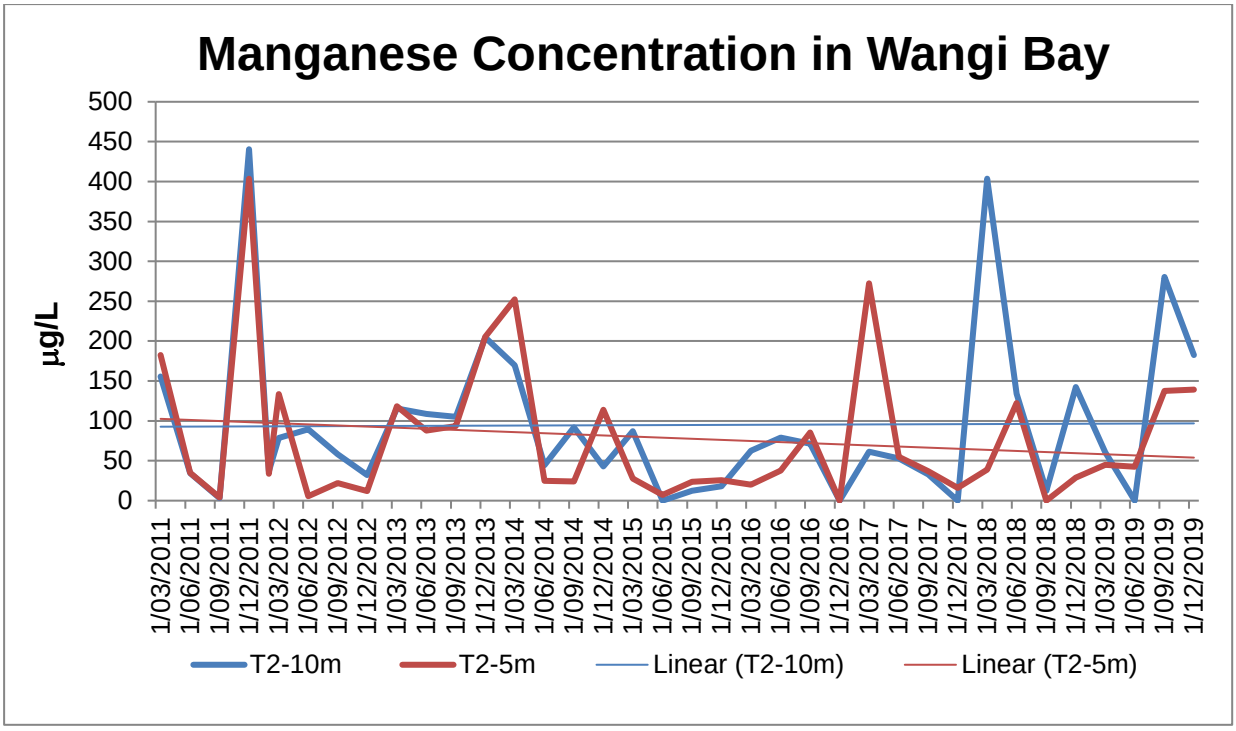


Figure 15. Manganese Monitoring Results and Linear Trend Line

8. REHABILITATION

All surface infrastructure associated with Myuna Colliery's operations is located at the Surface Facilities Area. The Surface Facilities Area encompasses a footprint of approximately 89 hectares, of which 25.2 hectares includes the surface infrastructure. These 25.2 hectares is the total area currently requiring rehabilitation prior to mine closure. The remainder of the Surface Facilities Area is predominantly natural bushland vegetation, the Wangi Creek watercourse and existing cleared easement corridors.

As per Myuna's currently approved MOP (2016 – 2022), final landform creation and rehabilitation activities will largely be undertaken following the completion of mining. Centennial Myuna will redevelop the existing Myuna Colliery Site for light industry based land uses. The area of the downcast shaft will be rehabilitated to natural bush land.

Table 24. Rehabilitation Status

Mine Area Type	Previous Reporting Period (Actual)	This Reporting Period (Actual)	Next Reporting Period (Forecast)
	2018 (ha)	2019 (ha)	2020 (ha)
A. Total mine footprint[1]	7426.5	7426.5	7426.5
B. Total active disturbance[2]	25.2	25.2	25.2
C. Land being prepared for rehabilitation[3]	Nil	Nil	Nil
D. Land under active rehabilitation[4]	Nil	Nil	Nil
E. Completed rehabilitation[5]	Nil	Nil	Nil

8.1. Next Reporting Period

The rehabilitation performance of Myuna Colliery for the next reporting period will be measured against the targets outlined in the currently approved MOP (2016 – 2022).

There are no proposed rehabilitation trials or research projects to be undertaken in the next report period.

There are no rehabilitation activities proposed for the next report period.

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

9. COMMUNITY

9.1. Community Consultation and Engagement

The Myuna Colliery Community Consultative Committee (CCC) has been established to provide a formal conduit for exchange of information and views between the local community and Myuna's Management Team.

Membership of the 2019 Myuna CCC was:

- Gerard Martin (Community Representative)
- Sandra O'Donnell (Community Representative);
- John Shoebridge (Community Representative);
- Ray Robinson (Community Representative);
- Cr Luke Cubis (Lake Macquarie City Council);
- John Turner (Myuna Mine Manager); and
- Angela van der Kroft (Myuna Environment and Community Coordinator).

Two CCC meetings were held during the reporting period, in April and October 2019, with updates being distributed to committee members in January and July.

Following the passing of John Shoebridge on 18 July 2019 and the resignation of Sandra O'Donnell from the CCC on 29 July 2019, Myuna are currently seeking community representatives to join the Committee.

Regular agenda items for the meetings included:

- Progress at the Mine – Operational;
- Monitoring and Environmental Performance;
- Community Complaints and Responses;
- Update on Management Plans & External Audits; and
- Information provided to the community and any feedback.

9.2. Community Sponsorships

Centennial Myuna continues to support the local community through various sponsorship schemes. The following is the sponsorship and support carried out locally during the calendar year:

- Wangi Dobell Festival of Arts and Crafts 2019 hosted by the Wangi Lions Club;
- Royal Motor Yacht Club Toronto event the Heaven Can Wait Charity Sailing Regatta;
- Awaba Oval Board (LMCC) Operating Committee for improvements to Awaba Sporting Complex;
- Australian Sports Foundation Team Lake Macquarie - International Children's Games in Russia in July 2019;
- Toronto Lions Club events; Float your Boat and Carols by the Lake; and
- Rotary Club of Toronto event Sunrise Paddlefest.

Centennial Myuna supported local sporting organisations, with sponsorship assistance for new equipment and operational costs. These sporting clubs included Southern Lakes United Football Club, Westlakes Wildcats Football Club, Southern Lakes Cricket Club, Macquarie Shores Swimming Club, Lake Macquarie Crocs Masters Swimming Club, Westlakes Athletics Club, Wangi RSL Amateur Sailing Club, Marmong Point Sailing Club, Toronto Ladies Golf, Westlakes District Netball Association, Macquarie Scorpions Rugby League Football Club and Toronto Awaba Stags Football Club.

Centennial Myuna supported community organisations and events including Meals on Wheels, Southlakes Carers Inc., Special Children's Christmas Party, Immune Deficiencies Foundation as well as Wyee Public School, Teralba Public School and Wangi Public School.

9.3. Community Complaints

A community complaints register is kept on site and published on the Centennial Myuna website. All community enquiries and complaints received by Myuna Colliery are to be recorded as per MY-EWP-038 Community Complaint and Enquiries Procedure. This information is then entered into the Centennial Coal Environment and Community Database (ECD).

There were no community complaints received in the 2019 report period.

Table 25. Complaints History

Year	Air	Water	Noise	Waste	Other	Total
2019	0	0	0	0	0	0
2018	0	0	0	0	0	0
2017	0	0	0	0	0	0
2016	0	0	0	0	0	0
2015	0	0	0	0	0	0
2014	0	0	0	0	0	0
2013	0	0	0	0	0	0

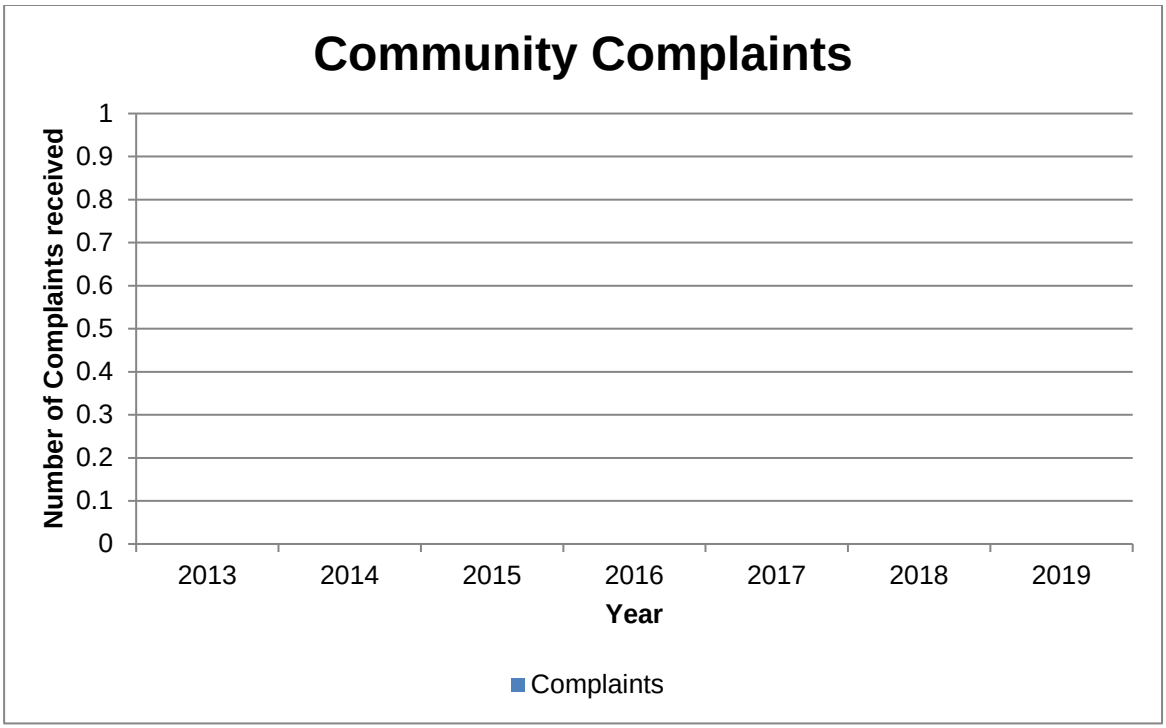


Figure 16. Annual Community Complaints

10. AUDITING

10.1. Independent Environmental Audit

Centennial Myuna engaged MCW Environmental Pty Ltd (MCW) as the independent expert approved by the DPE to carry out an Independent Environmental Audit (IEA) of Myuna Colliery in accordance with Condition 9, Schedule 5 of Project Approval 10_0080 MOD1.

The audit period was defined as from 31 May 2016 (last date of the previous IEA site inspection) to 7 May 2019 (date of site visit conducted by MCW Environmental). The Independent Environmental Audit assessed compliance with the PA10_0080 MOD1, EPL366, Mining Lease 1632 and Mining Purposes Lease 334. In addition the audit included a review of the adequacy of the strategies plans and programs required under the project approval.

Table 26. Independent Environmental Audit Compliance

Relevant Approval	Percent Compliant (%)	Number of Conditions Non-compliant	Number of Conditions Not Verified
Project Approval Myuna Mine PA 10_0080	82	7	4
Project Approval Myuna Mine PA 10_0080 Appendix 3 Statement of Commitments	100	0	0
Environmental Protection Licence No. 366	94	3	3
Mining Lease 1632	97	1	0
Mining Purposes Lease 334 (Covering Pit Top area only)	100	0	0
Mining Lease 1370	100	0	0

An Action Plan was developed and submitted to the Department of Planning and Environment which describes the corrective actions to be undertaken for each non compliance and recommendation. The Action Plan has a scheduled completion date for each action. The Audit Report and Action Plan has been published on the Centennial Coal website.

Progress against the action plan is shown in Table 27. The next Independent Environmental Audit is scheduled for May 2022.

Table 27. Independent Environmental Audit Action Plan

Item No.	Title Condition No.	Requirement	Compliance/ Recommendations	Action Required	Proposed Completion	Progress
1	PA 10_0080 S2.11	Operation of Plant and Equipment	Undertake repairs to the bund wall at the bulk oil storage area.	Repairs complete. No further action required.	N/A	Complete
2	PA 10_0080 S3.1	Subsidence	That Myuna develops and implements a process to assess settlement measurements against the 20mm vertical subsidence criteria that includes consideration of survey error; shrink/swell; and any other relevant factor. The procedure should define who is responsible for doing the works required and for reporting any non-compliance with the criteria.	Review Subsidence Management plan to incorporate a review process of subsidence data and roles and responsibilities of reporting any non-compliances.	28/02/2020	Complete
3	PA 10_0080 S3.1	Subsidence	That Myuna formalise and implement a process to demonstrate that mine workings are conducted in accordance with the first workings mine design.	Design and implement a documented process to periodically conduct surveys to verify workings are in accordance with the mine design.	30/10/2020	Ongoing
5	PA 10_0080 S3.9	First Workings	Seek formal confirmation from the DRE that it is satisfied that the first workings have been designed to remain stable and non-subsiding.	Submit documentation to DRE and request that they advise if they are satisfied that the workings are designed to remain stable and non-subsiding.	30/06/2021	Ongoing
6	PA 10_0080 S3.11	Noise Criteria	Implement the recommendations of the Advitech Noise Exceedance Investigation Report (once finalised).	Recommendations of the Advitech Noise Exceedance Investigation Report will be considered and implemented as appropriate and practical.	30/11/2020	Ongoing
7	PA 10_0080 S3.12	Operating Conditions	Ensure the real-time continuous noise monitor is used as described in the NMP as a tool to proactively guide the day to day planning of Myuna Colliery. This includes setting of trigger levels and sending alerts to enable managers to alter operational activities as required.	Noise monitor to be upgraded to a type capable of alarming. Trigger levels to be set for new monitor to allow it to be used in the making of operational decisions.	20/12/2020	Ongoing

Item No.	Title Condition No.	Requirement	Compliance/ Recommendations	Action Required	Proposed Completion	Progress
8	PA 10_0080 S3.12	Operating Conditions	Consider better integration of meteorological data to enable pro-active management under higher impact meteorological scenarios (e.g. winds about the west and north).	Investigate better integration of meteorological data to enable pro-active management under higher impact meteorological scenarios and implement if feasible to do so.	20/12/2020	Ongoing
9	PA 10_0080 S3.16	Greenhouse Gas Emissions	Include site specific measures to minimise the release of greenhouse gas emissions in the Myuna Appendix of the Northern Region AQGHGMP. The measures should be implemented by the site.	Include site specific measures in the Myuna Appendix of the Northern Region AQGHGMP for the minimisation of greenhouse gas emissions.	20/11/2019	Complete
10	PA 10_0080 S3 Note	SOIL AND WATER Under the Water Act 1912 and/or the Water Management Act 2000, the Proponent is required to obtain the necessary water licences for the project.	Confirm with NRAR that all applicable licences required at the site have been obtained including a Certificate of Title for WAL 41560; and clarify conditions of WAL41560. Where licences are required, work with NRAR to obtain these licences.	Confirm with NRAR that all applicable licences required at the site have been obtained including a Certificate of Title for WAL 41560; and clarify conditions of 20MW065029. Where there are corrections to be made with licencing requirements, liaise with NRAR to have these addressed	27/05/2022	Ongoing
11	PA 10_0080 S3.25	Water Management Plan	Implement the monitoring program for stream health and channel stability and visual monitoring for channel incision as outlined in the WMP.	Stream Health and Channel Stability Monitoring has been requisitioned for 2019. This will include visual monitoring for the occurrence of channel incision as per the WMP.	20/12/2019	Complete
12	PA 10_0080 S3.27	Water Management Plan	Ensure that surface and groundwater quality and quantity monitoring data is sufficiently reviewed / analysed to determine whether the TARPs require activation.	Implement a system to document and record review/analysis of surface and groundwater quality and quantity monitoring data to determine whether the TARPs require activation.	20/03/2020	Complete
13	ML 1632 Condition 12	Prevention of Soil Erosion and Pollution	As per the recommendation of the RCA report, consider obligations for ongoing management of the contamination in consultation with the EPA.	Consider obligations for ongoing management of the contamination in consultation with the EPA.	20/12/2019	Complete

10.1. Audit of Groundwater Conditions

In accordance with Condition 6 of Bore Licence 20BL172565 Centennial Myuna will engage an independent expert, approved by the Office of Water, to undertake an audit of the groundwater conditions, all monitoring records and any related impacts. The next audit will be undertaken in December 2020.

Progress against the action plan for the April 2016 Audit is shown in the table below.

Table 28. Independent Groundwater Conditions Audit Action Plan

Condition No.	Requirement	Compliance/ Recommendations	Action Required	Progress
	The approval of this licence is based on interception and extraction of groundwater from the central coast-hunter porous rock groundwater source. No authorisation is granted to intercept or extract surface or ground waters from any other water source.	2. Conduct additional model runs to assess pre-mining water budgets for the alluvium and compare this to current conditions. 3. Implement a groundwater elevation monitoring programme for the shallow alluvial bores on site to: a. Further characterise the influence of the mine relative to climatic changes. b. Further validate the predicted modelling impacts and the uncertainty associated with the predictions. 4. Clarify the rationale behind changing overburden thickness as part of model calibration via clarification in future annual reports.	1. Assess pre-mining water budget for the alluvium and compare with current conditions in the Annual Groundwater Management Report. 2. Implement a groundwater elevation monitoring program. 3. Provide clarification in the Annual Groundwater Management Report of the rationale behind changing overburden thickness as part of model calibration.	Completed. Section 5.2 2016 Annual Groundwater Report. Completed. Section 3.3 2016 Annual Groundwater Report. Completed. Section 5.1.1 2016 Annual Groundwater Report
	The licence holder must provide to the NSW Office of Water for approval a groundwater management plan (GMP) within three months of the issue of this licence, which includes: a) detailing monitoring, remediation and contingency measures,	5. The GMP is recommended to be updated to include a discussion of the long term water extraction, the discharge criteria set in the licence and the	4. Update the Groundwater Management Plan to include a discussion of the long term water extraction, the discharge criteria set	Completed. Section 5.3 Water Management

Condition No.	Requirement	Compliance/ Recommendations	Action Required	Progress
	and mine water discharge scenarios and criteria. b) long term water balance calculations for the site to show that the proposed volumes and rates of groundwater extraction are sustainable. c) measures to monitor the operation of the work, which will demonstrate surface and subsurface mining operations are conducted in a manner which minimises potential impacts on groundwater flow and quality, aquifer integrity, groundwater-dependent ecosystems and other off-site water related impacts, including: a. groundwater sources to which no extraction authorisation is included in this licence b. other groundwater users within a radius from the work defined in the approved groundwater management plan. c. and groundwater dependent ecosystem or surface water source which may be affected by operation of the work. d) verification of any predictive modelling or other assessments related to impacts on groundwater source(s), other users or groundwater dependent ecosystems e) a monitoring and response plan, which is approved by the NSW Office of Water. The plan shall include: i. methods to assess the extent of depressurisation created by a operation of the work and determining the volume of any inflow from overlying seams or other groundwater sources ii. contingency arrangements in the event of predicted interception of groundwater exceeding predictions iii. options to replace groundwater user supply for any affected licensed groundwater licence holder.	sustainability of the scheme, making reference to the impacts on sensitive features identified in this condition. The update should also consider the development of contingency measures following on from verification of the model with monitoring data from the surrounding alluvial system. Also refer to recommendations 2 to 4 with regard to model verification.	in the licence and the sustainability of the scheme, making reference to the impacts on sensitive features identified in this condition. 5. Update the Groundwater Management Plan to include a groundwater elevation monitoring program.	Plan. Completed. Section 6.1.2 Water Management Plan.

Condition No.	Requirement	Compliance/ Recommendations	Action Required	Progress
	The licence holder must submit a report to the NSW Office of Water (the annual groundwater management report or annual report) each year after the commencement of this licence, which will include: a) all raw water monitoring data, an interpretation of that data and a discussion of trends identified in the data and their implications. b) all groundwater extraction data (volumes and rates) taken by the works, the extent of aquifer depressurisation and the salinity impacts, compared with predictions of aquifer performance made in the environmental impact statement(s) or similar project documents. c) an overall comparison of groundwater performance with predictions for the life of the mine provided in the development application and supporting documentation d) water related activities performed and the level of compliance with the GMP, and an outline of proposed adaptive or remediation actions, and, e) assessment of extraction or other depressurisation impacts caused by the work(s) to external water sources, water users or groundwater dependent ecosystems, as specified in condition 2.	6. Include the manually recorded extraction data (field sheets) in an appendix of the annual reports. 7. Clarify the water quality analytes and criteria reported in the annual report with reference to both the surface water management plan and GMP. This would include a discussion to demonstrate that discharges are compliant with licence requirements.	6. Provide all groundwater extraction data in the appendix of the Annual Groundwater Management Report. 7. Conduct a gap analysis on the water quality reporting requirements of the Groundwater Management Plan and the Annual Groundwater Management Report. 8. Investigate and implement formats for presenting data in the Annual Groundwater Management Report in a clear and concise manner.	Completed. Appendix E 2016 Annual Groundwater report. Completed. Section 4.2 2016 Annual Groundwater Report. Completed. Section 4.2 2016 Annual Groundwater Report.
	The licensee shall install to the satisfaction of NSW Office of Water in respect of location, type and construction an appliance(s) to measure the quantity of water extracted from the works. The appliance(s) to consist of either a measuring weir or weirs with automatic recorder, or meter or meters of the dethridge type, or such other class of meter or means of measurement as may be approved by NSW Office of Water. The appliance(s) shall be maintained in good working order and condition. A record of all water extracted from the works shall be kept and supplied to the department upon request. The licensee when requested must supply a test certificates to the accuracy of the appliance(s) furnished either by the manufacturer or by some person duly qualified.	8. Seek approval from DPI-Water for the measurement device.	9. Acquire the specifications from DPI Water for an appliance to measure water volumes extracted. Verify the meter is an acceptable appliance. Seek approval from DPI-Water for the appliance.	Completed

11. INCIDENTS AND NON-COMPLIANCES DURING THE REPORTING PERIOD

Table 29. Incident/Non-Compliance Summary 1

Nature of the incident/non-compliance	Exceedance of PA10_0080 Air Quality Criteria (PM_{10})
Date of incident/ non-compliance (if known; if not known state not known)	8/01/2019
The location of the incident/ non-compliance (include a figure if appropriate), if known	"HVAS PM10" as indicated on plan MY11301, appended to this report.
Detail the cause of the incident/non-compliance	The exceedance is believed to have been caused by dust generated by coal haulage trucks operating on the haul road.
Detail action that has been, or will be, taken to mitigate any adverse effects of the incident/ non-compliance	There are no adverse environmental effects as a result of the non compliance.
Detail action that has been, or will be, taken to prevent recurrence of the incident/ non-compliance	Haulage company to bring a water cart to site for use during haulage operations and haul truck drivers reminded of their responsibility to operate the in-situ haul road dust suppression system as required and to maintain appropriate speed along the haul road to limit dust generation.
Consultation with relevant agency (who, when and the response), or agencies if more than one	Notification sent to DPE and RR.

Table 30. Summary of Reportable Incidents and Regulatory Actions

Compliance Type	**Agency(ies)**	**Number**	**Response**
Incidents	DPE	1	Nil
Caution Notices		Nil	
Warning Letters		Nil	
Penalty Notices		Nil	
Prosecutions		Nil	

Note: This table includes actions taken by DPE/DPIE, DRG, Resources Regulator and the EPA during the reporting period.

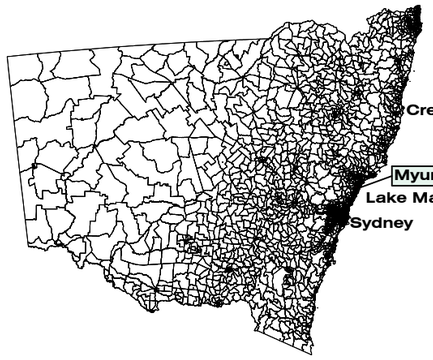
12. ACTIVITES TO BE COMPLETED IN THE NEXT REPORTING PERIOD

Planned activities for the next reporting year:

- Ongoing implementation of strategies contained in Myuna's approved Management Plans in order to manage the risks associated with the operation
- Review and revision of Management Plans as per approval (10_0080) conditions.
- Ongoing improvements to the surface water monitoring and management.

PLANS

New South Wales - Australia



ML1632

MPL 334

ML 1632

Lake Macquarie

Wangi Wangi

Swansea

DORA CREEK

Pulbah Island

Morisset Peninsula

Point Wolstoncroft

ML 1370

Sublease Area Part ML1632

0 0.5 1.0 1.5 2.0
Kilometres

LEGEND

- MOP Area - Mining Lease ML1632
- Mining Leases
- Cadastral Boundary
- Roads
- Water features
- Lake Macquarie
- Part 3A - Project Approval Area
- Development Consent SH 110/148
- Wallarah seam workings (January 2020)
- Great Northern seam workings (January 2020)
- Fassifern seam workings (January 2020)

DRAWN : DH	Centennial Myuna — MYUNA COLLIERY
DATE : 13.02.2018	
CHECKED :	TITLE
DATE :	AEMR - (Annual Environmental Management Plan)
APPROVED :	Annual review plan 2019
DATE :	
SCALE 1:20,000	CAD FILE H:\shared\PLANS\MY\MY11606.dwg H:\shared\PLOT\MY\MY11606_2019.pdf
PLAN NO. MY11606	REV. 2
	A1

APPENDIX 1 - Myuna Colliery Weed Action Plan 2019

RESTORING THE BALANCE

Myuna Colliery Weed Action Plan 2019

Centennial Coal

December 2018

This Annual Weed Action Plan has been prepared for the Myuna Colliery site off Summerhill Drive, Wangi Wangi, NSW. It has been produced for Angela Van der Kroft in December 2018 to provide an overview of previous control works conducted on the site and current weeds present on the site. This plan also discusses control requirements under the NSW Biosecurity Act 2017 and proposed control methods and timing for 2019.

SUBMITTED TO	DATE	REVISION
Angela Van der Kroft	18/12/2018	Version 1
Angela Van der Kroft	23/12/2018	Version 2

This document can only be considered as having permission for final distribution if an original signature of an authorized representative of HLM is found below:

23/12/2018

SIGNATURE DATE

Daniel Lewer

Managing Director

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Cover Photo: Coral Tree regrowth in Area 5

Contents

1. Introduction

Myuna Colliery is located off Summerhill Drive in the suburb of Wangi Wangi, New South Wales, an active underground mining operation which supplies coal to nearby Eraring Power Station directly via conveyor. The disturbance area associated with day to day operations covers less than one quarter of the total landholding, which when combined with previous disturbance impacts of road, access points and superseded infrastructure clearing or regular access has affected approximately one third of the total management area.

Observations of vegetation and landscape integrity indicate that more than one half of the landholding has never been disturbed or has been disturbed infrequently by mining and associated activities. These areas support functional natural vegetation communities with little to no weed invasion and minimal management requirements. The main management need in these areas is the maintenance of boundary edges to control weeds established there and reduce the likelihood of creeping establishment of weed species in from these edges. The labour and material input required for effective suppression of weeds and integrity of the natural system is minimal, as competition from indigenous species is high.

From 2012 to the end of 2018 there have been 7 Weed Action Plans conducted at Myuna Colliery, including an annual weed survey and on ground works. This has resulted in the ongoing suppression and removal of Lantana, Bitou Bush, Pampas Grass, Pine Trees and Castor Oil among others from those areas identified in **Figure 2**.

During 2018 HLM spent approximately 120 labour hours on ground at the site actively controlling high priority target weeds. This equates to six days with a crew of two carrying out primarily cut and paint bush regeneration methods, supported by foliar spraying for dense lantana, Cassia and Crofton weed infestations. Where suitable (i.e. away from waterways) selective herbicides such as Starane and 2-4-D were used to spray lantana to limit the off target damage to grasses and other non-susceptible species. This in turn helps to maintain active groundcover. This was primarily used on plants growing up to and through boundary fences in hard to reach locations for time efficient control.

2018 weed control work (outlined in **Figure 2** below) was targeted at all areas excluding Area 1, where no work was completed. Weeds targeted were Bitou Bush, Lantana, Crofton Weed and Cassia. Work included areas along Wangi Creek in Area 4 with Lantana, Bitou Bush and Tree Tobacco were targeted. Other weeds targeted in Area 4 were Castor Oil and Pampas Grass. Area 2 was treated for Cape Broom, Cassia and Blackberry.

Ongoing works will be required in Areas 4 and 5 to eradicate any new weed growth. Wangi Creek in Area 5 should be the focal point for 2019 with maintenance work in all other areas to follow. Area 2 along Summer Hill Drive boundary had a large infestation of Lantana and will require ongoing treatment in 2019 and beyond.

Weed Infestation Survey Summary by Area

Area 1 – Large Coral Tree and Scattered Cassia

Area 2 – Scattered pockets of Lantana and Bitou Bush and Pampas Gras in North East

Area 3 – Scattered singular Bitou Bush throughout site with seedlings along with a few scattered Lantana and Castor Oil Plants

Area 4 – Tobacco Bush around Coal Pad and Scattered Lantana along creek line

Area 5 – Scattered Lantana along creek line and roadsides

HLM undertook the following methodology to conduct the Weed Action Plan. This included conducting a 4WD/walking survey of the site, geo-referencing weed locations, researching and prioritising weeds identified onsite and outlining proposed timing and control methods for 2019.

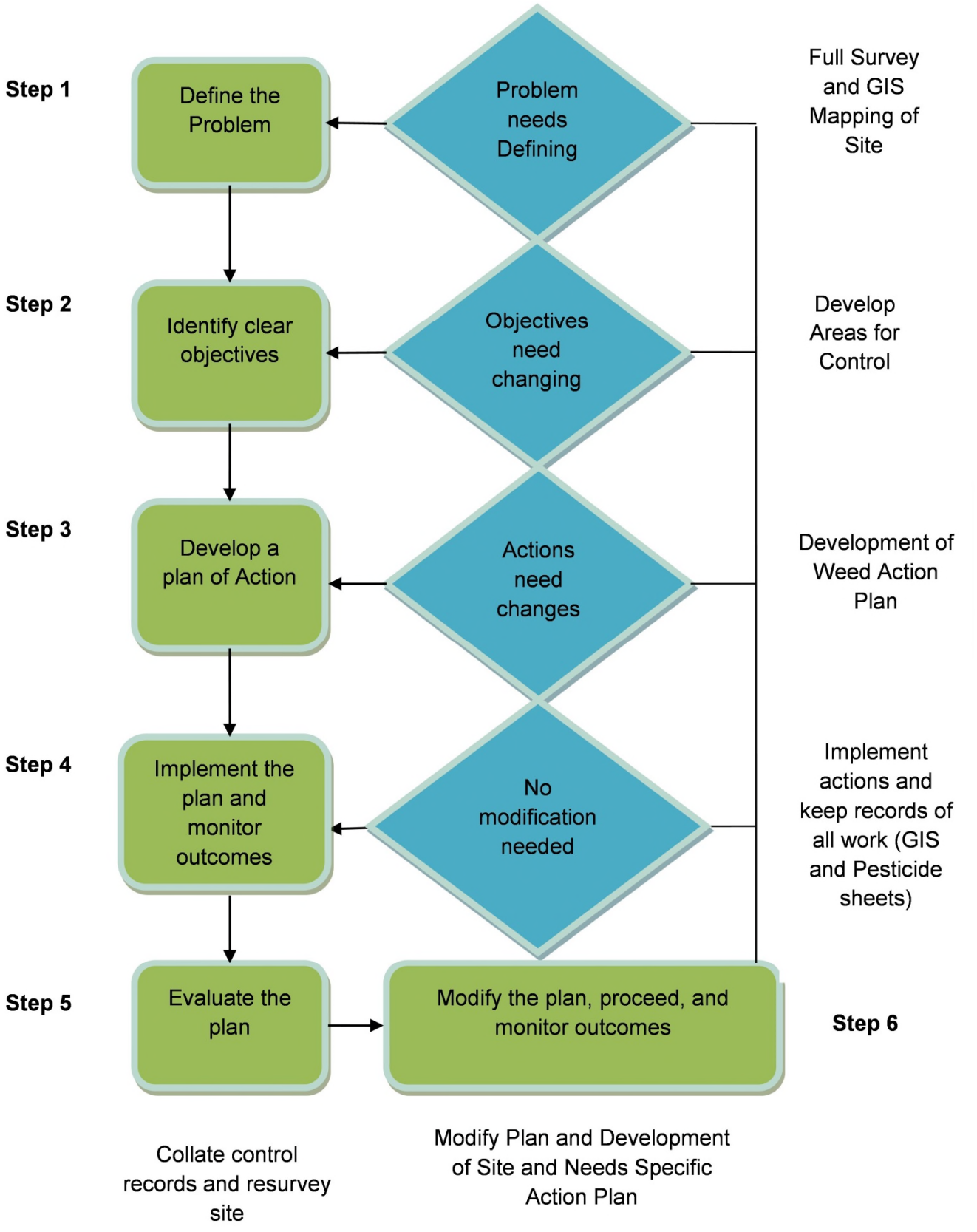


Figure 1 Weed Action Plan development methodology

Figure 2 Weed Control Areas 2018

2. Control Approach (2019 Control Works)

All areas (excluding Area 1) were treated for various weeds to maintain suppression and this should again be the focal point for 2019 with maintenance crucial to maintain pressure on weeds in these areas which is the Groundwater Dependant Ecosystem (GDE) area on site. Area 2 along Summer Hill Drive boundary had an infestation of Lantana and will require ongoing treatment in 2019 and beyond. Figure 1 in **Section 3** outlines the areas proposed for weed control works in 2018.

