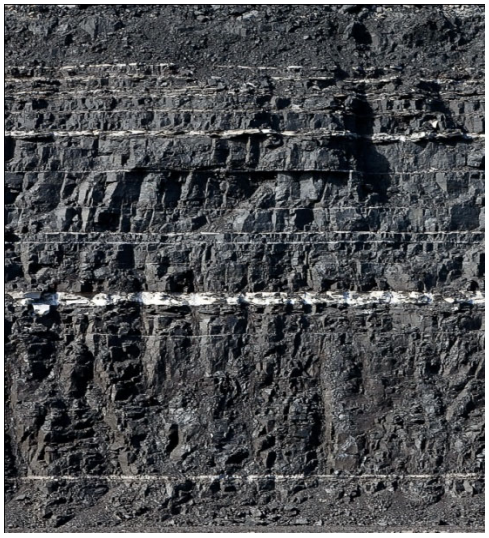
YANCOAL
兖煤澳大利亚有限公司
MT THORLEY WARKWORTH



Mount Thorley Warkworth

2021 Annual Review

Name of Operations	Mount Thorley Warkworth
Name of Operator	Coal & Allied (NSW) Pty Ltd (wholly owned subsidiary of Yancoal Australia Ltd)
Development consent /project approval	SSD-6464 & SSD-6465
Name of holder of development consent/project approval	Warkworth Mining Ltd Mt Thorley Operations Pty Ltd
Mining Lease #	Contained within Section 3.1 of this report
Name of holder of mining lease	Warkworth Mining Ltd Mount Thorley Operations Pty Ltd
Water Licence #	Contained within Section 3.1 of this report
Name of holder of water licence	Contained within Section 3.1 of this report
MOP/RMP start date	30/11/2021
MOP/RMP end date	02/07/2022
Annual Review Start Date	01/01/2021
Annual Review End Date	31/12/2021

I, Gary Mulhearn, certify that this audit report is a true and accurate record of the compliance status of Mount Thorley Warkworth for the period 1 January 2021 to 31 December 2021 and that I am authorised to make this statement on behalf of Coal & Allied (NSW) 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 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 the 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	Mr Gary Mulhearn
Title of Authorised Reporting Officer	Environment and Community Manager
Signature of Authorised Reporting Officer	
Date	2 September 2022

Executive Summary

Mount Thorley Warkworth (MTW) is an integrated operation of two open cut coal mines, Warkworth Mining Limited (WML) and Mount Thorley Operations (MTO). This Annual Review reports on the environmental performance of MTW for the period 1 January 2021 to 31 December 2021.

This report has been prepared in accordance with conditions of the development consents and Mining Leases (ML) held by MTW which require a report of the operation's environmental performance to be provided on an annual basis. The structure of the 2021 Annual Review aligns with the NSW Department of Planning and Environment (DPE) *Post-approval requirements for State significant mining developments – Annual Review Guideline* (October 2015).

MTW produced 16.51 million tonnes of run-of-mine (ROM) coal during 2021, and 11.212 million tonnes of saleable coal, against an approved ROM coal production rate of 28 million tonnes per annum (mtpa).

Noise

There were no non-compliances recorded against MTW's consented noise limits. There was an increase (from 72 to 106) in the number of supplementary attended noise measurements which exceeded the internal trigger levels for corrective action compared to 2020. A total of up to 907 hours of mine stoppages were recorded due to proactive and reactive measures to minimise noise and ensure compliance with noise criteria.

Blasting

During the reporting period 224 blast events were initiated at MTW. There were no non compliances against blasting conditions in MTWs development consents and licence conditions.

Air Quality

During 2021, MTW complied with all short term and annual average air quality criteria. A total of 1,459 hours of mine stoppage was recorded following implementation of proactive and reactive measures to minimise dust and ensure compliance with air quality criteria.

Heritage

Aboriginal and historic heritage matters continued to be managed in accordance with the MTW Aboriginal Heritage Management Plan (AHMP) and Historic Heritage Management Plan (HHMP). No aboriginal heritage assessments or salvage programs were conducted at MTW in 2021.

Annual AHMP and HHMP compliance inspections were conducted during the 2021 reporting period by a consultant archaeologist assisted by internal mine site personnel, representatives of the Aboriginal community and representatives from the sites Community Heritage Advisory Group (CHAG).

There were no incidents or any unauthorised disturbance to any heritage sites at MTW during the reporting period.

Surface Water

2021 was a wetter than average year with a total of 979.6 mm rainfall recorded at MTW's Charlton Ridge Meteorological station. The average annual rainfall at Charlton Ridge is 668mm, as calculated from 2007 to 2021 annual totals.

Construction of sediment water management structures for the western advancing pre-strip at Warkworth was completed in quarter one 2021. These structures were designed in accordance with the NSW Blue Book, *Managing Urban Stormwater: Soils and Construction, Volume 2E Mines and Quarries*. Remote boundary monitoring systems were installed on the additional new pre strip sediment dams (54N and 55N). Construction of the Warkworth North Pit North drainage upgrade works was completed during the reporting period to improve water management and mitigate the risk of unauthorised water releases from site.

There were four reportable water related incidents during the reporting period that occurred on 4 January, 19 March, 12 November and 26 November 2021. Further details on the incidents and the actions taken by MTW are provided in **Section 6.7.1 and Section 10**.

Groundwater

Groundwater monitoring activities were undertaken in 2021 in accordance with the MTW Water Management Plan and groundwater monitoring programme. The monitoring results are used to establish and monitor trends in physical and geochemical parameters of surrounding groundwater potentially influenced by mining.

Groundwater monitoring data is reviewed on a quarterly basis and is included in the March, June, September and December Monthly Environmental Monitoring Reports, available at https://www.mtwcoal.com.au/page/environment/environmental-monitoring/

Visual Amenity

Shade cloth was attached to the existing fence along Putty Road in July 2021 as a visual amenity mitigation measure. This visual screen fencing is an interim measure prior to the establishment of vegetation. Vegetation plantings were undertaken in 2020 to infill between existing trees/shrubs. Slashing works were also undertaken in 2021 along Putty Road and the Golden Highway, improving visual amenity.

Rehabilitation and Land Management

A total of 44.6ha of new rehabilitation was completed during 2021 against a Mining Operations Plan (MOP) target of 35.0ha. A further 59.1ha of Stage 2 rehabilitation was seeded with the target vegetation community seed mixes in 2021. Total disturbance undertaken was 53.6ha, which was higher than the 2021 MOP projection of 40.6ha.

The net rehabilitation progress (i.e. rehabilitation minus rehabilitation disturbance) for the current MOP period (2015 to 2021) is 442.3ha, which is 20.4ha higher than the MOP target of 421.9ha. The net rehabilitation exceeds the MOP forecast following completion of the Stage 2 rehabilitation

undertaken in 2021. Cumulative new disturbance over the MOP period is 471.7ha which is slightly above the MOP forecast of 465.7ha for the same period.

Biodiversity and Offset Management

Restoration of the Warkworth Sands Woodland vegetation community continued in the Northern Biodiversity Area, with 1,500 tube stock planted. Restoration activities for the Central Hunter Grey Box – Ironbark Woodland and River Oak Forest continued in the Southern Biodiversity Area, with 15,000 tube stock planted. Planting at the Goulburn River Biodiversity area to increase the suitability of habitat for the Regent Honeyeater continued with 12,000 infill tube stock planted into the cleared areas of Yellow Box – Grey Box – Red Gum Grassy Woodland and riparian woodland areas. The annual Rapid Condition Assessments were undertaken across all Biodiversity Areas in 2021.

Weed control, vertebrate pest management activities, seed collection, track maintenance, waste removal and fence repairs were conducted during 2021 across all Biodiversity Areas in accordance with the Offset Management Plans.

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1 STATEMENT OF COMPLIANCE

A Statement of Compliance against the relevant approvals is provided in **Table 1.1**. **Table 1.2** provides a brief summary of the non-compliances and a reference to where these are addressed within this Annual Review.

TABLE 1.1 STATEMENT OF COMPLIANCE

Approval	Were all conditions complied with?
DA SSD-6465 (MTO)	No
DA SSD-6464 (WML)	Yes

TABLE 1.2 NON COMPLIANCES

Relevant approval	Condition number	Condition description (summary)	Compliance status	Section in this Annual Review it is addressed.
SSD-6465 (MTO)	Schedule 3 Condition 25	Water Discharge	Non-compliant	10

TABLE 1.3 COMPLIANCE STATUS KEY FOR TABLE 1.2

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

Source: NSW Government Post-approval requirements for State significant mining developments – Annual Review Guideline (October 2015).

2 INTRODUCTION

Mount Thorley Warkworth Coal Mine (MTW), is an integrated operation consisting of Warkworth Mining Limited (WML) and Mount Thorley Operations (MTO) (**Figure 1**) situated 14 km southwest of Singleton, in the Upper Hunter Valley region of NSW. MTW is managed and operated by Coal & Allied (NSW) Pty Ltd, a wholly owned subsidiary of Yancoal Australia Limited (YAL). A summary of MTW tenements is shown in **Figure 2.**

2.1 Scope

This Annual Review (AR) covers the twelve-month reporting period from **1 January 2021 to 31 December 2021.**

This report summarises the environmental performance of MTW in accordance with conditions of the development consents and Mining Leases (ML) held by site. The structure of this 2021 Annual Review aligns with the *DPE Post-approval requirements for State significant mining developments – Annual Review Guideline* (October 2015).

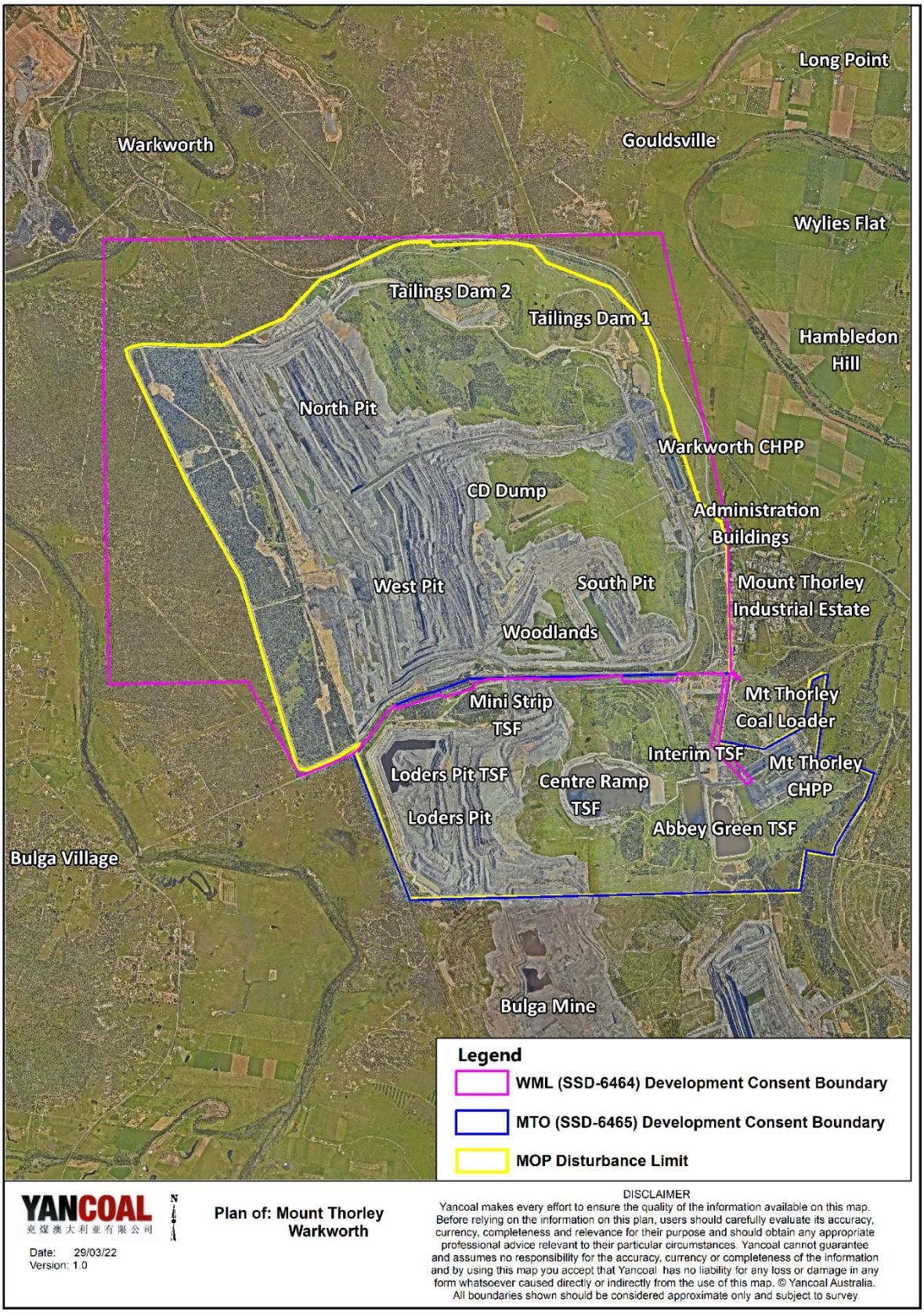


FIGURE 1: MTW SITE LAYOUT AND LOCALITY PLAN

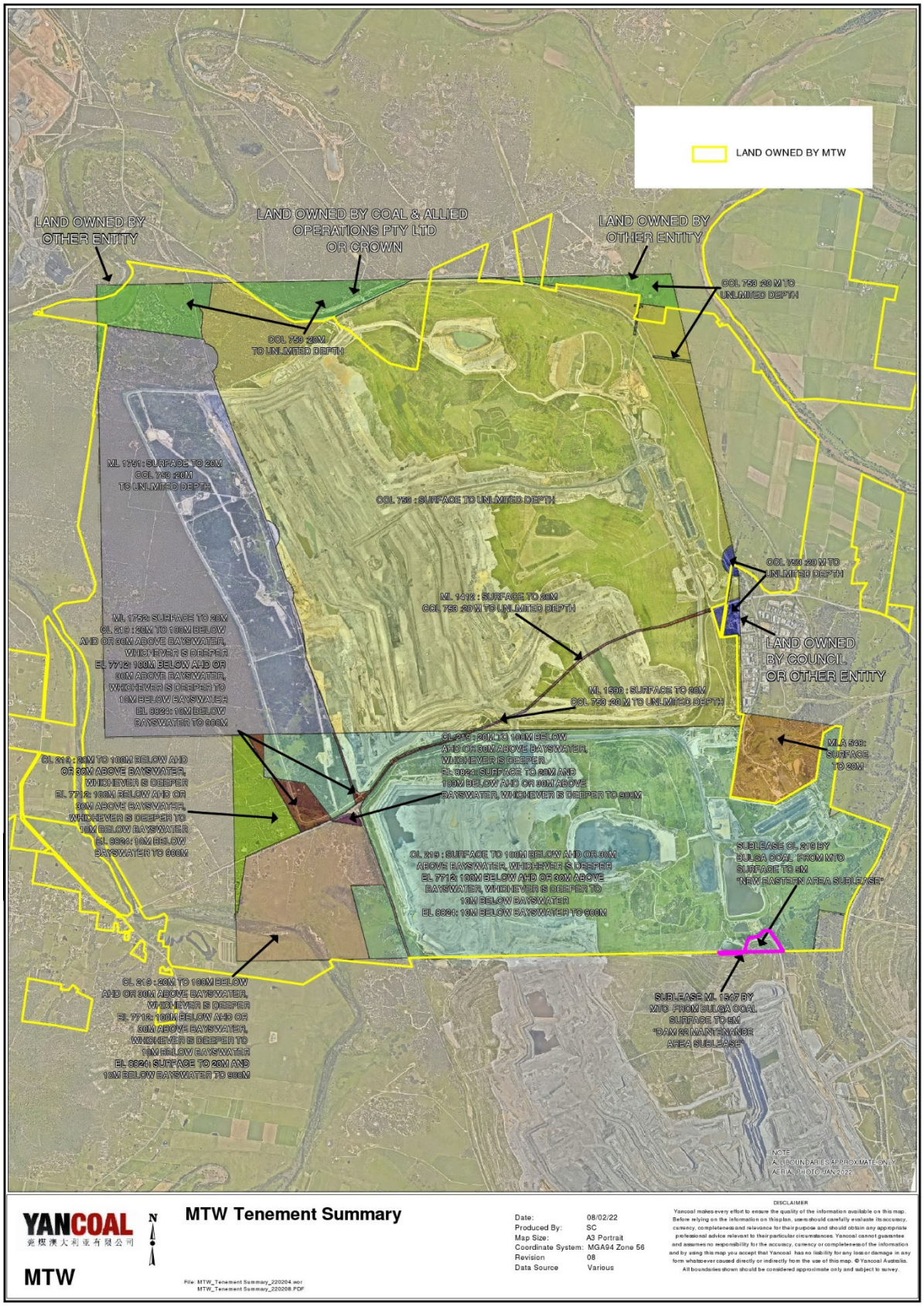


FIGURE 2: MTW TENEMENT SUMMARY

2.2 Mine Contacts

Table 2.1 outlines the contact details for site personnel responsible at Mount Thorley Warkworth.

TABLE 2.1 SITE PERSONNEL

Position	Name	Contact Number
General Manager – MTW	David Bennett	(02) 6570 1500
Environment & Community Manager - MTW	Gary Mulhearn	(02) 6570 1734

3 APPROVALS

3.1 Approvals, Leases and Licences

3.1.1 Current Approvals

The status of MTO and WML development consents, licenses and relevant approvals at 31 December 2021 are summarised in **Table 3.1** to **Table 3.6**.

TABLE 3.1 OPERATIONS APPROVALS- WARKWORTH

Approval Number	Description	Authority	Date of Approval / Variations
SSD-6464	Warkworth Continuation Project development consent	DPE	26/11/2015
EPBC 2009/5081	Approval under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) to extend the existing Warkworth Coal Mine over an additional 705 hectares of land at Warkworth NSW including associated modifications to existing mine infrastructure	Department of Agriculture, Water and the Environment (DAWE)	9/8/2012 – 31/3/2033 (varied on 14/10/2018)
EPBC 2002/629	Approval under the EPBC Act to construct and operate an open cut coal mine extension at the Warkworth Coal Mine	DAWE	18/2/2004 – 25/02/2039 (varied on 6/4/2004, 24/5/2004, 19/11/2004, 13/7/2012, 14/10/2018)

TABLE 3.2 OPERATIONS APPROVALS - MOUNT THORLEY

Approval Number	Description	Authority	Date of Approval / Variations
SSD-6465	Mount Thorley Continuation Project development consent	DPE	26/11/2015

TABLE 3.3 LICENCES AND PERMITS

Licence No	Description	Authority	Date of Approval / Variations
Warkworth			
EPL 1376	Environment Protection Licence	EPA	25/10/2021
5061122	Radiation Licence	EPA	29/06/2021
XSTR100160	Licence to Store – Explosives Act	WorkCover NSW	18/08/2019
Mount Thorley			
EPL 24	Environment Protection Licence	EPA	24/11/2016
EPL 1976	Environment Protection Licence	EPA	25/10/2021
5061110	Radiation Licence	EPA	11/08/2021

Note: Environment Protection Licences remain in force until the licence is surrendered by the licence holder or until it is suspended or revoked by the EPA or the Minister. A licence may only be surrendered with the written approval of the EPA.

TABLE 3.4 MINING TENEMENTS

Mining tenement	Type	Purpose	Status	Grant Date	Expiry Date
Warkworth Mining Ltd					
CCL 753	Consolidated Coal Lease	Prospecting and Mining Coal	Granted	23/05/1990	17/02/2023
ML 1412	Mining Lease	Prospecting and Mining Coal	Renewal Pending	11/01/1997	10/01/2018
ML 1590	Mining Lease	Prospecting and Mining Coal	Granted	27/02/2007	26/02/2028
ML 1751	Mining Lease	Prospecting, Mining Coal and Purposes	Granted	17/03/2017	17/03/2038

Mining tenement	Type	Purpose	Status	Grant Date	Expiry Date
Mount Thorley Operations Pty Ltd					
CL 219	Coal Lease	Prospecting and Mining Coal	Granted	23/09/1981	23/09/2023
(Part) ML 1547	Sub-Lease	Mining Purposes	Registered	The part sublease area known as the "Dam 22 Long Term Mining Sublease" was registered on 10th January 2018 for a term until 3 April 2025.	03/04/2025
ML 1752	Mining Lease	Prospecting, Mining Coal and Purposes	Granted	17/03/2017	17/03/2038
EL 7712	Exploration Licence	Prospecting Coal	Renewal Pending	23/2/2011	23/02/2026
EL 8824	Exploration Licence	Prospecting Coal	Granted	15/02/2019	15/02/2025
Mount Thorley Coal Loading Ltd					
ML 1828	Mining Lease	Mining Purposes	Granted	25/02/2022	25/02/2043

TABLE 3.5 WATER LICENCES

Licence Number	Type	Purpose	Legislation	Description	Renewal Date
20BL168821	Bore	Monitoring Bore	Part 5 Water Act 1912	Bores: MTAGP1, MTAGP2, ABGOH07, ABGOH43, ABGOH44, ABGOH45	Perpetuity
20BL171729	Bore	Monitoring Bore	Part 5 Water Act 1912	G3	Perpetuity
20BL171841	Bore	Monitoring Bore	Part 5 Water Act 1912	OH1126	Perpetuity
20BL171842	Bore	Monitoring Bore	Part 5 Water Act 1912	OH944	Perpetuity
20BL171843	Bore	Monitoring Bore	Part 5 Water Act 1912	OH1137	Perpetuity
20BL171844	Bore	Monitoring Bore	Part 5 Water Act 1912	Bores: OH1123 (E), OH1123 (W)	Perpetuity

Licence Number	Type	Purpose	Legislation	Description	Renewal Date
20BL171845	Bore	Monitoring Bore	Part 5 Water Act 1912	OH1124	Perpetuity
20BL171846	Bore	Monitoring Bore	Part 5 Water Act 1912	Bores: OH786, OH942	Perpetuity
20BL171847	Bore	Monitoring Bore	Part 5 Water Act 1912	Bores: OH1127, OH787	Perpetuity
20BL171848	Bore	Monitoring Bore	Part 5 Water Act 1912	OH1125	Perpetuity
20BL171849	Bore	Monitoring Bore	Part 5 Water Act 1912	OH1122	Perpetuity
20BL171850	Bore	Monitoring Bore	Part 5 Water Act 1912	OH1138	Perpetuity
20BL171891	Bore	Monitoring Bore	Part 5 Water Act 1912	Bores: OH1121, OH788, OH943	Perpetuity
20BL171892	Bore	Monitoring Bore	Part 5 Water Act 1914	Bores: WOH2153 (PZ2), WOH2154 (PZ1), WOH2155 (PZ4), WOH2156 (PZ3)	Perpetuity
20BL171893	Bore	Monitoring Bore	Part 5 Water Act 1918	Bores: WOH2141 (PZ6), Ground Water Alluvial Modelling	Perpetuity
20BL171894	Bore	Monitoring Bore	Part 5 Water Act 1913	WOH2139 (PZ5)	Perpetuity
20BL172272	Bore	Monitoring Bore	Part 5 Water Act 1912	PZ9S, PZ9D	Perpetuity
20BL172273	Bore	Monitoring Bore	Part 5 Water Act 1912	PZ8S, PZ8D	Perpetuity
20BL172439	Bore	Monitoring Bore	Part 5 Water Act 1912	Windermere	Perpetuity
20BL172518	Bore	Monitoring Bore	Part 5 Water Act 1912	Windermere: MBW01, MBW02, MBW03, MBW04	Perpetuity
20BL173276	Bore	Monitoring Bore	Part 5 Water Act 1912	Windermere	Perpetuity
20BL173065	Bore	Monitoring Bore	Part 5 Water Act 1912	SR012	Perpetuity
20FW213276 (formerly 20CW802601)	Flood Work Approval	Block Dam	Water Management Act 2000	Charlton Rd Levee	Expired
20WA209905 (Formerly 20SL051292)	Stream Diversion	Bywash Dams	Water Management Act 2000	Doctors Creek Bywash	31 July 2022
20CA209904 WAL - 19022	Stream Diversion	Bywash Dams	Water Management Act 2000	Sandy Hollow Creek	25 February 2023

TABLE 3.6 WATER ACCESS LICENCES

Licence Number	Description	Water Source	Water Sharing Plan	Water Source – Management Zone	Licence Allocation (ML)*	2021 Take (ML) Total
WAL963	Warkworth Mining Limited Hunter River Pump (General Security)	Hunter River	Hunter Regulated River WSP	Zone 2b (Hunter River from Wollombi Brook Junction to Oakhampton Rail Bridge)	243	0
WAL10543	Mount Thorley Joint Venture (MTJV) water supply scheme, held by Singleton Shire Council	Hunter River	Hunter Regulated River WSP	Zone 2b (Hunter River from Wollombi Brook Junction to Oakhampton Rail Bridge)	1,907 (MTW share is 1,009)	248.3
WAL43056	Warkworth Mining Limited (High Security)	Hunter River	Hunter Regulated River WSP	Zone 2b (Hunter River from Wollombi Brook Junction to Oakhampton Rail Bridge)	2,000	0
WAL43057	Warkworth Mining Limited (High Security)	Hunter River	Hunter Regulated River WSP	Zone 2b (Hunter River from Wollombi Brook Junction to Oakhampton Rail Bridge)	1,400	0
WAL10544	(Hunter Regulated River – Domestic and Stock)	Hunter River	Hunter Regulated River WSP	Zone 2b (Hunter River from Wollombi Brook Junction to Oakhampton Rail Bridge)	5	0
WAL18233	Old Farm	Hunter River Alluvium	Hunter Unregulated and Alluvial Water Sources WSP	Hunter Regulated River Alluvial Water Source – Downstream Glennies Creek Management Zone	5	0
WAL18558	Hawkes	Wollombi Brook	Hunter Unregulated and Alluvial Water Sources WSP	Lower Wollombi Brook Water Source	50	0
WAL19022	Sandy Hollow Creek	Unregulated River	Hunter Unregulated and Alluvial Water Sources WSP	Singleton Water Source	60	0

Licence Number	Description	Water Source	Water Sharing Plan	Water Source – Management Zone	Licence Allocation (ML)*	2021 Take (ML) Total
WAL40464 / WAL40465	Mt Thorley and Warkworth Pit Excavations	Permian Coal Seams	North Coast Fractured and Porous Rock Groundwater Sources WSP	Sydney Basin – North Coast Groundwater Source	180 / 750	428

** Licence allocations are for 1 July to 30 June reporting year. Actual usage can exceed licence allocation in the table above if carryover provisions are available and have been applied during the water year.*

3.1.2 Management Plans, Programmes and Strategies

Table 3.7 details the management plans and strategies which are required under the Warkworth (SSD-6464) and Mount Thorley (SSD-6465) Development Consent instruments.

A Mining Operations Plan (MOP) was developed to replace the previous MOP and cover the existing MTW operations, as well as the approved operations outlined in the Environmental Impact Statements for the Warkworth Continuation 2014 and Mt Thorley Operations 2014. The MOP outlines the proposed operational and applicable environmental management activities planned for MTW. Details regarding the submission and approval dates for the current MOP are shown in **Table 3.8**.

TABLE 3.7 STATUS OF MANAGEMENT PLANS REQUIRED UNDER WARKWORTH CONTINUATION (SSD-6464) AND MOUNT THORLEY OPERATIONS (SSD-6465) DEVELOPMENT CONSENTS

Plan / Program / Strategy	Status (approval date)
Air Quality Management Plan	20/07/2021
Noise Management Plan	21/01/2022
Blast Management Plan	20/07/2021
Water Management Plan	15/11/2021
WML Biodiversity Management Plan	20/09/2018
Rehabilitation Management Plan (addressed in MOP)	30/11/2021 (MOP Extension to 2 July 2022)
Environmental Management Strategy	20/07/2021
MTW Historic Heritage Management Plan	11/10/2017
MTW Aboriginal Heritage Management Plan	28/08/2019
Wollombi Brook Aboriginal Cultural Heritage Conservation Area Plan of Management	11/10/2017
Loder Creek Aboriginal Cultural Heritage Conservation Area Plan of Management	19/03/2019
Management Plan for Goulburn River Biodiversity Area	30/04/2018 (DPE)
Management Plan for Bowditch Biodiversity Area	30/04/2018 (DPE)
Management Plan for Southern Biodiversity Area	20/07/2021 (DPE)

Plan / Program / Strategy	Status (approval date)
Management Plan for Northern Biodiversity Area	20/07/2021 (DPE)
Management Plan for North Rothbury Biodiversity Area	30/04/2018 (DPE)
Warkworth Sands Woodland Integrated Management Plan	Pending (Submitted to OEH 15/02/2017)
Warkworth Sands Woodland Performance Criteria	Pending (Submitted to OEH 15/02/2017)

TABLE 3.8 MOP APPROVAL STATUS FOR MOUNT THORLEY WARKWORTH

Mining Operations Plan	Date Submitted	Date Approved
Mount Thorley Warkworth MOP Amendment A 2018 - 2021	11/10/2018	14/12/2018
Mount Thorley Warkworth MOP Amendment B 2018 - 2021	23/5/2019	11/6/2019
Mount Thorley Warkworth MOP Amendment C 2020 - 2021	31/3/2020	24/11/2020
Mount Thorley Warkworth MOP Extension to 02 July 2022	19/11/2021	30/11/2021

4 OPERATIONS DURING THE REPORTING PERIOD

4.1 Summary of Mining Activities

Areas to be mined are geologically modelled, a mine plan is formed and the relevant mining locations are surveyed prior to mining. **Figure 3** illustrates the mining process.

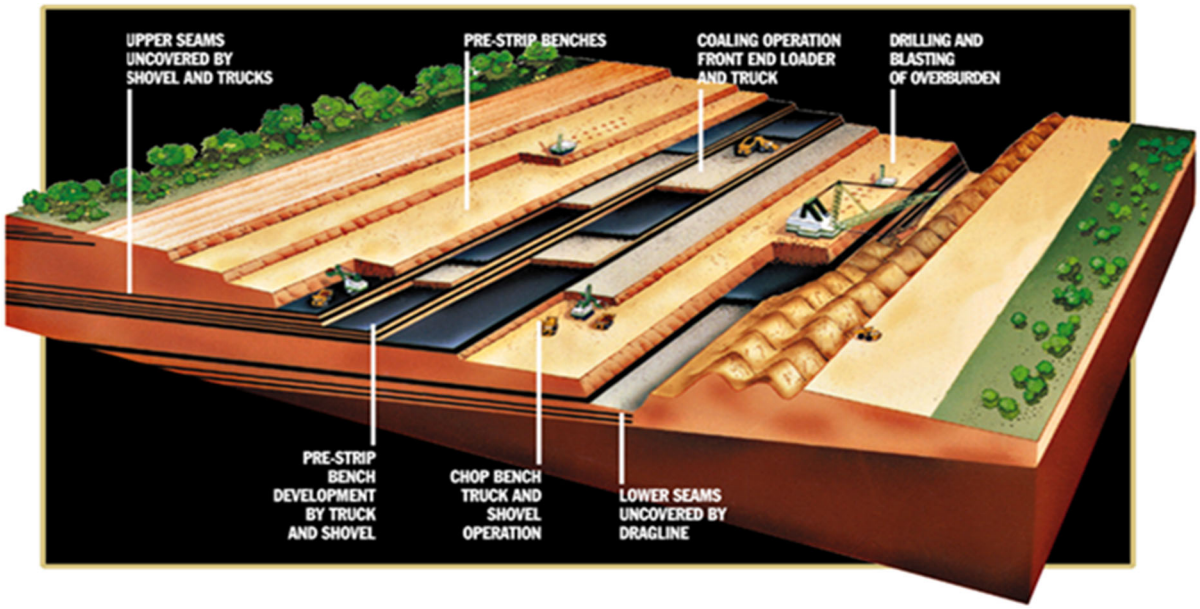


FIGURE 3: MINING PROCESS

Within Warkworth, mining activities will continue to advance in a westerly direction in both North and West Pits. North, West and South Pit voids are used for dumping overburden & coarse rejects from the North & South CHPP. Mount Thorley operations continues to be utilised for fine tailings and overburden emplacement. Exploration drilling was conducted within the relevant mining leases ahead of mining and within the pit to gain further information on the resource. All mining related activity is in line with the current MOP.

