WAMBO COAL PTY LTD
2018 ANNUAL REVIEW

1 January – 31 December 2018

Name of operation	Wambo Coal Mine
Name of operator	Wambo Coal Pty Ltd
Development consent /Project Approval #	DA305-7-2003, DA177-8-2004, EPBC 2003/1138, EPBC 2016/7636, EPBC 2016/7816
Name of holder of development consent	Wambo Coal Pty Ltd
Title/Mining lease #	CL365, CL374, CL397, CCL743, ML1402, ML1572, ML1594, A444, EL7211
Name of holder of mining lease	Wambo Coal Pty Ltd
Water licence #	As per **Table 3**
Name of holder of water licence	Wambo Coal Pty Ltd
MOP start date	1 January 2018
MOP end date	31 December 2020
Annual Review start date	1 January 2018
Annual Review end date	31 December 2018

I, Albert Scheepers, certify that this audit report is a true and accurate record of the compliance status of Wambo Coal Mine for the period 1 January 2018 to 31 December 2018 and that I am authorised to make this statement on behalf of Wambo Coal Pty Ltd.

Note:

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

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

Name of authorised reporting officer	Albert Scheepers
Title of authorised reporting officer	General Manager
Signature of authorised reporting officer	
Date	27/3/19

Statement of Compliance

Were all conditions of the relevant approval(s) complied with?	
EPL529	No
DA305-7-2003	No
DA177-8-2004	Yes
EPBC 2003/1138	Yes
EPBC 2016/7636	Yes
EPBC 2016/7816	No
CL365	Yes
CL374	Yes
CL397	Yes
CCL743	Yes
ML1402	Yes
ML1574	Yes
ML1592	Yes
A444	Yes
EL7211	Yes
Water licences (As per **Table 3**)	Yes

Non-Compliances

Relevant Approval	Condition #	Condition Description (summary)	Compliance Status	Comment	Where addressed in Annual Review
DA305-7-2003	6 (Sch. 4)	Night-time Noise Impact Assessment Criteria	Non-compliant	Exceedance of the Night-time Noise Impact Assessment Criteria.	Section 10.1
DA305-7-2003	6 (Sch. 4)	Night-time Noise Impact Assessment Criteria	Non-compliant	Unsustained and/or negligible exceedances of Night-time Noise Impact Assessment Criteria.	
DA305-7-2003	2 (Sch. 5)	Notification of Landowners	Non-compliant	Landowners were not notified of the exceedance of the Night-time Noise Impact Assessment Criteria.	
EPL529	L4.1	Noise Limits	Non-compliant	Exceedances of Night-time Noise Impact Assessment Criteria on two occasions.	
EPL529	M2.2	Air Monitoring Requirements	Non-compliant	Failure to record PM_{10} levels continuously at PM02, PM03 and PM04 (EPA ID. 14, 15 and 16, respectively) due to technical issues.	Section 10.2

Relevant Approval	Condition #	Condition Description (summary)	Compliance Status	Comment	Where addressed in Annual Review
EPL529	M9.4	Meteorological Monitoring Requirements	Non-compliant	Meteorological data recorded in 10 minute intervals, not in 15 minute intervals as required.	Section 10.3
DA305-7-2003	41 (Sch. 4)	Conservation Agreement	Non-compliant	The VCAs that were updated to include RWEA E in December 2017 have not been finalised by the Biodiversity Conservation Trust.	Section 10.4
EPL529	O2.4	Sewerage Treatment Plant	Non-compliant	First quarter service of STP not conducted.	Section 10.5
EPL529	P1.3	Surface Water Samples	Non-compliant	Failure to collect surface water samples at SW28 due to access issues.	Section 10.6
EPBC 2016/7816	2	Notification of Commencement	Non-compliant	Failure to notify the Department of the Environment and Energy of the commencement of the Action within 30 days.	Section 10.7

Compliance Status Key

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

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APPENDICES

1.0 Introduction

The Wambo Coal Mine (the Mine) is situated approximately 15 kilometres (km) west of Singleton, near the village of Warkworth, New South Wales (NSW) (**Figure 1**). The Mine is owned and operated by Wambo Coal Pty Limited (WCPL), a subsidiary of Peabody Energy Australia Pty Limited.

A range of open cut and underground mine operations have been conducted at the Mine since mining operations commenced in 1969. Mining under the current Development Consent (DA305-7-2003) commenced in 2004 and permits both open cut and underground operations and associated activities to be conducted. The approved run-of-mine (ROM) coal production rate is 14.7 million tonnes per annum and all product coal is transported from the Mine by rail.

Figure 2 shows the approved Mine layout including mining lease boundaries, current operational disturbance footprint and Remnant Woodland Enhancement Areas (RWEAs). **Figure 3** shows the approved Mine longwall layout.

This Annual Review details WCPL's environmental and community performance for the reporting period 1 January 2018 – 31 December 2018. This Annual Review has been prepared in accordance with the NSW Department of Planning and Environment (DPE) *Post-approval requirements for State significant mining developments – Annual Review Guideline – October 2015* (DPE 2015) and WCPL's statutory approvals (**Section 2.1**).

The Annual Review is not intended to be an exhaustive description of WCPL's operations, approvals and activities rather it is a summary of WCPL's compliance status with respect to WCPL's statutory approvals.

This Annual Review is distributed to a range of stakeholders including government authorities, Singleton Shire Council and members of the WCPL Community Consultative Committee (CCC). A copy of the Annual Review will be made available on the Peabody Energy website (www.peabodyenergy.com).

1.1 Mine Contacts

The contact details of key WCPL personnel who are responsible for the environmental management of the Mine are listed in **Table 1.**

Table 1: Contact Details of Key WCPL Personnel

Name	Role	Phone No.
Peter Jaeger	Manager: Environment & Community	(02) 6570 2206
Albert Scheepers	General Manager	(02) 6570 2208

LEGEND
Mining and Coal Lease Boundary
Mining Lease Application Boundary
Local Government Boundary
Mining Operation

Source: NSW Department of Resources & Energy (2018); Geoscience Australia (2009)

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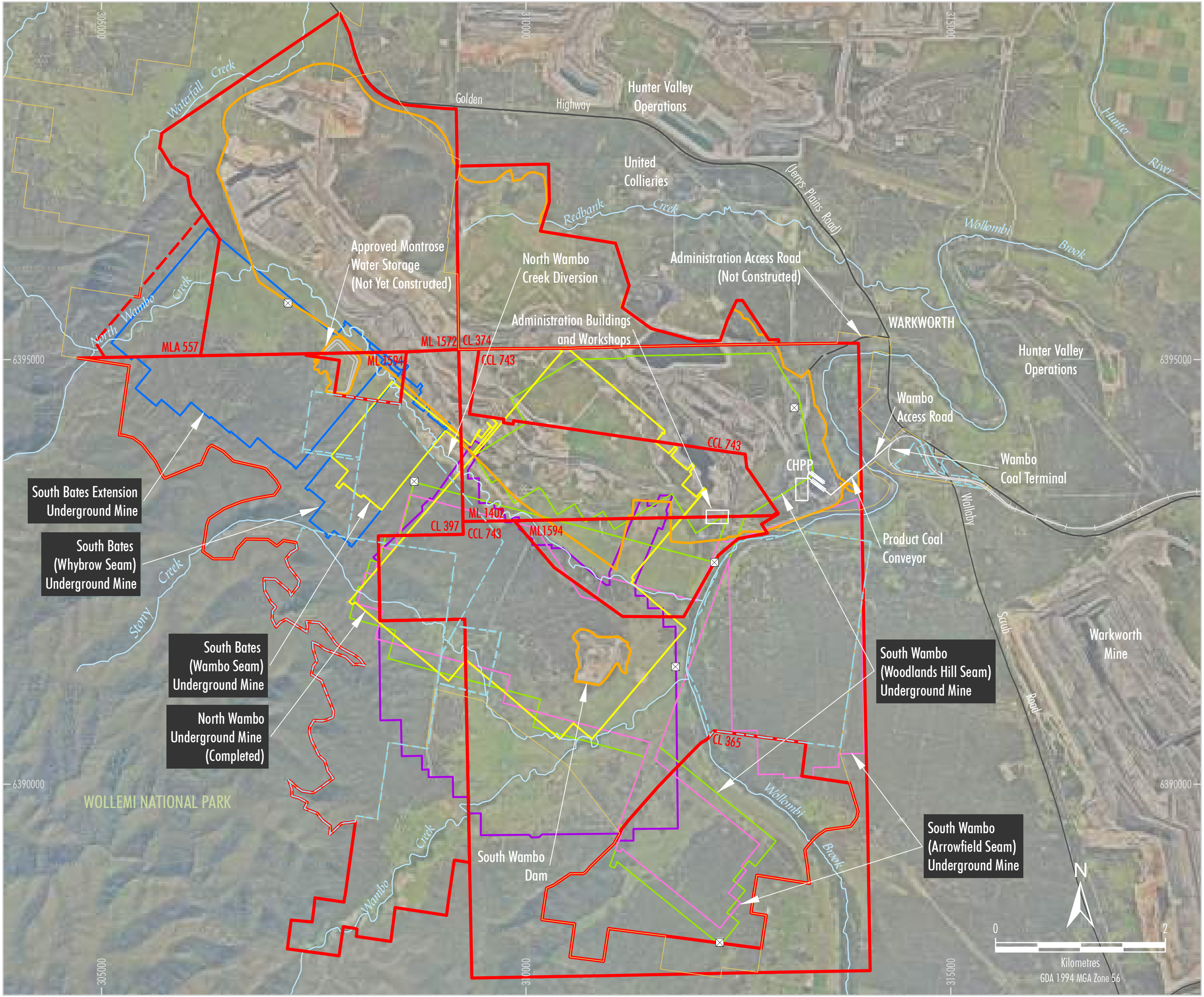
WAMBO COAL MINE

Regional Location

Figure 1



LEGEND
- Mining and Coal Lease Boundary
- Mining Lease Application Boundary
- WCPL Owned Land
- Existing/Approved Surface Development Area
- Approved Ventilation Shaft
- Remnant Woodland Enhancement Program (RWEP) Area

Approved Underground Development
- Whybrow Seam
- Wambo Seam
- Woodlands Hill Seam
- Arrowfield Seam
- Previous Underground Workings in Whybrow Seam

Source: WCPL (2019); Department of Lands (July 2011); WCPL Orthophoto (May 2017)

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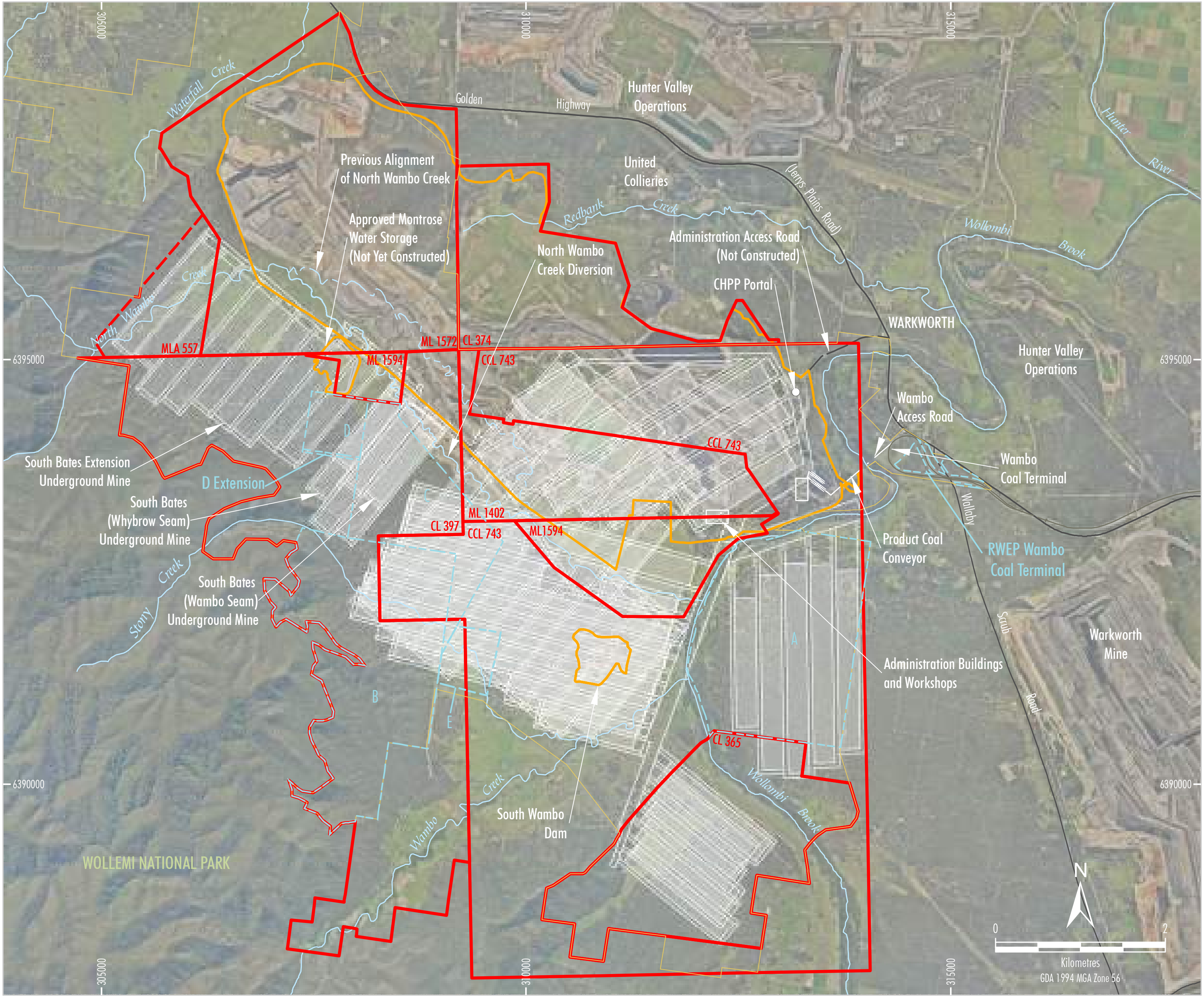
W A M B O   C O A L   M I N E

Approved Wambo Coal Mine General Arrangement

Figure 2

WAM-09-15_AR 2018_203A



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W A M B O   C O A L   M I N E

Approved Wambo Coal Mine Layout

Figure 3

WAM-09-15_AR 2018_201A

2.0 Approvals

2.1 Current Approvals

WCPL has a number of statutory approvals, leases and licences that regulate activities at the Mine (**Table 2** and **Table 3**). Conditions from WCPL's approvals that specifically relate to this Annual Review are detailed in **Appendix A.**

Table 2: WCPL's Statutory Approvals

Type	Description	Issued By[1]	Issue Date	Expiry Date
Development Approval	DA305-7-2003[2]	DPE	04/02/2004	31/12/2039
Development Approval	DA177-8-2004[3]	DPE	16/12/2004	16/12/2025
EPBC Approval[4]	EPBC 2003/1138	DoEE	23/11/2004	31/12/2029
EPBC Approval[4]	EPBC 2016/7636	DoEE	30/4/2017	01/03/2037
EPBC Approval[4]	EPBC 2016/7816	DoEE	4/5/2018	31/12/2039
Mining Lease	ML1402	DRG	23/09/1996	14/08/2022
Mining Lease	ML1572	DRG	21/12/2005	20/12/2026
Mining Lease	ML1594	DRG	01/05/2007	30/04/2028
Mining Lease Application[5]	MLA557	DRG	-	-
Consolidated Coal Lease	CCL743	DRG	09/03/1990	14/08/2022
Coal Lease	CL365	DRG	19/09/1990	19/09/2032
Coal Lease	CL374	DRG	06/12/1991	21/03/2026
Coal Lease	CL397	DRG	04/06/1992	04/06/2034
Exploration Licence	A444[6]	DRG	04/10/2007	16/05/2021
Exploration Licence	EL7211	DRG	22/01/2013	29/09/2019
Environment Protection Licence	EPL529	EPA	17/08/2017	-
S101 Approval[7]	Approval to discontinue use of the North East Tailings Dam (NETD)	DRG	03/09/2009	-

1. DoEE = Federal Department of the Environment and Energy, DRG = Division of Resources and Geosciences (formerly known as the Division of Resources and Energy), EPA = NSW Environment Protection Authority.
2. DA305-7-2003 has been modified 15 times since the original approval was granted in 2004. One modification application was withdrawn subsequent to WCPL submitting the application. The latest modification (MOD17), for approval to mine additional longwall panels in the Whybrow Seam at the South Bates Extension Underground Mine and to extend the life of the mine to 2039, was granted in December 2017. As at the end of December 2018, MOD16 had not been determined.
3. DA177-8-2004 has been modified twice since the original approval was granted in 2004. The last modification, for approval to establish a locomotive provisioning facility adjacent to the WCPL Rail Loadout Facility, was granted in February 2012.
4. EPBC = *Environment Protection and Biodiversity Conservation Act 1999.*
5. At the time of preparing this Annual Review, grant of this Mining Lease Application is pending.
6. A444 is an Authority to Prospect granted under the *Coal Mining Act 1973* and is deemed to be an Exploration Licence for the purposes of the *Mining Act 1992*.
7. Section 101 of the *Coal Mine Health and Safety Act 2002.*

Table 3: WCPL's Water Licences

Licence Number[1]	Description	Expiry Date	Entitlement	Category	Access Licence	Nominated Water Supply Work Approval	Expiry Date
Hunter Regulated River Water Source							
WAL 718 (20SL060212)	Hunter River Pump	Perpetuity	1000 unit shares (high security)	Regulated River (high security)	20AL200631	20WA200632	30/6/2027
WAL 8599 (20SL061206)	Hunter River Pump	Perpetuity	6 unit shares (high security)	Regulated River (high security)	20AL201457	20CA201459	25/09/2028
WAL 8600 (20SL061206)	Hunter River Pump	Perpetuity	868 unit shares (general security)	Regulated River (general security)	20AL201458	20CA201459	25/09/2028
WAL 8604 (20BL061206)	Hunter River Pump	Perpetuity	240 unit shares (supplementary water)	Supplementary Water	20AL203044	20CA201459	25/09/2028
Hunter Regulated River Water Source – Shared with United Colliery							
WAL 929 (20SL050661)	Other Pump	Perpetuity	3 unit shares	Domestic and Stock	20AL201147 (NOW Reference Number)	20WA201148	06/12/2027
WAL 1369 (20SL060416)	80 mm CP	Perpetuity	15 unit shares (supplementary water)	Supplementary Water	20AL203071 20AL204246 20AL204247	20CA201654	30/11/2028
WAL 15459 (20SL204246)	80 mm CP	Perpetuity	21 unit shares (general security)	Regulated River (general security)	20AL204246	20CA201654	30/11/2028
Hunter Unregulated and Alluvial Water Sources (Lower Wollombi Brook Water Source)							
WAL 18437 (20SL033872)	Wollombi Brook Pump	Perpetuity	350 unit shares	Unregulated River	20AL208641	20WA208642	31/07/2022
WAL 23897 (20BL167737)	Well No. 2	Perpetuity	70 unit shares	Aquifer	20AL211371	20WA211372	31/7/2022
North Coast Fractured and Porous Rock Groundwater Sources (Sydney Basin - North Coast Groundwater Source)							
WAL 39735[2] (20BL168643)	Dewatering Bore	Perpetuity	40 unit shares	Aquifer	20AL217073	20MW065010	-
WAL 39738[2] (20BL132753)	Old Well No. 1 (GW08)	Perpetuity	243 unit shares	Aquifer	20AL216848	20MW065010	-
WAL 39803[2] (20BL166910) (20BL173032) (20BL173033) (20BL173034) (20BL173035)	Dewatering (Bore No. 1)	Perpetuity	450 unit shares	Aquifer	20AL216872	20MW065010	-

Licence Number[1]	Description	Expiry Date	Entitlement	Category	Access Licence	Nominated Water Supply Work Approval	Expiry Date
WAL 41494[2] (20BL168017) (20BL172061) (20BL173040)	Dewatering (Bore No. 2 and 2a)	Perpetuity	750 unit shares	Aquifer	20AL216903	20MW065010	-
WAL 41528[2] (20BL167738)	Dewatering Bore	Perpetuity	57 unit shares	Aquifer	20AL218990	20MW065010	-
WAL 41520[2] (20BL173844)	Dewatering Bore	Perpetuity	9 unit shares	Aquifer	20AL217089	20MW065010	-
WAL 41532 (20BL172156)	Dewatering	Perpetuity	98 unit shares	Aquifer	20AL218994	20MW065010	-
20BL168997	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL168998	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL168999	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL169000	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL170638	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL172237	Monitoring Bore (GW14, GW18, GW21)	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL172238	Monitoring Bore (GW12)	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL172240	Monitoring Bore (GW15)	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL172242	Monitoring Bore (GW16, GW17)	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL172244	Monitoring Bore (GW20)	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL172255	Monitoring Bore (GW22)	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL172256	Monitoring Bore (GW13)	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL172257	Monitoring Bore (GW19)	Perpetuity	Groundwater monitoring	NA	-	-	-

Licence Number[1]	Description	Expiry Date	Entitlement	Category	Access Licence	Nominated Water Supply Work Approval	Expiry Date
20BL172332	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL173290	Monitoring Bore	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL173291	Monitoring Bore	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL173292	Monitoring Bore	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL173293	Monitoring Bore	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL173946	Monitoring	Perpetuity		NA	-	-	-
20BL173999	Monitoring Bore	Perpetuity	Groundwater monitoring	NA	-	-	5/12/2023
-	Bore	Perpetuity	Stock	Basic Rights	-	20WA214848	-
-	Bore	Perpetuity	Stock	Basic Rights	-	20WA214849	-
-	Bore	Perpetuity	Stock	Basic Rights	-	20WA214850	-
-	Bore	Perpetuity	Stock	Basic Rights	-	20WA214851	-
-	Spearpoints	Perpetuity	Stock/Domestic	Basic Rights	-	20WA215574	-

WAL = water access licence; mm = millimetres.

1. 20BL prefix bore licences with allocations have been replaced with Water Access Licences (WALs).
2. WaterNSW issued approval to consolidate six WALs on 20 December 2018. Notification to be lodged with NSW Land Registry Services in 2019.

2.2 Changes to Approvals

During the reporting period the following changes were made to WCPL's approvals:

- WCPL's Extraction Plan for South Bates Extension Underground Mine Longwalls 17 to 20 was submitted in April 2018, and approved for the extraction of Longwall 17 only on 7 September 2018[1].
- A new Mining Operations Plan (MOP)/Rehabilitation Management Plan (RMP) (for the period 2018-2020) was lodged with DRG in December 2017 and was approved on 1 February 2018.
- EPBC Approval 2016/7816 for the South Bates Extension Underground Mine was granted on 5 May 2018.

In 2018, WCPL made an Application for a Mining Lease (MLA 557) to cover the area of the South Bates Extension Underground Mine not covered by an existing ML (**Figure 2**).

2.3 Environmental Management System

WCPL operates an Environmental Management System to manage compliance and advance continual improvement across the Mine. During the reporting period, a number of management plans were revised and submitted for approval. A summary of the status of required management plans is presented in **Table 4.**

In accordance with Schedule 6, Condition 12 of DA305-7-2003, copies of these management plans have been made available to the public on the Peabody Energy website https://www.peabodyenergy.com/Operations/Australia-Mining/New-South-Wales-Mining/Wambo-Approvals,-Plans-Reports.

In accordance with Schedule 6, Condition 6 of DA305-7-2003, WCPL will review and, if necessary, revise the strategies, plans and programs required under DA305-7-2003 within three months of the submission of this Annual Review to relevant government regulators.

[1] On 4 September 2018, WCPL provided DPE with correspondence explaining that geological structures had been encountered that may require changes to the main headings and finishing ends of Longwalls 18, 19 and 20. Accordingly, WCPL requested that DPE approve the Extraction Plan for Longwalls 17 to 20 for extraction of Longwall 17 only. On 7 September 2018, DPE approved the extraction of Longwall 17 only, on the basis that WCPL would prepare an amended Extraction Plan for Longwalls 18, 19 and 20.

Table 4: Status of WCPL's Environmental Management Plans

Management Plan	Status	Approved Version[1]
North Wambo Extraction Plan for Longwalls 8 to 10A (and associated component plans)	Approved – 2015	April 2015
South Bates Underground Mine Extraction Plan for Longwalls 11 to 16 (and associated component plans)	Approved – 2017	July 2017[2]
South Bates Extension Underground Mine Extraction Plan for Longwalls 17 to 20 (and associated component plans)	Approved – 2018 (Longwall 17)	Revision A (April 18)[3]
Environmental Management Strategy	Approved – 2018	Version 5 (Mar 18)
Blast Management Plan[4]	Approved – 2017	Version 7 (Jul 17)
Noise Management Plan[5]	Approved – 2018	Version 5 (Jan 18)
Air Quality & Greenhouse Gas Management Plan (AQGGMP)	Approved – 2017	Version 5 (Aug 17)
Biodiversity Management Plan (previously the Flora and Fauna Management Plan)	Approved – 2018	Version 14 (Feb 18)
Bushfire Management Plan	Approved – 2014[6]	Version 4 (Aug 13)[6]
Site Water Management Plan	Approved – 2018	Various[7] (April 18)
MOP/RMP	Approved – 2018	MOP 2018-2020 (Dec 17)[8]
Conservation Management Plan (European) (CMP)	Under review[9]	Version 2 (July 12)
Aboriginal Heritage Management Plan for RWEP A	Approved – 2018	Revision A (March 18)

1. Approved version as at the end of the reporting period.
2. On 11 October 2017, DPE approved the South Bates Underground Mine Longwalls 11 to 16 Extraction Plan with the exception of the Site Water Management Plan (and associated component plans), which were unable to be approved until they were updated in consultation with DI-Water. In 2018, the South Bates Extension Underground Mine Longwalls 17 to 20 Extraction Plan (including the Site Water Management Plan which had been updated in consultation with DI-Water) was approved by DPE.
3. On 4 September 2018, WCPL provided DPE with correspondence explaining that geological structures had been encountered that may require changes to the main headings and finishing ends of Longwalls 18, 19 and 20. Accordingly, WCPL requested that DPE approve the Extraction Plan for Longwalls 17 to 20 for extraction of Longwall 17 only. On 7 September 2018, DPE approved the extraction of Longwall 17 only, on the basis that WCPL would prepare an amended Extraction Plan for Longwalls 18, 19 and 20.
4. Includes WCPL's Blast Fume Management Strategy (Version 3) which was approved in November 2015.
5. The Noise Management Plan was updated during the reporting period to address comments from DPE and incorporate MOD17. The Noise Management Plan was resubmitted for approval in January 2018 and was approved during the reporting period.
6. The Bushfire Management Plan was revised during 2017 and a copy of the revised plan was provided to the Singleton Shire Council and the NSW Rural Fire Service (RFS). Comments have not yet been received. WCPL will address comments once received and provide the updated plan to DPE for approval in 2019.
7. Includes WCPL's Surface Water Monitoring Program (Version 12) (SWMP), Groundwater Monitoring Program (Version 12) (GWMP), Erosion and Sediment Control Plan (Version 10) (ESCP), Surface and Groundwater Response Plan (Version 12) and Site Water Balance (Version 1). In 2018, the South Bates Extension Underground Mine Longwalls 17 to 20 Extraction Plan (including the Site Water Management Plan which had been updated in consultation with DI-Water) was approved by DPE.
8. A new MOP (for the period 2018 – 2020) was lodged with the NSW Resources Regulator in December 2017 and was approved on 1 February 2018.
9. In 2018, the CMP was revised and comments were incorporated from DPE and NSW Heritage Office. The CMP will be submitted for approval during the next reporting period.

3.0 Operations Summary

3.1 2018 Mining Operations

The Mine operates seven days a week, 24 hours a day on a rotating shift basis.

During the reporting period, the following mining operations were undertaken at the Mine:

- South Bates Underground Mine (completed longwall mining area):
  - Longwall 14 (commenced 30 July 2017 and completed 15 January 2018);
  - Longwall 15 (commenced 8 February 2018 and completed 4 July 2018); and
  - Longwall 16 (commenced 25 July 2018 and completed 4 November 2018).
- South Bates Extension Underground Mine (current longwall mining area):
  - Longwall 17 (commenced 3 December 2018).
- Open Cut:
  - continued mining operations (strips 1 to 3) in Montrose East Pit;
  - continued mining operations (strip 1) in Montrose West Pit; and
  - continued mining operations (strip 1) in the upper coal seam (Whybrow Seam) in the Roses Pit (South Bates Extended).

Table 5 shows the production summary for 2018, compared to the production for 2017 and the forecast production for 2018 and 2019.

Table 5: Production Summary

<table>
<tr><th>Material</th><th>Unit[1]</th><th>Approved limit</th><th>2017 reporting period (actual)</th><th>2018 reporting period (forecast)</th><th colspan="2">2018 reporting period (actual)</th><th>2019 reporting period (forecast)</th></tr>
<tr><td>Waste Rock/ Overburden</td><td>bcm</td><td>-</td><td>32,300,000</td><td>31,590,000</td><td colspan="2">34,256,229</td><td>26,490,000</td></tr>
<tr><td rowspan="3">ROM Coal/ Ore</td><td rowspan="3">Mt</td><td rowspan="3">14.7[2]</td><td rowspan="3">8.3</td><td rowspan="3">8.24</td><td colspan="2">7.71</td><td rowspan="3">7.59</td></tr>
<tr><td>U/G</td><td>2.54</td></tr>
<tr><td>O/C</td><td>5.17</td></tr>
<tr><td>Coarse Reject</td><td>Mt</td><td>-</td><td>2.16</td><td>2.41</td><td colspan="2">2.61</td><td>2.25</td></tr>
<tr><td>Fine Reject (Tailings)</td><td>Mt</td><td>-</td><td>0.94</td><td>0.43</td><td colspan="2">0.46</td><td>0.40</td></tr>
<tr><td>Saleable Product</td><td>Mt</td><td>15[3]</td><td>5.7</td><td>5.41</td><td colspan="2">4.81</td><td>5.02</td></tr>
</table>

1. bcm = bank cubic metres, Mt = million tonnes.
2. DA305-7-2003, Condition 7 Schedule 3.
3. DA177-8-2004, Condition 6 Schedule 3. Refers to product coal transported off-site.

U/G – Underground O/C – Open Cut

During the reporting period, a total of 4.85 Mt of product coal was transported off-site via rail (no coal was hauled off-site by trucks). A summary of 2018 daily train movements, required by Schedule 3, Condition 18 of DA177-8-2004 is provided in **Appendix B**. The excess saleable product transported off-site during the reporting period (i.e. approximately 0.04 Mt) was taken from the stockpile on-site. The actual ROM coal production (7.71 Mt) was less than the forecast ROM coal production (8.24 Mt) predominantly driven by unfavourable geological conditions in the underground. This was partially offset by increased volumes from the open cut. The actual waste rock/overburden produced was greater than forecast as an excavator was active for an additional eight months of the year (compared to the forecast scenario). **Figure 4** shows the amount of saleable product coal transported off-site on a weekly basis.

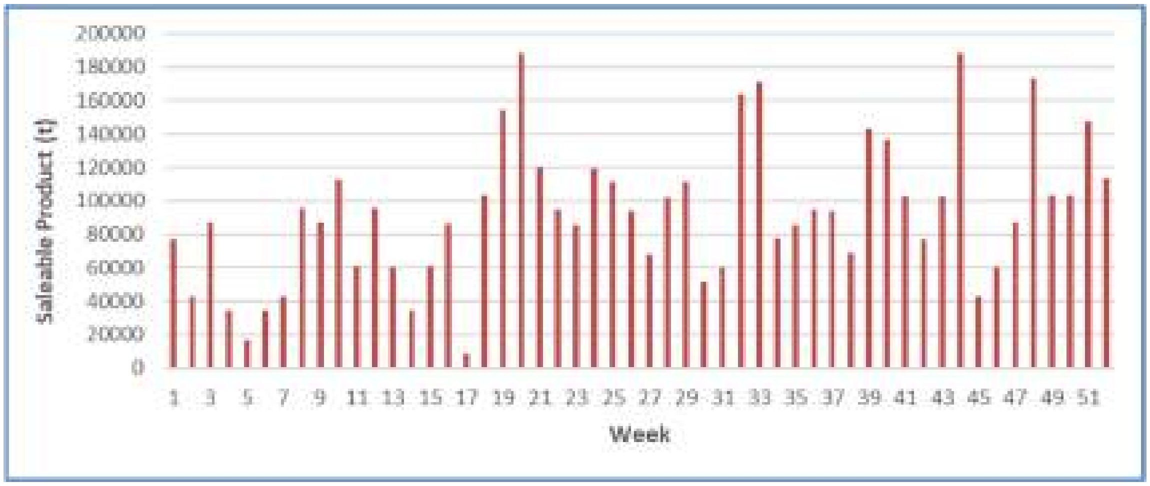

Figure 4: Coal Transported Off-site during the Reporting Period

3.2 Next Reporting Period

Operations during the next reporting period will be undertaken in accordance with the approved MOP and will include:

- Continued mining in Montrose East Pit, to allow mining of lower ratio reserves.
- Continued mining in Montrose West Pit, in an overall northerly direction towards Montrose East Pit.
- Commencement of mining in the Glen Munro Pit (South Wambo).
- Commencement of mining in the Highwall Pit.
- Continued mining at the South Bates Extension Underground Mine, including Longwall 17 (commenced in December 2018), Longwall 18 (anticipated to commence in July 2019) and Longwall 19 (anticipated to commence December 2019).

4.0 Actions Required from Previous Annual Reviews

A number of actions and improvements have been identified in previous Annual Reviews undertaken by WCPL. Actions and improvements recommended in the 2015 Annual Review, 2016 Annual Review and 2017 Annual Review and their current status are summarised in **Table 6**, **Table 7** and **Table 8**, respectively. In addition, further information/actions requested by DPE and DRG are also addressed in these tables.

Table 6: Actions from the 2015 Annual Review

Action/Improvement required from previous Annual Review	Requested by	Action taken by the Operator	Where discussed in Annual Review
A full review and update of the following plans and strategies:	WCPL	-	-
• Bushfire Management Plan;		Ongoing. WCPL revised the Bushfire Management Plan and provided a copy to the Singleton Shire Council and the NSW RFS in December 2017. Comments have not yet been received. WCPL will address comments once received and provide the updated plan to DPE for approval in 2019.	Section 2.3
WCPL will update the Surface Water Monitoring Program to reflect changes made to the stream flow monitoring program in 2015.		Complete. The Surface Water Monitoring Program was revised in March 2018 (Version 12) and submitted with the Extraction Plan for South Bates Extension Underground Mine Longwalls 17 to 20. On 7 September 2018, DPE approved the Extraction Plan for South Bates Extension Underground Mine Longwalls 17 to 20 (including the Surface Water Monitoring Program).	Section 6.1
Installation of GPS units on-site water carts pending review of budgets.		Ongoing. GPS units have not been installed. WCPL continues to monitor the frequency and movement of water carts across the site.	Section 5.3.4
Commissioning of an audit of the Hunter River Salinity Trading Scheme (HRSTS) discharge system to ensure its effectiveness;		Ongoing. The HRSTS discharge system was reviewed during 2016. This review consisted of updating the communication hardware in consultation with Water NSW, regular calibration of instrumentation and development of operating procedures. A guideline for a HRSTS system audit was completed in 2018. The audit was unable to be completed as WCPL was unable to discharge through the HRSTS in 2018.	Section 6.3.4
A scope of works to progress subsidence repairs will be developed in alignment with the subsidence audit in 2016.		Complete.	Sections 5.9.3 and 7.1.7

1. Letter from Division of Resources and Energy (DRE) (now DRG) to WCPL re 2016 Rehabilitation Audit, dated 4 August 2016.
2. Letter from DRE (now DRG) to WCPL re 2015 Annual Environmental Management Report (AEMR), dated 25 August 2016.

Table 7: Actions from the 2016 Annual Review

Action/Improvement required from previous Annual Review	Requested by	Action taken by the Operator	Where discussed in Annual Review
Subsidence repair trials will be undertaken in accordance with any recommendations made in the audit of known subsidence impacts.	WCPL	Complete. Subsidence repair trials were completed south of South Wambo Dam in 2016-17.	Sections 5.9.3 and 7.1.7
WCPL will submit a Conceptual Mine Closure Plan (CMCP) to DPE in the first half of 2017.		Ongoing. A revised CMCP is planned for submission to the NSW Resources Regulator and other relevant stakeholders within six months of determination of the United Wambo Open Cut Coal Mine Project (MOD16).	Section 7.1.2
WCPL will use the Initial Post-Establishment Monitoring Checklist (or an adapted version of the checklist) to confirm and record any deviations from the proposed rehabilitation method/activities for each rehabilitation area.		Complete	Section 9.3
Works associated with the North East Tailings Dam Rehabilitation Strategy (NETDRS), including the construction of a trial abutment and any additional works undertaken (if the trial is successful).		Ongoing. Cone Penetration Testing (CPT) of the NETD will commence in Q1 2019. Following CPT, it is anticipated the capping design will be finalised in Q4 2019. Intermittent disposal of double flocculated tailings in the NETD will commence in Q3 2019.	Section 7.1.1
WCPL will undertake a review and update of the following management plans and strategies:		-	-
• Environmental Management Strategy.		Complete. The Environmental Management Strategy was revised and submitted to DPE for approval on 26 July 2017. The Environmental Management Strategy was subsequently updated to address comments from DPE and resubmitted for approval in March 2018. This version of the Environmental Management Strategy was approved by DPE during 2018.	Section 2.3
• Conservation Management Plan for the Wambo Homestead Complex (WHC).		Ongoing. Development of the Conservation Management Plan (European) progressed in 2018, with WCPL updating the plan to incorporate stakeholder feedback. The Conservation Management Plan (European) is scheduled for submission for approval in 2019.	Section 2.3

Action/Improvement required from previous Annual Review	Requested by	Action taken by the Operator	Where discussed in Annual Review
• Bushfire Management Plan.		Ongoing. WCPL revised the Bushfire Management Plan and provided a copy to the Singleton Shire Council and the NSW RFS in December 2017. Comments have not yet been received. WCPL will address comments once received and provide the updated plan to DPE for approval in 2019.	Section 5.16

1. Letter from DRG to WCPL RE: 2016 Annual Environmental Management Report, dated 18 July 2017.
2. Letter from DPE to WCPL RE: Annual Review 2016, dated 19 May 2017.
3. Letter from DPE to WCPL RE: Annual Review 2016 Additional Information, dated 13 July 2017.

Table 8: Actions from the 2017 Annual Review[2]

Action/Improvement required from previous Annual Review	Requested by	Action taken by the Operator	Where discussed in Annual Review
A program of works for the repair of subsidence impacts identified by the audit will be developed based on the outcomes of the subsidence repair trials.	WCPL	Complete. Trials are currently being undertaken on remediation of subsidence impacts above the North Wambo Underground Mine.	Sections 5.9.3 and 7.1.7
Copies of the six monthly and monthly reports on blasting within 2 km of the WHC will be sent to the NSW Heritage Office.		Complete. Six monthly and monthly reports on blasting within 2 km of the WHC have been prepared and sent to the NSW Heritage Office during the next reporting period.	Section 5.2.4
An Extraction Plan for South Bates Extension Underground Mine Longwalls 17 to 20 will be prepared and submitted.		Complete. An Extraction Plan for South Bates Extension Underground Mine Longwalls 17 to 20 was prepared and submitted to DPE for approval in April 2018. On 4 September 2018, WCPL provided DPE with correspondence explaining that geological structures had been encountered that may require changes to the main headings and finishing ends of Longwalls 18, 19 and 20. Accordingly, WCPL requested that DPE approve the Extraction Plan for Longwalls 17 to 20 for extraction of Longwall 17 only. On 7 September 2018, DPE approved the extraction of Longwall 17 only, on the basis that WCPL would prepare an amended Extraction Plan for Longwalls 18, 19 and 20.	Section 2.3
The remaining 11 exploration holes will be inspected to determine rehabilitation status.		Ongoing. A comprehensive rehabilitation project is scheduled for commencement March-April 2019. Inspection of the remaining holes eleven holes will be incorporated into this project.	Section 5.10

2 In correspondence dated 7 September 2018, DPE confirmed that the 2017 Annual Review generally satisfied the requirements of the relevant approvals, and did not request any actions/improvements for future annual reviews.

Action/Improvement required from previous Annual Review	Requested by	Action taken by the Operator	Where discussed in Annual Review
The 'Montrose East Drop Structure', which is required to control water from the catchment area, will be completed and the light vehicle access boundary road will be narrowed (this area will be seeded with a tree corridor seed mix).		Complete.	-
Rehabilitation progress will be monitored as hot and dry conditions were experienced after sowing and the area may need to be re-seeded following substantial rain.		Complete. Rehabilitation progress was monitored throughout 2018 and no additional seeding was undertaken.	Section 7.1
The Initial Post-Establishment Monitoring Checklist will be implemented to confirm and record any deviations from the proposed rehabilitation method/ activities for each rehabilitation area.		Complete.	Section 9.3
An internal audit of topsoil stockpile management will be undertaken.		Complete. An audit of topsoil stockpile management was undertaken during the reporting period which led to several mitigation actions. These included: • conducting weed spraying to reduce the existing weed burden; • reshaping stockpiles were required; • installing additional signage; • conducting a topsoil inventory; • seeking and implementing management advice from an agronomist; and • updating the Topsoil Management Procedure to include a permit system for topsoil stripping activities on-site.	Section 5.14
Works associated with the NETDRS will continue. CPT will commence after the main deposition finishes in the Hunter Pit Tailings Dam (HPTD), scheduled for quarter two 2018. It is anticipated that CPT will be complete by quarter three 2018. Following CPT, details regarding capping design and capping works will be finalised.		Ongoing. CPT of the NETD will commence in Q1 2019. Following CPT, it is anticipated the capping design will be finalised in Q4 2019. Intermittent disposal of double flocculated tailings in the NETD will commence in Q3 2019.	Section 7.1

Action/Improvement required from previous Annual Review	Requested by	Action taken by the Operator	Where discussed in Annual Review
The following management plans and strategies will be finalised:		-	-
• Bushfire Management Plan;		Ongoing. WCPL revised the Bushfire Management Plan and provided a copy to the Singleton Shire Council and the NSW RFS in December 2017. Comments have not yet been received. WCPL will address comments once received and provide the updated plan to DPE for approval in 2019.	Section 2.3
• Environmental Management Strategy;		Complete. The Environmental Management Strategy was revised and submitted to DPE for approval on 26 July 2017. The Environmental Management Strategy was subsequently updated to address comments from DPE and resubmitted for approval in March 2018. This version of the Environmental Management Strategy was approved by DPE during 2018.	Section 2.3
• Conservation Management Plan (European) for the WHC; and		Ongoing. Development of the Conservation Management Plan (European) progressed in 2018, with WCPL updating the plan to incorporate stakeholder feedback. The Conservation Management Plan (European) is scheduled for submission for approval in 2019.	Section 2.3
• Site Water Management Plan.		Complete. The Surface Water Monitoring Program was revised in March 2018 (Version 12) and submitted with the Extraction Plan for South Bates Extension Underground Mine Longwalls 17 to 20. On 7 September 2018, DPE approved the Extraction Plan for South Bates Extension Underground Mine Longwalls 17 to 20 (including the Surface Water Monitoring Program).	Section 2.3
The AEMR is accepted subject to the following items:	RR[1]	-	-

Action/Improvement required from previous Annual Review	Requested by	Action taken by the Operator	Where discussed in Annual Review
1. It is understood that a remediation plan for the North Wambo Creek Diversion is being developed to address deficiencies identified in an independent audit required under consent. The final remediation plan is to be incorporated into the Mining Operations Plan (as an appendix) within three months of finalization, with remediation progress reported in the AEMR.		In progress. The final remediation plan (or Action Plan) for the North Wambo Creek Diversion (NWCD) is a component of the NWCD Plan (required under DA305-7-2003). The NWCD Plan is currently being updated and will be submitted to DPE for approval in April 2019. Within three months of approval of the NWCD Plan, the Action Plan will be incorporated into the MOP as an appendix.	Section 5.6
2. The hydrocarbon management procedure is reviewed to ensure that contamination is prevented in the first instance and contaminated material is appropriately managed so that it is not a risk to rehabilitation. Key management actions are to be described in the next revision of the Mining Operations Plan.		In progress. WCPL submitted an amendment to the approved MOP for 2018-2020. Approval of Amendment A is currently pending. MOP 2018-2020 Amendment A describes that: *WCPL will review the hydrocarbon management procedure to ensure that contamination is prevented in the first instance and contaminated material is appropriately managed so that it is not a risk to rehabilitation.*	Section 2.2

1. Letter from the NSW Resources Regulator (RR) to WCPL indicating satisfaction with the 2017 Annual Review (subject to the terms outlined), dated 5 October 2018.

5.0 Environmental Performance

5.1 Noise

Noise Impact Assessment Criteria for the Mine are defined in Table 9 of DA305-7-2003 (Condition 6, Schedule 4), Table 2 of DA177-8-2004 (Condition 3, Schedule 4) and EPL529 (Condition L4). Additional noise conditions relating to land acquisition, operating hours, rail noise, noise monitoring and WCPL's Noise Management Plan (NMP) are also detailed in these approval documents.

During the reporting period, the NMP was updated to address comments from DPE and to incorporate changes for MOD17. The noise monitoring network was updated and now consists of four real time noise monitors (unattended noise monitoring) and six attended noise monitoring locations (two of which are coincident with real time noise monitors).

As of February 2018, attended noise monitoring was undertaken monthly at N01, N03, N16, N20A, N21 and N26; and was discontinued at N23. For further detail, refer to WCPL's NMP.

5.1.1 Approval Criteria/EIS Predictions and Management Plan Requirements

A summary of the approval criteria for noise in relation to the attended noise monitoring locations is included in **Table 9**.

Table 9: Impact Assessment and Acquisition Criteria for Noise

Criteria[1]	dBA	Land Number[2]
Day - $L_{Aeq\ (15\ min)}$	35	All land
Evening/Night - $L_{Aeq\ (15\ min)}$	41	94
	40	3, 4B, 15B, 16, 23C, 25, 28A & B, 33, 39, 40 & 254A
	39	5, 6, 7, 37, 48
	38	1, 17, 18, 38, 49, 63, 75, 91
	37	27, 43, 137, 163, 246
	36	13B, 178, 188, 262A, B & C
	35	All other residential or sensitive receptors[3]
Night - $L_{A1\ (1\ min)}$	50	All land

Note: dBA = A-weighted decibels.

1. Criteria as per Condition 6, Schedule 4 of DA305-7-2003.
2. Properties identified in Table 9 of DA305-7-2003 (Condition 6, Schedule 4).
3. Excluding the receptors listed in Condition 1, Schedule 4 of DA305-7-2003.

Under the exemptions of the NSW Industrial Noise Policy, the noise impact assessment criteria in DA305-7-2003 do not apply under meteorological conditions of:

- wind speeds greater than 3 metres per second (m/s) at 10 metres above ground level;
- during rain; and/or
- temperature inversion conditions with atmospheric stability class G.

Condition L4.1 of EPL529 includes similar noise emission limits to those identified in DA305-7-2003. Condition L4.5 of EPL529 specifies that the noise emission limits identified in Condition L4.1 do not apply under meteorological conditions of:

- wind speeds greater than 3 m/s at 10 metres above the ground level; and/or
- temperature inversion conditions of greater than 3°C/100 m and wind speeds greater than 2 m/s at 10 metres above the ground.

A summary of the Environmental Impact Statement (EIS) predictions for noise is included in **Appendix C**, along with WCPL's performance against these predictions during the reporting period. For more information on the EIS predictions, refer to the EIS (Resource Strategies 2003).

In addition to the statutory requirements detailed in **Table 9**, WCPL is also required to meet additional requirements detailed within the approved WCPL NMP. These requirements include reporting of monthly attended monitoring results on WCPL's website (or when there is an exceedance of criteria) and provision of results to the WCPL CCC.

5.1.2 Performance during the Reporting Period

During the reporting period, WCPL complied with all statutory noise conditions and requirements detailed in the WCPL NMP, with the exception of the night-time noise impact assessment criteria. The attended noise-monitoring undertaken by Global Acoustics identified exceedances of the DA305-7-2003 noise impact assessment criteria on six separate occasions and the EPL529 criteria on two separate occasions (**Section 10.1**).

Results of monitoring were published on the WCPL website and details of non-compliances were provided to the WCPL CCC during meetings, in accordance with the WCPL NMP.

Forty-four (44) complaints were received relating to noise during the reporting period (**Section 8.3**).

WCPL did not receive any written requests for acquisition from the landowners of the land listed in Table 1 of DA305-7-2003 (Condition 1, Schedule 4) nor did it exceed the Land Acquisition Criteria listed in Table 10 of DA305-7-2003 (Condition 7, Schedule 4). One landowner (located on Redmonvale Road, Jerrys Plains) wrote to DPE and requested an Independent Noise Review. The Independent Noise Review will be completed during the next reporting period.

5.1.2.1 Comparison with EIS Predictions

An annual report summarising WCPL's 2018 attended noise monitoring data and comparisons against the EIS noise predictions is included in **Appendix C** (Global Acoustics 2019).

Global Acoustics (2019) compared predicted noise levels from the Year 9 scenario in the EIS against the actual noise levels measured during 2018. The comparison indicated that meteorological conditions included in the EIS modelled predictions did not regularly occur during attended monitoring. When meteorological conditions were relevant, the results show that measured noise levels from the Mine were generally within 3 dB of predicted levels at N16, and well under the predicted levels at other locations.

5.1.3 Trends and Key Management Implications

Global Acoustics (2019) considered that measured site noise levels at N03 and N16 have shown an upward trend over the past three years for both $L_{Aeq,15minute}$ and $L_{A1,1minute}$ noise levels. There are no significant differences in measured site noise levels at other monitoring locations (**Appendix C**). This upward trend could be attributed to approved mining progressing towards N16.

As with previous reporting periods, wind speeds and/or temperature inversion conditions were at levels greater than which the development consent conditions would apply for the Mine activities in some instances.

5.1.4 Implemented or Proposed Management Actions

WCPL will continue to implement the noise management measures detailed in the WCPL NMP, including documenting the timing and scale of any operational changes made in response to adverse conditions or noise alarms from monitoring units.

In April 2018, WCPL conducted Senior Management training on noise management measures and a review of the effectiveness of alarms associated with the real-time noise monitoring system. This led to a 2 dB reduction of the real-time monitoring noise alarm at the N20 monitor, located between the open cut mining operations and the nearest residences.

During the reporting period, additional attended monitoring sites were added at N20A, N21 and N26. Monitoring at these locations commenced in February 2018. Monitoring at N23 ceased in February 2018.

5.2 Blasting

Air Blast Overpressure Limits and Ground Vibration Impact Assessment Criteria for the Mine are defined in Tables 12 and 13 of DA305-7-2003 (Conditions 11 and 12, Schedule 4), Tables 3 and 4 of DA177-8-2004 (Conditions 8 and 9, Schedule 4) and EPL529 (Condition L5). Additional conditions relating to blasting hours and frequency, property inspections, assessments and investigations, cumulative impacts, operating conditions, blasting near the WHC, blast monitoring, blast fume and WCPL's Blast Management Plan (BMP) are also detailed in these approval documents.

5.2.1 Approval Criteria/EIS Predictions and Management Plan Requirements

A summary of the approval criteria for blasting is included in **Table 10.**

Table 10: Approval Criteria for Blasting

Parameter	Criteria[1]	Allowable Exceedance
Airblast Overpressure Level dB (Lin Peak)	115	5% of the total number of blasts over a 12 month period
	120	0%
Ground Vibration Peak Particle Velocity (mm/s)[2]	5	5% of the total number of blasts over a 12 month period
	10	0%

1. Criterion as per Conditions 11 & 12, Schedule 4 of DA305-7-2003.Criteria must not be exceeded at any residence on privately-owned land.
2. For St Philip's Church, WCPL shall ensure that ground vibration peak particle velocity generated by the Mine does not exceed 2.5 millimetres per second (mm/s).

A summary of the EIS predictions for blasting is included in **Section 5.2.2.1**, along with WCPL's performance against these predictions during the reporting period. For more information on the EIS predictions, refer to the EIS (Resource Strategies 2003).

In addition to the statutory requirements detailed in **Table 10,** WCPL is also required to meet additional requirements detailed within the approved WCPL BMP. These requirements include annual reporting on performance against the performance indicators detailed within the approved WCPL BMP (**Table 11**).

Table 11: Blast Management Plan Performance Indicators

Performance Indicator
Blast monitoring results show 100% compliance with the Blast Criteria.
Blast monitoring results show 100% compliance with the 5 mm/s criteria applied to Wambo Homestead Complex.
No 'Rating 3' fume events leaving the Approved Surface Development Area (Project Area) or closed portion of a public road.
No 'Rating 4' or 'Rating 5' fume events.

5.2.2 Performance during the Reporting Period

Air blast overpressure and ground vibration levels recorded during the monitoring period complied with the approval criteria at all monitoring locations. A total of 96 blasts were undertaken at the Mine during the reporting period. **Table 12** provides a summary of the results recorded at the blast monitoring sites compared to the approval criteria. It should be noted that BM01 and BM03 are used for performance-based monitoring and therefore any exceedances would not represent a non-compliance with the approval criteria.

A summary of the blast monitoring data is included in **Appendix D**.

Table 12: Blast Monitoring Results 2018

Parameter	Criteria	Results Exceeding Approval Criteria					
		BM02		BM05		BM07	
		No.	%	No.	%	No.	%
Airblast Overpressure Level (dB Lin Peak [dBL])	115	1	1.04	2	2.08	0	0
	120	0	0	0	0	0	0
Ground Vibration Peak Particle Velocity (mm/s)	5	0	0	0	0	0	0
	10	0	0	0	0	0	0

Less than 5% of all blasts recorded overpressure greater than 115 dBL, and no blasts recorded overpressure greater than 120 dBL at BM02, BM05 and BM07. Similarly, no blasts had a recorded ground vibration greater than 5 mm/s (i.e. less than 5%), and therefore no blasts had a recorded ground vibration greater than 10 mm/s. One blast during the reporting period recorded an overpressure over 120 dB (122.1 dB) at BM01 on 23 November 2018. The corresponding ground vibration for this blast was 0.11 mm/s. It is noted that BM01 is used for internal management purposes and is not a compliance point.

No blast fume events with Rating 3 (as defined in the *Australian Explosives Industry and Safety Group [AEISG], Code of Practice - Prevention and management of blast generated NOx Gases in surface blasting*) were recorded leaving the Approved Surface Development Area (Project Area) or closed portion of a public road during the reporting period. No Rating 4 or Rating 5 (AEISG) fume events were recorded at the Mine during the reporting period.

WCPL complied with all approval criteria and performance indicators during the reporting period.

Six (6) complaints were received regarding blasting (i.e. relating to vibrations, dust and fumes) from the Mine during the reporting period (**Section 8.3**).

5.2.2.1 Comparison with EIS Predictions

A comparison of WCPL's blast performance against the Year 13 predictions (Resource Strategies 2003) is summarised in **Table 13**.

Table 13: Comparison of EIS Predictions and 2018 Monitoring Data – Blasting

Land Holder	Midpoint Distance to Dwellings[1]	Predicted Levels		Closest WCPL Blast Monitor to Land Holder	Maximum Recorded Level During Report Period	
		Airblast (dB re 20 µPa)	Vibration (mm/s)		Airblast (dB re 20 µPa)	Vibration (mm/s)
2 Lambkin	4,500 m	112 dBL	1.6 mm/s	BM03[2]	117.6	0.44
25 Fenwick	3,300 m	114 dBL	1.9 mm/s	BM03[2]	117.6	0.44
13(B) Skinner	1,000 m	123 dBL	4.0 mm/s	N/A[3]	N/A[3]	N/A[3]
24 Long	600 m	127 dBL	5.4 mm/s	N/A[3]	N/A[3]	N/A[3]

Note: dB = decibels, µPa = micropascals, PVS = peak vector sum, m = metres, dBL = low frequency noise level.

1. Based on planned production/mine progression.
2. BM03 is used for performance based monitoring only. It is located on WCPL owned land to the south of the Mine, closer to the Mine than the dwellings.
3. This property is now owned by WCPL.

During the reporting period, a maximum air blast overpressure level of 117.6 dBL was recorded at BM03 (23 November 2018), which is located closer to blasting activity than the Fenwick and Lambkin dwellings. This was 3.6 dB above the predicted airblast overpressure level for Fenwick (114 dBL) and 5.6 dB above the predicted airblast overpressure level for Lambkin (112 dBL). For comparison, the overpressure level recorded at the other WCPL blast monitors during this blast was:

- 115.5 dBL at BM01 (approximately 3 km north of BM03 [also located on WCPL land]);
- 101.6 dBL at BM02 (approximately 5 km north east of BM03);
- 108.2 dBL at BM05 (approximately 10 km north west of BM03); and
- 99.9 dBL at BM07 (approximately 10 km north west of BM03).

The maximum ground vibration level recorded at BM03 was 0.44 mm/s (on 9 October 2018). This is well below the predicted levels for both Lambkin and Fenwick.

5.2.3 Trends and Key Management Implications

There were 96 blasts recorded during 2018, compared with 96 in 2017, 106 in 2016, 79 in 2015, 75 in 2014 and 62 in 2013. Air blast overpressure and ground vibration levels recorded during the 2018 blasts were similar to those recorded in the previous reporting periods. No exceedances of the blasting limits have been recorded at compliance monitoring sites (i.e. BM02, BM05 and BM07) during the last five reporting periods.

During the reporting period, blasting was undertaken within 2 km of the WHC on one occasion (19 November 2018). In accordance with Condition 62, Schedule 4 of DA305-7-2003, ground vibration and air blast levels were recorded for each event. The results of this blast are discussed in the WHC Structural Assessment Annual Report (Bill Jordan & Associates 2019).

Condition 64, Schedule 4 of DA305-7-2003 requires that:

> *64. Ground vibration and air blast levels experienced at the Wambo Homestead Complex blast monitoring station are not to exceed the structural damage assessment criteria prescribed by Australian Standard AS 2187.2-1993 (or its latest version) "Explosives – Storage Transport and Use" for Sensitive and Heritage Structures to prevent damage to the heritage items.*

As described in the approved WCPL BMP, the latest version of Australian Standards (AS) 2187.2-2006 no longer has reference to Sensitive and Heritage Structures which previously provided the criteria of a peak particle vibration (PPV) of 5 mm/s for the WHC. WCPL has continued to apply this conservative PPV limit and will undertake further monitoring and assessments if there is a need to modify this criteria in the future.

The ground vibration and air blast levels for the event did not exceed the blasting limits for the WHC.

In accordance with Condition 66, Schedule 4, the approved structural engineer (Bill Jordan & Associates) advised that the blast recording showed no characteristics of the ground motion which could have an effect on WHC (Bill Jordan & Associates 2019).

Bill Jordan & Associates (2019) also considered the highest ground vibrations recorded at BM03 between January and December 2018 and concluded that the recorded ground vibrations would have no effect on the WHC. The report prepared by Bill Jordan & Associates (2019) has been provided to the NSW Heritage Office.

WCPL achieved a data capture rate of 100% for overpressure and 100% for vibration during the reporting period[3].

5.2.4 Implemented or Proposed Management Actions

During the next reporting period, WCPL will continue to implement the approved WCPL BMP.

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3 Homestead (structural monitoring; BM01) and Harris (performance monitoring; BM03) monitors have been excluded from the above calculations due to not being compliance based monitoring points.

A copy of the report prepared by Bill Jordan & Associates (2019), which incorporates the six monthly report and the results of blasting within 2 km of the WHC, has been forwarded to the NSW Heritage Office.

5.3 Air Quality

Air Quality Criteria for the Mine are defined in Tables 2, 3 and 4 of DA305-7-2003 (Condition 4, Schedule 4), Tables 5, 6 and 7 of DA177-8-2004 (Condition 14, Schedule 4) and EPL529 (Condition P1). Additional conditions relating to air quality, odour and greenhouse gas emissions, land acquisition, operating conditions and WCPL's AQGGMP are also detailed in these documents.

5.3.1 Approval Criteria/EIS Predictions and Management Plan Requirements

A summary of the approval criteria for air quality is included in **Table 14.**

Table 14: Approval Criteria for Air Quality

	Pollutant	Averaging Period	Criterion [a, b]
Long-term Impact Assessment Criteria	TSP	Annual	[c]90 µg/m^3
	PM_{10}	Annual	[c]30 µg/m^3
	Deposited Dust[d]	Annual	[e]2 g/m^2/month (maximum increase)
			[c]4 g/m^2/month (maximum total)
Short-term Impact Assessment Criteria	PM_{10}	24 hour	[c]50 µg/m^3

Note: TSP = Total Suspended Particles, PM_{10} = particulate matter with a diameter less than 10 micrometers, µg/m^3 = micrograms per cubic metre, g/m^2/month = grams per square metre per month.

a. Criterion as per Condition 4, Schedule 4 of DA305-7-2003 and Condition 14, Schedule 4 of DA177-8-2004. This criterion must not be exceeded at any residence on privately-owned land or on more than 25% of any privately-owned land.

b. Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents or any other activity agreed by the Secretary.

c. Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources).

d. Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air - Determination of Particulate Matter - Deposited Matter - Gravimetric Method.

e. Incremental impact (i.e. incremental increase in concentrations due to the development on its own)

A summary of the EIS predictions for air quality is included in **Section 5.3.2.1**, along with WCPL's performance against these predictions during the reporting period. For more information on the EIS predictions refer to the EIS (Resource Strategies 2003).

In addition to the statutory requirements detailed in **Table 14**, WCPL is also required to meet additional requirements, in accordance with the approved WCPL AQGGMP. These requirements include reporting of greenhouse gas monitoring data in the Annual Review (**Section 5.4**).

5.3.2 Performance during the Reporting Period

Air quality monitoring was undertaken during the reporting period, in accordance with the approved WCPL AQGGMP. A summary of the air quality monitoring data is included in **Appendix D.**

During the reporting period, WCPL complied with all statutory conditions relating to air quality, with the exception of continuous monitoring of 24 hour PM_{10} levels at PM02 on one occasion, PM03 on two occasions and PM04 on four occasions (**Section 10.2**).

WCPL complied with all additional air quality requirements detailed in the WCPL AQGGMP.

The annual average TSP concentration at all four monitoring locations did not exceed the long-term impact annual average criteria of 90 $\mu g/m^3$ at any residence on any privately owned land.

The annual average dust deposition criterion did not exceed the annual average criteria of 4 g/m^2/month at any monitoring sites.

None of WCPL's PM_{10} monitors recorded annual averages above the compliance criteria of 30 $\mu g/m^3$ for the year.

There were 25 days in the reporting period where PM_{10} concentrations above 50 $\mu g/m^3$ were recorded at a monitor. Data on these days was examined in order to identify the likely contribution of WCPL activities to the measured results. There were nine days that the calculated site contribution influenced compliance with the impact assessment criteria of 50 $\mu g/m^3$ (refer to **Table 18**). **Section 5.3.3.2** describes the operational controls applied on each of these days.

Six (6) complaints were received regarding dust from the Mine during the reporting period (**Section 8.3**).

WCPL did not receive any written requests for acquisition from the landowners of the land listed in Table 1 of DA305-7-2003 (Condition 1, Schedule 4) nor did it exceed the Land Acquisition Criteria listed in Tables 5 to 7 of DA305-7-2003 (Condition 5, Schedule 4).

There were no other incidents relating to air quality, odour or greenhouse gases during the reporting period.

5.3.2.1 Comparison with EIS Predictions

The EIS (Resource Strategies 2003) included predicted cumulative TSP, PM_{10} and dust deposition levels for three operational scenarios (Years 2, 7 and 9). The Year 7 and 9 scenarios best represent current operations at the Mine.

A summary of the predicted cumulative annual average TSP, PM_{10} and dust deposition levels for the Year 7 and 9 scenarios at the residences assessed in the EIS (Resource Strategies 2003) air quality assessment, that are most representative of the WCPL air quality monitoring sites, is provided in **Table 15**. The monitored annual average TSP, PM_{10} and dust deposition levels during the reporting period are also provided in **Table 15**.

The annual average TSP concentrations were above the predicted cumulative TSP concentrations at the relevant residences assessed in the EIS (Resource Strategies 2003) (**Table 15**). This is consistent with the 2014, 2015, 2016 and 2017 results.

The annual average PM_{10} concentrations were below the predicted cumulative annual average PM_{10} concentrations at the relevant residences assessed in the EIS (Resource Strategies 2003) with the exception of AQ02 (WCPL owned residence) and AQ03. The results for AQ03 were similar to those predicted for Year 9 in the EIS. This is largely consistent with the 2014, 2015, 2016 and 2017 results.

Table 15: Comparison of EIS Predictions and 2018 Monitoring Data – Air Quality

Parameter	Receiver		EIS Prediction		2018 Monitoring
	Monitoring Site	EIS Residence	Year 7 (2011)	Year 9 (2013)	
Annual Average TSP ($\mu g/m^3$)[1]	HV01	19B (L Kelly)	46.7	40.5	77.1
	HV02	WCPL	12.6	13.4	70.8
	HV03	33 (DJ Thelander & JA O'Neill)	17.6	20.0	55.8
	HV04	40 (KM Muller)	32.8	30.5	75.3
Annual Average PM_{10} ($\mu g/m^3$)	AQ01 (PM01)	19B (L Kelly)	39.2	34.5	25.7
	AQ02 (PM02)	WCPL	11.0	11.8	23.6
	AQ03 (PM03)	33 (DJ Thelander & JA O'Neill)	16.2	18.1	18.6
	AQ04 (PM04)	40 (KM Muller)	29.1	26.6	25.1
Average Annual Deposited Dust (g/m^2/month)	D11	2 (W & D Lambkin)	0.35	0.35	1.9
	D19	19B (L Kelly)	1.48	1.10	3.0
	D21	33 (DJ Thelander & JA O'Neill)	0.36	0.42	1.6
	D22	40 (KM Muller)	0.73	0.73	2.5

1. TSP is estimated from PM_{10} monitoring data based on the relationship that 33% of TSP is PM_{10}.

The monitored dust deposition rates were above the predicted cumulative dust deposition rates at the relevant residences assessed in the EIS (Resource Strategies 2003) (**Table 15**). This is consistent with the 2014, 2015, 2016 and 2017 results.

The difference between the predicted and monitored TSP, PM_{10} and dust deposition levels is considered to be due to a number of factors, including:

- natural variability in background air quality (e.g. dust storms and bush fires);
- current WCPL mine layout/progression is similar but not the same as the modelled scenarios; and
- the EIS (Resource Strategies 2003) cumulative predictions included emissions from surrounding mining operations (i.e. United Colliery, Hunter Valley Operations and Warkworth Mine) but did not include emissions from general background sources as indicated by background monitoring to avoid double counting of existing mining-related emissions (this is particularly the case for TSP and dust deposition).

5.3.3 Trends and Key Management Implications

During the reporting period, the WCPL Environmental Department provided training to the open cut workforce, which included real time noise and dust monitoring training with operators responsible for on-shift monitoring of noise and dust.

WCPL also shut down or modified its open cut operations proactively as required in response to adverse wind conditions and utilised drone fly-overs and in-pit cameras to visually monitor and manage in-pit dust and post blast dust.

There were no other air quality, odour or greenhouse gas management implications arising from WCPL's operations for the reporting period.

5.3.3.1 TSP

TSP levels recorded by WCPL's four High Volume Air Samplers (HVAS) during the reporting period were higher than those previously recorded, as shown in **Table 16** and **Figure 5**. The data shows there was a general increase in recorded TSP levels from 2011 to 2014, with a dip in 2015 and 2016, before increasing again in 2017 and 2018. It is noted that 2017 and 2018 were drier years than 2015 and 2016 (**Section 5.5**).

Table 16: TSP Annual Averages (µg/m^3) (2011-2018)

HVAS	2011	2012	2013	2014	2015	2016	2017	2018
HV01	56.7	64.8	61	66	54.8	47.8	68.8	77.1
HV02	48.8	61.4	62	58	51.5	47.7	61.6	70.8
HV03	49.0	38.9	41	48	40.6	39.5	50.0	55.8
HV04	41.0	58.6	49	63	60.6	56.6	64.1	75.3

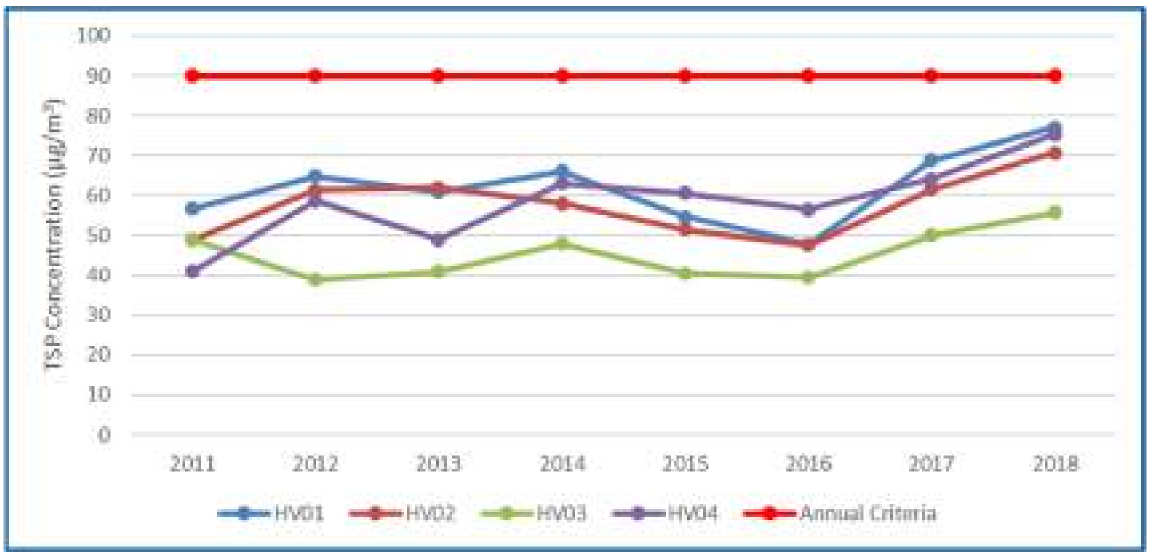

Figure 5: TSP Annual Averages (2011-2018)

Compared to the EIS predictions for Year 9 (**Table 15**) (Resource Strategies 2003), WCPL's recorded TSP levels (**Table 16**) are higher than the levels predicted.

5.3.3.2 PM_{10}

PM_{10} concentrations recorded by WCPL's four Tapered Element Oscillating Microbalance Analyser (TEOM's) during the reporting period were higher than those recorded previously, as shown in **Table 17** and **Figure 6**. The data shows that PM_{10} concentrations have remained relatively consistent over the previous seven years, however the highest concentrations recorded to date were observed in 2018.

Peabody

Table 17: PM_{10} Annual Averages (µg/m^3) (2011-2018)

TEOM	2011	2012	2013	2014	2015	2016	2017	2018
Annual Average in µg/m^3								
AQ01 (PM01)	16.8	21.0	19.3	18.0	15.7	15.6	20.6	25.7
AQ02 (PM02)	17.2	21.1	22.3	19.0	16.0	17.5	19.1	23.6
AQ03 (PM03)	16.7	16.6	16.5	15.3	12.9	14.1	14.6	18.6
AQ04 (PM04)	16.2	18.3	16.8	17.7	16.5	16.3	17.2	25.1
Maximum 24-hour Average in µg/m^3								
AQ01 (PM01)	49	47	65	55	52	49	66	151.9[1]
AQ02 (PM02)	83	76	97	70	55	49	52	163.5[1]
AQ03 (PM03)	43	47	71	51	43	39	39	143.8[1]
AQ04 (PM04)	43	45	65	56	71	44	49	125.0[1]
Number of Days Above 24-hour Average Criteria								
AQ01 (PM01)	0	0	4	2	1	0	5	15
AQ02 (PM02)	2	7	20	2	3	0	2	9
AQ03 (PM03)	0	0	1	1	0	0	0	6
AQ04 (PM04)	0	0	3	1	2	0	0	12

1. If the results on 22 and 23 November 2018 are discounted as they were the result of a state-wide dust storm, the maximum 24-hour averages are; 80.6 µg/m^3 at AQ01, 66.0 µg/m^3 at AQ02, 58.70 µg/m^3 at AQ03 and 70.9 µg/m^3 at AQ04.

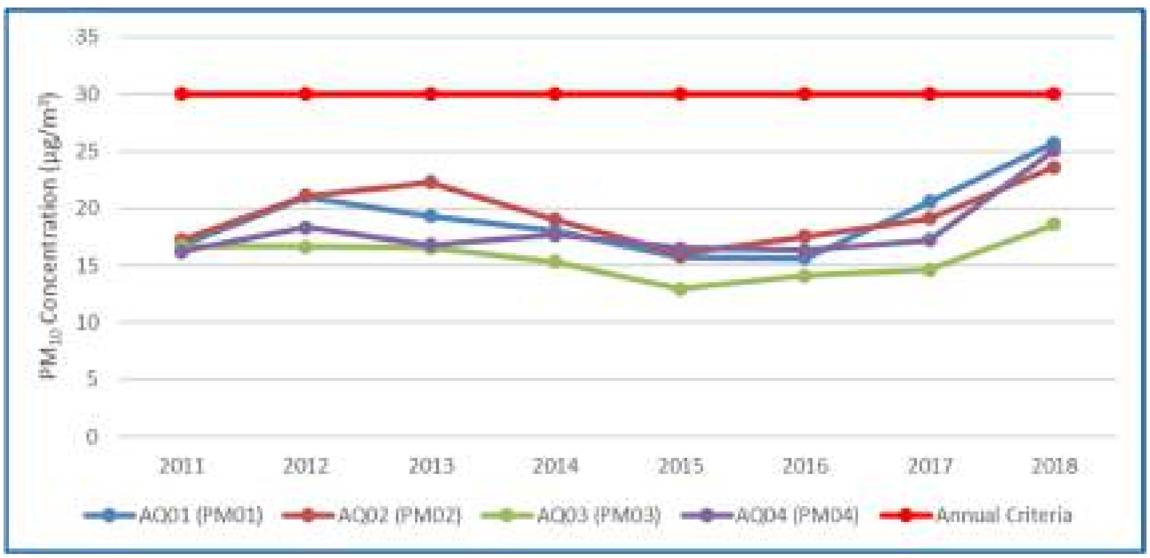

Figure 6: PM_{10} Annual Averages (2011-2018)

A review of the PM_{10} data for 2018 was completed by Jacobs (2019) and is included in **Appendix E**. The review estimated the contribution from WCPL on each day where 24-hour PM_{10} concentrations exceeded 50 µg/m^3. This estimation is conservative as it estimates the site contribution based on downwind concentration minus upwind concentration, on the assumption that no other sources are present.

Table 18 outlines the operational responses on each of the days during the reporting period with elevated PM_{10} concentrations.

Table 18: Operational Actions Implemented on Days of Elevated PM_{10}

Date	Measured 24-hour Average PM_{10} Concentration in µg/m³ (estimated site contribution by Jacobs in parentheses)				Time of Peak Dust	Operational Response	Comment on Compliance
	D1- Muller (AQ04)	D2 - Caban (AQ03)	D3 – Coralie (AQ01) [1]	D4 Thelander (AQ02)			
18/01/2018	51 (7.2)	40 (0.1)	32 (0.6)	29 (0.3)	10.00pm to 12.00am	Site analysis tool run to determine WCPL's contribution.	The exceedance occurred at the end of the day, limiting the ability of WCPL to implement proactive measures. WCPL contribution was 14%.
9/02/2018	56 (15.4)	39 (0.5)	39 (0.2)	28 (0.2)	8.00pm to 9.00pm	Site analysis tool run to determine WCPL's contribution. Three water carts operated during the day and night shifts. The shift report for 9 February indicates that only two excavators were running during the storm. The following table details excavator downtime 9 February 2018. **Day shift 9 February (0600 to 1800)** | **Cumulative Downtime (hours)** 6 Excavators | 3.25 (down) and 4.90 (weather) **Night shift 9 February (1800 to 0200)** | **Cumulative Downtime (hours)** 5 Excavators | 0.25 (down) and 10.40 (weather) Exceedance notified to DPE 16 February 2018.	24 hour PM_{10} levels recorded at the D1 monitor were consistent with regional dust levels at Warkworth, recorded by the Upper Hunter Air Quality Monitoring Network. Reasonable and feasible measures implemented on-site. WCPL contribution was 27.5%.
16/02/2018	59 (0.9)	52 (3.5)	50 (0)	55 (1.1)	8.00am to 9.00am and 4.00pm to 6.00pm	Site analysis tool run to determine WCPL's contribution. Nightshift report notes smoke haze and high winds. Delayed start on nightshift due to dust issues. All available water carts utilised.	Concentration above 50 µg/m³ would have occurred in the absence of WCPL and contribution was small (between 1.5 and 6.7%). Reasonable and feasible measures implemented on-site.

<table>
<tr><th rowspan="2">Date</th><th colspan="4">Measured 24-hour Average PM_{10} Concentration in µg/m^3 (estimated site contribution by Jacobs in parentheses)</th><th rowspan="2">Time of Peak Dust</th><th rowspan="2">Operational Response</th><th rowspan="2">Comment on Compliance</th></tr>
<tr><th>D1- Muller (AQ04)</th><th>D2 - Caban (AQ03)</th><th>D3 – Coralie (AQ01) [1]</th><th>D4 Thelander (AQ02)</th></tr>
<tr><td>20/03/2018</td><td>55 (13.1)</td><td>41 (0)</td><td>43 (0)</td><td>36 (0.8)</td><td>7.00pm to 8.00pm</td><td>Site analysis tool run to determine WCPL’s contribution.
Four water carts operated during the day and ran through shift change (day shift to night shift). Four excavators were running during day shift with two excavators not in operation. Six excavators were running during night shift however three of these excavators had a cumulative downtime of 3 hours due to the dusty conditions.
The shift report notes that the conditions on-site were hazy due to possible bushfire activity and that smoke was observed in air from bushfires.
Exceedance notified to DPE on 29 March 2018.</td><td>PM_{10} 24 hour averaged dust levels recorded at Warkworth and Jerrys Plains by the Upper Hunter Air Quality Monitoring Network during this period were generally consistent with PM_{10} levels recorded at D1.
Reasonable and feasible measures implemented on-site.
WCPL contribution was 23.8%.</td></tr>
<tr><td>15/04/2018</td><td>44 (0)</td><td>51 (4.5)</td><td>51 (3.2)</td><td>47 (0)</td><td>8.00am</td><td>Site analysis tool run to determine WCPL’s contribution.
PM10 24 hour averaged dust levels recorded at Warkworth and Jerrys Plains during this period were higher than the PM10 levels recorded at both Caban and Coralie.
On the 15th April, four water carts operated during both day and night shifts. Five excavators were running during day shift and night shift with one excavator not in operation. The following table details downtime.
<table><tr><th>Day shift 15 April ([illegible])</th><th>Cumulative Downtime (hours)</th></tr><tr><td>5 excavators</td><td>[illegible] hours</td></tr><tr><th>Night shift 15 April ([illegible])</th><th>Cumulative Downtime (hours)</th></tr><tr><td>5 excavators</td><td>[illegible] hours</td></tr></table>
Exceedance notified to DPE on 17 April 2018.</td><td>24 hour PM_{10} levels recorded at WCPL’s D2 and D3 monitors were lower than regional dust levels at Jerrys Plains and Warkworth, recorded by the Upper Hunter Air Quality Monitoring Network.
Reasonable and feasible measures implemented on-site.
Maximum WCPL contribution was 8.8%.</td></tr>
<tr><td>24/07/2018</td><td>28 (0)</td><td>53 (3)</td><td>23 (2)</td><td>19 (0)</td><td>9.00am</td><td>Site analysis tool run to determine WCPL’s contribution.</td><td>WCPL contribution was small (<6%).</td></tr>
</table>

Date	Measured 24-hour Average PM_{10} Concentration in µg/m³ (estimated site contribution by Jacobs in parentheses)				Time of Peak Dust	Operational Response	Comment on Compliance
	D1- Muller (AQ04)	D2 - Caban (AQ03)	D3 – Coralie (AQ01) [1]	D4 Thelander (AQ02)			
6/11/2018	30 (0.3)	39 (1.8)	53 (5.4)	30 (0)	8.00am to 10.00am	Site analysis tool run to determine WCPL's contribution. On 6th November two water carts operated at the start of the shift. The shift report notes no visible dust on camera and nothing coming from behind trucks at 8am, with wind levels increasing around 9.30am. All four water carts were hotseated during crib break. Noted dust visibility increasing at 2pm and that trucks were driving to conditions. Dust levels in pit noted OK at 3pm.	WCPL contribution was small (<10.5%). Reasonable and feasible measures implemented on-site.
09/12/2018	51 (14.4)	31 (0.3)	42 (0.1)	31 (0.6)	8.00pm to 10.00pm	Site analysis tool run to determine WCPL's contribution. Day shift report notes four water carts operating. Noted throughout the nightshift report (in 15 minute intervals) that dust levels were within 24hr limits.	WCPL contribution was 28%.
29/12/2018	43 (5)	30 (1.3)	52 (2.6)	26 (1.4)	12.00am to 2.00am	Site analysis tool run to determine WCPL's contribution. Day shift report notes all four water carts manned all shift and water carts hot seated during shift breaks. Dust levels noted throughout the day and trucks noted driving to conditions. Nightshift report notes dust levels monitored throughout the night and heavy equipment operated to conditions.	WCPL contribution was small (5%). Reasonable and feasible measures implemented on-site.

1. It is noted that the short-term impact assessment criteria in Condition 4, Schedule 4 of DA 305-7-2003 do not apply to the one privately-owned residence in Warkworth (as it is listed in Table 1 of the Consent). On this basis, Site AQ01 is not a compliance point.

5.3.3.3 Dust Deposition

Dust deposition levels recorded by WCPL's dust deposition gauges (DDGs) during the reporting period remained consistent with levels recorded in the previous six reporting periods as shown in **Table 19**.

Table 19: Dust Deposition Annual Averages (g/m^2/month) (2011-2018)[1]

DDG	2011	2012	2013	2014	2015	2016	2017	2018
Privately Owned Land								
D11	2.0	2.2	2.2	2.5	2.2	2.3	1.4	1.9
D21	1.2	1.4	1.9	1.9	2.0	1.7	1.2	1.6
D22	1.2	1.4	2.0	2.2	2.0	2.2	2.4	2.5
WCPL Owned Land								
D19	2.5	2.9	3.1	2.9	3.1	2.5	2.3	3.0

1. Sources of foreign material including bird droppings, insects, sticks and other organic matter can be identified in samples when analysed. Contamination is assessed based on field observations, laboratory observations, and historical data and wind patterns. All monthly dust results deemed to be contaminated were excluded from the annual average.

5.3.4 Implemented or Proposed Management Actions

During the reporting period, WCPL continued to conduct training sessions with the open cut workforce on real-time noise and dust monitoring and in particular, for the operators responsible for on-shift monitoring of noise and dust.

WCPL is currently reviewing alternatives to fitting water carts with GPS units to monitor the frequency and movement of the water carts across the site.

WCPL will continue to implement the approved WCPL AQGGMP.

5.4 Greenhouse Gas

There are no approval criteria for greenhouse gas emissions in WCPL's statutory approvals.

5.4.1 Approval Criteria/EIS Predictions and Management Plan Requirements

A summary of the EIS predictions for carbon dioxide (CO_2) emissions is included in **Section 5.4.2**, along with WCPL's performance against these predictions from 2013 to 2018. For more information on the EIS predictions refer to the EIS (Resource Strategies 2003).

WCPL is required to report greenhouse gas monitoring data in the Annual Review, in accordance with the approved WCPL AQGGMP.

5.4.2 Performance during the Reporting Period

WCPL calculates and reports on greenhouse gas emissions at the end of every financial year, hence the summary data provided in **Table 20** below is for the period 1 July 2017 to 30 June 2018. Data for the second half of the 2018 reporting period will be included in the 2019 Annual Review.

A total of 270,295 tonnes of CO_2 was emitted by the Mine's ventilation systems in 2018 compared to the predicted 2,644,503 tonnes.

The emissions predictions in the 2003 EIS were based on the assumption that the simultaneous mining of two longwalls (Wambo and Arrowfield/Bowfield) in conjunction with Arrowfield/Bowfield gas drainage would occur during 2018. During this reporting period, only one longwall was operational which accounts for actual emissions only being approximately 30% of the predicted volumes.

A total of 692,969 tonnes of CO_2-e was emitted from the operation from all other sources. This is higher than the predicted 80,126 tonnes of CO_2-e due to the inclusion of 472,331 tonnes of CO_2-e from the decommissioned North Wambo Underground Mine. Ventilation emissions have been gradually decreasing over the years due to the change from methane rich coal seam gas to CO_2 rich coal seam gas, as the Mine has progressed from the North Wambo Underground Mine to the South Bates (Whybrow and Wambo Seam) Underground Mine. This change is part of a regional gas change that happens to occur across the Wambo lease. The 2017-18 financial year was the second NGER year that Wambo had emissions from a decommissioned mine due to North Wambo Underground Mine closing in April 2016.

The total emissions emitted from the Mine during the reporting period (963,264 tonnes of CO_2-e) is similar to previous reporting periods (**Table 20**).

Table 20: Comparison of EIS Predictions and Monitoring Data – Greenhouse Gas

Parameter	Monitoring Point	Monitoring Frequency	Emissions Calculated	Calculated CO_2-e tonnes for 2013 – 2014	Calculated CO_2-e tonnes for 2014 – 2015	Calculated CO_2-e tonnes for 2015 – 2016	Calculated CO_2-e tonnes for 2016 – 2017	Calculated CO_2-e tonnes for 2017 – 2018	EIS predicted CO_2-e tonnes for 2018[1]
Ventilation Systems									
Methane	Main Ventilation Shaft	Real-time continuous	Emission factor to convert from tonnes of CH4 to tonnes of CO_2-e	591,362	703,596	618,127	137,521	227,824	
Carbon Dioxide	Main Ventilation Shaft	Real-time continuous	Tonnes of CO_2-e	23,205	26,750	30,552	33,184	43,471	
Total				**614,567**	**730,346**	**648,679**	**170,705**	**270,295**	**2,644,503**
Other (Diesel and Electrical Power)									
Diesel Use	Calculated from invoices	Annually	Emission factor to convert from kL use to tonnes of CO_2-e	98,084	92,935	97,983	97,274	92,034	
Oil Use	Calculated from invoices	Annually	Emission factor to convert from kL use to tonnes of CO_2-e	39 (plus 3,652 kL not combusted)[2]	280 (plus 321 kL not combusted)	339 (plus 104 kL not combusted)	44 (plus 206 kL not combusted)	163 (plus 643.5 kL not combusted)	
Grease Use	Calculated from invoices	Annually	Emission factor to convert from kL use to tonnes of CO_2-e	0 (plus 4,880 kL not combusted)[2]	0 (plus 63 kL not combusted)	0 (plus 42 kL not combusted)	0 (plus 26 kL not combusted)	0 (plus 67.1 kL not combusted)	
Electricity Use	Calculated from invoices	Annually	Emission factor to convert from kWh use to tonnes of CO_2-e	79,869	78,576	76,506	63,435	64,185	
ROM Coal Production	Calculated from weight meter and survey	Monthly	Fugitive emissions factor based on ROM production[3]	70,183 (UG Stockpile residual emissions) 12,155 (OC Fugitives)	59,124 (UG Stockpile residual emissions) 31,899 (OC Fugitives)	80,543 (UG Stockpile residual emissions) 24,634 (OC Fugitives)	69,202 (UG Stockpile residual emissions) 518,263 (closed mine calculation) 45,227 (OC Fugitives)	45,880 (UG Stockpile residual emissions) 472,331 (closed mine calculation) 18,231 (OC Fugitives)	
Gas Drainage[4]	-	Annually	Tonnes of CO_2-e	-	-	-	-	145	
Sub-Total				**260,330**	**262,814**	**280,005**	**793,445**	**692,969**	**80,126**
Total				**874,897**	**993,160**	**928,684**	**964,150**	**963,264**	**2,724,629**

Note: CO_2-e = carbon dioxide equivalent, CH4 = methane, kL = kilolitres, OC = Open Cut, UG = Underground, kWh = kilowatt hours.

1. Refer to Tables 16 and 17 of Appendix B of the WCPL EIS (Resource Strategies 2003).
2. Anomalous results recorded during 2014 for non-combustible grease and oil use are believed to be due to human error in internal accounting procedures.
3. Wambo Open Cut uses Method 2 in situ measured emissions calculations for fugitive emissions. This involves the application of a gas model to as-mined pit shells for the year to generate the measured emissions number.
4. Financial Year 17/18 was the first time that a gas drainage plant was used. The plant was used intermittently.

5.4.3 Trends and Key Management Implications

Levels of total CO_2 emissions monitored from the main ventilation shafts in 2013 to mid-2016 were indicative of the active mining at the North Wambo Underground Mine. Following the closing of the North Wambo Underground Mine in 2016, a significant proportion of the methane emissions previously recorded at the main ventilation shaft shifted to being presented under a 'closed mine calculation'. The overall annual emissions from the Mine during the last five reporting periods have remained relatively consistent.

Annual emissions from diesel and other sources associated with production-related electrical generation have overall remained relatively consistent with EIS predictions and between reporting periods.

5.4.4 Implemented or Proposed Management Actions

WCPL did not undertake any targeted energy saving projects during 2018, however energy efficiency is considered during the design and construction of haul roads and mine planning.

5.5 Meteorology

WCPL are required to maintain a meteorological monitoring station at the Mine and monitor the parameters specified in Table 11 of DA305-7-2003 (Condition 10, Schedule 4) and EPL529 (Condition M4), using the specified units of measure, averaging period, frequency and sampling method described in the tables. In July 2017, WCPL replaced the meteorological monitoring station.

WCPL maintains the meteorological monitoring station in accordance with AS 2923-1987. The following parameters are monitored by the meteorological monitoring station, in accordance with WCPL's statutory conditions:

- temperature (at 2 m and 10 m);
- rainfall;
- lapse rate[4];
- wind speed (at 10 m);
- wind direction (at 10 m);
- solar radiation (at 10 m);
- humidity; and
- sigma theta.

Table 21 summarises the annual rainfall, temperature and wind direction data for 2018, compared to previous reporting periods.

[4] WCPL calculates the lapse rate from measurements made at 2 m and 10 m, in accordance with DA305-7-2003.

Table 21: Environmental Performance – Meteorology (2014-2018)

Parameter	2014	2015	2016	2017	2018
Rainfall (mm)	556.44	789.49	721.18	442.50	536.2
Maximum Temperature (°C)[1]	45.3 (Nov)	40.8 (Nov)	41.6 (Dec)	46.8 (Feb)	43.8 (Jan)
Minimum Temperature (°C)[1]	-1.7 (June)	-0.85 (June)	-3.4 (July)	-3.5 (July)	-5.5 (July)
Mean Temperature (°C)[1]	18.1	19.2	18.4	18.5	18.7
Predominant Wind Direction	E/SE (summer) W/NW (winter)	S/SE (summer) W/SW (winter)[2]	S/SE (summer) SW (winter)	S/SE (summer) W/SW (winter)	S/SE/E (summer) NW (winter)

Note: °C = degrees Celsius, E = East, SE = South-east, W = West, NW = North-west, S = South, SW = South-west.

1. Measured at 2 m above ground.
2. The winter data (2015) was influenced by the use of the Charlton Ridge weather station which may explain the change in weather direction as WCPL's weather station was experiencing software issues.

The 2018 EPA Annual Return reported a non-compliance with the requirements of Condition M9.4 of EPL 529. The meteorological station was logging in 10 minute intervals, not in 15 minute intervals as required for the period 1 January to 18 December 2018 (**Section 10.3**). This issue has been rectified.

5.6 Biodiversity

During the reporting period, WCPL updated the Biodiversity Management Plan (BioMP) (previously called the Flora & Fauna Management Plan [FFMP]) as a component of the Extraction Plan for Longwalls 17 to 20 at the South Bates Extension Underground Mine (Version 14). The BioMP (Version 14) was approved in September 2018 and incorporates the Biodiversity Offset Management Strategy required under Condition 40, Schedule 4 of DA305-7-2003. It also addresses the requirements within the Voluntary Conservation Agreements (VCA) prepared under Condition 41(a), Schedule 4 of DA305-7-2003, and the requirements of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) approvals (EPBC 2003/1138, EPBC 2016/7636 and EPBC 2016/7816).

The BioMP also meets the requirement for a Biodiversity Management Plan under Condition 22C, Schedule 4 of DA305-7-2003 in support of the Extraction Plan for the South Bates Underground Mine Longwalls 11 to 16 and in support of the Extraction Plan for the South Bates Extension Underground Mine Longwalls 17 to 20.

The BioMP applies to all activities undertaken within WCPL's mining authorisations and approved mining areas that may impact on biodiversity, as well as biodiversity in WCPL's RWEAs and Open Cut Revegetation Areas. The BioMP has been developed to:

- identify lands to be managed in accordance with this BioMP;
- provide a framework for the management of biodiversity in the RWEAs and Open Cut Revegetation Areas;
- provide a clear, concise set of management actions and a schedule for the coordinated and effective delivery of biodiversity enhancement;
- define realistic Completion Criteria for RWEAs and Open Cut Revegetation Areas that can be quantitatively evaluated through a seasonally based monitoring program;
- define a seasonally based monitoring program suitable for determining management success (or otherwise);
- provide suitable contingency measures and associated Trigger Action Response Plans (TARPs) that adequately address any deviation from the Completion Criteria; and
- define the responsibilities for implementing, reviewing and reporting on the BMP.

5.6.1 Approval Criteria/EIS Predictions and Management Plan Requirements

Performance measures for subsidence impacts on biodiversity are detailed in Condition 22, Schedule 4 of DA305-7-2003 (**Section 5.9.2**). WCPL are required to monitor and report on biodiversity in accordance with the conditions of DA305-7-2003, DA177-8-2004, EPBC2003/1138, EPBC2016/7636, EPBC2016/7816 and the approved BioMP.

As part of the development of the BioMP, WCPL transferred across to a combined Landscape Function Analysis (LFA) and biometric monitoring methodology. The LFA target scores and floristic performance criteria are provided in **Table 22** and **Table 23**, respectively.

Table 22: LFA Target Scores

Site Type	LOI[1]	SI[1]	INFI[1]	NI[1]
Woodland Rehabilitation	>0.87	>59	>43	>36
Pasture Rehabilitation	>0.93	>61	>29	>25
NWCD	>0.84	>62	>41	>37
Wambo Creek	>0.84	>62	>41	>37

1. LOI = landscape organisation index, SI = stability index, INFI =infiltration, NI = nutrient index.

Table 23: Floristic Performance Criteria for Plant Community Types in RWEAs and Performance Targets for Older Woodland Areas and Rehabilitation Sites

	Attribute[1]									
	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	OR	HBT	FL
Rehabilitation										
Older Woodland Areas with a canopy of Sugar Gum	>15	15-40	5-40	5-15	5-10	5-15	<20	1	-	5
Areas of Narrow-leaved Ironbark – Bull Oak - Grey Box open forest	>20	10-40	5-10	15-50	5-10	5-40	<20	1	-	-
RWEAs										
PCT42[2]	>20	10-50	10-50	20-60	1-5	5-30	<10	1	-	-
PCT1658[2]	>20	10-40	10-50	4-20	5-30	5-35	<10	1	-	-
PCT1603[2]	>25	10-40	5-10	15-50	5-10	5-40	<5	1	-	-
PCT1604[2]	>35	15-40	5-20	30-50	5-15	5-40	<5	1	-	-
PCT1176[2]	>21	15-40	5-30	5-30	0-25	2-10	<5	1	-	-
PCT1584[2]	>45	15-45	5-40	5-40	10-20	5-20	0	1	-	-

1. NPS = the number of native plant species (native to NSW), NOS (%) (including *E.cladocalyx*) = projected native foliage cover of canopy, NMS (%) (including *A.saligna*) = projected native midstorey cover, NGCG = native groundcover of grasses, NGCS = native groundcover of shrubs, NGCO = native groundcover of other plant types (sedges, herbs etc.), EPC = exotic plant cover, OR = overstorey regeneration over the whole vegetation zone, FL= length of fallen logs >10 cm diameter within the vegetation plot.
2. PCT42: River Red Gum/River Oak riparian woodland wetland in the Hunter Valley.
   PCT1658: Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak – Coast Banksia woodland on sands of the Warkworth area.
   PCT1603: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter.
   PCT1604: Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter.
   PCT1176: Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin Bioregion.
   PCT1584: White Mahogany - Spotted Gum – Grey Myrtle semi-mesic shrubby open forest of the central and lower Hunter Valley.

5.6.2 Performance during the Reporting Period

VCAs for the offset areas were drafted in consultation with the Office of Environment and Heritage (OEH) during 2015 and were registered in 2017, in accordance with Condition 41, Schedule 4 of DA305-7-2003. WCPL applied to revise the VCAs to include RWEA E in December 2017. As at the end of the reporting period, the revised VCA had not been finalised by the Biodiversity Conservation Trust. A summary of the actions undertaken by WCPL to date, and its' compliance status is provided in **Section 10.4**.

During the reporting period, WCPL commissioned Eco Logical to monitor the fauna and vegetation structure within the RWEAs. Floristic surveys, bird surveys, LFA and riparian condition surveys were all conducted during October and November 2018 across both remnant woodland and post-mining rehabilitation areas. A copy of the 2018 Annual Flora and Fauna Monitoring Report (Eco Logical 2019) is included in **Appendix F.**

Remnant woodland sites are generally performing well, with reasonable numbers of native species and low cover of exotic species. Most sites are either meeting or just falling short of completion criteria (**Table 22** and **Table 23**), with no additional management required (Eco Logical 2019). Exotic species cover remains high in the River Red Gum / River Oak riparian woodland where historic disturbance has been greatest. Most sites in this area exceed completion criteria and VCA targets for exotic plant cover. Continued weed management will be required to achieve performance criteria in these riparian and floodplain areas. Plantings of canopy species could be considered in the open grassland areas on the Wollombi Brook floodplain in RWEA A, where natural regeneration is unlikely to occur in a reasonable timeframe. Plantings may also reduce issues with exotic flora species in these areas. The dieback of *Angophora floribunda* (Rough-barked Apple) observed within the Warkworth Sands area of RWEA A in 2016 appears to be recovering, with abundant epicormic growth observed in 2017 and 2018.

Bird surveys in remnant woodland sites reflected the good condition of these woodland areas with RWEAs continuing to support a large diversity of bird species including several threatened bird species. Numbers of bird species, numbers of birds and bird communities were largely consistent with the data available from previous monitoring years (Eco Logical 2019).

As reported previously, the NWCD has not yet met completion criteria for landscape function and this area will require continued active management actions to ensure that all completion criteria and other commitments are met in the near future. Woodland rehabilitation areas generally met most landscape function completion criteria, having a high cover of resource trapping leaf litter but fell below biometric completion criteria, with monitoring sites having relatively few native species and almost no groundcover or mid-storey.

Riparian condition scores for North Wambo Creek, Wambo Creek and Stony Creek were lower than the previous year. The lower scores were influenced most strongly by lower cover and abundance of native vegetation in the understorey. This is likely a result of the prevailing dry conditions over the past two years. Attributes relating to more permanent features such as habitat connectivity, tree canopy and logs and hollows remained similar.

During the 2018 surveys, subsidence cracks were observed in RWEA C, however, no significant effects on flora and fauna or performance criteria exceedances were recorded; future monitoring should continue to document and assess subsidence impacts across the site.

Aquatic monitoring was conducted by Niche Environment and Heritage in 2016 to assess the river health of drainages occurring above the North Wambo Underground Mine area, open cut operations and associated infrastructure. Aquatic monitoring is conducted every five years, as required by the BioMP, and is next scheduled for 2021.

5.6.3 Trends and Key Management Implications

The majority of remnant woodland areas remain in good condition with high numbers of native species, few exotic species present and with low cover and abundance. No major issues were identified that require urgent management. However, exotic species cover remains relatively high in riparian and floodplain areas (V1 and V2 plots of RWEA A) and continues to exceed performance criteria and also VCA targets in certain locations. Continued weed management will be required to achieve performance criteria in these riparian and floodplain areas.

Several weed species listed under the NSW *Biosecurity Act 2015* were observed in these areas that have potential to become problematic in the wider region e.g. *Olea europaea* subsp. *cuspidata* (African Olive).

The average number of native species detected within all communities was generally within the range of values recorded in previous monitoring years and was similar to the results from 2017 when dry conditions were experienced. Monthly rainfall data from 2018 from Singleton (Bureau of Meteorology 2018) reveals that for all months in 2018 until October below average rainfall was recorded. The two plots surveyed in November to complete the flora surveys for 2018 recorded higher diversity of native species than other plots within the same community that were surveyed in October. This suggests the majority of surveys, undertaken in October 2018, were undertaken following a dry period of below average rainfall, and many species were likely not detectable due to seasonal conditions.

The number of native species recorded in Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland has recovered significantly from 2017 which had recorded the lowest diversity since surveys began in 2010. The low diversity recorded in 2017 may have been a result of *Angophora floribunda* dieback in 2016 exposing the understorey to harsher conditions. The higher diversity recorded in 2018, along with observations of continued epicormic growth in the impacted trees, suggests the community is recovering from the dieback event in 2016. The community in which the dieback was observed is listed as a critically endangered ecological community under the Commonwealth EPBC Act. The dieback is not considered to be associated with activities undertaken on WCPL land as no undermining is being undertaken in that area and dieback was also observed at other locations within the locality in 2016. Evidence of recovery was observed on most trees that were impacted, and it appears likely that the majority of trees may recover in time.

RWEA and other remnant woodland sites at WCPL continue to support a large diversity of bird species and no introduced bird species were detected within RWEAs. One hundred and sixteen bird species have been recorded during timed bird surveys over the last four years, with 90 (77.5%) of these recorded during 2018, including 10 species not recorded in previous years. The number of species recorded had been declining each year since the highest diversity was recorded 2013, however the result in 2018 arrests this trend and is the third highest diversity recorded since surveys began in 2007. The average number of birds recorded per survey has remained relatively constant since 2014, when this data was first collected.

As vegetation and habitat attributes in RWEA areas have remained relatively stable over time, this variability in species richness between years is likely explained by a combination of factors such as varying numbers of nomadic and migratory bird species, weather and climate, sampling methods, differences in the skill of observers, the timing of surveys and surveys coinciding with the flowering of trees and also broader landscape scale changes across the Hunter Valley.

Comparison of numbers of threatened species (2015-2018) and the number of sites they were recorded at (2009 & 2014-2017) show that both the Speckled Warbler and Varied Sittella were recorded more widely during surveys in 2014. However additional survey effort during the 2014 monitoring may partially explain this observation, as the number of sites where these species have been recorded have remained similar since the 2015 monitoring. The number of individuals for threatened species recorded was within the range of those previously recorded suggesting no obvious declines are evident from the available data.

The aquatic monitoring report (Niche Environment and Heritage 2016) found that comparison with previous survey data showed no significant temporal trends attributable to current catchment management. Aquatic monitoring will be completed in 2021 as required by the BioMP.

5.6.4 Implemented or Proposed Management Actions

WCPL will continue to give priority to weed species listed under the NSW *Biosecurity Act 2015* that have the potential to become problematic in the wider region (e.g. *Olea europaea* subsp. *cuspidata* [African Olive]).

With mining of Longwalls 11 to 16 complete, rehabilitation works for the NWCD, including rehabilitation of subsidence effects, can be planned for areas overlying, and downstream of, Longwall 16. Development of a detailed rehabilitation plan for NWCD upstream of Longwall 16 is not considered practical at this time due to the number of current and future underground mining activities that may affect processes and condition of the watercourse. Some of those activities may also impact areas overlying, and downstream of, Longwall 16, and their influence will be considered as part of the proposed rehabilitation actions for that section of the diversion.

In late 2018, WCPL commissioned Alluvium to prepare a detailed five (5) Year NWCD Rehabilitation and Maintenance Plan, which will be developed in consultation with a stakeholder panel. **Table 24** provides an outline of the rehabilitation and maintenance works proposed.

Table 24: Outline of NWCD Rehabilitation and Maintenance Plan

2018	2019	2020
Continue inspections.	Commence implementation of NCWD Rehabilitation and Maintenance Plan.	Continue implementation of NCWD Rehabilitation and Maintenance Plan.
Annual Diversion and Subsidence Monitoring.	Annual Diversion and Subsidence Monitoring.	Technical panel review of actions implemented, monitoring results and update of rehabilitation plan as required.
Subsidence remediation measures (if required) as outlined in the approved Extraction Plan - South Bates Underground Mine Longwalls 11 to 16.	Subsidence remediation measures (if required) as outlined in the approved Extraction Plan - South Bates Underground Mine Longwalls 11 to 16.	Annual Diversion and Subsidence Monitoring.
Rehabilitation maintenance works, including: • Weed management (particular focus on *Galenia puescens*); • Repair areas of erosion; • Re-seeding with selected native pasture and tree species; • Revegetation trials with native grass species in selective areas of the diversion to assist in controlling weeds; and • Collection of native grass seeds within pasture areas on adjacent WCPL owned pasture lands.		
Prepare and commence implementation of a detailed five (5) Year NCWD Rehabilitation and Maintenance Plan.		

5.7 Aboriginal Heritage

WCPL manages Aboriginal heritage on-site in accordance with the relevant conditions of DA305-7-2003 and the conditions of Aboriginal Heritage Impact Permits (AHIPs) #2222, #C0001474, #C0002000 and #C0003213. These AHIPs allow for the disturbance and/or salvage of all known and unknown Aboriginal objects within the extent of the relevant AHIP boundaries. Any Aboriginal objects salvaged under these permits are managed in accordance with a Care Agreement.

In 2016, WCPL developed a Heritage Management Plan for the Mine, to consolidate all statutory requirements into one document and assist in the management of Aboriginal cultural heritage on-site. The Heritage Management Plan was finalised and approved during 2017, and subsequently updated and approved during the reporting period as part of the preparation of the Extraction Plan for Longwalls 17 to 20 at the South Bates Extension Underground Mine.

Consistent with the requirements of the approved Heritage Management Plan, WCPL has implemented a Surface Disturbance Permit (SDP) procedure and checklist, applicable to all surface works at Wambo Coal Mine. During the SDP assessment process, WCPL undertake a due diligence assessment to ensure that no artefacts that may have been identified in the area are damaged.

WCPL completed the following Aboriginal archaeological surveys and salvage operations during the reporting period:

- Due diligence surveys for five exploratory drill holes in May 2018. Three of the drill holes were located within the existing mining leases and covered by AHIP #2222 and two were outside the mine lease area and area covered by any AHIPs. A total of five sites were investigated, and no heritage evidence was identified during the survey or has been previously reported in these immediate locations. It was considered that the potential for impacts of significance to occur was consequently very low.
- A field inspection and attempted surface collection of site #37-5-0693 was undertaken on 16 February 2018. Despite an intensive search, the artefact reported at site #37-5-0693 could not be relocated. The result is attributed to changes in sediment deposition and vegetation cover between the time of the original recording (December 2015) and the February 2018 inspection.
- A field inspection and surface collection of the portion of Wambo Site 31 (OEH site #37-5-0034) was undertaken on 29 March 2018. Six stone artefacts were identified and subject to collection.
- A field inspection and surface collection of United IF-7 (OEH site #37-5-0698) and Wambo Site 218 (OEH #37-5-0340), was undertaken on 9 May 2018. Eight stone artefacts were recovered from United IF-7 and four artefacts were recovered from Wambo Site 218.
- Salvage of eleven open artefact sites in the South Bates Extension Underground Mine area (Wambo Sites 311, 321, 483, 485 – 489, 498, South Bates Soil Test 2/A and South Bates Soil Test 6/A), that were anticipated to be subject to potential impacts from continued vehicle access, was undertaken on 7 and 8 May 2018. A total of 1,089 artefacts were salvaged from the open sites.

Copies of the due diligence and salvage reports were forwarded to OEH and made available to all of the Registered Aboriginal Parties for the Mine. WCPL plans to continue due diligence surveys as required during the next reporting period. No change in the current procedure is planned.

During the previous reporting period, WCPL was notified by Glencore that two isolated artefacts previously identified during Aboriginal heritage surveys undertaken for the United Project (i.e. AHIMS 37-5-0694 [United IF-1] and AHIMS 37-5-0695 [United IF-2]), had been disturbed during progression of the approved Wambo Coal Mine open pit. Both of these sites are isolated artefacts of low scientific significance and are located in a disturbed context within the boundary of AHIP #2222.

Accordingly, WCPL prepared Aboriginal Site Impact Recording Forms for these sites and provided them to the Aboriginal Heritage Information Management System (AHIMS) so that the status of these sites can be updated. Further, WCPL undertook a review of the site database and confirmed that all relevant records associated with the United Project have been included in the WCPL database.

5.8 Non-Aboriginal Heritage

WCPL is required to prepare a CMP for the WHC in accordance with Conditions 58 and 59, Schedule 4 of DA305-7-2003. A CMP was prepared by WCPL in 2006 and reviewed in 2012 by heritage consultants Godden Mackay Logan. In 2018, the CMP was revised and comments were incorporated from DPE and NSW Heritage Office. The CMP will be submitted for approval during the next reporting period.

An annual photographic record of the elevations of all structures at the WHC was completed during the reporting period and will be lodged with the NSW Heritage Office, Singleton Shire Council and a copy of the report provided to DPE, in accordance with Condition 61, Schedule 4 of DA305-7-2003.

During the reporting period, WCPL undertook blasting that was within 2 km of the WHC on one occasion. Blasting was undertaken in accordance with the approved WCPL BMP and results of monitoring undertaken at the WHC indicated compliance with all criteria (**Section 5.2**). Copies of the ground vibration assessment reports for the WHC have been forwarded to NSW Heritage Office, in accordance with Condition 65, Schedule 4 of DA305-7-2003.

5.9 Subsidence

5.9.1 Extraction Plans

During the reporting period, WCPL received approval for the South Bates Extension Underground Mine Longwalls 17-20 Extraction Plan for Longwall 17 only. The South Bates Extension Underground Mine Longwalls 17-20 Extraction Plan was submitted to DPE in April 2018.

On 4 September 2018, WCPL provided DPE with correspondence explaining that geological structures had been encountered that may require changes to the main headings and finishing ends of Longwalls 18, 19 and 20. Accordingly, WCPL requested that DPE approve the Extraction Plan for Longwalls 17 to 20 for extraction of Longwall 17 only. On 7 September 2018, DPE approved the extraction of Longwall 17 only, on the basis that WCPL would prepare an amended Extraction Plan for Longwalls 18, 19 and 20.

5.9.1.1 Extraction Plan for South Bates Underground Mine Longwalls 11-16

The following reporting is required to be undertaken as part of the Extraction Plan for South Bates Underground Mine Longwalls 11-16:

- Incident Report – to be prepared as required and submitted (by email) to DPE (Manager, Mining Projects), DRG (Subsidence Executive Officer), Subsidence Advisory NSW (District Manager) and other regulators as specified in management plans.

- Subsidence Management Status Reports – to be updated fortnightly and submitted (by email) if new impacts are identified or upon request, to DPE (Manager, Mining Projects), DRG (Subsidence Executive Officer) and OEH (National Parks and Wildlife Service [NPWS]).
- Six Monthly Report – to be updated annually for the period 1 January to 30 June and submitted (by email) to DPE (Manager, Mining Projects), DRG (Subsidence Executive Officer), Subsidence Advisory NSW (District Manager), OEH/EPA (General Contact/NPWS) and DPI-Water (Manager Strategic Stakeholder Liaison) (now DI-Water).
- Annual Review – to be updated annually for the period 1 January to 31 December and submitted (by email and post) to DPE (Manager, Mining Projects), DRG (Subsidence Executive Officer), DRG (Director – Environmental Sustainability), Subsidence Advisory NSW (District Manager), OEH/EPA (General Contact/NPWS), DPI-Water (Manager Strategic Stakeholder Liaison) (now DI-Water), Singleton Shire Council (General Manager) and CCC Members.

The component management plans of the South Bates Underground Longwalls 11-16 Extraction Plan reference components of a number of existing EMPs to avoid duplication. If these EMPs are revised separately in accordance with DA305-7-2003, the EMPs in the Extraction Plan for South Bates Underground Longwalls 11-16 will be updated accordingly.

5.9.1.2 Extraction Plan for South Bates Extension Underground Mine Longwalls 17-20

The following reporting is required to be undertaken as part of the Extraction Plan for South Bates Extension Underground Mine Longwalls 17-20:

- Incident Report – to be prepared as required and submitted (by email) to DPE (Manager, Mining Projects), NSW Resources Regulator (Subsidence Executive Officer), Subsidence Advisory NSW (District Manager) and other regulators as specified in management plans.
- Subsidence Management Status Reports – to be updated fortnightly and submitted (by email) if new impacts are identified or upon request, to DPE (Manager, Mining Projects) and NSW Resources Regulator (Subsidence Executive Officer).
- Six Monthly Report – to be updated annually for the period 1 January to 30 June and submitted (by email) to DPE (Manager, Mining Projects) and NSW Resources Regulator (Subsidence Executive Officer).
- Annual Review – to be updated annually for the period 1 January to 31 December and submitted (by email and/or post) to DPE (Manager, Mining Projects), NSW Resources Regulator (Subsidence Executive Officer), NSW Resources Regulator (Manager Environmental Sustainability), Subsidence Advisory NSW (District Manager), OEH/EPA (General Contact), DI-Water (Water Regulation), Singleton Shire Council (General Manager) and CCC Members.

The component management plans of the South Bates Extension Underground Mine Longwalls 17-20 Extraction Plan reference components of a number of existing EMPs to avoid duplication. If these EMPs are revised separately in accordance with DA305-7-2003, the EMPs in the Extraction Plan for South Bates Extension Underground Mine Longwalls 17-20 will be updated accordingly.

5.9.2 Approval Criteria/EIS Predictions and Management Plan Requirements

In accordance with DA305-7-2003 (Tables 14A and 14B), WCPL must ensure that there are no exceedances of the Subsidence Impact Performance Measures detailed in **Table 25.**

Underground mining was undertaken at South Bates Underground Mine Longwalls 14, 15 and 16 and at South Bates Extension Underground Mine Longwall 17 during the reporting period.

No longwall panels encroached upon the Wollombi Brook, Warkworth Sands Woodland Community or the White Box, Yellow Box, Blakely's Red Gum Woodland/Grassy White Box Woodland Community.

South Bates Underground Mine Longwalls 14, 15 and 16 did not directly undermine the NWCD. South Bates Extension Underground Mine Longwall 17 did not directly undermine the NWCD during the reporting period. These longwalls were offset from the base of the Wollemi National Park escarpment by a minimum 26.5 degree angle of draw. No impacts to the escarpment were observed during the reporting period (**Section 5.9.3**).

Table 25: Subsidence Impact Performance Measures

Aspect	Performance Measures[1]
Water – Wollombi Brook	Negligible subsidence impacts. Negligible environmental consequences. Controlled release of excess site water only in accordance with EPL requirements.
Cliffs – Low level cliffs[2]	Minor environmental consequences (that is occasional rockfalls, displacement or dislodgement of boulders or slabs, or fracturing that in total do not impact more than 5% of the total face area of such features within the South Bates Extension Area).
Biodiversity – Wollemi National Park	Negligible subsidence impacts. Negligible environmental consequences.
Biodiversity – Warkworth Sands Woodland Community	Minor cracking and ponding of the land surface or other impact. Negligible environmental consequences.
Biodiversity – White Box, Yellow Box, Blakely's Red Gum Woodland/ Grassy White Box Woodland Community	Minor cracking and ponding of the land surface or other impact. Negligible environmental consequences.
Biodiversity – Central Hunter Valley Eucalypt Forest and Woodland Ecological Community[2]	Minor cracking and ponding of the land surface or other impact. Negligible environmental consequences.
Biodiversity – Other species, populations or communities listed under the *Biodiversity Conservation Act 2016* or the *Environment Protection and Biodiversity Conservation Act 2016*	Minor cracking and ponding of the land surface or other impact. Negligible environmental consequences.
Heritage – Wambo Homestead Complex	Negligible impact on heritage values, unless approval has been granted by the Heritage Branch and/or the Minister.
All Built Features	Always safe. Serviceability should be maintained wherever practicable. Loss of serviceability must be fully compensated. Damage must be fully repairable, and must be fully repaired or else replaced or fully compensated.
Public Safety	No additional risk.

1. Note, the requirements of this condition only apply to the impacts and consequences of mining operations undertaken following the date of approval of Modification 9.
2. These conditions are only applicable from the approval of MOD17 onwards (i.e. December 2017).

Wambo does not have approval for undermining of the WHC and as such no evidence of subsidence related impacts were identified during the reporting period. No impacts to non-Mine built features or threats to public safety resulting from the discussed mining activities were identified during the reporting period.

5.9.3 Performance during the Reporting Period

During the reporting period, WCPL undertook longwall mining in the South Bates Underground Mine Longwalls 14, 15 and 16 and South Bates Extension Underground Mine Longwall 17 (**Section 3.1**). Subsidence monitoring was undertaken in accordance with the approved South Bates Underground Mine Longwalls 11-16 Extraction Plan and South Bates Extension Underground Mine Longwalls 17-20 Extraction Plan.

Table 26 summarises the actual versus predicted subsidence results for Longwalls 14 to 15 at the South Bates (Wambo Seam) Underground Mine. The subsidence monitoring results for Longwall 16 at the South Bates (Wambo Seam) Underground Mine and Longwall 17 at the South Bates Extension Underground Mine will be reported in the next Annual Review. The monitoring shows that the actual maximum subsidence recorded for both sets of longwalls was similar to the predicted range.

Table 26: Subsidence Monitoring – Actual versus Predicted for South Bates Underground Mine Longwalls 14 to 15

Monitoring Line ID	Predicted S_{max} (mm)[1]	Actual S_{max} (mm)	Difference (mm)	Consistent With Predicted Range
South Bates (Wambo Seam) Underground Mine Longwalls 14 to 15[1]				
7XL-Line	4,050	3,927	123	Y
CL13B-Line	4,000	3,734	266	Y

1. *South Bates Underground Mine: Subsidence Review Report for South Bates WMLW14 and WMLW15* (Mine Subsidence Engineering Consultants [MSEC] 2018).

Ground movements resulting from the extraction of Longwalls 11 to 15 (and part of Longwall 16) at the South Bates Underground Mine have also been measured using LiDAR surveys (i.e. by comparing a survey undertaken in September 2015 [before extraction of Longwall 11 began] and in September 2018 [after the completion of Longwall 15 and extraction of approximately 570 m of Longwall 16]). It should be noted that LiDAR surveys have an accuracy in the order of ±50 to ±150 mm. The accuracy of the observed changes in surface levels (i.e. the difference between the two surveys), therefore is in the order of ±100 to ±300 mm.

MSEC (2018) concluded that the profiles of the observed changes in surface levels reasonably match the predicted profiles of vertical subsidence. However, the measured profiles are slightly broader than the predicted profiles, resulting in higher subsidence adjacent to the longwall maingates and tailgates.

The maximum measured changes in surface level along each of the cross lines (i.e. perpendicular to the longwalls) are similar to the maximum predicted vertical subsidence above each of the longwalls. The measured changes in surface level above the chain pillars also reasonably match the predicted values (MSEC 2018).

The maximum measured changes in surface level along each of the longitudinal lines (i.e. parallel to the longwall) reasonably match the predicted profiles of vertical subsidence. The measured changes are similar to, but, slightly greater than the predicted values. However, the exceedances are similar to the order of accuracy of the LiDAR surveys (MSEC 2018).

The measured changes in surface level are greater than predicted above the south-western ends of WYLW12, WYLW13 and WMLW14 due to the effects of the steep slopes associated with the spur, Stony Creek and beneath the escarpment. The measured values are also irregular near the finishing ends of the longwalls due to proximity to the NWCD and the Bates South Open Cut Pit (MSEC 2018).

MSEC (2018) has also considered the results from visual inspections of surface impacts above South Bates Underground Mine that were carried out by WCPL during the extraction of South Bates Underground Mine Longwalls 11 to 15.

The largest surface deformations occurred adjacent to the longwall maingates, tailgates and finishing ends. In some cases, a series of parallel cracks developed over 1 to 2 m resulting in localised slumping (i.e. potholing). More isolated cracking was recorded near the centrelines of the longwalls (MSEC 2018).

MSEC (2018) concludes that the observed surface deformations are reasonably consistent with those predicted to occur due to the complexity of predicting crack widths. Whilst the overall crack widths of the greatest disturbances were larger than predicted, these were due to several cracks concentrating within a confined zone, rather than the cracks developing with a wider separation. These larger impacts (i.e. potholing) represent less than 1% of the total length of mapped surface deformations due to Longwalls 14 and 15.

Bi-annual audits (May and November) of subsidence impacts were undertaken by SLR Consulting (SLR) during the reporting period to identify new subsidence impacts over the South Bates Underground Mine and to determine the status of known subsidence impacts (e.g. have they self-repaired, are they stable but pose a risk to long-term sustainable landuse, or are they deteriorating in condition).

The November 2018 audit identified a total of 93 sites with subsidence impacts across the site. Of these, SLR (2018) recommended that 41 be remediated and the remainder be monitored in case future remediation is required. The majority of the sites recommended for remediation overlie Longwalls 11 to 16 of the South Bates Underground Mine. In November 2018, all mining was completed in Longwalls 11 to 16 of the South Bates Underground Mine, with no further predicted subsidence impacts.

Temporary repairs were conducted during the reporting period with more comprehensive remediation works scheduled for the 2019 reporting period. A subsidence remediation action plan was developed during the reporting period proposing to conduct final remediation works over the South Bates Underground Mine and other historical subsidence areas in 2019.

Remediation will be undertaken using natural fill. This option generally involves the use of civil earthworks machinery (excavators, backhoes, bobcats, trucks etc.) and fill material (e.g. soils, sands, gravels, clays, wood mulch, chicken litter), to remediate subsidence impacts (e.g. surface cracking, sinkholes) caused by mining operations. These works would be undertaken in consideration of potential impacts including; additional surface disturbance (e.g. access tracks, stockpiles etc.), erosion, potential for increased spread of weeds, and potential impacts to sensitive area (e.g. archaeological sites or sensitive ecological areas). An update on the remediation activities will be provided in the next Annual Review.

Baseline cliff top mapping of the Wollemi National Park escarpment in the vicinity of the South Bates Underground Mine was undertaken during 2015 utilising an Unmanned Aerial Vehicle (Microdrone MD4-1000) and a high resolution camera along a designated route. Photos were taken of the cliff top at designated intervals and stitched to form a high resolution panoramic image which can be used to assess subsidence. The route has been recorded and programmed to be repeatable from year to year. The cliffs associated with the Wollemi Escarpment were visually inspected using drones that were flown in January 2016, June 2016, February 2017, September 2017 and October 2018. There were no cliff instabilities identified along the escarpment from these surveys.

5.9.4 Trends and Key Management Implications

It is considered by MSEC (2018) that the observed ground movements for South Bates Underground Mine Longwalls 14 and 15 were consistent with predictions.

Identified subsidence impacts will continue to be monitored and proactively repaired.

5.9.5 Implemented or Proposed Management Actions

During the next reporting period, WCPL will continue to implement the approved Extraction Plan for South Bates Extension Underground Mine Longwalls 17-20.

WCPL will also continue with the program of works for the remediation of the subsidence impacts identified by the bi-annual subsidence audits in areas away from active subsidence (**Section 5.9.3**).

MSEC (2018) concluded that the subsidence predictions could be slightly improved by broadening the multi-seam subsidence profiles to better match the measured movements. However, this would not change the impact assessments nor the methods used to manage the potential impacts. These changes to the subsidence model may be considered in future Extraction Plans including multi-seam mining (e.g. the South Wambo Underground Mine).

5.10 Exploration

During the reporting period, 97 exploration holes were drilled in WCPL's exploration licence and mining lease areas. Of these holes, 73 were non-core, 12 were fully cored holes and 12 were partially cored holes. Twenty four (24) holes were drilled within EL7211 and A444 and as such, these holes were subject to the Exploration Activity Application and Assessment Process. Twelve of these holes were drilled as part of a groundwater/alluvial investigation in the vicinity of North Wambo Creek. The remainder were drilled within WCPL's mining leases and were managed under WCPL's SDP system and the 2018-2020 MOP.

Rehabilitation of exploration sites is undertaken continuously throughout the exploration program and begins immediately after holes are geophysically logged. Of the 97 holes drilled, all holes have been grouted to surface or been converted to groundwater monitoring bores or piezometers, and preliminary rehabilitation has commenced on all sites. To date, no holes have been signed off as completely rehabilitated, however a comprehensive rehabilitation project is currently planned for commencement in March-April 2019. By the end of this rehabilitation project, all sites drilled during the reporting period will have the preliminary rehabilitation completed, and will require a follow up inspection to determine final rehabilitation status.

An update on the status of the exploration rehabilitation project will be provided in the Annual Review for the next reporting period.

5.11 Waste

Waste management at WCPL is undertaken by a licensed waste management company under the basic principles of the Total Waste Management System (TWMS). Significant benefits of the TWMS include:

- segregation of waste at the source;
- expansion of recycling capabilities;
- reduction in the risk of contaminating non-hazardous waste;
- comprehensive monthly reports detailing volumes, recycling, disposal and transportation of waste; and
- improved data capture to increase the efficiency and accuracy when reporting.

During the reporting period, a total of 3,989,905 kg of waste was generated by the Mine. Of this, 75.8% was recycled and 24.2% was taken to landfill or disposed of off-site as hazardous waste.

The total waste generated by the Mine in 2018 was more than in 2017, 2016, 2015 and 2013 (3,298,988 kg, 2,709,881 kg, 2,252,922 kg and 1,615,289 kg, respectively) but less than in 2014 (4,860,142 kg) (**Figure 7**). The main reasons for the differences in waste generated by the Mine are:

- The 2014 waste report incorrectly included sediment-laden water pumped from various on-site locations (and disposed of on-site) in the recycled effluent figure. This water should not have been included in WCPL's waste report. If this water is removed from the 2014 waste report the total waste generated in 2014 would be significantly less.
- The 2014 waste report also included 668,723 kg of waste recycled from the wash bay. There was no waste removed from the wash bay in 2015 or 2016.

The overall recycling rate for 2018 (75.8%) was more than reported in 2017 (75.7%), 2016 (71.8%) and 2015 (67.9%) but less than that reported for 2014 (82.8%) and 2013 (82.1%), however it is noted that the recycling rate for 2014 was heavily influenced by the incorrect inclusion of sediment-laden water in the recycled effluent figure for 2014.

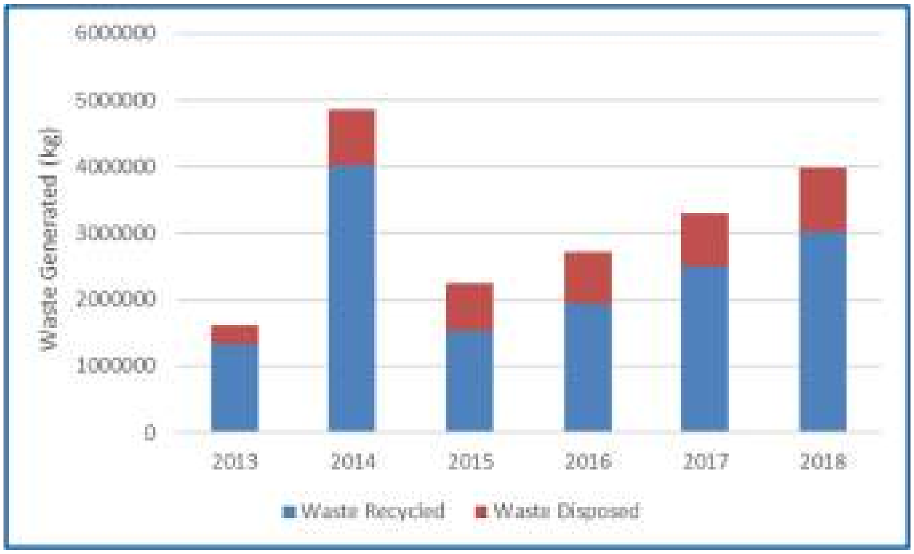

Figure 7: Waste Volumes (2013-2018)

5.12 Visual Amenity and Lighting

All mobile lighting plants are strategically positioned to avoid light being directed towards WCPL's neighbours and other identified potential sensitive receptors.

During 2016, WCPL monitored lighting impacts along the Montrose Ridge as mining continued to the north. As a result of this monitoring, WCPL installed low light lighting plant and continues to ensure frequent communication of potential lighting impacts at pre-start meetings.

In July 2017, an external lighting audit was undertaken which considered spill light, glare and sky glow from fixed and mobile light sources. The audit confirmed that the Mine is operating in compliance with *AS4282:1997 Control of the Obtrusive Effects of Outdoor Lighting* (**Section 9.4**).

There were seven (7) complaints received during the reporting period relating to lighting impacts from WCPL's mining operations (**Section 8.3**).

5.13 Contaminated Land

No contaminated land event, that posed a potential or material harm to the environment, occurred during the reporting period. Where possible, any contaminated material is managed on-site in the site bio-remediation area.

5.14 Topsoil Management

During the reporting period, WCPL undertook an inventory of topsoil stockpiles on-site, including location, volume and condition. This inventory (as at the end of the reporting period) is summarised in **Table 27** below. Topsoil stockpile locations, as at the end of the reporting period, are shown on **Figure 8**.

Table 27: Topsoil Inventory

Stockpile Reference Number	Location	Volume (m^3)
1a	RL160	107,317
1	RL160	2,607
2	RL160	1,905
3	RL160 Dump	1,663
4	Sarah Marie Dump	8,605
5	Sarah Marie Dump	8,671
6	Sarah Marie Dump	4,836
7	Ridge Reload	52,945
8	Ridge Dump	1,805
15	Charlies Hole Dump	13,606

Note: m^3 = cubic metres.

Topsoil is managed at the Mine in accordance with the Wambo Coal Topsoil Management Procedure. An audit of topsoil stockpile management was undertaken during the reporting period which led to several mitigation actions. These included:

- conducting weed spraying to reduce the existing weed burden;
- reshaping stockpiles where required;
- installing additional signage;
- conducting a topsoil inventory (as described above);
- seeking and implementing management advice from an agronomist; and
- updating the sites Topsoil Management Procedure to include a permit system for topsoil stripping activities on-site.

WCPL will continue to manage topsoil at the Mine in accordance with the Topsoil Management Procedure.

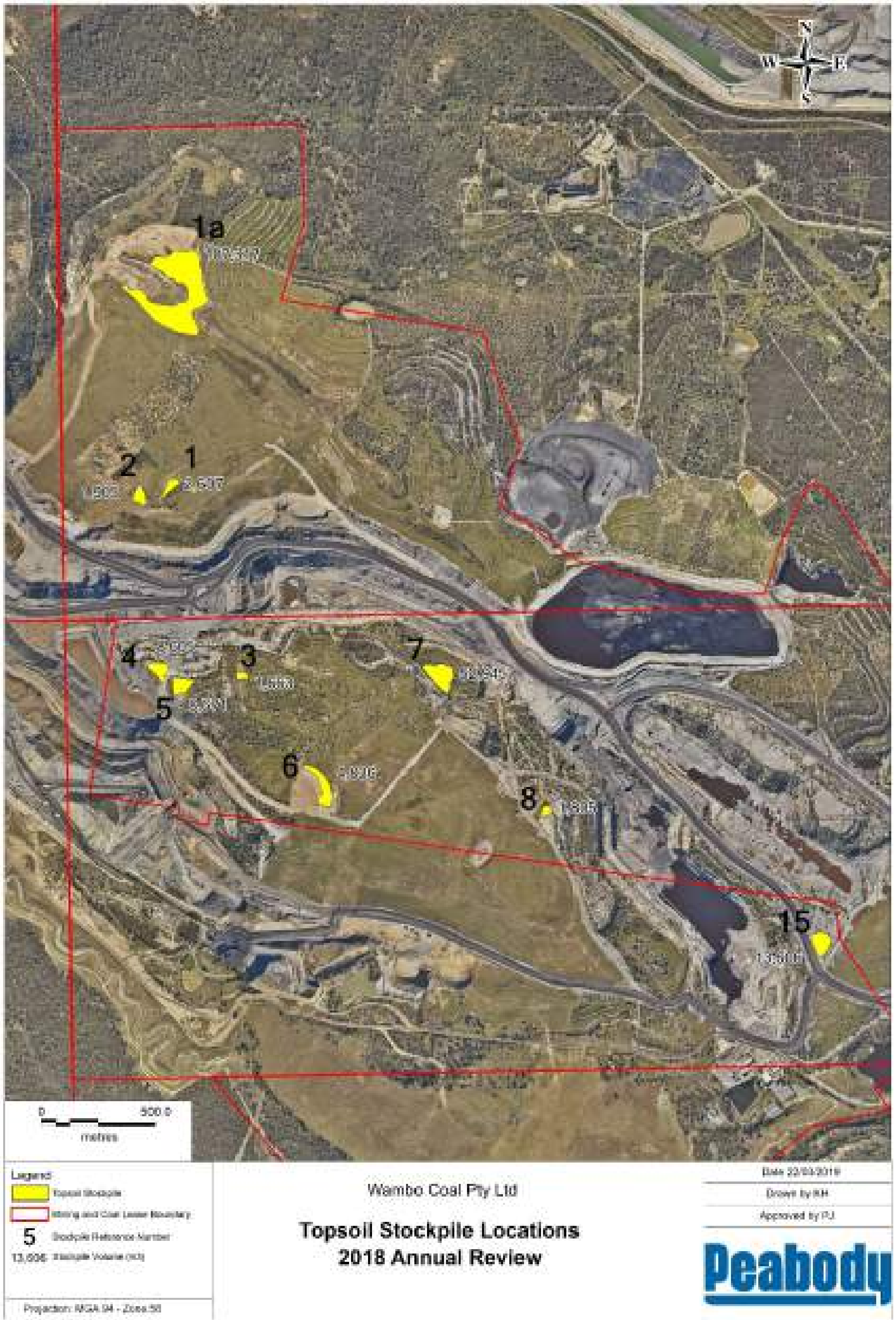

Figure 8: Topsoil Locations

5.15 Weed and Pest Management

During the reporting period, WCPL undertook a vertebrate pest management program in Spring, targeting wild dogs and foxes.

The results of the baiting program were considered to be positive due to the high rate of baits being taken by the target species (78% of baits). Rural & Environmental Management Pty Ltd (REM) (2018) concluded that there continues to be wild dog, fox, pig and hare activity in the area and recommended that the pest management program be undertaken again in the future to manage the pest populations. Pigs and hares were not a focus of the management programs, but were observed on a number of occasions.

WCPL commissioned REM to undertake management and control of weed species within the operational areas of the Mine during 2018. Weed management techniques included spraying and manual removal. During the reporting period, a total of 22 days of weed control work at the Mine was undertaken by a two person crew (REM 2019).

A summary of the total areas of specific weeds treated by REM (2019) is provided in **Table 28** and shown in **Figure 9**.

Table 28: Approximate Area of Weeds Treated at the Mine during 2018

Weeds Treated	Comment	Area (ha)
Prickly pear species (scattered)	RWEA A Woodlands and RWEA B, C and D	238.16
Mother of Millions	RWEA A Woodlands	2.62
Track maintenance (including spraying pear species along tracks)	RWEA A Woodlands	10.09
Total		**250.87**

Note: ha = hectares.

Pest and weed management will continue as required on-site and on agistment managed properties throughout the next reporting period.

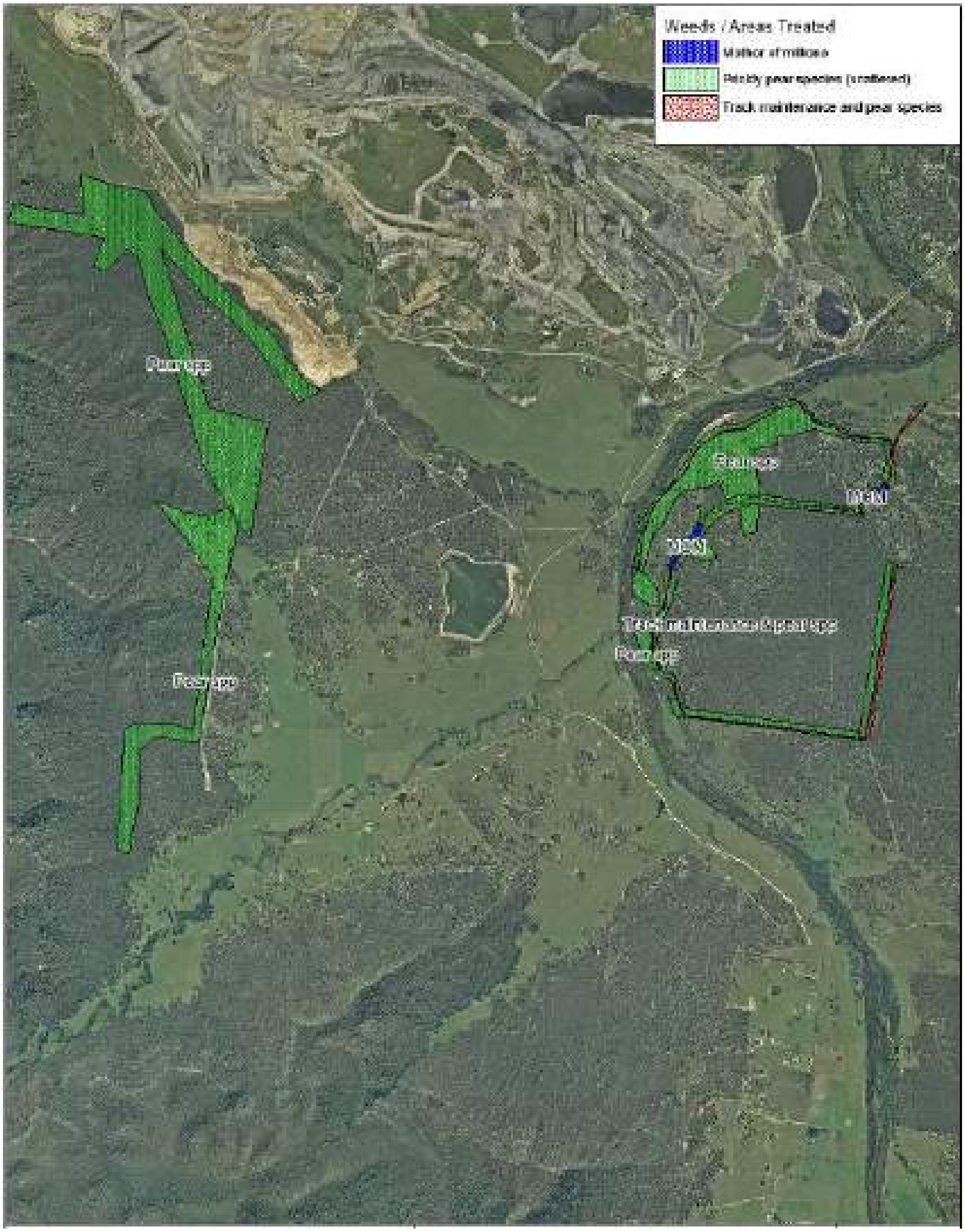

Figure 9: Weed Control Overview for the Mine (REM 2019)

5.16 Bushfire Management

No grassfires or bushfires were reported within the Mine during the reporting period. WCPL undertakes proactive grass slashing and maintenance around all site infrastructure and boundary fences where practical.

During the previous reporting period, WCPL revised the Bushfire Management Plan. A copy of the revised Bushfire Management Plan was provided to the Singleton Shire Council and the NSW RFS in December 2017. WCPL has followed up with both parties but has not yet received comments. WCPL will address any comments received from the Singleton Shire Council and RFS and provide the updated plan to DPE for approval in 2019.

As part of the Bushfire Management Plan update and to address recommendations made in the Bushfire Risk Assessment (undertaken in 2017), WCPL has designated a dam suitable for filling aerial vehicles (i.e. helicopters) and has identified water resources available for fire control activities.

5.17 Spontaneous Combustion Management

Inspections for spontaneous combustion form part of daily WCPL inspections across the three main operating areas (i.e. Open Cut, Underground and Coal Handling and Preparation Plant [CHPP]).

The 2017 Independent Environmental Audit (Hansen Bailey 2017) noted a minor (<1 m^3) spontaneous combustion event, which WCPL has managed and monitored.

No spontaneous combustion events were identified by WCPL during the reporting period.

6.0 Water Management

Water quality discharge criteria for the Mine are defined in Table 15 of DA305-7-2003 (Condition 24, Schedule 4) and EPL529 (Condition L2). Additional conditions relating to water supply, water and salt balances, discharge volume, effluent application to land, monitoring and recording requirements (including for the HRSTS), the NWCD, Chitter Dump Dam, South Wambo Dam, WCPL's Water Management Plan and independent water audits are also detailed in these documents. WCPL must also operate in accordance with the conditions of various water licences issued under the *Water Act 1912* and *Water Management Act 2000* as well as conditions of DA177-8-2004.

6.1 Surface Water Monitoring

WCPL undertakes surface water monitoring at the Mine in accordance with the approved SWMP, which is a component of the WCPL Water Management Plan. The SWMP has been developed to ensure WCPL complies with its statutory conditions relating to surface water monitoring at the Mine.

The Surface Water Monitoring Program was revised in March 2018 (Version 12) and submitted with the Extraction Plan for South Bates Extension Underground Mine Longwalls 17 to 20. On 7 September 2018, DPE approved the Extraction Plan for South Bates Extension Underground Mine Longwalls 17 to 20 (including the Surface Water Monitoring Program).

6.1.1 Approval Criteria/EIS Predictions and Management Plan Requirements

WCPL's EPL529 details the approval criteria for off-site water discharges (**Section 6.3.1**).

WCPL has developed impact assessment criteria for surface water quality and stream flow as part of the approved SWMP (Version 12).

For the surface water quality criteria, where actual site specific water quality monitoring data is available, the criteria have been set based on the 20th and 80th percentile for the available dataset. Where insufficient data is available, WCPL has adopted the applicable Australian and New Zealand Environment and Conservation Council (ANZECC) default guidelines values for slightly to moderately disturbed ecosystems (ANZECC 2000) or the Water Quality Objectives for the Hunter River. Applicable criteria are included in **Table 29** and **Table 30.**

Triggers for the local ephemeral creeks in the approved SWMP are based on the unexpected absence of flow in climatic situations when flows would be expected. The triggers would be met if there was no flow recorded at the flow monitoring site either on the day or the day after the recorded rainfall was equal to or greater than the nominated amount.

Table 29: Surface Water Quality Impact Criteria[1,2]

Sampling Site	Parameter[3]	Lower Limit	Upper Limit
SW02 – Wollombi Brook	pH	7.4	8.1
	EC (µS/cm)	599	1,947
	TSS (mg/L)	17 (low flow) to 308 (high flow)[4]	
SW05 – North Wambo Creek	pH	7.3	7.9
	EC (µS/cm)	1,155	2,246
	TSS (mg/L)	53 (low flow) to 1,110 (high flow)[4]	
SW07 – Wambo Creek	pH	7.4	7.9
	EC (µS/cm)	360	724
	TSS (mg/L)	29 (low flow) to 331 (high flow)[4]	
SW08 – Stony Creek	pH	6.8	7.4
	EC (µS/cm)	288	416
	TSS (mg/L)	5 (low flow) to 15 (high flow)[4]	
SW39 – Waterfall Creek	pH	7.3	7.8
	EC (µS/cm)	159	429
	TSS (mg/L)	582 (low flow) to 1,922 (high flow)[4]	

1. From Table 12, Version 12 of the WCPL SWMP.
2. An exceedance occurs when water quality results exceed the 80th Percentile Trigger Value (**Table 29**) after three consecutive sampling events.
3. EC = electrical conductivity, TSS = total suspended solids, µS/cm = microSiemens per centimetre, mg/L = milligrams per litre.
4. Low flow condition based on 80th percentile of recorded concentrations and high flow criteria based on maximum recorded concentrations.

Table 30: Surface Water Flow Impact Assessment Condition[1]

Watercourse and Flow Monitoring Site	Daily Rainfall when Flow Commenced on 80% of Recorded Occasions
Stony Creek (FM13)	20 mm
South Wambo Creek (FM15)	20 mm
North Wambo Creek (FM4)	20 mm

1. From Table 11, Version 12 of the WCPL SWMP.

In addition to the surface water monitoring requirements detailed in **Table 29** and **Table 30,** WCPL is also required to meet additional requirements, in accordance with the approved SWMP. These requirements include annual reporting on performance against the performance indicators detailed within the approved WCPL SWMP (**Table 31**).

Table 31: Surface Water Monitoring Program Performance Indicators

Performance Indicator
Number of complaints received relating to surface water.
Number of non-compliances received relating to surface water.
Number of exceedances of surface water impact assessment criteria[1].
Number of reportable environmental incidents relating to surface water.

1. An exceedance occurs when water quality results exceed the 80th Percentile Trigger Value (**Table 29**) after three consecutive sampling events.

6.1.2 Performance during the Reporting Period

An exceedance of the surface water quality triggers is considered to have occurred when water quality results exceed the 80th Percentile Trigger Value (**Table 29**) after three consecutive sampling events.

WCPL recorded no exceedances of the surface water quality impact assessment criteria during the reporting period.

No complaints relating to surface water were received during the reporting period.

A summary of the surface water quality monitoring data is included in **Appendix D.**

The WCPL stream flow monitoring system consists of (**Figure 10**):

- five monitoring stations on North Wambo Creek (US-FM1, FM1, FM2, FM3 and FM4);
- three monitoring stations on South Wambo Creek (FM9, FM15 and FM16);
- two monitoring stations on Stony Creek (FM12 and FM13); and
- one monitoring station on a major tributary to Stony Creek (FM14).

During the reporting period, stream flow data was recorded at FM2, FM3 and FM14.

There were no recordable flow events at US-FM1, FM1, FM4, FM12, FM13, FM15 and FM16.

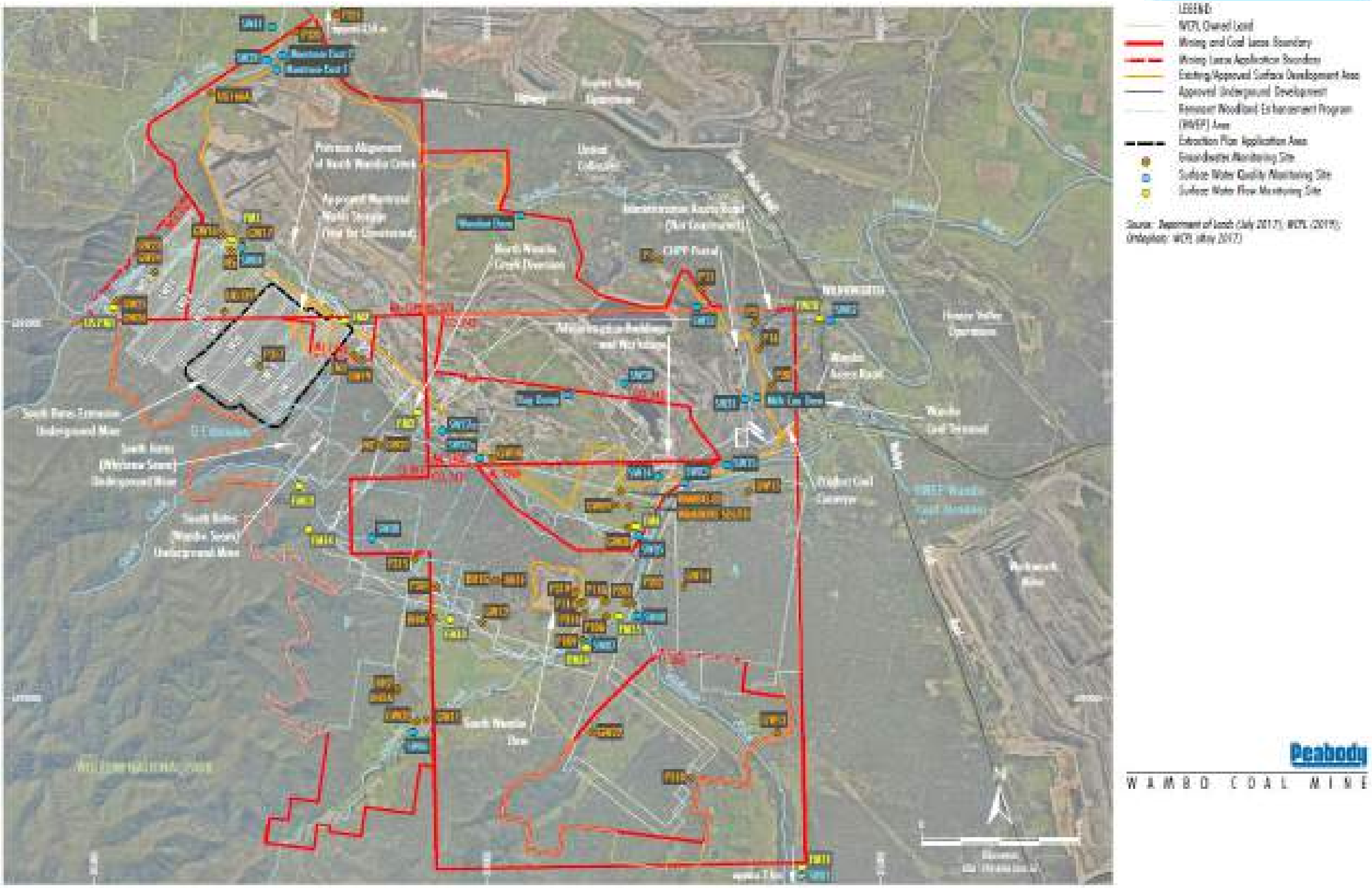

Figure 10: WCPL Surface and Groundwater Monitoring Locations

6.1.3 Trends and Key Management Implications

Consistent with the previous reporting period, there were no exceedances of the surface water quality triggers during the reporting period.