Community members continue to carry out landcare activities along the Donnelly Rd roadside to reduce weeds and plant local indigenous species. Continual removal of lantana and other weeds along the fence line will capitalise on this work by removing all mature Lantana and Bitou Bush plants in the area, and is also a low energy opportunity to cultivate positive neighbour relationships through contributing to an existing initiative. This area also represents the disturbed margin above a large expanse of intact bushland with a low weed load. Through being vigilant along the boundary, the risk of weed invasion into the high value bushland will be limited. Once primary weeding along the top ridge is complete the area can be designated a maintenance zone and will require only light annual follow up control of emerging seedlings and regrowth.

Working down the hill towards the creek line the lower flats have a higher weed load as moisture availability and disturbance frequency increases. Lantana and Bitou Bush are found along tracks and in mid-story openings. Field teams must leave the existing tracks and move through the bushland as isolated weeds are scattered throughout the vegetation and will need to be treated with cut and paint techniques.

Once the maintenance weeding has been completed, focus is to remain on Wangi Creek as the secondary focus for 2019. This area will require repeated backpack foliar spray, cut and paint, and isolated high volume spray treatments to bring the Lantana, Crofton Weed, Bitou Bush and Pampas Grass infesting the creek line under control. The main access point will be the gateway located at the south eastern tip of Area 5. This is easily accessed from Donnelly Road and will permit vehicle access in dry weather and all weather access on foot. Weed control will move from this point upstream to Wangi Road.

Areas 1 and 2 in particular still contain established Lantana, Cape Broom, Bitou Bush, Crofton Weed and Tree Tobacco, which will need to be moved into from areas controlled during 2018. The well-established nature of these infestations and the highly disturbed nature of the landscape makes this a higher energy input area in terms of intervention needed to allow the surrounding native species to establish dominance. Area 2 will require several more years of applied weed control to achieve effective management.

A proposed weed action plan budget which outlines a plan for ten days of onsite weed control with a crew of two, and the intended break up of effort over the site is included on Page 14.

As stated above it is considered top priority to work from the top of Area 5's boundary fence to Wangi Creek and these areas are to be completed before carrying out any maintenance program in previously treated areas in order to achieve these desired outcomes.

A New Daily Report sheet, Appendix 1, will better report on works completed in each program.

3. 2019 Target Areas

Myuna Colliery 2018 Weed Action Plan

Legend

- Weed Control Areas
- Myuna Colliery Boundary
- 2019 WAP Target Areas

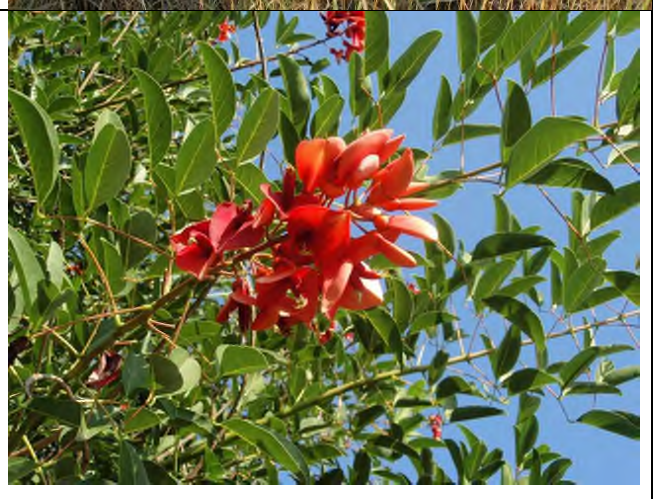
Figure 1 : Target Areas 2019

Drawn: D. Lewer Date 18/12/2018

4. Weed Species Classification and Profile

Table 1 Weed Species Declaration and Detail

Weed Name (Common Name) Weed Declaration	Description of Infestation/Field Notes	Weed Photograph
Lantana **Prohibition on Dealings** **Weed of National Significance (WoNS)**	A declared weed, this perennial large shrub is the dominant weed found over the whole site with the exception of dense, natural bushland on the north eastern hill as seen in Figure 4. In heavily disturbed areas it forms a dense mid-story and supresses the growth of native species. In less disturbed areas it is largely found as scattered shrubs within mixed native and weed based vegetation which is easily removed through cut ant paint or hand pulling. In this competitive environment with established and recruiting native vegetation removal has a good chance of success.	
Bitou Bush **Biosecurity Zone**	A declared weed, the South African shrub is very well suited to coastal areas where it forms dense monocultures. It is present over most of the site, interspersed with other vegetation as single plants or small clumps. All but the largest plants are easily removed by hand. Persistent ongoing removal will be needed.	
Pampas Grass **Regional Recommended Measure**	A declared weed particularly prevalent in disturbed areas such as mines and quarries. This perennial grass has a very high seed load and can outcompete most other vegetation in disturbed areas. Control all plants encountered to limit seed set and distribution.	
Crofton Weed **Environmental Weed**	Crofton weed is present throughout most wet or occasionally inundated areas in low to medium densities. Ongoing spot spraying and manual removal of isolated plants is required to remove established populations, and prevent the suppression of native species common in dense infestations. Primary infestations have been in Areas 2 and 4.	
Easter Cassia **Environmental Weed**	This weed is a spreading shrub to 3m high, flowering all year with the bright yellow flowers seen to the right, producing large amounts of viable seed in bean like seed pods. Found mostly on disturbed margins in the southern area of the site. Most common around the horse paddock.	

Camphor Laurel **Environmental Weed**	Large, broad tree with glossy leaves, pinkish new growth and a strong smell of camphor from crushed leaves. Invasive and coppice forming, particularly along drainage lines and water ways. This tree is scattered throughout the southern part of the site, largely through regenerating previously disturbed areas. Control with Cut and paint method as encountered.	
Fireweed **Prohibitions on Dealings** **Weed of National Significance (WoNS)**	Native to south eastern Africa it is highly invasive in disturbed areas and pasture. Quickly developing a persistent seed bank it flowers in late winter to early spring. Toxic to livestock primarily through liver damage It is primarily restricted to Area 2, and was treated through foliar spray in 2013. Follow up treatment in 2014 will be needed.	
Cape Broom **Prohibitions on Dealings** **Weed of National Significance (WoNS)**	Upright, evergreen shrub from 1-3m, usually with one main stem with many branchlets holding small dark green leaves. Finely hairy on the underside of leaves, bearing clusters of yellow pea like flowers followed by small brown to black seed pods. Highly invasive with weed declarations between category class 4 – 2 around New South Wales. Primarily found in the area surrounding the hose paddock (Area 2) extending into Area 3. Early control before seed set in spring. Plants must be two year old before they reproduce, so ongoing control of young plants is desirable.	
Coolatai Grass **Regional Recommended Measure**	This is an invasive perennial grass that is an environmental weed. Found in association with whisky grass onsite.	
Coral Tree **Environmental Weed**	Widely naturalised, this tree with distinctive scarlet flowers generally found near watercourses and drainage lines has the ability to grow readily from broken branches. Monitor and control populations where they show signs of expansion. Treatment for mature plants is cut and paint or direct injection of herbicide, followed up with foliar spray of regrowth. Note that freshly cut plant material is not to be left in contact with the ground. It must be hung in nearby vegetation and or removed to a designated waste area or facility.	

Spear Thistle **Environmental Weed**	An annual environmental weed of disturbed areas and roadsides. This weed can be treated with spot spraying. Scattered across disturbed and recovering areas of the site opportunistic control should be carried out while targeting high priority species.	
Buchan Weed **Environmental Weed**	An erect bristly herb to 1m with yellow flowers clustered at the top of branched, spike-like inflorescences. A major weed of agricultural cropping areas in South Australia, the infestation is restricted to around the coal stand pad and various dams/creeks nearby. Control optimal via foliar spray before flowering in spring. Control opportunistically at any time.	
Castor Oil **Environmental Weed**	This annual is a spreading, upright shrub to 6m with large dark green palmate leaves often with red veins and coloration. The leaves have a strong, unpleasant smell, with the dusty grey green branches and main stem highly visible. It develops large clusters of spiny seed pods, drying to a ruddy brown. Widespread and common in disturbed land, ongoing management of seedlings and adults is needed.	
Wild Tobacco **Environmental Weed**	An annual environmental weed of disturbed areas and roadsides. This weed can be treated with spot spraying or cut and paint methods	
Whiskey Grass **Environmental Weed**	This invasive perennial grass is an environmental weed of disturbed areas. Stems grow up to 1m long and brown off over summer, revealing a distinctive upright, orange tinged habit. It can also successfully invade undisturbed bushland. Effective control can be achieved through foliar spraying.	

Table 2 Weed Control Calendar and Methodolgy

Species	Scientific Name	Weed Status	Control Requirements	Treatment	Priority	Autumn (March-May 2019)			Winter (June-August 2019)			Spring (September – November 2019)			Summer (December 2019 – January/February 2020)		
Lantana	Lantana camara	Declared	The growth of the plant must be managed in a manner that reduces its numbers spread and incidence and continuously inhibits its reproduction.	Spot Spray Round Up Biactive© 1/100L Spot Spray Starane Advanced© 0.6/100L	High												
Pampas Grass	Cortaderia selloanana	Declared	The growth of the plant must be managed in a manner that reduces its numbers spread and incidence and continuously inhibits its reproduction.	Spot Spray Round Up Attack© 0.625/100L	High												
Bitou Bush	Chrysanthemoides monilifera	Declared	The growth of the plant must be managed in a manner that reduces its numbers spread and incidence and continuously inhibits its reproduction.	Hand Pull/Cut and Paint with Glyphosphate	High												
Crofton	Ageratina adenophora	Environmental	The growth of the plant must be managed in a manner that reduces its numbers spread and incidence and continuously inhibits its reproduction.	Spot Spray Round Up Biactive© 1/100L	Med												
Cape Broom	Genista monspessulana	Declared	No legislative requirements. Control should be conducted to prevent spread into rehabilitation areas.	Spot Spray Garlon™ 600 0.17/100L	High												
Easter Cassia	Senna pendula	Declared	The growth of the plant must be managed in a manner that reduces its numbers spread and incidence and continuously inhibits its reproduction.	Spot Spray Round Up Attack© 2L /100L Cut Stump 1 part Round Up Attack© : 1.5 parts water	Med												
Camphor Laurel	Cinnamomum camphora	Environmental	The growth of the plant must be managed in a manner that reduces its numbers spread	Cut Stump 1 part Round Up Attack© : 1.5 parts water	Med												

			and incidence and continuously inhibits its reproduction.														
Coral Tree	Erythrina sp	Environmental	No legislative requirements. Control should be conducted to prevent spread into rehabilitation areas.	Cut Stump/Inject 1 part Round Up Attack© : 1.5 parts water	Low												
Coolatai Grass	Hyparrhenia hirta	Declared	No legislative requirements. Control should be conducted to prevent spread into rehabilitation areas.	Spot Spray (PER11916) Round Up Biactive© 1.3L/100	High												
Buchan (mustard) Weed	Hirschfeldia incana	Environmental	No legislative requirements. Control should be conducted to prevent spread into rehabilitation areas.	Spot Spray Round Up Attack© 0.45L /100L	Low												
Spear Thistle	Cirsium vulgare	Environmental	No legislative requirements. Control should be conducted to prevent spread into rehabilitation areas.	Spot or Boom Spray Grazon Extra© 0.35/100L	Low												
Purple Top	Verbena bonariensis	Environmental	No legislative requirements. Control should be conducted to prevent remove weed from rehabilitation areas.	Spot Spray Round Up Attack© 0.65L /100L	Low												
Castor Oil	Ricinus communis	Environmental	No legislative requirements. Control should be conducted to prevent remove weed from rehabilitation areas.	Cut Stump 1 part Round Up Attack© : 1.5 parts water	Low												
Wild Tobacco	Solanum mauritianum	Environmental	No legislative requirements. Control should be conducted to prevent spread into rehabilitation areas.	Cut Stump 1 part Round Up Attack© : 1.5 parts water	Low												
Whiskey Grass	Andropogon virginicus	Environmental	No legislative requirements. Control should be conducted to prevent spread into rehabilitation areas.	Spot Spray Round Up Attack© 0.65L /100L	Low												
2019 Weed Survey and creation of 2020 Weed Action Plan																	

5. Myuna Colliery Weed Action Plan 2018

The Myuna Colliery Weed Action Plan has allocated 10 days with a crew of two onsite over a twelve-month period (decreased from 12 in 2018), plus project management and 2020 WAP development.

It is expected that this allocation would complete the primary weed control works program for Myuna and provide follow up for previous works. On completion of primary weeding the 2020 WAP program would be a reduced maintenance schedule requiring approximately 10 days over the twelve-month period.

Month 2019	**Allocation per month for 2019**
January	0
February	0
March	2 days
April	0
May	0
June	0
July	3 days
August	0
September	3 days
October	0
November	1 day
December - All Sites Weed Survey & 2020 WAP	1 day (no on ground works)
Total 2019 WAP Allocation	**10 Days**

Appendix 1. Daily Report Sheet

All chemical applications will require the detailed filling of this record sheet along with GPS data gathered for all areas controlled.

Myuna Colliery Weed Management Plan Action Record Sheet 2019-2023		
Date/Date Range	**Staff/Company undertaking Work**	**Primary Control / Follow Up** (circle choice)
Weed Species Targeted	**Actions/Methods Completed**	**Notes of actions** (e.g. GPS location, photos, number/areas of weeds controlled/ hours worked etc.)
Comments (including details of GPS/GIS Files from works completed)		

SMARTtrain

No. 222502

Location, Applicator, Date of Application

Property/Holding: (residential address)					Date:
Applicator's Full Name:			Owner (if not applicator):		
Address:			Address:		
		Phone:			Phone:
Mobile:	Fax:	E-mail:	Mobile:	Fax:	E-mail:
Sensitive Areas (including distances, buffers): N / W / Treated Area / E / S			Comments (including risk control measures for sensitive areas):		

Host/Pest

Paddock Number/Name:	Paddock Area:	Order of Paddocks Sprayed:
Crop/Situation:	Type of Animals:	
Crop/Pasture Variety:	Age/Growth Stage:	
Growth Stage:	Mob/Paddock/Shed:	
Pest/Disease/Weed:	Animals — Number Treated:	
	Pest Density/Incidence: Heavy ❑ Medium ❑ Light ❑	

Application Data

Full Label Product Name:			Rate/Dose:	Water Rate @ L/ha:
Permit No.:	Expiry Date:		Additives/Wetters:	
Total L or kg:	WHP:	ESI:	Date Suitable for Sale:	
Equipment Type:		Nozzle Type:	Nozzle Angle:	Pressure:
Date Last Calibrated:	Water Quality (pH or description):			

Weather

Showers ❑ Overcast ❑ Light Cloud ❑ Clear Sky ❑

Rainfall (24 hours before and after)
Before: mm During: mm After: mm

Time (show time in this column)	Temperature °C	Relative Humidity (%)	Wind Speed	Direction	Variability (e.g. gusting)
Start					
Finish					

Comments:

3050-spray record.p65, March 2002

APPENDIX 2 - 2019 Ecological Monitoring Report – Swamp Sclerophyll Forest on Coastal Floodplains EEC

APPENDIX 3 – Myuna Colliery Annual Groundwater Management Report 2019

Centennial Myuna Pty Limited

Myuna Colliery

2019 Annual Groundwater Review

March 2020

Abbreviations

AHD	Australian Height Datum
BOM	Bureau of Meteorology
CCL	Consolidated Coal Lease
EPA	NSW Environment Protection Authority
EPL	Environmental Protection Licence
GDEs	Groundwater Dependant Ecosystems
GHD	GHD Pty Ltd
GMP	Groundwater Management Plan
km	Kilometres
LDP	Licenced Discharge Point
LOR	Limit of Reporting
m	Metres
ML	Megalitres
ML/day	Megalitres per day
ML/year	Megalitres per year
Mtpa	Million tonnes per annum
ROM	Run of Mine
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
WMP	Water Management Plan
WSP	Water Sharing Plan

Glossary

Aquifer	A groundwater bearing formation sufficiently permeable to transmit and yield groundwater.
Australian Height Datum	A common national surface level datum approximately corresponding to mean sea level.
Bore	Constructed connection between the surface and a groundwater source that enables groundwater to be transferred to the surface either naturally or through artificial means.
Drawdown	A reduction in piezometric head within an aquifer.
Fassifern Seam	Deepest coal horizon of the Permian Age Newcastle Coal Measures mined at Myuna, with an average depth of 140 m.
Great Northern Seam	Lies above the Fassifern Seam in the Newcastle Coal Measures and has an average depth of 120 m.
Groundwater	Subsurface water that occurs in soils and geological formations.
Hydrogeology	The area of geology that deals with the distribution and movement of groundwater in soils and rocks.
Interseam	The strata between coal seams.
Licenced Discharge Point	A location where Myuna Colliery discharges water in accordance with conditions stipulated within the site Environmental Protection Licence.
Outcrop	Where the bedrock is exposed at the ground surface.
Permian Age	The youngest geological period of the Palaeozoic era, covering a span between approximately 290 and 250 million years.
pH	Value taken to represent the acidity or alkalinity of an aqueous solution. It is defined as the negative logarithm of the hydrogen concentration of the solution.
Run of Mine	Raw coal production (unprocessed)
Surface Facilities Area	Comprises surface land containing mining and non-mining infrastructure
Wallarah Seam	Uppermost coal horizon of the Permian Age Newcastle Coal Measures mined at Myuna, with an average depth of 80 m.

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Table index

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Appendices

1. Introduction

Myuna Colliery is an existing underground coal mine located in Wangi on the western side of Lake Macquarie in the Newcastle Coalfield, approximately 25 kilometres south of Newcastle as shown in Figure 1-1. Centennial Myuna Pty Ltd (Centennial Myuna) has owned and operated the mine since 2002.

Continuous miner bord and pillar operations have occurred at Myuna Colliery within the Wallarah, Great Northern and Fassifern seams since 1981. Centennial Myuna was granted approval in January 2012 under Project Approval 10_0080 to extract up to 2 million tonnes per annum (Mtpa) of run of mine (ROM) coal until 31 December 2032 within Mining Lease 1632 (ML1632) and Mining Lease 1370 (ML1370). Coal from Myuna is taken by dedicated overland coal conveyor to Eraring Power Station. A modification to Project Approval 10_0080 was approved in 2015 to increase the extraction rate to 3 Mtpa of ROM coal within ML1632 and ML1370.

1.1 Bore licence

Centennial Myuna was granted Bore Licence 20BL172565 in December 2010 for the purpose of dewatering up to 4,380 ML/year of groundwater from mine workings at Myuna Colliery.

The Water Sharing Plan (WSP) for the North Coast Fractured and Porous Rock Groundwater Sources commenced in July 2016. As this WSP has commenced, Bore Licence 20BL172565 is expected to be converted to a Water Access Licence (WAL) and Works Approval.

Condition 4 of Bore Licence 20BL172565 requires an Annual Groundwater Management Report to be prepared. The specific requirements of Condition 4 are outlined in Table 1-1, along with the sections of this Annual Groundwater Management Report where these have been addressed for 2018. Condition 4 refers to the Groundwater Monitoring Program (GMP) for Myuna Colliery (GHD, 2012).

The GMP was superseded by the approved Water Management Plan (WMP) (GHD, 2017a). The WMP incorporates the management and monitoring requirements of the GMP.

Table 1-1 Condition 4, Bore Licence 20BL172565

Conditions	Where addressed within this report
All raw monitoring data, an interpretation of that data and a discussion of trends identified in the data and the implications	Section 4 and Appendix C, Appendix D and Appendix E
All groundwater extraction data (volumes and rates) taken by the works, the extent of aquifer depressurisation and the salinity impacts, compared with the predictions of aquifer performance made in the environmental impact statement(s) or similar	Sections 4.1.1 and 5 and Appendix F
An overall comparison of groundwater performance with predictions for the life of the mine provided in the development application and supporting documentation	Section 5
Water related activities performed and the level of compliance with the GMP and an outline of proposed adaptive or remediation actions	Sections 3 and 6
Assessment of extraction or other depressurisation impacts caused by the work(s) to external water sources, water users or groundwater dependent ecosystems (GDEs)	Section 5.3

1.1.1 Water cycle accounting

In conjunction with this Annual Groundwater Management Report, an update of the water cycle accounting for 2019 for Myuna Colliery was undertaken. The results of this assessment are provided in Appendix A.

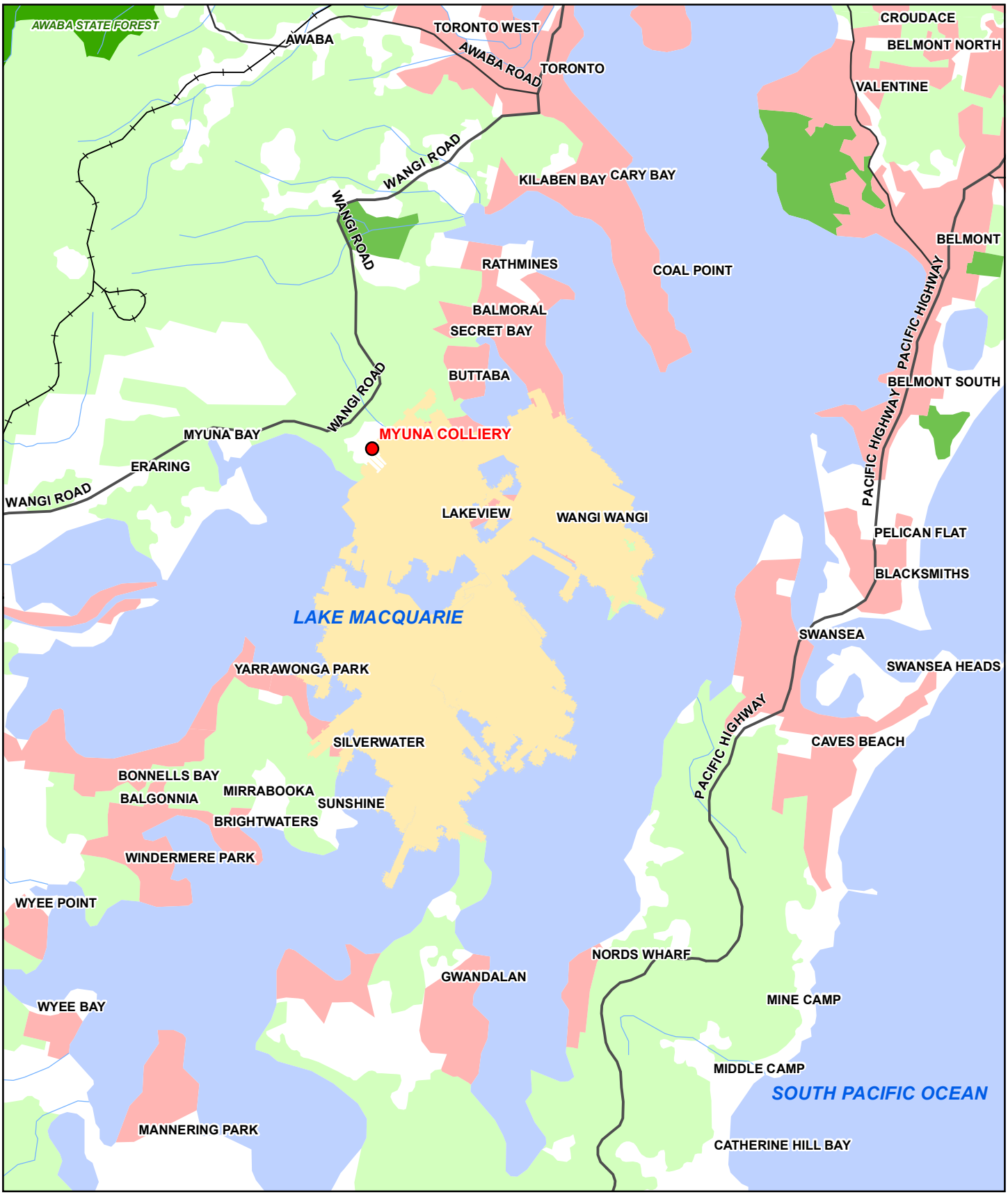
1.2 Environmental Protection Licence

Environment Protection Licences (EPLs) are issued by the NSW Environment Protection Authority (EPA) under the *Protection of the Environment Operations Act 1997*.

Myuna Colliery currently holds EPL 366, which includes requirements to monitor water quality and quantity of discharges from the site. Water is currently licensed to be discharged from the mine through the following licensed discharge points (LDPs):

- LDP 9 – Discharge of up to 13 ML/day to Wangi Creek via Mine Water Settling Ponds 2 and 3.
- LDP 10 – Emergency discharge to Wangi Creek via the Emergency Coal Stockpile Dam.

Groundwater extracted from the underground mine workings under Bore Licence 20BL172565 is currently discharged from site via LDP 9. Volumetric and water quality monitoring data at LDP 9 is therefore representative of groundwater volumes and groundwater quality extracted from the mine workings. Volumes of water extracted from each of the mined coal seams at Myuna Colliery is also recorded. Water quality analysis of groundwater extracted from each of the coal seams is undertaken on a quarterly basis.



LEGEND

- Myuna Colliery Surface Facilities
- Underground Working
- Existing Rail
- Freeway
- Principal Road
- Secondary Road
- Watercourse
- Watercourse Area
- Built Up Areas
- Recreation area
- Nature Conservation Reserve
- State Forest
- Forest Or Shrub

Paper Size A4

0 287.5 575 1,150 1,725 2,300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Centennial Myuna
Myuna 2019 Annual Groundwater Review

Job Number 125-22675
Revision A
Date 11 Feb 2020

Locality plan

Figure 1-1

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

G:\22\0105001\GIS\Maps\Deliverables\Hunter\Myuna\12522675\125-22675_001_Locality_A.mxd

Data source: ©Geoscience Australia: 250k Topographic Data, 2006, Centennial: Workings, 2010. Created by: smacdonald

2. Existing environment

2.1 Landforms and watercourses

The Myuna Colliery surface facilities area is located within the Wangi Creek catchment, which contributes to Lake Macquarie. The majority of existing workings in the Wallarah, Great Northern and Fassifern Seams are located beneath Lake Macquarie.

Ground elevations range from 0 m AHD to approximately 70 m AHD within the Myuna Colliery holding boundary.

2.2 Geology

The stratigraphy at Myuna is listed and described in Table 2-1. This information has been sourced from the Newcastle Coalfields Regional Geology 1:100,000 map (Edition 1, 1995).

Table 2-1 Stratigraphic sequence – Myuna Colliery

Period	Stratigraphy		Unit/Lithology	Coal Seams
	Group	Subgroup		
Quaternary			Alluvium	
Triassic	Narrabeen	Clifton	Conglomerate, sandstone, siltstone, claystone	
Permian	Newcastle Coal Measures	Moon Island Beach	Conglomerate, sandstone, siltstone, tuff, coal	Vales Point, Wallarah, Great Northern
		Awaba Tuff		
		Boolaroo	Sandstone, conglomerate, siltstone, coal, tuff	Fassifern, Upper Pilot, Lower Pilot, Hartley Hill
		Warners Bay Tuff		

The coal seams mined at Myuna Colliery are part of the late Permian Age Newcastle Coal Measures, which dips to the south east at a grade of generally less than 1 in 20. The Moon Island Beach, Awaba Tuff and Boolaroo Formations of the Newcastle Coal Measures outcrop and/or subcrop to the northwest, north, northeast, east and southeast of the Myuna Colliery holding boundary.

The Wallarah Seam ranges in thickness of between 2.0 m to 3.0 m across the Myuna Colliery holding boundary and is predominantly overlain by Karignan Conglomerate, described as a medium to coarse grained pebble conglomerate. The Dooralong Shale makes up the roof of the Wallarah Seam in the east and the Wallarah Seam is underlain by Mannering Park Tuff claystone/mudstone.

The Great Northern Seam generally varies in thickness of between 2.5 m to 3.0 m across the holding boundary. Teralba Conglomerate tends to form the roof of the Great Northern Seam in most areas, although this is replaced by shale, mudstone or tuffaceous siltstones in some areas. The Awaba Tuff siltstone/claystone underlies the Great Northern Seam in most areas.

Both the Wallarah and Great Northern Seams tend to split, deteriorate and thin along the north south zone to the west and south west of the holding boundary.

The Fassifern Seam is the most extensive coal reserve throughout the lease area, with a thickness in excess of 6.0 m in areas where the seam is not split. The seam is at its greatest thickness at Wangi Point. Between the Wangi Peninsula and Pulbah Island the seam splits in two. The lower split is the preferred mining section in this area. The splits coalesce to the south of Pulbah Island and beyond the Myuna Colliery holding boundary. Awaba Tuff generally overlies the Fassifern Seam, while the floor is composed of claystones.

2.3 Hydrogeology

The groundwater sources in the vicinity of Myuna Colliery are generally low yielding and predominantly within the Quaternary alluvium, weathered and/or fractured rock and coal seams.

2.3.1 Quaternary water sources

The Quaternary material includes alluvium which occurs along the watercourses draining into Lake Macquarie. The alluvium forms an unconfined shallow aquifer with a thickness of up to 10 m and is managed under the WSP for the Hunter Unregulated and Alluvial Water Sources. This WSP commenced in August 2009 and regulates the interception and extraction of surface water and alluvial groundwater within the defined WSP area.

2.3.2 Porous and fractured rock water sources

Groundwater flow within the Triassic and Permian rocks underlying the Myuna Colliery holding boundary is predominantly within the coal seams. The overburden and interseam strata tend to have very low hydraulic conductivities (unless fracturing creates a secondary permeability).

These water sources are managed under the WSP for the North Coast Fractured and Porous Rock Groundwater Sources. This WSP commenced in July 2016 and regulates the interception and extraction of groundwater from fractured and porous rock groundwater sources within the defined WSP area.

2.4 Registered bores

A search of the NSW bore database was undertaken by GHD (2015) in order to identify registered bores within a 3 km radius of the Myuna Colliery underground workings. The search of the database identified 59 bores, most of which are used to extract groundwater from the sandy strata on the eastern side of Lake Macquarie. The remaining bores extract groundwater from the weathered sandstone. The shallow bores were predominantly used for domestic purposes and ranged from depths of 1 m to 10.1 m below ground level (bgl). The locations of the identified bores are shown in Figure 2-1.

2.5 Groundwater dependent ecosystems

Potential GDEs within the vicinity of the mine workings have been mapped in the Groundwater Dependent Ecosystem Atlas (BOM, 2015). Potential GDEs within 3 km of Myuna Colliery include various vegetation communities that surround Lake Macquarie. Whiteheads Lagoon, Lake Petite and Lake Macquarie are listed by BOM (2015) as potential GDEs.

High priority GDEs are listed in WSPs. The closest high priority GDE listed in the Hunter Unregulated and Alluvial Water Sources WSP is coastal wetlands located approximately 20 km to the north of Myuna Colliery.

LEGEND

- Myuna Colliery Surface Facilities
- Registered bores

Paper Size A4

0 287.5 575 1,150 1,725 2,300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Centennial Myuna
Myuna 2019 Annual Groundwater Review

Job Number 125-22675
Revision A
Date 11 Feb 2020

NSW bore database search

Figure 2-1

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

G:\22\0105001\GIS\Maps\Deliverables\Hunter\Myuna\12522675\125-22675_002_NSWBoreDatabaseSearch_A.mxd

Data source: © ESRI: Aerial Imagery, 2012, Geoscience Australia: 250k Topographic Data, 2006, NOW: Groundwater Bores, 2015. Created by: smacdonald

3. Groundwater monitoring program

3.1 Underground water management data

The WMP requires transfers of underground water to the surface to be metered to assist in calculating groundwater inflows into the underground workings. The WMP also requires the monitoring of levels in underground water storages (when accessible). Monitoring of the underground storages and underground water transfers allows groundwater inflows to be more accurately calculated.

3.2 Underground water quality data

The WMP requires underground water quality to be assessed when it is transferred to the surface. The WMP requires that water quality sampling of water transferred to the surface is undertaken on a quarterly basis and samples analysed for total suspended solids (TSS), turbidity, pH, and total dissolved solids (TDS).

The WMP also requires that underground water storages be sampled on a quarterly basis when accessible and analysed for pH and TDS.

3.3 Groundwater monitoring bores

The groundwater monitoring network at Myuna Colliery includes ten shallow alluvial monitoring bores. These alluvial bores were installed in August 2012. Monitoring of groundwater level commenced in 2017 after WMP approval (GHD, 2017a). Details of the groundwater monitoring bores are provided in Table 3-1 and locations are shown in Figure 3-1.

Table 3-1 Groundwater monitoring bore details

Bore	Easting	Northing	Bore depth [1] (m)	TOC (m AHD)
MW01	366421.196	6340666.725	6	20.635
MW05	366382.919	6340757.928	18.5	20.574
MW06	366352.836	6340702.937	13	20.574
MW07	366099.275	6340745.9	8.5	25.75
MW08	366166.975	6340855.902	9	24.642
MW09	366358.936	6340904.374	7	19.427
MW10	366253.961	6341072.879	10	30.063
MW11	366298.845	6341178.276	7	14.395
MW12	366523.721	6340866.437	8	9.318
MW13	366673.814	6340926.691	11	5.065

Notes:

TOC: Top of casing

1. Measured from TOC

LEGEND

- Myuna Colliery Surface Facilities
- Groundwater Monitoring Location

Paper Size A4

0 12.5 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Centennial Myuna
Myuna 2019 Annual Groundwater Review

Job Number 125-22675
Revision A
Date 11 Feb 2020

Groundwater Monitoring Network

Figure 3-1

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

G:\22\0105001\GIS\Maps\Deliverables\Hunter\Myuna\12522675\125-22675_003_GWMonitoring_A.mxd

Data source: © ESRI: Aerial Imagery, 2012, Geoscience Australia: 250k Topographic Data, 2006, Centennial: Groundwater Monitoring, 2017. Created by: smacdonald

3.4 Reporting of monitoring

3.4.1 Data review

Groundwater quality

The WMP requires underground water quality monitoring data to be compared to Environmental Protection Licence (EPL) 366 concentration limits where applicable. If the monitoring results indicate an anomalous result an investigation will be initiated at the respective location.

Concentration limits specified by EPL 366 for Myuna Colliery which apply to LDP 9 and LDP 10 are presented in Table 3-2.

Table 3-2 EPL 366 discharge limits

Parameter	100 percent concentration limit
Oil and grease	10 mg/L
pH	6.5–8.5
Total suspended solids (TSS)	50 mg/L

Groundwater levels

Following the reporting of sufficient groundwater level data for the bores listed in Table 3-1, levels at these alluvial monitoring locations will be reviewed to validate the modelling prediction that mining activities will not impact on alluvial groundwater levels.