The planned 2022 production and waste schedule for MTW is summarised below:

- 17.75 Mt ROM coal;
- 12.19 Mt Product coal;
- 117.8 Mbcm overburden (including rehandle)
- 5.4 Mt Tailings and reject

The forecasted ROM coal production represents approximately 63% of the approved maximum ROM coal production for MTW. Coal will continue to be transported via conveyer to the Mount Thorley Coal Loader and railed to the port.

4.2 Mineral Processing

All processing and rejects/tailings disposal activities undertaken in 2021 were consistent with the approved MOP and no changes were made to the processing and rejects/tailings disposal methods.

The Loders Pit Tailings Storage Facility was developed during 2020 and tailings deposition commenced and continued throughout 2021. The Centre Ramp & Abbey Green Tailings Storage Facilities were also used as alternative locations when required to control water in Loders pit. Waste capping of Tailings Dam 2 continued throughout 2021 in limited quantities.

4.3 Production Statistics

MTW is permitted to extract up to 28 Mtpa of ROM coal, comprising up to 18 million tonnes of ROM coal from the Warkworth Mine and 10 million tonnes from the Mount Thorley Mine. MTW Production Statistics for the previous, current and future reporting period are summarised in **Table 4.1**. Error! Not a valid bookmark self-reference..

TABLE 4.1 SUMMARY OF PRODUCTION AT MTW IN 2021

Material	Approved Limits	Reporting Period 2020	Reporting Period 2021	Forecast for 2022
Prime Overburden Waste (kbcm)	N/A	98,217	87,472	104,621
MTO ROM Coal (Mtpa)	10 (SSD-6465)	0.88	0.43	0.73
WML ROM Coal (Mtpa)	18 (SSD-6464)	16.60	16.08	17.02
ROM Coal (Mtpa)	28 (Combined)	17.49	16.51	17.75
Coarse Reject (kt)	N/A	5,063	4,769	5,063
Fine Reject – Tailings (kt)	N/A	1,116	529.9	563
Product (kt)	N/A	11,929	11,212	12.19

All product coal was transported by rail. MTW transported 11,259 kt of product coal via rail during the 2021 reporting period.

4.4 Summary of Changes (Developments and Equipment Upgrades)

- A new Liebherr 9800 excavator was commissioned in July 2021
- 102 dragline ceased operation in March 2021 in Loders pit

5 ACTION(S) REQUIRED FROM PREVIOUS ENVIRONMENTAL MANAGEMENT REVIEW

There were no actions required by DPE to be addressed in the 2021 AR from the 2020 AR.

6 ENVIRONMENTAL MANAGEMENT AND PERFORMANCE

6.1 Meteorological Data

Meteorological data is collected to assist in day to day operational decisions, planning, and environmental management and to meet development consent requirements. MTW operates a real time meteorological (weather) station located on Charlton Ridge. The meteorological station measures wind speed, wind direction, temperature, humidity, solar radiation, rainfall, and sigma theta. Instruments are installed, calibrated, and maintained according to the relevant Australian Standard AS 3580.14 (2011). Meteorological data is available to site personnel and provides mining operations with trend assessment details to inform operational decisions aimed at minimising impacts. Daily Meteorological data summaries are presented in the Monthly Environmental Monitoring reports, available via the MTW website: https://www.mtwcoal.com.au/.

6.2 Noise

6.2.1 Noise Management

MTW manages noise to ensure compliance with permissible noise limits at nearby private residences. A combination of both proactive and reactive control mechanisms is employed on a continuous basis to ensure effective management of noise emissions is maintained. Noise management strategies and processes employed at MTW are detailed in the MTW Noise Management Plan available for viewing via the MTW website: https://www.mtwcoal.com.au/.

MTW's 2021 noise performance metrics are shown below:

- Community noise complaints received – reduced by 50% from 2020
- Number of Community Response Officer (CRO) (supplementary) noise measurements which exceed the internal trigger level for action – increased to 106 from 72 in 2021; and
- Number of equipment downtime hours logged in response to noise management triggers – decreased by ~ 17% from 2020.

A range of noise management processes were undertaken during 2021. These are described herein.

6.2.2 Sound Power Control

The new Liebherr 9800 excavator was commissioned in July 2021 with noise attenuation fitted, as is required by development consent conditions. For existing fleet, in addition to visual inspections, MTW implements a Sound Power Level screening program to assess the sound power outputs of individual pieces of equipment.

Forty-One sound power level assessments were undertaken by an external consultant, across 24 trucks, 2 water carts, 2 service carts, 1 loader, 2 graders, 6 dozers, 2 excavators, 1 shovel and 1 dragline. Of the assessments undertaken, 4 pieces of equipment exceeded MTW In-Service targets. Recommendations have been made for further treatment to address these items of equipment and maintenance has been scheduled to rectify defects.

6.2.2.1 Real Time Noise Management

MTW's Real-Time noise management framework provides an effective tool for managing instances of elevated noise, ensuring compliance is maintained, and responding to community concerns.

MTW utilise CROs to provide an interface between the mine and community. They are effective in implementing the management framework, validating real-time alerts through supplementary handheld noise measurements and audible observations, driving operational change as required, and responding to community complaints. A summary of supplementary handheld noise measurements conducted by the CROs in 2021 is presented in **Table 6.1**.

MTW's Insite website allows members of the general public to access noise, meteorological, air quality data as well as any operational changes made during shift via MTW's interactive website. Insite viewer access: http://insite.yancoal.com.au

TABLE 6.1 SUMMARY OF SUPPLEMENTARY ATTENDED NOISE MONITORING CONDUCTED BY COMMUNITY RESPONSE OFFICERS 2021

Monitoring Location	Number of Assessments	Number of measurements >WML trigger^	Number of measurements > MTO trigger^	Average WML noise level ($L_{Aeq\ 5min}$ dB(A))*	Average MTO noise level ($L_{Aeq\ 5min}$ dB(A))*
Wollemi Peak Road (Bulga RFS)	1314	66	13	34.1	33.2
Bulga Village	623	4	1	33.0	32.6
Inlet Road	493	13	1	33.1	31.9
Inlet Road West	365	1	0	30.3	29.3
Long Point	1029	3	0	31.3	35.0[1]
South Bulga	0	-	-	-	-
Wambo Road	47	4	-	35.7	33.0
Total	3871	91	15	-	-

^Triggers are internally set thresholds for operational response and are specified in the MTW Noise Management Plan. The number of measurements greater than the trigger cannot be used as an assessment or interpretation of compliance. A compliance assessment is provided in Sections 6.2.3 and 6.2.3.1.

**Average noise levels do not take account of measurements taken where the noise source of interest was recorded as inaudible.*

[1] Only one noise measurement taken where MTO was assigned a noise level

In response to the events listed in **Table 6.1** which were greater than the trigger, up to 907 hours of equipment downtime were recorded to manage noise during 2021.

6.2.3 Noise Performance

A total of 96 compliance measurements were undertaken by an independent acoustic specialist in accordance with the MTW Noise Monitoring Programme during the reporting period. Each measurement involves an assessment of mine noise against the various LAeq, 15 minute and LA1, 1min noise criteria. Noise monitoring results are shown in **Appendix 1** and are also presented in the Monthly Environmental Monitoring Reports, available via the MTW website https://www.mtwcoal.com.au/page/environment/environmental-monitoring/

In accordance with the requirements of the EPA's Noise Policy for Industry (NPfI), the applicability of the low frequency modification penalty has been assessed. There were four noise measurements taken during the reporting period which required the penalty to be applied. There were no noise measurements taken during the reporting period which exceeded consent conditions following application of NPfI low frequency modifying factor.

TABLE 6.2 ATTENDED NOISE MEASUREMENTS EXCEEDING CONSENT CONDITIONS FOLLOWING APPLICATION OF NPFI LOW FREQUENCY MODIFYING FACTOR

Location	Date/Time	Relevant Criteria	Criterion (dB)*	L_{Aeq}(dB)	Revised L_{Aeq} (dB)	Exceeds by (dB)
N/A	-	-	-	-	-	-

6.2.3.1 Comparison against Last Years' Results

A comparison of non-compliances and exceedances between years is used as a measure of the effectiveness of noise management measures employed on site.

Details of this comparison are provided in **Table 6.3** which demonstrates a continuation of the effective management delivered in 2021.

TABLE 6.3 COMPARISON OF 2021 NOISE MONITORING RESULTS AGAINST PREVIOUS YEARS'

Year	Number of assessments	Number of exceedances	Number of non-compliances
2021	576	0	0
2020	576	0	0
2019	588	1	0
2018	594	1	0
2017	576	0	0
2016	576	0	0
2015	665	0	0
2014	700	0	0
2013	456	11	7
2012	562	13	3
2011	572	11	4
2010	561	3	3
2009	569	10	4

A comparison of supplementary noise measurements undertaken during the previous and current reporting period is provided in **Table 6.4**. This data shows the considerable effort in undertaking supplementary noise measurements has continued in 2021, and average noise readings have been comparable.

TABLE 6.4 COMPARISON OF CRO (SUPPLEMENTARY) NOISE MEASUREMENT PERFORMANCE

Monitoring Location	Number of Assessments		Number of Measurements >WML Trigger^		Number of Measurements > MTO Trigger^		Average WML Noise Level ($L_{Aeq\ 5min}$ dB(A))*		Average MTO Noise Level ($L_{Aeq\ 5min}$ dB(A))*	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
Wollemi Peak Road (Bulga RFS)	1307	1314	42	66	12	13	33.3	34.1	32.6	33.2
Bulga Village	622	623	4	4	0	1	32.5	33.0	32.0	32.6
Inlet Road	521	493	10	13	0	1	32.7	33.1	31.9	31.9
Inlet Road West	374	365	0	1	0	0	29.9	30.3	29.4	29.3
Long Point	998	1029	0	3	0	0	31.0	31.3	-	35.0
South Bulga	0	0	-	-	-	-	-	-	-	-
Wambo Road	120	47	4	4	-	-	34.9	35.7	32.7	33.0
Total	3943	3871	60	91	12	15	-	-	-	-

^Triggers are internally set thresholds for operational response and are specified in the MTW Noise Management Plan. The number of measurements greater than the trigger cannot be used an assessment or interpretation of compliance. Compliance assessment is provided in 6.2.3 and 6.2.4.

**Average noise levels do not take account of measurements taken where the noise source of interest was recorded as inaudible.*

6.2.3.2 Validation of Real Time Monitoring Results

A comparison of real time and independent attended noise monitoring results was undertaken for 2021. The comparison identified that the majority of attended noise monitoring results were lower than the corresponding real time noise monitoring results i.e. real time noise monitor trigger is largely conservative for the most closely located real time noise monitors and for the mostly closely aligned 15-minute monitoring periods. There were exceptions to this, including;

- WML LAeq 15 minute attended monitoring measured noise levels were higher than the real time monitoring measured noise levels for one of eight attended monitoring locations in January, for two of eight attended monitoring locations in February, for four of eight monitoring locations in March and April, for 3 of eight monitoring locations in May, for 4 of eight monitoring locations in June and July, for 3 of eight monitoring locations in August and October, for one of eight monitoring locations in November and for 6 of eight monitoring locations in December.
- MTO LAeq, 15 minute attended monitoring measured noise levels were higher than the real time monitoring measured noise levels for four of eight attended monitoring locations in February, for one of eight monitoring locations in August, October and November and for 2 of eight monitoring locations in December.

On the occasions where the WML and MTO attended monitoring measured noise levels were higher, the recorded noise levels were generally well below noise limits specified in MTW's Noise Management Plan. The exceptions to this were measurements taken at the Wambo Road monitoring location in March and December, which were at or one dB less than the compliance limits respectively. The noise monitors can have difficulty assigning WML and MTO directional noise levels at times, such as where there is more than one noise source and where MTW is not the primary noise source. MTW's noise management process is that routine supplementary noise monitoring is also undertaken by the Community Response Officer each night and provides additional assessment of directional noise levels, allowing for swift targeted operational modifications where noise levels from MTW presents a risk of exceeding the specified noise limit(s).

The Wambo Road noise monitor is scheduled to be replaced by an Environmental Noise Compass (ENC) in 2022 and will be the second MTW owned monitor of this type installed in Bulga. Developed by Acoustic Research Labs, the ENC utilises a 26 microphone array and conventional beamforming techniques (borrowed from military / submarine applications) to resolve the source direction of measured noise in real time.

6.2.3.3 Comparison against EA Predictions

Table 6.5 provides a comparison of 2021 attended monitoring data and the predicted noise levels modelled in the 2014 Warkworth Continuation EIS. Comparison has been made against the modelled worst-case noise levels for Year 9 of the development (nominally 2023). The comparison data has been sourced from the modelled noise levels at the nearest residential receivers to the current monitoring locations. Reported 2021 data is the calculated quarterly average of WML contribution to measured LAeq (15 minute) results and the maximum monthly measured noise level obtained through

compliance assessment (irrespective of applicability of noise criteria due to meteorological conditions).

Where a monitoring event has been assessed as being "inaudible" or "not measurable", a conservative value of 25dB has been used to calculate the LAeq average for the quarter. The comparison shows that measured noise is within the predicted noise level range.

TABLE 6.5 PREDICTED NIGHT TIME WML (EIS 2014) LAEQ (15 MINUTE) NOISE LEVELS AND AVERAGED AND MAXIMUM 2021 MONITORING RESULTS

Monitoring Location	Year 9 Modelled Noise	Quarter 1 2021 average & maximum		Quarter 2 2021 average & maximum		Quarter 3 2021 average & maximum		Quarter 4 2021 average & maximum	
	$L_{Aeq\ (15\ minute)}$ (dB)	$L_{Aeq\ (15\ minute)}$ (dB)		$L_{Aeq\ (15\ minute)}$ (dB)		$L_{Aeq\ (15\ minute)}$ (dB)		$L_{Aeq\ (15\ minute)}$ (dB)	
		Avg	Max	Avg	Max	Avg	Max	Avg	Max
Wollemi Peak Road*/Bulga RFS	≤38	25.0	25	30.3	36	32.0	36	26.7	30
Bulga Village	≤38	29.0	33	30.0	33	31.0	37	27.3	29
Gouldsville Road	≤35	28.0	30	25.0	25	26.3	29	25.0	30
Inlet Road	≤37	27.7	33	32.0	33	28.3	35	30.0	35
Inlet Road West*	≤35	28.0	30	28.3	32	24.3	28	27.3	32
Long Point*	≤35	25.0	25	25.0	25	25.7	27	25.0	25
South Bulga	≤38	25.0	25	27.7	30	27.3	32	25.0	25
Wambo Road	≤38	32.0	38	32.3	34	29.3	38	31.0	37

**Denotes – No nearby receiver location modelled*

6.3 Blasting

6.3.1 Blast Management

During the reporting period, the MTW blast monitoring network operated in accordance with AS2187.2-2006 to measure ground vibration and air blast overpressure of each event at a high sampling frequency. Monitors function as regulatory compliance instruments in accordance with the MTW Blast Monitoring Programme (appended to Blast Management Plan) and are located on (or in locations representative of) privately owned land. During 2021 monitors were located at:

- Abbey Green (Abbey Green Station, Putty Road, Glenridding);
- Bulga Village (Wambo Road, Bulga);
- Putty Road, Mount Thorley (known as MTIE)
- Wambo Road (Wambo Road, Bulga);
- Warkworth Village (former Warkworth Public School, Warkworth); and
- Wollemi Peak Road (intersection of Putty & Wollemi Peak Roads, Bulga).

These locations are shown on **Figure 4** below.

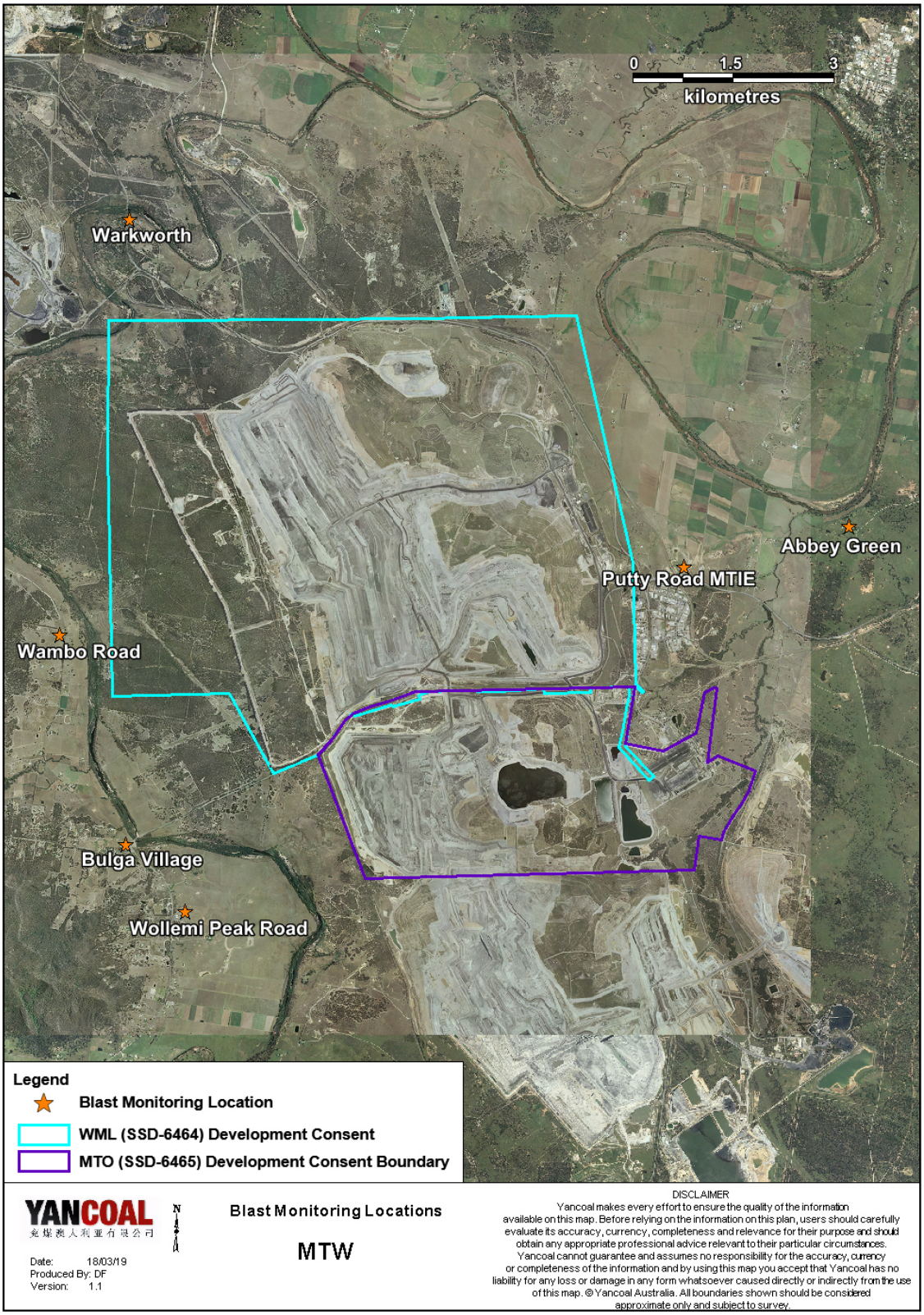


FIGURE 4: BLAST MONITORING LOCATIONS

6.3.2 Blast Performance

During the reporting period 224 blast events were initiated at MTW. Results of ground vibration and airblast overpressure recorded during 2021 are presented in **Figure 5** to **Figure 10**. All blasts returned results below the relevant airblast overpressure / ground vibration criteria for all monitoring locations.

Road closures occurred for all blasts within 500 metres of a public road. Public roads were also closed on occasions to mitigate potential impact upon road users from post blast emissions.

In accordance with Schedule 3, Conditions 9 and 10 of SSD-6464, Warkworth Mining Limited carried out blasting on site between 7am and 5pm Monday to Saturday inclusive. No blasts occurred on Sundays or on public holidays. Warkworth Mining Limited carried out not more than 3 blasts per day and not more than 12 blasts per week (averaged over a calendar year).

Note: No blasts were carried out at Mt Thorley Operations Limited in 2021.