The flow monitoring stations (and back up sensors) functioned successfully during the reporting period.

There were no other trends or key management implications identified.

6.1.4 Implemented or Proposed Management Actions

During the previous and current reporting periods, WCPL made the following adjustments to the flow monitoring network:

- In December 2017, a new flow monitoring station was installed on North Wambo Creek, approximately 1 km upstream of FM1 (US-FM1).
- In December 2017, FM1 was relocated approximately 300 to 400 m downstream on North Wambo Creek.
- In September 2018, a new flow monitoring site was installed on South Wambo Creek approximately 1 km upstream of SW06 (as a replacement for the old FM9).
- In September 2018, FM12 was relocated approximately 50 m downstream and FM13 was relocated approximately 50 m upstream on South Wambo Creek.

Cross section and long section surveys of the new and relocated sites were undertaken by AECOM during the reporting period.

During the next reporting period, WCPL will continue to implement the approved SWMP (Version 12).

6.2 Groundwater Monitoring

WCPL undertakes groundwater monitoring at the Mine in accordance with the approved GWMP, which is a component of the WCPL Water Management Plan. The GWMP has been developed to ensure WCPL complies with its statutory conditions relating to groundwater monitoring at the Mine.

The GWMP was revised in April 2018 (Version 12) and submitted with the Extraction Plan for South Bates Extension Underground Mine Longwalls 17 to 20. On 7 September 2018, DPE approved the Extraction Plan for South Bates Extension Underground Mine Longwalls 17 to 20 (including the GWMP).

6.2.1 Approval Criteria/EIS Predictions and Management Plan Requirements

The GWMP includes triggers for groundwater levels and quality in shallow bores. These triggers have been developed using statistical analysis of baseline monitoring data and data acquired to 2014 (from a number of monitoring bores on and around the Mine site) and the predicted effects presented in the EIS (Resource Strategies 2003) and subsequent Environmental Assessments.

The trigger values are not assessment criteria but are used to initiate investigations into the groundwater levels or groundwater quality as reported by the groundwater monitoring program. A summary of the groundwater triggers for shallow bores, as detailed in WCPL's approved GWMP (Version 12), is included in **Table 32**. In order to avoid false triggering, as a trigger would be initiated 20% of the time due to natural causes, triggers for groundwater level are defined to occur when two consecutive bi-monthly observations (over a 2-month interval) exceed or fall below the specified depth to groundwater.

Table 32: Water Quality and Level Trigger Values – Shallow Bores

Bore	Depth to Groundwater (mBTOC[1])		Conductivity (µS/cm)	pH	
	Min (10th percentile)	Max (90th percentile)	Maximum (Three Consecutive Bi-Monthly Exceedances)	Minimum (Two Consecutive Bi-Monthly Exceedances)	Maximum (Two Consecutive Bi-Monthly Exceedances)
P106	6.6	10.7	941	6.7	7.9
P109	4.6	6.7	NA	NA	NA
P114	5.4	7.6	6,141	6.5	7.8
P116	4.8	7.3	5,972	6.6	7.5
P202	7.8	9.6	8,172	6.7	7.7
P203	16.1	21.6	2,630	7.3	8.1
P301[2]	NA	NA	NA	NA	NA
P315	4.4	9.1	552	6.0	7.4
GW02	5.8	8.5	715	6.7	7.4
GW08[3]	NA	NA	NA	NA	NA
GW09[3]	NA	NA	NA	NA	NA
GW11	4.0	6.5	592	6.8	7.5
GW12	9.9	12.9	NA	NA	NA
GW13	4.8	5.4	4,370	6.9	7.1
GW15	10.4	11.1	730	6.7	7.2
GW16[4]	NA	NA	NA	NA	NA
GW17[4]	NA	NA	NA	NA	NA
P16	7.1	7.8	10,832	7.0	7.7
P20	7.1	8.2	10,625	7.0	7.6

1. mBTOC = metres below top of casing.
2. P301 is predicted to go dry by HydroSimulations (2014), therefore no trigger level has been established – i.e. the purpose of trigger levels is to identify unanticipated impacts.
3. WCPL will install replacement bores in the North Wambo Creek alluvium in areas that are not located above the old Wambo No. 1 Seam workings. Trigger levels will be established for these bores based on modelled groundwater levels and will replace GW08 and GW09 in this table.
4. GW16 and GW17 are located upstream of the NWCD and in close proximity to the approved open cut. There are no groundwater users located in the vicinity of North Wambo Creek upstream of the NWCD. Therefore, a trigger level for these two bores is not considered warranted. Monitoring data will be reviewed annually at these bores.

In addition to the groundwater monitoring triggers detailed in **Table 32,** WCPL is also required to meet additional requirements, in accordance with the approved GWMP, Extraction Plan for the South Bates Underground Mine Longwalls 11-16 and Extraction Plan for the South Bates Extension Underground Mine Longwalls 17-20. These requirements include annual reporting on performance against the performance indicators detailed within the approved WCPL GWMP (**Table 33**).

Table 33: Groundwater Monitoring Program Performance Indicators

Performance Indicator
The performance indicators will be considered to have been exceeded if Wambo receives complaints from groundwater users.
The performance indicators will be considered to have been exceeded if monitoring data suggests significant divergences away from the modelled groundwater.
The performance indicators will be considered to have been exceeded if the groundwater levels in alluvial bores exceed the groundwater level criteria listed in Table 9 of the GWMP.
The performance indicators will be considered to have been exceeded if the groundwater quality in alluvial bores exceeds the groundwater quality criteria listed in Table 10 of the GWMP.

Groundwater monitoring data from the Permian monitoring bores is assessed and reviewed as part of the Annual Review. Data is also used to validate the groundwater model.

6.2.2 Performance during the Reporting Period

Monitoring of groundwater levels and quality in alluvial and Permian bores was undertaken in accordance with WCPL's approved GWMP (Version 12).

A number of trigger level exceedances were recorded for groundwater levels and EC during the reporting period (**Table 34**). These exceedances are summarised in **Section 6.2.3** and discussed further in the report *Wambo Annual Review Groundwater Analysis* (HydroSimulations 2019a) (**Appendix G**).

Hydrographs for relevant groundwater monitoring bores were assessed to determine whether observed trends were due to climatic conditions or mining, and shallow bores were assessed for compliance with the groundwater level and water quality performance indicators (HydroSimulations 2019a).

No bores were decommissioned during the reporting period.

No complaints from groundwater users were received during the reporting period.

Table 34: Groundwater Trigger Level Exceedances[1]

Bore	Number of Trigger Level Exceedances[2]				
	Depth to Groundwater - Min (10th percentile)	Depth to Groundwater - Max (90th percentile)	EC	pH min	pH max
P106		6			
P109					
P114		6			
P116					
P202					
P206					
P301	N/A				
P315		6			
GW02		5			
GW08	N/A				
GW09	N/A – Bore Dry				
GW11		6	6	2	
GW12					
GW13		6			
GW15		6			2
GW16	N/A				
GW17	N/A				
P16		6			
P20		6			
Total	**0**	**53**	**6**	**2**	**2**

1. After: Table 4 in *Wambo Annual Review Groundwater Analysis* (HydroSimulations 2019a).
2. Blank cells represent no trigger exceedances.

6.2.3 Trends and Key Management Implications

Groundwater monitoring data collected during the reporting period has been reviewed and assessed against the triggers in the approved GWMP (**Table 32**) by HydroSimulations (2019a).

During the reporting period, there were no exceedances of the 10th percentile trigger.

The 90th percentile trigger allows identification of anomalously deep depths to groundwater. During the reporting period, exceedances of the 90th percentile level were recorded at P114, P106, P315, GW02, GW11, GW13, GW15, P16 and P20.

HydroSimulations recommended field investigation into the depth and borehole integrity of P106 to further investigate the dry readings at this bore in 2018. This will be conducted in 2019.

HydroSimulations concluded that the other trigger level exceedances did not warrant further investigation as these can be attributed to natural variability, climatic conditions and/or predicted impacts.

No exceedances of triggers for EC or pH occurred during the reporting period (HydroSimulations 2019a), with the exception of readings at GW11 (pH and EC) and GW15 (pH).

The increased salinity at GW11 is expected to be the result of a greater proportion of brackish water sourced from Permian strata contributing to the groundwater system due to the reduction in rainfall. The pH values at GW11 and GW15 that triggered the exceedance still remain within recommended ANZECC ranges for irrigation and stock water (pH 6 to 8.5) and Australian Drinking Water Guidelines for groundwater fit for human consumption (pH 6.5 to 8.5). HydroSimulations (2019a) concluded that with the change in pH being so marginal, it is not likely to have caused or be likely to cause a long-term, negative impact to the groundwater quality in the vicinity of these bores.

Hydrographs of observed groundwater levels were reviewed by HydroSimulations in combination with a review of subsidence parameters and WCPL's groundwater model. HydroSimulations concluded that the groundwater model performs well and remains fit for purpose to predict the timing and magnitude of impacts to groundwater caused by Wambo Coal Mine. Additional detail is available in **Appendix G**.

HydroSimulations conducted an assessment against the performance indicators and relevant subsidence impact performance measures for North Wambo Underground Longwalls 8-10A (HydroSimulations 2019b) and South Bates Underground Mine Longwalls 11-16 (HydroSimulations 2019c).

It was concluded by HydroSimulations (2019b; 2019c) that the subsidence impact performance measure of *Negligible impact to Wollombi Brook* was upheld for the extraction of North Wambo Underground Longwalls 8-10A and the extraction of South Bates Underground Mine Longwalls 11-16.

WCPL will continue to monitor the bores in accordance with the approved GWMP.

6.2.4 Implemented or Proposed Management Actions

During the next reporting period, WCPL will continue to implement the approved GWMP.

HydroSimulations (2019a) recommended:

- Investigation into depth to base of bore at GW08 as water levels during 2018 are recorded as being below the current elevation.
- Investigate the integrity of P106 and whether the 'dry' readings are correct for the original drilled depth of the hole.
- Monitoring of new bore drilled between LW14 and VWP N2 to confirm the groundwater recovery of the Wambo Seam associated with the completion of NWU operations.

6.3 HRSTS Discharges

WCPL is permitted to discharge water to the Hunter River in accordance with the conditions of EPL529 and the HRSTS guidelines. These guidelines include the following conditions:

- notification from DI-Water of discharge opportunity must be received;
- flow of water in Wollombi Brook at the DI-Water Bulga Gauging Station (FM11) needs to be more than 500 ML/day;
- pH will be measured continuously throughout the discharge with an inline instrument;
- EC will be measured continuously in µS/cm throughout the discharge with an instrument designed to measure between 0 and 10,000 µS/cm; and
- TSS will be measured once a day during discharge. A representative sample will be collected every day and sent to the lab for analysis.

WCPL has 35 credits under the HRSTS.

6.3.1 Approval Criteria/EIS Predictions and Management Plan Requirements

A summary of the approval criteria for off-site discharges (from EPL529) is included in **Table 35.**

Table 35: EPL529 Approval Criteria for Off-site Discharge

Parameter	Criteria[1]
pH	6.5-9.5[2]
TSS	120 mg/L[2]
EC	N/A
Volume	250 ML/day

1. Criteria as per EPL529.
2. 100th percentile concentration limit.

6.3.2 Performance during the Reporting Period

During the reporting period, WCPL did not discharge any water from Licensed Discharge Point (LDP) No. 4.

6.3.3 Trends and Key Management Implications

There were no discharge events in 2018, compared to none in 2017, eleven in 2016, six in 2015, one in 2014 and 27 in 2013. The total volume of water discharged in 2018 (0 ML) was the same as in 2017 (0 ML) and less than in 2016 (416 ML), 2015 (140.1 ML), 2014 (9.6 ML) and 2013 (1221.44 ML).

6.3.4 Implemented or Proposed Management Actions

A written report of the activities undertaken by WCPL under the HRSTS (for the period 1 July 2015 to 30 June 2016) was submitted to the EPA on 27 August 2018, in accordance with Condition R4 of EPL529.

The HRSTS discharge system was reviewed during 2016. This review consisted of updating the communication hardware in consultation with Water NSW, continued regular calibration of instrumentation and development of operating procedures. A guideline for a HRSTS system audit was completed in 2018. The audit was unable to be completed, as WCPL was unable to discharge through the HRSTS in 2018. During the next reporting period, WCPL will undertake the HRSTS system audit if discharges through the HRSTS occur.

During the next reporting period, WCPL forecasts compliance with the HRSTS requirements, and predicts that, if the opportunity arises, it will use all of its HRSTS credits, as dictated by River Register releases.

6.4 North Wambo Creek Diversion Discharge Flows

The NWCD Plan was approved by the then NSW Department of Planning (now DPE) in April 2008. A requirement of the approval was to comply with the requirements of the then Department of Water and Energy (now Department of Industry – Water). These requirements included reporting on the performance of the NWCD annually in the Annual Review.

During the reporting period, WCPL monitored flow within the North Wambo Creek at five locations:

- US-FM1, approximately 1 km upstream of FM1 (installed in December 2017);
- FM1, upstream of the NWCD;
- FM2, middle of the NWCD, downstream of FM1;
- FM3, middle of the NWCD, downstream of FM2; and
- FM4, downstream of the NWCD.

A review of the flow events at each monitoring site during the reporting period was undertaken by AECOM (2019) and a summary is provided in **Table 36**. There were no recordable flow events at FM1 (including the backup sensor), US-FM1 or FM4 during the period 1 February 2018 to 31 January 2019. Flow monitoring data is included in the AECOM report (**Appendix H**).

Table 36: NWCD Discharge Flow Monitoring – 2018

Flow Monitoring Station	No. of Flow Events Recorded	Maximum Stream Height Recorded (m)	Maximum Theoretical Flow Rate Recorded (ML/day)
FM2	9	0.043	2.46
FM3	12	0.118	6.77

6.5 Water Take

WCPL maintains a variety of WALs under the *Water Management Act 2000* which consist of High, General and Supplementary securities, as detailed in **Table 37**.

During the reporting period, WCPL extracted a total of 851 ML of water from the Hunter River under WAL 718 and 1,261 ML from porous rock groundwater sources. As show in **Table 37**, all water take was less than the allowable limits under the relevant WALs.

No water was used for irrigation purposes during the reporting period (from licence 20WA200632).

Table 37: Environmental Performance – Water Take

Licence Number[1]	Description	Expiry Date	Entitlement	Category	Passive take/ inflows (ML)	Active pumping (ML)	Total (ML)
Hunter Regulated River Water Source							
WAL 718 (20SL060212)	Hunter River Pump	Perpetuity	1000 unit shares (high security)	Regulated River (high security)	0	851	851
WAL 8599 (20SL061206)	Hunter River Pump	Perpetuity	6 unit shares (high security)	Regulated River (high security)	0	0	0
WAL 8600 (20SL061206)	Hunter River Pump	Perpetuity	868 unit shares (general security)	Regulated River (general security)	0	0	0
WAL 8604 (20BL061206)	Hunter River Pump	Perpetuity	240 unit shares (supplementary water)	Supplementary Water	0	0	0
Hunter Regulated River Water Source – Shared with United Colliery							
WAL 929 (20SL050661)	Other Pump	Perpetuity	3 unit shares	Domestic and Stock	0	0	0
WAL 1369 (20SL060416)	80 mm CP	Perpetuity	15 unit shares (supplementary water)	Supplementary Water	0	0	0
WAL 15459 (20SL204246)	80 mm CP	Perpetuity	21 unit shares (general security)	Regulated River (general security)	0	0	0
Hunter Unregulated and Alluvial Water Sources (Lower Wollombi Brook Water Source)							
WAL 18437 (20SL033872)	Wollombi Brook Pump	Perpetuity	350 unit shares	Unregulated River	0	0	0
WAL 23897 (20BL167737)	Well No. 2	Perpetuity	70 unit shares	Aquifer	<69 (as per numerical groundwater model)	0	<69

Licence Number[1]	Description	Expiry Date	Entitlement	Category	Passive take/ inflows (ML)	Active pumping (ML)	Total (ML)
North Coast Fractured and Porous Rock Groundwater Sources (Sydney Basin - North Coast Groundwater Source)							
WAL 39735[2] (20BL168643)	Dewatering Bore	Perpetuity	40 unit shares	Aquifer	227 (underground seepage)	941 (dewatering Bores 2A and 4C)	1,168
WAL 39738[2] (20BL132753)	Old Well No. 1 (GW08)	Perpetuity	243 unit shares	Aquifer			
WAL 39803[2] (20BL166910) (20BL173032) (20BL173033) (20BL173034) (20BL173035)	Dewatering (Bore No. 1)	Perpetuity	450 unit shares	Aquifer			
WAL 41494[2] (20BL168017) (20BL172061) (20BL173040)	Dewatering (Bore No. 2 and 2a)	Perpetuity	750 unit shares	Aquifer			
WAL 41528[2] (20BL167738)	Dewatering Bore	Perpetuity	57 unit shares	Aquifer			
WAL 41520[2] (20BL173844)	Dewatering Bore	Perpetuity	9 unit shares	Aquifer			
WAL 41532 (20BL172156)	Dewatering	Perpetuity	98 unit shares	Aquifer	0	93 (dewatering Bores 2A and 4C)	93

1. 20BL prefix bore licences with allocations have been replaced with WALs.
2. WaterNSW issued approval to consolidate six WALs on 20 December 2018. Notification to be lodged with NSW Land Registry Services in 2019.

6.6 Compensatory Water

WCPL did not provide any compensatory water to any water users during the reporting period.

6.7 Site Water Balance

WCPL reviewed the Site Water Balance at the end of the reporting period, in accordance with the requirements of the WCPL Water Management Plan. A summary of the WCPL site water balance for 2018 is provided in **Table 38**.

Table 38: 2018 Site Water Balance

Water Sources	Volume (ML)
Hunter River	851
Wollombi Brook	0
United Collieries	18
Rainfall/Runoff	979
Underground Seepage	227
Dewatering Bores 2A and 4C	1,034
Open Cut Seepage	0
Total Water Inputs	**3,109**
Water Usage	**Volume (ML)**
Dust Suppression	1,155
CHPP Consumption	1,388
Underground	60
United Collieries	0
Workshop Water	1
Domestic Usage	1
Total Water Usage	**2,606**[1]
Water Loss	**Volume (ML)**
Evaporation – Mine Water & Tailings Dam	645
HRSTS Discharge	0
Seepage	0
Water Balance	**-142**

1. Discrepancy due to rounding.

A total of 851 ML was extracted from the Hunter River during the reporting period. No water has been extracted from the Wollombi Brook since October 2017. This total is above the EIS forecast annual average extraction volume of 106 ML (Resource Strategies 2003). When combined with water sourced from the United Collieries (18 ML), this brings the total volume of water imported to approximately 27.9% of the total water input. This is higher than the EIS forecast of an average of 2.6% (Resource Strategies 2003) however, this increase is consistent with the identified trend of increases in water imports as coal production increases. This is also higher than in 2017 (14.4%), and is considered to be due to the ongoing dry conditions and increased demand for raw water in the CHPP.

A total of 979 ML of runoff from rainfall was intercepted during the reporting period.

Underground seepage represented 7.3% of total supply compared to the 2003 forecast of 13.8% (Resource Strategies 2003). The MOD17 Groundwater Assessment (HydroSimulations 2017) predicted that there would be an average seepage of 212 ML per annum (ML/a) and a maximum seepage of 376 ML/a from the combined sources of the South Bates Underground Mine and South Bates Extension Underground Mine. The underground seepage recorded during the reporting period (227 ML/a) is consistent with these predictions.

No water was exported off-site during the reporting period. No water was discharged during the reporting period.

6.8 Erosion and Sediment Control

WCPL has developed an ESCP to address the relevant consent conditions and regulatory requirements.

During the reporting period, Version 10 of the ESCP was approved as a component of the Extraction Plan for Longwalls 17 to 20 at the South Bates Extension Underground Mine.

6.8.1 Performance during the Reporting Period

During the reporting period, WCPL complied with all requirements detailed in the ESCP (Version 10).

No complaints were received relating to erosion and sediment control.

6.8.2 Trends and Key Management Implications

No trends or key management implications for erosion and sediment control were identified during the reporting period.

6.8.3 Implemented or Proposed Management Actions

During the reporting period, WCPL dredged Eagles Nest Dam.

During 2019, a site wide catchment plan will be developed for the site.

7.0 Rehabilitation

7.1 Rehabilitation Performance during the Reporting Period

Proposed rehabilitation and disturbance activities for the reporting period are detailed in WCPL's approved MOP (2018-2020).

7.1.1 Status of Disturbance and Rehabilitation

A summary of the proposed and actual rehabilitation activities undertaken in 2018 is provided in **Table 39**.

Table 39: Actual versus Proposed Rehabilitation Activities (2018)

	2018 Proposed	2018 Actual
Total Disturbance (ha)	35.5	35.5
Total Rehabilitation (ha)	58.5	58.5[1]
Cumulative Rehabilitation (ha)	657.5	657.5

1. Consisting of 22.0 ha at RL160, 15.6 ha at Montrose East, 7.7 ha at Roses, 5.4 at RL110 Embankment, 4.3 ha at Hot Tyre Bay and 4.3 ha at Le Baron.

Details of mining operations completed at the Mine during the reporting period are included in **Section 3.1**. At the end of the reporting period, the total mine disturbance and total rehabilitation undertaken were consistent with the forecast areas.

On 27 June 2016, WCPL was issued with a condition requiring the development of a rehabilitation strategy for the NETD to the satisfaction of the Minister for Industry, Resources & Energy (for inclusion in a MOP). WCPL finalised and submitted the NETDRS to DRG on 22 November 2016. In March 2017, the DRG provided confirmation that the NETDRS could not be approved, as the final landform was not consistent with the current development consent conditions for maximum emplacement heights. As a result, WCPL was required by the DRG to resubmit the NETDRS by the 31 May 2017.

As an alternate capping method, WCPL had commenced a trial using secondary flocculation in July 2016, with a flocculation plant located on the crest of the HPTD embankment. The trial consisted of a cell within the HPTD. The undrained shear strength data for secondary flocculated tailings in the trial cell as measured on-site with a hand shear vane on 2 March 2017 ranged from 30 kilopascals (kPa) up to about 350 kPa (Fitton Tailings Consultants 2017).

With the success of the HPTD trial, WCPL are developing a capping design viability study using intermittent disposal methodology of layering 200 mm of secondary flocculated tailings at a time. Each 200 mm layer of flocculated material deposited will be allowed to dry, to finally form a layered crust ~3m thick as part of the capping final design.

As recommended by WCPL's tailings consultant (Fitton Tailings Consultants 2017), Cone Penetration Testing (CPT) will be undertaken to understand the geotechnical characteristics of the tailings over the full depth of the facility, over a multiple location testing regime in both NETD and the HPTD facilities. This testing will enable a final capping design to be prepared that contains far fewer critical assumptions.

The following is a summary of key project milestones proposed by WCPL regarding the above mentioned capping method for both the NETD and HPTD:

- CPT testing of NETD to commence in Q1 2019 and HPTD to commence in Q3 2019.
- Finalise capping design for NETD and HPTD in Q4 2019.
- Capping Works - commence intermittent disposal of double flocculated tailings in NETD in Q3 2019 and HPTD in Q1 2020.

At the end of the reporting period, WCPL was actively mining in the following areas (as shown on **Figure 11**):

- South Bates Extension Underground Mine Longwall 17 (commenced 3 December 2018);
- Montrose West Pit (up to strip 1);
- Montrose East Pit (up to strip 3); and
- Roses Pit (up to strip 1).

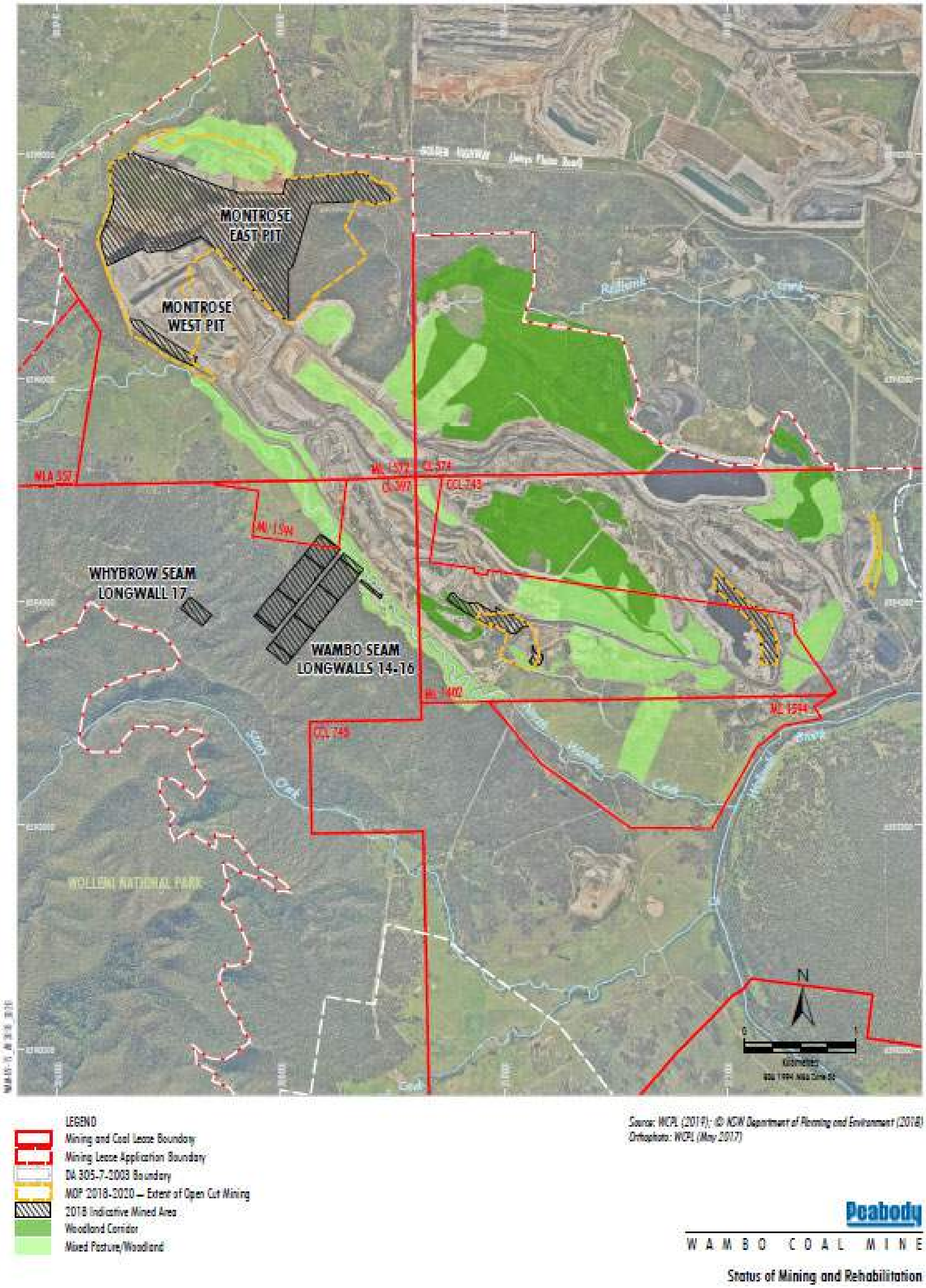

Figure 11: Status of Mining and Rehabilitation

7.1.1.1 RL160 Rehabilitation

Bulk push of overburden material began in September and final seeding of the RL160 Rehabilitation area (**Figure 12**) was completed in November 2018.

Topsoil was delivered through a 939 loader and open cut Cat truck fleet from topsoil stockpiles located on the Wombat Dump. Topsoil was spread by D10 dozers to a depth between 100 mm to 200 mm. The area was trimmed with a D6 dozer and gypsum applied at 4 tonnes per hectare (t/ha). Organic Growth Media (OGM) was applied at 40 t/ha however, only approximately 400 tonnes were spread due to the EPA restriction which was implemented in October 2018, preventing any further spreading of OGM products.

The area was chisel ploughed and cover crop (millet) seed was broadcast by New Holland tractor.

7.1.1.2 Montrose East Rehabilitation

Bulk push of overburden material began in January and final seeding of the Montrose East area (**Figure 13**) was completed in October 2018.

Topsoil was delivered through a 939 loader and open cut Cat truck fleet from topsoil stockpiles located on the Wombat Dump. Topsoil was spread by D10 dozers to a depth between 100 mm to 200 mm. The area was trimmed with a D6 dozer and gypsum applied at 6 t/ha. OGM was applied at 100 t/ha.

The area was chisel ploughed and cover crop (millet) seed was broadcast by New Holland tractor.

7.1.1.3 Roses Rehabilitation

Bulk push of overburden material began in May and final seeding of the Roses area (**Figure** 14) was completed in December 2018.

Topsoil was delivered through a 939 loader and open cut Cat truck fleet from topsoil stockpiles located on the Wombat Dump. Topsoil was spread by D10 dozers to a depth between 100 mm to 200 mm. The area was trimmed with a D6 dozer and gypsum applied at 5 t/ha. No OGM was spread at the Roses rehabilitation area due to the EPA restriction on the spreading of OGM.

The area was chisel ploughed and the cover crop (millet) seed was broadcast by New Holland tractor.

7.1.1.4 RL110 Embankment Rehabilitation

Rehabilitation of the RL110 Embankment (**Figure 15**) began in April 2018.

Topsoil was delivered through a 939 loader and open cut Cat truck fleet from topsoil stockpiles located on the Wombat Dump. Topsoil was spread by D10 dozers to a depth between 100 mm to 200 mm. The area was trimmed with a D6 dozer and gypsum applied at 6 t/ha. 250 tonnes of mulch compost mix was applied to the area.

Mixed Pasture/Native Open Woodland seed mix was broadcast by New Holland tractor in December 2018.

7.1.1.5 Hot Tyre Bay Rehabilitation

Bulk push of overburden material began in April and final seeding of the Hot Tyre Bay area (**Figure 16**) was completed in May 2018.

Topsoil was delivered through a 939 loader and open cut Cat truck fleet from topsoil stockpiles located on the Rug Dump. Topsoil was spread by D10 dozers to a depth between 100 mm to 200 mm. The area was trimmed with a D6 dozer and gypsum applied at 6 t/ha. OGM was applied at 100 t/ha.

The area was chisel ploughed and the pasture seed mix was broadcast by New Holland tractor.

7.1.1.6 Le Baron Rehabilitation

Bulk push of overburden material began in January and final seeding of the Le Baron rehabilitation area (**Figure 17**) was completed in April 2018.

Topsoil was delivered through a 939 loader and open cut Cat truck fleet from topsoil stockpiles located on the Wombat Dump. Topsoil was spread by D10 dozers to a depth between 100 mm to 200 mm. The area was trimmed with a D6 dozer and gypsum applied at 6 t/ha. OGM was applied at 100 t/ha. The area was chisel ploughed and the pasture seed mix was broadcast by New Holland tractor.

Figure 12: 2018 RL160 Rehabilitation

Figure 13: 2018 Montrose East Rehabilitation

Figure 14: 2018 Roses Rehabilitation

Figure 15: 2018 RL110 Embankment Rehabilitation

Figure 16: 2018 Hot Tyre Bay Rehabilitation

Figure 17: 2018 Le Baron Rehabilitation

7.1.2 Agreed Post Rehabilitation Land Use

The agreed post rehabilitation land use for the Mine is detailed in WCPL's EIS (Resource Strategies 2003), DA305-7-2003 and MOP (2018-2020). The final landform for WCPL proposes a balanced rehabilitation outcome which recognises the alternative land uses that exist in the region, and therefore aims to establish the potential for both sustainable agriculture and endemic woodland habitat. The proposed design of final landforms and the revegetation strategy are described in the MOP (2018-2020).

WCPL's CMCP will be developed and submitted to the NSW Resources Regulator, DPE and other relevant stakeholders within six months of the determination of the United Wambo Open Cut Coal Project (SSD-7142).

All rehabilitation activities undertaken during the reporting period were undertaken with consideration to the agreed post rehabilitation land use goals.

7.1.3 Key Rehabilitation Performance Indicators

Table 40 summarises WCPL's rehabilitation status at the end of the reporting period, compared to the previous reporting period, as well as the forecast for the next reporting period.

Land being prepared for rehabilitation in 2019 is consistent with the scheduled rehabilitation detailed in the MOP (2018-2020).

Table 40: 2018 Rehabilitation Status and Forecast for 2019

Mine Area Type	Previous Reporting Period (Actual) (ha)	This Reporting Period (Actual) (ha)	Next Reporting Period (Forecast) (ha)
A. Total mine footprint[1]	1,881.8	1,881.8	1,881.8
B. Total active disturbance[2]	1,261	1,011.7	1,092.4
C. Land being prepared for rehabilitation[3]	0	0	0
D. Land under active rehabilitation[4]	620.8	657.5	701.3
E. Completed rehabilitation[5]	0	0	0

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 MOP/RMP Guidelines). Please note that subsidence remediation areas are excluded.
2. Total active disturbance includes all areas ultimately requiring rehabilitation such as: on-lease exploration areas, stripped areas ahead of mining, infrastructure areas, water management infrastructure, sewage treatment facilities, topsoil stockpile areas, access tracks and haul roads, active mining areas, waste emplacements (active/unshaped/in or out-of-pit), and tailings dams (active/unshaped/uncapped).
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 the MOP/RMP Guidelines).
4. Land under active rehabilitation - includes areas under rehabilitation and being managed to achieve relinquishment – includes the following rehabilitation phases as described in the MOP/RMP Guidelines – “ecosystem and land use establishment” (area seeded OR surface developed in accordance with final land use) and “ecosystem and land use sustainability” (revegetation assessed as showing signs of trending towards relinquishment OR infrastructure development).
5. Completed rehabilitation – requires formal sign-off by DRG that the area has successfully met the rehabilitation land use objectives and completion criteria.

* Land under active rehabilitation for the previous reporting period has been updated from the value previously reported in WCPL's 2016 Annual Review, as more detailed rehabilitation mapping has been undertaken.

There was a discrepancy of approximately 21 ha in the previously reported rehabilitation figure which was due to 9 ha previously mapped as rehabilitation incorrectly, 9 ha of re-disturbance to areas previously rehabilitated and minor adjustments to rehabilitation mapping polygons (i.e. increased accuracy). This discrepancy has been resolved in the actual rehabilitation figure for 2018 and the forecast figure for 2019.

7.1.4 Renovation or Removal of Buildings

No buildings were renovated or removed during the reporting period.

7.1.5 Other Rehabilitation Activities

In consultation with DRE (now DRG), an extensive audit of historical exploration works commenced during 2015. The scope of the audit was to identify all historical exploration sites, rehabilitate as required and relinquish the sites to DRG. Of the identified sites:

- 9 sites were rehabilitated;
- 21 sites were inspected;
- 8 sites were identified as suitable for relinquishment; and
- 13 sites were identified as mined through.

In 2016, the scope of the audit was finalised and a total of 222 sites associated with historical exploration were identified in A444 and 17 in EL7211. The sites were identified as requiring inspection, possible rehabilitation and eventual relinquishment.

Both the EL7211 and A444 audits were completed during 2017. Copies of these reports were provided to DRG on 17 April 2017. In December 2017, DRG requested an ESF2 Form (Rehabilitation Completion and/or Review of Rehabilitation Cost Estimate) be completed to accompany the Audit Reports. The ESF2 form was submitted to DRG on 14 December 2017. Follow up required for remaining holes associated with this audit will be included in the work scheduled from April-May 2019 (refer to **Section 5.10**).

7.1.6 Variations in Activities Proposed in the MOP

During the reporting period, rehabilitation was undertaken in accordance with the activities proposed in the approved MOP (2018-2020).

7.1.7 Trials, Research Projects and Other Initiatives

During the reporting period, the MOP was updated to cover the period 2018-2020 and to incorporate the changes proposed as part of Modification 17 to DA305-7-2003. It also incorporates remediation activities on the Kharlibe property and some minor changes to scheduling of open cut mining activities.

The following rehabilitation trials were undertaken during the reporting period:

- capping studies of NETD;
- incorporation of organic matter with topsoil material; and
- application of gypsum to improve soil sodicity and structure in rehabilitation outcomes.

An audit of subsidence impacts was undertaken by SLR during the reporting period to identify new subsidence impacts over recent mining areas (Longwalls 11 to 16 at the South Bates Underground Mine) and to determine the status of known subsidence impacts (e.g. have they self-repaired, are they stable but pose a risk to long-term sustainable landuse, or are they deteriorating in condition). A program of works has also been developed for the remediation of the subsidence impacts identified by the subsidence audit in areas away from active subsidence (**Section 5.9.3**).

7.1.8 Key Issues That May Impact Successful Rehabilitation

Where possible, seeding of revegetation areas has been undertaken following substantial rainfall events, however, poorer than average rainfall for 2017 and 2018 has impacted on germination and pioneer growth. Revegetation will be assessed in 2019 for areas that require additional seeding.

7.2 Actions for the Next Reporting Period

7.2.1 Final Rehabilitation Outcomes

WCPL's CMCP will be revised and submitted to the NSW Resources Regulator and other relevant stakeholders within six months of the determination of the United Wambo Open Cut Coal Project (SSD-7142) (MOD16).

7.2.2 Rehabilitation Trials, Research Projects and Other Initiatives

The following rehabilitation trials will continue or commence in 2019:

- Capping trials of NETD (as described in **Section 7.1.1**).
- CPT of NETD will commence in Q1 2019.
- Following CPT, it is anticipated the capping design will be finalised in Q4 2019.
- Intermittent disposal of double flocculated tailings in the NETD will commence in Q3 2019.
- Subsidence repair trials (based on the program of works being developed by WCPL following the subsidence impact audit).
- Application of gypsum to improve soil sodicity and structure in rehabilitation outcomes.

7.2.3 Proposed Rehabilitation in the Next Reporting Period

The following areas, detailed in the MOP (2018-2020), are scheduled for rehabilitation during the next reporting period:

- RL160 Embankment (24.1 ha);
- Rug Dump (13.0 ha); and
- Montrose East (6.7 ha).

8.0 Community

WCPL operates a 24 hour Community Enquiry Line (02 6570 2245), a Blasting information Hotline (02 8250 5205), a SMS text messaging Blast notification service and a dedicated community email account (wambocommunity@peabodyenergy.com), to enable community members to make enquiries or lodge complaints regarding the operation of the Mine.

8.1 Community Engagement Activities and Initiatives

8.1.1 Community Consultative Committee

The WCPL CCC is made up of residents from the surrounding district, a representative of Singleton Shire Council and WCPL management. The CCC representatives act as the point of contact between the mine and the community. The CCC is chaired by an independent chairperson.

During the reporting period WCPL held three CCC meetings:

- Tuesday 10 April;
- Thursday 16 August; and
- Tuesday 11 December.

Minutes of these meetings are available on the Peabody Energy website https://www.peabodyenergy.com/Operations/Australia-Mining/New-South-Wales-Mining/Wambo-Approvals,-Plans-Reports.

8.1.2 Newsletters

No newsletters were published by WCPL during the reporting period.

8.1.3 Other Community Engagement Activities

During the reporting period, WCPL also conducted several educational site visits for the following institutions:

- 18 April – University of Wollongong. Students were studying Masters of Mining Engineering, Bachelors of Mining Engineering, Mechanical and Environmental.
- 28 May – Milbrodale, Broke and Jerrys Plains public schools.
- 30 November – 'Robogals'. Robogals is a volunteer-based organisation using robotics to encourage girls (and boys) in primary and secondary schools to develop and pursue an interest in science, technology, engineering and maths.

8.2 Community Contributions

During the reporting period, WCPL contributed to the community through the following:

- donation to subsidise rehabilitation of rescued native fauna;
- Singleton Youth Boxing Sponsorship for 2018;
- sponsorship of the Singleton District Junior Cricket Association (sponsorship would be used to purchase shirts);
- Outstanding Business Awards – Gold Sponsor (Employer of Choice category);

- Newcastle and Hunter Combined Schools ANZAC Service;
- contribution to the Hunter Transplant Research Foundation;
- contribution to the Hunter Coal Festival;
- sponsorship of Newcastle CF Race Day;
- Black Dog Institute through TVP Golf Day fundraiser;
- contribution towards the installation of Jerry's Plains Community Hall air conditioning;
- support for Camp Quality (sponsoring an employee to ride in 1000Ks 4 Kids);
- Tractor Trek Drought fundraiser for Little Wings Charity;
- Crockfest Music Festival Drought fundraiser;
- Lochinvar Public School 'Carols by Twilight' school fundraiser; and
- Wambo Singleton Hall of Fame.

8.3 Community Complaints

WCPL received a total of 65 community complaints during the reporting period, including five (5) for blasting, six (6) for dust, three (3) for a combination of blasting and dust, seven (7) for lighting and forty-four (44) for noise (**Figure 18**).

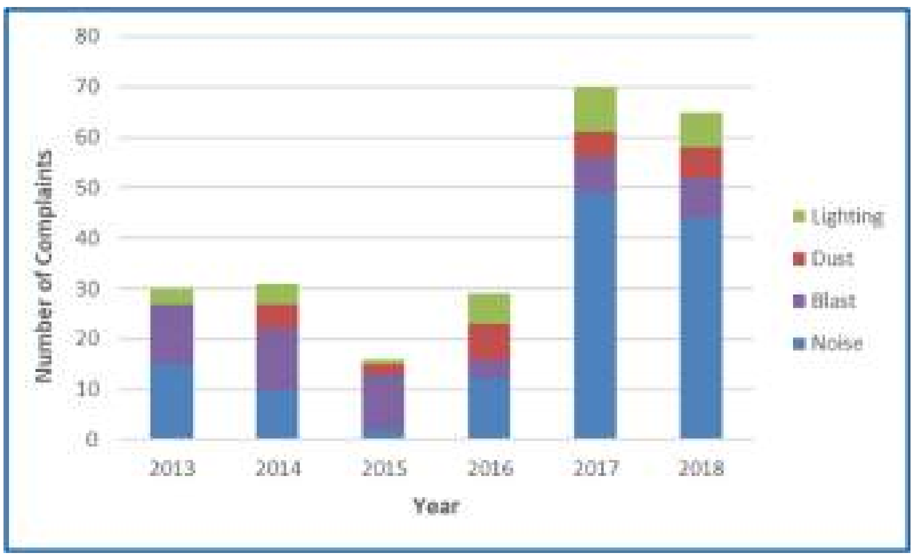

Figure 18: Community Complaints (2013-2018)

Complaints relating to blasting have remained relatively consistent, with eight (8) complaints recorded during 2018 (one [1] for blast fume, four [4] for vibration and three [3] for dust) compared with seven (7) in 2017 (one [1] for blast fume, four [4] for vibration, one [1] for dust and one [1] general), four (4) in 2016 (three [3] for vibration and one [1] for fume), eleven (11) in 2015 (all for vibration), twelve (12) in 2014 (three [3] for blast fume, seven [7] for noise and vibration, one [1] for dust and [1] general) and twelve (12) in 2013 (nine [9] for blast fume and three [3] for noise and vibration).

The number of noise complaints reduced in 2018 when compared to 2017. All complaints were reviewed, noise levels assessed against available data and followed up with as soon as possible.

During the reporting period, the number of dust complaints remained relatively consistent, with six (6) complaints received in 2018, compared with five (5) in 2017, seven (7) in 2016, two (2) in 2015, five (5) in 2014 and zero (0) in 2013.

A total of seven (7) complaints were received relating to lighting in 2018. This is consistent with the number of complaints received in 2017 (nine [9]) and 2016 (six [6]). Similar to the complaints relating to noise, this is considered to be in response to operations moving closer to sensitive receivers. The complaints typically related to impacts from lighting plants operating in the open cut pit at night.

When requested, detailed reports on WCPL operations at the time of the complaints were provided to DPE and EPA. A summary of the detailed reports provided to the DPE and EPA in response to the complaints is provided in **Section 10.8**.

8.3.1 Visual Impact Complaint

Condition 82, Schedule 4 of DA305-7-2003 requires that:

82. If a landowner of any dwelling assessed in the EIS as having a high potential visual impact requests the Applicant in writing to investigate ways to minimise the visual impact of the development on his/her dwelling, the Applicant must:

(a) within 28 days of receiving this request, commission a suitably qualified person whose appointment has been approved by the Secretary, to investigate ways to minimise the visual impacts of the development on the landowner's dwelling; and

(b) give the landowner a copy of the visual impact mitigation report within 14 days of receiving this report.

If both parties agree on the measures that should be implemented to minimise the visual impact of the development, then the Applicant shall implement these measures to the satisfaction of the Secretary.

If the Applicant and the landowner disagree on the measures that should be implemented to minimise the visual impact of the development, then either party may refer the matter to the Secretary for resolution.

If the matter cannot be resolved within 21 days, the Secretary shall refer the matter to an Independent Dispute Resolution Process (see Appendix 2).

On 7 December 2016, a landholder on Jerrys Plains Road emailed the Senior Compliance Officer of the DPE expressing their concerns arising from the visual impact caused by mining activity related to WCPL's Montrose East Pit arising since 5 November 2016 and requesting that action be taken in accordance with Condition 83, Schedule 4 of DA305-7-2003.

On 20 December 2016, Wambo Coal formally engaged Terras Landscape Architects (Terras) having received confirmation from the DPE that Terras's nominated director was a suitably qualified person to undertake the assessment and reporting.

During 2017, WCPL completed all recommendations made by Terras (2017), with the exception of the rehabilitation works on Montrose East Pit, which were ongoing due to drier weather.

Rehabilitation works on Montrose East Pit remained ongoing during the reporting period due to continued dry weather.

9.0 Independent Audits

9.1 2015 Independent Environmental Audit for EPBC 2003/1138

An Independent Environmental Audit (IEA) was undertaken by Umwelt in February 2015 to assess compliance against EPBC 2003/1138, the Biodiversity Offset Strategy (BOS) required by DA305-7-2003, and the commitments made in WCPL's FFMP. The audit report was finalised in May 2015 and submitted to DoEE and DPE in accordance with Condition 4 of EPBC 2003/1138 and Condition 50, Schedule 4 of DA305-7-2003. A copy of the audit report is available on the Peabody Energy website (www.peabodyenergy.com).

Two (2) non-compliances and 14 recommendations for improvement were identified during the audit. **Table 41** summarises the recommendations from this audit and WCPL's progress against the action plan developed to address these recommendations.

The next IEA for EPBC 2003/1138 and the BOS is due in 2020.

9.2 2015 Independent Environmental Audit for South Bates Underground Mine Extraction Plan

In 2015, WCPL commissioned an independent audit of subsidence, surface water and groundwater impacts prior to the submission of an Extraction Plan for Longwalls 11-13, in accordance with Condition 37, Schedule 4 of DA305-7-2003.

The report was finalised in June 2015 and submitted to DPE. **Table 42** summarises the recommendations from this audit and WCPL's progress against these recommendations.

9.3 2016 Independent Rehabilitation Audit for Annual Environment Management Report

In 2015, WCPL commissioned GHD to undertake an independent audit (GHD 2016) of the rehabilitation at the Mine to identify any potential deficiencies of the rehabilitation and improvement strategies. The audit report was finalised in June 2016 and submitted to DRG. **Table 43** provides an update on the status of the audit recommendations, including:

- Matters that have been addressed in MOP amendments.
- A strategy and timeframe for addressing matters that are still outstanding.
- Matters that are subject to further refinement (i.e. pending the results of monitoring).

9.4 2017 Lighting Audit

In July 2017, an external lighting audit of the Mine was commissioned by WCPL and undertaken by Electrical Projects Australia (2017) to consider the lighting associated with the Mine's surface mining operations, CHPP, train load out facility and general workshop/building lighting throughout the site.

The purpose of the audit was to ensure the Mine complies with *AS4282:1997 Control of the Obtrusive Effects of Outdoor Lighting*.

Electrical Projects Australia conducted site inspections on 4 July and 13 July 2017 and undertook a night lighting observation on 13 July 2017.

The audit confirmed that the Mine is compliant with *AS4282:1997 Control of the Obtrusive Effects of Outdoor Lighting*, however, Electrical Projects Australia recommended that the following would assist to reduce glare from the main workshop area:

- Use Type C cut-off fittings where possible.
- Aim any other type of fittings downwards below 30 degrees.
- Adjust any lighting that may be operated on a combination of PE cell and time clock or with an after-hours pushbutton facility to reduce use at night (if not required in some areas).

WCPL addressed all recommendations from Electrical Projects Australia during the reporting period.

9.5 2017 Independent Environmental Audit

An Independent Environmental Audit (IEA) was undertaken by Hansen Bailey in November and December 2017 to assess compliance against DA305-7-2003 and DA177-8-2004 (as modified). The audit also assessed compliance against EPL529 and ML1572. The audit report was finalised in December 2017 and submitted to DPE in accordance with Condition 7, Schedule 6 of DA305-7-2003. Following review of the IEA, DPE advised their agency requirements had not been addressed in the audit and requested the IEA be revised to include them. The revised IEA was submitted to DPE 19 September 2018 and approved 31 January 2019. A copy of the audit report is available on the Peabody Energy website (www.peabodyenergy.com).

Thirty-six (36) non-compliances, comprised of 25 issues were identified during the audit, including eight (8) which were classed as "administrative". The non-compliances were risk ranked. No high risks were identified during the audit. Eleven issues were identified as low risk and one issue as medium risk. The report also included numerous recommendations for improvement. **Table 44** summarises the recommendations from this audit and WCPL's progress against these recommendations.

The next IEA for DA305-7-2003 and DA177-8-2004 is due in 2020.

9.6 Independent Environmental Audit for South Bates Extension Underground Mine Extraction Plan

Condition 37, Schedule 4 of DA305-7-2003 requires that:

> *37. Prior to seeking approval from the Department for an extraction plan in any coal seam not previously subject to second workings within the relevant longwall domain, unless the Secretary directs otherwise, the Applicant must commission a suitably qualified person, whose appointment has been approved by the Secretary, to conduct an independent audit of the subsidence, surface water, and ground water impacts of the development.*
>
> *…*

“Longwall domain” is defined in DA305-7-2003 as “Areas 1, 2, 3 and 4 as identified in Figure 9 of the document titled South Wambo Underground Mine Modification Environmental Assessment (see condition 2(q) of Schedule 3)”.

Based on the above, Wambo Coal considered that an independent audit under Condition 37, Schedule 4 was not required prior to lodgement of an Extraction Plan for the South Bates Extension Underground Mine.

On 29 January 2018, DPE confirmed that an independent audit under Condition 37, Schedule 4 of DA305-7-2003 would not be required prior to lodgement of an Extraction Plan for the South Bates Extension Underground Mine.

Table 41: Actions Completed in 2018 and Outstanding Actions from the 2015 IEA for EPBC 2003/1138, the BOS and FFMP

No.	Recommendation	Action Plan Progress
EPBC 2003/1138		
3	Prior to undertaking any further activities within the RWEP areas, Wambo should revise the FFMP to clearly identify which activities are permitted within the RWEP areas and the environmental controls to manage these activities, and where necessary, the further approvals that need to be obtained. The revised FFMP should be provided to the Minister for approval.	Complete. The FFMP (renamed the BioMP) was updated and approved by DPE during the reporting period.
Biodiversity Offset Strategy (Conditions 44-50, Schedule 4 of DA305-7-2003)		
4	Update the FFMP to include more specific management measures relating to subsidence impacts in the RWEP areas.	Complete. The FFMP (renamed the BioMP) was updated and approved by DPE during the reporting period.
5	Update the Vegetation Clearance Protocol (VCP) to address the control of weeds during clearing activities.	
6	The FFMP should be revised to include more targeted management strategies for each RWEP area in consideration of the habitat features present.	
FFMP		
9	It is recommended that Wambo update site processes/procedures to ensure nesting/breeding times for species known to occur and likely to occur on-site are known and considered in the timing of clearing activities.	Complete. The FFMP (renamed the BioMP) was updated and approved by DPE during the reporting period.
10	It is recommended that Wambo install nest boxes and structures in accordance with the FFMP and/or commission an ecological assessment to determine the extent of hollow resources currently occurring in the Wambo land holding, particularly in offset areas and make recommendations regarding the identification of any areas that are low in hollow resources that could therefore benefit from the introduction of nest boxes.	Complete. Nest boxes installed in 2018.
13	Improve documentation of rehabilitation monitoring processes. Wambo could consider developing an inspection checklist to address the relevant requirements and document corrective actions.	Complete. The FFMP (renamed the BioMP) was updated and approved by DPE during the reporting period.
14	Wambo should complete incident notifications as required of the FFMP. Alternatively, if this was not the intention of the FFMP, the FFMP should be revised to reflect the intended reporting requirements and relevant legislative requirements and the revised FFMP provided to the Ministers for approval.	Complete. The FFMP (renamed the BioMP) was updated and approved by DPE during the reporting period.

Table 42: Outstanding Action from the 2015 IEA for South Bates Underground Mine Longwalls 11-13 Extraction Plan

No.	Recommendation	Action Plan Progress
Groundwater		
8	It is recommended that Wambo investigate the cause(s) of the water level and water quality changes at GW08 and GW09, and if appropriate recommend response actions.	Investigations are ongoing. WCPL will install a replacement bore in 2019.

Table 43: Actions from the 2016 Rehabilitation Audit

No.	Recommendation	Action Plan Progress
4	The Topsoil Management Procedure would benefit from the development of a checklist/ ITP with key activities to ensure that requirements are undertaken in accordance with the procedure.	Complete. The Topsoil Management Procedure was revised in 2018. Prior to conducting topsoil stripping, a 'Topsoil Stripping Permit' must be completed and signed off by the Environment and Community Manager and the Open Cut Manager.
5	Ensure that site personnel with responsibilities for topsoil removal and management are identified and are aware of their role and the need for communication with the Environment and Community Manager (or representative).	Responsibilities have been detailed in the latest version of the Topsoil Management Procedure, and relevant personnel made aware of their responsibilities.
6	Review the topsoil suitability key parameters and testing requirements and update the Topsoils Management Procedure accordingly.	Complete. The Topsoil Management Procedure was revised in 2018 (refer Section 3.3.4 of the Procedure).
7	Undertake a topsoil audit of existing topsoil stockpiles to establish the volume and condition of stored topsoil. Use this information to prioritise future utilisation of topsoil resource.	An audit of existing topsoil stockpile volumes was undertaken in 2015, 2016, 2017 and 2018. The Topsoil Management Procedure requires the condition of topsoil stockpiles to be assessed prior to reuse if the stockpile is greater than five years old.

No.	Recommendation	Action Plan Progress
8	Undertake an internal an audit of topsoil stockpiles and associated documentation to assess if topsoil stockpiles are being managed in accordance with the Topsoil Management Procedure.	An audit of topsoil stockpile management was undertaken during the reporting period which led to several mitigation actions. These included: • conducting weed spraying to reduce the existing weed burden; • reshaping stockpiles were required; • installing additional signage; • conducting a topsoil inventory; • seeking and implementing management advice from an agronomist; and • updating the Topsoil Management Procedure to include a permit system for topsoil stripping activities on-site.
9	Review the landform and drainage of existing rehabilitated areas (area at the top RL160) to identify flow paths and ensure that surface water does not enter the mine water system and ensure that water is directed to designed water storage areas.	Revision of landform drainage is ongoing across WCPL with a goal to ensure clean water drainage reports off-site where possible.
12	Consider testing soil key parameters prior to reuse of stockpiled soil as the soil parameters will change within the soil over time.	The 2018 revised Topsoil Management Procedure requires an assessment of topsoil quality prior to reuse if a stockpile is greater than five years old.
13	Consider various topsoil depths based on the soil complex to be utilised. Various reuse topsoil depths would be based on pre-stripping topsoil survey.	Topsoil stripping depths are defined in the Topsoil Management Procedure and MOP for various soil types. The MOP requires that topsoil replacement average depths of at least 100 mm.
21	Incorporate seed germination testing in the MOP and ensure that certificates for all seed collected or supplied by an external contractor is obtained. This provides quality assurance of seed and expected germination rates.	Seed germination testing will be incorporated in the next amendment to the MOP. WCPL currently ensures that certificates for all seed collected or supplied by an external contractor are obtained.
26	Slashing or controlled grazing is recommended for dense monoculture pastures such as those dominated by Rhodes grass. Depending on the length of time the grassland rehabilitation areas have been established and the seed mix used, reseeding with desirable species and/ or tube stock planting could be undertaken.	The status of the monoculture grassland rehabilitation areas will be reviewed and, if suitable, consideration will be given to reseeding with desirable species and/or undertaking tube stock planting.

Table 44: Actions from the 2017 IEA for DA305-7-2003 and DA177-8-2004

Ref	Audit Finding / Risk	Description	WCPL Response	Timing
Previous Audit Non-compliances				
5.8, 5.18, 5.24	-	Review actions recommended by previous audit which have not been completed. Update management plans as required to address recommendations that are relevant to contemporary operations Refs 4.5 – 4.9). • North Wambo Creek Diversion Plan not yet revised to include the required section on mechanism for the return of intercepted groundwater;	Noted. The design for the return of intercepted groundwater remains in draft. This condition has been included in the 2019 revision of the North Wambo Creek Diversion Plan.	Submitted for consultation 24 April 2019
DA 305-7-2003 Non-Compliance Recommendations				
Schedule 3, Condition 7B	Administrative	Recommend that formal written requests to the Secretary are made in the future if consultation with regulators is not intended to be conducted in relation to management plans.	Noted.	-
Schedule 3, Condition 10		Inspection of steam flow monitoring equipment to ensure damaged equipment is repaired or replaced ASAP.	Frequency of download and inspection regime has been increased to quarterly.	Quarterly
Schedule 4, Condition 8 and Condition 9	Low	Recommend that documented coordination with nearby mines and an agreed protocol is developed to manage cumulative noise impacts to the satisfaction of the Secretary.	WCPL will continue to manage noise impacts and contact neighbouring mines and develop a protocol to manage cumulative noise impacts. A copy of the Protocol will be submitted to the Secretary upon completion.	30 November 2019.
Schedule 4, Condition 23A	Medium	This non-compliance relates to an unlicensed release of runoff from a sump located adjacent to Wollombi Creek at Hales Crossing. Consideration should be given to the current Hales Crossing sump and pump arrangement to remove the risk of sump inundation. Options include relocating the sump and pump apparatus to a location outside the flood extents of Wollombi Brook.	Options to improve the Hales Crossing sump and pump arrangement are being considered, including relocating the existing sump or placing the pump onto a raised platform.	30 November 2019

Ref	Audit Finding / Risk	Description	WCPL Response	Timing
Schedule 4, Condition 25	Administrative	A comparison of the overall site water balance to the EIS predictions should be presented in future Annual Reviews. If the differences between the EIS water management system and operations are such that a meaningful comparison of the predictions is not possible, or the EIS does not provide sufficient detail on the water balance predictions to allow a comparison of the water balance (which looks likely based upon Appendix E of the EIS), this should be acknowledged.	Complete - EIS predictions added to the site water balance (Section 6.7) of the 2018 Annual Review.	Complete
Schedule 4, Condition 25	Administrative	The Annual Reviews do not explicitly forecast compliance with the HRSTS rules. It is recommended that the forecast presented in future Annual Reviews is expanded to explicitly address forecast compliance.	Complete - Forecast compliance with HRSTS rules included in Section 6.3 of the 2018 Annual Review.	Complete
Schedule 4, Condition 30 and 30A	Administrative	Site Water Management Plan should be updated to include the predicted salt balance.	A salt balance will be completed, and the results added to the next revision of the Site Water Balance Management Plan.	Site Water Balance (draft) has been revised to include. Remains in draft pending outcome of the JV
Schedule 6, Condition 12	Administrative	Letter (c) and (d) in Schedule 3 Condition 2 are located and made publicly available on website.	WCPL is unable to locate these documents.	-
DA 177-8-2004 Non-Compliance Recommendations				
Schedule 4, Condition 5		A summary of train movement times should be added to future Annual Reviews.	Daily train movement summaries have been added to the Annual Review. WCPL owns surrounding land, no issues have been raised and no complaints received.	Complete
Schedule 4, Condition 12		Written approval to be sought from the Director General to cease vibration monitoring.	Located correspondence from Department of Planning (dated 23 December 2008) with approval to discontinue monitoring.	Complete
Schedule 4, Condition 19	Administrative	Correspondence should be sought from RMS confirming that upgrades to the Golden Highway/Wallaby Scrub Road intersection are not required.	Mt Thorley Warkworth (MTW) has received DP&E approval to mine through Wallaby Scrub Road and Wallaby Scrub road has been officially closed.	Nothing further required

Table 2: WCPL Responses to Continual Improvement Recommendations

Ref	Description	WCPL Response	Timing
DA 305-7-2003 Continual Improvement Recommendations			
Schedule 4, Condition 4	It is recommended that details of any exceedances are explained in the Annual Reviews. This includes referencing any local bushfires/RFS activity/extreme weather events that may have been the cause.	Agreed. WCPL has added a section to the Annual Review which discusses exceedances and calculates the WCPL contribution to PM_{10} dust.	Complete
Schedule 4, Condition 11	ASAP investigate and remedy the likely calibration error for the overpressure microphone on the Thelander blast monitor, which developed in August 2017 after the last calibration check in July 2017.	Complete.	-
Schedule 4, Condition 12	Monitoring results for the period 23/2/2017 to 29/3/2017 were reported incorrectly (overpressure and vibration levels were swapped in the results table). Recommend that monitoring data is checked monthly to ensure results are reported correctly.	WCPL has improved its data management with the implementation of the Equis database and repository of results.	Complete
Schedule 4, Condition 15	A notification of entitlement to property inspection is sent to landowners within 2 km of the site that to ensure current owners are aware of this entitlement.	Agreed.	By 30 June 2019.
Schedule 4, Condition 19	Seek written approval for blasting within 500 m of Crown and HVO land before blasting within 500 m of this land in the next audit period.	Notification procedure developed in consultation with relevant stakeholders. Procedure forms part of the Site Blast Management Plan. A copy of the procedure was provided to DP&E as required and is on the website.	Complete.
Schedule 4, Condition 22	The Reject Emplacement Strategy (RES) should be submitted to DRG (not DP&E) and followed up to approval. It is noted that the plan is likely to require review following any positive determination of the United and Wambo Open Cut Coal Mine Project.	Noted	
Schedule 4, Condition 25	Improvements could be made in terms of the overall site water management if specific groundwater inflows to the open cut via alluvium and Permian could be pumped and/or metered.	Recommendations considered in 2018 Annual Review Groundwater Analysis by HydroSimulations. Changes such as the comparison of measured and predicted inflow volumes will be adopted in a future revision of the WCPL Groundwater Monitoring Program.	Next review of GWMP

Ref	Description	WCPL Response	Timing
Schedule 4, Condition 29	It is understood that a salt balance model has been developed for the site for the United/Wambo project. It is suggested that this salt balance be updated annually to include the seepage quality monitoring data. There is no recommendation in terms of frequency of monitoring. WCPL should determine the frequency of monitoring to apply for the salt balance model.	A salt balance will be completed and provision will be made for the balance to be updated annually. WCPL will determine the frequency of monitoring to apply for the salt balance model.	by 30 November 2019
Schedule 4, Condition 30	The GWMP should be updated with the suggestions provided by NSW government subsequent to approval of the GWMP in November 2015 and resubmitted. Updates should include: • A more contemporary reference to groundwater sampling techniques; • Amendment of the text relating to purging of groundwater bores to be consistent with the latest guidelines; • Outline the methods of water quality data upload from the laboratory; • The bore labels in Figure 7 need to be clear for all bores; and • General update of text relating to historical or proposed activities.	Complete, changes made in V12 of the GWMP, approved by DP&E 17 September 2018.	Complete
Schedule 4, Condition 34	Update GWMP to include Montrose Dam prior to its construction.	Current Mining Operation Plan refers to construction likely in 2023.	Prior to 2023 construction
Schedule 4, Condition 34	Consideration should be made to directly monitor the quality of groundwater seepage reporting to the underground and open-cut workings.	Addressed in 2018 Annual Review of Groundwater prepared by HydoSimulations for the WCPL Annual Review Samples will be taken at active underground areas, to complement the extensive groundwater monitoring network	Ongoing
Schedule 4, Condition 40	Offset area E is required to be secured under a conservation agreement by December 2017 and included in the Biodiversity Management Plan and MOP. A draft has been sent to OEH. This should aim to finalise by the due date.	WCPL submitted the Conservation Agreement variation in March 2018. OEH returned the document 9 April 2019. It will now be finalised for signing.	31 December 2019.

Ref	Description	WCPL Response	Timing
Schedule 4, Condition 47	Recommend that identification of 'Acacia anuera' is finalised and amended in the development consent to Acacia pendula at next modification, if required.	*Acacia anuera* was identified to most likely be *Acacia pendula* in 2004. Further investigations were undertaken in 2006 and 2008 with no conclusive identification of the species. WCPL follows the precautionary approach and treats the species as *Acacia pendula* due to its listing in the TSC Act and EPBC Act. Further investigations will be conducted during flowering season, to conclusively identify the species. The current consent condition references the *Acacia anuera* community identified in the 2003 EIS. WCPL will consider amending the development consent once further investigations re carried out. Sample collected by Ecologist during annual monitoring October 2018, unable to be positively identified as flowers or nuts were not present.	2019 annual monitoring. (Appropriate flowering season as determined by the WCPL Ecologist.)
Schedule 4, Condition 56	Seek to recover this contribution if regulators confirm that it has not been expended, or if it has seek the documented outcome of the Trust Fund.	Payment of $50 000 was made to the Hunter Aboriginal Cultural Heritage Trust Fund 7 November 2005. WCPL will seek to recover this contribution.	31 December 2019.
Schedule 4, Condition 56D	Aerial on page 8 of the induction should be updated to be current.	A copy of the 2017 aerial will be provided for the induction.	Complete (31 March 2018)
Schedule 4, Condition 70	Site 3 and site 9 non-indigenous heritage items should be identified in the field. Then correspondence as required in the condition should occur to close out this item.	Site 3 is identified as abandoned Homestead A and Site 9 is abandoned Tractor. An assessment will be made as to the significance of these items and as to whether they are moveable. This information will be documented in the next review of the Cultural Heritage Management Plan, scheduled for 2018. Correspondence will be drafted to the Power House Museum to advise the outcome and close out this item.	Complete - Correspondence sent 23 May 2019
Schedule 4, Condition 71	Consistent with previous audit, recommend consultation occurs and correspondence received from RMS is sought confirming the new intersection is not required or they are satisfied for inclusion in next IEA.	WCPL will follow up this recommendation prior to the next audit (2020)	

Ref	Description	WCPL Response	Timing
Schedule 4, Condition 82	Recommend the Montrose Tree Screen requires attention to ensure effectiveness in mitigating visual impacts	Included as MOP 2018-2020 commitment - Maintenance of the tree screen will continue	Spring 2019
Schedule 4, Condition 83	Provide a more recent notification to owners of private residences of right to visual mitigation under consent condition.	Condition 83 requires '*if a landowner of any dwelling assessed as having a high potential visual impact requests in writing.. to investigate ways to minimise the visual impact of the development on his/her dwelling…*' Table 4.4 in the EIS identifies Holt, Moses, Muller and Fenwick and subsequent text includes Skinner and Long as residences with high visual impacts. Only one property remains privately owned and is subject to an access and compensation agreement.	N/A
Schedule 4, Condition 84	The Annual Review for 2016 reports 6 lighting complaints for the period however only 5 are reported in the register. Recommend that all complaints are reported correctly in future.	Noted.	As required
Schedule 4, Condition 89	Recommend that DRE is consulted in the future to confirm satisfaction with spontaneous combustion management. This may occur through the Annual Review process, requesting a response to this query in the submission letter.	No issues of spontaneous combustion reported 2014, 2015 or 2016 Annual Reviews. Minor incident of spontaneous combustion reported in 2017 AR and mentioned to the Resource Regulator (Neil McIlhenny (NM)) during the annual inspection in September 2018. NM advised nothing further required.	Nothing further required at this time.
Schedule 4, Condition 94	Woodland corridors in the RL 160 dump areas are developed further to join the existing areas and the MOP is amended at next review to show proposed and defined corridors.	The establishment of woodland corridors is an important component of the biodiversity and offset strategy. WCPL will amend the MOP at the next review to show proposed and defined corridors.	During the next review of the MOP, following determination of the United JV.
Schedule 4, Condition 94A	Recommend soil surveys are undertaken the Soil Management Protocol is updated for any remaining areas to be stripped showing specific depths for specific areas.	Soil Management Protocol was updated in 2018, next revision will include any remaining areas to be stripped showing specific depths for specific areas.	Next review in 2019
Schedule 5, Condition 1	Notification to landowners of the publication of management documents and monitoring results on the website is updated at regular intervals (suggested 4-5 yearly).	Agreed. Included in 2018 Notification letter to landowners within 2kms. Letterbox drop 15/10/18	Complete
Schedule 5, Condition 1	Recommend neighbours are notified for all future exceedances of criteria.	Agreed.	As required

Ref	Description	WCPL Response	Timing
Schedule 6, Condition 2	Once the revised EMS is approved it must be sent to the relevant agencies, Council and CCC within 14 days.	EMS approved 26 March 2018 and sent to relevant agencies, Council and CCC within 14 days (sent 4 April 2018).	Complete
Schedule 6, Condition 6	Recommend that a register is kept to confirm reviews of strategies, plans, and programs required under this condition are undertaken following triggers specified in a-d.	The current register will continue to be updated as reviews to strategies, plans, and programs are made under this condition. Correspondence will continue to be sent each year following submission of the Annual Review to address this condition.	Complete
DA 177-8-2004 Continual Improvement Recommendations			
Schedule 4, Condition 5	No evidence of reporting on measures to minimise loading outside specified hours to DP&E's approval. Recommended that a summary of train movement times is added to future Annual Reviews.	WCPL owns surrounding land, no issues have been raised and no complaints received.	Complete
Schedule 4, Condition 6	Reviewed ARTC EPL 3142 and email from Matt Pearce of Aurizon dated 12/09/13. Email confirms that locomotives are required to be tested by the rail operator for compliance with noise requirements. Recommend that this is updated to remain contemporary.	WCPL tried unsuccessfully to have this correspondence updated with ARTC, prior to the audit in 2017. Another attempt will be made to satisfy this condition.	Prior to the next IEA in 2020.
Schedule 4, Condition 17	It is recommended that section 2.2.6 of the Site Water Management Plan is improved by providing a high level strategy for the decommissioning of water management structures (including the management of water during the decommissioning process).	Complete. Section 2.2.6 of the SWMP was revised to address this recommendation (Version 12) which was approved by DP&E 7 September 2018.	Complete.
Schedule 4, Condition 23	Recommend this condition is revised to remove at next modification.	This condition relates to minimising road safety impacts from train headlight glare on motorists. Audit confirms screening is in place and that no complaints or incidents occurred as a result of rail loop lighting. WCPL will investigate removing this condition during next modification (not in the Modification currently being assessed).	During the next DA 305-7-2003 Modification.

Ref	Description	WCPL Response	Timing
Schedule 4, Condition 24A	Internal inspections and photographs are taken of dirt tracking on the Golden Highway so that compliance with condition can be confirmed in future.	Noted. Compliant – Inspection and photographs completed by M Bartlett 17 October 2018, following period of rainfall. Road is sealed to the Golden Highway and no dirt tracking was noted.	Periodic inspections will continue
Schedule 4, Condition 32	The following area recommendations for the ESCP: • A description of the existing as-built ESC arrangements for each sediment-affected catchment would enhance the current understanding of the site ESC arrangements; and • A description of the known issues and actions would be useful in demonstrating that the ESCP is operating effectively and areas for improvement." (RE, 2018). Additionally, the ESCP structure and text would benefit from a review to improve the general readability of the document. This could involve ensuring that the plan structure is logical, the scope and progression of each section is clear, and overly lengthy or repetitious text is rationalised (RE, 2018).	ESCP was approved by DP&E in June 2018 and currently there is no plan to review this document. To be addressed in the next review, most likely following the determination of the United JV.	2019 (following determination of the United JV)
Schedule 4, Condition 44	Install nest boxes	Fifty nest boxes were installed in 2018. WCPL Biodiversity MP has been revised to include locations and nest box type installed at each location.	Complete
Schedule 4, Condition 90	Dangerous Goods and Hazardous Substances Management Plan (last updated in May 2015) is reviewed	Compete - Current version WI-SAH-MNP-0049 V1, located on Peabody SAWOL system is dated November 2018	Complete
Schedule 4 Condition 95	The mine exit strategy should be developed with Council within 5 years of closure (within the next audit period) or written extension sought from DPE if new approval is granted for the Wambo United Project.	Current approvals will see underground mining continue at WCPL until December 2039.	Ongoing

Ref	Description	WCPL Response	Timing
Schedule 5, Condition 1	Confirmation from DP&E should be sought in future to confirm this condition is not required to be triggered.	The Air Quality Greenhouse Gas Management Plan (Version 7, currently with DP&E for approval) contains a Landowner Notification Procedure as Appendix D. Section 4.6.1 of the Noise Management Plan addresses Landowner Notification. WCPL will consider this requirement and seek confirmation from DP&E if deemed necessary.	30 June 2019.
Other			
NA	AGE made the following recommendations for future groundwater modelling and assessments (see Appendix F): • Future groundwater modelling updates/reports need a clear description of the interactions/connectivity of the open cut and underground area and how this is representedin the modelling; • Future groundwater modelling updates/reports should comment on theinteraction/connectivity of the open cut and underground areas and whether it is visible inthe observational data; and • Future annual groundwater monitoring reviews should comment on the interaction/connectivity of the open cut and underground area and on the degree of matchof the predicted versus observed water levels.The predictions, actual and licensing requirements should be included in a tabular format in each Annual Review.	Recommendations provided to HydroSimulations. Groundwater model will be rerun for the Extraction Plan for Longwalls 21 and beyond (approximately 2020)	Approx 2020
	The status of the single groundwater licence under the *Water Management Act* 2000 should be regularly followed up with DPI-Water	Six WCPL groundwater licences have been consolidated – WAL39738, 39803, 41528, 39375, 41520, 41494. New WAL yet to issued by NSW Land Registry Services	Complete
N/A	Recommendations for future management of the North Wambo Creek Diversion: • The current diversion management and monitoring objectives are contained in several documents. It is recommended these are consolidated into a single management plan for the diversion. It is noted that Wambo is committed to the preparation and implementation of a new Diversion and Rehabilitation Plan;	NWCD Plan has been revised. Sent to DP&E and other relevant parties for consultation 24 April 2019.	Complete

Ref	Description	WCPL Response	Timing
N/A	• The diversion management program should be implemented to improve the operation of the diversion;	Agreed. The revised NWCD Plan contains a detailed rehabilitation plan including: Table 13: 5 Year NWCD Rehabilitation and Maintenance Plan Appendix C – Detailed Rehabilitation Plan	Rehabilitation and Maintenance activities to commence Q3 2019.
N/A	• Ongoing management is required in order to ensure that soil erosion is minimised and ground cover is given adequate opportunity to become established; and		
N/A	• Rehabilitation of subsided areas of the diversion is required in accordance with an Extraction Plan (or Subsidence Management Plan), including repairing surface subsidence cracks and undertaking subsidence remediation where necessary in areas where the diversion has been subsided.		
N/A	The area in RWEA B is rehabilitated to prevent further damage and reduce risks to the surrounding Central Hunter Grey Box-Ironbark Woodland EEC as per Ecological Australia's recommendations.	Most appropriate method of rehabilitation to be determined, in order to reduce impacts if rehabilitation is undertaken with machinery.	Q3 2019
N/A	Subsidence affected sites identified as 'intolerable' by SLR Consulting should be remediated to an acceptable standard as per SLR's recommendations. Photos of completion should be kept within the database along with a report checklist with date and signature demonstrating works were completed.	Most appropriate method of rehabilitation to be determined, in order to reduce impacts if rehabilitation is undertaken with machinery.	Q3 2019
N/A	Update the Weed Plan.	Agreed.	Q4 2019
N/A	Future Annual Reviews include figures of areas that have been treated for weeds during the annual review period with a focus on *Acacia saligna*.	Figures of areas treated completed for the 2017 and 2018 Annual Reviews, *Acacia saligna* will be targeted in 2019 weed management program.	2019 - Seasonal weed management
N/A	It is recommended that the road drain outside the coal stockpile perimeter collection drainage network be de-silted and monitored to confirm whether the flow direction of the drain is adequate.	WCPL has engaged consultants to review catchment drainage and assess the efficiency of drains and sediment dams in each catchment. Any sediment dams or road drains identified to be undersized or in need of de-silting (including the Gordon Below Franklin Dam) will be actioned appropriately. Investigations are ongoing with regards to the South Wambo Project	2019
N/A	It is recommended that accumulated sediment is removed from the Gordon Below Franklin where necessary in order to reinstate the design/operating storage capacity.		

No.	Recommendation	Action Plan Progress
DA305-7-2003 Non-compliance Recommendations		
3	Recommend that documented coordination with nearby mines and an agreed protocol is developed to manage cumulative noise impacts to the satisfaction of the Secretary.	WCPL will contact neighbouring mines and develop a protocol to manage cumulative noise impacts. A copy of the Protocol will be submitted to the Secretary upon completion.
4	Consideration should be given to the current Hales Crossing sump and pump arrangement to remove the risk of sump inundation. Options include relocating the sump and pump apparatus to a location outside the flood extents of Wollombi Brook.	Consideration will be given to flood levels in the vicinity of the Hales Crossing sump and pump arrangement. The existing pump may be able to be placed onto a raised platform or relocated.
5	A comparison of the overall site water balance to the EIS predictions should be presented in future Annual Reviews. If the differences between the EIS water management system and operations are such that a meaningful comparison of the predictions is not possible, or the EIS does not provide sufficient detail on the water balance predictions to allow a comparison of the water balance (which looks likely based upon Appendix E of the EIS), this should be acknowledged.	The EIS does not provide sufficient detail on the water balance predictions to allow a comparison of the water balance, therefore no comparison has been included in the Annual Review. A revised Site Water Balance was completed in support of MOD17 to DA305-7-2003.
6	The Annual Reviews do not explicitly forecast compliance with the HRSTS rules. It is recommended that the forecast presented in future Annual Reviews is expanded to explicitly address forecast compliance.	The Annual Review has been updated to include forecast compliance with HRSTS rules (**Section 6.3.4**).
7	Site Water Management Plan should be updated to include the predicted salt balance.	A salt balance was completed in support of MOD17 to DA305-7-2003 and the results added to the next revision of the Site Water Management Plan.
8	Letter (c) and (d) in Schedule 3 Condition 2 are located and made publicly available on website.	WCPL is unable to locate these documents.
DA305-7-2003 Continual Improvement Recommendations		
9	It is recommended that details of any exceedances are explained in the Annual Reviews. This includes referencing any local bushfires/RFS activity/extreme weather events that may have been the cause.	Agreed.
10	As soon as possible, investigate and remedy the likely calibration error for the overpressure microphone on the Thelander blast monitor, which developed in August 2017 after the last calibration check in July 2017. WCPL completed this after the site visit and prior to the finalisation of this report.	Complete.

No.	Recommendation	Action Plan Progress
11	Monitoring results for the period 23/2/2017 to 29/3/2017 were reported incorrectly (overpressure and vibration levels were swapped in the results table). Recommend that monitoring data is checked monthly to ensure results are reported correctly.	WCPL has improved its data management with the implementation of the Equis database and repository of results.
12	A notification of entitlement to property inspection is sent to landowners within 2 km of the site that to ensure current owners are aware of this entitlement.	Agreed.
13	Seek written approval for blasting within 500 m of Crown and HVO land before blasting within 500 m of this land in the next audit period.	Complete. The Blast Management Plan has been revised to include a procedure for blasting within 500 m of the Golden Highway. The procedure includes a Traffic Management Plan and Road Occupancy Licence for temporary road closures.
14	Improvements could be made in terms of the overall site water management if specific groundwater inflows to the open cut via alluvium and Permian could be pumped and/or metered.	HydroSimulations will consider this recommendation in 2018.
15	It is understood that a salt balance model has been developed for the site for the United/Wambo project. It is suggested that this salt balance be updated annually to include the seepage quality monitoring data. There is no recommendation in terms of frequency of monitoring. WCPL should determine the frequency of monitoring to apply for the salt balance model.	A salt balance was completed in support of MOD17 to DA305-7-2003 and the results added to the next revision of the Site Water Management Plan. Additional monitoring of surface water storage facilities was added to the SWMP and commenced in 2018. This information will inform the salt balance, scheduled for 2019.
16	The GWMP should be updated with the suggestions provided by NSW Government subsequent to approval of the GWMP in November 2015 and resubmitted. Updates should include: • a more contemporary reference to groundwater sampling techniques; • amendment of the text relating to purging of groundwater bores to be consistent with the latest guidelines; • outline the methods of water quality data upload from the laboratory; • the bore labels in Figure 7 need to be clear for all bores; and • ceneral update of text relating to historical or proposed activities.	These changes will be made during the next revision of the GWMP.
17	It is recommended that section 2.2.16 of the Site Water Management Plan is improved by providing a high level strategy for the decommissioning of water management structures (including the management of water during the decommissioning process) as part of any future update of the Site Water Management Plan.	Complete. A high level discussion was added to the SWMP, consistent with the MOP.

No.	Recommendation	Action Plan Progress
18	Update GWMP to include Montrose Dam prior to its construction.	The timing for the construction of Montrose Dam is to be confirmed. Montrose Dam will be added to the GWMP prior to construction.
19	Consideration should be made to directly monitor the quality of groundwater seepage reporting to the underground and open-cut workings	HydroSimulations will consider this recommendation in 2018.
20	Offset area E is required to be secured under a conservation agreement by December 2017 and included in the BioMP and MOP. A draft has been sent to OEH. This should aim to finalise by the due date.	WCPL contacted OEH and were advised in March 2019 that the agreements have been approved by the Biodiversity Conservation Trust and will be forwarded to WCPL for signing.
21	Recommend that identification of '*Acacia anuera'* is finalised and amended in the development consent to *Acacia pendula* at next modification, if required.	*Acacia anuera* was identified to most likely be *Acacia pendula* in 2004. Further investigations were undertaken in 2006 and 2008 with no conclusive identification of the species. WCPL follows the precautionary approach and treats the species as *Acacia pendula* due to its listing in the TSC Act and EPBC Act. Further investigations will be conducted during flowering season, to conclusively identify the species. The current consent condition references the *Acacia anuera* community identified in the 2003 EIS. WCPL will consider amending the development consent once further investigations re carried out.
22	Seek to recover this contribution if regulators confirm that it has not been expended, or if it has, seek the documented outcome of the Trust Fund.	Payment of $50,000 was made to the Hunter Aboriginal Cultural Heritage Trust Fund on 7 November 2005. WCPL will seek to recover this contribution.
23	Aerial on page 8 of the induction should be updated to be current.	A copy of the 2017 aerial has been provided for the induction.
24	Site 3 and site 9 non-indigenous heritage items should be identified in the field. Then correspondence as required in the condition should occur to close out this item.	Site 3 is identified as abandoned Homestead A and Site 9 is abandoned Tractor. An assessment will be made as to the significance of these items and as to whether they are moveable. This information will be documented in the next review of the Cultural Heritage Management Plan, scheduled for 2018. Correspondence has been drafted to the Power House Museum to and will be forwarded in 2019.
25	Provide a more recent notification to owners of private residences of right to visual mitigation under consent condition.	Condition 83, Schedule 4 of DA305-7-2003 requires '*if a landowner of any dwelling assessed as having a high potential visual impact requests in writing.. to investigate ways to minimise the visual impact of the development on his/her dwelling…*' Table 4.4 in the EIS identifies Holt, Moses, Muller and Fenwick and subsequent text includes Skinner and Long as residences with high visual impacts. Fenwick and Muller are the only properties that remain privately owned. Correspondence will be sent to these landowners to advise of their rights under Condition 83, Schedule 4 by 30 June 2018.

No.	Recommendation	Action Plan Progress
26	The Annual Review for 2016 reports 6 lighting complaints for the period however only 5 are reported in the register. Recommend that all complaints are reported correctly in future.	Noted.
27	Woodland corridors in the RL 160 dump areas are developed further to join the existing areas and the MOP is amended at next review to show proposed and defined corridors.	The establishment of woodland corridors is an important component of the biodiversity and offset strategy. MOP Plan 2 (*Mine Domains at Commencement of MOP*) shows the rehabilitation corridors.
28	Notification to landowners of the publication of management documents and monitoring results on the website is updated at regular intervals (suggested 4-5 yearly).	Agreed.
29	Once the revised Environmental Management Strategy is approved it must be sent to the relevant agencies, Council and CCC within 14 days.	Agreed.
DA177-8-2004 Non-compliance Recommendations		
30	Correspondence should be sought from NSW Roads and Maritime Services confirming that upgrades to the Golden Highway/Wallaby Scrub Road intersection are not required.	Mt Thorley Warkworth (MTW) has received DPE approval to mine through Wallaby Scrub Road. There has been ongoing correspondence between WCPL and NSW Roads and Maritime Services on this issue which will be finalised once MTW plans are known.
DA177-8-2004 Continual Improvement Recommendations		
31	No evidence of reporting on measures to minimise loading outside specified hours to DPE's approval. Recommended that a summary of train movement times is added to future Annual Reviews.	A summary of train movement times will be considered in the next Annual Review.
32	Reviewed the Australian Rail Track Corporation EPL 3142 and email from Matt Pearce of Aurizon dated 12/09/13. Email confirms that locomotives are required to be tested by the rail operator for compliance with noise requirements. Recommend that this is updated to remain contemporary.	WCPL tried unsuccessfully to have this correspondence updated with the Australian Rail Track Corporation, prior to the audit in 2017. Another attempt will be made to satisfy this condition.
33	Recommend this condition is revised to remove at next modification.	This condition relates to minimising road safety impacts from train headlight glare on motorists. Audit confirms screening is in place and that no complaints or incidents occurred as a result of rail loop lighting. WCPL will investigate removing this condition during the next modification (not in the Modification currently being assessed).

No.	Recommendation	Action Plan Progress
34	Confirmation from DPE should be sought in future to confirm this condition is not required to be triggered.	The AQGGMP (Version 7, currently with DPE for approval) contains a Landowner Notification Procedure as Appendix D. Section 4.6.1 of the Noise Management Plan addresses Landowner Notification. WCPL will consider this requirement and seek confirmation from DPE if deemed necessary.
Other		
35	It is recommended that the road drain outside the coal stockpile perimeter collection drainage network be de-silted and monitored to confirm whether the flow direction of the drain is adequate.	Complete. WCPL has engaged consultants to review catchment drainage and boundaries and assess the efficiency of drains and sediment dams in each catchment. Any sediment dams or road drains identified to be undersized or in need of de-silting (including the Gordon Below Franklin Dam) will be actioned appropriately.
36	It is recommended that accumulated sediment is removed from the Gordon Below Franklin where necessary in order to reinstate the design/operating storage capacity.	

10.0 Incidents and Non-compliances during the Reporting Period

No incidents were identified by WCPL during the reporting period.

The following non-compliances were recorded against EPL529 and DA305-7-2003 (refer **Statement of Compliance** at the front of this document):

- Exceedances of the night-time noise impact assessment criteria (**Section 10.1**).
- Failure to continuously monitor PM_{10} levels at three sites (**Section 10.2**).
- Monitoring frequency of meteorological data was 10 minutes, as opposed to 15 minutes (**Section 10.3**).
- Failure to finalise VCA's by the end of December 2017 (**Section 10.4**).
- First quarter service of Sewage Treatment Plant was not conducted (**Section 10.5**).
- Failure to collect surface water samples at SW28 due to access issues (**Section 10.6**).
- Failure to notify the Department of Environment and Energy of the commencement of the Action relating to EPBC 2016/7816 (**Section 10.7**).

In addition to the above, DPE and EPA requested detailed reports on WCPL operations following the receipt of a number of complaints during the reporting period. On each occasion, WCPL conducted a review of relevant monitoring data and operational activities at the time of the complaint and provided a summary to DPE and/or EPA (**Section 10.8**).

10.1 Night-time Noise Impact Assessment Criteria

During the reporting period, WCPL complied with all statutory noise conditions and requirements detailed in the WCPL NMP, with the exception of the night-time noise impact assessment criteria.

Operator-attended monitoring during the reporting period was undertaken in accordance with the WCPL NMP. **Table 45** considers the relevant criteria and identifies exceedances of the night-time noise impact assessment criteria as measured by Global Acoustics (2019).

The results obtained by Global Acoustics (2019) were considered in accordance with the WCPL NMP, Development Consent and Environment Protection Licence. During the reporting period:

- Six exceedances of Condition 6, Schedule 4 of DA305-7-2003 were identified during the reporting period, however, only the results for $L_{Aeq,15minute}$ on 5 April 2018 were considered to be both sustained and greater than negligible.
- While the measured noise levels exceeded the noise impact assessment criteria on five other occasions (17 May, 20 June, 5 September and at two locations on 17 December 2018), these exceedances were either not sustained, and/or, in accordance with the NSW EPA Noise Policy for Industry (EPA 2017), as they were only 1 dB over the criteria, they would be considered negligible (i.e. unlikely to be noticed by residents).
- Two exceedances of Condition L4.1 of EPL529 were identified ($L_{Aeq,15minute}$ on 5 April and 17 December 2018).

As a result of the above, noise exceedance investigations were undertaken and the noise exceedances were recorded as environmental incidents, documented in the Environmental Incident Register and reported to the relevant authorities (i.e. to DPE and EPA).

In April 2018 (following the exceedance of the DA305-7-2003 noise impact assessment criteria on 5 April 2018), WCPL conducted Senior Management training on noise management measures and a review of the effectiveness of alarms associated with the real-time noise monitoring system. This led to a 2 dB reduction of the real-time monitoring noise alarm at the N20 monitor, located between the open cut mining operations and the nearest residences.

Notification of relevant landowners was not completed following the April 2018 exceedance of the noise impact assessment criteria. WCPL considers this to be an administrative non-compliance with Condition 2, Schedule 5 of DA305-7-2003.

Table 45: Key Operator-attended Noise Monitoring Results

Date	Monitoring Location	Relevant Noise Impact Assessment Criteria	Recorded Noise Level	Low Frequency Noise Penalty Applied?[1]	Remeasurement Over Criteria?	Follow Up Measurement Over Criteria (i.e. sustained)?[2]	EPL Meteorological Conditions Applicable?[3]	EPL Noise Impact Assessment Criteria Exceeded?	Development Consent Meteorological Conditions Applicable?[4]	Development Consent Noise Impact Assessment Criteria Exceeded?[5]
5 April 2018	N26	40 dB ($L_{Aeq,15minute}$)	43 dB ($L_{Aeq,15minute}$)	2 dB ($L_{Aeq,15minute}$)	Yes	Yes	Yes	Yes	Yes	Yes
17 May 2018	N16	40 dB ($L_{Aeq,15minute}$)	41 dB ($L_{Aeq,15minute}$)	N/A	Yes	**No**	No	No	Yes	Yes
20 June 2018	N16	40 dB ($L_{Aeq,15minute}$)	46 dB ($L_{Aeq,15minute}$)	N/A	Yes	**No**	No	No	Yes	Yes
		50 dB ($L_{A1,1minute}$)	65 dB ($L_{A1,1minute}$)	N/A	Yes	**No**	No	No	Yes	Yes
5 September 2018	N16	40 dB ($L_{Aeq,15minute}$)	41 dB ($L_{Aeq,15minute}$)	N/A	No	**No**	No	No	Yes	Yes
		50 dB ($L_{A1,1minute}$)	51 dB ($L_{A1,1minute}$)	N/A	No	**No**	No	No	Yes	Yes
17 December 2018	N16	40 dB ($L_{Aeq,15minute}$)	41 dB ($L_{Aeq,15minute}$)	N/A	No	**No**	No	No	Yes	Yes
17 December 2018	N20A	50 dB ($L_{A1,1minute}$)	51 dB ($L_{A1,1minute}$)	N/A	N/A[6]	N/A[6]	Yes	Yes	Yes	Yes

[1] Noise levels attributed to the Mine by Global Acoustics (2019) have been assessed for the applicability of low-frequency modifying factors in accordance with the NSW EPA Noise Policy for Industry (EPA 2017).

[2] In consideration of the NSW Industrial Noise Policy, WCPL considers an exceedance to be sustained if the initial measurement, remeasurement and follow up measurements are all exceedances of the noise impact assessment criteria.

[3] Condition L4.1 of EPL529 includes similar noise emission limits to those identified in DA305-7-2003. Condition L4.5 of EPL529 specifies that the noise emission limits identified in Condition L4.1 do not apply under meteorological conditions of:

- Wind speeds greater than 3 m/s at 10 metres above the ground level; and/or
- Temperature inversion conditions of greater than 3°C/100 m and wind speeds greater than 2 m/s at 10 metres above the ground.

[4] Under the exemptions of the NSW Industrial Noise Policy, the noise impact assessment criteria in DA305-7-2003 do not apply under meteorological conditions of:

- Wind speeds greater than 3 m/s at 10 metres above ground level;
- During rain; and/or
- Temperature inversion conditions with atmospheric stability class G (i.e. greater than 4°C/100 m).

[5] In consideration of the NSW EPA Noise Policy for Industry (EPA 2017), an exceedance of less than or equal to 2 dB is considered to be negligible (i.e. unlikely to be noticed by residents).

[6] Global Acoustics were unable to complete a remeasurement or follow up measurement on this occasion. WCPL notes the exceedance was negligible.

10.2 PM_{10} Monitoring

During the reporting period a PM_{10} reading was missed seven times.

During these missed events, WCPL's three other PM_{10} monitors captured all data. This equates to a 99% capture rate for the PM_{10} monitoring system. At no point during the monitoring period was more than one monitoring point down. Failure to capture data can be attributed to an intermittent fault with the uninterruptible power supply of the PM03 monitor (January 2018), a storm affecting PM02 (March 2018) and storms affecting PM04 (September and December 2018).

10.3 Meteorological Monitoring

The 2018 EPA Annual Return reported a non-compliance with the requirements of Condition M9.4 of EPL 529. The meteorological station was logging in 10 minute intervals, not in 15 minute intervals as required for the period 1 January to 18 December 2018. This issue has been rectified.

10.4 Conservation Agreement

Condition 41, Schedule 4 of DA305-7-2003 requires that:

> *By the end of December 2017, unless otherwise agreed by the Secretary, the Applicant must:*
>
> *(a) enter into a conservation agreement/s pursuant to section 69B of the* National Parks and Wildlife Act 1974 *covering all offset areas listed in Table 16 (see condition 40) …*
>
> *…*

VCAs for the offset areas were drafted in consultation with the OEH during 2015 and were registered in 2017, in accordance with Condition 41, Schedule 4 of DA305-7-2003. WCPL applied to revise the VCAs to include RWEA E in December 2017.

In February 2018, WCPL requested that DPE approve an extension to the timeframe for entering into a Conservation Agreement as required by Condition 41, Schedule 4 of DA305-7-2003 on the basis that WCPL was in the process of varying the existing VCAs to include RWEA E, however it may take some time for the Biodiversity Conservation Trust to process the variation request. DPE approved the request for an extension to 31 July 2018, based on advice provided by the Biodiversity Conservation Trust that this would be a reasonable completion date.

WCPL contacted OEH and were advised in March 2019 that the agreements have been approved by the Biodiversity Conservation Trust and will be forwarded to WCPL for signing.

10.5 Sewage Treatment Plant Service

Condition O2.4 of EPL 529 requires a quarterly service to be completed at the sewage treatment plant. The first quarter service was not conducted between January and March 2018, however four services were conducted for the year. There are no known adverse effects from the missed service.

10.6 Surface Water Sampling at SW28

Surface water samples were unable to be collected at SW28 (Stoney Creek) on three occasions in 2018 as the surface water sampling contractor advised that access was unsafe following wet weather.

10.7 Notification of Commencement of the Action under EPBC 2016/7816

Condition 2 of EPBC 2016/7816 requires that:

> 2. *Within 30* ***days*** *after the* ***commencement of the action****, the person taking the action must advise the* ***Department*** *in writing of the actual date of* ***commencement of the action****.*

WCPL have provided a notification to the Department of the Environment and Energy of the actual date of commencement of the Action (3 December 2018), however this was not completed within 30 days of the commencement of the action.

10.8 Requests for Information

During the reporting period, DPE and EPA made a number of requests for information relating to complaints received as a result of WCPL operations (**Section 8.3**).

A summary of the information requests, relevant complaints and actions taken is provided in **Table 46**.

Table 46: DPE and EPA Requests for Information

Date of Complaint or Event	Relevant Agency	Comment
General		
22 January	DPE	On 22 January 2018, WCPL received correspondence from DPE requesting a summary of the complaints received over the previous month from a landholder. WCPL provided the requested information on 29 January 2018, including details of further correspondence that was not directly related to a specific complaint.
Noise		
5 April	EPA	On 1 June 2018, WCPL received a notice from the EPA to provide information and/or records relating to a noise exceedance on 5 April 2018 (identified through attended monitoring and self-reported to the EPA by WCPL on 12 April 2018). WCPL provided the requested information to EPA on 22 June 2018.
6 and 7 May 6 June	DPE DPE	On 5 June 2018, WCPL received a request from DPE for additional information relating to a noise complaint for 6 and 7 May 2018. On 29 June 2018, WCPL provided DPE with further information relating to this noise complaint and also included further information relating to a complaint made on 6 June 2018. The reports included: • Results from the real time noise monitoring network (recorded every 15 minutes). • Review of audio recordings to interpret contributing noise sources at the time of the complaint. • Results from the meteorological station (recorded every 15 minutes). • Operational activities (e.g. locations of active excavators/dozers, blasting times). • Management activities (e.g. shutdown or relocation of equipment, recent communications at pre-start meetings, planning).
20 June	EPA	On 26 June 2018, WCPL received a request from the EPA for additional information relating to a noise exceedance on 20 June 2018. The report included: • A plan of the premises with the location of each plant operating during the period of both exceedances on 20 and 21 June 2018. • A printout of the noise model for the periods of both exceedances on 20 and 21 June 2018 highlighting potential noise affected areas, and potential areas within the premises that would be likely to be generating noise. • The real time noise monitoring results for the hour before and hour after each exceedance and a table of 15 min averages. • A description of what noise assessment group the attended monitoring point N16 relates to in the Licence. WCPL provided the requested information to EPA and DPE.

Date of Complaint or Event	Relevant Agency	Comment
Dust		
6 December	DPE	On 7 December 2018, WCPL received email correspondence from DPE regarding a dust complaint (regarding visible dust). The complaint details 'excessive dust seen from a digger loading trucks' at WCPL at approximately 18:15 on 6 December 2018. Following the request for further information, WCPL undertook a detailed review of monitoring data and operations at the time of the event including: • Results from the meteorological station (recorded every 15 minutes). • Operational activities (e.g. locations of active excavators/dozers, blasting times). • Management activities (e.g. shutdown or relocation of equipment, recent communications at pre-start meetings, planning). The results of the review were reported to DPE on 14 December 2018.
Blasting		
9 February	EPA	On 13 February 2018, WCPL received a request from the EPA to provide a report on blasting activities undertaken on 9 February 2018. WCPL did not receive any direct community complaints following the blast event. Following the request for further information, WCPL undertook a detailed review of monitoring data and operations at the time of the event (in accordance with clause R3 of EPL529) including: • The cause, time and duration of the event. • Type, volume and concentration of pollutants discharged. • Name, address and business hours telephone number of employees or agents of the licensee, or a class of them, who witnessed the event. • The name, address and business hours telephone number of every other person (of whom the licensee is aware) who witnessed the event, unless the licensee has been unable to obtain that information after making reasonable effort. • Action taken by the licensee in relation to the event, including any follow up contact with any complainants. • Details of any measure taken or proposed to be taken to prevent or mitigate against a recurrence of such an event. • Any other relevant matters. • PM_{10} 10 minute averages for the relevant period. • Blast monitoring results. • Video footage of the event. • Wind conditions prior to blasting and modelling. • Trajectory of any dust and fume from both blasts and cumulative impacts of the blasts. • Gas monitoring results on or off the WCPL premises. • Location of the blast. The results of the information request were reported to the EPA on 2 March 2018.

11.0 Activities to be Reported in the next Reporting Period

The following activities will be undertaken and reported on by WCPL during the next reporting period:

- the Conservation Management Plan (European) will be submitted for approval;
- WCPL will address any comments received from Singleton Shire Council or the NSW RFS on the Bushfire Management Plan and provide the updated plan to DPE for approval;
- the CMCP will be submitted to the NSW Resources Regulator and other relevant stakeholders within six months of the determination of the United Wambo Open Cut Coal Mine Project (MOD16);
- the remaining 11 exploration holes will be inspected as part of the comprehensive rehabilitation program scheduled for commencement in March-April 2019;
- an Independent Noise Review will be undertaken as requested by a landowner (located on Redmonvale Road, Jerrys Plans);
- a description of subsidence remediation activities that are undertaken in areas overlying Longwalls 11 to 16 at the South Bates Underground Mine will be provided;
- an update on the comprehensive rehabilitation project of exploration sites scheduled to be undertaken in March and April 2019;
- a HRSTS system audit will be undertaken if discharges through the HRSTS occur during the next reporting period;
- the NWCD Plan will be revised and submitted to DPE for approval in April 2019. Within three months of approval of the NWCD Plan, the Action Plan will be incorporated into the MOP as an appendix; and
- WCPL will notify NSW Land Registry Services of the approval issued by WaterNSW to consolidate six WALs on 20 December 2018.

Where required, updated management plans and strategies will be submitted to relevant government authorities for approval and uploaded to the WCPL website.

12.0 References

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- Resource Strategies, 2003. *Wambo Development Project Environmental Impact Statement.* Prepared for Wambo Coal Pty Ltd. July 2003.
- Rural & Environmental Management Pty Ltd, 2018. *Wambo Coal Spring Vertebrate Pest Management Report: For Vertebrate Pest Management undertaken between 13 September to 28 September 2018*. Report prepared for Wambo Coal Pty Ltd. November 2018.
- Rural & Environmental Management Pty Ltd, 2019. *Weed Management Services 2018 Summary.* Report prepared for Wambo Coal Pty Ltd. January 2019.
- SLR Consulting Pty Ltd, 2018. *Wambo Bi-annual Subsidence Survey*. 7 December 2018.
- Terras Landscape Architects, 2017. *Visual Mitigation Report Wambo Coal – Montrose East Pit*. Report prepared February 2017.

APPENDIX A

APPROVAL CONDITIONS SPECIFICALLY RELATING TO THE ANNUAL REVIEW

Approval	Condition	Description	Where addressed in Annual Review
DA305-7-2003	Condition 25, Schedule 4	Each year, the Applicant must: (a) review the site water balance for the development against the predictions in the EIS; (b) re-calculate the site water balance for the development; (c) assess current and forecast compliance with the rules of the Hunter River Salinity Trading Scheme; and (d) report the results in the Annual Review.	Sections 6.3.4 and 6.7
DA305-7-2003	Condition 49, Schedule 4	The Applicant must: (a) review the performance of the Flora and Fauna Management Plan annually, in consultation with the Hunter Coalfield Flora & Fauna Advisory Committee (when established); and (b) revise the document as necessary to take into account any recommendations from the annual review.	Section 5.6
DA305-7-2003	Condition 78, Schedule 4	The Applicant must: (a) keep records of the: - amount of coal transported from the site each year; and - number of coal haulage truck movements generated each day by the development; and (b) include these records in the Annual Review.	Section 3.1
DA305-7-2003	Condition 86, Schedule 4	For the life of the development, the Applicant must: (a) monitor the greenhouse gas emissions generated by the development; (b) investigate ways to reduce greenhouse gas emissions generated by the development; (c) report on greenhouse gas monitoring and abatement measures in the Annual Review, to the satisfaction of the Secretary.	Section 5.4
DA305-7-2003	Condition 88, Schedule 4	For the life of the development, the Applicant must: (a) monitor the amount of waste generated by the development; (b) investigate ways to minimise waste generated by the development; (c) implement reasonable and feasible measures to minimise waste generated by the development; and (d) report on waste management and minimisation in the Annual Review, to the satisfaction of the Secretary.	Section 5.11

Approval	Condition	Description	Where addressed in Annual Review
DA305-7-2003	Condition 5, Schedule 6	By the end of March each year, the Applicant must submit a report to the Department reviewing the environmental performance of the development to the satisfaction of the Secretary. This review must: (a) describe the development (including any rehabilitation) that was carried out in the previous calendar year, and the development that is proposed to be carried out over the current calendar year; (b) include a comprehensive review of the monitoring results and complaints records of the development over the previous calendar year, which includes a comparison of these results against: - the relevant statutory requirements, limits or performance measures/criteria; - the monitoring results of previous years; and - the relevant predictions in the EIS; (c) identify any non-compliance over the previous calendar year, and describe what actions were (or are being) taken to ensure compliance; (d) identify any trends in the monitoring data over the life of the development; (e) identify any discrepancies between the predicted and actual impacts of the development, and analyse the potential cause of any significant discrepancies; and (f) describe what measures will be implemented over the current calendar year to improve the environmental performance of the development.	This Annual Review
DA305-7-2003	Condition 6, Schedule 6	Within 3 months of: (a) the submission of an annual review under Condition 5 above; … the Applicant must review, and if necessary revise, the strategies, plans, and programs required under this consent to the satisfaction of the Secretary.	Section 2.3
DA305-7-2003	Condition 12, Schedule 6	From the end of June 2011, the Applicant shall: (a) make copies of the following publicly available on its website: - … - the annual reviews of the development; - ...; and (b) keep this information up-to-date, to the satisfaction of the Secretary.	Section 1.0

Approval	Condition	Description	Where addressed in Annual Review
DA177-8-2004	Condition 4, Schedule 5	If the independent review determines that any relevant criteria in schedule 4 are being exceeded, but that more than one mine is responsible for this non-compliance, then together with the relevant mine/s, the Applicant shall: (a) implement all reasonable and feasible mitigation measures, in consultation with the landowner and appointed independent person, and conduct further monitoring until there is compliance with the relevant criteria; or (b) secure a written agreement with the landowner and other relevant mines to allow exceedances of the relevant criteria, to the satisfaction of the Director-General. If the independent review determines that any relevant acquisition criteria in schedule 4 are being exceeded, but that more than one mine is responsible for this non-compliance, then upon receiving a written request from the landowner, the Applicant shall acquire all or part of the landowner's land on as equitable a basis as possible with the relevant mine/s, in accordance with the procedures in conditions 6-7 below.	Section 9.6
DA177-8-2004	Condition 4, Schedule 6	Within 1 year of the date of this consent, and annually thereafter, the Applicant shall submit an Annual Review on the development to the Director-General and relevant agencies. This report must: (a) identify the standards and performance measures that apply to the development; (b) include a summary of the complaints received during the last year, and compare this to the complaints received in previous years; (c) include a summary of the monitoring results on the development during the last year; (d) include an accurate record of the amount of product coal transported on the development over the last year on a weekly basis; (e) include an analysis of these monitoring results against the relevant: - impact assessment criteria; - monitoring results from previous years; and - predictions in the SEE; (f) identify any trends in the monitoring over the life of the development; (g) identify any non-compliance during the last year; and, if necessary, (h) describe what actions were, or are being taken, to ensure compliance.	This Annual Review

Approval	Condition	Description	Where addressed in Annual Review
DA177-8-2004	Condition 8, Schedule 6	From 31 May 2012, the Applicant shall: (a) make copies of the following publicly available on its website: … - the annual reviews (over the last 5 years); …; and (b) keep this information up-to-date, to the satisfaction of the Director-General.	Section 1.0
EPBC 2016/7636	Condition 5	The person taking the action must publish a report on their website addressing compliance with each of the conditions of this approval, including implementation of any management plan, program, strategy and review required by condition 1. The reporting period and report publication must comply with conditions 5 and 12 of schedule 6 of the **state development consent**. Documentary evidence providing proof of the date of publication and non-compliance with any of the conditions of this approval must be provided to the **Department** at the same time as the compliance report is published. The person taking the action must continue to publish the report until such time as agreed in writing by the **Minister**.	Appendix I
EPBC 2016/7816	Condition 5	By 31 March of each year after the commencement of the action, the person taking the action must: publish a report on their website addressing compliance with each of the conditions of this approval, including implementation of any management plans and strategies required by conditions 22, 22C, 220 and 23 - 39 of Schedule 4 the state development consent over the previous calendar year; and provide documentary evidence providing proof of the date of publication to the Department, by email to EPBCMonitoring@environment.gov.au (or another email address as stipulated by the Department). The person taking the action must continue publishing annual compliance reports and make all reports available on their website for the life of the approval, unless agreed in writing by the Minister.	Appendix I
S101 Approval (NETD)	Condition h)	The North East Tailings Dam shall be reported on within the Annual Environmental Management Report for Wambo Coal. Consideration shall also be given to the rehabilitation performance for this site.	Sections 7.1.7 and 7.2.2

Approval	Condition	Description	Where addressed in Annual Review
CL365, CL397	Condition 3(f)	(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 the 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); (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.	This Annual Review
CCL743, ML1402	Conditions 4-5	The lease holder must lodge Environmental Management Reports (EMR) with the Director-General annually or at dates otherwise directed by the Director-General. The EMR must: a) report against compliance with the MOP; b) report on progress in respect of rehabilitation completion criteria; c) report on the extent of compliance with regulatory requirements; and d) have regard to any relevant guidelines adopted by the Director-General.	This Annual Review

Approval	Condition	Description	Where addressed in Annual Review
ML1594, ML1572, CL374	Condition 3	(1) Within 12 months of the commencement of mining operations and thereafter annually or, at such other times as may be allowed by the Director-General, the lease holder must lodge an Annual Environmental Management Report (AEMR) with the Director-General. (2) The AEMR must be prepared in accordance with the Director-General's guidelines current at the time of reporting and contain a review and forecast of performance for the preceding and ensuing twelve months in terms of: a) the accepted Mining Operations Plan; b) development consent requirements and conditions; c) Department of Environment and Conservation and Department of Planning licences and approvals; d) any other statutory environmental requirements; e) details of any variations to environmental approvals applicable to the lease area; and f) where relevant, progress towards final rehabilitation objectives. (3) After considering the AEMR the Director-General may, by notice in writing, direct the lease holder to undertake operations, remedial actions or supplementary studies in the manner and within the period specified in the notice to ensure that operations on the lease area are conducted in accordance with sound mining and environmental practice. (4) The lease holder shall, as and when directed by the Minister, co-operate with the Director-General to conduct and facilitate review of the AEMR involving other government agencies and the local council.	This Annual Review
Water Licence 20AL200631, 20AL203044, 20AL201457	Condition 1	The licence holder must provide the Minister with figures recording the quantity of water taken via the nominated water supply works approval, when required to do so, and in the form specified by the Minister.	Section 6.5

Approval	Condition	Description	Where addressed in Annual Review
Water Licence 20WA200632	Condition 9	The account holder must provide the Minister, in the approved form, with the following information when requested: A) A report detailing the quantity of water taken through the authorised work(s) and recorded by the approved measuring device, or where the work does not have a measuring device fitted to it, advise the Minister of the duration of any pumping, and B) Where the water is used for irrigation, the area of land irrigated, the planting date, area and yield of all crops grown on the property for each season. These details must include: i) The volume of water taken from the water source and applied directly to crops and/or pasture; ii) The volume of water taken from the water source and held in on-farm storages; iii) The volume of water taken from on-farm storages and applied to crops (including pasture); iv) The type and area of each crop (including pasture) irrigated; v) The method of irrigation for each class of crop and/or pasture; and vi) The volume of water applied to each individual class of crop and/or pasture.	Section 6.5

APPENDIX B

2018 DAILY TRAIN MOVEMENT SUMMARY

Date	No. Trains per day	Date	No. Trains per Day	Date	No. Trains per Day	Date	No. Trains per Day
1/01/2018	3	20/03/2018	3	22/05/2018	2	13/07/2018	2
2/01/2018	1	21/03/2018	1	23/05/2018	2	16/07/2018	2
4/01/2018	1	23/03/2018	2	24/05/2018	3	17/07/2018	1
5/01/2018	3	25/03/2018	2	25/05/2018	2	18/07/2018	2
6/01/2018	1	26/03/2018	3	26/05/2018	1	19/07/2018	1
11/01/2018	3	27/03/2018	1	27/05/2018	2	20/07/2018	2
13/01/2018	2	28/03/2018	2	28/05/2018	2	21/07/2018	3
17/01/2018	1	29/03/2018	1	29/05/2018	3	22/07/2018	4
19/01/2018	2	1/04/2018	2	30/05/2018	1	27/07/2018	2
20/01/2018	1	2/04/2018	1	31/05/2018	1	28/07/2018	1
21/01/2018	3	3/04/2018	1	1/06/2018	1	29/07/2018	1
22/01/2018	3	5/04/2018	3	3/06/2018	2	30/07/2018	2
26/01/2018	1	13/04/2018	3	4/06/2018	3	3/08/2018	1
29/01/2018	3	14/04/2018	2	5/06/2018	4	4/08/2018	3
30/01/2018	1	15/04/2018	1	6/06/2018	4	5/08/2018	2
31/01/2018	2	16/04/2018	1	7/06/2018	2	6/08/2018	1
9/02/2018	2	17/04/2018	3	12/06/2018	1	7/08/2018	5
10/02/2018	2	18/04/2018	1	13/06/2018	3	9/08/2018	4
13/02/2018	1	19/04/2018	2	14/06/2018	2	10/08/2018	3
15/02/2018	1	20/04/2018	1	16/06/2018	3	11/08/2018	2
17/02/2018	1	21/04/2018	3	17/06/2018	2	12/08/2018	2
19/02/2018	2	26/04/2018	1	18/06/2018	2	13/08/2018	3
23/02/2018	2	30/04/2018	4	19/06/2018	1	14/08/2018	4
24/02/2018	3	1/05/2018	1	20/06/2018	2	15/08/2018	4
25/02/2018	3	2/05/2018	2	22/06/2018	3	16/08/2018	5
26/02/2018	3	3/05/2018	1	23/06/2018	2	17/08/2018	2
27/02/2018	3	4/05/2018	2	24/06/2018	3	20/08/2018	5
28/02/2018	2	5/05/2018	1	25/06/2018	2	21/08/2018	3
1/03/2018	1	6/05/2018	1	26/06/2018	1	22/08/2018	2
2/03/2018	3	7/05/2018	2	27/06/2018	1	23/08/2018	2
3/03/2018	1	8/05/2018	3	28/06/2018	2	27/08/2018	2
6/03/2018	2	10/05/2018	1	29/06/2018	2	28/08/2018	3
7/03/2018	2	11/05/2018	2	30/06/2018	2	29/08/2018	5
8/03/2018	1	12/05/2018	5	1/07/2018	1	30/08/2018	2
10/03/2018	2	13/05/2018	5	2/07/2018	2	4/09/2018	2
11/03/2018	4	14/05/2018	2	2/07/2018	1	5/09/2018	2
12/03/2018	2	15/05/2018	3	3/07/2018	2	6/09/2018	1
13/03/2018	1	16/05/2018	2	5/07/2018	1	8/09/2018	3
14/03/2018	1	17/05/2018	2	7/07/2018	2	10/09/2018	1
15/03/2018	1	18/05/2018	4	9/07/2018	2	11/09/2018	3
16/03/2018	1	19/05/2018	2	10/07/2018	3	12/09/2018	2
18/03/2018	1	20/05/2018	4	11/07/2018	4	14/09/2018	2
19/03/2018	2	21/05/2018	3	12/07/2018	1	15/09/2018	2

Date	No. Trains per day	Date	No. Trains per Day	Date	No. Trains per Day	Date	No. Trains per Day
17/09/2018	2	9/11/2018	1				
20/09/2018	1	14/11/2018	2				
21/09/2018	1	15/11/2018	3				
22/09/2018	5	16/11/2018	1				
24/09/2018	1	18/11/2018	1				
25/09/2018	4	23/11/2018	3				
26/09/2018	3	24/11/2018	2				
27/09/2018	3	25/11/2018	2				
28/09/2018	4	26/11/2018	3				
29/09/2018	1	27/11/2018	4				
30/09/2018	1	28/11/2018	2				
1/10/2018	1	29/11/2018	1				
2/10/2018	1	30/11/2018	4				
3/10/2018	3	1/12/2018	4				
5/10/2018	2	2/12/2018	2				
6/10/2018	4	3/12/2018	3				
7/10/2018	3	4/12/2018	2				
8/10/2018	3	5/12/2018	1				
9/10/2018	1	6/12/2018	2				
10/10/2018	2	7/12/2018	1				
11/10/2018	2	8/12/2018	2				
12/10/2018	1	9/12/2018	2				
13/10/2018	1	10/12/2018	2				
14/10/2018	2	11/12/2018	1				
15/10/2018	3	12/12/2018	2				
16/10/2018	2	14/12/2018	2				
17/10/2018	2	15/12/2018	2				
18/10/2018	3	16/12/2018	2				
19/10/2018	1	17/12/2018	3				
20/10/2018	1	18/12/2018	3				
26/10/2018	2	19/12/2018	1				
27/10/2018	2	20/12/2018	2				
28/10/2018	5	21/12/2018	5				
29/10/2018	3	22/12/2018	2				
30/10/2018	2	23/12/2018	2				
31/10/2018	3	24/12/2018	2				
1/11/2018	1	27/12/2018	2				
2/11/2018	4	28/12/2018	2				
3/11/2018	5	29/12/2018	4				
4/11/2018	3	30/12/2018	4				
5/11/2018	4	31/12/2018	1				
6/11/2018	3						
7/11/2018	1						

APPENDIX C

ANNUAL NOISE MONITORING REPORT

Wambo Coal Mine
Annual Report

Environmental Noise Monitoring
1 January to 31 December 2018

Prepared for
Wambo Coal Pty Limited

Global Acoustics

Noise and Vibration Analysis and Solutions

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Wambo Coal Mine – Annual Report

Environmental Noise Monitoring
1 January to 31 December 2018

Reference: 18426_R01
Report date: 25 February 2019

Prepared for

Wambo Coal Pty Limited
PMB 1
Singleton NSW 2330

Prepared by

Global Acoustics Pty Ltd
PO Box 3115
Thornton NSW 2322

Prepared:	Jesse Tribby Consultant	QA Review:	Tony Welbourne Director

Global Acoustics Pty Ltd ~ Environmental noise modelling and impact assessment ~ Sound power testing ~ Noise control advice ~ Noise and vibration monitoring ~ OHS noise monitoring and advice ~ Expert evidence in Land and Environment and Compensation Courts ~ Architectural acoustics ~ Blasting assessments and monitoring ~ Noise management plans (NMP) ~ Sound level meter and noise logger sales and hire

EXECUTIVE SUMMARY

Global Acoustics was engaged by Wambo Coal Pty Ltd to provide a summary of the monthly environmental noise surveys conducted around Wambo Coal Mine (WCM), and the Wambo Coal Rail Spur (WCRS) from 1 January to 31 December 2018. The mine and spur operate under separate development consents and are monitored separately. However, reporting has been combined in this document.

WCM was granted consent (DA 305-7-2003) in February 2004, which enables the extension of current open cut and underground mining operations. The latest modification to this consent was approved in December 2017.

The WCRS consists of two Development Applications (DA's):

- The Wambo Rail Loop (DA 177-8-2004); and
- The Wambo Rail Line (DA 235/97).

The relevant sections of these consents are reproduced in Appendix A.

The *Wambo Coal Noise Management Plan* (WA-ENV-MNP-503, January 2018) was prepared in accordance with Schedule 4 of both consents. The Noise Monitoring Plan (NMP) indicates that monitoring will be conducted for WCM and WCRS activities, and includes noise criteria to be used for assessment.

Attended environmental noise monitoring described in this report was undertaken at six sites on a one night per month basis during 2018. Noise monitoring for January 2018 was conducted before the NMP was approved, and was only undertaken at four sites in accordance with the previous NMP. The surveys are to quantify and describe the existing acoustic environment around WCM and WCRS and compare results with relevant development consent conditions.

Noise levels from WCM complied with the relevant Project Approval and/or EPL criteria at all sites during 2018 attended monitoring, with the exception of six occasions. The following exceedances of Project Approval and/or EPL criteria were measured during 2018 monitoring:

- On the night of 5/6 April 2018, WCM exceeded the $L_{Aeq,15minute}$ criterion at N26 by 3 dB. A re-measure and follow-up measurement were undertaken with resulting levels above the relevant limits;
- On the night of 17/18 May 2018, WCM exceeded the $L_{Aeq,15minute}$ criterion at N16 by 1 dB. A re-measure was understand with resulting levels above the relevant limits. A follow-up measurement was undertaken with resulting levels below the relevant limits;
- On the night of 20/21 June 2018, WCM exceeded the $L_{Aeq,15minute}$ and $L_{A1,1minute}$ criteria at N16 by 6 and 15 dB, respectively. A re-measure was understand with resulting levels above the relevant limits. A follow-up measurement was undertaken with resulting levels below the relevant limits;
- On the night of 5/6 September 2018, WCM exceeded the $L_{Aeq,15minute}$ and $L_{A1,1minute}$ criteria at N16 both by 1 dB. A re-measure and follow-up measurement were undertaken with resulting levels below the

relevant limits;

- On the night of 17/18 December 2018, WCM exceeded the $L_{Aeq,15minute}$ criterion at N16 by 1 dB. A re-measure and follow-up measurement were undertaken with resulting levels below the relevant limits; and
- On the night of 17/18 December 2018, WCM exceeded $L_{A1,1minute}$ criterion at N20A by 1 dB.

Modifying factors were assessed in accordance with the NPfI. Site-only L_{Aeq} noise levels have been adjusted, where applicable, by low-frequency modifying factors. It is noted that wind speeds and/or temperature inversion conditions were at levels greater than which development consent conditions would apply for WCM activities in some instances.

There were no changes to train refuelling procedures so no monitoring for the WCRS was undertaken during 2018.

Measured site noise levels at location N03 and N16 have shown an upward trend over the past three years for both $L_{Aeq,15minute}$ and $L_{A1,1minute}$ noise levels. There are no significant differences in measured site noise levels at other monitoring locations.

Predicted noise levels from Year 9 WCM Environmental Impact Statement (EIS, 2003) were compared against actual noise levels during 2018. Results of the comparison indicate that meteorological conditions included in the EIS modelled predictions did not regularly occur during attended monitoring. When meteorological conditions were relevant, results show that measured noise levels from WCM were generally within 3 dB of predicted levels at N16. At other locations, measured noise levels from WCM were well under the predicted levels when meteorological conditions were relevant.

Global Acoustics Pty Ltd

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Appendices

1 INTRODUCTION

1.1 Background

Global Acoustics was engaged by Wambo Coal Pty Ltd to provide a summary of the monthly environmental noise surveys conducted around Wambo Coal Mine (WCM), and the Wambo Coal Rail Spur (WCRS) from 1 January to 31 December 2018. The mine and spur operate under separate development consents and are monitored separately. However, reporting has been combined in this document.

Wambo Coal operates both open cut and underground mining operations from their mine at Warkworth, NSW. The open cut operations include use of heavy mobile equipment in open cut pits, on haul roads and on waste rock emplacements. The underground operations have surface facilities. Both operations utilise a coal handling and preparation plant (CHPP) including conveyors, bins and other material-handling infrastructure.

The WCRS is located between Mt Thorley and Warkworth Village, New South Wales (as shown in Figure 1) and includes the following components:

- a product coal stockpile and reclaim area, product coal conveyor, train load-out bin, rail loop and a rail spur from the Wambo Coal Mine to Mount Thorley;
- rail transport of product coal to the market, an intermittent activity that can take place at any time; and
- a locomotive refuelling facility.

A noise survey around both the WCM and the WCRS is required monthly as detailed in the Noise Management Plan (NMP).

The surveys are to quantify and describe the existing acoustic environment around WCM and WCRS and compare results with relevant limits.

1.2 Monitoring Locations & Frequency

Attended environmental noise monitoring described in this report was undertaken at six sites on a one night per month basis during 2018. Noise monitoring for January 2018 was conducted before the NMP was approved, and was only undertaken at four sites in accordance with the previous NMP. Table 1.1 outlines the monitor type and frequency for the noise monitoring locations; attended monitoring locations are shown in Figure 1.

Table 1.1: WAMBO COAL MONITORING LOCATIONS & FREQUENCY

Site Reference	Site Location[3]	Monitor Type	Consent Requirements	Frequency [1]
N01	*Wambo Road Residence*	Attended	Mine & Rail Spur	Monthly
N03	*Kelly Residence*	Real-Time & Attended	Mine & Rail Spur	Continuous & Monthly
N16	*Jerrys Plains Road*	Attended	Mine	Monthly
N20A[4]	*Redmanvale Road Central*	Attended	Mine	Monthly
N20	Redmanvale Road Central	Real-Time	Mine	Continuous
N21[4]	*Wambo South*	Real-Time & Attended	Mine & Rail Spur	Continuous & Monthly
N23[3]	*Redmanvale Road*	Attended	Mine	Monthly
N26[4]	*Redmanvale Road South*	Attended	Mine	Monthly

Notes:

1. *Sourced from the Wambo Coal Noise Monitoring Plan -EMP011, February 2014 and NMP – WA-ENV-MNP-503, January 2018;*
2. *Attended locations are shown in italics;*
3. *Monitoring at this location occurred January 2018 only; and*
4. *Monitoring at this location commenced February 2018.*

Figure 1: WCM Attended Noise Monitoring Sites

1.3 Terminology & Abbreviations

Some definitions of terms and abbreviations, which may be used in this report, are provided in Table 1.2.

Table 1.2: TERMINOLOGY & ABBREVIATIONS

Descriptor	Definition
L_A	The A-weighted root mean squared (RMS) noise level at any instant
L_{Amax}	The maximum A-weighted noise level over a time period or for an event
L_{A1}	The noise level which is exceeded for 1 per cent of the time
$L_{A1,1minute}$	The noise level which is exceeded for 1 per cent of the specified time period of 1 minute
L_{A10}	The noise level which is exceeded for 10 percent of the time, which is approximately the average of the maximum noise levels
L_{A50}	The noise level which is exceeded for 50 per cent of the time
L_{A90}	The level exceeded for 90 percent of the time, which is approximately the average of the minimum noise levels. The L_{A90} level is often referred to as the "background" noise level and is commonly used to determine noise criteria for assessment purposes
L_{Amin}	The minimum A-weighted noise level over a time period or for an event
L_{Aeq}	The average noise energy during a measurement period
dB(A)	Noise level measurement units are decibels (dB). The "A" weighting scale is used to describe human response to noise
SPL	Sound pressure level (SPL), fluctuations in pressure measured as 10 times a logarithmic scale, the reference pressure being 20 micropascals
SEL	Sound exposure level (SEL), the A-weighted noise energy during a measurement period normalised to one second
Hertz (Hz)	Cycles per second, the frequency of fluctuations in pressure, sound is usually a combination of many frequencies together
VTG	Vertical temperature gradient in degrees Celsius per 100 metres altitude. Estimated from wind speed and sigma theta data
SC	Stability Class. Estimated from wind speed and sigma theta data
Day	This is the period 7:00am to 6:00pm
Evening	This is the period 6:00pm to 10:00pm
Night	This is the period 10:00pm to 7:00am

2 DEVELOPMENT CONSENT

2.1 Wambo Coal Mine Development Consent

WCM was granted consent (DA 305-7-2003) in February 2004, which enables the extension of current open cut and underground mining operations. The latest modification to this consent was approved in December 2017. The relevant sections of this modification are reproduced in Appendix A.

The *Wambo Coal Noise Management Plan* (WA-ENV-MNP-503, January 2018) was prepared in accordance with Schedule 4 of both consents. The Noise Monitoring Plan (NMP) indicates that monitoring will be conducted for WCM and WCRS activities and includes noise criteria to be used for assessment.

It should be noted that properties N01 and N03 are subject to acquisition upon request, as detailed in Schedule 4, Condition 1 of DA 305-7-2003. As such, there are no operational noise goals that apply to these properties.

Table 2.1 summarises relevant noise assessment criteria for WCM.

Table 2.1: WAMBO COAL MINE NOISE CRITERIA

Location	Day $L_{Aeq,15minute}$ dB	Evening / Night $L_{Aeq,15minute}$ dB	Night $L_{A1,1minute}$ dB
N01 [1]	NA	NA	NA
N03 [1]	NA	NA	NA
N16	35	40	50
N20A [3]	35	40	50
N21 [3]	35	40	50
N23 [2]	35	38	50
N26 [3]	35	40	50

Notes:

1. *N01 and N03 are acquisition upon request and criteria are NA 'not applicable';*
2. *Monitoring at this location occurred January 2018 only; and*
3. *Monitoring at this location commenced February 2018.*

In accordance with the consent, noise generated by WCM is to be measured in accordance with the relevant requirements, and exemptions (including certain meteorological conditions) of the NSW Industrial Noise Policy.

It has been assumed that in accordance with this requirement, noise limits apply under all conditions except during:

- rain;
- wind speeds (at 10m above ground) greater than 3 m/s; and/or
- atmospheric stability class G.

2.2 EPL Criteria and Weather Conditions

Noise criteria contained in the EPL are consisted with development consent criteria at all monitoring locations.

In accordance with Condition L4.5 of the EPL, noise limits identified in Table 2.1 apply under the following meteorological conditions:

- wind speeds of up to 3m/s at 10 metres above the ground level; or
- temperature inversion conditions of up to 3°C/100m and wind speeds of up to 2m/s at 10 metres above the ground.

2.3 Wambo Coal Rail Spur Development Consent

The WCRS consists of two Development Applications (DA's):

- The Wambo Rail Loop (DA 177-8-2004), modified in February 2012 to include a rail refuelling facility; and
- The Wambo Rail Line (DA 235/97).

The *Wambo Coal Noise Management Plan* (WA-ENV-MNP-503, January 2018) was prepared in accordance with Schedule 4 of both consents. The NMP indicates that monitoring will be conducted for WCRS activities, and the noise levels to be used for assessment. The relevant sections of the consents are reproduced in Appendix A.

Monitoring for noise from rail activities is undertaken at properties numbered N01, N03 and N21 for rail pass-by noise.

It should be noted that properties at N01 and N03 are subject to acquisition upon request, as detailed in Schedule 4, Condition 1 of DA 305-7-2003. As such, there are no operational noise targets that apply directly to these properties.

2.4 Modifying Factors

The EPA 'Noise Policy for Industry' (NPfI, 2017) was approved for use in NSW in October 2017, and supersedes the EPA's Industrial Noise Policy (INP, 2000). Assessment and reporting of modifying factors is to be carried out in accordance with Fact Sheet C of the NPfI.

NPfI modifying factors, as they are applicable to mining noise, are described in more detail below.

2.4.1 Tonality and Intermittent Noise

As defined in the NPfI:

> *Tonal noise contains a prominent frequency and is characterised by a definite pitch.*
>
> *Intermittent noise is noise where the level suddenly drops/increases several times during the assessment period, with a noticeable change in source noise level of at least 5 dB(A); for example, equipment cycling on and off. The intermittency correction is not intended to be applied to changes in noise level due to*

meteorology.

2.4.2 Low-Frequency Noise

As defined in the NPfI:

Low frequency noise is noise with an unbalanced spectrum and containing major components within the low-frequency range (10 – 160 Hz) of the frequency spectrum.

The NPfI contains the current method of assessing low-frequency noise, which is a 2 step process as detailed below:

Measure/assess source contribution C-weighted and A-weighted L_{eq},T levels over the same time period. The low frequency noise modifying factor correction is to be applied where the C-A level is 15 dB or more and:

• where any of the 1/3 octave noise levels in Table C2 are exceeded by ***up to and including*** *5 dB and cannot be mitigated, a 2 dBA positive adjustment to measured A weighted levels applies for the evening/night period; and*

• where any of the 1/3 octave noise levels in Table C2 are exceeded by ***more than*** *5 dB and cannot be mitigated, a 5 dBA positive adjustment to measured A weighted levels applies for the evening/night period and a 2 dBA positive adjustment applies for the daytime period.*

Table C2 and associated notes from the NPfI is reproduced below:

Table C2: One-third octave low-frequency noise thresholds.

Hz/dB(Z)	One-third octave $L_{Zeq,15min}$ threshold level											
Frequency (Hz)	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
dB(Z)	92	89	86	77	69	61	54	50	50	48	48	46	44

Notes:

- dB(Z) = decibel (Z frequency weighted).
- For the assessment of low-frequency noise, care should be taken to select a wind screen that can protect the microphone from wind-induced noise characteristics at least 10 dB below the threshold values in Table C2 for wind speeds up to 5 metres per second. It is likely that high performance larger diameter wind screens (nominally 175 mm) will be required to achieve this performance (Hessler, 2008). In any case, the performance of the wind screen and wind speeds at which data will be excluded needs to be stated.
- Low-frequency noise corrections only apply under the standard and/or noise-enhancing meteorological conditions.
- Where a receiver location has had architectural acoustic treatment applied (including alternative means of mechanical ventilation satisfying the Building Code of Australia) by a proponent, as part of consent requirements or as a private negotiated agreement, alternative external low-frequency noise assessment criteria may be proposed to account for the higher transmission loss of the building façade.
- Measurements should be made between 1.2 and 1.5 metres above ground level unless otherwise approved through a planning instrument (consent/approval) or environment protection licence, and at locations nominated in the development consent or licence.

3 METHODOLOGY

3.1 Overview

Attended monitoring was conducted during the night period in accordance with Australian Standard AS 1055 'Acoustics, Description and Measurement of Environmental Noise' and relevant NSW EPA requirements. The duration of all measurements was 15 minutes. The mine was operating during all monitoring periods.

3.2 Attended Noise Monitoring

Attended monitoring is preferred to the use of noise loggers when determining compliance with prescribed limits as it allows the most accurate determination of the contribution, if any, to measured noise levels by the source of interest, in this case WCM.

If the exact contribution of the source of interest cannot be established, due to masking by other noise sources in a similar frequency range, but site noise levels are observed to be well below (more than 5 dB lower than) any relevant criterion, a maximum estimate of the potential contribution of the site might be made based on other measured site-only noise levels, for example, L_{A10}, L_{A50} or L_{A90}. This is generally expressed as a 'less than' quantity, such as <20 dB or <30 dB.

The terms 'Inaudible' (IA) or 'Not Measurable' (NM) may also be used in this report. When site noise is noted as IA, no site noise was audible at the monitoring location. When site noise is noted as NM, this means some noise was audible but could not be quantified. If site noise was NM due to masking but estimated to be significant in relation to a relevant criterion, we would employ methods as per the NPfI (e.g. measure closer and back calculate) to determine a value for reporting.

All sites noted as NM in this report are due to one or more of the following reasons:

- Site noise levels were extremely low and unlikely, in many cases, to be even noticed;
- Site noise levels were masked by another relatively loud noise source that is characteristic of the environment (e.g. breeze in foliage or continuous road traffic noise) that cannot be eliminated by moving closer; and/or
- It was not feasible or reasonable to employ NPfI methods such as move closer and back calculate. Cases may include, but are not limited to, rough terrain preventing closer measurement, addition/removal of significant source to receiver shielding caused by moving closer, and meteorological conditions where back calculation may not be accurate.

A measurement of $L_{A1,1minute}$ corresponds to the highest noise level generated for 0.6 second during one minute. In practical terms this is the highest noise level emitted from the WCM noise source during the entire measurement period (i.e. the highest level of the worst minute during the 15 minute measurement).

3.3 Meteorological Data

Meteorological data was obtained from the WCM meteorological station; this was logged at 10-minute intervals. Atmospheric parameters include wind speed, wind direction, rainfall and sigma theta. This data allowed correlation of atmospheric parameters and measured noise levels.

When meteorological data is provided in less than 15 minute intervals, an analysis must be conducted to determine the meteorological conditions present for the majority of each measurement period and whether those conditions result in noise criteria being applicable or not.

3.4 Modifying Factors

Years of monitoring have indicated that noise levels from mining operations, particularly those measured at significant distances from the source are relatively continuous and broad spectrum. Given this, noise levels from WCM at the monitoring locations are unlikely to be intermittent or tonal.

Assessment of low-frequency modifying factors is necessary when application of the maximum correction could potentially result in an exceedance of the relevant site-only L_{Aeq} criterion. Low-frequency analysis is therefore undertaken for measurements in this report where:

- meteorological conditions resulted in criteria being applicable;
- contributions from WCM were audible and directly measurable, such that the site-only L_{Aeq} was not “NM” or less than a maximum cut off value (e.g. “<20 dB” or “<30dB”);
- contributions from WCM were within 5 dB of the relevant L_{Aeq} criterion, as 5 dB is the maximum penalty that can be applied by low-frequency modifying factors; and
- WCM was the only low-frequency noise source.

All measurements meeting these conditions were evaluated for possible low-frequency penalty applicability in accordance with the NPfI.

4 RESULTS

4.1 Quarter 1, 2018

4.1.1 Total Noise Levels

Noise levels measured at each location during attended 15-minute surveys are provided in Table 4.1.

Table 4.1: MEASURED NOISE LEVELS – QUARTER 1, 2018[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{A50} dB	L_{Aeq} dB	L_{A90} dB	L_{Amin} dB	L_{Ceq} dB
N01	16/01/2018 22:47	42	31	29	27	27	25	22	47
N03	16/01/2018 23:32	50	47	42	37	39	34	31	52
N16	16/01/2018 22:43	54	47	44	40	41	38	36	58
N23	16/01/2018 22:00	60	50	46	41	42	37	34	58
N01	20/02/2018 23:02	52	31	28	26	27	25	22	49
N03	21/02/2018 00:13	47	42	39	36	37	34	31	64
N16	20/02/2018 22:42	57	47	44	40	41	36	32	59
N20A	20/02/2018 22:32	46	43	40	37	38	34	31	54
N21	20/02/2018 23:33	40	32	28	25	25	22	20	50
N26	20/02/2018 23:23	41	32	28	26	26	24	22	46
N01	08/03/2018 22:28	61	41	33	29	33	28	26	49
N03	09/03/2018 00:34	50	41	38	35	36	34	32	65
N16	08/03/2018 23:38	47	44	41	37	38	34	32	57
N20A	08/03/2018 22:35	43	39	36	33	34	31	28	52
N21	08/03/2018 22:03	53	35	27	24	27	23	21	50
N26	08/03/2018 23:04	39	37	34	31	31	28	26	49

Notes:

1. *Levels in this table are not necessarily the result of activity at WCM or WCRS.*

4.1.2 Low Frequency Noise Assessment

Monitoring locations within the zone of affectation do not have criteria and have not been assessed for low frequency noise content.

For all other measurements, WCM only levels were assessed for the applicability of low-frequency modifying factors in accordance with the EPA's NPfI. Measurements during Quarter 1, 2018 that satisfied the conditions outlined in Section 3.4 are presented in Table 4.2.

Table 4.2: LOW FREQUENCY NOISE MODIFYING FACTOR ASSESSMENT – QUARTER 1, 2018

Location	Start Date and Time	Site Only L_{Aeq} dB	Site Only L_{Ceq} dB[3]	Site Only $L_{Ceq} - L_{Aeq}$ dB[1,3]	Max exceedance of ref spectrum dB [2,3]	Penalty dB
N16	16/01/2018 22:43	39	53	<15	NA	0
N23	16/01/2018 22:00	33	NA	NA	NA	0
N20A	20/02/2018 22:32	38	53	15	Nil	0
N16	08/03/2018 23:38	38	57	19	Nil	0

Notes:

1. *As per NPfI, if $L_{Ceq} - L_{Aeq}$ >= 15 dB further assessment of low frequency noise required as detailed in Section 3.4 of this report;*
2. *As per NPfI, compare measured spectrum against reference spectrum to determine if the low frequency modifying factor is triggered and application of penalty is required; and*
3. *Where it is not possible to determine the site only result due to the presence of other low frequency noise sources occurring during the measurement, or where site only level is 5 dB or more less than criterion, this is noted as NA (not available) and no further assessment has been undertaken.*

As detailed in Table 4.2, no low frequency modifying factors applied and no further analysis of low frequency noise was required.

4.1.3 Wambo Coal Mine Noise

Noise levels generated by activity at Wambo mine are shown in Table 4.3 and Table 4.4, where comparison of measured $L_{Aeq,15}$ minute and $L_{A1,1}$ minute levels for WCM is made with relevant noise criteria.

Table 4.3: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST NOISE CRITERIA – QUARTER 1, 2018

Location	Start Date and Time	Wind Speed m/s	VTG $^{0}C/100m$ [2]	Stability Class	Criterion $L_{Aeq,15min}$ dB	EPL/Consent Criterion Applies? [3]	WCM $L_{Aeq,15min}$ dB [4,5,6]	EPL/Consent Exceedance [7,8]
N01[1]	16/01/2018 22:47	1.8	3.0	F	NA	NA	IA	NA
N03[1]	16/01/2018 23:32	1.7	3.0	F	NA	NA	<30	NA
N16	16/01/2018 22:43	1.8	3.0	F	40	No/Yes	39	NA/Nil
N23	16/01/2018 22:00	4.0	-1.0	D	38	No	33	NA
N01[1]	20/02/2018 23:02	2.4	-1.0	D	Nil	NA	IA	NA
N03[1]	21/02/2018 00:13	1.8	0.5	E	Nil	NA	36	NA
N16	20/02/2018 22:42	2.4	-1.0	D	40	Yes	39	Nil
N20A	20/02/2018 22:32	2.5	-1.0	D	40	Yes	38	Nil
N21	20/02/2018 23:33	2.1	0.5	E	40	No/Yes	25	NA/Nil
N26	20/02/2018 23:23	2.0	0.5	E	40	No/Yes	26	NA/Nil
N01[1]	08/03/2018 22:28	2.0	0.5	E	Nil	NA	IA	NA
N03[1]	09/03/2018 00:34	1.9	0.5	E	Nil	NA	36	NA
N16	08/03/2018 23:38	1.9	0.5	E	40	Yes	38	Nil
N20A	08/03/2018 22:35	2.2	0.5	E	40	No/Yes	33	NA/Nil
N21	08/03/2018 22:03	2.1	3.0	F	40	No/Yes	IA	NA/Nil
N26	08/03/2018 23:04	1.6	0.5	E	40	Yes	30	Nil

Notes:

1. *Monitoring location is within Zone of Affectation, criterion not applicable (NA);*
2. *Vertical temperature gradient (VTG) calculated using sigma theta values according to INP procedures;*
3. *Per the EPL, the noise emission limits identified in the above table apply under meteorological conditions of wind speeds of up to 3 m/s at 10 metres above ground level, or temperature inversion conditions of up to 3ºC/100m, and wind speeds of up to 2 m/s at 10 metres above ground level. Per the Project Approval, the noise emission limits identified in the above table do not apply during rain and/or wind speeds (at 10m above ground) greater than 3 m/s and/or atmospheric stability class G;*
4. *Estimated or measured $L_{A15,minute}$ attributed to WCM;*
5. *NM denotes WCM audible but not measurable, IA denotes inaudible;*
6. *Includes application of low-frequency modifying factors;*
7. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent and so criterion is not applicable, or, there is no applicable criterion; and*
8. *Bold and red text indicate an exceedance of relevant criterion.*

Table 4.4: $L_{A1,1minute}$ GENERATED BY WCM AGAINST NOISE CRITERIA – QUARTER 1, 2018

Location	Start Date and Time	Wind Speed m/s	VTG $^0C/100m$ [2]	Stability Class	Criterion $L_{A1,1min}$ dB	EPL/Consent Criterion Applies? [3]	WCM $L_{A1,1min}$ dB [4,5]	EPL/Consent Exceedance [6,7]
N01[1]	16/01/2018 22:47	1.8	3.0	F	NA	NA	IA	NA
N03[1]	16/01/2018 23:32	1.7	3.0	F	NA	NA	47	NA
N16	16/01/2018 22:43	1.8	3.0	F	50	No/Yes	43	NA/Nil
N23	16/01/2018 22:00	4.0	-1.0	D	50	No	38	NA
N01[1]	20/02/2018 23:02	2.4	-1.0	D	Nil	NA	IA	NA
N03[1]	21/02/2018 00:13	1.8	0.5	E	Nil	NA	45	NA
N16	20/02/2018 22:42	2.4	-1.0	D	50	Yes	48	Nil
N20A	20/02/2018 22:32	2.5	-1.0	D	50	Yes	43	Nil
N21	20/02/2018 23:33	2.1	0.5	E	50	No/Yes	33	NA/Nil
N26	20/02/2018 23:23	2.0	0.5	E	50	No/Yes	32	NA/Nil
N01[1]	08/03/2018 22:28	2.0	0.5	E	Nil	NA	IA	NA
N03[1]	09/03/2018 00:34	1.9	0.5	E	Nil	NA	50	NA
N16	08/03/2018 23:38	1.9	0.5	E	50	Yes	48	Nil
N20A	08/03/2018 22:35	2.2	0.5	E	50	No/Yes	43	NA/Nil
N21	08/03/2018 22:03	2.1	3.0	F	50	No/Yes	IA	NA/Nil
N26	08/03/2018 23:04	1.6	0.5	E	50	Yes	36	Nil

Notes:

1. *Monitoring location is within Zone of Affectation, criterion not applicable (NA);*
2. *Vertical temperature gradient (VTG) calculated using sigma theta values according to INP procedures;*
3. *Per the EPL, the noise emission limits identified in the above table apply under meteorological conditions of wind speeds of up to 3 m/s at 10 metres above ground level, or temperature inversion conditions of up to 3ºC/100m, and wind speeds of up to 2 m/s at 10 metres above ground level. Per the Project Approval, the noise emission limits identified in the above table do not apply during rain and/or wind speeds (at 10m above ground) greater than 3 m/s and/or atmospheric stability class G;*
4. *Estimated or measured $L_{A1,1minute}$ attributed to WCM;*
5. *NM denotes WCM audible but not measurable, IA denotes inaudible;*
6. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent and so criterion is not applicable, or, there is no applicable criterion; and*
7. *Bold and red text indicate an exceedance of relevant criterion.*

4.2 Quarter 2, 2018

4.2.1 Total Noise Levels

Noise levels measured at each location during attended 15-minute surveys are provided in Table 4.5.

Table 4.5: MEASURED NOISE LEVELS – QUARTER 2, 2018[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{A50} dB	L_{Aeq} dB	L_{A90} dB	L_{Amin} dB	L_{Ceq} dB
N01	06/04/2018 00:07	43	34	31	30	30	28	26	52
N03	06/04/2018 01:01	80	68	42	36	56	34	32	64
N16	05/04/2018 23:59	52	48	43	40	41	37	35	59
N20A	05/04/2018 22:48	47	42	40	37	38	34	30	55
N21	06/04/2018 00:39	42	38	36	34	34	31	28	56
N26	05/04/2018 22:12	48	46	43	40	41	37	34	58
N26[2]	05/04/2018 23:23	46	44	42	40	40	38	34	57
N26[3]	10/04/2018 22:00	45	43	41	39	39	37	34	58
N01	17/05/2018 22:41	49	35	33	32	32	31	28	54
N03	18/05/2018 00:09	79	70	50	45	56	41	37	67
N16	17/05/2018 23:13	52	46	45	42	42	40	35	55
N16[2]	18/05/2018 00:17	58	43	41	41	41	40	39	57
N16[3]	22/05/2018 22:00	43	34	32	30	30	28	25	54
N20A	17/05/2018 22:05	51	41	39	35	36	32	27	53
N21	17/05/2018 22:05	41	38	36	34	34	33	31	57
N26	17/05/2018 22:38	41	35	31	28	29	26	23	48
N01	21/06/2018 00:18	63	39	35	33	35	31	28	54
N03	20/06/2018 23:42	59	53	45	41	43	37	35	61
N16	20/06/2018 22:54	65	56	49	44	46	39	36	58
N16[2]	21/06/2018 00:06	57	52	48	44	45	41	38	60
N16[3]	27/06/2018 22:39	43	41	39	37	37	36	33	59
N20A	20/06/2018 22:23	41	38	35	32	33	30	28	50
N21	21/06/2018 00:46	53	33	30	28	29	27	24	54
N26	20/06/2018 22:00	40	34	29	26	28	25	23	53

Notes:

1. *Levels in this table are not necessarily the result of activity at WCM or WCRS;*
2. *Re-measure; and*
3. *Follow-up monitoring.*

4.2.2 Low Frequency Noise Assessment

Monitoring locations within the zone of affectation do not have criteria and have not been assessed for low frequency noise content.