3.4.2 Reporting

Section 7 of the WMP requires water quality monitoring data to be recorded in the Annual Groundwater Review. The report should include a detailed assessment of groundwater quality data collected over the course of the monitoring period and an evaluation of any trends occurring.

4. Monitoring data

This section reports the groundwater monitoring data collected between January 2011 and December 2019 at Myuna Colliery and compares it to the requirements of the WMP.

4.1 Underground water management data

The underground mine water management system is periodically modified to adapt to the changing mining conditions. Within the current area of operations, water in the underground workings is collected and then transferred to a number of underground storages to allow the settling of fines prior to being pumped to the surface.

The major inputs into the underground water storages are:

- Groundwater inflow from the coal seam and adjacent strata (groundwater make).
- Transfer of dirty water from the surface.
- Transfer of water from the surface for mining activities.

4.1.1 Potable water transfer data

Centennial Myuna meter transfers of potable water from the surface to the underground workings. Transfers of potable water from the surface to the underground are presented in Table 4-1.

Total potable water usage at Myuna Colliery is metered. Potable water is used at the building facilities or transferred underground for use in mining activities. Potable water usage at the building facilities was estimated by Centennial Myuna to be approximately 5% of total potable water usage. Approximate potable water usage is presented in Table 4-1.

Table 4-1 Annual potable water transfers

Year	Total potable water usage (ML/year)	Approximate building facilities potable water usage (ML/year)	Approximate potable water transfers underground (ML/year)
2014	153	7.6	145.4
2015	154.7	7.7	147.0
2016	129.4	6.5	122.9
2017	50.4	2.5	47.8
2018	63.3	3.2	60.2
2019	64.1	3.2	60.9

4.1.2 Dewatering data

In accordance with the requirements of the WMP, the transfer of water from the underground workings to the surface has been monitored daily. Daily LDP 9 discharge data and daily transfer volumes from the underground workings to the surface are shown in Figure 4-1 and Figure 4-2 respectively. From 2011 to 2019 LDP 9 discharge volumes have ranged from 0 to 13.59 ML/day. From late 2010 to 2019 daily transfer volumes from the underground workings to the surface have ranged from 0 to 12.099 ML/day. Review of the extraction data from 2019 indicates that the extracted volumes from the underground workings are distributed as 26 %, 19 % and 55 % for the Wallarah, Great northern and Fassifern Seam workings, respectively.

Note that extraction volumes generally overestimate groundwater inflows into the mine since they also include dirty water and potable water transfers to the mine, however this depends on whether water is allowed to accumulate over time in void areas.

Visual inspection of the trend in Figure 4-1 and Figure 4-2 indicates that extraction from the underground workings was decreasing between mid-2013 and 2014. Extraction rates began to increase in 2015. Since 2015 extraction rates have remained relatively constant until the end of 2019. The historical observed trends in extraction rate are most likely attributable to the storage of groundwater inflows within old workings and/or underground dams rather than the immediate extraction of groundwater inflows.

Annual extraction volumes between 2011 and 2019 are listed in Table 4-2. Based on these recorded volumes, Centennial Myuna has consistently met Condition 17 of Bore Licence 20BL172565 which limits the annual extraction of groundwater to 4380 ML.

Table 4-2 Annual transfers of water from the underground workings

Year	Annual volume (ML)
2011	2047
2012	2580
2013	2281
2014	1614
2015	1930
2016	1902
2017	1824
2018	1820
2019	1752

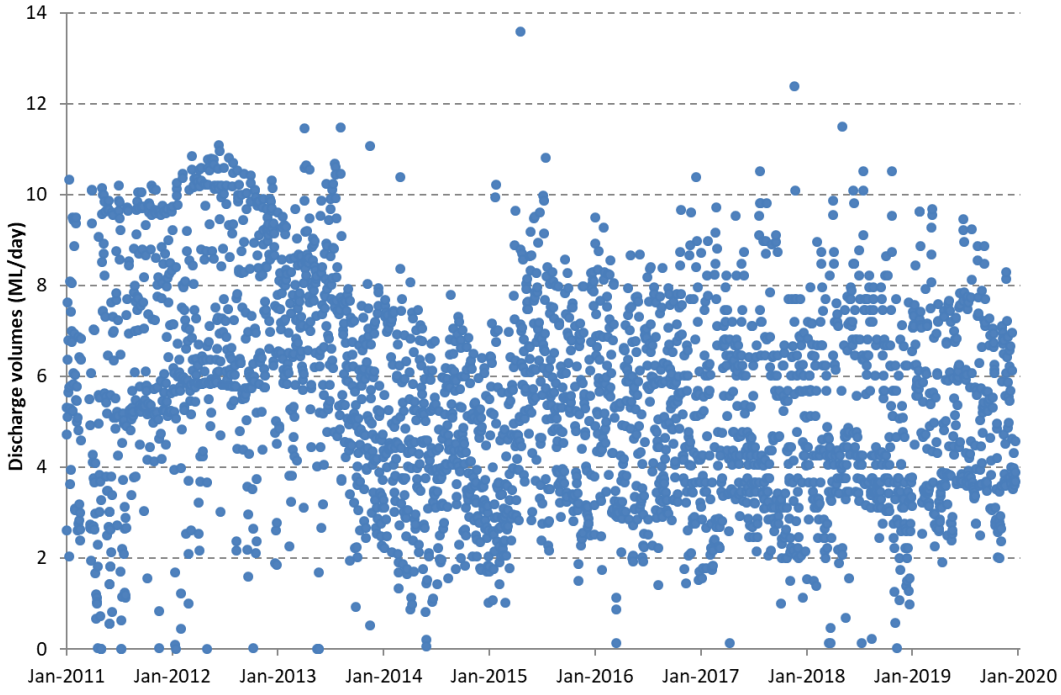


Figure 4-1 LDP 9 discharge volumes

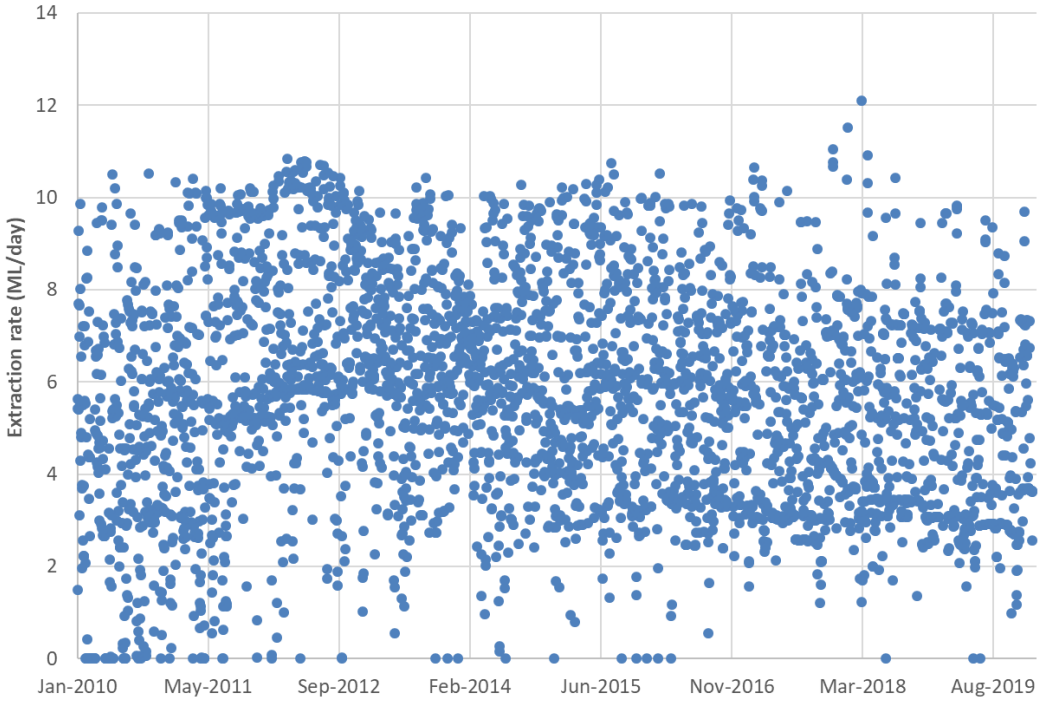


Figure 4-2 Daily underground water extraction

4.1.3 Underground water storages

The underground water storages in the Wallarah Seam, the Great Northern Seam and the Fassifern Seam were surveyed in December 2019 by Centennial Myuna and calculated volumes added to the values monitored from 2016 in Table 4-3. Centennial Myuna has estimated the volume of water storages in each of the seams based on an average seam height of 3 m and a recovery ratio of 0.33. Underground water storage areas are shown in Appendix B

There was no change in water storage volume in the Great Northern Seam and a small decrease (8 ML) in water storage volume in Wallarah Seam in 2019. The water storage volume in the Fassifern Seam increased by 178 ML in 2019.

The hydrogeological model developed for Myuna Colliery assumes that the volumes of each of these storages are constant over time. Comparison of surveyed underground water storages from March 2016 and December 2017 indicates there was a net decrease in underground water storage volume of 470 ML over this period. This indicates that transfer volumes for 2016 and 2017 from the underground workings (shown in Table 4-2) are likely to be higher than actual groundwater inflows.

Similarly in 2019, there was a net increase in underground water storages of 170 ML. Therefore underground dewatering volumes are likely lower than actual groundwater inflows over this period. This should be taken into account when comparing dewatering volumes to modelled groundwater inflows and in any future recalibration of the hydrogeological model.

Table 4-3 Underground water storage volumes

Seam	Water storage volume (ML)			
	March 2016	December 2017	December 2018	December 2019
Wallarah Seam	740	748	748	740
Great Northern Seam	1407	929	929	929
Fassifern Seam	1326	1326	1326	1504

4.2 Water quality data

4.2.1 Underground water

As discussed in Section 3.2, the WMP requires monitoring of underground water quality. Key results of monitoring undertaken by Centennial Myuna from 2014 to 2019, including sampling from underground water storages and underground water transfers, are outlined in Table 4-4 and Table 4-5. Reported metal concentrations are presented in dissolved form in Appendix C until April 2016, when sampling of dissolved metals was discontinued.

Table 4-4 Underground water storages – water quality data

Location	Date	pH	EC (µS/cm)	TDS (mg/L)	TSS (mg/L)	Turbidity (NTU)
2014 Data						
720 Dam	28/03/2014	7.77	48200	ND	ND	ND
324 Dam	3/04/2014	7.54	37000	ND	ND	ND
325 Dam	3/04/2014	7.95	30700	ND	ND	ND
930 Dam	24/09/2014	8.07	19300	ND	6	ND
2015 Data						
324 Dam	18/12/2015	7.63	ND	ND	<5	18.1
720 Dam	18/12/2015	7.82	ND	ND	13	2.7
642 Dam	18/12/2015	8.06	ND	ND	90	33.9
421 Dam	18/12/2015	7.96	ND	ND	88	55.7
2016 Data						
324 Dam	31/03/2016	7.73	ND	ND	<5	ND
720 Dam	5/04/2016	7.59	ND	ND	14	ND
421 Dam	20/04/2016	8.14	ND	7190	17	ND
642 Dam	22/04/2016	8.02	ND	22300	24	ND
324 Dam	22/06/2016	7.5	ND	25120	5	ND
421 Dam	22/06/2016	8.2	ND	6770	19	ND
720 Dam	28/06/2016	8	ND	28000	14	ND
642 Dam	29/06/2016	8	ND	13970	15	ND
642 Dam	15/09/2016	7.9	ND	29840	ND	ND
421 Dam	15/09/2016	8.2	ND	6340	ND	ND
324 Dam	15/09/2016	7.8	ND	21680	ND	ND
720 Dam	15/09/2016	7.8	ND	30800	ND	ND
324 Dam	15/11/2016	7	ND	26300	ND	ND
720 Dam	17/11/2016	7.5	ND	35240	ND	ND
421 Dam	17/11/2016	7.9	ND	12880	ND	ND
642 Dam	17/11/2016	7.6	ND	32040	ND	ND

Location	Date	pH	EC (µS/cm)	TDS (mg/L)	TSS (mg/L)	Turbidity (NTU)
2017 Data						
324 Dam	24/10/2017	7.2	ND	20,980	ND	ND
421 Dam	24/10/2017	7.9	ND	16,600	ND	ND
642 Dam	24/10/2017	7.7	ND	25,280	ND	ND
720 Dam	24/10/2017	7.8	ND	23,980	ND	ND
324 Dam	20/12/2017	7.4	ND	24,140	ND	ND
642 Dam	21/12/2017	7.7	ND	28,320	ND	ND
720 Dam	21/12/2017	7.9	ND	19,960	ND	ND
421 Dam	21/12/2017	8.1	ND	15,100	ND	ND
2018 Data						
421 Dam	20/02/2018	7.90	ND	36280	ND	ND
421 Dam	05/06/2018	8.20	ND	14130	ND	ND
421 Dam	14/08/2018	8.0	ND	13220	ND	ND
421 Dam	15/11/2018	7.8	ND	13800	ND	ND
720 Dam	20/02/2018	7.60	ND	23760	ND	ND
720 Dam	14/08/2018	7.4	ND	25580	ND	ND
720 Dam	15/11/2018	7.7	ND	22360	ND	ND
324 Dam	20/02/2018	7.70	ND	26500	ND	ND
324 Dam	05/06/2018	6.80	ND	28620	ND	ND
324 Dam	14/08/2018	7.4	ND	25280	ND	ND
324 Dam	15/11/2018	7.3	ND	24740	ND	ND
642 Dam	20/02/2018	8.00	ND	15100	ND	ND
642 Dam	05/06/2018	7.70	ND	29440	ND	ND
642 Dam	14/08/2018	7.7	ND	28040	ND	ND
642 Dam	15/11/2018	7.7	ND	29140	ND	ND
2019 Data						
421 Dam	05/03/2019	8.1	ND	12450	ND	ND
421 Dam	1/10/2019	7.9	ND	13600	ND	ND
720 Dam	13/03/2019	7.4	ND	17980	ND	ND
720 Dam	20/06/2019	7.9	ND	22840	ND	ND
720 Dam	1/10/2019	8.0	ND	13300	ND	ND
720 Dam	17/12/2019	8.1	ND	18800	ND	ND
324 Dam	6/03/2019	7.6	ND	24380	ND	ND
324 Dam	11/06/2019	6.9	ND	26100	ND	ND
324 Dam	30/09/2019	7.1	ND	25260	ND	ND
324 Dam	17/12/2019	6.9	ND	26260	ND	ND
642 Dam	5/03/2019	7.7	ND	27120	ND	ND
641 Dam	1/10/2019	7.8	ND	28820	ND	ND
641 Dam	19/12/2019	7.8	ND	30360	20	1.2

Notes:

720 Dam – underground storage dam within the Fassifern Seam

324 Dam – underground storage dam within the Wallarah Seam

325 Dam – underground storage dam within the Wallarah Seam

930 Dam – underground storage dam within the Fassifern Seam

642 Dam – underground storage dam within the Great Northern Seam

421 Dam – underground storage dam within the Great Northern Seam

ND – no data

Table 4-5 Underground water transfers – water quality data

Location	Date	pH	EC (µS/cm)	TDS (mg/L)	TSS (mg/L)	Turbidity (NTU)
2014 Data						
Fassi	29/09/2014	7.34	49100	ND	9	15.2
GN	29/09/2014	7.56	39600	ND	6	23.9
Fassi	1/10/2014	7.53	49600	ND	8	32.4
Wallarah	1/10/2014	7.30	40400	ND	<5	16.6
GN	1/10/2014	7.68	40200	ND	<5	26.8
Fassi	2/10/2014	7.68	50000	ND	5	21.4
GN	2/10/2014	7.78	40400	ND	<5	0.9
Fassi	3/10/2014	7.54	49000	ND	9	33
Wallarah	3/10/2014	7.34	40000	ND	7	16.2
GN	3/10/2014	7.73	45800	ND	8	9.6
Fassi	8/10/2014	7.52	50300	ND	<5	23.8
Wallarah	8/10/2014	7.27	40900	ND	<5	15.2
GN	8/10/2014	7.64	40600	ND	<5	0.8
2015 Data						
Fassi	16/12/2015	7.33	ND	ND	6	18.4
Wallarah	16/12/2015	6.79	ND	ND	<5	2.5
2016 Data						
Fassi	18/04/2016	7.7	ND	36300	<5	23.4
Wallarah	19/04/2016	6.82	ND	27500	<5	ND
GN	19/04/2016	7.54	ND	26100	<5	ND
Fassi	4/07/2016	7.4	ND	31140	19	ND
GN	4/07/2016	8.1	ND	6430	5	ND
Wallarah	5/07/2016	7	ND	25600	7	ND
Wallarah	13/09/2016	6.7	ND	29340	12	19
Wallarah	17/11/2016	6.8	ND	26200	14	1.3
Fassifern	24/11/2016	7.3	ND	30060	5	11
GN	25/11/2016	7.4	ND	25920	24	3.4
2017 Data						
GN	27/09/2017	7.4	ND	26,100	2	3.2
Wallarah	27/09/2017	7.0	ND	26,800	4	2.4
Fassi	27/09/2017	7.4	ND	31,760	2	6.6
Wallarah	23/10/2017	7.0	ND	28,540	2	2
Fassi	23/10/2017	7.4	ND	35,280	3	24
GN	25/10/2017	7.4	ND	29,740	10	10
GN	28/11/2017	7.4	ND	26,740	28	2.3
Wallarah	28/11/2017	6.9	ND	26,560	32	1.9
Fassi	28/11/2017	7.4	ND	29,440	26	5.1
GN	19/12/2017	7.4	ND	28,200	31	2.5
Fassi	19/12/2017	7.4	ND	29,120	14	7.1

Location	Date	pH	EC (µS/cm)	TDS (mg/L)	TSS (mg/L)	Turbidity (NTU)
2018 Data						
Fassi	27/02/2018	7.40	ND	28160	30	9.7
Fassi	04/06/2018	7.30	ND	30300	21	9.3
Fassi	23/08/2018	7.4	ND	32720	33	4.9
Fassi	13/11/2018	7.4	ND	30500	37	4.5
GN	05/03/2018	7.30	ND	29380	1	2.9
GN	01/06/2018	7.60	ND	29060	19	2.3
GN	14/08/2018	7.4	ND	26540	15	2.6
GN	23/11/2018	7.4	ND	26860	1	1.1
Wallarah	27/02/2018	6.70	ND	27300	19	1.3
Wallarah	01/06/2018	7.00	ND	27880	23	1.5
Wallarah	14/08/2018	7.0	ND	26720	20	1.6
Wallarah	13/11/2018	6.8	ND	26620	11	1.6
2019 Data						
Fassi	06/03/2019	7.4	ND	29480	ND	5.8
GN	11/03/2019	7.3	ND	25180	<1	1.8
Wallarah	12/03/2019	6.7	ND	25340	1	1.6
GN	14/06/2019	7.5	ND	27720	18	1.6
Fassi	14/06/2019	7.4	ND	31160	29	5.2
Wallarah	18/06/2019	6.8	ND	28660	28	1.7
GN	01/10/2019	7.5	ND	25020	17	7.4
Wallarah	01/10/2019	6.8	ND	26960	13	1.4
Fassi	01/10/2019	7.4	ND	26960	21	3.6
Fassi	19/12/2019	7.5	ND	29160	12	0.85
Wallarah	19/12/2019	6.9	ND	26460	13	1.3

Notes:
Fassi – underground water transfer from the Fassifern Seam
Wallarah – underground water transfer from the Wallarah Seam
GN – underground water transfer from the Great Northern Seam
ND – no data

The underground water quality was generally slightly alkaline and saline throughout 2014 to 2019, with the exception of Wallarah which was more circumneutral than other seams (see Table 4-4). Available parameters were consistently below or within EPL limits listed in Table 3-2 in 2019, similar to previous years. Generally, the underground water from the Fassifern Seam has a higher EC/TDS and dissolved iron concentration than the other seams as shown in Table 4-5 and Appendix C. Underground water from the Great Northern Seam generally has lower dissolved manganese concentrations as shown in Appendix C. No metal concentrations have been monitored in the last three years.

Historical exceedances of EPL limits are attributable to large rainfall events and are not due to underground water quality. It is considered that generally discharges from Myuna Colliery are compliant with EPL requirements.

4.2.2 Licensed discharges and trends

Following retention in a series of underground water storages, underground water is transferred to the surface and is currently discharged to Wangi Creek at Licensed Discharge Point 9 (LDP 9). Daily monitoring of oil and grease, pH, TSS and discharge volume is undertaken at LDP 9. Monthly water quality monitoring of the remaining parameters discussed below is undertaken at LDP 9. Dissolved concentrations for calcium, potassium, sodium, sulfur, antimony, barium, beryllium, boron, chromium, lead, mercury, silver, tin and titanium have not been analysed since March 2015. Of these parameters, sampling for total concentrations has continued on a monthly basis with the exception of total beryllium and total chromium for which sampling ceased in March 2015. Total silver and total tin were sampled on only one occasion in 2016 and not sampled since then. Total concentrations of lead and mercury were only sampled on one occasion in 2016, 2017 and were not sampled in 2018 and 2019. Future monitoring will be conducted in accordance with the WMP (GHD, 2017a).

Time series graphs for selected water quality parameters monitored at LDP 9 over the period January 2011 to December 2019 are provided in Appendix D. The EPL limits for oil and grease, pH and TSS specified by EPL 366 for LDP 9 discharges are also presented in the relevant figures. Site Specific Guideline Values (SSGVs) have been derived for Wangi Creek as part of the WMP (GHD, 2017a) and are presented in Table 4-6. SSGVs have been derived from surface water monitoring data collected upstream of LDP 9. SSGVs have been included in this report as a reference.

Water quality data at LDP 9 has also been compared to default guideline (DGV) ranges for physical and chemical stressors outlined in Table 3.3.2 of the ANZECC (2000) guidelines. DGV ranges for physical and chemical stressors outlined in ANZECC (2000) are still considered appropriate as they have not yet been superseded by ANZG (2018). Additionally, none of the DGVs for toxicants of concern have been modified by ANZG (2018).

Table 4-6 Site specific guideline values for Wangi Creek

Parameter	Units	SSGV
Physicochemical parameters		
pH	pH Units	6.2-8.5
TSS	mg/L	77
Nutrients		
Total phosphorus	mg/L	0.035
Dissolved Metals		
Aluminium	mg/L	0.724
Antimony	mg/L	0.27
Arsenic	mg/L	0.023
Barium	mg/L	0.04
Boron	mg/L	5.1
Cadmium	mg/L	0.0055
Cobalt	mg/L	0.001
Copper	mg/L	0.0013
Iron	mg/L	2.1
Lithium	mg/L	0.001
Manganese	mg/L	0.095
Molybdenum	mg/L	0.023
Nickel	mg/L	0.07

Parameter	Units	SSGV
Physicochemical parameters		
Selenium	mg/L	0.01
Silica	mg/L	22.94
Titanium	mg/L	0.01
Vanadium	mg/L	0.1
Zinc	mg/L	0.016

pH

pH measured at LDP 9 was found to generally range between 7.4 and 7.9, indicating slightly alkaline water similar to the underground water quality in Table 4-4 and Table 4-5. All reported pH results were within the range of 6.5 to 8.5 specified by EPL 366. pH ranged from 7-8 approximately in 2019. No visual trend in pH is present.

Total suspended solids

Concentrations of TSS at LDP 9 have generally been recorded below 40 mg/L. Results indicate eight occasions when TSS levels have been reported above the EPL limit of 50 mg/L. All of the exceedances occurred during the 2011-2016 period. TSS concentrations were all below 25 mg/L in 2019.

Oil and grease

The majority of oil and grease concentrations, including all 2019 data, were reported to be at or below the LOR. All reported oil and grease results were below the limit of 10 mg/L specified by EPL 366.

Total phosphorus

Total phosphorus concentrations at LDP 9 were generally below the LOR during 2019 with the exception of between March and June where values generally ranged between 0.06 mg/L and 0.19 mg/L. The peak total phosphorus concentration in 2019 was reported in April and was equal to the maximum historical concentration of 0.19 mg/L reported in October 2015.

Major ions

Major ion concentrations are high, reflecting the high salinity of the groundwater inflow into the underground workings, dominated by sodium and magnesium. The receiving environment is a marine environment due to its close proximity to Lake Macquarie. Some visual trends in major ion concentrations are evident, which are likely to reflect variations in EC and major ion concentrations between each seam.

Dissolved metals

The majority of dissolved aluminium, antimony, arsenic, beryllium, cadmium, chromium, cobalt, copper, iron, lead, mercury, nickel, selenium, silver, tin, titanium and vanadium concentrations have been reported to be at or below the LORs.

Dissolved zinc concentrations were elevated with values in the range of 0.05 to 0.23 mg/L during the 2011-2013 period. However, since 2014, with the exception of three values, dissolved zinc has remained below LOR (0.05 mg/L). Since September 2016 a lower LOR (0.005 mg/L) has been reported. Between September 2016 and December 2018, dissolved zinc values ranged from 0.005-0.05 mg/L, with the exception of March 2018 when a concentration of 0.06 mg/L was recorded. These concentrations exceeded, in most cases, the ANZECC (2000) marine water trigger value for the protection of 95 % aquatic species (0.015 mg/L) and the SSGV (0.016 mg/L). A study by GHD (2017b) for Centennial Myuna concluded that the risk of dissolved zinc adversely affecting the aquatic communities in Wangi Wangi Bay is negligible due to the effect of dilution to reduce zinc concentrations below the 95% species protection guideline and the high possibility that toxicity tolerance might have been developed by the aquatic receptors (GHD 2017b). Zinc concentrations in 2019 are below or equal to 0.016 mg/L, not exceeding the SSTV developed for zinc.

Dissolved molybdenum has been consistently below LOR (0.01 mg/L) until a lower LOR of 0.0001 mg/L was reported in 2017. Nevertheless, dissolved molybdenum concentrations remained low, within the range of 0.0006-0.003 mg/L during 2019.

Dissolved barium, boron and manganese concentrations have been detected above the LORs for each monthly monitoring event from January 2011. Note that dissolved barium and boron have not been sampled at LDP 9 since March 2015. These metals are present within the underground mine water as shown in Appendix C. Generally dissolved barium was below 0.25 mg/L in the underground mine water and no visual trend is evident. Concentrations of dissolved barium at LDP 9 was historically above the SSGV in the WMP (0.04 mg/L), however sampling of dissolved barium at LDP 9 was discontinued in 2015.

Dissolved boron concentrations reported at LDP 9 were found to vary between 0.23 mg/L and 1.04 mg/L, with concentrations below the LOR of 0.05 mg/L on two occasions (September 2014 and February 2015). An increasing visual trend in dissolved boron is evident (up to early 2015), which may be attributable to a greater proportion of underground water being extracted from the Fassifern Seam. All reported boron concentrations are below the ANZECC (2000) low reliability marine trigger value of 5.1 mg/L, which is the established background level in seawater, and the SSGV defined in the WMP for discharges from LDP 9 of 5.1 mg/L. Dissolved boron monitoring was discontinued in 2016.

Dissolved manganese concentrations ranged between 0.08 mg/L and 0.8 mg/L, predominantly above the SSGV trigger value for Wangi Creek defined in the WMP (0.095 mg/L), but consistently below the ANZECC (2000) freshwater trigger value for the protection of 95% aquatic species (1.9 mg/L). It is noted that there is no low reliability marine trigger value for manganese within ANZECC (2000).

It should be noted that exceeding ANZECC (2000) trigger values or trigger values defined in the WMP for dissolved metals does not result in a non-compliance of licence conditions of bore licence 20BL172565.

4.3 Groundwater monitoring network

As discussed in Section 3.3, the groundwater monitoring network at Myuna Colliery includes ten alluvial monitoring bores. Observed groundwater levels have been plotted and are presented in Appendix E.

Groundwater levels were relatively constant in 2019 at the majority of monitoring bores, varying by less than 1 m, with the exception of MW09 where the groundwater level varied by almost 2 m. Visual review of groundwater levels and Myuna Colliery site rainfall data generally does not indicate any relationship between rainfall and groundwater levels.

Groundwater quality plots are presented in Appendix E. Groundwater across the site varies from acidic to very slightly acidic. Groundwater varies from brackish at MW11 to fresh at MW09 and MW10. Metal concentrations are elevated at MW11 in comparison to other monitoring bores. With the exception of zinc, the majority of metal concentrations are below the limit of reporting at the remaining monitoring bores. Based on the reviewed parameters, there are no increasing trends of concern.

5. Groundwater modelling

A hydrogeological model was developed for Myuna Colliery as part of the *Northern Operations Water and Salt Balance* (GHD, 2014a). The hydrogeological model was updated to assess the groundwater make of Myuna Colliery for the 2014 Modification to Project Approval 10_0080. Further details regarding the development of the hydrogeological model are available in *Northern Operations Water and Salt Balance: Myuna Hydrogeological Model* (GHD, 2014b).

Under the 2014 Modification to Project Approval 10_0080, it was proposed to increase Run of Mine (ROM) production to 3 Mtpa.

5.1 Groundwater make

The hydrogeological model was calibrated in 2014 using the average recorded underground water extraction rate for year 2013 of 6.3 ML/day. Comparison of the modelled average groundwater make between 2013 and 2019 to the estimated actual groundwater make over this period (using transfer and dewatering data) is shown in Table 5-1. Numbers presented in Table 5-1 are consistent with the update of the water cycle accounting for 2019 for Myuna Colliery presented in Appendix A.

Table 5-1 Modelled and recorded groundwater make

Year	Modelled average groundwater make (ML/day)	Average dewatering rate (ML/day)	Approximate average transfer of dirty water to underground (ML/day)	Approximate transfer of potable water to underground (ML/day)	Change in underground stored water volume (ML/day)	Estimated actual groundwater make (ML/day)
2013	6.4	6.3	–	–	–	6.3
2014	6.5	4.4	–	0.4	–	4.0
2015	6.8	5.3	0.2	0.4	–	4.7
2016	7.0	5.6	0.2	0.3	-0.6	4.5
2017	7.3	5.2	0.1	0.1	-0.7	4.3
2018	7.5	5.3	0.04	0.2	–	5.1
2019	7.7	5.1	0.04	0.2	0.5	5.4

Note to table: negative change in underground water storages indicates that storages decreased in volume while a positive value indicates water storages increased in volume.

Comparison of the modelled and the estimated actual groundwater make indicates that the model overestimates groundwater make for the year 2019. Estimated actual groundwater make for 2019 is 70 % of modelled groundwater make.

The hydrogeological model was calibrated to the average recorded underground water extraction rate for year 2013. Data regarding transfers of water from the surface to the underground were not available for 2013 and therefore the hydrogeological model may have been calibrated to an overestimated groundwater make.

The lower estimated actual groundwater make in 2016 and 2017 compared to previous years, is partly attributable to consideration of changes in underground stored water volume. As discussed in Section 4.1.3, underground stored water volume data were not available prior to 2016. Disregarding changes in underground stored water volume, dewatered volumes from the underground workings has remained relatively constant between 2014 and 2019, while modelled groundwater make gradually increases over this time. Recalibration of the hydrogeological model would be beneficial for improving the fit between modelled and observed groundwater inflows and would assist in improving confidence in predictions of future mine inflow and predicting impacts on groundwater receptors. However, it is noted that current model predictions are likely to be conservative.

5.2 Aquifer transfers

The existing hydrogeological model was run for the period 2013 to 2019 to estimate alluvial groundwater inflows to underlying hard rock aquifers (if any). The extent of the alluvial sediments within the hydrogeological model is shown in Figure 5-1.

The modelled transfers of groundwater in and out of the alluvial sediments within the boundary of the hydrogeological model are shown in Figure 5-2. The model results indicate that there is no measureable change in transfers out of the alluvium over the period between 2013 and 2019. The model results indicate that there is a net transfer of groundwater into the alluvium from the porous and fractured rock aquifers.

For purposes of comparison, modelled transfers into and out of the alluvium have been plotted for pre-mining conditions (year 1980). Comparing pre-mining transfers to current conditions indicates that pre-mining transfers into the alluvium were slightly higher under pre-mining conditions and transfers out of the alluvium were slightly lower under pre-mining conditions. The modelling results indicate that the net change in alluvial transfers is less than 0.1 ML/year. It is considered that this change in alluvial transfers is negligible (not measureable).

Groundwater transfers between the alluvium and the porous and fractured rock aquifers occur naturally. It is considered that the extraction of groundwater from the underground workings at Myuna Colliery has had negligible impact on alluvial transfers.