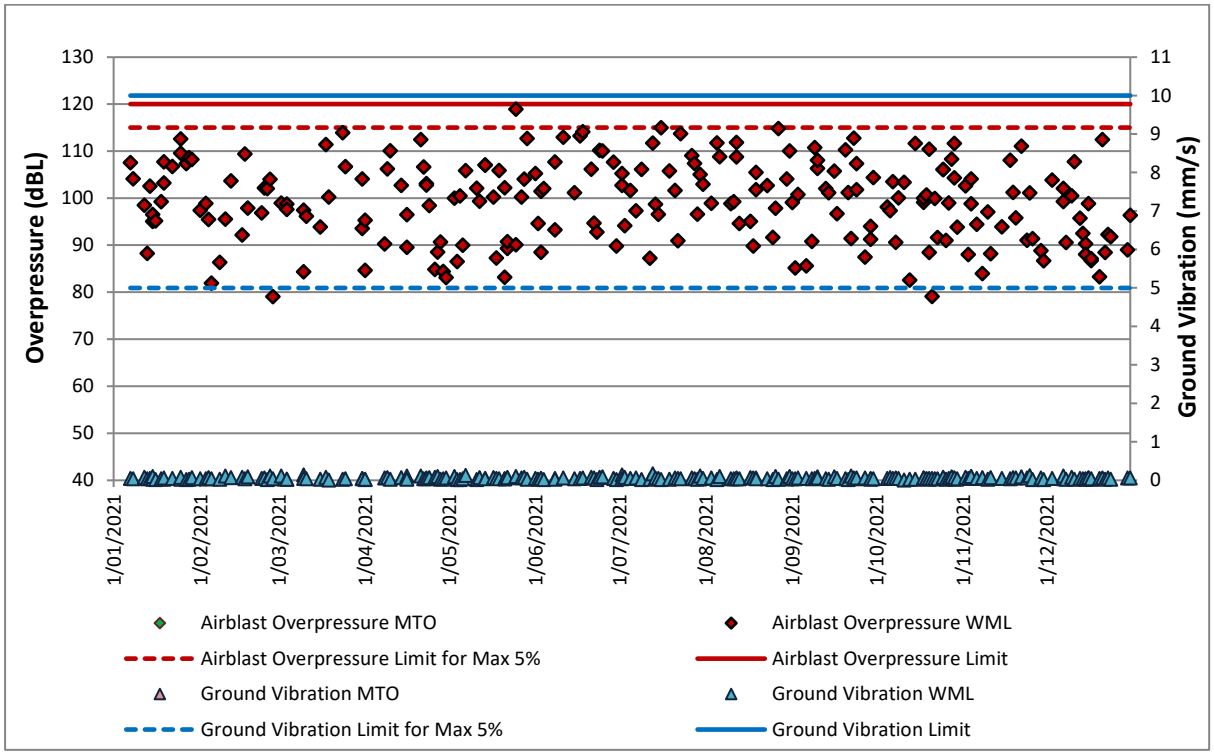


FIGURE 5: ABBEY GREEN BLAST RESULTS

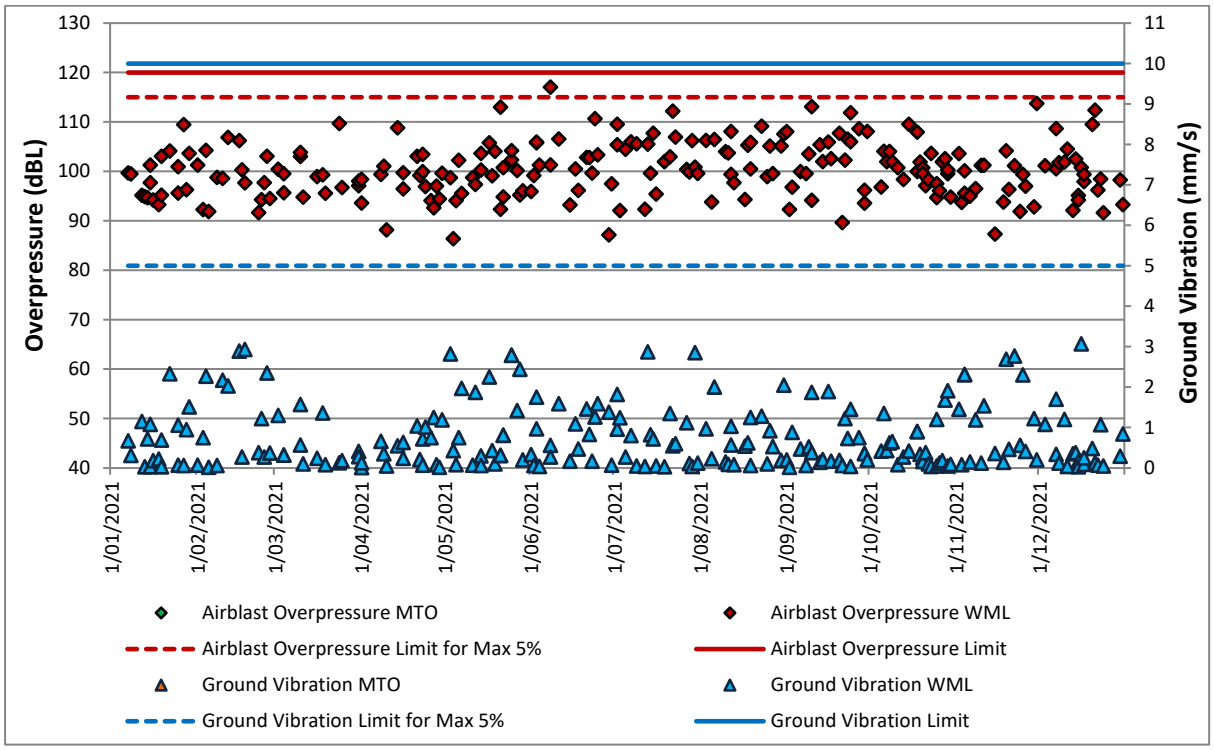


FIGURE 6: BULGA VILLAGE BLAST RESULTS

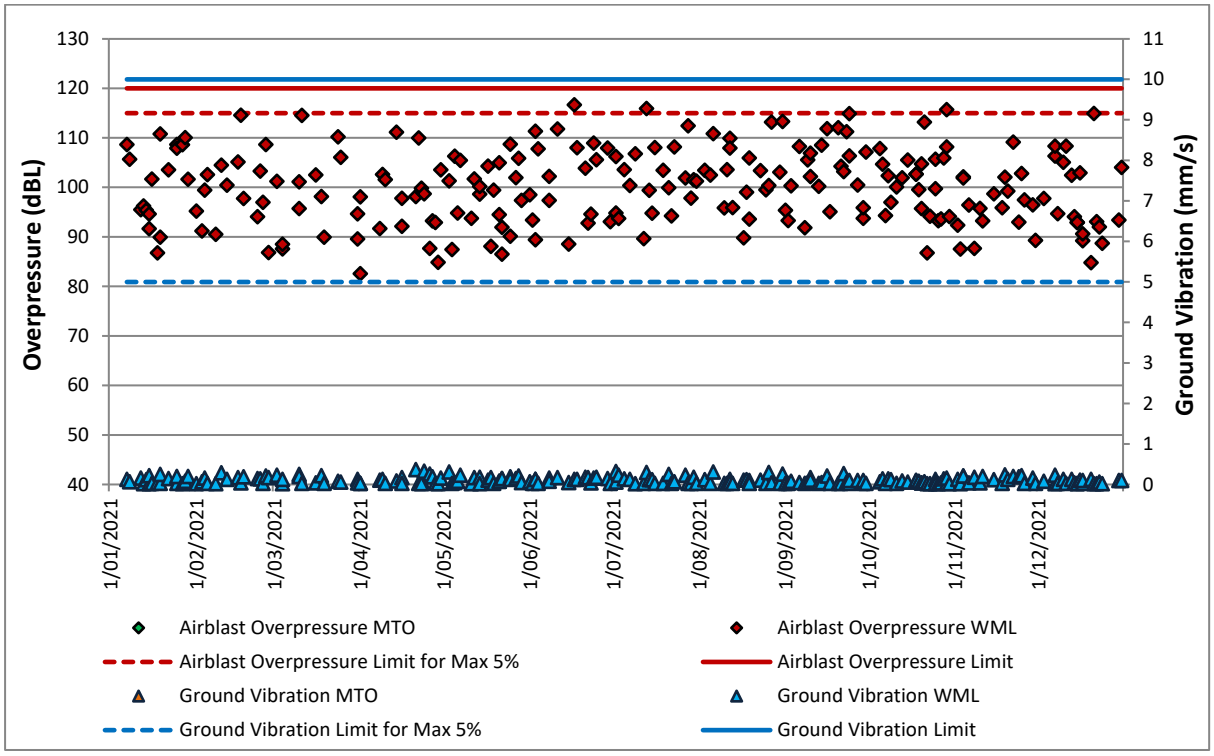


FIGURE 7: MTIE BLAST RESULTS

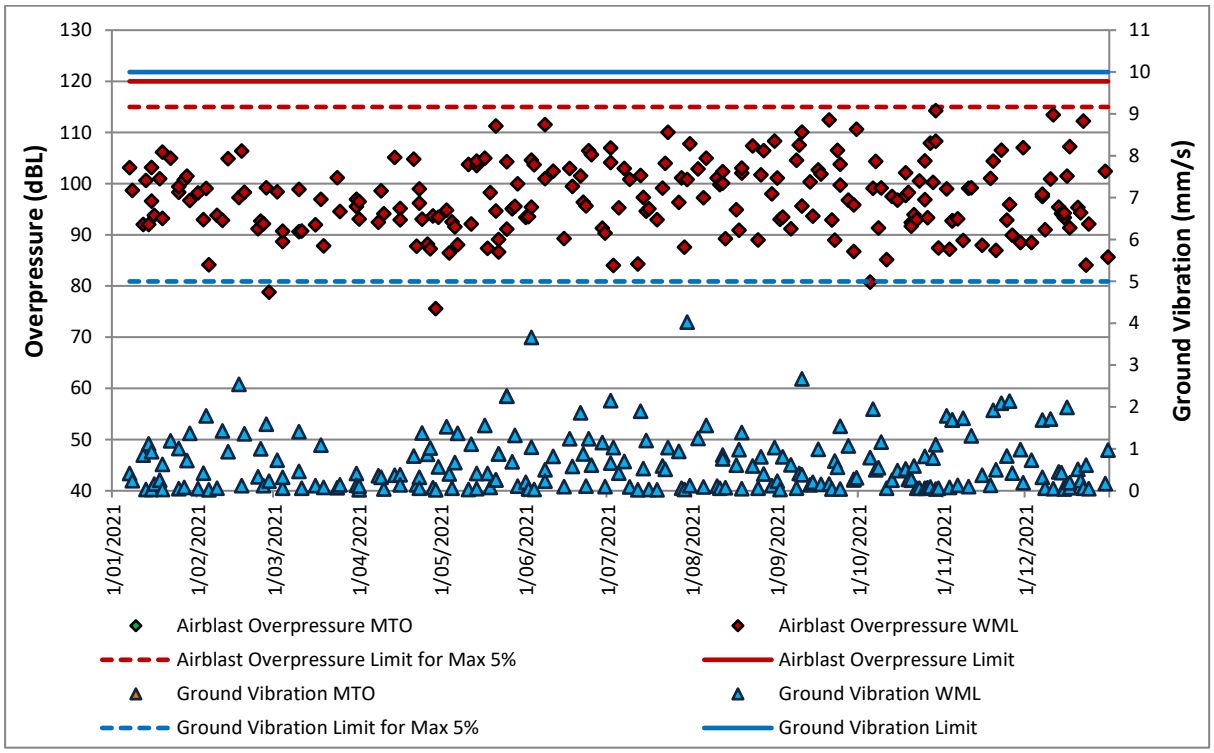


FIGURE 8: WOLLEMI PEAK ROAD BULGA BLAST RESULTS

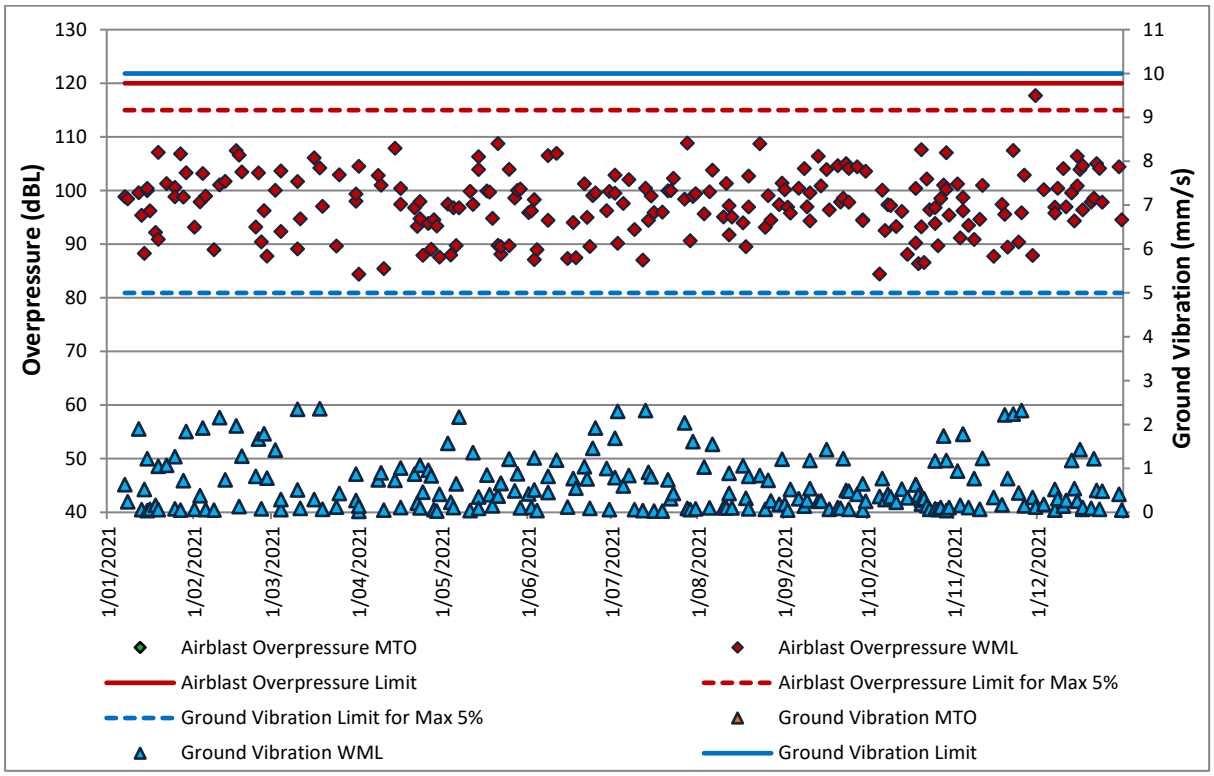


FIGURE 9: WAMBO ROAD BLAST RESULTS

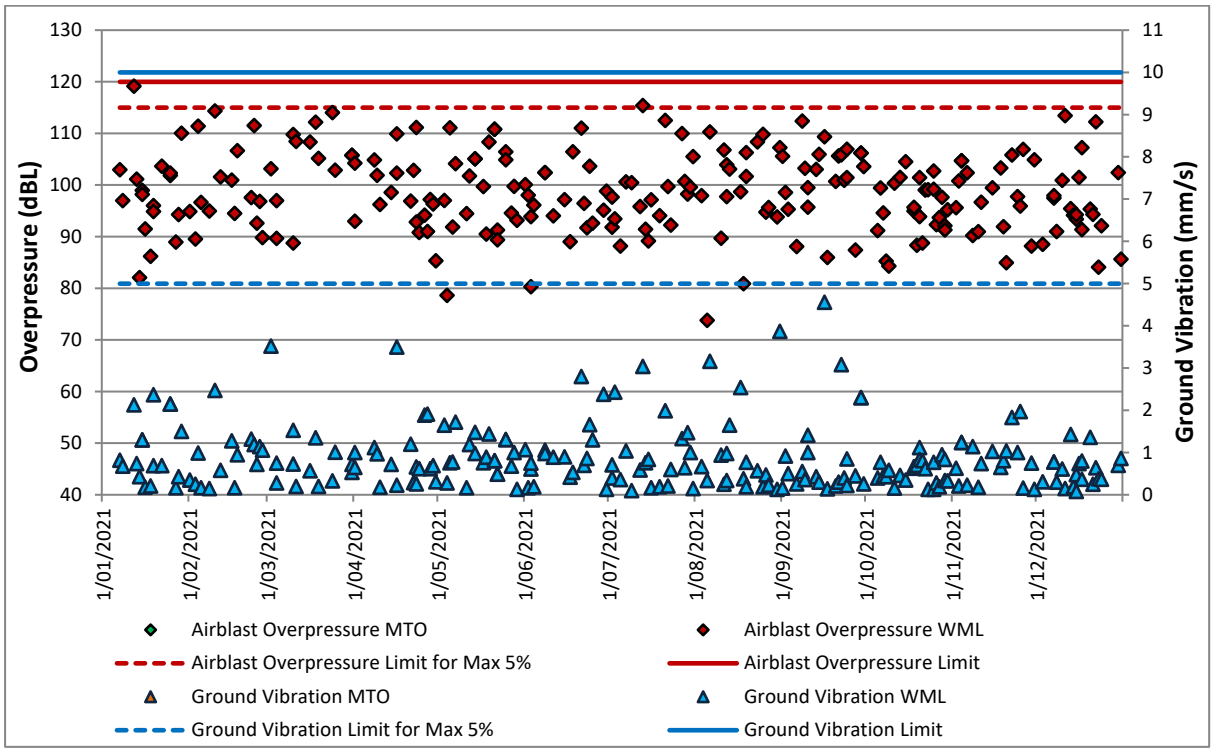


FIGURE 10: WARKWORTH BLAST RESULTS

6.3.2.1 Blast Fume Management

MTW operates a Post Blast Fume Generation Mitigation and Management Plan. This document outlines the practices to be utilised to reduce generation of post blast fume and reduce potential offsite impact from any fume which may be produced. This includes risk assessment of the likelihood of fume production, specialised blasting design, appropriate product selection, on-bench water management, implementation of fume management zones and use of blasting permissions to identify likely path of any fume which may be produced.

All blasts are observed for fume and any fume produced is ranked according to the Australian Explosive Industry & Safety Group (AEISG) Scale. During 2021, no blasts produced visible post-blast fume with a post-blast ranking Level 4 or higher according to the AEISG Scale.

Rankings for visible blast fume according to the AEISG scale for shots fired during 2021 and comparison to rankings distribution during previous years is provided in **Table 6.6.**

TABLE 6.6 VISIBLE BLAST FUME RANKINGS ACCORDING TO THE AEISG COLOUR SCALE

AEISG Ranking	2021	2020	2019
0	230	243	269
1	13	13	16
2	9	9	7
3	4	0	1
4	0	0	0
5	0	0	0
Total*	256	265	293

** Where a number of individual blasts were fired as a blast event, fume was assessed for each individual blast pattern rather than for the event as a whole.*

6.3.2.2 Comparison of Monitoring Results Against Previous Years' Performance and EA Predictions

Blasting results recorded in 2021 are similar to results recorded in previous years and are generally consistent with EA predictions.

6.4 Air Quality

6.4.1 Air Quality Management

Air quality management at MTW is prescribed by the Air Quality Management Plan (available at https://www.mtwcoal.com.au/page/environment/environmental-management-plans/), the management plan:

- Describes procedures required to ensure compliance with the approval conditions relating to air quality including the measures that MTW will use to manage air quality;
- Details the management framework and mitigation actions to be taken while operating; and
- Provides a mechanism for assessing air quality monitoring results against the relevant impact assessment criteria.

6.4.1.1 Real-Time Air Quality Management

MTW's real-time air quality monitoring stations continuously log information and transmit data to a central database, generating alarms when particulate matter levels exceed internal trigger limits. Following an alarm, an inspection is undertaken, and operations and equipment usage are modified as required to manage air quality in accordance with MTW's Air Quality Management Plan.

838 real-time alarms for air quality and wind conditions were received and acknowledged during 2021. In response, **1,459** hours of equipment downtime was recorded due to air quality management. A detailed breakdown of air quality related equipment stoppages (per month, per equipment type) is presented in **Figure 11**.

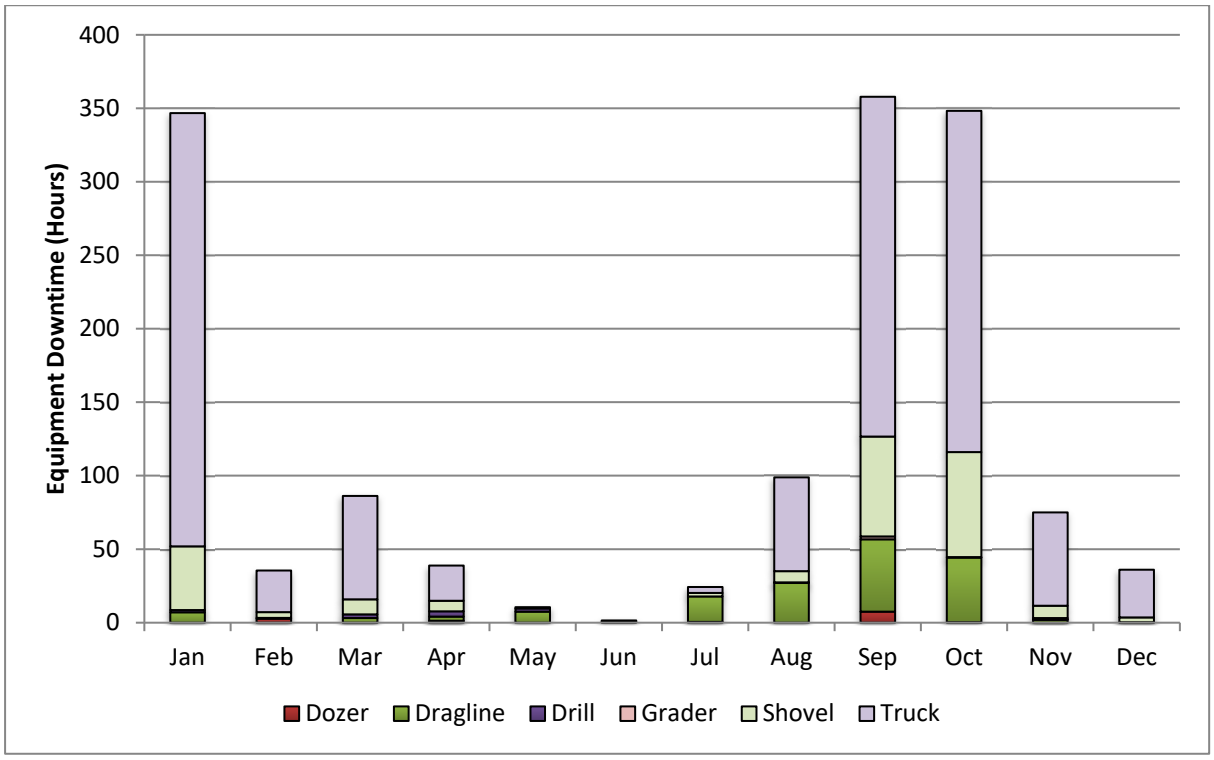


FIGURE 11: EQUIPMENT DOWNTIME FOR DUST MANAGEMENT BY MONTH (2021)

6.4.1.2 Temporary Stabilisation

An aerial seeding programme was undertaken in 2021, which aims to reduce airborne dust from inactive waste dumps and ahead of mining areas. 184 hectares of area was seeded (see **Figure 12**) using an exotic pasture grass and legume mix suitable for summer sowing. Fertiliser was mixed with the seed prior to loading to provide sufficient nutrients for plant growth.



FIGURE 12: AERIAL SEEDING AREAS

6.4.2 Air Quality Performance

6.4.2.1 Air Quality Monitoring

Air quality monitoring at MTW is undertaken in accordance with the MTW Air Quality Monitoring Programme and protocol for evaluating non-compliances. The monitoring network comprises an extensive array of monitoring equipment which is utilised to assess performance against the relevant conditions of MTW's approvals and EPL's. Air quality monitoring locations are shown in **Figure 13**. During 2021, MTW complied with all short term and annual average air quality criteria.

Air quality compliance criteria are shown in **Table 6.7,** along with a summary of MTW's performance against the criteria. Whilst MTW operates under two separate planning approvals the following compliance assessment has been undertaken on a 'whole of MTW site' basis, rather than individually assessing the contribution of each approval area to the measured results.

Air quality monitoring data is made publicly available through the MTW Monthly Environmental Monitoring Report available on the MTW website https://www.mtwcoal.com.au/page/environment/environmental-monitoring/, and daily data can be accessed on the MTW Insite website: https://insite.yancoal.com.au/mount-thorley-warkworth/data

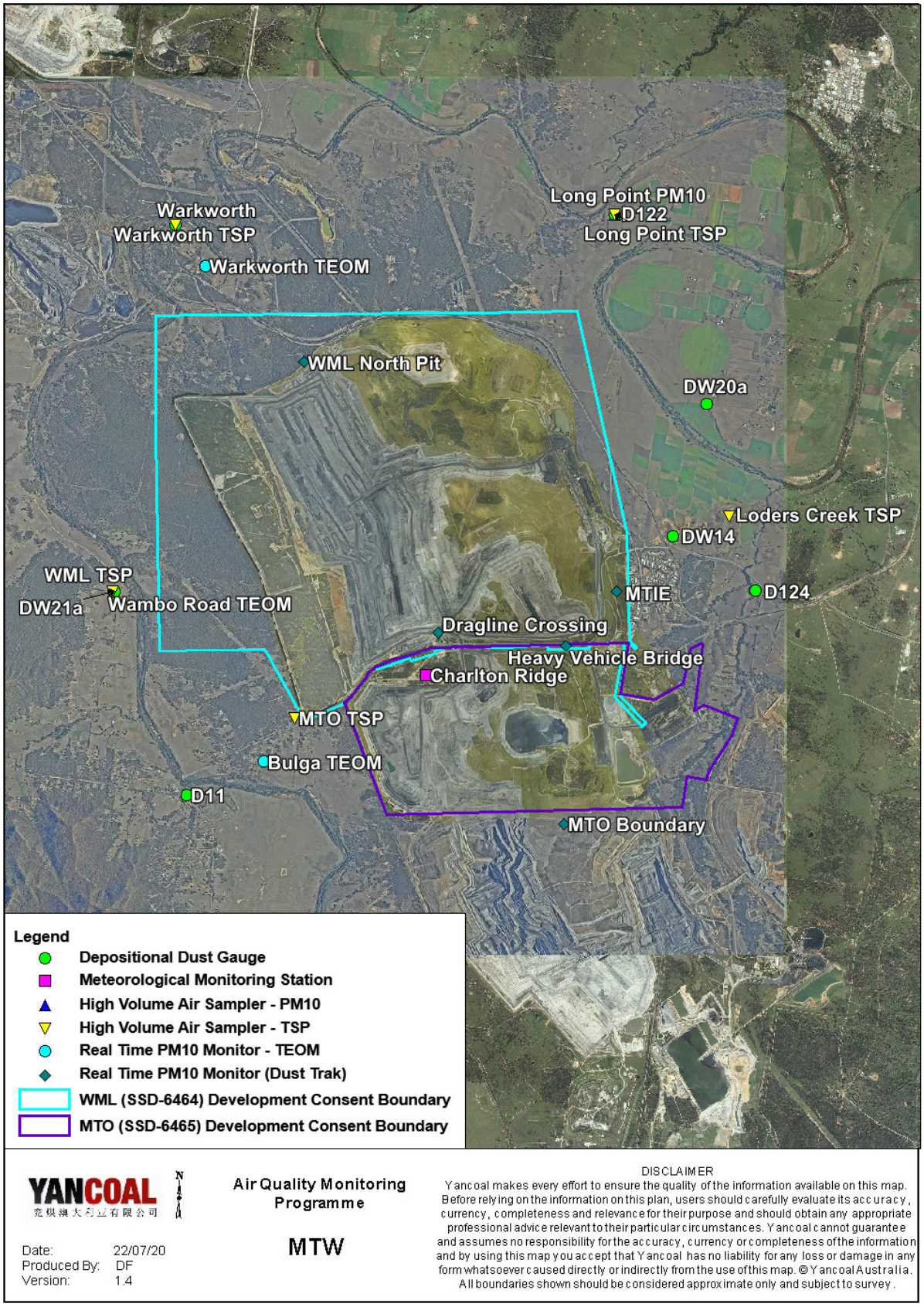


FIGURE 13: AIR AND METEOROLOGICAL MONITORING LOCATIONS MTW 2021

TABLE 6.7 AIR QUALITY IMPACT ASSESSMENT CRITERIA AND 2021 COMPLIANCE ASSESSMENT

Pollutant	Criterion	Averaging Period	Compliance
Deposited Dust	4 g/m^2/month	Maximum total deposited dust level	100%
	2 g/m^2/month	Maximum increase in deposited dust level	100%
Total Suspended Particulate matter (TSP)	90 µg/m^3	Long Term (Annual)	100%
Particulate matter <10µm (PM_{10})	30 µg/m^3	Long Term (Annual)	100%
	50 µg/m^3	Short Term (24 hour)	100%

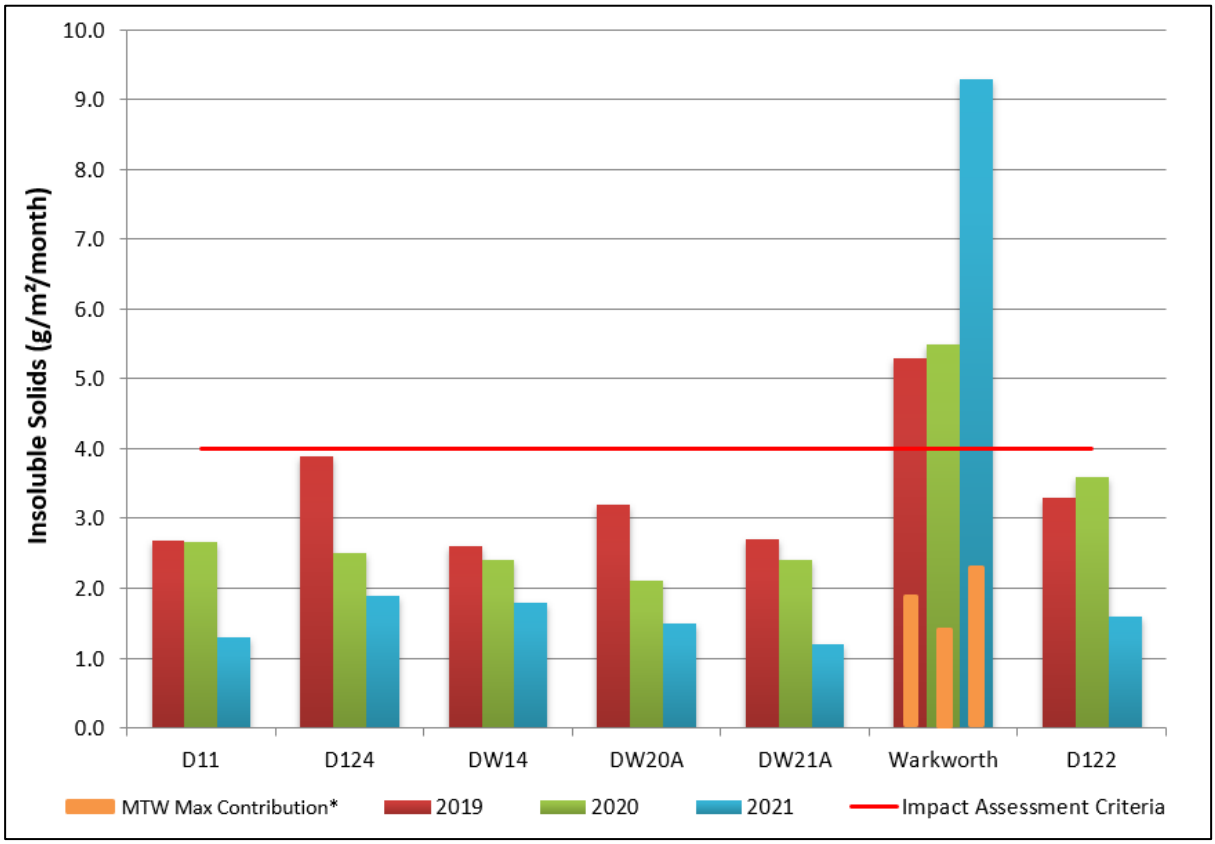
6.4.2.2 Deposited Dust

Deposited dust is monitored at six (6) locations situated on, or representative of privately-owned land generally in accordance with AS3580.10.1 (2003) and also at a 7th location (Warkworth). The Warkworth deposited dust gauge is not representative of privately-owned land as there are no longer privately owned properties in Warkworth. The annual average insoluble matter deposition rates in 2021 compared with the impact assessment criterion and previous years' data is shown in **Figure 14.**

There was one exceedance of the 4 g/m^2/month long-term impact assessment criteria, for maximum total deposited dust level, recorded at the Warkworth monitoring location. An external consultant was engaged to conduct an investigation which determined maximum MTW contribution to be less than or equal to 2.3g/m2/month, or ~25% of the total level of 9.3g/m2/month at Warkworth. Whilst the result exceeds the 2 g/m^2/month maximum allowable increase in deposited dust criterion, there are no privately-owned residences in Warkworth and as such, this does not constitute non-compliance, as per Schedule 3, Condition 17 of Warkworth Mining Limited Development Consent (SSD-6464) and Schedule 3, Condition 15 of Mount Thorley Operations Development Consent (SSD-6465). The results after investigation is shown on **Figure 14**.

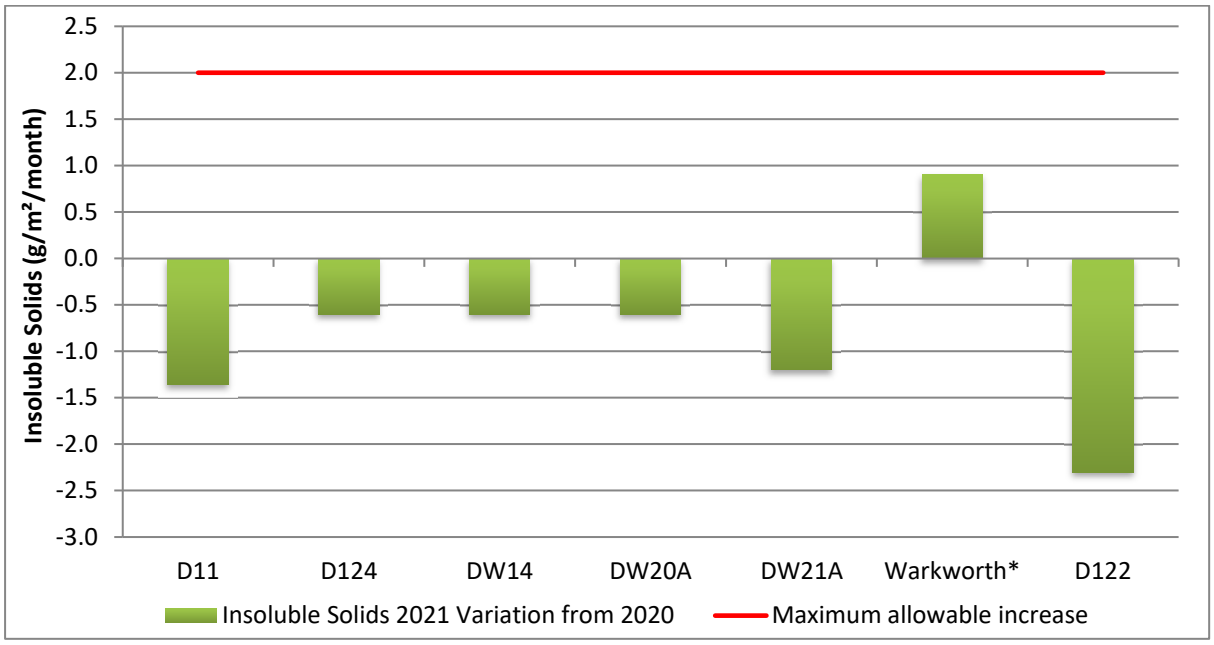
After analysis of the single exceedance, all annual average insoluble matter deposition rates recorded on or representing privately owned land were compliant with the long-term impact assessment criteria of 4g/m2/month. All monitoring locations representing privately owned residences also demonstrated compliance with the maximum allowable insoluble solids increase criteria of 2g/m2/month (**Figure 15**). MTW propose to amend its Air Quality Monitoring Programme to remove the Warkworth depositional dust gauge from its monitoring network, considering that there are no longer any privately-owned residences in Warkworth.

Note: During the July reporting period the Warkworth monitor recorded a monthly result above the long-term impact assessment criteria of 4.0 g/m^2 per month. An external consultant was engaged to conduct an investigation which determined the result to be anomalous and that MTW was not the primary contributor. Accordingly, the result was excluded from the annual average calculation.



** MTW's estimated maximum contribution to annual average deposited dust level (determined by external air quality consultant).*

FIGURE 14: 2021 DEPOSITIONAL DUST RESULTS COMPARED AGAINST THE IMPACT ASSESSMENT CRITERIA AND PREVIOUS YEARS' RESULTS



** Variation calculated from MTW's estimated maximum contribution to annual average deposited dust level (determined by external air quality consultant).*

FIGURE 15: VARIATION IN INSOLUBLE SOLIDS DEPOSITION RATE FROM 2020 TO 2021 COMPARED AGAINST THE IMPACT ASSESSMENT CRITERIA

6.4.2.3 Total Suspended Particulates (TSP)

Total Suspended Particulates (TSP) are measured at four (4) locations situated on or representative of privately-owned land in accordance with AS3580.9.3 (2003) and also at a 5th location (Warkworth HVAS). The Warkworth HVAS is not representative of privately-owned land as there are no longer privately owned properties in Warkworth.

Annual average TSP concentrations recorded in 2021 compared against the long-term impact assessment criterion and previous years' data, are shown **Figure 16**.

One high volume air sampler exceeded the annual TSP impact assessment criteria during the reporting period. This was investigated to determine the level of contribution from MTW activities in accordance with the compliance protocol outlined in the approved MTW Air Quality Management Plan. The recorded exceedance was determined to be compliant with the relevant criteria, as the measured result is not primarily attributable to MTW. The result after investigation is shown in **Figure 16.**

After analysis of the single exceedance, all annual average results were compliant with the impact assessment and land acquisition criteria.

A summary of the investigation undertaken for the annual TSP exceedance is provided in

Table 6.8.

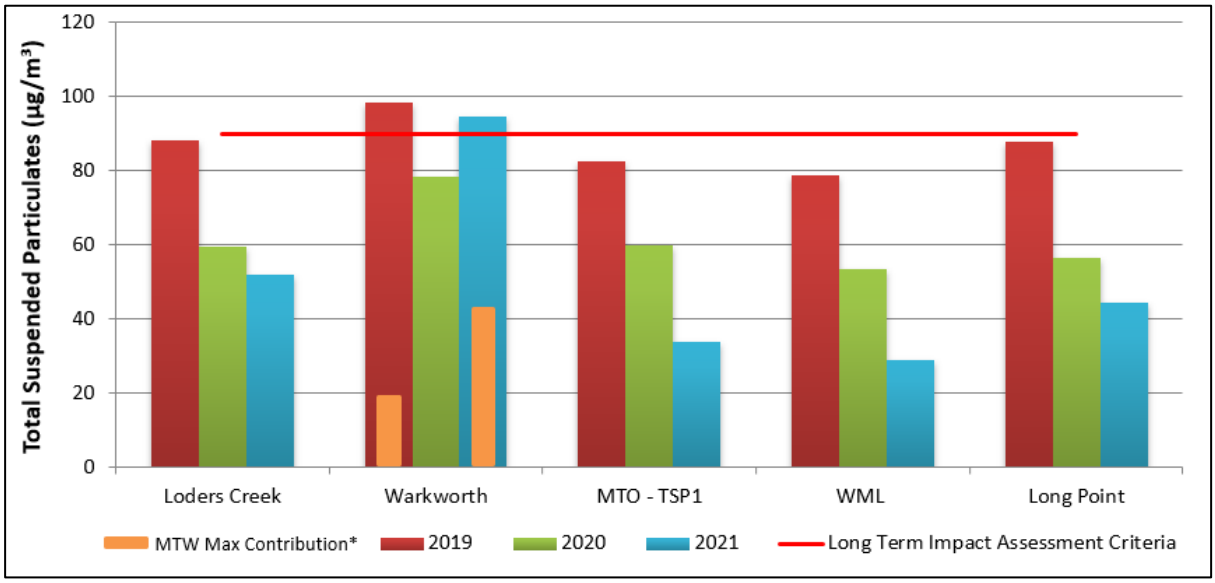
TABLE 6.8 ANNUAL TSP INVESTIGATION - 2021

Date	Site	Annual Average PM_{10} result ($\mu g/m^3$)	Calculated Annual TSP (µg/m3)	Discussion
2021	Warkworth HVAS TSP	94.6	≤42.8*	An external consultant was engaged to investigate the exceedance. The investigation determined that the maximum potential contribution from MTW at the Warkworth monitor during the review period was 42.8 µg/m3. This was based on an analysis of meteorological data, background TSP levels and position of the site in relation to MTW. As the measured result is not primarily attributable to MTW, it does not constitute non-compliance, as per MTW's approved Air Quality Management Plan. No further action is required.

* *MTW's estimated contribution to annual average TSP level ($\mu g/m^3$).*

During the reporting period, five (5) out of the 305 TSP measurements were not able to be fully collected on the scheduled sampling date (based on a sampling frequency of every six days) likely due to power failures and programming errors.

The annual average TSP concentrations recorded in 2021 are generally lower than those recorded in previous years, which is likely related to above average rainfall in 2020 and 2021.



** MTW's estimated maximum contribution to annual average TSP level (determined by external air quality consultant).*

FIGURE 16: 2021 TSP ANNUAL AVERAGE COMPARED AGAINST THE IMPACT ASSESSMENT CRITERIA AND PREVIOUS YEARS' RESULTS

6.4.2.4 Particulate Matter <10µm (PM10)

Compliance assessment for Particulate Matter <10µm (PM_{10}) is measured at four (4) locations on privately owned land in accordance with AS3580.9.6 (2003). During 2021, all short term and annual average results were compliant with the impact assessment criteria, as per MTW's approved Air Quality Management Plan.