For all other measurements, WCM only levels were assessed for the applicability of low-frequency modifying factors in accordance with the EPA's NPfI. Measurements during Quarter 2, 2018 that satisfied the conditions outlined in Section 3.4 are presented in Table 4.6.

Table 4.6: LOW FREQUENCY NOISE MODIFYING FACTOR ASSESSMENT – QUARTER 2, 2018

Location	Start Date and Time	Site Only L_{Aeq} dB	Site Only L_{Ceq} dB[3]	Site Only $L_{Ceq} - L_{Aeq}$ dB[1,3]	Max exceedance of ref spectrum dB[2,3]	Penalty dB
N20A	05/04/2018 22:48	38	55	17	1 dB at 80 Hz	2
N26	05/04/2018 22:12	41	57	16	4 dB at 100 Hz	2
N26[4]	05/04/2018 23:23	40	57	17	4 dB at 100 Hz	2
N26[5]	10/04/2018 22:00	39	56	17	3 dB at 80 Hz	2
N16	17/05/2018 23:13	41	54	13	NA	NA
N16[4]	18/05/2018 00:17	41	55	14	NA	NA
N20A	17/05/2018 22:05	36	52	16	Nil	Nil

Notes:

1. *As per NPfI, if $L_{Ceq} - L_{Aeq}$ >= 15 dB further assessment of low frequency noise required as detailed in Section 3.4 of this report;*
2. *As per NPfI, compare measured spectrum against reference spectrum to determine if the low frequency modifying factor is triggered and application of penalty is required;*
3. *Where it is not possible to determine the site only result due to the presence of other low frequency noise sources occurring during the measurement, or where site only level is 5 dB or more less than criterion, this is noted as NA (not available) and no further assessment has been undertaken;*
4. *Re-measure; and*
5. *Follow-up monitoring.*

As detailed in Table 4.6, low-frequency modifying factors have been applied to results in Table 4.7.

4.2.3 Wambo Coal Mine Noise

Noise levels generated by activity at Wambo mine are shown in Table 4.7 and Table 4.8, where comparison of measured $L_{Aeq,15}$ minute and $L_{A1,1}$ minute levels for WCM is made with relevant noise criteria.

Table 4.7: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST NOISE CRITERIA – QUARTER 2, 2018

Location	Start Date and Time	Wind Speed m/s	VTG $^0C/100m$ [2]	Stability Class	Criterion $L_{Aeq,15min}$ dB	EPL/Consent Criterion Applies? [3]	WCM $L_{Aeq,15min}$ dB [4,5,6]	EPL/Consent Exceedance [7,8]
N01[1]	06/04/2018 00:07	0.7	0.5	E	NA	NA	NM	NA
N03[1]	06/04/2018 01:01	0.3	3.0	F	NA	NA	35	NA
N16	05/04/2018 23:59	0.7	0.5	E	40	Yes	38	Nil
N20A	05/04/2018 22:48	0.1	3.0	F	40	No/Yes	40	NA/Nil
N21	06/04/2018 00:39	0.6	3.0	F	40	No/Yes	34	NA/Nil
N26	05/04/2018 22:12	0.7	-1.0	D	40	Yes	**43**	**3**
N26[9]	05/04/2018 23:23	0.3	0.5	E	40	Yes	**42**	**2**
N26[10]	10/04/2018 22:00	0.8	-1.0	D	40	Yes	**41**	**1**
N01[1]	17/05/2018 22:41	0.3	3.0	F	NA	NA	<30	NA
N03[1]	18/05/2018 00:09	0.1	3.0	F	NA	NA	45	NA
N16	17/05/2018 23:13	0.4	3.0	F	40	No/Yes	**41**	NA/**1**
N16[9]	18/05/2018 00:17	0.1	3.0	F	40	No/Yes	**41**	NA/**1**
N16[10]	22/05/2018 22:00	0.8	0.5	E	40	Yes	IA	Nil
N20A	17/05/2018 22:05	0.8	0.5	E	40	Yes	36	Nil
N21	17/05/2018 22:05	0.8	0.5	E	40	Yes	34	Nil
N26	17/05/2018 22:38	0.3	3.0	F	40	No/Yes	29	NA/Nil
N01[1]	21/06/2018 00:18	0.4	3.0	F	NA	NA	IA	NA
N03[1]	20/06/2018 23:42	0.9	3.0	F	NA	NA	39	NA
N16	20/06/2018 22:54	0.8	3.0	F	40	No/Yes	**46**	NA/**6**
N16[9]	21/06/2018 00:06	0.2	3.0	F	40	No/Yes	**45**	NA/**5**
N16[10]	27/06/2018 22:39	1.5	-2.0	A	40	Yes	<35	Nil
N20A	20/06/2018 22:23	1.6	-1.0	D	40	Yes	32	Nil
N21	21/06/2018 00:46	0.6	3.0	F	40	No/Yes	IA	NA/Nil
N26	20/06/2018 22:00	1.3	-1.0	D	40	Yes	26	Nil

Notes:

1. *Monitoring location is within Zone of Affectation, criterion not applicable (NA);*
2. *Vertical temperature gradient (VTG) calculated using sigma theta values according to INP procedures;*
3. *Per the EPL, the noise emission limits identified in the above table apply under meteorological conditions of wind speeds of up to 3 m/s at 10 metres above ground level, or temperature inversion conditions of up to 3ºC/100m, and wind speeds of up to 2 m/s at 10 metres above ground level. Per the Project Approval, the noise emission limits identified in the above table do not apply during rain and/or wind speeds (at 10m above ground) greater than 3 m/s and/or atmospheric stability class G;*
4. *Estimated or measured $L_{A15,minute}$ attributed to WCM;*
5. *NM denotes WCM audible but not measurable, IA denotes inaudible;*
6. *Includes application of low-frequency modifying factors;*
7. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent and so criterion is not applicable, or, there is no applicable criterion;*
8. *Bold and red text indicate an exceedance of relevant criterion;*
9. *Re-measure; and*
10. *Follow-up monitoring.*

Table 4.8: $L_{A1,1minute}$ GENERATED BY WCM AGAINST NOISE CRITERIA – QUARTER 2, 2018

Location	Start Date and Time	Wind Speed m/s	VTG $^{0}C/100m$ [2]	Stability Class	Criterion $L_{A1,1min}$ dB	EPL/Consent Criterion Applies? [3]	WCM $L_{A1,1min}$ dB [4,5]	EPL/Consent Exceedance [6,7]
N01[1]	06/04/2018 00:07	0.7	0.5	E	NA	NA	NM	NA
N03[1]	06/04/2018 01:01	0.3	3.0	F	NA	NA	38	NA
N16	05/04/2018 23:59	0.7	0.5	E	50	Yes	43	Nil
N20A	05/04/2018 22:48	0.1	3.0	F	50	No/Yes	47	NA/Nil
N21	06/04/2018 00:39	0.6	3.0	F	50	No/Yes	38	NA/Nil
N26	05/04/2018 22:12	0.7	-1.0	D	50	Yes	48	Nil
N26[8]	05/04/2018 23:23	0.3	0.5	E	50	Yes	46	Nil
N26[9]	10/04/2018 22:00	0.8	-1.0	D	50	Yes	45	Nil
N01[1]	17/05/2018 22:41	0.3	3.0	F	NA	NA	34	NA
N03[1]	18/05/2018 00:09	0.1	3.0	F	NA	NA	50	NA
N16	17/05/2018 23:13	0.4	3.0	F	50	No/Yes	46	NA/Nil
N16[8]	18/05/2018 00:17	0.1	3.0	F	50	No/Yes	43	NA/Nil
N16[9]	22/05/2018 22:00	0.8	0.5	E	50	Yes	IA	Nil
N20A	17/05/2018 22:05	0.8	0.5	E	50	Yes	46	Nil
N21	17/05/2018 22:05	0.8	0.5	E	50	Yes	41	Nil
N26	17/05/2018 22:38	0.3	3.0	F	50	No/Yes	33	NA/Nil
N01[1]	21/06/2018 00:18	0.4	3.0	F	NA	NA	IA	NA
N03[1]	20/06/2018 23:42	0.9	3.0	F	NA	NA	41	NA
N16	20/06/2018 22:54	0.8	3.0	F	50	No/Yes	**65**	NA/**15**
N16[8]	21/06/2018 00:06	0.2	3.0	F	50	No/Yes	**57**	NA/**7**
N16[9]	27/06/2018 22:39	1.5	-2.0	A	50	Yes	40	Nil
N20A	20/06/2018 22:23	1.6	-1.0	D	50	Yes	41	Nil
N21	21/06/2018 00:46	0.6	3.0	F	50	No/Yes	IA	NA/Nil
N26	20/06/2018 22:00	1.3	-1.0	D	50	Yes	38	Nil

Notes:

1. *Monitoring location is within Zone of Affectation, criterion not applicable (NA);*
2. *Vertical temperature gradient (VTG) calculated using sigma theta values according to INP procedures;*
3. *Per the EPL, the noise emission limits identified in the above table apply under meteorological conditions of wind speeds of up to 3 m/s at 10 metres above ground level, or temperature inversion conditions of up to 3ºC/100m, and wind speeds of up to 2 m/s at 10 metres above ground level. Per the Project Approval, the noise emission limits identified in the above table do not apply during rain and/or wind speeds (at 10m above ground) greater than 3 m/s and/or atmospheric stability class G;*
4. *Estimated or measured $L_{A1,1minute}$ attributed to WCM;*
5. *NM denotes WCM audible but not measurable, IA denotes inaudible;*
6. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent and so criterion is not applicable, or, there is no applicable criterion;*
7. *Bold and red text indicate an exceedance of relevant criterion;*
8. *Re-measure; and*
9. *Follow-up monitoring.*

4.3 Quarter 3, 2018

4.3.1 Total Noise Levels

Noise levels measured at each location during attended 15-minute surveys are provided in Table 4.9.

Table 4.9: MEASURED NOISE LEVELS – QUARTER 3, 2018[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{A50} dB	L_{Aeq} dB	L_{A90} dB	L_{Amin} dB	L_{Ceq} dB
N01	09/07/2018 22:37	41	35	34	33	33	31	29	56
N03	10/07/2018 00:31	60	47	41	37	39	35	32	57
N16	09/07/2018 23:18	45	40	37	33	34	31	29	55
N20A	09/07/2018 22:39	47	46	42	39	40	37	34	58
N21	09/07/2018 22:11	44	35	32	31	31	29	27	55
N26	09/07/2018 22:03	48	42	39	37	38	35	32	58
N01	09/08/2018 22:28	45	39	37	35	36	34	31	57
N03	10/08/2018 01:22	86	58	46	43	58	41	39	65
N16	09/08/2018 22:52	49	39	37	35	36	34	32	56
N20A	10/08/2018 00:11	46	43	42	39	39	36	32	59
N21	09/08/2018 22:00	41	38	36	34	34	33	31	58
N26	10/08/2018 00:42	48	44	41	38	39	36	32	57
N01	05/09/2018 22:33	47	42	40	38	38	37	34	59
N03	06/09/2018 01:21	50	47	45	42	42	38	34	64
N16	05/09/2018 23:59	51	47	44	42	42	40	37	59
N16[2]	06/09/2018 00:48	46	41	40	37	38	35	32	57
N16[3]	11/09/2018 22:20	43	38	36	34	34	32	29	56
N20A	05/09/2018 23:33	44	40	37	36	36	34	31	56
N21	05/09/2018 22:11	45	41	36	34	34	32	29	57
N26	06/09/2018 00:11	42	38	35	33	34	32	29	54

Notes:

1. *Levels in this table are not necessarily the result of activity at WCM or WCRS;*
2. *Re-measure; and*
3. *Follow-up monitoring.*

4.3.2 Low Frequency Noise Assessment

Monitoring locations within the zone of affectation do not have criteria and have not been assessed for low frequency noise content.

For all other measurements, WCM only levels were assessed for the applicability of low-frequency modifying factors in accordance with the EPA's NPfI. Measurements during Quarter 3, 2018 that satisfied the conditions outlined in Section 3.4 are presented in Table 4.10.

Table 4.10: LOW-FREQUENCY NOISE MODIFYING FACTOR ASSESSMENT – QUARTER 3, 2018

Location	Start Date and Time	Site Only L_{Aeq} dB	Site Only L_{Ceq} dB[3]	Site Only $L_{Ceq} - L_{Aeq}$ dB[1,3]	Max exceedance of ref spectrum dB[2,3]	Penalty dB
N26	09/07/2018 22:03	37	54	17	2 dB at 80 Hz	2
N20A	10/08/2018 00:11	38	55	17	2 dB at 100 Hz	2
N26	10/08/2018 00:42	38	54	16	Nil	Nil

Notes:

1. *As per NPfI, if $L_{Ceq} - L_{Aeq}$ >= 15 dB further assessment of low frequency noise required as detailed in Section 3.4 of this report;*
2. *As per NPfI, compare measured spectrum against reference spectrum to determine if the low frequency modifying factor is triggered and application of penalty is required; and*
3. *Where it is not possible to determine the site only result due to the presence of other low frequency noise sources occurring during the measurement, or where site only level is 5 dB or more less than criterion, this is noted as NA (not available) and no further assessment has been undertaken.*

As detailed in Table 4.10, no low frequency modifying factors applied and no further analysis of low frequency noise was required.

4.3.3 Wambo Coal Mine Noise

Noise levels generated by activity at Wambo mine are shown in Table 4.11 and Table 4.12, where comparison of measured $L_{Aeq,15}$ minute and $L_{A1,1}$ minute levels for WCM is made with relevant noise criteria.

Table 4.11: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST NOISE CRITERIA – QUARTER 3, 2018

Location	Start Date and Time	Wind Speed m/s	VTG ^{0}C/100m [2]	Stability Class	Criterion $L_{Aeq,15min}$ dB	EPL/Consent Criterion Applies? [3]	WCM $L_{Aeq,15min}$ dB [4,5,6]	EPL/Consent Exceedance [7,8]
N01[1]	09/07/2018 22:37	0.2	3.0	F	NA	NA	IA	NA
N03[1]	10/07/2018 00:31	0.8	0.5	E	NA	NA	36	NA
N16	09/07/2018 23:18	0.5	3.0	F	40	No/Yes	30	NA/Nil
N20A	09/07/2018 22:39	0.2	3.0	F	40	No/Yes	38	NA/Nil
N21	09/07/2018 22:11	0.8	0.5	E	40	Yes	<30	Nil
N26	09/07/2018 22:03	0.4	3.0	F	40	No/Yes	39	NA/Nil
N01[1]	09/08/2018 22:28	0.9	-1.0	D	NA	NA	<30	NA
N03[1]	10/08/2018 01:22	0.9	0.5	E	NA	NA	43	NA
N16	09/08/2018 22:52	0.9	0.5	E	40	Yes	34	Nil
N20A	10/08/2018 00:11	0.4	3.0	F	40	No/Yes	40	NA
N21	09/08/2018 22:00	0.9	0.5	E	40	Yes	34	Nil
N26	10/08/2018 00:42	0.8	-1.0	D	40	Yes	38	Nil
N01[1]	05/09/2018 22:33	0.9	3.0	F	NA	NA	36	NA
N03[1]	06/09/2018 01:21	0.7	3.0	F	NA	NA	42	NA
N16	05/09/2018 23:59	0.6	3.0	F	40	No/Yes	**41**	NA/**1**
N16[9]	06/09/2018 00:48	0.9	0.5	E	40	Yes	<35	Nil
N16[10]	11/09/2018 22:20	0.7	-1.0	D	40	Yes	IA	Nil
N20A	05/09/2018 23:33	0.6	3.0	F	40	No/Yes	35	NA/Nil
N21	05/09/2018 22:11	1.0	-1.0	D	40	Yes	34	Nil
N26	06/09/2018 00:11	0.6	0.5	E	40	Yes	34	Nil

Notes:

1. *Monitoring location is within Zone of Affectation, criterion not applicable (NA);*
2. *Vertical temperature gradient (VTG) calculated using sigma theta values according to INP procedures;*
3. *Per the EPL, the noise emission limits identified in the above table apply under meteorological conditions of wind speeds of up to 3 m/s at 10 metres above ground level, or temperature inversion conditions of up to 3ºC/100m, and wind speeds of up to 2 m/s at 10 metres above ground level. Per the Project Approval, the noise emission limits identified in the above table do not apply during rain and/or wind speeds (at 10m above ground) greater than 3 m/s and/or atmospheric stability class G;*
4. *Estimated or measured $L_{A15,minute}$ attributed to WCM;*
5. *NM denotes WCM audible but not measurable, IA denotes inaudible;*
6. *Includes application of low-frequency modifying factors;*
7. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent and so criterion is not applicable, or, there is no applicable criterion;*
8. *Bold and red text indicate an exceedance of relevant criterion;*
9. *Re-measure; and*

10. *Follow-up monitoring.*

Table 4.12: $L_{A1,1minute}$ GENERATED BY WCM AGAINST NOISE CRITERIA – QUARTER 3, 2018

Location	Start Date and Time	Wind Speed m/s	VTG ^{0}C/100m [2]	Stability Class	Criterion $L_{A1,1min}$ dB	EPL/Consent Criterion Applies? [3]	WCM $L_{A1,1min}$ dB [4,5]	EPL/Consent Exceedance [6,7]
N01[1]	09/07/2018 22:37	0.2	3.0	F	NA	NA	IA	NA
N03[1]	10/07/2018 00:31	0.8	0.5	E	NA	NA	44	NA
N16	09/07/2018 23:18	0.5	3.0	F	50	No/Yes	43	NA/Nil
N20A	09/07/2018 22:39	0.2	3.0	F	50	No/Yes	47	NA/Nil
N21	09/07/2018 22:11	0.8	0.5	E	50	Yes	32	Nil
N26	09/07/2018 22:03	0.4	3.0	F	50	No/Yes	42	NA/Nil
N01[1]	09/08/2018 22:28	0.9	-1.0	D	NA	NA	<30	NA
N03[1]	10/08/2018 01:22	0.9	0.5	E	NA	NA	46	NA
N16	09/08/2018 22:52	0.9	0.5	E	50	Yes	38	Nil
N20A	10/08/2018 00:11	0.4	3.0	F	50	No/Yes	46	NA/Nil
N21	09/08/2018 22:00	0.9	0.5	E	50	Yes	41	Nil
N26	10/08/2018 00:42	0.8	-1.0	D	50	Yes	42	Nil
N01[1]	05/09/2018 22:33	0.9	3.0	F	NA	NA	42	NA
N03[1]	06/09/2018 01:21	0.7	3.0	F	NA	NA	50	NA
N16	05/09/2018 23:59	0.6	3.0	F	50	No/Yes	**51**	NA/**1**
N16[8]	06/09/2018 00:48	0.9	0.5	E	50	Yes	44	Nil
N16[9]	11/09/2018 22:20	0.7	-1.0	D	50	Yes	IA	Nil
N20A	05/09/2018 23:33	0.6	3.0	F	50	No/Yes	39	NA/Nil
N21	05/09/2018 22:11	1.0	-1.0	D	50	Yes	42	Nil
N26	06/09/2018 00:11	0.6	0.5	E	50	Yes	39	Nil

Notes:

1. *Monitoring location is within Zone of Affectation, criterion not applicable (NA);*
2. *Vertical temperature gradient (VTG) calculated using sigma theta values according to INP procedures;*
3. *Per the EPL, the noise emission limits identified in the above table apply under meteorological conditions of wind speeds of up to 3 m/s at 10 metres above ground level, or temperature inversion conditions of up to 3ºC/100m, and wind speeds of up to 2 m/s at 10 metres above ground level. Per the Project Approval, the noise emission limits identified in the above table do not apply during rain and/or wind speeds (at 10m above ground) greater than 3 m/s and/or atmospheric stability class G;*
4. *Estimated or measured $L_{A1,1minute}$ attributed to WCM;*
5. *NM denotes WCM audible but not measurable, IA denotes inaudible;*
6. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent and so criterion is not applicable, or, there is no applicable criterion;*
7. *Bold and red text indicate an exceedance of relevant criterion;*
8. *Re-measure; and*
9. *Follow-up monitoring.*

4.4 Quarter 4, 2018

4.4.1 Total Noise Levels

Noise levels measured at each location during attended 15-minute surveys are provided in Table 4.13.

Table 4.13: MEASURED NOISE LEVELS – QUARTER 4, 2018[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{A50} dB	L_{Aeq} dB	L_{A90} dB	L_{Amin} dB	L_{Ceq} dB
N01	11/10/2018 23:19	50	40	36	33	34	32	30	55
N03	12/10/2018 00:05	39	37	35	33	34	31	29	62
N16	11/10/2018 22:59	51	43	40	37	38	35	31	56
N20A	11/10/2018 22:31	41	39	38	36	36	35	32	56
N21	11/10/2018 22:53	46	37	35	34	34	32	30	56
N26	11/10/2018 22:05	48	40	38	35	36	32	30	56
N01	01/11/2018 23:14	54	40	36	34	35	32	30	54
N03	02/11/2018 00:06	54	49	47	45	46	45	43	64
N16	01/11/2018 23:02	49	45	40	37	38	35	33	57
N20A	01/11/2018 22:32	44	38	35	32	33	31	27	53
N21	01/11/2018 22:46	45	42	40	38	38	36	33	58
N26	01/11/2018 22:00	51	41	40	39	39	37	35	55
N01	17/12/2018 22:49	56	44	41	35	37	33	31	57
N03	18/12/2018 00:57	61	56	49	47	48	46	43	64
N16	17/12/2018 23:46	49	46	43	40	41	37	34	59
N16[2]	18/12/2018 00:47	47	45	41	37	38	34	30	55
N16[3]	18/12/2018 22:00	52	49	47	43	44	40	38	66
N20A	17/12/2018 22:23	51	46	43	41	41	39	36	62
N21	17/12/2018 22:11	48	43	38	34	36	32	30	55
N26	17/12/2018 23:09	49	48	48	46	46	44	39	58

Notes:

4. *Levels in this table are not necessarily the result of activity at WCM or WCRS;*
5. *Re-measure; and*
6. *Follow-up monitoring.*

4.4.2 Low Frequency Noise Assessment

Monitoring locations within the zone of affectation do not have criteria and have not been assessed for low frequency noise content.

For all other measurements, WCM only levels were assessed for the applicability of low-frequency modifying factors in accordance with the EPA's NPfI. Measurements during Quarter 4, 2018 that satisfied the conditions outlined in Section 3.4 are presented in Table 4.14.

Table 4.14: LOW FREQUENCY NOISE MODIFYING FACTOR ASSESSMENT – QUARTER 4, 2018

Location	Start Date and Time	Site Only L_{Aeq} dB	Site Only L_{Ceq} dB[3]	Site Only $L_{Ceq} - L_{Aeq}$ dB[1,3]	Max exceedance of ref spectrum dB[2,3]	Penalty dB
N16	01/11/2018 23:02	35	53	18	1 @ 80 Hz	2
N21	01/11/2018 22:46	37	57	20	3 @ 80 Hz	2
N16[4]	18/12/2018 00:47	36	52	16	Nil	Nil

Notes:

1. *As per NPfI, if $L_{Ceq} - L_{Aeq}$ >= 15 dB further assessment of low frequency noise required as detailed in Section 3.4 of this report;*
2. *As per NPfI, compare measured spectrum against reference spectrum to determine if the low frequency modifying factor is triggered and application of penalty is required;*
3. *Where it is not possible to determine the site only result due to the presence of other low frequency noise sources occurring during the measurement, or where site only level is 5 dB or more less than criterion, this is noted as NA (not available) and no further assessment has been undertaken;*
4. *Re-measure; and*
5. *Follow-up monitoring.*

As detailed in Table 4.14, low-frequency modifying factors have been applied to results in Table 4.15.

4.4.3 Wambo Coal Mine Noise

Noise levels generated by activity at Wambo mine are shown in Table 4.15 and Table 4.16, where comparison of measured $L_{Aeq,15}$ minute and $L_{A1,1}$ minute levels for WCM is made with relevant noise criteria.

Table 4.15: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST NOISE CRITERIA – QUARTER 4, 2018

Location	Start Date and Time	Wind Speed m/s	VTG $^{0}C/100m$ [2]	Stability Class	Criterion $L_{Aeq,15min}$ dB	EPL/Consent Criterion Applies? [3]	WCM $L_{Aeq,15min}$ dB [4,5,6]	EPL/Consent Exceedance [7,8]
N01[1]	11/10/2018 23:19	0.8	3.0	F	NA	NA	IA	NA
N03[1]	12/10/2018 00:05	0.7	0.5	E	NA	NA	<30	NA
N16	11/10/2018 22:59	1.4	0.5	E	40	Yes	36	Nil
N20A	11/10/2018 22:31	1.7	0.5	E	40	Yes	35	Nil
N21	11/10/2018 22:53	1.4	0.5	E	40	Yes	<25	Nil
N26	11/10/2018 22:05	1.2	3.0	F	40	No/Yes	33	NA/Nil
N01[1]	01/11/2018 23:14	0.6	-1.0	D	NA	NA	<30	NA
N03[1]	02/11/2018 00:06	0.7	3.0	F	NA	NA	45	NA
N16	01/11/2018 23:02	0.7	0.5	E	40	Yes	37	Nil
N20A	01/11/2018 22:32	0.4	0.5	E	40	Yes	30	Nil
N21	01/11/2018 22:46	0.6	-1.0	D	40	Yes	39	Nil
N26	01/11/2018 22:00	0.1	3.0	F	40	No/Yes	32	NA/Nil
N01	17/12/2018 22:49	0.8	-1.0	D	NA	NA	<30	NA
N03	18/12/2018 00:57	1.1	3.0	F	NA	NA	47	NA
N16	17/12/2018 23:46	0.9	3.0	F	40	No/Yes	**41**	NA/**1**
N16[9]	18/12/2018 00:47	0.9	0.5	E	40	Yes	36	Nil
N16[10]	18/12/2018 22:00	3.1	-1.0	D	40	No	NM	NA
N20A	17/12/2018 22:23	0.9	0.5	E	40	Yes	37	Nil
N21	17/12/2018 22:11	1.3	-1.0	D	40	Yes	32	Nil
N26	17/12/2018 23:09	0.6	3.0	F	40	No/Yes	31	NA/Nil

Notes:

1. *Monitoring location is within Zone of Affectation, criterion not applicable (NA);*
2. *Vertical temperature gradient (VTG) calculated using sigma theta values according to INP procedures;*
3. *Per the EPL, the noise emission limits identified in the above table apply under meteorological conditions of wind speeds of up to 3 m/s at 10 metres above ground level, or temperature inversion conditions of up to 3ºC/100m, and wind speeds of up to 2 m/s at 10 metres above ground level. Per the Project Approval, the noise emission limits identified in the above table do not apply during rain and/or wind speeds (at 10m above ground) greater than 3 m/s and/or atmospheric stability class G;*
4. *Estimated or measured $L_{A15,minute}$ attributed to WCM;*
5. *NM denotes WCM audible but not measurable, IA denotes inaudible;*
6. *Includes application of low-frequency modifying factors;*
7. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent and so criterion is not applicable, or, there is no applicable criterion;*
8. *Bold and red text indicate an exceedance of relevant criterion;*
9. *Re-measure; and*

10. *Follow-up monitoring.*

Table 4.16: $L_{A1,1minute}$ GENERATED BY WCM AGAINST NOISE CRITERIA – QUARTER 4, 2018

Location	Start Date and Time	Wind Speed m/s	VTG $^0C/100m$ [2]	Stability Class	Criterion $L_{A1,1min}$ dB	EPL/Consent Criterion Applies? [3]	WCM $L_{A1,1min}$ dB [4,5]	EPL/Consent Exceedance [6,7]
N01[1]	11/10/2018 23:19	0.8	3.0	F	NA	NA	IA	NA
N03[1]	12/10/2018 00:05	0.7	0.5	E	NA	NA	31	NA
N16	11/10/2018 22:59	1.4	0.5	E	50	Yes	43	Nil
N20A	11/10/2018 22:31	1.7	0.5	E	50	Yes	40	Nil
N21	11/10/2018 22:53	1.4	0.5	E	50	Yes	<25	Nil
N26	11/10/2018 22:05	1.2	3.0	F	50	No/Yes	40	NA/Nil
N01[1]	01/11/2018 23:14	0.6	-1.0	D	NA	NA	<30	NA
N03[1]	02/11/2018 00:06	0.7	3.0	F	NA	NA	47	NA
N16	01/11/2018 23:02	0.7	0.5	E	50	Yes	46	Nil
N20A	01/11/2018 22:32	0.4	0.5	E	50	Yes	34	Nil
N21	01/11/2018 22:46	0.6	-1.0	D	50	Yes	43	Nil
N26	01/11/2018 22:00	0.1	3.0	F	50	No/Yes	34	NA/Nil
N01[1]	17/12/2018 22:49	0.8	-1.0	D	NA	NA	<30	NA
N03[1]	18/12/2018 00:57	1.1	3.0	F	NA	NA	57	NA
N16	17/12/2018 23:46	0.9	3.0	F	50	No/Yes	49	NA/Nil
N16[8]	18/12/2018 00:47	0.9	0.5	E	50	Yes	47	Nil
N16[9]	18/12/2018 22:00	3.1	-1.0	D	50	No	42	NA
N20A	17/12/2018 22:23	0.9	0.5	E	50	Yes	**51**	**1**
N21	17/12/2018 22:11	1.3	-1.0	D	50	Yes	36	Nil
N26	17/12/2018 23:09	0.6	3.0	F	50	No/Yes	37	NA/Nil

Notes:

1. *Monitoring location is within Zone of Affectation, criterion not applicable (NA);*
2. *Vertical temperature gradient (VTG) calculated using sigma theta values according to INP procedures;*
3. *Per the EPL, the noise emission limits identified in the above table apply under meteorological conditions of wind speeds of up to 3 m/s at 10 metres above ground level, or temperature inversion conditions of up to 3ºC/100m, and wind speeds of up to 2 m/s at 10 metres above ground level. Per the Project Approval, the noise emission limits identified in the above table do not apply during rain and/or wind speeds (at 10m above ground) greater than 3 m/s and/or atmospheric stability class G;*
4. *Estimated or measured $L_{A1,1minute}$ attributed to WCM;*
5. *NM denotes WCM audible but not measurable, IA denotes inaudible;*
6. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent and so criterion is not applicable, or, there is no applicable criterion;*
7. *Bold and red text indicate an exceedance of relevant criterion;*
8. *Re-measure; and*
9. *Follow-up monitoring.*

4.5 Review of Site Noise Level Trends

Trends in measured site noise levels incorporating data from start of Quarter 1 2016 to the end of Quarter 4 2018 were reviewed to assess changes in measured $L_{Aeq,15minute}$ and $L_{A1,1minute}$ levels for WCM over the past three years of regular attended monitoring.

As of February 2018, attended noise monitoring ceased at N23 and commenced at N20A, N21, and N26. Trends for these have been provided for informational purposes, but do not represent a three-year perspective.

Figure 2 to Figure 8 display measured $L_{Aeq,15minute}$ and $L_{A1,1minute}$ levels for the four monitoring locations with linear trend lines included to show any changes in data measurements.

It should be noted that for the purpose of graphing data, all measurements that were either inaudible (IA), not measurable (NM), <30 dB or <20 dB have been assigned a value of 0.

4.5.1 N01 – Lambkin

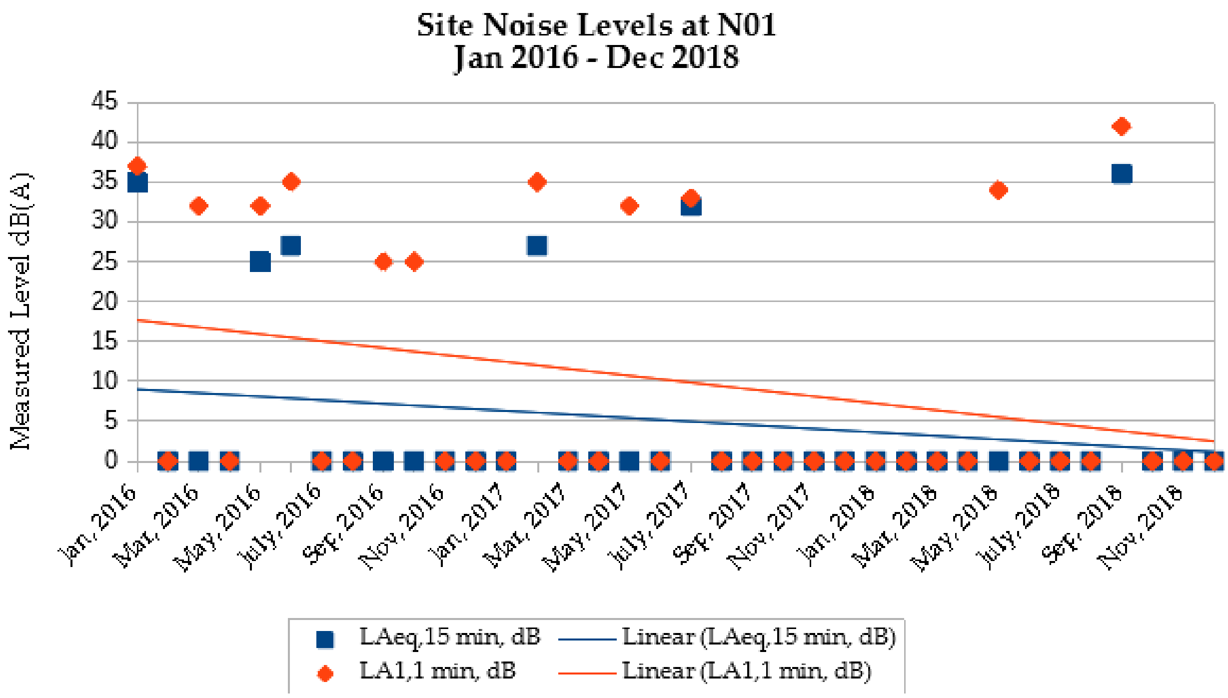

Figure 2: Summary of Measured Site Noise levels, N01 – Lambkin

There are no significant differences in measured site $L_{Aeq,15minute}$ and $L_{A1,1minute}$ noise levels at monitoring location N01 over the 2016 to 2018 period.

Both levels showed a decreasing trend, most likely due to a larger number of inaudible or non-measurable levels in 2018.

4.5.2 N03 – Kelly

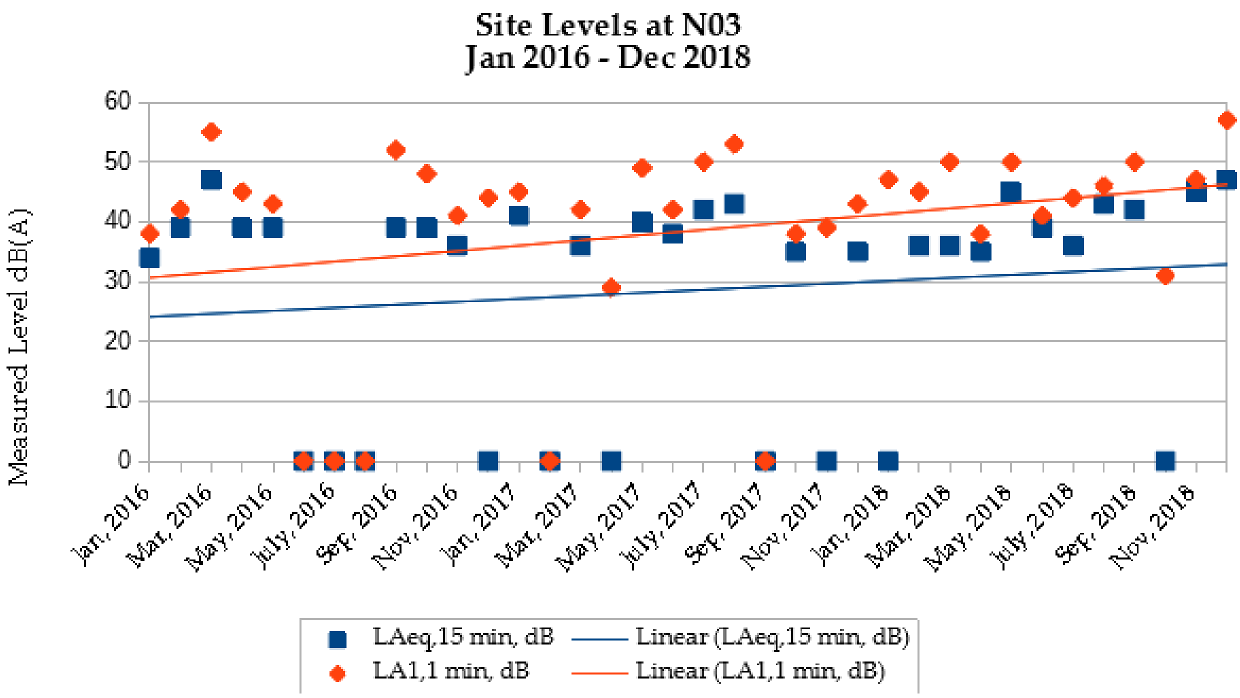

Figure 3: Summary of Measured Site Noise levels, N03 – Kelly

Measured site noise levels at location N03 have shown an upward trend over the past three years for both $L_{Aeq,15minute}$ and $L_{A1,1minute}$ noise levels.

Fewer measurements in 2018 were either inaudible or non-measurable which further reinforced the trend.

4.5.3 N16 – Muller

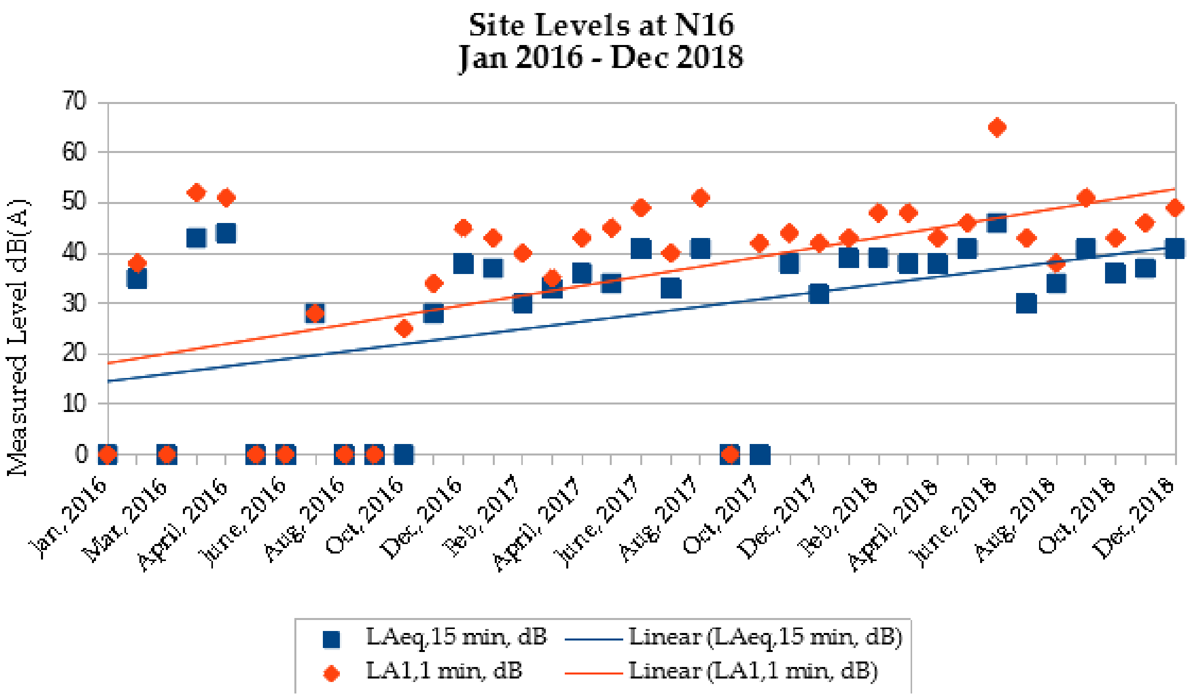

Figure 4: Summary of Measured Site Noise levels, N16 – Muller

Measured site noise levels at location N16 have shown an upward trend over the past three years for both $L_{Aeq,15minute}$ and $L_{A1,1minute}$ noise levels. This can possibly be attributed to N16 being in the direction of pit progression.

No measurements in 2018 were either inaudible or non-measurable which further reinforced the trend.

4.5.4 N20A – Thelander/O'Niell

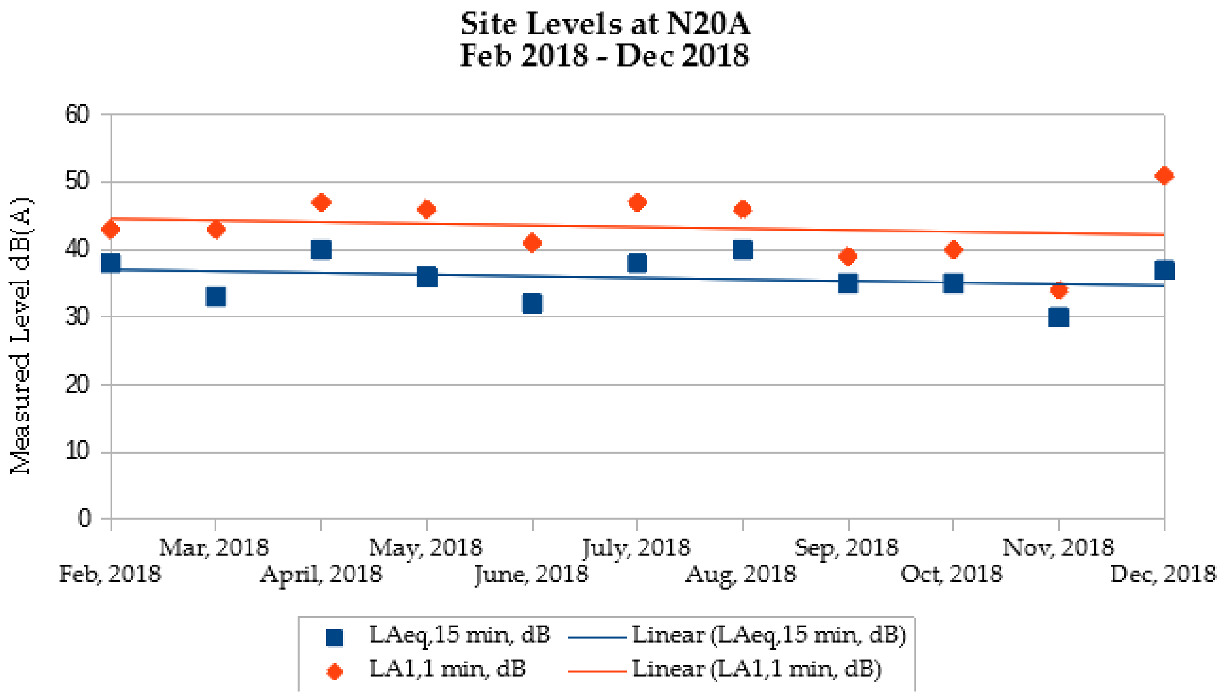

Figure 5: Summary of Measured Site Noise levels, N20A – Thelander/O'Niell

Monitoring at this location commenced in February 2018.

There are no significant differences in measured site noise levels at monitoring location N20A over the 2018 period.

4.5.5 N21 – Fenwick

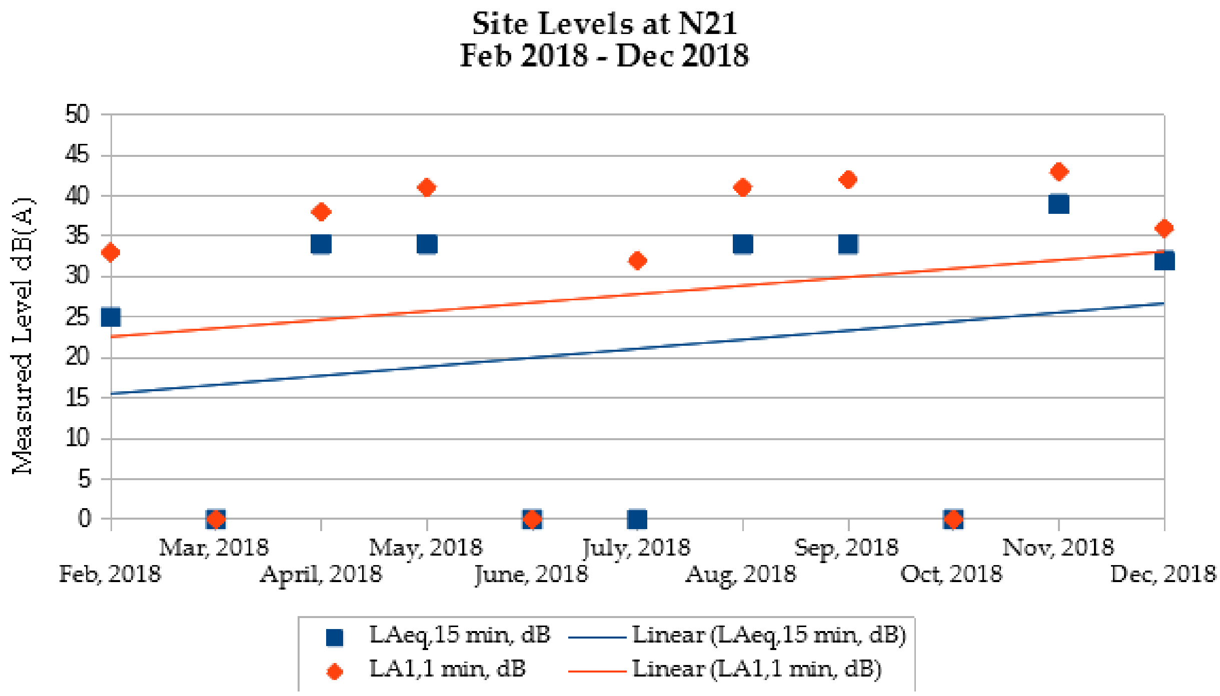

Figure 6: Summary of Measured Site Noise levels, N21 – Fenwick

Monitoring at this location commenced in February 2018.

There are no significant differences in measured site noise levels at monitoring location N21 over the 2018 period.

Due to a large number of non-measurable measurements, the trends are not reliable.

4.5.6 N23 – Carter

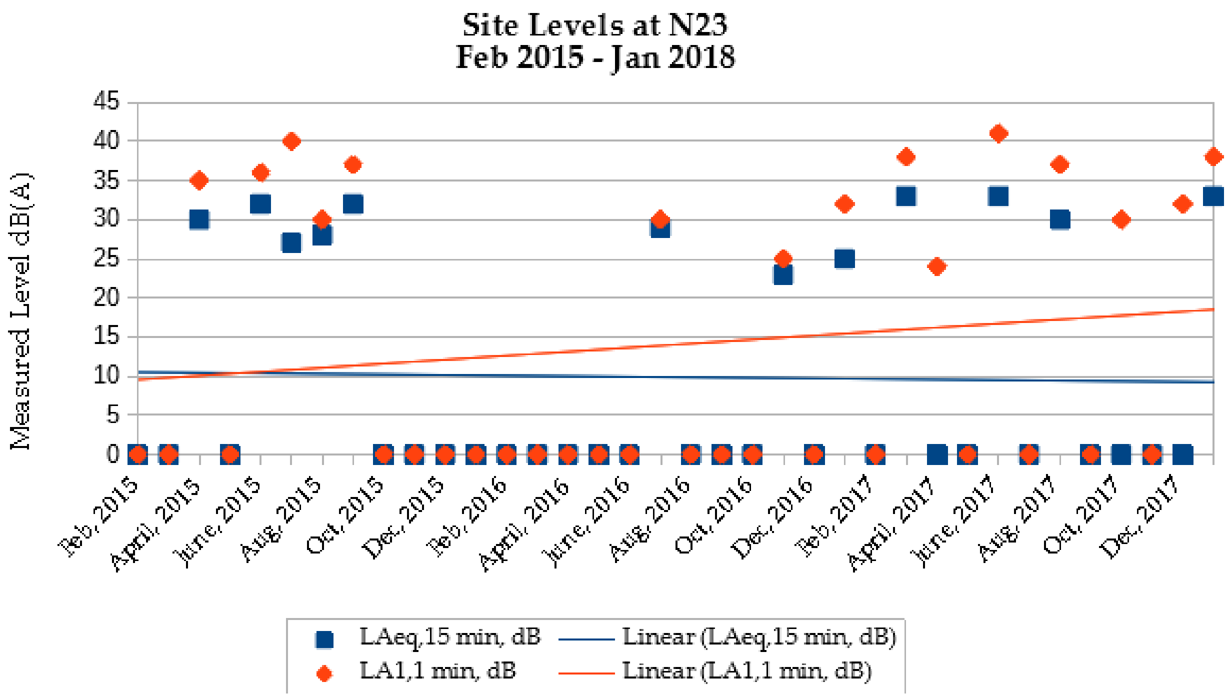

Figure 7: Summary of Measured Site Noise levels, N23 – Carter

Monitoring at this location ceased in February 2018. Trends for the three-year period through January 2018 have been provided for informational purposes only.

There are no significant differences in measured site noise levels at monitoring location N23 over the 2016 to 2018 period.

Due to a large number of non-measurable results, the trends are not reliable.

4.5.7 N26 – Colefax

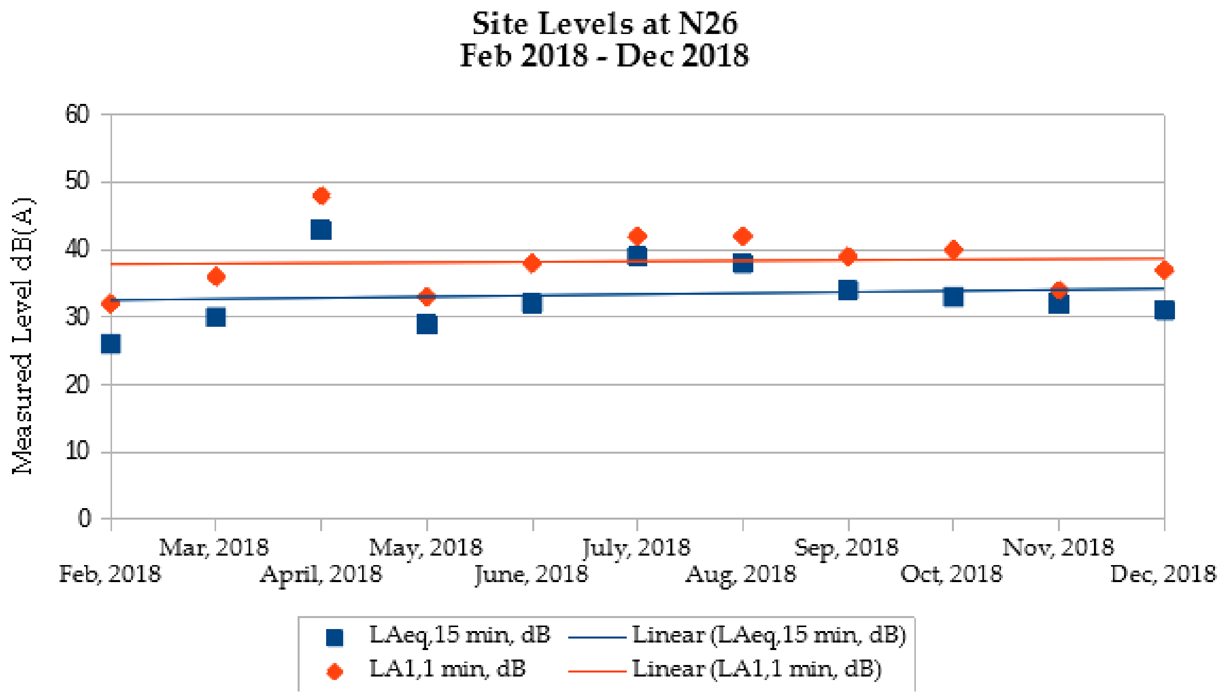

Figure 8: Summary of Measured Site Noise levels, N26 – Colefax

Monitoring at this location commenced in February 2018.

There are no significant differences in measured site noise levels at monitoring location N20A over the 2018 period.

4.6 Comparison with EIS

Predicted Year 9 operational noise levels from Table 5.4.1 of the EIS (June 2003) are reproduced for the monitoring locations during the night period only as shown in Table 4.17.

Year 9 predictions have been used for comparison of measured levels. As detailed in the EIS, Year 9 operations are representative of the nearest open-cut operations to Bulga Village including Wambo and Arrowfield Seam underground, CHPP and train loading system operations (with train movement).

Table 4.17: WAMBO OPERATIONAL $L_{Aeq,15minute}$ dB EIS PREDICTIONS, YEAR 9

Location	Adverse SE Wind Summer, Autumn, Spring - Night	Adverse Inversion W Wind Winter - Night
N01, Lambkin	21	35
N03, Kelly	57 [3]	56 [3]
N16, Muller	37 [1]	25
N20A, Thelander/O'Niell	40 [2]	18
N21, Fenwick	29	35
N23, Carter	40 [2]	18
N26, Colefax	40 [2]	18

Source: Wambo EIS (June 2003)

Notes from Table 5.4.1 of EIS:

1. *Marginal Noise Management Zone 1 to 2 dBA above project specific criteria;*
2. *Moderate Noise Management Zone 3 to 5 dBA above project specific criteria; and*
3. *Noise Affectation Zone >5 dBA above project specific criteria.*

Table 3.2.3 of the EIS details applicable periods for predicted noise levels. This table has been reproduced below. It should be noted that data in Table 4.18 and Table 4.19 in this report detail the differences against predicted levels for the relevant seasons and periods. This comparison addresses the primary enhancement drivers being wind speed, wind direction and temperature gradient. Air temperature and relative humidity have not been included in the comparison as their influence on propagation is relatively minor.

Table 3.2.3 Non-Adverse (Calm) and Adverse Noise Modelling Meteorological Parameters

Season	Period	Air Temp	Relative Humidity	Wind Velocity[1]	Temperature Gradient[1]
Non-Adverse Annual	Daytime	18°C	60%	0 m/s	0°C/100 m
Adverse Summer Autumn Spring	Evening and Night-time	12°C	75%	SE 3 m/s	0°C/100 m
Adverse Winter	Evening and Night-time	6°C	90%	W 2 m/s	3°C/100 m

Note 1: NSW INP (2000) default adverse wind speed 3 m/s and default inversion 3°C/100m plus 2 m/s wind.

Source: Wambo EIS (June 2003)

4.6.1 Year 9 Comparison

Measured operational levels have been compared to the predicted levels for Year 9 in the EIS for the relevant meteorological conditions. In the tables below, a positive difference is where the measured level is greater than the predicted level and a negative difference is where the measured levels are less than the predicted level. Notation used in the tables to denote differences is irrespective of the integer value sign. For example, the notation >-17 means the values are more than 17 dB less than the predicted level.

Table 4.18 provides the difference between measured and predicted levels with 3 m/s winds from the south east (SE) during the night period in summer, autumn and spring.

Table 4.18: 2018 WAMBO OPERATIONAL $L_{Aeq,15minute}$ dB DIFFERENCE AGAINST PREDICTED SE WIND CONDITIONS DURING SUMMER, AUTUMN AND SPRING – NIGHT, YEAR 9[1,2,4]

Location	Jan 18	Feb 18	Mar 18	Apr 18	May 18	Sep 18	Oct 18	Nov 18	Dec 18
N01, Lambkin[5]	IA [3]	NR	NR	NR	NR	NR	IA	NR	NR
N03, Kelly[6]	>-27 [3]	-21 [3]	-21 [3]	NR	NR	NR	NR	NR	-10 [3]
N16, Muller	+2 [3]	NR	+1 [3]	NR	+3 [3]	NR	-1 [3]	NR	-4 [3]
N20A, Thelander/O'Niell [7]	-	NR	NR	NR	NR	NR	-5 [3]	NR	NR
N21, Fenwick [7]	-	NR	IA	NR	NR	NR	>-4 [3]	NR	NR
N23, Carter [8]	NR	-	-	-	-	-	-	-	-
N26, Colefax [7]	-	NR	-10 [3]	0 [3,9,10]	NR	NR	-7 [3,10]	NR	NR

Notes:

1. *NR denotes met conditions not relevant, NA denotes not applicable, IA denotes conditions relevant but Wambo inaudible during monitoring, NM denotes conditions relevant but Wambo not measurable during monitoring;*
2. *SE wind conditions assumes winds at speeds between 0.1 and 3.0 m/s from a wind direction of 112.5 to 157.5 degrees during monitoring. Assumes no inversion conditions, i.e. the VTG is less than -0.5 °C/100m (equivalent to stability categories A to D) during monitoring. All met data is taken from a height of 10 metres (meteorological station);*
3. *Wind conditions relevant, however VTG is positive (greater than 0 degrees per 100 metres) during monitoring;*
4. *Measurements during Summer, Autumn and Spring only;*
5. *This property has been acquired by another mine, and, was previously acquisition (by Wambo) on request; no criteria applied there during 2018;*
6. *Acquisition upon request; and*
7. *Monitoring at this location commenced February 2018;*
8. *Monitoring at this location ceased February 2018;*
9. *Re-measure; and*
10. *Measured site-only L_{Aeq} compared prior to application of low-frequency modifying factors.*

Table 4.19 provides the difference between measured and predicted levels with up to 2 m/s winds from the west (W) and a 3 degree per 100 metre vertical temperature gradient (VTG) during the night period in winter only.

Table 4.19: 2018 WAMBO OPERATIONAL $L_{Aeq,15minute}$ dB DIFFERENCE AGAINST PREDICTED W WIND CONDITIONS DURING WINTER – NIGHT, YEAR 9[1,2,4]

Location	June 18	July 18	August 18
N01, Lambkin[5]	NR	NR	NR
N03, Kelly[6]	NR	NR	-13 [3]
N16, Muller	NR	NR	NR
N20A, Thelander/O'Niell [7]	NR	NR	NR
N21, Fenwick [7]	NR	NR	NR
N26, Colefax [7]	NR	NR	NR

Notes:

1. *NR denotes met conditions not relevant, NA denotes not applicable, IA denotes conditions relevant but Wambo inaudible during monitoring, NM denotes conditions relevant but Wambo not measurable during monitoring;*
2. *W wind conditions assumes winds at speeds between 0.1 and 2.0 m/s from a wind direction of 247.5 to 292.5 degrees during monitoring. Inversion conditions assumes a 3°C/100m VTG during monitoring. All met data is taken from a height of 10 metres (meteorological station);*
3. *Wind conditions relevant, however VTG is less than 3.0 degrees per 100 metres during monitoring;*
4. *Measurements during Winter only;*
5. *This property has been acquired by another mine, and, was previously acquisition (by Wambo) on request; no criteria applied there during 2018;*
6. *Acquisition upon request; and*
7. *Monitoring at this location commenced February 2018.*

As shown in the tables above, a comparison of predicted and measured levels from Wambo Year 9 operation shows very limited measurements that fall within meteorological conditions predicted. This comparison does not take into account operational activities at the time of monitoring compared to predicted scenarios.

5 CONCLUSION

5.1 Attended Noise Monitoring

Noise levels from WCM complied with the relevant Project Approval criteria at all sites during 2018 attended monitoring, with the exception of six occasions. The following exceedances of Project Approval criteria were measured during 2018 monitoring:

- On the night of 5/6 April 2018, WCM exceeded the $L_{Aeq,15minute}$ criterion at N26 by 3 dB. A re-measure and follow-up measurement were undertaken with resulting levels above the relevant limits;
- On the night of 17/18 May 2018, WCM exceeded the $L_{Aeq,15minute}$ criterion at N16 by 1 dB. A re-measure was understand with resulting levels above the relevant limits. A follow-up measurement was undertaken with resulting levels below the relevant limits;
- On the night of 20/21 June 2018, WCM exceeded the $L_{Aeq,15minute}$ and $L_{A1,1minute}$ criteria at N16 by 6 and 15 dB, respectively. A re-measure was understand with resulting levels above the relevant limits. A follow-up measurement was undertaken with resulting levels below the relevant limits;
- On the night of 5/6 September 2018, WCM exceeded the $L_{Aeq,15minute}$ and $L_{A1,1minute}$ criteria at N16 both by 1 dB. A re-measure and follow-up measurement were undertaken with resulting levels below the relevant limits;
- On the night of 17/18 December 2018, WCM exceeded the $L_{Aeq,15minute}$ criterion at N16 by 1 dB. A re-measure and follow-up measurement were undertaken with resulting levels below the relevant limits; and
- On the night of 17/18 December 2018, WCM exceeded $L_{A1,1minute}$ criterion at N20A by 1 dB.

Noise levels from WCM complied with relevant EPL criteria at all sites during 2018 attended monitoring, with the exception of two instances. The following exceedances of EPL criteria were measured during 2018 monitoring:

- On the night of 5/6 April 2018, WCM exceeded the $L_{Aeq,15minute}$ criterion at N26 by 3 dB. A re-measure and follow-up measurement were undertaken with resulting levels above the relevant limits; and
- On the night of 17/18 December 2018, WCM exceeded $L_{A1,1minute}$ criterion at N20A by 1 dB.

Modifying factors were assessed in accordance with the NPfI. Site-only L_{Aeq} noise levels have been adjusted, where applicable, by low-frequency modifying factors. It is noted that wind speeds and/or temperature inversion conditions were at levels greater than which development consent conditions would apply for WCM activities in some instances.

There were no changes to train refuelling procedures so no monitoring for the WCRS was undertaken during 2018.

5.2 Site Noise Level Trends

Measured site noise levels at location N03 have shown an upward trend over the past three years for both $L_{Aeq,15minute}$ and $L_{A1,1minute}$ noise levels.

Measured site noise levels at location N16 have shown an upward trend over the past three years for both $L_{Aeq,15minute}$ and $L_{A1,1minute}$ noise levels. This can possibly be attributed to N16 being in the direction of pit progression.

There are no significant differences in measured site noise levels at other monitoring locations.

5.3 Comparison with EIS

Predicted noise levels from Year 9 were compared against actual noise levels during 2018. Results of the comparison indicate that meteorological conditions included in the EIS modelled predictions did not regularly occur during attended monitoring. When meteorological conditions were relevant, results show that measured noise levels from WCM were generally within 3 dB of predicted levels at N16. At other locations, measured noise levels from WCM were well below the predicted levels when meteorological conditions were relevant.

Global Acoustics Pty Ltd

APPENDIX

A DEVELOPMENT CONSENT

A.1 WAMBO COAL MINE DEVELOPMENT CONSENT

A.1.1 Relevant Wambo Coal Mine Development Consent Conditions

The relevant sections of the December 2017 modified conditions are reproduced below:

SCHEDULE 4
SPECIFIC ENVIRONMENTAL CONDITIONS

ACQUISITION UPON REQUEST

1. Upon receiving a written request for acquisition from the landowner of the land listed in Table 1, the Applicant must acquire the land in accordance with the procedures in conditions 9-11 of schedule 5:

Table 1: Land subject to acquisition upon request

2 – Lambkin	23A & B - Kannar
13C - Skinner	31A,B,C & D - Fisher
19A & B – Kelly	51 – Hawkes
22 – Henderson	56 - Haynes

Note: For more information on the numbering and identification of properties used in this consent, see Attachment 1 of the EIS for the Wambo Development Project. Lands titled 23A & B – Kannar, 31A,B,C & D – Fisher, 51 – Hawkes and 56 – Haynes have been acquired and are now mine-owned.

[1]NOISE

Noise Impact Assessment Criteria

6. The Applicant must ensure that the noise generated by the Wambo Mining Complex does not exceed the noise impact assessment criteria presented in Table 9.

Table 9: Noise impact assessment criteria dB(A))

Day $L_{Aeq(15\ minute)}$	Evening/Night $L_{Aeq(15\ minute)}$	Night $L_{A1(1\ minute)}$	Land Number
35	41	50	94 – Curlewis
			3 – Birrell

[1] Incorporates EPA GTAs

Day $L_{Aeq(15\ minute)}$	Evening/Night $L_{Aeq(15\ minute)}$	Night $L_{A1(1\ minute)}$	Land Number
35	40	50	4B – Circosta 15B - McGowen/Caslick 16 – Cooper 23C – Kannar 25 – Fenwick 28A & B – Garland 33 -Thelander/O'Neill 39 – Northcote 40 – Muller 254A – Algie
35	39	50	5 – Strachan 6 - Merrick 7 - Maizey 37 - Lawry 48 - Ponder
35	38	50	1 - Brosi 17 - Carter 18 - Denney 38 - Williams 49 - Oliver 63 - Abrocuff 75 - Barnes 91 - Bailey
35	37	50	27 - Birralee 43 - Carmody 137 - Woodruff 163 - Rodger/Williams 246 - Bailey
35	36	50	13B - Skinner 178 - Smith 188 - Fuller 262A, B & C - Moses
35	35	50	All other residential or sensitive receptors, excluding the receptors listed in condition 1 above

Notes:

- Noise generated by the Wambo Mining Complex is to be measured in accordance with the relevant requirements, and exemptions (including certain meteorological conditions), of the NSW Industrial Noise Policy

Land Acquisition Criteria

7. If the noise generated by the Wambo Mining Complex exceeds the criteria in Table 10, the Applicant must, upon receiving a written request for acquisition from the landowner, acquire the land in accordance with the procedures in conditions 9-11 of schedule 5.

Table 10: Land acquisition criteria dB(A)

Day/Evening/Night $L_{Aeq(15\ minute)}$	Property
43	94 - Curlewis
	23C – Kannar
	254A - Algie
40	All other residential or sensitive receptor, excluding the receptors listed in condition 1 above

Note: Noise generated by the Wambo Mining Complex is to be measured in accordance with the notes presented below Table 9 above. Property 23C – Kannar has been acquired and is now mine-owned.

Operating Conditions

8. The Applicant must:
   (a) implement best management practice to minimise the operational, low frequency and traffic noise of the Wambo Mining Complex;
   (b) operate a comprehensive noise management system for the Wambo Mining Complex that uses a combination of predictive meteorological forecasting and real-time noise monitoring data to guide the day to day planning of mining operations and the implementation of both proactive and reactive noise mitigation measures to ensure compliance with the relevant conditions of this consent;
   (c) maintain the effectiveness of noise suppression equipment (if fitted) on plant at all times and ensure defective plant is not used operationally until fully repaired;
   (d) ensure that noise attenuated plant (if used) is deployed preferentially in locations relevant to sensitive receivers;
   (e) minimise the noise impacts of the Wambo Mining Complex during meteorological conditions when the noise limits in this consent do not apply;
   (f) co-ordinate the noise management for the Wambo Mining Complex with the noise management at nearby mines (including HVO South, HVO North and Mt Thorley Warkworth mines) to minimise the cumulative noise impacts of these mines and the Wambo Mining Complex,

to the satisfaction of the Secretary.

Noise Management Plan

9. The Applicant **must** prepare a Noise Management Plan for the Wambo Mining Complex to the satisfaction of the Secretary. This plan must:
   (a) be prepared in consultation with the EPA, and submitted to the Secretary for approval by the end of June 2013;
   (b) describe the measures that would be implemented to ensure:
      - best management practice is being employed;
      - the noise impacts of the Wambo Mining Complex are minimised during meteorological conditions when the noise limits in this consent do not apply; and
      - compliance with the relevant conditions of this consent;
   (c) describe the proposed noise management system in detail;
   (d) include a monitoring program that:
      - uses a combination of real-time and supplementary attended monitoring measures to evaluate the performance of the Wambo Mining Complex;
      - adequately supports the proactive and reactive noise management system for the Wambo Mining Complex;
      - includes a protocol for determining exceedances of the relevant conditions in this consent;
      - evaluates and reports on the effectiveness of the noise management system for the Wambo Mining Complex;
      - provides for the annual validation of the noise model for the Wambo Mining Complex; and
   (e) include a protocol that has been prepared in consultation with the owners of nearby mines (including HVO South, HVO North and Mount Thorley Warkworth mines) to minimise the cumulative noise impacts of these mines and the Wambo Mining Complex.

The Applicant must implement the approved management plan as approved from time to time by the Secretary.

A.2 WAMBO RAIL SPUR DEVELOPMENT CONSENT

The relevant sections of the February 2012 modified conditions for the rail spur are reproduced below:

SCHEDULE 4
GENERAL ENVIRONMENTAL CONDITIONS

ACQUISITION UPON REQUEST

1. Upon receiving a written request for acquisition from the landowner of the land listed in Table 1, the Applicant shall acquire the land in accordance with the procedures in conditions 1-3 of schedule 5.

Table 1: Land subject to acquisition upon request

19 - L Kelly	55 - E & C Burley

Note: For more information on the numbering and identification of properties used in this consent, see Attachment 1A and Attachment 1B of the SEE for the Alterations to the Wambo Development Project – Rail and Train Loading Infrastructure.

2. While the land listed in Table 1 is privately owned, the Applicant shall implement all practicable measures to ensure that the impacts of the development comply with the predictions in the SEE, and the relevant conditions in this consent, at any residence on this land, to the satisfaction of the Director-General.

NOISE

Noise Impact Assessment Criteria

3. The Applicant shall ensure that noise generated by the development, combined with noise generated by any development in the Wambo Mining Complex, does not exceed the noise criteria provided in Table 2, unless higher noise criteria are specified in the consent for the Wambo Coal Mine (DA 305-7-2003).

Table 2: Noise impact assessment criteria dB(A)

Day $L_{Aeq(15\ minute)}$	Evening/Night $L_{Aeq(15\ minute)}$	Night $L_{A1(1\ minute)}$	Land Number
35	35	50	All private residential or sensitive receptors, excluding the receptors listed in Table 1

Notes:

- *Noise generated by the project is to be measured in accordance with the relevant requirements, and exemptions (including certain meteorological conditions), of the NSW Industrial Noise Policy.*
- *For this condition to apply, the exceedance of the criteria must be systemic.*

Construction Hours

4. The Applicant shall ensure that all construction work is carried out from 7 am to 6 pm Monday to Saturday (inclusive) and 8 am to 6 pm Sundays and Public Holidays.

Operating Hours

5. The Applicant shall:
   (a) take all practicable measures to minimise train movements at the development on Friday evening (6 pm-9 pm) and Sunday morning (9 am-12 am);
   (b) report on the implementation and effectiveness of these measures,

   to the satisfaction of the Director-General.

Rail Noise

6. The Applicant shall seek to ensure that its rail spur is only accessed by locomotives that are approved to operate on the NSW rail network in accordance with noise limits L6.1 to L6.4 in RailCorp's EPL (No. 12208) and ARTC's EPL (No. 3142) or a Pollution Control Approval issued under the former *Pollution Control Act 1970*.

Noise Monitoring

7. The Applicant shall monitor the noise generated by the development, and noise generated by the Wambo Mine, in general accordance with the Noise Management Plan for the Wambo Mining Complex and the *NSW Industrial Noise Policy*.

7A. By 31 May 2012, the Applicant shall review and update the Noise Management Plan for the Wambo Mining Complex, including a noise monitoring protocol for evaluating compliance with the criteria in condition 3 above.

7B. During the first 12 months of operation of the Rail Refuelling Facility, the Applicant must conduct attended noise monitoring at the nearest private receptor during refuelling events, no less often than every three months.

A.3 WAMBO RAIL LINE DEVELOPMENT CONSENT

The relevant sections of the 1998 conditions for the rail line are reproduced below:

Operational Noise

8. The Applicant shall ensure noise emissions from the operations of the railway line when measured at any residence along the railway line corridor shall not exceed the following EPA criteria:

(a) planning level of $L_{Aeq\,24hr}$ 55dBA; and

(b) maximum passby level of L_{Amax} 85dBA

The noise criteria levels shall be measured under prevailing weather conditions in accordance with EPA requirements and to be consistent with EPA's requirements as applied to the New South Wales coal industry, or otherwise agreed to by the EPA.

9. Prior to the commencement of operations, the Applicant shall prepare in consultation with the EPA and Singleton Shire Council an Operational Noise Management Plan. The Operation Noise Management Plan shall demonstrate that all practical design and noise mitigation methods have been undertaken to achieve the noise levels specified in Condition 8.

APPENDIX D

ENVIRONMENTAL MONITORING DATA SUMMARIES

Date	Blast ID	BM01 - Homestead		BM02 - Kelly		BM03 - Harris		BM05 - Muller		BM07 - Thelander	
		Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant
		dBL	mm/sec	dBL	mm/sec	dBL	mm/sec	dBL	mm/sec	dBL	mm/sec
1/6/2018	Montrose RCA_220	95.8	0.0	94.7	0.0	95.5	0.0	103.2	0.2	100.5	0.2
1/13/2018	M_27RCA_220	105.4	0.2	107.8	0.2	97.8	0.1	103.9	0.3	104.0	0.2
1/18/2018	M_27RCA_222	90.4	0.0	97.0	0.1	87.9	0.0	111.2	0.2	102.4	0.2
1/19/2018	HD_1WWA_225	98.4	0.1	100.8	0.1	96.1	0.1	109.1	0.5	101.8	0.4
1/22/2018	M_27WMA_226	89.5	0.1	91.9	0.1	90.8	0.0	103.8	1.0	97.9	0.8
2/9/2018	M_27RCA_223 & M_27RCA_232	99.9	0.0	98.8	0.1	96.4	0.0	102.2	0.4	96.2	0.4
2/9/2018	M_27WWA_228	100.6	0.1	100.4	0.1	92.5	0.1	101.3	1.3	97.4	1.1
2/14/2018	ME_WTA_233	101.8	0.1	96.9	0.1	88.8	0.1	103.7	0.3	97.1	0.1
2/14/2018	M_27_WWA_230	103.9	0.1	96.2	0.1	94.0	0.1	103.0	1.4	97.6	1.1
2/21/2018	RP_1WWA_237	104.0	0.4	93.6	0.1	98.5	0.1	99.3	0.0	89.7	0.0
2/24/2018	B235 Montrose East	104.8	0.1	95.2	0.1	95.0	0.1	100.2	0.2	101.2	0.1
2/24/2018	B236 Hilldale	108.0	0.1	93.5	0.1	95.9	0.0	101.0	0.2	94.9	0.1
2/24/2018	B234 Montrose 27	99.8	0.1	98.7	0.1	97.6	0.1	107.9	2.1	99.6	1.0
3/15/2018	HD_1WWA_238	105.7	0.3	112.5	0.2	101.7	0.2	104.6	0.9	97.6	0.8
3/15/2018	M_27RCA_240	88.6	0.0	97.1	0.1	89.7	0.0	99.9	0.2	96.9	0.1
3/15/2018	HD_1WWA_239	102.7	0.1	107.1	0.1	98.7	0.0	106.1	0.2	97.6	0.1
3/19/2018	ME_WMA_244	96.2	0.3	99.1	0.2	98.0	0.2	112.0	0.4	105.6	0.2
3/26/2018	M_27_WWA_242	94.7	0.0	103.1	0.0	94.7	0.0	106.3	0.3	103.6	0.2
3/28/2018	Montrose WWA 245	96.0	0.1	99.8	0.1	98.3	0.1	108.7	1.1	106.7	0.7
3/28/2018	Montrose WWA242	94.8	0.0	84.6	0.0	80.4	0.0	93.9	0.1	89.4	0.1
4/5/2018	M_27WWA_247	93.7	0.0	92.3	0.0	92.6	0.0	106.1	0.4	100.0	0.4
4/9/2018	HD_1RCA_246	100.6	0.1	100.9	0.1	86.0	0.0	100.1	0.1	92.2	0.1
4/13/2018	ME_WTA_225	105.4	0.2	94.1	0.2	98.0	0.1	95.1	0.3	89.5	0.2
4/13/2018	M_27RCA_254	99.9	0.0	92.3	0.1	88.2	0.0	102.1	0.2	95.3	0.2
4/16/2018	M_27WWA_257	110.3	0.1	94.4	0.1	90.8	0.1	102.2	0.5	92.8	0.7
4/19/2018	M_27WWA_258	99.7	0.1	96.5	0.1	97.8	0.1	104.3	1.5	98.0	1.4
4/26/2018	M_WWA 249	99.4	0.1	92.8	0.1	87.8	0.0	108.5	0.5	103.3	0.5

Date	Blast ID	BM01 - Homestead		BM02 - Kelly		BM03 - Harris		BM05 - Muller		BM07 - Thelander	
		Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant
		dBL	mm/sec	dBL	mm/sec	dBL	mm/sec	dBL	mm/sec	dBL	mm/sec
4/26/2018	M_WWA 256	106.6	0.1	97.9	0.1	87.8	0.1	108.0	1.5	105.6	1.3
5/3/2018	ME_WTA_243	99.9	0.2	105.5	0.2	98.4	0.1	105.3	0.3	100.4	0.2
5/3/2018	M_27RCA_261	87.9	0.0	88.9	0.0	88.3	0.0	102.9	0.2	91.1	0.2
5/3/2018	HP_1WWA_260_B	100.6	0.1	96.0	0.1	99.4	0.0	98.3	0.2	94.4	0.2
5/8/2018	MW_Dozerpush_253	105.3	0.2	103.7	0.1	104.5	0.1	107.4	0.7	103.0	0.7
5/8/2018	HD_1WWA_262	94.0	0.1	96.4	0.1	91.6	0.0	104.7	0.2	99.1	0.1
5/18/2018	M_RCA_263	100.4	0.2	103.4	0.2	101.9	0.1	104.9	1.5	98.9	1.7
5/18/2018	M_WRA_267	91.2	0.0	90.6	0.0	89.3	0.0	103.9	0.4	96.7	0.3
5/18/2018	M_WMA_266	91.2	0.0	93.1	0.0	90.9	0.0	104.6	0.4	94.8	0.4
5/24/2018	HD_RCA_268	89.1	0.0	81.7	0.0	81.1	0.0	100.7	0.1	98.8	0.1
5/24/2018	M_27WWA_251	91.2	0.1	93.8	0.1	87.9	0.1	104.0	0.9	103.1	0.8
5/29/2018	ME_WTA_269	96.7	0.2	98.5	0.2	93.4	0.1	103.4	0.4	94.0	0.2
6/8/2018	ME_WMA_277	96.9	0.1	101.7	0.1	97.7	0.1	105.1	0.3	97.3	0.2
6/8/2018	M_27WMA_270	108.3	0.2	111.6	0.2	106.6	0.1	107.9	1.9	101.8	1.4
6/14/2018	MW_DZ_275	106.8	0.0	89.4	0.0	93.6	0.0	92.7	0.1	82.3	0.1
6/14/2018	M28_RCA_278	102.2	0.0	99.1	0.0	97.4	0.0	103.1	0.3	98.5	0.4
6/22/2018	HD_RCA_280	92.6	0.1	91.8	0.0	92.0	0.0	95.8	0.1	92.4	0.1
6/22/2018	M28_RCA_279	92.3	0.1	96.4	0.0	92.4	0.0	104.5	0.5	100.8	0.5
6/29/2018	HD_1WWA_283	100.9	0.2	103.3	0.1	95.3	0.1	99.7	0.5	92.7	0.3
6/29/2018	MP_27WWA_282	97.4	0.1	96.0	0.1	95.1	0.1	96.1	1.0	98.5	1.0
7/5/2018	M_WWA_284	106.7	0.1	102.8	0.1	111.3	0.1	111.1	1.4	108.5	2.5
7/12/2018	ME_WMA_285	93.1	0.1	99.8	0.1	93.5	0.1	99.1	0.2	89.5	0.1
7/12/2018	M_27RCA_289	87.8	0.0	89.0	0.0	90.1	0.0	101.9	0.3	95.2	0.2
7/21/2018	HD_1WWA_276	111.3	0.1	113.2	0.1	101.9	0.1	110.3	0.3	101.2	0.2
7/21/2018	M_27WWA_287	100.9	0.2	100.8	0.1	92.6	0.1	104.2	2.8	101.6	3.3
7/28/2018	ME_WTA_292	89.8	0.2	98.7	0.2	93.1	0.1	103.2	0.3	94.8	0.2
7/31/2018	HD_1WWA_294	116.1	0.3	106.7	0.2	107.0	0.2	108.6	1.3	102.5	0.6
8/10/2018	MW_WWA_291	111.3	0.6	108.6	0.3	112.4	0.4	109.8	1.0	105.3	1.4

Date	Blast ID	BM01 - Homestead		BM02 - Kelly		BM03 - Harris		BM05 - Muller		BM07 - Thelander	
		Peak Air Blast dBL	Peak Resultant mm/sec	Peak Air Blast dBL	Peak Resultant mm/sec	Peak Air Blast dBL	Peak Resultant mm/sec	Peak Air Blast dBL	Peak Resultant mm/sec	Peak Air Blast dBL	Peak Resultant mm/sec
8/10/2018	M_27RCA_296	95.3	0.0	95.3	0.1	95.6	0.0	104.4	0.6	99.8	0.5
8/17/2018	ME_WMA_293	94.6	0.2	100.0	0.2	92.2	0.1	108.3	0.3	100.7	0.3
8/17/2018	HD_WWA_330	93.8	0.0	95.0	0.0	90.5	0.0	98.0	0.2	89.7	0.1
8/17/2018	M_27_WMA_295	96.3	0.1	96.6	0.1	93.1	0.0	97.0	0.6	93.1	0.6
8/21/2018	M_27WWA_298	101.7	0.0	88.6	0.1	90.5	0.1	102.1	0.4	104.3	0.6
8/29/2018	M-24_WMA_306	94.9	0.1	96.8	0.0	96.6	0.0	102.7	0.4	96.4	0.2
8/29/2018	M_27 RCA_301	97.3	0.1	93.8	0.1	95.8	0.1	109.8	0.6	101.6	0.7
8/29/2018	M_27WRA_299	90.3	0.0	93.8	0.1	93.1	0.0	103.6	0.5	99.8	0.6
9/7/2018	M_27WRA_302	96.8	0.1	100.0	0.0	102.4	0.0	108.9	0.4	98.5	0.6
9/7/2018	ME_2WMA_259	92.4	0.1	95.0	0.1	99.7	0.1	111.7	0.9	101.0	0.9
9/11/2018	ME_WMA_309	99.4	0.1	86.9	0.1	84.1	0.0	96.4	0.1	86.8	0.0
9/14/2018	M_WTA_312	92.2	0.0	90.3	0.0	94.9	0.0	103.6	0.2	94.0	0.2
9/14/2018	M_RCA_311	95.7	0.1	99.6	0.1	95.4	0.1	108.2	0.9	97.6	1.1
9/21/2018	HD_WWA_305	94.8	0.2	95.7	0.1	91.5	0.1	107.7	0.6	99.7	0.6
9/21/2018	M_WMA_315 and M_WRA_307	92.7	0.1	94.7	0.1	91.9	0.0	113.0	0.4	105.7	0.3
9/28/2018	ME_WTA_317	98.8	0.2	97.3	0.1	96.3	0.1	100.3	0.2	92.9	0.2
9/28/2018	M_27WRA_313	90.2	0.0	86.5	0.0	91.5	0.0	105.7	0.4	99.5	0.5
9/28/2018	MW_PRESPLIT_304	100.5	0.1	90.5	0.1	96.5	0.1	96.9	0.4	88.6	0.4
10/3/2018	HD_WWA_308 and HD_RCA_318	98.2	0.1	97.5	0.1	96.7	0.1	105.2	0.4	97.0	0.3
10/9/2018	MW_WWA_310	105.8	0.5	104.5	0.2	105.3	0.4	106.0	0.5	101.6	0.9
10/19/2018	HD_1RCA_3321	91.7	0.0	91.1	0.0	85.6	0.0	92.6	0.1	88.9	0.0
10/19/2018	M_27WMA_316	106.0	0.4	106.2	0.2	105.7	0.1	107.3	1.8	97.2	1.6
10/30/2018	M_27WRA_322	91.8	0.0	95.0	0.0	87.8	0.0	106.0	0.4	102.6	0.5
10/30/2018	M_27WRA_323	99.6	0.1	100.5	0.1	94.3	0.1	115.7	0.7	107.4	0.4
10/30/2018	ME_WMA_324	99.1	0.2	98.6	0.1	97.1	0.1	116.5	1.5	108.9	1.6
11/2/2018	MW_DOZERPUSH_325	104.1	0.1	108.1	0.1	94.6	0.1	100.7	0.2	104.3	0.4

Date	Blast ID	BM01 - Homestead		BM02 - Kelly		BM03 - Harris		BM05 - Muller		BM07 - Thelander	
		Peak Air Blast dBL	Peak Resultant mm/sec	Peak Air Blast dBL	Peak Resultant mm/sec	Peak Air Blast dBL	Peak Resultant mm/sec	Peak Air Blast dBL	Peak Resultant mm/sec	Peak Air Blast dBL	Peak Resultant mm/sec
11/7/2018	M_27WMA_326	113.2	0.2	117.0	0.1	113.1	0.1	109.1	2.1	102.6	1.5
11/14/2018	ME_2WMA_327	98.7	0.1	94.9	0.1	95.7	0.1	107.3	0.6	97.4	0.6
11/19/2018	HS_WRA_320	109.0	0.6	96.3	0.3	99.8	0.1	110.1	0.0	92.5	0.0
11/23/2018	MW_RCA_335	115.5	0.2	101.6	0.1	117.6	0.1	108.2	0.2	99.9	0.2
11/23/2018	M_27WRA_329	122.1	0.1	102.9	0.1	110.1	0.1	112.5	0.3	111.4	0.3
11/28/2018	M_27WRA_332	92.6	0.1	98.4	0.1	92.4	0.0	112.7	0.7	103.8	0.5
11/28/2018	M_27WRC_334	90.3	0.1	93.7	0.1	91.9	0.0	102.6	0.5	95.1	0.5
12/3/2018	M_27WRA_330	95.2	0.1	94.4	0.1	89.2	0.1	98.1	0.3	96.7	0.2
12/8/2018	M_27WRC_336	98.5	0.1	93.8	0.1	97.0	0.0	104.1	1.0	97.4	0.7
12/8/2018	M_27WMA_343	92.7	0.1	96.2	0.1	91.7	0.1	104.9	0.8	102.2	0.6
12/17/2018	HD_WWA_338	100.4	0.2	90.5	0.0	96.2	0.1	95.7	0.6	90.1	0.4
12/17/2018	M_27WMA_345	90.5	0.1	103.5	0.1	92.5	0.0	105.2	0.7	100.5	0.4
12/28/2018	M_27WRA_344	96.2	0.0	104.6	1.8	83.8	0.1	97.8	0.1	67.4	0.1
12/28/2018	M_27WRA_337	96.2	0.0	93.3	0.0	83.8	0.1	103.5	0.4	103.4	0.6
12/28/2018	M_27WRC_339	98.0	0.1	94.6	0.1	93.7	0.1	114.0	0.6	108.7	0.5
12/28/2018	ME_WMA_342	99.7	0.3	95.9	0.2	89.9	0.2	110.6	1.4	101.5	1.1

Date	D11			D19			D21			D22		
	Ash Residue (g/m^2 /month)	Insoluble Solids (g/m^2 /month)	AR/IS Ratio	Ash Residue (g/m^2 /month)	Insoluble Solids (g/m^2 /month)	AR/IS Ratio	Ash Residue (g/m^2 /month)	Insoluble Solids (g/m^2 /month)	AR/IS Ratio	Ash Residue (g/m^2 /month)	Insoluble Solids (g/m^2 /month)	AR/IS Ratio
Jan-18	2.60	4.90	53.06	4.10	6.10	67.21	3.10	4.30	72.09	2.70	3.30	81.82
Feb-18	1.50	1.90	78.95	5.40	7.10	76.06	2.10	2.60	80.77	3.10	3.80	81.58
Mar-18	1.20	1.30	92.31	3.80	5.60	67.86	1.90	2.50	76.00	3.00	3.70	81.08
Apr-18	1.80	2.40	75.00	2.60	3.90	66.67	1.40	1.70	82.35	2.50	3.10	80.65
May-18	1.60	2.50	64.00	2.10	2.90	72.41	1.10	1.40	78.57	2.70	3.60	75.00
Jun-18	1.60	2.40	66.67	1.80	2.70	66.67	0.80	1.20	66.67	2.40	3.30	72.73
Jul-18	1.20	1.70	70.59	1.70	2.60	65.38	0.60	1.00	60.00	1.50	2.10	71.43
Aug-18	1.60	2.20	72.73	1.80	2.70	66.67	0.60	0.90	66.67	1.80	2.40	75.00
Sep-18	1.90	2.40	79.17	3.20	4.50	71.11	1.70	2.20	77.27	2.70	3.20	84.38
Oct-18	3.10	1.50	206.67	2.90	3.80	76.32	1.20	1.40	85.71	2.00	2.40	83.33
Nov-18	2.20	2.90	75.86	4.40	6.60	66.67	1.90	2.70	70.37	2.40	3.30	72.73
Dec-18	1.90	2.50	76.00	2.60	4.40	59.09	2.20	2.80	78.57	2.60	3.50	74.29
Average	1.85	2.38	77.62	3.03	4.41	68.81	1.55	2.06	75.30	2.45	3.14	77.98

Date of Run	PM01 - Coralie (Sentinex 19)		PM02 - Wambo Road (Caban) (Sentinex 20)		PM03 - Thelander (Sentinex 21)		PM04 - Muller (Sentinex 22)	
	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average
1/01/2018	**36.3**	**36.30**	25.6	25.60	**NaN**	**NaN**	23.5	23.50
2/01/2018	28.1	**32.20**	21.9	23.75	**NaN**	**NaN**	23.4	23.45
3/01/2018	24.8	29.73	18.5	22.00	14.5468	14.55	18.1	21.67
4/01/2018	29.6	29.70	25.2	22.80	24.5	19.52	27.1	23.03
5/01/2018	**31.4**	**30.04**	27.9	23.82	22.4	20.48	**32.1**	24.84
6/01/2018	**41.5**	**31.95**	**31**	25.02	22.7	21.04	**34**	26.37
7/01/2018	26.6	**31.19**	**30.4**	25.79	22.4	21.31	26.7	26.41
8/01/2018	**45.2**	**32.94**	**37.5**	27.25	24.9033	21.91	**34.9**	27.48
9/01/2018	28.9	**32.49**	22.8	26.76	17.8	21.32	22	26.87
10/01/2018	**32.7**	**32.51**	22	26.28	24.2	21.68	24.6	26.64
11/01/2018	**42.1**	**33.38**	29.4	26.56	**32.2**	22.85	**33.9**	27.30
12/01/2018	**34.1282**	**33.44**	**30.5**	26.89	25.4	23.11	**33.2**	27.79
13/01/2018	12.4	**31.83**	19.2	26.30	18.2	22.66	19.2	27.13
14/01/2018	11.7	**30.39**	12.6	25.32	8.4	21.47	19.6	26.59
15/01/2018	21.1	29.77	15.3	24.65	12.3	20.77	17.9	26.01
16/01/2018	**31.7**	29.89	25.2	24.69	24.5	21.03	**32.7**	26.43
17/01/2018	**34.4**	**30.15**	28.1	24.89	28.5	21.53	**30.1**	26.65
18/01/2018	**33.2**	**30.32**	**40.7**	25.77	28.2	21.95	**51.2**	28.01
19/01/2018	**60.5**	**31.91**	**36.7**	26.34	**39.8**	23.00	**49.5**	29.14
20/01/2018	**45.3**	**32.58**	27.1	26.38	**32**	23.50	**47.3**	**30.05**
21/01/2018	**40.7**	**32.97**	24.6	26.30	26.6	23.66	**32**	**30.14**
22/01/2018	**37.5**	**33.17**	28.2	26.38	21	23.53	**43.2**	**30.74**
23/01/2018	**42.1**	**33.56**	**42.7**	27.09	**31.4**	23.90	**55**	**31.79**
24/01/2018	**46.4**	**34.10**	**44.1**	27.80	**35.8**	24.44	**48.8**	**32.50**
25/01/2018	**32.8**	**34.05**	27.9	27.80	26.8	24.55	**30.6**	**32.42**
26/01/2018	**36.4**	**34.14**	29.9	27.88	**31.9**	24.85	**37**	**32.60**
27/01/2018	**40.1**	**34.36**	19.3	27.57	21	24.70	**32.3**	**32.59**
28/01/2018	**34.7**	**34.37**	18.9	27.26	17.9	24.44	26.7	**32.38**
29/01/2018	**53.6**	**35.03**	25.6	27.20	25.3	24.47	**35.1**	**32.47**
30/01/2018	**38.6**	**35.15**	**34.9**	27.46	25.6	24.51	**36.9**	**32.62**
31/01/2018	15.5	**34.52**	15.8	27.08	11.8	24.07	**31.6**	**32.59**
1/02/2018	**32.4**	**34.45**	19.7	26.85	20.6	23.96	28.6	**32.46**
2/02/2018	18.7	**33.97**	13.1	26.43	12	23.57	20.3	**32.09**
3/02/2018	22.4	**33.63**	13	26.04	14.1	23.27	23.9	**31.85**
4/02/2018	15.2	**33.11**	12.6	25.65	15.7	23.04	19.3	**31.49**
5/02/2018	22.6	**32.81**	19.5	25.48	20.4	22.97	28.8	**31.42**
6/02/2018	23.4	**32.56**	19.2	25.31	17.2	22.80	22.9	**31.19**
7/02/2018	26.3	**32.40**	19.6	25.16	19.6	22.71	25.9	**31.05**
8/02/2018	21.7	**32.12**	29.8	25.28	25.5	22.79	**35.8**	**31.17**
9/02/2018	**43.4**	**32.40**	**42.5**	25.71	26.0064	22.87	**59.6**	**31.88**
10/02/2018	**37.9**	**32.54**	26.5	25.73	28.4	23.01	**38.6**	**32.05**
11/02/2018	**39.1**	**32.69**	**33.8**	25.92	26.9	23.11	**33.2**	**32.07**
12/02/2018	**46.4**	**33.01**	**36.1**	26.16	**32.3**	23.34	**35.9**	**32.16**
13/02/2018	**35.4**	**33.07**	25.5	26.15	25.8	23.39	**32.6**	**32.17**
14/02/2018	22.3518	**32.83**	25.4	26.13	17.9	23.27	15.6	**31.80**
15/02/2018	**80.6**	**33.87**	**66**	27.00	**58.7**	24.07	**70.9**	**32.65**
16/02/2018	**50.6**	**34.22**	**55.3**	27.60	**52**	24.69	**52.8**	**33.08**

Date of Run	PM01 - Coralie (Sentinex 19) PM10 24 Hour Result (ug/m³)	PM01 - Coralie (Sentinex 19) YTD Average	PM02 - Wambo Road (Caban) (Sentinex 20) PM10 24 Hour Result (ug/m³)	PM02 - Wambo Road (Caban) (Sentinex 20) YTD Average	PM03 - Thelander (Sentinex 21) PM10 24 Hour Result (ug/m³)	PM03 - Thelander (Sentinex 21) YTD Average	PM04 - Muller (Sentinex 22) PM10 24 Hour Result (ug/m³)	PM04 - Muller (Sentinex 22) YTD Average
17/02/2018	**46.2**	**34.47**	**33.7**	27.73	**30.4**	24.82	**41.4**	**33.26**
18/02/2018	**38.2**	**34.55**	**34.5**	27.86	**30.5**	24.94	**43.2**	**33.46**
19/02/2018	**59.9**	**35.06**	**31.1**	27.93	**34.1**	25.13	**46.9**	**33.73**
20/02/2018	19.9	**34.76**	14.5	27.66	14	24.90	16.3	**33.39**
21/02/2018	20	**34.47**	27.5	27.66	16.1	24.73	19.3	**33.12**
22/02/2018	24.5	**34.29**	14.9	27.42	15.7	24.55	27.7	**33.01**
23/02/2018	**30.2**	**34.21**	21.4	27.31	24.6	24.55	**30.4**	**32.96**
24/02/2018	27.4	**34.09**	24.7	27.26	13.7	24.34	27.6	**32.87**
25/02/2018	12.8	**33.71**	15.1	27.04	10.1	24.08	16.9	**32.58**
26/02/2018	5.6	**33.21**	4.1	26.64	4.8	23.73	4.6	**32.09**
27/02/2018	19.8	**32.98**	14.7	26.44	15.3	23.58	16.1	**31.82**
28/02/2018	22.6	**32.81**	15.6	26.25	11.3	23.36	16.2	**31.55**
1/03/2018	**37.5**	**32.88**	**30.3**	26.32	**34.2**	23.55	28	**31.49**
2/03/2018	28.8	**32.82**	20	26.22	22.2	23.53	23.7	**31.36**
3/03/2018	**32.9**	**32.82**	29.5	26.27	25.2	23.56	**30.8**	**31.35**
4/03/2018	18.7	**32.59**	**NaN**	26.27	16.6	23.44	23.8	**31.23**
5/03/2018	22	**32.43**	19.4486	26.16	16.4	23.33	18.3	**31.03**
6/03/2018	12.9	**32.13**	8.8	25.89	9.2	23.10	10.7	**30.72**
7/03/2018	22.7	**31.99**	12.2	25.68	16.7	23.00	14.7	**30.48**
8/03/2018	25.1	**31.88**	9.7	25.44	14.3	22.87	17.5	**30.28**
9/03/2018	18.1687	**31.68**	8.4	25.18	13.4729	22.73	18.409	**30.11**
10/03/2018	26.9	**31.61**	10.5	24.97	16.6	22.64	20.3	29.97
11/03/2018	20.5	**31.45**	14	24.81	15.4	22.53	28.6	29.95
12/03/2018	25.7	**31.37**	22.2618	24.77	19.5	22.49	28.4	29.93
13/03/2018	28.9	**31.34**	19.4	24.70	21.9	22.48	23.7	29.84
14/03/2018	22.7	**31.22**	18.8	24.61	19.4	22.43	25.7	29.78
15/03/2018	29.5	**31.20**	29.1	24.68	16.4	22.35	25.7	29.73
16/03/2018	**40.3**	**31.32**	**38.3**	24.86	**35.7**	22.53	**37**	29.82
17/03/2018	**34.4**	**31.36**	**35.5**	25.00	28.5	22.61	**38.7**	29.94
18/03/2018	**39.8**	**31.47**	**34**	25.12	24.8	22.64	**33.2**	29.98
19/03/2018	**70.1**	**31.96**	**50.5**	25.45	**45.5**	22.94	**62.1**	**30.39**
20/03/2018	**43.4**	**32.11**	**41.6**	25.66	**37.8**	23.14	**55.3**	**30.71**
21/03/2018	12.1	**31.86**	12.6	25.49	8.4	22.95	17.8	**30.55**
22/03/2018	9.6	**31.58**	8.4	25.28	8.5	22.76	9.6	**30.29**
23/03/2018	15	**31.38**	11.5	25.11	10.9	22.62	12	**30.07**
24/03/2018	17.7	**31.22**	15.9	25.00	14	22.51	17.1	29.91
25/03/2018	22.1	**31.11**	21.8	24.96	11.1	22.37	13.6	29.72
26/03/2018	16.3	**30.93**	13.3	24.82	8.5	22.20	9.2	29.48
27/03/2018	23.5	**30.85**	14.2	24.69	16.9	22.14	24.7	29.42
28/03/2018	24.5	**30.77**	21.5	24.66	17.9	22.09	22.2	29.34
29/03/2018	19.2	**30.64**	18.3	24.58	18.7	22.05	23.1	29.27
30/03/2018	21.1	**30.54**	21.9	24.55	18.5	22.01	25.4	29.22
31/03/2018	**33.6**	**30.57**	**30.1**	24.61	**34.9**	22.16	**33.8**	29.27
1/04/2018	25.5368	**30.51**	**34.5722**	24.73	21.8282	22.15	**30.0069**	29.28
2/04/2018	23.9	**30.44**	23.6	24.71	20.1	22.13	20	29.18
3/04/2018	27.2	**30.41**	21.7	24.68	24.5	22.16	28.2	29.17
4/04/2018	20.6681	**30.30**	15.2854	24.58	17.9257	22.11	22.6424	29.10

Date of Run	PM01 - Coralie (Sentinex 19)		PM02 - Wambo Road (Caban) (Sentinex 20)		PM03 - Thelander (Sentinex 21)		PM04 - Muller (Sentinex 22)	
	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average
5/04/2018	24.1	**30.24**	22.4	24.56	17.9	22.07	23.6	29.04
6/04/2018	19.9	**30.13**	29.8	24.61	20.7	22.05	29.2	29.04
7/04/2018	24.6	**30.07**	**33.5**	24.70	22.6	22.06	26.7	29.02
8/04/2018	24.2	**30.01**	28.6	24.74	28.7	22.13	**31.7**	29.05
9/04/2018	26.3	29.98	**44.8**	24.95	24.3	22.15	**41.8**	29.18
10/04/2018	24.9	29.93	23.8	24.94	27.6	22.20	**35.6**	29.24
11/04/2018	**32.1**	29.95	**49.5**	25.18	24.4	22.23	**46.9**	29.42
12/04/2018	26.2	29.91	**42.8**	25.36	21.8	22.22	23.4	29.36
13/04/2018	**31**	29.92	**36.1**	25.46	18.8	22.19	21.6	29.28
14/04/2018	22	29.84	28.8	25.49	17.7	22.14	16.3	29.16
15/04/2018	**53.6**	30.07	**55**	25.78	**50.2**	22.42	**44.3**	29.30
16/04/2018	22	29.99	19	25.71	13.9	22.33	12.9	29.15
17/04/2018	**34.9**	**30.04**	17.7	25.64	19.9	22.31	20.9	29.07
18/04/2018	**42.3**	**30.15**	18.9	25.58	19.7	22.29	29.6	29.07
19/04/2018	**32.2**	**30.17**	16.9	25.50	13.5	22.20	21.4	29.00
20/04/2018	18.7	**30.07**	14.5	25.39	17.3	22.16	17.1	28.90
21/04/2018	**30.2**	**30.07**	25.7	25.40	26.1	22.20	26.9	28.88
22/04/2018	18.7	29.97	14.9	25.30	17.1	22.15	26	28.85
23/04/2018	22.4	29.90	17.2	25.23	15.3	22.09	20	28.77
24/04/2018	**30.7**	29.91	17.8	25.16	19.4	22.06	25.4	28.74
25/04/2018	22.9	29.85	17.2	25.09	14.7	22.00	19.6	28.66
26/04/2018	27.2	29.82	22	25.07	19.4	21.98	21.9	28.61
27/04/2018	18.4	29.73	17.4	25.00	16.3	21.93	**38.9**	28.69
28/04/2018	14.8	29.60	12	24.89	15	21.87	28.8	28.69
29/04/2018	20.8	29.53	12.9	24.79	15.5	21.81	27.9	28.69
30/04/2018	15.7	29.41	15.1	24.71	11.5	21.72	15.8	28.58
1/05/2018	18.1	29.32	26	24.72	16.5	21.68	20.7	28.52
2/05/2018	21.6	29.25	26.5	24.73	16.9869	21.64	**30.1**	28.53
3/05/2018	22.3	29.20	**32.6**	24.80	23.7	21.66	28.9	28.53
4/05/2018	**46.2**	29.34	**46.4**	24.97	**38.5**	21.80	**35.8**	28.59
5/05/2018	23.2	29.29	**33.3**	25.04	19.7	21.78	**34.8**	28.64
6/05/2018	29.5	29.29	26.2	25.05	26.3	21.82	**43.1**	28.75
7/05/2018	19	29.21	**36.6**	25.14	16.5	21.77	26.5	28.74
8/05/2018	27	29.19	**36.9**	25.23	19.8	21.76	**38.4**	28.81
9/05/2018	23.1	29.14	**36.3**	25.32	21.2	21.75	**34**	28.85
10/05/2018	**31**	29.16	**44.6**	25.47	21	21.75	21	28.79
11/05/2018	27.8	29.15	**42.6**	25.60	18.3	21.72	20.2	28.73
12/05/2018	14	29.03	8.7	25.47	7.2	21.61	9.7	28.58
13/05/2018	15	28.93	12	25.37	8.9	21.51	14.2	28.47
14/05/2018	18.7	28.85	19.4	25.33	14.2	21.46	28	28.47
15/05/2018	21.9	28.80	24.2	25.32	15.5	21.41	**34.2**	28.51
16/05/2018	**30.6**	28.81	19.8	25.28	26.3	21.45	**37.9**	28.58
17/05/2018	24.9	28.78	25.9	25.28	13.9	21.39	**32.4**	28.61
18/05/2018	24.9	28.75	**47.7**	25.44	16.1	21.35	**39.7**	28.69
19/05/2018	22.2	28.71	**38.8**	25.54	14.4	21.30	24.4	28.66
20/05/2018	19.2	28.64	26.8	25.55	9.4	21.22	13.6	28.55
21/05/2018	25.7	28.62	27.2	25.56	10.1	21.14	14.4	28.45

Date of Run	PM01 - Coralie (Sentinex 19)		PM02 - Wambo Road (Caban) (Sentinex 20)		PM03 - Thelander (Sentinex 21)		PM04 - Muller (Sentinex 22)	
	PM10 24 Hour Result (ug/m³)	YTD Average	PM10 24 Hour Result (ug/m³)	YTD Average	PM10 24 Hour Result (ug/m³)	YTD Average	PM10 24 Hour Result (ug/m³)	YTD Average
22/05/2018	16.2	28.53	22.9	25.54	10.5	21.06	16.9	28.37
23/05/2018	16.5	28.45	**34.2**	25.60	13.2	21.00	27.8	28.37
24/05/2018	27.3	28.44	**33.7**	25.66	20.4	21.00	25.9	28.35
25/05/2018	**30.6**	28.45	**36.1**	25.73	22.8	21.01	**35.4**	28.40
26/05/2018	25.6	28.43	**30.5**	25.77	19.8	21.00	**39**	28.47
27/05/2018	18.6	28.37	**39.2**	25.86	17.8	20.98	25.7	28.45
28/05/2018	28.2	28.37	**40.7**	25.96	18.2	20.96	**44.1465**	28.56
29/05/2018	22.2	28.33	**33**	26.01	14.7	20.92	22.6	28.52
30/05/2018	11.9	28.22	5.8	25.87	5.2	20.81	4.9	28.36
31/05/2018	7.8	28.08	7.6	25.75	5.1	20.71	7.7	28.22
1/06/2018	10.9	27.97	12.2	25.66	7.9	20.62	12.6	28.12
2/06/2018	12.3	27.87	10.9	25.56	7.9	20.54	6.6	27.98
3/06/2018	13.2	27.77	10.6	25.46	9.2	20.46	14.7	27.89
4/06/2018	12.3	27.67	9	25.36	9.1	20.39	15.4	27.81
5/06/2018	11.3	27.57	10.2	25.26	8.3	20.31	17.5	27.75
6/06/2018	2.73028	27.41	5.7	25.13	9.3	20.24	14.9	27.66
7/06/2018	17	27.34	10.3	25.04	16.3	20.22	28.1	27.67
8/06/2018	15.6	27.27	15.4	24.98	9.1	20.15	15.6	27.59
9/06/2018	10	27.16	7.5	24.87	6.4	20.06	7.5	27.47
10/06/2018	7.4	27.04	8.9	24.77	6.3	19.97	8.6	27.35
11/06/2018	11.3	26.94	6	24.65	9.2	19.90	17	27.29
12/06/2018	17.1	26.88	12.6	24.58	8.5	19.83	17.2	27.22
13/06/2018	14.6	26.80	10.7	24.49	7.4	19.76	9.6	27.12
14/06/2018	15.9	26.74	13.4	24.43	8.4	19.69	10.7	27.02
15/06/2018	15.1	26.67	17.1	24.38	9	19.62	10.2	26.92
16/06/2018	12.5	26.58	13.5	24.32	7.2	19.55	9.4	26.81
17/06/2018	8	26.47	8.4	24.22	6	19.46	6.7	26.69
18/06/2018	10.5	26.38	3.78264	24.10	5.2	19.38	2.26458	26.55
19/06/2018	7.3	26.27	4.6	23.98	1.68429	19.27	5.2	26.42
20/06/2018	12.5	26.19	9.6	23.90	10	19.22	11.1	26.33
21/06/2018	20	26.15	14	23.84	10.6	19.17	15	26.26
22/06/2018	12.9	26.07	9.3	23.76	5.1	19.09	12	26.18
23/06/2018	13.4	26.00	10.1	23.68	6.8	19.01	9.6	26.09
24/06/2018	24.6	25.99	16.1	23.63	11.8	18.97	23.2	26.07
25/06/2018	22.9	25.97	19.7	23.61	14	18.94	26.2	26.07
26/06/2018	24.3	25.96	17.7	23.58	15.9	18.93	29.7	26.09
27/06/2018	**35**	26.02	18.1	23.55	15.8	18.91	21.8	26.07
28/06/2018	7.8	25.91	6.6	23.45	5	18.83	6.9	25.96
29/06/2018	7.2	25.81	5.6	23.35	3.7	18.75	4.2	25.84
30/06/2018	10.9	25.73	7.6	23.26	5.3	18.67	6.7	25.73
1/07/2018	10.9	25.65	7.6	23.18	5.3	18.60	6.7	25.63
2/07/2018	18.1	25.60	14	23.13	11.9	18.56	30	25.65
3/07/2018	12.2	25.53	7.5	23.04	8.6	18.50	15.7	25.60
4/07/2018	12.3	25.46	7.4	22.96	11.7	18.47	17.7	25.56
5/07/2018	20.2	25.43	13.2	22.90	8.8	18.41	13.2	25.49
6/07/2018	15.4	25.38	14.1	22.86	4.6	18.34	6.5	25.39
7/07/2018	19.4	25.35	22.9	22.86	9.8	18.29	10.2	25.31

Date of Run	PM01 - Coralie (Sentinex 19)		PM02 - Wambo Road (Caban) (Sentinex 20)		PM03 - Thelander (Sentinex 21)		PM04 - Muller (Sentinex 22)	
	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average
8/07/2018	17.4	25.30	15.6	22.82	9	18.24	9.9	25.23
9/07/2018	14.5	25.25	22.5	22.82	8.4	18.19	8.9	25.14
10/07/2018	12.9	25.18	14.2	22.77	9.8	18.15	22.8	25.13
11/07/2018	20.4	25.16	26	22.79	13.2	18.12	**32.8**	25.17
12/07/2018	20.2	25.13	20.7	22.78	11.4	18.09	23.5	25.16
13/07/2018	16.8	25.09	16.6	22.75	10.5	18.05	12.1	25.09
14/07/2018	**32.6**	25.13	19.7	22.73	6.8	17.99	7.8	25.00
15/07/2018	11.8	25.06	**35.6**	22.80	7.5	17.93	9.5	24.92
16/07/2018	15.5	25.01	22.8	22.80	7.9	17.88	8.8	24.84
17/07/2018	17.5	24.97	26.7	22.82	10.2	17.84	11.3	24.77
18/07/2018	20.6	24.95	**37.5**	22.89	10.5	17.81	16.3	24.73
19/07/2018	**39.8**	25.03	**58.2**	23.07	**33.8**	17.89	**34.9**	24.78
20/07/2018	**37.5**	25.09	**46.6**	23.18	**31.3**	17.96	**40.1**	24.86
21/07/2018	**33.9**	25.13	30	23.22	17.7	17.95	23.6	24.85
22/07/2018	14.7	25.08	17.5	23.19	12.7	17.93	22.4	24.84
23/07/2018	28.1	25.10	27.8	23.21	15.1	17.91	**47.9**	24.95
24/07/2018	25.5	25.10	**43.9**	23.31	17.5	17.91	28	24.97
25/07/2018	25.2	25.10	**53.8**	23.46	19	17.92	29.2	24.99
26/07/2018	19.7	25.07	28.3	23.49	14.9	17.90	21.9	24.97
27/07/2018	22.3	25.06	**34.4**	23.54	14.7	17.89	23.1	24.96
28/07/2018	**40.3**	25.13	**46.8**	23.65	20.7	17.90	**54.9**	25.11
29/07/2018	**43.4**	25.22	**46.8**	23.76	27.2	17.94	**69.1**	25.32
30/07/2018	26.2	25.22	21.5	23.75	17.7	17.94	23.5	25.31
31/07/2018	16.2	25.18	17	23.72	9.9	17.91	11.9	25.25
1/08/2018	18.8	25.15	21.5	23.71	12.2	17.88	23.8	25.24
2/08/2018	26.6	25.16	20.7	23.69	28.4	17.93	**48.6**	25.35
3/08/2018	29	25.17	**31.4**	23.73	18.1	17.93	**30.6**	25.37
4/08/2018	**50**	25.29	**49**	23.85	**42.6**	18.04	**44.8**	25.46
5/08/2018	22.1	25.28	27	23.86	18.4	18.05	**32.7**	25.50
6/08/2018	20	25.25	18.3	23.84	15.2	18.03	17.6	25.46
7/08/2018	27.4	25.26	29	23.86	25.3	18.07	22.4	25.45
8/08/2018	13.7	25.21	10.7	23.80	7.3	18.02	7.7	25.36
9/08/2018	22	25.19	20.9	23.79	10.6	17.98	18.6	25.33
10/08/2018	16.5	25.15	16	23.75	9.3	17.94	12.1	25.27
11/08/2018	**30.2**	25.18	**33.2**	23.79	15.9	17.93	18.4	25.24
12/08/2018	15.6	25.13	9.2	23.73	5.1	17.88	7.9	25.17
13/08/2018	14.6	25.09	22	23.72	7.5	17.83	13.1	25.11
14/08/2018	13.8	25.04	29.3	23.75	7.1	17.78	13.2	25.06
15/08/2018	14.5	24.99	**35.6**	23.80	11.5	17.75	16.4	25.02
16/08/2018	19.8	24.97	**31.5**	23.83	16.3	17.75	27.3	25.03
17/08/2018	22.2	24.96	29.7101	23.86	11.3	17.72	17.4	25.00
18/08/2018	24.7	24.96	**34.4**	23.90	15.5	17.71	27.6	25.01
19/08/2018	22.4	24.94	14.8	23.87	9.8	17.67	21	24.99
20/08/2018	18.5	24.92	20.5	23.85	7.4	17.63	19	24.97
21/08/2018	13.8	24.87	**32.1**	23.89	10.1	17.60	19.4	24.94
22/08/2018	15.6	24.83	21.4	23.88	14	17.58	23.7	24.94
23/08/2018	**30.2**	24.85	23.4	23.87	24	17.61	**47.2**	25.03

Date of Run	PM01 - Coralie (Sentinex 19)		PM02 - Wambo Road (Caban) (Sentinex 20)		PM03 - Thelander (Sentinex 21)		PM04 - Muller (Sentinex 22)	
	PM10 24 Hour Result (ug/m³)	YTD Average	PM10 24 Hour Result (ug/m³)	YTD Average	PM10 24 Hour Result (ug/m³)	YTD Average	PM10 24 Hour Result (ug/m³)	YTD Average
24/08/2018	26.4319	24.86	27.3	23.89	26.2	17.65	**42.1**	25.10
25/08/2018	22.4	24.85	14.9	23.85	19.2	17.65	**34.9**	25.15
26/08/2018	15.5	24.81	10.2	23.79	13	17.63	16.1	25.11
27/08/2018	17.9	24.78	14	23.75	12.6	17.61	14.5	25.06
28/08/2018	21.2	24.77	17.8	23.73	14.7	17.60	22.9	25.05
29/08/2018	21.3	24.75	16.8757	23.70	13.6	17.58	22.2	25.04
30/08/2018	21.2	24.74	17.7	23.67	19.2	17.59	27.2	25.05
31/08/2018	**30.2**	24.76	26.4	23.68	23.9	17.62	**34.1**	25.09
1/09/2018	19.1	24.74	12.6	23.64	13.3	17.60	13	25.04
2/09/2018	19.2	24.71	9.4	23.58	14	17.58	15.5	25.00
3/09/2018	12.9	24.66	7.5	23.51	10.6	17.55	25.9	25.00
4/09/2018	12.4	24.62	3.2	23.43	6.1	17.51	13.6	24.96
5/09/2018	21	24.60	7.6	23.37	9.5	17.48	19.8	24.94
6/09/2018	20.5	24.58	17.2	23.34	15.5	17.47	28.7	24.95
7/09/2018	7.50278	24.52	5.11087	23.27	6.19574	17.42	10.8674	24.90
8/09/2018	6.3	24.44	4.6	23.19	4.3	17.37	11.2	24.84
9/09/2018	10.3	24.39	9.5	23.14	3.7	17.31	5.4	24.76
10/09/2018	15.4	24.35	16.4	23.11	12.1	17.29	18.5	24.74
11/09/2018	20	24.33	24.2	23.12	15.3	17.29	25	24.74
12/09/2018	25.3	24.34	25.5	23.13	15.6	17.28	21.7	24.73
13/09/2018	**41.2**	24.40	**42.4**	23.20	**36.0794**	17.35	**44.8**	24.81
14/09/2018	**45.8**	24.49	**40.9**	23.27	26.5	17.39	**44.7**	24.88
15/09/2018	**40.8**	24.55	**43.1**	23.35	24.4	17.42	28.9	24.90
16/09/2018	21.1	24.54	19.1	23.33	19.5	17.42	**36.8**	24.95
17/09/2018	29.8	24.56	27	23.35	28.3	17.47	**36.5**	24.99
18/09/2018	**39.4**	24.61	**35.9**	23.40	21.4	17.48	28.9	25.01
19/09/2018	**35.9**	24.66	**36**	23.44	**30.1**	17.53	**35.1**	25.04
20/09/2018	21.2	24.64	23.2	23.44	18.2	17.53	**34**	25.08
21/09/2018	22.8	24.64	25.1	23.45	18.3	17.54	**33**	25.11
22/09/2018	**46.2**	24.72	23.9	23.45	13.4	17.52	18	25.08
23/09/2018	**51.1**	24.82	**31.7**	23.48	24.3	17.55	26.9	25.09
24/09/2018	23.3	24.81	18.7	23.46	13.5	17.53	25.4	25.09
25/09/2018	20	24.79	13.6	23.43	12.1	17.51	19.7	25.07
26/09/2018	16.4	24.76	10.1	23.38	10.4	17.48	**NaN**	25.07
27/09/2018	17.1	24.73	13.8	23.34	12.3	17.46	18.9052	25.05
28/09/2018	27.2	24.74	22	23.34	9.6	17.44	12.9	25.00
29/09/2018	18.4	24.72	17.5	23.31	13	17.42	15.9	24.97
30/09/2018	20.9	24.71	17.7	23.29	16.3	17.41	21.2	24.95
1/10/2018	16.1	24.67	15.5	23.27	11.7	17.39	20.3	24.94
2/10/2018	21.1	24.66	27.1	23.28	15.6	17.39	26.2	24.94
3/10/2018	29.3	24.68	**31.9**	23.31	18.9	17.39	26.9	24.95
4/10/2018	13.5	24.64	11.3	23.27	12.1	17.37	14.4	24.91
5/10/2018	3.5	24.56	2.8	23.19	2.6	17.32	3	24.83
6/10/2018	9.4	24.51	8.1	23.14	6.6	17.28	14.1	24.79
7/10/2018	8.2	24.45	7.7	23.08	5.7	17.24	7.9	24.73
8/10/2018	12.6	24.41	8.7	23.03	8.5	17.21	11.6	24.68
9/10/2018	19.2	24.39	15.7	23.01	10.9	17.19	20.5	24.67

Date of Run	PM01 - Coralie (Sentinex 19)		PM02 - Wambo Road (Caban) (Sentinex 20)		PM03 - Thelander (Sentinex 21)		PM04 - Muller (Sentinex 22)	
	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average
10/10/2018	10.6	24.34	9.4	22.96	8.4	17.15	13.4	24.63
11/10/2018	12.1	24.30	9.8	22.91	8.8	17.12	9.4	24.58
12/10/2018	17.5	24.27	8.9	22.86	10.7	17.10	10.8	24.53
13/10/2018	23.5	24.27	10.7	22.82	13.3	17.09	15.2	24.49
14/10/2018	25.2	24.27	15.3	22.79	15.3	17.08	18.9	24.48
15/10/2018	22	24.27	15.3	22.77	20.7	17.09	18	24.45
16/10/2018	20.5	24.25	15.5	22.74	14	17.08	18.3	24.43
17/10/2018	16	24.22	15.4	22.72	8.4	17.05	12.8	24.39
18/10/2018	12.4	24.18	9.6	22.67	8.2	17.02	9.7	24.34
19/10/2018	14.1	24.15	12.8	22.64	9.2	17.00	12.4	24.30
20/10/2018	22.1	24.14	15.8	22.61	11.8	16.98	13.8	24.26
21/10/2018	16	24.11	13.4	22.58	16	16.98	13.5	24.23
22/10/2018	23.5	24.11	21.4	22.58	21.6	16.99	23.1	24.22
23/10/2018	12.7	24.07	18	22.56	14.4	16.98	14.2	24.19
24/10/2018	26.3	24.08	28.6	22.58	26.4	17.01	**32**	24.22
25/10/2018	18.6	24.06	21.5	22.58	22.2	17.03	26.3	24.22
26/10/2018	**36.5**	24.10	23.7	22.58	25.4	17.06	**51.2**	24.31
27/10/2018	**39.7**	24.16	**30.9**	22.61	23	17.08	**30.8**	24.33
28/10/2018	**32.7**	24.19	24.1	22.62	27.1	17.11	27.2	24.34
29/10/2018	**39.4**	24.24	22.3	22.62	**30.9**	17.16	**32.9**	24.37
30/10/2018	26.1	24.24	21.7	22.61	22.6	17.18	**34.8**	24.41
31/10/2018	**45.2**	24.31	**42.3**	22.68	**31**	17.22	**45.9**	24.48
1/11/2018	**32**	24.34	**37.1**	22.72	**31.6**	17.27	**42.6**	24.54
2/11/2018	**44.9**	24.40	**46.2**	22.80	24.5	17.29	29	24.55
3/11/2018	**36**	24.44	27	22.82	21	17.31	22.1	24.54
4/11/2018	**40.8**	24.49	**42.3**	22.88	**37.8**	17.37	**37.6**	24.59
5/11/2018	**32.3**	24.52	24.8	22.89	19.7	17.38	21.8	24.58
6/11/2018	**53.1**	24.61	**40.7**	22.94	**32.3**	17.43	**31.7**	24.60
7/11/2018	27.3	24.62	27.3	22.96	19.1	17.43	19.3	24.58
8/11/2018	12.4	24.58	11.1	22.92	11.1	17.41	11.3	24.54
9/11/2018	23.7	24.58	19.1	22.91	19.5	17.42	27.4	24.55
10/11/2018	26.5	24.58	19.9	22.90	21.9	17.44	24.4	24.55
11/11/2018	24.7	24.58	22.9	22.90	19.4	17.44	24.1	24.55
12/11/2018	17	24.56	17.9	22.88	17	17.44	22.8	24.54
13/11/2018	25.1	24.56	23.1	22.88	25.6	17.47	24.8	24.54
14/11/2018	27.8	24.57	28.6	22.90	22.1	17.48	23	24.54
15/11/2018	25.7	24.58	23.9	22.90	19.6	17.49	18.7	24.52
16/11/2018	14.3	24.54	11.5	22.87	9.9	17.46	13	24.48
17/11/2018	19.9	24.53	14	22.84	17.8	17.46	19.7	24.47
18/11/2018	23.5	24.53	14.5	22.81	17.9	17.47	19.5	24.45
19/11/2018	24.5	24.53	20.4	22.81	19.9	17.47	28.2	24.47
20/11/2018	**34.4**	24.56	25.9	22.82	24.2	17.49	**40.3**	24.51
21/11/2018	**57.6**	24.66	**65.2**	22.95	**53.9**	17.61	**48.5**	24.59
22/11/2018	**151.9**	25.05	**163.5**	23.38	**143.8**	18.00	**125**	24.90
23/11/2018	**103.3**	25.29	**102.4**	23.62	**96.2**	18.24	**88.1**	25.09
24/11/2018	23.4	25.28	16.6	23.60	20.1	18.24	14.5	25.06
25/11/2018	**31.6**	25.30	25.4	23.61	26.5	18.27	20.1	25.04

Date of Run	PM01 - Coralie (Sentinex 19)		PM02 - Wambo Road (Caban) (Sentinex 20)		PM03 - Thelander (Sentinex 21)		PM04 - Muller (Sentinex 22)	
	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average	PM10 24 Hour Result (ug/m^3)	YTD Average
26/11/2018	29.5	25.31	24.6	23.61	24.6	18.29	**34.4**	25.07
27/11/2018	**42.3**	25.37	**39**	23.65	**35.5**	18.34	**37.8486**	25.11
28/11/2018	12	25.33	9.3	23.61	10	18.31	11.3	25.07
29/11/2018	11.7	25.28	8.1	23.56	8.7	18.29	10	25.02
30/11/2018	18.8	25.26	14.2	23.54	12.5	18.27	20.3	25.01
1/12/2018	25.9	25.27	24.2	23.54	18.1	18.27	**34.8**	25.04
2/12/2018	**43.3**	25.32	**35.7**	23.58	29.6	18.30	**30.9**	25.06
3/12/2018	23	25.31	20.6	23.57	18.5	18.30	18	25.04
4/12/2018	**43.1**	25.37	**30.8**	23.59	**30.4**	18.34	**30.4**	25.05
5/12/2018	**32.9**	25.39	20	23.58	23.5	18.35	22.8	25.04
6/12/2018	22.3	25.38	19.2	23.56	18.8	18.35	20.9	25.03
7/12/2018	23.75	25.37	21.06	23.56	15.4	18.35	20.5	25.02
8/12/2018	**31**	25.39	**33.3**	23.59	25.5	18.37	**36.3**	25.05
9/12/2018	**44**	25.45	**33.7**	23.61	**33.9**	18.41	**48.2**	25.12
10/12/2018	**34.8**	25.47	**36.7**	23.65	**31.6**	18.45	**36.7**	25.15
11/12/2018	17	25.45	16.3	23.63	14.5	18.44	15.9	25.13
12/12/2018	16.5	25.42	13.1	23.60	12.5	18.42	14.4	25.10
13/12/2018	17	25.40	15.3	23.58	11.1	18.40	13	25.06
14/12/2018	23.7	25.39	17.3	23.56	16.6	18.40	19.3	25.04
15/12/2018	25.5	25.39	23.9	23.56	24.3	18.41	27.1	25.05
16/12/2018	27.7	25.40	28.7	23.57	28.4	18.44	**NaN**	25.05
17/12/2018	28.9	25.41	21.9	23.57	18.1	18.44	**NaN**	25.05
18/12/2018	**36.7**	25.44	27.6	23.58	27.6	18.47	**NaN**	25.05
19/12/2018	27.2	25.45	23.8	23.58	27	18.49	18.1	25.03
20/12/2018	21.8	25.44	21.2	23.58	15.5	18.48	14.3	25.00
21/12/2018	20.1	25.42	13.4	23.55	16.2	18.48	15.4	24.97
22/12/2018	13.8	25.39	7	23.50	8.7	18.45	14.2	24.94
23/12/2018	18.7	25.37	15.9	23.48	14.7	18.44	17.5	24.92
24/12/2018	25.8	25.37	18.7	23.47	17.6	18.44	24.1	24.92
25/12/2018	12	25.33	13.5	23.44	11.4	18.42	12.6	24.88
26/12/2018	20.9	25.32	19.9	23.43	20.2	18.42	29.8	24.90
27/12/2018	**53.4**	25.40	**35.7**	23.46	29.7	18.45	**39.5**	24.94
28/12/2018	**50.4**	25.47	**35.4**	23.49	**36.3**	18.50	**42.7**	24.99
29/12/2018	**49.8**	25.54	**33.1**	23.52	29.7	18.53	**41.2**	25.03
30/12/2018	**60.7**	25.63	**31.3**	23.54	**32.8**	18.57	**41.7**	25.08
31/12/2018	**43.7**	25.68	**41.9**	23.59	**41.6**	18.64	**43.7**	25.13

PM02 was inoperable for one day in March due to storms.
PM03 was inoperable for two days in January due to an intermittent fault with the UPS.
PM04 was inoperable for one day in September and three days in December due to storms.

Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Comments
SW01	Jan-18	7.84	913	6	
SW01	Feb-18	7.89	921	8	
SW01	Mar-18	7.98	968	10	
SW01	Apr-18	7.66	939	-	
SW01	May-18	7.75	1020	5	
SW01	Jun-18	7.72	984	6	
SW01	Jul-18				Pool
SW01	Aug-18				Pool
SW01	Sep-18				Pool
SW01	Oct-18				No flow
SW01	Nov-18	7.6	1030	8	
SW01	Dec-18				Pool
SW02	Jan-18				Pool
SW02	Feb-18	7.61	1310	5	
SW02	Mar-18	7.22	1310	46	
SW02	Apr-18	7.33	1260	-	
SW02	May-18				Pool
SW02	Jun-18				Pool
SW02	Jul-18				Pool
SW02	Aug-18				Pool
SW02	Sep-18				Pool
SW02	Oct-18				Pool
SW02	Nov-18				Dry
SW02	Dec-18				Dry
SW03	Jan-18	7.87	2600	17	
SW03	Feb-18	7.71	2310	113	
SW03	Mar-18				Pool
SW03	Apr-18				Pool
SW03	May-18	7.75	2430	7	
SW03	Jun-18				Pool
SW03	Jul-18				Pool
SW03	Aug-18				Pool
SW03	Sep-18				Pool
SW03	Oct-18	7.87	2620	12	Trickle
SW03	Nov-18				Pool
SW03	Dec-18				Pool
SW04	Jan-18				Dry
SW04	Feb-18				Pool
SW04	Mar-18				Dry
SW04	Apr-18				Dry
SW04	May-18				Dry
SW04	Jun-18				Dry
SW04	Jul-18				Dry
SW04	Aug-18				Dry
SW04	Sep-18				Dry
SW04	Oct-18				Pool
SW04	Nov-18				Pool
SW04	Dec-18				Dry

Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Comments
SW05	Jan-18				Dry
SW05	Feb-18				Dry
SW05	Mar-18				Pool
SW05	Apr-18				Pool
SW05	May-18				Pool
SW05	Jun-18				Dry
SW05	Jul-18				Dry
SW05	Aug-18				Dry
SW05	Sep-18				Dry
SW05	Oct-18				Pool
SW05	Nov-18				Pool
SW05	Dec-18				Dry
SW06	Jan-18				Pool
SW06	Feb-18				No flow
SW06	Mar-18				Pool
SW06	Apr-18				Pool
SW06	May-18				Pool
SW06	Jun-18				Dry
SW06	Jul-18				Dry
SW06	Aug-18				Dry
SW06	Sep-18				Dry
SW06	Oct-18				Pool
SW06	Nov-18				Dry
SW06	Dec-18				Dry
SW07	Jan-18				Dry
SW07	Feb-18				Pool
SW07	Mar-18				Pool
SW07	Apr-18				Pool
SW07	May-18				Pool
SW07	Jun-18				Dry
SW07	Jul-18				Dry
SW07	Aug-18				Dry
SW07	Sep-18				Dry
SW07	Oct-18				Dry
SW07	Nov-18				Dry
SW07	Dec-18				Dry
SW08	Jan-18				Dry
SW08	Feb-18				Unsafe access
SW08	Mar-18				Unsafe access
SW08	Apr-18				Unsafe access
SW08	May-18				Unsafe access
SW08	Jun-18				Dry
SW08	Jul-18				Dry
SW08	Aug-18				Dry
SW08	Sep-18				Dry
SW08	Oct-18				Dry
SW08	Nov-18				Dry
SW08	Dec-18				Unsafe access

Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Comments
SW14	Jan-18	8.4	525	5	
SW14	Feb-18	8.79	564	17	
SW14	Mar-18	8.9	533	<5	
SW14	Apr-18	8.47	631	436	
SW14	May-18	8.31	609	7	
SW14	Jun-18	8.42	589	<5	
SW14	Jul-18	8.44	535	<5	
SW14	Aug-18	8.63	533	15	
SW14	Sep-18	8.62	551	<5	
SW14	Oct-18	8.9	545	<5	
SW14	Nov-18	8.73	558	309	
SW14	Dec-18	8.76	374	<5	
SW15	Jan-18	8.85	9200	170	
SW15	Feb-18	8.83	8550	309	
SW15	Mar-18	8.76	8680	239	
SW15	Apr-18	9.19	7910	5800	
SW15	May-18	8.92	8900	204	
SW15	Jun-18	8.84	8190	82	
SW15	Jul-18	7.59	8430	20	
SW15	Aug-18	9.17	8830	122	
SW15	Sep-18	9.07	9210	86	
SW15	Oct-18	9.27	7570	128	
SW15	Nov-18	8.91	10300	5580	
SW15	Dec-18	8.85	9140	55	
SW27	Jan-18				Pool
SW27	Feb-18	7.41	580	548	
SW27	Mar-18				Pool
SW27	Apr-18				Pool
SW27	May-18				Pool
SW27	Jun-18				Pool
SW27	Jul-18				Dry
SW27	Aug-18				Pool
SW27	Sep-18				Dry
SW27	Oct-18				Pool
SW27	Nov-18				Pool
SW27	Dec-18				Pool
SW31	Jan-18	9.08	9920	415	
SW31	Feb-18	9.14	10500	9980	
SW31	Mar-18	9.08	7220	278	
SW31	Apr-18	9.14	7580	4050	
SW31	May-18	9.04	8440	390	
SW31	Jun-18	9.09	8810	114	
SW31	Jul-18	9.03	8260	52	
SW31	Aug-18	9.14	8480	20	
SW31	Sep-18	9.2	9770	59	
SW31	Oct-18	9.34	5520	35	
SW31	Nov-18	8.94	8660	4590	
SW31	Dec-18	9.18	7780	62	

Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Comments
SW32a	Jan-18				Pool
SW32a	Feb-18	7.42	466	507	
SW32a	Mar-18	7.57	710	150	
SW32a	Apr-18				Dry
SW32a	May-18				Dry
SW32a	Jun-18				Dry
SW32a	Jul-18				Dry
SW32a	Aug-18				Dry
SW32a	Sep-18				Dry
SW32a	Oct-18	7.53	629	368	
SW32a	Nov-18				Pool
SW32a	Dec-18				Dry
SW38	Jan-18	9.09	9570	745	Jan-18
SW38	Feb-18	9.12	9980	554	Feb-18
SW38	Mar-18	9.13	8640	582	Mar-18
SW38	Apr-18	9.12	8750	5060	Apr-18
SW38	May-18	9.06	8760	220	May-18
SW38	Jun-18	8.96	8640	250	Jun-18
SW38	Jul-18	8.98	8360	52	Jul-18
SW38	Aug-18	9.06	8900	74	Aug-18
SW38	Sep-18	8.96	10100	92	Sep-18
SW38	Oct-18	9.23	7580	39	Oct-18
SW38	Nov-18	8.95	7500	38	Nov-18
SW38	Dec-18	9.04	8430	<5	Dec-18
SW39	Jan-18				Dry
SW39	Feb-18				Dry
SW39	Mar-18				Pool
SW39	Apr-18				Pool
SW39	May-18				Pool
SW39	Jun-18				Dry
SW39	Jul-18				Dry
SW39	Aug-18				Dry
SW39	Sep-18				Dry
SW39	Oct-18				Pool
SW39	Nov-18				Dry
SW39	Dec-18				Dry
SW40	Jan-18				Pool
SW40	Feb-18				Pool
SW40	Mar-18				Pool
SW40	Apr-18				Pool
SW40	May-18				Pool
SW40	Jun-18				Pool
SW40	Jul-18				Pool
SW40	Aug-18				Pool
SW40	Sep-18				Pool
SW40	Oct-18				Pool
SW40	Nov-18				Pool
SW40	Dec-18				Pool

Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Comments
SW41	Jan-18				N/A
SW41	Feb-18				N/A
SW41	Mar-18				N/A
SW41	Apr-18				N/A
SW41	May-18				N/A
SW41	Jun-18				Dry
SW41	Jul-18				Dry
SW41	Aug-18				Dry
SW41	Sep-18				Dry
SW41	Oct-18				Pool
SW41	Nov-18				Dry
SW41	Dec-18				Dry
SW52	Jan-18				N/A
SW52	Feb-18	9.33	5230	75	
SW52	Mar-18	9.39	2120	22	
SW52	Apr-18	9.27	2270	1270	
SW52	May-18	9.24	2630	22	
SW52	Jun-18	9.22	2780	12	
SW52	Jul-18	9.2	2870	29	
SW52	Aug-18	9.31	3170	45	
SW52	Sep-18	9.37	4080	30	
SW52	Oct-18	9.64	2260	28	
SW52	Nov-18	9.83	2780	1490	
SW52	Dec-18	10.2	2470	40	

APPENDIX E

WAMBO MINE 2018 AIR QUALITY MONITORING REVIEW

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11 March 2019

Attention: Nicole Dobbins
Wambo Coal Pty Ltd
PMB 1, Singleton NSW 2330

Project Name: Wambo Coal
Project Number: IA209700

Dear Nicole

Wambo Mine 2018 Air Quality Monitoring Review

I have completed a review of Wambo Coal's air quality monitoring data for 2018. Please see attached for the outcomes of the analyses.

In summary there were 25 days in 2018 when the PM_{10} concentration at one or more of the four monitoring locations exceeded 50 µg/m^3. The data on each of these days were examined in order to identify the likely contribution of Wambo Coal activities to the measured results. The analysis indicated that activities at Wambo mine were likely to have contributed to some of the measured results however none of the calculated site contributions exceeded Wambo Coal's Development Consent acquisition criteria for 24-hour average PM_{10} of 50 µg/m^3. There were nine days identified when calculated site contribution influenced compliance with the impact assessment criterion of 50 µg/m^3.

The site contribution to monitored levels was calculated by an upwind-downwind approach. There are some limitations to this approach, which have been identified, and it was noted that the calculated site contributions will have some embedded uncertainty.

Yours sincerely

Shane Lakmaker
Principal (Air Quality)
(02) 4979 2663
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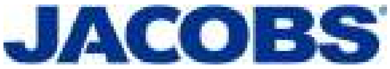

11 March 2019

1. Background

Wambo Coal has a network of air quality and meteorological monitoring equipment around Wambo Mine which is designed to meet relevant conditions under its Development Consent (DA 305-7-2003). **Figure 1** shows the location of the four Tapered Element Oscillating Microbalance (TEOM) instruments which are setup to continuously measure PM_{10} concentrations. The monitors are referred to by the following identification labels:

- D1 – Muller – AQ04
- D2 – Caban – AQ02
- D3 – Coralie – AQ01
- D4 – Thelander – AQ03

Data from the TEOMs are managed by Novecom's Sentinex system. Also shown in **Figure 1** is the location of Wambo Coal's automatic weather station (see legend).

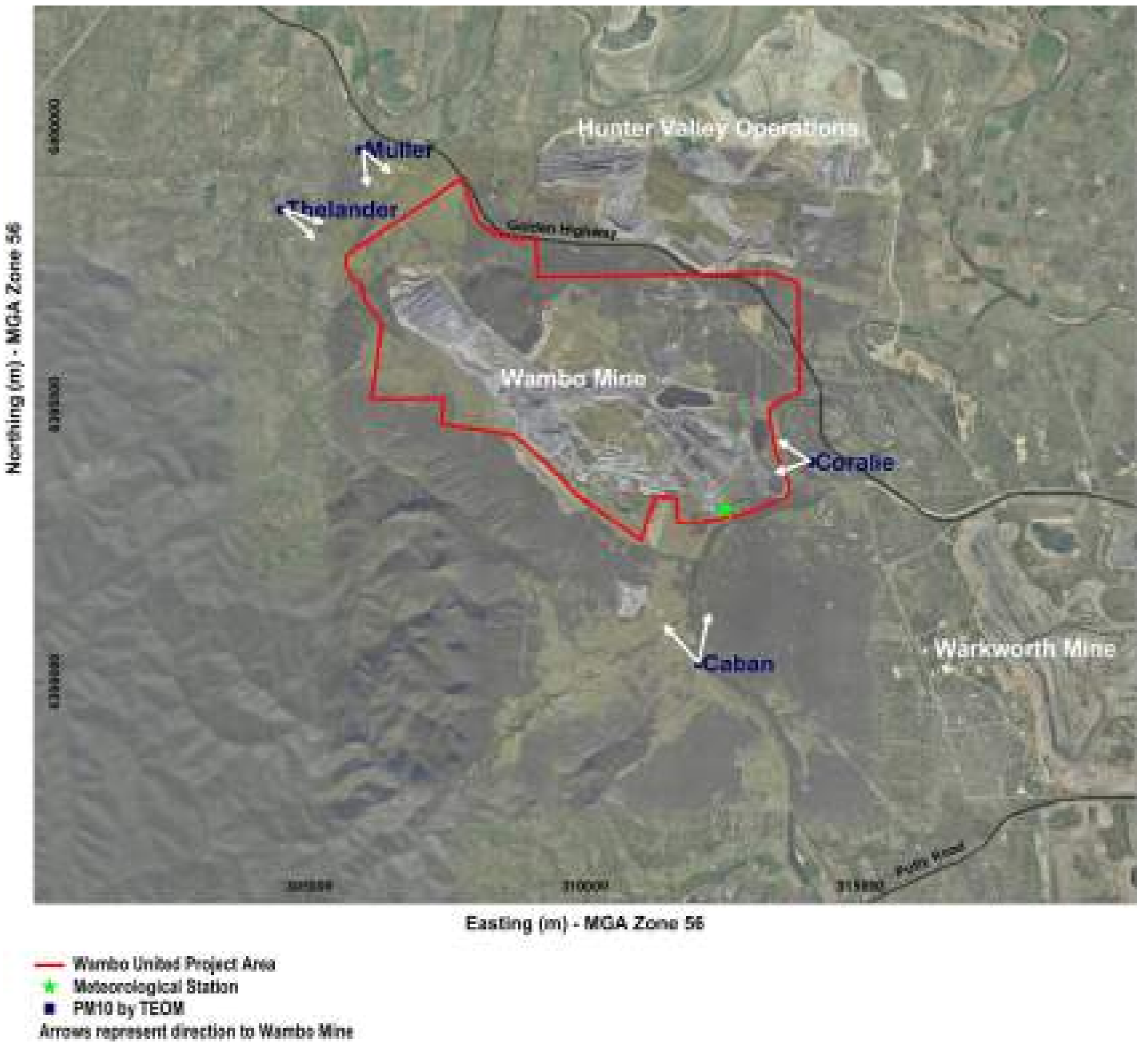

Figure 1 Location of monitoring stations around Wambo Mine

A review of the Wambo Coal's monitoring data has been carried out. The purpose of the review was to identify all days in 2018 when the PM_{10} concentration at one or more locations exceeded 50 µg/m^3, and to identify the likely contribution of Wambo Coal activities to the measured results on these days.

2. Approach to Review

The monitoring data review involved:

- Obtaining and collating the monitoring data into 10-minute average records of PM_{10} concentrations and 10-minute average records of wind speed and wind direction. Data from the 2018 calendar year were examined. All data were supplied to Jacobs by Wambo Coal. It was assumed that the data were validated.
- Preparing summary statistics. These statistics included, for each of the four sites, the maximum 24-hour average, the number of days above the 24-hour average criteria, and the annual average.
- Analysing all days in 2018 when the PM_{10} concentration at one or more location exceeded 50 µg/m^3. The data for each "exceedance" day was analysed by preparing graphs showing the 10-minute average PM_{10} concentrations at each monitoring location, with wind conditions, for each day of interest.
- Summarising the exceedance days and calculating the likely contribution of Wambo Coal activities to the measured results.

The contribution of Wambo Coal activities to the measured results was calculated by first determining the wind direction ranges which coincided with a wind direction from Wambo Mine towards each monitor (see **Table 1**). The site contribution to each monitor was then calculated for every 10-minute average record in each exceedance day based on the concurrent wind direction, and using downwind concentration minus upwind concentration calculations. Finally, the site contribution to each monitor was calculated as a 24-hour average. The limitation with this method is that the calculated contribution may not consider dust that is generated by the mining activities but transported towards a monitor at an earlier or later time under different wind conditions (that is, re-suspended dust). In addition, this procedure does not account for any dust generating activities which may have been located between the mine and the monitor. These factors mean that the calculated site contribution will have some embedded uncertainty.

Table 1 Wind directions to Wambo mining activities

Monitoring site	Directions to Wambo mining activities
Muller	Between 130 and 180 degrees from true north
Caban	Between 320 and 10 degrees from true north
Coralie	Between 255 and 300 degrees from true north
Thelander	Between 110 and 140 degrees from true north

Outcomes of the review are provided below.

3. Monitored Results

The data capture rates are shown in **Table 2**. Generally, a data capture rate of 90 to 95% is considered acceptable for air quality monitoring networks as this takes into account downtime from servicing, maintenance, calibrations and reasonable periods to deal with breakdowns. All sites achieved greater than 90% data capture.

Table 2 Data capture rates

Year	D1 – Muller	D2 – Wambo	D3 – Coralie	D4 - Thelander
2018	97.9%	98.5%	98.3%	95.6%

Table 3 summarises the measured PM_{10} concentration data for each site. There were 25 unique days when the PM_{10} concentration exceeded 50 µg/m^3 at one or more locations.

Table 3 Summary of measured PM_{10} concentrations in 2018

Statistic	D1 – Muller	D2 – Caban	D3 – Coralie	D4 - Thelander
Maximum 24-hour average (µg/m^3)	123	163	153	145
Number of days above 50 µg/m^3	13	10	13	5
Annual average (µg/m^3)	24	22	24	18

Table 4 lists the 25 days when the 24-hour average PM_{10} concentration exceeded 50 µg/m^3 at one or more locations.

Table 4 Days above 50 µg/m^3 PM_{10} at one or more locations

Exceedance day	Measured 24-hour average PM_{10} concentration in µg/m^3			
	D1 – Muller	D2 – Caban	D3 – Coralie	D4 - Thelander
18/01/2018	51	40	32	29
19/01/2018	48	36	61	40
23/01/2018	52	40	38	29
9/02/2018	56	39	39	28
15/02/2018	67	63	77	59
16/02/2018	59	52	50	55
19/02/2018	39	28	56	33
19/03/2018	62	51	71	46
20/03/2018	55	41	43	36
11/04/2018	47	51	33	25
15/04/2018	44	51	51	47
18/07/2018	35	58	40	36
24/07/2018	28	53	23	19
27/07/2018	54	46	40	20
28/07/2018	67	45	41	27
26/10/2018	52	24	37	25

Exceedance day	Measured 24-hour average PM_{10} concentration in µg/m^3			
	D1 – Muller	D2 – Caban	D3 – Coralie	D4 - Thelander
6/11/2018	30	39	53	30
21/11/2018	46	65	56	52
22/11/2018	123	163	153	145
23/11/2018	84	98	99	92
9/12/2018	51	31	42	31
27/12/2018	40	33	58	28
28/12/2018	44	35	53	34
29/12/2018	43	30	52	26
30/12/2018	42	27	64	30

Figure 2 shows all measured 24-hour average concentrations from each monitoring site in 2018. The Development Consent includes two relevant criteria for 24-hour average PM_{10}, as follows:

- 50 µg/m^3 as a total impact due to the development and other sources ("impact" criterion)
- 50 µg/m^3 as an incremental increase due to the development on its own ("acquisition" criteria)

The most significant exceedances of 50 µg/m^3 were measured in November. **Section 4** provides a summary of the data on each exceedance day, in order to determine the likely contribution of Wambo Coal's activities to the measured results.