LEGEND

- Myuna Colliery Surface Facilities
- Alluvial Soils within Model Extent

Paper Size A4

0 215 430 860 1,290 1,720

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Centennial Myuna
Myuna 2019 Annual Groundwater Review

Job Number 125-22675
Revision A
Date 11 Feb 2020

Modelled alluvial sediments

Figure 5-1

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

G:\22\0105001\GIS\Maps\Deliverables\Hunter\Myuna\12522675\125-22675_004_ModelledAlluvialSediments_A.mxd

Data source: © ESRI: Aerial Imagery, 2012, Geoscience Australia: 250k Topographic Data, 2006. Created by: smacdonald

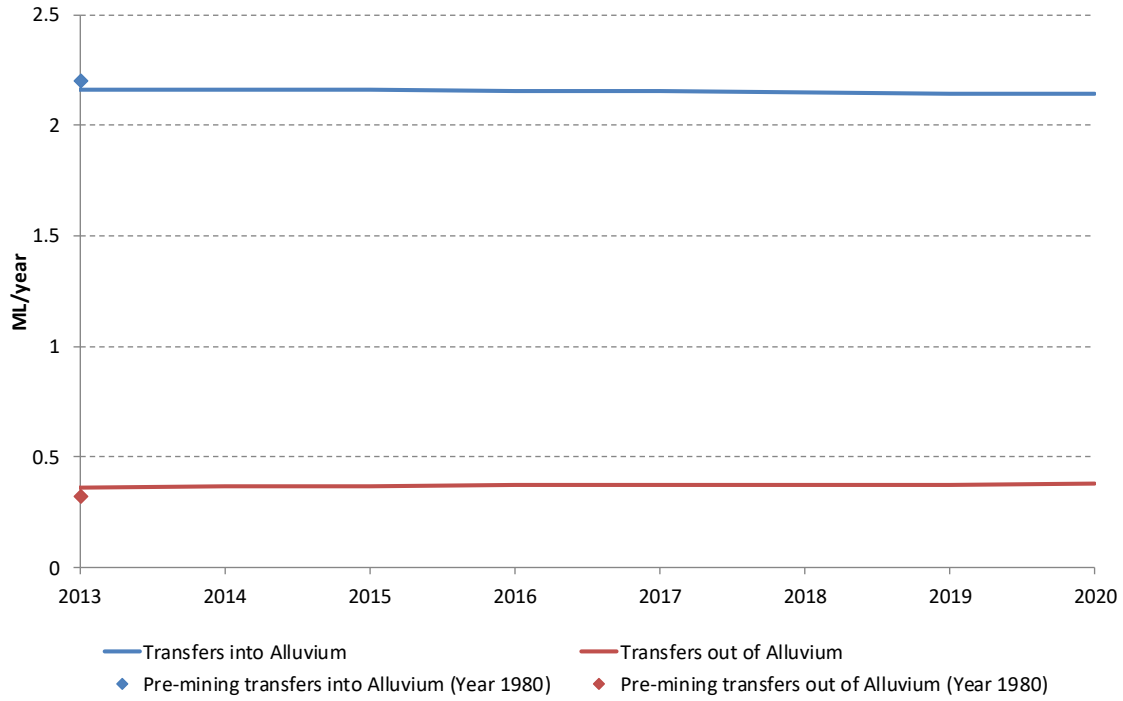


Figure 5-2 Modelled aquifer transfers

5.3 Groundwater impacts

The hydrogeological model has been used to predict the likely depressurisation of aquifers due to activities at Myuna Colliery. Aquifer depressurisations has been predicted for the end of 2019 (present day) within the Quaternary alluvium, Narrabeen strata, Wallarah Seam, Great Northern Seam and Fassifern Seam.

5.3.1 Alluvial groundwater

The results of the hydrogeological model indicate that there will be no drawdown of alluvial aquifers greater than 0.1 m due to mining at Myuna Colliery. This prediction is based on no increase in the hydraulic conductivity of strata within the surface zone, which is a reasonable assumption since mining is via the bord and pillar method. This prediction will be validated as more alluvial groundwater level monitoring data becomes available.

5.3.2 Porous and fractured rock aquifers

The predicted zones of aquifer depressurisation for the Narrabeen strata, Wallarah Seam, Great Northern Seam and Fassifern Seam for the end of 2018 are shown in Figure 5-3, Figure 5-4, Figure 5-5 and Figure 5-6 respectively.

The radius of the zone of depressurisation within the porous and fractured rock aquifers is typically up to 2.5 km from the mine workings.

LEGEND

- Myuna Colliery Surface Facilities
- Modelled Groundwater Drawdown Contour (m)

Paper Size A4

0 215 430 860 1,290 1,720

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Centennial Myuna
Myuan 2019 Annual Groundwater Review

Narrabeen Strata modelled groundwater drawdown contour, existing conditions (2019)

Job Number 125-22675
Revision A
Date 11 Feb 2020

Figure 5-3

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

G:\22\0105001\GIS\Maps\Deliverables\Hunter\Myuna\12522675\125-22675_005_Drawdown_Existing_Narrbeen_A.mxd

Data source: © ESRI: Aerial Imagery, 2012, Geoscience Australia: 250k Topographic Data, 2006. Created by: smacdonald

LEGEND

- Myuna Colliery Surface Facilities
- Modelled Groundwater Drawdown Contour (m)

Paper Size A4

0 215 430 860 1,290 1,720

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Centennial Myuna
Myuna 2019 Annual Groundwater Review

Wallarah Seam modelled groundwater drawdown contour, existing conditions (2019)

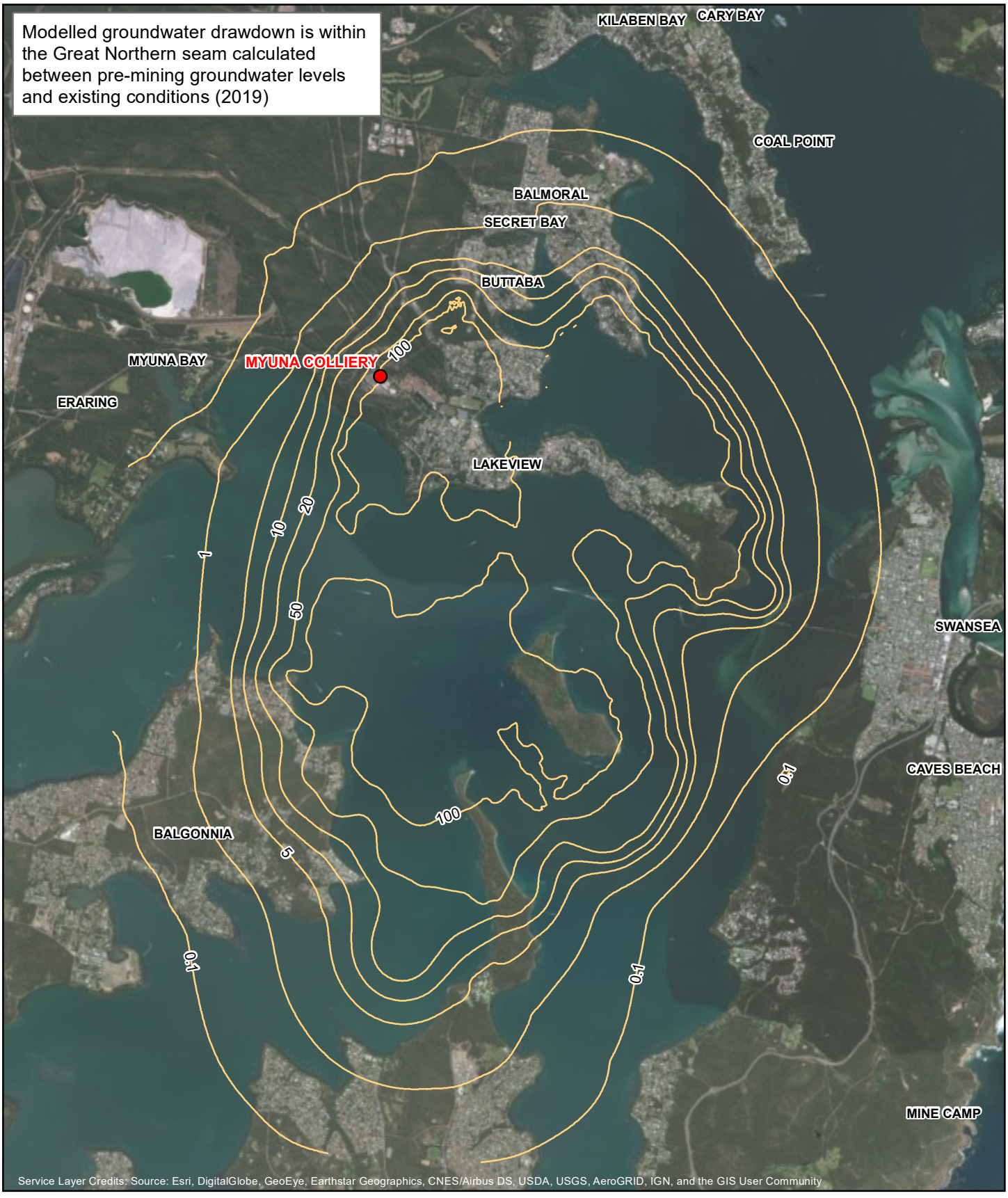
Job Number 125-22675
Revision A
Date 11 Feb 2020

Figure 5-4

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

G:\22\0105001\GIS\Maps\Deliverables\Hunter\Myuna\12522675\125-22675_006_Drawdown_Existing_Wallarah_A.mxd

Data source: © ESRI: Aerial Imagery, 2012, Geoscience Australia: 250k Topographic Data, 2006. Created by: smacdonald



LEGEND

- Myuna Colliery Surface Facilities
- Modelled Groundwater Drawdown Contour (m)

Paper Size A4

0 215 430 860 1,290 1,720

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Centennial Myuna
Myuna 2019 Annual Groundwater Review

Great Northern Seam modelled groundwater drawdown contour, existing conditions (2019)

Job Number 125-22675
Revision A
Date 11 Feb 2020

Figure 5-5

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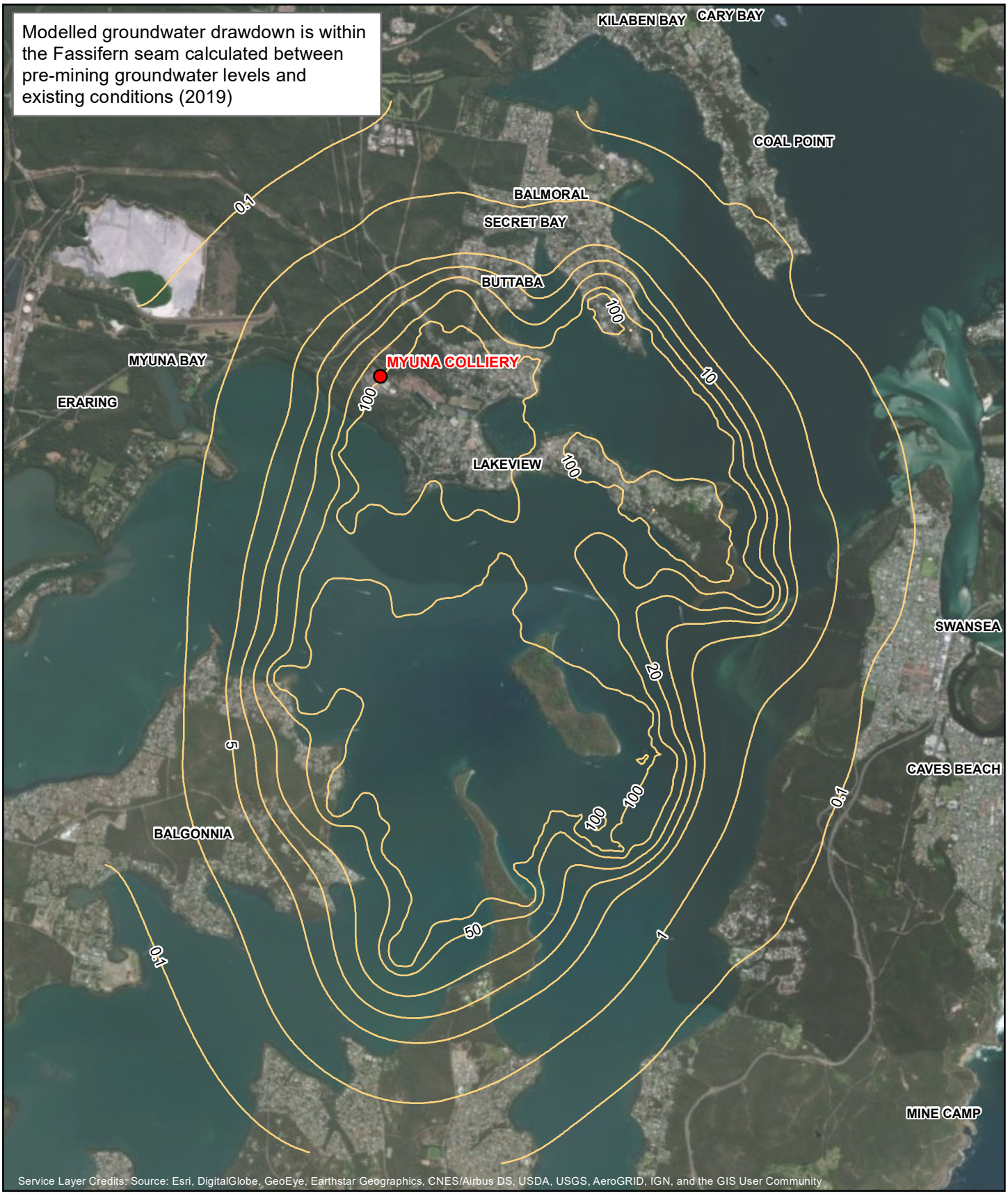
G:\22\0105001\GIS\Maps\Deliverables\Hunter\Myuna\12522675\125-22675_007_Drawdown_Existing_GreatNorthern_A.mxd

Data source: © ESRI: Aerial Imagery, 2012, Geoscience Australia: 250k Topographic Data, 2006. Created by: smacdonald



LEGEND

- Myuna Colliery Surface Facilities
- Modelled Groundwater Drawdown Contour (m)

Paper Size A4

0 215 430 860 1,290 1,720

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Centennial Myuna
Myuna 2019 Annual Groundwater Review

Fassifern Seam modelled groundwater drawdown contour, existing conditions (2019)

Job Number 125-22675
Revision A
Date 11 Feb 2020

Figure 5-6

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

G:\22\0105001\GIS\Maps\Deliverables\Hunter\Myuna\12522675\125-22675_008_Drawdown_Existing_Fassifern_A.mxd

Data source: © ESRI: Aerial Imagery, 2012, Geoscience Australia: 250k Topographic Data, 2006. Created by: smacdonald

5.3.3 Registered bores

In order to assess the potential impacts on registered groundwater users, the predicted groundwater drawdown has been compared to the registered bores identified in Section 2.4. As discussed in Section 2.4, the majority of registered bores are shallow bores extracting groundwater from sandy strata on the eastern side of Lake Macquarie and the remainder of the bores are extracting from the weathered sandstone.

The locations of registered bores identified in Section 2.4 have been compared to the predicted zone of aquifer depressurisation for the Narrabeen strata. As shown in Figure 5-7, all of the registered bores, except GW063014, lie outside the predicted zone of depressurisation. Bore GW063014 is 7 m deep and would be screened within the shallow zone where the predicted aquifer depressurisation is less than 0.1 m. Therefore it can be concluded that there has been no impact on registered groundwater users from groundwater interception and extraction activities at Myuna Colliery.

5.3.4 Groundwater dependent ecosystems

It is assumed that the potential GDEs identified in Section 2.5 only interact with shallow aquifers. Hydrogeological modelling has predicted that the drawdown in the shallow zone (i.e. up to 10 m below ground level) is less than 0.1 m. Therefore the modelling has predicted that there has been negligible impact on potential GDEs.

LEGEND

- Myuna Colliery Surface Facilities
- Registered bores
- Modelled Groundwater Drawdown Contour (m)

Paper Size A4

0 215 430 860 1,290 1,720

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Centennial Myuna
Myuna 2019 Annual Groundwater Review

Comparison of modelled existing groundwater drawdown in Narrabeen Strata and registered bores

Figure 5-7

Job Number	125-22675
Revision	A
Date	11 Feb 2020

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G:\22\0105001\GIS\Maps\Deliverables\Hunter\Myuna\12522675\125-22675_009_Drawdown_Comparison_Narrabeen_A.mxd

Data source: © ESRI: Aerial Imagery, 2012, Geoscience Australia: 250k Topographic Data, 2006, NOW: Groundwater Bores, 2015. Created by: smacdonald

6. Conclusions

An Annual Groundwater Management Report has been prepared in accordance with Condition 4 of Bore Licence 20BL172565. All extraction and water quality data have been presented in Section 4, Appendix C and Appendix D. Annual groundwater extraction volumes at Myuna Colliery have been consistently below the licence limit of 4380 ML, specified in Condition 17.

An assessment of impacts of groundwater drawdown on alluvial groundwater levels, registered groundwater users and GDEs has been undertaken using the Myuna Colliery hydrogeological model. No observable impacts on these groundwater features have been predicted.

Groundwater monitoring undertaken has been assessed against the requirements specified in the WMP. The WMP requires standing levels of the main underground water storages to be monitored so that significant changes to groundwater inflows can be detected and recorded and to assist in the prediction of future groundwater inflows. Centennial Myuna undertook surveying of underground water storages in 2016, 2017, 2018 and 2019. It is recommended that Centennial Myuna continues to monitor the levels in key underground water storages on an annual basis as specified in Section 5.1 of the WMP.

Recalibration of the hydrogeological model would be beneficial for improving the fit between modelled and observed groundwater inflows and to assist in improving confidence in predictions of future mine inflow and predicting impacts on groundwater receptors.

As discussed in Section 4.2.2, sampling of a number of dissolved and total metal concentrations has ceased at LDP 9. Sampling of water quality will continue in accordance with the approved WMP (GHD, 2017a).

7. References

ANZECC (2000), *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

ANZG (2018) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Australian and New Zealand Governments and Australian state and territory governments, viewed 24 January 2019, http://www.waterquality.gov.au/anz-guidelines/.

BOM (2015), *Groundwater Dependent Ecosystem Atlas*, accessed from http://www.bom.gov.au/water/groundwater/gde/.

GHD (2012), *Myuna Colliery Groundwater Monitoring Program*.

GHD (2014a), *Northern Operations Water and Salt Balance*.

GHD (2014b), *Northern Operations Water and Salt Balance: Myuna Hydrogeological Model*.

GHD (2015), *Myuna Colliery Annual Groundwater Management Report*.

GHD (2017a), *Myuna Colliery Water Management Plan.*

GHD (2017b) *Myuna Colliery Stage 1 Toxicity Assessment: ERA.*

NSW Department of Mineral Resources (1995), 1:100,000 *Newcastle Coalfield Regional Geology map*.

Appendices

Appendix A – 2019 annual water balance

Centennial Myuna Pty Ltd

Myuna Colliery

Site water balance - 2019 update

March 2020

Table of contents

Table index

Figure index

1. Introduction

Myuna Colliery is an underground coal mine owned and operated by Centennial Myuna Pty Limited (Centennial Myuna), a wholly owned subsidiary of Centennial Coal Company Limited (Centennial). Myuna Colliery's Surface Facilities Area is located in Wangi Wangi on the western side of Lake Macquarie, 25 km south-west of Newcastle.

GHD Pty Ltd (GHD) was engaged by Centennial Myuna to prepare an annual water balance for 2019 for Myuna Colliery.

1.1 Background

A water balance model was developed for Myuna Colliery in 2010 (GHD 2010), and has been progressively updated over time to reflect changes in operations. Further detail on the modelling methodology and data is included in GHD (2010).

1.2 Purpose of this report

The purpose of this report is to present the annual water balance for 2019 for Myuna Colliery, provide a forecast for the water balance for 2020 and list changes to the model compared to that presented in GHD (2010). This report is intended to be read in conjunction with the Annual Groundwater Management Report, and both support the Annual Review for 2019.

1.3 Limitations

This report: has been prepared by GHD for Centennial Myuna Pty Ltd and may only be used and relied on by Centennial Myuna Pty Ltd for the purpose agreed between GHD and the Centennial Myuna Pty Ltd as set out in this report.

GHD otherwise disclaims responsibility to any person other than Centennial Myuna Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible. The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect. GHD has prepared this report on the basis of information provided by Centennial Myuna Pty Ltd and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

2. Data

The water and salt balance for Myuna Colliery involved the collation and interpretation of data from various sources. The purpose of this section is to summarise the data used. The sources of data used are shown in Table 2-1.

Table 2-1 Summary of data sources

Data	Source
Historical rainfall and evaporation record	SILO (DSITI 2019)
Catchment areas and land use	Interpreted from contours and aerial imagery provided by Centennial Myuna
Storage geometry	Storage capacities provided by Centennial Myuna Maximum surface area interpreted from site contours and aerial imagery
Operational processes	Developed in consultation with Centennial Myuna
Operational pumping	Developed in consultation with Centennial Myuna
Groundwater flows	Derived from Myuna Annual Groundwater Management Report
Monitoring data	Provided by Centennial Myuna

2.1 Site rainfall

Site rainfall data was obtained from the Myuna Meteorological station on 17 January, for the period from 1 January 2018 to 16 January 2020. This gauge is located at the Myuna Colliery pit top.

Figure 2-1 presents the distribution of annual total rainfall and evaporation from the SILO dataset between January 1889 and December 2019. Figure 2-1 also compares SILO rainfall to site-based rainfall recorded between 2015 to 2019.

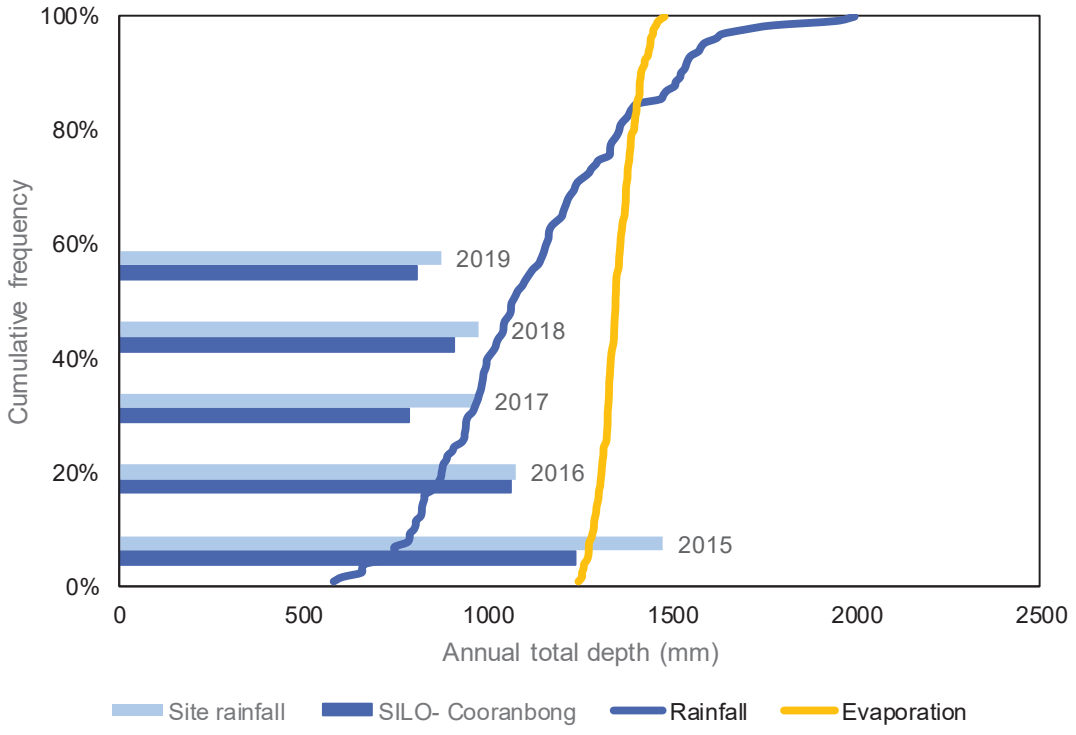


Figure 2-1 Historical rainfall record

Figure 2-1 shows that the site rainfall record matches with the SILO record and that 2019 was a below average rainfall year at the site.

2.2 Operations

Operational rules and parameters were developed in consultation with Centennial Myuna. The operational processes and pumping rules for the purpose of the water and salt balance are summarised in Table 2-2 and Table 2-3.

Table 2-2 Operational process

Water management feature	Demand
Potable water use	30.84 kL/day for Bathhouse, Buildings, Admin 14.66 kL/day for CHP 7.64 kL/day for Washdown
Underground dewatering	Up to 10.5 ML/day

Table 2-3 Operational pumping

Water management feature	Pump rate (L/s)	Pump trigger on	Pump trigger off
CHP Dam to Underground workings through Pump	30	CHP Dam freeboard less than 1.0 m	CHP Dam freeboard greater than or equal to 1.0 m
CHP Dam to Underground workings through Siphon	23	CHP Dam freeboard less than 0.2 m	CHP Dam freeboard greater than or equal to 0.2 m

2.3 Groundwater inflows

The results of hydrogeological modelling undertaken for the Myuna Colliery Annual Groundwater Management Report (GHD 2018) were used as basis to estimate future groundwater inflows. Comparison of the modelled groundwater inflows between 2013 and 2018 to the estimated observed groundwater make is shown Figure 2-2.

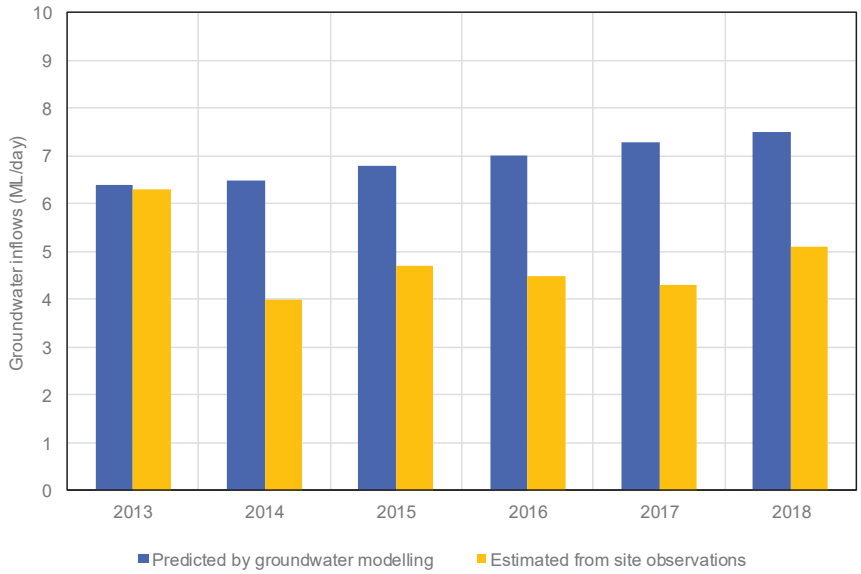


Figure 2-2 Groundwater inflows

Figure 2-2 shows that groundwater modelling has generally conservatively over predicted groundwater inflows over recent years.

3. Validation

The water and salt balance model for the project was simulated from 1 January 2019 to 1 January 2020 (the validation period). The simulation used observed site rainfall and operated under the existing conditions, with predicted groundwater inflows scaled to match site observations. The purpose of validation is to test whether the model is of adequate accuracy for making predictions (refer to Section 4). The model was validated against observed LDP9 discharge, CHP Dam transfers and underground water storage volume.

A comparison of the cumulative observed and modelled discharge from LDP9, pumped flows from CHP Dam to underground workings and underground water storage volume are shown in Figure 3-1, Figure 3-2 and Figure 3-3.

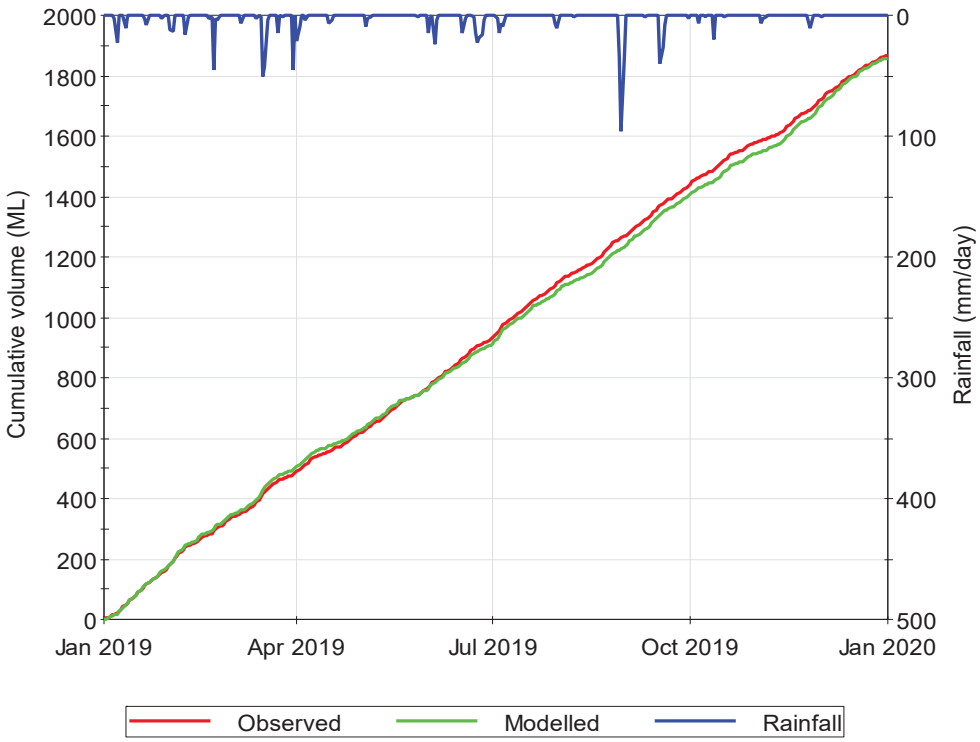


Figure 3-1 Cumulative observed and modelled LDP9 discharge

Figure 3-1 shows that the modelled cumulative LDP9 discharge matches both annual total and the total flow rate of observed LDP9 discharge over the validation period. This validates the calibration of groundwater inflows.

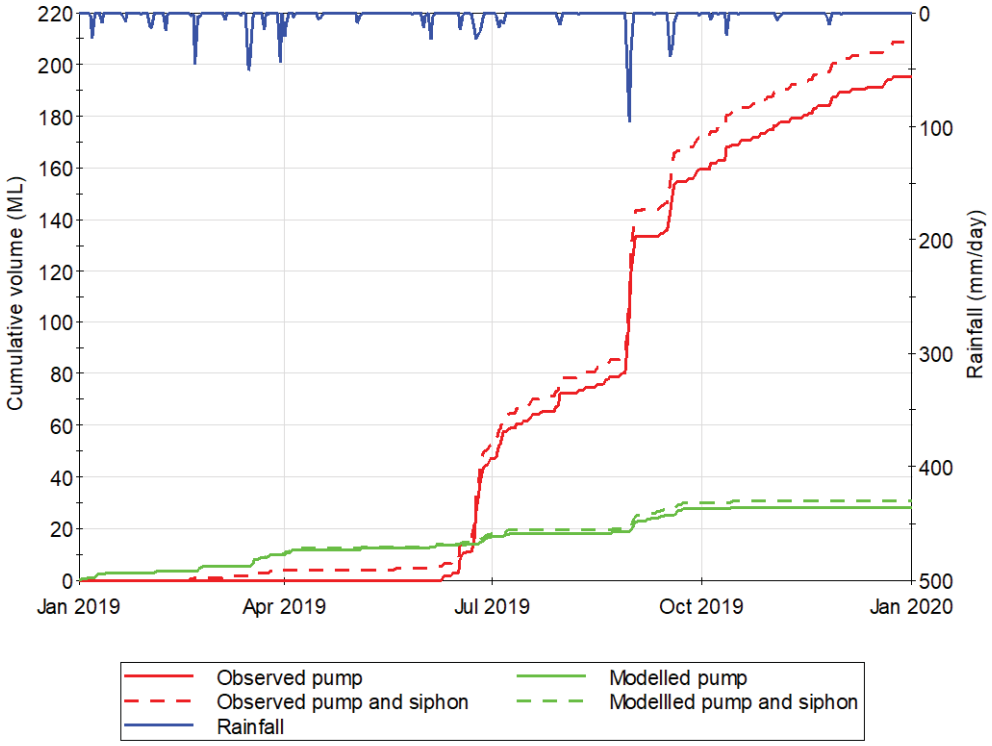


Figure 3-2 Cumulative observed and modelled pumping from CHP Dam to underground workings

Figure 3-2 shows that observed pump and siphon's cumulative volume have been below 10 ML for first half of 2019. Then started increasing rapidly, on the second half, ending the year with pump and siphon cumulative volume at an estimated 208.5 ML. The model was unable to replicate this sudden increase by mid of 2019 of cumulative flows through pump and siphon, and, therefore, the total flows from CHP Dam to underground workings, which were modelled to be about 85% lower than observed.

Given that an adequate validation was achieved in the 2016, 2017 and 2018 annual water balances, the most likely cause of this large discrepancy can be attributed to inaccurate meter readings. It is recommended that the CHP Dam pump and siphon monitoring program be recalibrated to improve confidence in the reading.

The discrepancy of transfers from the CHP Dam to the underground workings is more than 10% of the total LDP9 discharges in terms of volume and therefore is significant to the overall validation of the model.

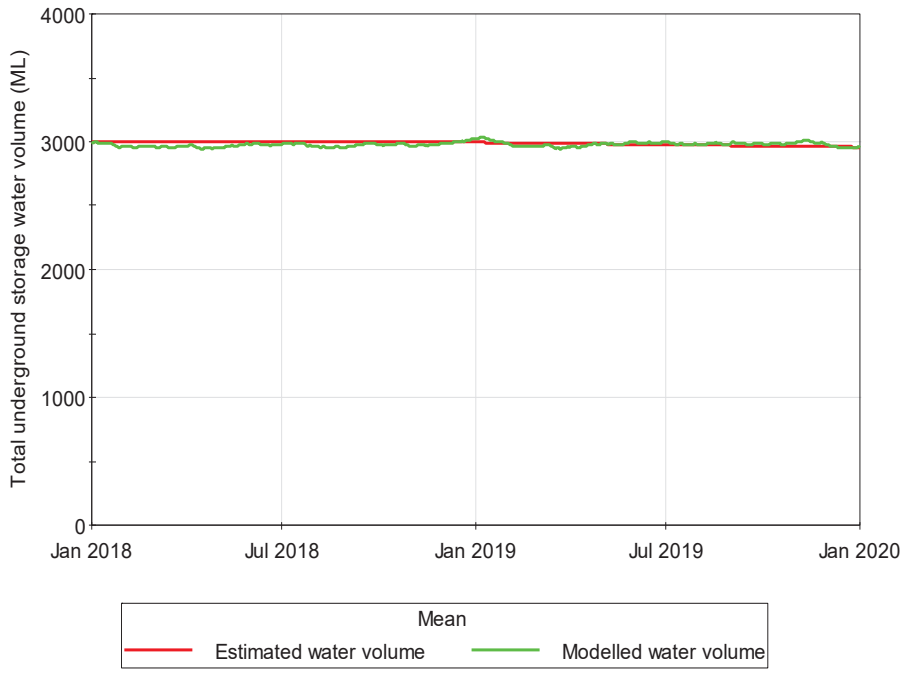


Figure 3-3 Estimated and modelled underground water storage volume

Figure 3-3 shows that underground water storage have been consistent at 3000 ML volume storage since start of 2018 and that the water balance model is able to replicate the estimated underground water storage volume over the validation period. This validates the calibration of groundwater inflows.