6.4.2.5 Short term PM10 impact assessment criteria

Monitoring results for PM_{10} (24 hour) collected through High-Volume Air Sampler monitoring are compared against the short-term impact assessment criteria (**Figure 17**). All 24hr average results recorded by MTW's surrounding network of TEOM monitors are presented on a quarterly basis in **Figure 18** to **Figure 21.**

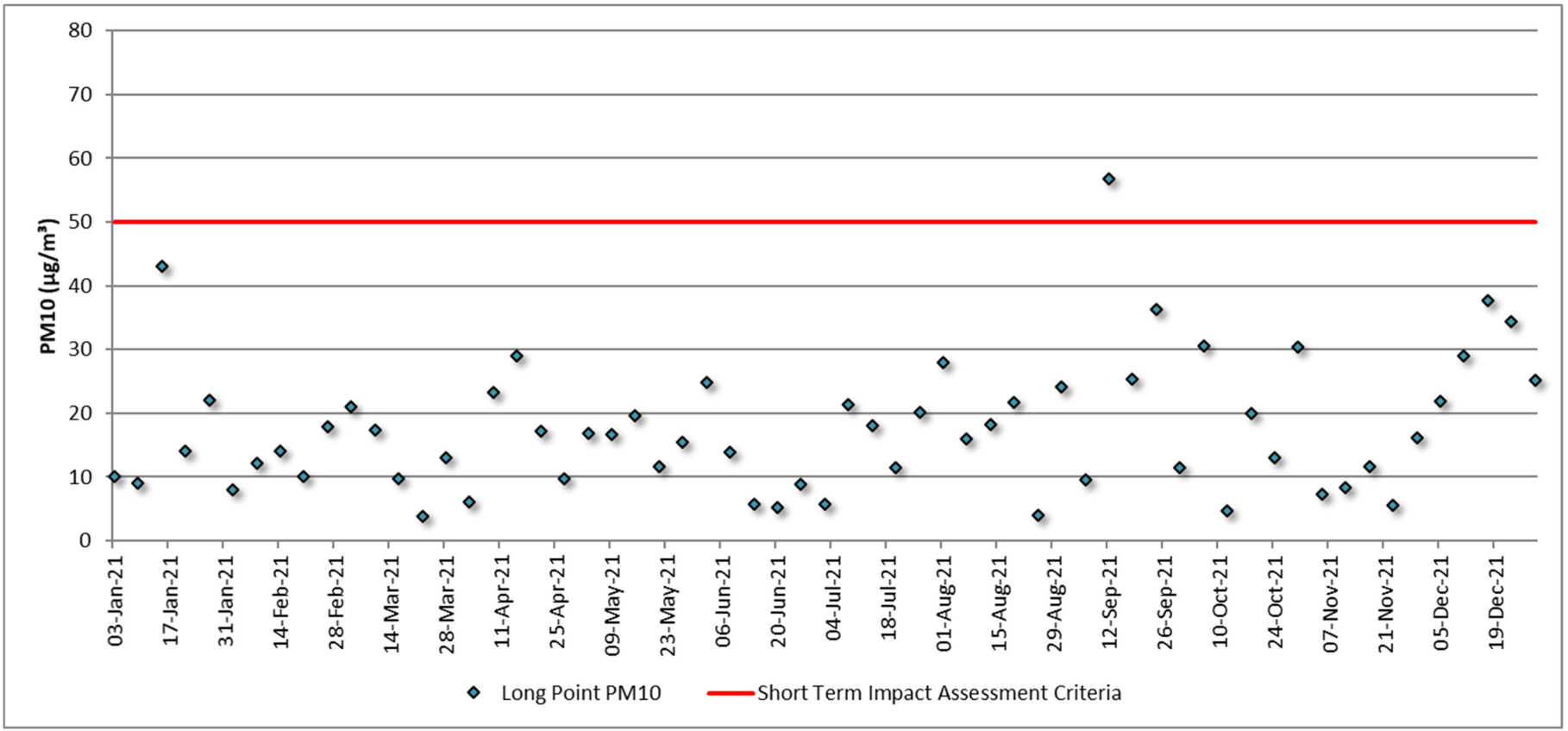


FIGURE 17: PM10 24HR MONITORING RESULTS (MEASURED BY MTW PM10 HVAS MONITOR)

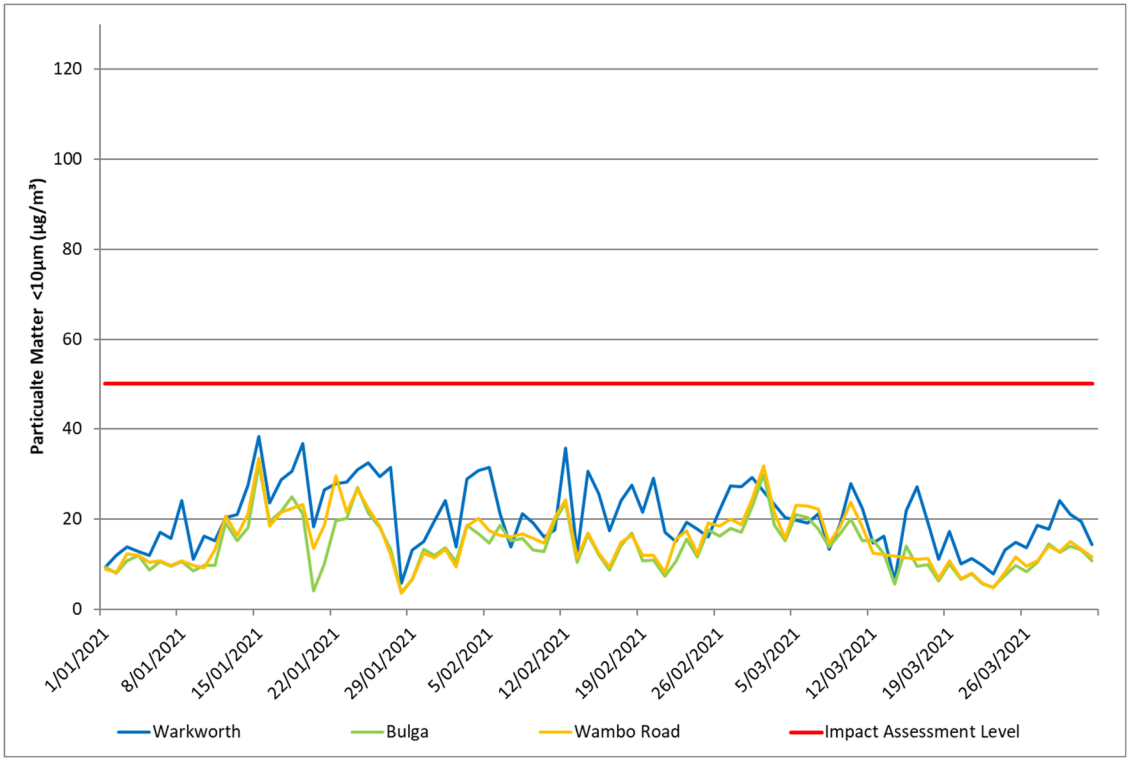


FIGURE 18: 24HR AVERAGE PM10 MEASURED AT TEOM MONITORS SURROUNDING MTW - QUARTER ONE 2021

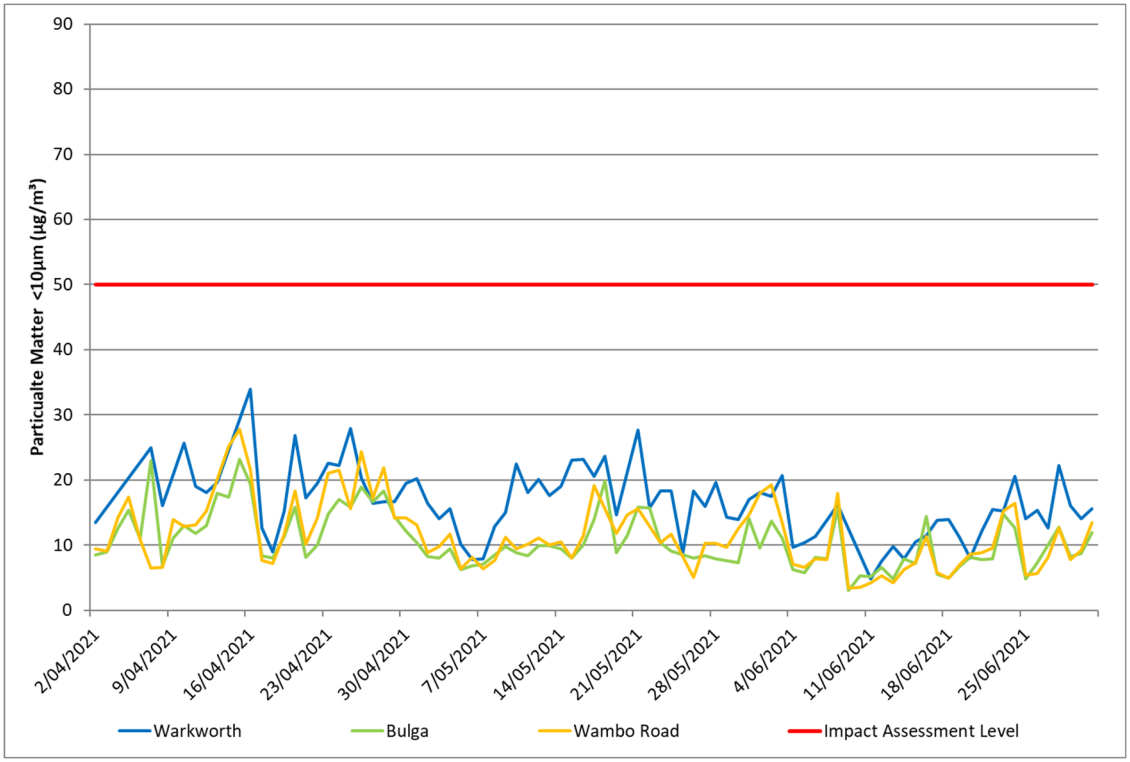


FIGURE 19: 24HR AVERAGE PM10 MEASURED AT TEOM MONITORS SURROUNDING MTW - QUARTER TWO 2021

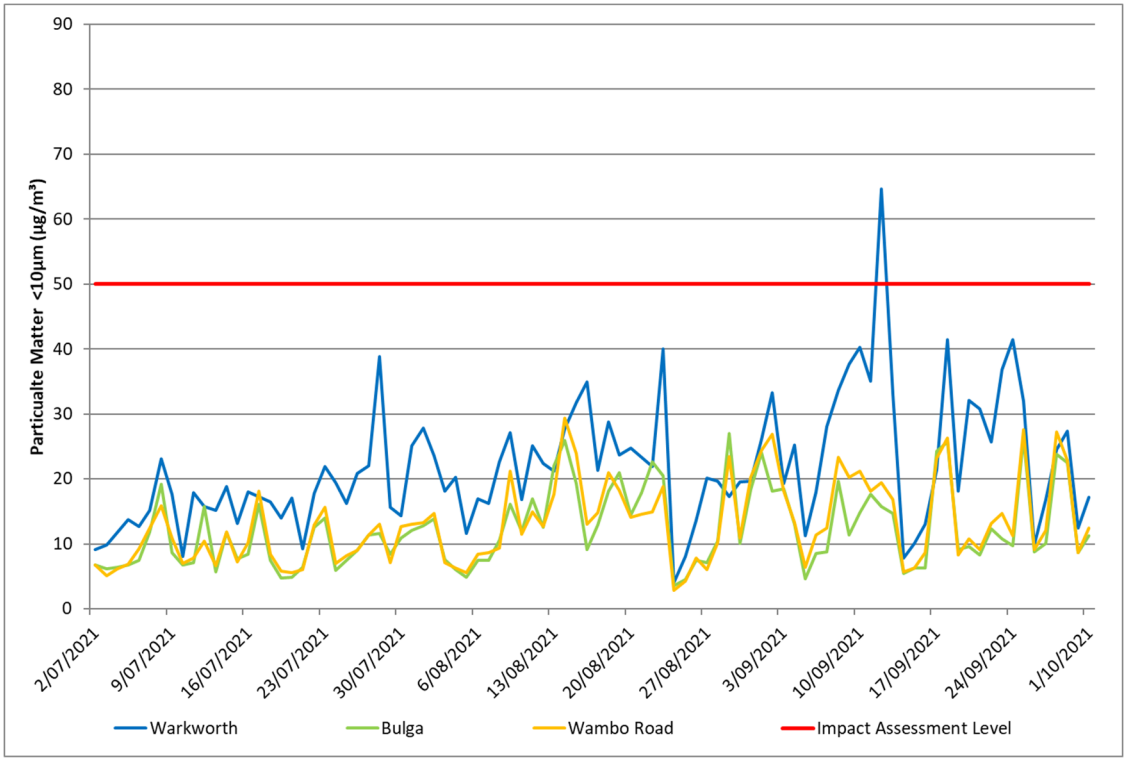


FIGURE 20: 24HR AVERAGE PM10 MEASURED AT TEOM MONITORS SURROUNDING MTW - QUARTER THREE 2021

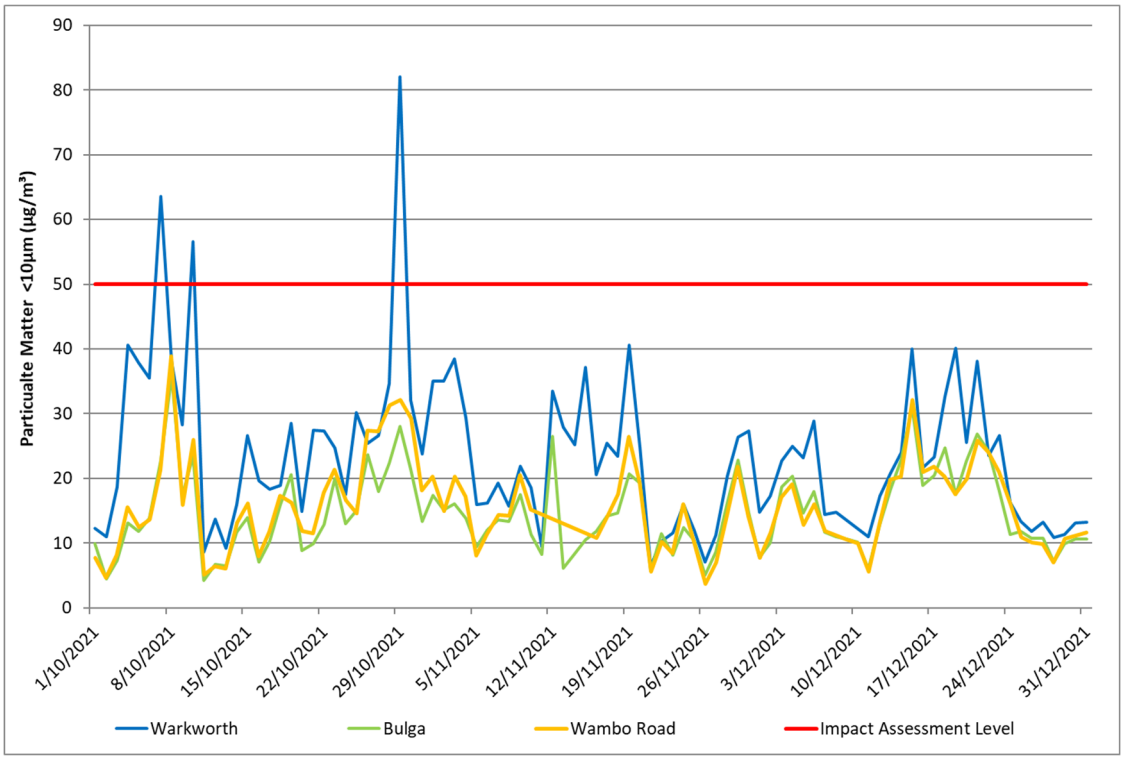


FIGURE 21: 24HR AVERAGE PM_{10} MEASURED AT TEOM MONITORS SURROUNDING MTW - QUARTER FOUR 2021

One high volume air sample and four TEOM PM_{10} measurement results potentially exceeded the 24 hour short term impact assessment criteria during the reporting period. The exceedances were investigated to determine the level of contribution from MTW activities in accordance with the compliance protocol outlined in the MTW Air Quality Management Plan. MTW was not a significant contributor to the exceedances and therefore no non-compliances were recorded.

A summary of the investigations undertaken for each short term PM10 exceedance are provided in **Table 6.9**

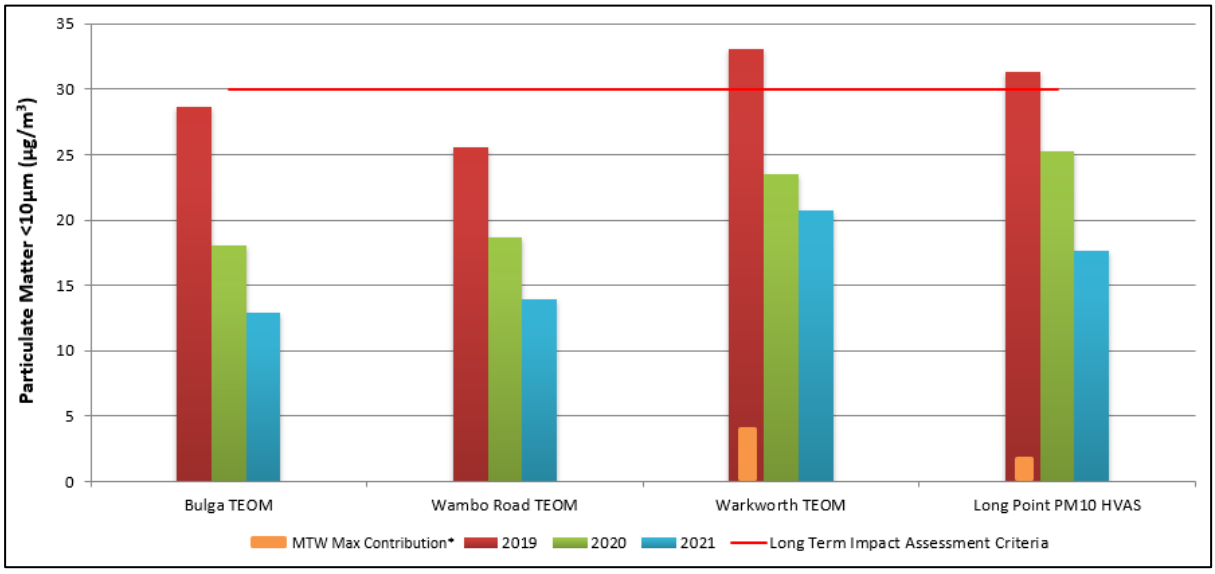
TABLE 6.9 24 HOUR PM_{10} INVESTIGATIONS - 2021

Date	Site	24hr PM_{10} result ($\mu g/m^3$)	Estimated contribution from MTW ($\mu g/m^3$)	Discussion
12/09/2021	Warkworth TEOM	64.6	0.8	An analysis of meteorological data has determined the maximum potential MTW contribution to the result to be in the order of 0.8µg/m3 or <2% of the measured result. As the calculated contribution was less than 75% of the measured result, MTW operations are not considered to be a significant contributor to the result, as described in the MTW Air Quality Management Plan.
12/09/2021	Long Point HVAS PM_{10}	56.7	41.0	An analysis of meteorological data and background PM10 levels has determined the maximum potential MTW contribution to the result to be in the order of 41.0µg/m3 or ~72% of the measured result. As the calculated contribution was less than 75% of the measured result, MTW operations are not considered to be a significant contributor to the result, as described in the MTW Air Quality Management Plan.
07/10/2021	Warkworth TEOM	63.6	15.5	An analysis of meteorological data has determined the maximum potential MTW contribution to the result to be in the order of 15.5µg/m3 or ~24% of the measured result. As the calculated contribution was less than 75% of the measured result, MTW operations are not considered to be a significant contributor to the result, as described in the MTW Air Quality Management Plan.

Date	Site	24hr PM_{10} result ($\mu g/m^3$)	Estimated contribution from MTW ($\mu g/m^3$)	Discussion
10/10/2021	Warkworth TEOM	56.5	7.5	An analysis of meteorological data has determined the maximum potential MTW contribution to the result to be in the order of 7.5µg/m3 or ~13% of the measured result. As the calculated contribution was less than 75% of the measured result, MTW operations are not considered to be a significant contributor to the result, as described in the MTW Air Quality Management Plan.
29/10/2021	Warkworth TEOM	82.0	11.6	An analysis of meteorological data has determined the maximum potential MTW contribution to the result to be in the order of 11.6µg/m3 or ~16% of the measured result. As the calculated contribution was less than 75% of the measured result, MTW operations are not considered to be a significant contributor to the result, as described in the MTW Air Quality Management Plan.

6.4.2.6 Long term PM_{10} impact assessment criteria

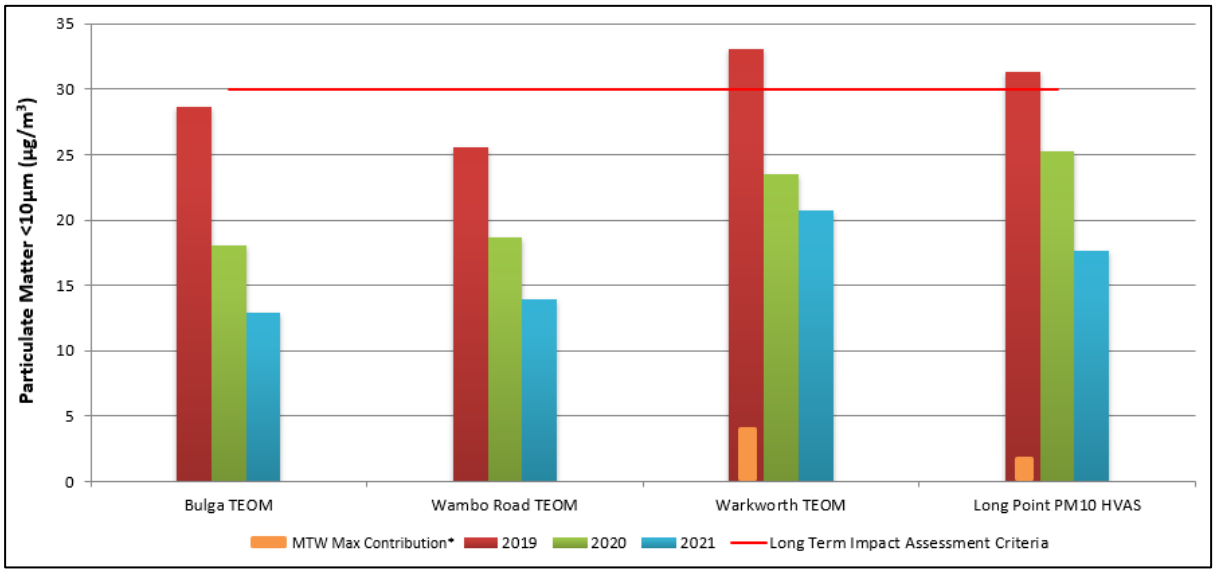
Annual average PM_{10} concentrations have been compared with the long term PM_{10} impact assessment criterion and previous years' data (



** MTW's estimated maximum contribution to annual average PM10 level (determined by external air quality consultant).*

Figure 22). All annual average PM_{10} concentrations recorded on privately owned land (or representative of the nearest privately-owned property) were compliant with the assessment criterion.

The Bulga, Wambo Road, Warkworth and Long Point monitoring locations recorded decreases in annual average PM_{10} concentrations compared to 2020 and 2019. This decrease is considered largely attributable to above average rainfall.



** MTW's estimated maximum contribution to annual average PM10 level (determined by external air quality consultant).*

FIGURE 22: ANNUAL AVERAGE PM10 RESULTS 2019 TO 2021

6.4.2.7 Comparison of 2021 Air Quality data against EA predictions

Annual average PM_{10} results were close to or below the modelled range for Year 9 of the development (nominally 2023) which is the mine plan year in the EA which provides the most appropriate comparison year. Refer to **Table 6.10**

TSP annual averages at three of five monitoring locations were higher than modelled predictions for the Year 9 scenario. Refer to **Table 6.11.**

The difference between modelled predictions and the measured results can be explained as a function of model inputs which do not account for PM_{10} or TSP contribution from regional particulate events such as bushfires, stock movement, dust from local roads and driveways and agricultural activity.

TABLE 6.10 2021 PM10 ANNUAL AVERAGE RESULTS COMPARED AGAINST CUMULATIVE PREDICTIONS FOR YEAR 9 - WARKWORTH CONTINUATION EIS (2014).

Monitoring Location	Long Term (annual average) PM_{10} criteria	
	Year 9 EIS Prediction (µg/m³)	2021 Annual Average (µg/m³)
Bulga OEH TEOM	22	12.9
Wambo Road TEOM	14	13.9
Warkworth OEH TEOM	32	20.7
Long Point PM_{10}	16	17.6

TABLE 6.11 2021 TSP ANNUAL AVERAGE RESULTS COMPARED AGAINST CUMULATIVE PREDICTIONS FOR YEAR 9 – WARKWORTH CONTINUATION EIS (2014).

Monitoring Location	Long Term (annual average) TSP criteria	
	Year 9 EIS Prediction (µg/m³)	2021 Annual Average (µg/m³)
MTO TSP1	50	33.9
Loders Creek TSP	41	52.0
WML- HV2a	35	29.0
Warkworth	68	94.6
Long Point	38	44.6

6.5 Heritage Summary

6.5.1 Heritage Management

During the reporting period, Aboriginal Cultural Heritage and Historic Heritage was managed in accordance with the site's approved Aboriginal Heritage and Historic Heritage Management Plans. A summary of the performance in each of these areas is outlined below.

6.5.2 Heritage Performance

6.5.2.1 Aboriginal Heritage

6.5.2.1.1 Aboriginal Heritage Activities

No Aboriginal cultural heritage assessments or salvage programs were required at MTW during the reporting period. Aboriginal cultural heritage was managed in accordance with the MTW Aboriginal Heritage Management Plan (AHMP) and the Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW (the Due Diligence Code).

MTW was issued Care Agreement C0003708 on 26 April 2019 by the Office of Environment and Heritage (now Heritage NSW), which approved the transfer and safekeeping of Aboriginal objects and

was a replacement of Care Agreement C0001841. On 19 October 2020, the Aboriginal objects specified in Care Agreement C003708 were transferred to the updated location for safekeeping. Heritage NSW was advised of the transfer on 29 October 2020.

There were no additional Aboriginal cultural heritage sites identified during the reporting period.

An AHMP compliance inspection covering the 2021 reporting period was undertaken on 2-3 November 2021. This inspection was conducted by representatives of the Aboriginal community, internal MTW personnel and a consultant archaeologist. A total of 53 Aboriginal cultural heritage sites were reviewed during this program, with no adverse findings identified. The Aboriginal Heritage Management Plan Inspection report is shown in **Appendix 2**.

The Upper Hunter Valley Aboriginal Cultural Heritage Working Group (CHWG) is the primary forum for Aboriginal community consultation on matters pertaining to cultural heritage. The CHWG is comprised of representatives from MTW and Registered Aboriginal Parties (RAPs) from Upper Hunter Valley Aboriginal community groups, corporations and individuals. There were no meetings of the CHWG during the reporting period. Further consultation with the CHWG is planned for the next reporting period to discuss upcoming salvage programs and general cultural heritage management processes.

6.5.2.1.2 Audits and Incidents

During the reporting period there were 35 Ground Disturbance Permits (GDP's) assessed for cultural heritage management considerations at MTW. Ground disturbance works were conducted based on an Aboriginal cultural heritage sites avoidance policy so that no un-salvaged sites were impacted by these activities. There were no known incidents, nor any unauthorised disturbance caused to Aboriginal cultural heritage sites at MTW during 2021.

6.5.2.2 Historic Heritage

6.5.2.2.1 Historic Heritage Activities

An Historic Heritage Management Plan (HHMP) compliance inspection covering the 2021 reporting period was conducted on 2-3 November 2021. This inspection was conducted by a consultant archaeologist, assisted by representatives of the Community Heritage Advisory Group (CHAG) and internal MTW personnel. A total of 3 historic heritage sites were inspected during this program. The Historic Heritage Management Plan Inspection Report is shown in **Appendix 3**.

In 2012 the CHAG was established as a community consultation forum for matters pertaining to management of historic (non-Indigenous) heritage located on MTW lands. The CHAG is comprised of community representatives with particular knowledge and interests in the historic heritage of the region such as historical groups, individuals and local government.

The MTW Historic Heritage Conservation Fund (HHCF) was launched by Singleton Council in December 2018, in accordance with Schedule 17 of the HHMP. Including the 2021 reporting period, MTW has made $409,333 of contributions to the HHCF since its launch. Singleton Council advised

correspondence received September 2020, that a total of 3 applications were made in 2020. There were no applications received for HHCF funding in 2021. MTW will continue to consult with Council during 2022 on the HHCF processes, including methods to promote/advertise the fund, to ensure the positive outcomes that the funding is intended to achieve can be realised in the Singleton area.

There were no incidents or any unauthorised disturbance caused to historic heritage sites at MTW during 2021.

6.6 Visual Amenity and Lighting

6.6.1 Visual Amenity and Lighting Management

MTW aims to minimise visual amenity impacts from its operations. Two of the main controls used are lighting management and visual screening.

6.6.2 Visual Amenity and Lighting Performance

6.6.2.1 Lighting

MTW aims to provide sufficient lighting for work to be undertaken safely, whilst minimising disturbance to neighbouring residents and public road users, particularly nearby residents in Bulga Village, Mount Thorley, Warkworth Village, Long Point, Milbrodale and motorists on the Putty Road and Golden Highway.

Actions undertaken in 2021 to manage lighting impacts at MTW included:

- Routine night shift inspections conducted by Community Response Officers to observe operating practices and to ensure lights are not shining towards nearby residential areas or affecting public roads;
- Yellow lights are used in preference to white lights in areas based on risk and external exposure;
- Alternate sheltered dumps are operated, or work areas are shut down if lighting or visual amenity issues arise and cannot be sufficiently managed.

6.6.2.2 Visual Screening

Visual screening of MTW's operations incorporates various methods to best suit the terrain and infrastructure constraints around the boundary of the mine.

Visual bunding has an immediate screening effect, providing complete screening in areas where vegetation would be inadequate to filter views or where additional height is required. Bunds may be vegetated where practicable and feasible for visual amenity and to mitigate erosion.

Built screens (i.e. solid fences or walls), may be used as an alternative when bunds and tree screens are not practicable. Temporary screens (i.e. fencing and shade mesh) may also be used as required for interim screening.

Shade cloth was attached to the existing fence along Putty Road in July 2021. This visual screen fencing is an interim measure prior to the establishment of vegetation. Vegetation plantings were undertaken in 2020 to infill between existing trees/shrubs. Slashing works were also undertaken in 2021 along Putty Road and the Golden Highway, improving visual amenity.

6.7 Water

6.7.1 Water Management

An adaptive management approach is implemented at MTW to achieve the following objectives for water management:

- Fresh water usage is minimised;
- Impacts on the environment and MTW neighbours are minimised; and
- Interference to mining production is minimal.

This is achieved by:

- Preferentially using mine water for coal preparation and dust suppression where feasible;
- An emphasis on control of water quality and quantity at the source;
- Segregating waters of different quality where practical;
- Recycling on-site water;
- Ongoing maintenance and review of the water management system; and
- Releasing water to the environment in accordance with statutory requirements.

Plans showing the layout of all water management structures and key pipelines are shown in **Figure 23**. During the reporting period an updated Water Management Plan was approved in November 2021.
The MTW Water Management Plan contains further detail on management practices and is available on the MTW website https://www.mtwcoal.com.au/.

Improvements to water management in 2021 included;

- Construction of sediment water management structures for the western advancing pre-strip at Warkworth completed in quarter one 2021. These structures were designed in accordance with the NSW Blue Book, Managing Urban Stormwater: Soils and Construction, Volume 2E Mines and Quarries.

- Remote boundary monitoring system installed on the additional new dams (54N and 55N).

- Upgrade and install of additional pumping infrastructure to manage Dams 1S, 2S and 3S to reduce risk during high intensity rainfall events.

- Construction of the Warkworth North Pit North drainage upgrade works was completed during the reporting period to improve water management and mitigate the risk of unauthorised water releases from site.