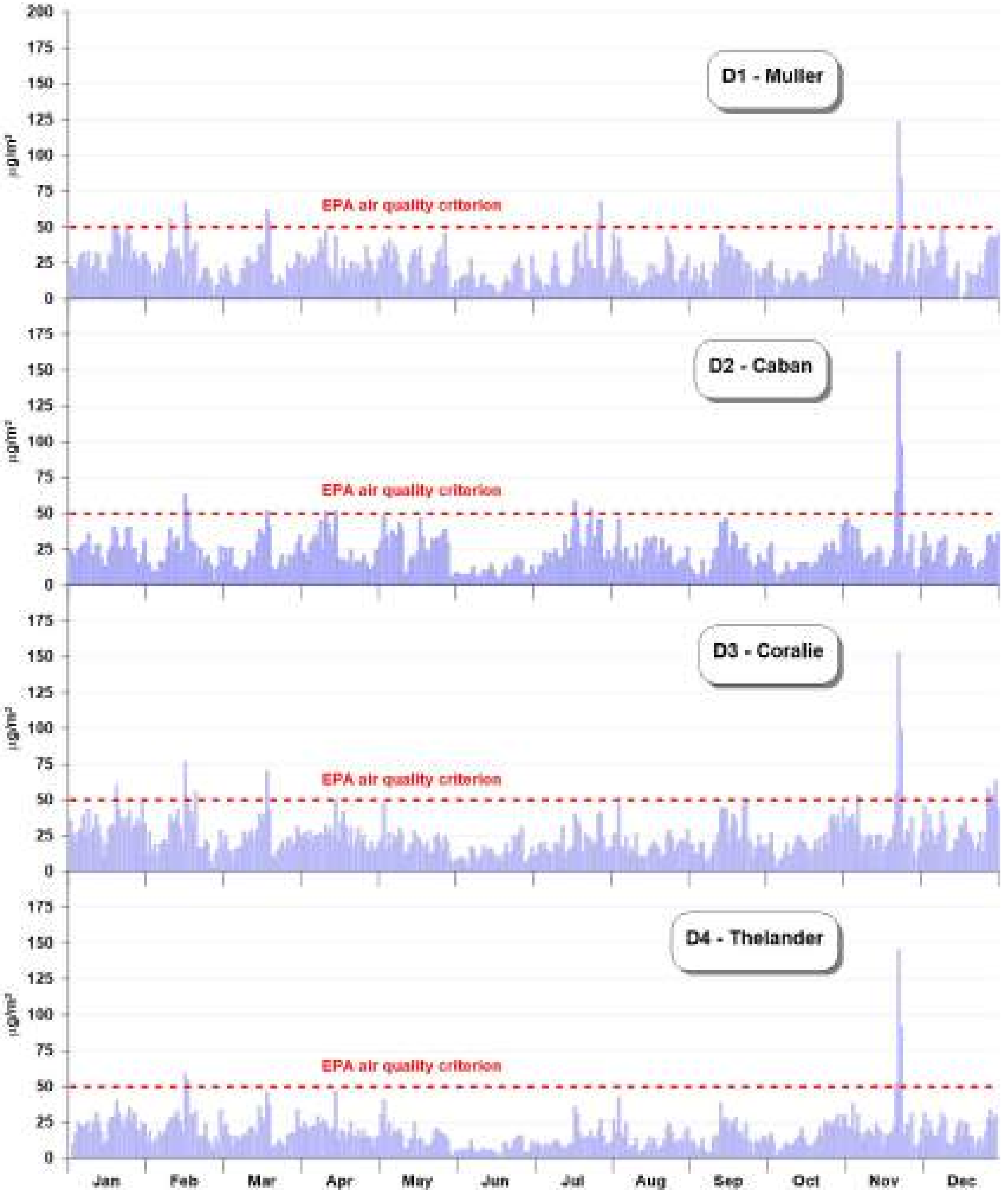

Figure 2 Measured 24-hour average PM_{10} concentrations

4. Summary

Table 5 lists the 25 days when the 24-hour average PM_{10} concentration exceeded 50 µg/m^3 at one or more locations, along with the calculated site contribution for each of these days based on analyses of the PM_{10} data and wind observations. **Appendix A** provides the graphical analyses of the monitoring data for all 25 exceedance days. These analyses, and accompanying data, were used to determine if activities at Wambo Mine were likely to have influenced the measured exceedance at one or more of the monitoring locations.

The air quality and meteorological monitoring data indicated that exceedances of 50 µg/m^3 (24-hour average PM_{10}) were likely to have been influenced by activities at Wambo Mine on 9 of the 25 exceedance days in 2018. None of the calculated site contributions were above Wambo Coal's Development Consent acquisition criterion.

Table 5 Site contribution for days above 50 µg/m^3 PM_{10} at one or more locations

Exceedance day	Measured 24-hour average PM_{10} concentration in µg/m^3 (calculated site contribution in parentheses)				Exceedance influenced / caused by Wambo Mine?
	D1 – Muller	D2 – Caban	D3 – Coralie	D4 – Thelander	
18/01/2018	51 (7.2)	40 (0.1)	32 (0.6)	29 (0.3)	Yes
19/01/2018	48 (2.6)	36 (1.4)	61 (0.2)	40 (0.2)	No
23/01/2018	52 (1.8)	40 (1.1)	38 (0.4)	29 (0.6)	No
9/02/2018	56 (15.4)	39 (0.5)	39 (0.2)	28 (0.2)	Yes
15/02/2018	67 (11.7)	63 (1.3)	77 (0.1)	59 (0.8)	No
16/02/2018	59 (0.9)	52 (3.5)	50 (0)	55 (1.1)	Yes
19/02/2018	39 (3.3)	28 (0)	56 (0)	33 (1.9)	No
19/03/2018	62 (2.5)	51 (0.5)	71 (1.3)	46 (0)	No
20/03/2018	55 (13.1)	41 (0)	43 (0)	36 (0.8)	Yes
11/04/2018	47 (2.4)	51 (1.4)	33 (0)	25 (0)	No
15/04/2018	44 (0)	51 (4.5)	51 (3.2)	47 (0)	Yes
18/07/2018	35 (0.6)	58 (1.4)	40 (1.5)	36 (0)	No
24/07/2018	28 (0)	53 (3)	23 (2)	19 (0)	Yes
27/07/2018	54 (0.3)	46 (0.1)	40 (0.1)	20 (0)	No
28/07/2018	67 (0.8)	45 (3.2)	41 (1)	27 (0.1)	No
26/10/2018	52 (1.1)	24 (0)	37 (0.3)	25 (0.5)	No
6/11/2018	30 (0.3)	39 (1.8)	53 (5.4)	30 (0)	Yes
21/11/2018	46 (0)	65 (2.6)	56 (3.3)	52 (0)	No
22/11/2018	123 (0)	163 (1.5)	153 (19.4)	145 (0)	No
23/11/2018	84 (0)	98 (0.1)	99 (12.7)	92 (0)	No
9/12/2018	51 (14.4)	31 (0.3)	42 (0.1)	31 (0.6)	Yes
27/12/2018	40 (1.7)	33 (0.5)	58 (0)	28 (0.7)	No
28/12/2018	44 (4.6)	35 (2.4)	53 (0.1)	34 (1)	No
29/12/2018	43 (5)	30 (1.3)	52 (2.6)	26 (1.4)	Yes

Exceedance day	Measured 24-hour average PM_{10} concentration in µg/m^3 (calculated site contribution in parentheses)				Exceedance influenced / caused by Wambo Mine?
	D1 – Muller	D2 – Caban	D3 – Coralie	D4 – Thelander	
30/12/2018	42 (5.1)	27 (2.3)	64 (1.1)	30 (0.6)	No

5. Conclusion

The main conclusions of this monitoring data review were as follows:

- There were 25 unique days when the PM_{10} concentration exceeded 50 µg/m^3 at one or more monitoring locations in 2018.
- There were 9 days identified (of the 25 exceedance days) when the calculated site contribution influenced compliance with the impact assessment criterion.
- None of the calculated site contributions exceeded Wambo Coal's Development Consent acquisition criteria.

Appendix A Exceedance Day Analyses

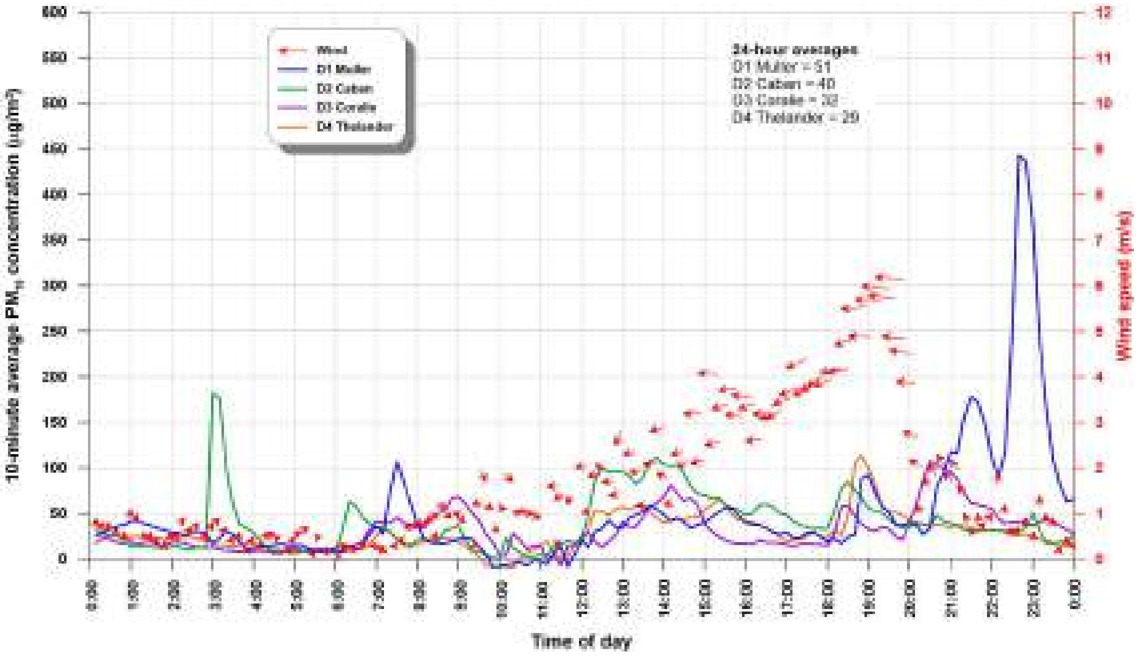

Figure A1 PM_{10} concentrations and wind conditions on 18 Jan 2018

Analysis:

- 24-hour average PM_{10} concentration exceedance of 50 µg/m^3 at D1 was likely influenced by activities at Wambo Mine.
- Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

11 March 2019

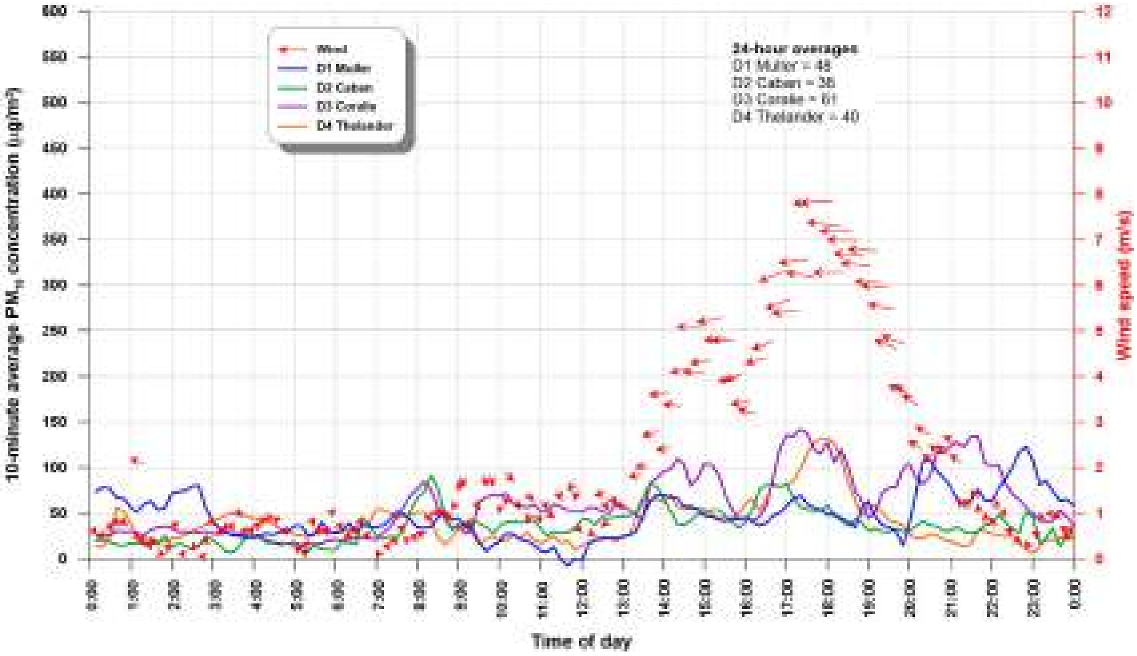

Figure A2 PM$_{10}$ concentrations and wind conditions on 19 Jan 2018

Analysis:

- 24-hour average PM$_{10}$ concentration exceedance of 50 µg/m^3 at D3 was not caused by activities at Wambo Mine.
- Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

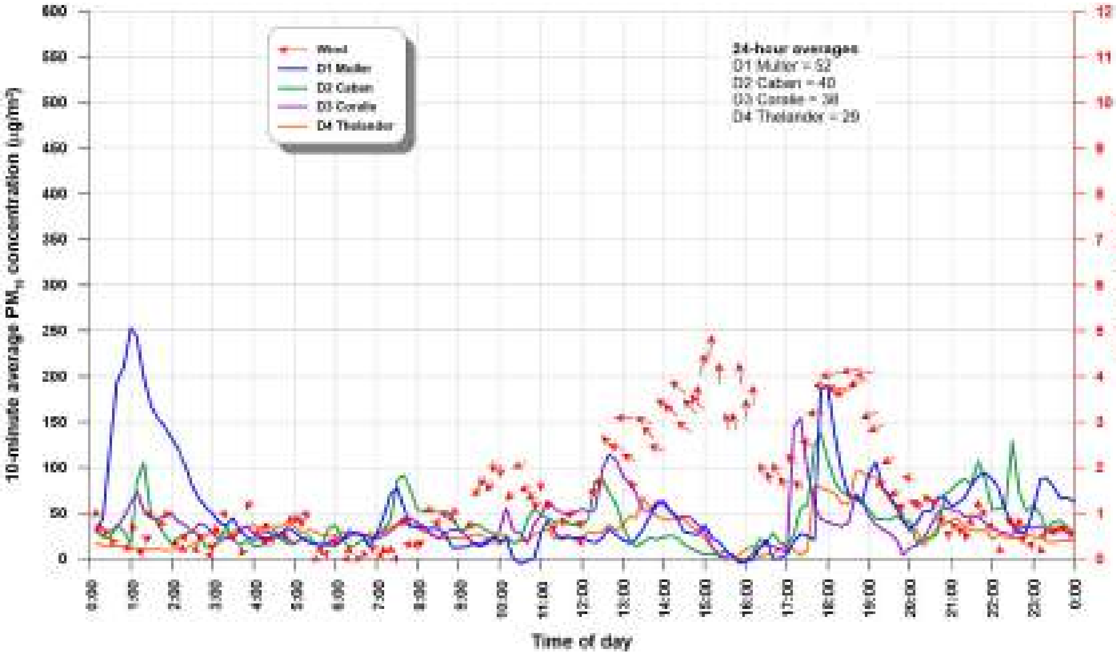

Figure A3 PM_{10} concentrations and wind conditions on 23 Jan 2018

Analysis:

- 24-hour average PM_{10} concentration exceedance of 50 µg/m³ at D1 was not caused by activities at Wambo Mine.
- Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m³.

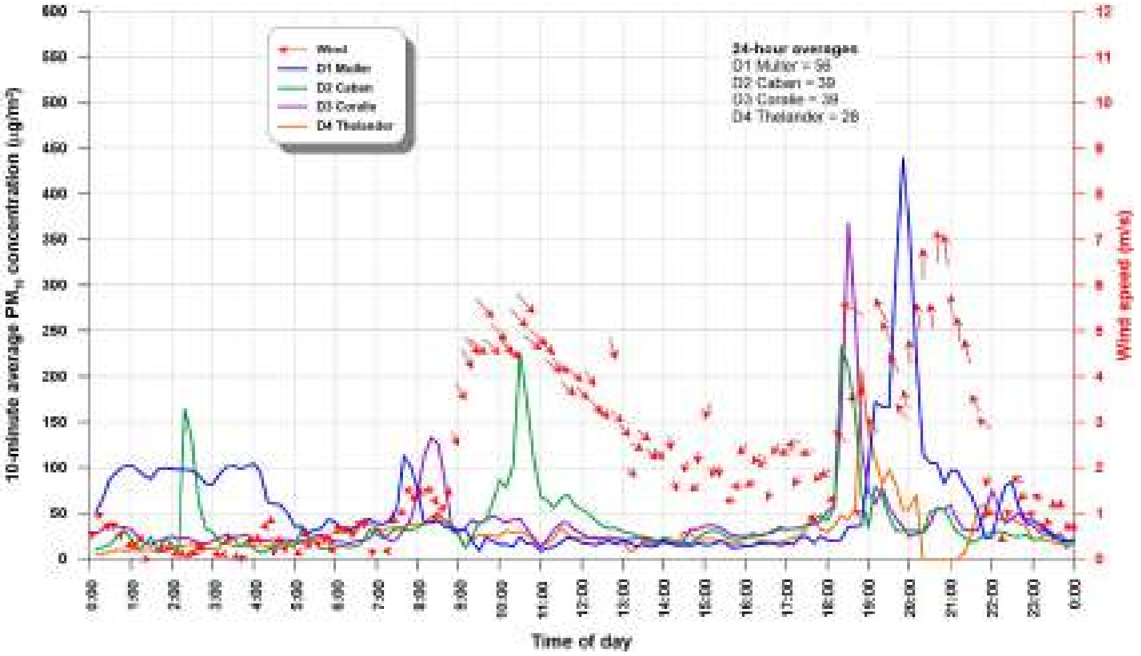

Figure A4 PM_{10} concentrations and wind conditions on 9 Feb 2018

Analysis:

- 24-hour average PM_{10} concentration exceedance of 50 µg/m³ at D1 was likely influenced by activities at Wambo Mine.
- Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m³.

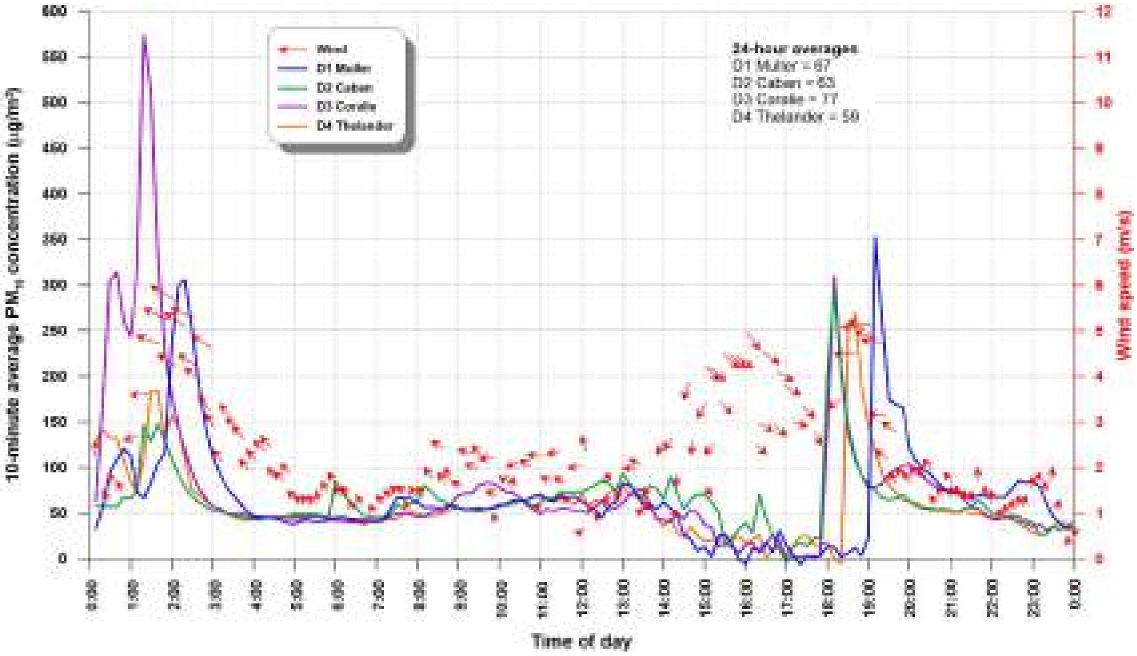

Figure A5 PM_{10} concentrations and wind conditions on 15 Feb 2018

Analysis:

- 24-hour average PM_{10} concentration exceedances of 50 µg/m^3 at all monitors were not caused by activities at Wambo Mine.
- Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

11 March 2019

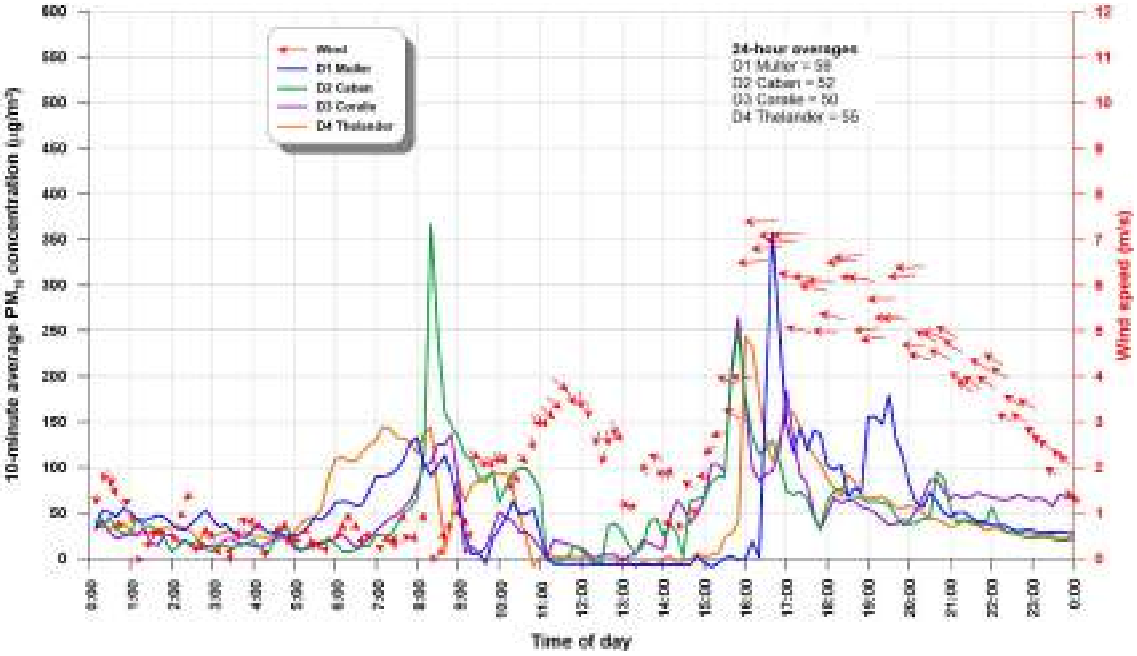

Figure A6 PM_{10} concentrations and wind conditions on 16 Feb 2018

Analysis:

- 24-hour average PM_{10} concentration exceedance of 50 µg/m^3 at D2 was likely influenced by activities at Wambo Mine.
- Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

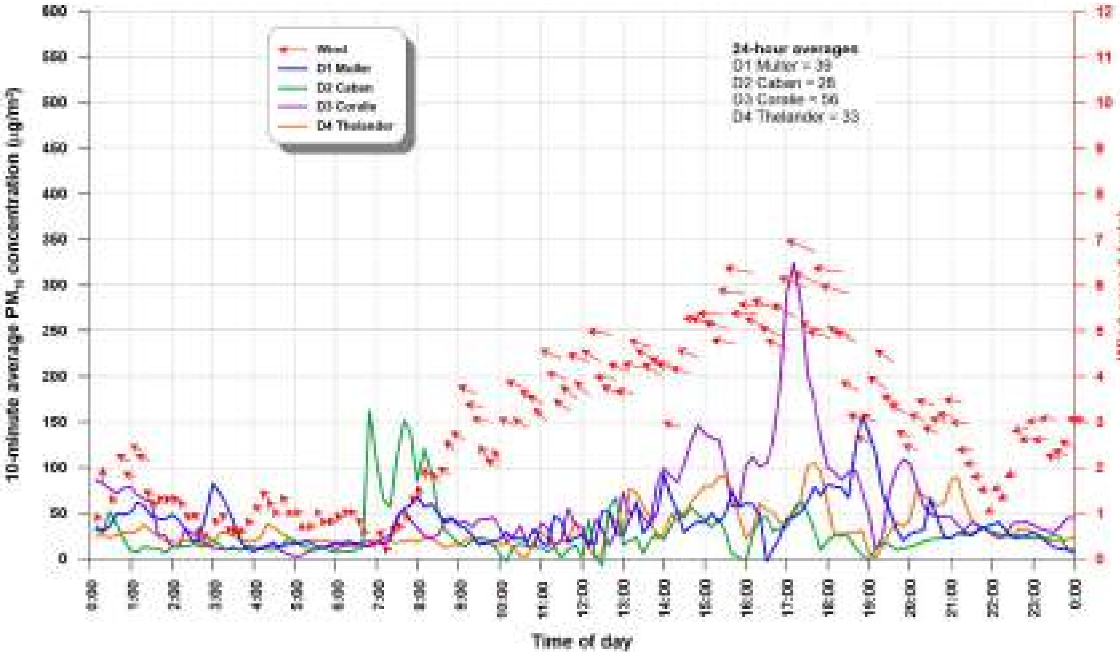

Figure A7 PM_{10} concentrations and wind conditions on 19 Feb 2018

Analysis:

- 24-hour average PM_{10} concentration exceedance of 50 µg/m^3 at D3 was not caused by activities at Wambo Mine.
- Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

11 March 2019

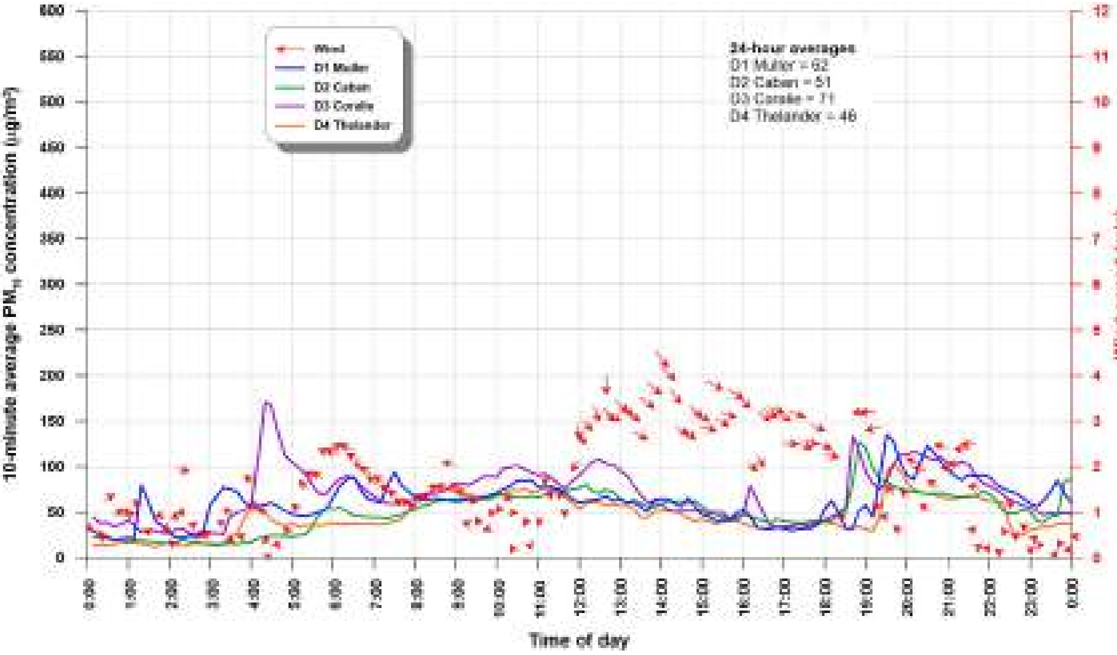

Figure A8 PM_{10} concentrations and wind conditions on 19 Mar 2018

Analysis:

- 24-hour average PM_{10} concentration exceedances of 50 µg/m^3 at D1, D2 and D3 were not caused by activities at Wambo Mine.
- Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

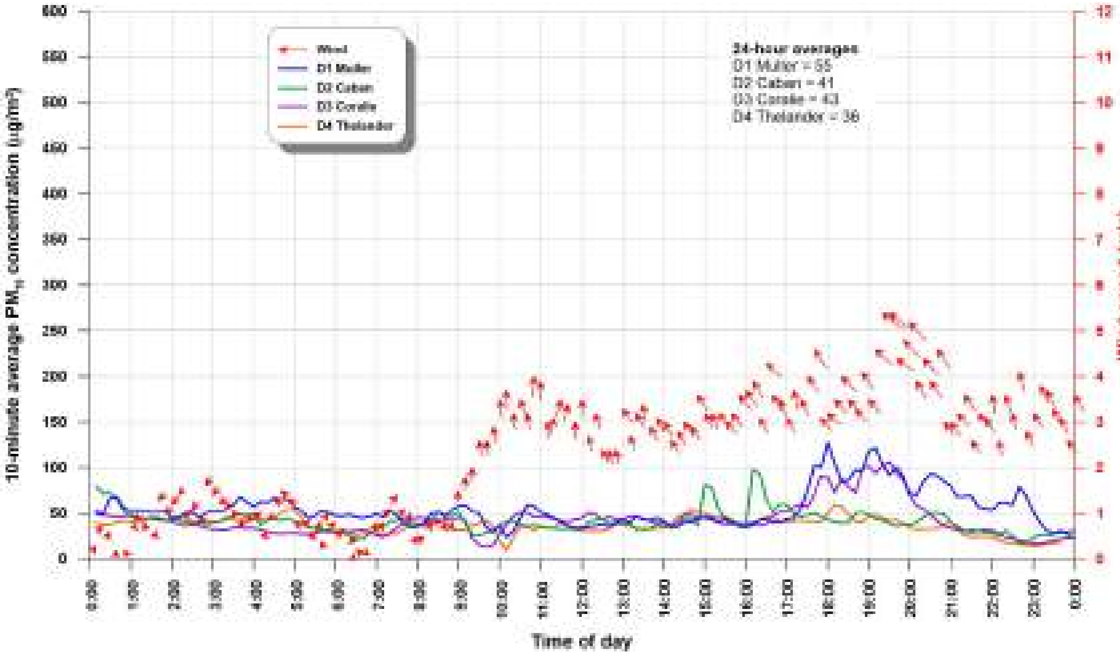

Figure A9 PM$_{10}$ concentrations and wind conditions on 20 Mar 2018

Analysis:

- 24-hour average PM$_{10}$ concentration exceedance of 50 µg/m^3 at D1 was likely influenced by activities at Wambo Mine.
- Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

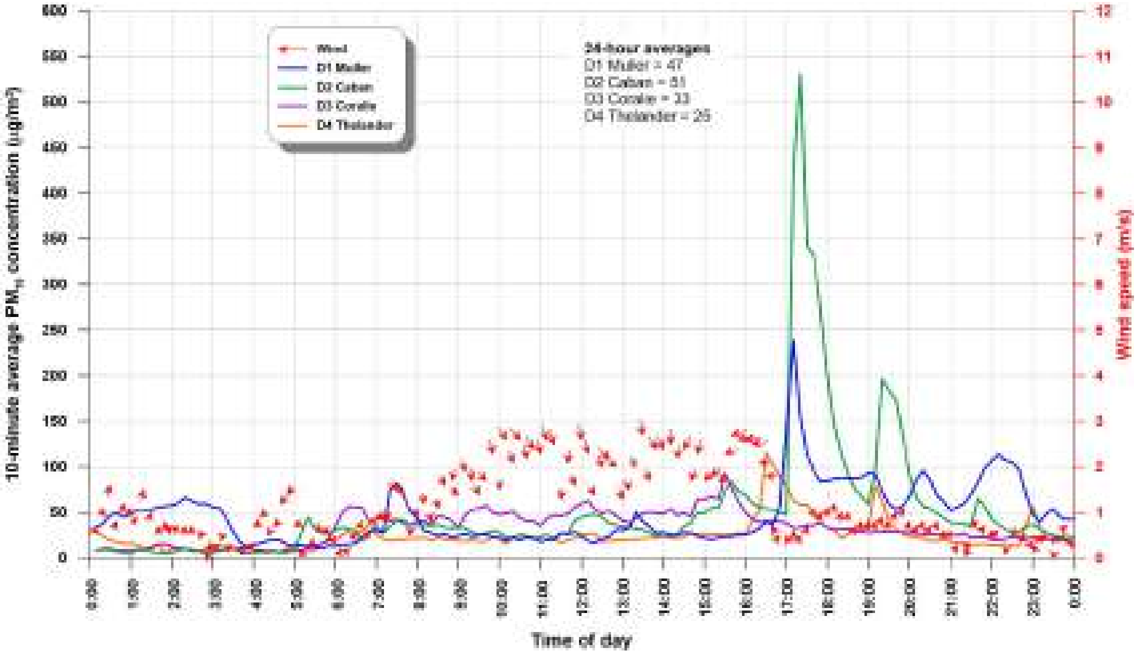

Figure A10 PM_{10} concentrations and wind conditions on 11 Apr 2018

Analysis:

- 24-hour average PM_{10} concentration exceedance of 50 µg/m^3 at D2 was not caused by activities at Wambo Mine.
- Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

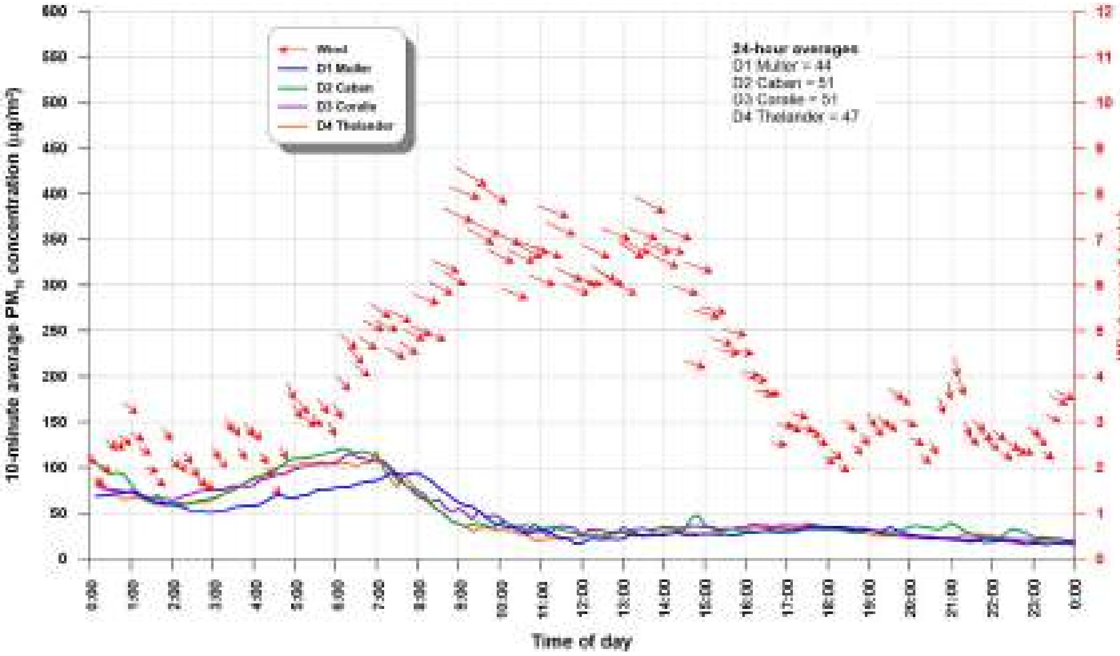

Figure A11 PM_{10} concentrations and wind conditions on 15 Apr 2018

Analysis:

- 24-hour average PM_{10} concentration exceedances of 50 µg/m^3 at D2 and D3 was likely influenced by activities at Wambo Mine.
- Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

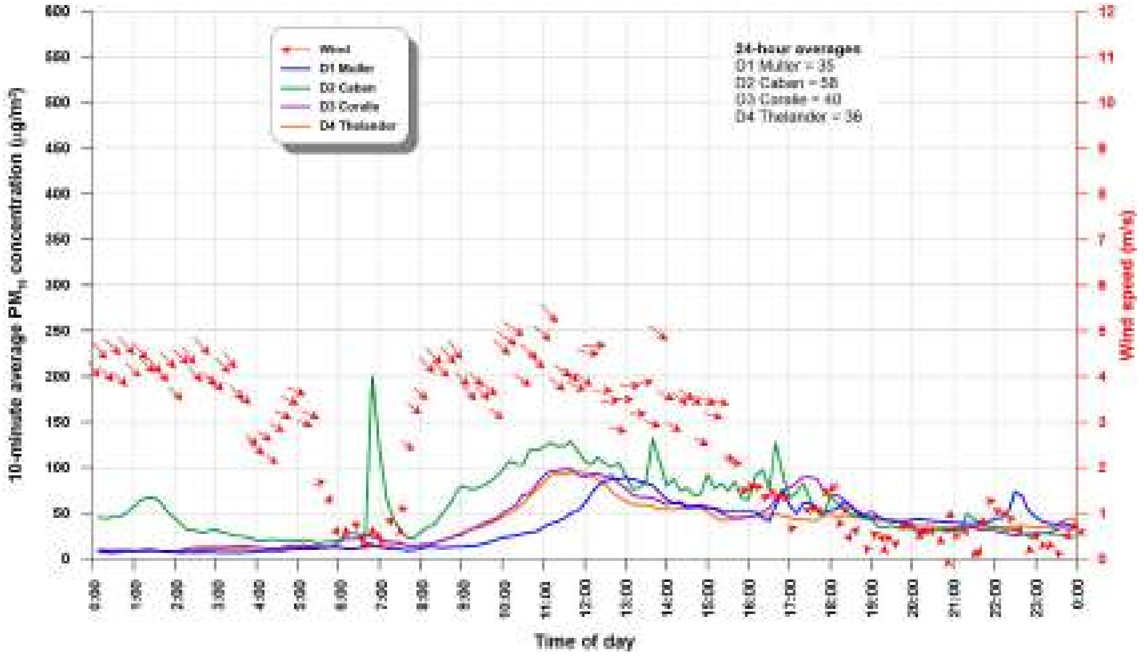

Figure A12 PM_{10} concentrations and wind conditions on 18 Jul 2018

Analysis:

- 24-hour average PM_{10} concentration exceedance of 50 µg/m^3 at D2 was not caused by activities at Wambo Mine.
- Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

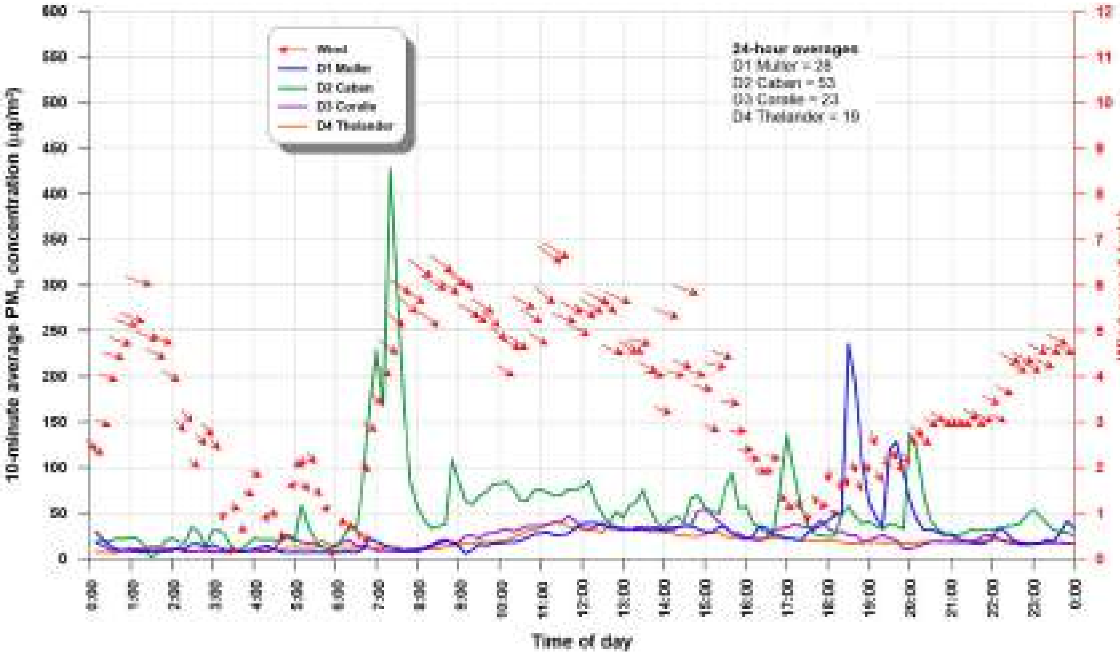

Figure A13 PM_{10} concentrations and wind conditions on 24 Jul 2018

Analysis:

- 24-hour average PM_{10} concentration exceedance of 50 µg/m^3 at D2 was likely influenced by activities at Wambo Mine.
- Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

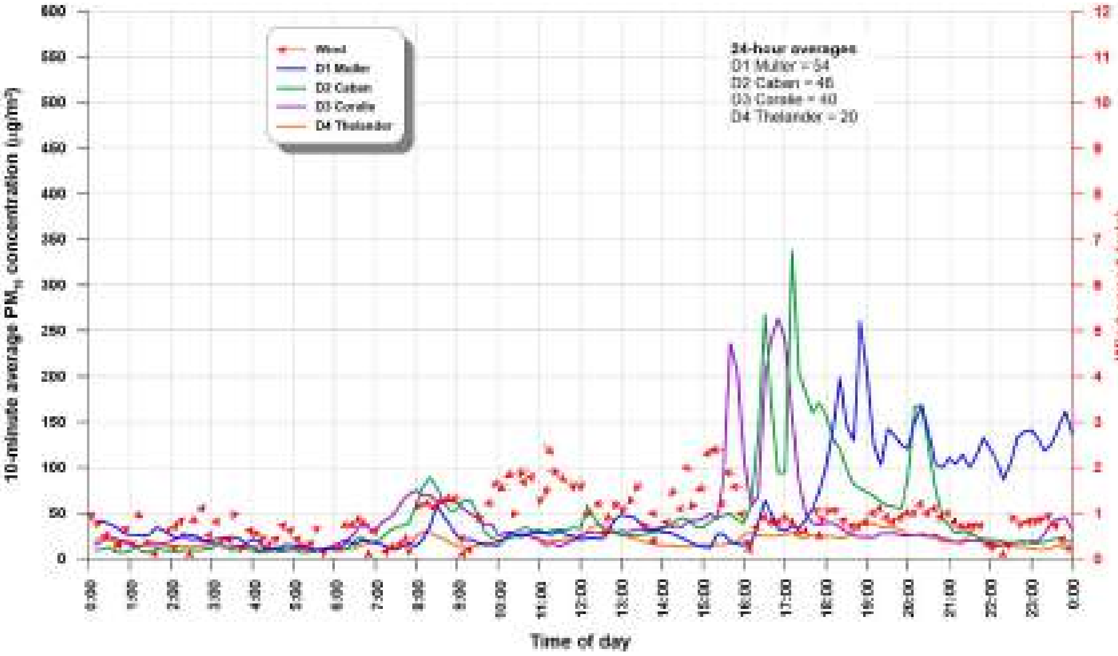

Figure A14 PM_{10} concentrations and wind conditions on 27 Jul 2018

Analysis:

- 24-hour average PM_{10} concentration exceedance of 50 µg/m^3 at D1 was not caused by activities at Wambo Mine.
- Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

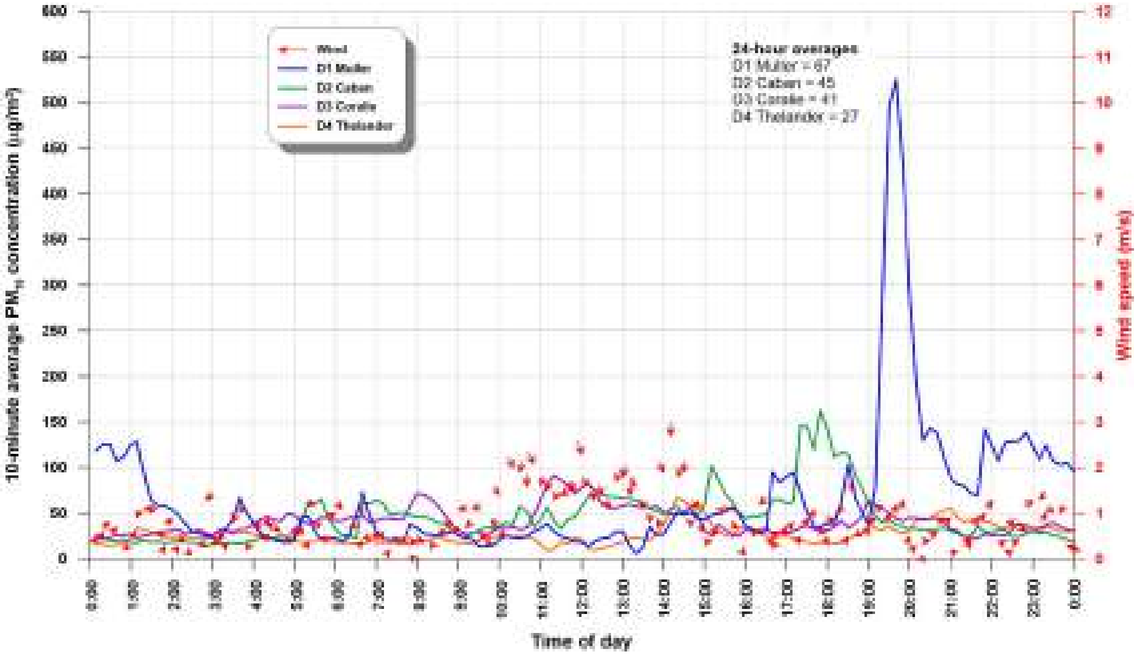

Figure A15 PM_{10} concentrations and wind conditions on 28 Jul 2018

Analysis:

- 24-hour average PM_{10} concentration exceedance of 50 µg/m^3 at D1 was not caused by activities at Wambo Mine.
- Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

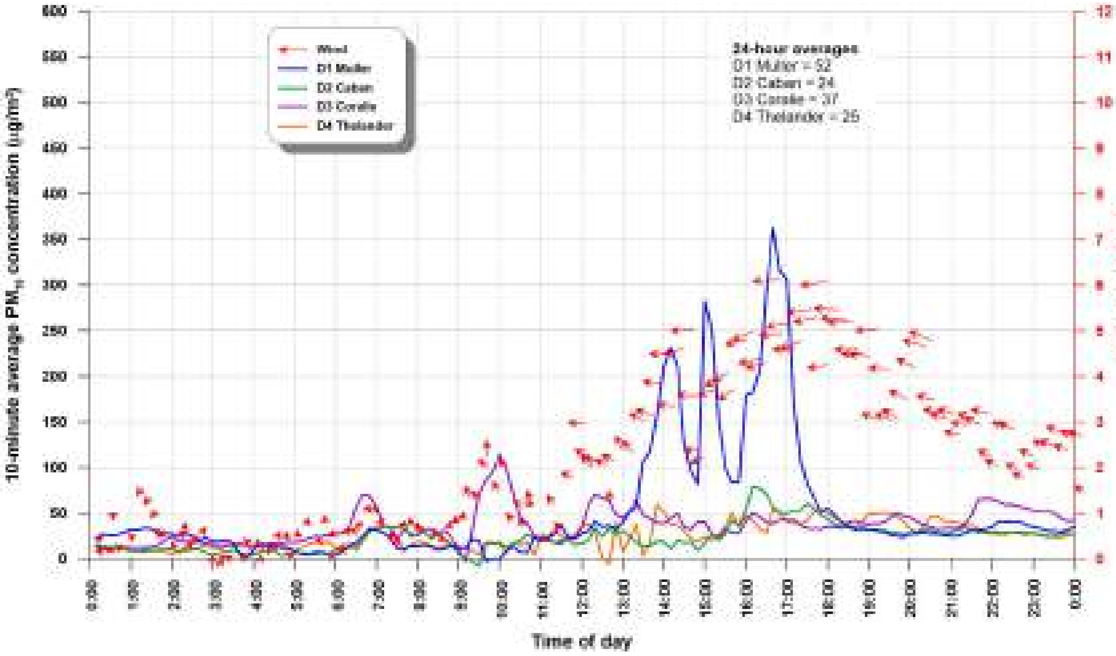

Figure A16 PM_{10} concentrations and wind conditions on 26 Oct 2018

Analysis:

- 24-hour average PM_{10} concentration exceedance of 50 µg/m^3 at D1 was not caused by activities at Wambo Mine.
- Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

11 March 2019

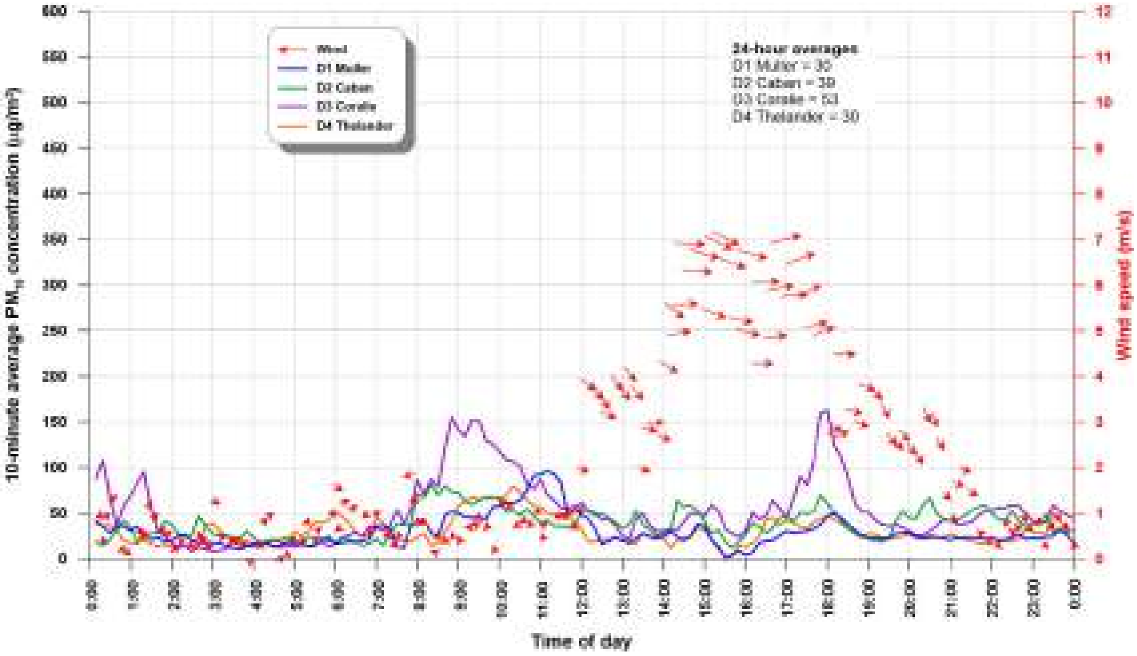

Figure A17 PM_{10} concentrations and wind conditions on 6 Nov 2018

Analysis:

- 24-hour average PM_{10} concentration exceedance of 50 µg/m^3 at D3 was likely influenced by activities at Wambo Mine.
- Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

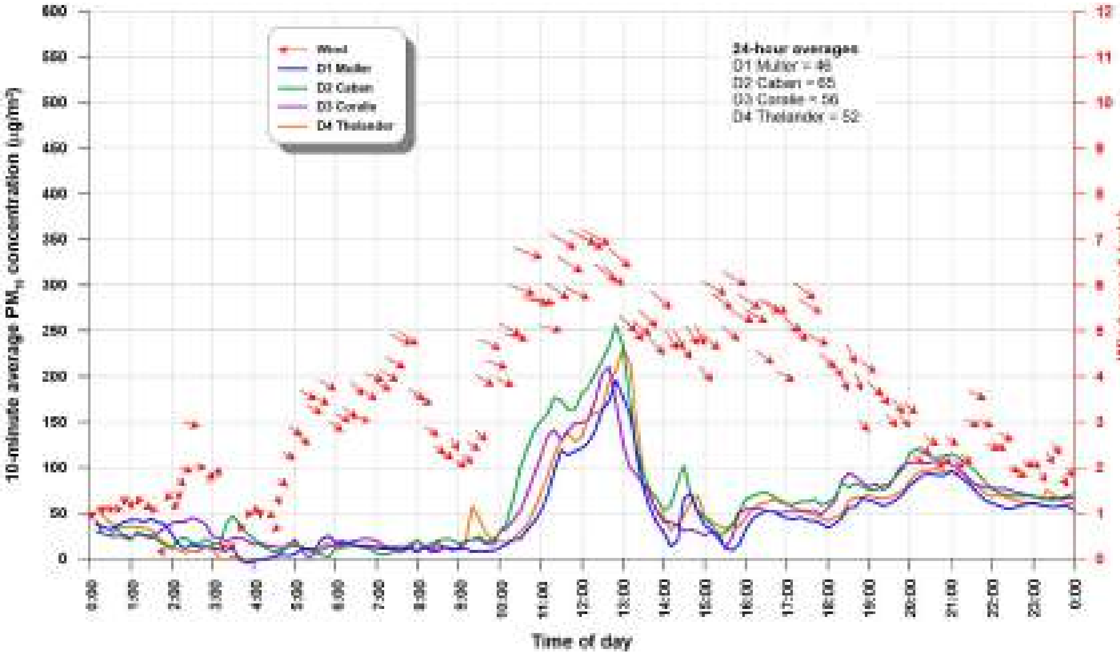

Figure A18 PM_{10} concentrations and wind conditions on 21 Nov 2018

Analysis:

- 24-hour average PM_{10} concentration exceedances of 50 µg/m^3 at D2, D3 and D4 were not caused by activities at Wambo Mine.
- Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

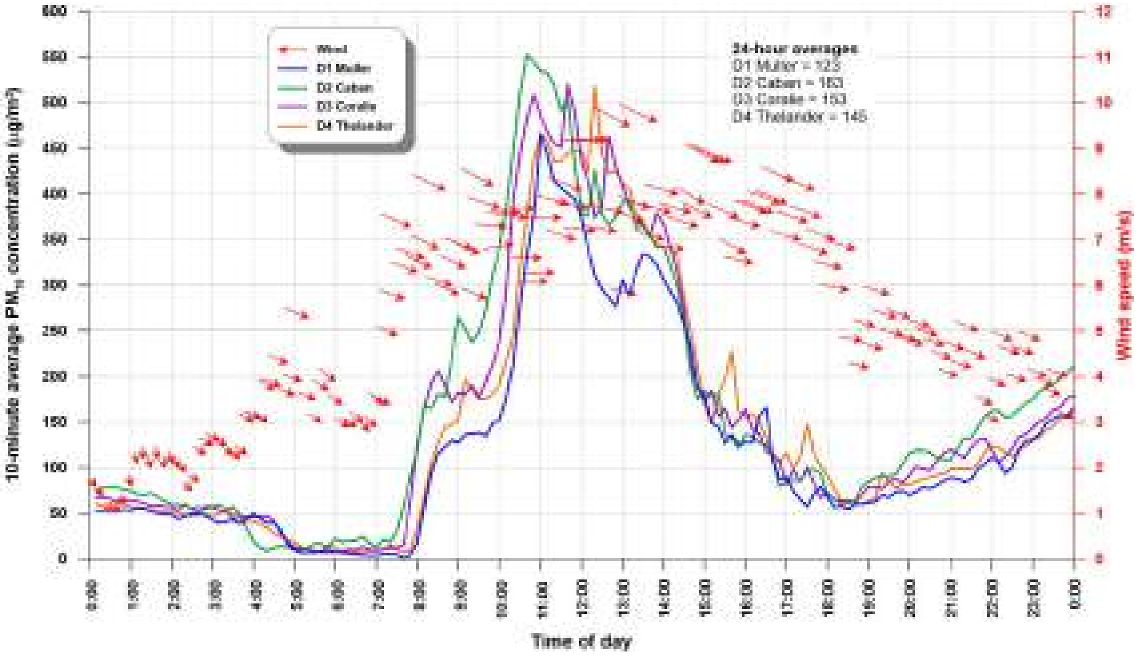

Figure A19 PM_{10} concentrations and wind conditions on 22 Nov 2018

Analysis:

- 24-hour average PM_{10} concentration exceedances of 50 µg/m^3 at all monitors were not caused by activities at Wambo Mine.
- Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

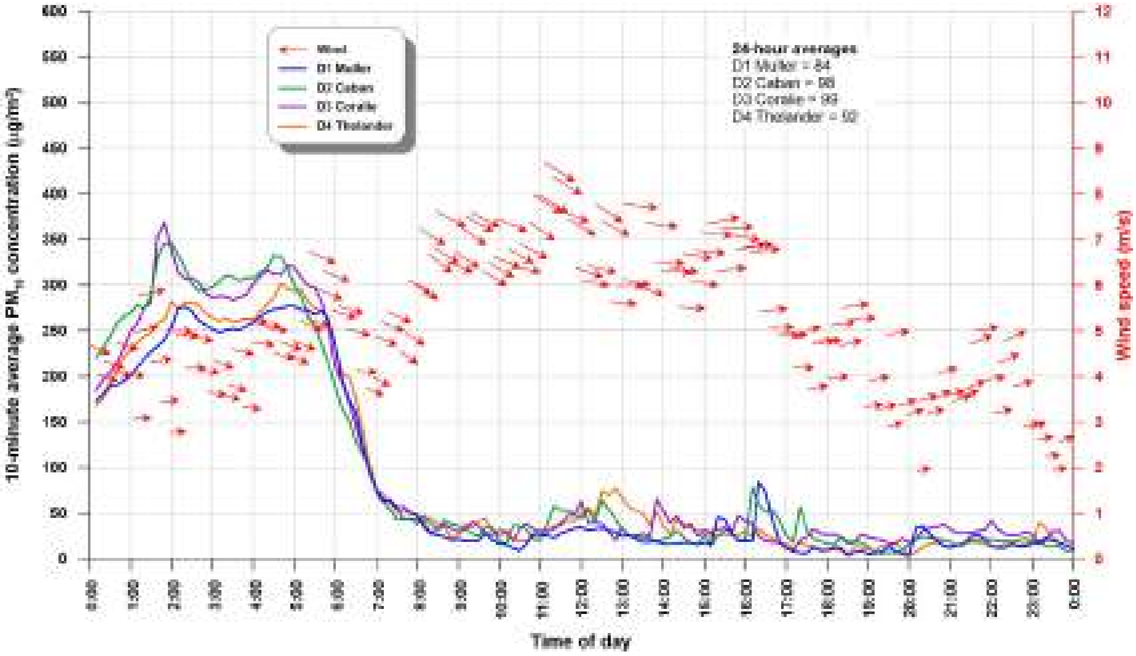

Figure A20 PM$_{10}$ concentrations and wind conditions on 23 Nov 2018

Analysis:

- 24-hour average PM$_{10}$ concentration exceedances of 50 µg/m^3 at all monitors were not caused by activities at Wambo Mine.
- Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

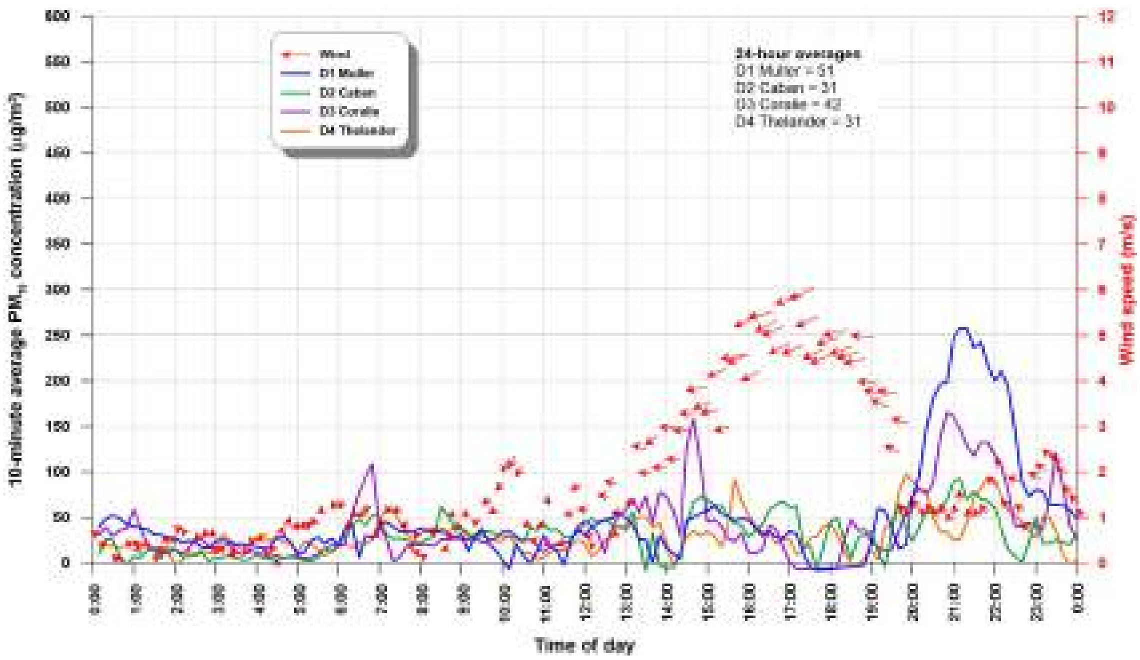

Figure A21 PM_{10} concentrations and wind conditions on 9 Dec 2018

Analysis:

- 24-hour average PM_{10} concentration exceedance of 50 µg/m^3 at D1 was likely influenced by activities at Wambo Mine.
- Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

JACOBS

11 March 2019

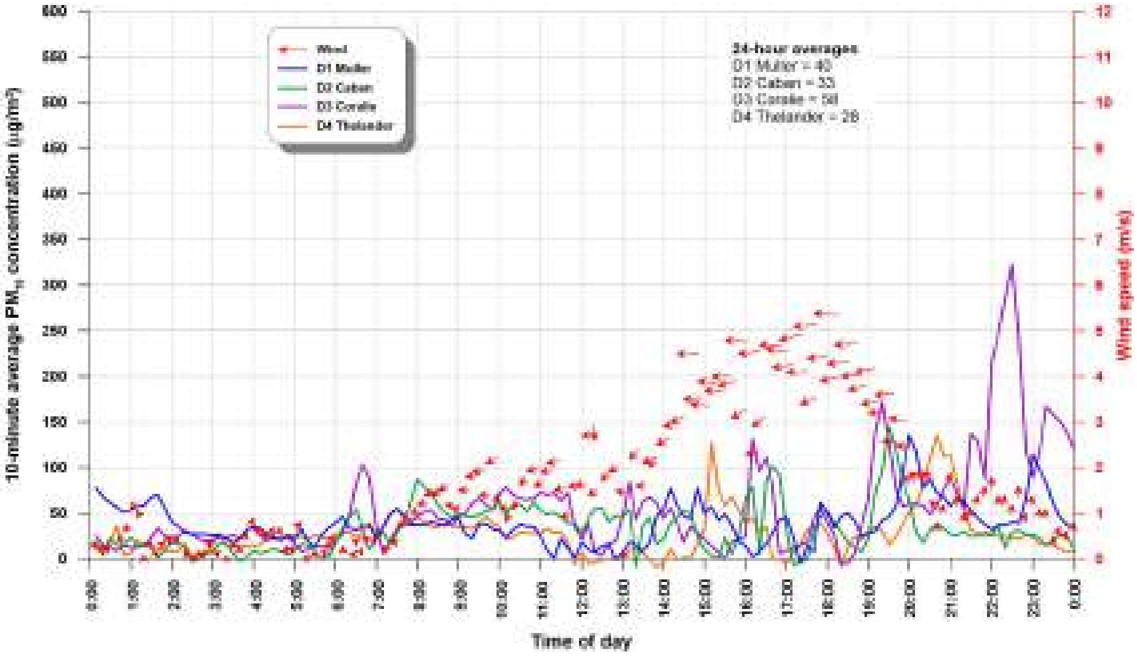

Figure A22 PM_{10} concentrations and wind conditions on 27 Dec 2018

Analysis:

- 24-hour average PM_{10} concentration exceedance of 50 µg/m³ at D3 was not caused by activities at Wambo Mine.
- Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m³.

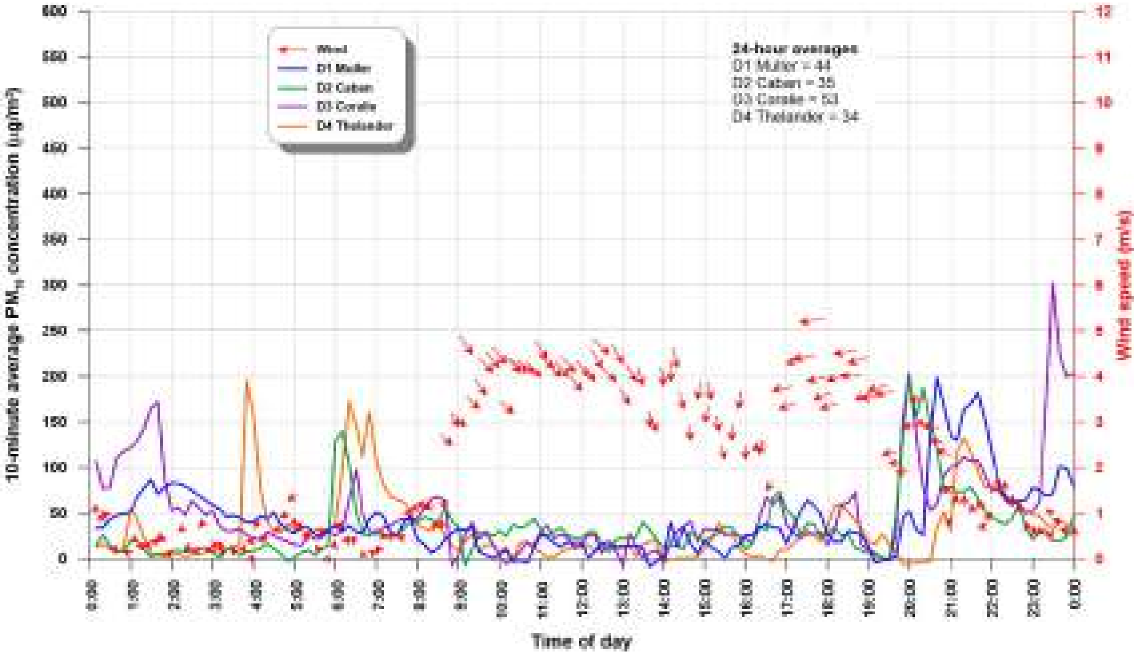

Figure A23 PM$_{10}$ concentrations and wind conditions on 28 Dec 2018

Analysis:

- 24-hour average PM$_{10}$ concentration exceedance of 50 µg/m^3 at D3 was not caused by activities at Wambo Mine.
- Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

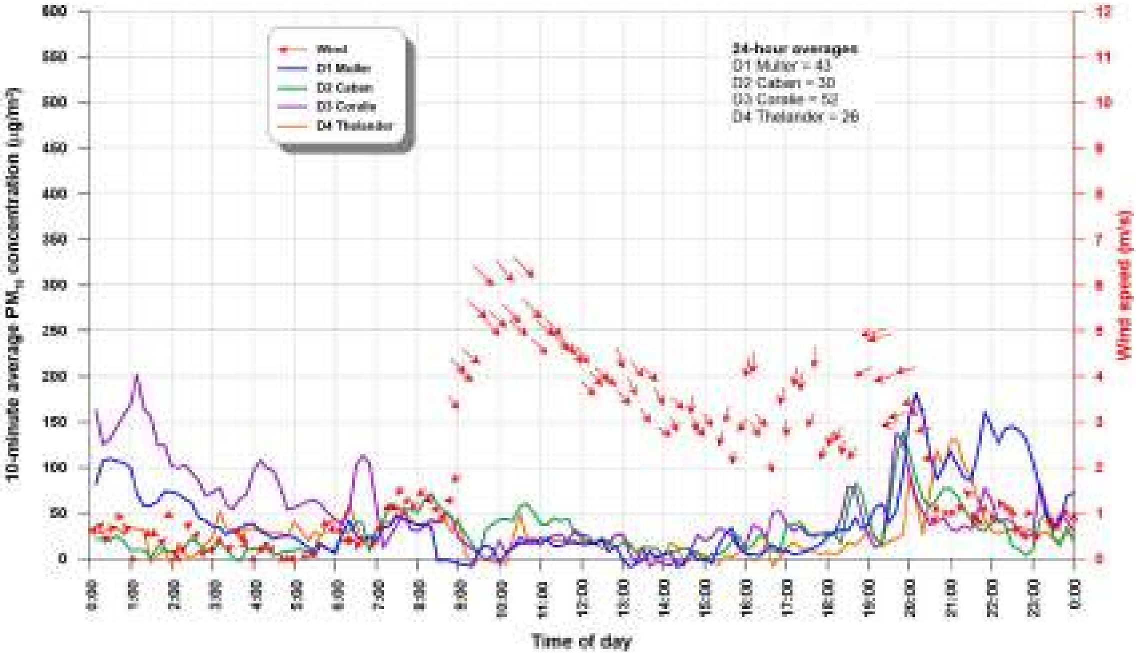

Figure A24 PM_{10} concentrations and wind conditions on 29 Dec 2018

Analysis:

- 24-hour average PM_{10} concentration exceedance of 50 µg/m^3 at D3 was likely influenced by activities at Wambo Mine.
- Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

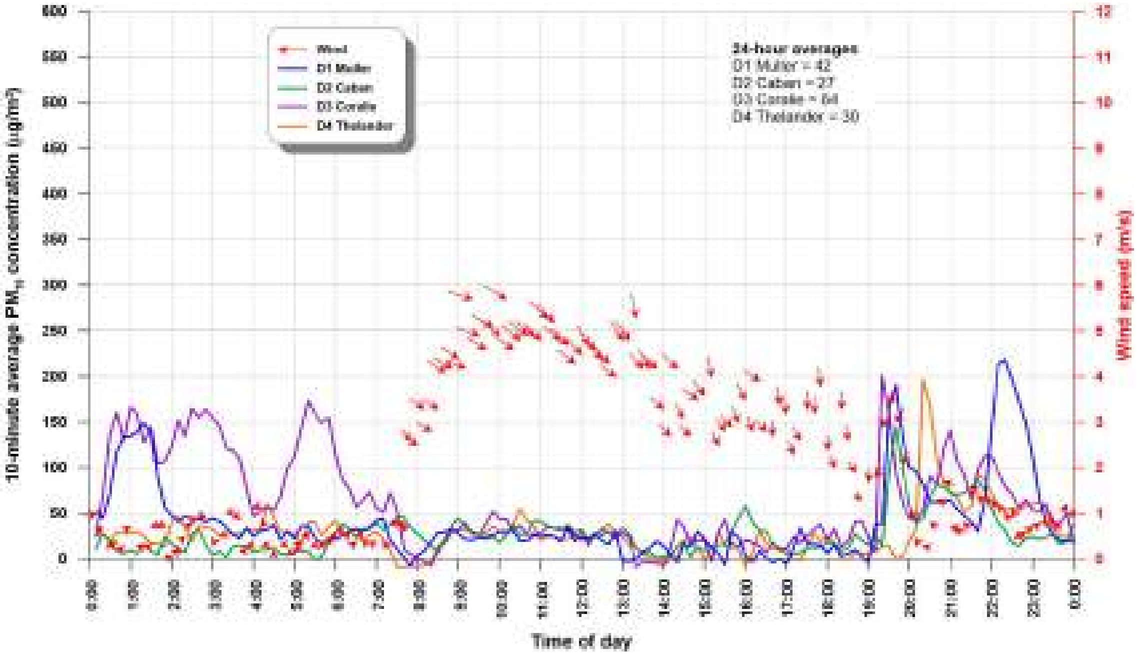

Figure A25 PM_{10} concentrations and wind conditions on 30 Dec 2018

Analysis:

- 24-hour average PM_{10} concentration exceedance of 50 µg/m^3 at D3 was not caused by activities at Wambo Mine.
- Wambo mine site contribution did not exceed the Development Consent acquisition criterion of 50 µg/m^3.

APPENDIX F

ANNUAL FLORA AND FAUNA MONITORING REPORT 2018

eco logical AUSTRALIA

Wambo Coal Mine

Annual Flora and Fauna Monitoring Report 2018 – Volume 1

Prepared for
Wambo Coal Pty. Ltd.

25 March 2019

DOCUMENT TRACKING

Item	Detail
Project Name	Wambo Coal Mine Annual Flora and Fauna Monitoring, 2018
Project Number	18NEW-10937
Project Manager	Tom Schmidt (02) 4910 3411 Level 7, 19 Bolton Street, Newcastle, NSW
Prepared by	Tom Schmidt, Dee Ryder, Daniel McKenzie
Reviewed by	Daniel Magdi
Approved by	Daniel Magdi
Status	Final
Version Number	1
Last saved on	25 March 2019
Cover photo	Clockwise from left: Landscape function analysis transect 1R, *Acacia saligna*, Grey Gum/Narrow-leaf/Ironbark/Bulloak/Honeymyrtle Forest, and *Acacia* species establishing on the North Wambo Creek Diversion. Photos by ELA.

This report should be cited as 'Eco Logical Australia 2018. *Wambo Coal Mine Flora and Fauna Monitoring Report - Volume 1*. Prepared for Wambo Coal Pty Ltd.

ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd with support from Wambo Coal Pty Ltd.

Contents

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Abbreviations

Abbreviation	Description
AEMR	Annual Environmental Management Report
BC Act	NSW Biodiversity Conservation Act 2016
BOA	Biodiversity Offset Area
BMP	Biodiversity Management Plan
BVT	Biometric Vegetation Type
CEEC	Critically Endangered Ecological Community
DBH	Diameter at Breast Height
DPI	NSW Department of Primary Industries
EEC	Endangered Ecological Community
ELA	Eco Logical Australia Pty Ltd
EPBC Act	Federal *Environment Protection and Biodiversity Conservation Act* 1999
EPC	Exotic Plant Cover
FL	The length of Fallen Logs >10 cm diameter
HBT	Hollow-bearing Tree
INFI	Infiltration Index
LFA	Landscape Function Analysis
LOI	Landscape Organisation Index
NGCG	Native Ground Cover - Grasses
NGCO	Native Ground Cover - Other
NGCS	Native Ground Cover - Shrubs
NI	Nutrient Index
NMS	Native Mid-storey Cover – the projected native foliage cover of mid-storey (%)
NOS	Native Overstorey – the projected native foliage cover of canopy (%)
NPS	The number of Native Plant Species
OEH	NSW Office of Environment and Heritage
OR	Overstorey Regeneration
PCT	Plant Community Type
RWEA	Remnant Woodland Enhancement Area
RWEP	Remnant Woodland Enhancement Program
SI	Stability Index

Abbreviation	Description
SSA	Soil Surface Assessment
TEC	Threatened Ecological Community
VCA	Voluntary Conservation Area
WCPL	Wambo Coal Pty Ltd
WONS	Weed of National Significance

Key findings

The following section details the key findings of the 2018 spring flora and fauna monitoring. Several different components make up this monitoring program. Floristic surveys, bird surveys, Landscape Function Analysis and riparian condition surveys were conducted during September, October and November 2018 across both remnant woodland and post-mining rehabilitation areas.

Remnant woodland sites are generally performing well, with reasonable numbers of native species and low cover of exotic species. Most sites are either meeting or falling just short of completion criteria, with no additional management required. However, exotic species cover remains high in the River Red Gum / River Oak riparian woodland where historic disturbance has been greatest. Most sites in this area exceed completion criteria and voluntary conservation area (VCA) targets for exotic plant cover and continued weed management will be required to achieve performance criteria in these riparian and floodplain areas. Plantings of canopy species could be considered in the open grassland areas of on the Wollombi Brook floodplain in Remnant Woodland Enhancement Area (RWEA) 'A', where natural regeneration is unlikely to occur in a reasonable timeframe. Plantings may also reduce issues with exotic flora species in these areas.

Bird survey results from remnant woodland sites reflected the good condition of these woodland areas with RWEA areas continuing to support a large diversity of birds including several threatened species. Numbers of bird species, numbers of birds and bird communities were largely consistent with the data available from previous monitoring years.

The North Wambo Creek Diversion has not yet met completion criteria for landscape function and this area will require continued active management actions to ensure that all completion criteria and other commitments are met in the near future. Woodland rehabilitation areas generally met landscape function completion criteria, having a high cover of resource trapping leaf litter but fell below biometric completion criteria, with monitoring sites having relatively few native species and almost no groundcover or mid-storey. Recommendations to improve woodland rehabilitation areas have been presented by ELA in previous monitoring reports and include focussing on the correct application of subsoil and topsoil and consideration of species diversity, structural diversity, local provenance as well as species performance in new areas of woodland rehabilitation. Pasture rehabilitation areas are generally meeting landscape function performance targets for all attributes with the exception of landscape organisation, which showed improvement from 2017.

Riparian condition scores for North Wambo Creek, Wambo Creek and Stony Creek were lower than the previous year. The lower scores were influenced most strongly by lower cover and abundance of native vegetation in the understorey. This is likely a result of the prevailing dry conditions over the past two years. Attributes relating to more permanent features such as habitat connectivity, tree canopy and logs and hollows remained similar. Monitoring in 2019 should focus on confirming that understorey vegetation shows signs of recovery and that the overall condition of riparian areas is improving. Recommendations from previous monitoring reports, such as preventing stock from accessing riparian areas and planting native trees in over-cleared areas are likely to improve condition of these riparian areas.

Subsidence cracks were observed in RWEA C, however, no significant effects on flora and fauna or performance criteria exceedances were recorded; future monitoring should continue to document and assess subsidence impacts across the site.

1 Introduction

Wambo Coal Pty Limited (WCPL) is situated approximately 15 kilometres (km) west of Singleton, near the village of Warkworth, New South Wales (NSW). A range of open cut and underground mine operations have been conducted at WCPL since mining operations commenced in 1969. Mining under the current Development Consent (DA 305-7-2003) commenced in 2004 and permits both open cut, underground operations and associated activities to be conducted. As part of the development consent, a Remnant Woodland Enhancement Program (RWEP) has been established as a biodiversity offset for lands disturbed by open cut coal mining activities. The RWEP aims to conserve local and regional biodiversity by protecting and enhancing the habitat for flora and fauna within these areas through a conservation agreement.

HLA - Envirosciences Pty Ltd initially established a program to monitor the fauna and vegetation structure within the RWEP areas, as well as to monitor stream and riparian condition within North Wambo, Wambo and Stony Creeks, with the aim of measuring and documenting the status and change in ecological condition. Eco Logical Australia (ELA) was commissioned by WCPL to undertake this monitoring program during spring 2017. This monitoring program is conducted in response to the 2004 Development Consent condition (DA 305-7-2003 Schedule 4 Condition 48) and informs WCPL's Annual Environmental Management Report (AEMR).

ELA's scope of works was to:

- collect floristic and fauna habitat data from established monitoring locations throughout land owned by WCPL, including remnant woodland enhancement areas (RWEA) (otherwise known as Biodiversity Offset Areas (BOA) or Voluntary Conservation Areas (VCA))
- conduct Landscape Function Analysis (LFA) at established sites along the North Wambo Creek Diversion and mine rehabilitation areas
- conduct riparian condition monitoring at North Wambo, South Wambo and Stony Creeks
- conduct bird monitoring at established monitoring locations throughout land owned by WCPL, primarily in land set aside as part of the RWEP
- report on any mine subsidence observations
- document results and compare to performance criteria or past results (where relevant) and identify what and where management actions may be required.

1.1 Report structure

This report has been set out in the following manner:

- **Key findings** - summary of the key findings of the monitoring works
- **Introduction** - provides background information to the current report
- **Remnant woodland enhancement areas (RWEAs) -** provides methods, results and interpretation of data, as well as recommendations from flora and bird surveys primarily within RWEA areas
- **Rehabilitation areas -** provides methods, results and interpretation of data from LFA and biometric flora survey plots (woodland rehabilitation only) from the North Wambo Creek Diversion and areas of post-mining land rehabilitation
- **Riparian condition assessment** - provides methods, results and interpretation of data, as well as management recommendations for riparian transects at North Wambo, Wambo and Stony Creeks.
- **Mine subsidence observations and other management issues -** provides observations of mine subsidence and other management issues on land owned by WCPL.

Raw data and photographs from monitoring sites are included in **Volume 2**.

2 Remnant Woodland Enhancement Areas (RWEAs)

2.1 Floristic monitoring

2.1.1 Introduction

The aim of floristic and fauna habitat monitoring is to measure the current condition of vegetation within the RWEA's in terms of floristics and habitat complexity. The results aim to provide direction to management of these areas and for the monitoring program in the future.

2.1.2 Methods

Data was collected by ELA ecologists Lily Gorrell and Alex Gorey from October 9 - 16 2018, and Tom Schmidt and Dee Ryder on 20 and 21 November 2018. A standard biometric plot 50 x 20 m (**Figure 1**) was used to measure the following parameters and collect data following the BioBanking methodology (DECC 2008a):

- full floristic species list (including cover abundance scores) in a nested 0.04 ha plot (20 m x 20 m)
- canopy regeneration over whole vegetation zone
- estimation of projected native foliage cover of ground cover from 50 points and canopy and mid-storey layer from 10 points along the 50 m transect
- occurrence and abundance of weed species in 0.04 ha plot (20 m x 20 m)
- number of hollow-bearing trees and length of logs (>10cm diameter) in the plot
- photograph of each plot (at start of 50 m transect).

The abundance of each species in the 0.04 ha plot was estimated, using a modified Braun-Blanquet scale, as used in previous floristic monitoring at WCPL. These are listed below:

- 1 = few, small cover (<5%)
- 2 = numerous (<5%)
- 3 = 5 – 25%
- 4 = 25 – 50%
- 5 = 50 – 75%
- 6 = >75%.

All vascular plants species were recorded and identified to the lowest taxonomic level possible, with samples of unknown species collected for further identification where possible. Nomenclature followed the Flora of New South Wales (Harden 1992; 1993; 2000; 2002), and any subsequent recent taxonomic changes as presented on PlantNET (RBGDT 2015).

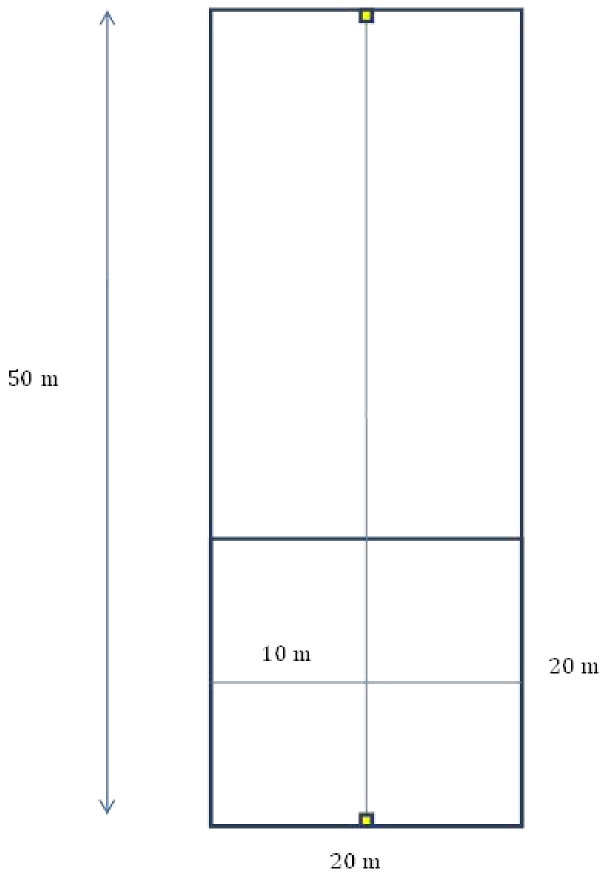

Figure 1: Biometric vegetation plot dimensions

Flora monitoring plots were located within the ten vegetation communities originally mapped and described by Orchid Research (2003). Since this time, a number of changes in vegetation mapping standards in NSW have occurred. Previously a set list of plant communities known as Biometric Vegetation Types (BVT) were used as a state-wide standard by the NSW Office of Environment and Heritage (OEH). These BVTs have now been modified and are now known as Plant Community Types (PCT's). As such, the ten vegetation communities originally mapped and described by Orchid Research (2003) have been converted to their equivalent PCT within this report. Several of these communities are also listed under both State and Federal legislation as Endangered Ecological Communities (EECs) under different nomenclature. **Table 1** clarifies the conversion of vegetation communities.

Data was collected from the 34 locations previously surveyed as part of this monitoring program, with the exception of site V13-B1, which was moved slightly to the north-west to better sample the intended vegetation community during monitoring undertaken in 2016. Plot locations are shown in Figure 2.

Floristic data was also collected from an additional four sites in woodland rehabilitation areas to measure biometric attributes in addition to LFA. The results from these plots are included in **Section 3.**

Table 1: Original vegetation classification, plant community type classification and TEC status for each monitoring plot in remnant vegetation

Vegetation Community (Orchid Research 2003)	Plant Community Type (PCT)	TEC	Plot name
River Oak / Rough-barked Apple Forest	PCT 42: River Red Gum / River Oak riparian woodland wetland in the Hunter Valley	Listed *Biodiversity Conservation Act 2016* (BC Act), E: Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions	V1-A1
			V1-A2
			V1-B1
			V1-B2
			V1-B3
River Red Gum Woodland			V2-A1
			V2-B1
			V2-B2
Yellow Box / Blakely's Red Gum / Rough-barked Apple Forest			V3-B1
Coast Banksia / Rough-barked Apple / Blakely's Red Gum Forest	PCT 1653: Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area	Listed BC Act, E: Warkworth Sands Woodland in the Sydney Basin Bioregion, also listed as CE under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as Warkworth Sands Woodland of the Hunter Valley	V5-B1
			V5-B2
			V5-B3
			V5-B4
Narrow-leaf Ironbark/Grey Box/Bulloak/Honeymyrtle Forest	PCT 1603: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	Listed BC Act, E: Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions, may also be listed as CE under the EPBC Act as Central Hunter Valley eucalypt forest and woodland, dependant on condition and landscape position	V6-A1c
			V6-A3
			V6-B1
			V6-B1c
			V6-B2
			V6-B2c
			V6-B3
			V6-B4
Grey Gum/Narrow-leaf/ Ironbark/Bulloak/Honeymyrtle Forest			V11-B1
			V11-B2
Spotted Gum/Narrow-leaf	PCT 1604: Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass	Listed BC Act, E: Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the New South	V9-A1

Vegetation Community (Orchid Research 2003)	Plant Community Type (PCT)	TEC	Plot name
Ironbark/Bulloak/Paperbark Forest	woodland of the central and lower Hunter	Wales North Coast and Sydney Basin Bioregions, may also be listed as CE under the EPBC Act as Central Hunter Valley eucalypt forest and woodland, dependant on condition and landscape position	V9-B1
			V9-B2
			V10-B1
Slaty Gum/Narrow-leaf Ironbark/Bulloak/Paperbark Forest	PCT 1176: Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin Bioregion	Listed BC Act, V: Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion, may also be listed as CE under the EPBC Act as Central Hunter Valley eucalypt forest and woodland, dependant on condition and landscape position	V10-A1
			V10-A2
			V10-B3
White Mahogany/Rough-barked Apple Forest	PCT 1584: White Mahogany - Spotted Gum - Grey Myrtle semi-mesic shrubby open forest of the central and lower Hunter Valley	-	V13-B1
Brush Wilga/Native Olive Shrubland	PCT 1603: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	Listed BC Act, E: Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	V14-A1
			V14-B1
			V14-B2

*** CE – Critically Endangered, E – Endangered, V- vulnerable**

Cover/abundance scores for each species within each plot in the RWEAs was provided by WCPL from 2010 onwards, with the exception of woodland rehabilitation sites, which were only sampled for the first time by ELA during monitoring undertaken in 2015. Biometric plot data using the current method was collected for the first time during monitoring undertaken in 2014.

Data was examined for changes in native species richness within each sampled plant community over nine monitoring periods from 2010 to 2018 and cover of exotic species over the last three monitoring periods (2016, 2017 and 2018). Monitoring point photographs were also compared where possible to determine if major structural elements of each community had changed since the earliest photos available were taken (generally in 2013). Data from each vegetation community was compared to established performance criteria, biometric benchmarks and compared with reference sites outside of the RWEA areas where possible.

Vegetation community condition benchmarks (developed by OEH for each PCT) have been modified to provide realistic, ambitious but achievable performance criteria for each PCT. Monitoring results can then be compared to these criteria to determine if management actions are likely to be required. As existing woodland rehabilitation areas have been designed and implemented applying old techniques that do not reflect the current best practice of utilising species of local provenance, performance criteria for these older rehabilitation areas have been developed by modifying condition benchmarks for *Grey Box –Slaty Box shrub – grass woodland*, which is expected to have a similar vegetation structure, albeit different species composition, to the mature rehabilitated woodland community.

A green, yellow, amber and red colour system has been developed to rank each measured attribute according to performance and management actions required (**Table 2**). The structure of this table has been derived from (DECC 2008b). The number of hollow-bearing trees and length of fallen logs have been presented as a measure of fauna habitat attributes. However, no performance criteria have been set for these attributes in remnant vegetation, as in situations where historical logging or clearing has been intensive, it may take many years for a suitable density of hollows and logs to form naturally.

Table 2: Colour ranking system for floristic attributes and performance targets

Attribute	Red (needs greater improvement)	Orange (in need of improvement)	Yellow (not meeting target but values still acceptable)	Green (excellent – within target range)
Native species richness	0–10%	>10 – <50% of target range	50 – <100% of target range	≥ target range
Native overstorey cover % (*pfc)	0 – 10% or >200% of target range	> 10 – <50% or >150 – 200% of target range	50 – <100% or >100 – 150% of target range	within target range
Native mid-storey cover %(*pfc)	0 – 10% or >200% of target range	>10 – <50% or >150 – 200% of target range	50 – <100% or >100 – 150% of target range	within target range
Native ground cover – grasses %	0 – 10% or >200% of target range	>10 – <50% or >150 – 200% of target range	50 – <100% or >100 – 150% of target range	within target range
Native ground cover – shrubs %	0 – 10% or >200% of target range	>10 – <50% or >150 – 200% of target range	50 – <100% or >100 – 150% of target range	within target range
Native ground cover – other %	0 – 10% or >200% of target range	>10 – <50% or >150 – 200% of target range	50 – <100% or >100 – 150% of target range	within target range

Attribute	Red (needs greater improvement)	Orange (in need of improvement)	Yellow (not meeting target but values still acceptable)	Green (excellent – within target range)
Proportion of native overstorey species regenerating	0	0-0.5	0.5-1	1
Exotic cover	>66%	33-66	5-33	0-5%

Several abbreviations for measured attributes are used in tables throughout the following section. An explanation of these is provided below.

- NPS– the number of native plant species
- NOS (%) - projected native foliage cover of canopy
- NMS (%) – projected native mid-storey cover
- NGCG (%) – native groundcover of grasses
- NGCS (%) – native groundcover of shrubs
- NGCO (%) – native groundcover of other plant types (sedges, herbs etc.)
- EPC (%)– exotic plant cover
- OR – proportion of overstorey species regenerating over the whole vegetation zone
- HBT – number of hollow-bearing trees present in the 20 x 50 m vegetation plot
- FL – length of fallen logs >10 cm diameter

In addition to those performance criteria listed above, Annexure C of the VCAs for the RWEA areas requires that WCPL aim for an exotic plant cover within the Conservation Areas that does not exceed the percentages detailed in **Table 3**. Photo-monitoring points established as part of the VCAs in 2013 were compared to photos at the same location during the current vegetation monitoring.

Table 3: Exotic plant cover criteria for VCA areas

RWEA	Aim	Timing
Coal Terminal	Exotic plant cover within the Conservation Area must not be permitted to exceed: - 5% of the foliage cover at monitoring site CT1*; and - 15% of the foliage cover at monitoring site CT2*.	In Year 1 and at the end of Year 5
RWEAs A, B, C and D	Exotic plant cover within the Conservation Area must not be permitted to exceed: - 70% of the foliage cover at monitoring site A1 within Area A; - 20% of the foliage cover at monitoring site A2 within Area A; - 30% of the foliage cover at monitoring site A3 within Area A; - 10% of the foliage cover at monitoring site A4 within Area A; - 5% of the foliage cover at monitoring site B1 within Area B; - 5% of the foliage cover at monitoring site B2 within Area B; - 5% of the foliage cover at monitoring site C1 within Area C; and - 5% of the foliage cover at monitoring site D1 within Area D,	In Year 1
	Exotic plant cover within the Conservation Area must not be permitted to exceed: - 60% of the foliage cover at monitoring site A1 within Area A; - 15% of the foliage cover at monitoring site A2 within Area A; - 20% of the foliage cover at monitoring site A3 within Area A; - 5% of the foliage cover at monitoring site A4 within Area A; - 5% of the foliage cover at monitoring site B1 within Area B; - 5% of the foliage cover at monitoring site B2 within Area B; - 5% of the foliage cover at monitoring site C1 within Area C; and - 5% of the foliage cover at monitoring site D1 within Area D,	Years 2-5

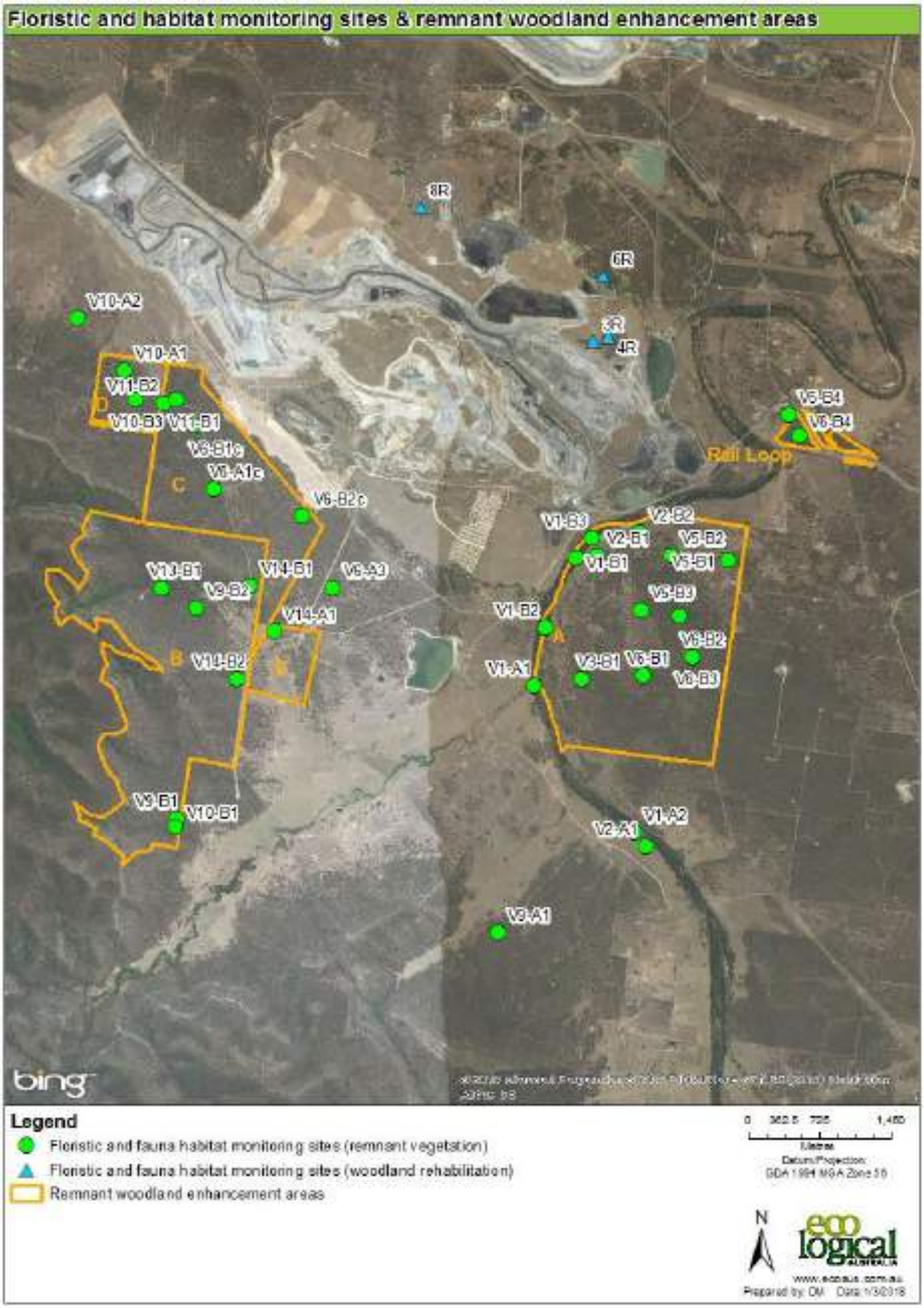

Figure 2: Floristic and habitat monitoring sites and RWEAs

2.1.3 Results

The floristic and biometric data collected during floristic and fauna habitat monitoring is summarised below, with the full floristic plot data and other data including plot photographs provided in **Volume 2**.

River Red Gum / River Oak riparian woodland wetland in the Hunter Valley

This community is one of the most disturbed vegetation communities on WCPL land, as it occurs on more fertile soils on the banks and floodplains of Wollombi Brook, is naturally disturbed by flood events and has been historically used more intensively for agricultural purposes.

River Red Gum / River Oak riparian woodland is distinguished by an overstorey of *Eucalyptus camaldulensis* (River Red Gum), *Casuarina cunninghamiana* subsp. *cunninghamiana* (River Oak), *Angophora floribunda* (Rough-barked Apple) and *Eucalyptus melliodora* (Yellow Box) on floodplains and riparian areas. This PCT conforms to the NSW BC Act listed EEC *Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions.* This community also contains the endangered Hunter Valley population of *Eucalyptus camaldulensis* listed under the BC Act.

The River Red Gum / River Oak riparian woodland at WCPL is typical of other remaining stands throughout the Hunter Valley, with generally a high cover of weed species and a reduced number of native species (**Plate 1**).

Plate 1: River Red Gum / River Oak riparian woodland wetland on North Wambo Creek

Nine monitoring plots are located within this PCT. V1 monitoring sites are located within *Casuarina cunninghamiana* dominated forest along the banks of Wollombi Brook. V2 monitoring sites are located on the partially cleared red gum dominated floodplains of Wollombi Brook and the V3 monitoring site is located in a slightly wetter site on the boundary of the floodplain and sand dunes supporting Warkworth Sands type vegetation.

Three sites (V1-A1, V1-A2 and V2-A1) appear to have been originally intended as reference sites at the commencement of the monitoring program, as they are located outside of the RWEP areas. However, cattle have been fenced out of the immediate riparian zone on Wollombi Brook (including sites V1-A1, V1-A2) and thus treatments for both reference sites and management sites are similar.

Floristic results for this vegetation zone in relation to performance criteria are presented in **Table 5**. As reported in previous years, the main management issue in this zone is the high cover of exotic plant species. The remaining performance measures are generally being met, with the exception of native grass cover which fell slightly below the performance criteria.

Trends over time

The average number of native species recorded per monitoring plot in River Red Gum / River Oak riparian woodland has generally increased over time, however the lower result in 2018 for sites within the RWEA's arrests the increasing trend observed over the past four years. The number of native species recorded is still the third highest since monitoring began in 2010. The three reference sites have remained relatively consistent for the past three years in terms of average number of native species.

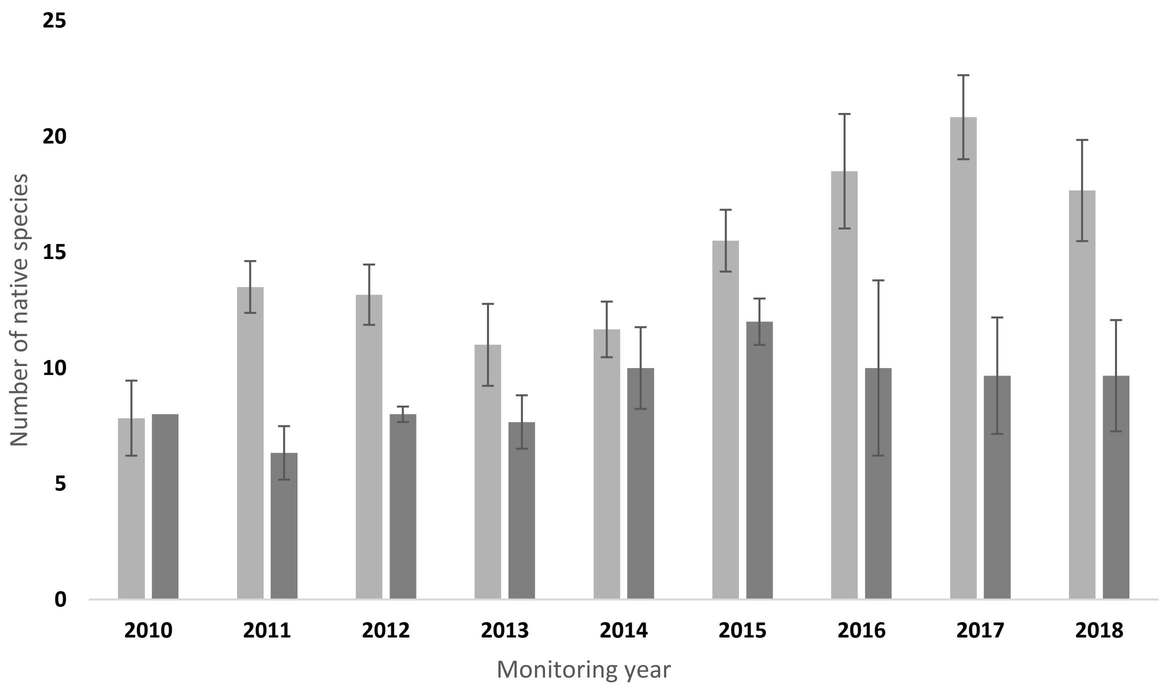

Figure 3: Average number of native species per plot in monitoring sites within riparian woodland in RWEA A (light grey) and from three reference sites outside the boundary of RWEA's (dark grey). Error bars represent standard error

Total cover of exotic species has been recorded since 2014 and results are quite variable over time, even within each site. However, in general, exotic cover has remained high across all riparian woodland monitoring sites over the monitoring periods, with the exception of site V3-B1 which has consistently had very low exotic plant species cover.

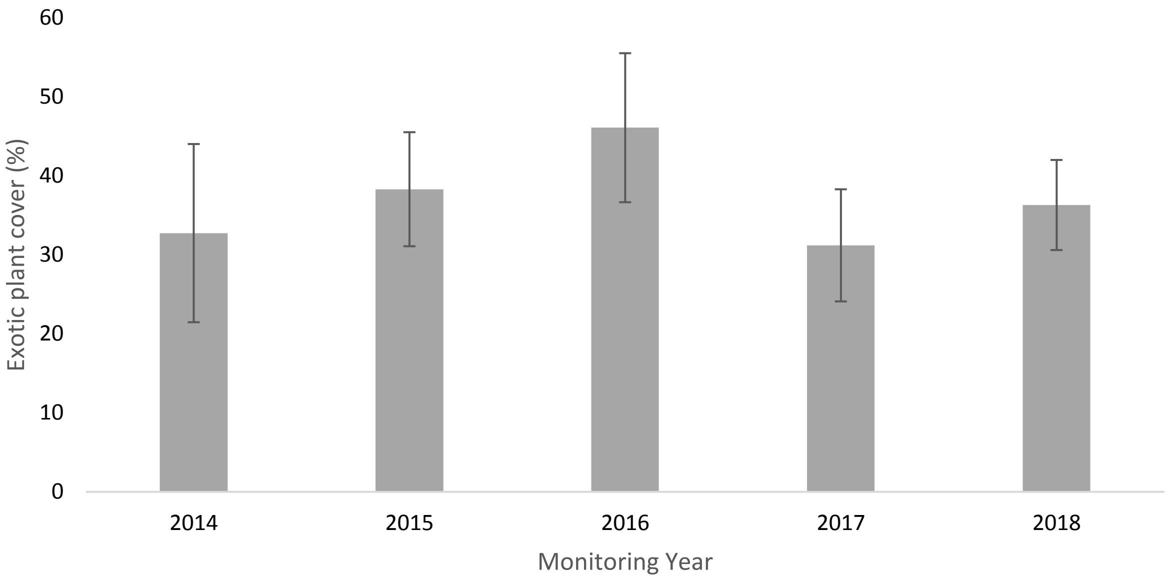

Figure 4: Average exotic plant species cover (%) within all riparian woodland monitoring sites per year

Several priority weeds are present in the River Red Gum / River Oak riparian woodland PCT, these are listed in **Table 4** below, along with their biosecurity duty according to NSW Department of Primary Industries (DPI 2017). All plants listed under the NSW *Biosecurity Act 2015* are regulated with a general biosecurity duty to prevent, eliminate or minimise any biosecurity risk they may pose. Any person who deals with any plant, who knows (or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable.

The same weed species have generally been recorded at the same sites and with a similar cover/abundance scores to the previous monitoring periods. However, *Opuntia aurantiaca* (Tiger Pear) was recorded at two additional sites during 2018.

Photo monitoring points in this zone, show no obvious changes within this vegetation zone between years 2015 and 2018 (**Plate 2** & **Plate 3**), and 2013 and 2018 monitoring (**Plate 3** & **Plate 4**), though evidence of recent dry seasonal conditions is visible (**Plate 2**). The maintenance of general vegetation condition is also evidenced in canopy cover and mid-storey cover scores, which have remained relatively similar over recent years despite some obvious observer bias inherent when different observers estimate cover and in some cases issues with distinguishing mid-storey cover from canopy cover.

Table 4: Declared weeds observed within the River Red Gum / River Oak riparian woodland PCT plots in 2018

Scientific Name	Common Name	Site	Biosecurity duty (NSW Biosecurity Act 2015)
Asparagus asparagoides	Bridal Creeper	V2-B1, V2-B2	**Prohibition on dealings -** Must not be imported into the State or sold
Echium plantagineum	Patterson's Curse	V1-A1, V1-A2, V1-B3, V2-B1	**Regional Recommended Measure** - Land managers should mitigate the risk of new weeds being introduced to their land. Land managers should mitigate spread from their land. The plant should not be bought, sold, grown, carried or released into the environment.
Lycium ferocissimum	African Boxthorn	V1-A2, V1-B2,	**Prohibition on dealings -** Must not be imported into the State or sold
Olea europaea subsp. *cuspidata*	African Olive	V1-B1, V1-B3, V2-B2	**Regional Recommended Measure** Land Area 1: Singleton and Maitland. Land Area 2: outbreaks in Hunter region except Singleton and Maitland. Land Area 1: Land managers should mitigate the risk of new weeds being introduced to their land. Land managers should mitigate spread from their land. Land Area 2: Land managers should mitigate spread from their land. Land managers should mitigate the risk of new weeds being introduced to their land. Plant should not be bought, sold, grown, carried or released into the environment.
Opuntia aurantiaca	Tiger Pear	V1-B3, V2-B1, V3-B1	**Regional Recommended Measure** - Land managers should mitigate the risk of new weeds being introduced to their land. Land managers should mitigate spread from their land.
Opuntia stricta	Prickly Pear	V1-B3, V2-B1, V2-B2	**Prohibition on dealings -** Must not be imported into the State or sold
Salix species	Willows	V1-A1, V1-B1	**Prohibition on dealings -** Must not be imported into the State or sold
Senecio madagascariensis	Fireweed	V1-A1, V1-A2, V1-B1, V1-B2, V1-B3, V2-A1, V2-B1, V3-B1	**Prohibition on dealings -** Must not be imported into the State or sold

Plate 2: Flora monitoring site V3-B1 during 2015

Plate 3: Flora monitoring site V3-B1 during 2018

Plate 4: Monitoring site A3 during 2013

Plate 5: Monitoring site A3 during 2018

Table 5: Floristic results and performance criteria for River Red Gum / River Oak riparian woodland wetland

Vegetation Community (Orchid Research 2003)	Plant Community Type (PCT)	RWEP Area	Plot Name	NPS	NOS (%)	NMS (%)	NGCG	NGCS	NGCO	EPC	OR	HBT	FL (m)
River Oak / Rough-barked Apple Forest	PCT 42: River Red Gum / River Oak riparian woodland wetland in the Hunter Valley	Outside of RWEP	V1-A1	6	14	0	2	0	0	50	1	0	52
		Outside of RWEP	V1-A2	9	3.5	8.5	20	0	0	30		0	48
		A	V1-B1	21	36	0	20	0	0	44		1	48
		A	V1-B2	14	13.5	12.9	14	2	0	44		1	7
		A	V1-B3	13	34	8	22	0	0	36.5		1	20
River Red Gum Woodland		Outside of RWEP	V2-A1	14	6.2	0	28	0	4	16		0	5
		A	V2-B1	12	20	7	0	0	6	38		0	4
		A	V2-B2	21	10	8.4	4	10	4	62		0	0
Yellow Box / Blakely's Red Gum / Rough-barked Apple Forest		A	V3-B1	25	19	0.7	38	2	30	6		0	29
Average values for RWEA monitoring sites				17.7	22.1	6.2	16.3	2.3	6.7	38.4	1	0.5	18
Performance criteria				>20	10-50	10-50	20-60	1-5	5-30	<10	1	-	-

Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area

Within WCPL owned land, this community is mostly restricted to the eastern side of Wollombi Brook, primarily within the RWEP area A (**Plate 6**). This PCT forms the Commonwealth EPBC Act listed Critically Endangered Ecological Community (CEEC) *Warkworth Sands Woodland of the Sydney Basin Bioregion* and is also listed under the NSW BC Act. This PCT occurs on aeolian sand deposits and is restricted to the Warkworth area.

Plate 6: Warkworth Sands Woodland within RWEA A

The average number of native species met the performance criteria in 2018, recovering from 2017 when a low diversity was recorded (**Figure 5**). This result suggests the community has some resilience to the dry conditions and canopy dieback experienced in the past two years.

As with previous years of monitoring, exotic species cover was relatively low across most of the monitoring plots. As observed in 2017, the environmental weed *Bryophyllum* sp. (Mother of Millions) was observed to be abundant in certain locations in this vegetation community, both within RWEA A and inside the Rail Loop area. *Bryophyllum* sp. is listed as a priority weed in the Hunter under the NSW *Biosecurity Act 2015*. It is understood that this species is currently the focus of a weed management program.

Photo-monitoring point A2 within this PCT shows little change in vegetation structure between the 2013 and 2018 monitoring periods (**Plate 7** & **Plate 8**). However, the epicormic growth following the *Angophora floribunda* dieback in 2016 can be observed in the 2018 photo. Canopy and mid-storey cover scores collected by ELA from the 2015 to 2018 monitoring periods have remained generally similar between years.

Canopy dieback of *A. floribunda* in some areas of this community was observed during the 2016 monitoring program. These trees displayed abundant epicormic growth in 2017, and during 2018 this recovery continued, and it appears most trees have survived this dieback event to date (**Plates 9** & **10**).

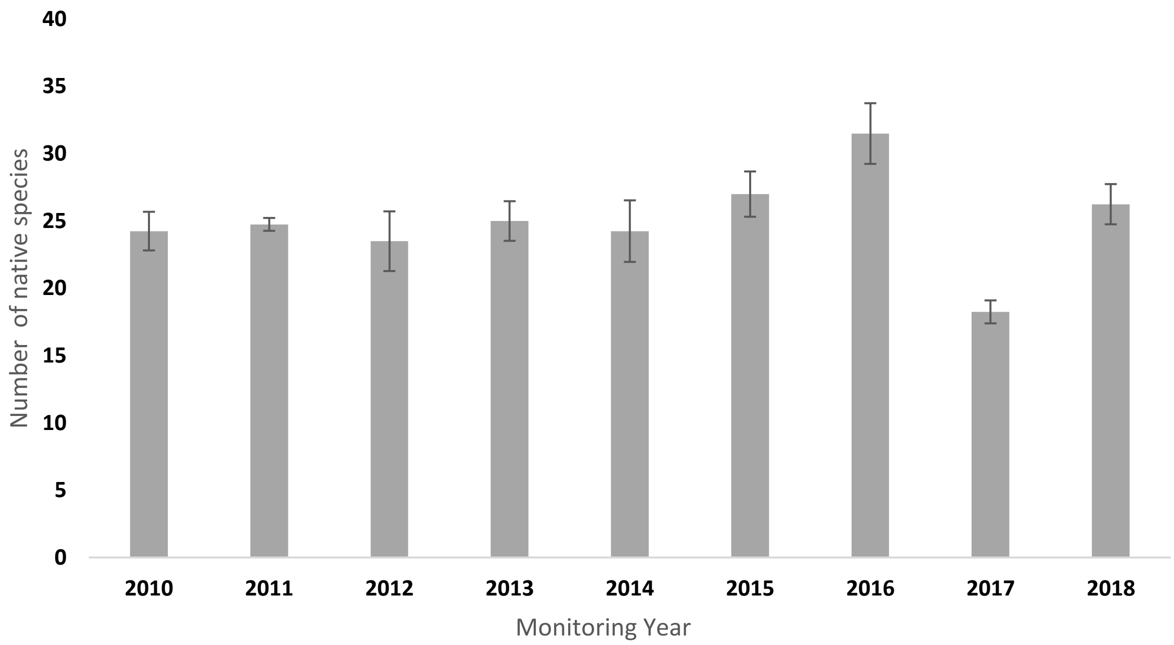

Figure 5: The average number of native species recorded within Warkworth Sands Woodland monitoring plots over time, showing an increase in 2018 following the 2017 decline.

Plate 7: Photo monitoring point A2 during 2013

Plate 8: Photo monitoring point A2 during 2018

Plate 9: Severe *Angophora floribunda* canopy dieback in parts of Warkworth Sands Woodland in RWEA A during 2016

Plate 10: *R*ecovery of *Angophora floribunda* canopy dieback during 2018

Table 6: Floristic results in regards to performance criteria for Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland

Vegetation Community (Orchid Research 2003)	Plant Community Type (PCT)	RWEP Area	Plot Name	NPS	NOS (%)	NMS (%)	NGCG	NGCS	NGCO	EPC	OR	HBT	FL
Coast Banksia / Rough-barked Apple / Blakely's Red Gum Forest	PCT 1658: Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area	A	V5-B1	30	9.5	1.7	14	2	24	18	1	0	10
		A	V5-B2	23	10	2.2	6	2	66	2		0	14
		A	V5-B3	25	4.8	3.9	6	2	48	0		0	14
		Rail Loop	V5-B4	27	9.2	3.2	32	0	12	0		0	16
Average values for RWEP and Rail Loop monitoring sites				26.3	8.4	2.8	14.5	1.5	37.5	5	1	0	13.5
Performance criteria				>20	10-40	10-50	4-20	5-30	5-35	<10	1	-	-

Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter

This community on land owned by WCPL is generally dominated by the canopy species *Eucalyptus crebra* (Narrow-leaved Ironbark) and occasionally *Eucalyptus moluccana* (Grey Box) (**Plate 11**). A sparse mid-storey or shrub layer of *Allocasuarina luehmannii* (Bull Oak), *Bursaria spinosa* subsp. *spinosa* (Blackthorn) and *Notelaea microcarpa* var. *microcarpa* (Mock Olive), with a grassy understorey is often present. *Eucalyptus punctata* (Grey Gum) and *Melaleuca decora* also occur in patches.

Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest forms the BC Act listed EEC C*entral Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions*. Sections of this community in good condition with a Eucalypt canopy are also likely to be the *Central Hunter Valley eucalypt forest and woodland* CEEC under the Commonwealth EPBC Act.

This community appears to be performing well with generally very low cover of exotic species and high diversity of native species present at each monitoring plot. The number of native species recorded in 2018 was higher than in the previous year at most of the monitoring sites in this community, and the average score achieved the target for the performance criteria for this attribute (Table 7). Performance criterion were met for all other attributes, except for Native Ground Cover Shrubs, which despite being higher than in 2017 was still below the target. Examination of biometric data reveals that no significant changes in exotic cover, canopy or mid-storey have occurred in the majority of these monitoring plots since 2014 when biometric data was first collected. This stability over time can be seen in the photo monitoring point A4 (**Plates 12-13**) with no major changes visible between the 2013 and 2018 monitoring periods.

Minor mine subsidence cracks are present at four of the eight monitoring plots within this PCT. However, no significant vegetation damage has been observed.

Plate 11: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest at WCPL

Table 7 : Floristic results and performance criteria for Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest

Vegetation Community (Orchid Research 2003)	Plant Community Type (PCT)	RWEP Area	Plot Name	NPS	NOS (%)	NMS (%)	NGCG	NGCS	NGCO	EPC	OR	HBT	FL
Narrow-leaf Ironbark / Grey Box / Bulloak / Honeymyrtle Forest	PCT 1603: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	C	V6-A1c	44	10	4	14	0	0	0	1	0	79
		Outside of RWEP	V6-A3	21	5	4	38	4	20	0		0	16
		A	V6-B1	30	23.5	8.5	2	2	6	2		0	58
		C	V6-B1c	29	4.9	6.5	26	4	22	0		0	19
		A	V6-B2	25	7.7	6.7	16	16	8	4		0	68
		C	V6-B2c	43	13	0	16	0	0	0		0	40
		A	V6-B3	31	7	6.7	8	8	14	4		0	25
		Rail Loop	V6-B4	17	13.7	3.2	8	2	4	2		0	6
Grey Gum / Narrow-leaf Ironbark / Bulloak / Honeymyrtle Forest		C	V11-B1	24	10	4	18	2	16	0		0	26
		C	V11-B2	32	18	14	40	0	10	0		0	20
Average values for RWEP and Rail loop monitoring sites				30.6	12	6	16.4	3.8	8.9	1.2	1	0	37.9
Performance criteria				>25	10-40	5-10	15-50	5-10	5-40	<5	1	-	-

The average number of native species recorded from plots in this PCT has increase following a decline recorded in 2017 and is similar to the highest scores recorded during 2015 and 2016 monitoring (**Figure 6**). This pattern is not followed by the reference site data which has continued to decline, although this is based from a single plot, potentially explaining the discrepancy.

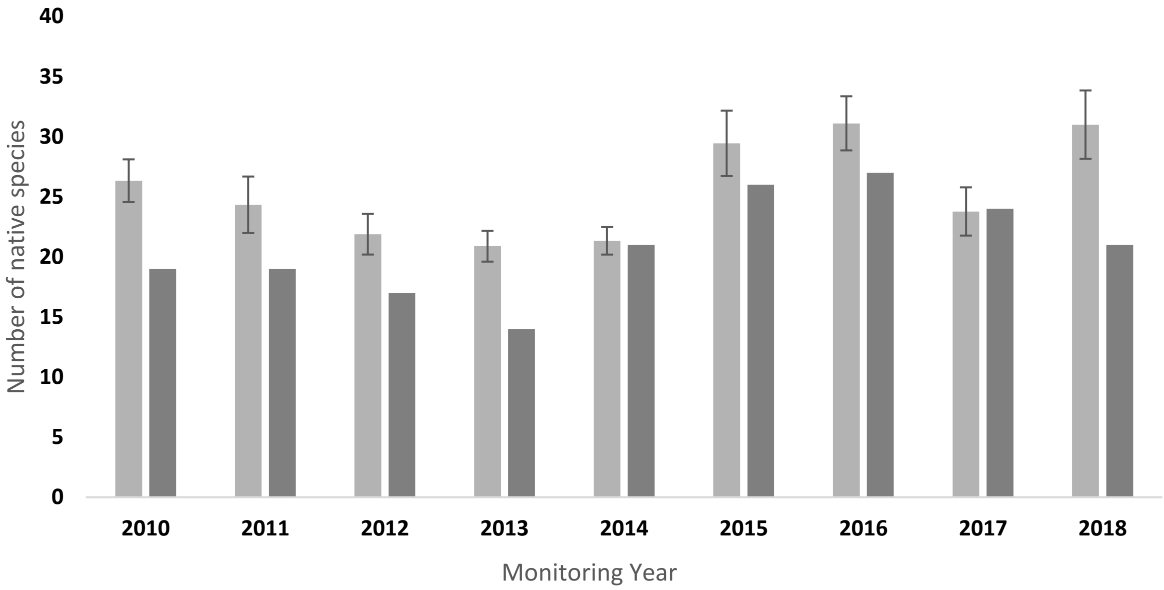

Figure 6: Average number of native species recorded in Narrow-leaved Ironbark - Bull Oak - Grey Box open forest within RWEAs (light grey) compared to reference site V6-A3 (dark grey). Error bars represent the standard error of the mean

Plate 12: Photo-monitoring point A4 during 2013

Plate 13: Photo-monitoring point A4 during 2018

Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter

Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter at WCPL is characterised by an overstorey of *Eucalyptus crebra*, *Corymbia maculata* (Spotted Gum) and *Eucalyptus moluccana*. *Eucalyptus punctata* and *Eucalyptus dawsonii* (Slaty Gum) are also occasionally present. The mid-storey or shrub layer often includes *Melaleuca decora*, *Bursaria spinosa* subsp. *spinosa*, *Allocasuarina luehmannii* and *Olearia elliptica* (Sticky Daisy Bush). This community corresponds to the EEC Central Hunter Ironbark -Spotted Gum –Grey Box Forest listed under the BC Act. Sections of this community in good condition with a Eucalypt canopy are also likely to be the Central Hunter Valley eucalypt forest and woodland CEEC, listed under the Commonwealth EPBC Act.

This PCT appears to be performing well in regard to performance criteria with large numbers of native species present at each monitoring plot, despite falling just short of the performance criteria for this attribute. The number of native species in this PCT was in line with previous years, and very similar to 2017 (**Figure 7**). Most other attributes met performance criteria, or fell just short in the case of cover for overstorey and ground cover of grasses and shrubs (**Table 8**), however all values fell within the acceptable range and no management actions are required. Monitoring plot V10-B1 had the lowest number of native species, despite being the most diverse site in previous years. Generally, few weed species are present within this PCT, with the exception of small infrequent occurrences of *Opuntia* species (Prickly Pear, Creeping Pear or Tiger Pear).

Photo-monitoring points in this community show little change in vegetation structure between the 2013 and 2018 monitoring periods (**Plate 14 & Plate 15**).

Plate 14: Photo-monitoring point B2 during 2013

Plate 15: Photo-monitoring point B2 during 2018

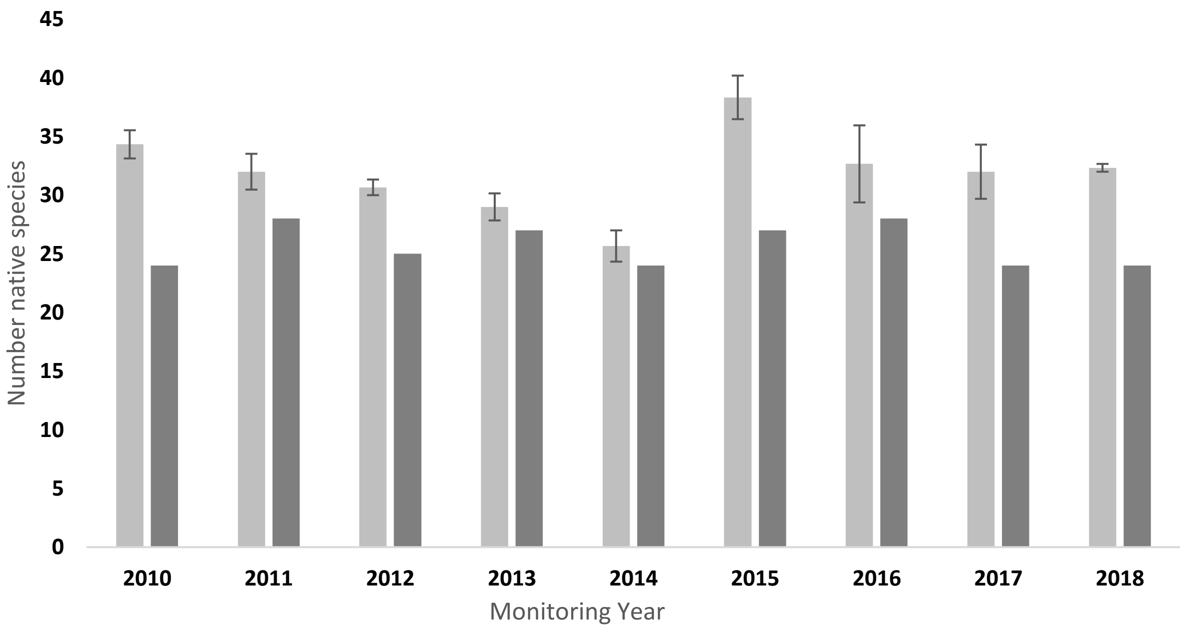

Figure 7: The average number of native species in Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland within RWEAs (light grey) compared to the recorded number at reference site V9-A1 (dark grey). Error bars represent the standard error of the mean

Table 8: Floristic results, performance criteria and OEH benchmarks for Narrow-leaved Ironbark - Grey Box - Spotted Gum woodland at Wambo

Vegetation Community (Orchid Research 2003)	Plant Community Type (PCT)	RWEP Area	Plot Name	NNS	NOS (%)	NMS (%)	NGCG	NGCS	NGCO	EPC	OR	HBT	FL
Spotted Gum / Narrow-leaf Ironbark/ Bulloak / Paperbark Forest	PCT1604: Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass of the central and lower Hunter	Outside of RWEP	V9-A1	32	12	7.5	6	8	6	2	1	0	18
		B	V9-B1	30	11	6.7	26	38	16	0		0	36
		B	V9-B2	31	14.7	4.5	32	22	12	0		0	58
		B	V10-B1	26	10.5	7.5	14	4	28	0		0	42
Average values for RWEP monitoring sites				29	12.1	6.2	24	21.3	18.7	0	1	0	45.3
Performance criteria				>35	15-40	5-20	30-50	5-15	5-40	< 5	1	-	-

Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin Bioregion

The canopy of Slaty Box - Grey Gum shrubby woodland is typically dominated by *Eucalyptus dawsonii* and several other species including *E. punctata*, *E. moluccana* and *E. crebra*. *Acacia salicina* (Cooba) and *Allocasuarina luehmannii* may form a small tree layer or be part of the upper-most canopy. The shrub layer includes species such as *Olearia elliptica*, *Acacia cultriformis* (Knife-leaved Wattle), *Canthium odoratum* (Shiny-leaved Canthium), *Notelaea microcarpa* var. *microcarpa* and *Dodonaea viscosa* subsp. *cuneata* (Wedge-leaf Hopbush). The groundcover is generally sparse to very sparse and is relatively species poor (**Plate 16**). This community is listed under the BC Act as the EEC *Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion.* Sections of this community in good condition with a Eucalypt canopy are also likely to be the *Central Hunter Valley eucalypt forest and woodland* CEEC under the Commonwealth EPBC Act.

At WCPL, the Slaty Box - Grey Gum shrubby woodland community primarily occurs on the smaller ridge tops and slopes and is patchily distributed at lower elevations. *Eucalyptus crebra* is often present and may co-dominate the canopy with *E. dawsonii*.

This PCT is generally in good condition, particularly on the slopes and ridgetops where historical disturbance from forestry and grazing has been minimal. A large number of native species, few weed species and a sparse weed cover was recorded. Occasional occurrences of the priority weed *Opuntia* spp. were observed at low densities, similar to other woodland areas at WCPL. Very minor changes in exotic species cover values has occurred between 2014 and the present, with exotic cover remaining very low and recorded as zero in the past two monitoring years.

The monitoring sites in this community are located in or near RWEA D. All performance criteria were met in 2018, except for NOS which was below the target range. Plot photographs show the canopy in good condition and the lower score is likely a result of observer bias, and no management action is required. The recorded number of native species in 2018 was within the range previously recorded and similar to 2017 (**Figure 8**).

Plate 16: A typical example of Slaty Box woodland at WCPL during 2018

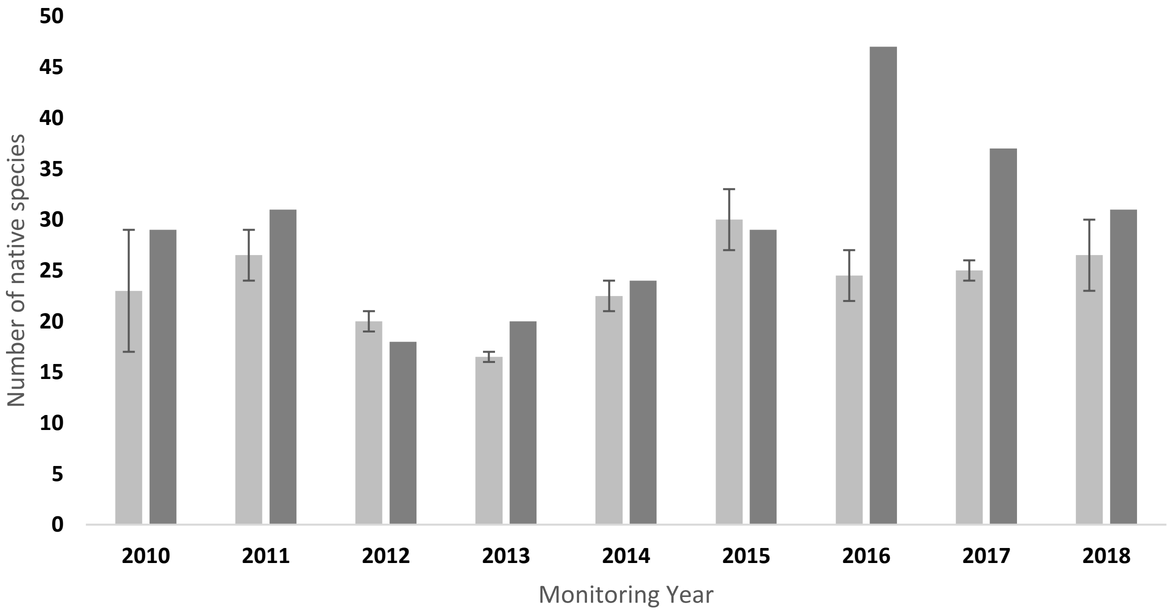

Figure 8: The average number of native species recorded in Slaty Box shrubby woodland within RWEAs (light grey) compared to reference site V10-A2 (dark grey). Error bars represent the standard error of the mean

Table 9: Floristic results, performance criteria and OEH benchmarks for Slaty Box - Grey Gum shrubby woodland

Vegetation Community (Orchid Research 2003)	Plant Community Type (PCT)	RWEP Area	Plot Name	NPS	NOS (%)	NMS (%)	NGCG	NGCS	NGCO	EPC	OR	HBT	FL
Slaty Gum / Narrow-leaf Ironbark / Bulloak / Paperbark Forest	1176: Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin Bioregion	D	V10-A1	33	7.4	7.5	24	0	4	0	1	0	44
		Outside of RWEP area	V10-A2	23	3.5	2.7	7.5	0	0.5	0		0	16
		D	V10-B3	34	10	2.2	32	10	2	0		0	47
Average values for RWEP monitoring sites				33.5	8.7	4.9	28	5	3	0	1	0.0	45.5
Performance criteria				21	15-40	5-30	5-30	0-25	2-10	< 5	1	-	-

White Mahogany - Spotted Gum - Grey Myrtle semi-mesic shrubby open forest of the central and lower Hunter Valley

At WCPL, this community occurs along Stony Creek and is sheltered by steep sandstone escarpments to the south and a large ridgeline to the north. This PCT is in good condition with many native species and occasional large remnant trees with hollows. One monitoring plot (V13-B1) samples this PCT. Exotic plant species cover is very low and sparse with no exotic cover recorded along the biometric transect (**Table 10**).

This monitoring site fell one species short of the required number of native species, with the recorded number still being very high with 44 native species recorded in the 20 x 20 plot. This result is considered acceptable and is an increase from the previous two years. Over-storey cover (9%) was slightly lower than the performance criteria (15-45%) and significantly lower than in 2017. The reason for this result is unclear, however it likely attributable to observer variation, as the general condition of the vegetation and canopy in this area remains good. No decline in number of native species or increase in exotic cover was observed from the previous monitoring event in 2017. Recorded values for this community generally met the performance criteria or were in the acceptable range and no additional management is required.

Plate 17: White Mahogany - Spotted Gum - Grey Myrtle forest at V13-B1

Table 10: Biometric scores and performance citeria for White Mahogany - Spotted Gum - Grey Myrtle semi-mesic shrubby open forest at Wambo

Vegetation Community (Orchid Research 2003)	Plant Community Type (PCT)	RWEP Area	Plot Name	NPS	NOS (%)	NMS (%)	NGCG	NGCS	NGCO	EPC	OR	HBT	FL
White Mahogany / Rough-barked Apple Forest	PCT 1584: White Mahogany - Spotted Gum - Grey Myrtle semi-mesic shrubby open forest of the central and lower Hunter Valley	B	V13-B1	44	9	21	18	30	18	0	1	0	46
Performance criteria				>45	15-45	5-40	5-40	10-20	5-20	0	1	-	-

Brush Wilga/Native Olive Shrubland

The monitoring plots within this PCT are dominated by the shrubs *Notelaea microcarpa* var. *microcarpa*, *Geijera salicifolia* (Brush Wilga), *Olearia elliptica* and the small tree *Brachychiton populneus* (Kurrajong) (**Plate 18**). Occasional *Eucalyptus crebra* or *E. moluccana* are present as canopy species. The PCT sampled by floristic monitoring may be partially a derived community, resulting from the historic removal of overstorey species in Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest combined with a south facing aspect. These areas are in good condition, with a large number of native species and few exotic species. Exotic species cover has remained consistently very low over time at these monitoring plots.

The average number of native species recorded within this PCT in the RWEA areas was slightly less than performance criteria this year and the number of native species recorded has dropped slightly at all monitoring sites within this community for the past two years in a row (**Figure 9, Table 11**). Similar numbers of native plant species were observed at these sites during 2014 monitoring. The numbers of native plant species in this community have fluctuated over time in a similar fashion to other communities, with a slight dip in the number of species recorded during 2012, and 2013, 2014 monitoring, before peaking during the 2015/16 monitoring. The reference site V14-A1 mirrors this pattern closely, suggesting that the cause of these fluctuations also affected areas outside of the RWEA and is likely to be primarily due to variance in annual rainfall and other factors unrelated to management actions within RWEAs.

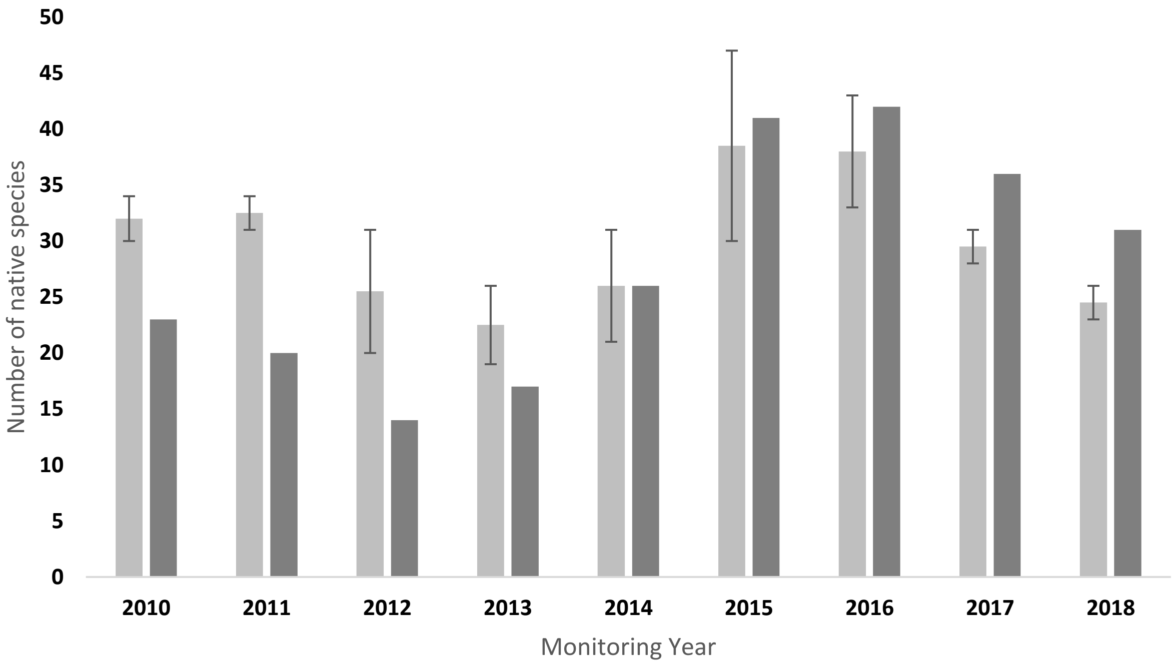

Figure 9: The average number of native species recorded in Brush Wilga/Native Olive shrubland within RWEAs (light grey) compared to reference site V10-A2 (dark grey)

Plate 18: Brush Wilga/Native Olive Shrubland at V14-A1 in 2018

Table 11: Biometric scores and performance citeria for Brush Wilga/Native Olive Shrubland at WCPL

Vegetation Community (Orchid Research 2003)	Plant Community Type (PCT)	RWEP Area	Plot Name	NNS	NOS (%)	NMS (%)	NGCG	NGCS	NGCO	EPC	OR	HBT	FL
Brush Wilga/Native Olive Shrubland	PCT 1603: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter *	Outside of RWEP	V14-A1	31	2.4	28	12	10	8	0	1	0	0
		B	V14-B1	26	5.5	15	30	14	22	0		0	55
		B	V14-B2	23	7.5	32.5	26	10	20	0		0	5
Average values for RWEP monitoring sites				24.5	6.5	23.8	28	12	21	0	1	0	30
Performance criteria				>30	5-40	5-40	30-50	5-10	10-40	<5	1	-	-

*considered a variant of this PCT

2.1.4 Conservation agreement requirements and photo monitoring points

Annexure C of the VCAs requires that WCPL aim for an exotic plant cover within the Conservation Areas that does not exceed the exotic cover percentages detailed in **Table 9**. As in 2017, two of the 10 monitoring plots (A2 and A3) exceed the exotic cover limits for the 2-5 year targets. Site A2 had numerous *Anagallis arvensis* (Scarlet Pimpernel) and several other common pasture weeds with scattered *Opuntia* spp. (Tiger Pear and Prickly Pear). Site A3, within the riparian zone of Wollombi Brook, continues to have a moderate cover (5-25%) of *Ehrharta erecta* (Panic Veldtgrass) along with 17 other common exotic flora species.

Site A1 falls below the exotic cover limit and the exotic cover has fallen since 2017. However, exotic cover remains high, dominated by *Galenia pubescens* (Galenia), with several other common weeds of pasture/native grasslands such as *Bidens subalternans* (Greater Beggar's Ticks), *Echium plantagineum* (Patterson's Curse) and *Ehrharta erecta*.

Exotic cover is very low or zero at the remaining sites, and all these fell below the exotic cover limits. No exotic cover was recorded at Site CT2, the same result as 2017. In 2016 this site had a very high exotic cover (52%) which was dominated by *Melinis repens* (Red Natal Grass). It is suspected that the dry conditions over the past two years have impacted *Melinis repens*, it was only recorded from one plot in 2018.

Table 12: Exotic plant cover at monitoring sites in regard to VCA targets

RWEA	Site Code for VCA	Corresponding flora monitoring plot	Exotic cover limits yr 1	Exotic cover limits yrs 2-5	Total exotic cover from biometric plots in 2018
Coal Terminal (Rail Loop)	CT1	V6-B4	5	5	2
Coal Terminal (Rail Loop)	CT2	V5-B4	15	15	0
A	A1	V2-B1	70	60	38
A	A2	V5-B1	20	15	18
A	A3	V1-B2	30	20	44
A	A4	V6-B1	10	5	2
B	B1	V13-B1	5	5	0
B	B2	V9-B1	5	5	0
C	C1	V11-B1	5	5	0
D	D1	V10 -B3	5	5	0

Comparison of photo-monitoring sites between 2013 and 2018 monitoring show little change in vegetation over this time period. Dry conditions during the 2018 monitoring are apparent in some photographs, with less green vegetative growth visible, but in general, no major changes in species composition or structure are apparent. Similar dry conditions were also reported in 2017.

Evidence of the canopy dieback in RWEA A observed during 2016 monitoring is still visible at site A2, however the new growth first reported in 2017 is continuing to develop covering tree branches. The condition of the PCTs in these RWEAs is assessed in detail in the previous sections, with photos of each monitoring site included in **Volume 2.**

2.1.5 Discussion and recommendations

The majority of remnant woodland areas remain in good condition with high numbers of native species, few exotic species present and with low cover and abundance. No major issues were identified that require urgent management. However, as reported in previous years, exotic species cover remains relatively high in riparian and floodplain areas (V1 and V2 plots of RWEA A) and continues to exceed performance criteria and also VCA targets in certain locations. Continued weed management will be required to achieve performance criteria in these riparian and floodplain areas.

Several weed species listed under the NSW *Biosecurity Act 2015* were observed in these areas that have potential to become problematic in the wider region e.g. *Olea europaea* subsp. *cuspidata* (African Olive). It is recommended to give priority to species such as this in the mine's weed control program. As discussed in previous monitoring reports, planting of canopy species should be considered in RWEA 'A', where natural regeneration is unlikely to occur in a reasonable timeframe (i.e. the open grassland areas of on the Wollombi Brook floodplain). Once established, these plantings may also reduce issues with exotic flora species in these areas.

The average number of native species detected within all communities was generally within the range of values recorded in previous monitoring years and was similar to the results from 2017 when dry conditions were experienced. Monthly rainfall data from 2018 from Singleton (BOM 2018) reveals that for all months in 2018 until October below average rainfall was recorded. The two plots surveyed in November to complete the flora surveys for 2018 recorded higher diversity of native species recorded than other plots within the same community that were surveyed in October. This suggests the majority of surveys, undertaken in October 2018 were undertaken following a dry period of below average rainfall, and many species were likely not detectable due to seasonal conditions.

The number of native species recorded in Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland has recovered significantly from 2017 which had recorded the lowest diversity since surveys began in 2010. The low diversity recorded in 2017 may have been a result of *Angophora floribunda* dieback in 2016 exposing the understorey to harsher conditions. The higher diversity recorded in 2018, along with observations of continued epicormic growth in the impacted trees, suggests the community is recovering from the dieback event. in 2018 The community in which the dieback was observed is listed as a CEEC under the Commonwealth EPBC Act. The dieback is not considered to be associated with activities undertaken on WCPL land as no undermining is being undertaken in that area and dieback was also observed at other locations within the locality in 2016. Evidence of recovery was observed on most trees that were impacted, and it appears likely that the majority of trees may recover in time.

2.2 Bird Monitoring within RWEA's

The bird monitoring program is a requirement of the current Development Consent conditions and has been designed in an effort to measure the performance of the WCPL RWEP. The consent conditions (DA 305-7-2003) specify that "Terrestrial fauna surveys should be conducted to monitor the usage of enhancement areas by vertebrate fauna. Monitoring may include fauna species diversity and abundance or, alternatively, the use of indicator species to measure the effectiveness of enhancement measures".

Methods, results (including a comparison with previous monitoring), and interpretation of results, are included below.

Data from previous year's bird surveys was limited to:

- RPS Australia East (RPS) 2009. Annual Ecological Monitoring Report. Remnant Woodland Enhancement Monitoring Program Riparian and Bed and Bank Stability Monitoring, Stoney Creek, South Wambo Creek and North Wambo Creek. Prepared for Wambo Coal Pty Limited.
- Niche 2014b. EMP010 Monitoring 2014 – Indicator Species (birds). Prepared for Wambo Coal Pty Limited.
- Eco Logical Australia (ELA) 2016a. Wambo Coal Mine Flora and Fauna Monitoring Report (2015) - Volume 1. Prepared for Wambo Coal Pty Ltd.
- Eco Logical Australia (ELA) 2017a. Wambo Coal Mine Flora and Fauna Monitoring Report (2016) - Volume 1. Prepared for Wambo Coal Pty Ltd.
- Eco Logical Australia (ELA) 2018a. Wambo Coal Mine Flora and Fauna Monitoring Report (2017) - Volume 1. Prepared for Wambo Coal Pty Ltd.

2.2.1 Methods

Bird monitoring during spring 2018 was consistent with the two previous monitoring events in timing of surveys and methods. During the survey, two observers spent 10 minutes recording birds seen and heard within 50 m radius (0.8 ha) of a central point, followed by an additional 10 minutes searching the balance of a 2 ha plot, and recording the total numbers of birds detected (seen and heard). One morning and one afternoon survey was conducted per site.

The majority of the twenty-six (26) sites (**Figure 12**) were surveyed between September 3 and 7, 2018, with the remaining surveys completed during November 20 to 21 2018.

The total number of bird species recorded each year 2007-18, average number of bird species per 20-minute bird survey, average number of birds per survey, bird density and the distribution and relative abundance of threatened species were examined. Broad comparisons between the bird species recorded in previous years and the current year were also made.

2.2.2 Results

The 2018 monitoring observed a total of 90 bird species from 26 monitoring sites during formal bird surveys. This number is higher than the median from all 26 sites in previous monitoring periods (2007-2017 - 78 species), and is within range of previous surveys, which have varied between a low of 64 species in 2012 to a high of 96 species in 2013 (**Figure 10)**.

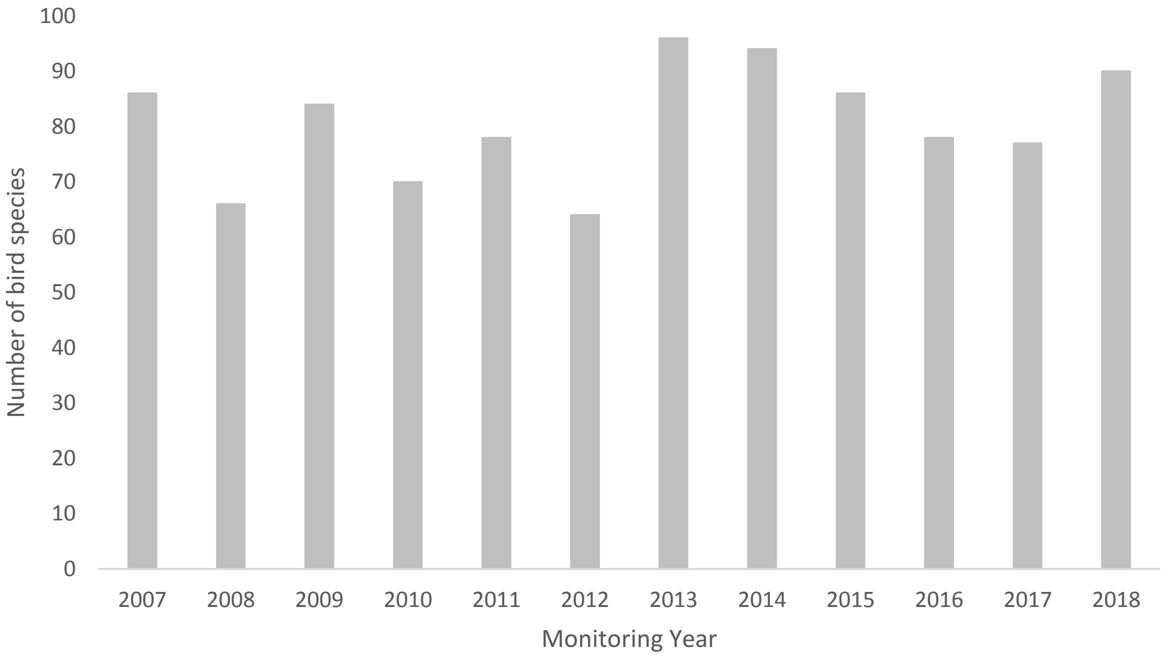

Figure 10: Number of bird species recorded at monitoring plots 2007 - 2018

The average number of bird species per 20-minute bird survey in 2018 was 12.3, higher than in 2017 (9.94), but similar to other recent monitoring periods in in 2015 (12.4) and 2016 (12.1).

In 2018, the number of species detected at each site varied between 10 (at site BP2) and 28 (at BP7 and BP25), with an average of 20 species recorded per monitoring site. This is the highest average species diversity per site that has been recorded from the years with available data, with the next highest being in 2015 (19.2) (**Figure 11)**.

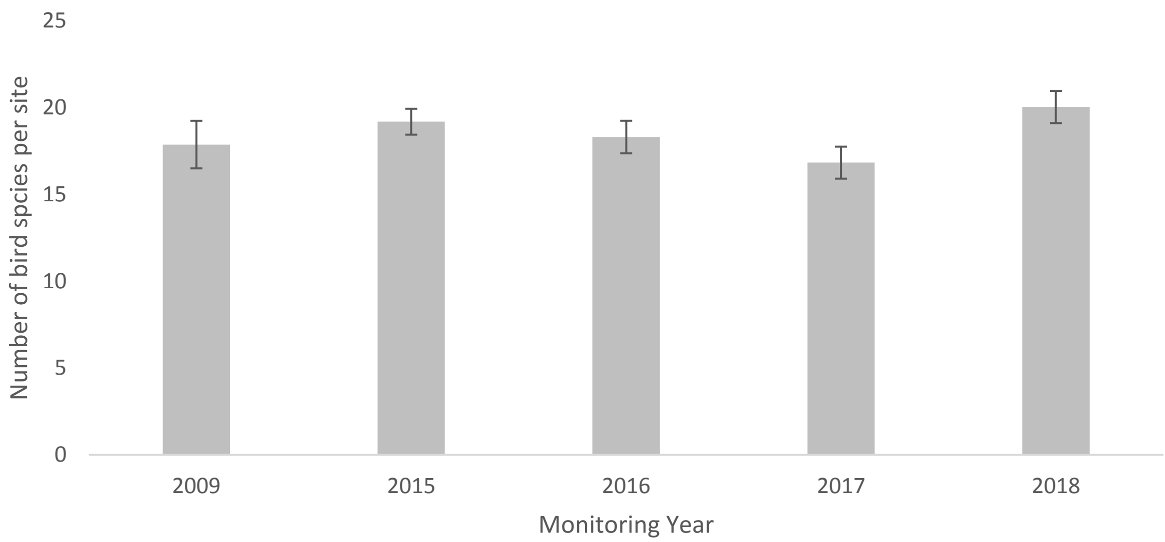

Figure 11: Average number of bird species recorded per monitoring site during 2009 and 2015-2018

The average number of birds recorded per survey was similar to that recorded in recent years with 25.6 birds recorded per survey during 2018 and a bird density of 12.8 birds/ha/20 mins. This result is the lowest recorded since data on the number of birds recorded was first collected in 2014, however it is similar to the numbers previously recorded which range between 26.1 (2017) and 30.8 (2014) birds per survey. Numbers of birds were not presented in RPS (2009) and it is assumed only bird species were recorded.