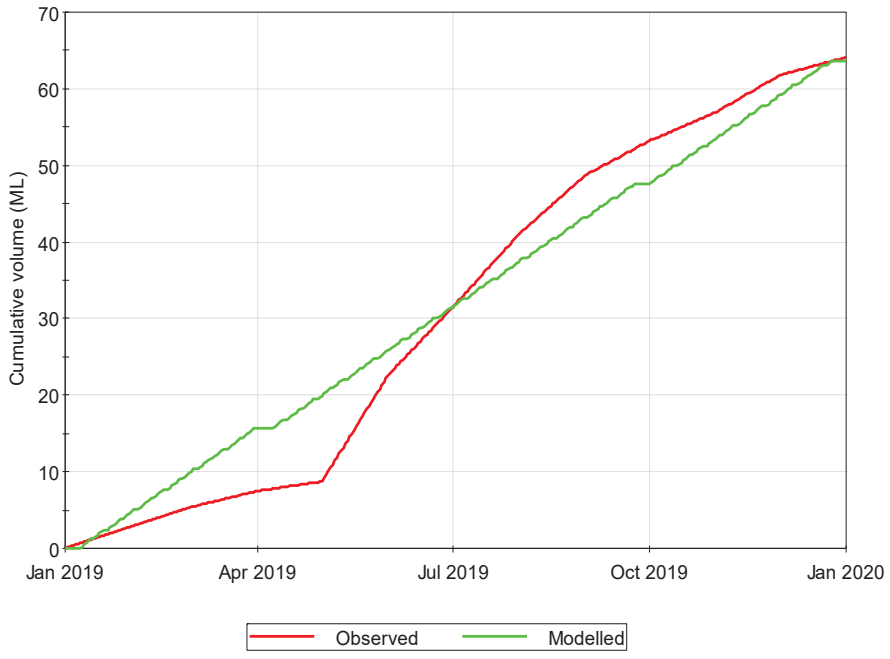


Figure 3-4 Cumulative observed and modelled potable water usage

Figure 3-4 shows that the modelled cumulative potable water usage has a close agreement with modelled cumulative potable water usage in terms of annual total. The validation demonstrates that the water balance model is able to replicate the general trend over time. The discrepancies can be attributed to the model's inability to replicate the daily operations at the site.

4. Model results

The validated site water and salt balance model for Myuna Colliery was used to estimate the site water from 1 January 2019 to 1 January 2021 (the prediction period). The simulation was initiated with the current site water inventory.

4.1 Interpretation of results

To consider potential climate variability, a total of 131 different rainfall patterns were simulated. The results presented show the average, 10th percentile and 90th percentile values. The purpose of displaying the three results is to indicate both the average value and the likely possible range. The 10th percentile represents the value at which 10% of the modelled outputs were less than this value. Similarly, the 90th percentile represents the value at which 90% of the modelled outputs were less than this value.

The 10th and 90th percentile values have been used rather than minimum and maximum values to exclude infrequent extreme wet and dry conditions. The set of 10th or 90th percentile values do not necessarily all correspond to the same rainfall series, that is, they do not correspond to a 10th percentile “dry” or 90th percentile “wet” year.

4.2 Qualification of predictions

GHD has developed the water and salt balance model for Myuna Colliery based on information supplied by Centennial Myuna and external data sources. Where data was not available, GHD has made assumptions as appropriate.

Data used to develop the model are categorised as follows:

- Relatively reliable data: SILO rainfall and evaporation data, surface catchment areas based on topographic maps.
- Less reliable data: runoff volumes from impervious and forested catchments, operational precedence for transfers between storages, storage geometry, salinity parameters

The items identified as ‘less reliable data’ present a risk that the model predictions are inaccurate. The accuracy may be improved as additional site data is collected. This additional data will allow refinement of the model inputs and hence increase the reliability of the model predictions. The adoption of historical rainfall and evaporation data within the detailed water balance model does not take into account the potential impacts of climate change.

4.3 Water balance

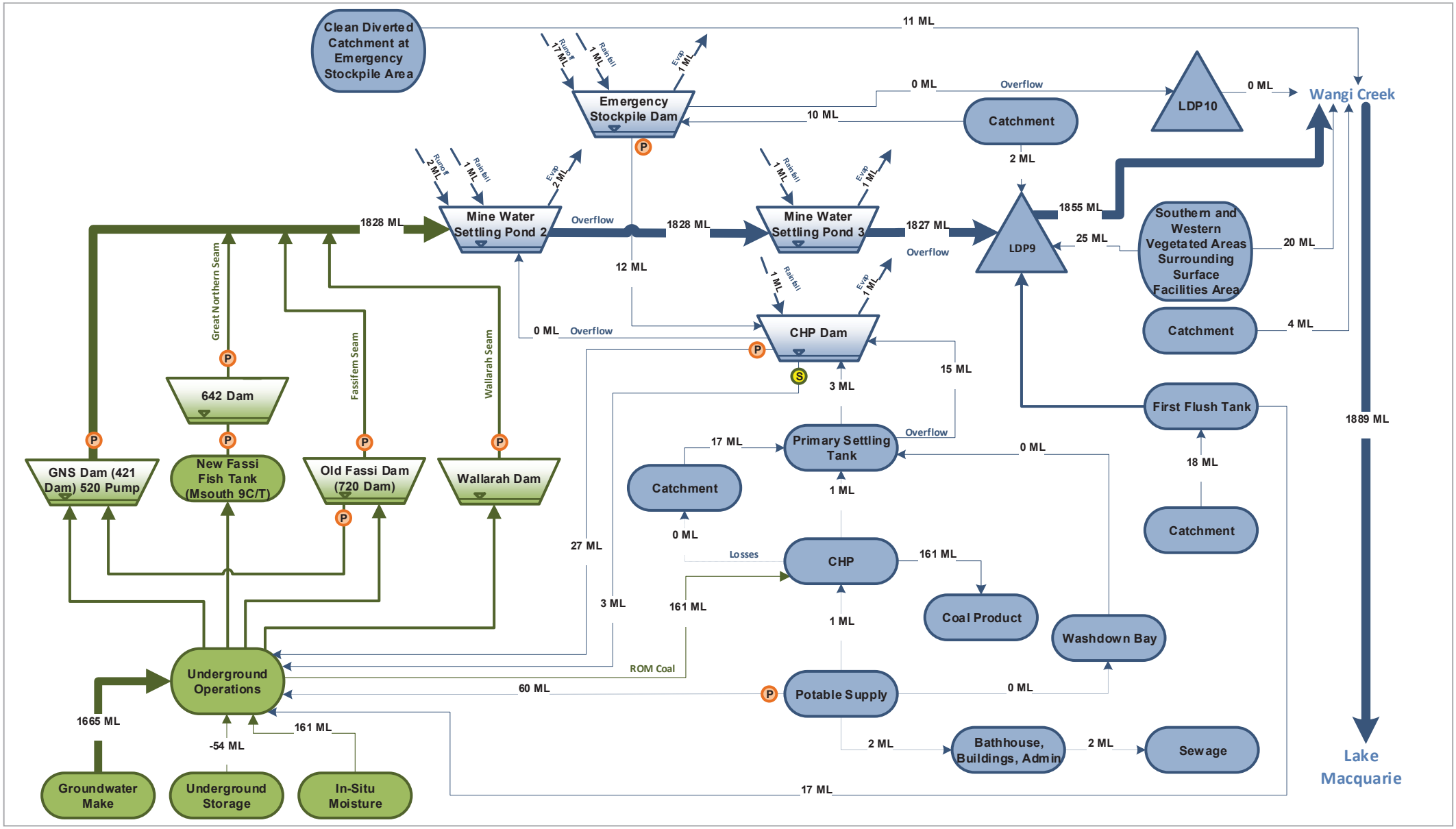
The annual water transfers for Myuna Colliery for 2019 and 2020 are shown in Table 4-1 and a water cycle schematic for 2019 and 2020 are shown in Figure 4-1 and Figure 4-2, respectively. The results shown are the modelled outputs from the water balance model and include modelled estimates of water volumes that cannot be directly measured.

Table 4-1 Annual water balance for 2019 and forecast for 2020

Water management element	Modelled 2019 (ML/year)	Mean forecast 2020 (ML/year)
INPUTS		
Direct rainfall	4	5
Catchment runoff	108	150
Groundwater inflows	1665	1681
In situ coal moisture	161	161
Potable supply	64	64
TOTAL INPUTS	**2001**	**2061**
OUTPUTS		
Evaporation	5	5
LDP9	1855	1840
LDP10	0	0
Discharge to Wangi Creek	34	50
Product coal moisture	161	161
Sewage	2	2
CHP losses	0	0
TOTAL OUTPUTS	**2057**	**2058**
CHANGE IN STORAGE		
Underground water storages	-55	0
Surface water storages	-1	2
TOTAL CHANGE IN STORAGE	**-56**	**2**
BALANCE		
Inputs – outputs – change in storage	0	0

Table 4-1 indicates that, on average, 83% of total water inflows to Myuna Colliery during 2019 were from groundwater inflows into the underground workings which were then subsequently dewatered and discharged to Wangi Creek via LDP9. A relatively minor volume of catchment runoff and in-situ coal moisture, after losses from evaporation, ultimately discharges to Wangi Creek or as product coal moisture. A slight reduction in underground water storage volume was observed in 2019.

The modelled forecast for 2020 indicates that, on average, direct rainfall and catchment are expected to be higher, given that 2019 was a below average rainfall year. Assuming a similar ratio between groundwater inflows predicted by groundwater modelling and actual groundwater inflows, groundwater inflows are forecast to increase slightly. Based on the modelling assumptions, no change to underground storage is forecast.



Legend

- Underground storage
- Underground process
- Surface storage
- Surface process
- Licensed discharge point
- Surface water flow
- Groundwater flow
- X (X,X) — Mean (10^{th} percentile, 90^{th} percentile)

GHD

Centennial Coal Company Limited
Myuna Colliery
Site water balance assessment

Water management schematic
Existing conditions (2019)

Project No. 12516285
Revision No. A
Date 19/03/2020

FIGURE 4-1

Created by: Tyler Tinkler

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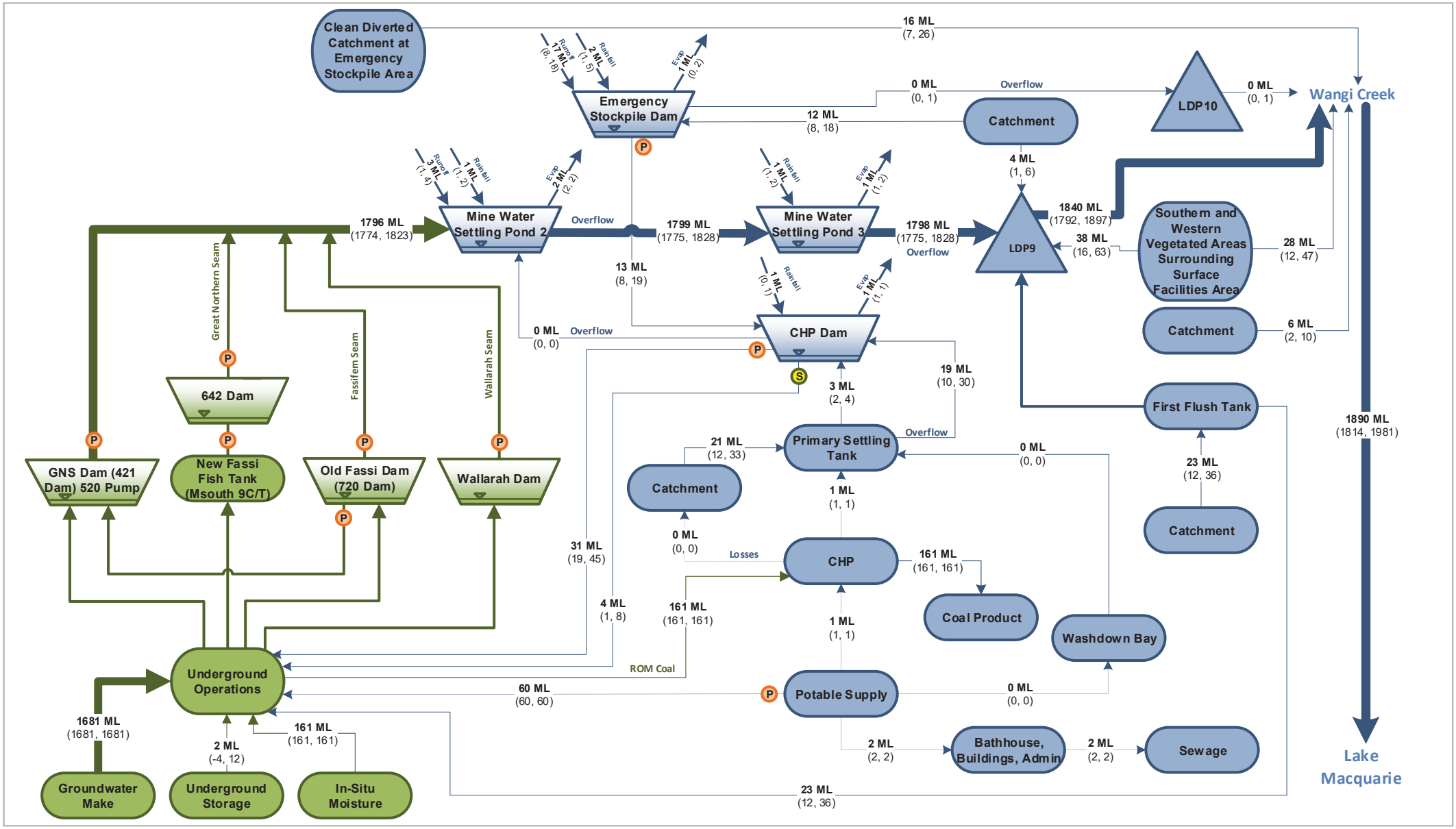

Legend

- Underground storage
- Underground process
- Surface storage
- Surface process
- Licensed discharge point
- Surface water flow
- Groundwater flow
- X (X,X) — Mean (10^{th} percentile, 90^{th} percentile)

GHD

Centennial Coal Company Limited
Myuna Colliery
Site water balance assessment

Water management schematic
Future conditions (2020)

Project No. 12516285
Revision No. A
Date 19/03/2020

FIGURE 4-2

Created by: Tyler Tinkler

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Printdate: 19/03/2020 14:54

5. Conclusion and recommendations

The site water balance for Myuna Colliery was used to estimate the actual groundwater inflows during 2019 and the model was successfully validated against site observations. The water balance for 2020 is forecast to be similar to 2019, with slight increases to the groundwater inflows.

It is recommended that the existing monitoring program at Myuna Colliery be continued and that the flow meters on the CHP Dam pump and siphon be checked and calibrated.

6. References

GHD (2010) Myuna Colliery Extension of Mining: Water Resources Assessment

GHD

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12516545-50615/https://projectsportal.ghd.com/sites/pp01_05/centennialannualwate/ProjectDocs/12516545-REP-Myuna_Colliery-Site_water_balance-2019.docx

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	J Macatanong	T Tinkler		S Gray		21/03/2020

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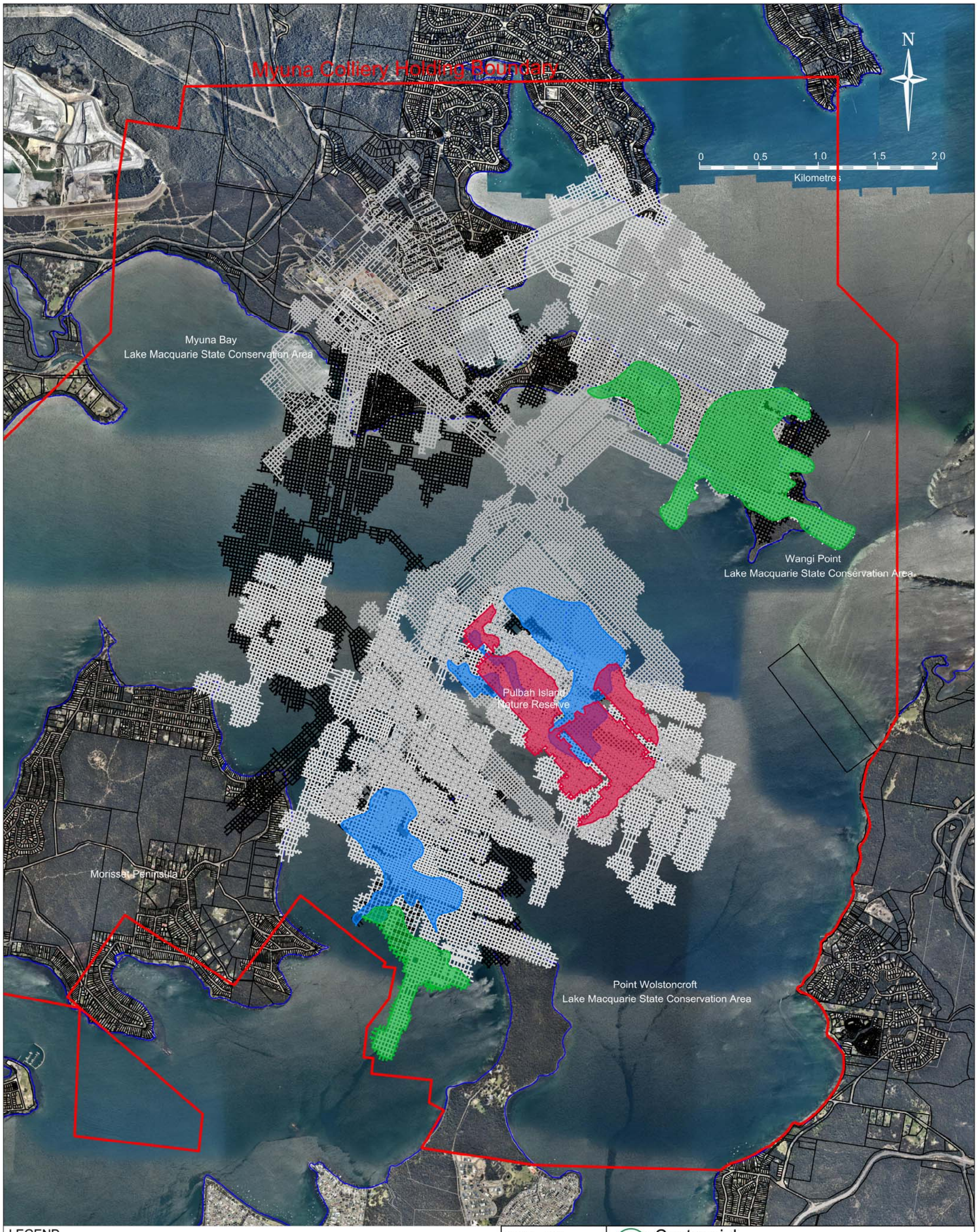
Appendix B – Underground water storages



LEGEND

- Myuna Coal Operation Boundary
- Lake Macquarie and Wyong Cadastre
- Fassifern seam workings
- Great Northern seam workings
- Wallarah seam workings

- December 2019 - Wallarah seam Stored water Volume = 748 megalitres
- December 2019 - Great Northern seam Stored water Volume = 929 megalitres
- December 2019 - Fassifern seam Stored water Volume = 1,504 megalitres

Note: Seam water bodies - Volume calculated using an average seam height of 3m and a recovery ratio of 33.3%.

DRAWN : DH	Centennial Myuna — MYUNA COLLIERY
DATE : 13.06.2012	
CHECKED :	TITLE: MYUNA COLLIERY COLLIERY HOLDING SHOWING SURFACE DETAIL AND UNDERGROUND WORKINGS AND AREAS OF STORED WATER December 2019
DATE :	
APPROVED :	
DATE :	
SCALE: Scale Bar	CAD FILE: MY11145_rev4 — PLAN NO.: MY11145 — REV.: 4 — A3

Appendix C – Underground water quality data

Table C-1 Underground water storages – water quality data

Location	Date	Fe (filt) (mg/L)	Mn (filt) (mg/L)	Ba (filt) (mg/L)	B (filt) (mg/L)
2014 Data					
720 Dam	28/03/2014	<0.05	0.755	0.11	0.84
324 Dam	3/04/2014	<0.05	0.843	0.124	<0.05
325 Dam	3/04/2014	<0.05	0.022	0.164	<0.05
930 Dam	24/09/2014	ND	ND	ND	ND
2015 Data					
324 Dam	18/12/2015	<0.50	0.709	ND	ND
720 Dam	18/12/2015	<0.10	0.157	ND	ND
642 Dam	18/12/2015	<0.05	0.007	ND	ND
421 Dam	18/12/2015	<0.05	<0.001	ND	ND
2016 Data					
324 Dam	31/03/2016	<0.5	0.17	0.099	<0.5
720 Dam	5/04/2016	<0.1	0.62	0.096	1.43
421 Dam	20/04/2016	ND	0.008	0.279	0.17
642 Dam	22/04/2016	<0.05	0.005	0.585	0.38

Notes:

720 Dam – underground storage dam within the Fassifern Seam
324 Dam – underground storage dam within the Wallarah Seam
325 Dam – underground storage dam within the Wallarah Seam
930 Dam – underground storage dam within the Fassifern Seam
642 Dam – underground storage dam within the Great Northern Seam
421 Dam – underground storage dam within the Great Northern Seam
ND – no data

Table C-2 Underground water transfers – water quality data

Location	Date	Fe (filt) (mg/L)	Mn (filt) (mg/L)	Ba (filt) (mg/L)	B (filt) (mg/L)
2014 Data					
Fassi	29/09/2014	1.85	0.549	0.104	0.84
GN	29/09/2014	0.53	0.095	0.218	0.65
Fassi	1/10/2014	2.35	0.677	0.106	1.28
Wallarah	1/10/2014	0.46	1.21	0.144	0.54
GN	1/10/2014	0.13	0.099	0.22	0.93
Fassi	2/10/2014	2.04	0.554	0.102	0.83
GN	2/10/2014	<0.05	0.077	0.204	0.65
Fassi	3/10/2014	2.02	0.559	0.086	0.91
Wallarah	3/10/2014	<0.05	0.846	0.108	<0.05
GN	3/10/2014	<0.05	0.239	0.12	0.76
Fassi	8/10/2014	3.04	0.692	0.098	1.24
Wallarah	8/10/2014	0.34	0.905	0.116	0.49
GN	8/10/2014	<0.05	0.077	0.198	0.88

Location	Date	Fe (filt) (mg/L)	Mn (filt) (mg/L)	Ba (filt) (mg/L)	B (filt) (mg/L)
2015 Data					
Fassi	16/12/2015	1.4	0.471	ND	ND
Wallarah	16/12/2015	0.11	1.17	ND	ND
2016 Data					
Fassi	18/04/2016	1.39	0.398	0.11	1.26
Wallarah	19/04/2016	<0.5	0.889	0.103	0.34
GN	19/04/2016	<0.5	0.056	0.186	0.71
Fassi	4/07/2016	<0.05	0.421	0.136	1.35
GN	4/07/2016	ND	0.005	0.269	0.18
Wallarah	5/07/2016	ND	1.12	0.125	0.34

Notes:

Fassi – underground water transfer from the Fassifern Seam

Wallarah – underground water transfer from the Wallarah Seam

GN – underground water transfer from the Great Northern Seam

ND – no data

Appendix D – Time series water quality graphs for Licence Discharge Point 9

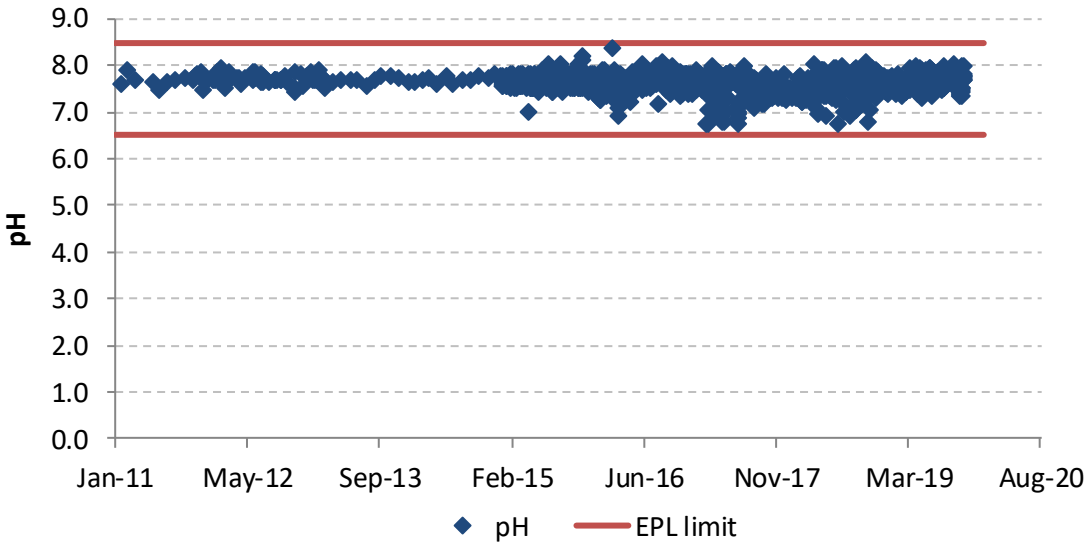


Figure D-1 pH recorded at monitoring site LDP 9

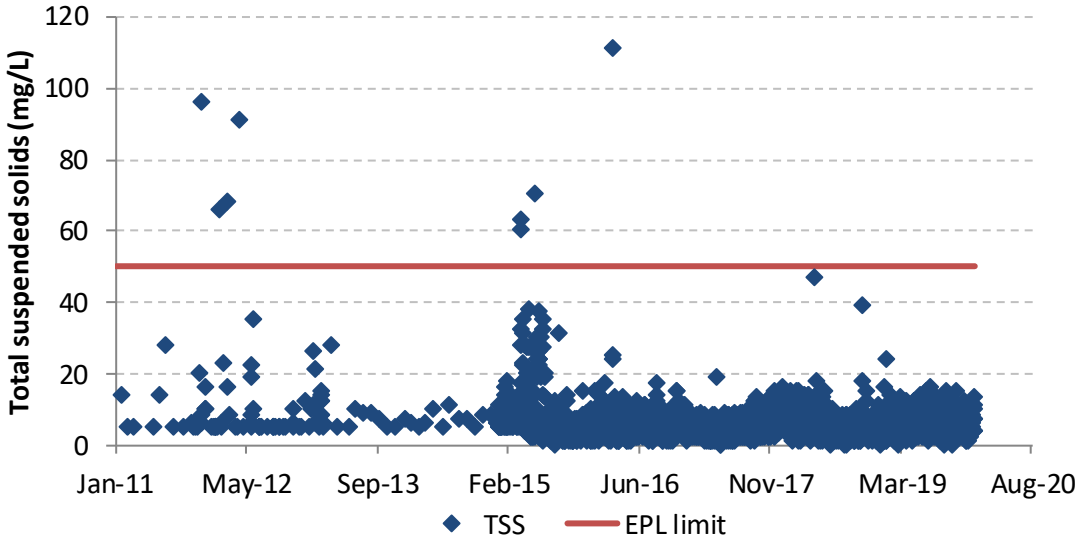


Figure D-2 Total suspended solids recorded at monitoring site LDP 9

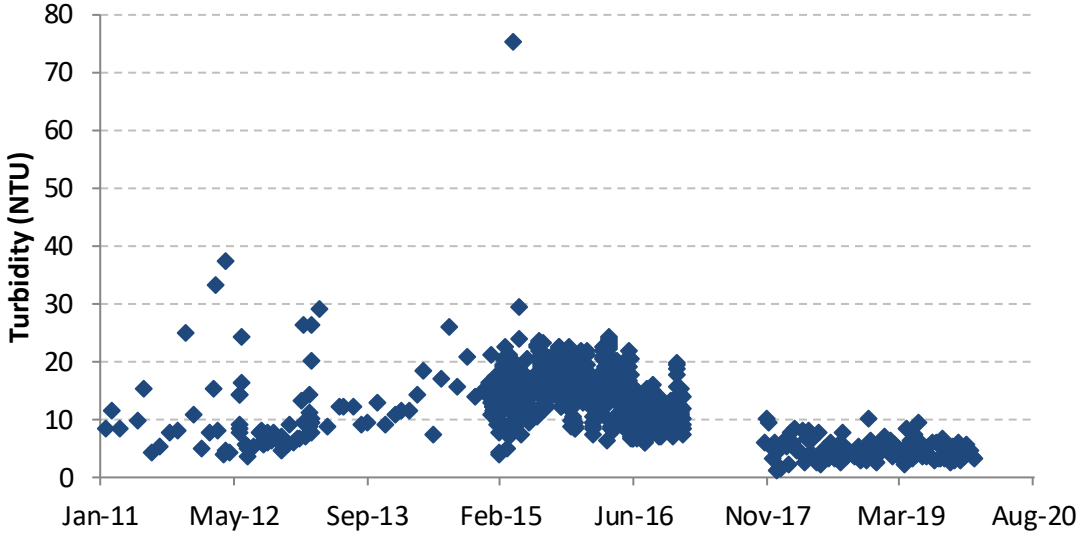


Figure D-3 Turbidity recorded at monitoring site LDP 9

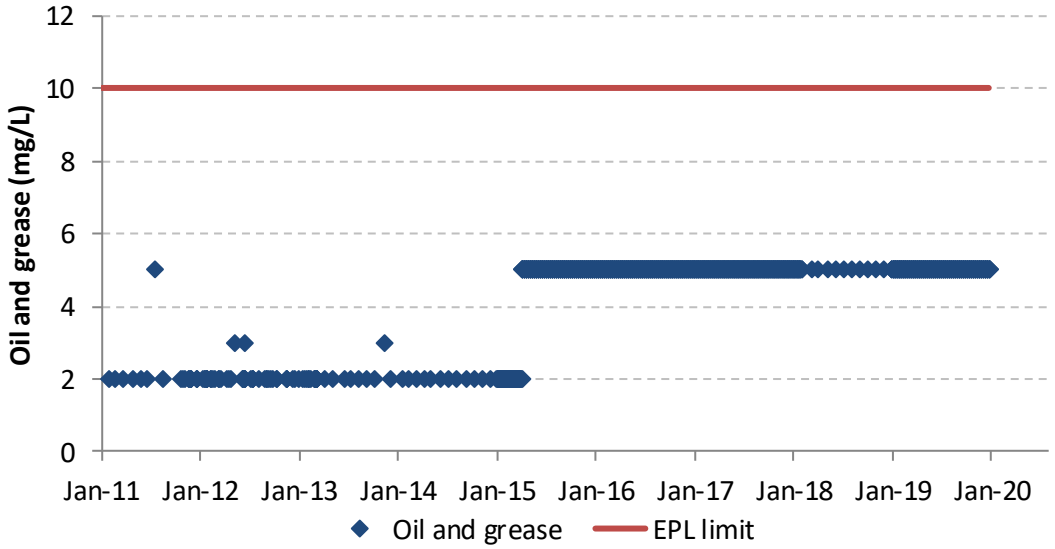


Figure D-4 Oil and grease recorded at monitoring site LDP 9

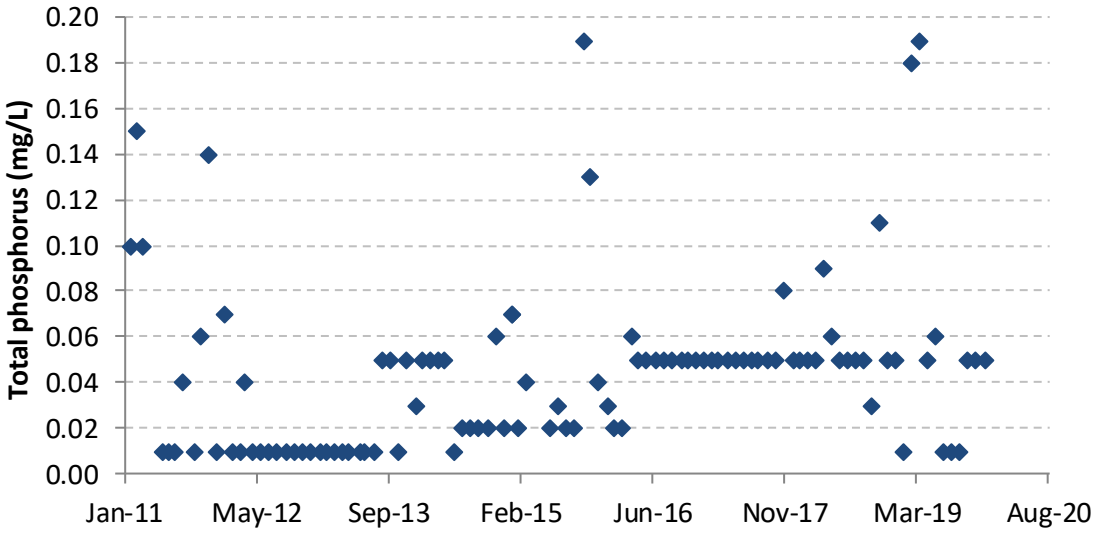


Figure D-5 Total phosphorus recorded at monitoring site LDP 9

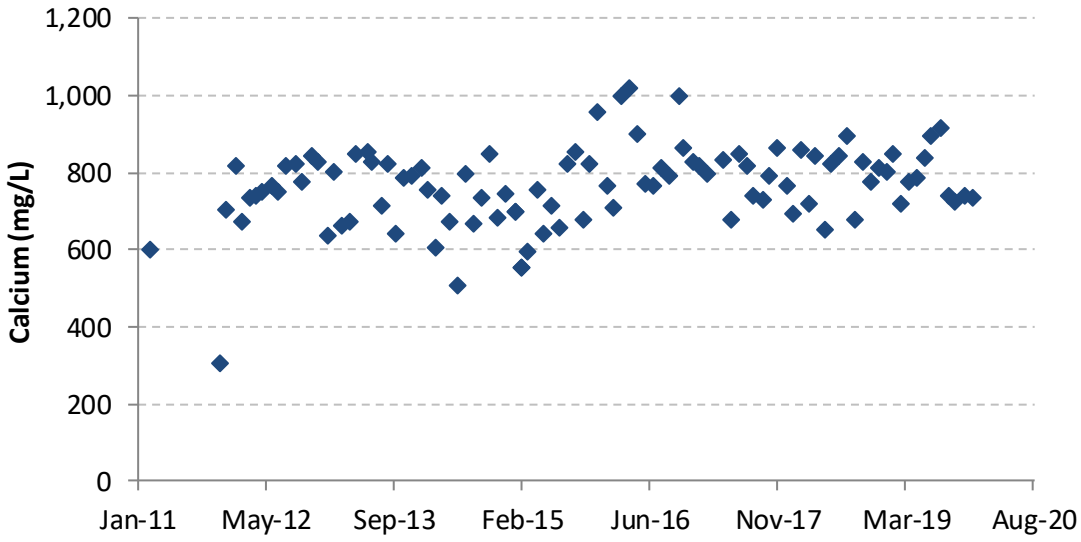


Figure D-6 Calcium recorded at monitoring site LDP 9

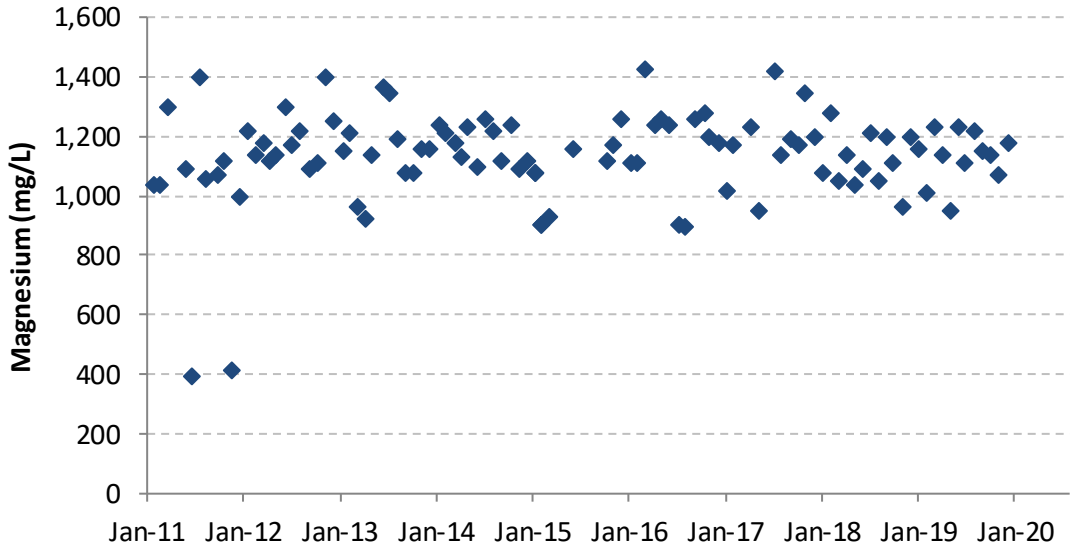


Figure D-7 **Magnesium recorded at monitoring site LDP 9**

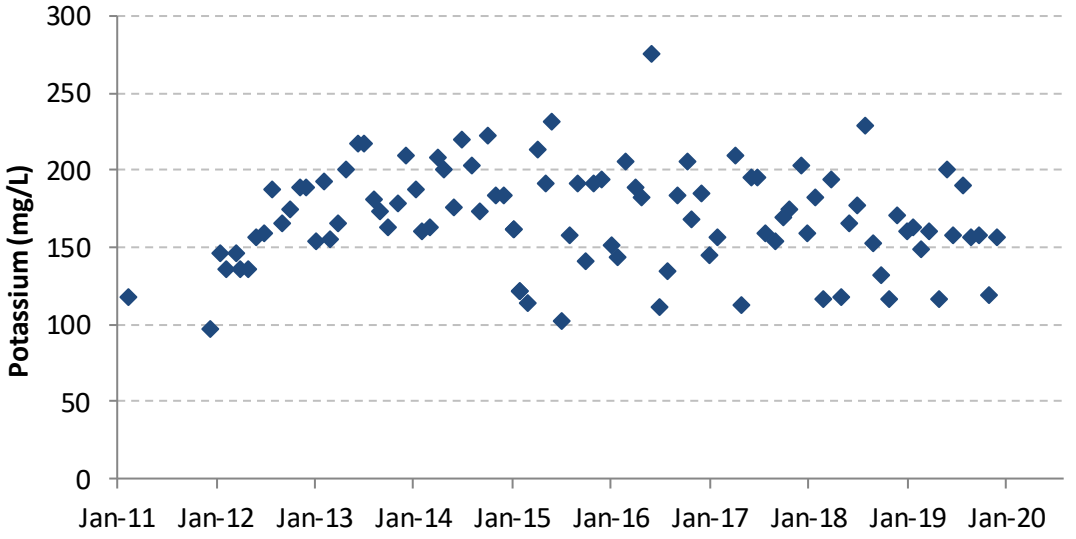


Figure D-8 **Potassium recorded at monitoring site LDP 9**

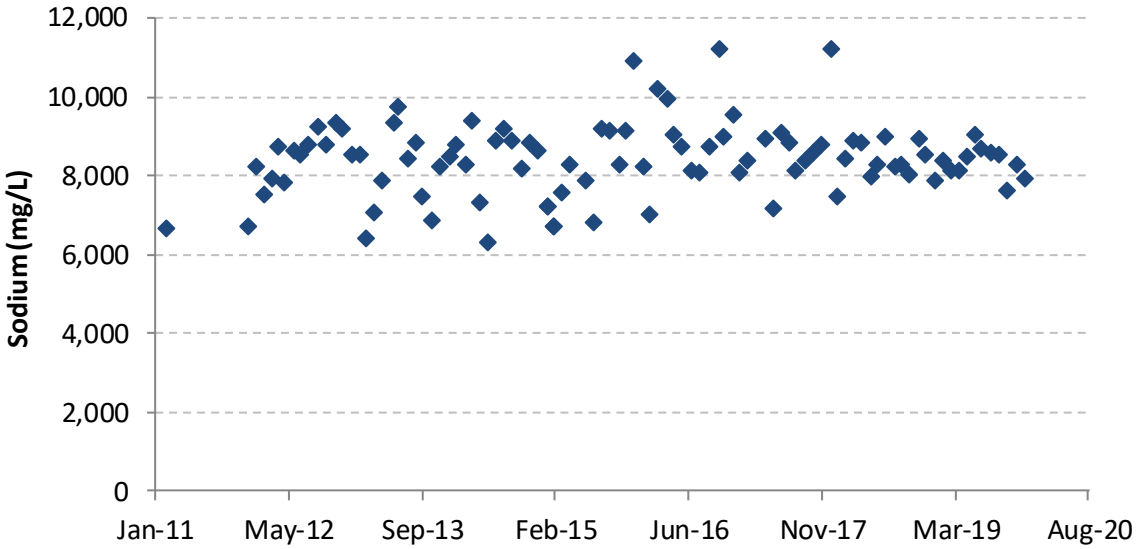


Figure D-9 **Sodium recorded at monitoring site LDP 9**

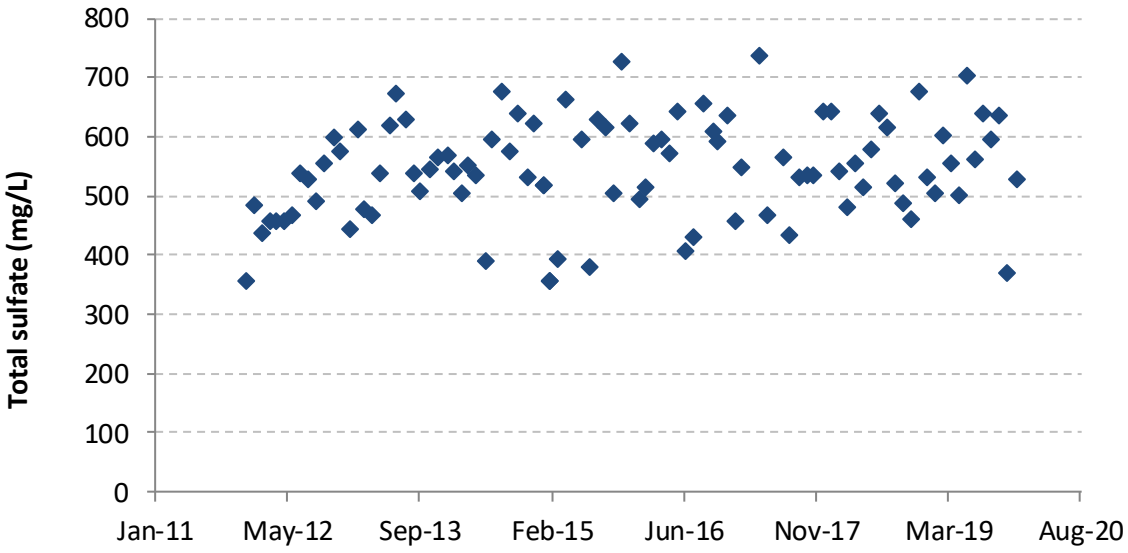


Figure D-10 Total Sulfate recorded at monitoring site LDP 9

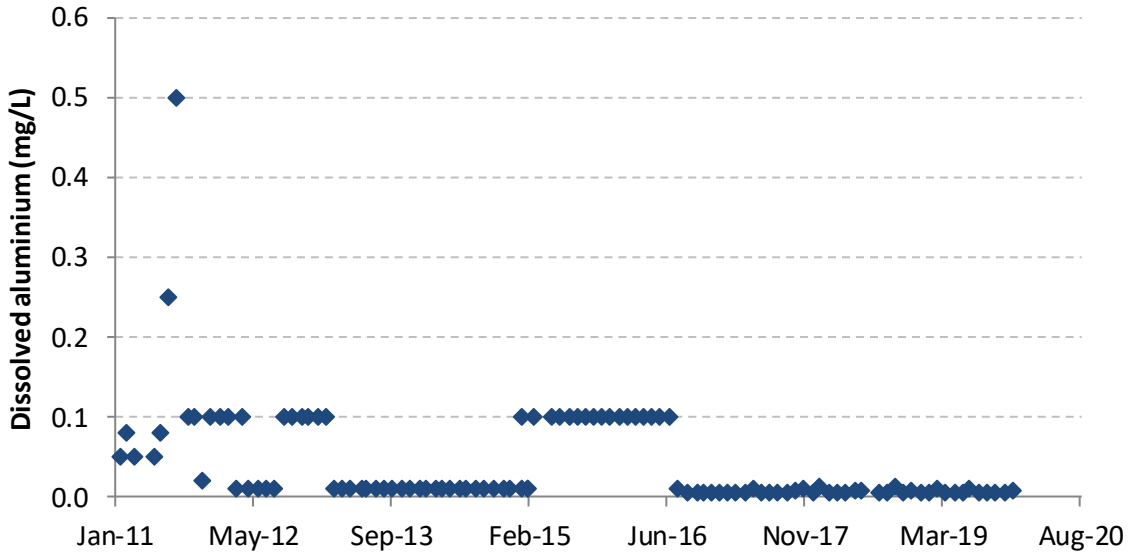


Figure D-11 Dissolved aluminium recorded at monitoring site LDP 9

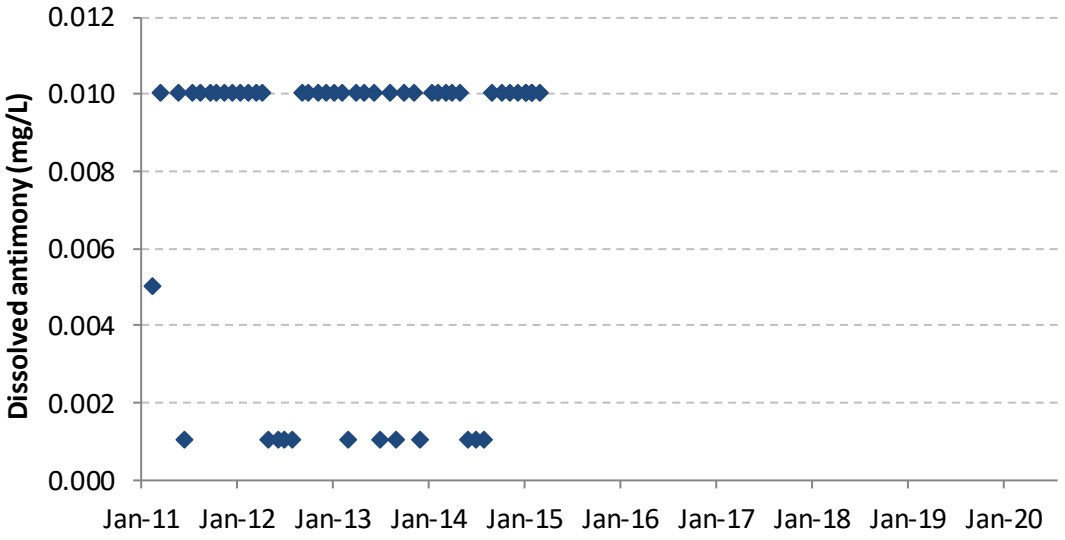


Figure D-12 Dissolved antimony recorded at monitoring site LDP 9

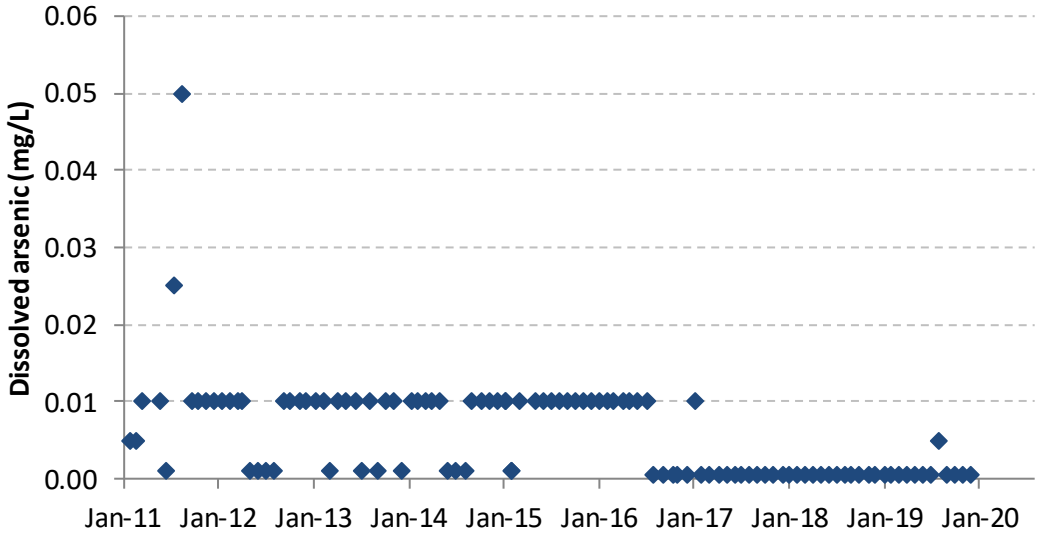


Figure D-13 Dissolved arsenic recorded at monitoring site LDP 9

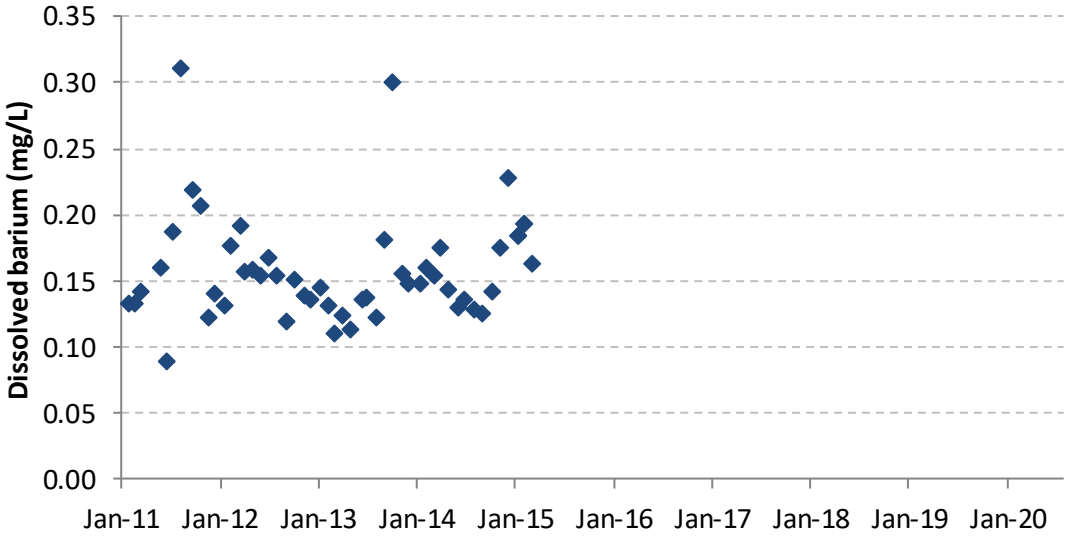


Figure D-14 Dissolved barium recorded at monitoring site LDP 9

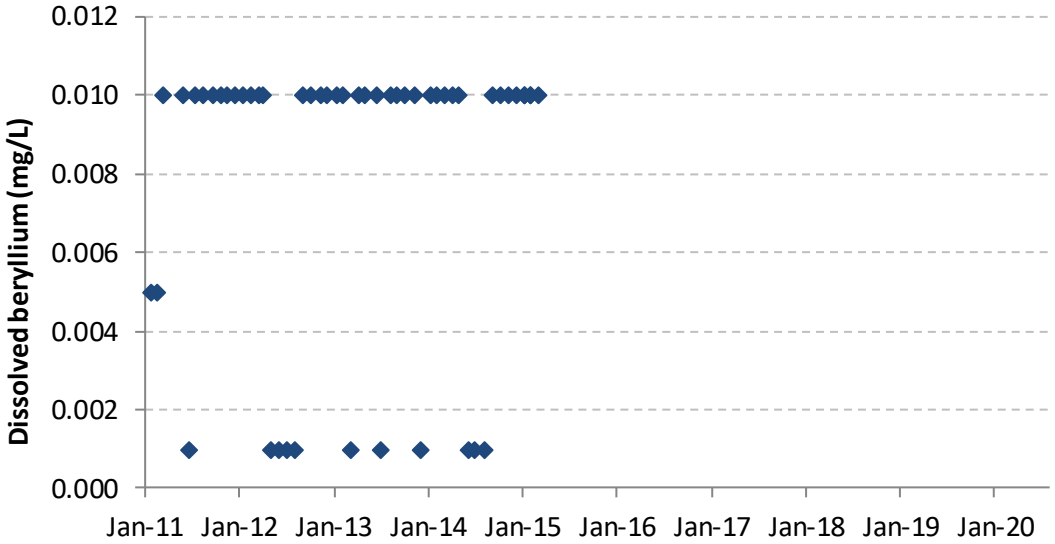


Figure D-15 Dissolved beryllium recorded at monitoring site LDP 9

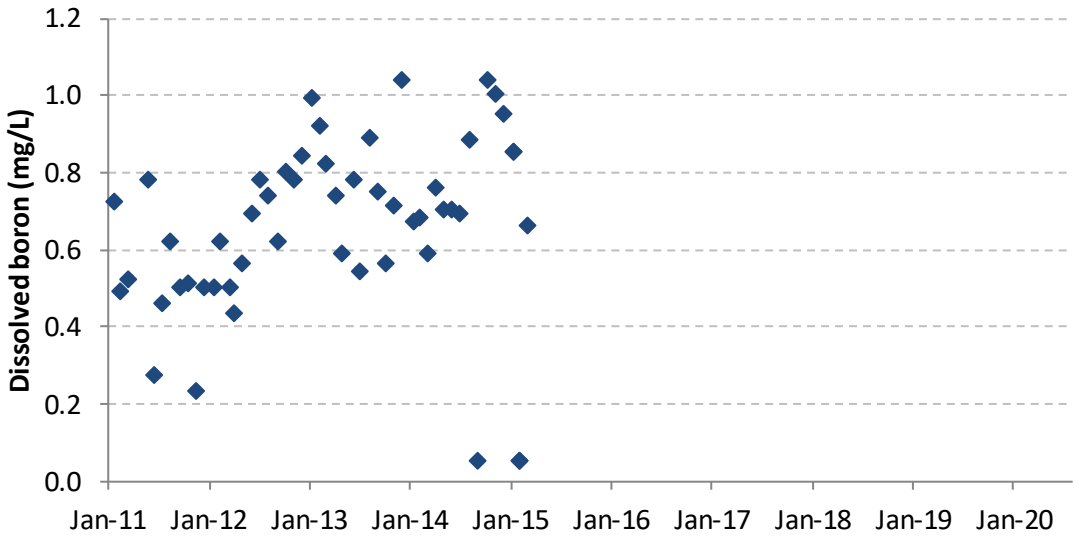


Figure D-16 Dissolved boron recorded at monitoring site LDP 9

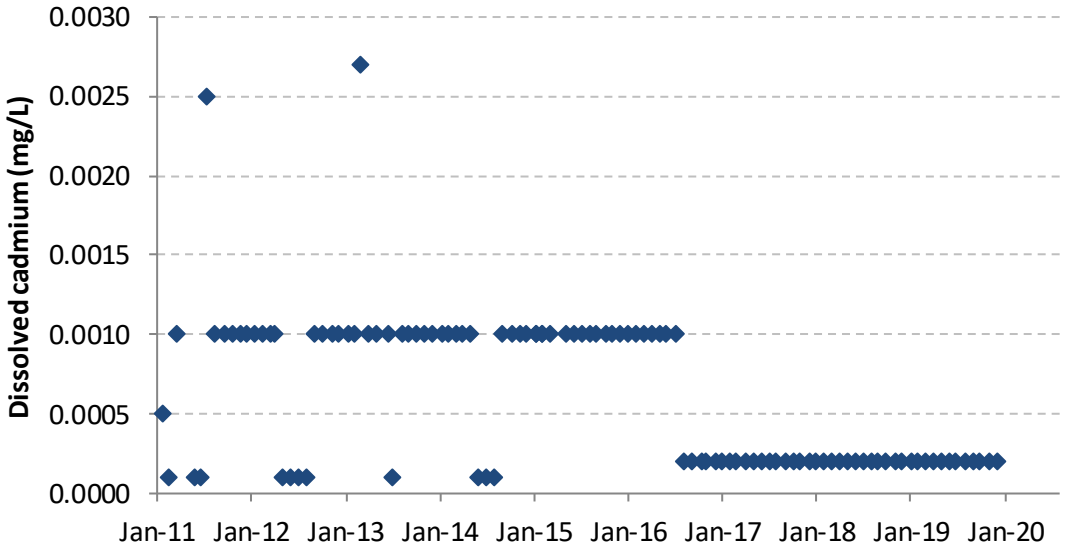


Figure D-17 Dissolved cadmium recorded at monitoring site LDP 9

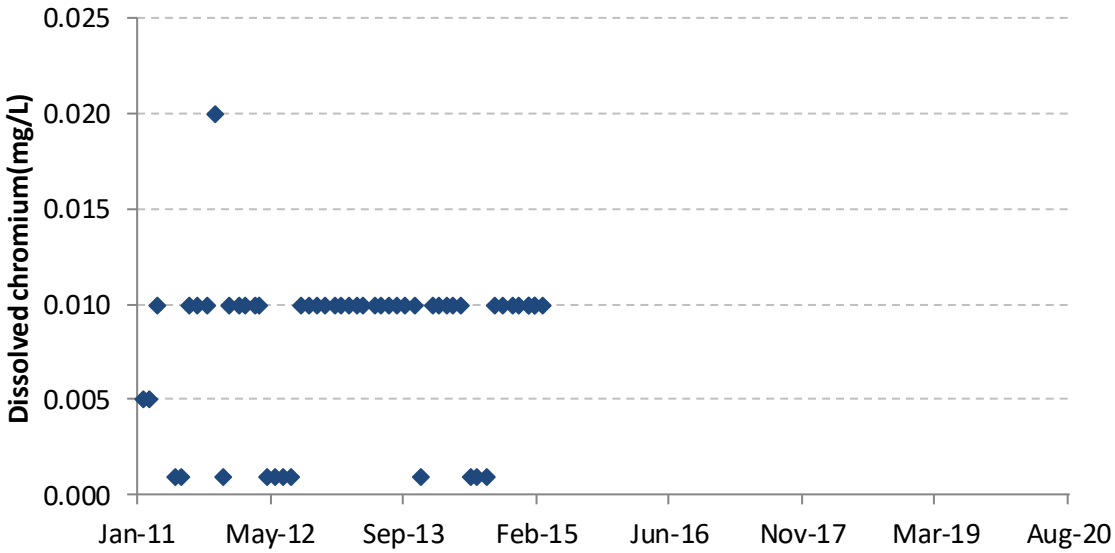


Figure D-18 Dissolved chromium recorded at monitoring site LDP 9

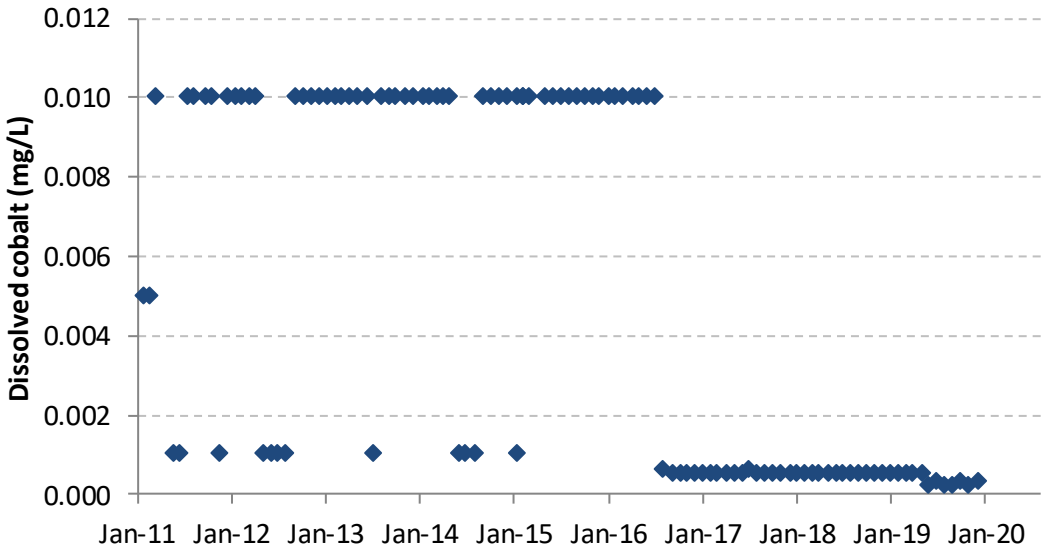


Figure D-19 Dissolved cobalt recorded at monitoring site LDP 9

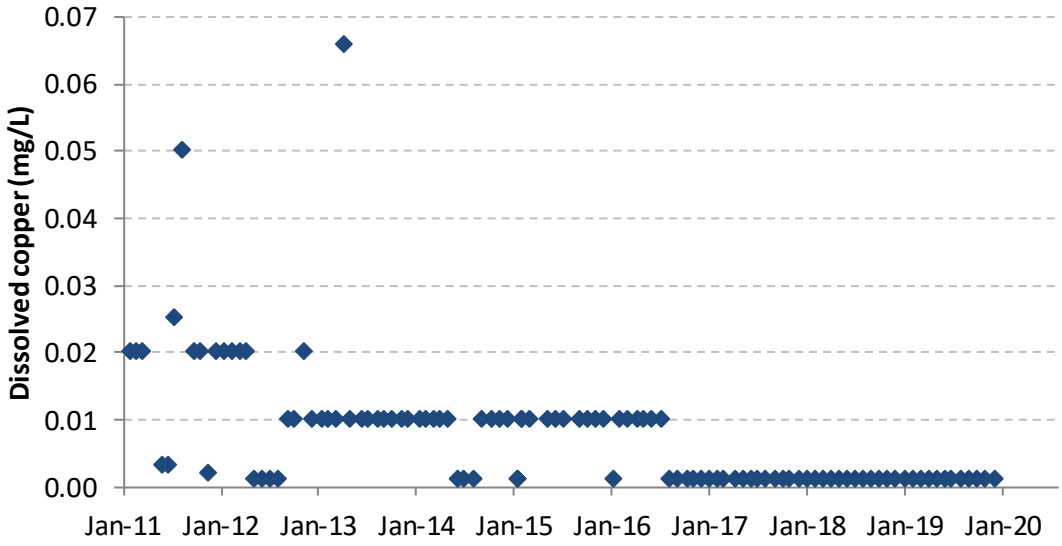


Figure D-20 Dissolved copper recorded at monitoring site LDP 9

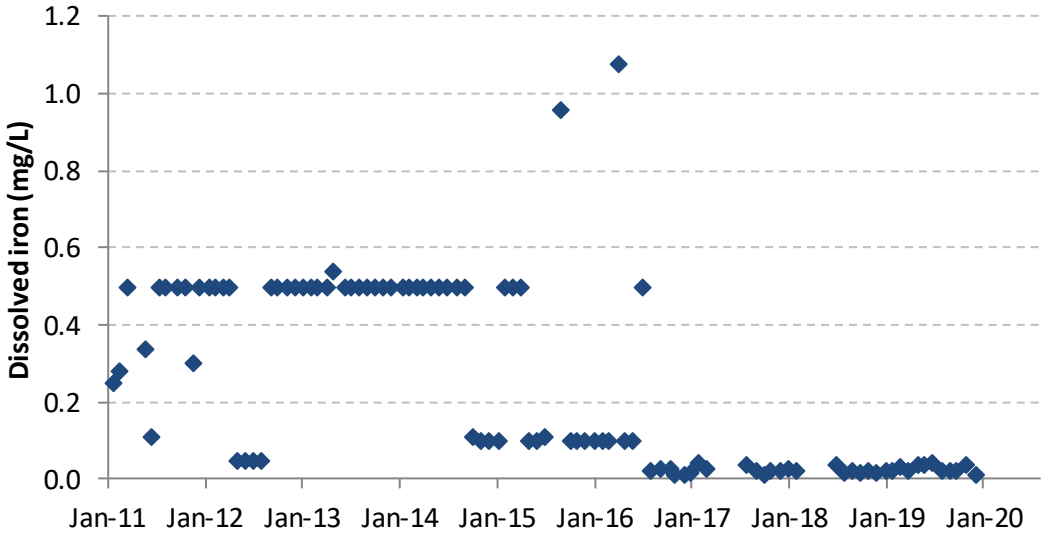


Figure D-21 Dissolved iron recorded at monitoring site LDP 9

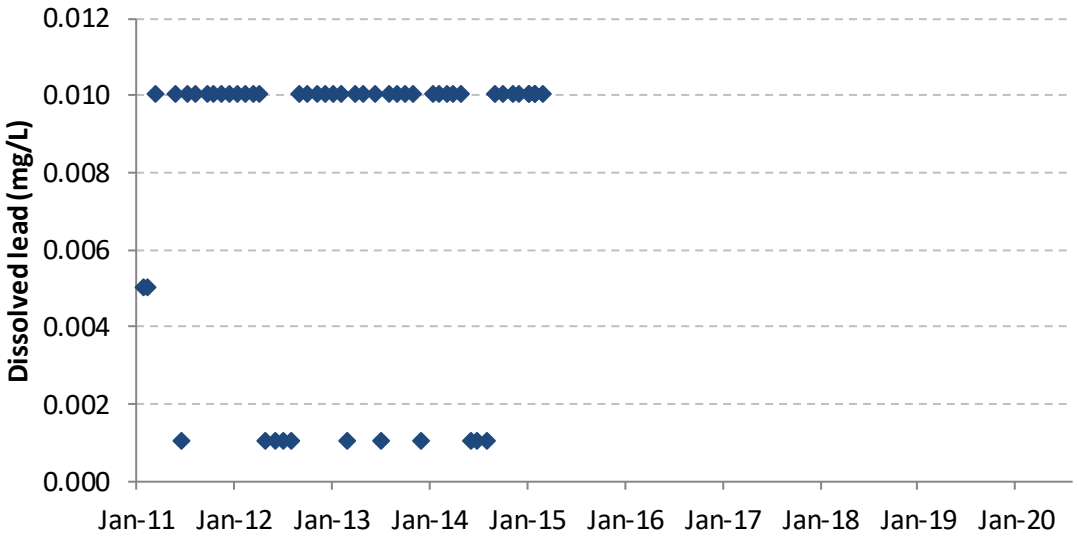


Figure D-22 Dissolved lead recorded at monitoring site LDP 9

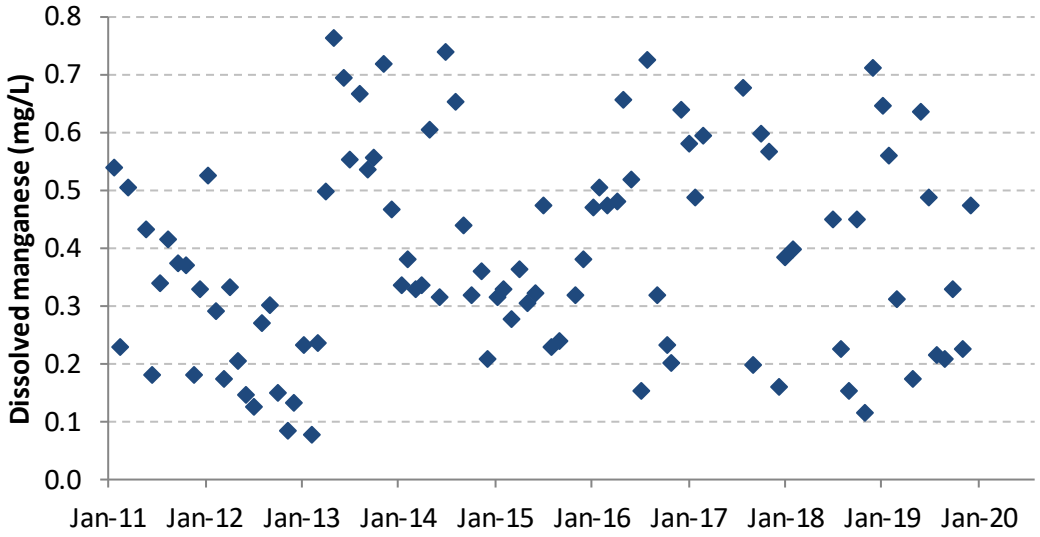


Figure D-23 Dissolved manganese recorded at monitoring site LDP 9

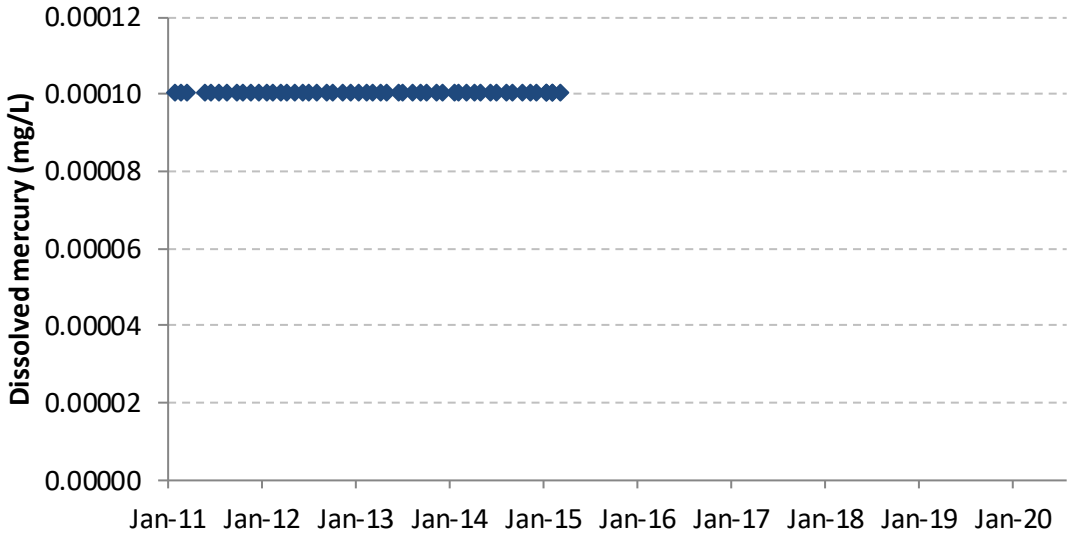


Figure D-24 Dissolved mercury recorded at monitoring site LDP 9

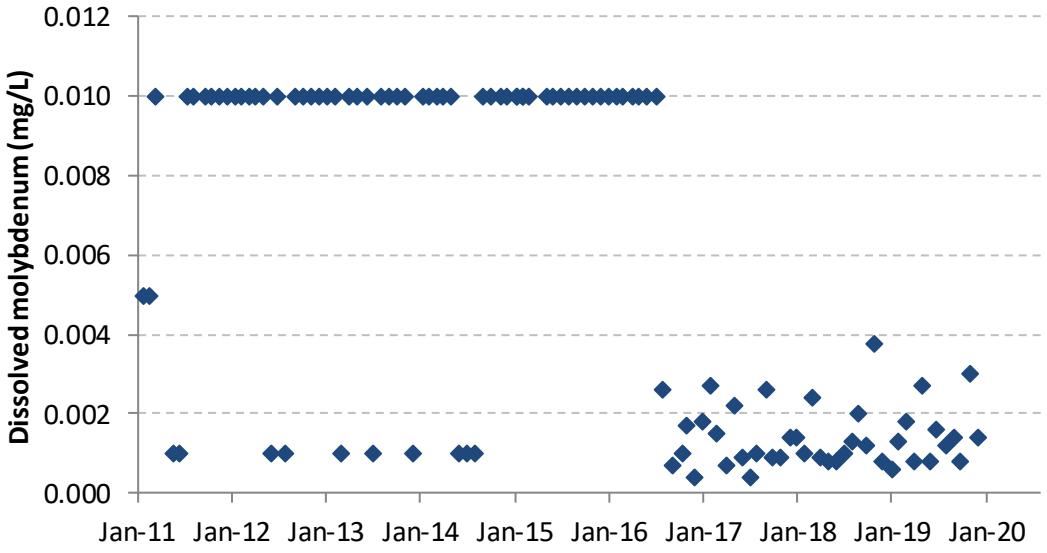


Figure D-25 Dissolved molybdenum recorded at monitoring site LDP 9

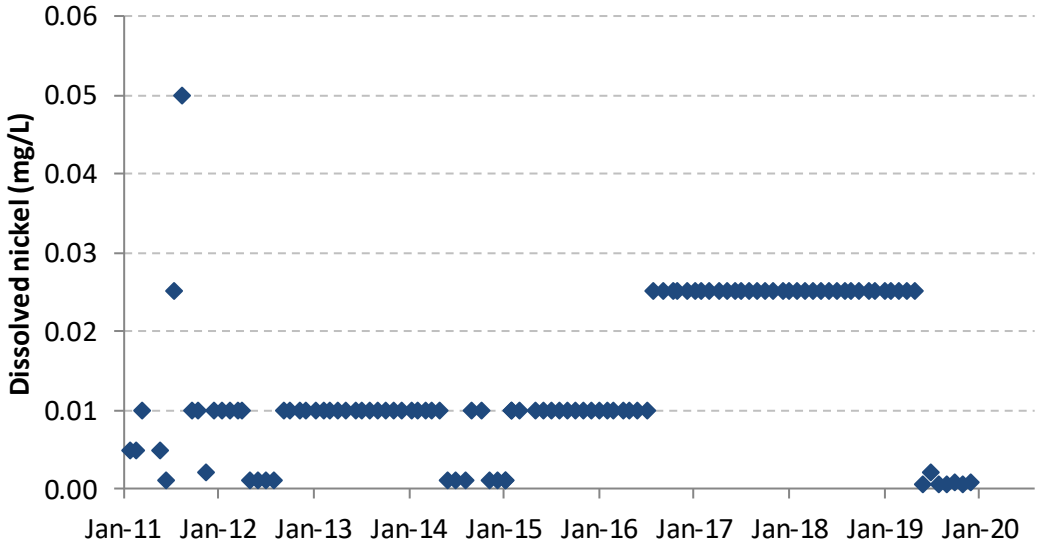


Figure D-26 Dissolved nickel recorded at monitoring site LDP 9

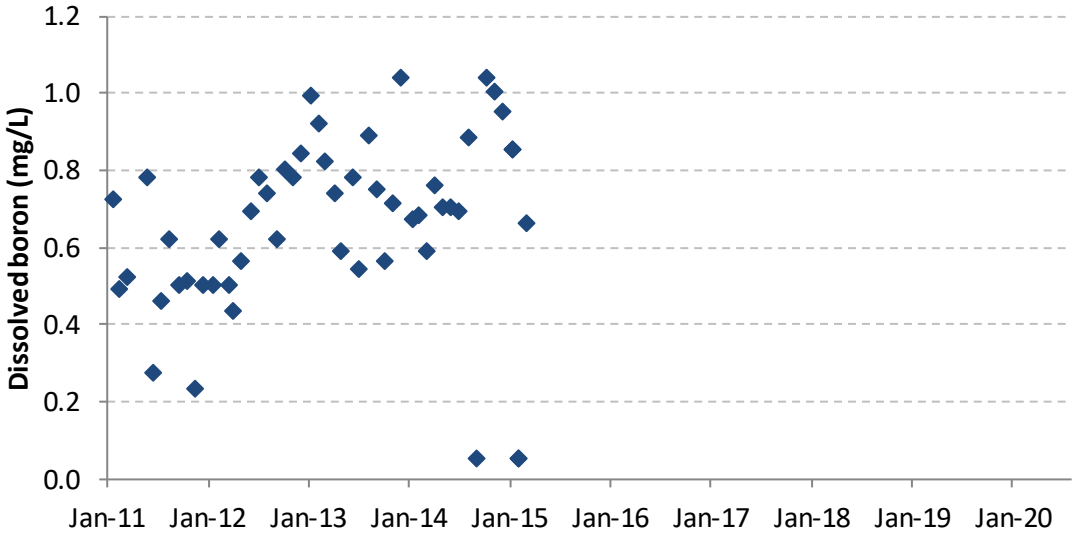


Figure D-27 Dissolved boron recorded at monitoring site LDP 9

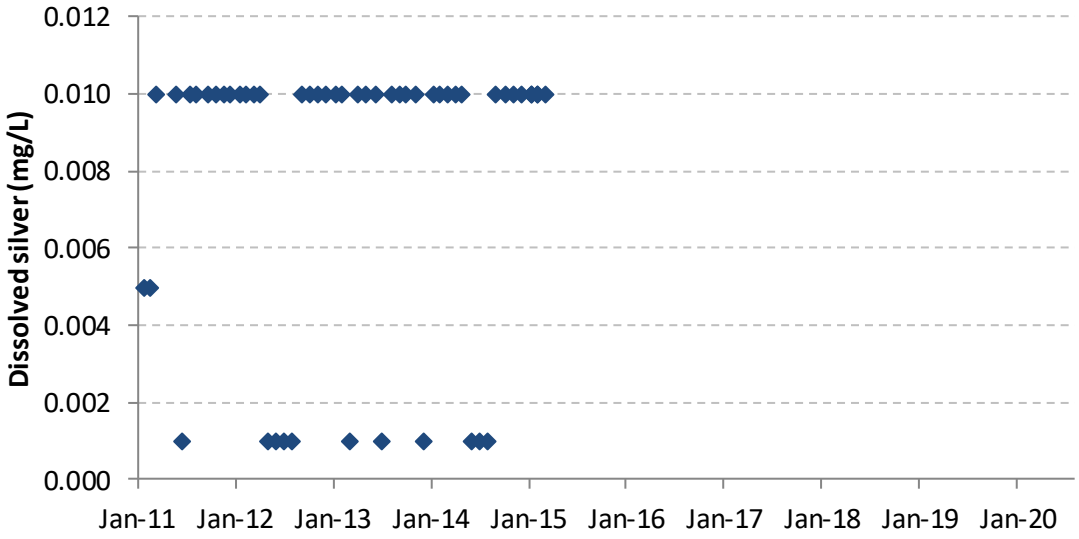


Figure D-28 Dissolved silver recorded at monitoring site LDP 9

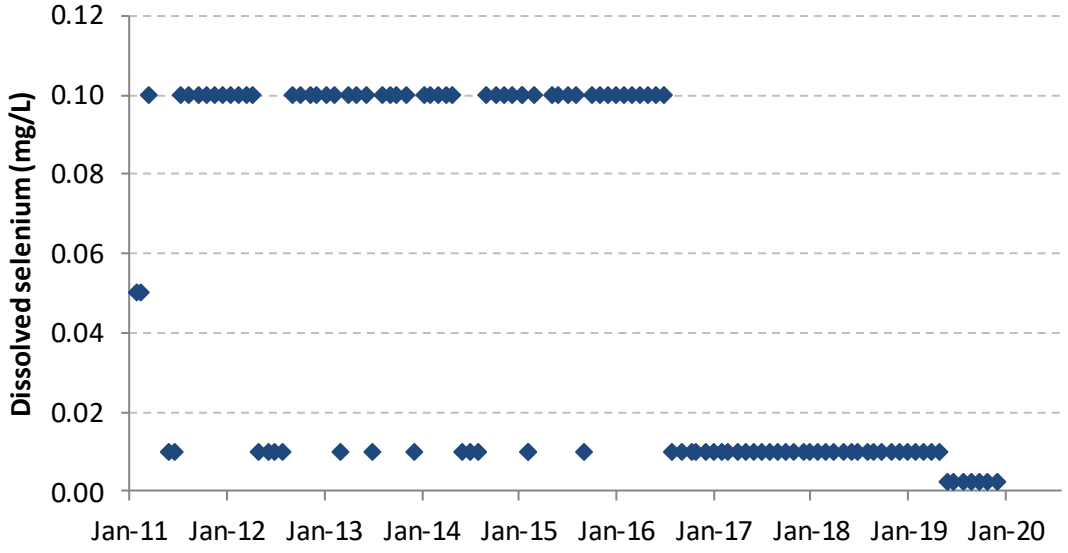


Figure D-28 Dissolved selenium recorded at monitoring site LDP 9

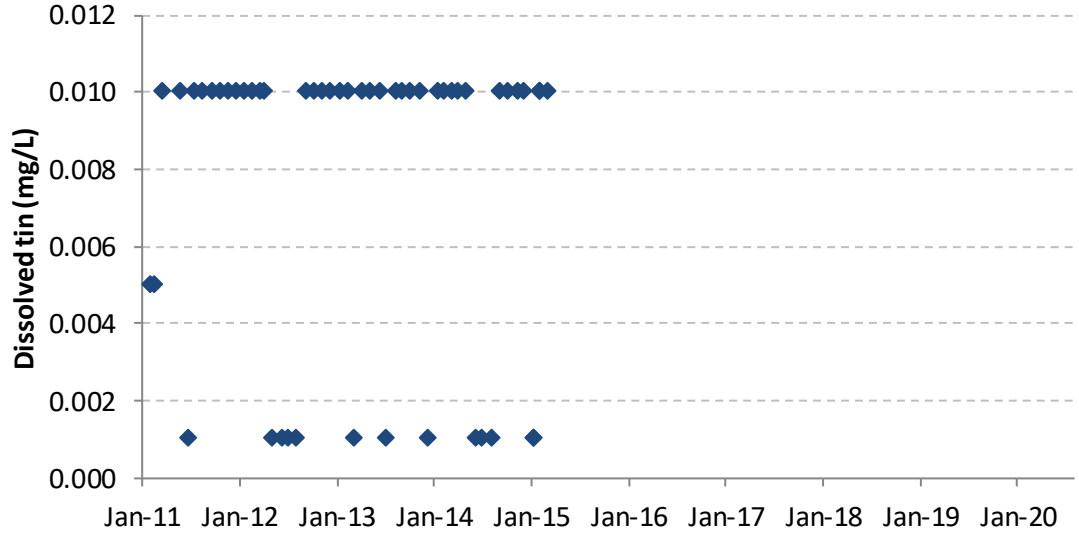


Figure D-29 Dissolved tin recorded at monitoring site LDP 9

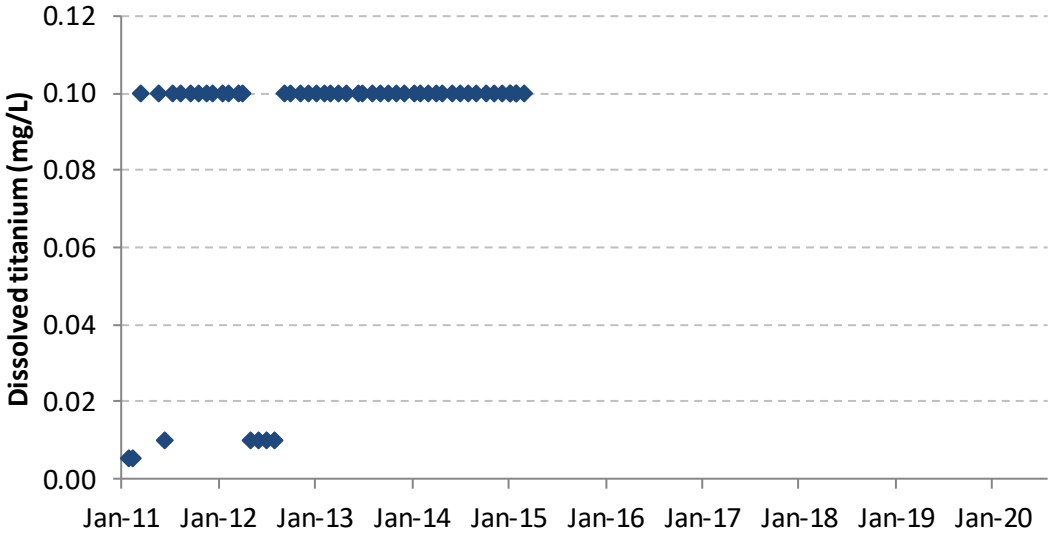


Figure D-30 Dissolved titanium recorded at monitoring site LDP 9

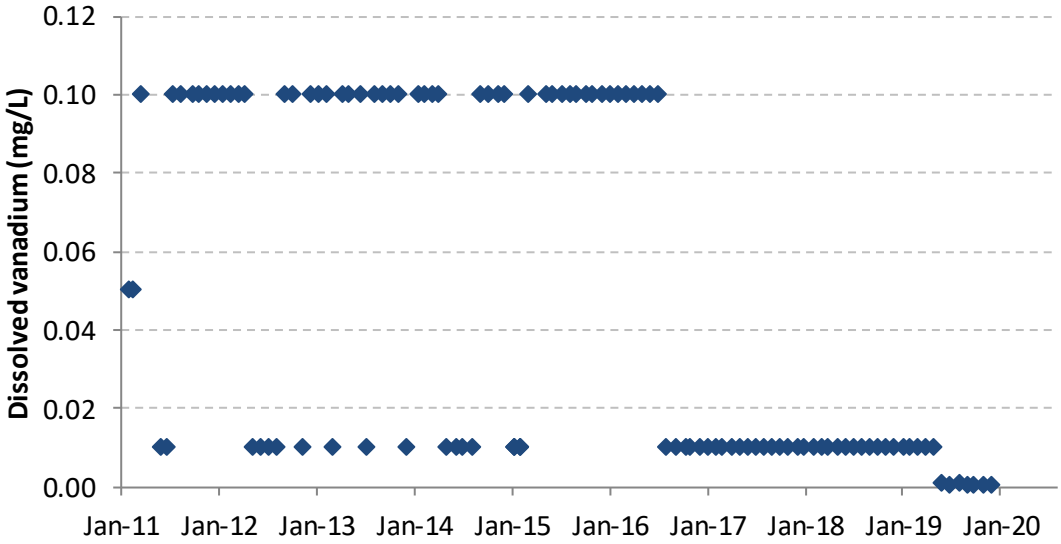


Figure D-31 Dissolved vanadium recorded at monitoring site LDP 9

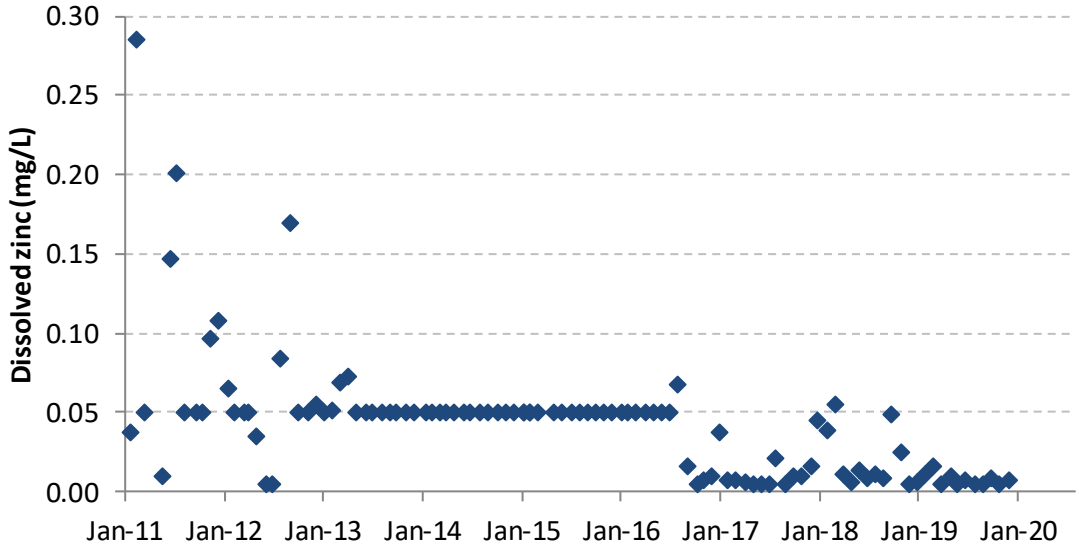


Figure D-32 Dissolved zinc recorded at monitoring site LDP 9

Appendix E – Groundwater monitoring data

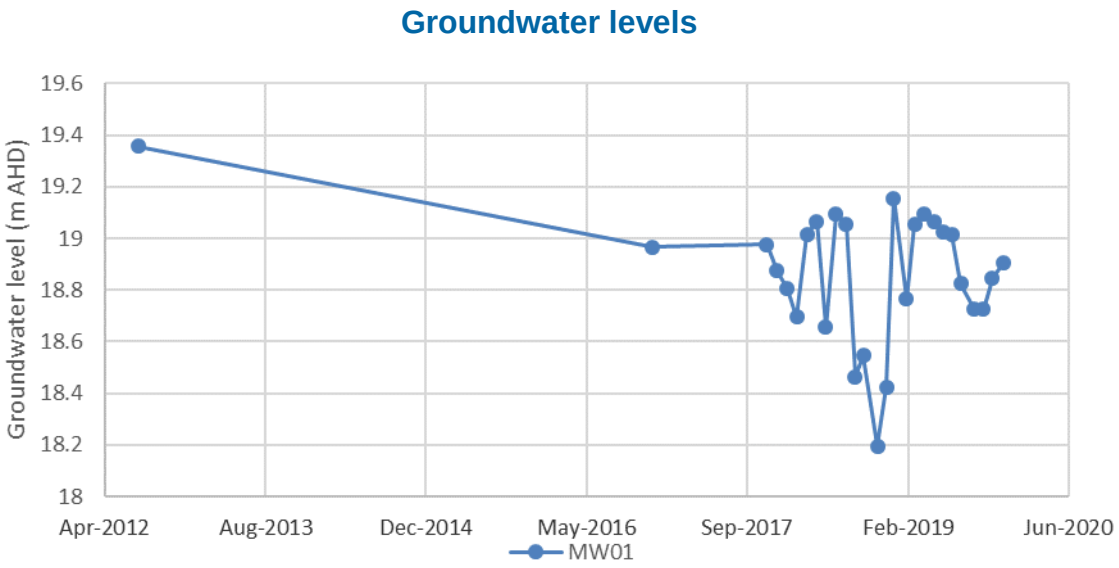


Figure E-1 Groundwater level recorded in MW01

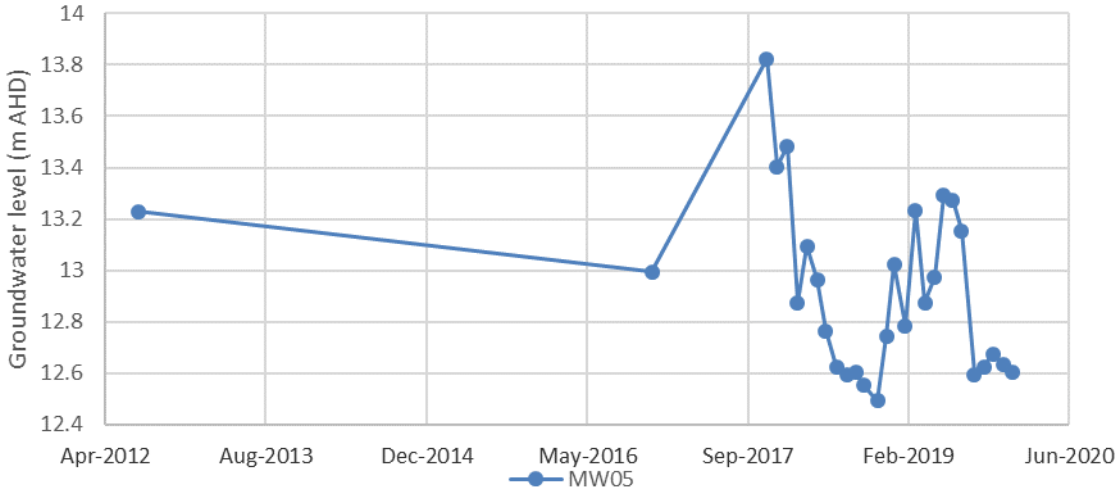


Figure E-2 Groundwater level recorded in MW05

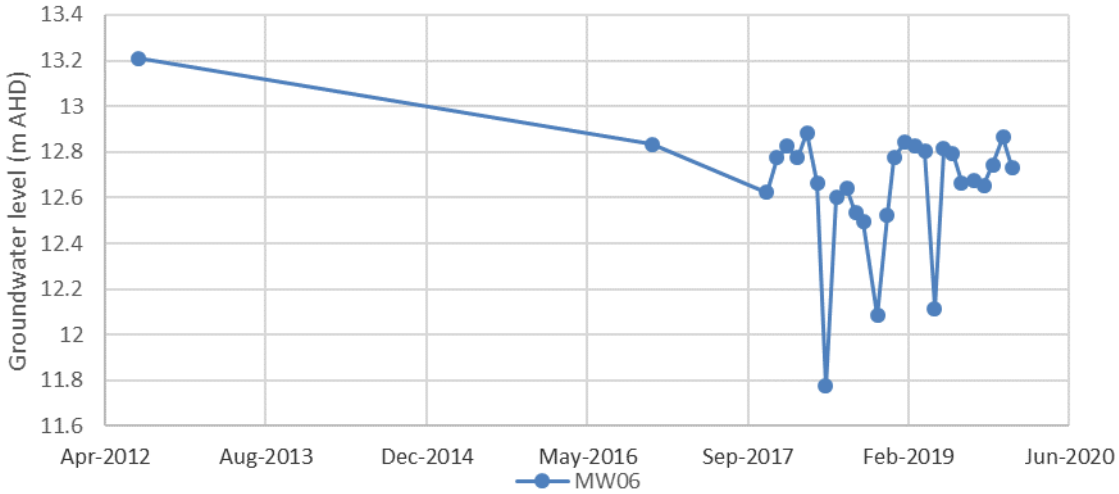


Figure E-3 Groundwater level recorded in MW06

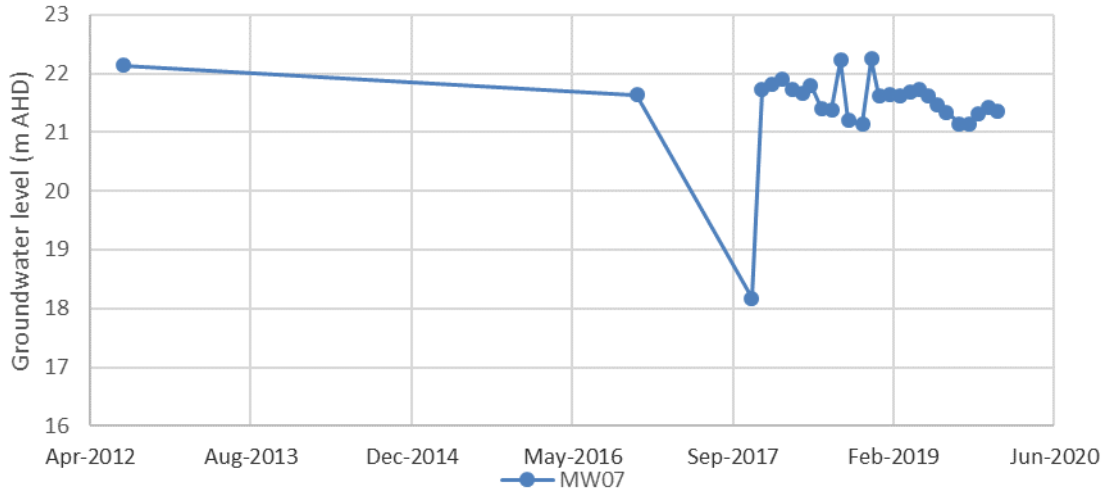


Figure E-4 Groundwater level recorded in MW07

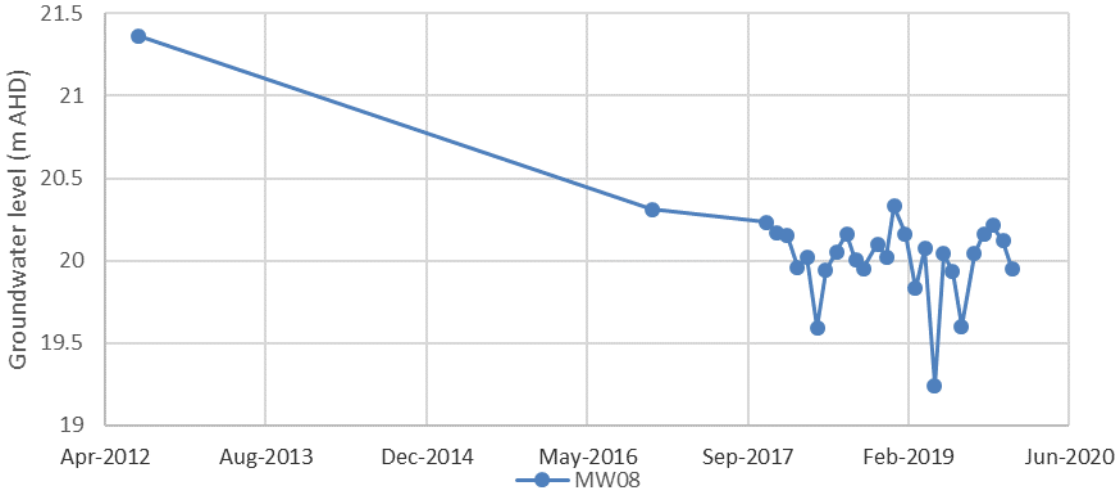


Figure E-5 Groundwater level recorded in MW08

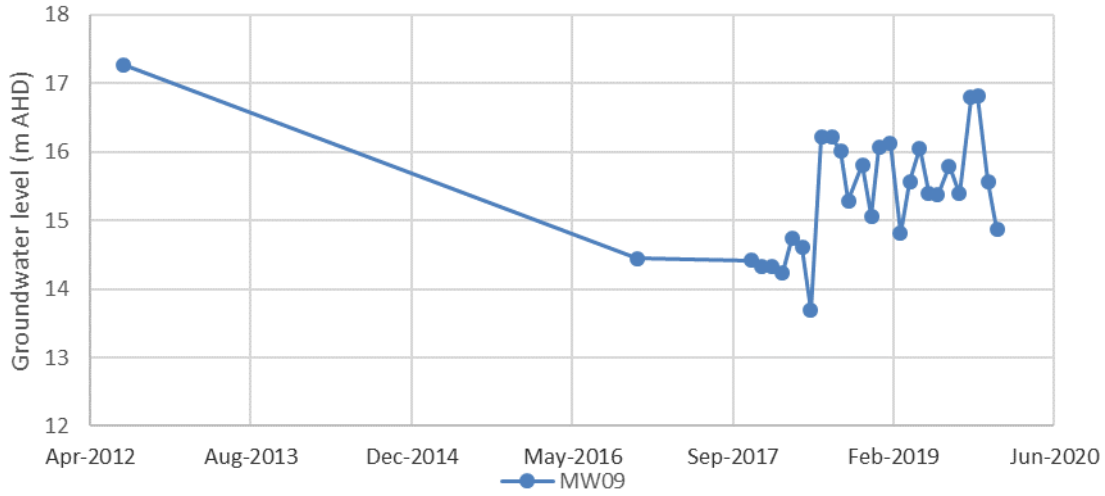


Figure E-6 Groundwater level recorded in MW09

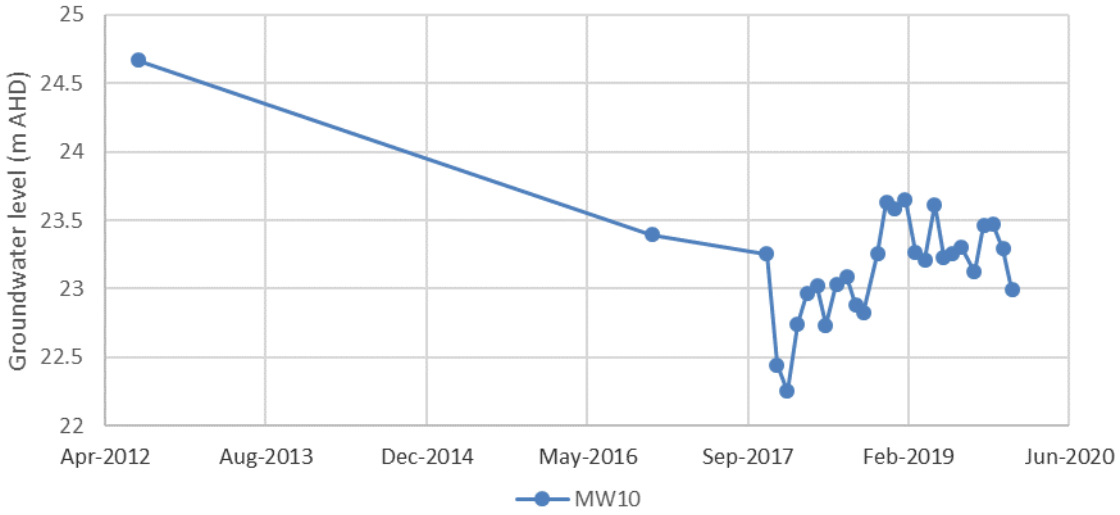


Figure E-7 Groundwater level recorded in MW10

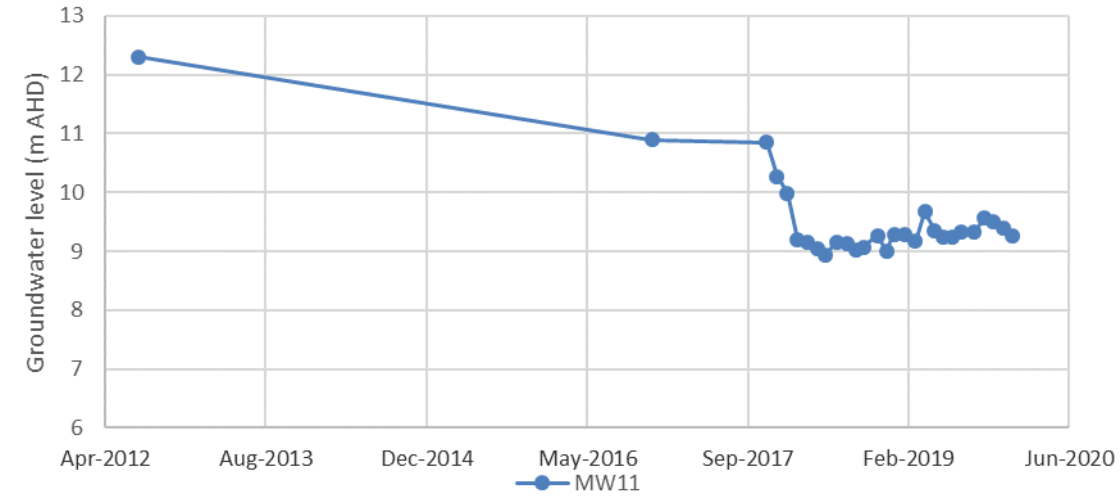


Figure E-8 Groundwater level recorded in MW11

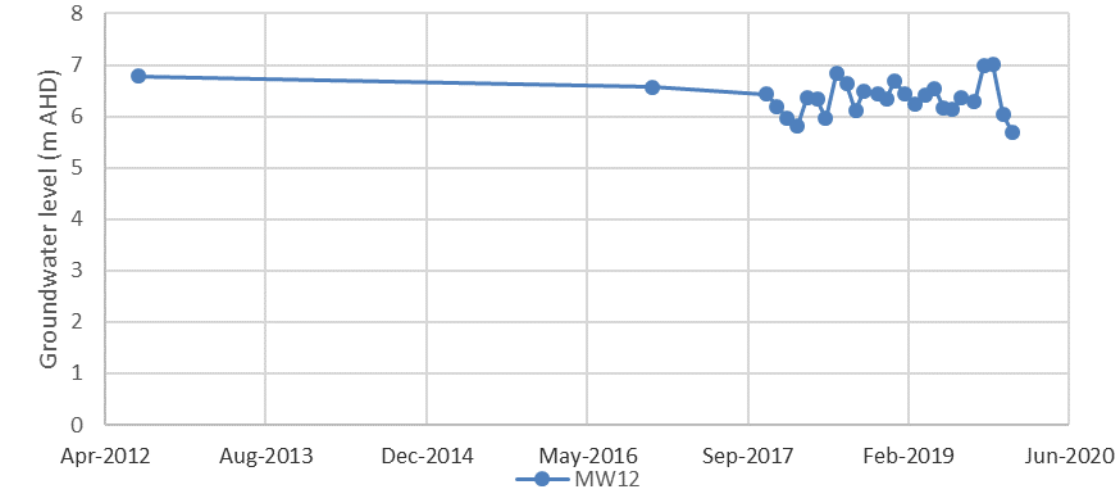


Figure E-9 Groundwater level recorded in MW12

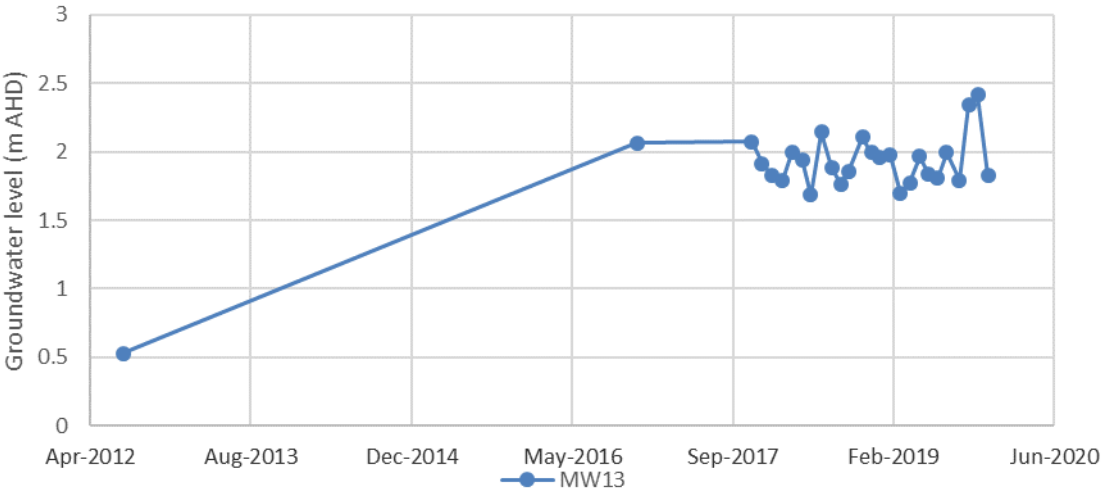


Figure E-10 Groundwater level recorded in MW13

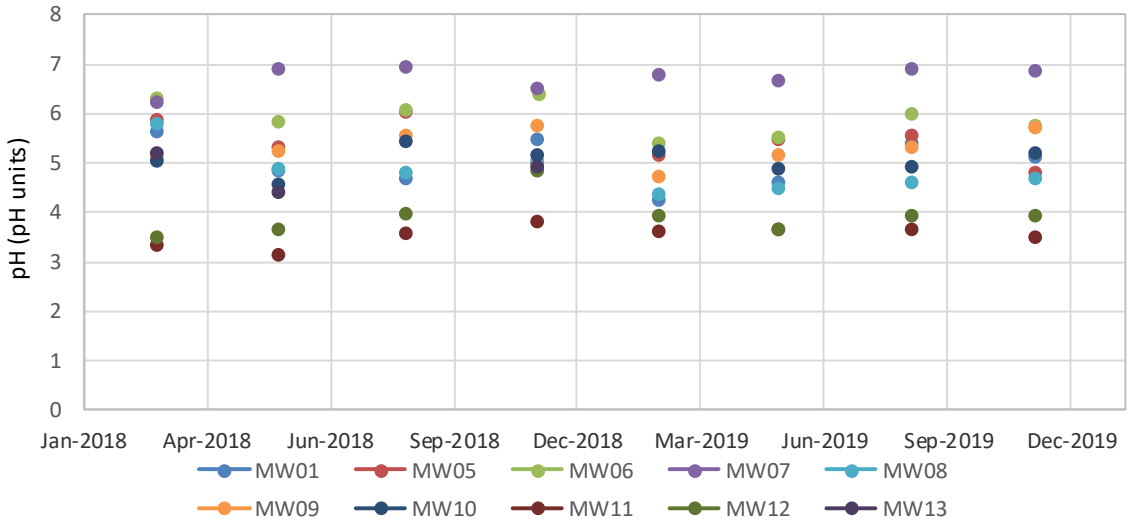


Figure E-10 pH monitored in groundwater

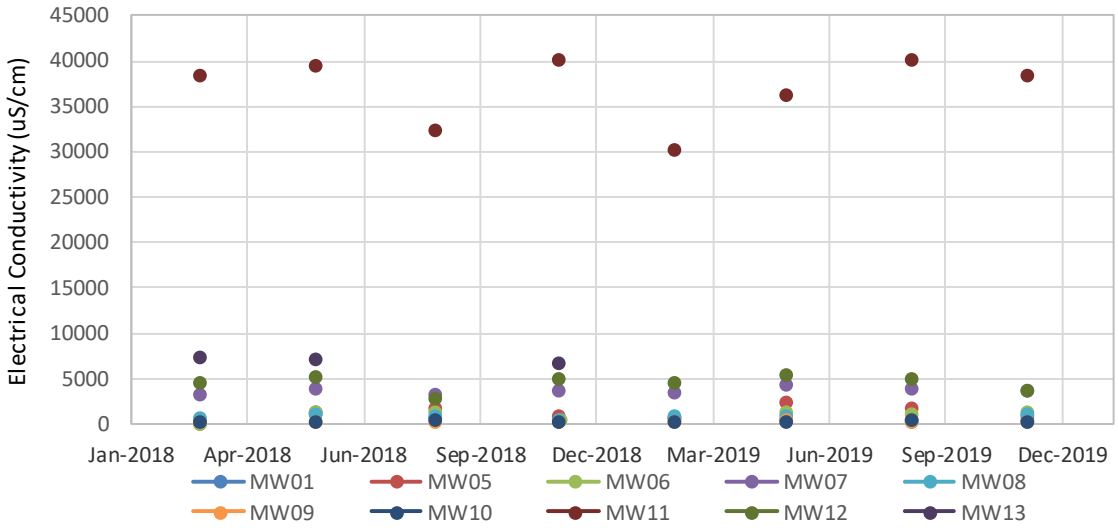


Figure E-11 Electrical conductivity monitored in groundwater

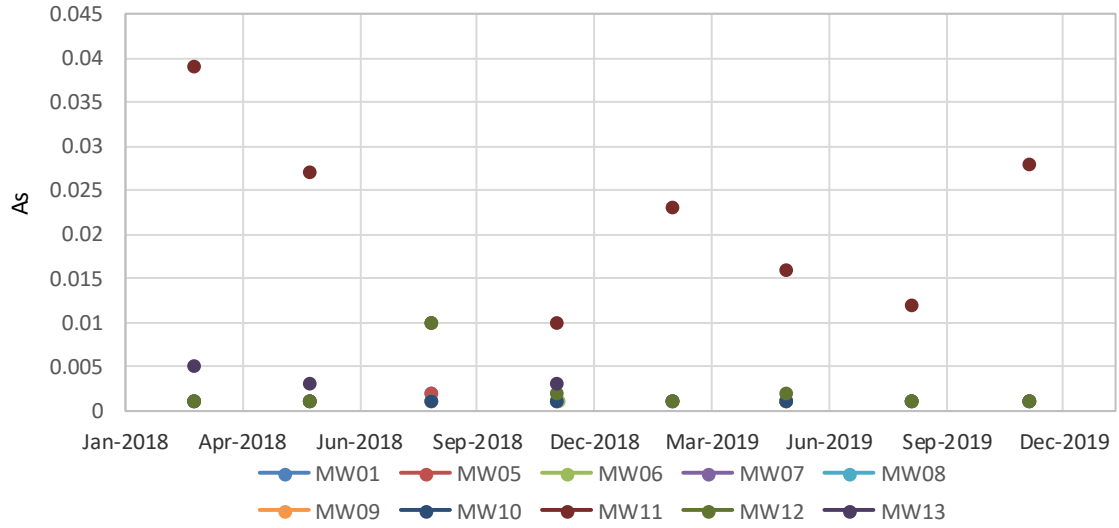


Figure E-12 Arsenic monitored in groundwater (mg/L)