- Develop concept sediment dam sizing for the rehabilitation areas catchment that reports to Dam 3S in accordance with the key principles outlined within the 'Blue Book' (Managing Urban Stormwater: Soils and Construction Vol. 1, 4th edition and Vol. 2E Mines and Quarries (Landcom, 2004 and DECC, 2008)) to mitigate the risk of unauthorised water releases from site from Dam 1S. The Water Management Plan was updated with this concept in 2021, and further design works / geotechnical assessments progressing to construction are planned to occur in 2022.

There were four reportable water related incidents during the reporting period that occurred on 4 January, 19 March, 12 November and 26 November 2021 per below summary. Further details on these incidents and the actions taken by MTW are provided in **Section 10**.

- The incident on 4 January 2021 involved the overtopping of four boundary dams at Warkworth (Dam 46N, Dam 52N, Dam 53N, Dam SSD09) and a mine water dam at Mount Thorley Operations (Dam 1S) as a result of a greater than design rainfall event (79.4 mm). Two penalty notices were received from the EPA in July 2021, and one penalty notice was received from DPE in August 2021.
- The incident on 19 March 2021 involved the overtopping of three boundary dams at Warkworth (Dam 53N, 54N and 55N) and a mine water dam at Mount Thorley Operations (Dam 1S) as a result of a greater than design rainfall event (175.2 mm). MTW received notification on 4 November 2021 from DPE stating no comments on the incident reports. There has been no response from the EPA.
- The incident on 12 November 2021 involved the overtopping of two boundary dams at Warkworth (Dam 54N and Dam 53N) as a result of a greater than design rainfall event (110.6 mm). WML received notification on 20 January 2021 from the EPA stating they would not be taking regulatory action.
- The incident on 26 November 2021 involved the overtopping of a boundary dam at Warkworth (Dam 53N) as a result of a greater than design rainfall event (84 mm). WML received notification on 20 January 2022 from the EPA stating they would not be taking regulatory action.

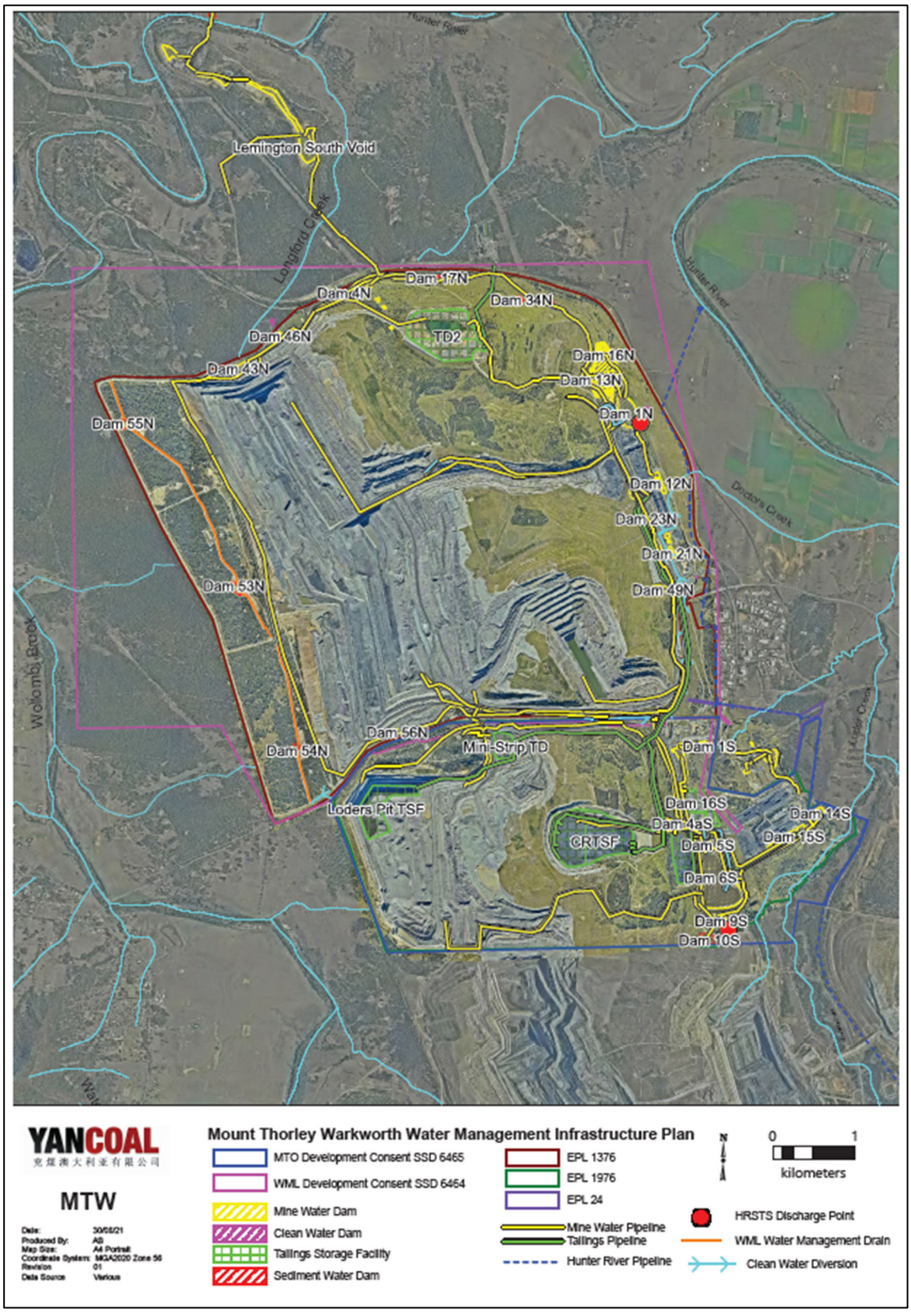


FIGURE 23: WATER MANAGEMENT INFRASTRUCTURE PLAN

6.7.2 Water Balance Performance

MTW uses a water balance to record and assess water flux, but also to forecast and plan water management needs. These annual site water balances are then compared to previous results. A 2021 static water balance for MTW is presented in **Table 6.12** and a simplified schematic of this balance is included in **Figure 24**. A salt flux schematic is shown **in Figure 25**.

TABLE 6.12 STATIC MODEL RESULTS, ANNUAL WATER BALANCE

Water Stream	Volume (ML) (% Total)
Inputs	
Rainfall Runoff	10,014 (84%)
Hunter River (MTJV supply scheme)	259 (2%)
Potable (Singleton Shire Council / trucked)	48 (<1%)
Groundwater	428 (4%)
Recycled to CHPP from tailings (not included in total)	5,529
Imported (LUG bore)	41 (<1%)
Imported (Hunter Valley Operations)	0 (0%)
Water from ROM Coal	1,138 (10%)
Total Inputs	**11,928**
Outputs	
Dust Suppression	3,030 (27%)
Evaporation – mine water dams	2,074 (19%)
Entrained in process waste	2,451 (22%)
Sharing with other mines	0 (0%)
Discharged (HRSTS)	1,688 (15%)
Water in coarse reject	640 (6%)
Water in product coal	1,160 (10%)
Miscellaneous use (wash-down etc.)	110 (1%)
Total Outputs	**11,153**
Change in storage	**775**

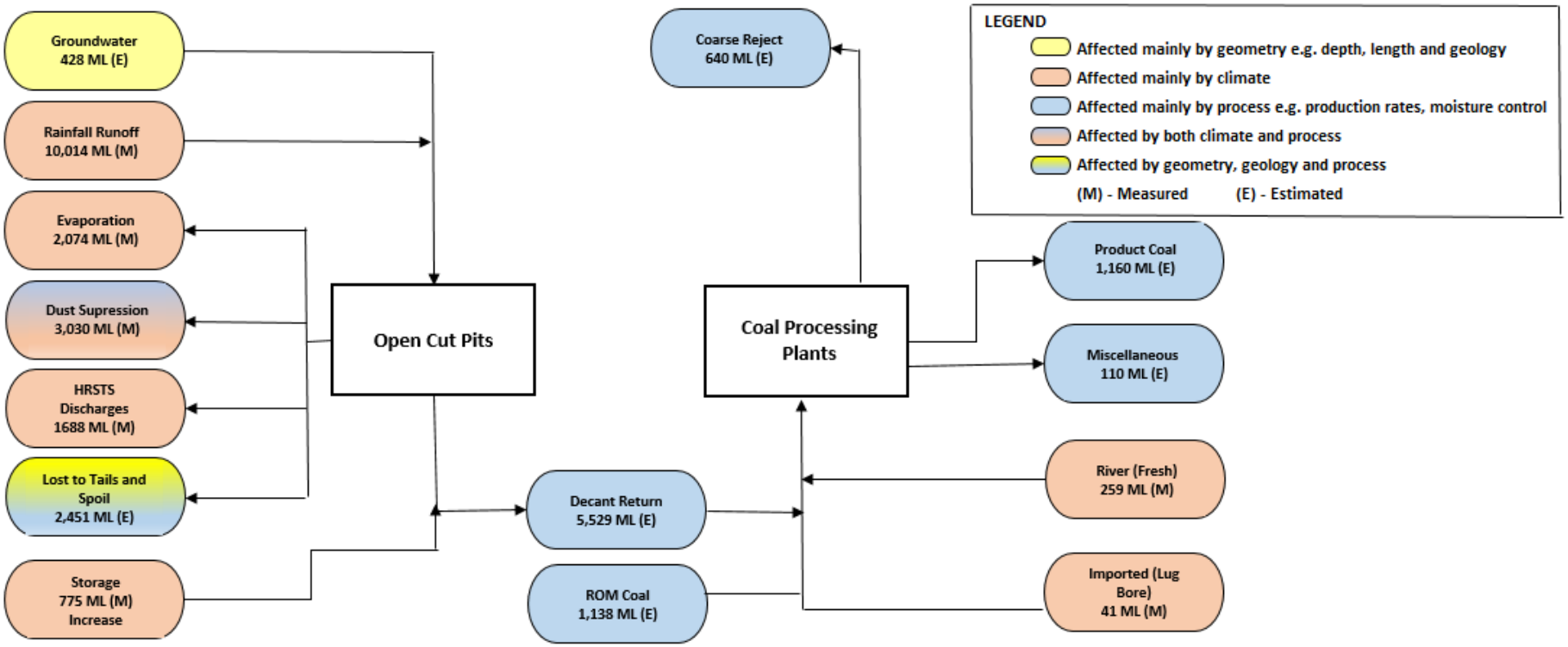


FIGURE 24: SCHEMATIC DIAGRAM MTW WATER FLUX

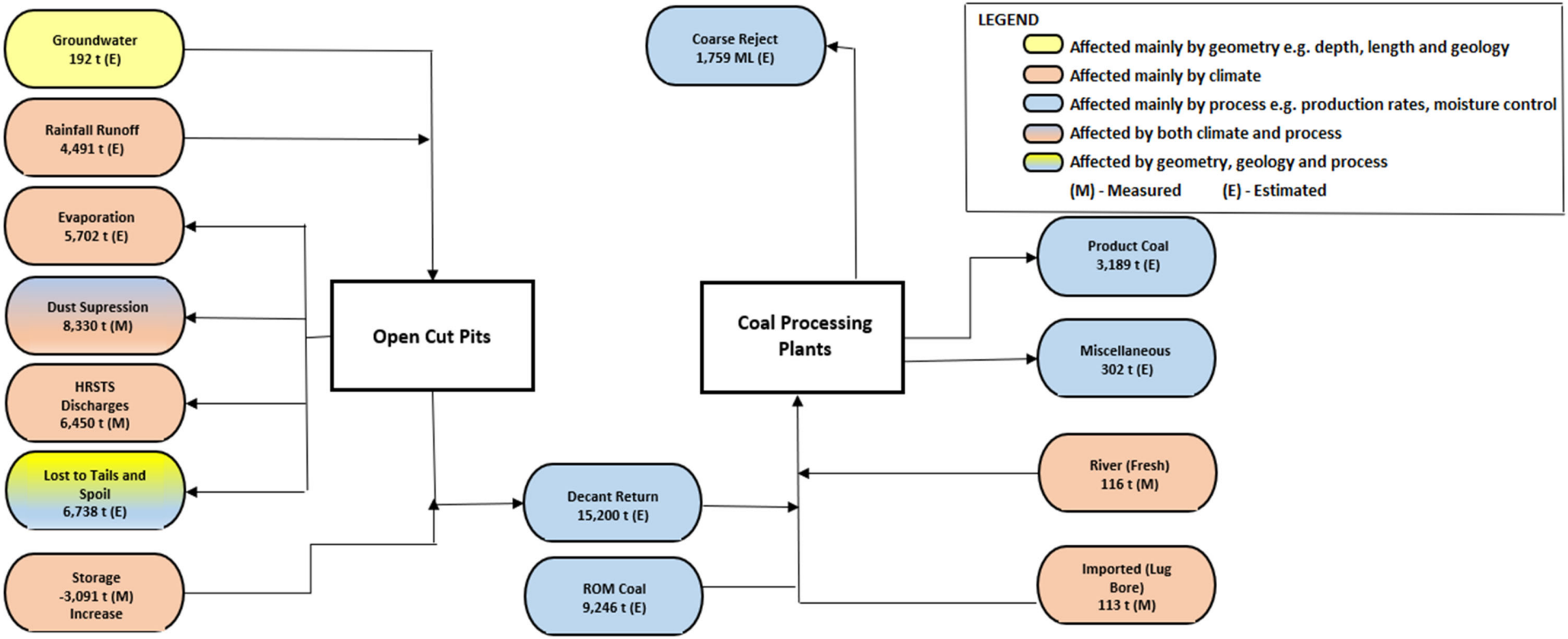


FIGURE 25: SCHEMATIC DIAGRAM MTW SALT FLUX

6.7.2.1 Water Inputs

A total of 979.6mm of rainfall was recorded at MTW in 2021 producing a calculated 10,014 ML of runoff from developed, disturbed and mining catchments. Water falling on clean water catchments is diverted off site into natural systems where possible. Rainfall runoff was the largest input to the site mine water balance in 2021.

With high rainfall during the year, minimal water was required to be imported to meet site demand. During the reporting period 41 ML was imported from the LUG bore by MTW. This volume was a significant decrease on the previous reporting period (565ML extracted), due to on site water availability.

MTW also sources water from the Hunter River via the Mount Thorley Joint Venture (MTJV) water supply scheme. Singleton Shire Council holds the high security water licence on behalf of the scheme members. Singleton Shire Council maintains and operates the scheme to supply raw water to MTW, Glencore's Bulga Coal complex, and to meet Council's own needs. MTW's share of the MTJV allocation is 1,009 ML per water reporting year.

A total of 259 ML of water was abstracted from the Hunter River during the reporting period for MTW operations which was significantly less than the volume of water extracted in the previous reporting period. (1,455 ML extracted in 2020).

Groundwater Licences under Part 5 of the Water Act 1912 are held for each mining excavation area, to account for passive take via seepage inflows. Water Licences held by MTW are detailed in **Table 3.5** and **Table 3.6..**

Licence conditions require the volume and quality of water taken by the works to be measured and reported on an annual water calendar year basis (i.e. financial year). Groundwater inflows via pit wall seepage are at low rates, with a significant proportion evaporating at the coal face. The remainder reports to the pit floor, where it may accumulate along with direct rainfall, rainfall runoff and leakage from spoils. As a result, it is not possible to physically measure the volume of water taken by these groundwater licences, nor the quality of waters extracted via seepage to the pits. Ground water inflows volumes are estimated based on modelling from Australasian Groundwater and Environmental Consultants Pty Ltd (2015), *Mount Thorley and Warkworth Mines Long Term Approvals Model Update* (Project No G1468G, February 2015).

6.7.2.2 Water Outputs

Significant water uses at MTW in 2021 were for dust suppression on haul roads, mining areas and coal stockpiles (3,030 ML), evaporation from Dams (2,074 ML) and water entrained in process waste (2,451 ML). Water usage for dust suppression on haul roads was comparable to the 2020 reporting period with similar climatic conditions during the reporting period.

MTW participates in the Hunter River Salinity Trading Scheme (HRSTS), allowing discharge from licensed discharge points during declared discharge events associated with increased flow in the Hunter River. During high flows, each HRSTS participant is entitled to discharge a share of the total allowable discharge into a block of water passing down the Hunter River according to the number of HRSTS salt credits that they hold. Credits may be traded between participants to ensure that saline water is being managed in the most cost-effective way.

There are 1000 credits, each entitling the holder to discharge 1/1000 of each high flow day's total allowable discharge. The credits may be traded between participants so that those holders who do not need to discharge can trade their entitlement to others with the greatest need HRSTS discharge opportunity. HRSTS discharges are undertaken in accordance with HRSTS regulations (including the need to hold HRSTS credits for the discharges undertaken), and the licence conditions of EPL 1376 and EPL 1976.

MTW maintains two licensed HRSTS discharge monitoring locations:

- Dam 1N, located at WML North, which discharges to Doctor's Creek; and
- Dam 9S, located at MTO South, which discharges to Loders Creek.

During the reporting period, no discharge occurred from Dam 1N (WML) under the HRSTS. A total of 1,688 ML was discharged from Dam 9S (MTO) during the reporting period.

6.7.3 Surface Water Management

Surface water monitoring activities continued in 2021 in accordance with the MTW Water Management Plan and MTW Surface Water Monitoring Programme. MTW maintains a network of surface water monitoring sites located at selected site dams and surrounding natural watercourses as shown in **Figure 26**. Water quality monitoring is undertaken to verify the effectiveness of the water management system onsite, and to identify the emergence of potentially adverse effects on surrounding watercourses. Primary water storage dams are monitored routinely to verify the quality of mine water, used in coal processing, dust suppression, and other day to day activities around the mine.

Surface water monitoring data review involves a comparison of measured pH, EC and TSS results against internal trigger values which have been derived from the historical data set. The response to measured samples outside the trigger limits is detailed in the MTW Water Management Plan.

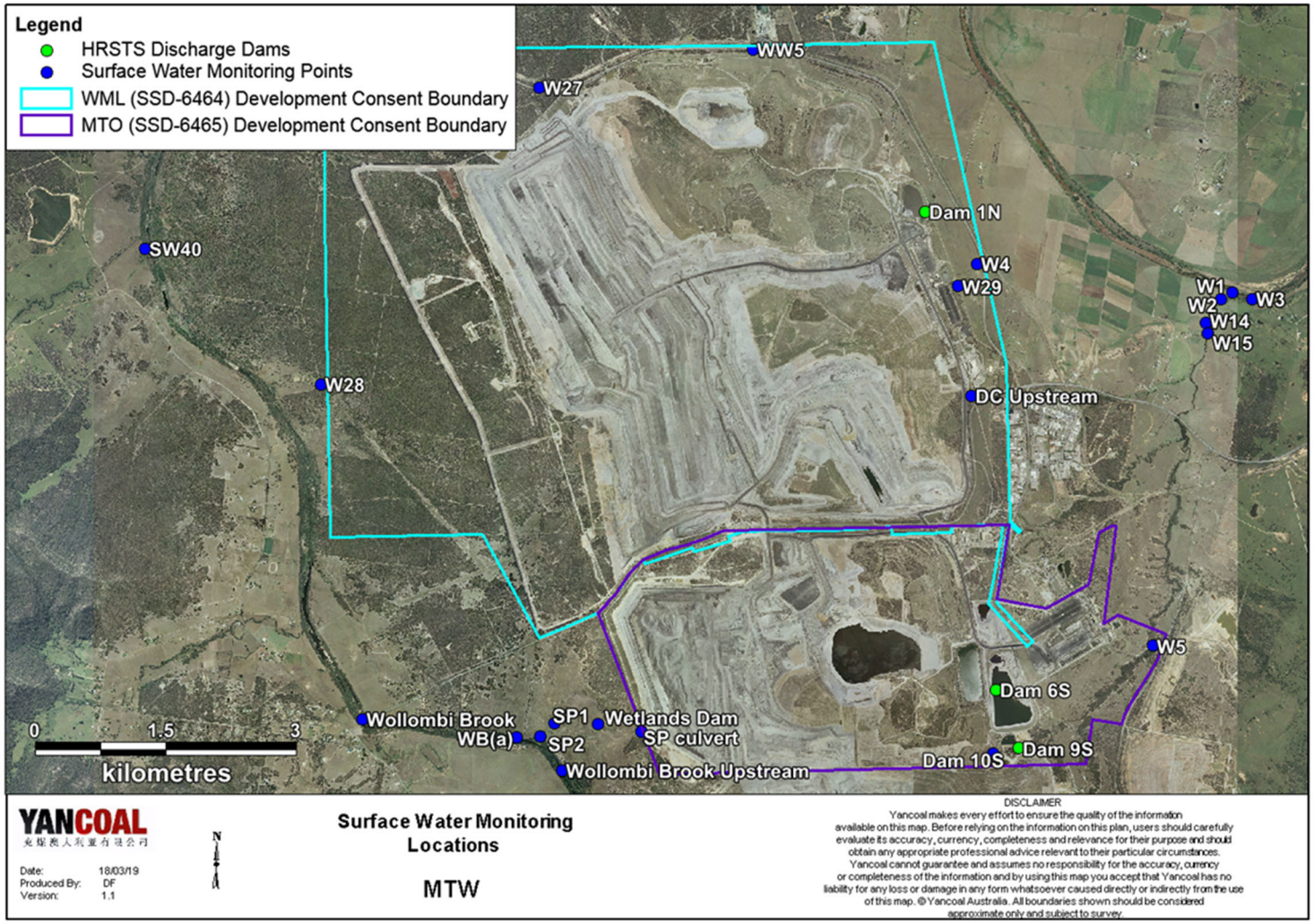


FIGURE 26: SURFACE WATER MONITORING POINTS

6.7.4 Surface Water Performance

Routine surface water monitoring was undertaken from twelve (12) sites and rain event sampling was undertaken from thirteen (13) sites. Sampling of surface waters was carried out in accordance with AS/NZS 5667.6 (1998). Analysis of surface water was carried out in accordance with approved methods by a NATA accredited laboratory.

Water quality is evaluated through the assessment of pH, Electrical Conductivity (EC) and Total Suspended Solids (TSS). All surface water sites were also sampled for comprehensive analysis annually. The sampling frequency for ephemeral water sites was modified in 2016, from quarterly to a rain-event trigger system in an effort to ensure samples taken were more representative of typical water quality for those streams (up to eight sampling events per annum can now be taken under the revised sampling protocol). Due to above average rainfall during the reporting period, three rain event sampling runs were completed in 2021. All required sampling and analysis was undertaken, except as detailed in **Table 6.13**. Trigger tracking results are described in **Table 6.14**.

TABLE 6.13 MTW WATER MONITORING DATA RECOVERY FOR 2021 (BY EXCEPTION)

Location	Data Recovery (%)	Comment
W27	67%	Insufficient water for sampling in March.
W1	50%	No safe access to site in March and June
W3	25%	No safe access to site in March, June and December
Dam 6S	92%	Insufficient water for sampling in June.

Note: Missing data indicates that there was insufficient water to take a sample, or that there was no safe access.

A summary of all surface water monitoring results is provided in the MTW Monthly Environmental Monitoring Reports and can be viewed via MTW's website (https://www.mtwcoal.com.au/).

Figure 27 to **Figure 32** show long term water quality trends for the Hunter River, Wollombi Brook, other surrounding tributaries and site dams.

Measurements of EC were generally stable during the reporting period across the majority of sites and consistent with historical seasonal trends. A single elevated EC level was recorded at the WW5 (unnamed creek) monitoring site during the reporting period. This site will continue to be monitored for future elevated levels and investigated as required.

Measurements of pH were generally stable during the reporting period across the majority of sites and consistent with historical seasonal trends. A few sites triggered 5th percentile/lowers limits during the first month of the reporting period and returned to within trigger limits the remainder of the year. One site triggered the 95th percentile/upper limit in the last month of the reporting period and will be monitored for future elevated levels. Refer to **Table 6.14** for trigger results.

A number of TSS limits were triggered in the reporting period, which were generally associated with rainfall events or sampling from pooled section of watercourses; these are outlined below in **Table 6.16**. MTW undertook investigations into the elevated TSS readings at W2 (Loders Creek), W4 (Doctors Creek), W5 (Loders Creek), W14 (Loders Creek), W15 (Loders Creek), W27 (Longford Creek) and W28 (Unname Creek) during the reporting period. The investigations concluded that the elevated results were most likely attributed to the rainfall event received prior to sampling. Monitoring results will continue to be watched. These results are also provided in the Monthly reports provided on the MTW Insite website (https://www.mtwcoal.com.au/).

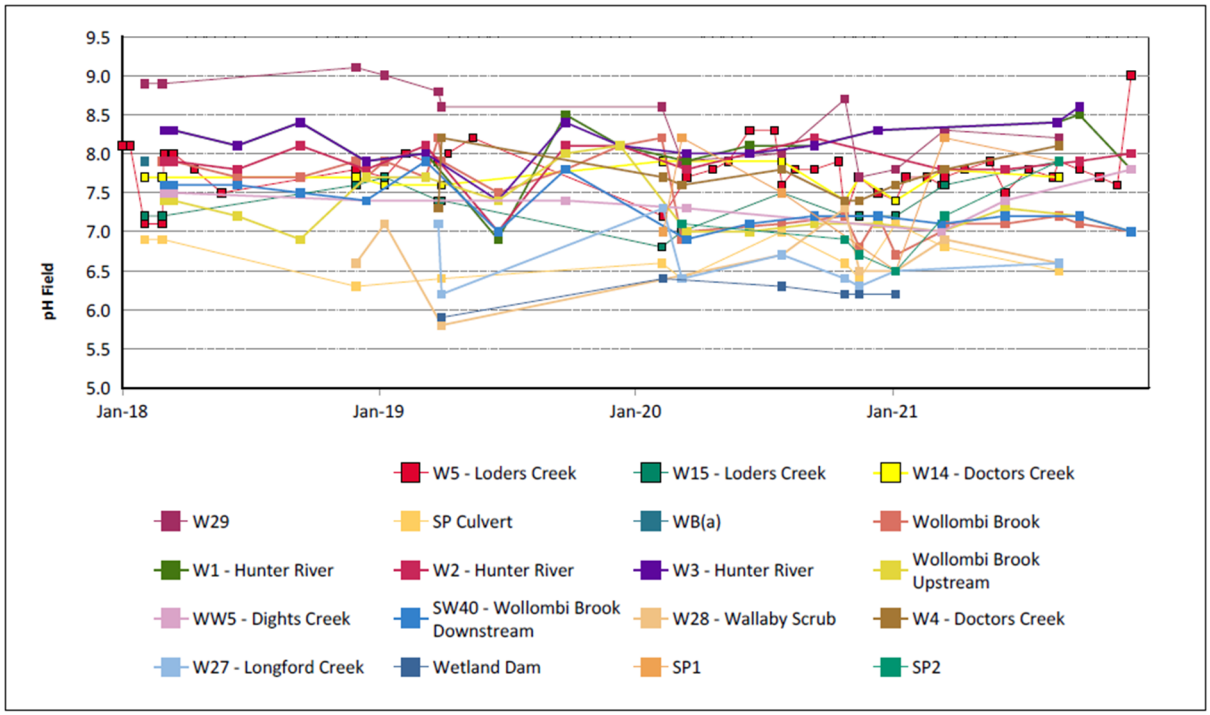
TABLE 6.14 SURFACE WATER MONITORING - TRIGGER TRACKING RESULTS

Site	Date	Trigger Limit Breached	Action Taken in Response
SP1	05/01/2021	pH –5th Percentile	Monitoring results back within trigger limits for March and August 2021 sample rounds. No follow up required.
W5	05/01/2021	pH –5th Percentile	Monitoring results back within trigger limits for February 2021 and all subsequent sample rounds. No follow up required.
W5	6/12/2021	pH –95th Percentile	Watching Brief*
W15	05/01/2021	pH –5th Percentile	Cyclical lower-pH measurements are consistently seen in the historical trend for this Loders Creek monitoring location. Monitoring results back within trigger limits for March 2021 sample round. No follow up required.
W29	05/01/2021	pH –5th Percentile	Monitoring results back within trigger limits for March and August 2021 sample rounds. No follow up required.
W3	23/09/2021	pH –5th Percentile	Watching Brief*
WW5	6/12/2021	EC – 95th Percentile	Watching Brief*
W1	6/12/2021	TSS – 50mg/L (ANZECC criteria)	Watching Brief* Note: Unlikely to be associated with MTW mining related impacts.
W2	11/03/2021	TSS – 50mg/L (ANZECC criteria)	Unlikely to be associated with MTW mining related impacts. Elevated TSS results most likely attributable to sampling from water with no flow. Note: Result is not considered to be a valid representation given that there was no flow at the time of sampling. Monitoring results back within trigger limits for June and December 2021 sample rounds. No follow up required.
W4	05/01/2021	TSS – 50mg/L (ANZECC criteria)	Watching Brief*. Elevated TSS associated with high runoff due to rainfall event (79.4mm on 4 January). Consistent with and higher than upstream sample W29 (which is closer to MTW); no mine site sources of sediment identified (no dam overtopping and/or site discharges recorded during the event).
W4	15/03/2021	TSS – 50mg/L (ANZECC criteria)	Watching Brief*. Elevated TSS associated with rainfall event (36.2mm on 14 March) and is considered related to sampling from slow flowing water. Consistent with and higher than upstream sample W29 (which is closer to MTW); no mine site sources of sediment identified. Monitoring results back within trigger limits for August 2021 sample round. No follow up required.
W5	05/01/2021	TSS – 50mg/L (ANZECC criteria)	Elevated TSS associated with high runoff due to rainfall event (79.4mm on 4 January), resulting in mobilisation of sediment in Loders Creek. No

Site	Date	Trigger Limit Breached	Action Taken in Response
			MTW site sources of sediment identified. No follow up required.
W5	15/03/2021	TSS – 50mg/L (ANZECC criteria)	Elevated TSS associated with rainfall event (36.2mm on 14 March), resulting in mobilisation of sediment in Loders Creek. No MTW site sources of sediment identified. Monitoring results back within trigger limits for August 2021 sample round. No follow up required.
W14	05/01/2021	TSS – 50mg/L (ANZECC criteria)	Elevated TSS associated with high runoff due to rainfall event (79.4mm on 4 January). No mine site sources of sediment identified. Upstream sample W29 (which is closer to MTW) indicates source of sediment may be partially attributable to runoff from downstream farming properties. No follow up required.
W14	15/03/2021	TSS – 50mg/L (ANZECC criteria)	Elevated TSS associated with rainfall event (36.2mm on 14 March), resulting in mobilisation of sediment in Doctors Creek. No mine site sources of sediment identified. Upstream sample W29 (which is closer to MTW) indicates source of sediment may be partially attributable to runoff from downstream farming properties. No follow up required.
W14	25/08/2021	TSS – 50mg/L (ANZECC criteria)	Elevated TSS associated with rainfall event (31.4mm on 24 August), resulting in mobilisation of sediment in Doctors Creek. No mine site sources of sediment identified. Upstream sample W29 (which is closer to MTW) indicates source of sediment may be partially attributable to runoff from downstream farming properties. No follow up required.
W15	05/01/2021	TSS – 50mg/L (ANZECC criteria)	Investigation undertaken. Note: Elevated TSS results most likely attributable to high runoff due to rainfall event (79.4mm on 4 January), resulting in mobilisation of sediment in Loders Creek. In addition, TSS results were potentially affected by turbid water associated with the overtopping of one mine water dam at MTO and several MTCL dams/catchment basins which were reported to EPA and DPE.
W15	15/03/2021	TSS – 50mg/L (ANZECC criteria)	Elevated TSS associated with rainfall event (36.2mm on 14 March), resulting in mobilisation of sediment in Loders Creek. No mine site sources of sediment identified. Monitoring results back within trigger limits for August 2021 sample round. No follow up required.
W27	05/01/2021	TSS – 50mg/L (ANZECC criteria)	Investigation undertaken. Note: Elevated TSS results most likely attributable to high runoff due to rainfall event (79.4mm on 4 January). In addition, TSS results were potentially affected by turbid water associated with the overtopping of an MTW mine water dam as a result of the rainfall event which was reported to EPA and DPE.
W27	25/08/2021	TSS – 50mg/L (ANZECC criteria)	Watching Brief* Elevated TSS results most likely attributable to high runoff due to rainfall event (31.4mm on 24 August). Note: location was too shallow to sample in March 2021 sample round.
W28	05/01/2021	TSS – 50mg/L (ANZECC criteria)	Investigation undertaken. Note: Elevated TSS results most likely attributable to high runoff due to rainfall event (79.4mm on 4 January). In addition, TSS results were potentially affected by turbid water associated with the overtopping of MTW

Site	Date	Trigger Limit Breached	Action Taken in Response
			sediment dams as a result of greater than design rainfall, which were reported to EPA and DPE.
W28	15/03/2021	TSS – 50mg/L (ANZECC criteria)	Elevated TSS associated with rainfall event (36.2mm on 14 March). No mine site sources of sediment identified. No follow up required.
W28	25/08/2021	TSS – 50mg/L (ANZECC criteria)	Elevated TSS associated with rainfall event (31.4mm on 24 August). No mine site sources of sediment identified.