The most species-diverse sites during 2018 were BP7 and BP25 (28 species). BP11, which was the most diverse site in the previous two years, also had high diversity with 26 species. BP2 had the lowest species diversity in 2018, with 10 species recorded.

Bird assemblages over time were not compared statistically, however, assemblages appear broadly similar to the previous four years and also to data from 2009 monitoring. When comparing the 20 most widely recorded species from each year, the results from 2018 contains an average of 13 of the same species recorded in the top 20 for previous years. The most widely recorded species in 2018 were *Pardalotus punctatus* (Spotted Pardalote), *Lichenostomus chrysops* (Yellow-faced Honeyeater), and *Strepera graculina* (Pied Currawong), all of which were also regularly recorded in previous years.

Six threatened species listed under the NSW BC Act were recorded during 2018 surveys; *Artamus cyanopterus* (Dusky Woodswallow), *Pomatostomus temporalis temporalis* (Grey-crowned Babbler), *Daphoenositta chrysoptera* (Varied Sittella), *Glossopsitta pusilla* (Little Lorikeet), *Chthonicola sagittata* (Speckled Warbler) and *Climacteris picumnus victoriae* (Brown Treecreeper (eastern subspecies)). This result is lower than the eight threatened species recorded in 2017, but within the range recorded from 2014 to 2017 (five to eight species). These threatened species form a group that are regularly recorded during the monitoring surveys, with all six of these species being recorded every year from 2014 to 2018, with the exception of Brown Treecreeper and Little Lorikeet which were not recorded in 2014.

Comparison of numbers of threatened species between the 2015-2018 monitoring periods and the number of sites they were recorded at during the 2009 and 2014 to 2018 monitoring periods show that the number of Speckled Warbler individuals in 2018 is the lowest recorded (12), and were recorded from eight sites in 2018, although they have previously been recorded from as few as seven sites in 2015. The results from 2018 for the remaining species fall within the range of previously recorded values.

2.2.3 Discussion

RWEA and other remnant woodland sites at WCPL continue to support a large diversity of bird species and no introduced bird species were detected within RWEP areas.

One hundred and sixteen bird species have been recorded during timed bird surveys over the last four years, with 90 (77.5%) of these recorded during 2018, including ten species not recorded in the previous three years.

As vegetation and habitat attributes in RWEA areas have remained relatively stable over time (see previous section), this variability in species richness between years are likely explained by a combination of factors such as varying numbers of nomadic and migratory bird species, weather and climate, sampling methods, differences in the skill of observers, the timing of surveys and surveys coinciding with the flowering of trees and also broader landscape scale changes across the Hunter Valley. The total number of bird species detected each year has varied over time and the 90 species recorded during 2018 is within the range of previous years. The number of species recorded had been declining each year since the highest diversity was recorded 2013, however the result in 2018 arrests this trend and is the third highest diversity recorded since surveys began in 2007. The average number of birds recorded per survey has remained relatively constant since 2014, when this data was first collected.

Comparison of numbers of threatened species (2015-2018) and the number of sites they were recorded at (2009 & 2014-2017) show that both the Speckled Warbler and Varied Sittella were recorded more widely during surveys in 2014. However additional survey effort during the 2014 monitoring may partially explain this observation, as the number of sites where these species have been recorded have remained similar since the 2015 monitoring. The number of individuals for threatened species recorded was within the range of those previously recorded suggesting no obvious declines are evident from the available data.

As mentioned in previous reports, the analysis of bird data in order to measure the effectiveness of woodland enhancement measures is limited by both the design of the current monitoring program, previous changes in methodology, the type of data previously collected, and limited data from previous bird monitoring. Interpretation of the data was further limited as RPS (2009) did not record relative abundance data and provided a species list only, while different survey methodology between Niche (2014b) and the past four years prevented a direct comparison with bird community data collected in 2014. A previous flora and fauna monitoring review by ELA (2016b) has discussed these issues in detail and recommendations included in the review remain relevant.

Figure 12: Bird monitoring locations and remnant woodland enhancement areas

3 Rehabilitation areas

3.1 Introduction

Rehabilitation areas are monitored using a combination of LFA and biometric plots (woodland rehabilitation areas).

LFA is currently used to monitor the progress of the North Wambo Creek diversion, woodland rehabilitation and pasture rehabilitation towards achieving a suitable condition for their intended land use post-mining. The rehabilitation objectives for the North Wambo Creek Diversion (WCPL 2015) include:

- To establish pasture species consistent with revegetation strategy
- Tree species established along creek lines consistent with the riparian zone
- Creek diversion stable and will not present a greater safety hazard than surrounding land
- Creek diversion able to shed water safely without causing excessive erosion, jeopardising landform integrity or increasing pollution of downstream watercourses
- All watercourses subject to subsidence impacts shall be hydraulically and geomorphologically stable, with riparian vegetation established that is the same or better than prior to commencement of mining.

Completion criteria for the North Wambo Creek diversion, mixed woodland/pasture areas and woodland corridors for LFA have been developed from previous monitoring results from relatively undisturbed and natural landscapes surrounding the mine. These are listed in each results table below.

Additional completion criteria for these rehabilitation areas is listed in the Mining Operations Plan (WCPL, 2015) and include ensuring that:

- Minimum 70% of area has a vegetative cover
- No single bare area >20m^2
- Biometric monitoring confirms exotic cover <33%]
- No tunnel or gully erosion is to be present
- Rill erosion is to be limited to <200 mm deep and/or <200 mm wide.

Woodland rehabilitation monitoring sites currently occur within plantings of *Eucalyptus cladocalyx* (Sugar Gum) that do not match up with the species composition of natural vegetation communities surrounding the mine and completion criteria based for biometric monitoring has also been developed for these areas.

LFA monitoring at WCPL focusses on scores for Landscape Organisation, Stability, Infiltration/Runoff and Nutrient Cycling. Landscape organisation relates to the proportion of the transect occupied by patches - patches being landscape elements that are relatively permanent and provide stable, resource accumulating structures, such as grassy tussocks and other ground cover, leaf litter and logs. Therefore, a larger Landscape Organisation Index (LOI) number implies a more stable transect that traps water and nutrients and is less prone to soil erosion.

A Soil Surface Assessment (SSA) is completed for each patch type on each LFA transect. Five 'query zones' are selected for each patch type where possible. Scores are recorded for rain splash protection, vegetation cover, plant litter cover, cryptogam cover (cover of algae, mosses and liverworts, lichen and fungi), crust brokenness, erosion type and severity, deposited materials, surface roughness, surface nature and the stability and texture of the soil. These soil surface indicators are then used to give Stability, Infiltration/Runoff and Nutrient Cycling scores for each transect.

Stability is defined as the ability of the soil to withstand erosive forces, and to reform after disturbance. The stability index is derived from data collected during the SSA's, such as crust broken-ness, surface resistance, slake tests, erosion type and severity, deposited materials, cryptogam cover, rain splash protection and leaf litter cover.

Infiltration concerns the way water interacts with soil to become soil water (and becomes available for plants) or runoff water where water is lost from the system or transports materials (such as soil, nutrients and seed) away. Scores for vegetation cover, surface roughness, slake tests, litter cover, origin and decomposition, surface resistance to disturbance and soil texture contribute to the infiltration index.

Nutrient cycling is defined as how efficiently organic matter is cycled back into the soil. Scores for vegetation cover, litter cover, origin and decomposition, cryptogam cover and surface roughness contribute to nutrient cycling values.

3.2 Methods

LFA data was collected from a total of 23 monitoring sites, including eight in the riparian rehabilitation areas at the North Wambo Creek Diversion, four in woodland rehabilitation areas and ten in pasture rehabilitation areas and one on Wambo Creek (**Figure 13**). LFA methods followed the method for Landscape organisation and SSA, as provided in Tongway and Hindley (2004). LFA data was collected between 17-21 September, and 19- 20 November 2017 by ELA ecologists Daniel McKenzie, Dee Ryder and Tom Schmidt.

Sites on the North Wambo Creek Diversion were adjusted slightly during the 2016 and 2017 monitoring to better sample the slope and riparian zone and avoid crossing the regularly disturbed creek channel as per LFA methodology. Monitoring site 14R is located away from the creek diversion on Wambo Creek and provides an example of a cleared agricultural riparian zone that has been relatively undisturbed by open-cut mining activities. Site 5R, located within an area designated for pasture rehabilitation was moved down slope slightly during 2017 monitoring, to avoid a road which had recently been constructed through the previous monitoring plot. No sites were adjusted in 2018.

Raw numerical values from previous years were available for Landscape organisation, Stability, Infiltration and Nutrient cycling indices. Data for pasture and woodland sites was available for the 12 monitoring periods from 2006 – 2017, while creek diversion sites were first sampled at the completion of the creek diversion construction and subsequent seeding in 2008. Trends in these values over time along with general field observations were used to inform management recommendations.

Performance criteria have previously been developed from a range of scores from previous monitoring years from nearby sites with relatively undisturbed riparian habitat. The following colour system is used to highlight the performance of each LFA site as shown below in **Table 13.**

Table 13: Colour system devised to highlight the performance of each LFA site

Green	Yellow	Orange	Red
Area generally meets or exceeds target values and values do not show trend of decline over time – where monitoring sites are meeting targets and values are relatively consistent, reduce monitoring to infrequent LFA when changes in landscape or management practices occur i.e. fire or grazing)	Area generally falls below target values but within 75% of targets or appears to be on a trajectory of improvement without the need for management intervention – further monitoring required	Area generally falls between 75% and 50% of target values or shows little sign of improvement over several monitoring events – further monitoring and possibly management actions required	Area falls below 50% of target and is unlikely to improve without management actions or shows trend of decline which is unlikely to improve without management actions

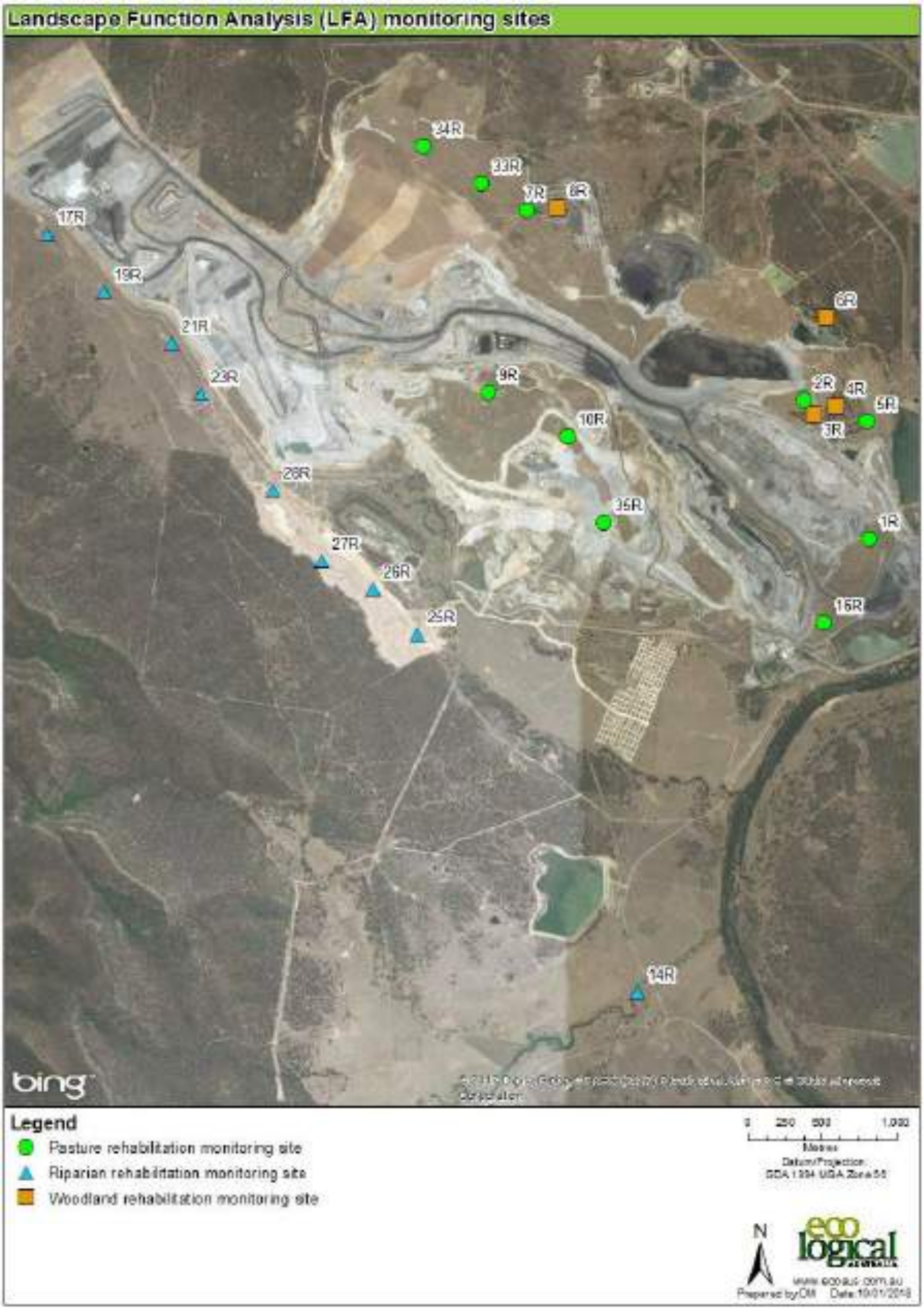

Figure 13: LFA monitoring sites

3.3 Results

3.3.1 North Wambo Creek Diversion

Monitoring sites within the North Wambo Creek Diversion area are variable in condition with monitoring sites described in **Table 15**. All monitoring sites are open pasture areas and generally have few native plant species and consist of predominantly low pasture, primarily *Cynodon dactylon* (Common Couch), with tussocks of *Chloris gayana* (Rhodes Grass) and *Setaria* species (**Plate 20**). However, as observed in 2017, promising signs for the future of the diversion area are present, with *Acacia* and *Eucalyptus* sp. seedlings and shrubs observed in the south of the diversion area as a result of direct seeding works. Natural establishment of *Casuarina cunninghamiana* and *Eucalyptus* sp. in the creek bed, particularly in the north of the creek diversion, also continues (**Plate 21**).

Plate 19: North Wambo Creek Diversion during 2018 at site 26R

Plate 20: Redgum and River Oak establishing within the diverted creek channel on North Wambo Creek (site 23R)

Table 14: North Wambo Creek Diversion LFA results in 2018 (Plots are organised by location - upstream to downstream)

Monitoring Plot	LOI	ST	INFI	NI
17R	0.81	56.3	34.9	30.7
19R	0.54	59.5	29.1	30
21R	0.76	62.2	39.4	23.4
23R	0.47	50.3	22.1	29.9
28R	0.59	58.5	31.1	18.7
27R	0.45	51.8	25.9	25.1
26R	0.81	62.5	24.6	19.1
25R	0.71	66.7	28.3	21.7
Average score	**0.64**	**58.5**	**29.4**	**24.4**
Target score	**>0.84**	**>62**	**>41**	**>37**
14R (reference site)	**1**	**52.5**	**47.1**	**30.7**

The average LOI score did not meet the performance target and has remained similar during the previous four years of monitoring, despite some minor changes in the location of transects and reshaping/ripping of areas in the south of the diversion during 2015 and 2017 to prevent further erosion and to control weeds. The three sites which decreased most in LOI in 2018 were the northernmost sites, 17R, 19R and 21R. These sites have typically had the highest scores, with these transects positioned on lower gradients and disturbance for the diversion less extensive and less recent. The lower scores are a result of a decrease in grass cover and increase bare ground. Two monitoring sites (23R and 27R) had transects comprised of more than 50% bare soil (average 54%), although both sites had less bare soil than in 2017. Monitoring sites 27R and 28R had were ripped and reshaped prior to the 2017 survey in an effort to control weeds, establish cover and prevent erosion. Both sites recorded an increase in LOI score in 2018, although low grass appeared to have established better on the ripped slope at Site 27R. Site 23R had issues with erosion (also noted in previous reports), with rills, scalds and eroding creek banks recorded. Several rills are likely to exceed the depth specified in the completion criteria in regard to erosion control (WCPL 2015).

LOI scores improved or were similar to 2017 for the southern sites. These are sites where slopes are steeper, more prone to erosion and more recent disturbance has occurred. The increased LOI scores indicate increased grassy cover at these sites. The addition of four sites in the more recently constructed southern portion of the diversion during 2015 is observable in the data via a drop in LOI scores. The very low scores reported from the first monitoring year in 2008 may reflect the bare soil of the newly created diversion followed by the establishment of a cover crop in the following years (**Figure 14**).

The average stability index at creek diversion sites during 2018 remain similar to the previous year and falls below the performance target. The lowest stability scores were recorded at the sites 23R and 27R which had higher proportion of bare soil and hence a larger propensity for soil erosion. The average stability index (58.5) is above that recorded at the analogue site 14R (52.5).

The average infiltration and nutrient indices also fell below performance, with lower scores than the previous year for the first time since 2012 for infiltration, since 2015 for nutrients (**Figure 16** and **Figure 17**). The lower average scores for both indices are the result of slightly poorer results across most sites rather than a large change at any individual or group of sites. These scores fall into the 'orange' category in relation to the performance criteria, where management actions may be required, therefore if results in 2019 do not show improvement, management should be considered improve results.

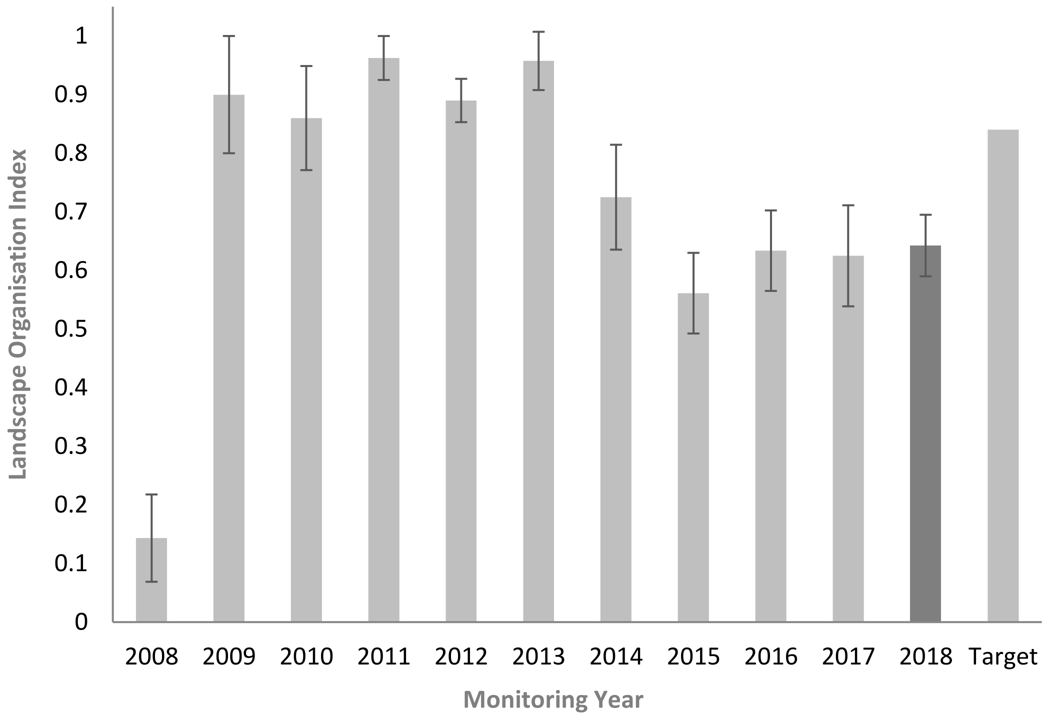

Figure 14: **Average landscape organisation scores from the creek diversion sites**. Average scores onwards from 2015 incorporate four additional sites (25r, 26R, 27R and 28R). Error bars represent standard error of the mean. Only 3 sites 19R, 21R and 23R were sampled in 2008. The target bar represents completion criteria for the Landscape Organisation Index.

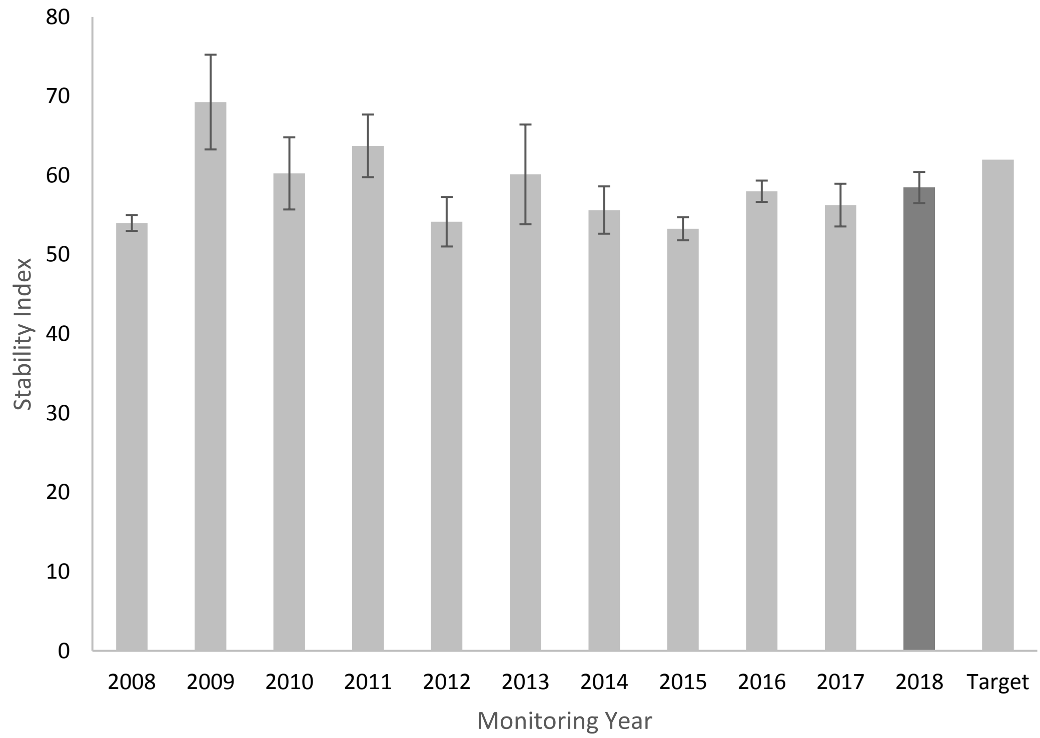

Figure 15: Average stability index values from the creek diversion sites. Values are derived from sites 17r, 19r, 21r and 23r each year since 2009-2014. Average scores from 2015 onwards incorporate four additional sites (25r-28r). Error bars represent standard error of the mean. Only sites 19R, 21R and 23R were sampled in 2008. The target bar represents completion criteria for the Stability Index.

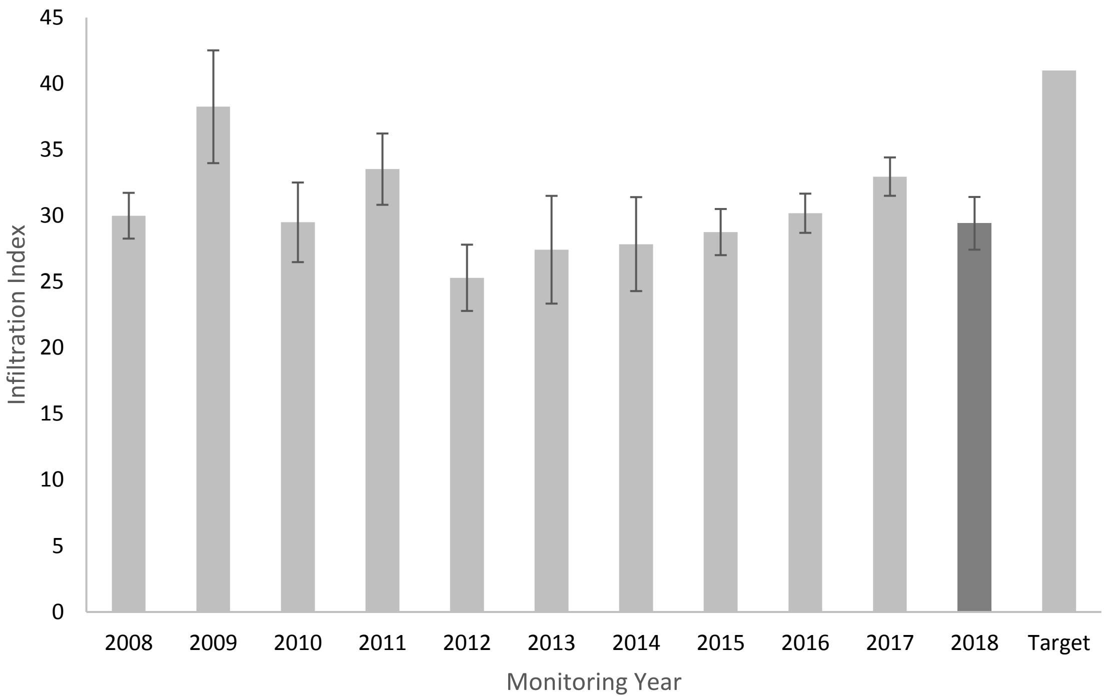

Figure 16 : Mean infiltration index values from the creek diversion sites. Values are derived from sites 17r, 19r, 21r and 23r each year between 2009 -2014. Average scores from 2015 onwards incorporate four additional sites (25r-28r). Error bars represent standard error of the mean. Only sites 19R, 21R and 23R were sampled in 2008. The target bar represents completion criteria for the Infiltration Index.

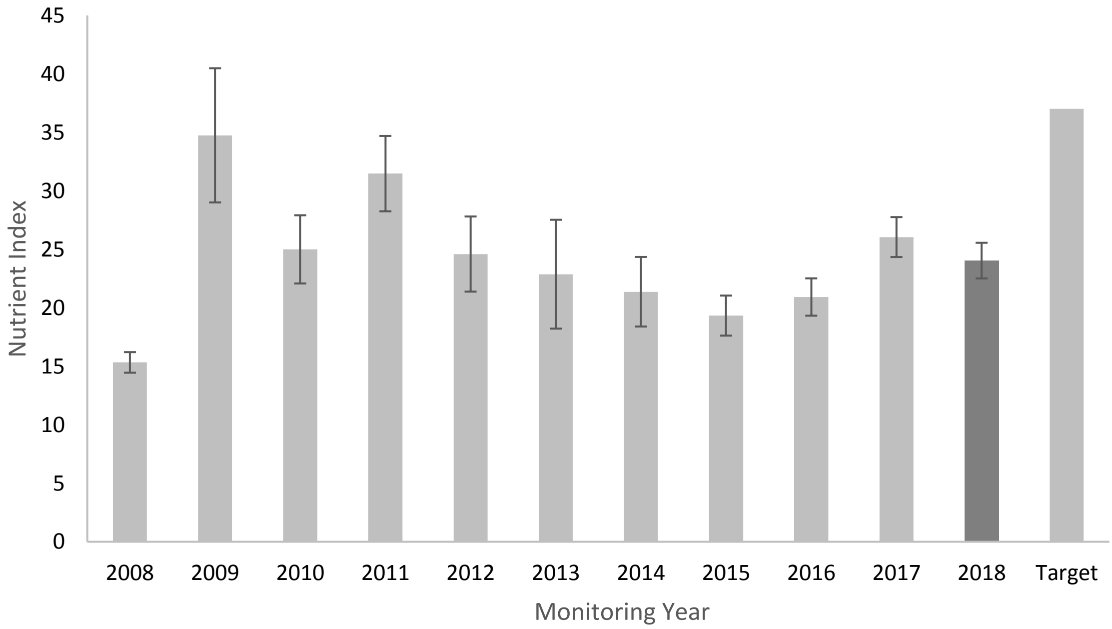

Figure 17: Mean nutrient index values from the creek diversion sites. Values are derived from sites 17r, 19r, 21r and 23r each year between 2009 -2014. Average scores from 2015 onwards incorporate four additional sites (25r-28r). Error bars represent standard error of the mean. Only sites 19R, 21R and 23R were sampled in 2008. The target bar represents completion criteria for the Nutrient Index.

Table 15: Site description of each creek diversion transect

Transect	Notes	Photograph
17R	Transect consists of relatively flat ground covered in pasture. Low grass, primarily *Cynodon dactylon* and grass tussocks, primarily exotic *Chloris gayana* make up 78% of the transect. A reduction in low grass and tussock cover in 2018 corresponds with an increase in bare ground, suggesting the grass cover the grass cover may have been dying off in the dry conditions.	
19R	Transect relatively flat and comprised primarily of low grass (54%) dispersed with patches of bare soil (46%). A 17% increase in bare soil from 2017 has resulted in a lower LOI score for this site. The increase in bare soil may be associated with the dry conditions causing the grass to die off. Young *Eucalyptus* and *Acacia* species are growing on creek banks downstream. Recent ripping activities have taken place near this transect.	

Transect	Notes	Photograph
21R	Transect relatively flat grassland dominated by low grass (57%) and bare soil (25%). Patches of the exotic *Galenia pubescens* are also present (3%). Bare soil has increased by 11% from 2017.	
23R	Low grass occurs over 36% of the transect, an increase of 11% from 2017. Large bare patches of stony soil occur towards the middle and end of transect and bare soil patches cover 53% of the area. Some areas of active erosion including some 30cm deep rills occur in the surrounding area. The creek bank is in this area has been undercut and slumping on western bank. A stand of ~ 5m tall *Casuarina cunninghamiana* and seedlings and some young Eucalypts are growing on creek banks.	

Transect	Notes	Photograph
28R	Transect primarily samples the relatively steep eastern creek bank. The majority of this transect was ripped to control *Galenia pubescens* and erosion prior to the 2017 monitoring. Minimal vegetation has developed on the ripped slope and minor new erosion is evident. Bare soil comprises 41%, with low grass (25%) and tussocks (22%) other dominant components. Logs and dense tussock grasses are present at the bottom of the slope. Subsidence cracks were observed near this transect.	
27R	Transect samples the relatively steep western bank of the cutting. The majority of this transect was ripped to control *Galenia pubescens* and erosion prior to the 2017 monitoring. Low sparse grasses and logs dominate the flat area adjacent to the creek channel. Low grass covers 36% of the transect and bare soil 55%. Logs (6%) and litter (2%) comprise the remainder. The low grass *Cynodon dactylon* has established on the ripped bank and woodchip mulch has also help stabilise the soil and allow vegetation to establish, contributing to a 16% higher LOI score for this site.	

Transect	Notes	Photograph
26R	Transect samples the relatively steep eastern bank to the edge of the creek channel. Low grass dominated this transect in 2018 covering 74% of the transect. Bare soil areas make up 19 % of the transect. *Acacia* sp. shrubs are establishing on some sections of the bank near this transect.	
25R	This slope is relatively steep with low grass dominating 61% of transect and having the highest contribution to soil stability. Bare soil is most prevalent at the top of transect where some minor erosion is occurring and makes up 30% of the transect. Large tussock grasses (*Chloris gayana*) and logs are present at the bottom of the transect near the creek channel. *Acacia* sp. shrubs are establishing on some sections of the bank near this transect.	

3.3.2 Woodland rehabilitation

Vegetation in woodland rehabilitation areas consisted primarily of *Eucalyptus cladocalyx* and occasionally *Corymbia maculata* (**Plate 21**). *Acacia saligna* (Golden Wreath Wattle) forms the dominant mid-storey species at site 4R and is also present at 8R, however, the previously observed die-off of this species continues. *E. cladocalyx* is native to South Australia and *Acacia saligna* is native to the south of Western Australia, but both have been planted widely in eastern Australia.

The substrate in these areas consists of fine grey sediment intermixed with rocks and forms a sandy clay, it appears topsoil was not used in the establishment of these woodland rehabilitation areas. As a result, the understorey in these areas remains very sparse with occasional native species present at low densities including *Enchylaena tomentosa* (Ruby Saltbush), *Calotis* spp. (Burr-Daisy) and several native grasses including *Cymbopogon refractus* (Barbed Wire Grass).

No significant issues with exotic weeds were identified in these areas, however patches of *Galenia pubescens* were common in monitoring plot 6R, with the same cover recorded in 2017. Results from these woodland rehabilitation areas remain very similar to 2015 (when they were first sampled floristically). With the exception of site 6R, the number of native species remains very low when compared to natural woodland sites nearby. Three of the four sites continue to have less than 10 native species within the 20 x 20 m monitoring plot. The mid-storey and groundcover that is present remains very sparse, with no groundcover score recorded along biometric transects for two of the four monitoring sites.

Plate 21: Woodland rehabilitation area dominated by *E. cladocalyx* at site 8R in 2018

Monitoring site 6R is different to the other three woodland rehabilitation sites with more than double the number of local native species (19 species), greater canopy cover and more groundcover than the other patches of woodland rehabilitation.

As these areas have been established using outdated rehabilitation techniques, performance criteria have been developed for these older rehabilitation areas. However, a generally small number of native species and very low native groundcover mean that these sites generally fall below the performance criteria.

Table 16: Biometric scores for woodland rehabilitation areas and performance criteria for older woodland rehabilitation areas

Vegetation Type	Plot Name	NPS (native to NSW)	NOS (%) (including *E. cladocalyx*)	NMS (%) (including *A. saligna*)	NGCG	NGCS	NGCO	EPC*	OR	HBT	FL
Woodland Rehabilitation	3R	4	30	2	0	0	0	0	Planted	0	0
	4R	6	25	0	0	0	0	0		0	0
	6R	19	40.5	0	4	0	0	8		0	25.5
	8R	7	16	0.5	2	0	0	0		0	0
Average values		9	27.9	0.6	1.5	0	0	2	0	0	6.38
Performance criteria for older woodland rehabilitation areas		> 15	15-40	5-40	5-15	5-10	5-15	<20	1	-	5

Woodland rehabilitation areas were sampled as per the previous monitoring design, with four LFA monitoring locations at sites 3R, 4R, 6R and 8R. Scores fell within the range of the recorded scores from 3 reference sites sampled over 5 years starting in 2010 and ending in 2014. Site 6R was the best performing site and met all the established performance targets, site 4R also met all targets. All sites met the performance target for soil stability. All sites, except for 4R, had lower scores for stability than in 2017. LOI at sites 3R and 8R was substantially short of the performance target, with these sites having large areas of exposed bare soil. Leaf litter was the main patch type at all woodland rehabilitation sites and the main contributor to stability of soil, water infiltration/runoff and nutrient cycling. LFA results are presented in **Table 17** below.

Table 17: LFA scores and performance criteria for woodland rehabilitation areas

Monitoring Plot	LOI	ST	INFI	NI
3R	0.68	61.9	35.7	34
4R	0.87	63.7	45.7	42.9
6R	0.92	65.4	55.1	47.1
8R	0.71	59.7	34.6	28.7
Average score	0.79	62.67	42.77	38.17
Target score	**>0.87**	**>59**	**>43**	**>36**
Reference site range (2010-2014)	0.57 - 1.00	48.30 - 70.50	35.90 - 58.46	31.10 - 54.46

Both photos taken at the sites and collected data, show that these sites have remained quite stable over the last five years despite some dieback of *Acacia saligna* and growth of trees (**Plate 22** & **Plate 23**). Some very low scores that are possibly erroneous are present in the provided database between the 2006 and 2008 monitoring periods. This has been discussed in previous monitoring reports. Average stability score was larger than in the previous three years, continuing a trend of a marginal increase each year since 2015, although higher scores were recorded in between 2012 and 2014. Nutrient and infiltration indices were lower than in 2017 but within the range of the previous three years.

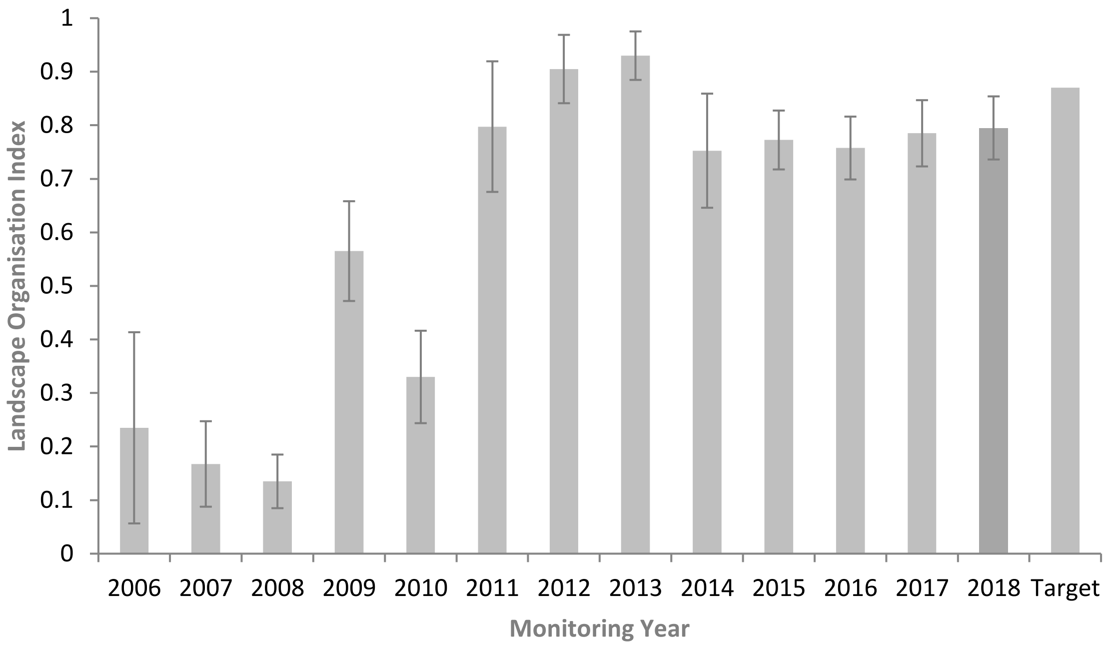

Figure 18: Average landscape organisation scores across the four woodland rehabilitation sites since 2006

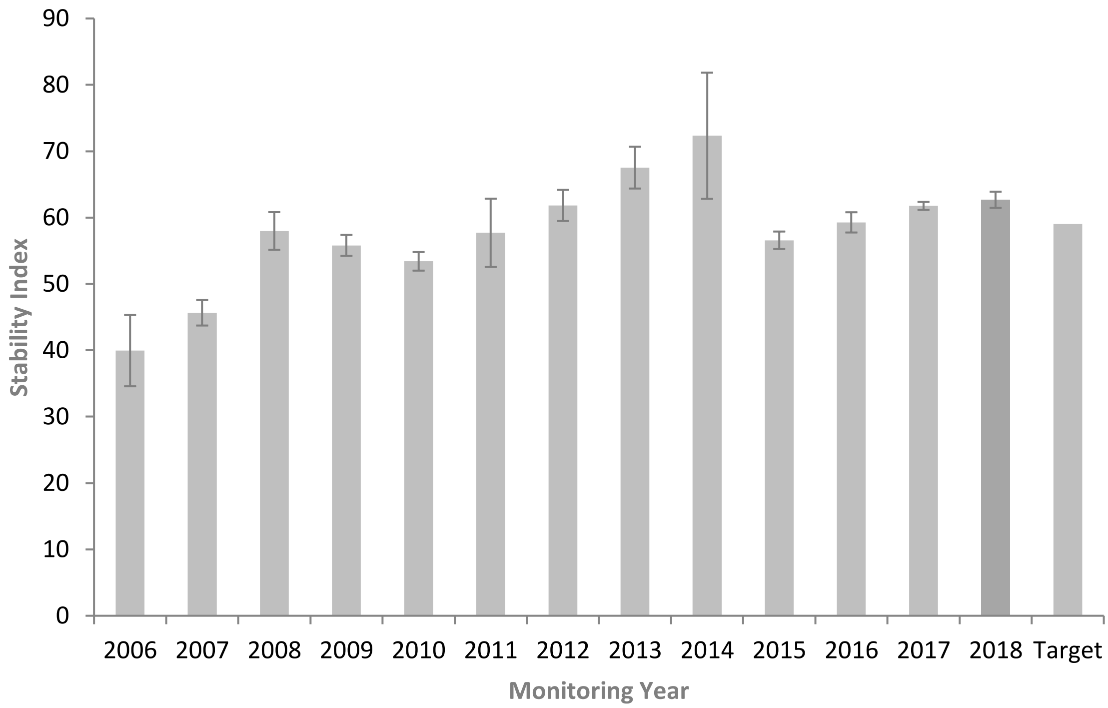

Figure 19: Average stability scores across the four woodland rehabilitation sites since 2006

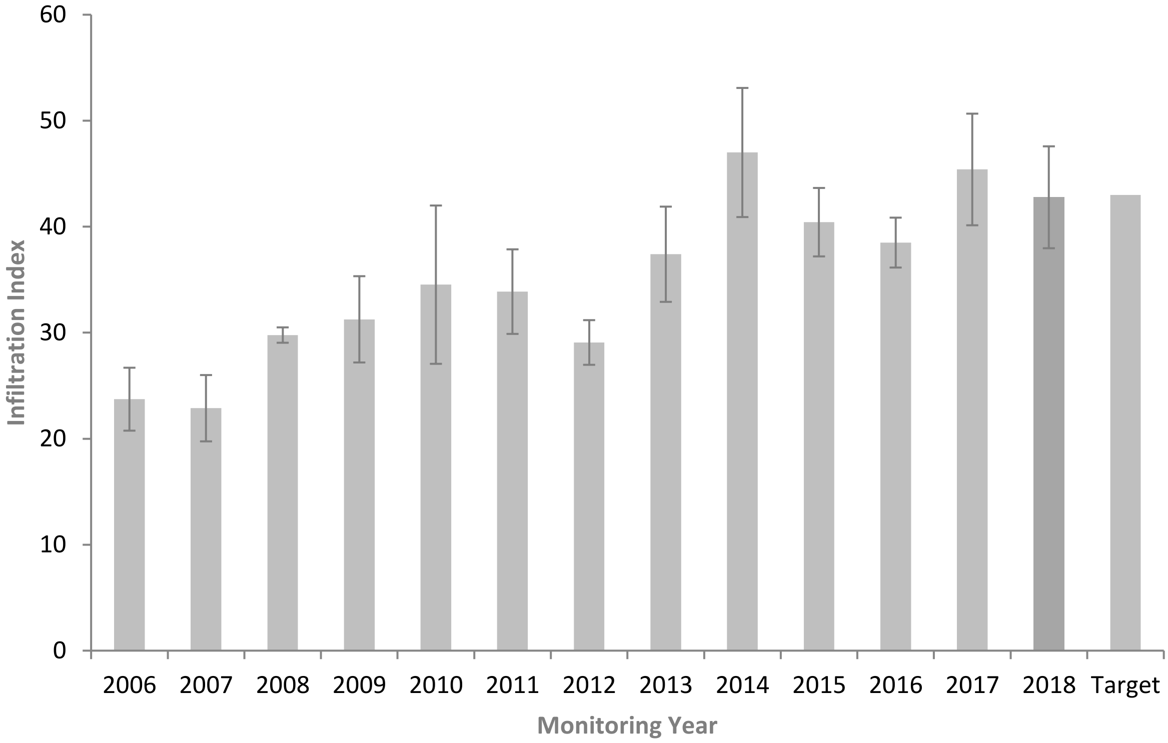

Figure 20: Average infiltration scores across the four woodland rehabilitation sites since 2006

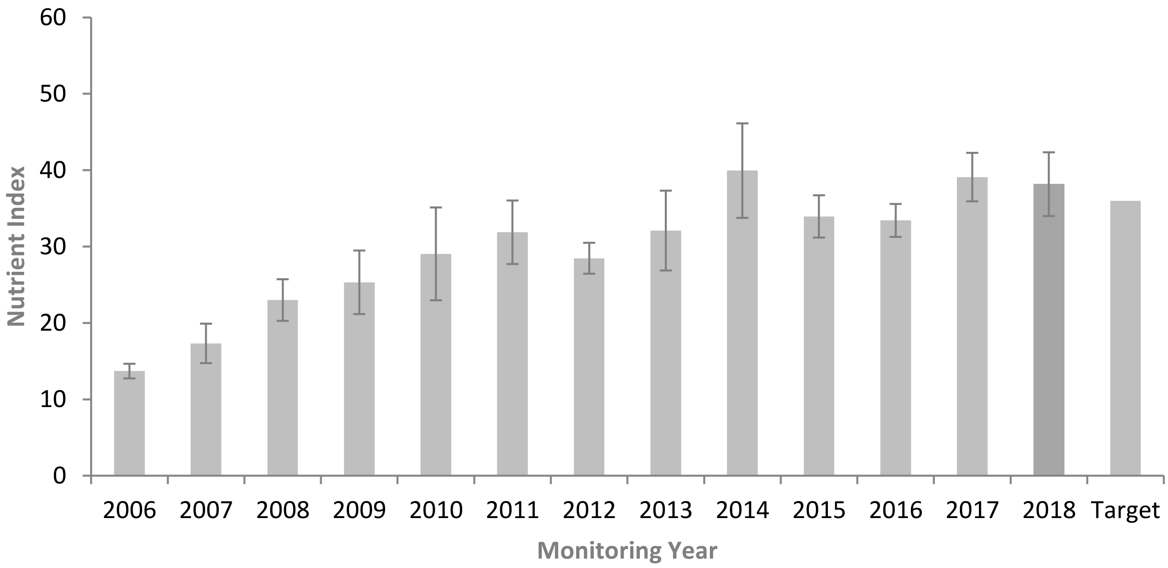

Figure 21 Average nutrient index scores across the four woodland rehabilitation sites since 2006

Plate 22: Site 3R during 2014

Plate 23: Site 3R during 2018

Table 18: Site description of each woodland rehabilitation transect

Transect	Notes	Photograph
3R	A relatively flat transect through a planting of *Eucalyptus cladocalyx*. Scattered and sparse *Corymbia maculata* are also present. Three native groundcover species (*Enchylaena tomentosa*, *Cymbopogon refractus* and *Chloris divaricata*) were recorded in the 20 x 20 m plot, although the cover of these species remains very sparse. Leaf litter is the major patch type making up 68% of the LFA transect. Bare rocky soil areas make up 23% of the transect, and logs the remaining 9%.	
4R	This transect travels along a small ridge and slopes slightly towards the end. The transect is surrounded by plantings of *Eucalyptus cladocalyx*, *Corymbia maculata and Acacia saligna*. Understory vegetation is very sparse to absent across the plot. Leaf litter is the major patch type on the LFA transect, covering 79% of the transect. Patches of bare soil make up 13%, with logs making up the remainder.	

Transect	Notes	Photograph
.6R	This site is the best performing woodland rehabilitation monitoring site. A canopy of *Eucalyptus cladocalyx* is present with several native mid-storey species and native grasses and herbs. The weed *Galenia pubescens* also occurs in small patches. A dense and deep cover of leaf-litter is present (81% of transect length) and is by far the major contributor to site stability, infiltration and nutrient cycling scores	
8R	This transect is located on a lightly sloping site with plantings of *Eucalyptus cladocalyx* and *Corymbia maculata*. Leaf litter covers 67% of the transect length, with 29% bare soil and the remainder of rock.	

3.3.3 Pasture rehabilitation

Pasture rehabilitation is currently meeting performance targets for all attributes with the exception of LOI, which still had a relatively high average score, with 76% of transect area covered by resource accumulating patches (**Table 19**). As reported in previous years, the average LOI was reduced by the influence of sites 2R and 5R, which performed the worst in terms of LOI with 52 and 53 % respectively of the transect being comprised of bare soil.

LOI scores during 2018 were mixed when compared to the previous year, with five sites improving and five scoring lower, with an average 3% reduction in the area of bare soil patches from 2017. Site 7R had much lower LOI score than in 2017, with a 22% increase in bare soil which corresponded to a reduction in short grassy patches. Site 35R had a 25% increase in resource accumulating patches with a high proportion of the transect covered by grassy patches (85%).

From the 2010 to 2012 monitoring periods and again in the 2014 monitoring period, most sites (all sites in 2012) recorded a LOI score of 1 or very close to 1, indicating that there were no bare soil patches present in the transects at all. While no raw data sheets prior to the 2015 monitoring are available to investigate this claim, examination of site photos suggest some of these previous LOI scores may be erroneous.

Average indices for stability, infiltration and nutrient cycling generally remained consistent with previous monitoring years (**Figure 23, Figure 24** and **Figure 25**).

Comparison with site photos from 2014 monitoring indicate that the native *Acacia salicina* (Willow Wattle) has grown substantially and has spread through pasture site 2R, while vegetation at other sites remains very similar.

A new site was added in 2017 (named 35R) in an area of recently established pasture rehabilitation. As the rehabilitation at this site was so recent in 2017, scores were excluded from average calculations for pasture sites in that report. This site has been included in calculations of average scores for pasture sites the first time in 2018.

Plate 24: Pasture rehabilitation area dominated by *Chloris gayana* (Rhodes Grass), near site 33R in 2018

Table 19: LFA scores and performance criteria for pasture rehabilitation areas 2018

Monitoring Plot	LOI	ST	INFI	NI
1R	0.86	63.3	46.6	34.8
2R	0.48	49.1	24.9	23.6
5R	0.47	58.5	29	24.3
7R	0.66	65	37.4	33.4
9R	0.86	61.9	39.7	31.9
10R	0.97	68.8	45.6	38.8
16R	0.88	66.6	41.6	36.3
33R	0.88	62.3	44.7	37.2
34R	0.65	57	36.4	30.7
35R	0.86	66.5	34.5	26.8
Average score	0.76	61.9	38.43	30.23
Target score	0.93	61	29	25

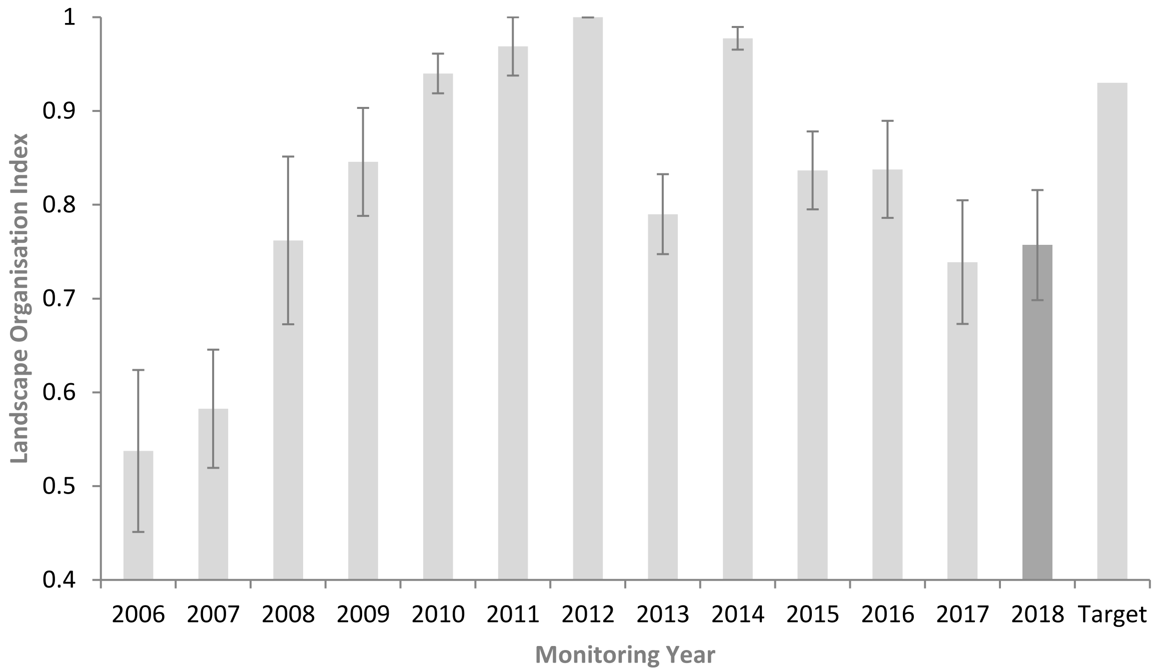

Figure 22: Average Landscape Organisation Index scores from pasture rehabilitation sites 2006-2018. Error bars represent standard error and the target bar represents performance criteria. Only four sites were sampled in 2006 and 2007, increasing to nine sites in 2010.

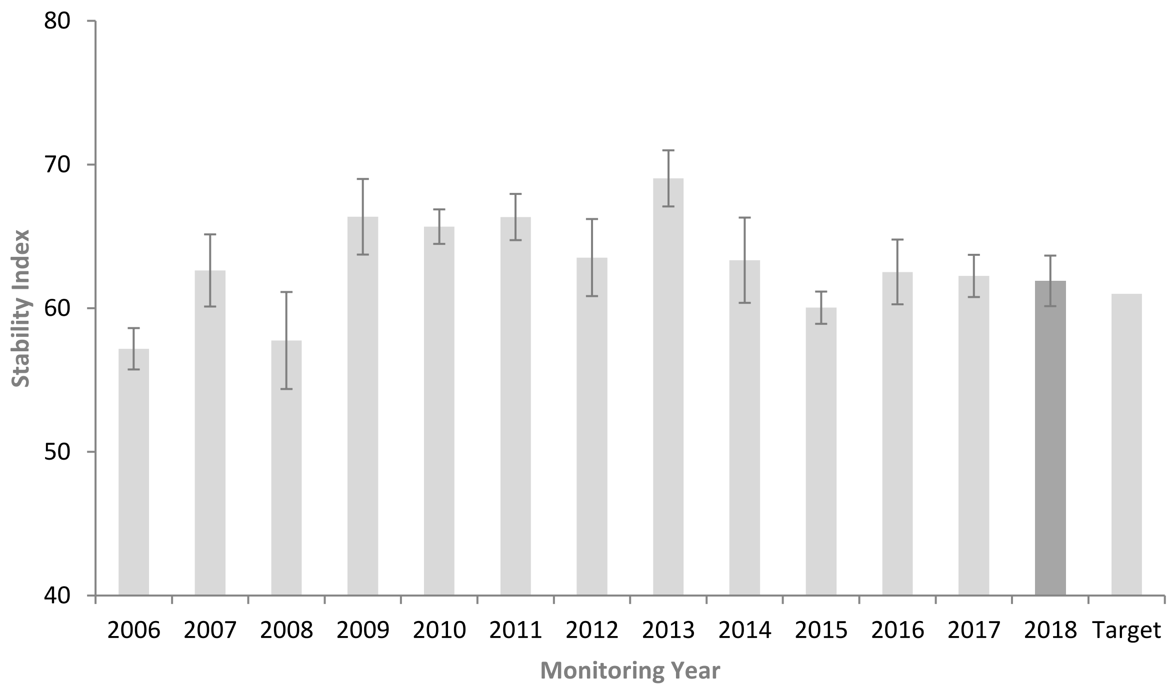

Figure 23: Average Stability Index scores from pasture rehabilitation sites 2006-2018. Error bars represent standard error and the target bar represents performance criteria.

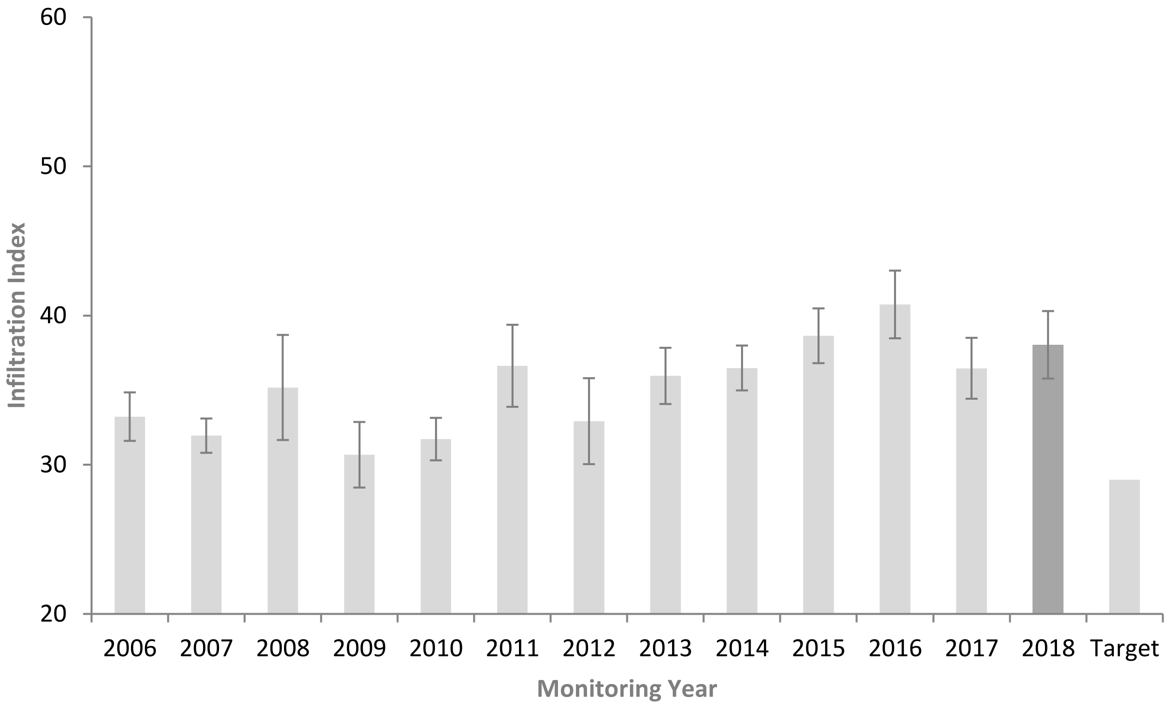

Figure 24: Average Infiltration Index scores from pasture rehabilitation sites 2006-2018. Error bars represent standard error and target bar represents performance criteria.

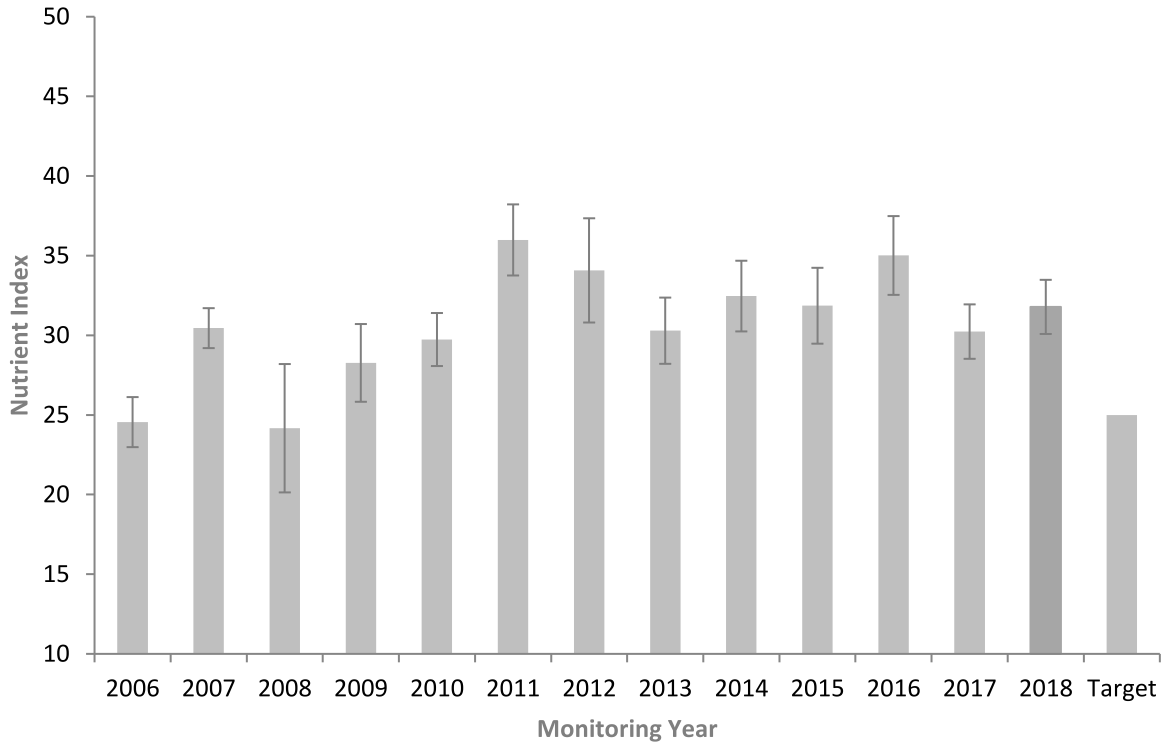

Figure 25: Average Nutrient Index scores from pasture rehabilitation sites 2006-2018. Error bars represent standard error and target bar represents performance criteria.

Table 20: Site description of each pasture rehabilitation transect

Transect	Notes	Photograph
1R	Low grassy patches (49%), tussocks of the exotic *Chloris gayana* (20%), associated grassy leaf litter (16%) dominate the transect and are the main stabilising features of this rehabilitation area near the coal preparation plant. Comparison of photos from Niche (2014c) of this site, show that tussock grasses appear to have become sparser over time at this site. This site was surveyed in November 2018 after recent rainfall and therefore appears greener than sites that were surveyed in September.	
2R	This transect runs down a very slight slope and was dominated by bare soil (52%), grassy patches (22%), tussocks (15%) and leaf litter (11%). Leaf litter was mostly dead exotic vegetation and grass that had died off with the dry climatic conditions at the time of survey. The large area of exposed bare soil and sparse cover within vegetated patches contributed to this site failing to meet performance criteria for all attributes. The soil in this area is local red/brown clay soil which has facilitated the colonisation of native species such as *Cymbopogon refractus* and Acacia spp. Comparison of photos from Niche (2014c) of this site, show *Acacia salicina* has become more abundant in the area over time.	

Transect	Notes	Photograph
5R	This transect was moved slightly downhill from its previous location during 2017 as an access road had been constructed through the original transect. This site is dominated by bare soil areas (53%). As a result of the abundance of bare soil this site again had the lowest landscape organisation score. Exotic tussock grasses (*Setaria* sp.) (28%), litter (17%) and rocks (1%) make up the remainder of the transect. Some large *A. salicina* are present surrounding the transect area.	
7R	Transect was dominated by *C. gayana* tussocks (39%), bare soil (34%), litter (22%) and short grass (5%). The increase in bare soil corresponds to a reduction in short grass from 2017 and has resulted in the largest decrease in LOI score for any site in 2018 and has dropped to well below the performance criteria for this attribute. The locally native *Acacia salicina* continues to colonise the rehabilitation in this area.	

Transect	Notes	Photograph
9R	A large rocky soil scald dominates the start of this transect, however an increase in short grass has resulted in an increase in the stability index for this site above the performance criteria. The scald and other bare patches cover 14% of the transect. Grassy patches (67%) and tussocks (19%) dominate the remainder of the plot. This site was surveyed in November 2018 after recent rainfall and therefore appears greener than sites that were surveyed in September.	
10R	Dense tussocks of *Chloris gayana* (46%), leaf litter fallen from the dense tussocks and dry dead exotic perennial vegetation (27 %) and grassy patches (24%) made up the majority of this transect. Bare soil patches were minimal making up just 3% of the transect length. This site was surveyed in November 2018 after recent rainfall and therefore appears greener than sites that were surveyed in September. No star pickets are present at this transect.	

Transect	Notes	Photograph
16R	Transect primarily composed of grassy patches (58%), in between tussocks of *Chloris gayana* (23% of the transect length), with litter and bare soil also contributing. A slight increase in bare soil (12% of transect) meant that the LOI score dropped to just below the performance criteria for this attribute. This site was surveyed in November 2018 after recent rainfall and therefore appears greener than sites that were surveyed in September.	
33R	Transect primarily composed dense tussocks of *C. gayana* (72%), low grass and small patches of the environmental weed *G. pubescens* made up the remaining patches. Bare soil patches made up 12% of the transect. *C. gayana* grass tussocks were the main contributor to stability, infiltration and nutrient cycling scores for the site.	

Transect	Notes	Photograph
34R	Transect primarily composed of dense tussocks of *C. gayana* (29%) with fallen dead grass (leaf litter - 33%) and low spreading grassy patches (2.7%). Bare soil patches comprised 35 % of the transect length. Grass tussocks were the primary contributor to the site stability score.	
35R (new site in 2017)	A new site was added during 2017 in a recently seeded area of pasture rehabilitation. Low grass (85%) dominated this new area of rehabilitation, with bare soil (14%) making up most the remaining transect. This site was surveyed in November 2018 after recent rainfall and therefore appears greener than sites that were surveyed in September.	

3.4 Conclusion and recommendations

3.4.1 North Wambo Creek diversion

The North Wambo Creek Diversion did not meet the completion targets for LFA, with no individual monitoring site meeting the target for LOI. The stability index results were similar to recent years. Infiltration and nutrient indices were lower than recent years and management actions may be required to increase vegetation cover, litter and soil roughness if no improvements are recorded in 2019. The two monitoring sites that had soil ripping and reshaping (to control weeds and erosion) prior to 2017 monitoring recorded improved scores for most attributes in 2018.

While some *Casuarina* and *Eucalyptus* sp. have begun to establish within the creek channel and patches of small *Acacia* and *Eucalyptus* seedlings are present in places, as a whole the creek diversion remains primarily open pasture which is dominated by exotic species such as *Chloris gayana*. Riparian vegetation is considered unlikely to be 'better' than prior to the diversion and the proposed net increase in riparian vegetation (which included establishing *Angophora floribunda*, *Casuarina cunninghamiana* and a selection of native grasses in the riparian zone) (Resource Strategies, 2003) has yet to be achieved.

Overall the creek diversion appears relatively stable without excessive erosion. However, some areas of erosion that exceed completion criteria targets are present, with some deeper rills and large areas of bare soil observed at some monitoring sites.

It is recommended to continue active management of the diversion area to encourage the establishment of native species, particularly tree and shrub species, while preventing excessive erosion issues.

3.4.2 Woodland rehabilitation

Woodland rehabilitation monitoring sites met LFA performance targets for soil stability and nutrient index and were just below the target scores for LOI and infiltration. The high scores are largely due to the presence of leaf litter layers which provide protection from soil erosion and reduce the area of bare soil. All sites appear visually similar to the previous three years of monitoring and this similarity was also observed in the recorded data, with similar landscape organisation and biometric scores recorded as previous years. The areas surrounding monitoring sites 3R, 4R and 8R are remain structurally similar as each other, while site 6R has a much larger number of species present, larger trees and more groundcover than the other three sites.

Comparison of the earliest available photos from 2014, appear to show a dieback in the non-local native *Acacia saligna* which occurs as a mid-storey species at most woodland rehabilitation sites. Other than this and an apparent slight growth of trees, rehabilitated woodland monitoring sites in 2018 all appear very similar to photos taken in 2014.

Issues with the woodland rehabilitation monitoring sites have been addressed in previous monitoring reports and include

- a lack of groundcover and mid-storey at most sites
- poor native species diversity when compared to remnant woodland sites
- the dominant Eucalypt species at these sites is not locally endemic to the Hunter Valley and originates in South Australia
- two large and deep holes, possibly related to mine subsidence, were observed near site 4R in areas of woodland rehabilitation.

Most of these issues likely relate to either a lack of, or no topsoil being used in these areas prior to tree planting. This is clearly visible where pasture rehabilitation areas with red-brown topsoil adjoin woodland rehabilitation areas with pale grey soil and rock.

Previous recommendations to improve LFA results include increasing the complexity of ground cover or woody debris to improve LOI scores and over time improve stability, infiltration and nutrient indices. However due to the large effort and cost involved in trying to enhance older rehabilitation areas, WCPL could instead focus on ensuring new areas of woodland rehabilitation are planned and implemented using best practice techniques.

3.4.3 Pasture rehabilitation

Average LFA scores for pasture rehabilitation generally met completion criteria, with the exception of LOI, which was still quite high and improved from 2017, despite not meeting the criteria. Average scores were reduced by sites 2R and 5R which had a relatively high proportion of bare soil along the LFA transect.

LOI scores in 2018 were mixed with five sites having higher scores, and five having lower scores than in 2017. Actions to improve poorly performing pasture sites could involve the slashing of large grass tussocks and subsequent mulching of bare areas to improve the soil profile and encourage establishment of vegetation in bare areas.

Sites 2R and 5R remain the worst performing sites within pasture rehabilitation areas in regard to LFA indices. However, areas surrounding 2R have several native species present and both sites have *Acacia salicina* colonising the area and pasture sites with some of the best LFA scores have large dense tussocks of *Chloris gayana.* It is important to consider the final intended land-use and that LFA completion targets for pasture rehabilitation have been based on scores from areas of pasture surrounding the mine and do not directly reflect the suitability of the land to support grazing.

4 Riparian condition assessment

4.1 Introduction

The riparian EFA monitoring program is a requirement of the 2004 Development Consent conditions. The objective of the monitoring program is to evaluate how the riparian environment is responding to management initiatives (such as cattle exclusion) and document any impacts arising from mine subsidence.

North Wambo Creek drains the mid and eastern sections of the North Wambo Underground Mine development area and flows south-east into Wollombi Brook, approximately 600 m south of the Mine. North Wambo Creek has been highly disturbed both by historic and present grazing activities and by the North Wambo Creek Diversion. The diversion channels the creek around the open-cut mining operation.

Stony Creek drains from Mount Wambo in a north-east direction and meanders across the western boundary of coal lease (CL) 397 near the south-western boundary of the North Wambo Underground Mine and passes in a south-easterly direction through the existing underground development area of WCPL to join Wambo Creek. Wambo Creek then runs east to join Wollombi Brook. Much of the riparian zone along Wambo Creek has been disturbed by historic agricultural activities.

4.2 Methods

Field sampling for the riparian monitoring was undertaken between 4 and 7 September 2018. The *Rapid Appraisal of Riparian Condition* method, developed by Jansen et. al. (2005) and used during the 2016 and 2017 monitoring, was utilised during the 2018 survey period. Using this method, an overall score is obtained at each monitoring site by examining the width of riparian vegetation, proximity to large patches of native vegetation, vegetation cover, debris (leaf litter, standing dead trees and fallen logs) and other features (native canopy and understory regeneration, tussock grasses and reeds on creek banks). Areas monitored included:

- North Wambo Creek
- Wambo Creek
- Stony Creek.

Methods followed Jansen et. al. (2005) with four 40 m long cross-section transects used to sample approximately 500 m length of riparian zone. The location of sample sites and transects is illustrated in **Figure 26** with photographs presented in **Volume 2**.

The three creeks and sample sites were compared in regard to the following sub-indices:

- *Habitat* - longitudinal continuity of canopy vegetation (> 5 m wide); width of riparian canopy vegetation; and proximity to nearest patch of native vegetation > 10 ha
- *Cover* - vegetation cover and structural complexity
- *Native* - dominance of native species versus exotic species
- *Debris* - leaf litter; standing dead trees; hollow-bearing trees; and fallen logs
- *Features* - other indicative features such as regeneration, presence of large native tussock grasses (e.g. *Austrostipa* spp.) and reeds.

The five sub-indices were assessed across the three separate reaches of each creek and were combined to create a *Total Score.* Although not directly comparable, site photos and scores from available past monitoring reports (ELA (2016 and 2017), Niche (2014d) and RPS (2009)) were also reviewed.

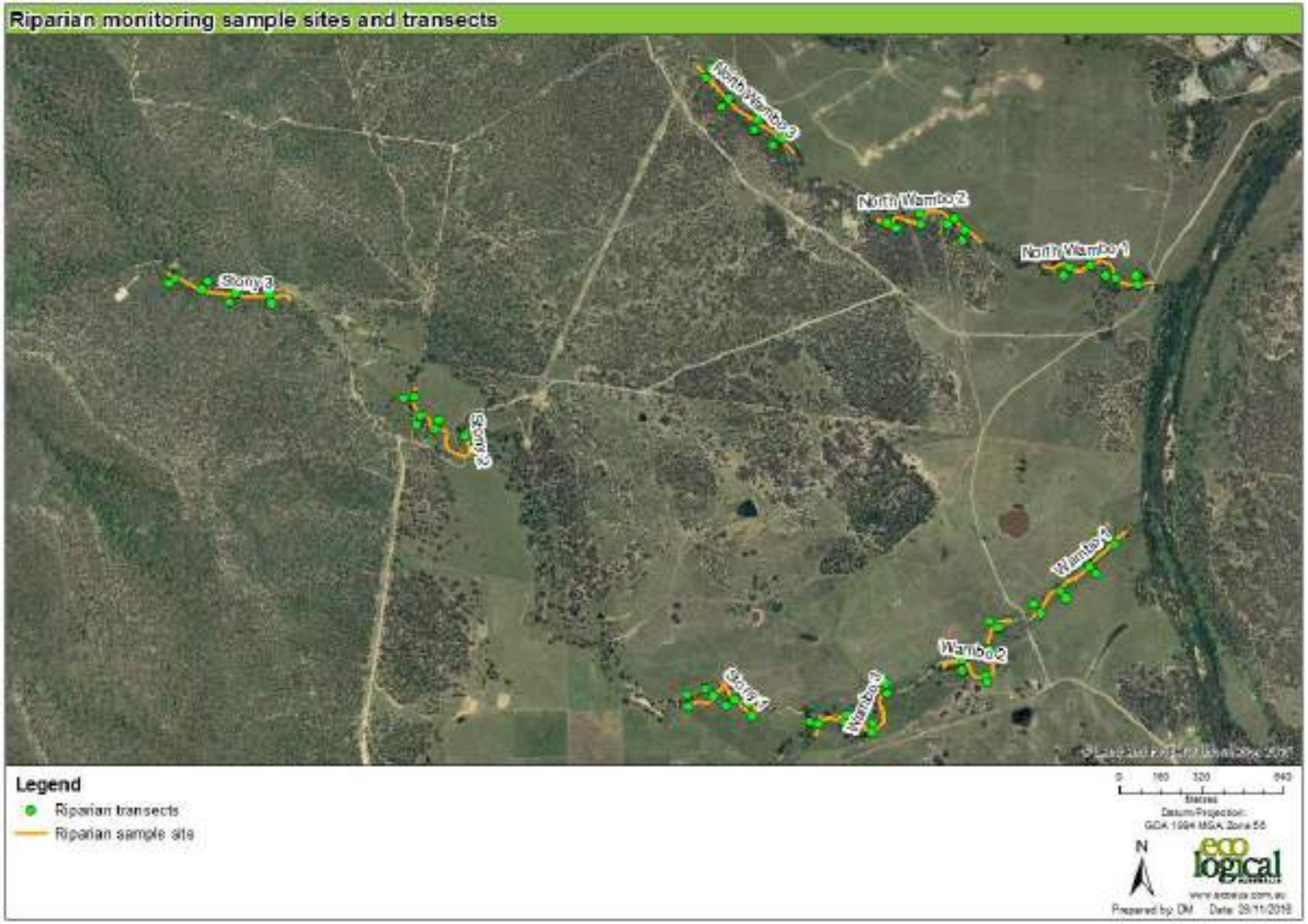

Figure 26: Location of riparian monitoring cross-sections and transects

4.3 Results

The results of the riparian condition monitoring are presented below, with raw data included in **Volume 2** of this report.

The average total score for all three creeks was lower than in 2017. South Wambo Creek and Stony Creek recorded the lowest scores of the past three years, while the average total score for North Wambo Creek remained above the 2016 score (**Figure 27**). South Wambo Creek remains the lowest scoring creek system based on the sub-indices measured.

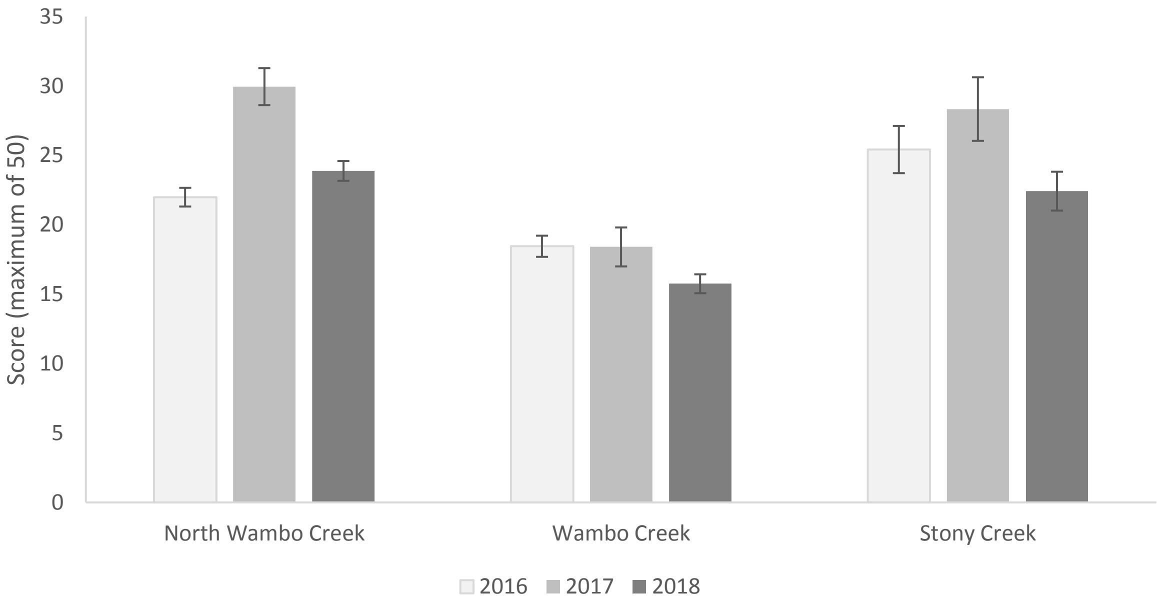

Figure 27: Average "Total Score" for North Wambo Creek, Wambo Creek, and Stony Creek, from surveys in 2016 - 2018

The lower average score for all sites reflects a slightly lower score for most of the sub-indices rather than a large change in any particular indices. However, the largest decreases in scores were recorded for *cover* and *natives*, which decreased at all creeks, with larger differences measured at sites in the upper reaches of Stony Creek and North Wambo Creek. Lower scores for *cover* and *natives* suggest changes to the understorey vegetation such as increased exotics or decreased native cover may have occurred.

Each creek system had one sub-index which scored higher than in 2017; higher scores were recorded for *habitat* at Stony Creek and North Wambo Creek, and *debris* at South Wambo Creek. Higher scores for habitat suggest the canopies remain in good condition. A higher *debris* score for South Wambo Creek was driven by scores at the lower two sites and may be a result of the dry conditions causing an increase in grassy litter. Lower scores for *natives* and *cover* were also recorded here which could relate to the higher debris score through die-off of grasses.

Large variability in the *habitat* and *debris* sub-indices was observed between longitudinal transects at Stony Creek and reflect the differences in vegetation and habitat features between the cleared lower reaches that are currently grazed by cattle and the heavily forested upper reaches.

No recent subsidence impacts were recorded at North Wambo Creek, Wambo Creek, or Stony Creek, during this riparian condition survey.

Site scores from available past monitoring reports (Niche (2014) and RPS (2009)) show similar results with Stony Creek (particularly the upper reaches) being regarded as in good condition, North Wambo Creek as being either in good or moderate condition and Wambo creek being in moderate condition. Site photos from Niche (2014) are similar to 2018, however it is clear vegetation has increased in height and canopy density in some places over this time period.

4.4 Conclusions and recommendations

All creeks recorded lower average scores than the previous year. These results were influenced most strongly by the sub-indices *cover* and *natives* which are associated with understorey vegetation cover, condition and exotics. Comparison of site photos shows conditions during 2018 to be very dry and this is considered to the main contributor these results. Sub-indices relating to more permanent features such as habitat connectivity, tree canopy and logs and hollows remained similar or improved. Monitoring in 2019 should note understorey vegetation condition to ensure signs of improvement are present, and cattle grazing is not having any significant impacts.

The recommendations in previous monitoring reports still applicable to these areas. These include restricting cattle access to the currently grazed areas of South Wambo and Stony Creek to encourage tree regeneration and prevent erosion. During the dry conditions, cattle exclusion is particularly important as the understorey vegetation is under stress and cattle grazing places additional pressure on the vegetation and is more likely to increase erosion. Plantings of trees in over-cleared riparian areas (that are unlikely to regenerate naturally with cattle exclusion) will also be beneficial to this area and the surrounding environment.

5 Mine subsidence observations and other management issues

Mine subsidence and land management issues observed during the 2018 monitoring surveys across the RWEAs and rehabilitated landforms are described below.

5.1 Remnant woodland enhancement areas

5.1.1 Subsidence observations

Minor mine subsidence cracks were noted during flora field work at or nearby to sites V6B2, V6-B2c, V10-A2, V11-B1 within the Narrow-leaved Ironbark and Slaty Gum communities. Large mine subsidence cracks were noted near flora site V6-B1c (**Plate 25** and **Plate 25**). A number of the tracks in the west of RWEA C have become unsuitable for vehicles due to damage by subsidence cracks, resulting in several of the bird monitoring sites, such as BP20 and BP21, now only accessible by foot.

Plate 25: Deep mine subsidence cracks near flora monitoring site V6-B1c

Plate 26: Deep mine subsidence cracks near flora monitoring site V6-B1c

5.1.2 Performance criteria and results

Performance criteria and findings for 2018 for subsidence impacts are presented in Table 21, which is based on Table 20 in the *Wambo Coal Biodiversity Management Plan* (WCPL 2017). These performance criteria exclude any impacts and consequences of mining that occurred prior to February 2011 in accordance with Condition 22, Schedule 4, of Development Consent DA 305-7-2003.

Table 21: Subsidence performance measures, indicators and 2018 findings

Biodiversity feature	Performance measure	Performance indicator (WCPL 2017)	2018 findings
Wollemi National Park	Negligible subsidence impacts and environmental consequences	The performance indicators will be considered to have been exceeded if conventional vertical subsidence exceeds 20 millimetres (mm) or the limit of survey accuracy (whichever is greater) at the base of the Wollemi National Park escarpment. The performance indicators will be considered to have been exceeded if visual inspections identify cliff or rock face instability at the Wollemi National Park escarpment.	N/A - Vertical subsidence as the base of escarpment or cliff or rock face instability not inspected as part of the flora and fauna monitoring program in 2018. However, no major rock falls were observed during the 2018 monitoring program.
Other species, populations or communities listed under the *Biodiversity Conservation Act 2016* or *Environmental Protection and Biodiversity Conservation Act 1999*	Minor cracking and ponding of the land surface or other impact. Negligible environmental consequences.	The performance indicator will be considered to have been exceeded if annual monitoring at flora monitoring sites V6-B1c and V11-B1 or bird monitoring sites (BP14, BP16, BP20, BP21) above Longwalls 11 to 16 indicate a statistically significant downward trend or change between monitoring periods not observed at analogue/reference sites.	Subsidence cracks were recorded at both sites V6-B1c and V11-B1. No significant vegetation damage was observed at these sites and plot data reveals similar numbers of native species were recorded in 2018 as in previous years. Slightly lower scores for overstorey and mid-storey cover were recorded for these sites in 2018, however this change was also recorded at the reference sites and other sites in this PCT and is therefore considered likely to be a result of variation in observer estimates of cover between years rather than a result of subsidence impacts in this area. Vegetation at these sites and in the wider area remained in good condition at the time of survey considering the dry conditions. Bird monitoring sites showed no downward trend or significant change (**Figure 28**).

Biodiversity feature	Performance measure	Performance indicator (WCPL 2017)	2018 findings
			Future monitoring should focus on ensuring subsidence in these areas have not resulted in significant environmental consequences.
Warkworth Sands Woodland Community		The Warkworth Sands Woodland Community is absent from the South Bates Underground Mine area. Monitoring and performance indicators relevant to mine subsidence in the Warkworth Sands Woodland Community will be addressed in future revisions of the BMP prior to any extraction under the Warkworth Sands Woodland Community	Area not currently undermined – no subsidence observations.
White Box, Yellow Box, Blakely's Red Gum Woodland/Grassy White Box Woodland Community		The White Box, Yellow Box, Blakely's Red Gum Woodland/Grassy White Box Woodland Community is absent from the South Bates Underground Mine area. Monitoring and performance indicators relevant to mine subsidence in the White Box, Yellow Box, Blakely's Red Gum Woodland/Grassy White Box Woodland Community will be addressed in future revisions of the BMP prior to any extraction under the White Box, Yellow Box, Blakely's Red Gum Woodland/Grassy White Box Woodland Community.	Area not currently undermined – no subsidence observations.
Central Hunter Valley Eucalypt Forest and Woodland Ecological Community		Minor cracking and ponding of the land surface or other impact. Negligible environmental consequences	No additional observations of damage to this community beyond that described in the 2016 flora and fauna monitoring report (ELA 2016). Predominantly minor surface cracks observed.

Overall the four bird monitoring sites located above Longwalls 11 to 16 showed no significant changes change or downward trends in the number of species recorded (Figure 28).

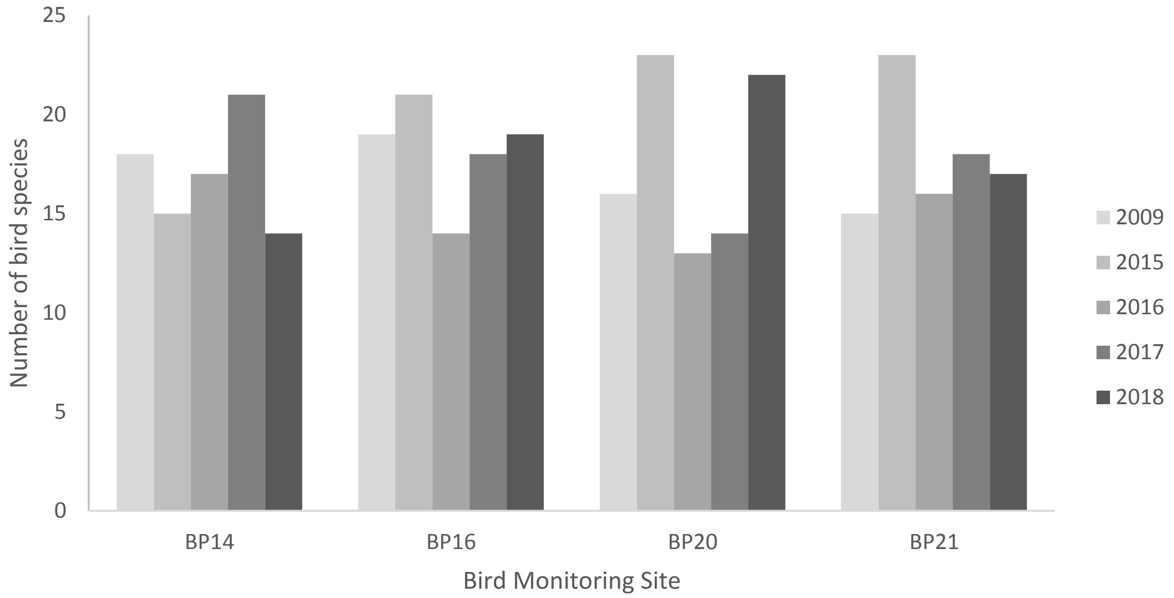

Figure 28: Total number of bird species recorded at sites located over longwalls 11 to 16 in 2009 and 2015-2018

5.1.3 Conclusion and recommendations

Subsidence was observed in the RWEA C above Longwalls 11 to 16. Monitoring data does not indicate any exceedance of the performance criteria or any significant effects on flora and fauna at this stage, however future monitoring should continue to document and assess subsidence impacts across the site.

5.2 Rehabilitated land

The condition of rehabilitated land has been discussed in **Section 3**. However, some relevant opportunistic observations were made while traversing the mine site. Subsidence cracks were observed near site 28R (**Plate 27**). Erosion issues were also present, eroded banks were recorded within the creek diversion near site 23R, and in a large area near site 33R where vegetation had failed to establish (**Plate 28**).

5.3 Weed issues

Environmental weeds have largely been discussed in previous sections. No new observations of significant weed issues were recorded during the 2018 monitoring, however, management of weeds across WCPL land should continue, particularly for priority weeds and Weed of National Significance (WONS), to prevent their spread.

Plate 27: Subsidence cracks near rehabilitation monitoring site 28R

Plate 28: A pasture rehabilitation area suffering from soil erosion issues between monitoring sites 33R and 7R in 2018

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Item	Detail
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Cover photos	Clockwise from left: Riparian survey site, *Acacia* species establishing near the North Wambo Creek Diversion, remnant woodland photo monitoring and Landscape Function Analysis in pasture rehabilitation. Photos by ELA.

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1 Introduction

This document provides raw data and photographs collected during spring 2018 monitoring at Wambo Coal Pty Ltd.

2 Flora monitoring

2.1 Monitoring data

Data collected during the 2018 floristic surveys are presented below in **Table 1.**

Several abbreviations for measured attributes are used in tables throughout the following section. An explanation of these is provided below.

- NPS – the number of native plant species within 20 x 20 plot
- NOS (%) - projected native foliage cover of canopy
- NMS (%) – projected native midstorey cover
- NGCG – native groundcover of grasses
- NGCS – native groundcover of shrubs
- NGCO – native groundcover of other plant types (sedges, herbs etc.)
- EPC – exotic plant cover
- OR – proportion of overstorey species regenerating over the whole vegetation zone
- HBT – number of hollow-bearing trees present in the 20 x 50 m vegetation plot
- FL – length of fallen logs >10 cm diameter

Table 1: Biometric plot data for remnant woodland areas

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	L-litter	Bare ground/Rock
V1-A1	6	14	0	2	0	0	50	0		52	46	2
V1-A2	9	3.5	8.5	20	0	0	30	1		48	34	14
V1-B1	21	36	0	20	0	0	44	1		48	34	0
V1-B2	14	13.5	12.9	14	2	0	44	0		7	40	2
V1-B3	13	34	8	22	0	0	36.5	0	1	20	50	0
V2-A1	14	6.2	0	28	0	4	16	0		5	34	14
V2-B1	12	20	7	0	0	6	38	0		4	50	6
V2-B2	21	10	8.4	4	10	4	62	0		0	30	2
V3-B1	25	19	0.7	38	2	30	6	0		29	42	0
V5-B1	30	9.5	1.7	14	2	24	18	0		10	46	0
V5-B2	23	10	2.2	6	2	66	2	1	1	14	24	2
V5-B3	25	4.8	3.9	6	2	48	0	1		14	44	0
V5-B4	27	9.2	3.2	32	0	12	0	0		16	56	4
V6-A1c	44	10	4	14	0	0	0	0		79	68	8
V6-A3	21	5	4	38	4	20	0	0		16	54	4
V6-B1	30	23.5	8.5	2	2	6	2	3		58	78	8
V6-B1c	29	4.9	6.5	26	4	22	0	0	1	19	64	0
V6-B2	25	7.7	6.7	16	16	8	4	0		68	66	0
V6-B2c	43	13	0	16	0	0	0	0		40	78	6
V6-B3	31	7	6.7	8	8	14	4	0		25	70	0

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	L-litter	Bare ground/Rock
V6-B4	17	13.7	3.2	8	2	4	2	0		6	58	20
V11-B1	24	10	4	18	2	16	0	0		26	68	0
V11-B2	32	18	14	40	0	10	0	0		20	58	0
V9-A1	32	12	7.5	6	8	6	2	0		18	66	16
V9-B1	30	11	6.7	26	38	16	0	0	1	36	42	0
V9-B2	31	14.7	4.5	32	22	12	0	0		58	46	0
V10-A1	33	7.4	7.5	24	0	4	0	0		44	66	0
V10-A2	23	3.5	2.7	7.5	0	0.5	0	0	1	16	17	0
V10-B1	26	10.5	7.5	14	4	28	0	1		42	64	0
V10-B3	34	10	2.2	32	10	2	0	2		47	60	0
V13-B1	44	9	20.5	18	30	18	0	0	1	46	48	0
V14-A1	31	2.4	28	12	10	8	0	0		0	64	10
V14-B1	26	5.5	15	30	14	22	0	0	1	55	44	0
V14-B2	23	7.5	32.5	26	10	20	0	0		5	30	0

Table 2: Biometric plot data for woodland rehabilitation monitoring plots

Plot Name	NPS	OS	MS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	L-litter	Bare ground/Rock
3R	4	30	2	0	0	0	0	0	Planted	0	68	23
4R	6	25	0	0	0	0	0	0		0	84	16
6R	19	40.5	0	4	0	0	8	0		25.5	82	6
8R	7	16	0.5	2	0	0	0	0		0	60	40

Table 3: Flora species list from RWEA monitoring plots

Scientific Name	Common Name	Native/ Exotic	V1 A1	V1 A2	V1 B1	V1 B2	V1 B3	V2 A1	V2 B1	V2 B2	V3 B1	V5 B1	V5 B2	V5 B3	V5 B4	V6 A1	V6 A3	V6 B1	V6 B1 c	V6 B2	V6 B2 c	V6 B3	V6 B4	V9 A1	V9 B1	V9 B2	V10 -A1	V10 -A2	V10 -B1	V10 -B3	V11 -B1	V11 -B2	V13 -B1	V14 -A1	V14 -B1	V14 -B2
Abutilon oxycarpum	Lantern Bush	N																														1	1	1	1	
Acacia amblygona	Fan Wattle	N															1	1	1		3			2		2		1			2					
Acacia binervia	Coast Myall	N																							1			1	3	2		3				
Acacia decora	Western Silver Wattle	N																												3						
Acacia decurrens	Black Wattle, Green Wattle	N		3			3							3	2																					
Acacia falciformis	Broad-leaved Hickory	N																																		
Acacia filicifolia	Fern-leaved Wattle	N				3		1		3																										
Acacia implexa	Hickory Wattle	N																			2			1												
Acacia parramattensis	Parramatta Wattle	N							3																											
Acacia salicina	Cooba	N																												2					3	
Acacia sp.		N																										1								
Acacia sp. (bipinnate)		N			1							1																								
Acetosa sagittata	Rambling Dock, Turkey Rhubarb	E																																		
Acetosella vulgaris	Sorrel, Sheep Sorrel	E																																		
Adiantum aethiopicum	Common Maidenhair	N																															1			
Aira cupaniana	Silvery Hairgrass	E						1																												
Ajuga australis	Austral Bugle	N									1							1																		1
Allocasuarina luehmannii	Bulloak	N										1		3	2	2	4	2	3	1	4	3	4	3		3	2	2			2	3				
Alternanthera sp.		N									1																1									
Amyema cambagei	She-oak Mistletoe	N																																		
Amyema congener subsp. congener		N																																		
Amyema gaudichaudii	Paperbark Mistletoe	N																							1		2									
Anagallis arvensis	Scarlet/Blue Pimpernel	E	3		2	2	3	1	3	2	1	2																						1		
Angophora floribunda	Rough-barked Apple	N									1	3	4	2	4																					
Argemone ochroleuca	Mexican Poppy	E																																		
Aristida ramosa	Purple Wiregrass	N									2	2		1	2	2	2	2	1	2	2	1	4	2	1		1	3		2				2	1	2
Aristida sp. (Large)	Wiregrass	N																																		
Aristida vagans	Threeawn Speargrass	N									2			2	3	2	4	2	2	2	2	2			2	3	2	2	1		2	3	1		2	2
Arthropodium milleflorum	Vanilla Lily	N													1	1		1	2	1	1			1	1			1			1	1				
Asparagus asparagoides	Bridal Creeper	E							1	2																										
Asparagus sp.		E				1	1			1	1			1																						
Aster spp.		E					2																													
Austrodanthonia spp.		N														1										2				2						
Austrostipa ramosissima	Stout Bamboo Grass	N		1		3										3				2									1				3			3
Austrostipa scabra subsp. scabra		N														2																		2	2	2
Austrostipa sp.(tussock)		N																									1			2						
Austrostipa verticillata	Slender Bamboo Grass	N																																1		
Backhousia myrtifolia	Grey Myrtle	N				1																														
Banksia integrifolia	Coast Banksia	N										2	2	3																						
Bertya oleifolia		N																															1		1	

Scientific Name	Common Name	Native/ Exotic	V1 A1	V1 A2	V1 B1	V1 B2	V1 B3	V2 A1	V2 B1	V2 B2	V3 B1	V5 B1	V5 B2	V5 B3	V5 B4	V6 A1	V6 A3	V6 B1	V6 B1 c	V6 B2	V6 B2 c	V6 B3	V6 B4	V9 A1	V9 B1	V9 B2	V10 -A1	V10 -A2	V10 -B1	V10 -B3	V11 -B1	V11 -B2	V13 -B1	V14 -A1	V14 -B1	V14 -B2
Bidens pilosa	Cobbler's Pegs	E	3									1	2																							
Bidens subalternans	Greater Beggar's Ticks	E			1	2			3																											
Bothriochloa macra	Red Grass	N																																		
Brachychiton populneus subsp. populneus	Kurrajong	N							2			1	1			1				2							1						1	4	1	
Breynia oblongifolia	Coffee Bush	N					1			1		3	2	1	1	1						1		1	2	1	1			1	1	1	1		1	1
Breynia sp.		N			2																															
Briza minor	Shivery Grass	E					2																													
Bromus catharticus	Prairie Grass	E																																		
Brunoniella australis	Blue Trumpet	N															2			1	1	1		1					1			1			1	
Bryophyllum delagoense	Mother of Millions	E											2																							
Bursaria spinosa	Native Blackthorn	N										1			1	1			2						4	3	2	3	4	1	2	3	2			2
Callitris glaucophylla	White Cypress Pine	N																										1								
Calotis cuneifolia	Purple Burr-Daisy	N																			1															
Calotis hispidula		N									1																									
Calotis lappulacea	Yellow Burr-daisy	N										2									1															
Cardiospermum grandiflorum	Balloon Vine	E		3	2	2	3																													
Carex inversa	Knob Sedge	N																																		
Cassinia arcuata	Sifton Bush	N																1													1					
Cassinia cunninghamii		N																										3								
Cassytha pubescens	Common Devil's Twine	N																															2			
Casuarina cunninghamiana	River Oak	N	5	3	4	4	4																													
Cayratia clematidea	Slender Grape	N																															1			
Centella asiatica	Pennywort	N									1																									
Centipeda minima	Spreading Sneezeweed	N									2																									
Cerastium glomeratum	Mouse-ear Chickweed	E							2																											
Cheilanthes distans	Bristly Cloak Fern	N						1								2		1	2								2	1		1		2		2	3	2
Cheilanthes sieberi subsp. sieberi		N				2	2	2	1	2			1	2	1		1	3	2	2	2	4	2	2	2	2	1	2	2	1	2		2	1		2
Chloris divaricata var. divaricata		N														1																				
Chloris gayana	Rhodes Grass	E																																		
Chloris ventricosa	Tall Chloris	N														1					1													1		
Choretrum candollei	White Sour Bush	N						1																				1			1	1				
Chrysocephalum apiculatum	Common Everlasting, Yellow Buttons	N			1		1	3				1			1																					
Cirsium vulgare	Spear Thistle	E	1	1	1		2																													
Clematis aristata	Old Man's Beard	N			1		1																						2							
Commelina cyanea	Scurvey Weed	N			2		2					1	1		1								1													
Conyza bonariensis	Flaxleaf Fleabane	E	1	1		2			1			1	1																							
Conyza sumatrensis	Tall fleabane	E			1		1			1	1																									
Corymbia maculata	Spotted Gum	N																						3	2	4			3				3			
Cymbonotus lawsonianus	Bear's Ear	N																		1		1						1	1					1		
Cymbopogon refractus	Barbed Wire Grass	N						2		2	2				2	2	3	2	3	2	4	2		3	3	2	2	2	3	2	2	2	2		3	
Cynodon dactylon	Common Couch	N	3	4	2		1	3	1	2	3		1	1	3			1		1			1				1	1					2			

Scientific Name	Common Name	Native/ Exotic	V1 A1	V1 A2	V1 B1	V1 B2	V1 B3	V2 A1	V2 B1	V2 B2	V3 B1	V5 B1	V5 B2	V5 B3	V5 B4	V6 A1	V6 A3	V6 B1	V6 B1 c	V6 B2	V6 B2 c	V6 B3	V6 B4	V9 A1	V9 B1	V9 B2	V10 -A1	V10 -A2	V10 -B1	V10 -B3	V11 -B1	V11 -B2	V13 -B1	V14 -A1	V14 -B1	V14 -B2
Cyperus gracilis	Slender Flat-sedge	N									1	2	1				1						2			1							1	1		
Cyperus polystachyos		N																					1	2									1			
Cyperus spp.		N								1			1			1				1	1	1			1				1					1		
Daucus spp.		N					1																													
Daviesia genistifolia	Broom Bitter Pea	N																								1										
Desmodium brachypodum	Large Tick-trefoil	N														1			2	1	2	2			1	1	1						1	1	1	1
Desmodium rhytidophyllum		N														1					1					2										
Desmodium varians	Slender Tick-trefoil	N														1	1		1		1	1				2		1	3				2	1		
Dianella longifolia		N								1																	1		1							
Dianella prunina		N														1			1		1				1			1			1	2				
Dianella revoluta var. revoluta		N														1	1				2		1	1	2	1		1	2	1			1			
Dichelachne sp.		N																	1			1													2	
Dichondra repens	Kidney Weed	N			1					1			3			1		2		2	1	3		1	1	1	1	1	2			1	1	2	1	3
Dichondra sp.		N																																		
Digitaria spp.		N									2					1															1	1				
Dodonaea viscosa subsp. cuneata		N														1	1		1					1	1	2			1		3	1				
Echinopogon caespitosus	Bushy Hedgehog-grass	N												1																						
Echium plantagineum	Patterson's Curse	E	1	3			2		2																											
Ehrharta erecta	Panic Veldtgrass	E	3	3	3	3	3		2	3		1	2					1						1												
Einadia hastata	Berry Saltbush	N		1		1			3	1		2		3	1	1		1	1	1		1	1								1		1	1	1	
Einadia nutans		N														1	1				1		1				1							1		
Einadia sp.1		N											3			1					1															
Einadia sp.2 (trigonos)		N																			1															
Entolasia marginata	Bordered Panic	N										2											1										2			
Entolasia stricta	Wiry Panic	N														1								2							2	3			2	
Epacris sp.		N																																		
Eragrostis brownii	Brown's Lovegrass	N																	1						2		2				1					1
Eragrostis curvula	African Lovegrass	E	1				2	1							2																					
Eragrostis leptostachya	Paddock Lovegrass	N													1	1		1			1	1														
Eragrostis sp.		N																2																		
Eremophila debilis	Amulla	N														1	1		1		2	1							1					1		
Eucalyptus blakelyi	Blakely's Red Gum	N									4																									
Eucalyptus camaldulensis	River Red Gum	N						3	4	4																										
Eucalyptus crebra	Narrow-leaved Ironbark	N									1					4	4	1	4		4	1	1	4	3	3	3	4	2		4	3	3			2
Eucalyptus dawsonii	Slaty Gum	N										1															3			3						
Eucalyptus moluccana	Grey Box	N														2		3		3	3	3											3		3	
Eucalyptus punctata	Grey Gum	N																							1				3		4	3				
Euchiton involucratus	Star Cudweed	N																																		
Eustrephus latifolius		N			2																													1		
Exocarpos cupressiformis	Native Cherry	N																																		
Exocarpus strictus	Cherry Ballart	N							1	3	1		1												2											
Fabaceae sp.		N																																		

Scientific Name	Common Name	Native/ Exotic	V1 A1	V1 A2	V1 B1	V1 B2	V1 B3	V2 A1	V2 B1	V2 B2	V3 B1	V5 B1	V5 B2	V5 B3	V5 B4	V6 A1	V6 A3	V6 B1	V6 B1 c	V6 B2	V6 B2 c	V6 B3	V6 B4	V9 A1	V9 B1	V9 B2	V10 -A1	V10 -A2	V10 -B1	V10 -B3	V11 -B1	V11 -B2	V13 -B1	V14 -A1	V14 -B1	V14 -B2
Facelis retusa	Annual Trampweed	E		1			1																													
Gahnia aspera	Rough Saw-sedge	N																								2	1	2		1		1	2	1	1	
Gahnia sp.		N																																		
Galenia pubescens	Galenia	E		3				1	4	1			1																							
Galium propinquum	Maori Bedstraw	N															1																	1		
Geijera salicifolia var. salicifolia		N														1																			2	2
Geitonoplesium cymosum	Scrambling Lily	N																															2			
Geranium sp.		N																																		
Glossocardia bidens	Cobblers tack	N																1			1															
Glycine clandestina		N								1	1			1	1	1		1		1					1		1	1			1		1		1	1
Glycine microphylla		N						1		2		2	2	1	1		2					1			1	1			1			1				
Glycine tabacina	Variable Glycine	N									1	1			1		1		1	1				1			1	1		1			1	1		
Gomphocarpus fruticosus	Narrow-leaved Cotton Bush	E			1																	1														
Goodenia hederacea	Ivy Goodenia	N																										1								
Goodenia rotundifolia		N																	1		1			1	1	1			2		1	2				
Grevillea montana		N																								2		1			1	1				
Grevillea robusta	Silky Oak	N			2																															
Heliotropium amplexicaule	Heliotrope	E				1	3																													
Hibbertia obtusifolia	Hoary guinea flower	N										1	1															1				1				
Hibbertia sp.		N																						1												
Hibiscus heterophyllus subsp. heterophyllus	Native Rosella	N																															2			
Hovea sp.		N												1																						
Hydrocotyle verticillata	Sheild Pennywort	N			2																															
Hypericum gramineum	Small St Johns Wort	N																																		
Hypochoeris radicata	Catsear	E	2	1	1	1	3	3	1			2	2		1																					
Imperata cylindrica		N										2	3																							
Isolepis inundata		N																																		
Isopogon dawsonii	Nepean Conebush	N												3																						
Jacksonia scoparia		N																							1				1							
Juncus polyanthemus		N									4				1																					
Juncus sp.		N	1		1							2																								
Juncus usitatus		N																																		
Laxmannia gracilis	Slender Wire Lily	N													1								1	2					1							
Lepidosperma laterale		N																														3				
Leptospermum petersonii	Lemon-scented Teatree	N				3																														
Leptospermum polyanthum		N			2																															
Leptospermum sp.		N					5								1																					
Leucopogon muticus	Blunt Beard-heath	N																														2				
Lomandra confertifolia subsp. pallida		N									1			5						2		1				2				1		2				
Lomandra filiformis	Wattle Matt-rush	N														1					1															
Lomandra filiformis subsp. coriacea		N								1								2		2					1				2			1				
Lomandra filiformis subsp. filiformis		N						1									1													2						

Scientific Name	Common Name	Native/ Exotic	V1 A1	V1 A2	V1 B1	V1 B2	V1 B3	V2 A1	V2 B1	V2 B2	V3 B1	V5 B1	V5 B2	V5 B3	V5 B4	V6 A1	V6 A3	V6 B1	V6 B1 c	V6 B2	V6 B2 c	V6 B3	V6 B4	V9 A1	V9 B1	V9 B2	V10 -A1	V10 -A2	V10 -B1	V10 -B3	V11 -B1	V11 -B2	V13 -B1	V14 -A1	V14 -B1	V14 -B2
Lomandra longifolia	Spiny-headed Mat-rush	N		1	2							4	3																				2			
Lomandra multiflora	Many-flowered Mat-rush	N														1					2	2				1		1			1					
Lomandra multiflora subsp. multiflora	Many-flowered Mat-rush	N									2		2	2	2			1					1													
Lomandra sp.		N										2			2				2				1	1			1		1				1	1	1	
Lycium ferocissimum	African Boxthorn	E		3		1																		1			1	1								
Macrozamia flexuosa		N																	1						1											
Macrozamia reducta		N																								1			1							
Maireana microphylla	Small-leaf Bluebush	N														1		1			1													1		
Maytenus silvestrus		N														1								1					1							
Melaleuca decora		N																2	3	3	2	3	1	3	4		4	3	3		3	3				
Melaleuca thymifolia		N									2																									
Melia azedarach	White Cedar	N								1		1																					1			
Melichrus urceolatus	Urn Heath	N																								2										
Melinis repens	Red natal grass	E													1																					
Microlaena stipoides var. stipoides	Weeping Grass	N		4	2	2	2		2	3		3	3	1				1					1				1	1	2			1		2		1
Minuria leptophylla		N																																		
mistletoe on acacia		N																																		
Modiola caroliniana		E	1																																	
Native unidentified shrub		N																																		
Notelaea longifolia	Large Mock-olive	N																			1			1									1			
Notelaea microcarpa var. microcarpa		N			1	3			2	2	1	2	2	3	1	4	1	1	2	3	2	1			1	2	3		1	3		3	3	4	4	5
Oenothera stricta subsp. stricta	Common Evening Primrose	E																																		
Olea europaea subsp. cuspidata		E			1		1			1										1											1					
Olearia elliptica	Sticky Daisy Bush	N														2	1		3	4	2				3	3			3	2	2	3		1	2	4
Oplismenus aemulus		N			3	1	1			1																1							1			1
Oplismenus imbicilus		N			1																								1							
Opuntia aurantiaca	Tiger Pear	E				1			1		1	2	1		1			1		1		1		2												
Opuntia humifusa	Creeping pear	E												1																						
Opuntia stricta	Prickly Pear	E					1		1	1		1	2	2	1	1	1	1	2	2	1	2	2	3	1		2	1		2	1	2		1		1
Oxalis corniculata	Creeping Oxalis	E		1					1	1								1																		
Oxalis perennans		N						2	1	1	1	3	3	2	1	1		1				1						1						1		2
Oxalis radicosa		N				1																											1			
Oxalis spp.		N																																	1	
Pandorea pandorana	Wonga Wonga Vine	N																															2			
Panicum simile	Two-colour Panic	N																	1												2					
Paspalidium distans		N																			1															
Pavonia hastata		E				2	2	2	2	5	2																									
Pennisetum clandestinum	Kikuyu Grass	E	1																																	
Persicaria sp.		N																																		
Persoonia linearis	Narrow-leaved Geebung	N												2											1				1			1				
Petrorhagia nanteuilii		E				1		2		1																										
Phebalium squamulosum ssp. Squamulosum	Forest Phebalium	N																															2			

Scientific Name	Common Name	Native/ Exotic	V1 A1	V1 A2	V1 B1	V1 B2	V1 B3	V2 A1	V2 B1	V2 B2	V3 B1	V5 B1	V5 B2	V5 B3	V5 B4	V6 A1	V6 A3	V6 B1	V6 B1 c	V6 B2	V6 B2 c	V6 B3	V6 B4	V9 A1	V9 B1	V9 B2	V10 -A1	V10 -A2	V10 -B1	V10 -B3	V11 -B1	V11 -B2	V13 -B1	V14 -A1	V14 -B1	V14 -B2
Phragmites australis	Common Reed	N	2	2	2	1								1																						
Phyllanthus virgatus		N														1					1															
Pimelea linifolia	Slender rice flower	N										1			2																					
Pimelea latifolia subsp. hir suta		N																															2			
Plantago debilis		N																				1														
Plantago lanceolata	Lamb's Tongues	E	1	1				2																												
Poa annua	Summer grass	E																																		
Polyscias sambucifolia	Elderberry Panax	N																																		
Pratia purpurascens	Whiteroot	N								1	1							1							2											
Pseudognaphalium luteoalbum	Jersey Cudweed	E	1		1																															
Psydrax oderatum		N																																		
Pteridium esculentum		N										4	3	2																						
Pultenaea spinosa	Spiny Bush-pea	N																								2										
Rhagodia parabolica	Mealy Saltbush	N																																		
Richardia humistrata		E						2		1		1	2								1															
Romulea sp.		E																																		
Rostellularia adscendens		N														1					1															
Rubus parvifolius	Native Raspberry	N	1			1																														
Rumex brownii	Swamp Dock	N		1		1				1																										
Rytidosperma (Austrodanthonia) spp.		N																			1									1						
Salix spp.	Willow	E	3		1																															
Schoenus brevifolius		N																	1		1															
Senecio madagascariensis	Fireweed	E	2	1	1	1	3	2	1		1				1		1				1	1	1				1	1				1		1		
Senecio quadridentatus	Cotton Fireweed	N							1																											
Setaria sp.		E									1	1																								
Sida corrugata		N					1	1											1		1	1				1	1			1			1	1	1	
Sida rhombifolia	Paddy's Lucerne	E				1										1																				
Sida sp.		N	1																																	1
Silene gallica var. gallica	French Catchfly	E						1	1																											
Solanum nigrum	Black-berry Nightshade	E	1	1	1	1	2																	1												
Solanum prinophyllum	Forest Nightshade	N											1									1										1				
Solanum spp.		N																																		
Solivia sessilis	Bindii	E																																		
Sonchus asper	Prickly Sowthistle	E			1		2																													
Sonchus oleraceus	Common Sowthistle	E	2	1	2	2	2			1			1																							
Spartothamnella juncea	Bead-bush	N												1		1		1		1		1			1								1	2	2	2
Sporobolus creber	Western Rat's Tail Grass	N																			1						1						2			
Sporobolus elongatus		N						1																												
Stackhousia viminea		N														1					1															
Stellaria media	Chickweed	E	2	1			3																													
Stephania japonica		N			2																															
Swainsona galegifolia	Smooth Darling Pea	N																														1	2	1		

Scientific Name	Common Name	Native/ Exotic	V1 A1	V1 A2	V1 B1	V1 B2	V1 B3	V2 A1	V2 B1	V2 B2	V3 B1	V5 B1	V5 B2	V5 B3	V5 B4	V6 A1	V6 A3	V6 B1	V6 B1 c	V6 B2	V6 B2 c	V6 B3	V6 B4	V9 A1	V9 B1	V9 B2	V10 -A1	V10 -A2	V10 -B1	V10 -B3	V11 -B1	V11 -B2	V13 -B1	V14 -A1	V14 -B1	V14 -B2
Tagetes minuta	Stinky Roger	E							1				1																							
Thistle sp.		E		1																		1														
Tradescantia fluminensis	Wandering Jew	E				2																														
Trifolium arvense	Hare's Foot Clover	E																																		
Trifolium campestre	Hop Clover	E						1																												
Unidentified native creeper		N																																		
Unidentified grass		N									1			3																						
Unidentified herb		N																				1				1										
Unidentified native shrub		N																												2						
Unidentified succulent		N																	1																	
Unidentified twiner	Unidentified native twiner	N																																		
Verbascum virgatum	Twiggy Mullein, Green Mullein	E																																		
Verbena bonariensis	Purpletop	E	1					2			1							1																		
Verbena rigida	Veined Verbena	E				2	2	1	2	4	1			1																						
Veronica plebeia	Trailing Speedwell	N						2	1			1	1					2				1									1					
Veronica sp.		N																																		
Viola sp.		N			1																															
Vittadinia sulcata		N										1					1	2		2		1					2			2			1	1		1
Vulpia bromoides	Squirrel Tail Fescue	E																																		
Vulpia myuros	Rat's Tail Fescue	E																																		
Wahlenbergia communis	Tufted Bluebell	N													1																					

Table 4: Woodland rehabilitation species list and cover scores

Scientific Name	Common Name	Native/Exotic	4R	8R	3R	6R
Acacia amblygona	Fan wattle	N				1
Acacia decora	Showy Wattle	N				1
Acacia saligna		NLN	3	1		
Acacia sp.1		N				1
Acacia sp.2		N				
Allocasuarina sp.		N				
Allocasuarina sp. seedling		N	1			
Aristida ramosa	Purple Wiregrass	N		1		
Asteraceae sp.		N				1
Austrostipa ramosissima	Stout Bamboo Grass	N				3
Austrostipa sp.		N				1
Bothriochloa macra	Red Grass	N		1		
Bursaria spinosa	Native Blackthorn	N				1
Calotis cuneifolia	Purple Burr-Daisy	N	2			2
Calotis lappulacea	Yellow Burr-daisy	N				2
Chloris divaricata		N			1	

Scientific Name	Common Name	Native/Exotic	4R	8R	3R	6R
Chloris gayana	Rhodes Grass	E	1	1		
Chloris sp				1		
Chloris ventricosa	Tall Chloris	N				1
Corymbia maculata	Spotted Gum	N	2	2	1	2
Cymbopogon refractus	Barbed Wire Grass	N	1	1	1	2
Dichondra repens	Kidney Weed	N				1
Einadia hastata	Berry Saltbush	N				1
Enchylaena tomentosa	Ruby Saltbush	N	2	1	1	2
Eucalyptus sp.		N	1			
Eucalyptus cladocalyx		NLN	3	4	4	4
Eucalyptus crebra	Narrow-leaved Ironbark	N		1		
Eucalyptus fibrosa	Red Ironbark	N				2
Galenia pubescens	Galenia	E	1			2
Glycine sp.		N				1
Plantago debilis		N				2
Sida rhombifolia	Paddy's Lucerne	E				2
Small sedge		N				1

Scientific Name	Common Name	Native/Exotic	4R	8R	3R	6R
Unidentified creeper		N				1
Unidentified grass		N				2
Unidentified shrub		N				1

NLN = non-local Australian native species

2.2 Photographs of floristic monitoring plots

A photograph has been taken at the start and end of the 50 m central transect within each floristic monitoring plot.

2.2.1 River Red Gum / River Oak riparian woodland wetland in the Hunter Valley

Plate 1: V1-A1 – start

Plate 2: V1-A1 – end

Plate 3: V1-A2 – start

Plate 4: V1-A2 – end

Plate 5: V1-B1 – start

Plate 6: V1-B1 – end

Plate 7: V1-B2 – start

Plate 8: V1-B2 – end

Plate 9: V1-B3 – start

Plate 10: V1-B3 – end

Plate 11: V2-A1 – start

Plate 12: V2-A1 – end

Plate 13: V2-B1 – start

No end photograph of V2-B1

Plate 14: V2-B2 – start

Plate 15: V2-B2 – end

Plate 16: V3-B1 – start

Plate 17: V3-B1 – end

2.2.1 Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area

Plate 18: V5-B1 – start

Plate 19: V5-B1 – end

Plate 20: V5-B2 – start

Plate 21: V5-B2 – end

Plate 22: V5-B3 – start

Plate 23: V5-B3 – end

Plate 24: V5-B4 – start

Plate 25: V5-B4 – end

2.2.2 Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter

Plate 26: V6-A1c – start

Plate 27: V6-A1c – end

Plate 28: V6-A3 – start

Plate 29: V6-A3 – end

Plate 30: V6-B1 – start

Plate 31: V6-B1 – end

Plate 32: V6-B1c – start

Plate 33: V6-B1c – end

Plate 34: V6-B2 – start

Plate 35: V6-B2 – end

Plate 36: V6-B2c – start

Plate 37: V6-B2c – end

Plate 38: V6-B3 – start

Plate 39: V6-B3 – end

Plate 40: V6-B4 – start

Plate 41: V6-B4 – end

Plate 42: V11–B1 – start

Plate 43: V11-B1 – end

Plate 44: V11-B2 – start

Plate 45: V11-B2 – end

2.2.3 Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter

Plate 46: V9-A1 – start

Plate 47: V9-A1 – end

Plate 48: V9-B1 – start

Plate 49: V9-B1 – end

Plate 50: V9-B2 – start

Plate 51: V9-B2 – end

Plate 52: V10-B1 – start

Plate 53: V10-B1 – end

2.2.4 Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin Bioregion

Plate 54: V10-A1 – start

Plate 55: V10-A1 – end

Plate 56: V10-A2 – start

Plate 57: V10-A2 – end

Plate 58: V10-B3 – start

Plate 59: V10-B3 – end

2.2.5 White Mahogany - Spotted Gum - Grey Myrtle semi-mesic shrubby open forest of the central and lower Hunter Valley

Plate 60: V13-B1 – start

Plate 61: V13-B1 – end

2.2.6 Brush Wilga/Native Olive Shrubland

Plate 62: V14-A1 – start

Plate 63: V14-A1 – end

Plate 64: V14-B1 – start

Plate 65: V14-B1 – end

Plate 66: V14-B2 – start

Plate 67: V14-B2 – end

2.3 Photo-monitoring points

Plate 68: A1 – 2013

Plate 69: A1 – 2018

Plate 70: A2 – 2013

Plate 71: A2 – 2018

Plate 72: A3 – 2013

Plate 73: A3 – 2018

Plate 74: A4 – 2013

Plate 75: A4 – 2018

Plate 76: B1 – 2013

Plate 77: B1 – 2018

Plate 78: B2 – 2013

Plate 79: B2 – 2018

Plate 80:C1 – 2013

No photograph of C1 taken in 2018

Plate 81: C2 – 2013

Plate 82: C2 – 2018 (monitoring post in background)

Plate 83: CT1 – 2013

Plate 84: CT1 – 2018

Plate 85: CT2 – 2013

Plate 86: CT2 – 2018

Plate 87: D1 – 2013

Plate 88: D1 – 2018

3 Landscape function analysis – site photos

3.1 North Wambo Creek diversion and riparian areas

Plate 89: 17R

Plate 90: 19R

Plate 91: 21R

Plate 92: 23R

Plate 93: 25R

Plate 94: 26R

Plate 95: 27R

Plate 96: 28R

3.2 Woodland rehabilitation areas

Plate 97: 3R

Plate 98: 4R

Plate 99: 6R

Plate 100: 8R

3.3 Pasture rehabilitation areas

Plate 101: 1R

Plate 102: 2R

Plate 103: 5R

Plate 104: 7R

Plate 105: 9R

Plate 106: 10R

Plate 107: 16R

Plate 108: 33R

Plate 109: 34R

Plate 110: 35R

4 Riparian condition assessment

4.1 Riparian condition data

Table 5: Riparian condition scores

Site	Habitat	Cover	Natives	Debris	Features	Total
Maximum Score	**11**	**12**	**9**	**10**	**8**	**50**
North Wambo 1	5.25	6.5	2.75	3.5	1.87	19.87
North Wambo 2	8.75	7.25	3.25	4	2.25	25.5
North Wambo 3	9.75	6	3	5.25	2.25	26.25
Wambo 1	1.75	6	2.5	2	1.25	13.5
Wambo 2	2.75	5.75	2.25	3	1.25	15
Wambo 3	6	7.25	2.25	2.5	0.75	18.75
Stony Creek 1	1.75	6.75	2.75	4.5	2	17.75
Stony Creek 2	6	6	2.75	2.75	2	19.5
Stony Creek 3	11	6.5	3.5	6.75	2.25	30

5 Bird monitoring

5.1 Bird monitoring data

Table 6: Species and maximum count of birds, heard and observed over two site visits; morning and afternoon during spring 2018 surveys

Scientific name	Common Name	Monitoring site and maximum count from the two bird surveys																											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	Total	No. sites
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	0	0	4	0	0	0	0	0	0	0	1	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	10	3
Acanthiza lineata	Striated Thornbill	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	15	0	0	0	0	0	0	0	18	3
Acanthiza nana	Yellow Thornbill	4	3	3	0	0	2	0	0	0	4	0	0	0	0	3	0	3	0	0	0	0	0	4	4	0	0	30	9
Acanthiza pusilla	Brown Thornbill	0	0	2	0	1	0	0	1	0	2	3	1	2	2	0	2	0	2	4	3	1	6	0	0	0	0	32	14
Acanthiza reguloides	Buff-rumped Thornbill	0	1	0	6	6	8	0	0	0	1	0	0	0	0	4	3	0	0	0	0	0	0	3	0	0	0	32	8
Acanthorhynchus tenuirostris	Eastern Spinebill	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	4	4
Accipiter fasciatus	Brown Goshawk	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Aegotheles cristatus	Australian Owlet-nightjar	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Alisterus scapularis	Australian King-Parrot	0	0	0	0	2	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	9	4
Anthochaera carunculata	Red Wattlebird	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Aquila audax	Wedge-tailed Eagle	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	3
Artamus cyanopterus	Dusky Woodswallow	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	7	3
Artamus personatus	Masked Woodswallow	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	30	3

Scientific name	Common Name	Monitoring site and maximum count from the two bird surveys																											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	Total	No. sites
Artamus superciliosus	White-browed Woodswallow	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	5	0	2	0	0	40	20	72	5
Cacatua galerita	Sulphur-crested Cockatoo	0	0	1	1	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	2	4	0	0	11	7
Cacomantis flabelliformis	Fan-tailed Cuckoo	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4
Cacomantis pallidus	Pallid Cuckooo	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	2
Calyptorhynchus funereus	Yellow-tailed Black-Cockatoo	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	4	0	0	0	0	1	0	0	0	0	0	13	3
Chalcites lucidus	Shining Bronze-Cuckoo	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	4	4
Chenonetta jubata	Australian Wood Duck	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1
Chthonicola sagittata	Speckled Warbler	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	2	1	0	1	0	1	2	0	2	0	0	11	8
Climacteris picumnus	Brown Treecreeper	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Colluricincla harmonica	Grey Shrike-thrush	0	0	0	0	1	0	1	1	2	1	1	0	0	1	0	0	1	1	0	1	0	0	1	1	1	2	16	14
Coracina novaehollandiae	Black-faced Cuckoo-shrike	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	1	2	0	0	3	1	0	1	11	8
Coracina papuensis	White-bellied Cuckoo-shrike	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Coracina tenuirostris	Cicadabird	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	4	2
Corcorax melanorhamphos	White-winged Chough	15	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	12	10	5	0	0	5	0	0	5	0	62	7
Cormobates leucophaea	White-throated Treecreeper	0	1	0	1	1	0	0	1	0	1	1	1	0	1	0	1	0	1	0	1	1	0	0	0	1	0	13	13
Corvus coronoides	Australian Raven	0	0	1	0	0	1	1	1	0	0	0	1	1	0	0	2	5	1	0	0	0	1	1	2	1	1	20	14
Cracticus nigrogularis	Pied Butcherbird	1	1	0	0	0	1	2	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	1	0	9	8

Scientific name	Common Name	Monitoring site and maximum count from the two bird surveys																											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	Total	No. sites
Cracticus tibicen	Australian Magpie	0	0	0	1	2	0	0	0	0	0	1	0	2	0	2	0	1	0	0	0	0	0	2	3	0	0	14	8
Cracticus torquatus	Grey Butcherbird	0	0	0	1	1	0	0	1	0	0	0	1	2	0	0	0	1	1	2	0	0	0	2	1	1	2	16	12
Dacelo novaeguineae	Laughing Kookaburra	0	1	0	1	0	0	0	2	0	0	2	0	0	0	0	0	0	1	0	2	0	0	0	1	1	0	11	8
Daphoenositta chrysoptera	Varied Sittella	0	0	0	4	0	6	0	0	0	0	6	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	17	4
Dicaeum hirundinaceum	Mistletoebird	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
Egretta novaehollandiae	White-faced Heron	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1
Eolophus roseicapillus	Galah	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	2	0	0	6	4
Eopsaltria australis	Eastern Yellow Robin	0	2	0	1	1	1	1	1	1	1	1	1	1	5	1	0	1	0	0	1	1	1	0	0	0	2	24	18
Eudynamys orientalis	Eastern Koel	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	1	0	0	4	4
Eurystomus orientalis	Dollarbird	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
Geopelia humeralis	Bar-shouldered Dove	0	0	0	1	2	2	1	0	1	0	0	0	0	0	0	1	0	0	0	1	1	1	0	0	1	2	14	11
Gerygone albogularis	White-throated Gerygone	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	4	4
Glossopsitta pusilla	Little Lorikeet	0	0	0	0	0	0	2	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	17	3
Grallina cyanoleuca	Magpie-lark	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3	3
Haliastur sphenurus	Whistling Kite	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	2
Hirundo neoxena	Welcome Swallow	0	0	0	0	0	0	0	0	5	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	1	2	11	5
Lalage sueurii	White-winged Triller	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	3	2
Leucosarcia picata	Wonga Pigeon	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2

Scientific name	Common Name	Monitoring site and maximum count from the two bird surveys																											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**Total**	**No. sites**
Lichenostomus chrysops	Yellow-faced Honeyeater	5	0	4	0	1	0	15	2	2	2	4	1	2	4	1	2	4	3	1	4	6	3	1	2	0	1	70	22
Lichenostomus leucotis	White-eared Honeyeater	0	0	1	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4	4
Lichenostomus melanops	Yellow-tufted Honeyeater	0	0	0	0	0	0	0	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	2
Lichenostomus penicillatus	White-plumed Honeyeater	2	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	10	5
Malurus cyaneus	Superb Fairy-wren	5	5	10	0	0	1	0	5	0	5	4	0	0	0	0	4	2	5	0	4	0	0	0	0	3	0	53	12
Malurus lamberti	Variegated Fairy-wren	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	5	2
Manorina melanocephala	Noisy Miner	2	0	4	5	0	0	0	0	0	0	0	0	0	0	4	4	1	3	1	0	0	0	1	2	0	4	31	11
Manorina melanophrys	Bell Miner	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Meliphaga lewinii	Lewin's Honeyeater	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3
Melithreptus brevirostris	Brown-headed Honeyeater	0	0	0	0	0	0	0	0	0	2	5	4	0	0	0	0	0	0	0	1	1	0	0	0	0	2	15	6
Melithreptus lunatus	White-naped honeyeater	1	0	0	0	0	0	1	1	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	6	5
Menura novaehollandiae	Superb Lyrebird	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Merops ornatus	Rainbow Bee-eater	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	6	3
Microcarbo melanoleucos	Little Pied Cormorant	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1
Microeca fascinans	Jacky Winter	0	0	0	0	0	0	2	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	6	5

Scientific name	Common Name	Monitoring site and maximum count from the two bird surveys																											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	Total	No. sites
Neochmia temporalis	Red-browed Finch	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	4	2
Ocyphaps lophotes	Crested Pigeon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	2	2
Oriolus sagittatus	Olive-backed Oriole	0	0	0	0	0	0	0	1	1	0	1	1	2	0	1	0	0	0	1	2	0	0	2	3	0	1	16	11
Pachycephala rufiventris	Rufous Whistler	1	0	0	0	0	0	0	0	1	2	0	2	2	1	0	0	1	0	1	3	1	1	2	3	1	1	23	15
Pardalotus punctatus	Spotted Pardalote	4	3	2	6	1	8	1	6	3	1	1	1	1	0	5	1	1	4	3	2	1	1	1	2	0	1	60	24
Pardalotus striatus	Striated Pardalote	2	0	1	0	0	0	0	0	0	0	2	0	0	0	0	1	1	0	0	0	5	0	1	1	0	0	14	8
Pelecanus conspicillatus	Australian Pelican	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Petrochelidon ariel	Fairy Martin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
Petrochelidon nigricans	Tree Martin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Petroica goodenovii	Red-capped Robin	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	4	3
Petroica rosea	Rose Robin	0	0	2	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4	3
Phaps chalcoptera	Common Bronzewing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Philemon corniculatus	Noisy Friarbird	1	0	0	0	1	0	1	0	1	2	0	1	2	1	0	1	0	0	1	6	0	0	1	2	0	0	21	13
Platycercus elegans	Crimson Rosella	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	2
Plectorhyncha lanceolata	Striped Honeyeater	0	0	2	0	2	0	0	0	0	0	2	0	1	0	0	0	0	2	1	0	0	0	1	0	2	4	17	9
Pomatostomus temporalis	Grey-crowned Babbler	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	4	5	16	4
Psophodes olivaceus	Eastern Whipbird	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2
Ptilonorhynchus violaceus	Satin Bowerbird	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1
Rhipidura albiscapa	Grey Fantail	1	2	1	1	0	1	1	1	0	0	0	0	0	4	5	1	1	1	1	4	1	1	0	0	1	0	28	17

Scientific name	Common Name	Monitoring site and maximum count from the two bird surveys																											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**Total**	**No. sites**
Rhipidura leucophrys	Willie Wagtail	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	7	7
Scythrops novaehollandiae	Channel-billed Cuckoo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
Sericornis frontalis	White-browed Scrubwren	2	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	1	2	0	1	0	0	0	0	2	0	11	7
Smicrornis brevirostris	Weebill	0	0	0	0	1	0	0	0	0	1	1	2	0	0	1	1	1	0	1	0	1	1	2	3	0	1	17	13
Strepera graculina	Pied Currawong	1	1	1	1	1	0	0	0	1	1	0	1	0	1	2	1	1	1	1	0	2	1	1	0	2	2	23	19
Taeniopygia bichenovii	Double-barred Finch	5	0	0	0	0	0	3	0	0	2	0	0	0	0	0	0	0	0	0	6	3	0	2	2	3	0	26	8
Todiramphus sanctus	Sacred Kingfisher	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
Zosterops lateralis	Silvereye	12	0	0	0	5	0	0	0	0	4	0	6	2	0	0	0	0	0	0	2	0	30	0	0	0	0	61	7
TOTAL number of species recorded at site		**20**	**10**	**21**	**17**	**17**	**11**	**28**	**21**	**20**	**20**	**26**	**22**	**18**	**14**	**17**	**19**	**24**	**23**	**17**	**22**	**17**	**16**	**21**	**25**	**28**	**27**		

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APPENDIX G

WAMBO ANNUAL REVIEW GROUNDWATER ANALYSIS

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DATE:	28 March 2019
TO:	Nicole Dobbins Environmental Advisor
	Wambo Coal Pty Ltd Peabody Energy Australia PMB 1, Singleton NSW 2330
FROM:	Adam Skorulis, Dr Noel Merrick, Braiya White
RE:	Wambo Annual Review Groundwater Analysis
OUR REF:	WAM028 – Report HS2019/13

INTRODUCTION

This letter report contains the analysis and information required to address the following components of the Annual Environmental Management Review (AEMR) for Wambo Coal Mine for the 2018 calendar year:

1 Review hydrographs for relevant groundwater monitoring bores and conduct a cause-and-effect analysis to determine whether trends are due to climatic conditions or mining.

2 Assess shallow bores for compliance with the groundwater level and water quality performance indicators (Tables 9 and 10 of the GWMP).

3 Compare groundwater monitored levels to model predictions from the South Bates Extension Modification Groundwater Assessment (HydroSimulations, 2017a).

Each scope item is addressed separately in the following sections.

1 ANNUAL REVIEW OF MONITORING DATA

Key data assessment results of time series groundwater level and Electrical Conductivity (EC) data, in relation to trigger levels prescribed in the Groundwater Monitoring Program (Peabody, 2015a) for the 2018 monitoring period, are outlined below. Trends from the entire period of observation have also been assessed to provide context for the 2018 monitoring period.

1.1 Key Groundwater Monitoring Sites

Bores at key sites have been selected (HydroSimulations, 2017b) to identify potential impacts from recent areas of longwall (SBU LW15, LW16 and LW17) and open cut mining at, and nearby, Wambo Coal Mine (WCM). Mining at the North Wambo Underground (NWU) Mine was completed in April 2016.

1.1.1 North Wambo Underground (NWU) impacts

Available EC and groundwater level monitoring data have been assessed at key locations P114, P116, P202, P206, P106 and P109 (**Figure 1**).

1.1.1.1 Observations and Assessment

Groundwater level at location P114 shows a strong relationship with the long-term rainfall trend (rainfall residual mass) from 2003 to late 2014 (**Figure 2**). Following this, the groundwater level departs from the rainfall trend and declines gradually to August 2015 before dropping rapidly to the last date of measurement in August 2016 (since then, to December 2018 the bore has been reported as 'Dry'). Water levels obtained in August 2016 are ~4 m lower than those measured in 2014-2015. A decline in water level of 1.7 m during this period was attributed to subsidence occurring in the strata overlying Longwall 10a (LW10a) (MSEC, 2017). P114 is located over NWU LW10a (**Figure 1**), which commenced extraction in July 2015. The rapid decline in groundwater level following the beginning of extraction is therefore interpreted as an NWU mining impact. Groundwater EC at P114 was fresh (<1000 µS/cm) from August 2003 to October 2011 before a sharp increase in December 2011 to brackish conditions with EC of 3000-7000 µS/cm occurring until August 2015. Following this, EC has further increased to a value of approximately 10000 µS/cm recorded from December 2015, remaining in this range up to the last measurement in August 2016. Above average rainfall in February 2016 contributed to a slight freshening of water quality dropping the salinity to 8000 µS/cm, as well as a minor increase in groundwater level. Measurements of salinity have not been obtained since August 2016 due to the bore being dry.

At location P116 (**Figure 3**) groundwater level shows a moderate response to the long-term rainfall trend and good correlation with the HydroSimulations' interpolated Wollombi Brook stage height. The average groundwater level from late 2003 to April 2007 increases by about 1.5m to a new average from June 2007, to December 2016. This may indicate recovery from drawdown caused by the mining of Homestead LW9 in the Whybrow Seam that removed coal to within 10m of P116. However, it is more likely to represent a return to above average rainfall following the 'Millennium Drought' that affected much of Eastern Australia in the 2000's. This is indicated by a large increase in the rainfall trend, a 3m increase in groundwater level at P116, and increases in Wollombi Brook stage height. Groundwater levels during 2016 declined by ~1 m, with only a minor increase occurring between August 2016 and October 2016. At this time a mining effect due to the extraction of LW10a in the NWU was suspected as the declining groundwater levels in P116 did not reflect the rise in Wollombi Brook stage height and rainfall trend that was occurring contemporaneously. Since LW10A extraction in late 2015, groundwater levels have declined towards the lower groundwater trigger level which reflects the 90th percentile of historic groundwater measurements up to April 2015 (HydroSimulations, 2018b). This declining trend continues during 2018 and is related to the ongoing period of below average rainfall, with the groundwater level at P116 now sitting below the recorded base of alluvium.

From 2003 to mid-2007, prior to the commencement of longwall extraction in the NWU, EC levels at P116 showed high variability, fluctuating between 3000 and 6500 µS/cm, indicating that the groundwater was saline during this period. Prior to this, following the extraction of Homestead LW9 and LW9a, EC measurements from 1998 to 2000 recorded fresher water quality but with the same rate of variability between measurements with EC falling between 500 and 4000 µS/cm. It is suspected that drought conditions prior to the extraction of LW1 at NWU were the controlling factor in the increase of salinity at Bore P116 at this time. Since July 2007, groundwater at bore P116 has been significantly fresher, falling between 500 and 2000 µS/cm (average ~950 µS/cm) up until December 2017. Notable spikes in EC level are seen to occur in conjunction with declines in groundwater level below approximately 53 mAHD (April 2010 – August 2011 and August 2014 – March 2015 and June 2017 - December 2018). Throughout 2018 salinity has continued to rise above values recorded in the last 10 years, with an EC of 3070 µS/cm recorded in December 2018. As with previous changes in EC observed at P116, the increased salinity for 2018 is highly likely to be controlled by declining groundwater levels intercepting saline Permian groundwater at the base of the Wambo Creek Alluvium, with the decrease in groundwater level associated with the period of below average rainfall. This relationship between groundwater levels and salinity is consistent with assessments regarding the origin and mechanisms of saline water observed at the mine conducted by HydroSimulations (HydroSimulations, 2016 and 2017b).

P202 (**Figure 4**) groundwater level shows good correlation with HydroSimulations' interpolated Wollombi Brook stage height, and a moderate correlation with the long-term rainfall trend. An increase in average groundwater level of ~1 m is seen following a high river stage in June 2007, which continues up until December 2017. This may indicate recovery from drawdown caused by the extraction of Homestead LW9a mining of the Whybrow seam 160 m west of P202. However, it is more likely to represent a return to an above average rainfall trend (as explained in the P116 paragraph above). During 2018, groundwater levels have steadily dropped by ~1 m. This is likely to be controlled by the low rainfall conditions as stage height at Wollombi Brook exhibits a similar declining trend. Groundwater EC at P202 is on average brackish (4000-5000 µS/cm) for the period of record. Fluctuations between fresher and more saline conditions occur frequently. Between 2003 and mid- 2007 variations in salinity are closely associated with climatic conditions. For example, groundwater exhibited a freshening trend (~2800 µS/cm) in June 2007 as a result of increased groundwater levels due to increased rainfall. Following this period, groundwater EC fluctuates independently of groundwater level, stream stage and long-term rainfall trends. Periods of high salinity occurred from June 2008 to April 2010 and April 2014 to February 2015, with the maximum measured salinity of 10520 µS/cm being recorded in December 2014. Following this period EC returned to brackish conditions until October 2017 when EC declined sharply from 3800 µS/cm to 380 µS/cm (the lowest recorded EC by >2000 µS/cm). It is possible that the October 2017 sample was taken incorrectly, as the cause of the fluctuations in EC is not apparent and EC measurements in December 2017 'recovered' to 3700 µS/cm. EC continued to rise slowly throughout 2018 with measurements in December 2018 reaching 4400 µS/cm.

P206 (**Figure 5**) groundwater levels show similar trends to those seen in P202, with an increase in average water level of 1.5 m following a high river stage in June 2007. This may indicate recovery from drawdown caused by the extraction of Homestead LW9a in the Whybrow seam 70 m to the west of P206. Again however, it is more likely to represent a return to an above average rainfall trend (as explained in the P116 paragraph above). From June 2007 good correlation is seen between the HydroSimulations' interpolated stream stage and the long-term rainfall trend, with increases in groundwater level linked to high stream stage and rainfall events. Groundwater level is observed to decline by 2 m during 2016, with a further decline of 2.77m during 2017. Wollombi Brook stage height is also observed to decline at both the downstream Warkworth and upstream Bulga gauging stations during this time (see the interpolated stage height in **Figure 5**). During 2018 groundwater levels show no significant change, plateauing around the 90th percentile trigger level. As with other bores in this region, decreased rainfall is likely to be driving the low groundwater levels observed at P206. Groundwater EC at P206 is mostly stable, falling between 2000 – 3000 µS/cm, but can be seen to decline rapidly in correlation with spikes in groundwater level associated with high river stage and rainfall events. This may indicate the infiltration of rain water into the borehole or gravel pack surrounding the bore during large storm events as seen in June 2007 and April 2015. Minor freshening's also occur at smaller spikes in groundwater level associated with rainfall and stage height. During 2018, EC has sat consistently around 2000 µS/cm.

Groundwater level in P106 shows good correlation with the long-term rainfall trend (**Figure 6**) and the interpolated stage height for Wollombi Brook. Larger fluctuations in groundwater level are observed at P106 in comparison with bores P114, P116, P202 and P206 (**Figures 2-5**). This is likely to be indicative of the connectivity of groundwater in P106 with the ephemeral flow in Wambo Creek, or lower specific yield in its associated alluvium. Groundwater EC at P106 is relatively fresh (less than 1000 µS/cm) and responds to the climatic influence on groundwater levels. Low groundwater levels correlate with increased EC, where a gradual decline is seen in correlation with an increasing trend in rainfall from June 2007 to December 2016, as observed in the other bores located between NWU mine area and the confluence of Wambo Creek and Wollombi Brook. Groundwater level responses to climatic factors such as rainfall trend and stage height during 2016 appear to be muted when compared with events of similar magnitude in earlier observations. This indicates a possible mild mining effect caused by LW10a extraction. All observations since 2017, report P106 as dry. Data available to HydroSimulations indicates the depth of P106 to be 14 m. For P106 to reporting a true 'dry' reading, the groundwater level at P106 would need to have dropped by ~5.5m between December 2016 and February 2017, the largest decline observed between 2 bi-monthly measurements since the beginning of observation by a factor of 5. HydroSimulations recommends further investigation of the bore to check that it has not silted up or suffered collapse.

Time series groundwater level in P109 (**Figure 7**) is very similar to P106. A strong climatic response can be observed, with larger fluctuations in groundwater levels likely indicative of ephemeral flow in Wambo Creek or lower specific yield in the associated alluvium. Groundwater EC is stable at around 600 - 700 µS/cm aside from a 6-month period April-August 2013 where EC was 1000 µS/cm. During 2018, EC remained stable with an average value of 770 µS/cm. This correlates with a period of low rainfall and groundwater level. Groundwater levels during the 2018 monitoring period show a consistent decline in response to climatic conditions. This indicates a continued influence of ephemeral flow in Wambo Creek.

1.1.2 North Wambo Underground or Dewatering Impact at GW08 and GW09

Since April 2012, the groundwater levels in bores GW08 and GW09 have decreased by ~4 m (**Figure 8**). Available groundwater level monitoring data has been assessed for GW08 and GW09 to determine the cause of the decreased water level.

1.1.2.1 Assessment

GW08 and GW09 are located to the east of NWU. The closest NWU longwalls to GW09 are LW9 (extracted mid 2014 - early 2015) and LW8b (extracted late 2015 – early 2016) (Figure 1). The closest NWU Longwalls to GW08 are LW10 and LW10a (extracted consecutively from early to late 2015) (Figure 1). Significant drawdown in both GW08 and GW09 (Figure 8) begins in mid-2012, at the time when NWU LW5 was being extracted (1.1 km from GW09 and 1.4 km from GW08) and LW6 development headings were driven. Prior to 2012 there was a slow decline in groundwater levels, probably due to the combined effects of approaching NWU mining of the Wambo Seam, the approaching Wambo open cut, and perhaps the approaching United mining in the Arrowfield Seam below, which finished in 2012. An increase in the rate of decline occurs from 2012, coincident with the commencement of dewatering of the Wambo Seam in the old workings adjacent to North Wambo LW8b by means of two production bores.

The water levels in these bores show only a minor response to rainfall; indicating that the stresses causing the declining levels are greater than the capacity of the alluvium to respond to rainfall events. No data was collected between December 2014 and April 2016. Since this time GW09 has been dry, while GW08 has continued to show declining water levels. The further reduction in water levels following April 2016 suggests that extraction occurring at LW8b had an effect on groundwater levels at both bores. This suggests that the earlier decline from 2013 to 2014 was not solely due to the effect of the dewatering bores. Groundwater levels at GW08 increase in April 2017 followed by a gradual decline in groundwater level of ~1.3 m to December 2018, corresponding to the long-term rainfall trend. Although a NWU mining effect may be ongoing, any possible recovery could be masked by the below average rainfall. It should be noted that the base of bore GW08 appears to be incorrect. Data provided to HydroSimulations notes that the base of the bore is 53 mAHD, however, water levels at this bore have given readings throughout 2018 of less than 53 mAHD.

1.1.3 Montrose open cut impact

Groundwater level data has been assessed at GW16, GW17 and VWP N5 (**Figure 1**) to determine whether the Montrose open cut (about 300 m distant) has had an impact on alluvial groundwater levels. Observations have been made at GW16 and GW17 since August 2010 and at N5 since July 2015.

1.1.3.1 Long term observations

Both GW16 (**Figure 9**) and GW17 (**Figure 10**) show good correlation with the long-term rainfall trend, with a period of increasing water level from the beginning of observation until mid-2012 coinciding with above average rainfall. A decrease in groundwater level of ~5 m is seen in both locations from August 2013 to February 2015 during average rainfall conditions, before increasing again by about 3 m to June 2015. The second half of 2015 shows another decrease in groundwater level of 3 m at GW16 and 2 m at GW17. Increases in groundwater level of 4 m and 5 m at GW16 and GW17 respectively, are observed to be correlated with an increasing rainfall trend during February 2016. At GW16 this is followed by a 5 m decrease in groundwater level to August 2016, which recovers by 2 m for October and December 2016 observations. Since December 2016, GW16 has experienced a decline in groundwater level of ~3 m, to 101 mAHD in December 2018. GW17 groundwater levels following February 2016 decline by 4 m to December 2016. A similar gradual decline in groundwater level at GW17 has also occurred since December 2016 until the end of the 2018 monitoring period, with water levels dropping by 3 m during this time. An increase of ~1 m is observed between October and December 2017 at GW17, however this increase has no apparent connection with climatic factors.

The EC at GW16 has indicated that groundwater has become steadily more saline up to the end of collected data in 2018. The trend has been apparent since early 2016, however it has been punctuated by several decreases in salinity in response to periods of higher rainfall. For example, a spike in salinity of 1138 µS/cm was observed in February 2017 before freshening to 777 µS/cm in April 2017 and gradually increasing to ~1000 µS/cm afterwards. These fluctuations match observed periods of declining groundwater level. EC observations at GW17 for 2017 and 2018 are slightly more saline than those recorded in 2016, with values between 5300-5500 µS/cm. EC at GW17 seems to respond significantly less to changes in the rainfall trend and groundwater level in comparison to GW16 and remain relatively consistent throughout the reporting period. The EC records continue to remain disparate at the two bores – fresh at GW16 (in alluvium) and saline at GW17 (beneath alluvium).