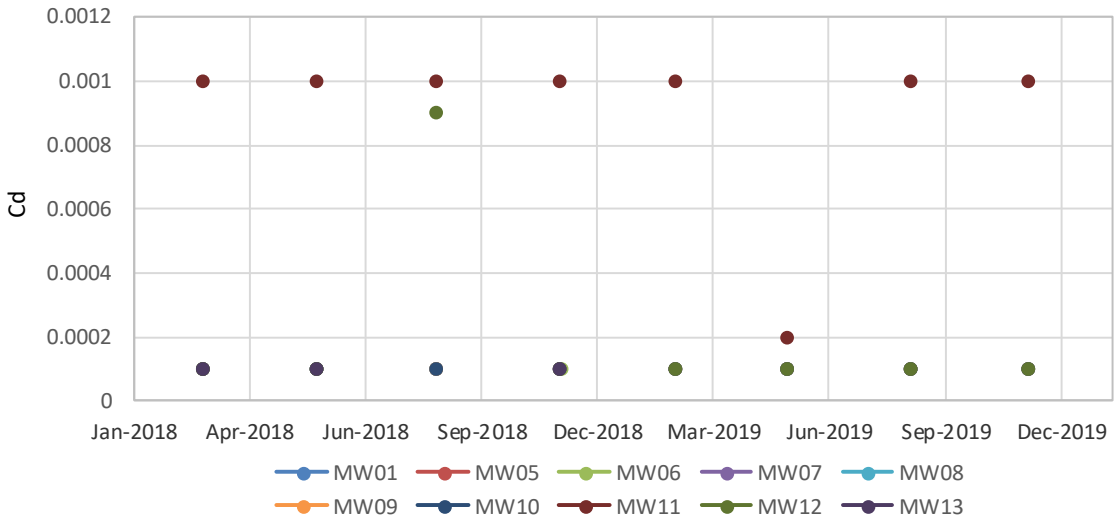


Figure E-13 Cadmium monitored in groundwater (mg/L)

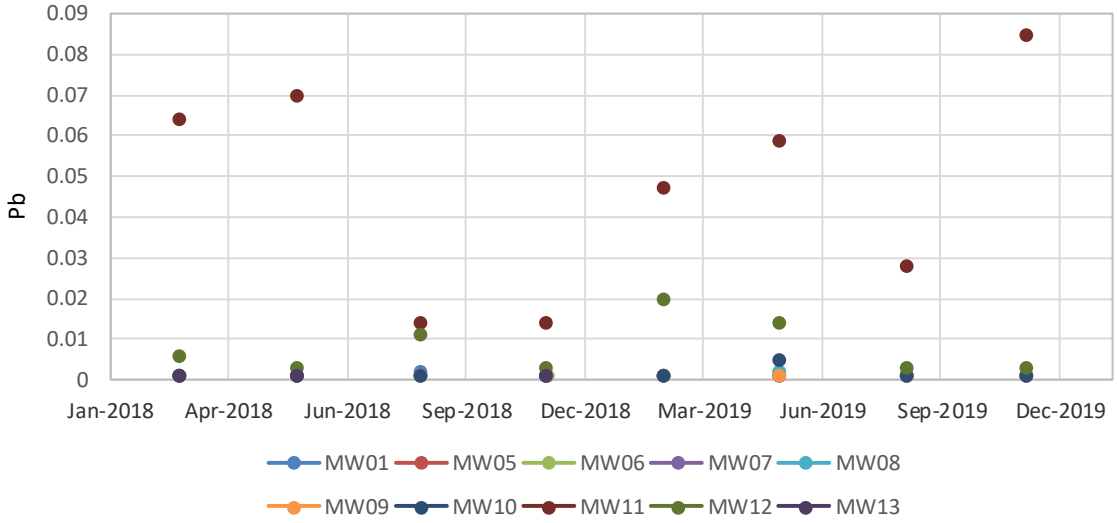


Figure E-14 Lead monitored in groundwater (mg/L)

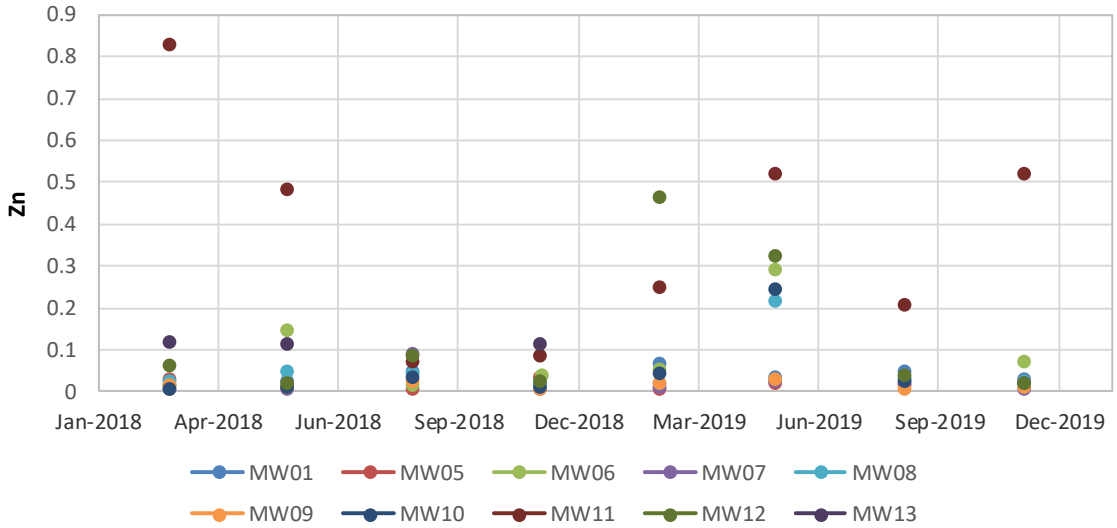


Figure E-15 Zinc monitored in groundwater (mg/L)

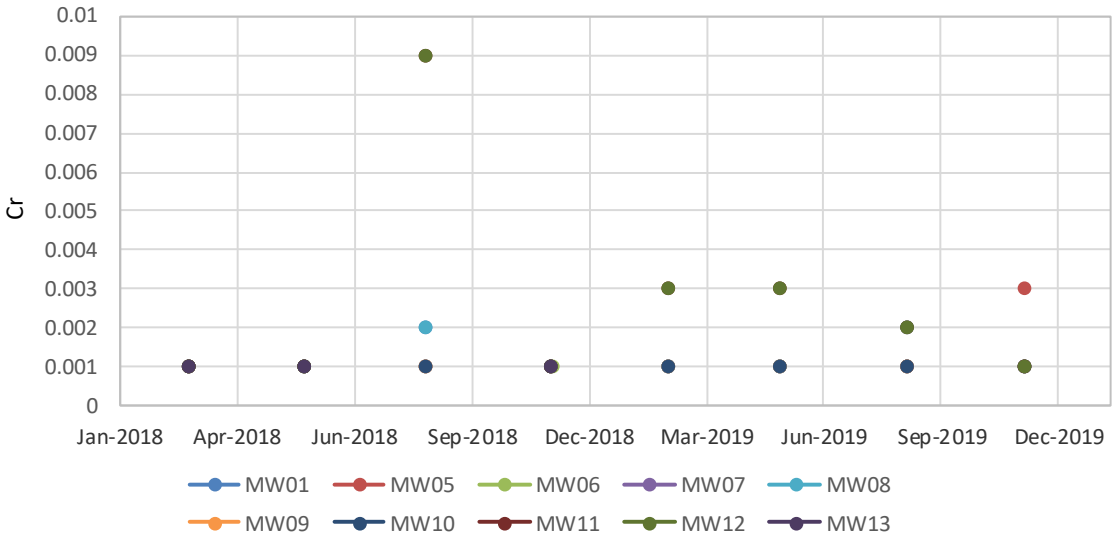


Figure E-16 Chromium monitored in groundwater (mg/L)

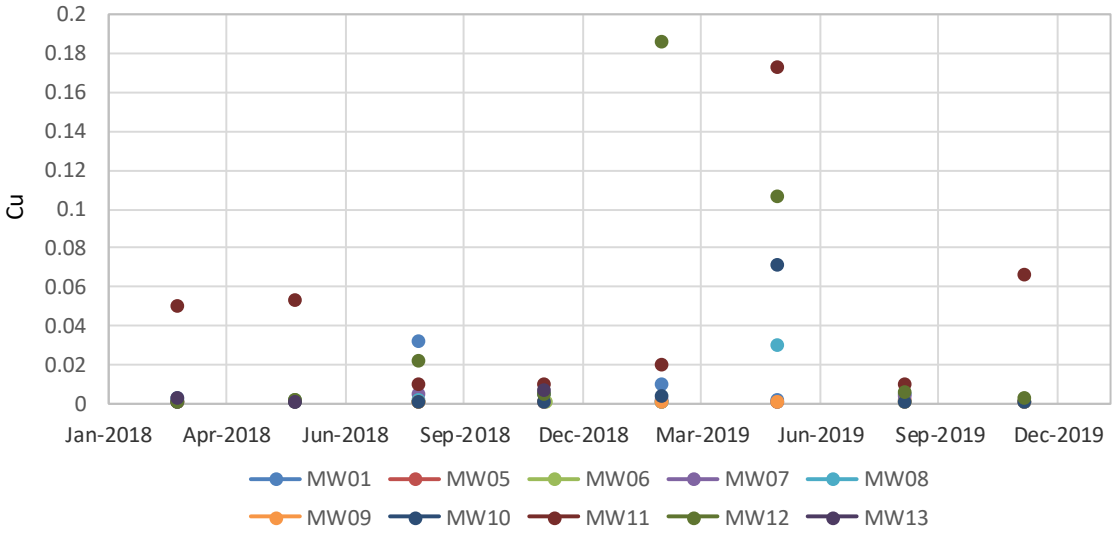


Figure E-17 Copper monitored in groundwater (mg/L)

Appendix F – Underground extraction data

Colliery Name	Date	Volume (ML/day)	Colliery Name	Date	Volume (ML/day)	Colliery Name	Date	Volume (ML/day)
Myuna	1/01/2019	3.304	Myuna	1/05/2019	3.591	Myuna	1/09/2019	3.638
Myuna	2/01/2019	3.332	Myuna	2/05/2019	5.023	Myuna	2/09/2019	5.738
Myuna	3/01/2019	3.664	Myuna	3/05/2019	5.926	Myuna	3/09/2019	7.884
Myuna	4/01/2019	3.351	Myuna	4/05/2019	6.754	Myuna	4/09/2019	6.655
Myuna	5/01/2019	3.158	Myuna	5/05/2019	6.73	Myuna	5/09/2019	4.095
Myuna	6/01/2019	3.781	Myuna	6/05/2019	3.87	Myuna	6/09/2019	4.757
Myuna	7/01/2019	6.549	Myuna	7/05/2019	2.495	Myuna	7/09/2019	5.203
Myuna	8/01/2019	7.08	Myuna	8/05/2019	3.18	Myuna	8/09/2019	5.31
Myuna	9/01/2019	7.077	Myuna	9/05/2019	3.814	Myuna	9/09/2019	5.336
Myuna	10/01/2019	7.431	Myuna	10/05/2019	5.9	Myuna	10/09/2019	5.351
Myuna	11/01/2019	7.143	Myuna	11/05/2019	7.472	Myuna	11/09/2019	5.43
Myuna	12/01/2019	7.112	Myuna	12/05/2019	7.59	Myuna	12/09/2019	7.212
Myuna	13/01/2019	7.334	Myuna	13/05/2019	7.667	Myuna	13/09/2019	8.869
Myuna	14/01/2019	4.503	Myuna	14/05/2019	4.46	Myuna	14/09/2019	8.484
Myuna	15/01/2019	6.247	Myuna	15/05/2019	3.834	Myuna	15/09/2019	7.101
Myuna	16/01/2019	7.569	Myuna	16/05/2019	3.831	Myuna	16/09/2019	7.185
Myuna	17/01/2019	6.706	Myuna	17/05/2019	6.089	Myuna	17/09/2019	7.696
Myuna	18/01/2019	8.438	Myuna	18/05/2019	7.448	Myuna	18/09/2019	5.658
Myuna	19/01/2019	5.757	Myuna	19/05/2019	7.193	Myuna	19/09/2019	3.687
Myuna	20/01/2019	5.573	Myuna	20/05/2019	3.806	Myuna	20/09/2019	3.641
Myuna	21/01/2019	6.26	Myuna	21/05/2019	2.785	Myuna	21/09/2019	3.601
Myuna	22/01/2019	5.829	Myuna	22/05/2019	2.755	Myuna	22/09/2019	3.658
Myuna	23/01/2019	5.905	Myuna	23/05/2019	2.384	Myuna	23/09/2019	3.488
Myuna	24/01/2019	5.92	Myuna	24/05/2019	2.539	Myuna	24/09/2019	5.233
Myuna	25/01/2019	5.767	Myuna	25/05/2019	2.606	Myuna	25/09/2019	5.653
Myuna	26/01/2019	5.577	Myuna	26/05/2019	2.913	Myuna	26/09/2019	5.658
Myuna	27/01/2019	5.779	Myuna	27/05/2019	4.691	Myuna	27/09/2019	5.471
Myuna	28/01/2019	6.131	Myuna	28/05/2019	5.965	Myuna	28/09/2019	5.42
Myuna	29/01/2019	5.723	Myuna	29/05/2019	4.472	Myuna	29/09/2019	5.502
Myuna	30/01/2019	5.824	Myuna	30/05/2019	4.278	Myuna	30/09/2019	6.693
Myuna	31/01/2019	7.253	Myuna	31/05/2019	5.512	Myuna	1/10/2019	7.272
Myuna	1/02/2019	9.62	Myuna	1/06/2019	6.99	Myuna	2/10/2019	6.903
Myuna	2/02/2019	9.62	Myuna	2/06/2019	6.819	Myuna	3/10/2019	4.647
Myuna	3/02/2019	8.869	Myuna	3/06/2019	6.749	Myuna	4/10/2019	3.098
Myuna	4/02/2019	7.429	Myuna	4/06/2019	5.144	Myuna	5/10/2019	3.841
Myuna	5/02/2019	7.135	Myuna	5/06/2019	4.922	Myuna	6/10/2019	4.148
Myuna	6/02/2019	7.1	Myuna	6/06/2019	7.285	Myuna	7/10/2019	3.098
Myuna	7/02/2019	7.078	Myuna	7/06/2019	7.287	Myuna	8/10/2019	3.086
Myuna	8/02/2019	4.767	Myuna	8/06/2019	6.828	Myuna	9/10/2019	3.087
Myuna	9/02/2019	3.247	Myuna	9/06/2019	3.636	Myuna	10/10/2019	3.051
Myuna	10/02/2019	2.532	Myuna	10/06/2019	3.702	Myuna	11/10/2019	5.543
Myuna	11/02/2019	3.222	Myuna	11/06/2019	5.363	Myuna	12/10/2019	5.306
Myuna	12/02/2019	5.451	Myuna	12/06/2019	5.994	Myuna	13/10/2019	7.052
Myuna	13/02/2019	5.866	Myuna	13/06/2019	5.91	Myuna	14/10/2019	6.935
Myuna	14/02/2019	4.664	Myuna	14/06/2019	5.978	Myuna	15/10/2019	6.646
Myuna	15/02/2019	3.514	Myuna	15/06/2019	6.205	Myuna	16/10/2019	6.731
Myuna	16/02/2019	3.4925	Myuna	16/06/2019	6.114	Myuna	17/10/2019	6.258
Myuna	17/02/2019	3.471	Myuna	17/06/2019	4.442	Myuna	18/10/2019	6.151

Colliery Name	Date	Volume (ML/day)	Colliery Name	Date	Volume (ML/day)	Colliery Name	Date	Volume (ML/day)
Myuna	18/02/2019	3.4495	Myuna	18/06/2019	6.261	Myuna	19/10/2019	6.069
Myuna	19/02/2019	3.342	Myuna	19/06/2019	7.509	Myuna	20/10/2019	3.109
Myuna	20/02/2019	6.115	Myuna	20/06/2019	7.827	Myuna	21/10/2019	2.717
Myuna	21/02/2019	7.917	Myuna	21/06/2019	7.57	Myuna	22/10/2019	2.803
Myuna	22/02/2019	4.714	Myuna	22/06/2019	4.555	Myuna	23/10/2019	2.746
Myuna	23/02/2019	3.591	Myuna	23/06/2019	3.717	Myuna	24/10/2019	2.847
Myuna	24/02/2019	3.438	Myuna	24/06/2019	3.755	Myuna	25/10/2019	3.513
Myuna	25/02/2019	6.062	Myuna	25/06/2019	3.831	Myuna	26/10/2019	4.196
Myuna	26/02/2019	7.164	Myuna	26/06/2019	3.856	Myuna	27/10/2019	4.859
Myuna	27/02/2019	7.117	Myuna	27/06/2019	3.641	Myuna	28/10/2019	4.954
Myuna	28/02/2019	4.409	Myuna	28/06/2019	3.701	Myuna	29/10/2019	2.578
Myuna	1/03/2019	3.431	Myuna	29/06/2019	3.788	Myuna	30/10/2019	2.019
Myuna	2/03/2019	3.479	Myuna	30/06/2019	3.677	Myuna	31/10/2019	2.626
Myuna	3/03/2019	3.202	Myuna	1/07/2019	7.665	Myuna	1/11/2019	2.739
Myuna	4/03/2019	3.216	Myuna	2/07/2019	9.457	Myuna	2/11/2019	2.824