* = Watching brief established pending outcomes of subsequent monitoring events.



Note: Missing data indicates that there was insufficient water to take a sample, or that there was no safe access.

FIGURE 27: WATERCOURSE PH TRENDS 2018 TO 2021

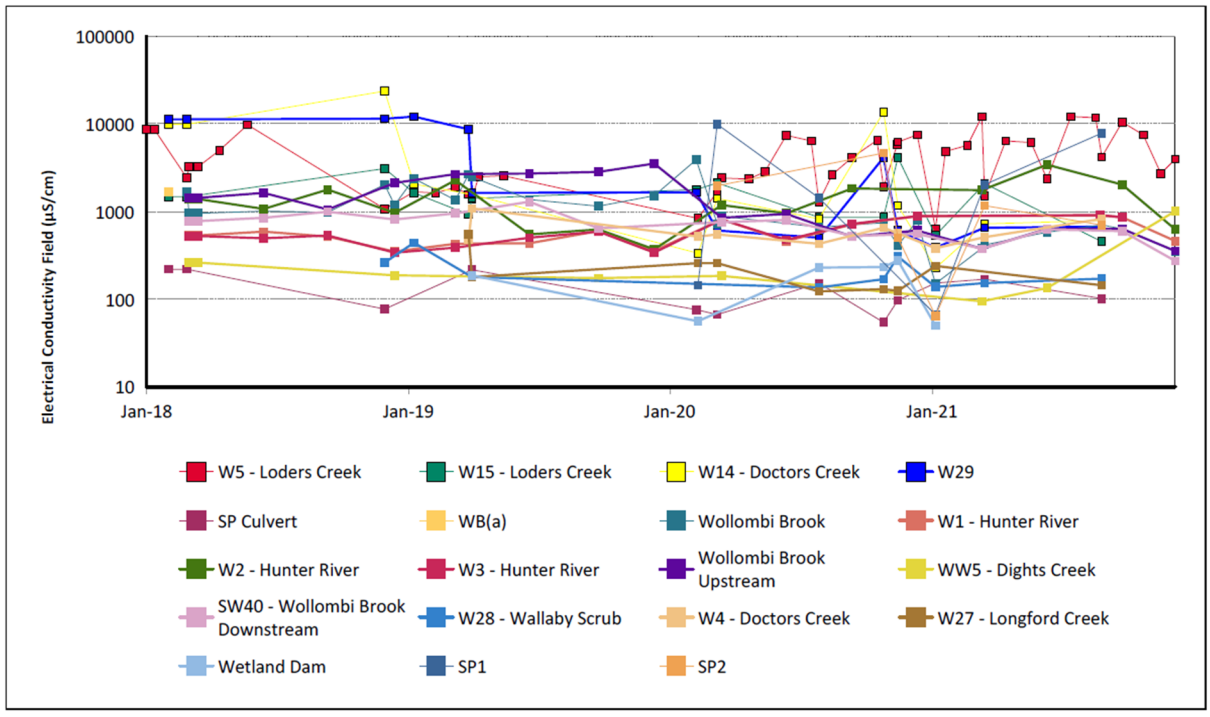


FIGURE 28: WATERCOURSE EC TRENDS 2018 TO 2021

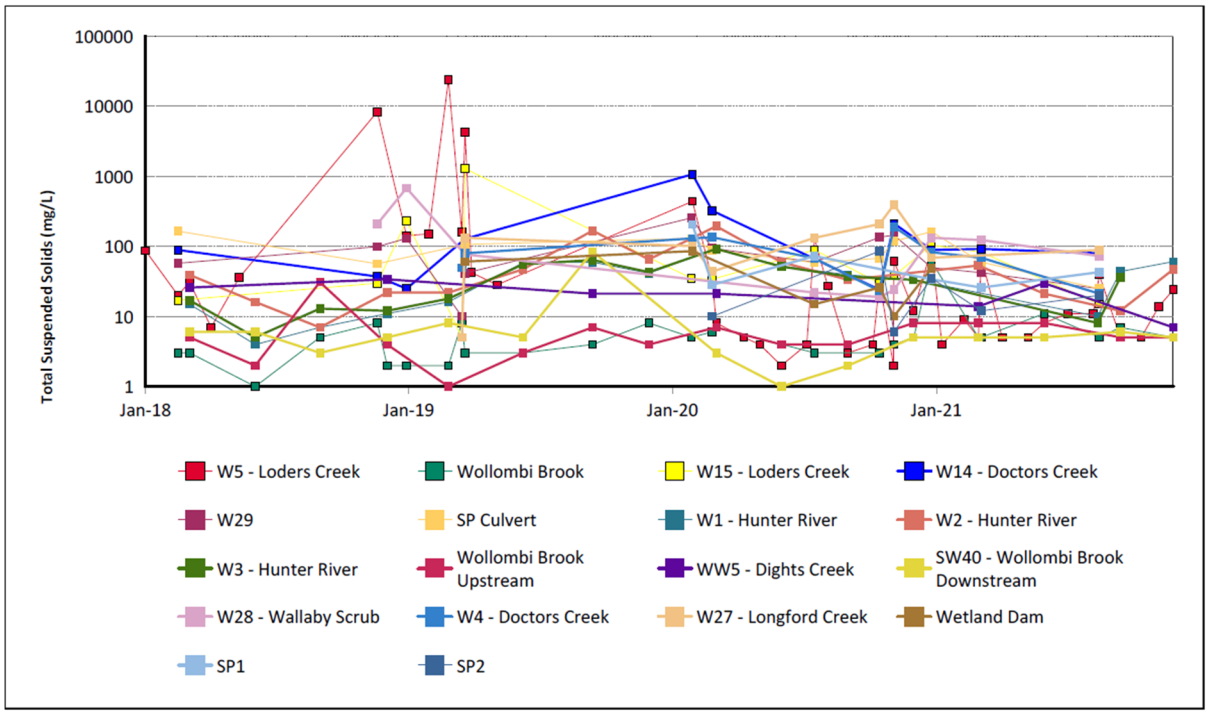


FIGURE 29: WATERCOURSE TSS TRENDS 2018 TO 2021

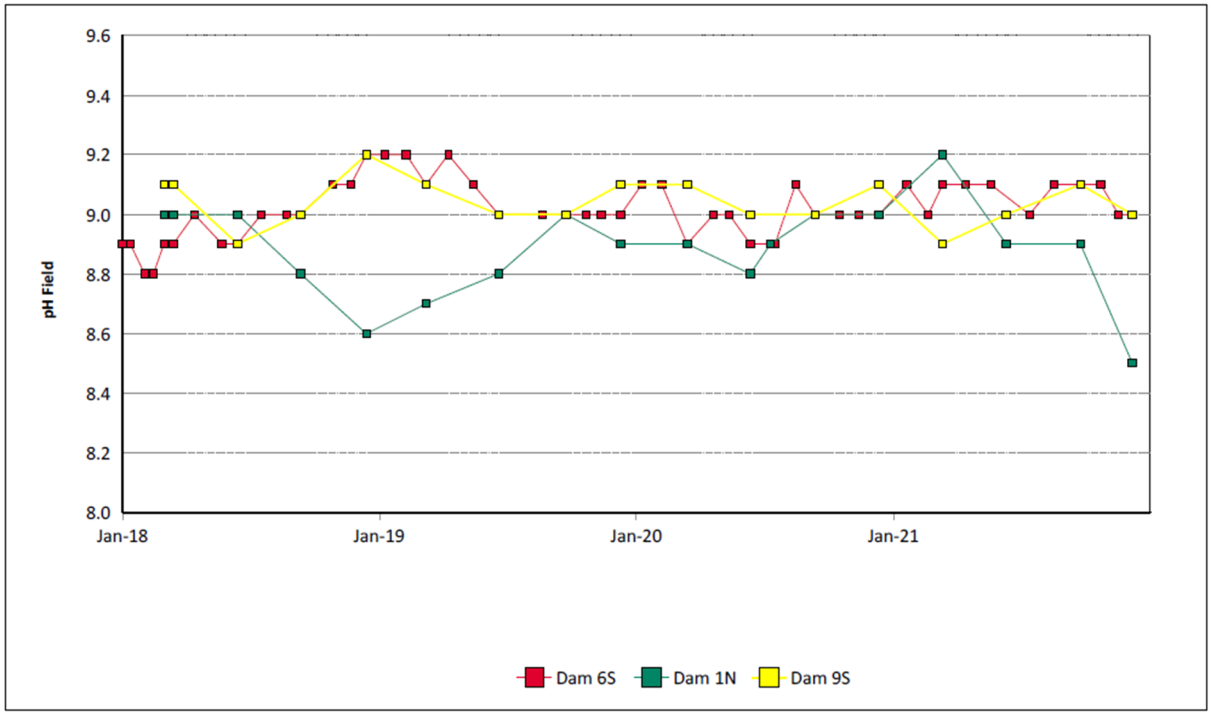


FIGURE 30: SITE DAMS PH TRENDS 2018 TO 2021

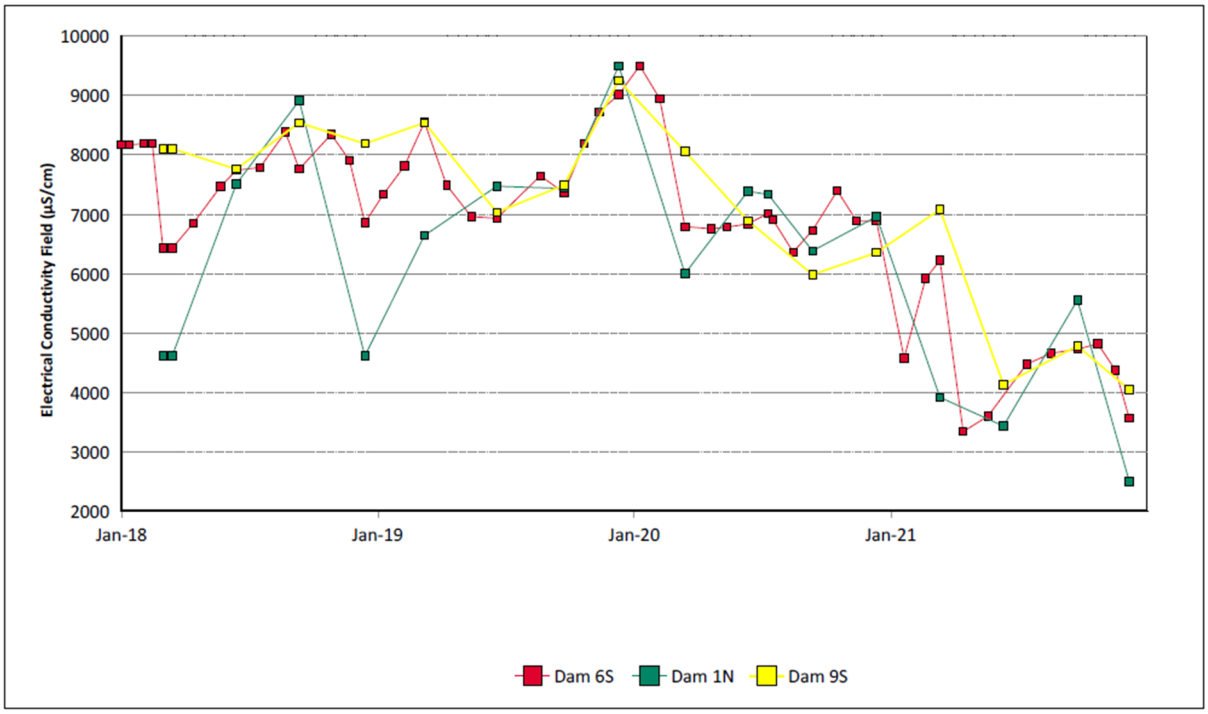


FIGURE 31: SITE DAMS EC TRENDS 2018 TO 2021

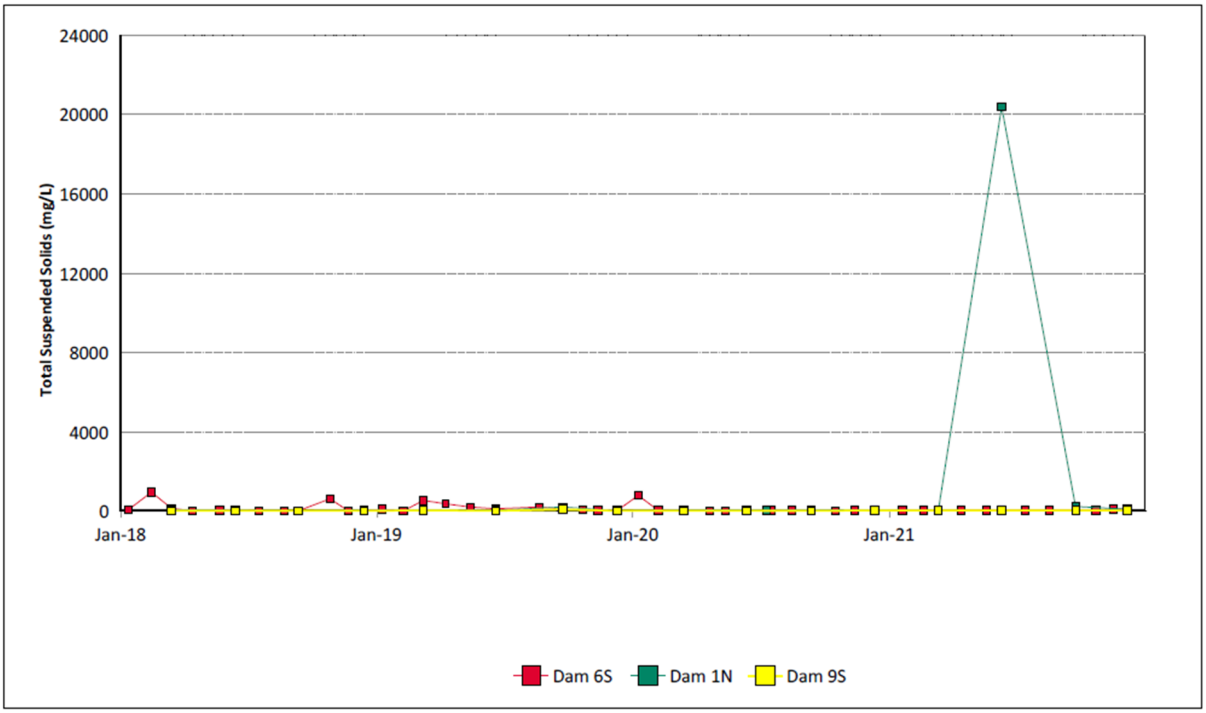


FIGURE 32: SITE DAMS TSS TRENDS 2018 TO 2021

6.7.4.1 Stream Health and Channel Stability

A programme to monitor and report on the stream and riparian vegetation health in Loders Creek and Wollombi Brook which may be potentially affected by the development commenced in 2016. The monitoring programme has previously been conducted in conjunction with a similar programme managed by Bulga Surface Operations.

The annual monitoring program includes the following:

- Documenting locations and dimensions of significant erosive or depositional features;
- Photographs upstream, downstream, at both the left and right banks;
- Rating the site with the Ephemeral Stream Assessment protocol developed by the CSIRO to assess the erosional state of the creek at the monitoring location (a measure of channel stability);
- Rating the site with the Rapid Appraisal of Riparian Condition (RARC) protocol developed by Land & Water Australia. This assesses the ecological condition of riparian habitats using indicators that reflect functional aspects of the physical, community and landscape features of the riparian zone (a measure of stream health); and
- Taking measurements of the channel cross-sections (transects) for comparison purposes for any future monitoring.

A copy of the annual stream health and stability monitoring report is provided as **Appendix 4**. This round of monitoring was subjected to a wetter year than the previous rounds of monitoring and that was reflected by an increase in vegetation growth. MTW advised that there has been 703.43ML discharged from the MTW discharge point between January and November 2021. There has been 736 mm of rainfall recorded within the on-site rainfall gauge for the period January to Mid-November 2021. In comparison, the Bureau of Meteorology shows 843 mm of rainfall recorded at Singleton (Singleton Defence AWS 61430) for the same period.

The results of this monitoring survey indicate that both stream health and channel stability fluctuate over different sections of Loders Creek. The survey identified that some sections of Loders Creek are currently eroding and are vulnerable to further erosion with areas of significant erosion observed. These areas are generally associated with exposed dispersive sub-soils, which hamper vegetation establishment by the development of a hard surface crust when the soil is dry, and the 'melting' nature of the soil when wet.

The survey identified that the majority of Loders Creek displayed stable environments. Generally, the monitoring identified that the creeks have not significantly changed from what was observed during the 2020 survey. Many sections of the creek experience active erosion as a result of natural influences as well as the increased rainfall experienced in the region since 2020. An additional erosion point LC14 was identified during the 2021 survey. This erosion was most likely caused by cattle grazing in the area.

As outlined in the report, stream health and channel stability monitoring results in 2021 indicated that channel stability in Wollombi Brook had remained generally the same as the previous year's

monitoring cycle conditions and that the majority of Loders Creek displayed stable environments. Generally, the monitoring identified that both creeks have not significantly changed from what was observed during the previous survey.

6.7.5 Groundwater Management

Groundwater monitoring activities were undertaken in 2021 in accordance with the MTW Water Management Plan and groundwater monitoring program. The monitoring results are used to establish and monitor trends in physical and geochemical parameters of surrounding groundwater potentially influenced by mining.

The groundwater monitoring program at MTW measures the quality of groundwater against background data, EIS predictions and historical trends. Groundwater quality is evaluated through the parameters of pH, EC, and standing water level. A comprehensive suite of analytes are measured on an annual basis, including major anions, cations and metals. MTW modified its groundwater sampling methodology during the reporting period following a recommendation in the 2018 annual groundwater review undertaken by an independent groundwater consultant. Accordingly bore purging is undertaken across the monitoring network for routine samples (where infrastructure allows) to ensure a representative sample is collected in accordance with industry standards.

Groundwater monitoring data is reviewed on a quarterly basis. The review involves a comparison of measured pH and EC results against internal trigger values (5th and 95th percentile) which have been derived from the historical data set. The response to results outside the trigger limits is detailed in the MTW Water Management Plan.

The monitoring locations are shown in **Figure 33** and the annual Ground Water Review report can be found in **Appendix 5.**

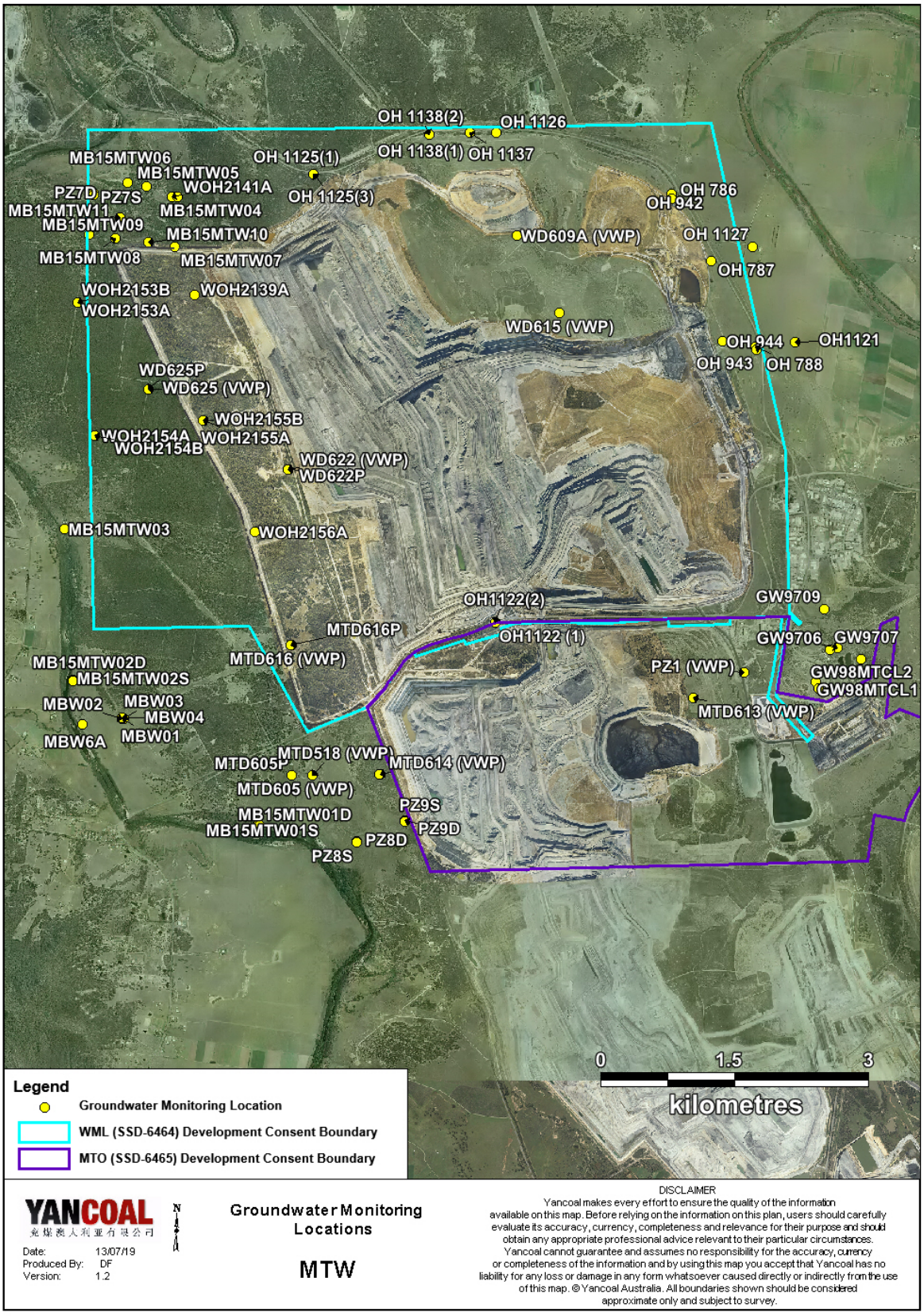


FIGURE 33: GROUNDWATER MONITORING NETWORK AT MTW IN 2021

6.7.6 Groundwater Performance

Sampling of ground waters was carried out on 271 occasions from 61 bores across MTW in accordance with AS/NZS 5667.6 (1998). Where laboratory analysis was undertaken, this was performed by a NATA accredited laboratory. Groundwater sampling and analysis was undertaken as required with the following exceptions detailed in **Table 6.15**.

TABLE 6.15 MTW WATER MONITORING DATA RECOVERY FOR 2021 (BY EXCEPTION)

Location	Data Recovery (%)	Comment
PZ7S	75%	No safe access in February.
PZ9S	25%	Insufficient water for sampling in February, May and September.
GW98MTCL2	75%	Sampling unable to be completed in April due to blocked bore.
OH1121	50%	No safe access in April and December.
OH1125 (3)	75%	Insufficient water for sampling in November and December.
OH1137	50%	Insufficient water for sampling in April and June.
WOH2156B	0%	Insufficient water for sampling in 2021
OH943	50%	Insufficient water for sampling in April and June.

6.7.7 Annual Ground Water Review

Groundwater monitoring results are reviewed against the approved trigger limits within MTW's approved Water Management Plan on a quarterly basis by MTW. A comparison of the water quality information across MTW's monitoring bore network is provided graphically in **Appendix 5.** The approved trigger limits are based on the historical water quality data as shown in the relevant site Environmental Impact Assessments. These trigger limits are updated annually based on collected site data as described in the MTW Water Management Plan. A summary of the management actions taken in response to any exceedances of the trigger limits during the period is provided in the Monthly Environmental Monitoring Reports, available via MTW's website (https://www.mtwcoal.com.au/).

An annual groundwater review was undertaken by an independent groundwater consultant. The scope of the review included an assessment of the water quality and groundwater levels recorded

during the 2021 reporting period as well as a review of the historical results against the predictions in the site groundwater model. A copy of the full report is included in **Appendix 5.**
Key findings from the independent groundwater consultant's report were:

- Groundwater level in coal seams in the western down-dip depressurised zone generally declined or remained stable during the 2021 monitoring period. The exception being OH1125(3) in the Bowfield coal seam which increased until-mid 2021 before declining rapidly in September.
- Excepting PZ9D which was stable, groundwater level in shallow overburden monitoring bores underlying the Wollombi Brook alluvium and Warkworth Sands increased gradually during the 2021 monitoring period. Minimal interaction between the Wollombi Brook alluvium and the shallow overburden is evident.
- Groundwater level in coal seams eastward and up-dip of mining recorded variable results during 2021. Bayswater monitoring bores were stable, whilst groundwater levels in Vaux seam bores increased during the monitoring period.
- Groundwater level in Hunter River alluvial bores were stable during 2021. The exception being OH786 which recorded fluctuating groundwater levels. Monitoring bore OH944 was dry throughout the 2021 monitoring period.
- Groundwater level in Wollombi Brook Alluvium monitoring bores increased or remained stable during the year. Groundwater level in PZ8S increased throughout the 2021 monitoring period, correlating strongly with the CRD, indicating no mining related impacts. Excepting a decrease in June, groundwater level in PZ9S has been relatively stable since June 2020.
- Groundwater level in Warkworth Sands monitoring bore PZ7S increased during the 2021 monitoring period, this is likely due to increased rainfall in the region in 2020 and 2021, indicated by an increasing CRD.
- Various pH trigger exceedances were recorded in bores in the Western depressurized zone; Wambo seam bores WOH2154B (in February and May) and WD622P (in February); Blakefield seam bore WOH2139A (in February, May, October and November) and Woodlands Hill seam bore WD625P (in August).
- Multiple pH trigger exceedances were recorded in shallow overburden monitoring bores underlying Wollombi Brook Alluvium and Warkworth Sands. These include three consecutive trigger exceedances in PZ7D (in May, August and November), four consecutive exceedances in MB15MTW01D (February, May, August and November), PZ9D (in April) and MB15MTW03 (in November).
- Three pH trigger exceedances were recorded in shallow overburden monitoring bore MTD616P (in February, May and November). Two groundwater EC exceedances were recorded in shallow overburden monitoring bore MTD605P (in May and November).
- Two bores eastward and up-dip of mining at MTW recorded pH trigger exceedances during the 2021 monitoring period. These were Bayswater coal seam bore GW98MTCL2 (in June) and Warkworth seam bore OH1138(1) (in January, February, March, April, June and August).
- One pH exceedance was recorded in Hunter River Alluvium bore OH788 (in September) during 2021. Several EC trigger exceedances were also record in Hunter River alluvial bores, OH787 (in April, June and September), OH788 (in June and September) and OH943 (September and December).
- Wollombi Brook Alluvium bore PZ7S recorded a single EC trigger exceedance (in August) during the 2021 monitoring period. No investigation was undertaken as consecutive exceedances were not recorded.

- VWP sensors installed into the Bayswater coal seam recorded varied results during the 2021 monitoring period. Sensor in WD625, MTD616 and MTD605 recorded decreasing pressure heads throughout the year; pressure heads in WD615 and MTD613 increased. Pressure head in the Bayswater seam at WD622 was stable during 2021.
- VWP pressure head in sensors installed into the Mt Arthur coal seam decreased during the 2021 monitoring period. The exception being sensors in WD625 and WD622 in which pressure head was stable throughout 2021. Data in MTD614 Mt Arthur sensor is erroneous and should be inspected.
- Sensors installed into Woodlands Hill coal seam recorded decreasing or stable pressure heads during the 2021 monitoring period.
- Excepting the sensor in MTD518 in which pressure head increased, Wambo coal seam VWP sensor pressure heads decreased throughout the year.
- VWP pressure heads recorded in Vaux coal seam VWP sensors varied in 2021. Sensors installed in WD625 and WD622 were stable, whilst, sensors installed in MTD616 and MTD605 decreased during the monitoring period. The sensor in MTD614 has recorded erroneous data and should be inspected.
- Whybrow coal seam VWP sensor pressure heads increased during the 2021 monitoring period. The exception being the sensor at MTD614 which recorded stable pressure head during the year.
- VWP pressure heads in the Glen Munro seam (at MTD614) and Piercefield seam (at WD615) were stable during the 2021 monitoring period. Blakefield seam sensor at MTD605 recorded decreasing pressure head throughout the year. MTD614 sensor in Bowfield seam recorded erroneous data and should be inspected.
- Observed groundwater level trends generally correlate with modelled predictions. The exceptions being Blakefield seam bore OH1122(1) in which observed groundwater levels are >35m higher than model predictions, a weak correlation between modelled and observed level data in Bowfield seam monitoring bores and GW98MTCL2 with differences between observed data and modelled data >10 m. There is no modelled data for bores constructed after 2015.

Key recommendations from the independent groundwater consultant's report include:

- Calibration factors for VWP PZ1 should be determined so that pressure head trends can be discussed in future annual reviews;
- Cable/wire connections to VWP logger boxes should be inspected at VWP MTD616 (sensor at 383 m) and MTD605 (sensor at 429 m) to determine if erroneous data is due to a poor connection;
- Mount Arthur and Vaux seam VWP sensor cables should be inspected in MTD614 for damage to determine if erroneous data is due to a poor connection to the logger;
- pH trigger exceedance investigations should be undertaken for WOH2139A, PZ7D, OH1138(1) and OH787 as they recorded three consecutive pH exceedances in 2021; and
- The groundwater model should be updated to incorporate newly constructed monitoring installations and to better model existing monitoring installations.

MTW will assess and progress the recommendations of the groundwater consultant for the 2021 reporting period including completion of investigation into instances of trigger exceedances, as per MTW's Water Management Plan.

6.7.8 Compensatory Water Supply

Under the *Water Management Act 2000*, there are three types of basic landholder rights in NSW:

- **Domestic and stock rights** - Owners or occupiers of land overlaying an aquifer or with river, estuary or lake frontage can take water without a licence for domestic (household) purposes or for stock watering.
- **Harvestable rights** - Harvestable rights allows landholders to capture and store a proportion of the rainfall runoff from their landholding in one or more harvestable rights dams without requiring a water access licence, water supply work approval, or water use approval.
- **Native title** - Anyone who holds native title with respect to water, as determined under the Commonwealth Native Title Act 1993, can take and use water for a range of personal, domestic and non-commercial purposes.

MTW is required by development consent conditions to provide compensatory water supply to the owner of any privately owned land whose basic landholder water rights (as defined in the *Water Management Act 2000*) are adversely and directly impacted as a result of the development.

During the 2021 reporting period there was no need for compensatory water supply to be provided to others as a result of the development.