N5 (**Figure 11**), is a multi-piezometer grouted bore located 2km north of current mining in the South Bates Extension Underground Mine (SBE) (Figure 1) at an elevation of 110.1 mAHD. It has four VWPs installed at depths of 30 m (N5-4: Permian Overburden), 73 m (N5-3: Whybrow Seam), 89.5 m (N5-2: Whybrow – Wambo Seam Interburden) and 133 m (N5-1: Wambo Seam) that have been recording since July 2015. Since stabilising in October 2015, the shallowest Permian sensor (N5-4) has been recording a consistent groundwater level that shows a good correlation with the rainfall trend during the 2018 reporting period. A decline in groundwater level of ~10 m was observed in the three lower sensors during the 2016 monitoring period. A decline of ~4 m and ~2 m was observed at the Wambo Seam sensor N5-1 during 2017 and 2018 monitoring periods respectively. Water levels in the Whybrow seam (N5-3) and Whybrow-Wambo interburden (N5-2) sensors were relatively stable and consistent throughout the 2018 monitoring period, with small fluctuations in the range of ~1.5 m occurring over the period.

1.1.3.2 Assessment

As reported in HydroSimulations, (2018a), it is suspected that due to the amplitude of change in groundwater levels at GW16 and GW17, mining occurring at the adjacent Montrose open cut is likely to be affecting groundwater levels at these bores. However, a reduction in rainfall for the 2018 monitoring period is also likely to be contributing to suppressed groundwater levels at both bores. Due to this the extent to which mining has affected GW16 and GW17 remains uncertain.

The negligible changes in EC at GW16 and GW17 is likely to be due to the bores being located upgradient of the Montrose pit, therefore no effect to EC should occur as a result of the open cut operation.

Groundwater levels in the uppermost sensors at N5 have stabilised following regional depressurisation that occurred as a result of open cut mining, and extraction of the Wambo Seam at NWU and the Whybrow Seam and Wambo Seam at South Bates Underground Mine (SBU). Dewatering that is still occurring within the Montrose open-cut, Wambo Seam workings at SBU and the beginning of mining in the Whybrow Seam at South Bates Extension Underground Mine LW17 are likely to be controlling the continued, yet gradual, depressurisation observed in sensor N5-1 within the Wambo Seam.

1.1.4 South Bates Underground (SBU) Impact

Groundwater level data have been assessed at VWPs N2 and N3 as well as GW21 to identify the impact of the extraction of South Bates LW11, LW12, LW13 and LW14. Data at the VWPs has been recorded since July 2015 and GW21 has recorded bi-monthly data since October 2010.

1.1.4.1 Observations

N2 (**Figure 12**) is located between NWU and SBU (Figure 1), at an elevation of 122.5 mAHD. It is a multi-piezometer grouted bore with six VWPs installed at depths of 40 m (N2-6: Permian overburden), 70 m (N2-5: Permian overburden), 100 m (N2-4: Permian overburden) and 140 m (N2-3: Whybrow Seam), 173 m (N2-2: Whybrow to Wambo Seam interburden), and 204 m (N2-1: Wambo Seam) that have been recording since July 2015. The uppermost sensor (N2-6) at 40 m depth has not recorded data since late 2016 following the extraction of SBU LW11 in the Whybrow Seam. The sensor at 70 m depth (N2-5) is reporting a groundwater level that is at or below the sensor elevation for the second half of 2017 and the entire 2018 monitoring period. This follows a 15 m decline in groundwater level that began following the beginning of SBU LW11 extraction in the Whybrow Seam in early 2016. Groundwater level observations at N2-5 are likely to no longer be reliable. The other Permian sensor, N2-4 at 100 m depth, reflects a similar trend, with groundwater levels declining by 6 m associated with the start of SBU LW11 extraction in the Whybrow Seam. Groundwater level observations have been at or below the sensor elevation since early 2017 and may no longer be reliable. Sensors N2-2 (Whybrow-Wambo Interburden) and N2-3 (Whybrow Seam) have both shown a gradual decline in groundwater levels since recording began, these declines have not been observed to increase in rate associated with SBU longwall extraction, with an overall difference between 2015 and 2018 water levels of ~8 m at N2-2 (2 m additional in 2018) and ~5 m at N2-3 (1 m additional in 2018). The Wambo Seam sensor at 204 m depth (N2-1) has consistently shown a greater amount of fluctuation or noise than other sensors at N2. N2-1 recorded a decline in groundwater level of approximately 25 m from the beginning of observation in August 2015 to the beginning of 2017. During the first half of 2017, the groundwater level continued to decline at a rate similar to previously observed, before dropping suddenly by 2 m in June 2017. This drop was followed by a recovery of approximately 8 m, until February 2018. At this time water levels dropped 10 m to -26 mAHD concurrent with the commencement of extraction at SBU LW15 in the Wambo Seam. Water levels at N2-1 remained around -26 mAHD until April 2018, after which, an apparent recovery of ~15 m occurs. As mining continues in the Wambo Seam at SBU (LW15 and LW16) during this time, it is unlikely the readings at N2-1 for the latter part of 2018 are valid.

N3 (**Figure 13**), located above the northern edge of SBU LW11 with a ground elevation of 104.9 mAHD. It is a multi-piezometer grouted bore with six VWPs installed at depths of 30 m (N3-6: Permian overburden), 55 m (N3-5: Permian overburden), 75 m (N3-4: Permian overburden), 109 m (N3-3: Whybrow Seam), 142 m (N3-2: Whybrow to Wambo Seam interburden) and 190 m (N3-1: Wambo Seam) that have been recording since July 2015. All sensors besides N3-5, within Permian Overburden at 55 m depth, have not recorded accurate groundwater levels since May 2016. The behaviour of these sensors before failure have been described in previous Annual Reviews (HydroSimulations 2016, 2017). The Permian overburden sensor at 55 m depth (N3-5) shows a gradual increase from near zero pressure head at the beginning of recording to peak at a level ~10 m above the sensor in May 2016. Groundwater level then declines and remains stable at approximately 1.5 m above the sensor until July 2017. By the end of the 2018 monitoring period, groundwater levels in this sensor have declined to reach a near-zero pressure head.

GW 21 (**Figure 14**) is located within 10 m of N2 (Figure 1), between NWU LW1 and SBU LW13. Early observations were infrequent (only three between October 2010 and October 2013 before more regular bi-monthly monitoring was conducted), or reported the bore as dry, so it is difficult to identify any climate driven trends in groundwater level. A gradual decline in groundwater level with no response to the rainfall trend from July 2011 is seen through to December 2015 where the bore was again reported as dry. The 2016 monitoring period showed some groundwater level response to increases in the rainfall trend in both February (very minor ~10 cm) and October (~30 cm). At the end of the 2016 monitoring period groundwater level was ~20 cm above the base of the bore. All observations since 2017 reported GW21 as being dry. Below average rainfall, as indicated by the decreasing rainfall trend is also observed for this period. As the bore has not previously shown a consistent response to rainfall trends it is difficult to discern whether groundwater level behaviour for this period is occurring as a result of climatic fluctuation or mining at SBU.

1.1.4.2 Assessment

The three uppermost sensors located in the Permian overburden at N2 are no longer recording (N2-6) or are reporting groundwater levels at-or-below their respective sensors during 2018 (N2-5, N2-4). The groundwater level declines at these sensors appear to be related to SBU mining activity, with impacts occurring following start of SBU LW11 extraction in the Whybrow Seam. The declining groundwater levels in the Wambo-Whybrow interburden (N2-2) and Whybrow Seam sensors (N2-3) show evidence of a mining effect that likely began during the extraction of NWU longwalls, that has continued due to and during SBU longwall extraction. During 2018, the decline has continued, at a consistent rate during the extraction of SBU longwalls in sensors N2-2 and N2-3 indicating an ongoing mining effect due to SBU Mining. The sharp decline in groundwater level observations at N2-1 in early 2018 may be consistent with a significant mining effect caused by SBU LW15 extraction in the Wambo Seam. However, the observed recovery that occurred during LW14 extraction in late 2017, as well as during LW15 and LW16 extraction is not consistent with the depressurisation expected following ongoing Wambo Seam mining. It is possible that N2-1 observations are no longer reliable.

The decline in groundwater level in Permian sensors prior to failure also shows evidence of a South Bates mining effect at N3. The sensor failure is most likely related to subsidence following the extraction of LW11. The single remaining sensor (N3-5) recording in the Permian Overburden declines gradually during 2017 but stabilises during 2018 suggesting that mining has not continued to further drawdown the Permian strata in this region.

A mining effect is likely observed at GW21 resulting from NWU longwall extraction prior to the first observation made. Due to dry conditions at this bore a mining effect caused by SBU is not able to be observed. A lack of an expected mining effect from SBU longwall extraction has previously been suggested (HydroSimulations, 2017a), due to the mitigating effect of a fault between GW21 and SBU.

However, analysis of the Permian Overburden sensors in N2 shows a clear SBU mining effect and desaturation of the same strata in which GW21 is located. During 2018, no further mining effect can be observed at GW21 due to the groundwater level being below the base of the bore. It should be noted that the examination of data from a new bore drilled between LW14 and the fault could be of interest to determine the behaviour of groundwater in the area.

1.1.5 New Alluvial Monitoring Sites at North Wambo Creek

During 2017 and 2018 several investigative bores were drilled into the North Wambo Creek Alluvium to gain a better understanding of the nature of the alluvial groundwater system in this area (see SLR, 2017 and AGE, 2019 for further information). Four bores from each drilling investigation were converted into monitoring bores to provide a mechanism for monitoring and assessing whether alluvial water levels have been affected by mining activity occurring in the South Bates Extension and Montrose Open Cut.

Table 1 lists each of the new alluvial bores and their associated depths and screen elevation, as well as the thickness of alluvium encountered. The monitoring bores drilled by AGE in 2018, In-Stream 1, In-Stream 3, Site 7b, and Site 11, were all recorded as being dry at the time of drilling. No further groundwater data is available for these bores at this time, therefore no hydrographs have been included in this annual review. The paired monitoring bores, GW23 and GW24, and GW25 and GW26, were installed by SLR in 2017. Hydrographs showing available water level and EC data are presented in **Figure 15** and **Figure 16**, and an assessment of this data is presented below. Refer to **Figure 1** for the geographical location of each of these bores.

Table 1 New Alluvial Monitoring Sites at North Wambo Creek

Bore	Easting	Northing	Screen Elevation (mBGL)	Alluvium thickness (m)	Total Depth (mBGL)	Date Drilled
In-Stream 1	305736	6395614	1.1 – 2.6	2.0	2.6	18/12/2018
In-Stream 3	306008	6395769	2.85 – 5.85	6.0	6.7	17/12/2018
Site 7b	305867	6395617	4.14 – 7.14	7.0	7.2	18/12/2018
Site 11	306076	6395720	5.5 – 8.5	7.0	8.5	18/12/2018
GW23 (shallow)	305789	6395670	5.2 – 8.2	6.0	8.4	14/11/2017
GW24 (deep)	305791	6395668	11.7 – 13.2	6.0	15.0	14/11/2017
GW25 (shallow)	305297	6395291	2.6 – 5.6	5.0	6.0	16/11/2017
GW26 (deep)	305299	6395288	11.7 – 13.2	6.0	15.0	16/11/2017

The paired site GW23 and GW24 is located on the northern bank of North Wambo Creek overlying the proposed South Bates Extension LW25 (**Figure 1**). The site is 1.2 km south of the Montrose Open Cut and 2.1 km from LW17, where extraction commenced in December 2018. The shallow bore GW23 has a screen installed in the unconsolidated alluvium at this location. The deeper bore, GW24, is screened in the consolidated bedrock (SLR, 2017). The hydrograph in **Figure 15** shows the shallow monitoring bore, GW23, reports dry water levels from June 2018 onwards. GW24 records water levels at all sampling events during the 2018 monitoring period. Groundwater levels recorded between November 2017 and October 2018 show a steady decline, with water levels dropping 2 m over this time. The decline at both bores correlates well with the gradual decline in rainfall residual mass for this period, indicating it is likely that climate is responsible for this behaviour. This is further supported by the results of streamflow monitoring assessments conducted by both AECOM (2019) and EIS (2019) for watercourses within the Wambo Coal mining lease and indicated that no flow events occurred at monitoring station FM1 (see **Figure 1**) in North Wambo Creek during 2018.

The presence of water at GW24 compared to the dry conditions at GW23 indicates that the consolidated strata has greater water storage capacity and is less likely to be adversely affected by drought conditions compared to the unconsolidated alluvium.

Paired monitoring bores GW25 and GW26 are located approximately 600 m upstream of GW23 and GW24. The hydrograph in **Figure 16** shows similar trends in groundwater level decline at GW25 and GW26 as those discussed above. The unconsolidated strata at GW25 is dry following the February sampling event. The consolidated bedrock bore (GW26) declines steadily during 2018, consistent with the extended period of below average rainfall.

EC data has been collected consistently at the two deep bores GW24 and GW26, while no EC data has been collected yet for GW25 and only 2 observations have been collected at GW23. This is due to ongoing dry conditions. The two EC observations at GW23 show reasonably saline groundwater (4500 5000 µS/cm), while EC observations at both 'deep' bores are observed with relatively elevated EC before declining to a consistent level following the drying of the shallower sites. GW24 reports an EC of 3400 µS/cm before declining to ~1700 µS/cm from April 2018. GW26 initially reports an EC of 1400 µS/cm before declining to a consistent level of ~1050 µS/cm. It is possible that saline conditions exist within the unconsolidated material associated with North Wambo Creek, while the underlying bedrock contains fresh groundwater. When the unconsolidated material is saturated (GW23, GW25), saline groundwater is transmitted into the underlying bedrock. When the unconsolidated material is dry, no transmission of saline water occurs to the bedrock giving rise to the trends observed in Figure 15 and Figure 16. More monitoring data is required before this hypothesis can be confirmed.

1.2 Peabody (2018) Wambo Coal Groundwater Monitoring Program - Trigger Levels

Trigger values are used to initiate investigations into the groundwater levels or groundwater quality at Wambo Coal Mine. The trigger levels in Table 2 are presented in the Wambo Groundwater Monitoring Program (Peabody 2018; Table 9 and Table 10) as the result of statistical analysis on pre-mining baseline monitoring data. Triggers for groundwater level occur when a single bi-monthly observation exceeds the maximum or falls below the minimum specified depth to groundwater. Triggers for EC occur when three consecutive bi-monthly observations (a 6-month period) exceed the specified trigger level. Triggers for pH occur when two consecutive bi-monthly observations (a 4-month period) exceed or fall below the specified trigger level.

Table 2 Peabody (2018) Groundwater Level and Quality Trigger Levels

Bore	Groundwater Level (mAHD) *(metres above Australian Height Datum)*		Groundwater Quality		
	Maximum (10th percentile depth)	Minimum (90th percentile depth)	EC (µS/cm)	pH min	pH max
P106	54.47	50.37	941	6.7	7.9
P109	57.84	55.74	#N/A		
P114	56.04	53.84	6141	6.5	7.8
P116	54.24	51.74	5972	6.6	7.5
P202	52.47	50.67	8172	6.7	7.7
P206	44.13	38.63	2630	7.3	8.1
P301	#N/A				
P315	90.34	85.64	552	6.0	7.4
GW02	76.70	74.00	715	6.7	7.4
GW08	#N/A				
GW09	#N/A				
GW11	76.00	73.50	592	6.8	7.5
GW12	77.38	74.38	#N/A		
GW13	57.76	57.16	4370	6.9	7.1
GW15	51.96	51.26	730	6.7	7.2
GW16	#N/A				
GW17	#N/A				
P16	50.38	49.68	10832	7	7.7
P20	50.30	49.20	10625	7	7.6

#N/A = Not applicable

1.2.1 2018 Groundwater Level Statistics

Table 3 presents 10th and 90th percentile statistics for groundwater levels at nominated water level trigger sites for the 2018 monitoring period.

Table 3 2018 10th and 90th Percentile Groundwater Levels

Bore	Groundwater Level (mAHD) *(metres above Australian Height Datum)*		Depth to Groundwater (mBTOC) *(metres below top of casing)*	
	2018 Minimum (90th percentile depth)	2018 Maximum (10th percentile depth)	2018 Minimum (10th percentile)	2018 Maximum (90th percentile)
P106*	dry		dry	
P109	56.0	56.2	6.2	6.4
P114*	dry		dry	
P116	52.0	52.2	6.8	7.1
P202	51.0	51.3	9	9.3
P206	38.7	39.3	21	21.5
P301	70.8	71.8	16.4	17.3
P315*	dry		dry	
GW02	73.3	73.9	8.6	9.2
GW08	52.5	52.9	7.1	7.5
GW09*	dry		dry	
GW11	70.4	71.0	6.7	7.2
GW12	74.6	74.6	12.7	12.7
GW13	55.8	56.3	6.2	6.8
GW15	50.7	51.0	11.4	11.6
P16	48.2	48.5	9.0	9.3
P20	48.6	48.9	8.5	8.8

* 'Bore Dry'

1.2.2 Trigger Level Exceedances

Table 4 presents counts of trigger level exceedances for the 2018 monitoring period.

Table 4 Trigger Level exceedances in the 2018 monitoring year

Bore	Number of Trigger Level Exceedances in 2018 Observations				
	Minimum depth-to-water (10th percentile)*	Maximum depth-to-water (90th percentile)**	EC	pH min	pH max
P106		6 (Dry)			
P109			#N/A		
P114		6 (Dry)			
P116					
P202					
P206					
P301	#N/A				
P315		6 (Dry)			
GW02		5			
GW08	#N/A				
GW09	#N/A – Bore Dry				
GW11		6	6	2	
GW12			#N/A		
GW13		6			
GW15		6			2
GW16	#N/A				
GW17	#N/A				
P16		6			
P20		6			

Blank cells represent no trigger exceedance, #N/A = Not applicable
*Minimum depth-to-water is equivalent to maximum groundwater level (mAHD)
**Maximum depth-to-water is equivalent to minimum groundwater level (mAHD)

1.2.2.1 Minimum (10th Percentile) Triggers

The 10th percentile triggers allow identification of anomalously shallow depths to groundwater.

As mentioned in previous Annual Reviews for Wambo Coal Mine (HydroSimulations, 2016, 2017b & 2018a), the baseline data used to generate trigger levels for groundwater level and quality was collected during a period of below average rainfall (July 2003 – August 2007). As a result, 10th percentile trigger exceedances should not necessarily be attributed to mining activity, as higher than average rainfall may be the controlling factor behind the exceedance. Under most circumstances, a high water level is not necessarily problematic unless the groundwater EC increases from evaporative processes. Rainfall during the 2018 monitoring period has remained below average. As such no 10th percentile trigger exceedances occurred during this period.

1.2.2.2 Maximum (90th Percentile) Triggers

The 90th percentile triggers allow identification of anomalously deep depths to groundwater.

P114, P106, P315, GW02, GW11, GW13, GW15, P16 and P20 have exceeded the trigger level for the 90th percentile (maximum) depth to water in the 2018 monitoring year.

P114

As stated earlier, the low groundwater levels at P114 (**Figure 2**) are a clear effect from the mining of LW10A in conjunction with the ongoing period of below average rainfall. Every observation in the 2018 monitoring period falls below the maximum depth-to-water trigger level with the bore reporting dry.

P106

At P106 (**Figure 6**) all observations for the 2018 monitoring period are dry and therefore observed groundwater level are below the maximum depth-to-water trigger level. As was stated earlier (**Section 1.1.1.1**), it is unlikely this large apparent decline in groundwater level is mining related. Dipping the bore for depth, and investigating integrity is recommended by HydroSimulations.

P315

Water levels at bore P315 (**Figure 17**) exceeded the 90th percentile trigger in February 2018 and have since been recording dry conditions. This trigger exceedance was previously investigated and reported on by HydroSimulations (2018b) with the conclusion that the dry conditions at the bore can be attributed to below average rainfall. This is expected to still be true at this location.

As with P315, the trigger exceedances at GW02 (**Figure 18**) were investigated in HydroSimulations, 2018b. From this report and the current assessment of water levels it appears that rainfall deficit continues to be controlling the declining groundwater levels at GW02.

GW11

GW11 (**Figure 19**) has consistently reported groundwater levels below the maximum depth-to-water trigger for the 2018 monitoring period. Following exceedances in 2016, previous AEMR reports (HydroSimulations, 2017b) proposed that the alluvial water loss may have been caused by drawdown associated with mining at NWU in downstream alluvial sources at Wambo Creek. However, water levels recovered in 2017 (despite a drop of 3.4 m in June 2017, believed to be a data collection error (HydroSimulations, 2018 b)) placing the bore above the 90th percentile trigger level. The decline in water levels during the 2018 monitoring period correlates well with the decline in rainfall residual mass also observed for this period. As such it is expected that below average rainfall has resulted in the six groundwater level trigger exceedances recorded for 2018.

GW13

GW13 is located on the eastern side of Wollombi Brook about 3 km from NWU workings (**Figure 1**). During the 2018 monitoring period, all water level observations exceeded the maximum depth-to-water trigger level, with water levels in December 2018 being 1.5 m below the 90th percentile trigger level (**Figure 20**). Such an exceedance has been occurring at GW13 since June 2016. An investigation into the cause of this was conducted by HydroSimulations in 2018 (HydroSimulations, 2018b) where it was concluded that the combination of low rainfall and potential drawdown associated with extraction at the Warkworth Open Cut (2.8 km from GW13) is likely to be driving these exceedances. It was also mentioned in this report that the number and magnitude of exceedances is likely to be a result of creating trigger levels using baseline data that was insufficient and not wholly characteristic of groundwater response to climate at GW13.

GW15

GW15 (**Figure 21**) has displayed a declining groundwater trend since March 2016, with all readings for the 2018 monitoring period falling below the 90th percentile trigger. As concluded in HydroSimulations 2018b, these low water levels correspond to trends observed in the rainfall residual mass and the interpolated stage height for Wollombi Brook, both indicating declining levels since March 2016. While the approaching Warkworth Open Cut may be responsible for some decline in groundwater level at GW15, it is difficult to determine with the current below average rainfall conditions. It is most likely that climatic conditions are responsible for the groundwater level trigger exceedances at GW15.

P16

Bore P16 is located approximately 4.5km from LW11, adjacent to Wollombi Brook and downstream of underground mining at Wambo (**Figure 1**). P16 is less than 200 m from excavation that occurred at the South Wambo Boxcut (also known as the Glen Munro Pit), which was completed in July 2017. The South Wambo Boxcut was excavated at the former site of Chitter Dam and will serve as the access portal to approved South Wambo underground mining in the Woodlands Hill and Arrowfield Seams. Bore P16 groundwater level and EC are displayed in **Figure 23** with the rainfall residual mass curve and interpreted Wollombi Brook stage height to aid interpretation. The groundwater level at P16 has been declining since March 2016 and remained below the baseline period 90th percentile trigger level since March 2017. The rainfall residual mass curve and interpreted Wollombi Brook stage height have also displayed a declining trend over the same period, indicating that P16 has received decreasing recharge over this period from both rainfall and stream flow.

Current rainfall and stream level trends indicate decreased recharge, and the groundwater level at P16 is currently the lowest on record by approximately 0.8 m. This includes observations in the baseline period that were taken during the millennium drought. The baseline period used for the 90th and 10th percentile water level triggers covers a broad range of climatic conditions and gives a small (0.7 m) bandwidth for natural variation. While some of the decline in groundwater level at P16 can be attributed to recent weather conditions, excavation at the South Wambo Boxcut appears to have caused additional drawdown in the range of 1 m.

P16 was constructed as part of an assessment to identify whether the clean sandy alluvial aquifer located to the East of Wollombi Brook extended to the West of the channel, overlying United Underground longwalls (GeoTerra, 2003). The study found that colluvial and silty alluvial material ranging in thickness from 1.9-11.5 m (11 m at P16) existed at sites to the West of Wollombi Brook, but that this material is not part of the Wollombi Brook Alluvial Aquifer.

The groundwater assessment for the South Wambo Boxcut (HydroSimulations, 2016) predicts a small amount of additional drawdown in Permian strata at P16 due to the excavation of the boxcut, on top of broader regional depressurisation from mining activity such as NWU, United Underground and the United Wambo Joint Venture. The drawdown observed at P16 is consistent with the magnitude of the drawdown predicted in HydroSimulations (2016b).

The exceedance of the maximum depth-to-water trigger can be attributed to a minor mining effect from the South Wambo Boxcut and the extended period of lower than average rainfall. As excavation of the boxcut was completed in July 2017, the impacts are unlikely to increase and no change to the monitoring frequency is recommended at P16.

P20

The monitoring record at P20 (**Figure 23**) shows a similar decline in water level as at P16 and has been below the 90th percentile trigger level from August 2017 to June 2018. As for P16, the baseline monitoring period included observations during the millennium drought, capturing the groundwater level response for a broad range of climatic conditions. P20 has received decreased recharge from both rainfall and Wollombi Brook over the period of trigger exceedance. Although P20 is further from the excavation activity at the South Wambo Boxcut, it is also currently reporting the lowest groundwater levels on record (0.5 m below the previous maximum depth to groundwater). While the decline in groundwater level is strongly linked to the rainfall deficit at this site, a minor effect caused by excavation activity at South Wambo Boxcut is likely observed at P20.

As for P16, HydroSimulations (2016b) predicted drawdown in Permian strata at P20 due to excavation of the South Wambo Boxcut, while no drawdown is predicted in unconsolidated material as is it simulated as dry. The predicted drawdown was of a smaller magnitude at P20 than at P16 due to the increased distance from the boxcut. This matches well with the observed data as the apparent impact at P20 is about half of the impact at P16.

1.2.2.3 EC Triggers

EC trigger levels were exceeded at three bores during the 2018 monitoring period, GW11 (**Figure 19**), GW16 (**Figure 9**), GW17 (**Figure 10**). Each of these exceedances have occurred concurrently with exceedances of the maximum depth-to-groundwater triggers for each bore. Each monitoring location has been exhibiting high salinity since 2017. The maximum EC value recorded at GW11 during the 2018 monitoring period was 676 µS/cm, 84 µS/cm above the trigger (February 2018), 1327 µS/cm at GW16 in December 2018, 504 µS/cm above the trigger, and 5490 µS/cm for GW17 in October 2018, 186 µS/cm above the trigger. The increased salinity at each of these monitoring locations is expected to be the result of a greater proportion of brackish water sourced from Permian strata contributing to the groundwater system due to the reduction in rainfall.

1.2.2.4 pH Triggers

Two pH trigger exceedances occurred during 2018, one below the minimum (GW11- **Figure 19**), and one above the maximum (GW15- **Figure 21**). pH at GW11 fell below the minimum pH trigger (6.8) in February and April 2018 by 0.2 and 0.1 units respectively. The pH of the groundwater sampled after these dates proceeded to increase to 7 pH units, 0.2 units above the minimum. GW15 recorded an exceedance of the maximum pH trigger level of 7.2 in February and April 2018, with the sampled pH being 0.2 and 0.3 units above this.

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, ARMCANZ, 2000) recommend that groundwater used for irrigation and stock watering falls within a pH range of 6 – 8.5 in order to prevent fouling or corrosion of infrastructure. The Australian Drinking Water Guidelines (NHMRC, MRMMC, 2011) outline that groundwater with a pH between 6.5 and 8.5 is fit for human consumption. The pH values at GW11 and GW15 that triggered the exceedance still remain within both of these recommended ranges. With the change in pH being so marginal it is not considered to have caused or be likely to cause a long-term, negative impact to the groundwater quality in the vicinity of these bores.

2 OBSERVED AND MODELLED GROUNDWATER LEVELS

Hydrographs of observed groundwater levels and HydroSimulations (2017a) modelled groundwater levels at key sites are presented from **Figure 24** to **Figure 35**. The following sections contain an assessment of the modelled groundwater levels where mining impacts might be observed.

2.1 Montrose Open Cut

The elevation of modelled heads at GW16 (**Figure 24**) and GW17 (**Figure 25**) is reasonably close to the overall elevation of water levels observed at each monitoring location. The variability that appears in the observed data is unable to be replicated by the model as no stage height data is available for North Wambo Creek, a key influence on groundwater levels at this location. The modelled water levels for GW17 are quite conservative, with the predicted mine impact being greater than observed. As GW17 is closer to the open cut (**Figure 1**), it is predicted to be impacted at an earlier time and to a greater extent than GW16. The apparent underestimation of the model at GW16 is likely related to the period of below average rainfall observed in 2017 and 2018 that is not included in the model. The observed rate of decline in groundwater levels at GW16 is higher than predicted during 2018 and is likely to be a result of both climate and a mining effect. The predicted decline in groundwater level at GW17 is greater than observed at the end of 2017. Although the model overestimates the drawdown at GW17, the predicted rate of decline reduces at the end of 2017 and compares well with the trend in the observed data.

The performance of the modelled heads at N5 (**Figure 26**) is poor, with modelled heads much higher than those within the observed data. The timing of the observed drawdown due to the open cut is accurate, but the vertical hydraulic head gradients have not been reproduced. As reported in the 2017 AEMR (HydroSimulations, 2018a), the model requires lower vertical hydraulic conductivities in this area, which if implemented would have the effect of providing greater protection for the alluvium from underground mining effects.

2.2 North Wambo Underground (NWU)

The performances of modelled heads at six standpipes in **Figures 28-33** (P114, P116, GW08, GW09, P106 and P109) have been assessed against observed data where NWU mining activity may impact groundwater levels.

Previous reporting for P114 (HydroSimulations, 2016) had underestimated the drawdown associated with NWU LW10a extraction. Following an interrogation of the groundwater model, as further explained in HydroSimulations (2017a), it was found that the underestimation was only apparent due to the model's inability to represent the layering at a fine vertical scale, and that the base of P114 extends into model layer 2. The modelled heads presented for P114 (**Figure 27**) are a weighted average from layer 1 and layer 2 heads according to the degree of partial penetration. The resulting calibration is a very good representation of the observed data, however an assessment of 2018 predictions was unable to be carried out due to the bore being dry. Subsidence in the vicinity of P114 following the extraction of LW10a, ranges from 1.5m to 1.8m (MSEC, 2017).

The maximum modelled heads for P116 (**Figure 28)** are well correlated with the declining trend apparent in the observed heads. Climatic variation is not as apparent in the modelled heads as it is in the observed heads as the simulated river stage for the model is represented as a long-term average and does not include short-term transient variation. An overestimation of simulated specific yield may also be responsible for the overestimation of groundwater head elevation in the model, due to the location of the bore within the official alluvial extent but outside the limits determined by geophysics. Accordingly, it should be attributed to regolith instead of alluvium. As P116 does not lie directly over NWU workings predicted drawdown as a result of mining activity is limited, with only a minor response simulated while drawdown appears in the observed heads (following the extraction of LW10).

HydroSimulations' modelled heads at GW08 (**Figure 29**) and GW09 (**Figure 30**) show a good match with the overall trends seen in the observed data. The timing of mining related drawdown in both modelled and observed heads following the extraction of LW5 is well correlated despite simulated heads being lower than observed. At GW08, observed water levels fell below simulated heads in 2015. This relationship continues during the 2018 monitoring period with modelled heads showing a milder response to drawdown than that seen in the observed heads. Despite this the difference in elevation between modelled and observed heads is quite small, being within 1 m of one another. At GW09, the bore has gone dry due to mining related drawdown, so it is not possible to compare the performance of observed groundwater level with that modelled for 2018.

The simulated groundwater levels at P106 (**Figure 31**) follow the observed declining trend and match the upper envelope of measurements. The amplitude of water level change is not reproduced due to the absence of streamflow dynamics in the model. Since 2017, P106 reported dry making the comparison between simulated and observed data difficult. It may be that this dry observation is a result of a bore malfunction and does not necessarily indicate a failing of the model to predict a mining impact

At P109 (**Figure 32**), agreement was very good from 2003 to 2007 but the model has continued a declining trend in contrast to generally higher and more dynamic water level observations. The model is probably missing a component of enhanced recharge from intermittent streamflow along Wambo Creek. As a result, the model would overestimate drawdown impacts in this area. During the 2018 monitoring period, simulated groundwater decline matches relatively well with the observed declining trend in groundwater level, although the mechanisms for this decline (low rainfall vs mining effect) are different.

2.3 South Bates Underground (SBU)

The performances of modelled heads at the GW21 standpipe bore (**Figure 33**) and N2 and N3 VWPs (**Figure 34** and **Figure 35**) have been assessed against observed data where South Bates mining activity may impact groundwater levels.

As reported in previous AEMR reports (HydroSimulations, 2018a), GW21 modelled heads show little correlation with observed groundwater levels (**Figure 33**). Comparisons between modelled and observed heads are complicated by observed data being collected following the extraction of LW1, which is likely to have caused water levels at this location to drop. Water levels at GW21 have been reported as dry since 2017. The model results indicate a strong, on-going mining effect caused by both NWU and SBU longwall extraction. Longwall extraction completed at SBU and currently occurring at South Bates Extension (SBE) is expected to be causing observed water levels to fall below the base of the bore.

Both N2 (**Figure 34**) and N3 (**Figure 35**) modelled heads face difficulty in accurately representing groundwater level in the Permian overburden sensors as three sensors are located within one model layer at each location. Water levels at the remaining active sensor for N3, N3-5 (Permian Overburden), are overestimated by the model. However, the model shows good correlation with the gradual declining trend apparent in the observed heads throughout 2017 and 2018. The 70 m sensor at N2 (N2-5) shows an excellent match with observed data until the end of December 2018. The lower sensors in N2 overestimate groundwater level but are accurate in indicating an ongoing mining effect from NWU that continues through the beginning of SBU mining. The modelled head in the Wambo Seam (N2-1) does not match the increase in groundwater level observed at the end of December 2018. This may be due to inherent difficulties in representing the fault that divides NWU and SBU. It may also be related to an inaccurate representation of the end of dewatering at NWU, which would limit the recovery of modelled heads to match observed.

2.4 Assessment

The groundwater levels as predicted by HydroSimulations (2017a) generally show a good match with the magnitude and timing of impacts associated with Wambo Coal Mine. Areas where the model is not performing well can usually be attributed to;

- difficulties in accurately simulating complex geological features, such as the fault between SBU and NWU,
- multiple sensors being simulated in a single model layer, or
- the long-term average rainfall and evapotranspiration rates used in the model not capturing the variation in alluvial groundwater levels caused by periods of above or below average rainfall.

Overall, the groundwater model performs well and remains fit for purpose to predict the timing and magnitude of impacts to groundwater caused by Wambo Coal Mine.

None of the other trigger level exceedances described in this report are considered to warrant further investigation as these can be attributed to natural variability, climatic conditions and/or predicted impacts.

3 2017 WCPL INDEPENDENT ENVIRONMENTAL AUDIT

In September 2017 an Independent Environmental Audit against Development Consents DA 305-7-2003 and DA 177-8-2004 was conducted for the Department of Planning & Environment (DP&E). Two recommendations relating to Groundwater inflows and seepage were made as follows;

1. Schedule 4, Condition 25: Improvements could be made in terms of the overall site water management if specific groundwater inflows to the open cut via alluvium and Permian could be pumped and/or metered.

2. Schedule 4, Condition 34: Consideration should be made to directly monitor the quality of groundwater seepage reporting to the underground and open-cut workings.

Both recommendations have been considered in 2018, with communication between WCPL and HydroSimulations indicating that changes such as the comparison of measured and predicted inflow volumes will be adopted in future revisions of the WCPL Groundwater Monitoring Program.

4 RECOMMENDATIONS

- Investigation into depth to base of bore at GW08 as water levels during 2018 are recorded as being below the current elevation.

- Investigation in to the integrity of P106 and whether the 'dry' readings are correct for the original drilled depth of the hole.

- Monitoring of new bore drilled between LW14 and VWP N2 to confirm the groundwater recovery of the Wambo Seam associated with the completion of NWU operations.

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Figures

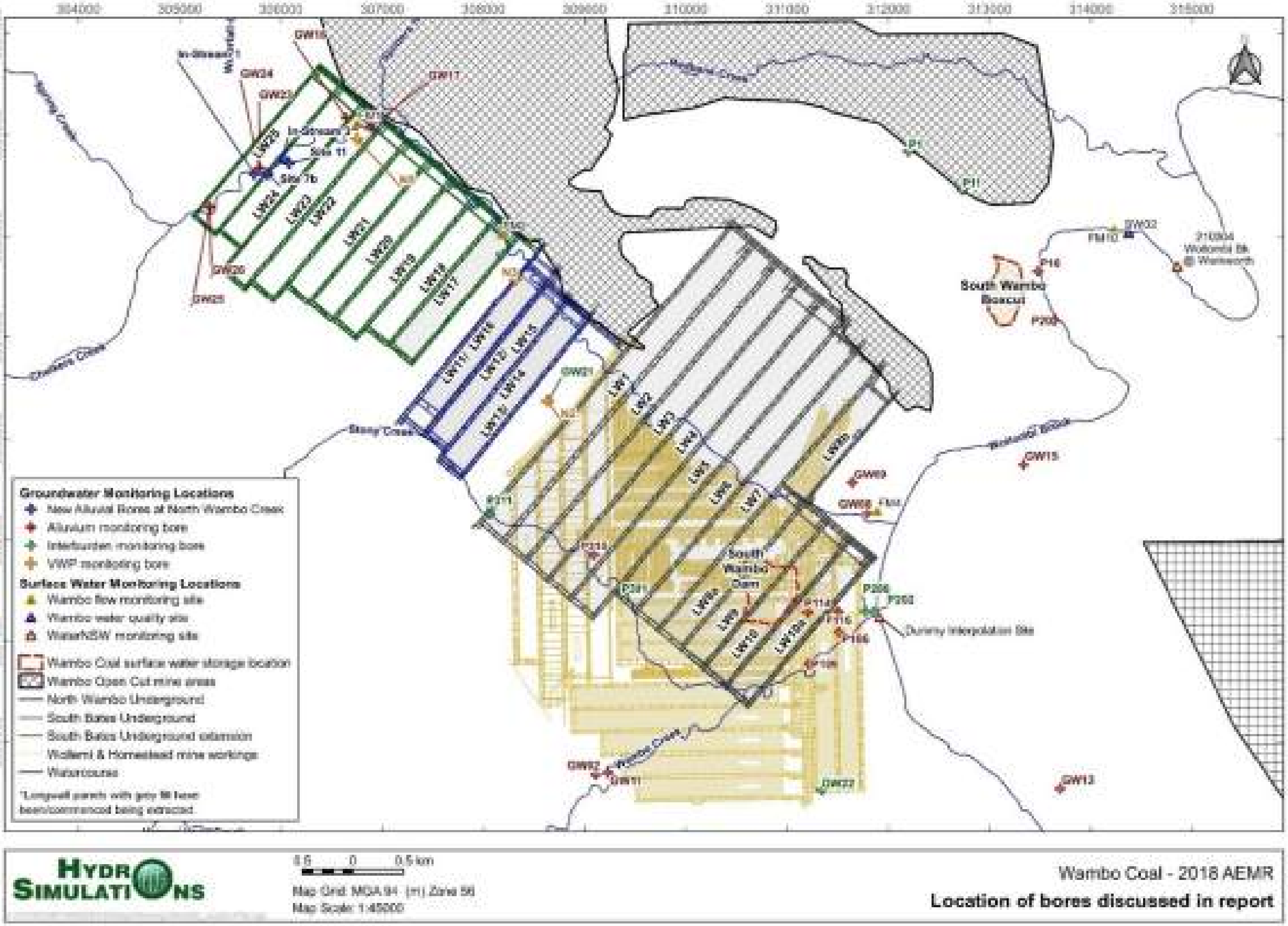

Figure 1 Locations of bores discussed in this report

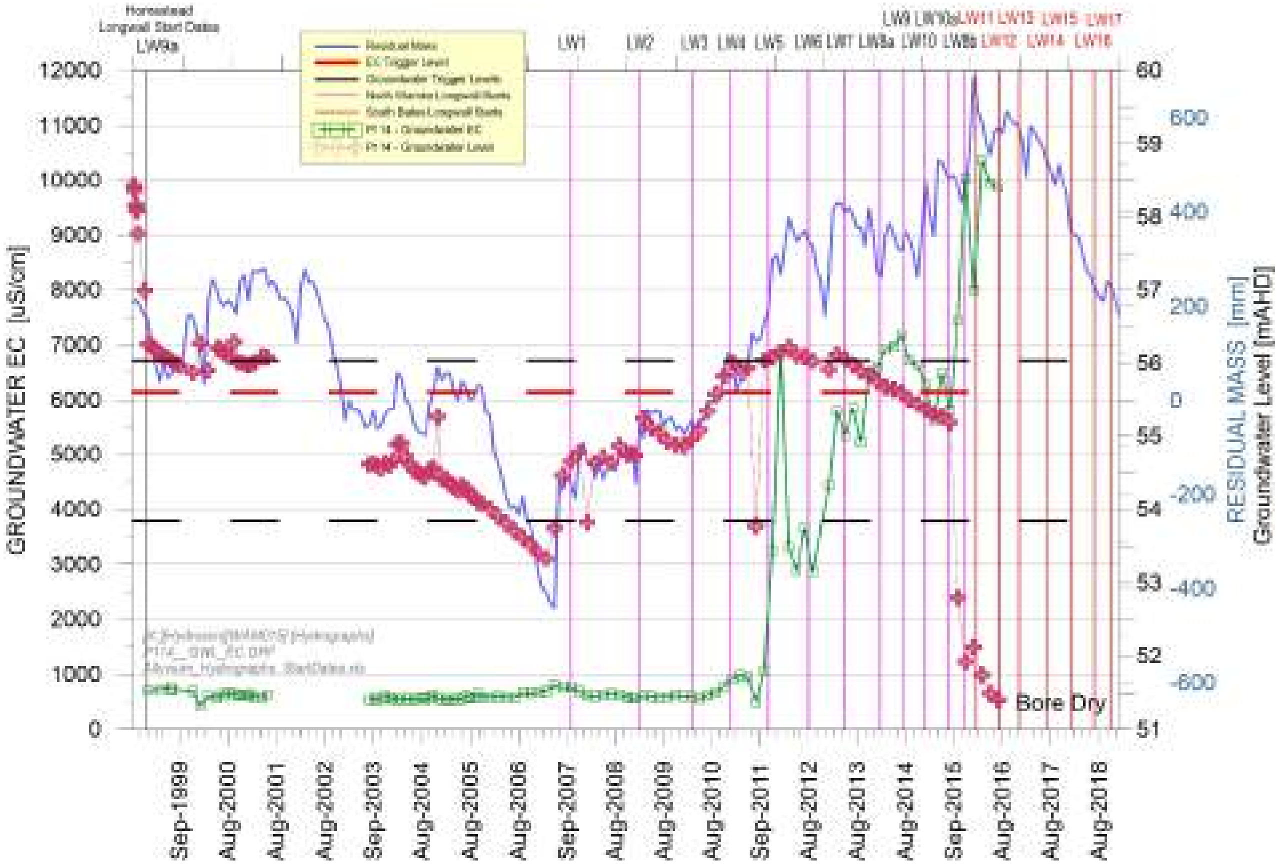

Figure 2 P114 Groundwater Level and EC

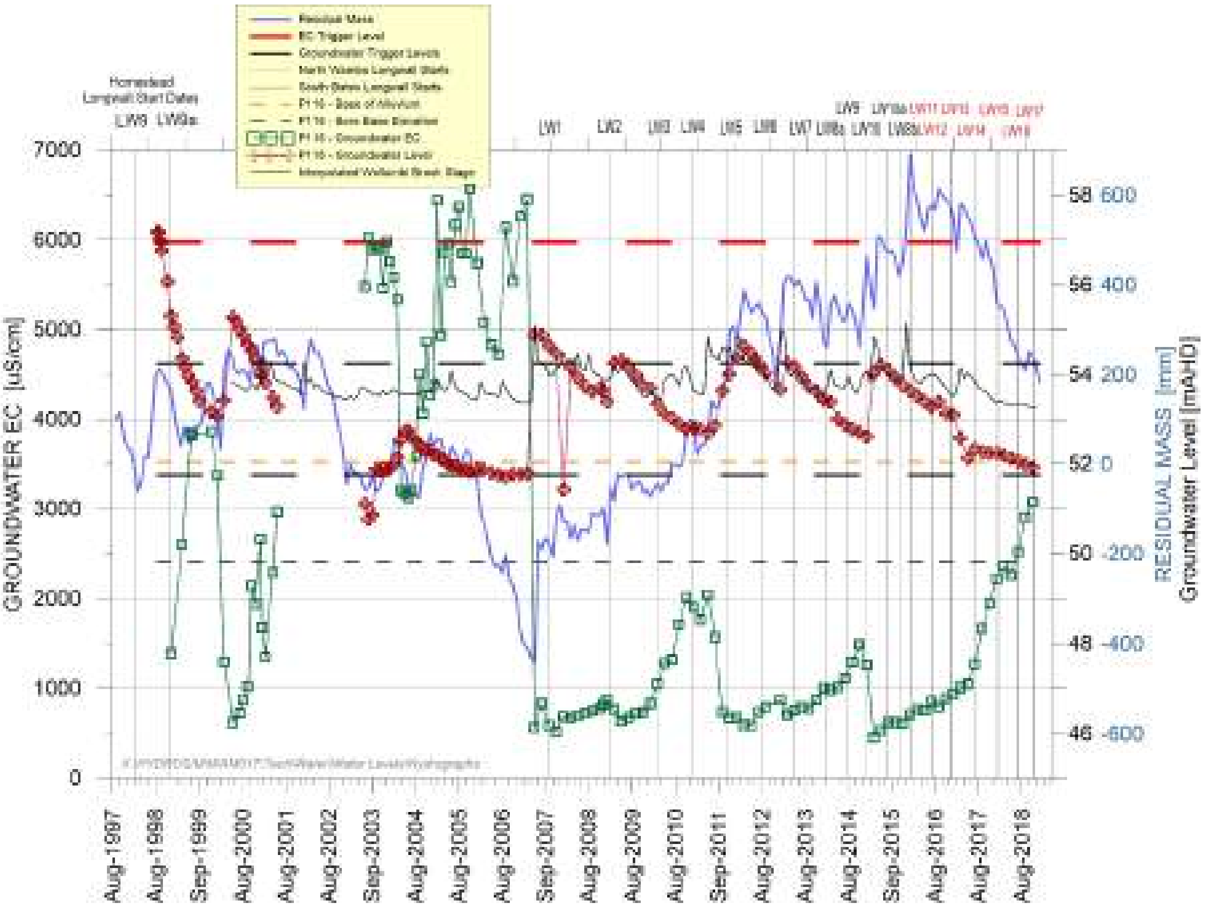

Figure 3 P116 Groundwater Level and EC

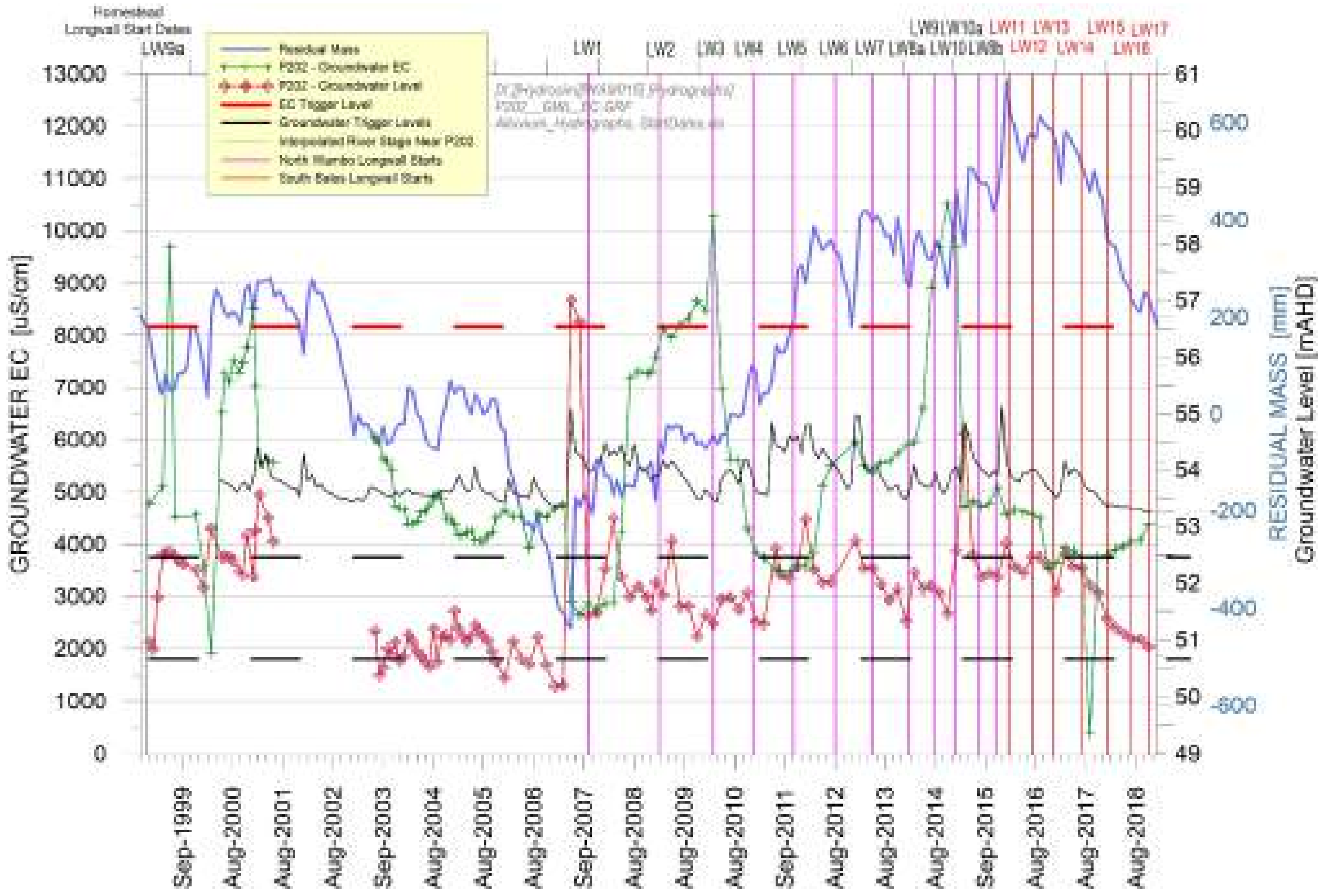

Figure 4 P202 Groundwater Level and EC

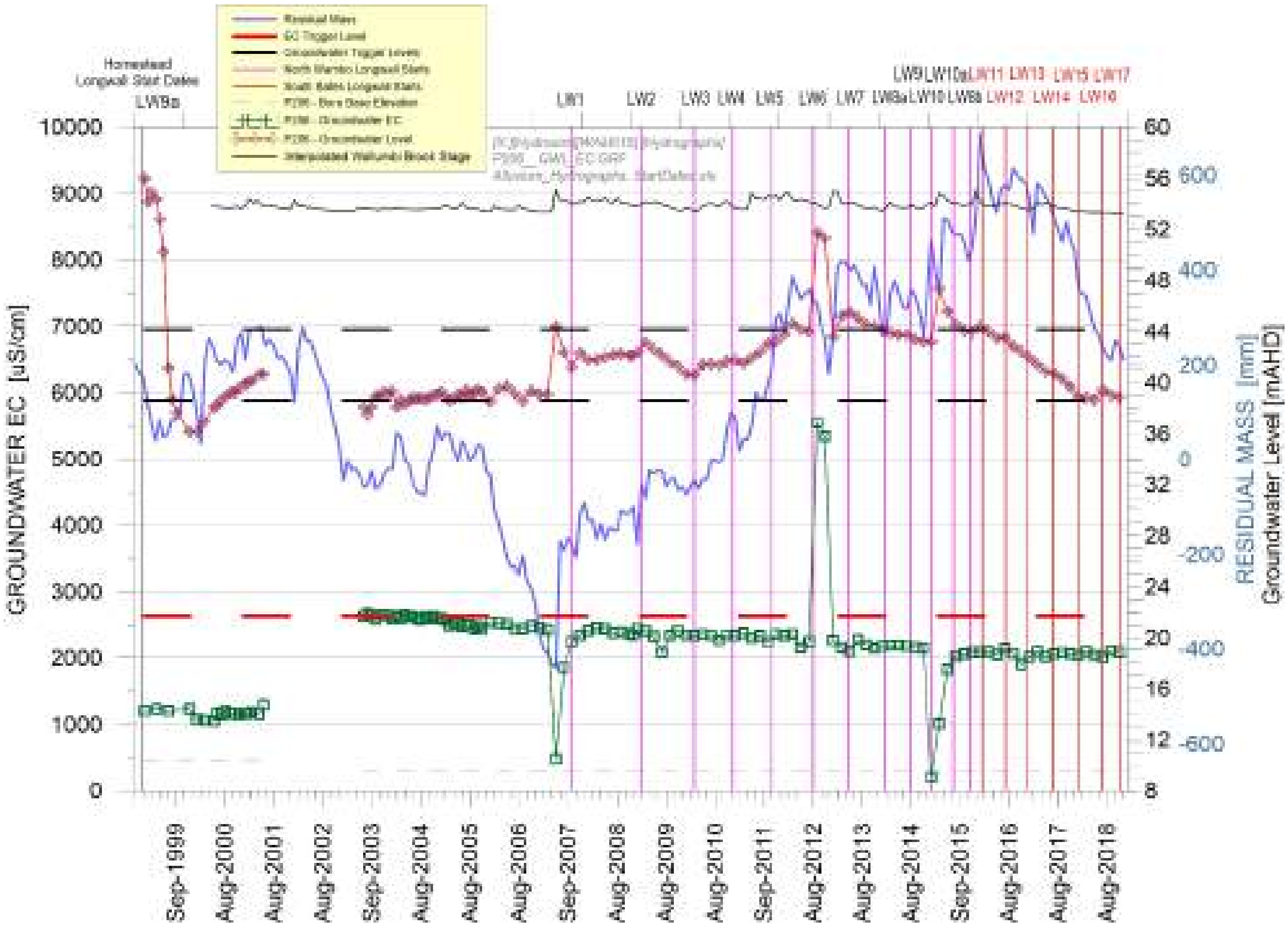

Figure 5 **P206 Groundwater Level and EC**

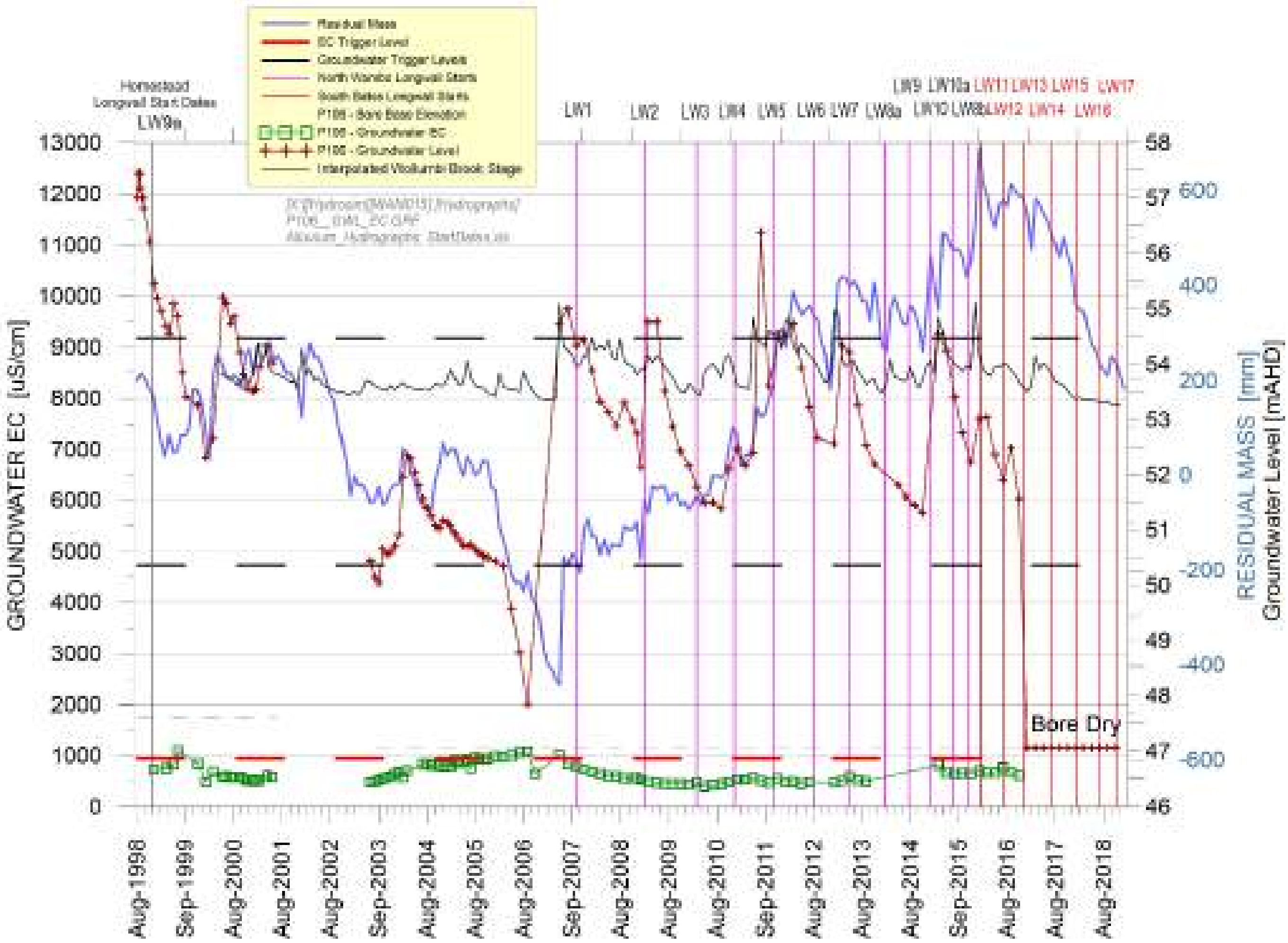

Figure 6 P106 Groundwater Level, EC and Interpolated Wollombi Brook stage height

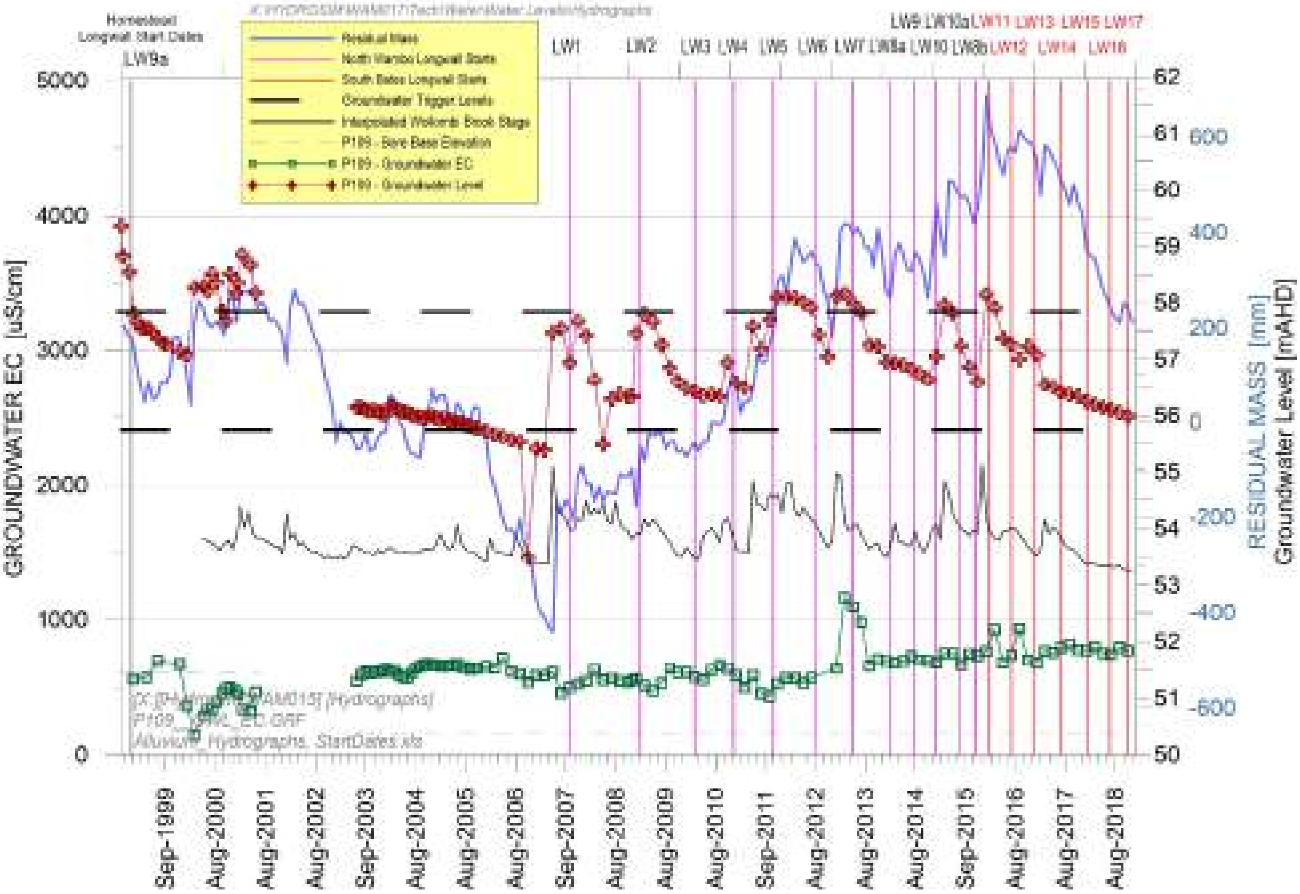

Figure 7 P109 Groundwater Level, EC and Interpolated Wollombi Brook stage height

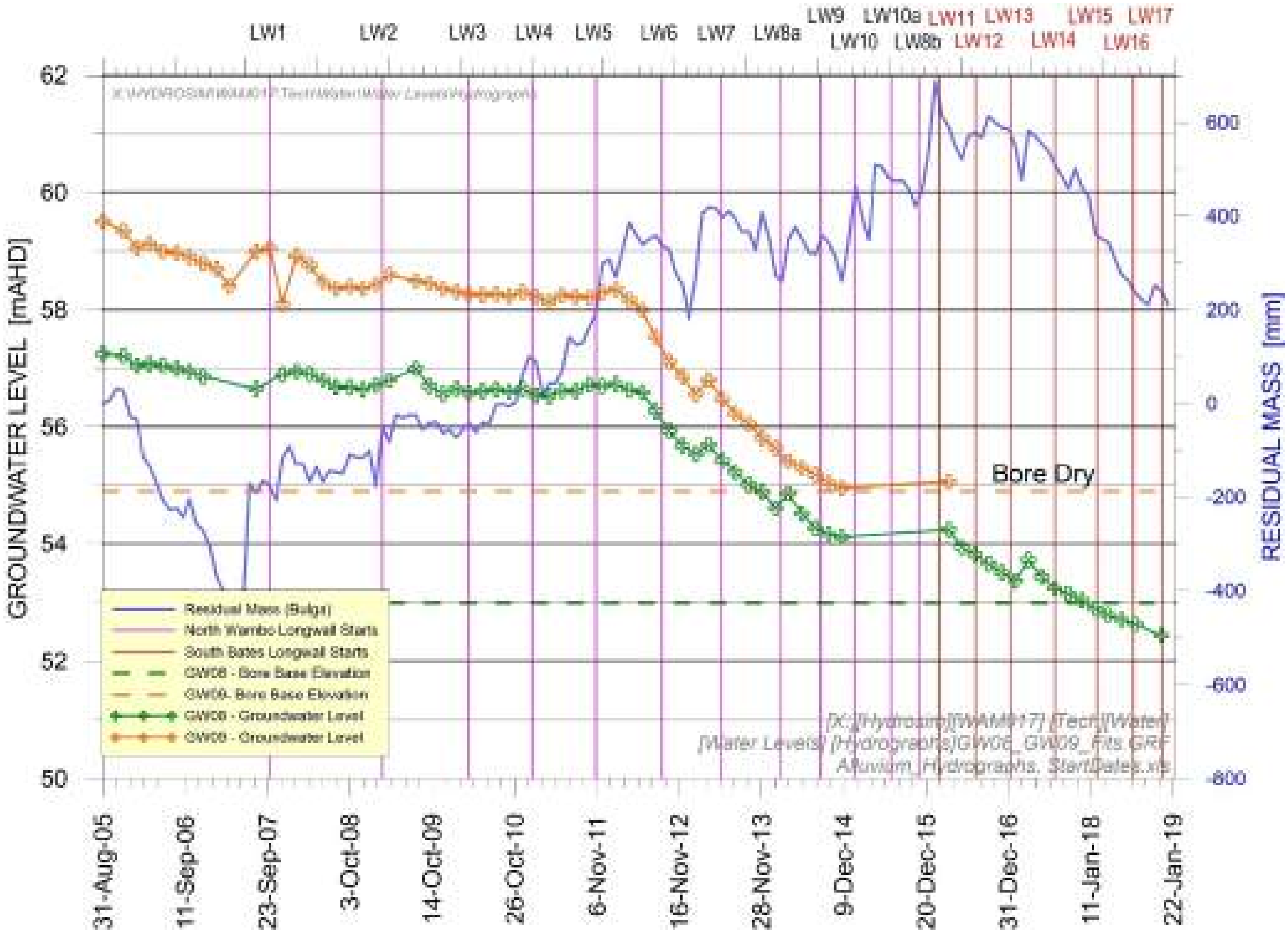

Figure 8 GW08 and GW09 Hydrographs

Figure 9 GW16 groundwater level and EC

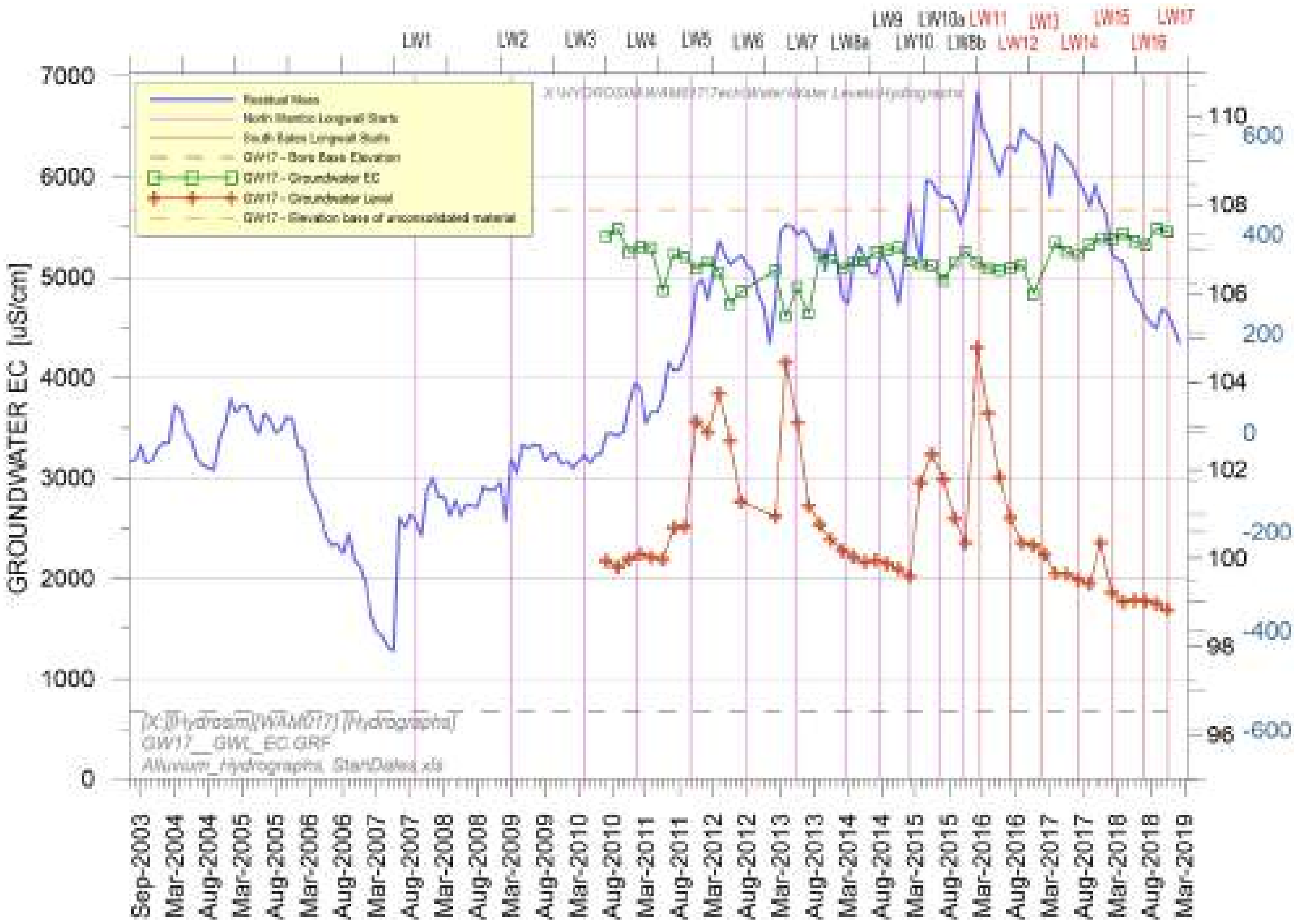

Figure 10 GW17 Groundwater Level and EC

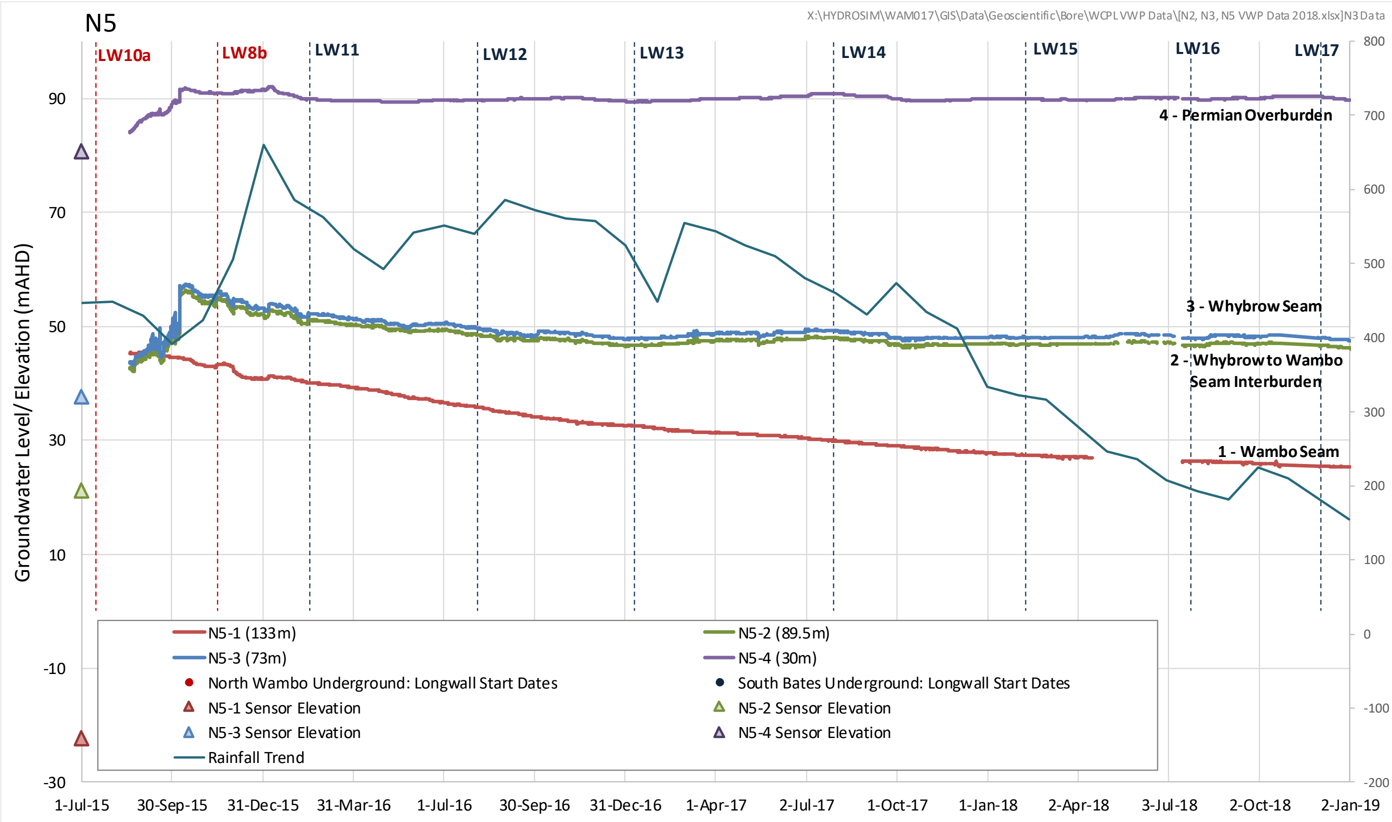

Figure 11 N5 Hydrograph

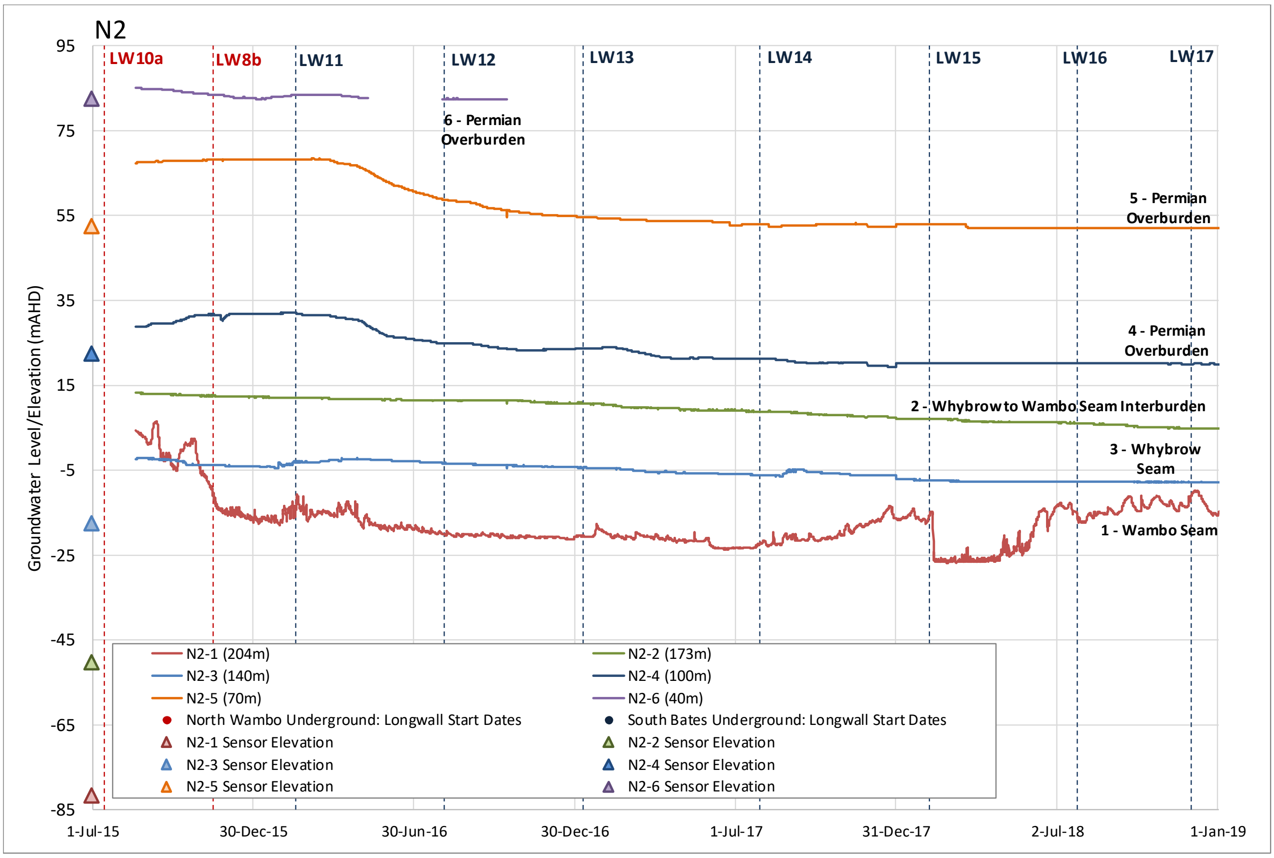

Figure 12 N2 Hydrograph

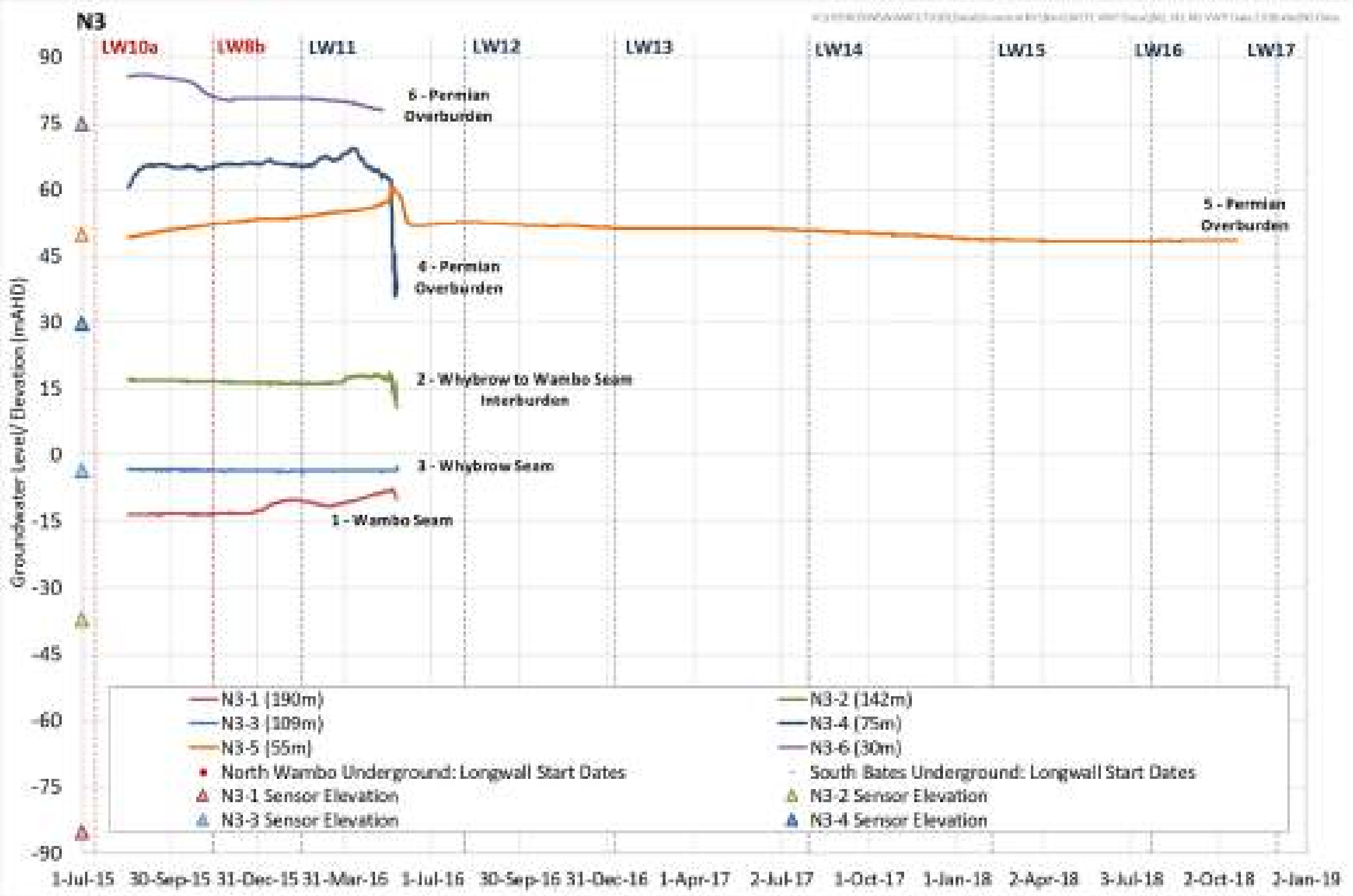

Figure 13 N3 Hydrograph

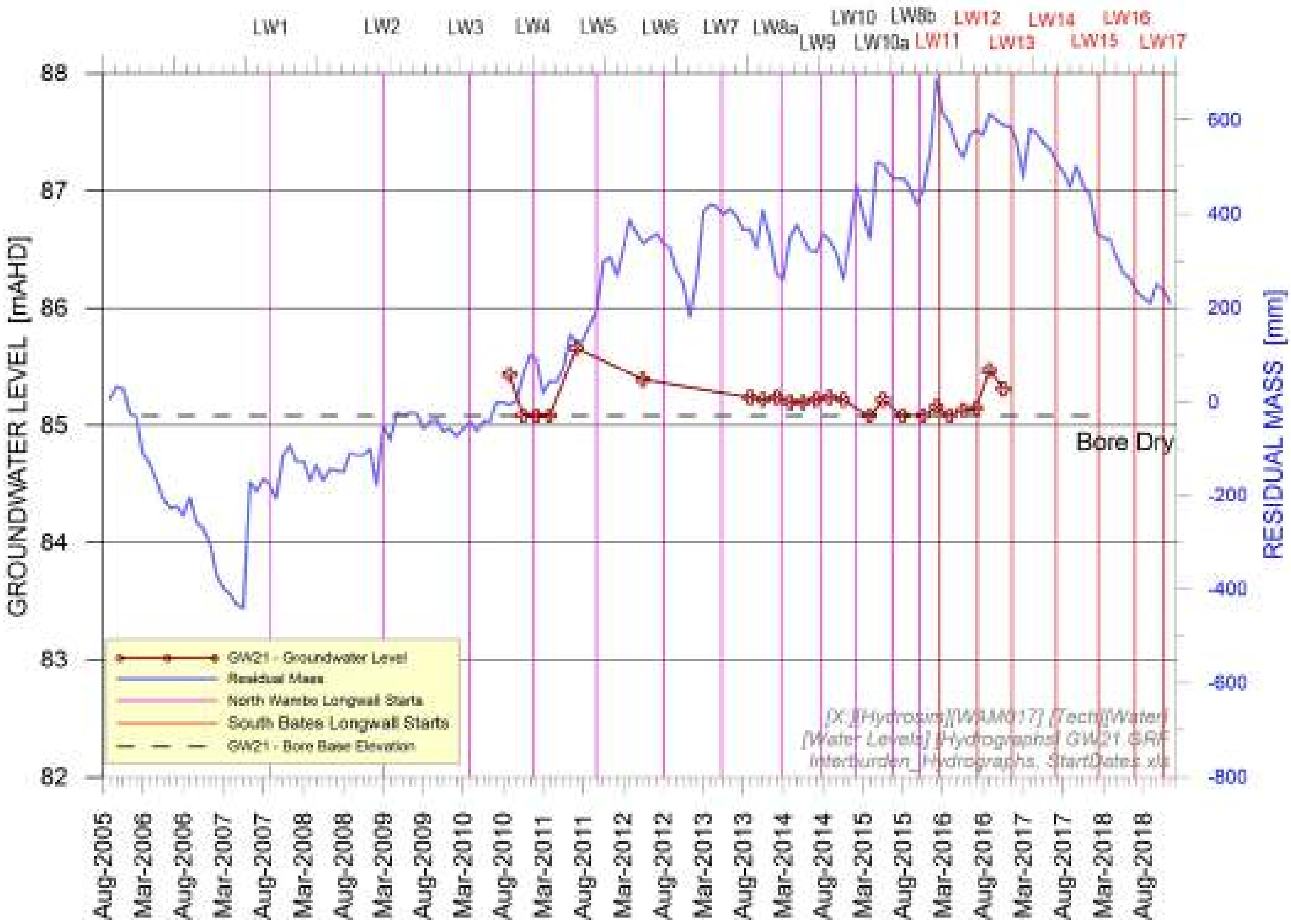

Figure 14 GW21 Groundwater Level

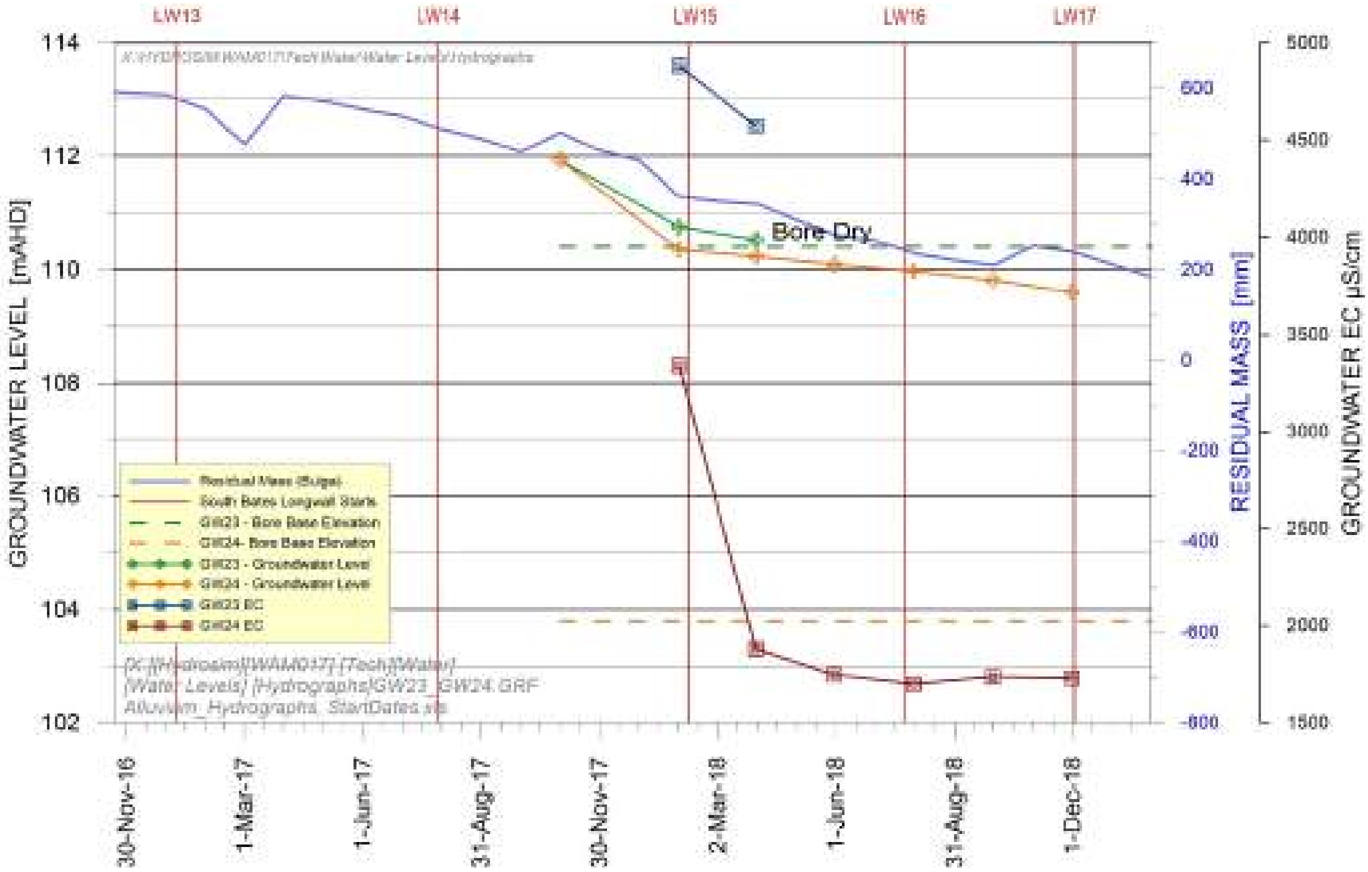

Figure 15 GW23 and GW24 Groundwater Level and EC

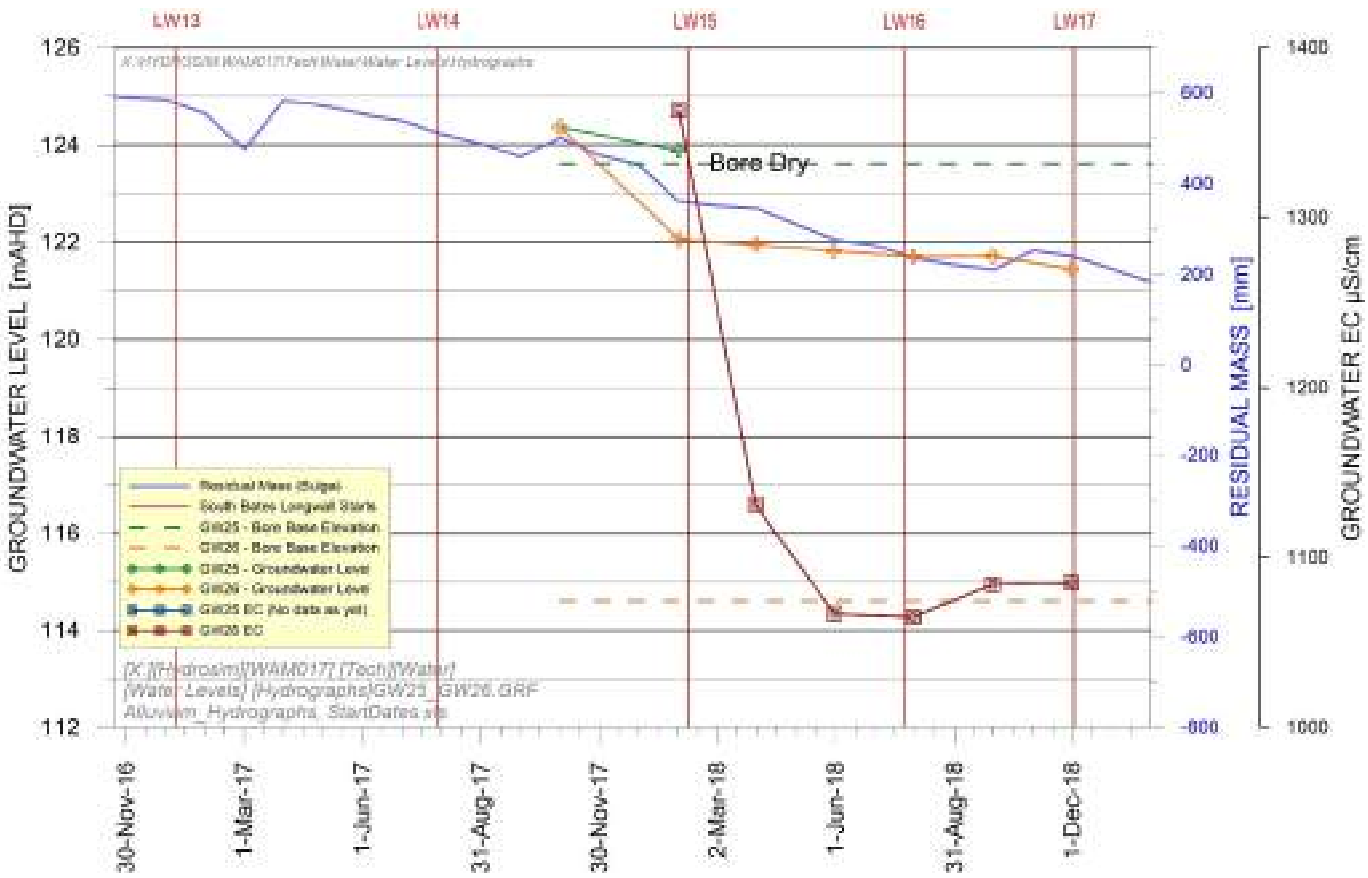

Figure 16 GW25 and GW26 Groundwater Level and EC

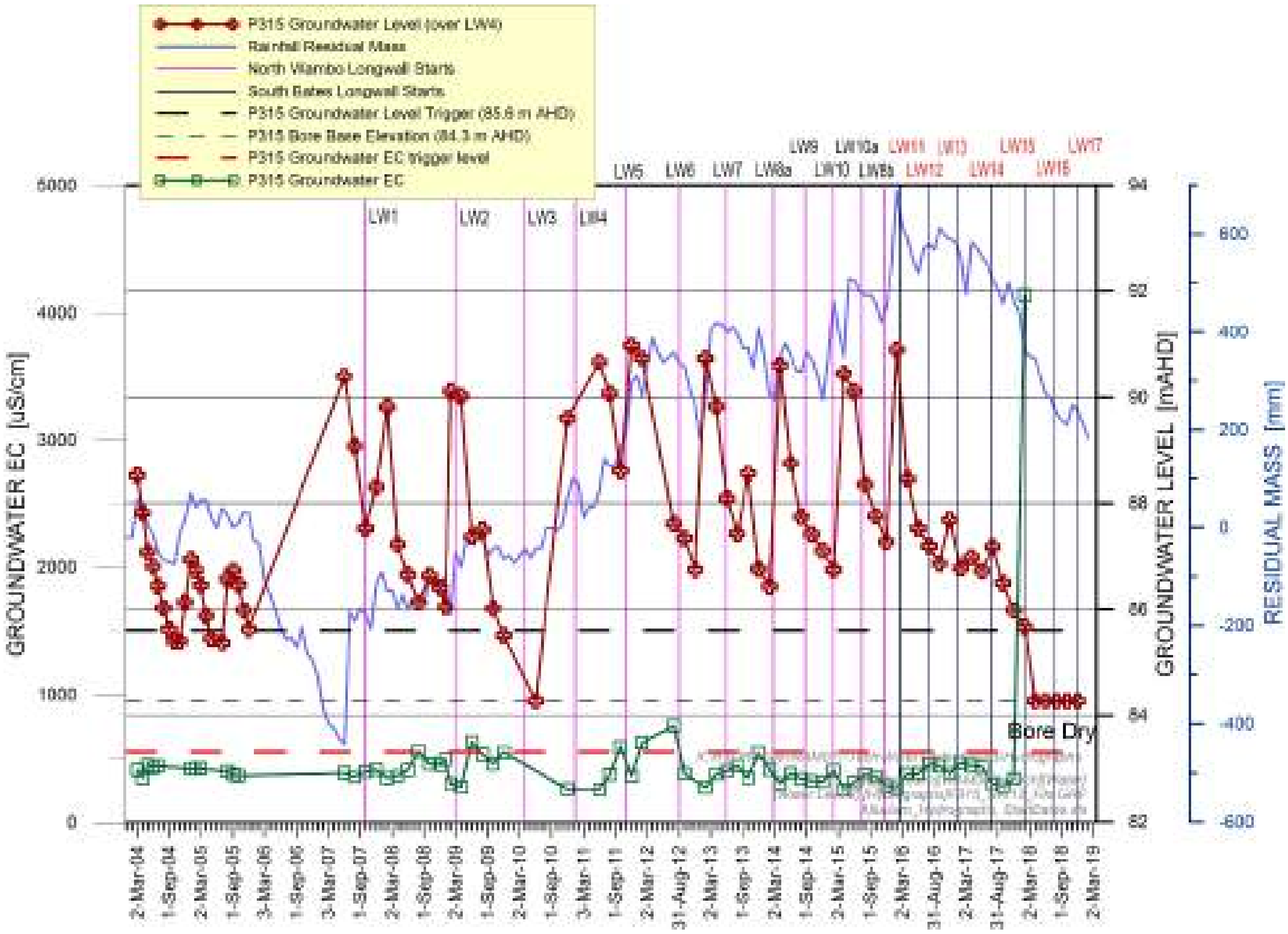

Figure 17 P315 groundwater level and EC

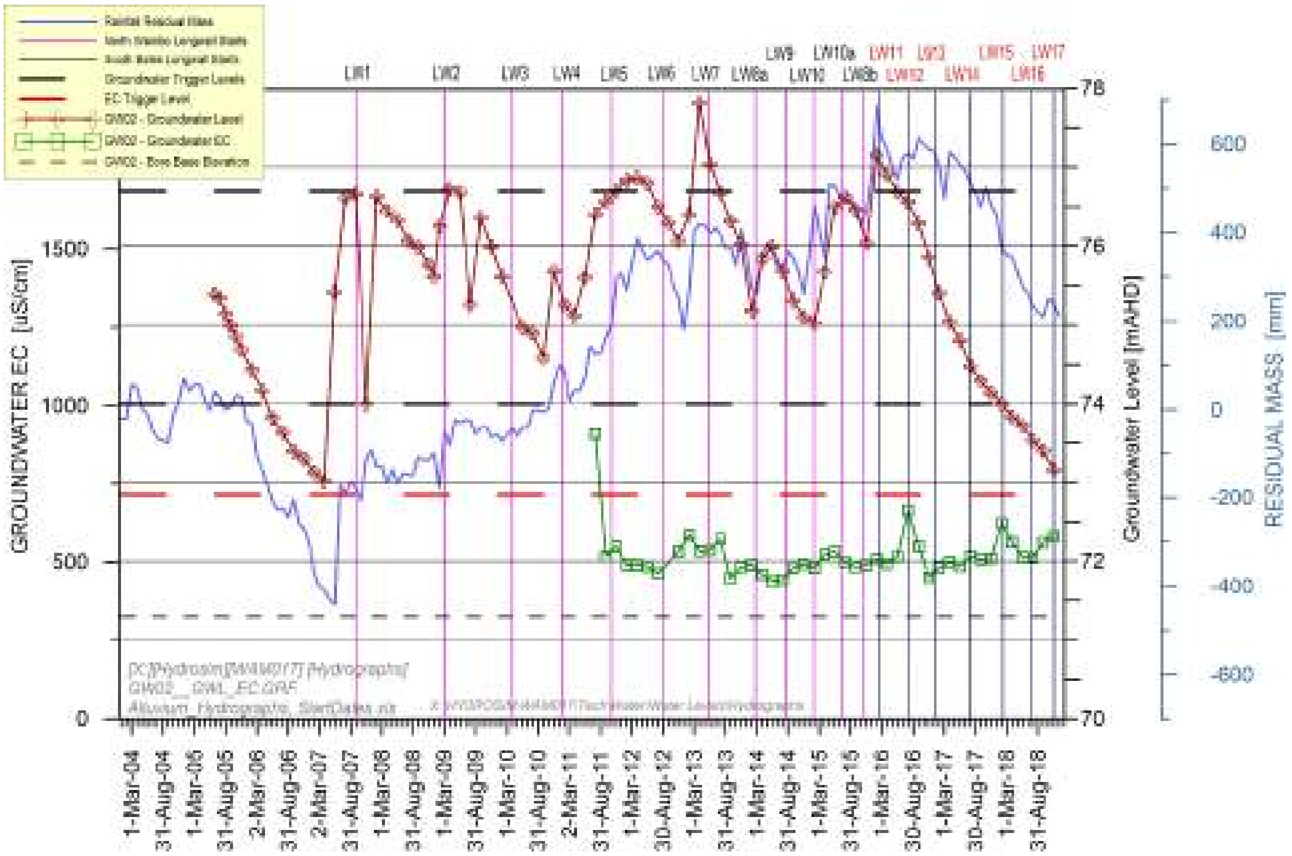

Figure 18 GW02 groundwater level and EC

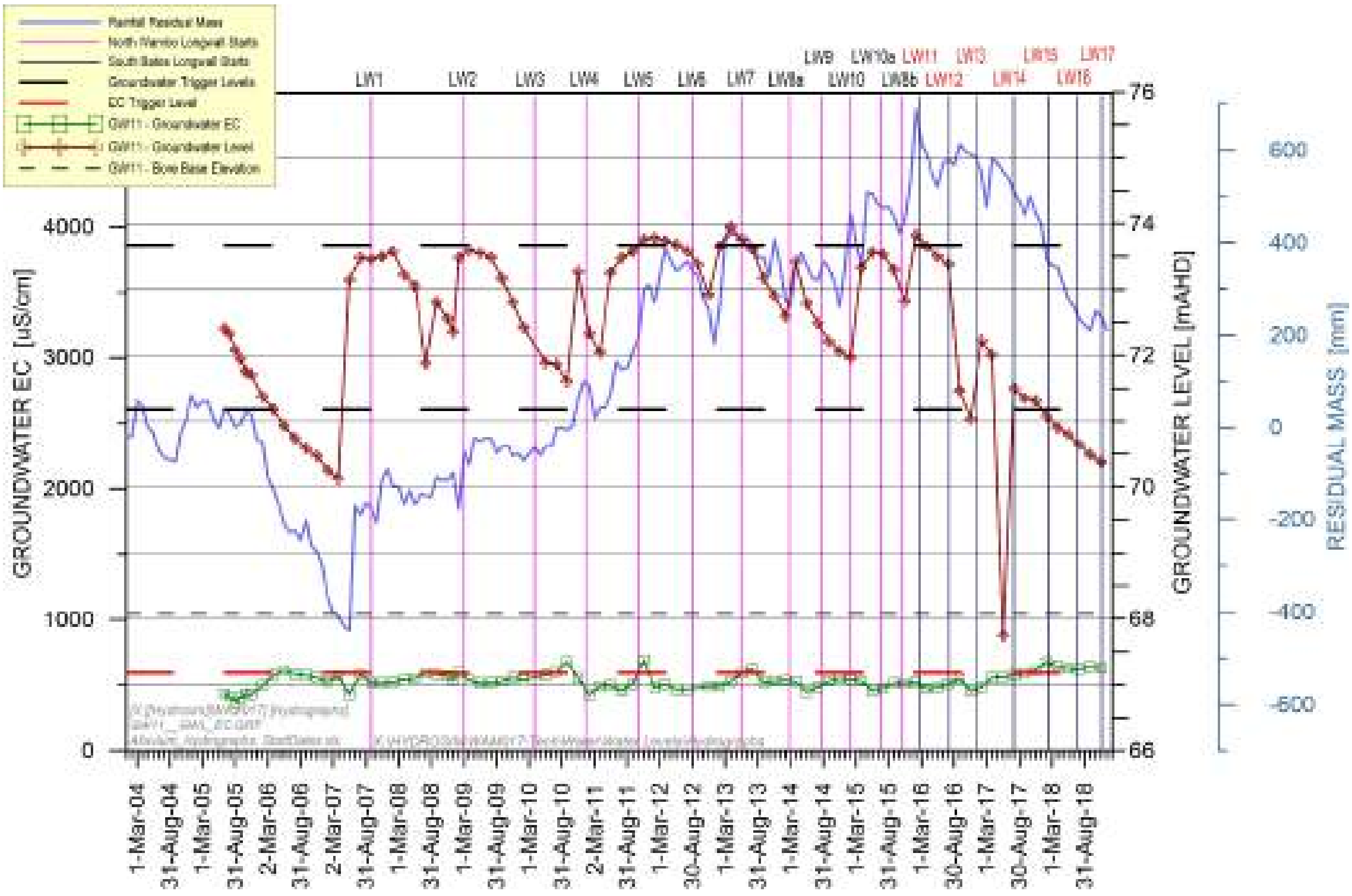

Figure 19 **GW11 Groundwater Level**

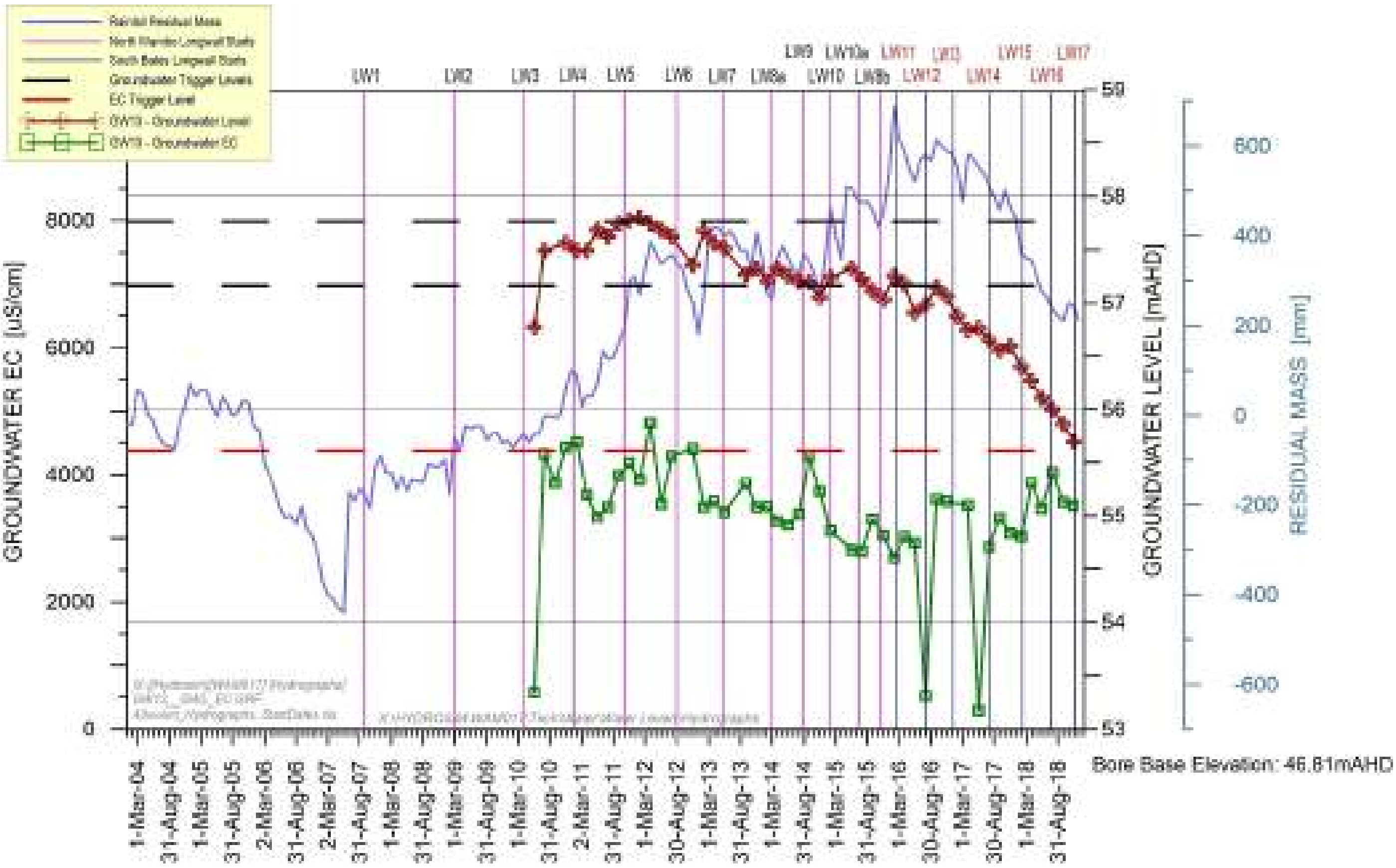

Figure 20 GW13 Groundwater Level

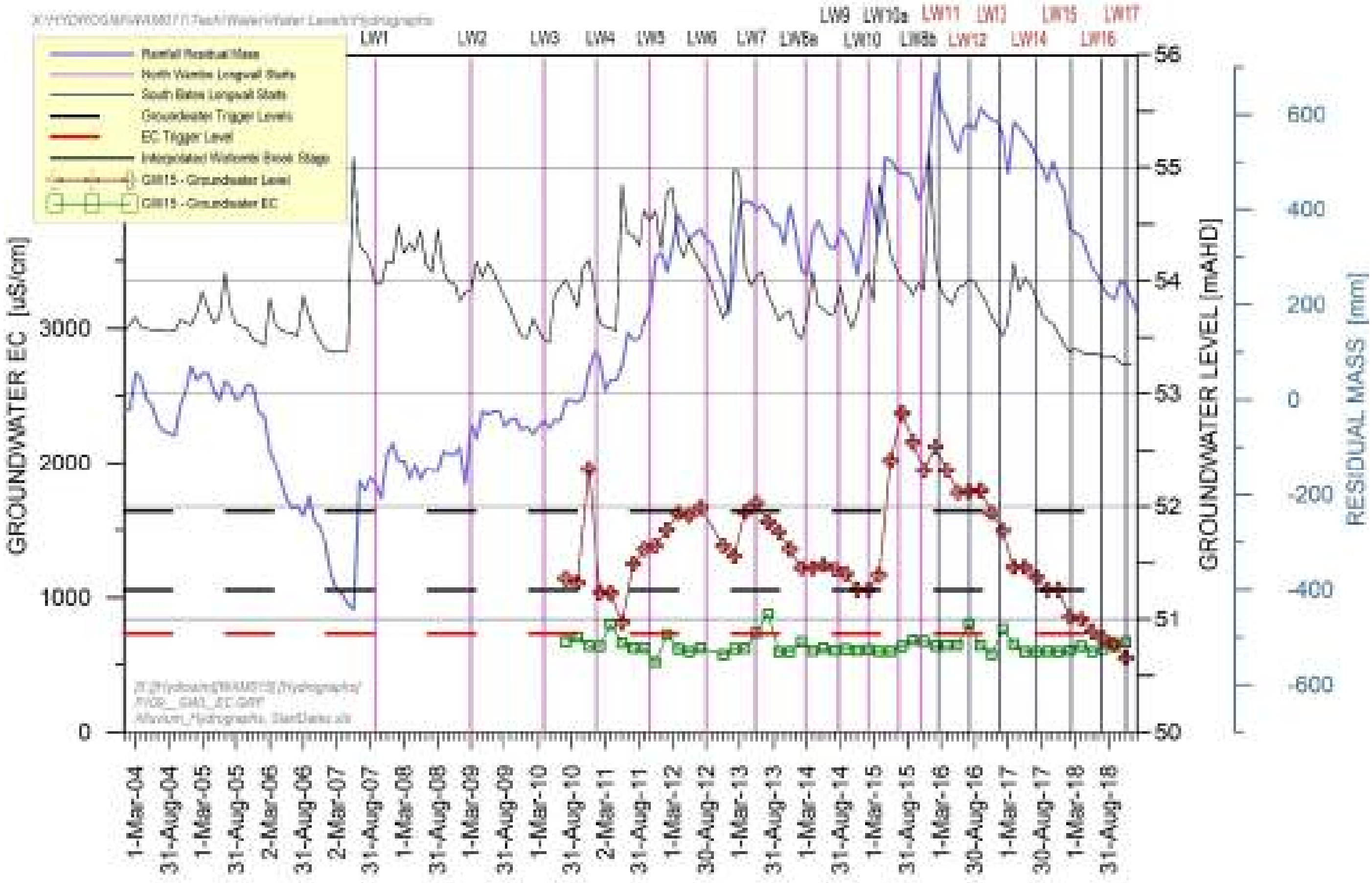

Figure 21 GW15 Groundwater Level

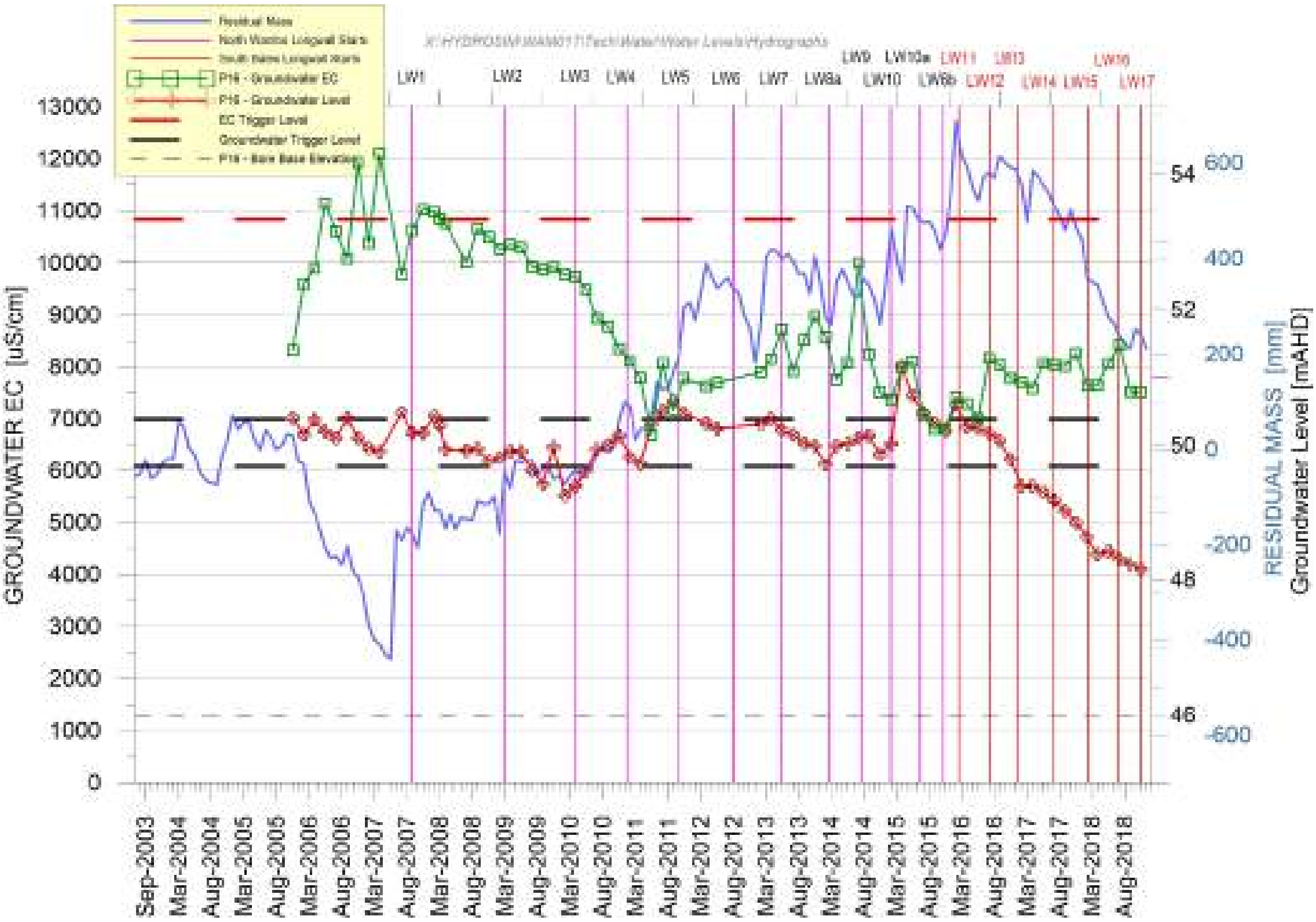

Figure 22 P16 Groundwater Level

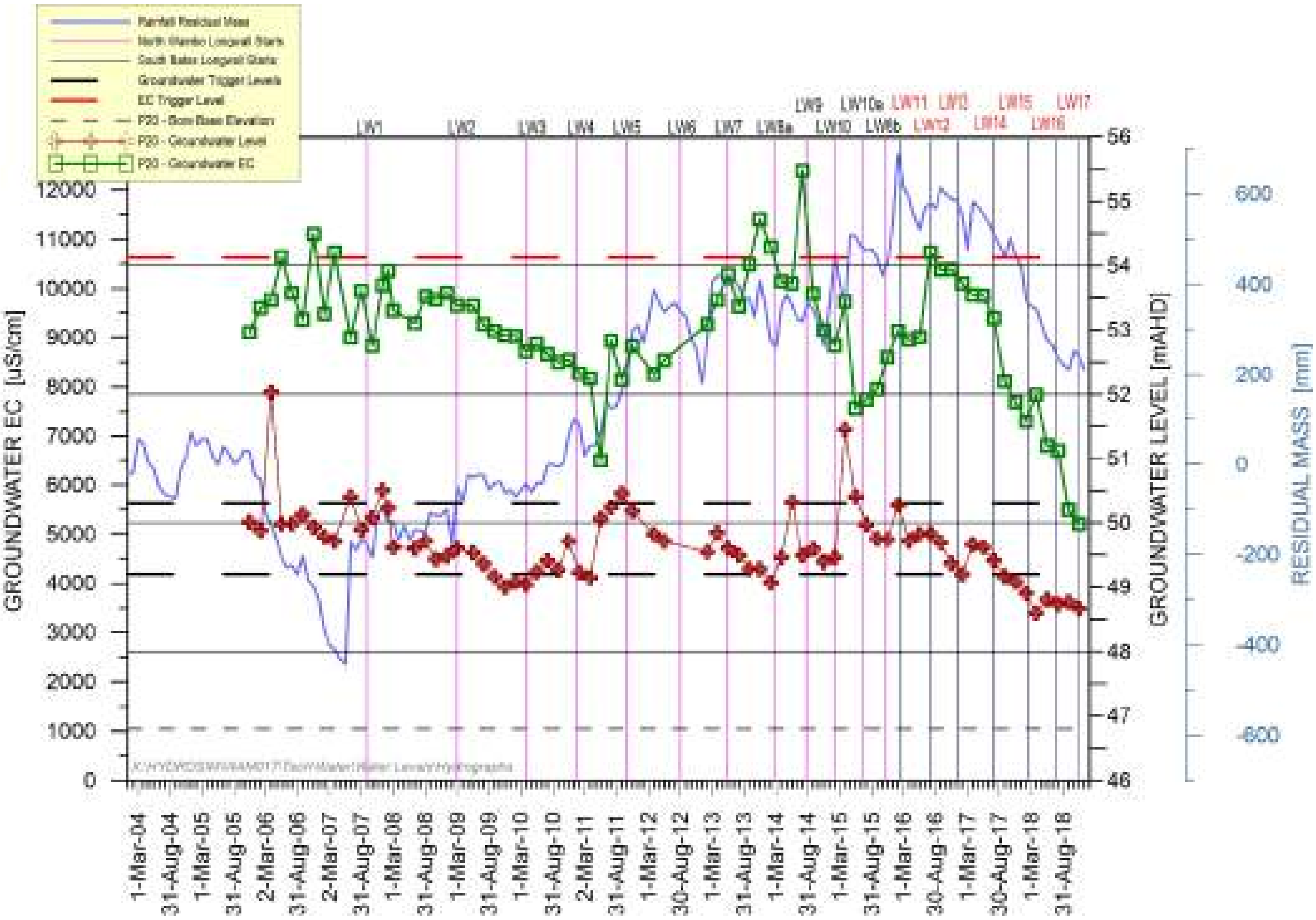

Figure 23 P20 Groundwater Level

Figure 24 GW16 Calibration Hydrographs

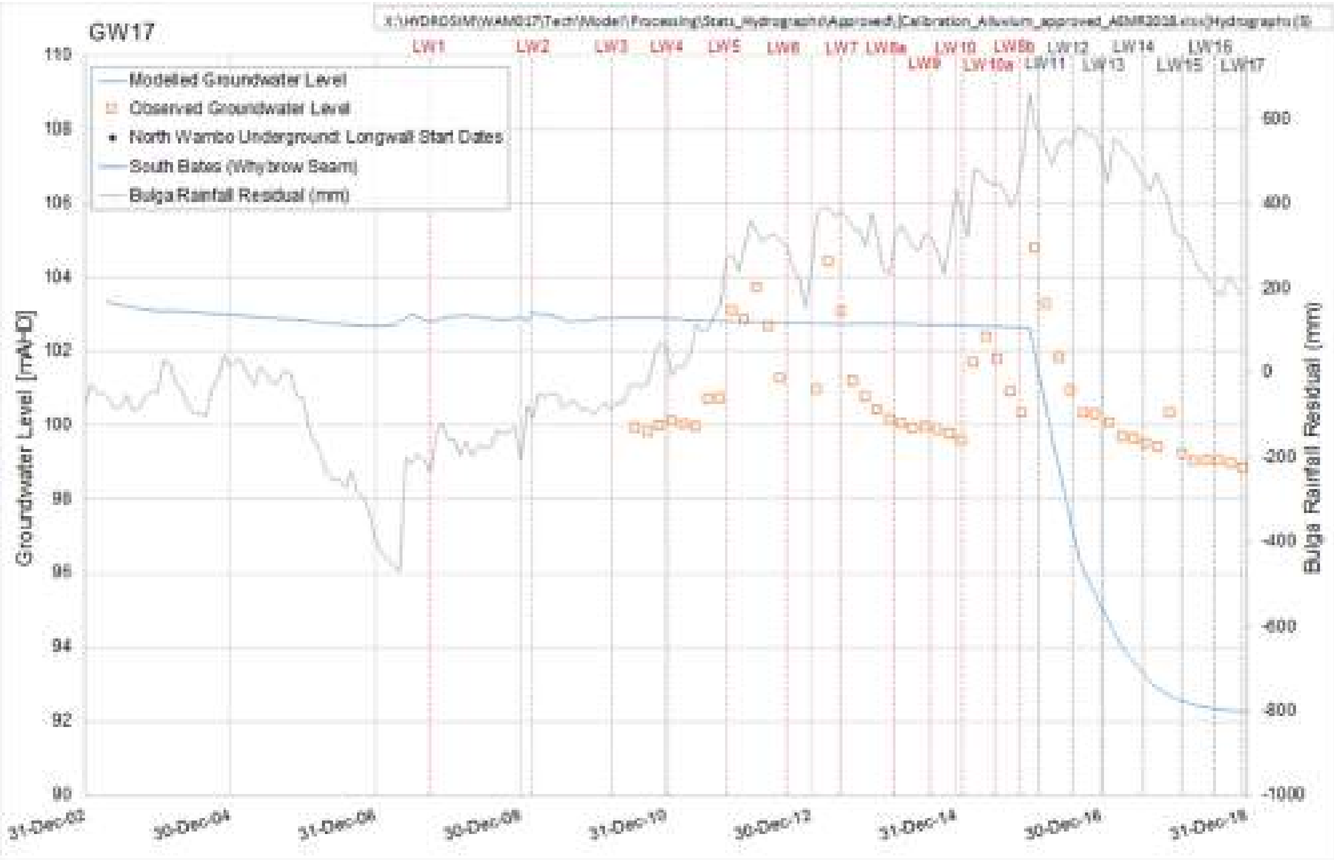

Figure 25 GW17 Calibration Hydrographs

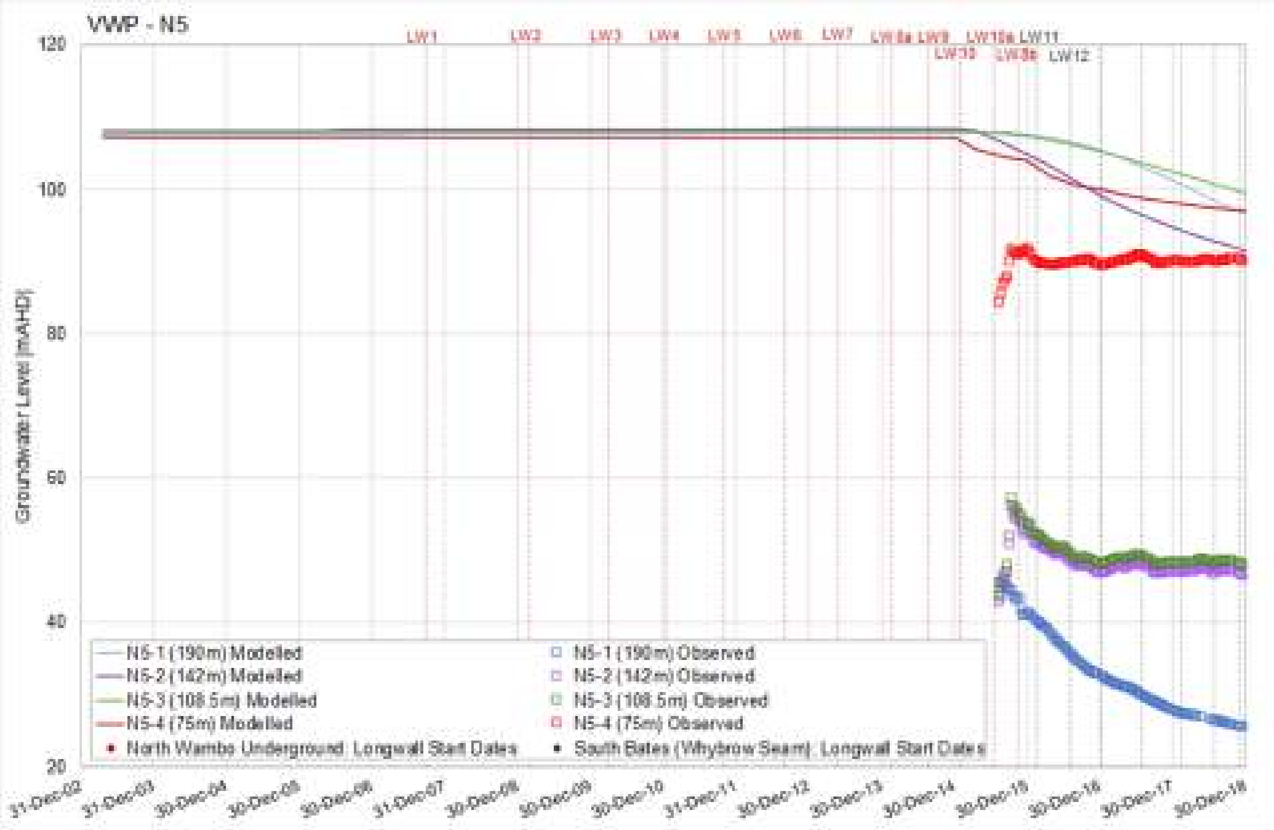

Figure 26 N5 Calibration Hydrographs

Figure 27 P114 Calibration Hydrographs

Figure 28 P116 Calibration Hydrographs

Figure 29 GW08 Calibration Hydrographs

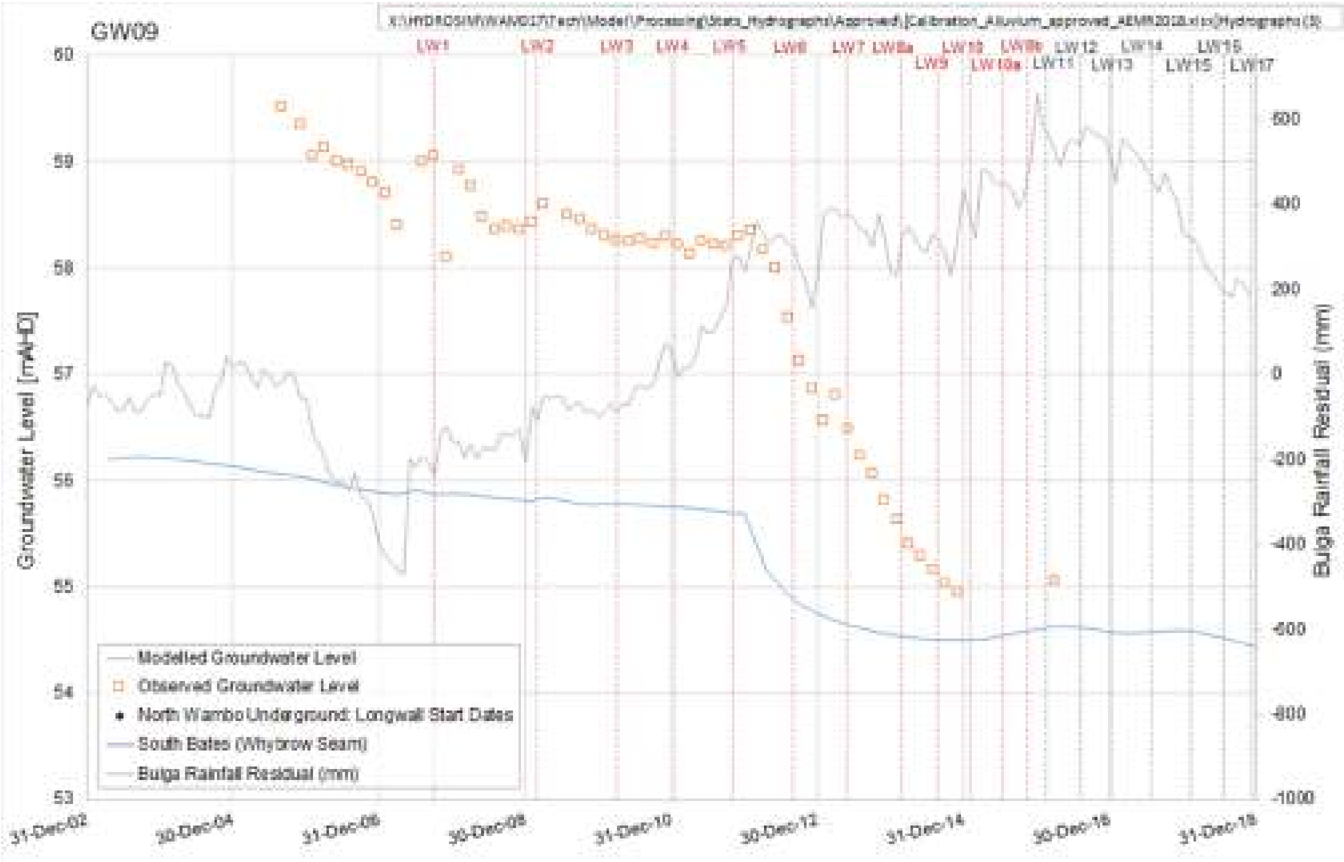

Figure 30 GW09 Calibration Hydrographs

Figure 31 P106 Calibration Hydrographs

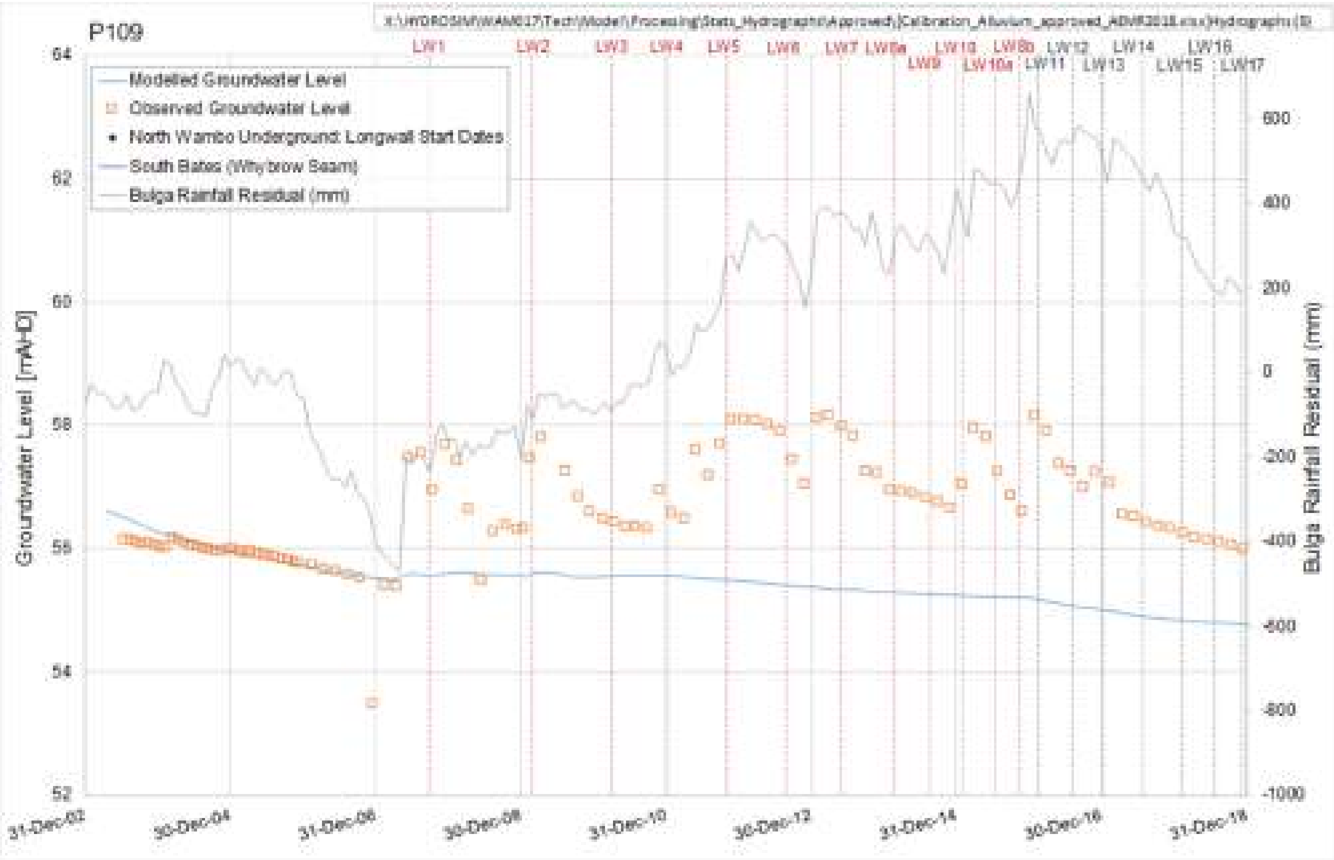

Figure 32 P109 Calibration Hydrographs

Figure 33 GW21 Calibration Hydrographs

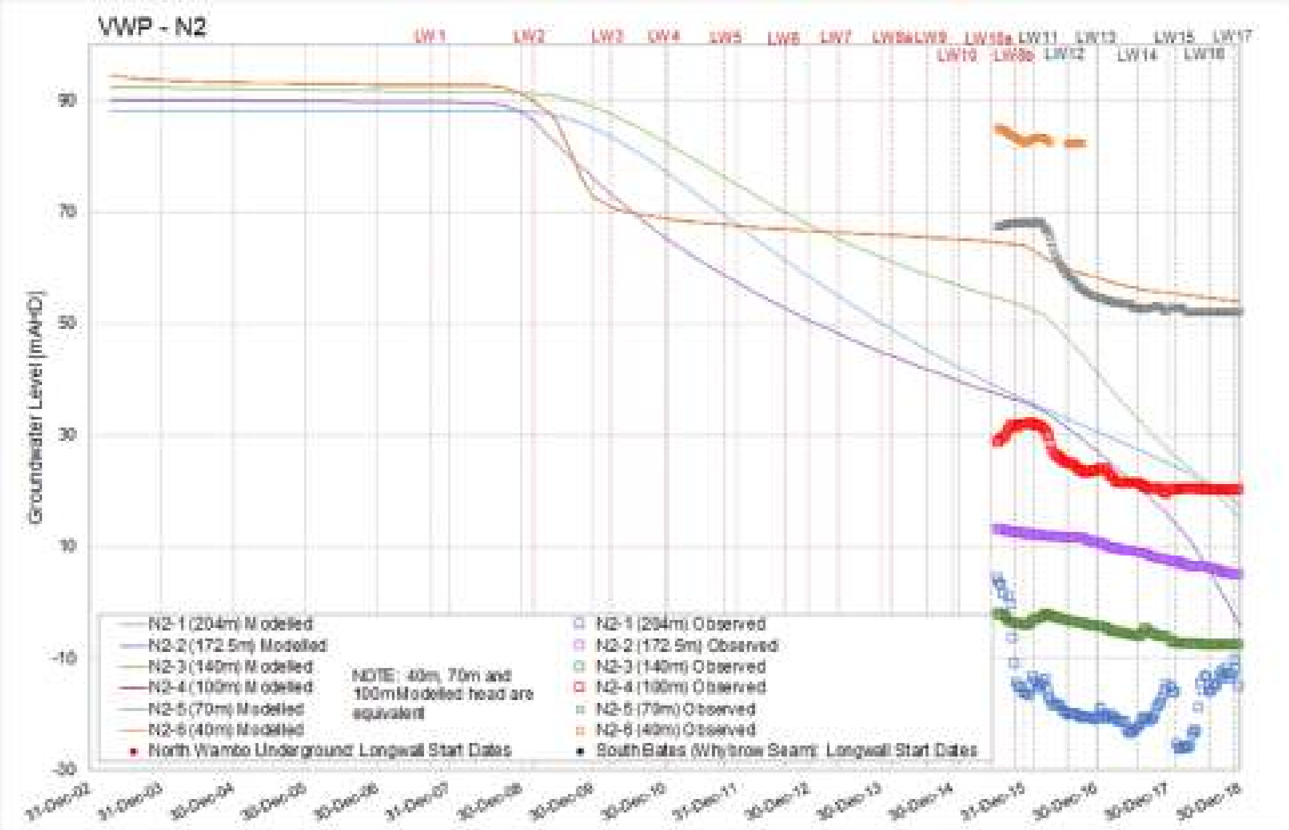

Figure 34 N2 Calibration Hydrographs

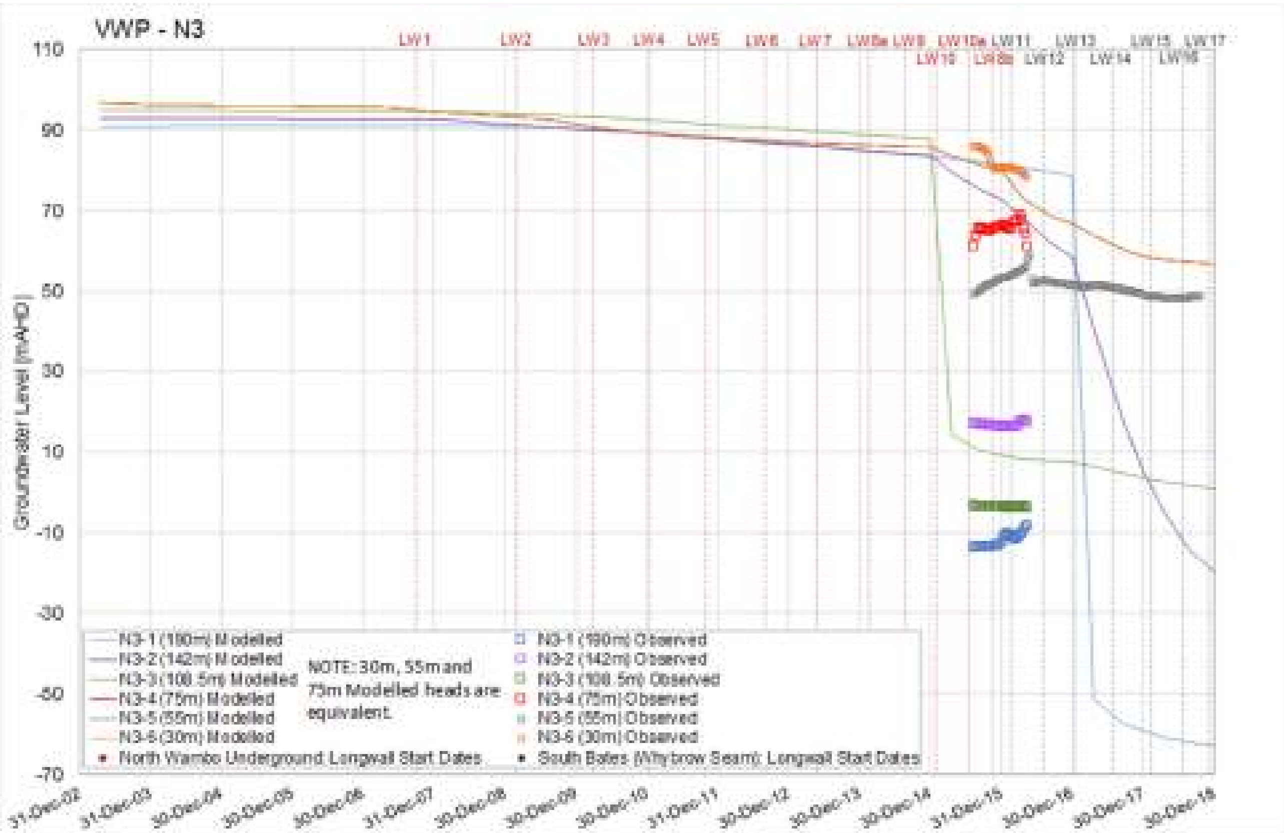

Figure 35 N3 Calibration Hydrographs

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DATE:	28 March 2019
TO:	Nicole Dobbins Environmental Advisor Wambo Coal Pty Ltd Peabody Energy Australia PMB 1, Singleton NSW 2330
FROM:	Adam Skorulis, Braiya White and Dr Derek Yates
RE:	Compliance with subsidence performance measure in the South Bates Underground Mine Extraction Plan - Longwalls 11 to16
OUR REF:	HS2019/17

1 INTRODUCTION

This letter report contains the analysis and information required to address the compliance of the subsidence performance measure as outlined in the South Bates Underground (SBU) Extraction Plan for Longwalls 11 to 16. The subsidence impact performance measure assessed is: *Negligible impact to Wollombi Brook*. Compliance has been assessed using the performance indicators in **Table 1** for the monitoring period: 1 Jan to 31 Dec 2018. Over the course of the monitoring period extraction commenced at Longwall 15 (8th February 2018), Longwall 16 (25th July 2018), and South Bates Extension Longwall 17 (3rd December 2018).

Table 1 Subsidence performance measure – LW11 to LW16 SBU

Feature	Subsidence Impact Performance Indicator(s)	Subsidence Impact Performance Measure
Wollombi Brook	*Surface water quality in Wollombi Brook exceeds the surface water quality criteria in the SWMP[1].*	*Negligible impact to Wollombi Brook*
	Groundwater levels in alluvial bores exceed the groundwater level criteria in the GWMP[2].	
	Groundwater quality in alluvial bores exceeds the groundwater quality criteria in the GWMP.	
	Zero flow is recorded at the Warkworth gauging station (FM10) and measurable flow is recorded at the Bulga gauging station (FM11).	

[1] Wambo Coal Surface Water Monitoring Program (Peabody 2018a)
[2] Wambo Coal Groundwater Monitoring Program (Peabody 2018b)

2 WOLLOMBI BROOK SURFACE WATER QUALITY

The impact assessment criteria for Wollombi Brook (**Table 2**) are sourced from the most recent Surface Water Monitoring Program (SWMP) (Peabody, 2018a), and are based on the 20th and 80th percentile values for the specified parameters from the available dataset. The site assessed, SW02 (**Figure 1**), is located downstream of Wambo Coal Mine, where impacts to water quality caused by mining are most appropriately assessed. However, SBU mining is about 4 km from Wollombi Brook and is likely to have considerably less effect than other mine areas closer to Wollombi Brook, such as North Wambo Underground (NWU) mine.

Table 2 Surface water impact criteria (trigger value)

Sampling Site	Parameter	Lower Limit	Upper Limit
SW02 – Wollombi Brook	pH	7.4	8.1
	EC (µS/cm)	599	1947
	TSS (mg/L)	17 (low flow) – 308 (high flow)^	

^ Low flow conditions are based on 80th percentile of recorded concentrations and high flow criteria on maximum recorded concentrations

The data assessed for the monitoring period is sourced from monthly environmental reporting conducted by Wambo Coal Mine, as well as the WaterNSW online resource (NSW Office of Water, 2019) that provides daily flow and electrical conductivity (EC) data.

An exceedance occurs when water quality results exceed the 80th percentile trigger values for two consecutive sampling events for Level 1 response management measures and three consecutive sampling events for Level 2 response contingency phase (Peabody, 2018c).

Throughout the monitoring period there have been no exceedances of the EC upper limits at SW02 (**Figure 2**). EC was recorded by Wambo Coal Mine to fall below the lower trigger on three occasions during the monitoring period. The EC recorded during 2018 is the highest from all samples taken since 2014, with February and March readings of 1310 µS/cm, and the sample in April being slightly fresher at 1260 µS/cm. No further water quality data was collected after this date as stream levels were below the cease-to-flow limit. The dry conditions at Wollombi Brook appear to be related to reduced rainfall for the duration of the monitoring period, which according to the residual mass curve (**Figure 2**) are the lowest on record since 2014.

A 'Low Flow' exceedance of the Total Suspended Solid levels (TSS) occurred in March 2018, with TSS recording levels of 46 mg/L (**Figure 3**). TSS levels in the month prior were 5 mg/L, while those in the month following the exceedance were less than 5 mg/L. It is likely that a small stream-flow event, which occurred in early March, raising water levels by 10cm, would have mobilised fine bed material that had accumulated within the Brook due to limited flow and rainfall.

The pH level fell below the lower trigger level on two occasions in March (pH 7.2) and April (pH 7.3) 2018. It is likely that the rainfall events during this period (as mentioned above) are responsible for these exceedances as rainfall is generally slightly acidic and could result in the observed reduction in pH.

3 ALLUVIAL GROUNDWATER LEVEL

Alluvial groundwater level criteria assessed for exceedances in this letter are sourced from the most recent GWMP (Groundwater Monitoring Program) (Peabody, 2018). These are based on minimum and maximum depth-to-water trigger levels derived from 10th and 90th percentiles of historical recordings.

The GWMP lists 19 bores with trigger levels, though five bores have N/A entries. The trigger values are not assessment criteria but are used to initiate investigations according to the Surface and Ground Water Response Plan (SGWRP) (Peabody, 2018c). The SGWRP provides a protocol for the investigation, notification, and mitigation of identified exceedances of these assessment criteria. To investigate potential groundwater leakage from Wollombi Brook, the Trigger Action Response Plan (TARP) in the SGWRP considers the water level responses at 10 named bores (Peabody, 2018c):

- Level 1 – Response Management Measures: Groundwater monitoring of standing water levels in bores P106, P109, P114, P116 within the Wambo Creek alluvium and GW13 and GW15 within the Wollombi Brook alluvium, identifies a decreasing trend, beyond natural fluctuations and predicted modelled impacts; for more than two consecutive monitoring events, and/or

- Level 2 – Response Contingency Phase: Groundwater monitoring of standing water levels in bores GW08 and GW09 and GW016 and GW017 within the North Wambo Creek alluvium, exceed the standing water trigger values as provided in the GWMP, beyond natural fluctuations, for more than three consecutive monitoring events.

3.1 Level 1 Response Management Measures

Groundwater level at four alluvial TARP bores have shown exceedances of the trigger levels during the 2018 monitoring period – P106, P114, GW13 and GW15 (**Figures 4 to 7**). Each of these bores have exceeded the maximum depth-to-water trigger level six times during the 2018 monitoring period. Five Non-TARP alluvial bores have recorded exceedances for the 2018 monitoring period – P315, GW02, GW11, P16, P20 (**Figures 8 to 12**).

3.1.1 TARP Bores

Data available to HydroSimulations indicates the depth of P106 to be 14 m (**Figure 4**). For P106 to reporting a true 'dry' reading, the groundwater level at P106 would have to have dropped by ~5.5m between December 2016 and February 2017, the largest decline observed between 2 bi-monthly measurements since the beginning of observation by a factor of 5. While a low river stage and decreasing rainfall trend, or an ongoing mining effect caused by Longwall 10a extraction may be responsible for the 'dry' observations. HydroSimulations recommends further investigation of the bore to check that it has not silted up or suffered collapse. The apparent decline in groundwater level is unrelated to SBU mining.

P114 (**Figure 5**) is reporting as dry for the entire monitoring period, indicating a maximum depth-to-water trigger exceedance for all 2017 observations. This is a clear ongoing effect from the mining of Longwall 10a. The mining effect is unrelated to SBU mining.

GW13 (**Figure 6**) observations are below the trigger level for the entire 2018 monitoring period, groundwater levels the lowest on record. The approaching Warkworth open cut in conjunction with below average rainfall is the likely cause, given its proximity to GW13 (approximately 1 km east). NWU completed operations in December 2015 and is between GW13 and SBU. It is therefore unlikely that NWU or SBU are the cause of declining groundwater levels at GW13.

GW15 (**Figure 7**) has reported water levels below the maximum depth-to-water for the entire 2018 monitoring period. This bore is 1.4 km from the boundaries of the approaching Warkworth Open Cut. Although rainfall has been below average for this monitoring period, mining at the open cut may be causing additional drawdown of water levels at GW15.

3.1.2 Non-TARP Bores with Trigger Exceedances

Dry conditions have been recorded for P315 (**Figure 8)** following the first exceedance the 90th percentile trigger in February 2018. The cause of this exceedance was concluded to be a result of below average rainfall for the monitoring period in the trigger investigation conducted by HydroSimulations (2018d).

Five exceedances were recorded at GW02 (**Figure 9**) for the 2018 monitoring period. As with P315 these exceedances are interpreted to be caused by the ongoing period below average rainfall (HydroSimulations, 2018d).

GW11 (**Figure 10**) reports groundwater levels below the maximum depth-to-water trigger for all observations within the 2018 monitoring period. Following exceedances in 2016, previous AEMR reports (HydroSimulations, 2017) proposed that the alluvial water loss may have been caused by drawdown associated with mining at NWU in downstream alluvial sources at Wambo Creek. However, water levels recovered in 2017 (despite a drop of 3.4 m in June 2017, believed to be a data collection error (HydroSimulations, 2018d)), place the bore above the 90th percentile trigger level. There is no SBU mining effect observed at GW11 during the 2018 period of measurement. As such it is expected that reduced rainfall has resulted in the six groundwater level trigger exceedances recorded for 2018.

The monitoring bores P16 (**Figure 11**) and P20 (**Figure 12**) are located downstream of the mining operations along Wollombi Brook and less than a kilometre upstream to the FM10 Wambo flow monitoring site. At P16 a declining groundwater level of approximately 1.5 m is observed from March 2016 to December 2017. During 2017, P16 reports six groundwater levels below the maximum depth-to-water trigger with the last record exceeding the trigger level by 0.84m. Again in 2018, P16 has recorded 90th percentile groundwater level exceedances for the entire monitoring period, with water levels recorded in December 2018 being 1.5 m below the maximum depth-to-water trigger. Although rainfall has continued to decline throughout 2018, the observations are the lowest recorded for the entire period of measurement and do not show the same previously observed response to peaks in rainfall and river stage. As discussed in HydroSimulations (2018d), an effect from the excavation of the South Wambo Boxcut is expected to have contributed to the decline in water levels observed during late 2016 and through to the end of 2018, with the excavation of the South Wambo Boxcut (within 200 m of P16) completed in July 2017. No mining effect related to SBU is evident at P16.