Myuna	5/03/2019	3.158	Myuna	3/07/2019	9.213	Myuna	3/11/2019	2.002
Myuna	6/03/2019	3.493	Myuna	4/07/2019	8.954	Myuna	4/11/2019	3.465
Myuna	7/03/2019	3.598	Myuna	5/07/2019	7.841	Myuna	5/11/2019	2.801
Myuna	8/03/2019	4.899	Myuna	6/07/2019	6.007	Myuna	6/11/2019	2.936
Myuna	9/03/2019	5.626	Myuna	7/07/2019	6.035	Myuna	7/11/2019	2.719
Myuna	10/03/2019	5.401	Myuna	8/07/2019	6.002	Myuna	8/11/2019	2.708
Myuna	11/03/2019	5.386	Myuna	9/07/2019	5.993	Myuna	9/11/2019	2.379
Myuna	12/03/2019	7.491	Myuna	10/07/2019	6.146	Myuna	10/11/2019	2.647
Myuna	13/03/2019	8.066	Myuna	11/07/2019	5.916	Myuna	11/11/2019	3.601
Myuna	14/03/2019	8.687	Myuna	12/07/2019	4.313	Myuna	12/11/2019	5.882
Myuna	15/03/2019	9.271	Myuna	13/07/2019	3.591	Myuna	13/11/2019	7.07
Myuna	16/03/2019	9.55	Myuna	14/07/2019	3.677	Myuna	14/11/2019	7.112
Myuna	17/03/2019	9.682	Myuna	15/07/2019	6.035	Myuna	15/11/2019	6.958
Myuna	18/03/2019	4.353	Myuna	16/07/2019	7.723	Myuna	16/11/2019	6.728
Myuna	19/03/2019	3.67	Myuna	17/07/2019	7.751	Myuna	17/11/2019	6.835
Myuna	20/03/2019	5.651	Myuna	18/07/2019	7.473	Myuna	18/11/2019	6.803
Myuna	21/03/2019	6.849	Myuna	19/07/2019	7.622	Myuna	19/11/2019	6.495
Myuna	22/03/2019	4.99	Myuna	20/07/2019	3.922	Myuna	20/11/2019	4.724
Myuna	23/03/2019	2.99	Myuna	21/07/2019	3.816	Myuna	21/11/2019	3.843
Myuna	24/03/2019	2.743	Myuna	22/07/2019	3.717	Myuna	22/11/2019	3.712
Myuna	25/03/2019	2.956	Myuna	23/07/2019	3.638	Myuna	23/11/2019	3.632
Myuna	26/03/2019	2.255	Myuna	24/07/2019	4.201	Myuna	24/11/2019	3.589
Myuna	27/03/2019	2.718	Myuna	25/07/2019	5.753	Myuna	25/11/2019	4.514
Myuna	28/03/2019	2.725	Myuna	26/07/2019	4.297	Myuna	26/11/2019	5.572
Myuna	29/03/2019	5.534	Myuna	27/07/2019	3.777	Myuna	27/11/2019	6.071
Myuna	30/03/2019	6.95	Myuna	28/07/2019	4.565	Myuna	28/11/2019	8.143
Myuna	31/03/2019	2.673	Myuna	29/07/2019	7.732	Myuna	29/11/2019	8.289
Myuna	1/04/2019	4.564	Myuna	30/07/2019	9.234	Myuna	30/11/2019	6.425
Myuna	2/04/2019	6.067	Myuna	31/07/2019	8.132	Myuna	1/12/2019	7.215
Myuna	3/04/2019	4.309	Myuna	1/08/2019	6.066	Myuna	2/12/2019	6.876
Myuna	4/04/2019	6.043	Myuna	2/08/2019	3.579	Myuna	3/12/2019	5.874
Myuna	5/04/2019	7.588	Myuna	3/08/2019	3.672	Myuna	4/12/2019	4.867
Myuna	6/04/2019	7.214	Myuna	4/08/2019	3.581	Myuna	5/12/2019	3.751

Colliery Name	Date	Volume (ML/day)	Colliery Name	Date	Volume (ML/day)	Colliery Name	Date	Volume (ML/day)
Myuna	7/04/2019	7.21	Myuna	5/08/2019	3.582	Myuna	6/12/2019	4.979
Myuna	8/04/2019	3.235	Myuna	6/08/2019	3.564	Myuna	7/12/2019	5.554
Myuna	9/04/2019	2.601	Myuna	7/08/2019	3.494	Myuna	8/12/2019	5.469
Myuna	10/04/2019	2.656	Myuna	8/08/2019	3.437	Myuna	9/12/2019	6.228
Myuna	11/04/2019	3.123	Myuna	9/08/2019	3.313	Myuna	10/12/2019	6.580
Myuna	12/04/2019	2.852	Myuna	10/08/2019	3.362	Myuna	11/12/2019	5.684
Myuna	13/04/2019	2.798	Myuna	11/08/2019	3.379	Myuna	12/12/2019	6.665
Myuna	14/04/2019	3.375	Myuna	12/08/2019	5.762	Myuna	13/12/2019	3.774
Myuna	15/04/2019	3.454	Myuna	13/08/2019	4.487	Myuna	14/12/2019	3.665
Myuna	16/04/2019	3.607	Myuna	14/08/2019	2.754	Myuna	15/12/2019	4.003
Myuna	17/04/2019	3.571	Myuna	15/08/2019	2.769	Myuna	16/12/2019	3.637
Myuna	18/04/2019	3.869	Myuna	16/08/2019	3.955	Myuna	17/12/2019	4.637
Myuna	19/04/2019	3.112	Myuna	17/08/2019	5.675	Myuna	18/12/2019	6.954
Myuna	20/04/2019	1.918	Myuna	18/08/2019	5.708	Myuna	19/12/2019	6.122
Myuna	21/04/2019	3.885	Myuna	19/08/2019	5.588	Myuna	20/12/2019	3.513
Myuna	22/04/2019	3.831	Myuna	20/08/2019	7.338	Myuna	21/12/2019	3.834
Myuna	23/04/2019	3.854	Myuna	21/08/2019	8.557	Myuna	22/12/2019	3.541
Myuna	24/04/2019	4.96	Myuna	22/08/2019	8.864	Myuna	23/12/2019	3.984
Myuna	25/04/2019	7.449	Myuna	23/08/2019	7.732	Myuna	24/12/2019	4.321
Myuna	26/04/2019	7.315	Myuna	24/08/2019	7.327	Myuna	25/12/2019	3.721
Myuna	27/04/2019	4.822	Myuna	25/08/2019	7.383	Myuna	26/12/2019	3.617
Myuna	28/04/2019	3.585	Myuna	26/08/2019	6.3	Myuna	27/12/2019	3.736
Myuna	29/04/2019	3.626	Myuna	27/08/2019	3.592	Myuna	28/12/2019	3.679
Myuna	30/04/2019	3.649	Myuna	28/08/2019	2.5	Myuna	29/12/2019	3.686
			Myuna	29/08/2019	3.947	Myuna	30/12/2019	3.898
			Myuna	30/08/2019	5.045	Myuna	31/12/2019	4.582
			Myuna	31/08/2019	4.461			

This report: has been prepared by GHD for Centennial Myuna Pty Limited and may only be used and relied on by Centennial Myuna Pty Limited for the purpose agreed between GHD and the Centennial Myuna Pty Limited as set out in this report.

GHD otherwise disclaims responsibility to any person other than Centennial Myuna Pty Limited arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

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The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

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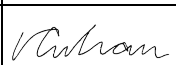
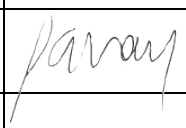
Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	I Gilmore, V Perez Landa	I Gilmore		S Gray		25/03/2020
1	I Gilmore, V Perez Landa	I Gilmore		S Gray		26/03/2020

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