6.8 Waste

6.8.1 Management

The management of waste generated on the MTW site is undertaken in accordance with the site MTW non-mineral waste management strategy which is designed to;

- track and record all wastes leaving the site to meet all regulatory requirements; and
- implement appropriate segregation, collection, handling, transport and disposal of waste in a way which minimises the impacts on the environment.

All waste not suitable for reuse on site is removed by a licensed waste contractor and disposed of or recycled accordingly at licensed waste management facilities within the local Hunter region. Appropriate segregation is implemented across various waste streams at MTW to maximise diversion from landfill and minimise the impact to the environment by recycling or reuse. Some waste categories are processed and disposed of on the MTW site, as per NSW EPA exemption approvals, set out in the MTW Environment Protection Licenses. The effluent treatment and disposal facilities at MTW consist of sewage treatment plants which treat, disinfect and dispose, or re-use the treated effluent on site. All waste management contractors engaged for waste collection, handling and transportation at MTW are licensed by the NSW EPA.

6.8.2 Performance

During the reporting period MTW continued to undertake regular inspections of areas where wastes are generated and stored, to reinforce the principles of a considerate waste management approach including waste stream segregation to increase material recycling and promote diversion from landfill. In 2021 76% of all non-mineral waste generated and removed from MTW was diverted from landfill and processed at licensed recycling and secondary use facilities. The remaining 24% was disposed of as end-of-life waste at a local licensed landfill facility. There were no community complaints or regulatory non-compliance notices receiving in 2021, in relation to waste management during the reporting period.

7 REHABILITATION

7.1 Summary of Rehabilitation

A total of 44.6ha of new rehabilitation was undertaken during 2021 against a Mining Operations Plan (MOP) target of 35.0ha. A further 59.1ha of Stage 2 rehabilitation was seeded to the target vegetation community seed mixes in 2021 to further reduce the legacy rehabilitation areas that are in the Growth Medium Development phase.

Total disturbance undertaken during 2021 was 53.7ha, which was higher than the MOP projection of 40.6ha. The disturbance during 2021 was made up of 47.2ha of new disturbance and 6.5ha of disturbance of previously rehabilitated area.

TABLE 7.1 KEY REHABILITATION PERFORMANCE INDICATORS

Mine Area Type	Previous Reporting Period (Actual) Year 2020 (ha)	This Reporting Period (Actual) Year 2021 (ha)	Next Reporting Period (Forecast) Year 2022 (ha)
A. Total mine footprint[1]	3,934.1	3,982.9	4,025.4
B. Total Active Disturbance[2]	2,601.3	2,601.5	2,684.0
C. Land being prepared for rehabilitation[3]	104.9	57.0	20.0
D. Land under active rehabilitation[4]	1,227.9	1,324.4	1,321.4
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 DRE 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 stockpiles areas, access tracks and haul road, 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 DRE 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 DRE MOP/RMP Guidelines – "ecosystem and land use establishment" 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 DRE that the area has successfully met the rehabilitation land use objectives and completion criteria.*

7.1.1 Management of Rehabilitation

Performance criteria for each rehabilitation phase is provided in detail in the MOP for MTW. The criteria have been developed so that the rehabilitation success can be quantitatively tracked as it progresses through the phases outlined below:

- Stage 1 – Decommissioning
- Stage 2 – Landform Establishment
- Stage 3 – Growth Medium Development
- Stage 4 – Ecosystem and Land use Establishment
- Stage 5 – Ecosystem and Land use Sustainability
- Stage 6 – Rehabilitation Complete

The performance criteria are objective target levels or values that can be measured to quantitatively demonstrate the progress and ultimate success of a biophysical process. A monitoring methodology has been developed to measure the performance criteria outlined in the MOPs utilising a combination of tools that provide quantitative data to assess changes occurring over time.

The target levels or values have been based on monitoring results from reference sites and were detailed in the MOP Amendment A approved by Resources Regulator in December 2018. The results of the rehabilitation monitoring programme for native vegetation areas are compared against the target levels to determine if rehabilitation has been successful or if additional intervention is needed.

Monitoring of rehabilitated land returned to native vegetation commenced in 2015. The results of this monitoring and monitoring programs conducted in 2017 and 2019 have been presented in previous MTW Annual Reviews (AR's). Monitoring has been conducted across 12 reference sites within two vegetation communities Central Hunter Grey Box-Ironbark Woodland EEC, and Ironbark-Spotted Gum-Grey Box Forest EEC. Previous monitoring programs have established 50 permanent monitoring transects across MTW rehabilitation areas with the majority of these sites having been revisited in successive years to provide information on the progression of sites over time. Sites have been selected to include rehabilitation of varying ages and different rehabilitation methods.

Monitoring of rehabilitated land was undertaken in 2021 and the results are presented in **Appendix 6**. During the 2021 monitoring program, monitoring of the six Central Hunter Ironbark-Spotted Gum-Grey Box Forest EEC reference sites has been discontinued as the target vegetation community for the rehabilitated mined land is the Central Hunter Grey Box-Ironbark Woodland EEC. The six Central Hunter Grey Box-Ironbark Woodland EEC reference sites continue to be monitored to allow comparisons to be made with the rehabilitation sites.

The 2021 monitoring program targeted 69 sites, including:

- Six Central Hunter Grey Box-Ironbark Woodland reference sites;
- 32 previously established Woodland – EEC rehabilitation sites;

- 26 newly established Woodland – EEC rehabilitation sites; and
- Five previously established Woodland – Other rehabilitation sites.

The key issues affecting successful rehabilitation at MTW and the control measures implemented to address these issues are listed below:

Issue 1 – Weed competition affecting native vegetation establishment.

Control Measures.

Use of mine spoil as growth medium to avoid use of weedy topsoils in rehabilitation. This technique has proven successful in establishing diverse native vegetation when combined with the use of composts and other ameliorants to improve the physical, chemical and nutritional quality of the mine spoil. Suitable alternative compost products have been sourced and used since 2019 in place of the Mixed Waste Compost, which was banned from use by the EPA in 2018.

Weed control on topsoil stockpiles.

Topsoil stockpiles established prior to 2011 were seeded with exotic pasture species to provide a suitable cover for erosion protection. These competitive exotic species are causing weed problems in rehabilitation areas when the soil from these stockpiles is used on areas being returned to native vegetation. MTW has a topsoil stockpile maintenance program in place to spray out the exotic pasture species and sow native species on these old stockpiles. Stockpiles may require a number of weed control passes to adequately reduce weed levels before sowing to native species. New topsoil stockpiles are being treated in much the same way as new rehabilitation areas, in terms of weed control and soil amelioration, before being sown to native species. Establishment of native species on topsoil stockpiles will reduce the presence of weeds and provide a soil seed bank in rehabilitation areas that contains seeds from desirable native species.

Pre- and post-sowing weed control in rehabilitation.

MTW has implemented an extensive weed control program in rehabilitation areas to reduce the amount of weeds and assist the establishment of native vegetation. This program involves the use of boom sprays for both pre-sowing and pre-emergent spray passes to control weeds volunteering from the topsoil. After the native species have germinated, a weed-wiper can be used to control weeds that are taller than the native species. Herbicide can be wiped onto the taller weeds without affecting the emerging native species. Crews using backpack sprays and Quikspray units are also used to selectively control weeds that are growing amongst desirable native species.

Issue 2 – **Topsoil/spoils prone to dispersion leading to surface crusting, erosion and poor vegetation establishment.**

Control Measures.
Addition of ameliorants to topsoil/spoil. MTW conducts soil testing on the topsoil/spoil material that is used in rehabilitation areas. Based on the results of the soil testing, ameliorants such as compost, gypsum, lime and fertilisers are then used to address the physical, chemical and nutritional deficiencies of the topsoil/spoil. Subsequent applications of ameliorants are undertaken as required to address poor performing rehabilitation areas with continuing soil quality issues.

Issue 3 – Lack of native seed in topsoil seed bank leading to poor vegetation establishment.

Control Measures.
Sourcing of diverse native seed mixes. MTW has generally found that the soil seed bank in topsoils from both stripping areas and topsoil stockpiles cannot be relied on to contain sufficient native seed propagules for successful native vegetation establishment in rehabilitation. MTW has established medium term contracts with seed suppliers to provide some security of supply to suppliers who are then able to collect and store sufficient quantities of seed to meet MTW's future demands. The seed supply contracts include quality assurance controls to ensure the seed being purchased is of suitable quality i.e. satisfactory provenance, correct species, high seed count and viability.

7.2 Decommissioning

Capping of the Interim Tailings Storage Facility continued during 2021 using breaker rock from the South CHPP. A capping of inert spoil will be placed over the breaker rock before rehabilitating the area.

During 2017, capping of Tailings Dam 2 commenced using small contractor-owned equipment to place selected mine spoil in layers across the tailings dam surface. Capping work was suspended during 2017 due to settlement cracking occurring in an area where the tailings surface had low strength. Stage 1 capping work was recommenced during 2020 in areas where geotechnical studies identified that the tailings strength was sufficient to support the capping process. The focus of activity during 2021 has been on pumping activities to keep the surface of the tailings storage facility dry. The aim of this work is to increase the strength of the top layer of the tailings to allow the Stage 1 capping work to continue.

7.3 Rehabilitation Performance

Error! Not a valid bookmark self-reference.**Table 7.2** summarises actual rehabilitation and disturbance completed compared with the rehabilitation commitments in the MTW MOP. **Appendix 7** provides the Annual Rehabilitation Report Form, including rehabilitation progress for each domain through the rehabilitation phases.

The area of new and Stage 2 rehabilitation that was sown during the reporting period was 68.7ha above the MOP target for MTW. The area of rehabilitation disturbance was 5ha higher than the MOP target for MTW, leading to a net rehabilitation result for 2021 that was 63.7ha above the MOP commitment. The net rehabilitation result over the MOP period (2015 to 2021) is 442.3ha versus a MOP commitment of 421.9ha, ahead by 20.4ha.

The amount of new disturbance undertaken in 2021 was 8.1ha higher than the MOP projections. The cumulative new disturbance over the period of the current MOP is also 6.1ha higher than the projected disturbance.

The 2021 rehabilitation areas for MTW are shown in **Appendix 8.**

TABLE 7.2 REHABILITATION AND DISTURBANCE COMPLETED IN 2021

MOP	Pit Area	2021 Totals (ha)		Cumulative Totals During MOP Period* (ha)	
		Actual	MOP Commitment	Actual	MOP Commitment
Rehabilitation					
MTW	Mt Thorley	32.2[1]	18.2	183.3	192.8
	Warkworth	71.5[2]	16.8	391.0	355.3
	MTW Total	**103.7**	**35.0**	**574.3**	**548.1**
Rehabilitation Disturbance					
MTW	Mt Thorley	0.3	0.0	53.2	52.8
	Warkworth	6.2	1.5	78.8	73.4
	MTW Total	**6.5**	**1.5**	**132.0**	**126.2**
New Disturbance					
MTW	Mt Thorley	8.3	4.6	43.8	71.9
	Warkworth	38.9	34.5	428.0	393.8
	MTW Total	**47.2**	**39.1**	**471.8**	**465.7**
Net Rehabilitation (Rehabilitation minus Rehabilitation Disturbance)					
MTW	Mt Thorley	31.9	18.2	130.1	140.0
	Warkworth	65.3	15.3	312.2	281.9
	MTW Total	**97.2**	**33.5**	**442.3**	**421.9**

Note: Rehabilitation areas relate to areas at or past the phase of Ecosystem and Landuse Establishment.

** MOP Period is 2015 – 2021*

[1] Includes 10.3ha of Stage 2 Seeding

[2] Includes 48.8ha of Stage 2 Seeding

Progressive rehabilitation commitments are outlined in the Warkworth Continuation 2014 and Mt Thorley Operations 2014 Environmental Impact Statements. These documents modelled a total of 1,103 ha of rehabilitation to be completed by the end of 2017, and a further 505.8ha to be completed by the end of 2023. At the end of the reporting period there had been 1,324.4 hectares of rehabilitation completed across MTW, 221.4ha ahead of the EIS forecast for the end of 2017. At the end of 2021 the cumulative rehabilitation total is 284.4ha behind the EIS forecast for the end of 2023. It is considered unlikely that there will be this amount of rehabilitation available to be completed in the period 2022 to 2023 so the completed rehabilitation at the end of 2023 is expected to be approximately 190ha (12%) less than the EIS forecast.

7.4 Rehabilitation Programme Variations

A MOP extension was submitted during the reporting period which will allow the current approved MOP to cover the transition period to 02 July 2022 for the submission of the Rehabilitation Management Plans required under the new standard conditions for mining leases. The MOP extension included the following changes:

- MOP Plan 3H to provide rehabilitation and mining progression to the end of 2022;
- updated MOP Plan 4 and Plan 5 which included a change to the final landform on Tailings Dam 1 to provide a dump location for material excavated out of the North Out-of-Pit (NOOP) Dam;
- inclusion of Appendix E Seeding Program for Growth Medium Areas; and
- revised Rehabilitation Cost Estimates for Mount Thorley and Warkworth.

7.5 Rehabilitation Trials

Trials were conducted in 2020 to investigate the effect of not adding compost to topsoils. These trials are of particular interest for rehabilitation where topsoil has been used that has a high weed seed load. It is thought that not adding compost to “weedy” topsoils could reduce the growth of competitive weed species and hence result in better establishment of native species. Rehabilitation areas within the trials have received identical treatments apart from the addition of compost to some areas to allow for a comparison of results on composted versus un-composted areas.

The early results indicate that the germination of native species was indeed improved in the areas that didn’t receive compost application. There is a marked increase in the amount in the amount of exotic grass cover in the areas that did received compost application and this is likely to be holding back the germination of native species. These trials will continue to be monitored to determine if the growth rates of the native species is satisfactory in the areas that didn’t receive compost application.

A compost that is produced by Remondis from source-segregated green waste and food waste, without the addition of Biosolids, was used on rehabilitation areas in 2021. This product has also been passed over a 15mm screen at the completion of the composting process, with the +15mm portion being what was spread on rehabilitation areas. This type of compost is lower in nutrients than the

MWOO products and composts that have had Biosolids added during the composting process. It was thought that a lower nutrient compost may be better where there is a risk of a high weed seed load. To date, the Remondis compost has only been used on a spoil/compost area where the native germination results don't appear to be as good as previous spoil/compost areas that had used a compost made with the addition of Biosolids.

Trials will be conducted during 2022 to compare the performance of high and low nutrient composts on both mine spoil and topsoil growth mediums.

7.1 Rehabilitation Maintenance

Management of rehabilitated areas is undertaken as required or when issues are identified through monitoring, auditing or inspections. Rehabilitation maintenance activities are described further in the sections below.

Post rehabilitation broadacre weed control

Broadacre weed treatment within rehabilitation areas is undertaken using agricultural methods comprising boom sprays and wick wipers. In existing rehabilitation areas boom spraying is primarily used to manage cover crop and fallow areas prior to sowing to final native seed mixes. Pre-emergent application of herbicide is occasionally necessary to control emerging weeds in the period between sowing and germination of the desired plants. Wick wiping targets rapidly growing exotic grasses and other erect growing weeds in the period following native germination but while desirable species remain below the wiper target zone. During 2021 areas totalling 117.4ha of existing rehabilitation received boom spray and/or wick wiper treatment.

Hand spraying and manual removal of weeds is also undertaken in rehabilitation areas with establishing native vegetation. During 2021 areas totalling 138.5ha were treated using selective weed control methods (i.e. backpack spray, Quikspray, cut and paint, manual removal). Selective weed control is being used more extensively due to a change in rehabilitation methodology to move more quickly to sowing rehabilitation areas with the diverse native seed mixes.

Rehabilitation areas receiving weed control during 2021 are shown in **FIGURE** 34 below. Note some areas may have received a combination of treatments during the reporting period.

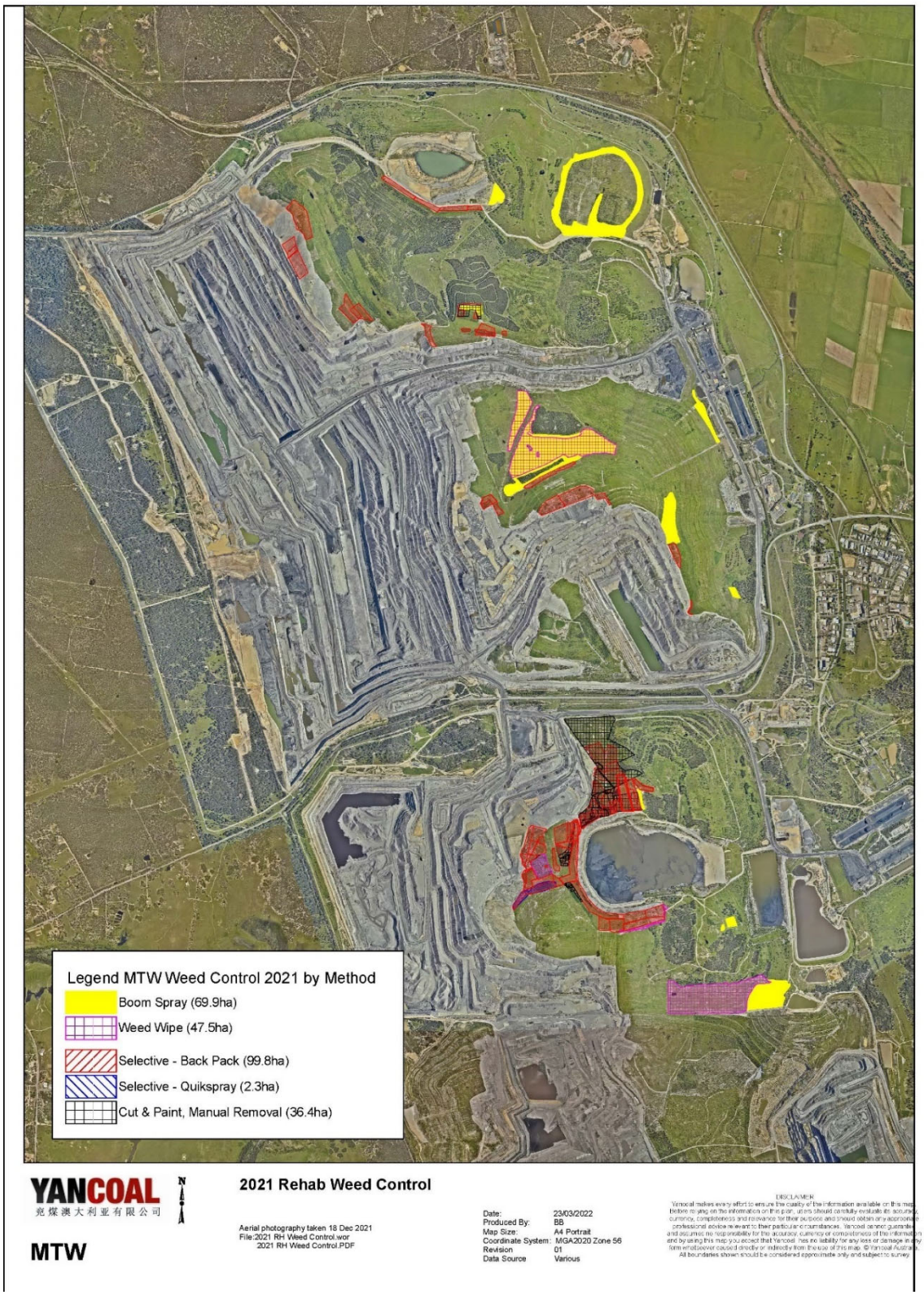


FIGURE 34: 2021 REHABILITATION WEED CONTROL LOCATIONS

7.2 Topsoil Management

Topsoil is managed according to MTW's Disturbance and Rehabilitation procedures. **Table 7.4**outlines the topsoil used and stockpiled during 2021. There was 8.6 ha of rehabilitation top soiled during 2021, using stockpiled and pre-stripped soil resources. The topsoil stockpile inventory updated at the end of 2021 wrote off 37,615m3 of stockpiled topsoil due to poor quality.

TABLE 7.3 SOIL MANAGEMENT

Soil Used this Period (m^3)	Soil Prestripped this Period (m^3)	Stockpile Inventory to Date (m^3)	Stockpile Inventory Last Report (m^3)
8,600	50,207	670,921	666,929

7.3 Tailings Management

Detail of capping activities on tailings storage facilities at MTW is covered in **Appendix 7**. Minimising the amount of standing water on tailings storage facilities, by managing the decant water, is important during and post tailings deposition to assist with closure of these facilities. Effective removal of decant water enables better consolidation of the tailings material, which in turn facilitates earlier capping and rehabilitation of the storage facility. **Table 7.4** outlines the current state of decant water pumping infrastructure across the active and inactive TSF's at MTW.

TABLE 7.4 TAILINGS MANAGEMENT

Facility	Status	Decant System
Centre Ramp TSF	Active	Decant pumps in place, regular pumping
Abbey Green South	Active	Decant pumps installed as required due to infrequent filling regime.
TD2	Inactive (Capping in progress)	Diesel pump in place
Interim TSF	Inactive (Capping in progress)	Floating solar pump installed
Ministrip TSF	Active	Diesel Pump in place, pumping as required
Loders Pit TSF	Active	Tailings deposition commenced in January 2021, decant pumps in place, regular pumping

7.4 Weed Control

7.4.1 Weed Treatment

The weeds identified at MTW occur primarily in areas that have been disturbed such as post mining rehabilitation areas, previous civil works areas, soil stockpiles, water management structure surrounds, and general areas of minor ground disturbance. A total of 97 days of weed management work was undertaken on site at MTW during 2021, with 640 ha of land treated, including maintenance of access tracks and 56 environmental monitoring points. The weeds targeted during the 2021 weed management programme were based on the results of the 2020 weed survey. **Figure 35** illustrates the target species and weed treatment areas across MTW. Weed treatment areas are assessed following the completion of periods of work to determine the effectiveness of control works.

The species focussed on during treatment included:

- African boxthorn *(Lycium ferocissimum)*
- African lovegrass (Eragrostis curvula)
- African olive (Olea europaea)
- Blue heliotrope (Heliotropium amplexicaule)
- Galenia (Galenia pubescens)
- Golden dodder (Cuscuta campestris)
- Inkweed (Phytolacca octandra)
- Lantana (Lantana Camara)
- Mother of millions (Bryophyllum delagoense)
- Narrow leaf cotton bush (Gomphocarpus fructicosus)
- Opuntia (Pear) species (Tiger, Prickly and Creeping Pear)
- Saligna (Acacia saligna)
- St Johns Wort (Hypericum perforatum)
- Various grasses (Various spp)

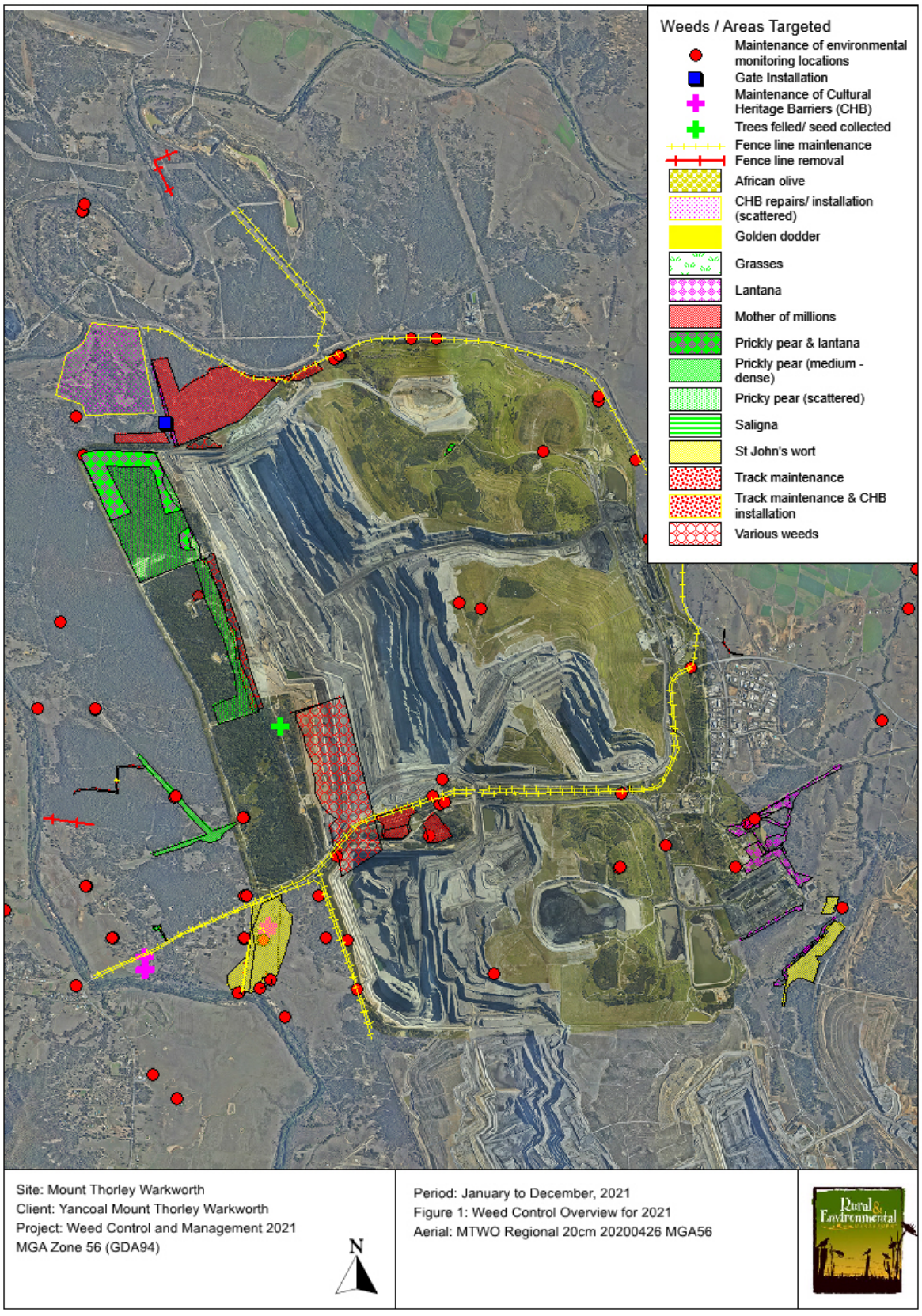


FIGURE 35: ANNUAL WEED CONTROL OVERVIEW FOR 2021

7.4.2 Annual Weed Survey

The management and control of weeds at MTW is governed by the Annual Weed Survey (AWS). The AWS lists Weeds of National Significance (WONS), noxious, environmental and other non-declared weed species identified across MTW and provides a framework to allow for structured weed management and control across operational and non-operational areas of MTW.

The following summarises the results of the weed survey undertaken during December 2021 and is based upon the NSW Biosecurity Act 2015 which came into force from 1 July 2017 and repealed 14 Acts including the Noxious Weeds Act 1993. The new legislation has resulted in the development of the Hunter Regional Strategic Weed Management Plan 2017-2022 which covers the area occupied by MTW.

Six WONS were identified during the survey, they included:

- African boxthorn *(Lycium ferocissimum)* State – Asset protection
- Fireweed *(Scenecio madagascariensis)* State – Asset protection/ Regional – additional species of concern
- Lantana *(Lantana camara)* State – Asset protection

Pear Species:

- Creeping pear *(Opuntia humifusa)* State – Asset protection
- Prickly pear *(Opuntia stricta)* State – Asset protection/ Additional species of concern
- Tiger pear *(Optunia aurantiaca)* State – Asset protection

Fourteen other priority weeds were identified at MTW during the survey, including:

- African olive *(Olea europea subspecies cuspidae)* Regional – Asset protection
- African lovegrass *(Eragrostis curvulva)* Regional – Additional species of concern
- Balloon vine *(Cardiospermum grandiflorum)* Regional – Additional species of concern
- Blue heliotrope *(Heliotropium amplexicaule)* Regional – Additional species of concern
- Castor oil plant *(Ricinus communis)* General biosecurity duty
- Fleabane *(Conyza bonariensis)* General biosecurity duty
- Galenia *(Galenia pubescens)* Regional – Additional species of concern
- Golden dodder (Cuscuta campestris) General biosecurity duty
- Green cestrum *(Cestrum parqui)* Regional - Asset protection
- Mother of millions *(Bryophyllum delagonese)* Regional - Asset protection
- Patersons curse (Echium plantagineum), Regional – Asset protection
- Saffron thistle *(Cartharmus lanatus)* General biosecurity duty
- Scotch thistle (Onopordum acanthium), General biosecurity duty
- St Johns Wort *(Hypericum perforatum)* Regional – Additional species of concern

Thirteen weeds that are not officially declared or listed were also recorded at MTW including:

- Blackberry nightshade *(Solanum nigram)*
- Century plant *(Agave americana)*

- Golden wreath wattle or Saligna *(Acacia saligna)*
- Inkweed *(Phytolacca octandra)*
- Lambs tongue *(Verbascum Thapsus)*
- Mustard weed *(Sisymbrium sp)*
- Narrow leaved cotton bush *(Gomphocarpus fructicosus)*
- Paddy's lucerne (Sida rhombifolia)
- Purpletop / Purple verbena (Verbena bonariensis)
- Rhodes grass *(Chloris gayana Kunth)*
- Stinking Rodger *(Tangetes minuta)*
- Spiny Rush (Juncas acutus)
- Tree Tobacco (Nicotiana glauca)

Species identified during the 2021 survey will form the basis of ongoing weed management works during 2022.

7.5 Vertebrate Pest Management

As part of MTW's Vertebrate Pest Action Plan a baiting programme is carried out on a seasonal basis. Three 1080 ground baiting programmes consisting of approximately 60 bait sites utilising meat baits and ejector baits were undertaken during autumn, winter and spring to target wild dogs and foxes. Baits were checked over a three-week period and replaced each week when taken. The programmes were undertaken in conjunction with neighbouring landholders where possible.

Table 7.5 summarises the results from the programmes carried out at MTW during 2021 with baiting locations and results for the programmes are illustrated in **Figure 37, 37** and **38**.

TABLE 7.5 VERTEBRATE PEST CONTROL SUMMARY

Season	1080 Baiting			
	Total Lethal Baits Laid	Takes by Wild Dog	Takes by Fox	Takes by Feral Pigs
Autumn	129	60	6	1
Winter	116	49	11	2
Spring	119	42	17	11
Total	**364**	**151**	**34**	**14**

Additional pest management programmes included:

- Feral pig 1080 baiting programme carried out across MTW in winter resulted in 4 feral pigs poisoned.

MTW will continue to carry out quarterly vertebrate pest control programmes during 2022 to limit feral pest impacts on landholdings and surrounding neighbours.