P20, located downstream of P16 has recorded water levels below the maximum depth-to-water trigger for the entire 2018 monitoring period. Groundwater levels stabilised during the second half of 2018, no longer dropping as rapidly as those observed in 2017 and early 2018, however they are still the lowest water levels recorded for P20. Groundwater levels in December 2018 were 0.5 m below the 90th percentile trigger level. A minor mining effect associated with the excavation of the South Wambo Boxcut is apparent from 2017 onwards (HydroSimulations, 2018d), with current groundwater levels the lowest on record despite the presence of groundwater level observations taken during the millennium drought. No mining effect related to SBU is evident at P20.

3.2 Level 2 - Response Contingency Phase

An assessment of groundwater level for bores GW08, GW09, GW16 and GW17 (**Figures 13 to 16**) is required as part of the TARP for Wollombi Brook and Wambo Creek Alluvium. The current GWMP (Peabody, 2018) does not provide trigger values for these bores. An assessment has been conducted on all bores within the Level 2 TARP to examine groundwater data during the 2018 monitoring period, and identify any trends occurring beyond natural fluctuations.

GW08 (**Figure 13**) and GW09 (**Figure 14**) have both displayed an ongoing NWU mining effect since mid-2012. Observations at GW09 indicate that the bore has been dry for the 2018 monitoring period. These conditions have occurred since early 2016. Groundwater levels at GW08 have declined steadily over 2018, dropping 0.5 m during this period. The ongoing decline in groundwater levels and 'dry' observations at GW08 and GW09 respectively, may now also be related to the decrease in the long-term rainfall trend that continued throughout 2018. Any possible recovery associated with the cessation of dewatering, could be muted by the conditions of below average rainfall.

HydroSimulations (2018b) has suggested the installation of 3 replacement bores near GW08 and GW09. Despite the possibility of recovery being muted by below average rainfall, HydroSimulations would see value in the installation of new standpipe bores, monitoring both alluvium and underlying interburden material above NWU workings. This would allow for a better understanding of recovery or ongoing impacts associated with NWU mining.

As mentioned in previous reports, groundwater levels and the rapid water level rises following rainfall events observed at GW16 (**Figure 15**) and GW17 (**Figure 16**) are a result of their connectivity to the ephemeral North Wambo Creek (HydroSimulations 2016, 2017). Extraction at the Montrose Open Cut, and the resultant regional depressurisation was expected to be impacting groundwater levels at GW16 and GW17 during 2017 (HydroSimulations, 2018a). Over the course of 2018, rainfall has continued to fall below average, affecting groundwater levels at all bores monitored by Wambo. As a result, it is difficult to identify the magnitude of the mining effect due to Montrose Open Cut at GW16 and GW17 for the 2018 monitoring period. It is suspected that if recovery had occurred over this time that the reduced rainfall would be concealing this. As mining at NWU was completed in December 2015 it is not likely that longwall extraction in this region was responsible for the declining groundwater levels observed at GW16 and GW17 during 2018.

4 ALLUVIAL GROUNDWATER QUALITY

The criteria used to assess whether exceedances in alluvial groundwater quality have occurred during the monitoring period were sourced from the most recent GWMP (Peabody, 2018). The GWMP lists 15 bores with EC and pH trigger values, but three have N/A entries.

Water quality triggers for EC are based on 90th percentile values from recorded historical data at each bore. An exceedance of the 90th percentile EC value over three consecutive bi-monthly observations triggers an investigation.

At Wambo, pH is consistently between 6 and 8 at most alluvial monitoring locations. 10th and 90th percentile values are used as minimum and maximum trigger values. An investigation is triggered following exceedances on two consecutive bi-monthly monitoring events.

Monitoring bore GW15 recorded two exceedances of the prescribed pH trigger levels during the 2018 monitoring period. GW15 exceeded the maximum designated pH level for that bore in February and April 2018. In both cases pH did not go beyond the limits of the neutral pH range, between 6 and 8.5 pH units (ANZECC ARMCANZ, 2000), with exceedances being no more than 0.3 pH units above the maximum trigger values. Therefore, these exceedances are not considered to be of concern.

5 WOLLOMBI BROOK FLOW DIFFERENTIAL

The performance indicator for flow at Wollombi Brook is exceeded if the Warkworth gauging station (FM10) records zero flow while the Bulga gauging (FM11) station records measurable flow at the same time (**Figure 1**).

HydroSimulations downloaded discharge rate data in ML/day from the WaterNSW website (NSW Office of Water, 2018) for the 'Wollombi Bk at Bulga' (station number: 210028) and 'Wollombi Bk at Warkworth' (station number: 210004), which correlate with FM11 and FM10 respectively. Wollombi Brook discharge is initially presented using a logarithmic y-axis scale (**Figure 17**) to clearly capture the relationship between gauging stations in periods of both low and high flow. It is again presented for the final month of 2017 and the 2018 monitoring period , using a linear y-axis (**Figure 18**) to display the apparent differential between flow at the gauging stations for periods of low and near zero flow.

Prior to 2016, discharge rates at both Wollombi Brook gauging stations show excellent correlation, with fluctuations of similar magnitude observed at both stations (HydroSimulations, 2018b). FM10 generally exhibited higher discharge than FM11 during periods of low flow. This is attributed to FM10 being positioned in a larger catchment area fed by several tributaries, including Wambo, Sandy and North Wambo Creeks (HydroSimulations, 2018b).

In late 2016, continuing into early 2017, a departure from the historically well correlated discharges was observed with zero discharge being recorded at FM10 while FM11 continued to record flow. This occurred again between September and December 2017. During both exceedances, flow at FM11 was low, recording less than 1 ML/day (HydroSimulations, 2018b).

The previous subsidence compliance assessment report for SBU (HydroSimulations, 2018b) indicated an exceedance of the performance indicator for flow at Wollombi Brook, and that an investigation into the flows along Wollombi Brook should be undertaken to identify the cause of zero downstream flow at FM10 while flow was being recorded at FM11.

This investigation was carried out by Environmental Instrument Solutions (EIS) in January 2019 (EIS, 2019). EIS conducted a long-term flow analysis utilising data from the equivalent government monitored stations for FM10 and FM11 (as above), as well as data from the Brickman's Bridge Station (36 km upstream of Bulga). The contribution of North Wambo Creek for the 2017 monitoring period was also analysed by utilising flow data collected by Wambo at two monitoring sites on North Wambo Creek FM2 and FM4 (**Figure 1**). The data indicated that little correlation between stream-flow was evident from short-term analyses, particularly during periods of below average flow. Over the long-term, flows were generally higher upstream than downstream suggesting that the use of flow differentials for subsidence compliance measures was likely to be inefficient. EIS (2019) concluded that stream flows along Wollombi Brook show no discernible mining impacts for the 18 years where data is available, and therefore mining at SBU was unlikely to be influencing low flow conditions observed in 2017. In addition, EIS (2019) observed that North Wambo Creek had only one flow event in 2017 which may have contributed to flows in Wollombi Brook, but was otherwise not expected to have any measurable influence on flows in the brook.

EIS has concluded that the factors that govern flow within Wollombi Brook are as follows:

- Stream bed material composition – the sandy nature of Wollombi Brook favours subsurface flows during 'drier' climatic conditions, particularly during extended periods of low rainfall.

- Intensity of pump extraction from Wollombi Brook – water is extracted from Wollombi Brook by Wambo and adjacent mining operations. In 2017 the total volume extracted was 139 ML. EIS remark that extraction can considerably influence the flow differential between FM11 and FM10 in periods of low/no flow.

- Hydrogeological interactions – it was noted that the "disappearance" of flows into the sub-surface occurs naturally within Wollombi Brook. The extent of connectivity between surface and groundwater is not fully known. Due to the stream bed composition this is believed to be an important factor in flow dynamics at Wollombi Brook.

The 2018 monitoring period was a period of continued decline in the long-term rainfall, which has led to no-flow conditions at both Bulga and Warkworth stations along Wollombi Brook. Flows of less than 0.05 ML/day were recorded at Bulga until the end of the first week of January 2018, however, since then no discharge has been measured. The Warkworth station has not recorded flows since September 2017. As discussed previously, several groundwater monitoring bores have experienced 'dry' conditions throughout the 2018 monitoring period, indicating that the water table in this area has dropped substantially due to the reduced rainfall. EIS (2019) note that due to below average groundwater levels in 2018 it is unsurprising that no flows have been observed Wollombi Brook for this period. Given this information and the long-term findings from the flow analysis (EIS, 2019) a mining affect from SBU is not believed to be influencing the no-flow conditions observed at Wollombi Brook for the 2018 monitoring period.

6 ASSESSMENT OF PERFORMANCE MEASURE AND RECOMMENDATIONS

Over the course of the 2018 monitoring period, exceedances have been observed at:

- P106 – observed dry bore not consistent with previous observations, further investigation should be conducted into the integrity of P106.
- P114 – which can no longer be considered representative of alluvium.
- GW13 – most likely affected by Warkworth Mine.
- GW15 – most likely affected by Warkworth Mine.
- GW08 – ongoing mining effect exacerbated by extended period of below average rainfall.
- GW09 – ongoing mining effect exacerbated by extended period of below average rainfall.
- GW16 – most likely affected by Montrose Open Cut and extended period of below average rainfall.
- GW17 - most likely affected by Montrose Open Cut and extended period of below average rainfall.
- FM10 – zero flow at downstream gauging station

Due to the low rainfall for the 2018 period, exceedances of water level and EC cannot confidently be attributed to SBU mining. Findings from EIS (2019) indicate that it is unlikely that SBU mining has influenced the low/no flow conditions observed at FM10 and FM11 gauging stations throughout 2018. Therefore, the subsidence impact compliance measures have been upheld for the 2018 monitoring period and mining at SBU has had *negligible impact to Wollombi Brook*.

A summary assessment is given in **Table 3**.

Table 3 Subsidence impact performance measure – SBU LW11-LW16

Feature	Subsidence Impact Performance Indicator(s)	Subsidence Impact Performance Measure	Subsidence Impact Performance Indicator Exceeded?	Overall Subsidence Impact Compliance Upheld
Wollombi Brook	*Surface water quality in Wollombi Brook exceeds the surface water quality criteria in the SWMP.*	*Negligible impact to Wollombi Brook*	**Yes**	**Yes**
	Groundwater levels in alluvial bores exceed the groundwater level criteria in the GWMP.		**Yes (at P106, P114, GW13, GW15, GW08, GW09, GW16, GW17)**	
	Groundwater quality in alluvial bores exceeds the groundwater quality criteria in the GWMP.		**Yes (GW15, GW16, GW17)**	
	Zero flow is recorded at the Warkworth gauging station (FM10) and measurable flow is recorded at the Bulga gauging station (FM11).		**Yes***	

*EIS (2019) identifies the need to revise this performance indicator

7 REFERENCES

Environmental Instrument Solutions (EIS) (2019) *Wollombi Brook Low Flow Review.* Report prepared for Wambo Coal Pty. Ltd. January 2019.

HydroSimulations (2016a) *Wambo Annual Review Groundwater Analysis*. Report HC2016/07 for Wambo Coal Pty Ltd. March 2016

HydroSimulations (2016b) *South Wambo Underground Mine Modification - Groundwater Assessment*. Report HC2016/01 for Wambo Coal Pty Ltd. March 2016

HydroSimulations (2018a) *Wambo Annual Review Groundwater Analysis*. Report HS2018/09 for Wambo Coal Pty Ltd. March 2018.

HydroSimulations (2018b) *Compliance with subsidence performance measure in the South Bates Underground Mine Extraction Plan - Longwalls 11 to16*. Report HS2018/11 for Wambo Coal Pty Ltd. March 2018.

HydroSimulations (2018c) *Additional Alluvial Monitoring Locations* Report HS2018/28 for Wambo Coal Pty Ltd, July 2018

HydroSimulations (2018d) *Wambo Coal Groundwater Trigger Exceedance Assessment.* Report HS2018/48 for Wambo Coal Pty Ltd. October 2018.

NSW Office of Water (2019) http://realtimedata.water.nsw.gov.au/water.stm?ppbm=DAILY_REPORTS&dr&3&drkd_url Accessed 01/03/2019

Peabody (2018a) *Wambo Coal Surface Water Monitoring Program.* Document No. WA-ENV-MNP-509.2. April 2018.

Peabody (2018b) *Wambo Coal Groundwater Monitoring Program.* Document No. WA-ENV-MNP-509.1. April 2018.

Peabody (2018c). *Wambo Coal Surface and Ground Water Response Plan.* Document No. WA-ENV-MNP-509.4. April 2018.

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Figures

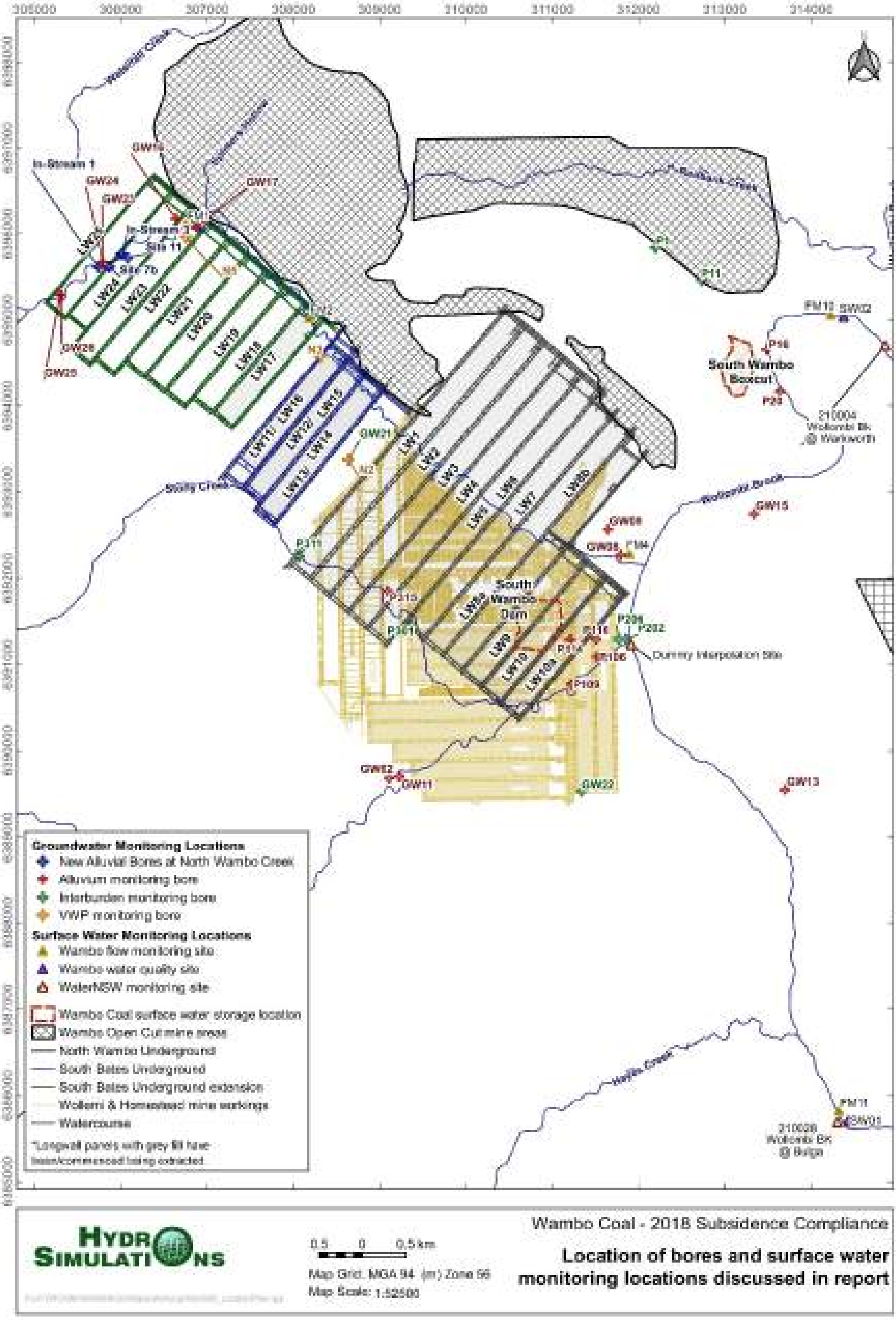

Figure 1 Locations of groundwater and surface water sites discussed in this report.

Figure 2 SW02 - EC Surface water quality data and trigger levels

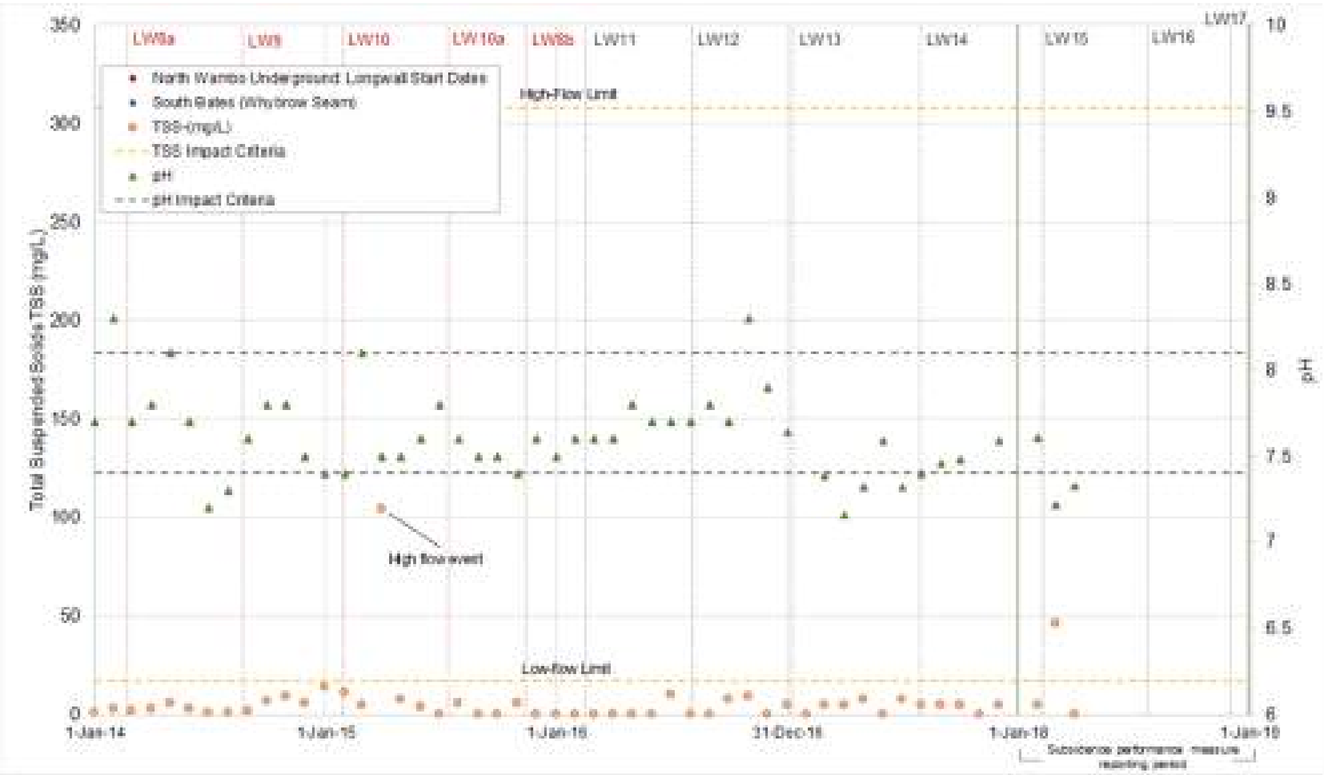

Figure 3 SW02 – pH and TSS Surface water quality trigger level

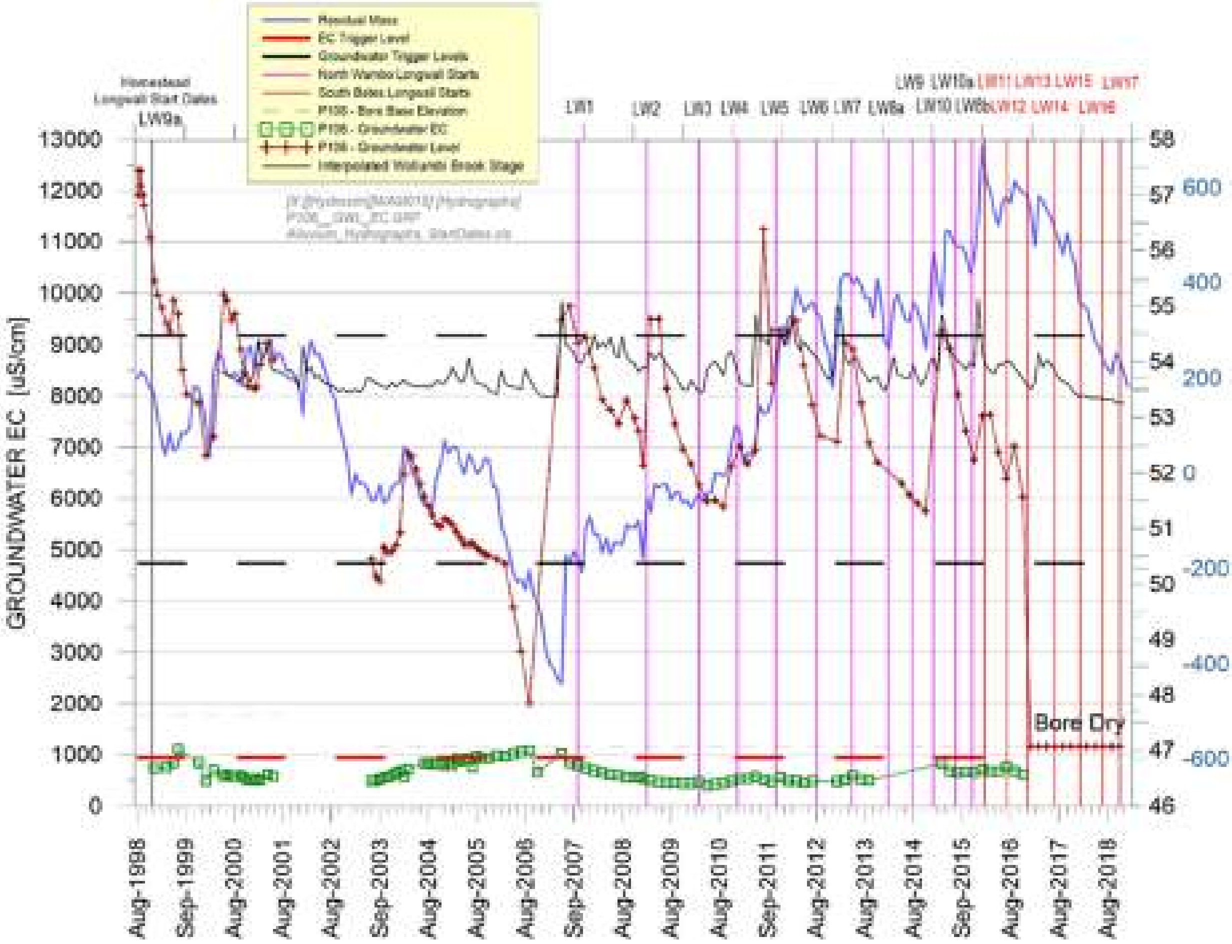

Figure 4 **P106 Groundwater Level and EC data and trigger levels**

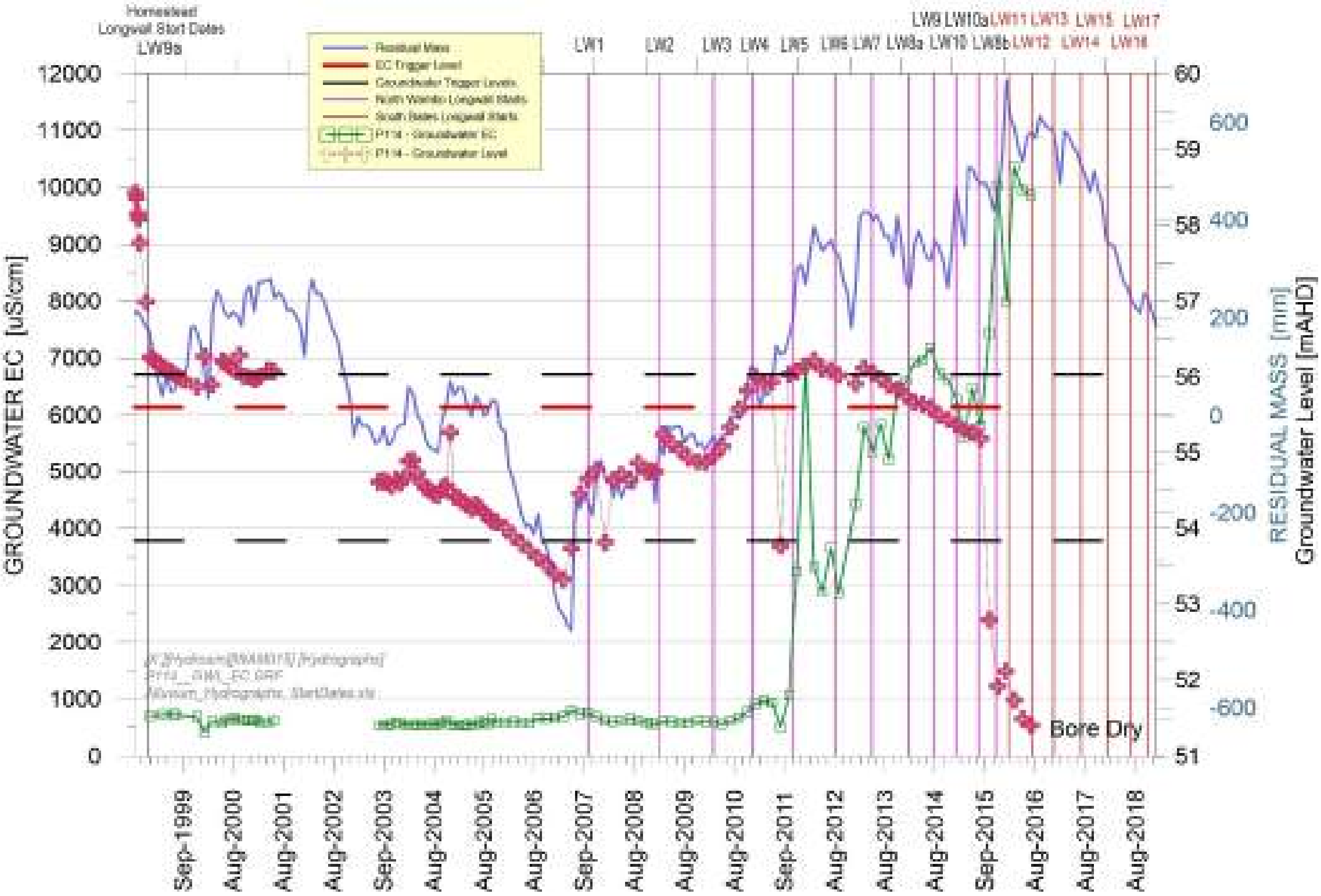

Figure 5 P114 Groundwater Level and EC data and trigger levels

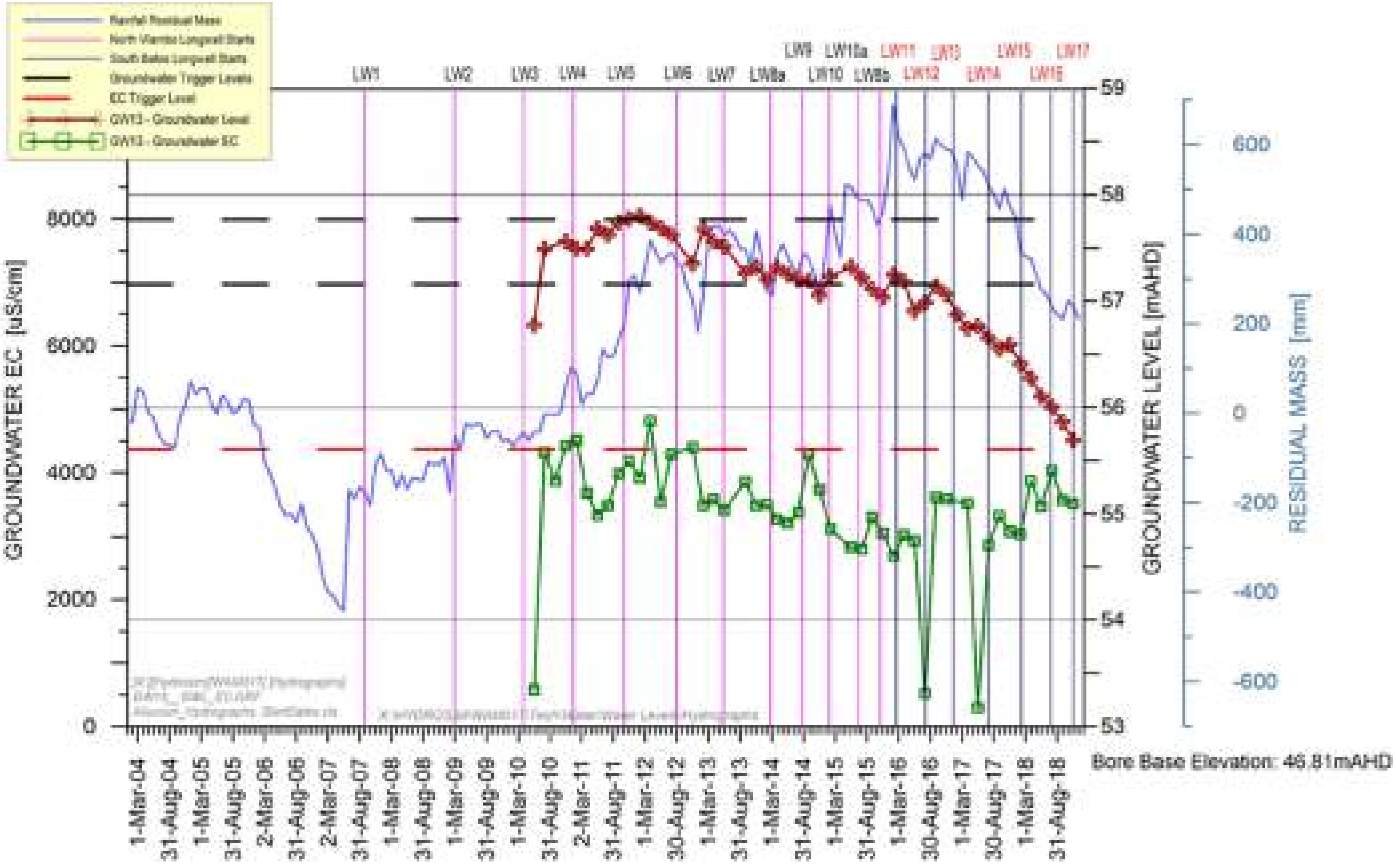

Figure 6 GW13 Groundwater Level and EC data and trigger levels

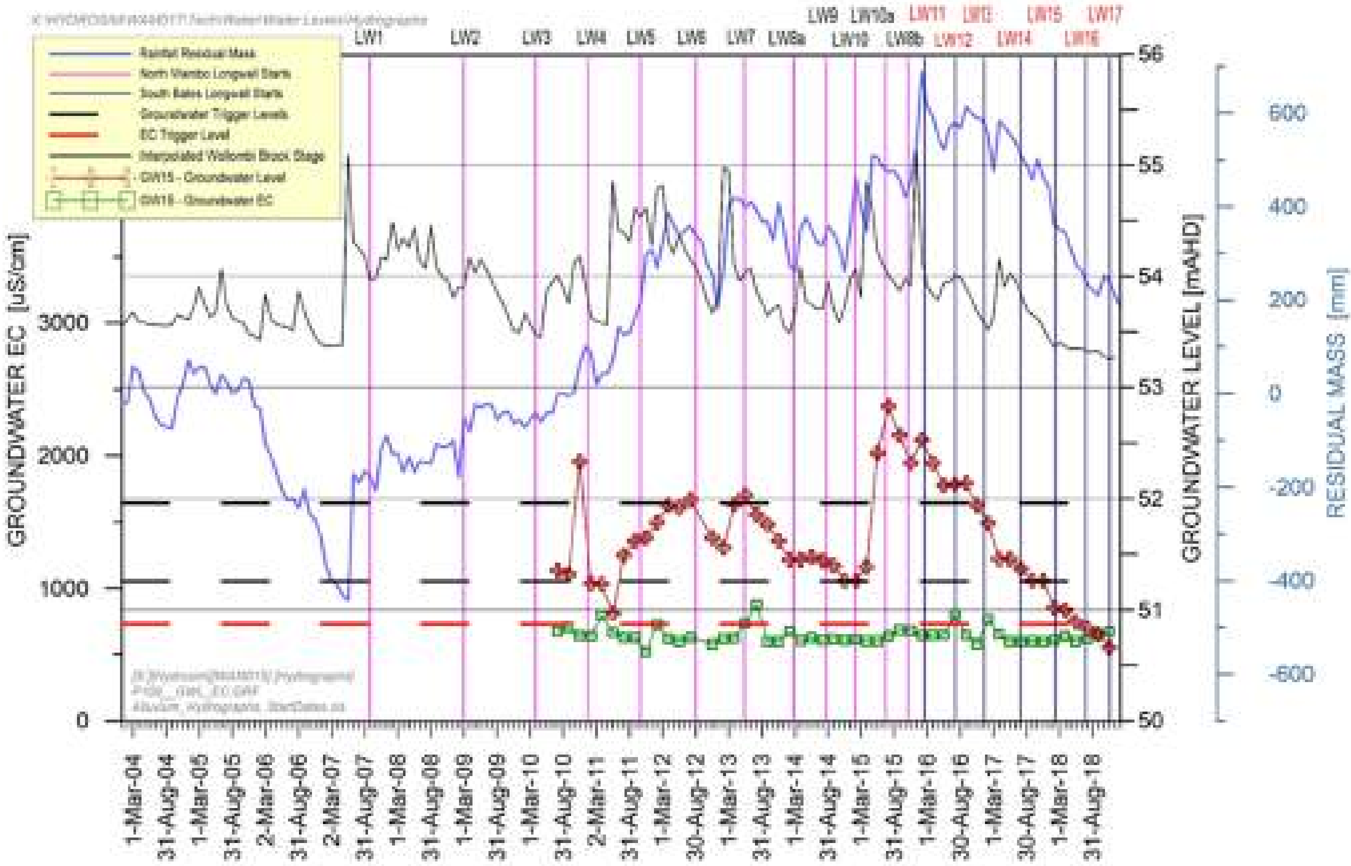

Figure 7 GW15 Groundwater Level and EC data and trigger levels

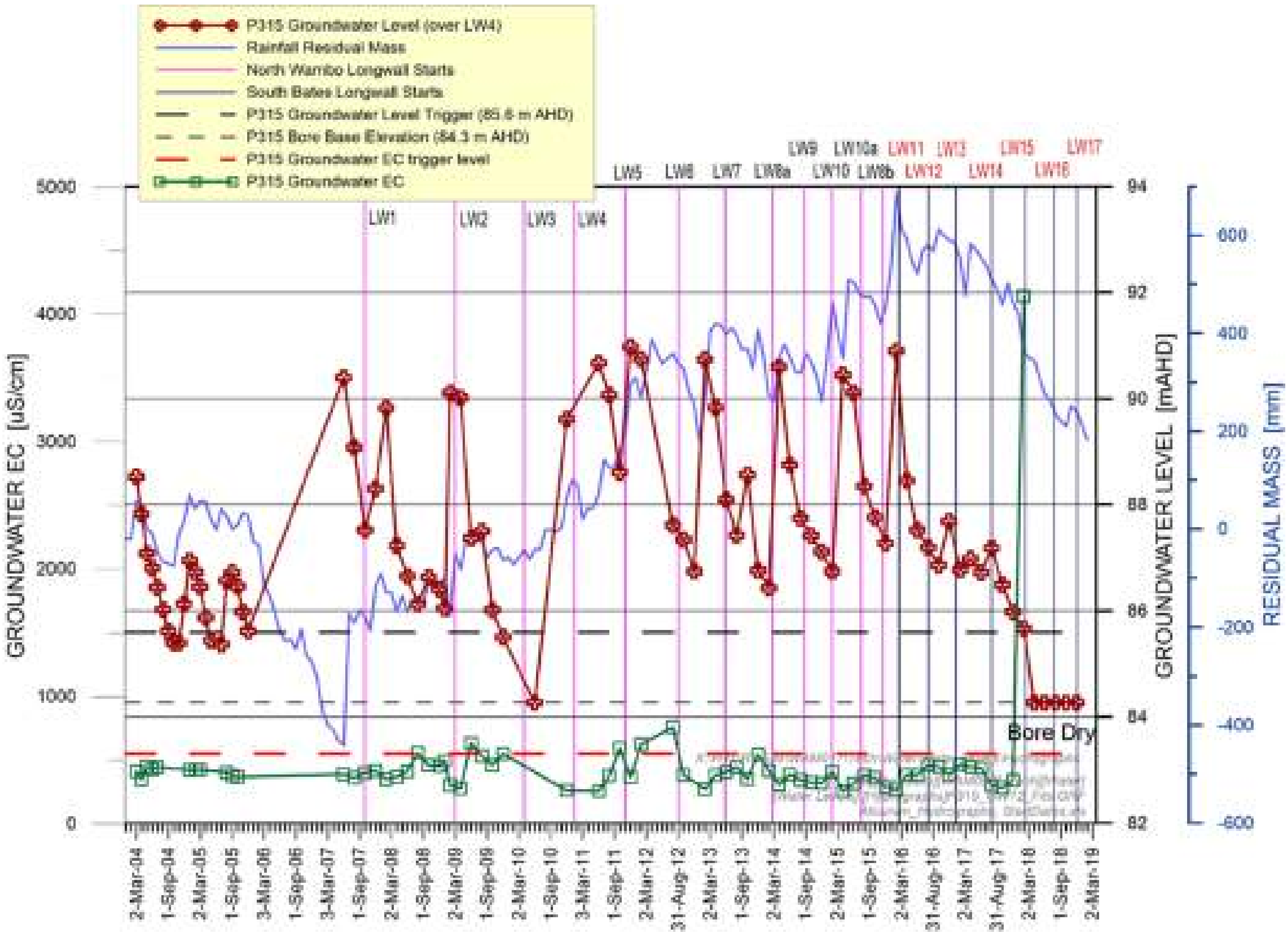

Figure 8 P315 Groundwater Level and EC data and trigger levels

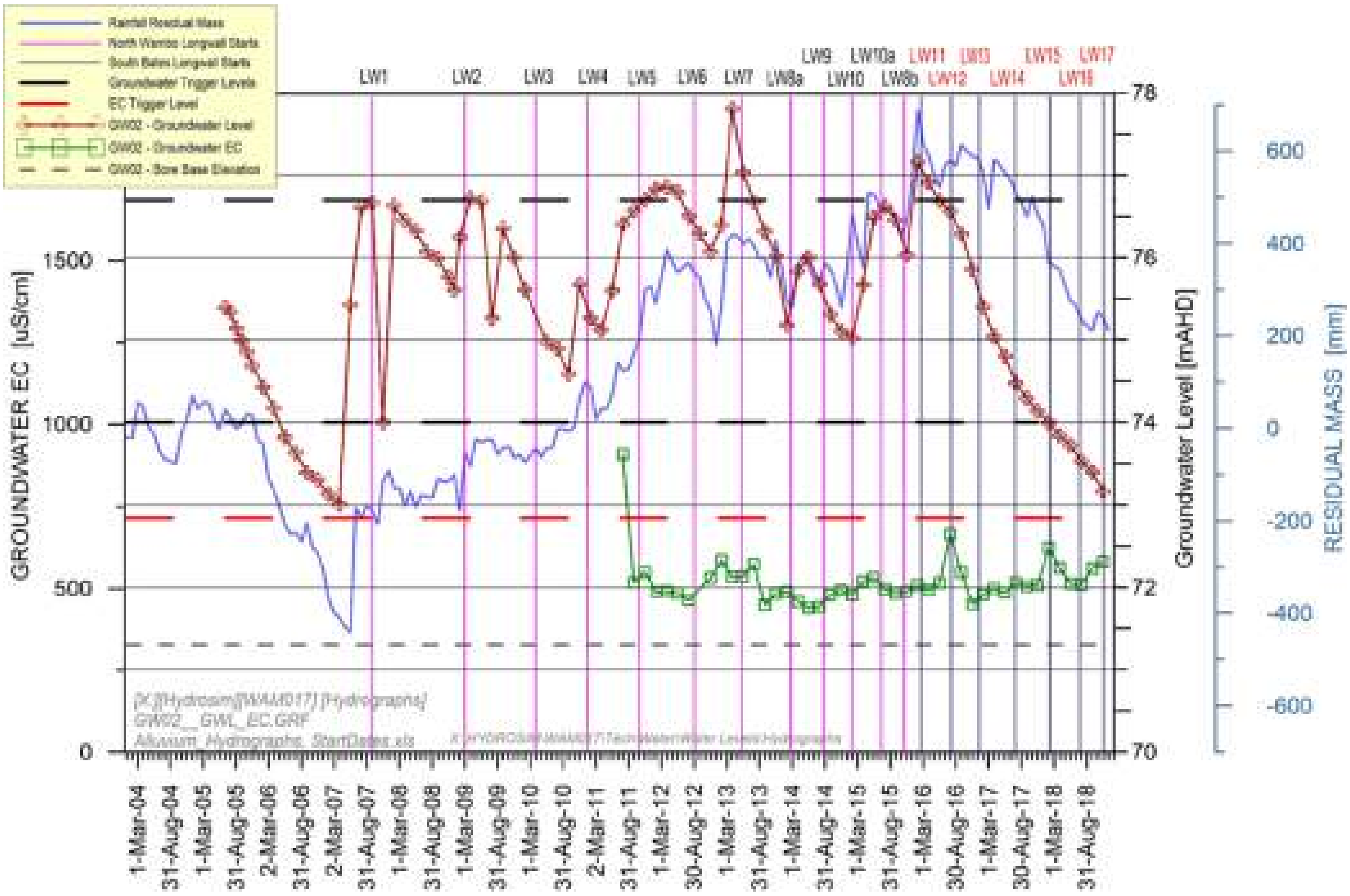

Figure 9 GW02 Groundwater Level and EC data and trigger levels

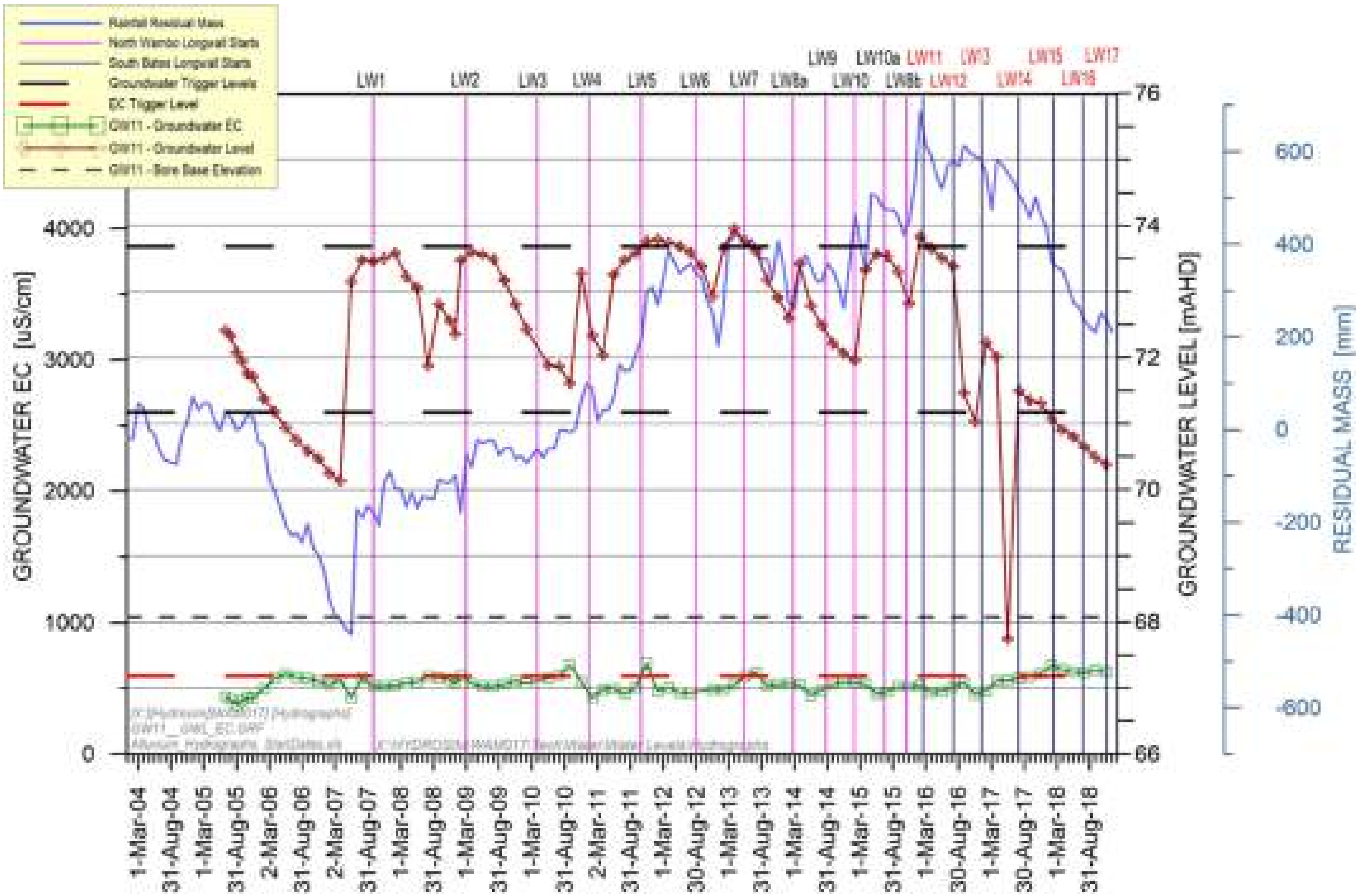

Figure 10 GW11 Groundwater Level and EC data and trigger levels

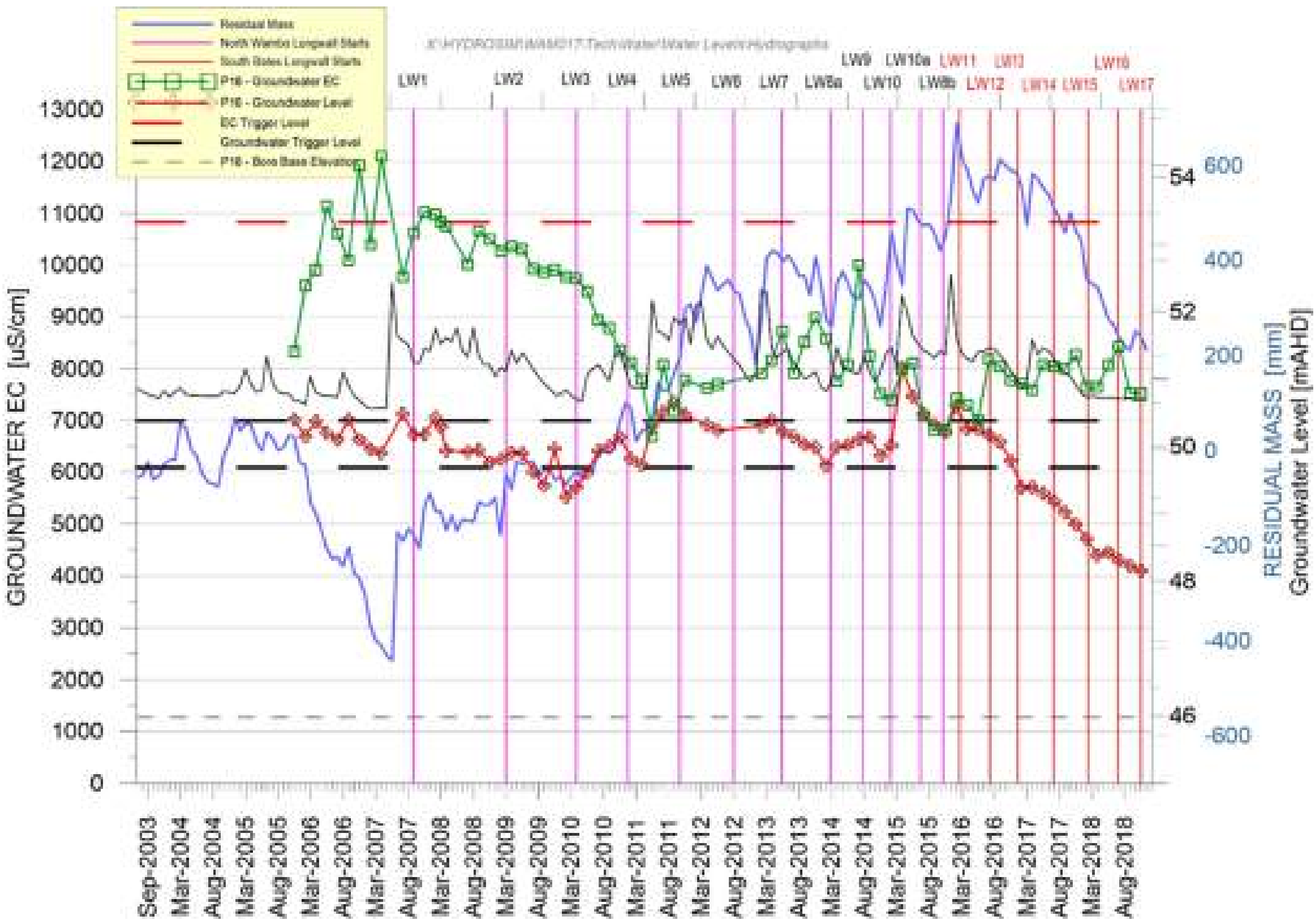

Figure 11 P16 Groundwater Level and EC

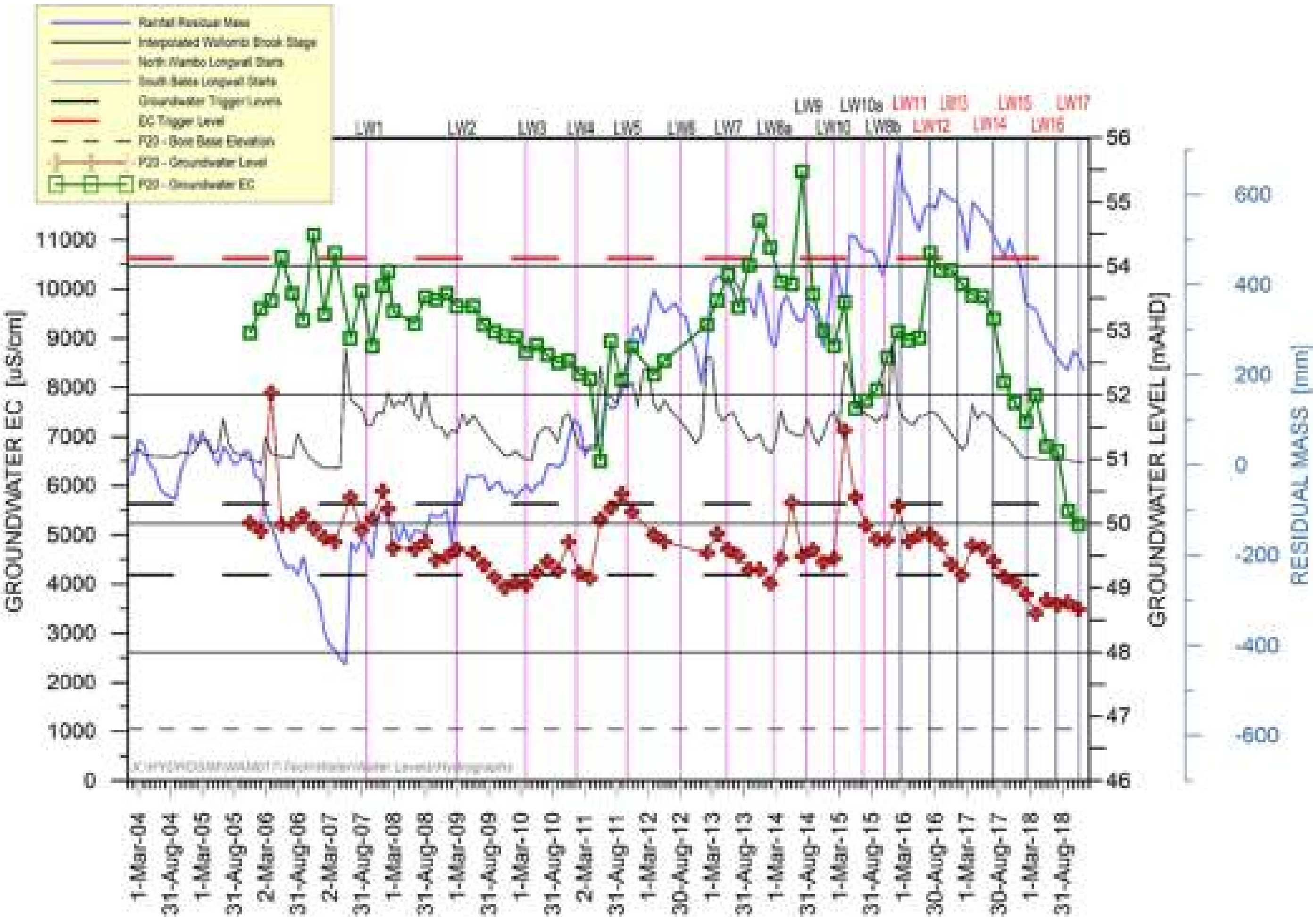

Figure 12 P20 groundwater level and EC

Figure 13 GW08 groundwater level and EC

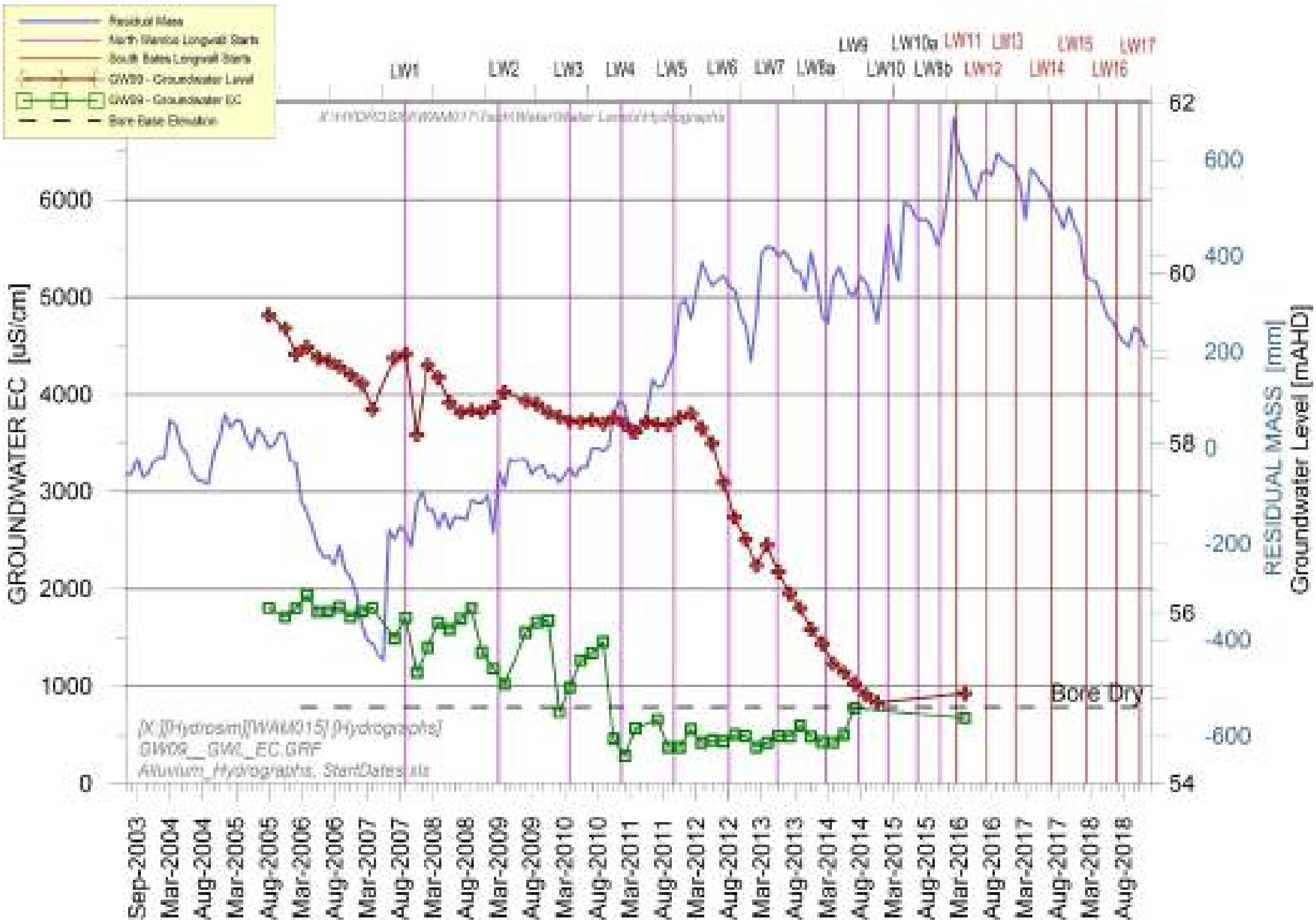

Figure 14 GW09 groundwater level and EC

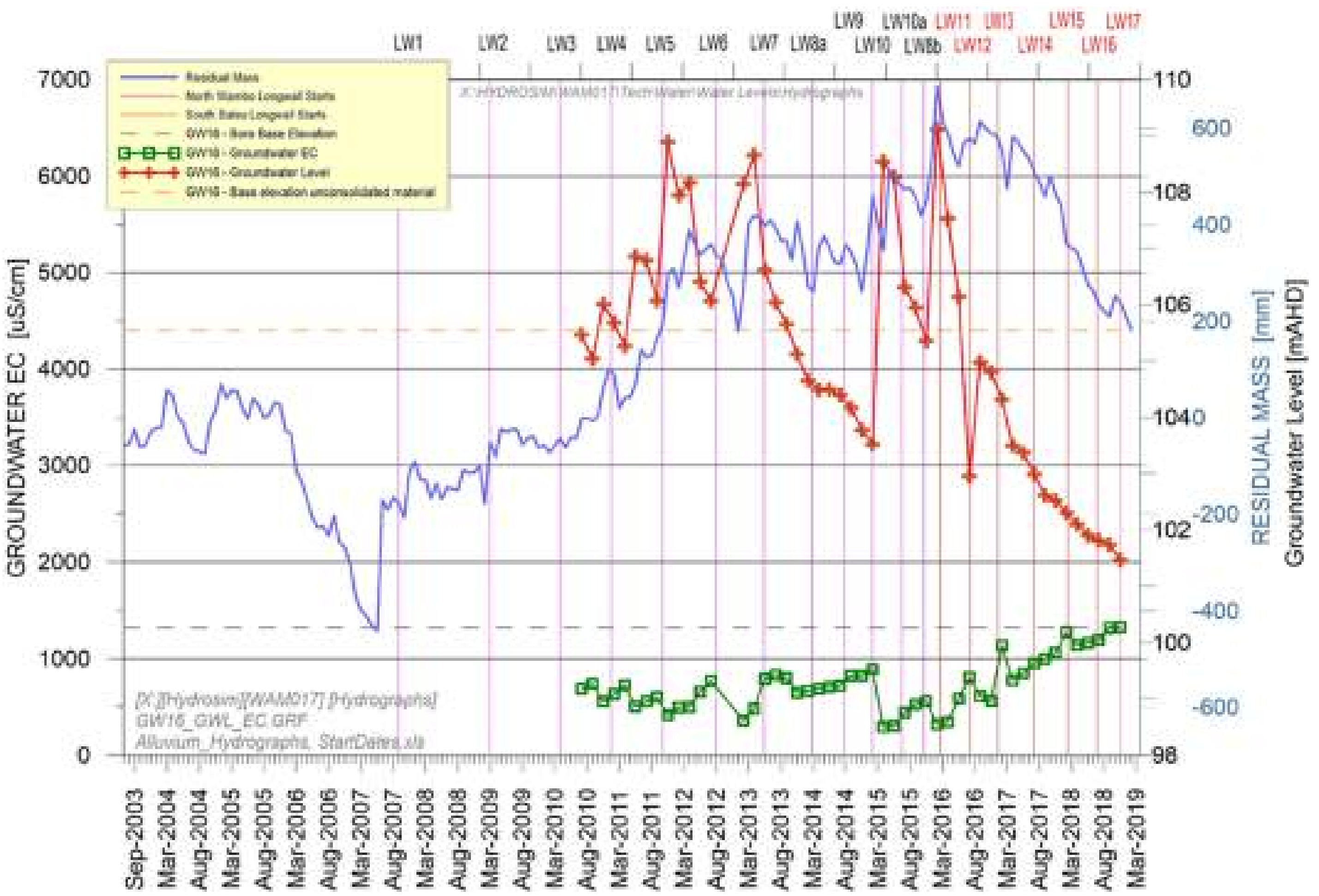

Figure 15 GW16 groundwater level and EC

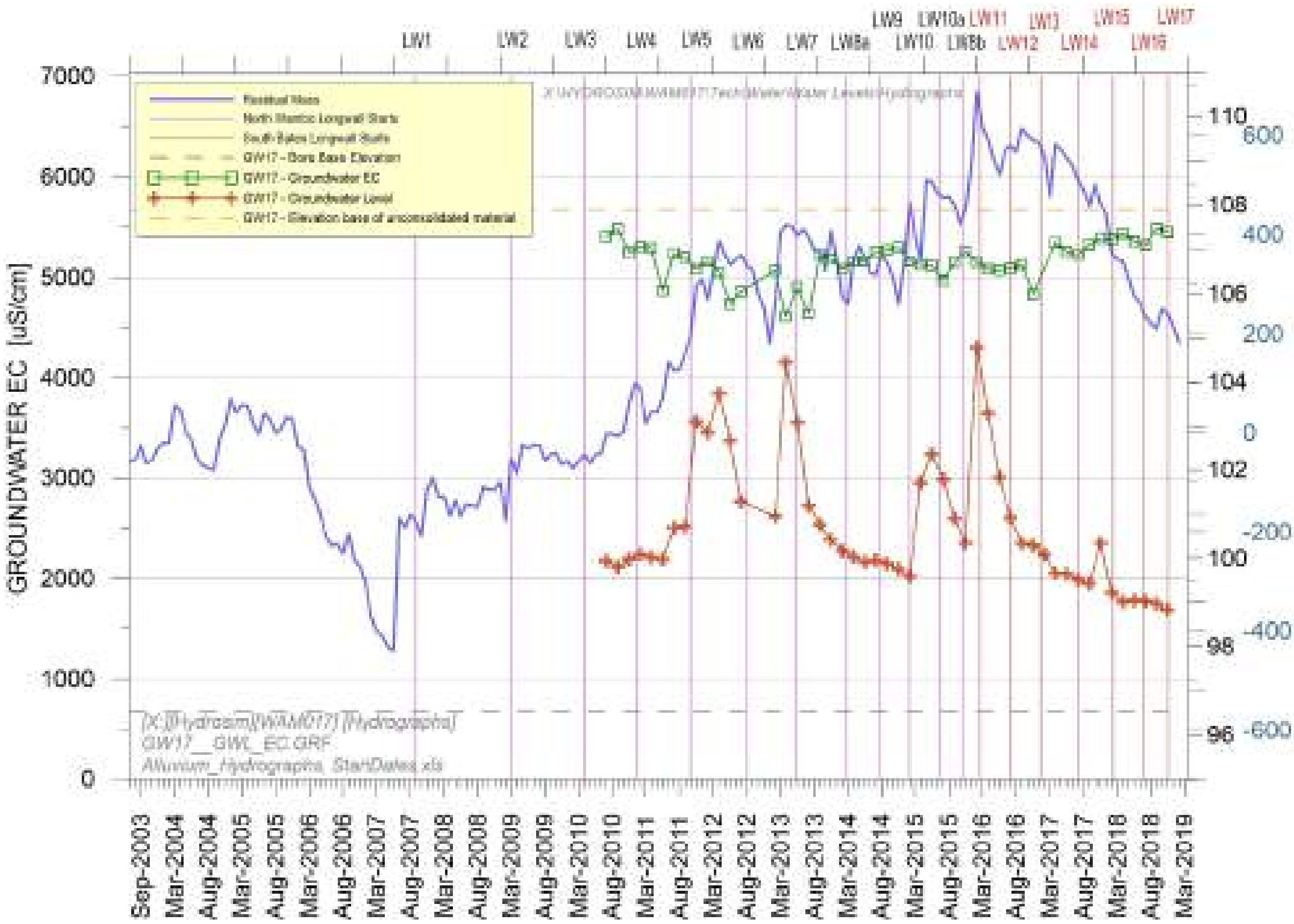

Figure 16 GW17 groundwater level and EC

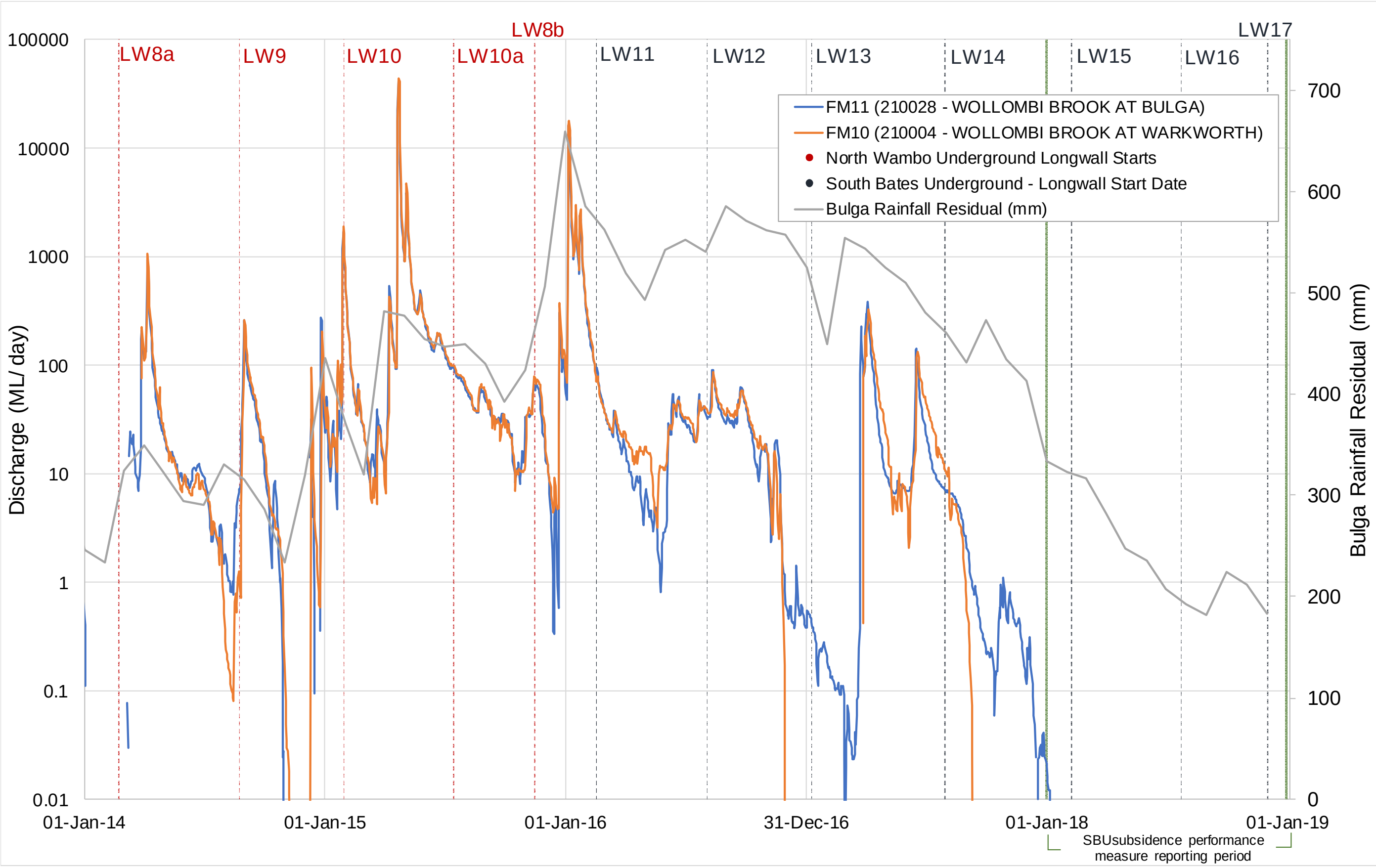

Figure 17 Wollombi Brook flow recording (logarithmic y-axis) and rainfall residual mass

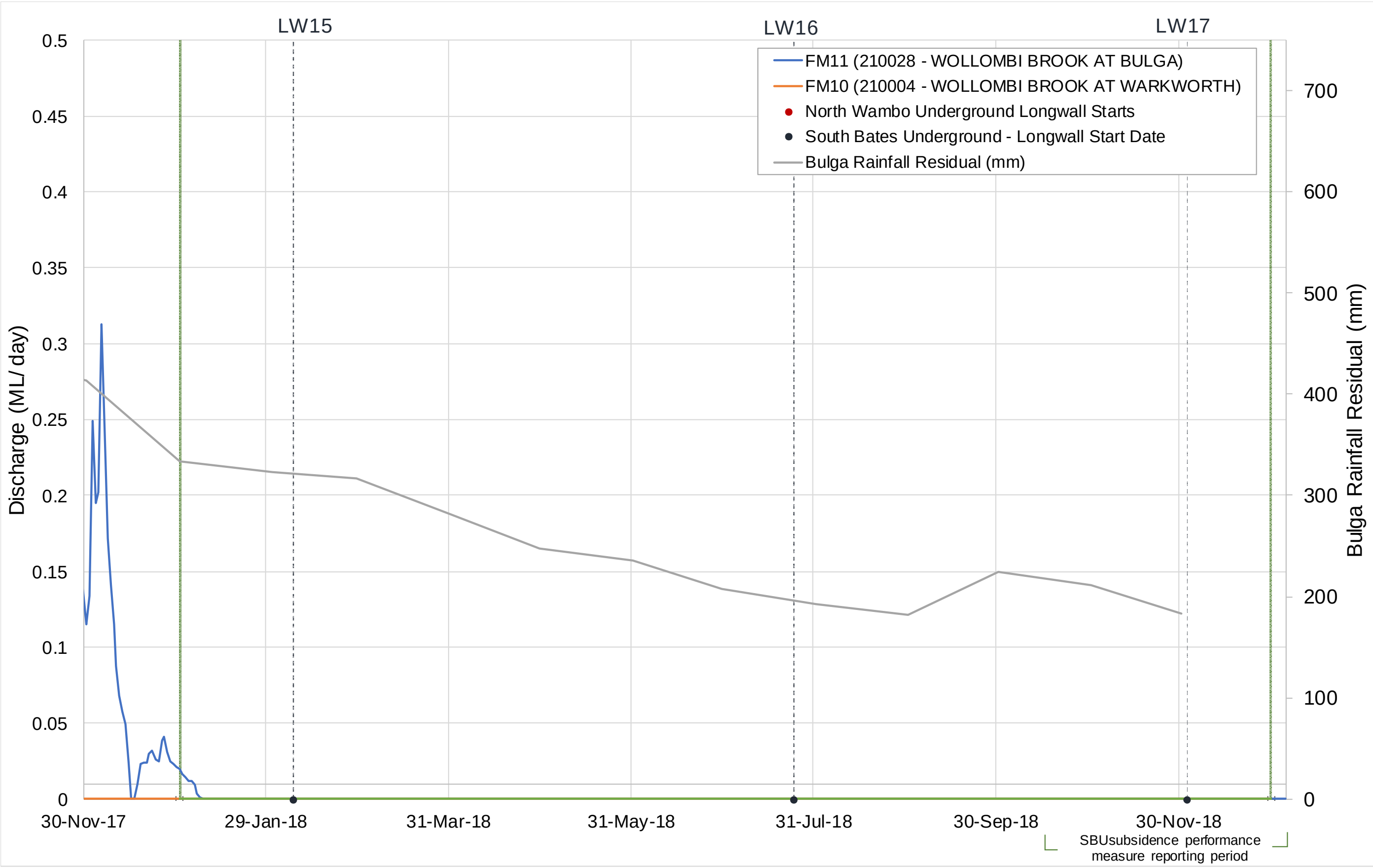

Figure 18 Wollombi Brook flow recording

APPENDIX H

STREAM FLOW MONITORING REPORT

AECOM Imagine it. Delivered.

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28 February 2019

Commercial-in-Confidence

Nicole Dobbins
Environmental Advisor
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Dear Nicole

Report on stream flow events along North Wambo, South Wambo and Stoney Creeks for the period 1 February 2018 to 31 January 2019.

Please find contained within this report a summary of probable flow events which occurred along North Wambo, South Wambo and Stoney Creeks from and inclusive of 1 February 2018 to 31 January 2019.

The flow monitoring network now comprises of twelve flow monitoring stations. These flow monitoring stations are distributed along the following creeks:-

- North Wambo Creek has six flow monitoring stations;
- South Wambo Creek has three flow monitoring station, and;
- Stoney Creek has two monitoring station with an additional flow monitoring station located on a major tributary to Stoney Creek.

Further details of the configuration and location of each flow monitoring station can be viewed in **Section 1.0** below.

Theoretical flow rates were calculated from the pressure data downloaded from each station's data logger. The pressure data was converted to a stream height in metres using the following formula:-

Measured Water Level (m) = Measured Pressure (kPa) X Conversion Factor (0.1019972 m/kPa)

This conversion factor was obtained from the Manufacturers of the pressure transducers.

In August 2018 Wambo's Environmental Team requested AECOM in conjunction with Chris Frink from Environmental Instrument Solutions to locate a site on South Wambo Creek for the establishment of a flow monitoring station and to find alternate locations for the two flow monitoring station on Stoney Creek (Stoney Creek Up FM12 and Stoney Creek Down FM13).

In September 2018 a new flow station on South Wambo Creek was established approximately 1 kilometre up stream of surface water sampling site SW06 on the old Brossi property. This flow station was installed as a replacement to old Flow Station 9, see below.

At the same time the Stoney Creek Up (FM12) was relocated approximately 50 metres downstream from its original location, and Stoney Creek Down (FM13) was also relocated approximately 50 metres upstream from its original location.

AECOM performed the cross section and long section surveys, including the establishment of the sensor height to the cease to flow point at the new, Brossi, flow monitoring station on South Wambo Creek and the re-located flow monitoring stations on Stoney Creek The survey data was supplied to Wambo Coal to forward onto Environmental Instrument Solutions.

Environmental Instrument Solutions provided AECOM via Wambo Coal the data required to construct the revised/new Theoretical Flow Curves. From these curves polynomial equations were derived and applied to the height data collected to produce theoretical flow rate for a probable flow event when they occurred at a flow monitoring station.

At the time this report was being prepared the revised data required to produce the theoretical flow curves for the installation of the new flow monitoring station, Brossi, on South Wambo Creek and the re-located flow monitoring stations on Stoney Creek was being processed by Environmental Instrument Solutions.

1.0 Flow Station Locations, Configurations and General Observations

1.1 Flow Monitoring Station FM1A

Flow Monitoring Station FM1 was originally located at the top of North Wambo Creek and was re-located approximately 300 to 400m further downstream in December 2017 (GPS E307013 N6396135). The station contains a Campbell Scientific (CSA) CS451 SDI-12 pressure transducer connected to a CSA CR800 series data logger, the logger and sensor are powered by a 12 volt lead acid battery with solar charging. Average stream height is logged on an hourly basis along with maximum and minimum stream height occurring in the hour. In addition an Insitu Rugged TROLL 100 absolute pressure sensor was also installed and is logging data at ten minute intervals.

1.2 New Flow Monitoring Station (Upper North Wambo Creek).

This flow monitoring station was installed on North Wambo Creek during December 2017 and is located approximately 1 kilometre upstream of the original site of Flow Monitor Station 1 (GPS E305250 N6395200). This station contains an Insitu Rugged TROLL 100 absolute pressure sensor. Data is logged at 10 minute intervals.

1.3 Flow Monitoring Station FM2

Flow Monitoring Station FM2 is located downstream from relocated Flow Station FM1A approximately midway along the old North Wambo Creek diversion. This station contains a CSA CS450 SDI 12 pressure transducer connected to a CSA CR200X series data logger, the logger and sensor are powered by a 12 volt lead acid battery with solar charging. Average stream height data is collected at ten minute intervals.

An Insitu Rugged BaroTROLL was installed in the data logger enclosure at this site. This BaroTROLL is utilised to compensate the pressure data collected from the Rugged TROLL100s located at Flow Stations FM1 (old and new locations), the New Flow Station on North Wambo Creek and Flow Station FM4 for changes in atmospheric pressure. This sensor logs the atmospheric pressure internally at 15 minute intervals.

During the November 2018 data collection it was identified that this BaroTROLL utilised to correct for differences/changes in atmospheric pressure which are applied to the LevelTROLL sensors located at the flow monitoring stations along North Wambo Creek had failed during October 2018. This was reported to Wambo Coal's Environmental Team. Authorisation was sought and received to replace this BaroTROLL with a new one, however due to the time of year and availability of the sensor the replacement sensor was not installed until 24 January 2019.

1.4 Flow Monitoring Station FM3

Flow Monitoring Station FM3 was originally located on North Wambo Creek between the old Wambo Underground Surface Infrastructure and the Open Cut Overburden. Due to the expansion of mining activity in the area the station was removed on 8 November 2012 and repositioned approximately midway along the new diversion of North Wambo Creek downstream of Flow Station FM2. Flow Station FM3 was reinstalled on 21 and 22 May 2013.

This station comprises a CSA CS451 SDI-12 pressure transducer connected to a CSA CR200X series data logger, the logger and sensor are powered by a 12 volt lead acid battery with solar charging. Average stream height data is logged every 10 minutes.

1.5 Flow Monitoring Station FM4

Flow Monitoring Station FM4 is located at the Wambo Mine Road culvert which crosses North Wambo Creek upstream of the confluence of North Wambo Creek and Wollombi Brook.

This flow station has a CSA CS451 SDI-12 pressure transducer connected to a CSA CR200X series data logger, the logger and sensor are powered by a 12 volt lead acid battery with solar charging. Average stream height data is logged at 10 minute intervals.

During May 2013 (27 May 2013), at the request of Wambo Coal, an Insitu Rugged TROLL100 absolute pressure sensor was installed at this site as a backup sensor. This sensor logs pressure internally at 15 minute intervals.

1.6 Flow Monitoring Station FM15

Flow Monitoring Station FM15 is located on South Wambo Creek just upstream of the confluence of South Wambo Creek and Wollombi Brook and approximately 100 to 200m downstream of its original location. This flow monitoring station was relocated to its current location in December 2016 following its destruction during a flood event in February 2013.

This station comprises of an Insitu Rugged TROLL100 absolute pressure sensor which has been configured to record data at 10 minute intervals.

1.7 Flow Monitoring Station FM16

Flow Station FM16 is located on South Wambo Creek approximately 200 to 300 metres up stream of the washout on Wambo Mine Road.

The station comprises an Insitu Rugged TROLL100 absolute pressure sensor which has been configured to record data at 10 minute intervals.

The atmospheric pressure correcting sensor (BaroLogger) used for correcting the absolute pressure readings from flow Stations FM5 and FM6 is located in the logger box of old Flow Station 6.

1.8 Flow Monitoring Station 9

Flow Monitoring Station 9 is located on South Wambo Creek approximately 200 to 300m upstream of the confluence of South Wambo and Stoney Creeks.

This flow station has a HSA WL2100W SDI-12 connected to a CSA CR200X Series data logger. Average stream height data is logged at 10 minute intervals.

It was observed during the April 2013 inspection and data download that a significant amount of sediment had been deposited on top of the pressure sensor during the high flow events which occurred in January and February 2013. It is estimated from looking at the gauging board where the sensor is located that approximately 500mm of sediment was deposited in the stream bed. This situation is still unchanged.

The data retrieved from this flow station is unusable. This was communicated to Wambo Coal's Environmental team after the May 2015 data collection and they decided not to continue with the data collection at this site.

This flow station was re-established on South Wambo Creek during September 2018 and now is known as Brossi. The station is approximately 2 kilometres upstream from its original location and was installed following the adoption by Wambo Coal of a recommendation from Environmental Instrument Solutions' hydrographer.

The station now comprises of an Insitu Rugged TROLL100 absolute pressure sensor which has been configured to record data at 10 minute intervals.

The atmospheric pressure correcting sensor (BaroLogger) used for correcting the absolute pressure readings for this flow monitoring station is located in the logger box of old Flow Station 6.

1.9 Stoney Creek Up Flow Monitoring Station FM12

This flow monitoring station was installed in December 2015 and is located on Stoney Creek above the proposed area to be mined. GPS co-ordinates are Easting 307607 Northing 6392828. Due to the remote location of this flow station the flow sensor is an Insitu RuggedTROLL 100 absolute pressure sensor. This flow station was re-located during September 2018 approximately 50 metres downstream from its original location following the adoption by Wambo Coal of a recommendation from Environmental Instrument Solutions' hydrographer.

This sensor logs stream height at 10 minute intervals internally.

Figure 1 below presents a view looking upstream of the new location of this flow monitoring station while **Figure 2** presents a view of the flow monitoring station's sensor housing with the sensor inside.

Figure 1 Re-Located Flow Monitoring Station FM12 - Stoney Creek Up – Upstream View – September 2018.

Figure 2 Re-Located Flow Monitoring Station FM12 – Stoney Creek Up – Sensor Housing – September 2018.

1.10 Stoney Creek Tributary Flow Station FM14

This flow station was installed in December 2015 and is located on a major tributary of Stoney Creek above the proposed area to be mined. GPS co-ordinates are Easting 307716 Northing 6392242. Due to the remote location of this flow station the flow sensor is an Insitu RuggedTROLL 100 absolute pressure sensor.

The sensor logs stream height at 10 minute intervals internally.

1.11 Stoney Creek Down Flow Station FM13

This flow station was installed in December 2015 and is located approximately 100m further downstream of Flow Station 7 below the proposed area to be mined. GPS co-ordinates are Easting 309530 Northing 6391043. For continuity with the other two new flow stations the flow sensor at this flow station is an Insitu RuggedTROLL 100 absolute pressure sensor. This flow station was re-located during September 2018 approximately 50 metres upstream from its original location following the adoption by Wambo Coal of a recommendation from Environmental Instrument Solutions' hydrographer.

Figure 3 below presents a view looking upstream of the new location of this flow monitoring station while **Figure 4** presents a view of the flow monitoring station's sensor housing with the sensor inside.

Figure 3 Re-Located Flow Monitoring Station FM13 - Stoney Creek Down – Upstream View – September 2018.

Figure 4 Re-Located Flow Monitoring Station FM13 – Stoney Creek Down – Sensor Housing – September 2018.

1.12 Stoney Creek Barro Correction Sensors.

The absolute pressure readings recorded by the Insitu Rugged TROLL100 sensors utilised in the Stoney Creek Up and Down plus the Tributary Flow Monitoring Stations require correction for fluctuations in atmospheric pressure. To achieve this two Insitu RuggedBARRO sensors set to log atmospheric pressure every 10 minutes, are required due to the vertical height difference between the Stoney Creek Up and Tributary flow stations and the Stoney Creek Down Flow Station.

The atmospheric pressure correction sensor for the Stoney Creek Up and Tributary Flow Stations is located on the infrastructure associated with former Flow Station 8.The atmospheric pressure correction sensor associated with the Stoney Creek Down Flow Station is located on the infrastructure related to former Flow Station 7.

2.0 Summary of Results

Tables 1 to **4** below present a summary of probable flow events for each flow station (including the backup sensors located at flow stations FM1 and FM4) for the period from 1 February 2018 to 31 January 2019.

The results represent a theoretical flow and have been calculated using polynomial equations derived from theoretical flow rating curves. These theoretical flow curves were constructed from data received by AECOM from Wambo Coal and Environmental Instrument Solutions with the exception of the relocated Stoney Creek flow monitoring station and the new monitoring station, Brossi, on South Wambo Creek.

Theoretical flow curves generated by AECOM were utilised to calculate theoretical flow along Stoney Creek and its tributary when probable flow events occurred. No probable flow events were detected at the Stoney Creek Flow Monitoring Station FM12 and FM13 after their relocation in September 2018.

No probable flow events were detected at the new flow monitoring station, Brossi, on South Wambo Creek since its installation in September 2018.

The data for each theoretical flow rating curve has been generated from cross and long section surveys. From the surveys a cross sectional area and the wetted perimeter for various theoretical stream heights were derived.

From these derived values the hydraulic radius was calculated for each theoretical stream height. The hydraulic radius is calculated as follows:

$Rh = A/P$

Where:-

Rh = Hydraulic Radius

A = Calculated cross section area for a give stream height

P = Calculated wetted perimeter for a given stream height

The stream slope was calculated from the long section surveys and the Manning's coefficient of rugosity was determined from the conditions observed in the stream bed and surrounding flood plain.

These values were then entered into the Manning's equation and a theoretical stream velocity was calculated. The Manning's equation is as follows:-

$V = (Rh^{2/3} \text{ X } Sw^{1/2})/n$

Where:-

Rh = Hydraulic radius for a given stream height

Sw = Stream slope derived from the long section survey

n = Manning's coefficient of rugosity

The Manning's coefficient of rugosity was sourced from AS 3778.3.3 - 2001 *"Measurement of water flow in open channels, part 3.3: Velocity - area methods – Measurement by slope – area methods".*

The theoretical velocity, derived from the Manning's equation, was then multiplied by the calculated cross sectional area for a given stream height to give a theoretical flow rate Q. The resultant theoretical flow rates were calculated for a series of stream heights and graphed to generate theoretical flow rating curves. **Appendix B** contains these theoretical flow rating curves for each Flow Monitoring Stations.

Note: AECOM did not perform the re-cross section and re-long section surveys at Flow Monitoring Stations 2 and 4. However a long section only survey at Flow Monitoring Station 3 was performed following the re-adjustment of the sensor height in relation to the cease to flow point. Therefore depicted stream cross section profiles as presented in **Appendix C** are as presented in previous reports for these flow monitoring stations.

The data collected from each Flow Station was presented as a pressure reading in kPa. This pressure was converted to a stream height in metres using the following equation:-

Stream Height (m) = Stream Height (kPa) X 0.101972 (m/kPa)

The calculated stream height was then compared to the cease to flow point at each site. The cease to flow point was identified in conjunction with the long section surveys and represents a point in the reach/stream which the height of the stream must attain before it starts to flow.

The relative level of the cease to flow point was compared to the relative level of the sensor at each station. The difference in height between the cease to flow point and the sensor was calculated. This difference was used to screen the data collected from each station for probable flow events.

Once a flow event had been recognised at a flow monitoring station the resultant stream heights were applied to the polynomial equation derived from theoretical flow rating curve, for that flow station, to give a theoretical stream flow rate for the identified flow event at the station. In some instances more than one polynomial equation was required; see flow rating curves in **Appendix B**.

There were no recordable flow events at the following flow stations during the period 1 February 2018 to 31 January 2019:-

- Old Flow Monitoring Station FM1 Backup Sensor – North Wambo Creek;
- New Flow Monitoring Station Upstream of Old Flow Monitoring Station FM1 – North Wambo Creek;
- Re-Located Flow Monitoring Station FM1A and its backup sensor – North Wambo Creek;
- Flow Monitoring Station FM4 and its backup Sensor – North Wambo Creek;
- Flow Monitoring Station FM15 - South Wambo Creek;
- Flow Monitoring Station FM16 - South Wambo Creek;
- Flow Monitoring Station FM12 (Stoney Creek up) – Stoney Creek, and;
- Flow Monitoring Station FM13 (Stoney Creek Down) - Stoney Creek;

No flow events were recorded at the new flow station (Brossi) on South Wambo Creek since installation in September 2018.

All results displayed in the following tables in respect to stream flow are theoretical and should be treated as such. Note the barometric sensor (baroTROLL) utilised to correct for barometric fluctuations in the data collected from the sensors and backup sensor along North Wambo Creek failed after 8 October 2018. Data from that date to 24 January 2019 cannot be corrected reliably for atmospheric pressure fluctuations and has been excluded.

Table 1 Flow Monitoring Station FM2 North Wambo Creek Mid Old Diversion – Summary of Results – 1 February 2018 to 31 January 2019.

Flow Event No.	Start Date & Time	End Date & Time	Duration (Days)	Average Stream Height (m)	Maximum Stream Height (m)	Average Theoretical Flow Rate		Maximum Theoretical Flow Rate	
						m^3/s	ML/d	m^3/s	ML/d
1	25/02 17:00	25/02 17:40	0.03	0.017	0.028	0.012	1.00	0.019	1.61
2	25/02 19:50	25/02 20:40	0.03	0.006	0.012	0.004	0.34	0.008	0.66
3	26/02 06:20	26/02 11:50	0.23	0.006	0.021	0.004	0.37	0.014	1.21
4	4/03 18:50	4/03 19:30	0.03	0.003	0.006	0.002	0.19	0.004	0.33
5	26/03 06:00	26/03 06:20	0.01	0.002	0.003	0.001	0.09	0.002	0.16
6	4/10 19:00	4/10 21:30	0.10	0.012	0.033	0.008	0.69	0.022	1.90
7	10/10 22:30	10/10 23:00	0.02	0.003	0.004	0.002	0.17	0.003	0.25
8	18/10 17:00	18/10 17:40	0.03	0.010	0.025	0.007	0.57	0.017	1.46
9	28/11 08:40	28/11 09:20	0.03	0.017	0.043	0.011	0.95	0.028	2.46

Table 2 Flow Monitoring Station FM3 North Wambo Creek Mid New Diversion – Summary of Results – 1 February 2018 to 31 January 2019.

Flow Event No.	Start Date & Time	End Date & Time	Duration (Days)	Average Stream Height (m)	Maximum Stream Height (m)	Average Theoretical Flow Rate		Maximum Theoretical Flow Rate	
						m^3/s	ML/d	m^3/s	ML/d
1	25/02 16:30	25/02 18:40	0.09	0.030	0.072	0.020	1.71	0.048	4.15
2	25/02 19:50	25/02 21:40	0.08	0.016	0.036	0.011	0.94	0.024	2.06
3	26/02 06:30	26/02 07:50	0.06	0.018	0.041	0.012	1.06	0.027	2.34

Flow Event No.	Start Date & Time	End Date & Time	Duration (Days)	Average Stream Height (m)	Maximum Stream Height (m)	Average Theoretical Flow Rate		Maximum Theoretical Flow Rate	
						m^3/s	ML/d	m^3/s	ML/d
4	4/03 19:20	4/03 19:50	0.02	0.002	0.004	0.002	0.14	0.002	0.21
5	26/03 05:30	26/03 06:00	0.02	0.015	0.025	0.010	0.84	0.017	1.44
6	4/10 19:10	4/10 21:40	0.10	0.031	0.092	0.020	1.76	0.061	5.30
7	10/10 20:50	11/10 01:40	0.20	0.011	0.020	0.007	0.64	0.013	1.15
8	18/10 17:00	18/10 18:30	0.06	0.018	0.034	0.012	1.03	0.023	1.97
9	15/11 17:20	15/11 17:40	0.01	0.006	0.012	0.004	0.32	0.008	0.69
10	28/11 08:00	28/11 12:50	0.20	0.025	0.118	0.017	1.46	0.078	6.77
11	31/12 19:00	31/12 20:10	0.05	0.022	0.052	0.015	1.26	0.035	2.99
12	21/01 00:40	21/01 04:50	0.17	0.025	0.068	0.017	1.45	0.045	3.88

Table 3 Flow Monitoring Station FM14 (Stoney Creek Tributary) Stoney Creek – 1 February 2018 to 1 January 2019.

Flow Event No.	Start Date & Time	End Date & Time	Duration (Days)	Average Stream Height (m)	Maximum Stream Height (m)	Average Theoretical Flow Rate		Maximum Theoretical Flow Rate	
						m^3/s	ML/d	m^3/s	ML/d
1	23/10 21:58	24/10 07:38	0.40	0.080	0.150	0.024	2.05	0.096	8.30
2	24/10 20:38	25/10 09:28	0.53	0.141	0.183	0.099	8.53	0.176	15.2
3	25/10 21:28	26/10 08:18	0.45	0.172	0.305	0.256	22.1	0.781	67
4	28/10 20:48	29/10 07:38	0.45	0.113	0.169	0.049	4.22	0.138	11.9
5	30/10 02:28	30/10 07:48	0.22	0.105	0.176	0.059	5.06	0.153	13.2
6	7/11 18:58	8/11 08:58	0.58	0.212	0.429	0.599	51.7	1.677	145
7	8/11 22:18	9/11 01:08	0.12	0.030	0.061	0.002	0.13	0.004	0.34
8	9/11 01:48	9/11 07:38	0.24	0.118	0.187	0.075	6.49	0.193	16.6

A summary of total monthly rain fall data presented in **Table 5** below was derived from the Wambo Coal's Meteorological Station located next to the helicopter pad near the Mine Infrastructure Area.

Table 4 Monthly Total Rain Fall Data – 1 February 2018 to 31 January 2019.

Month	Wambo Coal's Meteorological Station Total Rain Fall (mm)	Number of Days Rain Fell in the Month
February – 2018	82.0	5
March – 2018	85.2	7
April – 2018	20.8	5
May – 2018	7.4	3
June – 2018	29.6	12
July – 2018	1.0	2
August – 2018	26.6	4
September – 2018	21.2	10

Month	Wambo Coal's Meteorological Station Total Rain Fall (mm)	Number of Days Rain Fell in the Month
October – 2018	124.0	12
November – 2018	60.6	7
December – 2018	78.2	10
January – 2019	78.2	13

The daily rain fall data was used to cross reference the raw data collected from the Flow Monitoring Stations to help identify periods where a flow event may have occurred.

Appendix C contains graphical depictions on stream height and theoretical flow in conjunction with daily and cumulative rain in three month increments.

- Increment one – 1 February to 30 April 2018;
- Increment two – 1 May to 31 July 2018;
- Increment three – 1 August to 31 October 201, and;
- Increment four – 1 November 2018 to 31 January 2019.

The results presented in the above tables should be read with the following qualifying statements in mind:-

- All flow events represent a theoretical flow and have been derived from stream height data. The stream height data was then applied to polynomial equations derived from theoretical flow rating curves to give a theoretical flow. These theoretical flow rating curves were generated using cross and long section surveys in conjunction with the Manning's equation. These theoretical flow rating curves were constructed by AECOM in 2016 for flow station FM15 while the theoretical rating curves for the remaining flow monitoring station were derived from data points received by AECOM in January 2018 as mentioned above;
- North Wambo, South Wambo and Stoney Creeks are ephemeral and as such only flow after significant rainfall events, therefore the theoretical flow rating curves in **Appendix B** have not been calibrated/checked against actual physical measurements of flow using a current meter;
- Some flow events may have been overlooked due to, but not limited to, poor data quality, data missing, inconsistent data, sensor failure or loss, logger failure, power supply problems and changes to stream bed characteristics;
- The three flow monitoring stations installed on Stoney Creek and its associated tributary have been positioned such as to be outside a proposed underground mine area and designed to monitor stream flow and any associated effect of underground mining on stream flow. These stations were installed by AECOM on 7 December 2016 and replace flow monitoring stations 7 and 8;
- The flow monitoring stations FM12 and FM 13 located on Stoney Creek were relocated during September 2018. AECOM performed the cross and long section survey and provided this information to Wambo Coal Environmental Team for forwarding onto their contracted hydrographer. At the time this report was being written the resultant theoretical flow curves had not been received by AECOM. However this has had no impact on presenting any results since the relocation of these flow monitoring stations due to no observed flow events, and;
- Flow Monitoring Station 9 on South Wambo Creek approximately 2 kilometres upstream from its original location. As with the relocation of FM 12 and 13 AECOM performed the cross and long section survey and provided this information to Wambo Coal Environmental Team for forwarding onto their contracted hydrographer. At the time this report was being written the resultant theoretical flow curve had not been received by AECOM. However this has had no impacted on presenting any results since the installation of this flow monitoring stations due to observed flow events.

3.0 Recommendations

The following actions are recommended by AECOM to help improve the quality of the data received from the flow monitoring stations at Wambo Coal:-

- Following the failure of the barometric correction sensor utilised to correct for difference in barometric pressure for the sensors located on North Wambo Creek at New Flow Monitoring Station Upstream of Old FM1 backup sensor at Old FM1, New FM1A and FM4 due its age. AECOM recommends that the backup sensor at Old Flow Monitoring Station 1 and 4 be replaced as a priority as these are of the same age as this barometric correction sensor and could possibly fail soon; and
- The GPS location of all flow monitoring stations and where applicable the barometric correction sensor be determined along with the elevation. The GPS location then supplied to Wambo Coal Environmental so they can prepare a map showing the locations of each flow monitoring station which can be used in response to an emergency (rescue team knows where to go) and included in the annual stream flow report;

If you have any questions or require any clarification of aspects in this report please contact us in the Singleton office.

Yours faithfully

p.p.

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encl: Appendix A - Flow Station Field Sheets and Station Data Logger Status Sheets.
Appendix B - Theoretical Flow Rating Curves.
Appendix C - Stream Height, Theoretical Flow, Daily and Cumulative Rainfall Charts.

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 5/2/18

Station ID: SCTRIB Time: 9 00

Solar Panel Condition: NA

Solar Panel Output: NA (V) Solar Panel Cleand: ~~Y / N~~ NA

Battery Voltage: NA Battery Replaced: ~~Y / N~~ NA

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used = 100% Data wrap On
Battery Used = 20%

Station ID: SCUP Time: 935

Solar Panel Condition: NA

Solar Panel Output: NA (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: NA Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used = 100 Data wrap ON
Battery Used 18%

Initials:

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 5/2/18

Station ID: Stony Ck Barrop Time: 1020

Solar Panel Condition: NA

Solar Panel Output: NA (V) Solar Panel Cleand: Y / N

Battery Voltage: NA Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: ~~Dry No Flow Flow~~

General Site Observation: Memory Used = 100% Data Wiped Out
Battery Used = 18%

Station ID: Stony Ck Down Time: 1030

Solar Panel Condition: NA

Solar Panel Output: NA (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: NA Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used = 100% Data Wiped Out
Battery Used = 20%

Initials: [signature]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 5/2/18

Station ID: Stony Dams Bores Time: 1100

Solar Panel Condition:

Solar Panel Output: NA (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: NA Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used = 100% Data Wipe on
Battery Used = 18%

Station ID: F5 Time: 1130

Solar Panel Condition: N/A

Solar Panel Output: NA (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: N/A Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used = 50% Data wipe on
Battery Used - 99%

Initials:

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 5/2/18

Station ID: 6 Time: 1145

Solar Panel Condition: NA

Solar Panel Output: NA (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: NA Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: MEMORY USED – 50%

BATTERY USED – 9%

Station ID: ST WAMBO BACKO Time: 1150

Solar Panel Condition: NA

Solar Panel Output: NA (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: NA Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation:

Initials: [signature]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 6/2/18

Station ID: S4 Time: 945

Solar Panel Condition: Very Dusty

Solar Panel Output: 19.46 (V) Solar Panel Cleand: Y / N

Battery Voltage: 13.34 Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation:

Station ID: S4BU Time: 1000

Solar Panel Condition: NA

Solar Panel Output: NA (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: NA Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used = 100% Data wrap on
Battery Used = 41%

Initials: [signature]

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60246366 Date: 6/2/18

Station ID: 3 Time: 1015

Solar Panel Condition: Bird Droppings

Solar Panel Output: 20.12 (V) Solar Panel Cleand: Y / N

Battery Voltage: 13.28 Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation:

Station ID: Sth Wambo Ck U/S Time: 1045

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: Y / N

Battery Voltage: N/A Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used 12 % Data Wipe on

Battery Used 1 %

Initials:

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 6/2/18

Station ID: FM1 old Location Time: 1110

Solar Panel Condition: Backup Sensor N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: N/A Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used = 100% Data wrap on

Battery Used = 42%

Station ID: FM1 New location Time: 1125

Solar Panel Condition: Good

Solar Panel Output: Cycling (V) Solar Panel Cleand: Y / N

Battery Voltage: 13.91 Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation:

Initials:

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 6/2/18

Station ID: FM1 New location Backup Sensor Time: 11:30

Solar Panel Condition: —

Solar Panel Output: NA (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: NA Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used 12 % Data Wrap Off

Battery Used 1 %

Station ID: FM2 Time: 1155

Solar Panel Condition: Good

Solar Panel Output: ~~[illegible]~~ 21.28 (V) Solar Panel Cleand: Y / N

Battery Voltage: 13.28 Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation:

Initials: [signature]

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Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 6/2/18

Station ID: Nth Wambo Ck Time: 1200

Solar Panel Condition: — NA

Solar Panel Output: NA (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: NA Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used = 100% Data Battery Used = 0.6% wrap on

Station ID: Time:

Solar Panel Condition:

Solar Panel Output: (V) Solar Panel Cleand: Y / N

Battery Voltage: Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: Current Offset: Datum Changed: Y / N

New Datum: New Offset:

Stream Obsevations: Dry No Flow Flow

General Site Observation:

Initials:

60248386 - Wambo Flow Station 1 CR800 Data Logger Status Summary 6/02/2018 10:23:58

Datalogger Information

Reported Station Name: 6722
OS Version: CR800.Std.27
OS Date: 131010
OS Signature: 6757
PakBus Address: 801
Security Settings(1): 0
Security Settings(2): 0
Security Settings(3): 0
Panel Temperature: 33.81 °C
Memory: 4194304 bytes
CPU Drive Free: 442368 bytes
USR Drive Free: 0 bytes
Watchdog Errors: 1 - Reset this value. If errors continue, contact Campbell Scientific.

Program Information

Current Program: CPU:WaterLevel_V2_1A_10.CR8
Start Time: 13/12/2017 11:24:39
Run Signature: 52401
Program Signature: 58453
Results for Last Program Compiled: CPU:WaterLevel_V2_1A_10.CR8 -- Compiled in SequentialMode.
Memory Free: 21644 bytes

Program Errors

Program Errors: 0
Skipped Scans: 0
Skipped Slow Scans: 0
Skipped System Scans: 0
Skipped Records in Hourly: 0
Skipped Records in Daily: 0
Skipped Records in BatteryData: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.91
Lithium Battery: 3.43
Number of times the datalogger's 12V supply has dropped below operating threshold: 4 - Check your battery
Number of times voltage has dropped below 5V: 0

60248386 - Wambo Flow Station 2 CR200 Series Data Logger Status Summary 6/02/2018 10:54:30

Datalogger Information

OS Version: v07
OS Date: 090723
PakBus Address: 2
Watchdog Errors: 0

Program Information

Current Program: WaterLevel_CSA.

Program Errors

Skipped Scans: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.34

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

60248386 - Wambo Flow Station 3 CR200 Series Data Logger Status Summary 6/02/2018 09:16:25

Datalogger Information

OS Version: v07
OS Date: 090723
PakBus Address: 3
Watchdog Errors: 0

Program Information

Current Program: WaterLevel_CSA.

Program Errors

Skipped Scans: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.27

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

60248386 - Wambo Flow Station 4 CR200 Series Data Logger Status Summary
6/02/2018 09:48:31

Datalogger Information
OS Version: CR200X.Std.01
OS Date: 100810
PakBus Address: 4
Watchdog Errors: 0

Program Information
Current Program: WaterLevel_CSA_V2a.CR2

Program Errors
Skipped Scans: 0
Variable Out of Bounds: 0

Battery Information
Battery Voltage: 13.36

RF Information
Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

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Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 28/5/18

Station ID SCTRIB Time: 9:40

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: ~~Y / N~~ N/A

Battery Voltage: N/A Battery Replaced: Y / N N/A

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory used = 100%. Data wrap on

Battery used = 22%.

Station ID: SC up Time: 10:35

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: ~~Y / N~~ N/A

Battery Voltage: N/A Battery Replaced: ~~Y / N~~ N/A

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: MEMORY USED = 100%. DATA WRAP ON

BATTERY USED = 21%.

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Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 24/5/18

Station ID: STONEY CK DAM Time: 11:24

Solar Panel Condition: N/A

Solar Panel Output: NA (V) Solar Panel Cleand: ~~Y / N~~ N/A

Battery Voltage: N/A Battery Replaced: ~~Y / N~~ N/A

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: ~~Dry~~ ~~No Flow~~ ~~Flow~~

General Site Observation: MEMORY USED = 100% BATM WRAP ON
BATTERY USED = 21%

Station ID: STONEY CK DAM Time: 12:00

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: ~~Y / N~~ NA

Battery Voltage: N/A Battery Replaced: ~~Y / N~~ N/A

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: MEMORY USED = 100% BATM WRAP ON
BATTERY USED = 22%

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AECOM

Quarterly Flow Station Field Sheet

Client: Warnbo Project Number: 60248386 Date: 24/5/18

Station ID: STONEY CREEK DOWN JARRO Time: 12:10

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: Y / N

Battery Voltage: N/A Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — ~~Datum Changed: Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: MEMORY USED = 100% DATA WRAP ON

BATTERY USED < 21

& Dirt in Sensor

Station ID: FS 6 Time: 1250

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) ~~Solar Panel Cleand: Y / N~~

Battery Voltage: N/A ~~Battery Replaced: Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: Current Offset: Datum Changed: Y / N

New Datum: New Offset:

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory Used = 62%

Battery Used = 11%

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Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 24/5/18

Station ID: SH Wambo Crk Barro Time: 13:00

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: Y / N

Battery Voltage: N/A Battery Replaced. Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: ______ Current Offset: ______ Datum Changed: Y / N

New Datum: ______ New Offset: ______

Stream Obsevations: Dry No Flow Flow

General Site Observation: MEMORY USED : 62%

~~DATA~~ BATTERY USED : 11%

Station ID: ______ Time: ______

Solar Panel Condition: ______

Soler Panel Output: ______ (V) Solar Panel Cleand: Y / N

Battery Voltage: ______ Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: ______ Current Offset: ______ Datum Changed: Y / N

New Datum: ______ New Offset: ______

Stream Obsevations: Dry No Flow Flow

General Site Observation: ______

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Quarterly Flow Station Field Sheet

Client: Wambo Project Number. 60248386 Date: 28.05.18

Station ID: S4 Time: 09:20

Solar Panel Condition: VERY DUSTY

Solar Panel Output: 19.86 (V) Solar Panel Cleand: Y / N

Battery Voltage: 13.61 Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation:

Station ID: S4 B4 Time: 9:45

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: NA Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: USED MEMORY = 100 % [illegible] WARNS
BATTERY USED = 41 %

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Quarterly Flow Station Field Sheet

Client: Wambo   Project Number: 60248386   Date: 28-05-18

Station ID: 3 "Site 3" (Campbell)   Time: 10:00   – reinstalled 22/5/13

Solar Panel Condition: VERY DUSTY

Solar Panel Output: 18.45 (V)   Solar Panel Cleand: Y / N

Battery Voltage: 13.50   Battery Replaced: Y / N

Data Collected: Y / N   Sensor Operating: Y / N   Logger Operating: Y / N

Current Datum: –   Current Offset: –   ~~Datum Changed: Y / N~~

New Datum: –   New Offset: –

Stream Obsevations: Dry   No Flow   Flow

General Site Observation: SENSOR COVERED WITH MUD (DAMP)

Station ID: Nth Wambo Ck u/s Rail   Time: 11:10

Solar Panel Condition: N/A

Solar Panel Output: N/A (V)   Solar Panel Cleand: ~~Y / N~~

Battery Voltage: N/A   Battery Replaced: ~~Y / N~~

Data Collected: Y / N   Sensor Operating: Y / N   Logger Operating: Y / N

Current Datum: –   Current Offset: –   Datum Changed: Y / N

New Datum: New Offset:

Stream Obsevations: Dry   No Flow   Flow

General Site Observation. memory used = 25% . DATA wrapon

Battery used = 3%

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Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60246386 Date: 28/5/18

Station ID: FM1 old location Backup sensor Time: 11:32

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: Y / N N/A

Battery Voltage: N/A Battery Replaced: Y / N N/A

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory used = 100% Data wrapped

Battery used = 45%

Station ID: FM1 new location Time: 1145

Solar Panel Condition: DIRTY

Solar Panel Output: cycling (V) Solar Panel Cleand: Y / N

Battery Voltage: 14.03 Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation:

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AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 25/5/18

Station ID: FM / New [illegible] Back up sensor Time: 1155

Solar Panel Condition: —

Solar Panel Output: N/A (V) Solar Panel Cleand: Y / N

Battery Voltage: N/A Battery Replaced: Y / N

Date Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: memory used 25% [illegible] wrap on
Battery used 3%

Station ID: FMn Time: 12:20

Solar Panel Condition: Dirty

Solar Panel Output: 18.501 (V) Solar Panel Cleand: Y / N

Battery Voltage: 13.42 Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation:

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AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 25/5/18

Station ID: Nth Wambo Ck. Time: 1230

Solar Panel Condition: — N/A

Solar Panel Output: n/a (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: n/a Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: memory used = 100%.

battery used = 87%.

Station ID: ______ Time: ______

Solar Panel Condition: ______

Solar Panel Output: ______ (V) Solar Panel Cleand: Y / N

Battery Voltage: ______ Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: ______ Current Offset: ______ Datum Changed: Y / N

New Datum: ______ New Offset: ______

Stream Obsevations: Dry No Flow Flow

General Site Observation: ______

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Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 28/5/18

Station ID: FS5 Time: 15:00

STH WAMBO CREEK

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: ~~Y / N~~ N/A

Battery Voltage: N/A Battery Replaced: ~~Y / N~~ N/A

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: memory used = 62 % data wrap on

Battery used = 11 %

Station ID: FS6 Time: 1315

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: ~~Y / N~~ N/A

Battery Voltage: N/A Battery Replaced: ~~Y / N~~ N/A

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: memory used = 62 % data wrap on

battery used = 11 %

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Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 28/5/18

Station ID: 5th Wambo Creek Sand Time: 15:20

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: ~~Y / N~~ N/A

Battery Voltage: N/A Battery Replaced: ~~Y / N~~ N/A

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: 62 %

41 %

Station ID: ______ Time: ______

Solar Panel Condition: ______

Solar Panel Output: ______ (V) Solar Panel Cleand: Y / N

Battery Voltage: ______ Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: ______ Current Offset: ______ Datum Changed: Y / N

New Datum: ______ New Offset: ______

Stream Obsevations: Dry No Flow Flow

General Site Observation: ______

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60248386 – Wambo Flow Station 4 CR200 Series Data Logger Status Summary 28/05/2018 09:31:29

Datalogger Information

OS Version: CR200X.Std.01
OS Date: 100810
PakBus Address: 4
Watchdog Errors: 0

Program Information

Current Program: WaterLevel_CSA_V2a.CR2

Program Errors

Skipped Scans: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.64

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

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Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 8/8/18

Station ID: SCT R16 Time: 9.05

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: ~~Y / N~~ N/A

Battery Voltage N/A Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory used = 100 % Data wrapping
Battery used = 24 %.

Station ID: SCUP Time: 9:40

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: N/A Battery Replaced: Y / N N/A

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory used = 100 %. Data wrapping
Battery used = 22 %

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Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 8/8/18

Station ID: STONEY CK DAMN Time: 10:10

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: N/A Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry ~~No Flow Flow~~

General Site Observation: MEMORY USED = 100 % DATA WRAPON
BATTERY USED = 22 %

Station ID: STONEY CK DAM Time: 10:35

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: ~~Y / N~~ N/A.

Battery Voltage: N/A Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: MEMORY USED = 100 % DATA WRAP ON
BATTERY USED = 24 %

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Quarterly Flow Station Field Sheet

Client: Wambo　Project Number: 60248386　Date: 8/8/18

Station ID: STONEY CREEK DOWN WARRO　Time: 10:50

Solar Panel Condition: N/A

Solar Panel Output: N/A (V)　Solar Panel Cleand: ~~Y / N~~ N/A

Battery Voltage: N/A　Battery Replaced: ~~Y / N~~

Data Collected: Y / N　Sensor Operating: Y / N　Logger Operating: Y / N

Current Datum: —　Current Offset: —　Datum Changed ~~Y / N~~

New Datum: —　New Offset: —

Stream Obsevations: Dry　No Flow　Flow

General Site Observation: MEMORY USED = 100% DATA WRAP ON
BATTERY USED = 22%

Station ID: FS5 South Wambo　Time: 11:10

Solar Panel Condition: N/A

Solar Panel Output: N/A (V)　Solar Panel Cleand: ~~Y / N~~ N/A

Battery Voltage: N/A　Battery Replaced: ~~Y / N~~

Data Collected: Y / N　Sensor Operating: Y / N　Logger Operating: Y / N

Current Datum: —　Current Offset: —　Datum Changed ~~Y / N~~

New Datum: —　New Offset: —

Stream Obsevations: Dry　No Flow　Flow

General Site Observation: MEMORY USED = 71%
BATTERY = 15%

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Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 8/8/18

Station ID: FS6 Time: 1125

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: Y / N N/A

Battery Voltage: N/A Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: MEMORY USED = 71%. DATA WRAP ON
BATTERY USED 13%

Station ID: South Wambo Creek BARRD Time: 11:30

Soler Panel Condition: N/A

Solar Panel Output: N/A (V) Soler Panel Cleand Y / N N/A

Battery Voltage: N/A Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry ~~No Flow Flow~~

General Site Observation: MEMORY USED 71%. DATA WRAP ON
BATTERY USED 15%.

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Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 9/8/18

Station ID: SU Time: 8:50

Solar Panel Condition: OK

Solar Panel Output: 18.48 (V) Solar Panel Cleand: Y / N

Battery Voltage: 13.72 Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation:

Station ID: S4 Bu Time: 9:05

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: Y / N

Battery Voltage: N/A Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — ~~Datum Changed: Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: USED MEMORY 100% - DATA WRAP ON
USED BATTERY 45%.

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Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 9/8/18

Station ID: 3 Time: 930

Solar Panel Condition: Dusty

Solar Panel Output: 19.92 (V) Solar Panel Cleand: Y / N

Battery Voltage: 13.58 Battery Replaced Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~ —

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Stream dry but sensor in a small pool of muddy water

Station ID: u/s FM1 (nth wambo ck) Time: 10:15

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand. Y / N

Battery Voltage: N/A Battery Replaced Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~ n/a

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: memory used 31%. Data went on Battery used 5%

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Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 9/8/18

Station ID: FM1 old location B/H sensor Time: 10:40

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: N/A Battery Replaced: Y / N N/A

Data Collected Y / N Sensor Operating Y / N Logger Operating Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation. MEMORY USED = 100% DATA WRAP ON

BATTERY USED = 86%.

Station ID: FM1 NEW LOCATION Time: 10:50

Solar Panel Condition. DIRTY

Solar Panel Output: cycling (V) Solar Panel Cleand Y / N

Battery Voltage: 14.11 Battery Replaced Y / N

Data Collected Y / N Sensor Operating Y / N Logger Operating Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation:

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AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 9/8/18

Station ID: FM1 NEW LOCATION S/M SENSOR Time: 11 10

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: ~~Y / N~~ N/A

Battery Voltage: N/A Battery Replaced: ~~Y / N~~ N/A

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: MEMORY USED 31%. Bat was on

Battery USED = 5%

Station ID: FM2 Time: 11:40

Solar Panel Condition: DIRTY

Solar Panel Output: 18.55 (V) Solar Panel Cleand: Y / N

Battery Voltage: 13.45 Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation:

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AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248366 Date: 9/8/18

Station ID: NTH WAMBO C.K Time: 11:45

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: ~~Y / N~~ N/A

Battery Voltage: N/A Battery Replaced: ~~Y / N~~ N/A

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: MEMORY USED = 100%.

BATTERY USED = 48%.

Station ID: ________ Time: ________

Solar Panel Condition: ________

Solar Panel Output: ________ (V) Solar Panel Cleand: Y / N

Battery Voltage: ________ Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: ________ Current Offset: ________ Datum Changed: Y / N

New Datum: ________ New Offset: ________

Stream Obsevations: Dry No Flow Flow

General Site Observation: ________

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60248386 – Wambo Flow Station 1 CR800 Data Logger Status Summary 9/08/2018 10:56:17

Datalogger Information

Reported Station Name: 6722
OS Version: CR800.Std.27
OS Date: 131010
OS Signature: 6757
PakBus Address: 801
Security Settings(1): 0
Security Settings(2): 0
Security Settings(3): 0
Panel Temperature: 22.47 °C
Memory: 4194304 bytes
CPU Drive Free: 442368 bytes
USR Drive Free: 0 bytes
Watchdog Errors: 0

Program Information

Current Program: CPU:WaterLevel_V2_1A_10.CR8
Start Time: 13/12/2017 11:24:39
Run Signature: 52401
Program Signature: 58453
Results for Last Program Compiled: CPU:WaterLevel_V2_1A_10.CR8 -- Compiled in SequentialMode.
Memory Free: 21644 bytes

Program Errors

Program Errors: 0
Skipped Scans: 0
Skipped Slow Scans: 0
Skipped System Scans: 0
Skipped Records in Hourly: 0
Skipped Records in Daily: 0
Skipped Records in BatteryData: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 14.03
Lithium Battery: 3.36
Number of times the datalogger's 12V supply has dropped below operating threshold: 0
Number of times voltage has dropped below 5V: 0

60248386 – Wambo Flow Station 2 CR200 Series Data Logger Status Summary 9/08/2018 11:37:40

Datalogger Information

OS Version: v07
OS Date: 090723
PakBus Address: 2
Watchdog Errors: 0

Program Information

Current Program: WaterLevel_CSA.

Program Errors

Skipped Scans: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.52

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

60248386 – Wambo Flow Station 3 CR200 Series Data Logger Status Summary
9/08/2018 09:35:51

Datalogger Information
OS Version: v07
OS Date: 090723
PakBus Address: 3
Watchdog Errors: 0

Program Information
Current Program: WaterLevel_CSA.

Program Errors
Skipped Scans: 0
Variable Out of Bounds: 0

Battery Information
Battery Voltage: 13.61

RF Information
Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

60248386 – Wambo Flow Station 4 CR200 Series Data Logger Status Summary
9/08/2018 08:58:11

Datalogger Information
OS Version: CR200X.Std.01
OS Date: 100810
PakBus Address: 4
Watchdog Errors: 0

Program Information
Current Program: WaterLevel_CSA_V2a.CR2

Program Errors
Skipped Scans: 0
Variable Out of Bounds: 0

Battery Information
Battery Voltage: 13.72

RF Information
Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 16/11/18

Station ID: S4 Time: 830

Solar Panel Condition: Dirty

Solar Panel Output: 17.81 (V) Solar Panel Cleand: Y / N

Battery Voltage: 13.50 Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed. Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: pooled water from recent rainfall

Station ID: S4 By Time: 845

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: N/A Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations. Dry No Flow Flow

General Site Observation: USED MEMORY 100% DATA LOADED ON

USED BATTERY 47%

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AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 16/11/18

Station ID: S3 Time: 9:05

Solar Panel Condition: DIRTY

Solar Panel Output: 19.77 (V) Solar Panel Cleand: Y / N

Battery Voltage: 13.55 Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Pools of water in creek.

Sensor under pool of water.

Station ID: NTH WAMBO CREEK U/S FM1 Time: 9:50

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: N/A Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: MEMORY USED = 43%. BATT WARNING

BATTERY USED = 7%

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AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 16/11/16

Station ID: FM1 OLD LOCATION Blue SENSOR Time: 10:15

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: Y / N

Battery Voltage: N/A Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: MEMORY USED = 100% DATA WRAP ON BATTERY USED = 46%

Station ID: FM1 NEW LOCATION Time: 10:35

Solar Panel Condition: GLASS SCREEN SHATTERED - NEEDS REPLACING.

Solar Panel Output: Cycles (V) Solar Panel Cleand: Y / N

Battery Voltage: 14.08 Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: Solar panels protective glass needs replacing. Solar panel still operating as battery charging

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AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number. 60248388 Date: 11/11/18

Station ID: FM1 NEW LOCATION B/M SENSOR Time: 10:50

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: N/A Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: ~~Y / N~~

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation. MEMORY USED = 43% DATA WRAP ON BATTERY USED = 7%

Station ID: FM2 Time: 1115

Solar Panel Condition: DIRTY

Solar Panel Output: 18.20 (V) Solar Panel Cleand: Y / N

Battery Voltage: 13.51 Battery Replaced: Y / N

Date Collected: Y / N Sensor Operating. Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations. Dry No Flow Flow

General Site Observation: POOLS OF WATER IN CREEK

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AECOM

Quarterly Flow Station Field Sheet

Client: Wambo　　Project Number: 60248386　　Date: 16/11/15

Station ID: NTH WAMBO CK　　Time: 11:50

Solar Panel Condition: N/A

Solar Panel Output: N/A (V)　　Solar Panel Cleand: ~~Y / N~~ N/A

Battery Voltage: N/A　　Battery Replaced: ~~Y / N~~

Data Collected: Y / N　　Sensor Operating: Y / N　　Logger Operating: Y / N

Current Datum: —　　Current Offset: —　　Datum Changed: Y / N

New Datum: —　　New Offset: —

Stream Obsevations: Dry　No Flow　Flow

General Site Observation. MEMORY USED = 100 % DATA WRAP ON

BATTERY USED = 15 14% — USED 10%

Station ID: ______　　Time: ______

Solar Panel Condition: ______

Solar Panel Output: ______ (V)　　Solar Panel Cleand: Y / N

Battery Voltage. ______　　Battery Replaced: Y / N

Data Collected: Y / N　　Sensor Operating: Y / N　　Logger Operating: Y / N

Current Datum: ______　　Current Offset: ______　　Datum Changed: Y / N

New Datum: ______　　New Offset: ______

Stream Obsevations. Dry　No Flow　Flow

General Site Observation: ______

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AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 19/11/18

Station ID: SCTRID Time: 9:20

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: N/A Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: MEMORY USED = 100%. DATA WRAPPING

BATTERY USED = 76%

Station ID: SCUP Time: 10:10

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: N/A Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: MEMORY USED = 100%. DATA WRAPPING

BATTERY USED = 75%.

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AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 15/11/18

Station ID: SYDNEY CK / SHARO Time: 1045

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: N/A Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: MEMORY USED = 100%. DATA WRAP ON
BATTERY USED = 25%.

Station ID: BROSS1 Time: 11:30

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: N/A Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: ~~Y / N~~

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: MEMORY USED 17%. DATA WRAP ON
BATTERY USED = 11%.

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Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 15/11/18

Station ID: STONEY CK DOWN Time: 11:55

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: Y / N

Battery Voltage: N/A Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: MEMORY USED = 100%. DATA WRAP ON
BATTERY USED = 26%.

Station ID: STONEY CK DOWN BANK Time: 12:10

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: Y / N

Battery Voltage: N/A Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation:
MEMORY USED = 100%. DATA WRAP ON
BATTERY USE = 25%.

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AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number. 60248386 Date: 19/11/18

Station ID: FS5 South Wambo Time: 12:30

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: Y / N

Battery Voltage: N/A Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: memory used = 84% data wrap on
battery used = 15%

Station ID: FS6 Time: 1250

Solar Panel Condition: N/A

Solar Panel Output: N/A (V) Solar Panel Cleand: Y / N

Battery Voltage: N/A Battery Replaced. Y / N

Data Collected: Y / N Sensor Operating Y / N Logger Operating: Y / N

Current Datum. — Current Offset: — Datum Changed: Y / N

New Datum: — New Offset: —

Stream Obsevations: Dry No Flow Flow

General Site Observation: memory used = 84% data wrap on
battery used = 15%.

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AECOM

Quarterly Flow Station Field Sheet

Client: Wambo Project Number: 60248386 Date: 19/11/18

Station ID: South Wambo Ck. Barro Time: 1300

Solar Panel Condition. n/a

Solar Panel Output. n/a (V) Solar Panel Cleand: ~~Y / N~~

Battery Voltage: n/a Battery Replaced: ~~Y / N~~

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum —— Current Offset: —— Datum Changed: Y / N

New Datum: —— New Offset: ——

Stream Obsevations: Dry No Flow Flow

General Site Observation: Memory used = 84 / Data wrapped

Battery used = 15

Station ID. ________ Time: ________

Solar Panel Condition: ________

Solar Panel Output. ________ (V) Solar Panel Cleand: Y / N

Battery Voltage: ________ Battery Replaced: Y / N

Data Collected: Y / N Sensor Operating: Y / N Logger Operating: Y / N

Current Datum: ________ Current Offset: ________ Datum Changed: Y / N

New Datum. ________ New Offset: ________

Stream Obsevations: Dry No Flow Flow

General Site Observation: ________

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60248386 – Wambo Flow Station 1 CR800 Data Logger Status Summary 16/11/2018 10:46:22

Datalogger Information

Reported Station Name: 6722
OS Version: CR800.Std.27
OS Date: 131010
OS Signature: 6757
PakBus Address: 801
Security Settings(1): 0
Security Settings(2): 0
Security Settings(3): 0
Panel Temperature: 20.61 °C
Memory: 4194304 bytes
CPU Drive Free: 442368 bytes
USR Drive Free: 0 bytes
Watchdog Errors: 0

Program Information

Current Program: CPU:WaterLevel_V2_1A_10.CR8
Start Time: 13/12/2017 11:24:39
Run Signature: 52401
Program Signature: 58453
Results for Last Program Compiled: CPU:WaterLevel_V2_1A_10.CR8 -- Compiled in SequentialMode.
Memory Free: 21644 bytes

Program Errors

Program Errors: 0
Skipped Scans: 0
Skipped Slow Scans: 0
Skipped System Scans: 0
Skipped Records in Hourly: 0
Skipped Records in Daily: 0
Skipped Records in BatteryData: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 14.03
Lithium Battery: 3.34
Number of times the datalogger's 12V supply has dropped below operating threshold: 0
Number of times voltage has dropped below 5V: 0

60248386 - Wambo Flow Station 2 CR200 Series Data Logger Status Summary 16/11/2018 11:26:41

Datalogger Information

OS Version: v07
OS Date: 090723
PakBus Address: 2
Watchdog Errors: 0

Program Information

Current Program: WaterLevel_CSA.

Program Errors

Skipped Scans: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.53

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

60248386 – Wambo Flow Station 3 CR200 Series Data Logger Status Summary 16/11/2018 09:19:31

Datalogger Information

OS Version: v07
OS Date: 090723
PakBus Address: 3
Watchdog Errors: 0

Program Information

Current Program: WaterLevel_CSA.

Program Errors

Skipped Scans: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.54

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

60248386 – Wambo Flow Station 4 CR200 Series Data Logger Status Summary 16/11/2018 08:39:41

Datalogger Information

OS Version: CR200X.Std.01
OS Date: 100810
PakBus Address: 4
Watchdog Errors: 0

Program Information

Current Program: WaterLevel_CSA_V2a.CR2

Program Errors

Skipped Scans: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.52

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

Appendix B

Stream Theoretical Flow Rating and Profile Curves

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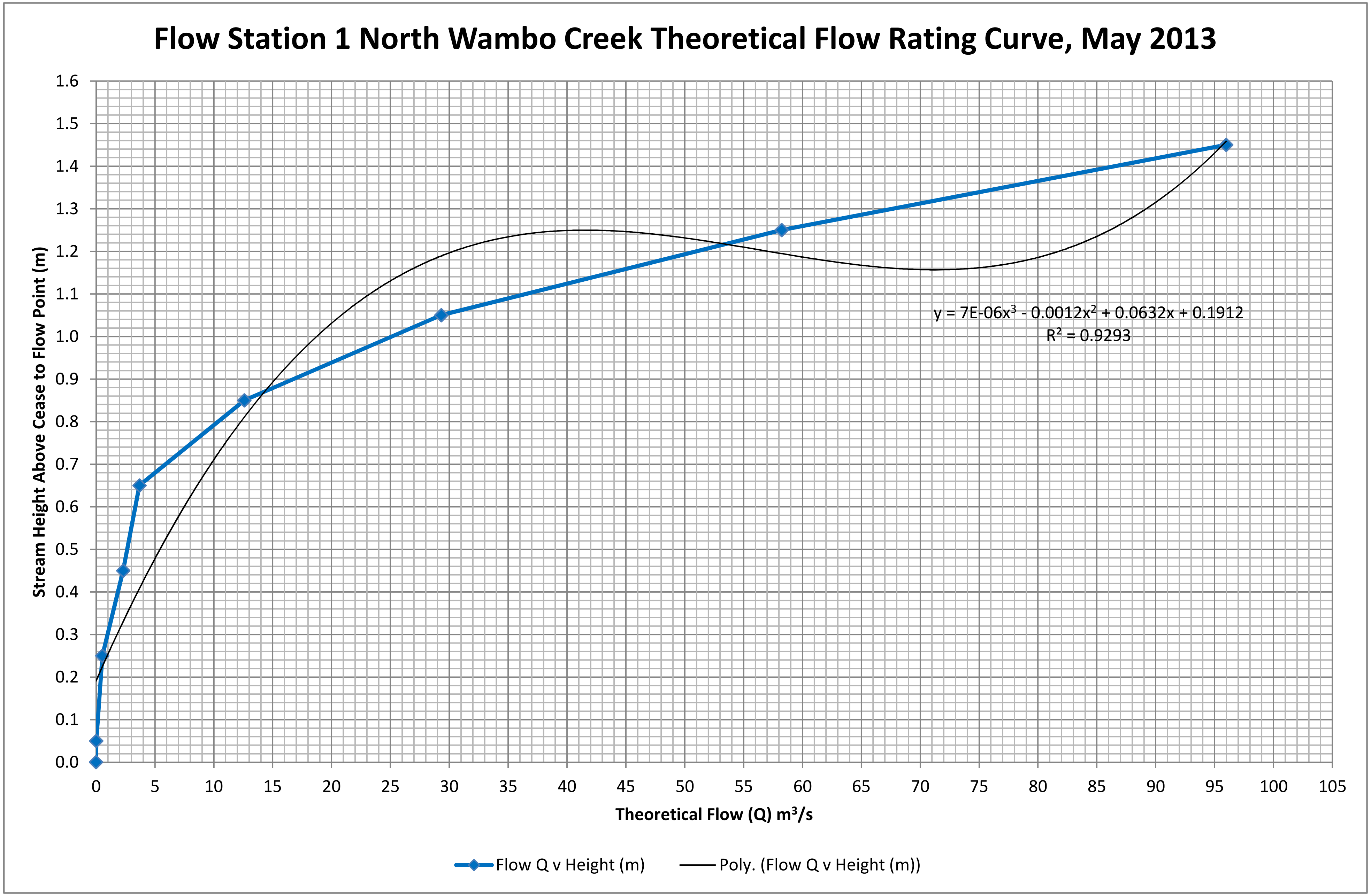
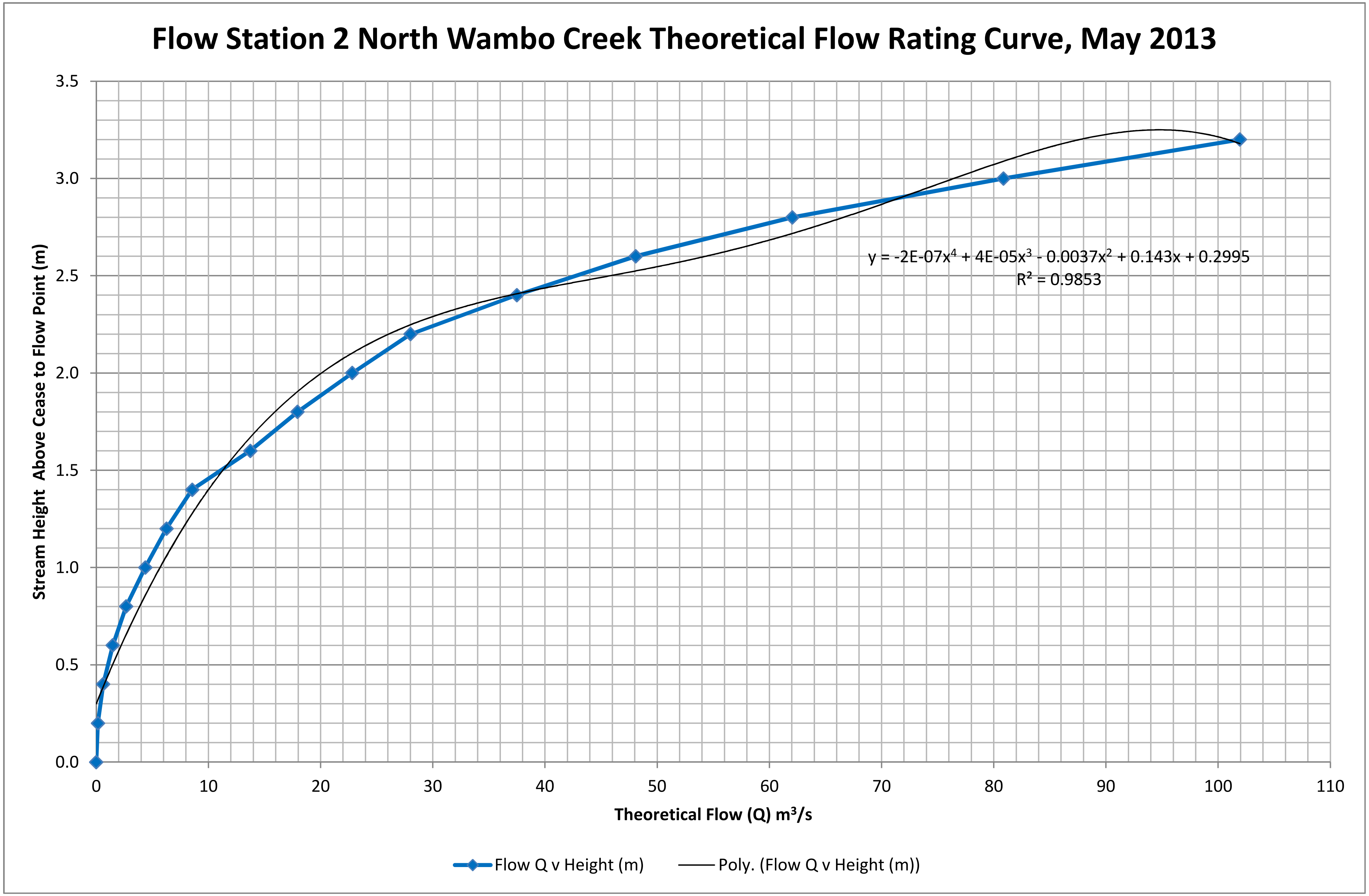
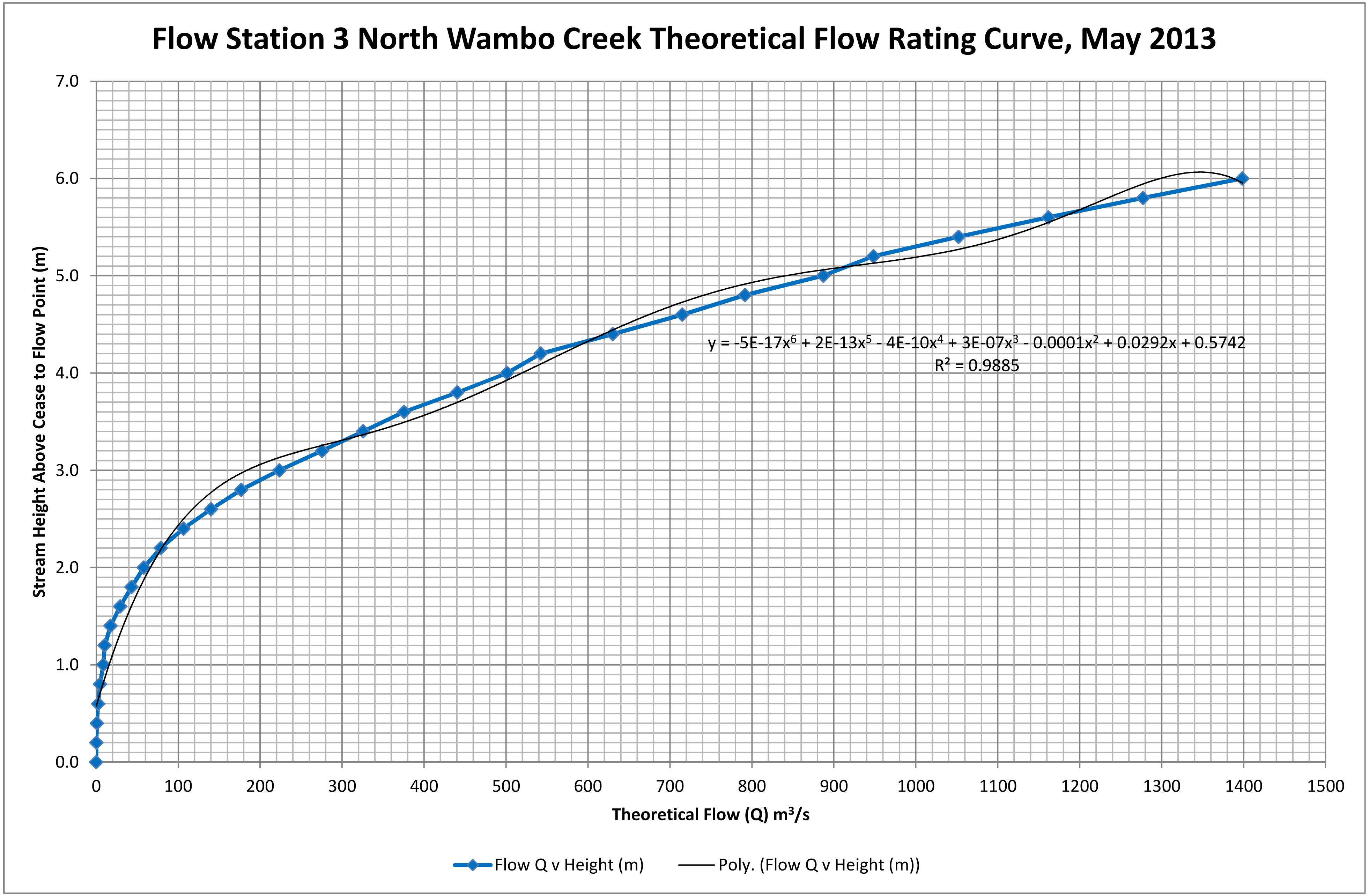
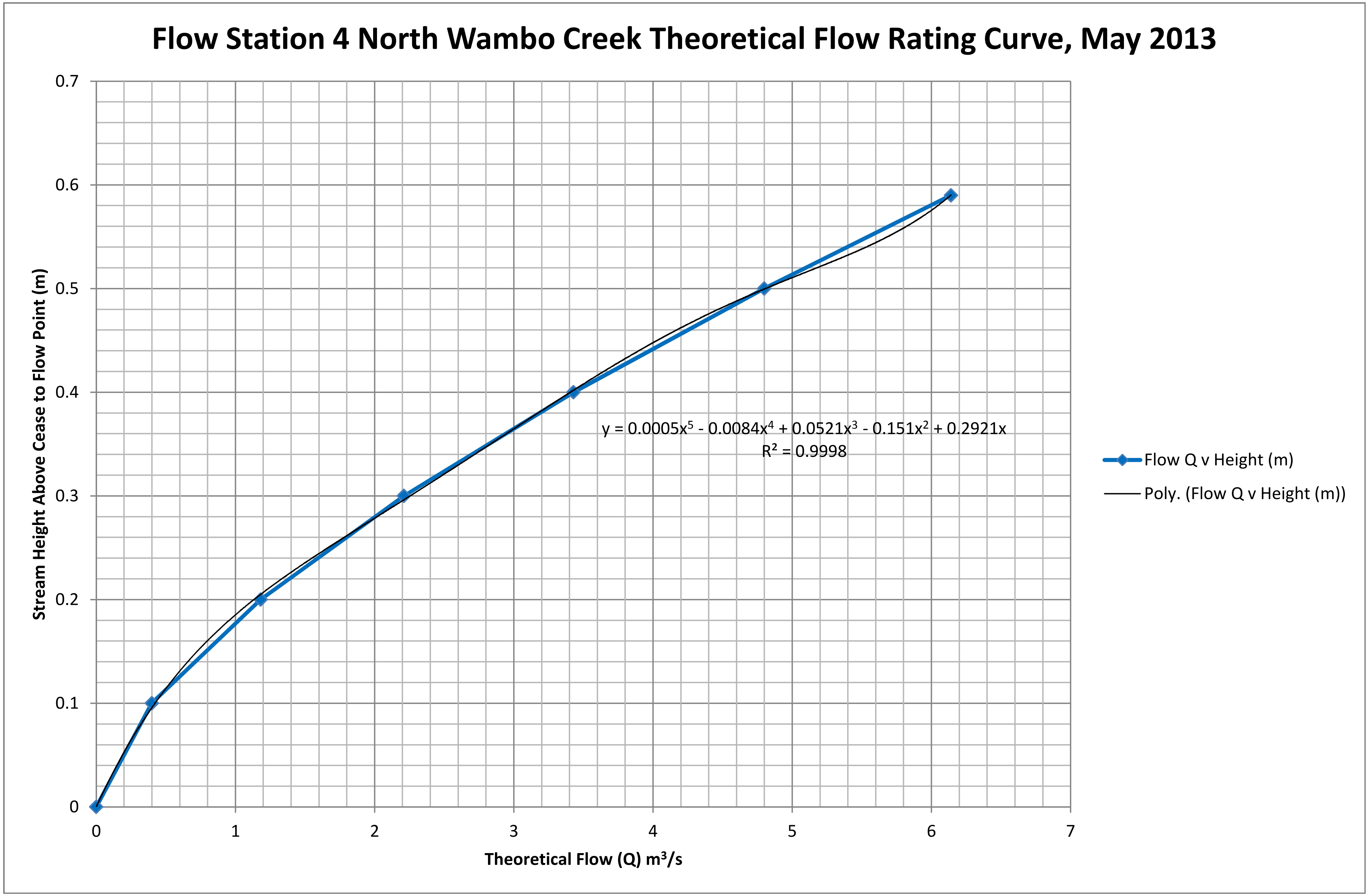

Flow Station 1 North Wambo Creek Theoretical Flow Rating Curve, May 2013
Stream Height Above Cease to Flow Point (m)
Theoretical Flow (Q) m³/s
y = 7E-06x³ - 0.0012x² + 0.0632x + 0.1912
R² = 0.9293
Flow Q v Height (m)
Poly. (Flow Q v Height (m))
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105



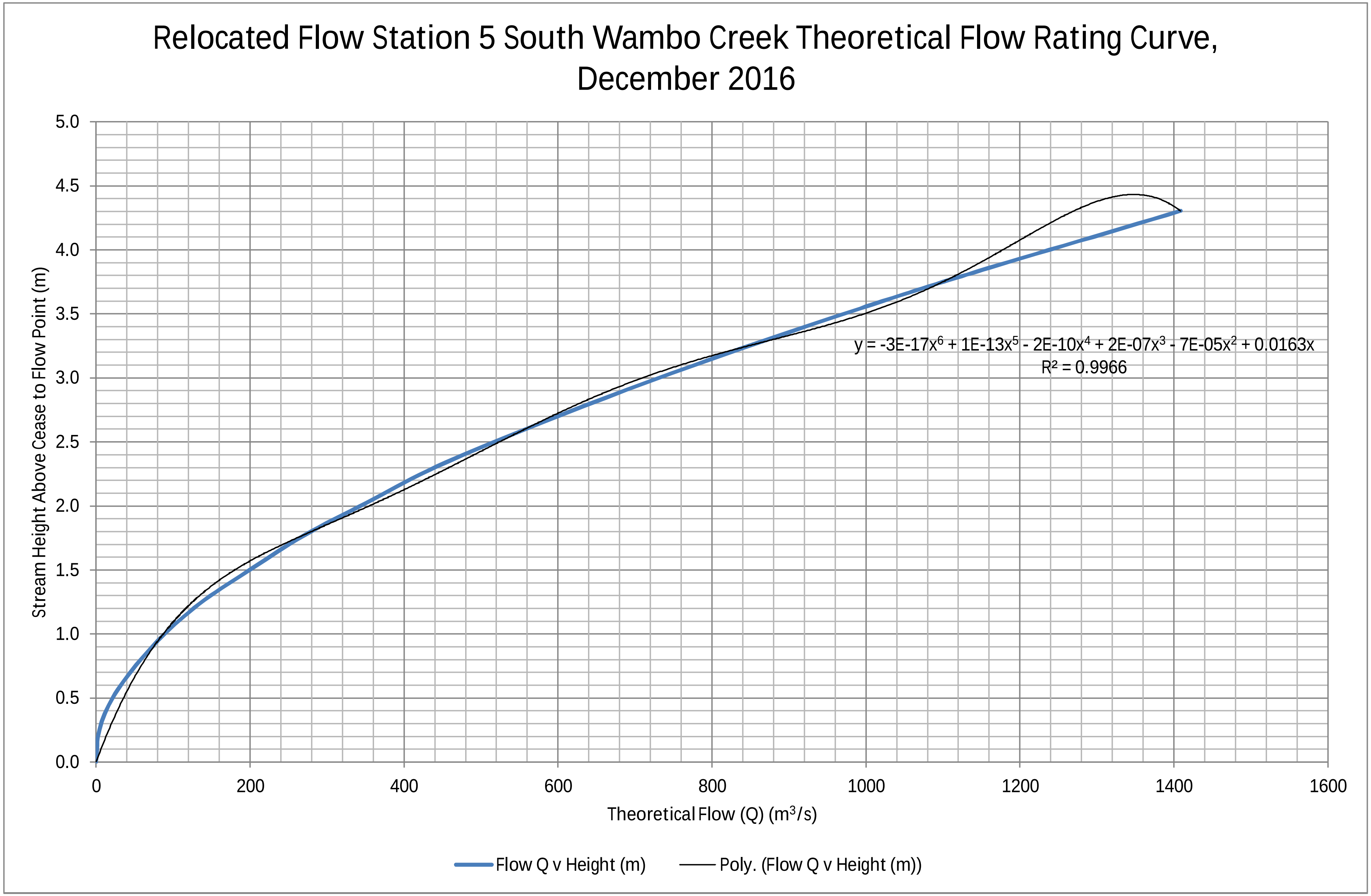
Flow Station 2 North Wambo Creek Theoretical Flow Rating Curve, May 2013
Stream Height Above Cease to Flow Point (m)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
100
110
Theoretical Flow (Q) m³/s
y = -2E-07x⁴ + 4E-05x³ - 0.0037x² + 0.143x + 0.2995
R² = 0.9853
Flow Q v Height (m)
Poly. (Flow Q v Height (m))

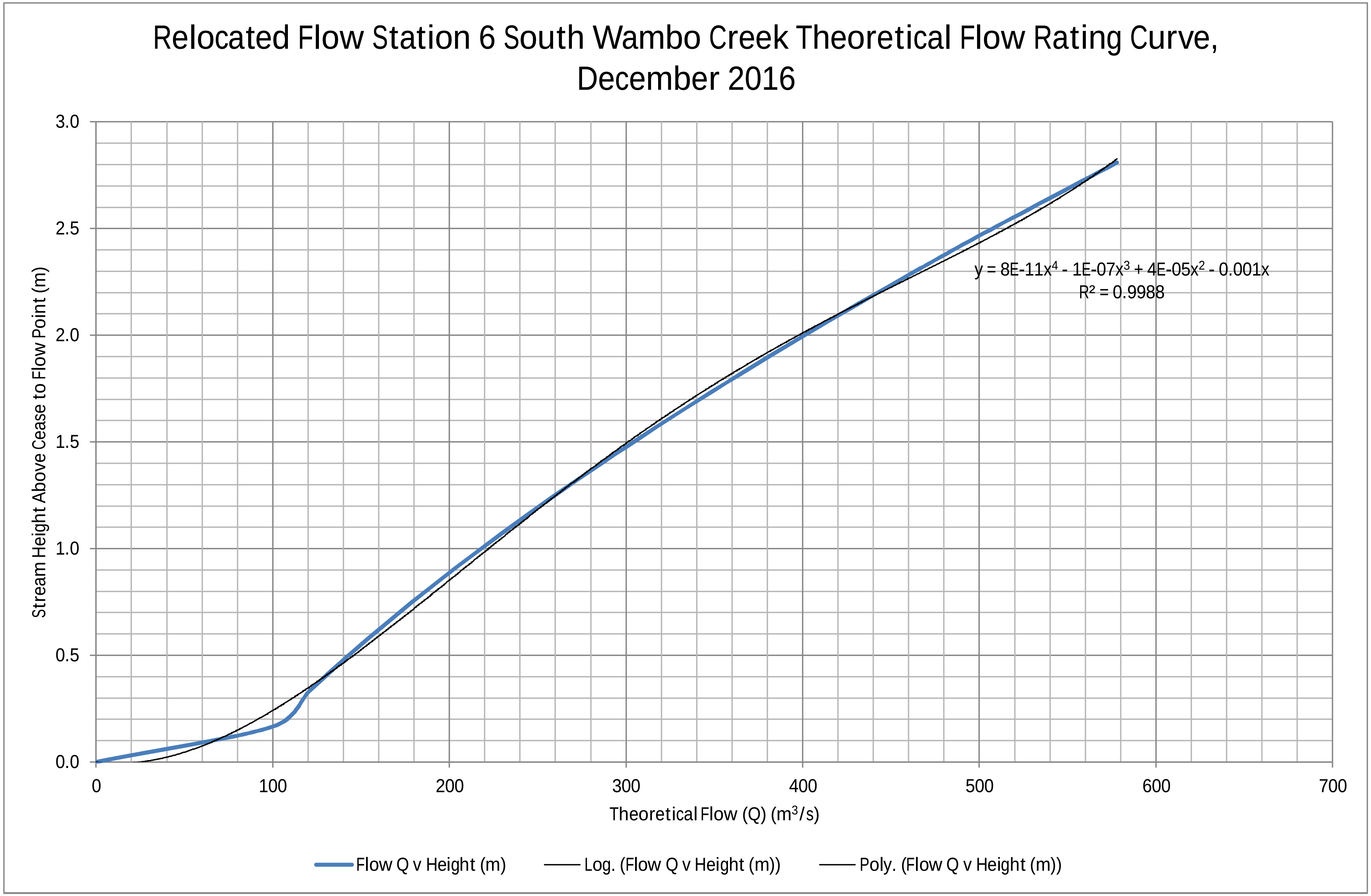


Flow Station 3 North Wambo Creek Theoretical Flow Rating Curve, May 2013
Stream Height Above Cease to Flow Point (m)
Theoretical Flow (Q) m³/s
y = -5E-17x⁶ + 2E-13x⁵ - 4E-10x⁴ + 3E-07x³ - 0.0001x² + 0.0292x + 0.5742
R² = 0.9885
Flow Q v Height (m)
Poly. (Flow Q v Height (m))
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500



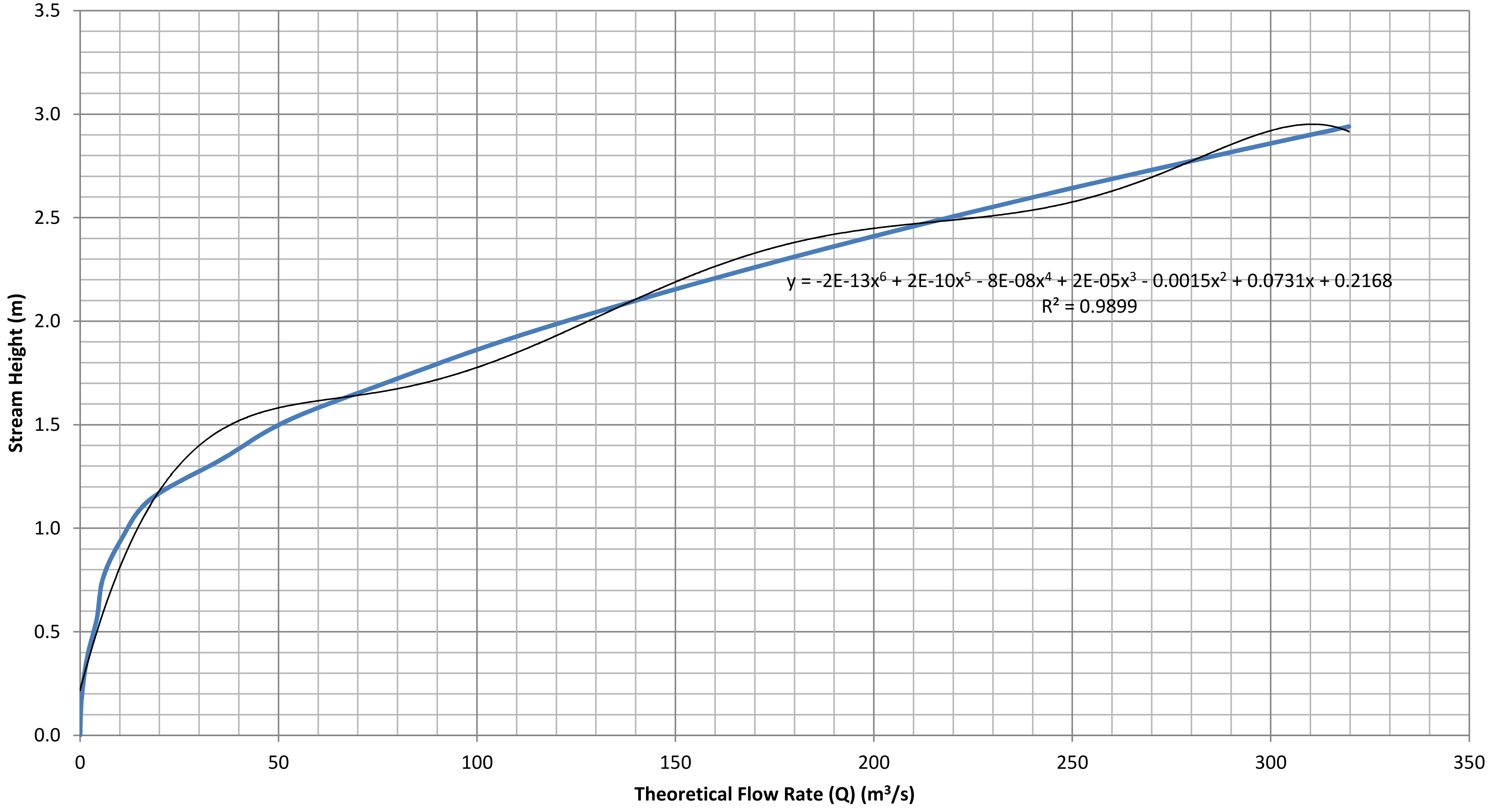
Flow Station 4 North Wambo Creek Theoretical Flow Rating Curve, May 2013
Stream Height Above Cease to Flow Point (m)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0
1
2
3
4
5
6
7
Theoretical Flow (Q) m³/s
y = 0.0005x⁵ - 0.0084x⁴ + 0.0521x³ - 0.151x² + 0.2921x
R² = 0.9998
Flow Q v Height (m)
Poly. (Flow Q v Height (m))

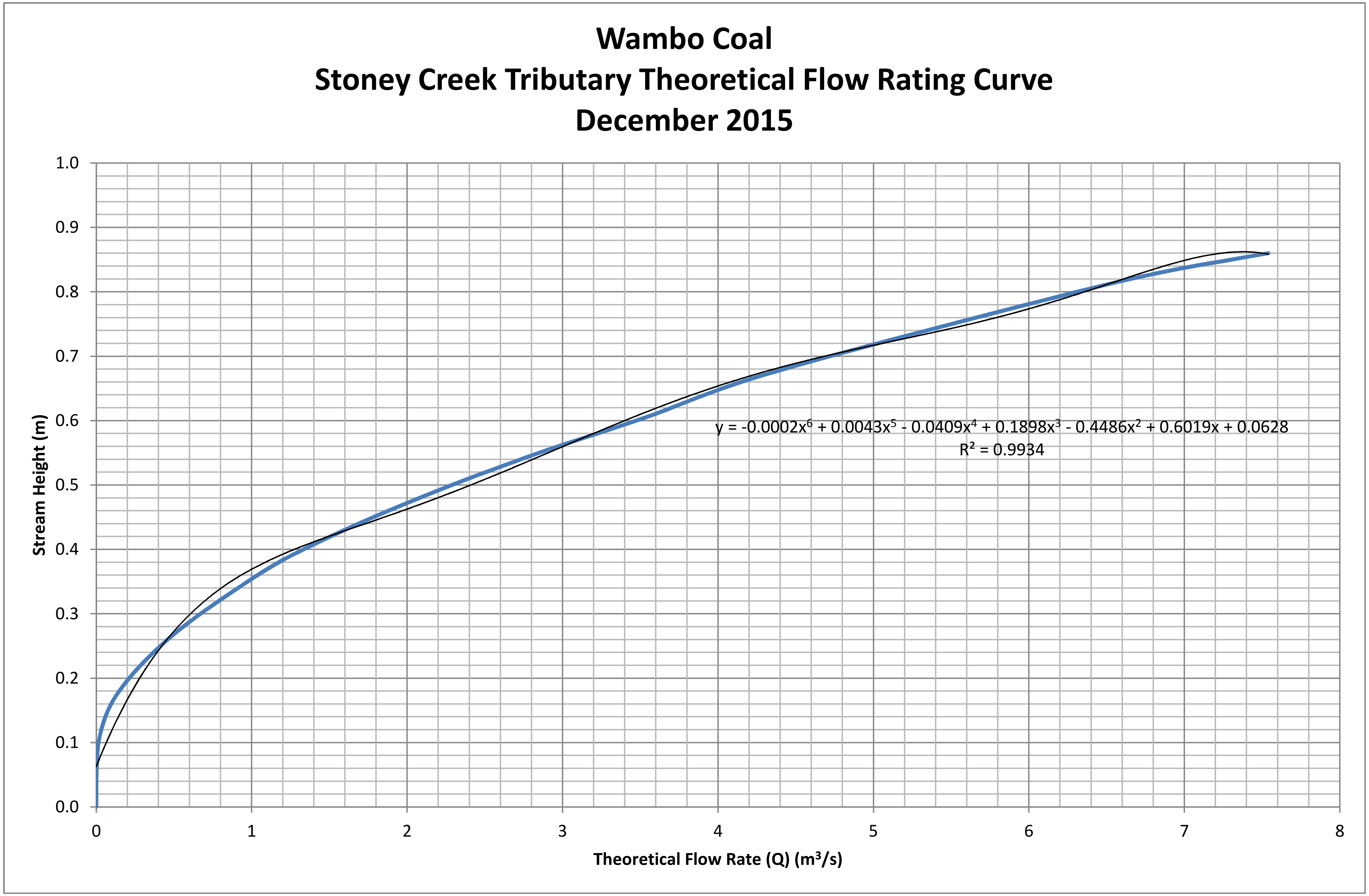

Relocated Flow Station 5 South Wambo Creek Theoretical Flow Rating Curve, December 2016
Stream Height Above Cease to Flow Point (m)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
200
400
600
800
1000
1200
1400
1600
Theoretical Flow (Q) (m3/s)
y = -3E-17x6 + 1E-13x5 - 2E-10x4 + 2E-07x3 - 7E-05x2 + 0.0163x
R² = 0.9966
Flow Q v Height (m)
Poly. (Flow Q v Height (m))

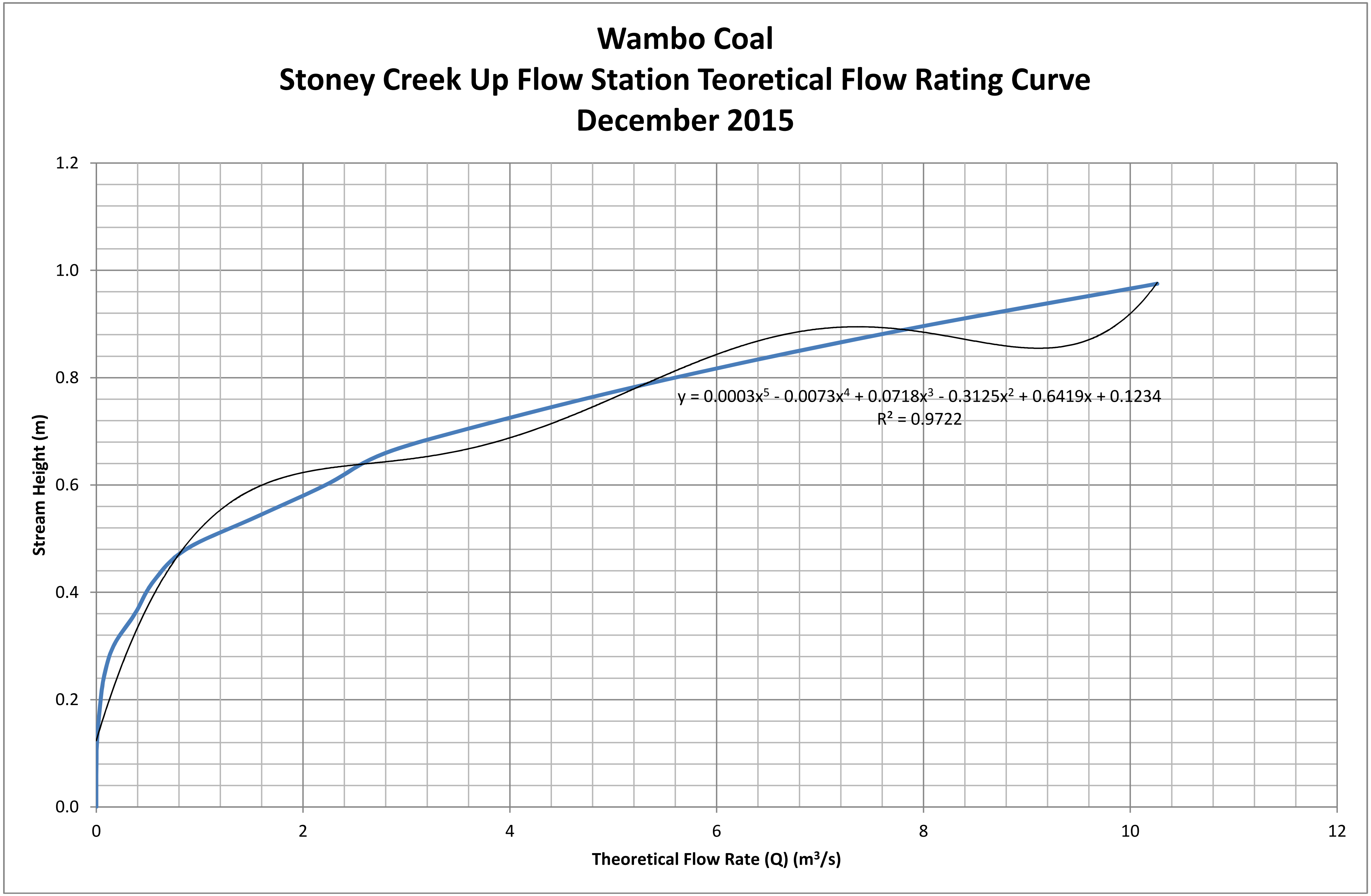


Relocated Flow Station 6 South Wambo Creek Theoretical Flow Rating Curve, December 2016
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Stream Height Above Cease to Flow Point (m)
0
100
200
300
400
500
600
700
Theoretical Flow (Q) (m3/s)
y = 8E-11x4 - 1E-07x3 + 4E-05x2 - 0.001x
R² = 0.9988
Flow Q v Height (m)
Log. (Flow Q v Height (m))
Poly. (Flow Q v Height (m))

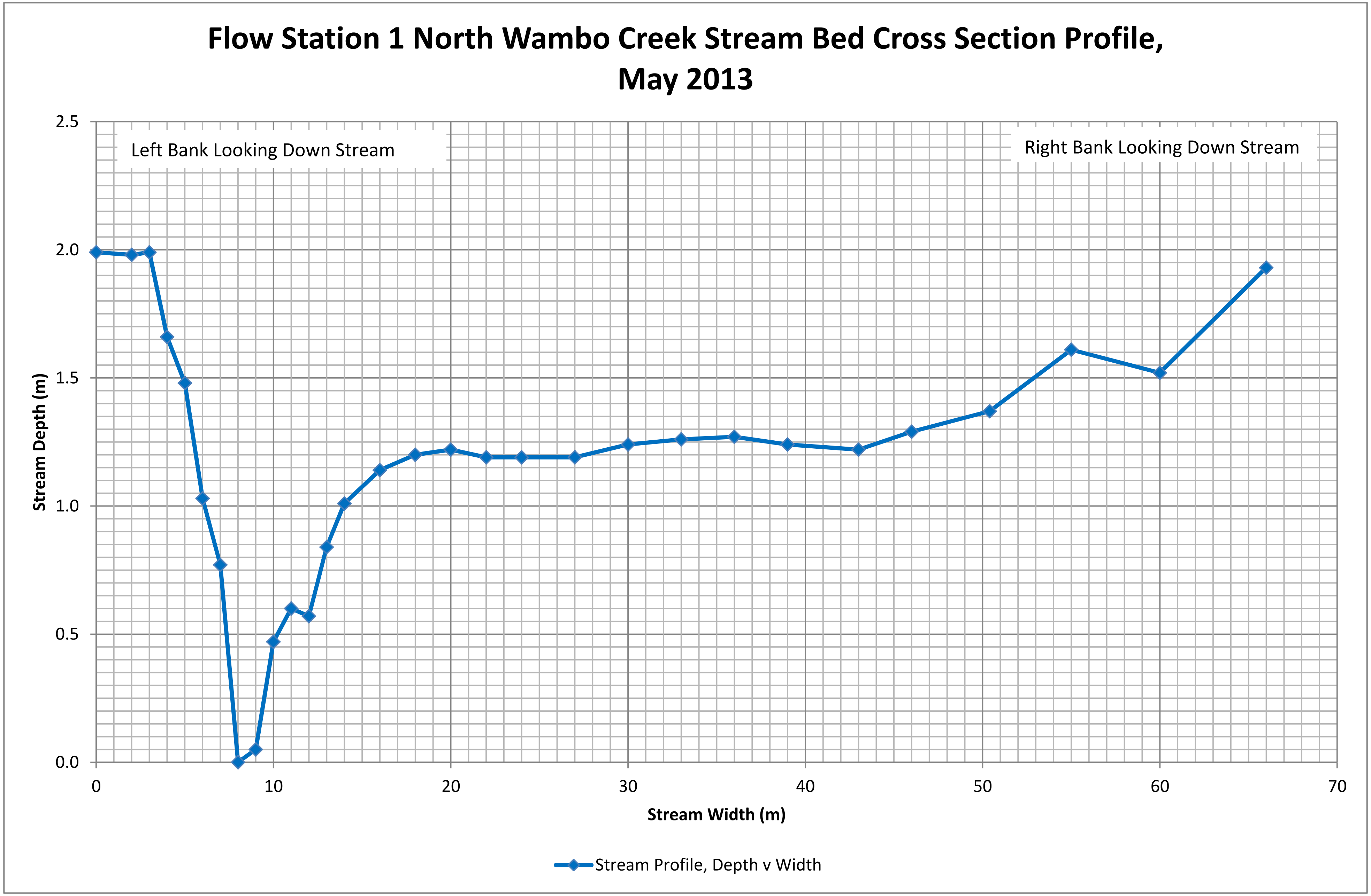
Wambo Coal
Stoney Creek Down Flow Station Theorectical Flow Rating Curve
December 2015

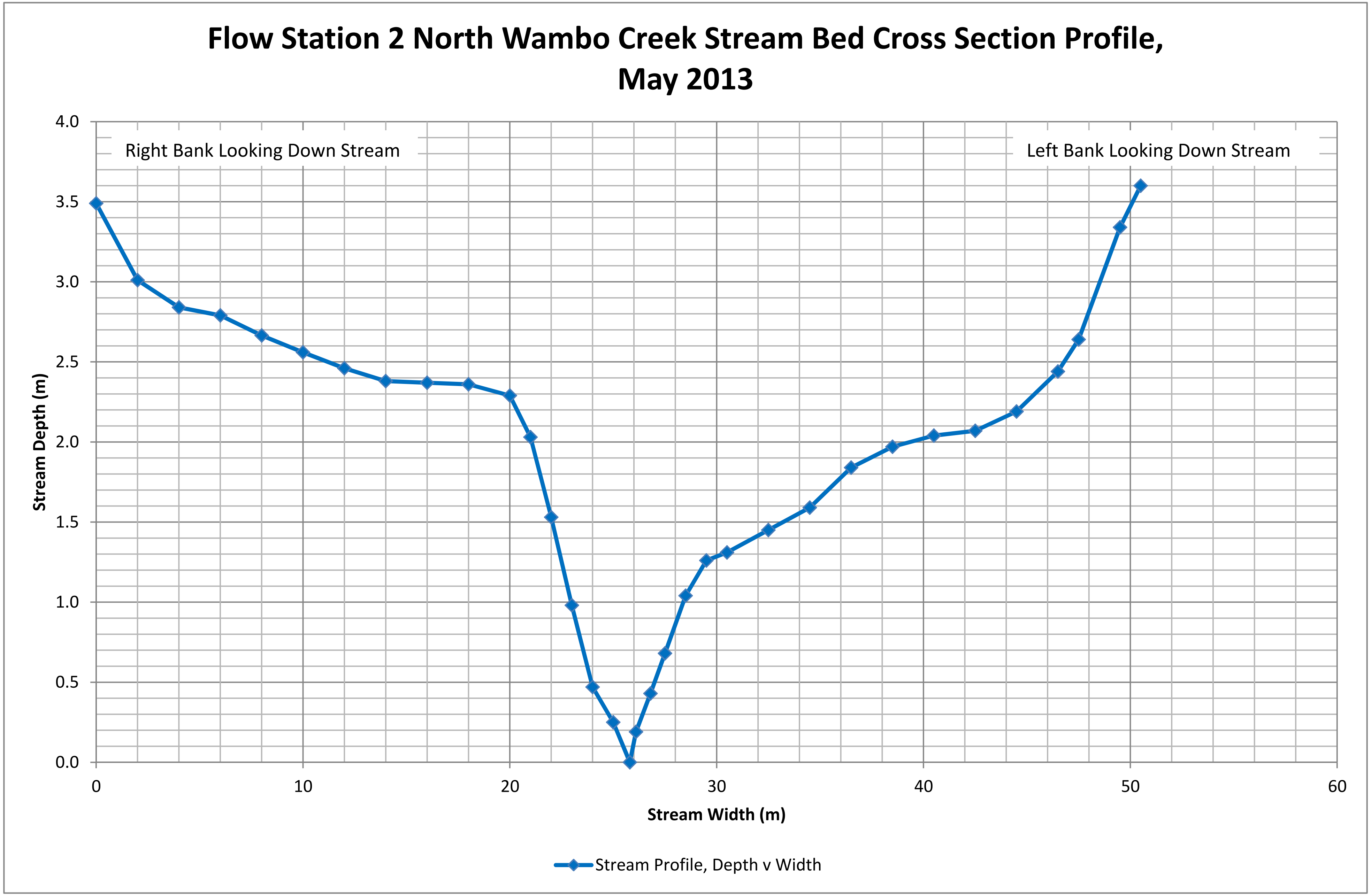



Wambo Coal
Stoney Creek Tributary Theoretical Flow Rating Curve
December 2015
y = -0.0002x⁶ + 0.0043x⁵ - 0.0409x⁴ + 0.1898x³ - 0.4486x² + 0.6019x + 0.0628
R² = 0.9934
Stream Height (m)
Theoretical Flow Rate (Q) (m³/s)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
0
1
2
3
4
5
6
7
8

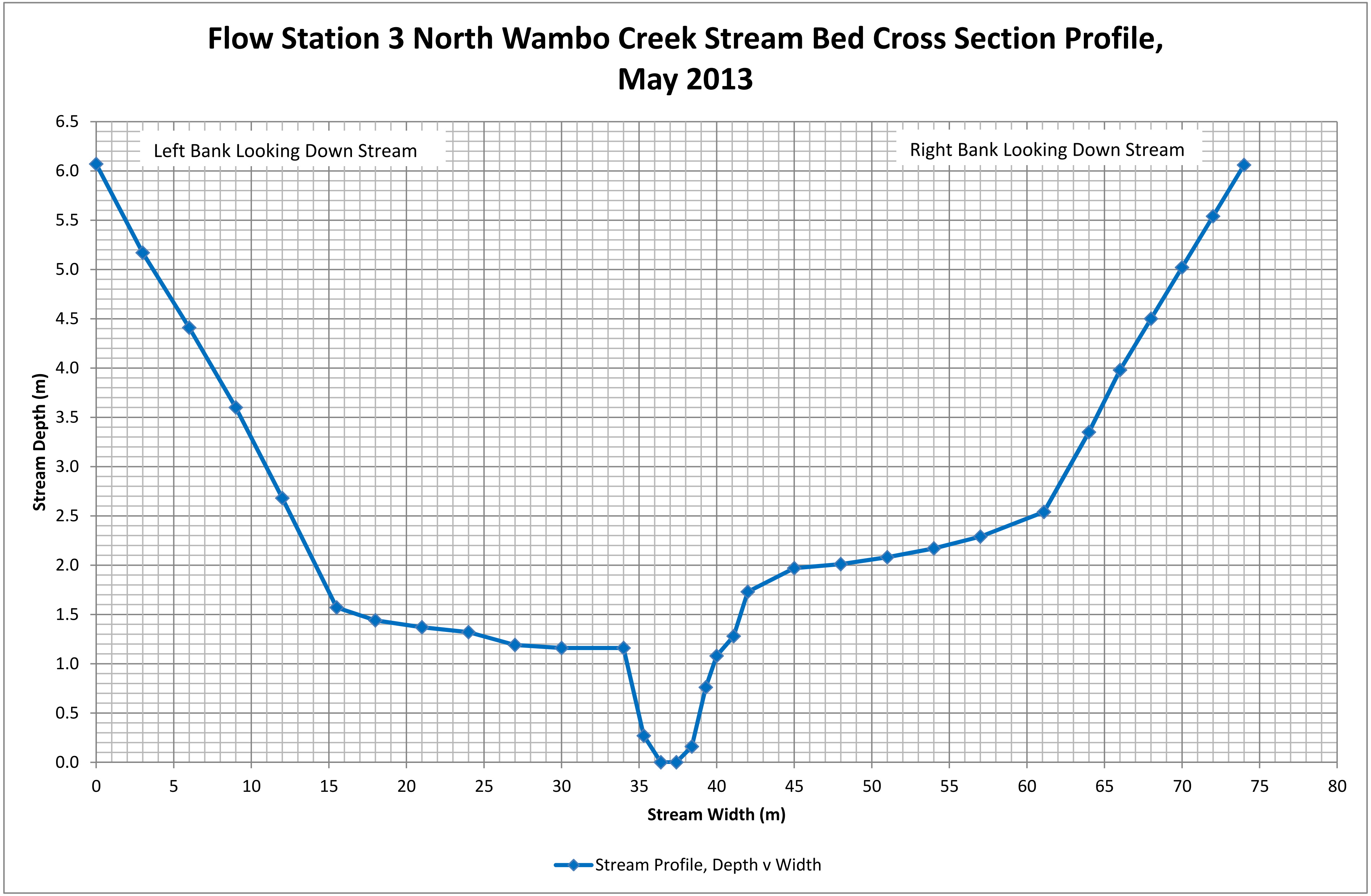


Wambo Coal
Stoney Creek Up Flow Station Teoretical Flow Rating Curve
December 2015
y = 0.0003x⁵ - 0.0073x⁴ + 0.0718x³ - 0.3125x² + 0.6419x + 0.1234
R² = 0.9722
Stream Height (m)
Theoretical Flow Rate (Q) (m³/s)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0
2
4
6
8
10
12

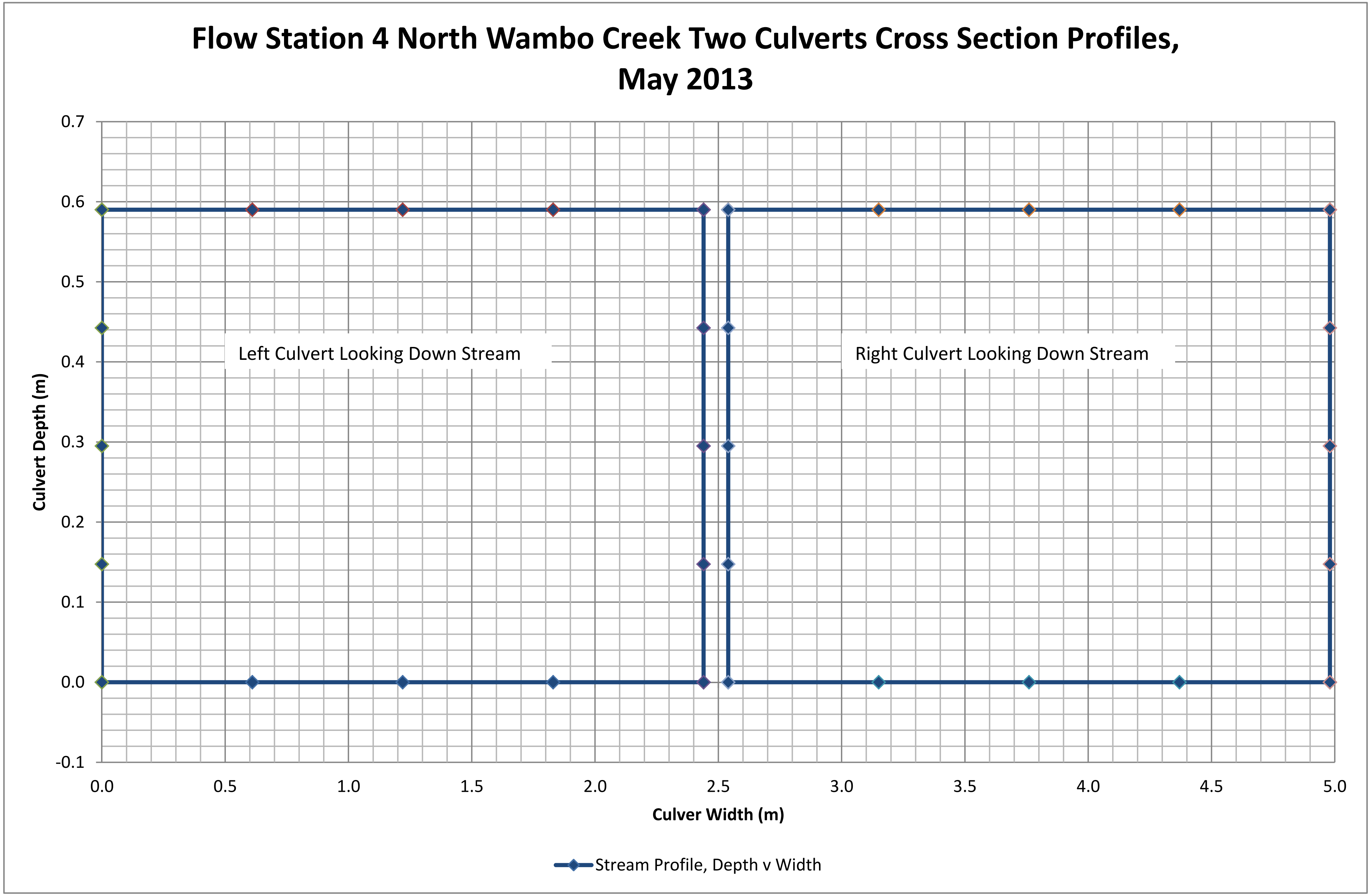

Flow Station 1 North Wambo Creek Stream Bed Cross Section Profile,
May 2013
Left Bank Looking Down Stream
Right Bank Looking Down Stream
Stream Depth (m)
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
Stream Width (m)
Stream Profile, Depth v Width



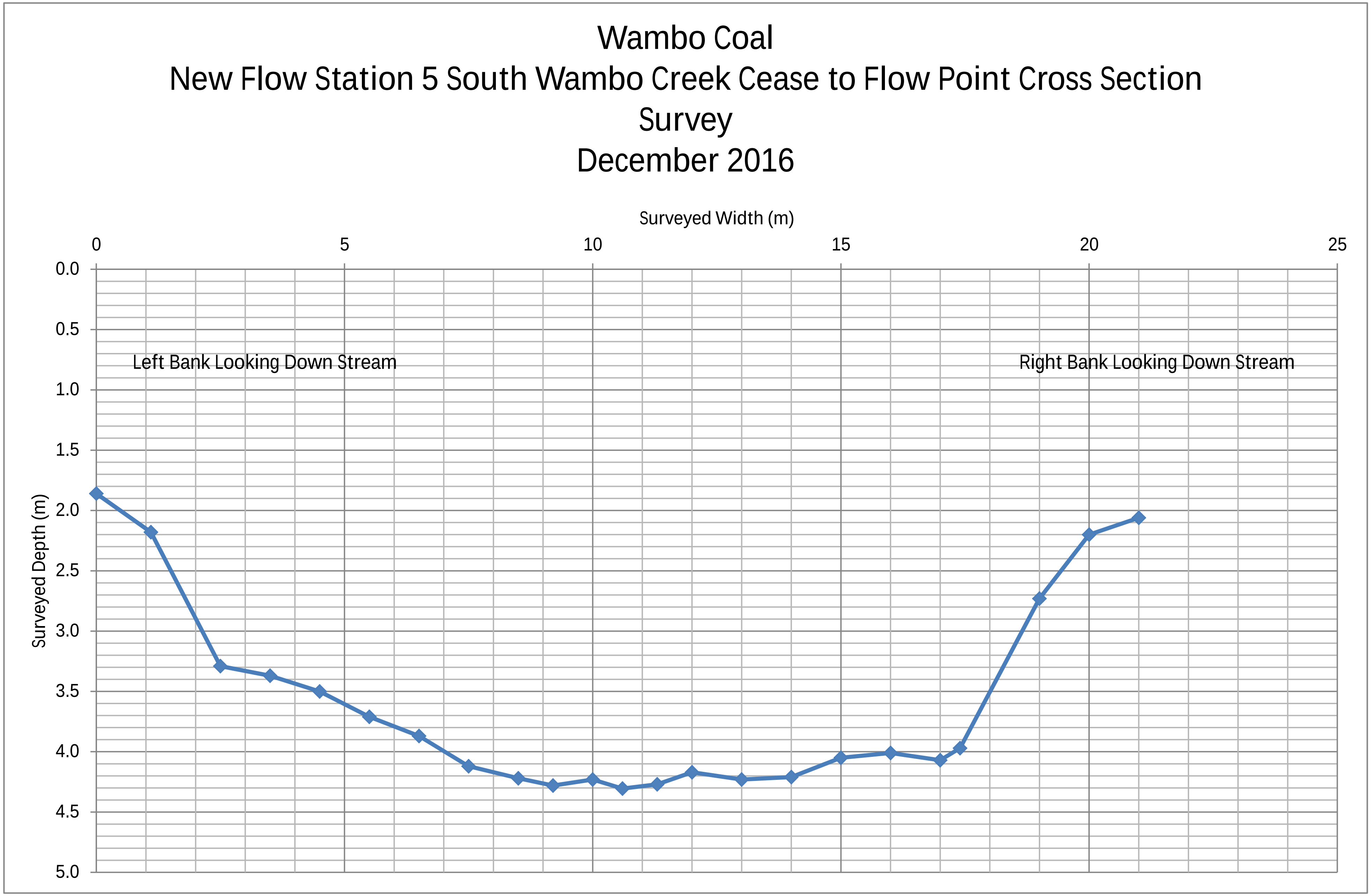
Flow Station 2 North Wambo Creek Stream Bed Cross Section Profile, May 2013
Right Bank Looking Down Stream
Left Bank Looking Down Stream
Stream Depth (m)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
Stream Width (m)
Stream Profile, Depth v Width



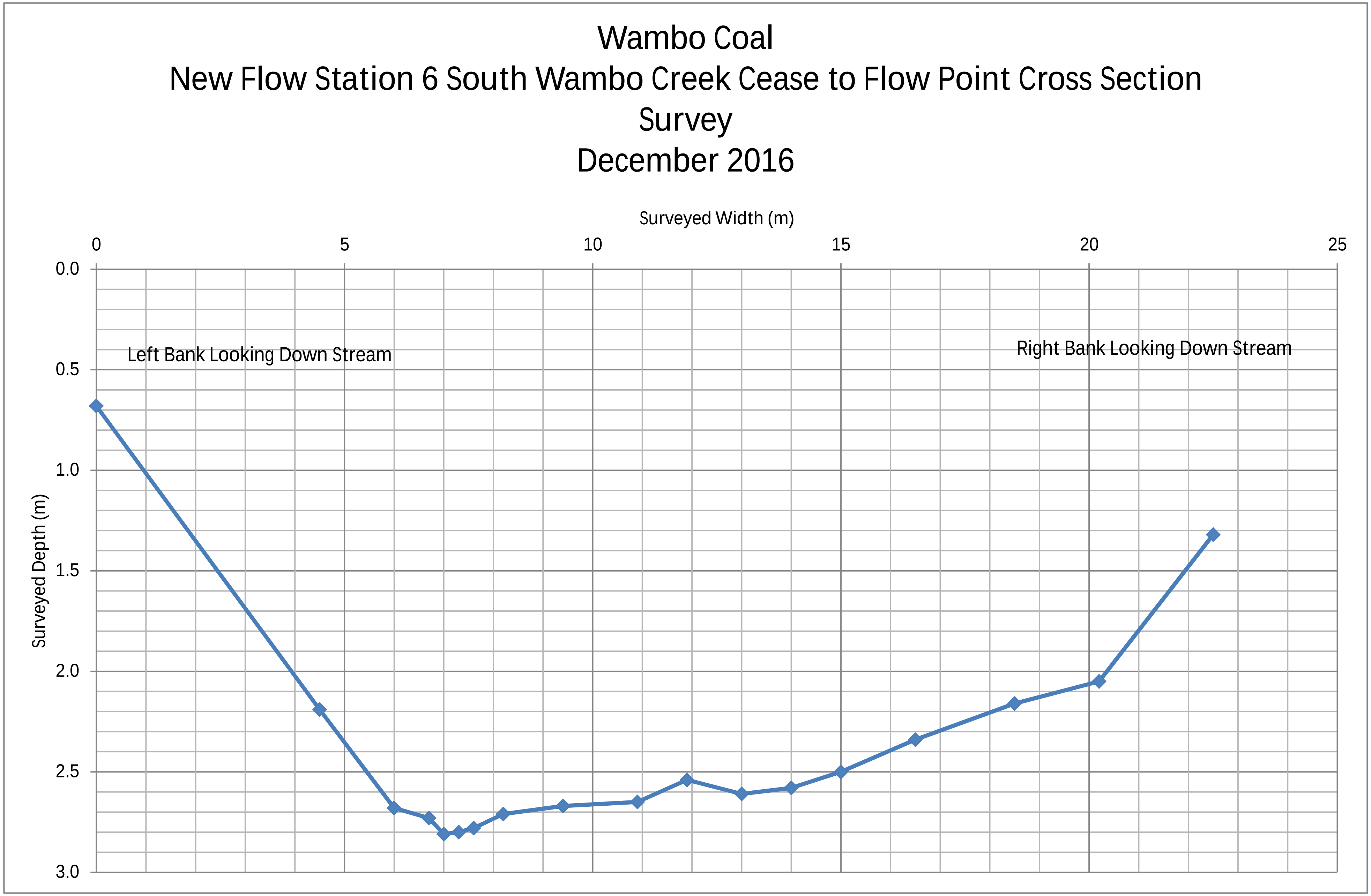
Flow Station 3 North Wambo Creek Stream Bed Cross Section Profile, May 2013
Left Bank Looking Down Stream
Right Bank Looking Down Stream
Stream Depth (m)
Stream Width (m)
Stream Profile, Depth v Width



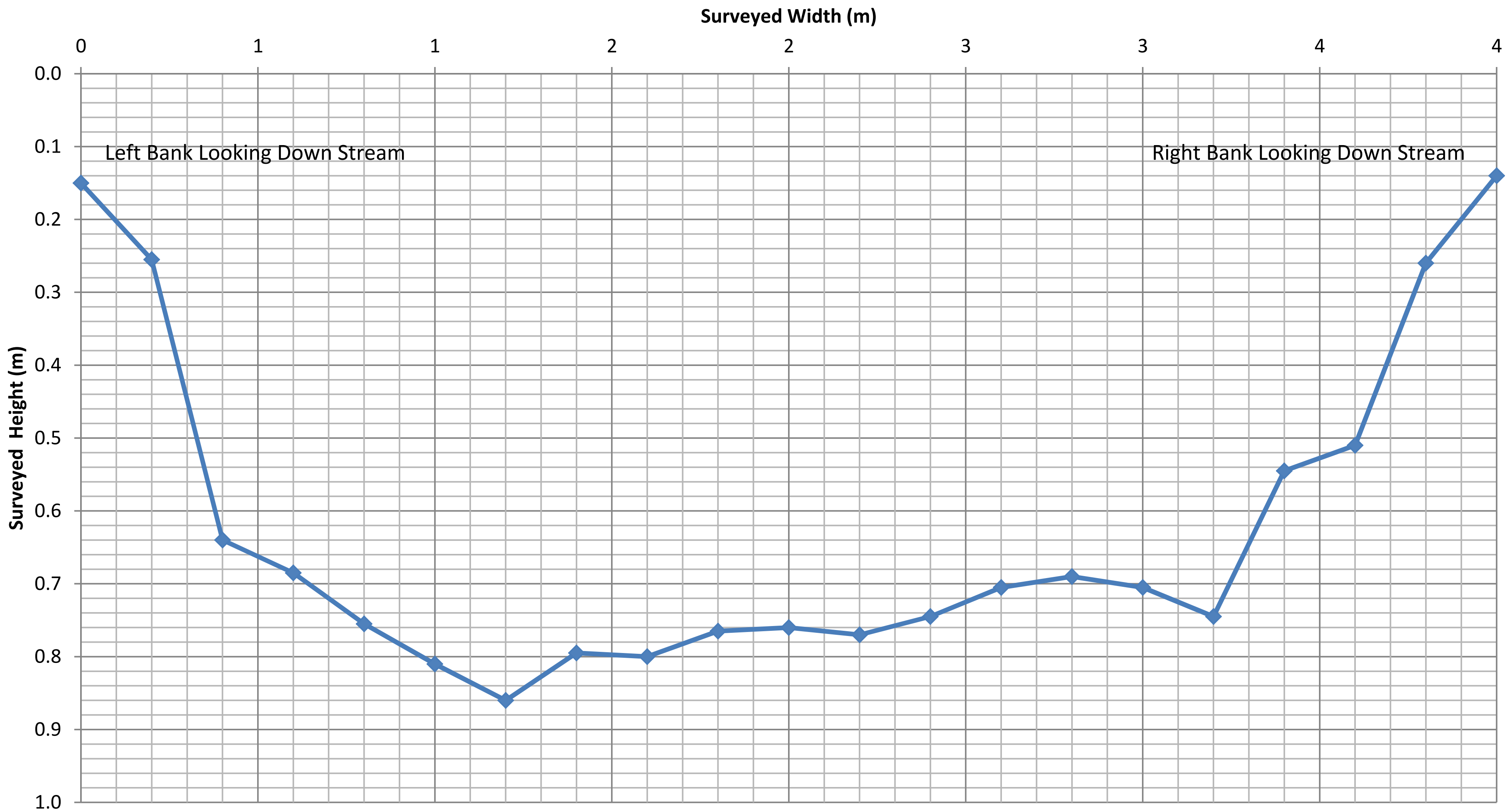
Flow Station 4 North Wambo Creek Two Culverts Cross Section Profiles, May 2013
Left Culvert Looking Down Stream
Right Culvert Looking Down Stream
Culvert Depth (m)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Culver Width (m)
Stream Profile, Depth v Width

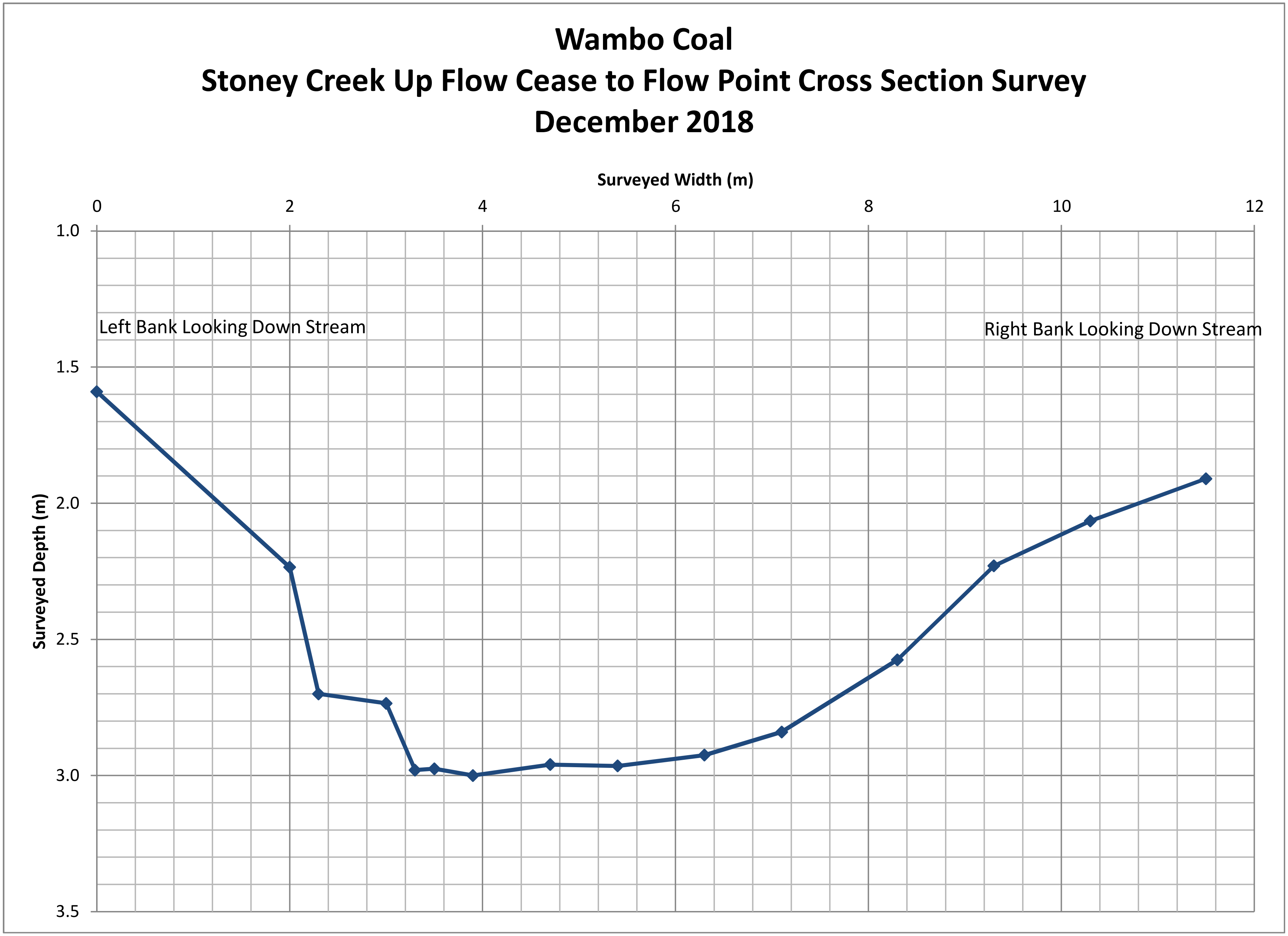


Wambo Coal
New Flow Station 5 South Wambo Creek Cease to Flow Point Cross Section
Survey
December 2016
Surveyed Width (m)
0
5
10
15
20
25
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Surveyed Depth (m)
Left Bank Looking Down Stream
Right Bank Looking Down Stream

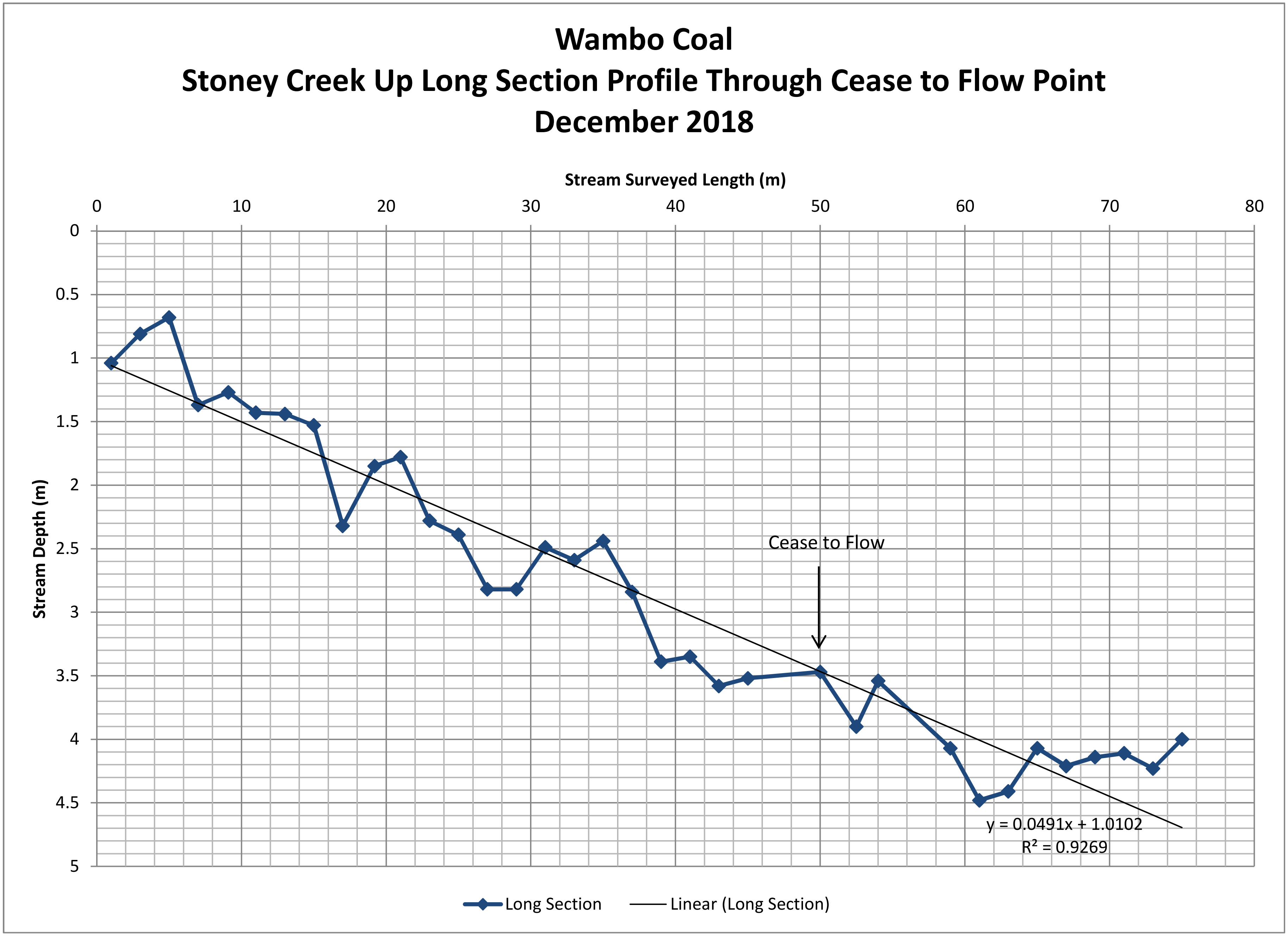

Wambo Coal
New Flow Station 6 South Wambo Creek Cease to Flow Point Cross Section
Survey
December 2016
Surveyed Width (m)
0
5
10
15
20
25
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Surveyed Depth (m)
Left Bank Looking Down Stream
Right Bank Looking Down Stream

Wambo Coal
Stoney Creek Tributary Cease to Flow Point Cross Section
December 2015

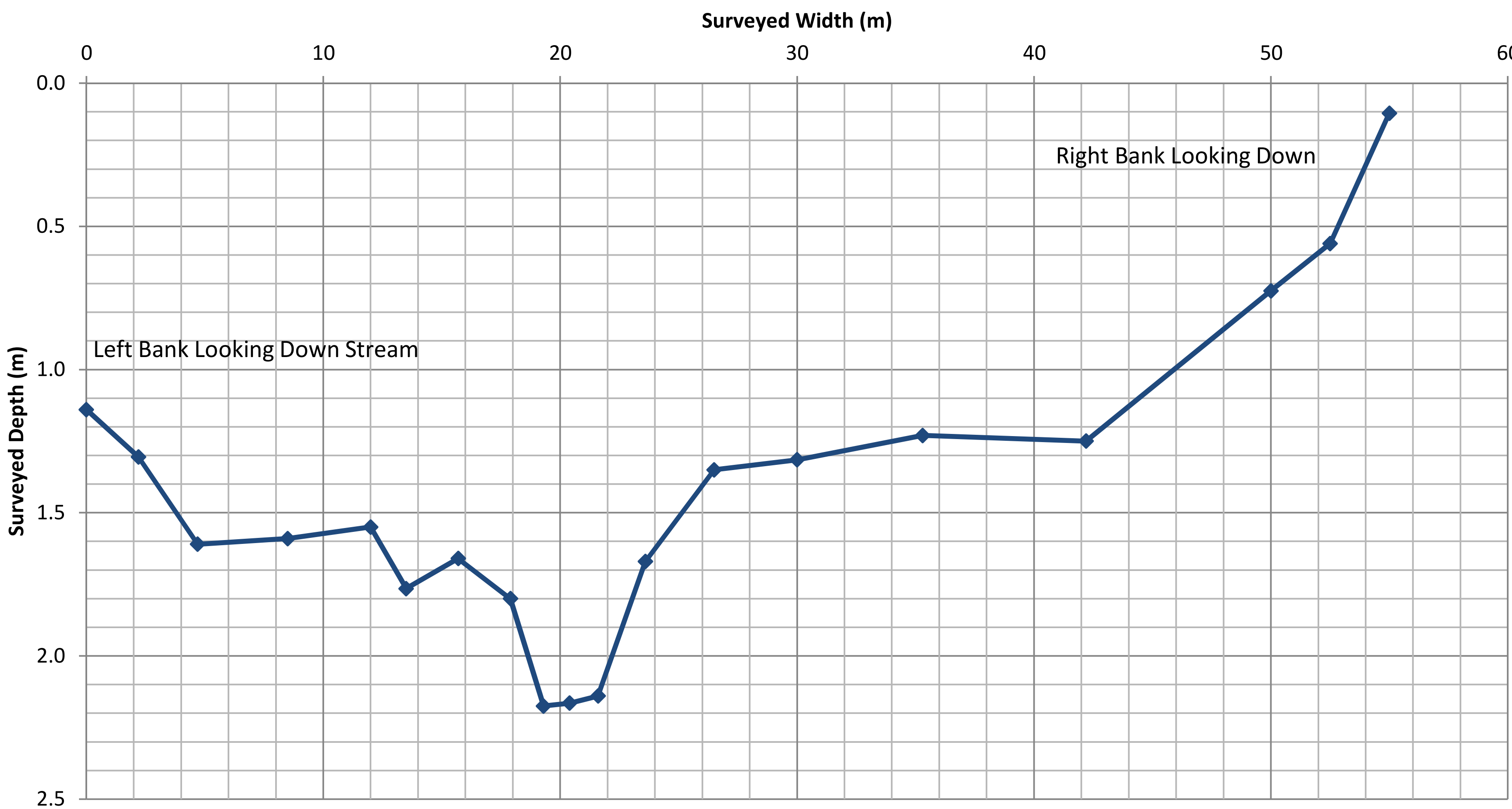


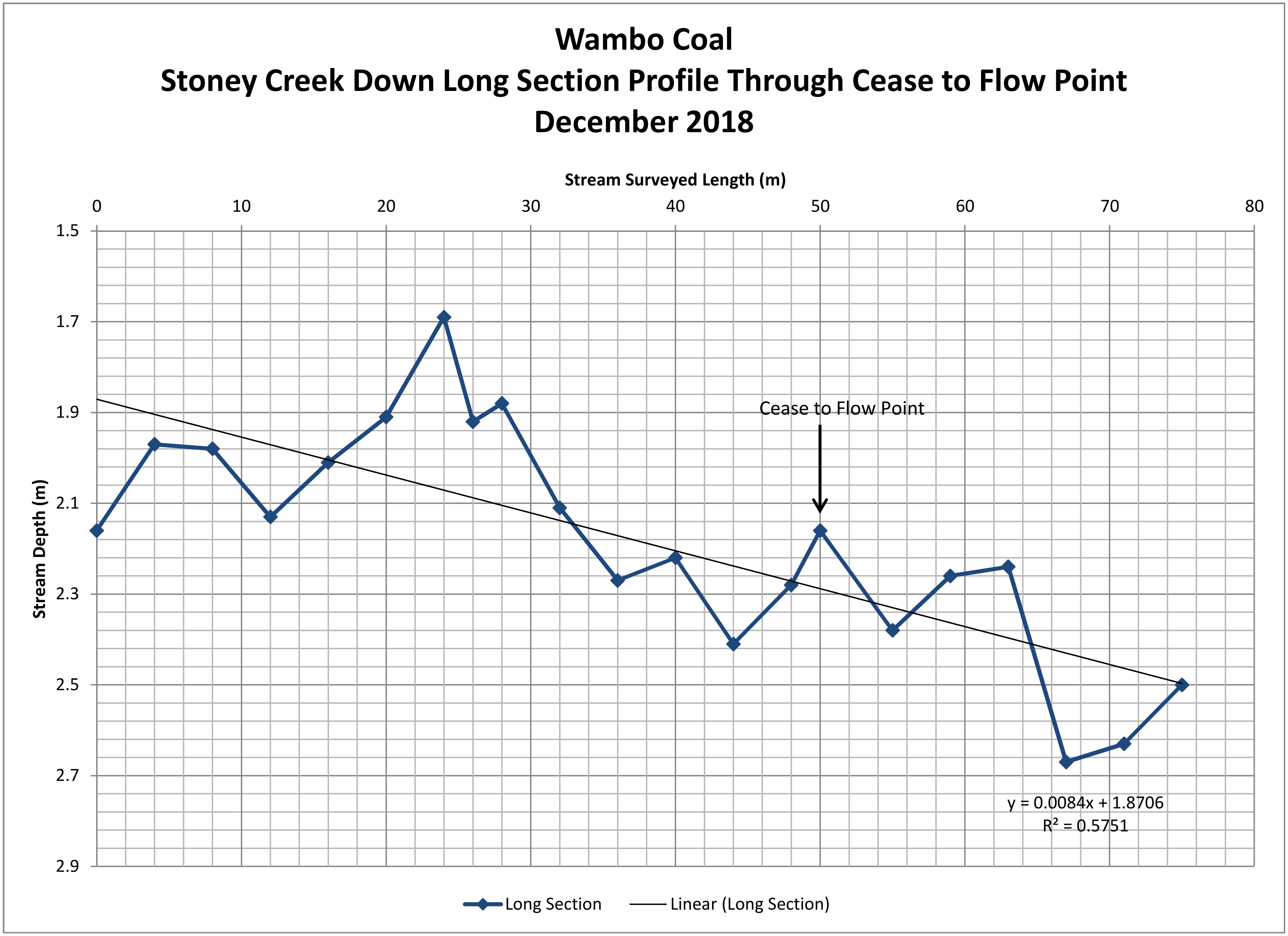


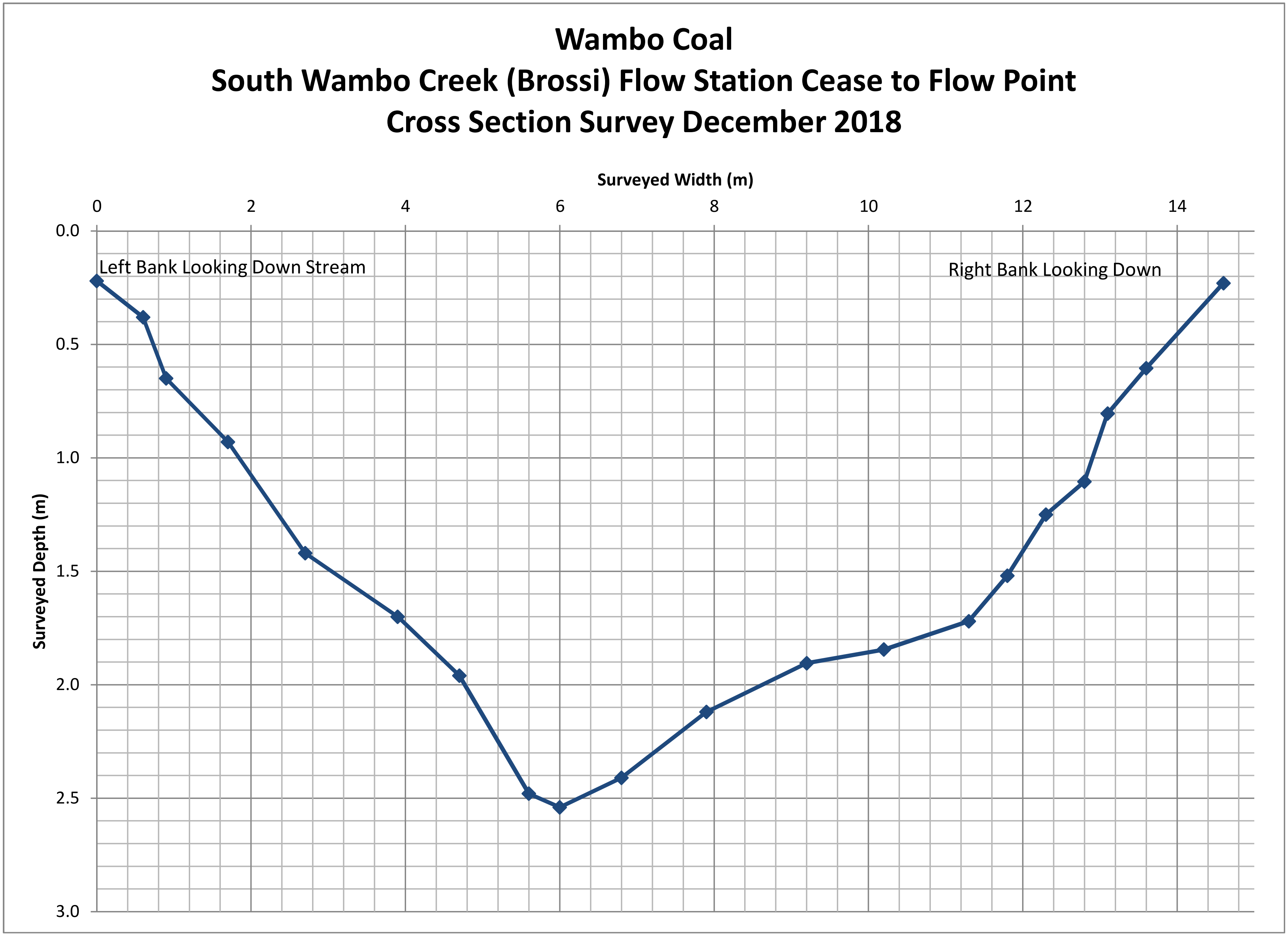
Wambo Coal
Stoney Creek Up Flow Cease to Flow Point Cross Section Survey
December 2018
Surveyed Width (m)
0
2
4
6
8
10
12
1.0
1.5
2.0
2.5
3.0
3.5
Surveyed Depth (m)
Left Bank Looking Down Stream
Right Bank Looking Down Stream


Wambo Coal
Stoney Creek Up Long Section Profile Through Cease to Flow Point
December 2018
Stream Surveyed Length (m)
0
10
20
30
40
50
60
70
80
Stream Depth (m)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Cease to Flow
y = 0.0491x + 1.0102
R² = 0.9269
Long Section
Linear (Long Section)

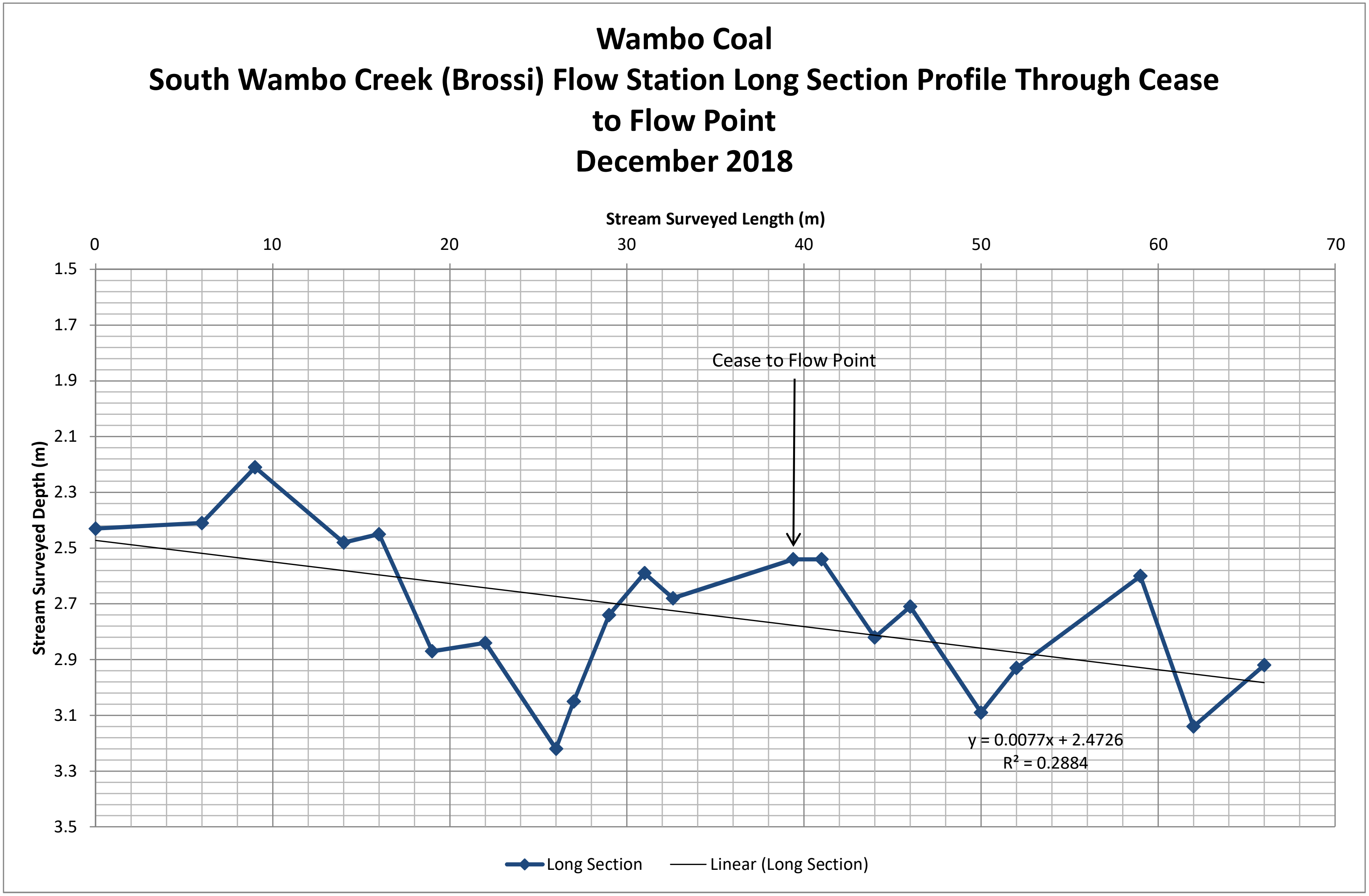
Wambo Coal
Stoney Creek Down Flow Station Cease to Flow Point Cross Section Survey
December 2018




Wambo Coal
Stoney Creek Down Long Section Profile Through Cease to Flow Point
December 2018
Stream Surveyed Length (m)
0
10
20
30
40
50
60
70
80
1.5
1.7
1.9
2.1
2.3
2.5
2.7
2.9
Stream Depth (m)
Cease to Flow Point
y = 0.0084x + 1.8706
R² = 0.5751
Long Section
Linear (Long Section)



Wambo Coal
South Wambo Creek (Brossi) Flow Station Cease to Flow Point
Cross Section Survey December 2018
Surveyed Width (m)
0
2
4
6
8
10
12
14
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Surveyed Depth (m)
Left Bank Looking Down Stream
Right Bank Looking Down


Wambo Coal
South Wambo Creek (Brossi) Flow Station Long Section Profile Through Cease to Flow Point
December 2018
Stream Surveyed Length (m)
0
10
20
30
40
50
60
70
1.5
1.7
1.9
2.1
2.3
2.5
2.7
2.9
3.1
3.3
3.5
Stream Surveyed Depth (m)
Cease to Flow Point
y = 0.0077x + 2.4726
R² = 0.2884
Long Section
Linear (Long Section)

Appendix C

Stream Height, Theoretical Flow, Daily and Cumulative Rainfall Charts

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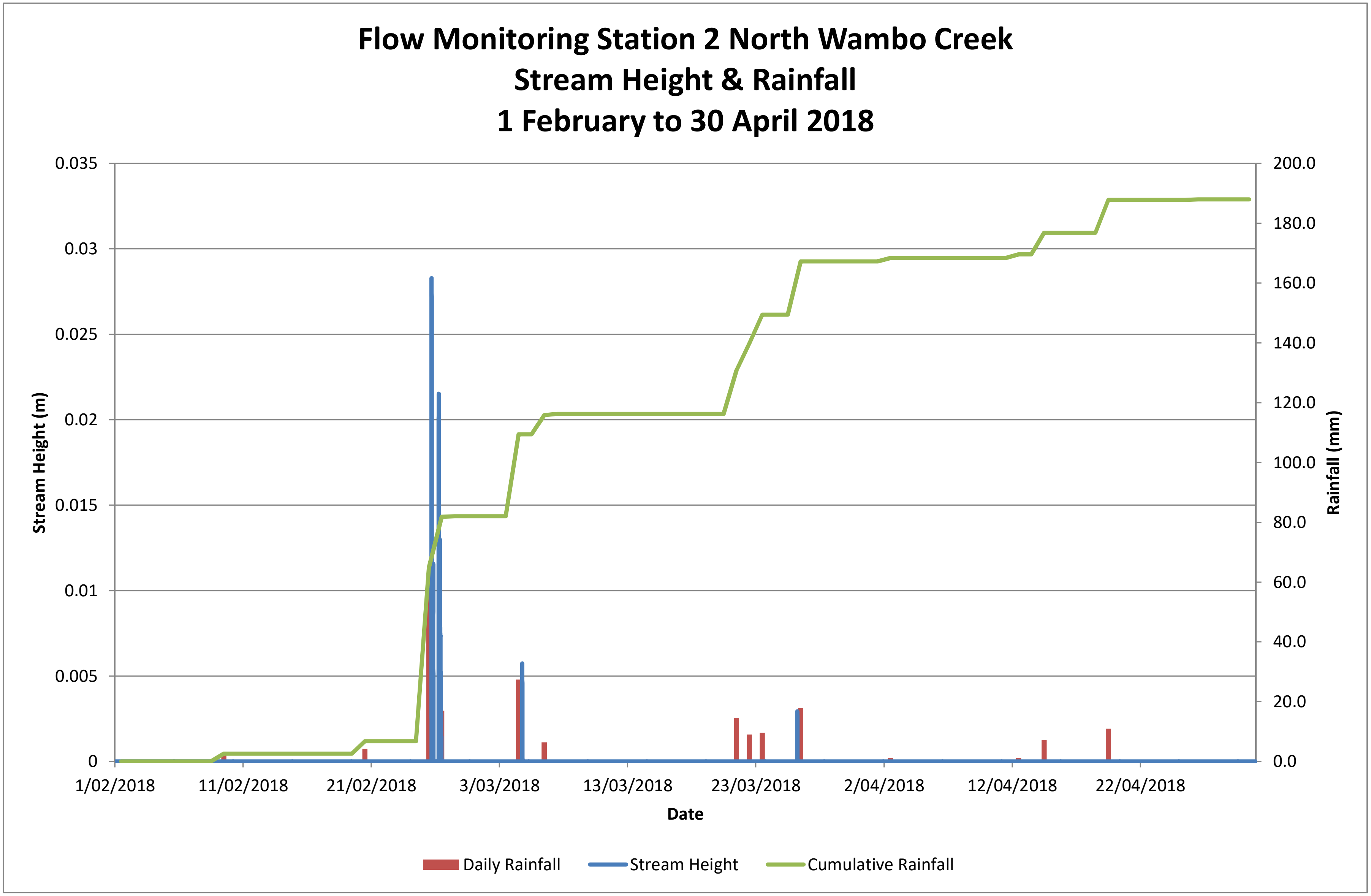
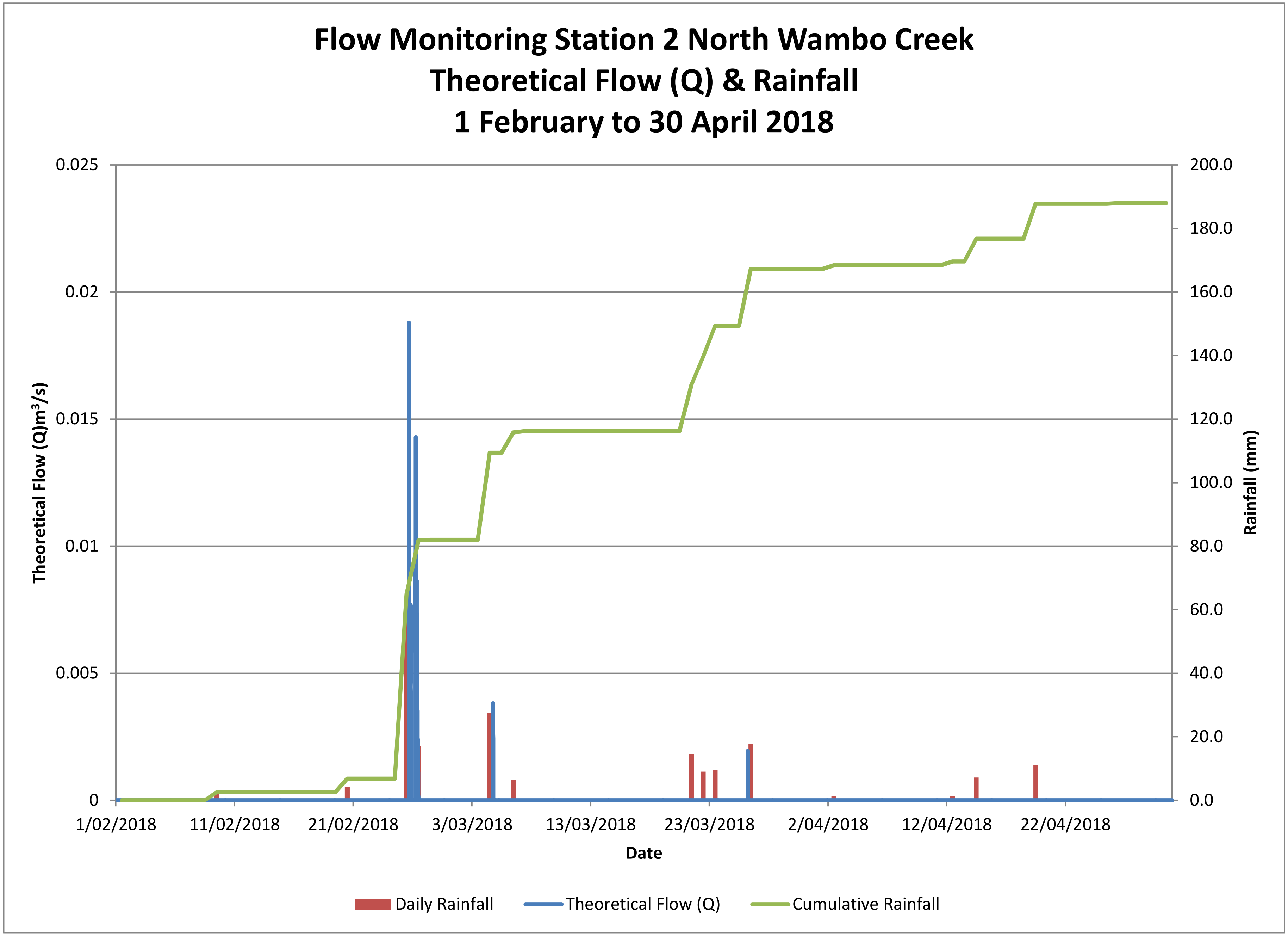
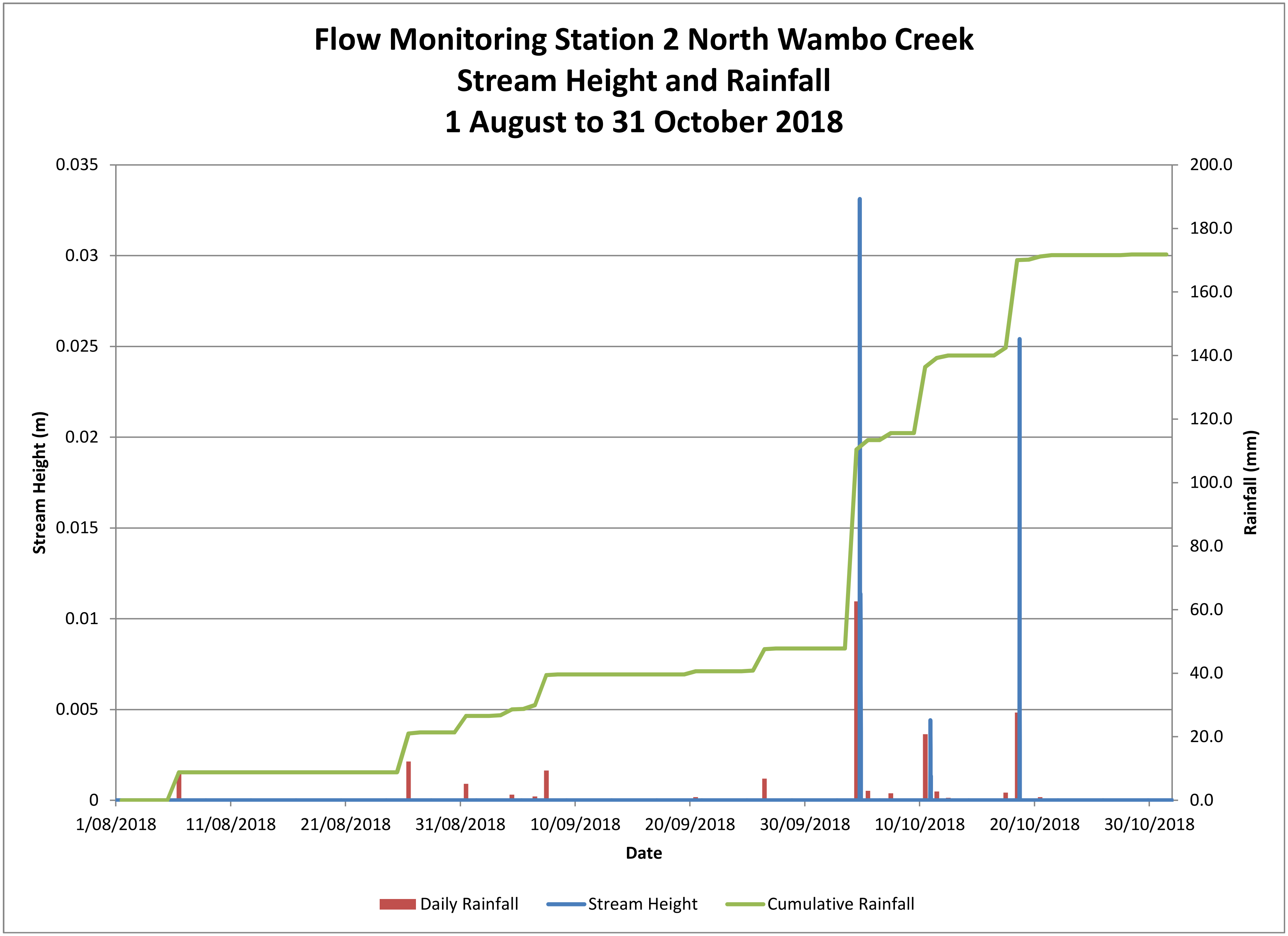
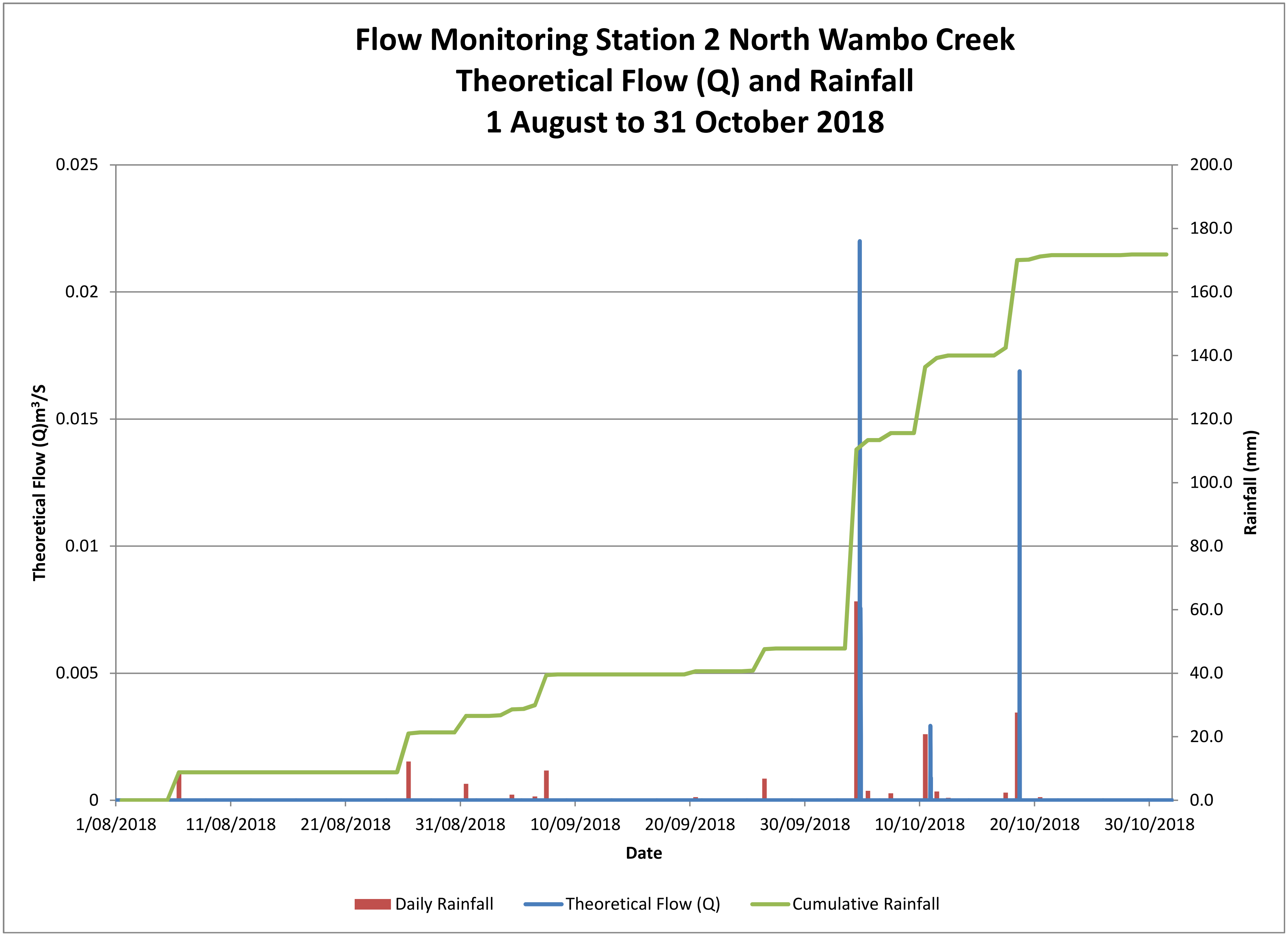
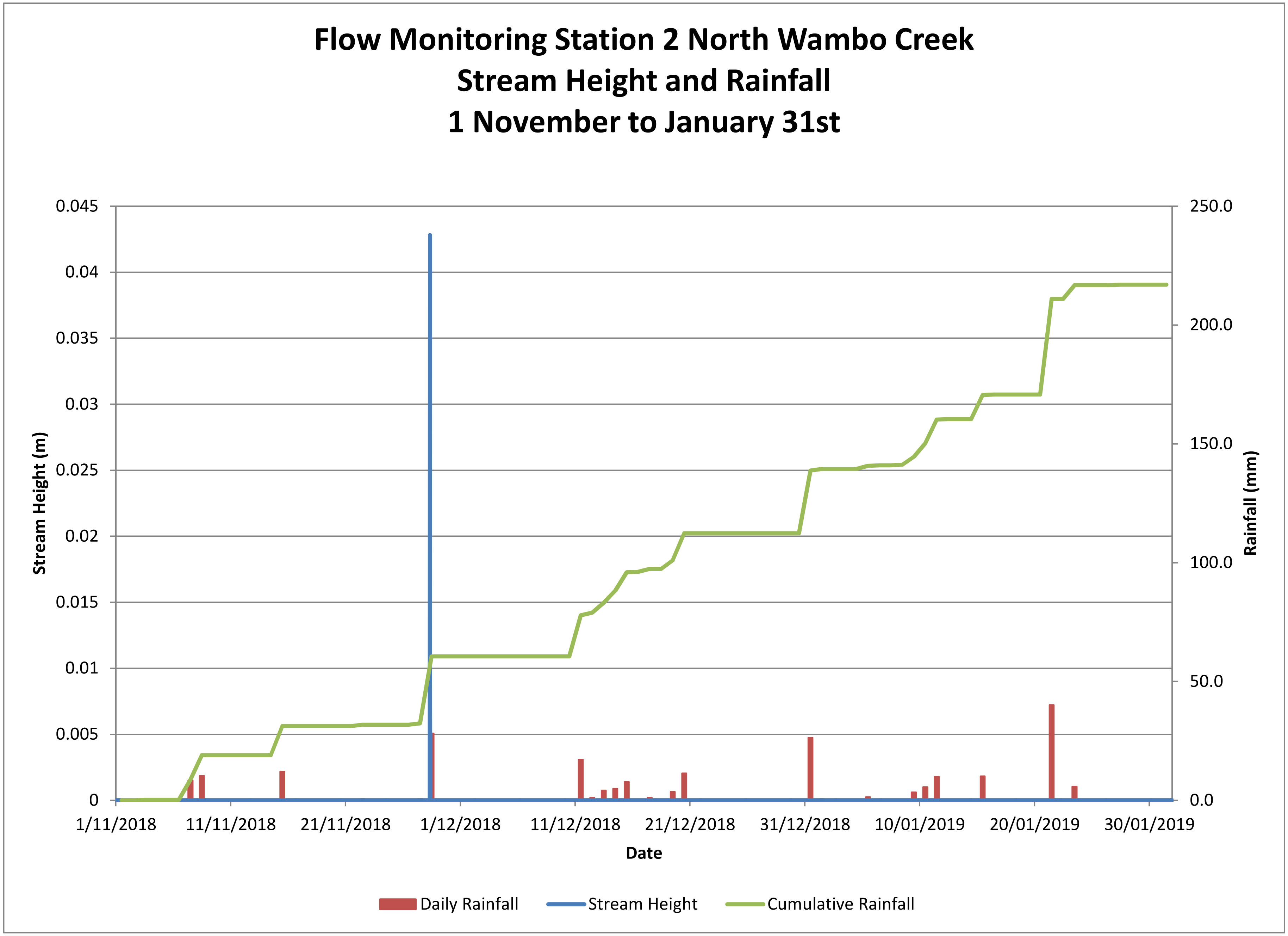

Flow Monitoring Station 2 North Wambo Creek
Stream Height & Rainfall
1 February to 30 April 2018
Stream Height (m)
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
Rainfall (mm)
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
1/02/2018
11/02/2018
21/02/2018
3/03/2018
13/03/2018
23/03/2018
2/04/2018
12/04/2018
22/04/2018
Date
Daily Rainfall
Stream Height
Cumulative Rainfall


Flow Monitoring Station 2 North Wambo Creek
Theoretical Flow (Q) & Rainfall
1 February to 30 April 2018
Theoretical Flow (Q)m³/s)
Rainfall (mm)
0.025
0.02
0.015
0.01
0.005
0
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
1/02/2018
11/02/2018
21/02/2018
3/03/2018
13/03/2018
23/03/2018
2/04/2018
12/04/2018
22/04/2018
Date
Daily Rainfall
Theoretical Flow (Q)
Cumulative Rainfall

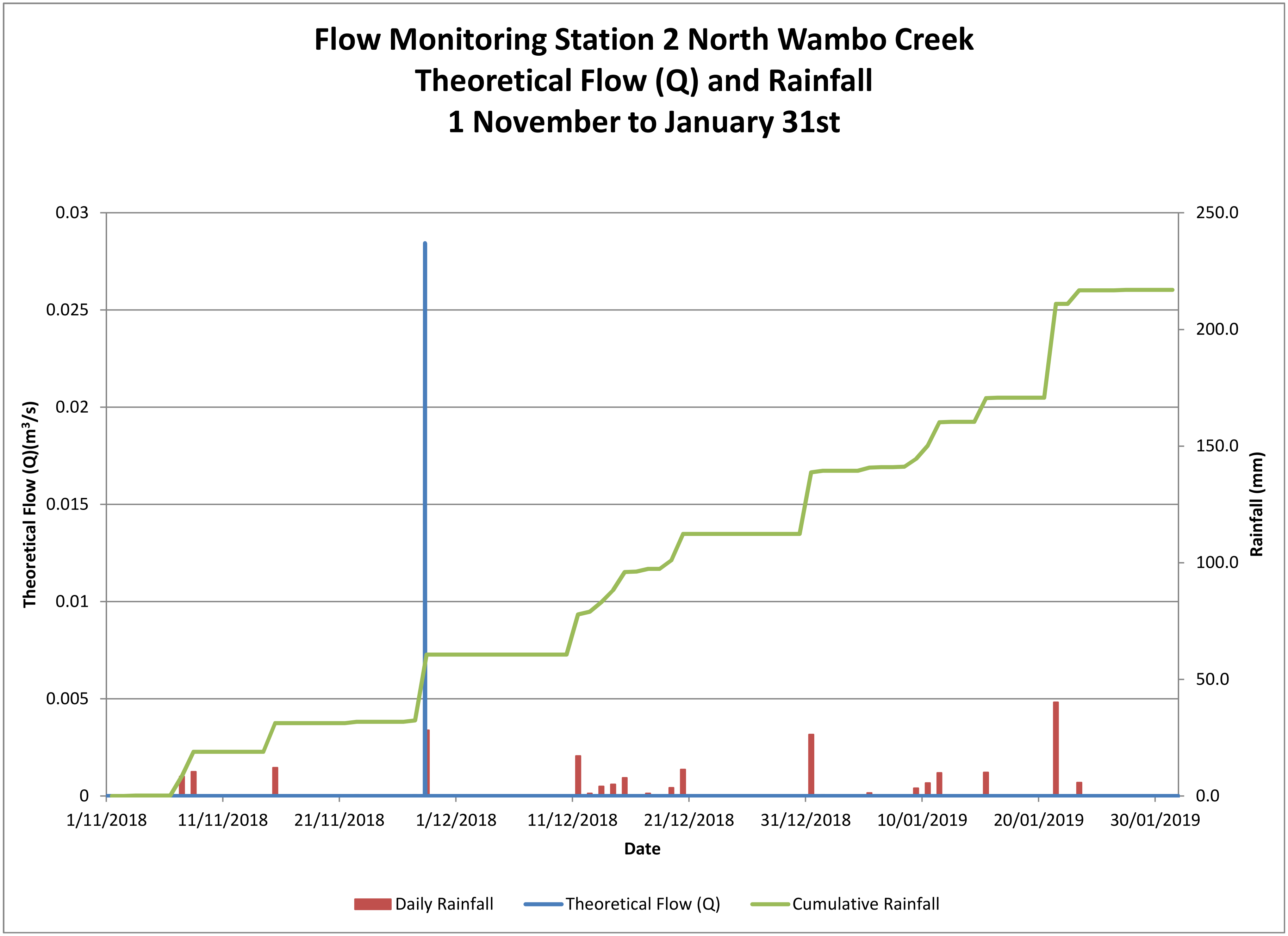


Flow Monitoring Station 2 North Wambo Creek
Stream Height and Rainfall
1 August to 31 October 2018
Stream Height (m)
Rainfall (mm)
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
1/08/2018
11/08/2018
21/08/2018
31/08/2018
10/09/2018
20/09/2018
30/09/2018
10/10/2018
20/10/2018
30/10/2018
Date
Daily Rainfall
Stream Height
Cumulative Rainfall

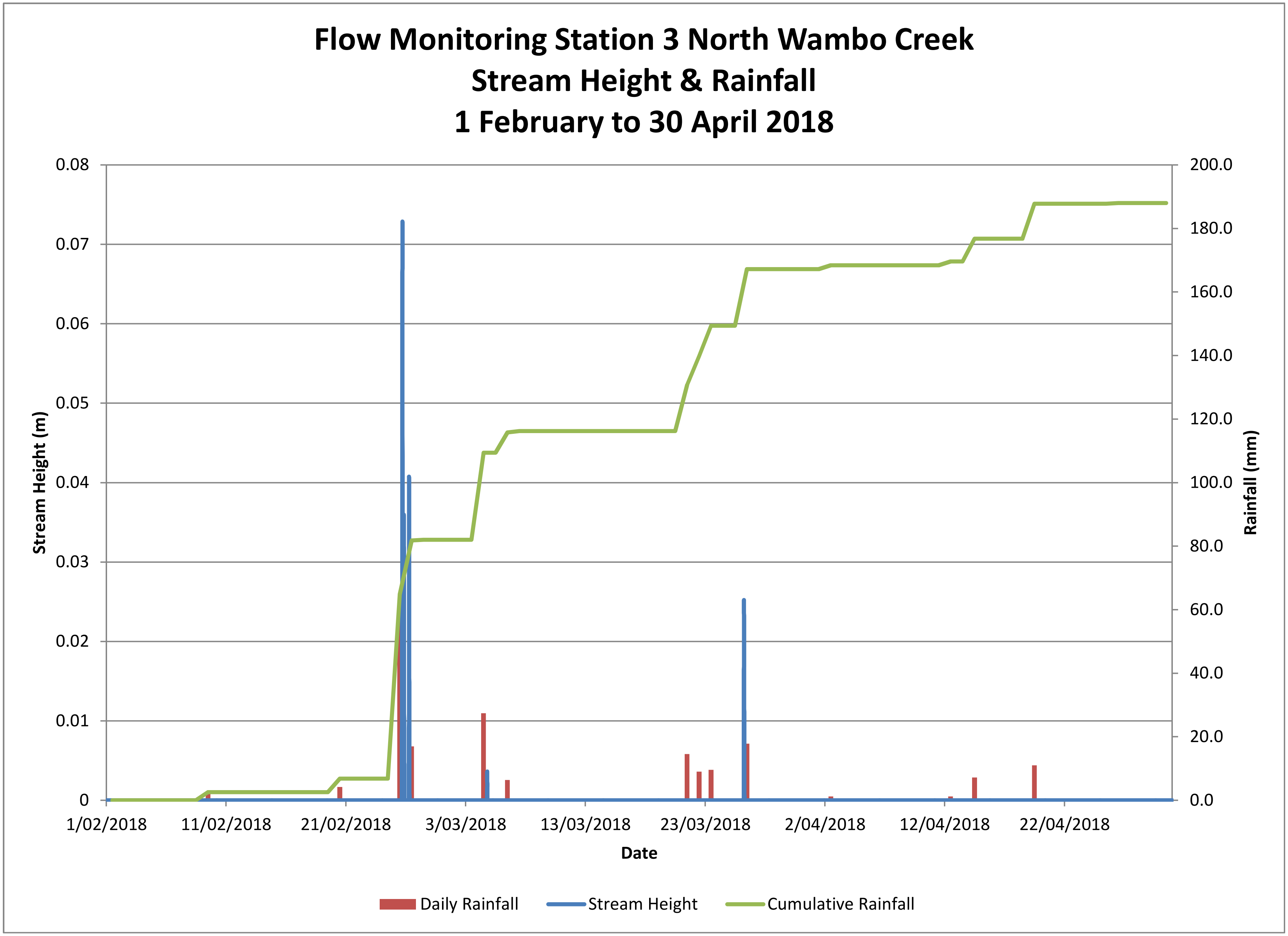

Flow Monitoring Station 2 North Wambo Creek
Theoretical Flow (Q) and Rainfall
1 August to 31 October 2018
Theoretical Flow (Q)m³/S
Rainfall (mm)
0.025
0.02
0.015
0.01
0.005
0
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
1/08/2018
11/08/2018
21/08/2018
31/08/2018
10/09/2018
20/09/2018
30/09/2018
10/10/2018
20/10/2018
30/10/2018
Date
Daily Rainfall
Theoretical Flow (Q)
Cumulative Rainfall



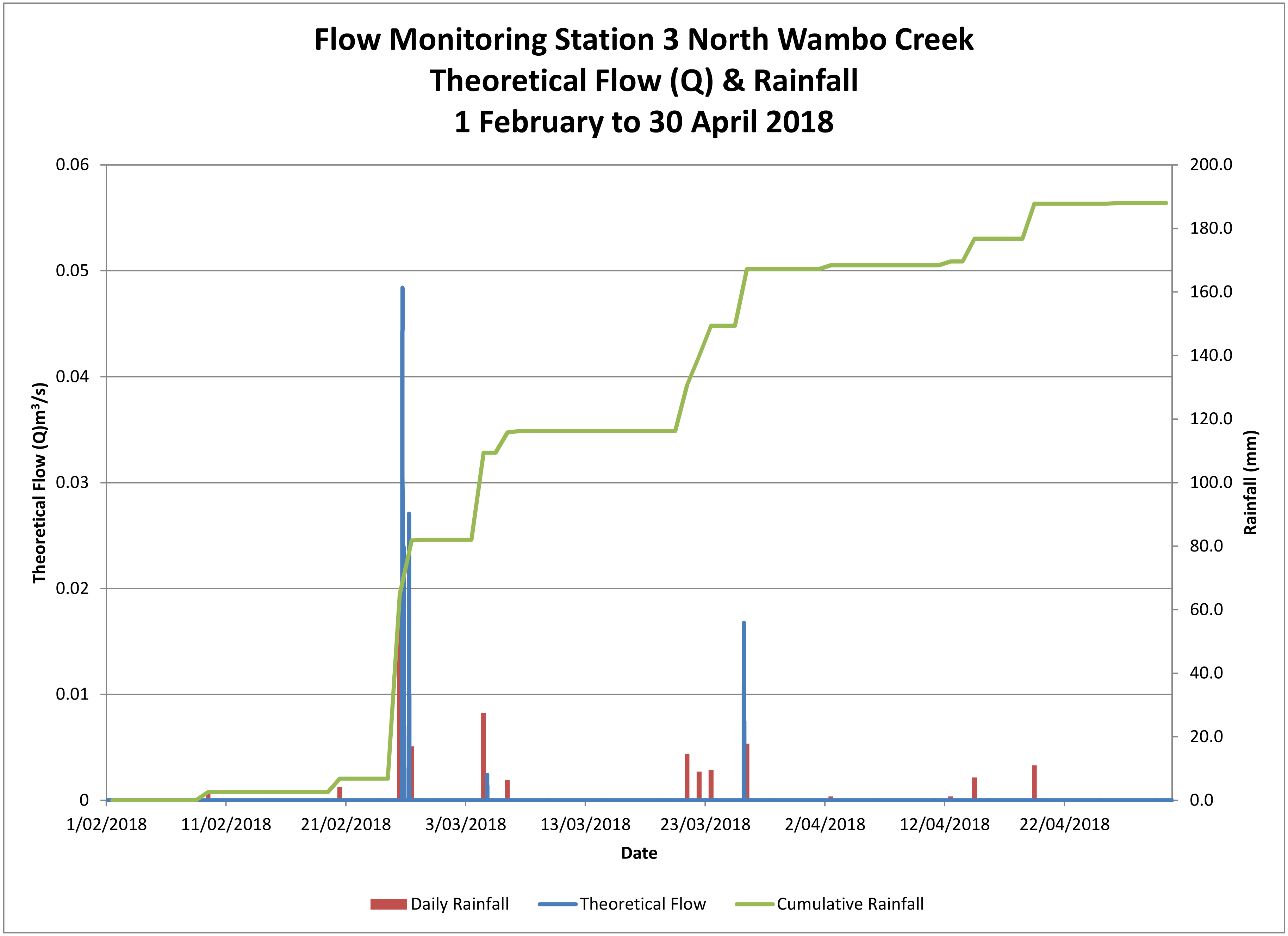
Flow Monitoring Station 2 North Wambo Creek
Stream Height and Rainfall
1 November to January 31st
Stream Height (m)
Rainfall (mm)
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
250.0
200.0
150.0
100.0
50.0
0.0
1/11/2018
11/11/2018
21/11/2018
1/12/2018
11/12/2018
21/12/2018
31/12/2018
10/01/2019
20/01/2019
30/01/2019
Date
Daily Rainfall
Stream Height
Cumulative Rainfall



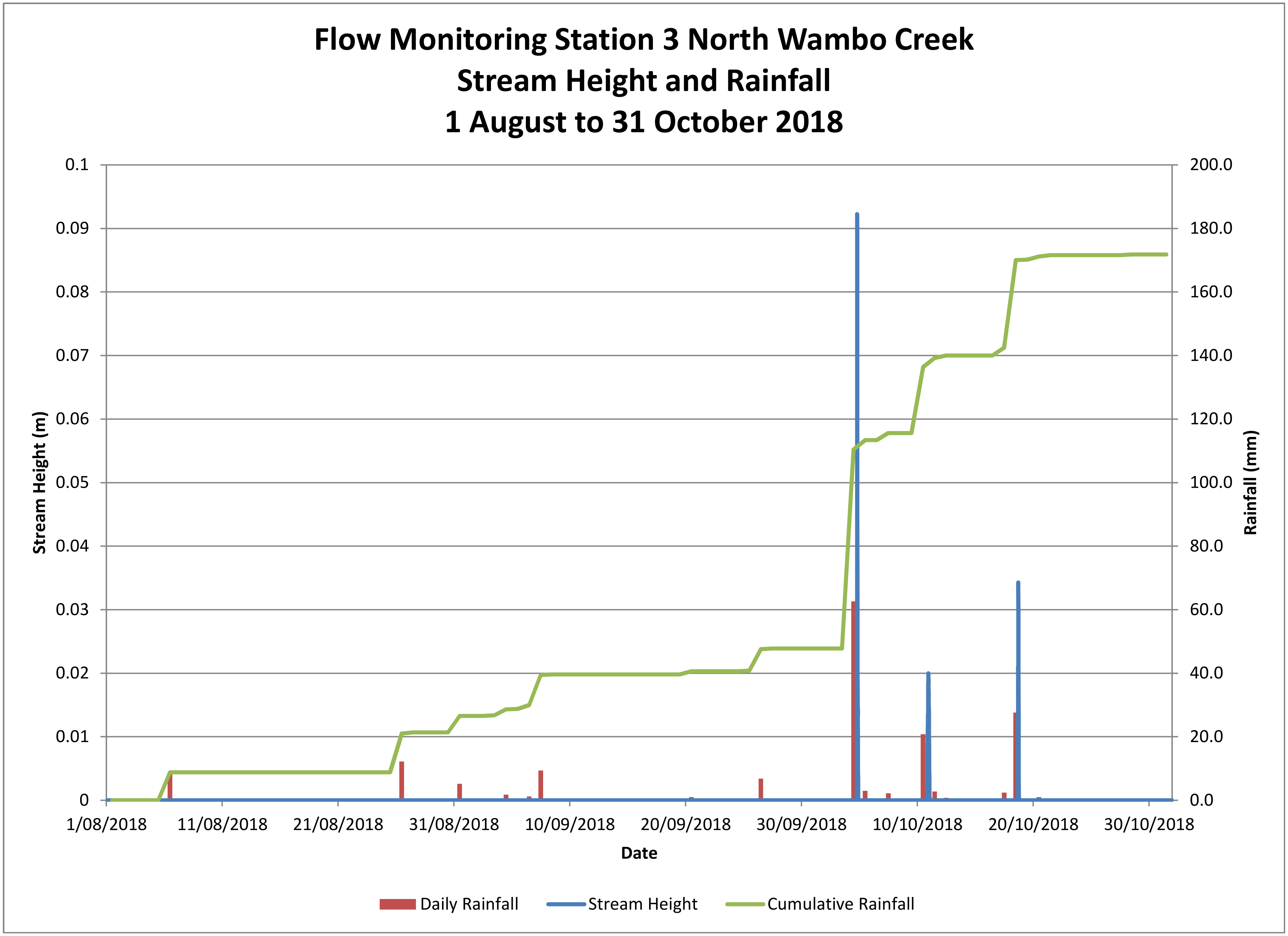
Flow Monitoring Station 2 North Wambo Creek
Theoretical Flow (Q) and Rainfall
1 November to January 31st
Theoretical Flow (Q)(m³/s)
0.03
0.025
0.02
0.015
0.01
0.005
0
Rainfall (mm)
250.0
200.0
150.0
100.0
50.0
0.0
1/11/2018
11/11/2018
21/11/2018
1/12/2018
11/12/2018
21/12/2018
31/12/2018
10/01/2019
20/01/2019
30/01/2019
Date
Daily Rainfall
Theoretical Flow (Q)
Cumulative Rainfall

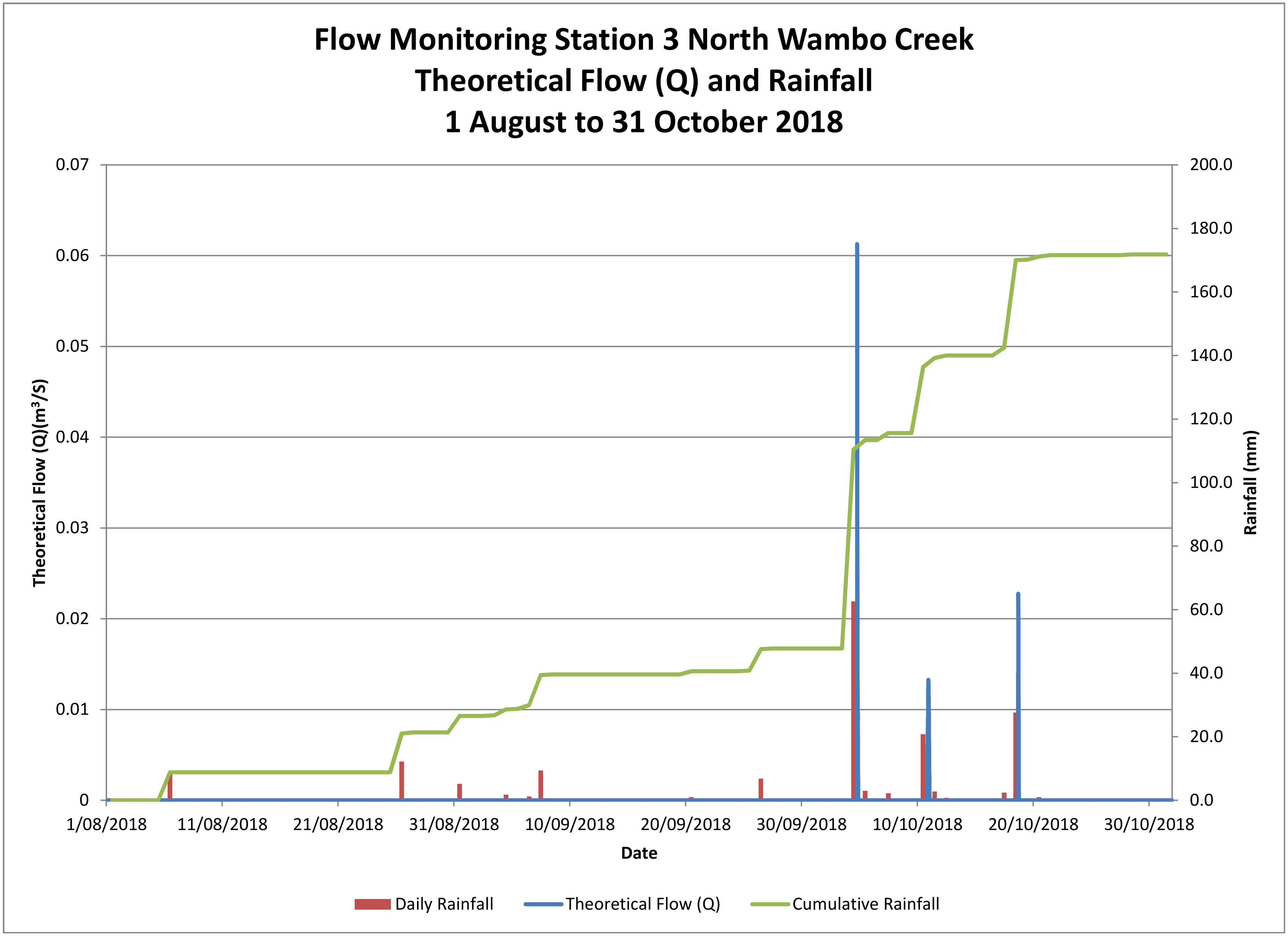


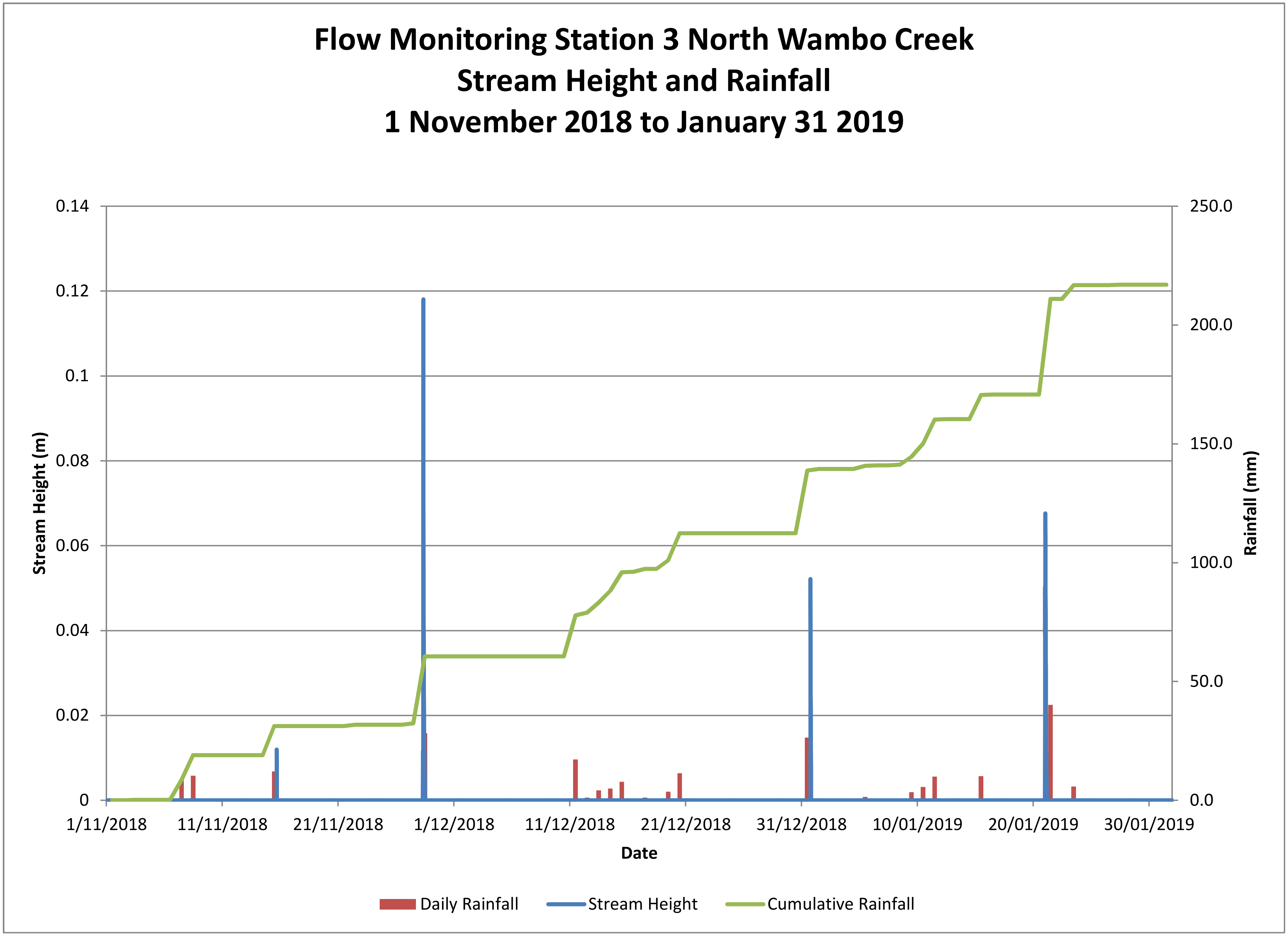
Flow Monitoring Station 3 North Wambo Creek
Stream Height & Rainfall
1 February to 30 April 2018
Stream Height (m)
Rainfall (mm)
Date
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
1/02/2018
11/02/2018
21/02/2018
3/03/2018
13/03/2018
23/03/2018
2/04/2018
12/04/2018
22/04/2018
Daily Rainfall
Stream Height
Cumulative Rainfall

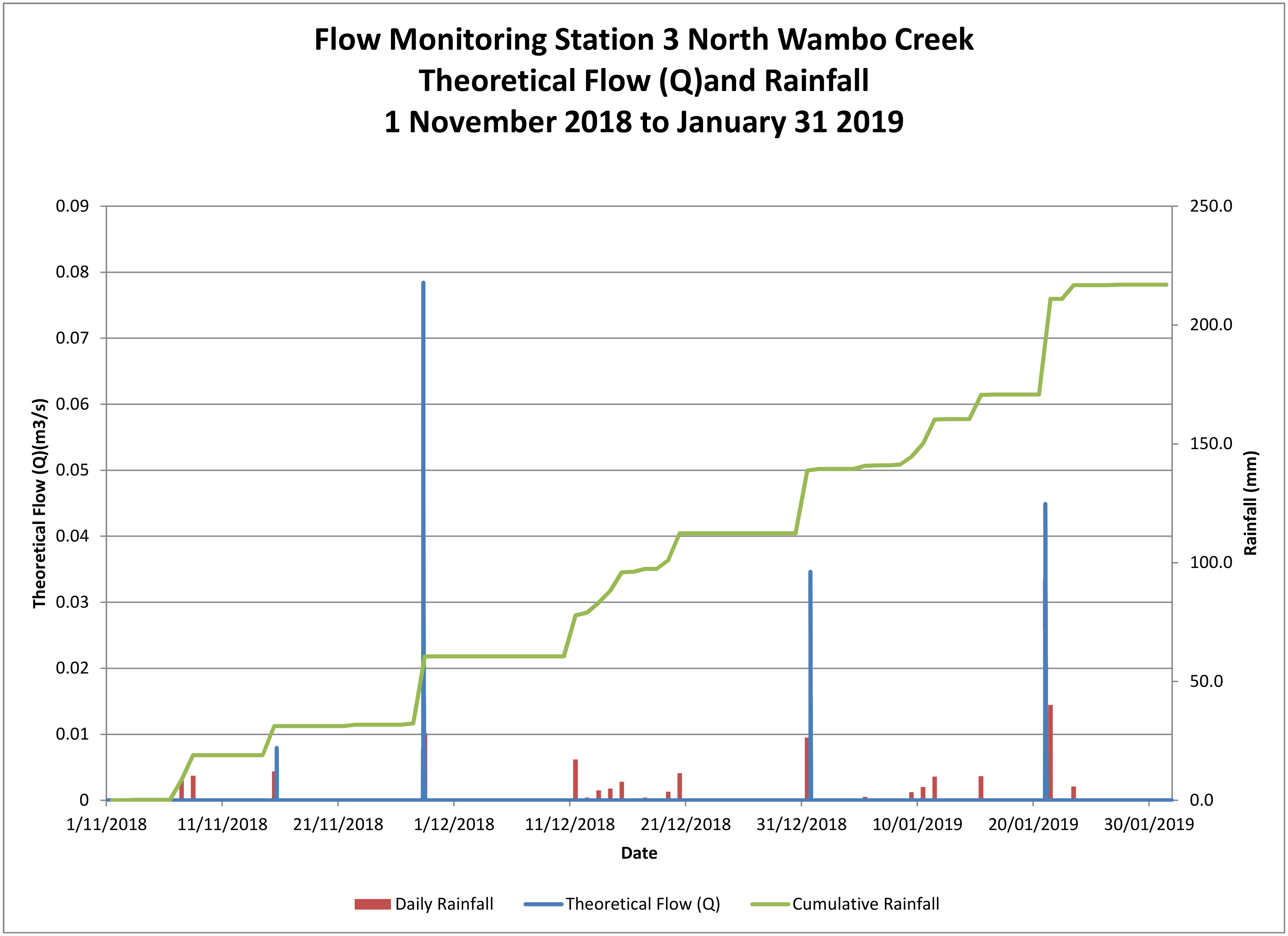


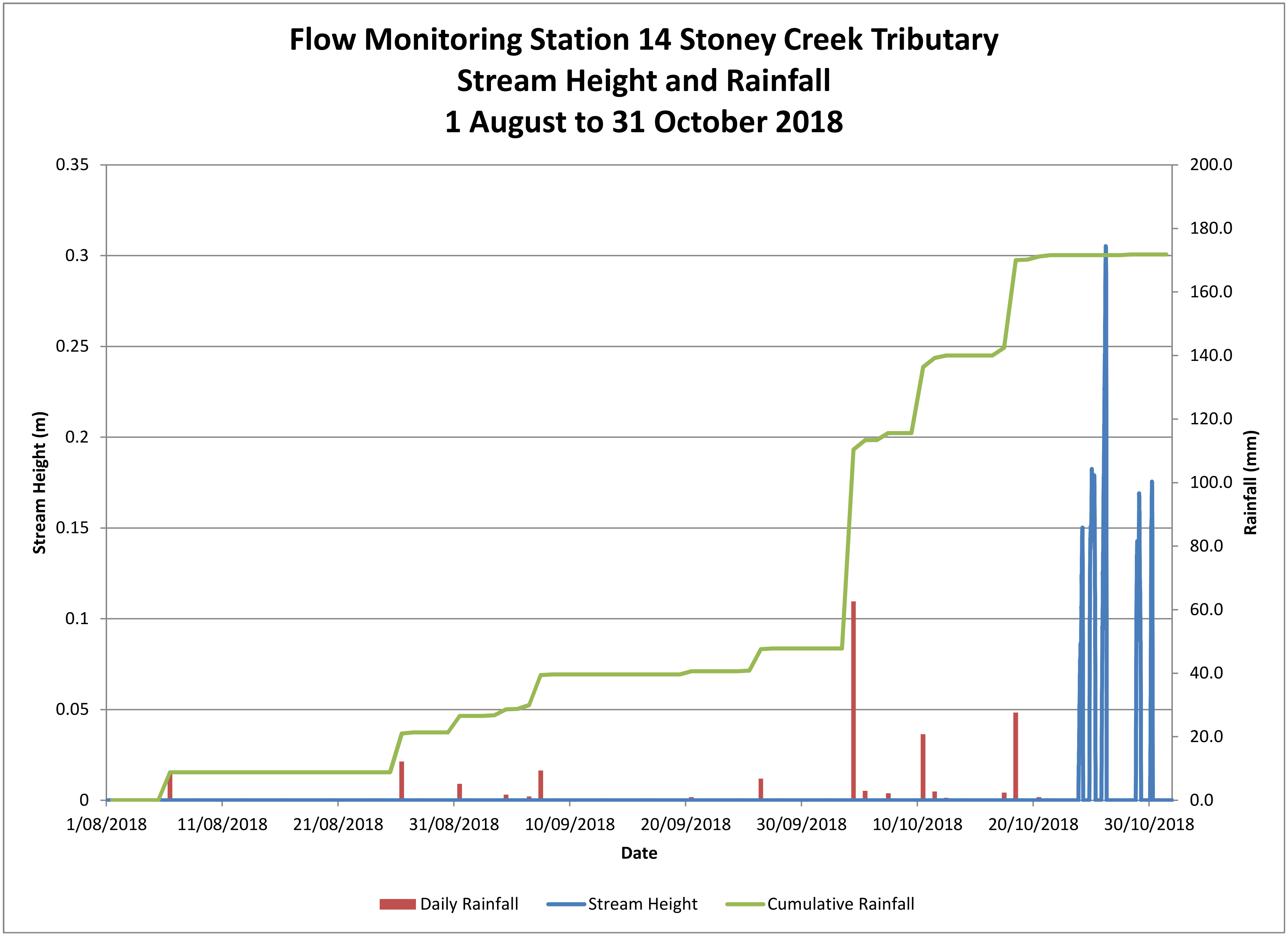
Flow Monitoring Station 3 North Wambo Creek
Theoretical Flow (Q) & Rainfall
1 February to 30 April 2018
Theoretical Flow (Q)m³/s)
Rainfall (mm)
0.06
0.05
0.04
0.03
0.02
0.01
0
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
1/02/2018
11/02/2018
21/02/2018
3/03/2018
13/03/2018
23/03/2018
2/04/2018
12/04/2018
22/04/2018
Date
Daily Rainfall
Theoretical Flow
Cumulative Rainfall


Flow Monitoring Station 3 North Wambo Creek
Stream Height and Rainfall
1 August to 31 October 2018
Stream Height (m)
Rainfall (mm)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
1/08/2018
11/08/2018
21/08/2018
31/08/2018
10/09/2018
20/09/2018
30/09/2018
10/10/2018
20/10/2018
30/10/2018
Date
Daily Rainfall
Stream Height
Cumulative Rainfall

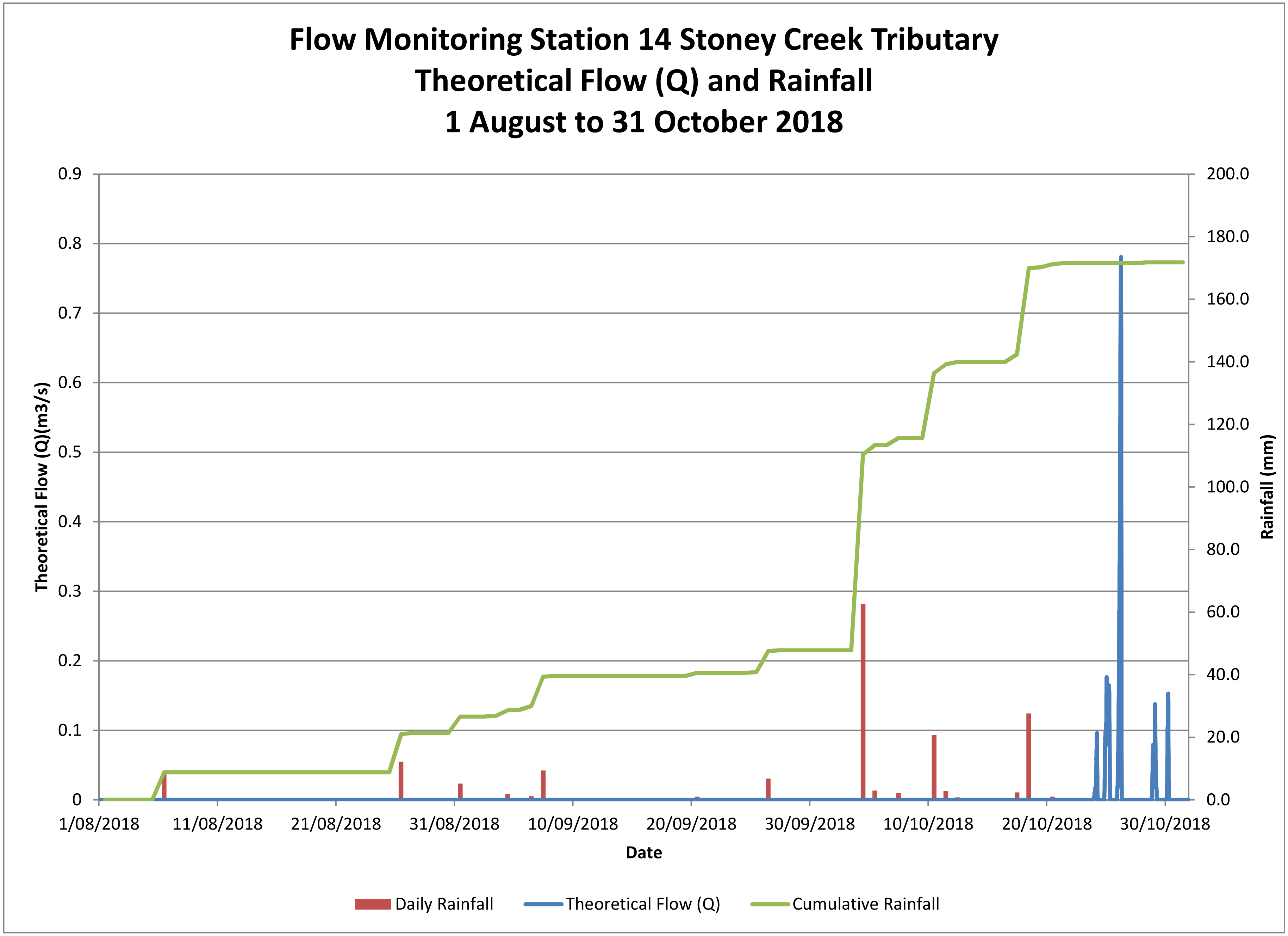

Flow Monitoring Station 3 North Wambo Creek
Theoretical Flow (Q) and Rainfall
1 August to 31 October 2018
Theoretical Flow (Q)(m³/S)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Rainfall (mm)
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
1/08/2018
11/08/2018
21/08/2018
31/08/2018
10/09/2018
20/09/2018
30/09/2018
10/10/2018
20/10/2018
30/10/2018
Date
Daily Rainfall
Theoretical Flow (Q)
Cumulative Rainfall


Flow Monitoring Station 3 North Wambo Creek
Stream Height and Rainfall
1 November 2018 to January 31 2019
Stream Height (m)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Rainfall (mm)
250.0
200.0
150.0
100.0
50.0
0.0
1/11/2018
11/11/2018
21/11/2018
1/12/2018
11/12/2018
21/12/2018
31/12/2018
10/01/2019
20/01/2019
30/01/2019
Date
Daily Rainfall
Stream Height
Cumulative Rainfall

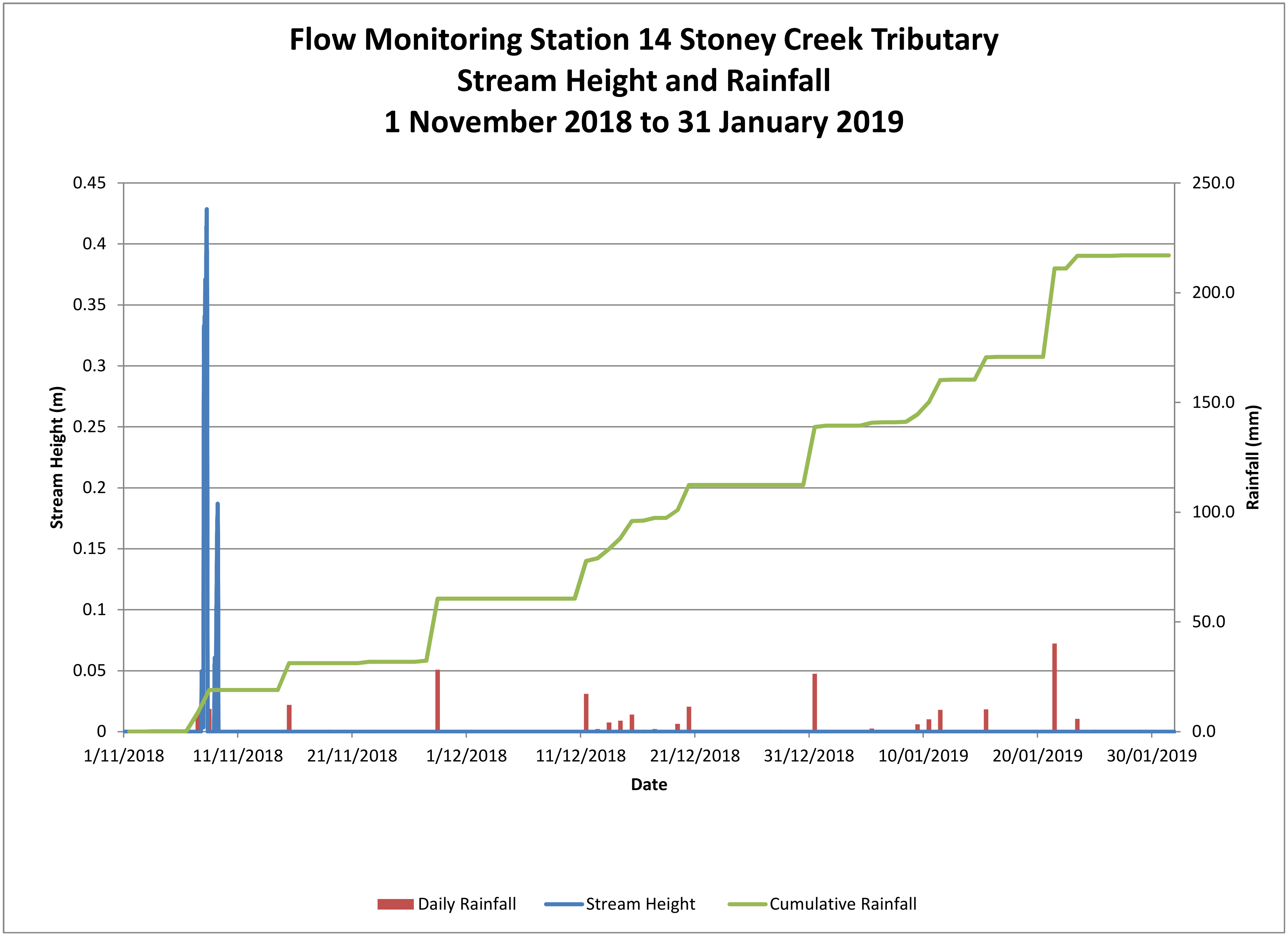

Flow Monitoring Station 3 North Wambo Creek
Theoretical Flow (Q)and Rainfall
1 November 2018 to January 31 2019
Theoretical Flow (Q)(m3/s)
Rainfall (mm)
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
250.0
200.0
150.0
100.0
50.0
0.0
1/11/2018
11/11/2018
21/11/2018
1/12/2018
11/12/2018
21/12/2018
31/12/2018
10/01/2019
20/01/2019
30/01/2019
Date
Daily Rainfall
Theoretical Flow (Q)
Cumulative Rainfall



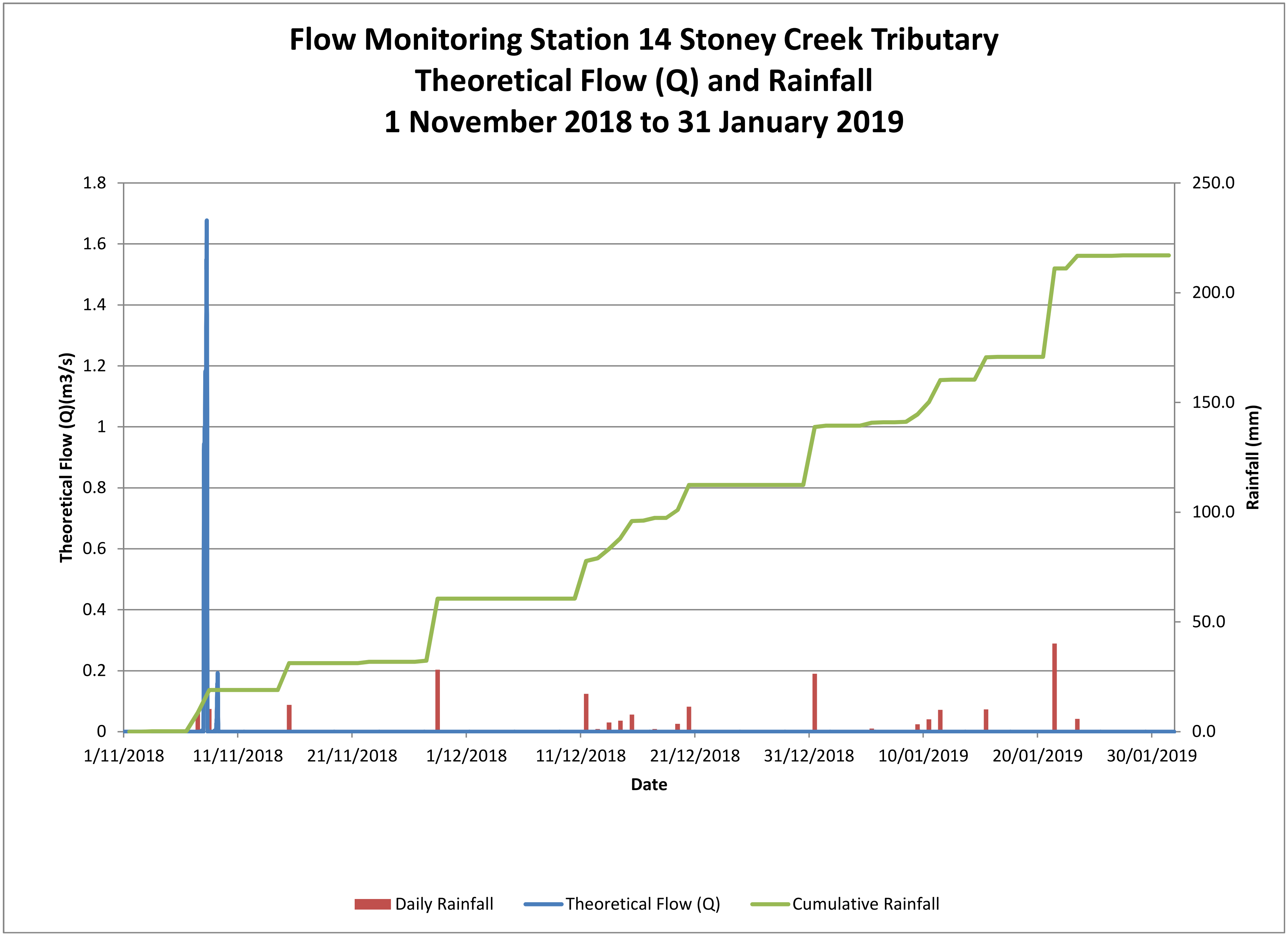
Flow Monitoring Station 14 Stoney Creek Tributary
Stream Height and Rainfall
1 August to 31 October 2018
Stream Height (m)
Rainfall (mm)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
1/08/2018
11/08/2018
21/08/2018
31/08/2018
10/09/2018
20/09/2018
30/09/2018
10/10/2018
20/10/2018
30/10/2018
Date
Daily Rainfall
Stream Height
Cumulative Rainfall



Flow Monitoring Station 14 Stoney Creek Tributary
Theoretical Flow (Q) and Rainfall
1 August to 31 October 2018
Theoretical Flow (Q)(m3/s)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Rainfall (mm)
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
1/08/2018
11/08/2018
21/08/2018
31/08/2018
10/09/2018
20/09/2018
30/09/2018
10/10/2018
20/10/2018
30/10/2018
Date
Daily Rainfall
Theoretical Flow (Q)
Cumulative Rainfall



Flow Monitoring Station 14 Stoney Creek Tributary
Stream Height and Rainfall
1 November 2018 to 31 January 2019
Stream Height (m)
Rainfall (mm)
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
250.0
200.0
150.0
100.0
50.0
0.0
1/11/2018
11/11/2018
21/11/2018
1/12/2018
11/12/2018
21/12/2018
31/12/2018
10/01/2019
20/01/2019
30/01/2019
Date
Daily Rainfall
Stream Height
Cumulative Rainfall


Flow Monitoring Station 14 Stoney Creek Tributary
Theoretical Flow (Q) and Rainfall
1 November 2018 to 31 January 2019
Theoretical Flow (Q)(m3/s)
Rainfall (mm)
Date
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
250.0
200.0
150.0
100.0
50.0
0.0
1/11/2018
11/11/2018
21/11/2018
1/12/2018
11/12/2018
21/12/2018
31/12/2018
10/01/2019
20/01/2019
30/01/2019
Daily Rainfall
Theoretical Flow (Q)
Cumulative Rainfall

APPENDIX I

WAMBO COAL PTY LTD
2018 ANNUAL COMPLIANCE REPORT
(EPBC 2016/7636 AND EPBC 2016/7816)

WAMBO COAL PTY LTD
2018 ANNUAL COMPLIANCE REPORT

(EPBC 2016/7636 and EPBC 2016/7816)

1 January – 31 December 2018

Document Control

Title	Wambo Coal 2018 Annual Compliance Report (EPBC 2016/7636 and EPBC 2016/7816)
General Description	Review of compliance with the conditions of EPBC 2016/7636 and EPBC 2016/7816
Document Owner	Manager: Environment & Community

Revisions

Rev No	Date	Description	By	Checked	Signature
1	March 2019	Original	WCPL	ND/PJ	

This report addresses Condition 5 of the Wambo Coal Pty Limited (WCPL) Environment Protection and Biodiversity Conservation (EPBC) Approval 2016/7636 for the South Wambo Underground Mine Extension, which states:

The person taking the action must publish a report on their website addressing compliance with each of the conditions of this approval, including implementation of any management plan, program, strategy and review required by condition 1. The reporting period and report publication must comply with conditions 5 and 12 of schedule 6 of the state development consent. Documentary evidence providing proof of the date of publication and noncompliance with any of the conditions of this approval must be provided to the Department at the same time as the compliance report is published. The person taking the action must continue to publish the report until such time as agreed in writing by the Minister.

Table 1 provides a reconciliation of the conditions of EPBC 2016/7636 and their compliance status.

This report also addressed Condition 5 of the WCPL EPBC Approval 2016/7816 for the South Bates Extension Underground Mine, which states:

By 31 March of each year after the commencement of the action, the person taking the action must: publish a report on their website addressing compliance with each of the conditions of this approval, including implementation of any management plans and strategies required by conditions 22, 22C, 22D and 23 - 39 of Schedule 4 the state development consent over the previous calendar year; and provide documentary evidence providing proof of the date of publication to the Department, by email to EPBCMonitoring@environment.gov.au (or another email address as stipulated by the Department). The person taking the action must continue publishing annual compliance reports and make all reports available on their website for the life of the approval, unless agreed in writing by the Minister.

Table 2 provides a reconciliation of the conditions of EPBC 2016/7816 and their compliance status.

Table 1: EPBC (2016/7636) Compliance Summary

Condition	Status	Comment
1. The person taking the action must: a. Not clear more than 0.9 ha of Central Hunter Valley Eucalypt Forest and 3.4 ha of foraging habitat for the Regent Honeyeater *(Anthochaera phrygia).*	Compliant	The action has not yet been commenced. WCPL has not cleared more than 0.9 hectares (ha) of Central Hunter Valley Eucalypt Forest or more than 3.4 ha of foraging habitat for the Regent Honeyeater (*Anthochaera Phrygia*) as part of the action.
b. Implement conditions 1, 2 and 2A of schedule 3 of the **state development consent** to minimise the impacts of the action on **protected matters**.	Compliant	WCPL implements Conditions 1, 2 and 2A, Schedule 3 of the Development Consent (DA305-7-2003).
c. Implement environmental performance conditions 22 - 41A and 44·-·50 in Schedule 4 of the **state development consent**, where the conditions relate to avoiding, mitigating, managing, offsetting, monitoring or recording, or reporting on impacts to **protected matters**. In implementing these conditions, the approval holder must protect at least 18.3 ha of Central Hunter Valley Eucalypt Forest and at least 27.7 ha of foraging habitat for the Regent Honeyeater *(Anthochaera phrygia)* in perpetuity.	Compliant	WCPL implements Conditions 22 to 41A, Schedule 4 and Conditions 44 to 50, Schedule 4 of the Development Consent (DA305-7-2003). WCPL has applied to amend an existing Voluntary Conservation Agreement (VCA) under the NSW *National Parks and Wildlife Act, 1974* to conserve Remnant Woodland Enhancement Program Area E in perpetuity, which includes 18.3 ha of Central Hunter Valley Eucalypt Forest and Woodland and 27.7 ha of foraging habitat for the Regent Honeyeater.
2. Within 30 days after the **commencement** of the action, the person taking the act on must advise the **Department** in writing of the actual date of **commencement** of the action.	Not applicable	The action has not yet been commenced. Mining at the approved South Wambo Underground Mine is planned to commence after completion of mining at the South Bates Underground Mine. WCPL will advise the Department in writing of the commencement of the action within 30 days of commencement.
3. Unless otherwise agreed to in writing by the **Minister**, the person taking the action must publish all management plans, programs, strategies and reviews required by condition 1. Each management plan, program, strategy and review must be published on the website, and notification must be provided to the Department, within 1 month of being approved by the Secretary of the NSW Department of Planning & Environment (or nominee of the Secretary).	Compliant	Copies of all management plans, programs, strategies and reviews required by condition 1 of EPBC 2016/7636 are available to the public on the Peabody Energy website https://www.peabodyenergy.com/Operations/Australia-Mining/New-South-Wales-Mining/Wambo-Approvals,-Plans-Reports. Relevant management plans include the Site Water Management Plan, Biodiversity Management Plan and Life of Mine Rejects Emplacement Strategy. An Extraction Plan for areas related to the action has not yet been prepared. Notification is provided to the Department within one month of the approval of any management plans, programs, strategies and reviews by the Secretary of the NSW Department of Planning & Environment (or nominee of the Secretary).

Condition	Status	Comment
4. The person taking the action must maintain accurate records substantiating all activities associated with or relevant to the conditions of approval, including measures taken to implement a management plan, program, strategy and review required by condition 1, and make them available upon request to the **Department**. Such records may be subject to audit by the **Department** or an independent auditor in accordance with section 458 of the EPBC Act, or used to verify compliance with the conditions of approval.	Compliant	WCPL maintains accurate records substantiating all activities associated with or relevant to the conditions of approval, including measures taken to implement a management plan, program, strategy and review required by condition 1. WCPL will make these records available upon request to the Department.
5. The person taking the action must publish a report on their website addressing compliance with each of the conditions of this approval, including implementation of any management plan, program, strategy and review required by condition 1. The reporting period and report publication must comply with conditions 5 and 12 of schedule 6 of the **state development. consent**. Documentary evidence providing proof of the date of publication and non-compliance with any of the conditions of this approval must be provided to the **Department** at the same time as the compliance report is published. The person taking the action must continue to publish the report until such time as agreed in writing by the **Minister**.	Compliant	The WCPL 2017 Annual Review (including this report) will be published on the Peabody Energy website https://www.peabodyenergy.com/Operations/Australia-Mining/New-South-Wales-Mining/Wambo-Approvals,-Plans-Reports.
6. Any potential or actual contravention of the conditions of this approval, including contravention of a commitment made in a management plan, program, strategy and review required by condition 1 must be reported to the **Department** within 7 days of the person taking the action becoming aware of the actual or potential contravention.	Not applicable	No events contravening (or potentially contravening) the conditions of this approval have occurred.
7. Upon the direction of the **Minister**, the person taking the action must ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the **Minister**. The independent auditor must be approved by the **Minister** prior to the commencement of the audit. Audit criteria must be agreed to by the **Minister** and the audit report must address the criteria to the satisfaction of the **Minister**.	Not applicable	Upon the direction of the Minister, WCPL will ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the Minister.
8. If, at any time after 5 years from the date of this approval, the person taking the action has not substantially commenced the action, then the person taking the action must not substantially commence the action without the written agreement of the **Minister**.	Not applicable	WCPL has not yet commenced the action. Mining at the approved South Wambo Underground Mine is planned to commence after completion of mining at the South Bates Underground Mine. If WCPL has not substantially commenced the South Wambo Underground Mine prior to 30 April 2022 (i.e. five years after the date EPBC 2016/7636 was granted), WCPL will seek the written agreement of the Minister prior to substantially commencing the action.

Table 2: EPBC (2016/7816) Compliance Summary

Condition	Status	Comment
1. The person taking the action must: a. Implement administrative conditions 1, 2 and 2A of Schedule 3 of the **state development consent** to minimise the impacts of the action on **protected matters**.	Compliant	WCPL implements Conditions 1, 2 and 2A, Schedule 3 of the Development Consent (DA305-7-2003).
b. Implement environmental performance conditions 22, 22C, 22D and 23 - 39 of Schedule 4 of the **state development consent**, where the conditions relate to avoiding, mitigating, managing, offsetting, monitoring or recording, or reporting on impacts to **protected matters**.	Compliant	WCPL implements Conditions 22, 22C, 22D, Schedule 4 and Conditions 23 to 39, Schedule 4 of the Development Consent (DA305-7-2003).
c. Notify the **Department** in writing of any proposed change to the **conditions** of the **state development consent**, referred to in conditions 1a and 1b, within 14 **days** of formally proposing a change or becoming aware of any other proposed change.	Not applicable	No changes to the Development Consent (DA305-7-2003) conditions referred to in conditions 1a and 1b have been proposed since the grant of EPBC 2016/7816.
d. Notify the **Department** in writing of any change to **conditions** of the **state development consent**, referred to in conditions 1 a to 1 b, within 14 **days** of a change to **conditions** being finalised.	Not applicable	No changes to the Development Consent (DA305-7-2003) conditions referred to in conditions 1a and 1b have been proposed since the grant of EPBC 2016/7816.
2. Within 30 **days** after the **commencement of the action**, the person taking the action must advise the **Department** in writing of the actual date of **commencement of the action**.	Not compliant	WCPL have provided a notification to the Department of the actual date of commencement of the action (3 December 2018), however this was not completed within 30 days of the commencement of the action.
3. Unless otherwise agreed to in writing by the **Minister**, the person taking the action must publish all management plans and strategies required by conditions 22, 22C, 22D and 23 - 39 of Schedule 4 of the **state development consent** on their website. Each management plan and strategy must be published on the website within 1 month of being approved by the **Secretary** and remain there for a peiord [*sic*] no less than 5 years.	Compliant	Copies of all management plans, programs, strategies and reviews required by condition 1 of EPBC 2016/7636 are available to the public on the Peabody Energy website https://www.peabodyenergy.com/Operations/Australia-Mining/New-South-Wales-Mining/Wambo-Approvals,-Plans-Reports. Relevant management plans include the Extraction Plan for South Bates Extension Underground Mine Longwalls 17-20, Site Water Management Plan, Biodiversity Management Plan and Life of Mine Rejects Emplacement Strategy. Notification is provided to the Department within one month of the approval of any management plans, programs, strategies and reviews by the Secretary of the NSW Department of Planning & Environment (or nominee of the Secretary).

Condition	Status	Comment
4. The person taking the action must maintain accurate records substantiating all activities associated with or relevant to these conditions of **approval**, including measures taken to implement the management plans and strategies required by conditions 22, 22C, 220 and 23 - 39 of Schedule 4 of the **state development consent**, and make them available upon request to the **Department**. Such records may be subject to audit by the **Department** or an independent auditor in accordance with section 458 of the **EPBC Act**, or used to verify compliance with the conditions of this **approval**.	Compliant	WCPL maintains accurate records substantiating all activities associated with or relevant to the conditions of approval, including measures taken to implement a management plan, program, strategy and review required by condition 1. WCPL will make these records available upon request to the Department.
5. By 31 March of each year after the **commencement** of the action, the person taking the action must: publish a report on their website addressing compliance with each of the **conditions** of this **approval**, including implementation of any management plans and strategies required by **conditions** 22, 22C, 220 and 23 - 39 of Schedule 4 the **state development consent** over the previous calendar year; and provide documentary evidence providing proof of the date of publication to the **Department**, by email to EPBCMonitoring@environment.gov.au (or another email address as stipulated by the **Department**). The person taking the action must continue publishing annual compliance reports and make all reports available on their website for the life of the approval, unless agreed in writing by the **Minister**.	Compliant	The WCPL 2017 Annual Review (including this report) will be published on the Peabody Energy website https://www.peabodyenergy.com/Operations/Australia-Mining/New-South-Wales-Mining/Wambo-Approvals,-Plans-Reports.
6. Any potential or actual contravention of the **conditions** of this **approval**, including contravention of a commitment made in a management plan or strategy required by conditions 22, 22C, 220 and 23 - 39 of Schedule 4 of the **state development consent** must be reported to the **Department** no later than 7 **days** of the person taking the action becoming aware of the actual or potential contravention, by email to EPBCMonitoring@environment.gov.au or an address as stipulated by the **Department**.	Not applicable	No events contravening (or potentially contravening) the conditions of this approval have occurred.
7. Upon the direction of the **Minister**, the person taking the action must ensure that an independent audit of compliance with the **conditions** of **approval** is conducted and a report submitted to the **Minister**. The independent auditor must be approved by the **Minister** prior to the commencement of the audit. Audit criteria must be agreed to by the **Minister** and the audit report must address the criteria to the satisfaction of the **Minister**.	Not applicable	Upon the direction of the Minister, WCPL will ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the Minister.
8. If, at any time after 5 years from the date of this **approval**, the person taking the action has not substantially commenced the action, then the person taking the action must not substantially commence the action without the written agreement of the **Minister**.	Compliant	WCPL commenced the action within five years of the date of the approval of EPBC 2016/7816.