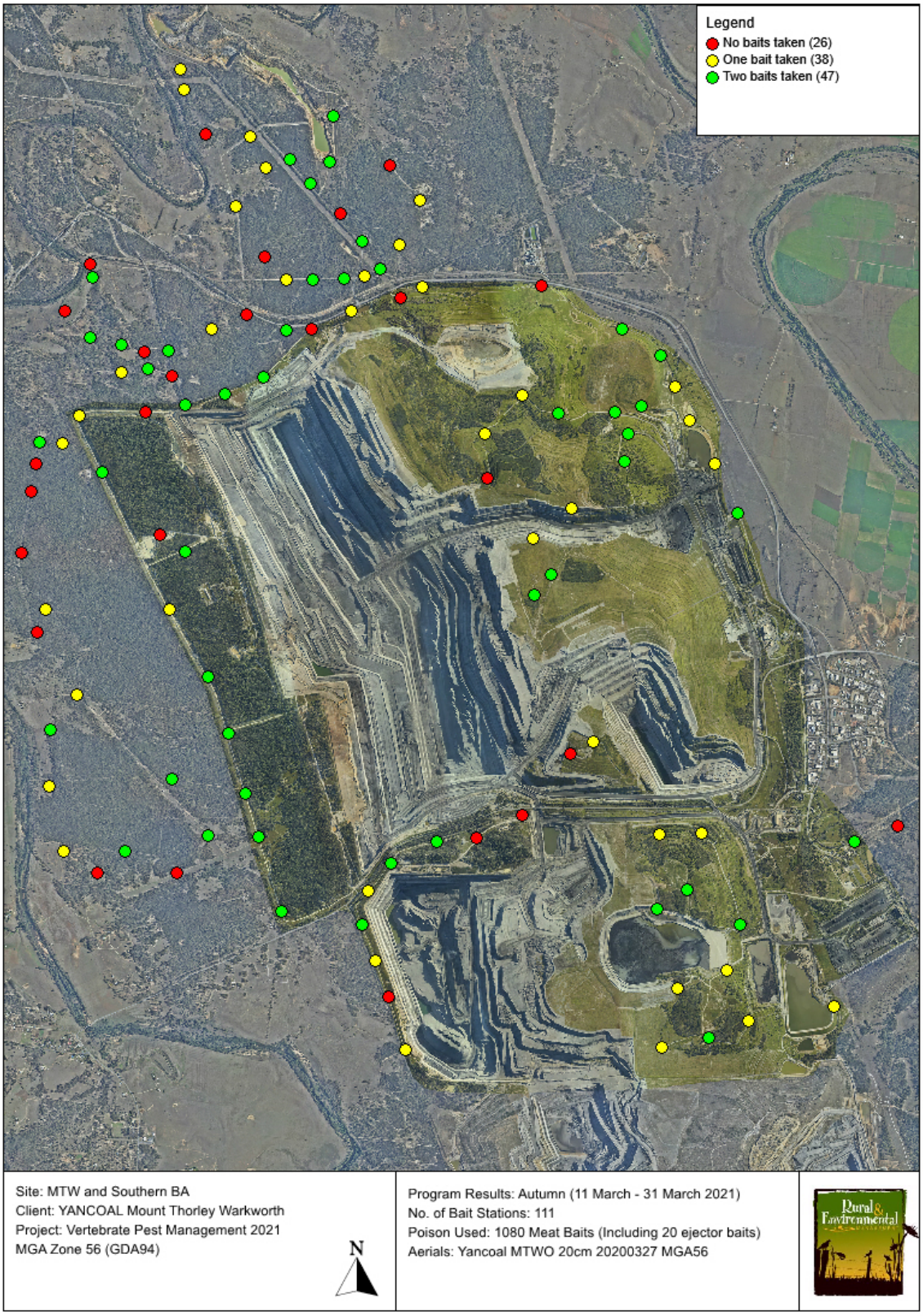


FIGURE 36: BAITING STATION LOCATIONS AND RESULTS AT MTW DURING AUTUMN 2021 VERTEBRATE PEST MANAGEMENT PROGRAMME



FIGURE 37: BAITING STATION LOCATIONS AND RESULTS AT MTW DURING AUTUMN/WINTER 2021 VERTEBRATE PEST MANAGEMENT PROGRAMME

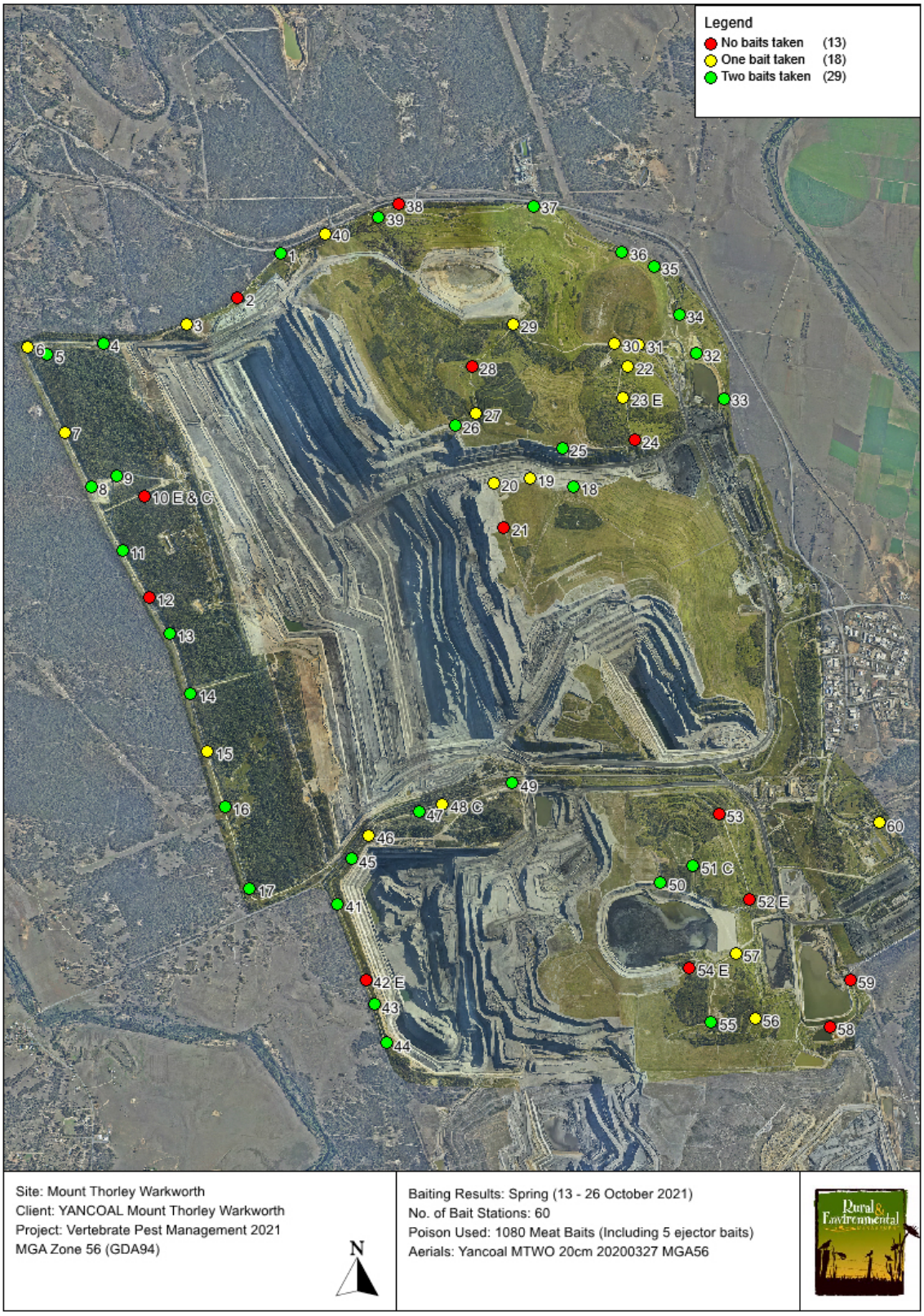


FIGURE 38: BAITING STATION LOCATIONS AND RESULTS AT MTW DURING SPRING 2021 VERTEBRATE PEST MANAGEMENT PROGRAMME

7.6 Biodiversity Offsets

7.6.1 Management

MTW's impacts on biodiversity values are offset through the protection and management of Biodiversity Areas (BAs). The BA's that are related to MTW illustrated in **Figure 39** and also listed in **Table 7.7** below:

TABLE 7.6 MTW BIODIVERSITY AREAS

Biodiversity Areas	Area (ha)	Environmental Approvals				Offset Feature/s
		State		Federal		
		NSW 2014	NSW 2015	EPBC 2002/629	EPBC 2009/5081	
Southern	986	211	775		94	Warkworth Sands Woodland; Central Hunter Grey Box – Ironbark Woodland; Habitat for Swift Parrot, Regent Honeyeater, Southern Myotis and Large-eared Pied Bat.
Northern	341	39	302		341	Warkworth Sands Woodland; Central Hunter Grey Box – Ironbark Woodland; Habitat for Swift Parrot, Regent Honeyeater, Southern Myotis and Large-eared Pied Bat.
North Rothbury	41		41		41	North Rothbury Persoonia
Goulburn River (MTW Portion)	1,066		1,066	1,066		Central Hunter Valley Eucalypt Forest (CHVEF); Ironbark/Stringybark Communities; Box shrubby/grassy Woodlands; Habitat for Swift Parrot and Regent Honeyeater
Bowditch	602		602	520	82	CHVEF; Ironbark/Stringybark Communities; Habitat for Swift Parrot and Regent Honeyeater
Putty	383				383	CHVEF; Habitat for Swift Parrot and Regent Honeyeater
Seven oaks	519				519	CHVEF; Habitat for Swift Parrot and Regent Honeyeater
Condon View (MTW Portion)	345				345	CHVEF; Habitat for Swift Parrot and Regent Honeyeater

The MTW BA's are managed in accordance with site specific Offset Management Plans (OMPs). All of the OMPs are available on MTW's website.

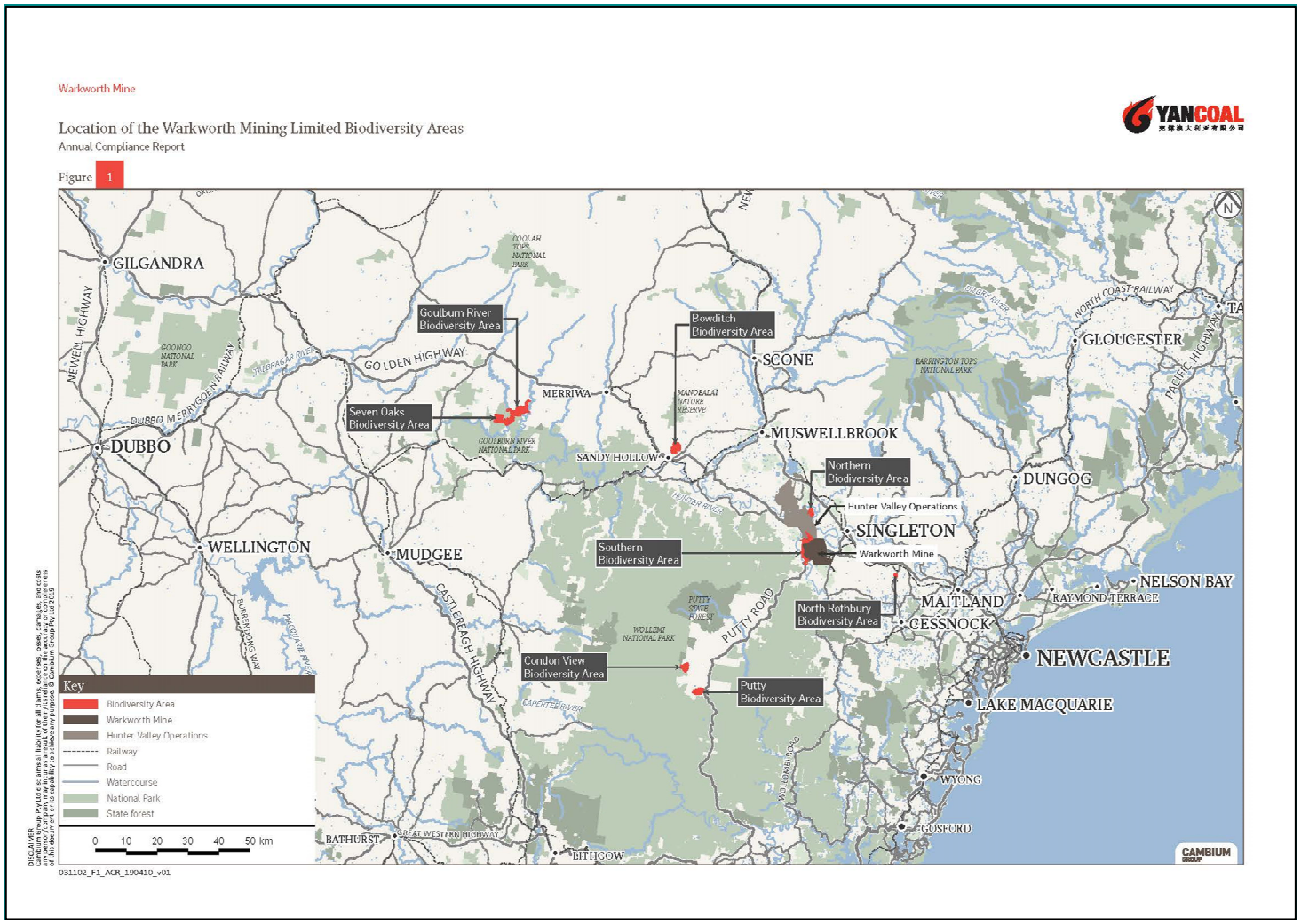


FIGURE 39: MTW BIODIVERSITY OFFSET LOCALITY MAP

7.6.2 Biodiversity Area Management Activities

The OMPs describe the Conservation Management Strategies. The following are the key actions completed throughout 2021 across all the BAs:

7.6.2.1 Weed Control

Weed control at the Local BAs targeted the following species:

- African boxthorn *(Lycium ferocissimum)*
- African lovegrass *(Eragrostis curvulva)*
- Blue heliotrope *(Heliotropium amplexicaule)*
- Coolatai grass *(Hyparrhenia hirta)*
- Farmers friends *(Biden pilosa)*
- Galenia *(Galenia pubescens)*
- Green cestrum *(Cestrum parqui)*
- Lantana *(Lantana camara)*
- Mother of millions *(Bryophyllum delagonese)*
- Paterson's curse *(Echium plantagineum)*
- Prickly pear *(Opuntia stricta)*
- Stinking roger *(Tagetes minuta)*
- Telegraph weed *(Heterotheca grandiflora)*
- Tiger pear *(Optunia aurantiaca)*
- Whisky grass (Andropogon virginicus)
- St Johns Wort (Hypericum perforatum)

Weed control at the Regional BAs targeted the following species:

- Bathurst Burr (Xanthium spinosum)
- Blackberry *(Rubus fruticosus)*
- Blue heliotrope *(Heliotropium amplexicaule)*
- Bridal creeper *(Asparagus asparagoides)*
- Common Thornapple *(Datura stramonium)*
- *Cotton Bush (Gomphocarpus fructicosus)*
- Farmers friends *(Bidens pilosa)*
- Fireweed *(Scenecio madagascariensis)*
- Fleabane *(Erigeron bonariensis)*
- *Giant Parramatta grass (Sporobolus fertilis)*
- *Great Mullien (Verbascum Thapsus)*
- Green cestrum *(Cestrum parqui)*
- Lantana *(Lantana camara)*
- Mallow *(Malva parviflora)*
- Mexican Poppy *(Argemone ochroleuca)*
- Mothvine (Araujia sericifera)

- Narrow leaf cotton bush *(Gomphocarpus fructicosus)*
- Paddy's lucene *(Sida rhombifolia)*
- Prickly pear *(Opuntia stricta)*
- *Purple top (Verbena bonariensis)*
- *Rhodes Grass (Chloris gayana)*
- Scotch thistle *(Onopordum acanthium)*
- *St Barnabys thistle (Centaurea solstitialis)*
- St John's wort *(Hypericum perforatum)*
- Stinking Roger *(Tangetes minuta)*
- Tiger Pear *(Optunia aurantiaca)*
- Tree of heaven *(Ailanthus altissima)*
- Variegated thistle *(Silybum marianum)*

7.6.2.2 Infrastructure Management and Improvement

In 2021 fence repairs were undertaken at the Southern, North Rothbury, Putty and Bowditch BAs. A new 470m section of boundary fence was installed at the Putty BA. Internal fences were removed from the Southern, Northern and Condon View BAs. Track repairs were undertaken in the Southern BA and all tracks were maintained to reduce encroaching vegetation and improve access. Regular property inspections were undertaken on all BAs.

7.6.2.3 Fire Management

Slashing of fire breaks was undertaken on the Southern, Northern and Goulburn River BAs. A Hazard Reduction Burn for North Rothbury BA was approved however weather conditions were outside the prescribed limits, so the burn has been rescheduled for 2022. Overall fuel load assessments were not undertaken in 2021 and have been rescheduled for early 2022.

7.6.2.4 Strategic Grazing

No strategic grazing was undertaken in the BAs in 2021.

7.6.2.5 Vertebrate Pest Management

Three 1080 ground baiting programmes targeting wild dogs and foxes were undertaken across the Local Biodiversity Areas and two 1080 ground baiting programmes were undertaken across the Regional Biodiversity Areas. Baits were checked over a three-week period and replaced each week when taken. Baiting was carried out in autumn, winter and spring and was undertaken in conjunction with neighbouring landholders where possible. **Table 7.7** summarises the results from the programmes during 2021.

TABLE 7.7 SUMMARY OF VERTEBRATE PEST MANAGEMENT 2021

Season	1080 Baiting				
	Total Lethal Baits Laid	Takes by Wild Dog	Takes by Fox	Takes by Feral Pigs	Takes by other/unknown
Autumn (Local BAs)	114	82	16	8	26
Winter (Local BAs)	116	95	19	3	10
Spring (Local BAs)	119	88	28	14	36
Autumn (Regional BAs)	205	55	27	17	9
Spring (Regional BAs)	184	69	39	24	27
Total	**738**	**389**	**129**	**66**	**108**

Additional pest management programmes included:

- A feral pig 1080 baiting and ground shooting program controlled 87 at the Goulburn River BA in March.
- Noisy Miner ground shoot at the Goulburn River BA in August to assist the survivability of the Regent Honeyeater: 230 Noisy Miners controlled over a seven-day programme under Licence to Harm Protected Animals (Biodiversity Conservation Act 2016). This is the fifth consecutive year of this programme making this the longest running and most successful noisy miner management programme in the country. The 2021 programme included the whole BA and monitoring results conclude that ongoing noisy miner management is successfully suppressing noisy miner numbers at the Goulburn River Biodiversity Area.
- A ground shooting program controlled 26 feral pigs in August.
- Opportunistic shooting of other vertebrate pests included two deer, three foxes and one feral cat.
- Aerial shoot conducted by NPWS at the Goulburn River BA in April and October.
- Aerial shoot conducted by HLLS controlled 49 feral pigs at the Goulburn River BA in October.
- The Professional Wild Dog Controller Programme has trapped and euthanised more than 438 problem wild dogs in the four years it has been running. This is a four-year programme with the primary goal to reduce the impacts of wild dog predation on livestock production, the social wellbeing of livestock producers, and native fauna, through professional and targeted control of problem dogs in the Upper Hunter district. A total of 19 wild dogs have been controlled on Yancoal land since July 2017.

Vertebrate pest management programmes will continue to be carried out during 2022 to limit feral pest impacts on landholdings and surrounding neighbours.

7.6.2.6 Seed Collection

Seed collection was undertaken by contractors in the Northern and Southern BA's during 2021, focussing on the WSW, River Oak Forest and Ironbark vegetation community. Seed collection was also undertaken on the Goulburn River BA for Yellow Box – Grey Box – Red Gum grassy woodland and River Oak riparian woodland. Tube stock for 2022 plantings is currently being propagated from the seed collected.

7.6.2.7 Revegetation

MTW has committed to restoring the Endangered Ecological Communities of Warkworth Sands Woodland and Central Hunter Grey Box – Ironbark Woodland in the Southern and Northern Biodiversity Areas. Work commenced in 2014 and overall there is more than 500 hectares of grassland area to be planted and managed over 15 years to restore these Endangered Ecological Communities.

In 2021, restoration work included infill planting Central Hunter Grey Box – Ironbark Woodland and River Oak Forest in the Southern BA with 9,000 tube stock planted into rip lines. Warkworth Sands Woodland planting progressed at the Northern BA with 3,632m³ of WSW sand from ahead of mining at MTW spread into strips and seeded with native grasses to increase the groundcover diversity then planted with 1,500 tubestock.

Infill planting at the Goulburn River Biodiversity area to increase the suitability of habitat for the Regent Honeyeater continued with 12,000 tube stock planted into the cleared areas of Yellow Box – Grey Box – Red Gum Grassy Woodland and riparian woodland areas. Access to the site was restricted again during 2021 due to high river levels, which meant that not all areas could be accessed for infill planting. Supplementary infill planting will continue in 2022.

The next round of planting is planned for spring 2022 and will include 6,000 Warkworth Sands Woodland tubestock in the Northern BA and 4,000 in the Southern BA. Additional infill of the Central Hunter Grey Box – Ironbark Woodland and River Oak Forest planting areas at the Southern BA will continue as required.



FIGURE 40: DRONE IMAGE OF NORTHERN BIODIVERSITY PLANTING AREA



FIGURE 41: IRON BARK WOODLANDS PLANTING STRIP SOUTHERN BIODIVERSITY AREA

7.7 Monitoring Activities

The Local and Regional Biodiversity Areas Annual Compliance Reports respectively (provided in **Appendix 9**) provide a summary of the monitoring activities undertaken, which are consistent with

the requirements of the relevant Biodiversity Management Plans. The sections below provide a summary. Monitoring results for 2021 are also provided in **Appendix 9**.

7.7.1.1 Bird Assemblages Monitoring

Bird assemblage monitoring was not required to be undertaken during 2021. The results from the 2020 bird assemblage monitoring were presented in the 2020 Annual Report for Local Offsets. The next bird assemblage monitoring will occur in 2022.

7.7.1.2 Habitat Restoration Monitoring

The habitat restoration monitoring programme assesses the changes in key attributes within the BA through time as grassland communities are restored to woodland.

Habitat restoration monitoring was not required to be undertaken during 2021. The results from the last round of habitat restoration monitoring conducted in 2020 were presented in the 2020 Annual Report for Local Offsets. A separate monitoring program was undertaken across the Northern BA in Spring 2021 and included an additional eight transitional plots to capture the WSW planting activities undertaken between 2014 - 2021. The monitoring demonstrated that the woodland areas were near benchmark condition however the cleared grasslands still require substantial effort to decrease weed density and increase native species diversity and cover. A combination of weed control, planting, seeding and soil translocation will all be required to improve vegetation condition. The next habitat restoration monitoring will occur in 2022.

7.7.1.3 Rapid Condition Assessments

The Rapid Condition Assessment technique is used as a preliminary assessment of woodland condition within the BA. Each year the sites in mature and regrowth vegetation are revisited to record the presence or absence of key habitat components and threatening processes. The results of the Rapid Condition Assessment, together with property inspection and plot reference points will be used to monitor woodland condition and identify emerging threats. The 2021 monitoring results showed an improvement in woodland conditions across all BAs and supports the continued implementation of the conservation management strategies. Refer to **Appendix 9** for monitoring results.

7.8 Audits and Reviews

The NSW Resources Regulator undertook a Targeted Assessment Program (TAP) at MTW on 18 May 2021 which focused on landform establishment in relation to rehabilitation activities. The recommendations identified in the TAP report will be included in a Rehabilitation Management Plan that will be prepared in accordance with the requirements under the new standard conditions for mining leases and implemented during 2022.

8 COMMUNITY

8.1 Complaints

A total of 177 complaints were recorded during the reporting period, with a decrease of approximately 25% compared to 2020. The 177 complaints were registered by approximately 44 people (some complainants remained anonymous), with just over 66% of complaints received from 9 individuals. Most complaints were received from residents in the Bulga area. A breakdown of complaints by type is shown in **Table 8.1**.

Blasting has emerged as a key concern for near neighbours. Whilst there has been a decrease in complaints regarding blasting by ~15% in comparison to 2020, the highest number of complaints recorded in 2021 were for blasting. Just over 50% of blasting complaints were received from 1 individual.

There has been a trending decrease (overall 56%) in noise complaints from 2019, with a 50% decrease from 2020. The decrease experienced from 2019 is considered partially attributed to routine noise measurements undertaken by the Community Response Officers from 2019 to 2021 and corresponding mitigating actions taken where required.

Dust concern has remained quite consistent for the community since 2020. 2021 showed a slight increase of complaints regarding dust by ~7% in comparison to 2020, although a decrease of 78% in comparison to 2019. The decrease from 2019 may be attributed to the above average rainfall conditions in 2021 (980 mm) and 2020 (828mm) in comparison to the below average rainfall in 2019 (304 mm).

The average annual rainfall recorded at MTW's Charlton Ridge Meteorological station is 668mm, as calculated from 2007 to 2021 annual totals.

Lighting has remained a key concern for the community. 2021 showed a slight reduction of complaints regarding lighting by 5% in comparison to 2020, although an increase of 26% in comparison to 2019. This increase from 2019 may be partially attributed to the progression of mining in the Warkworth Pit, which is progressively removing natural topographical shielding, as well as normal dumping activity on elevated dumps.

In summary:

- 15% reduction in blasting complaints;
- 50% decrease in noise complaints;
- Dust, Lighting, Water and Other related complaint numbers have remained fairly consistent since 2020.

TABLE 8.1 SUMMARY OF COMPLAINTS BY TYPE FOR 2019 TO 2021

Complaint type	2021	2020	2019
Noise	49	98	112
Blasting	58	68	94
Dust	32	30	146
Lighting	34	36	27
Water	0	0	0
Other	4	3	6
Total	177	235	385

8.2 Review of Community Engagement

8.2.1 Communication

Members of the community are encouraged to contact MTW and engage in a way that suits them. Communication avenues in place to support MTW include:

- MTW free call Community Information Line (1800 727 745), which is advertised regularly in local newspapers and community newsletters;
- Online, via MTW's website (www.mtwcoal.com.au) with information about MTW including approvals documents, public reports, environmental monitoring results, blasting and road closures, and information about the MTW Community Consultative Committee (CCC) including the minutes of CCC meetings;
- MTW maintains a 24 hour freecall environmental hotline (1800 656 892), which allows community members to register a concern or complaint at any time of the day or night, 365 days a year. The hotline is advertised in telephone directories, on the MTW website, regularly in local newspapers, and in MTW publications;
- MTW maintains a Blast Information Line (1800 099 669) which provides information on blasts and road closures;
- Near neighbour engagement, including proactive visits to neighbours surrounding MTW; and
- MTW also issues correspondence to specific community members who may be affected by certain changes, to inform of upcoming consultation activities and as a feedback mechanism.

A range of consultation and engagement activities have continued in 2021, which included:

- The MTW Social Impact Management Plan was implemented. This plan collates together all commitments that were part of the Environmental Assessment for MTW's Continuation Project process and identifies where the company will undertake actions to mitigate some of the potential impacts in the area. The main topics include:-
    - Voluntary Planning Agreement;

- Property Agreements Strategy, around acquisition and mitigation rights in the area.
- Management of properties in and around Bulga that MTW has had to acquire.
- Conservation funds and how MTW operate these.
- Support for local Schools
- Scholarships and Apprenticeships;
- Acquisition of Commercial Facilities, for example the Bulga Tavern where MTW has worked to upgrade this facility to support the business sustainability;
- Ongoing Community Support Program; and
- the MTW CCC, which is identified as one of the primary communication areas where the company reports back through the CCC on how their business is performing.

- Engagement and consultation with near neighbours to provide project updates at key project milestones and activities, and in response to concerns/queries raised by individual near neighbours;
- MTW are supportive of the Upper Hunter Mining Dialogue School Tours program.

8.2.2 Community Consultation Committee

The MTW CCC met on a quarterly basis to discuss our operations. The Committee is comprised of MTW representatives, community members and other key external stakeholders, including Singleton Council. The MTW CCC minutes were made available on the MTW website (www.mtwcoal.com.au). The community is invited to visit the MTW website to learn more about the MTW CCC, as well as other aspects of MTW operations and projects.

During the reporting period the CCC members were:

- Dr Col Gellatly - Independent Chair
- Cr Hollee Jenkins - Singleton Council Representative
- Mr Adrian Gallagher – Community Representative (resigned 16/11/2021)
- Mr Ian Hedley – Community Representative
- Mr Stewart Mitchell – Community Representative
- Ms Antoinette Silk – Community Representative
- Mrs Barb Brown – Community Representative
- Mr Neville Hodkinson – Stakeholder Representative - Singleton Shire Healthy Environment Group
- Mr Denis Maizey – Community Representative (DPE endorsed 2/7/2021)
- Mr Graeme O'Brien – Community Representative (Alternate)

Company representatives attending the CCC included:

- Mr David Bennett - MTW General Manager
- Mr Gary Mulhearn – MTW Environment & Community Manager
- Mr Chris Collier – MTW Technical Services Manager
- Ms Olivia Lane – MTW Environment & Community Advisor

- Mr Joshua van Bezouwen – MTW Environment & Community Advisor
- Ms Aleisha Tindall – MTW Community Response Officer

8.2.3 Community Support and Development

In 2021, MTW continued its focus on ensuring the long-term sustainability of the communities in which it operates, through the facilitation of community development programmes such as:

- Voluntary Planning Agreement
- Mount Thorley Warkworth Community Support Program

8.2.3.1 Voluntary Planning Agreement

In 2021, MTW continued contributions to the voluntary planning agreement funds required by development consents SSD-6464 and SSD-6465, and as agreed with Singleton Council. During 2021, MTW contributed a further $800,000 excluding GST, bringing total VPA contributions at end of 2021 to $6.4M of the total commitment value of $11M.

Singleton Council operates the Mount Thorley Warkworth VPA Community Committee which discusses the Bulga Community Project Fund component of the VPA funds. During 2021, the committee was chaired by Mayor Sue Moore and includes senior staff from Council, community representatives, and a Yancoal representative. Pleasingly, there has been good progress with projects in the Bulga / Milbrodale area from the Bulga Community Project Fund. Council published a newsletter in December 2021 with progress to date, a summary of which is reproduced in **Table 8.2.**

TABLE 8.2 MTW VPA PROJECTS STATUS

Approved Project	Project Lead	Project Update	Allocated Funding
Lockable noticeboard	Singleton Council	completed 2020	$2,000.00
Outdoor Exercise equipment	Singleton Council	completed 2019	$30,000.00
Recreation area improvements project	Singleton Council	completed 2019	$50,000.00
Electronic message board	Singleton Council	Sign installed December 2021	$27,014.00
Bulga Stock Reserve Plan of Management & Masterplan	Singleton Council	Documents adopted by Council February 2021	$60,000.00
Bulga Stock Reserve Stage 1 maintenance works	Singleton Council	Maintenance works completed September 2021	$46,811.82
Bulga Stock Reserve Stage 2 detailed survey	Singleton Council	Survey in progress	$15,000.00
Bulga Stock Reserve Stage 3 Aboriginal cultural study	Singleton Council	Project planning in progress	$10,000.00
Bulga Stock Reserve Stage 4 detailed design plans	Singleton Council	Project planning in progress	$25,000.00

Approved Project	Project Lead	Project Update	Allocated Funding
Wollombi Brook Walking Trail Masterplan and land purchase exploration	Singleton Council	Final draft masterplan completed. Community engagement to be finalised	$20,000.00
Milbrodale Public School - Welsh's Road sealing 600m	Singleton Council	Works to commence February 2022	$517,259.68
Bulga Hall media system and verandah	Bulga Hall Committee	Works to commence in 2022	$100,000.00
Bulga Hall additional funding – replacement of hall ceiling	Bulga Hall Committee	works in conjunction with the project above	$53,000.00
Old Bulga School restoration	Bulga Milbrodale Progress Association	Building plans in progress	$430,000.00
Milbrodale Public School Yarning Circle	Milbrodale Public School	Project in progress	$3,000.00
Milbrodale public School storage room renovations	Milbrodale Public School	Project planning in progress	$22,000.00
Bulga Recreation Ground RV dump point	Singleton Council	Project planning and design in progress	$60,000.00
Friends of St Mark's Cemetery - replacement fence	Friends of St Marks Cemetery	Project planning in progress	$19,349.48
Project management incidentals	Singleton Council	Project planning in progress	$24,000.00
Project Officer resource – 3 year contract	Singleton Council	Year 1 - completed	$390,000.00
		TOTAL ALLOCATED FUNDING	**$1,904,434.98**

8.2.3.2 MTW Community Support Program

In 2021 MTW continued implementation of the Yancoal Community Support Program (CSP). The CSP intends to make a genuine positive difference to the communities in which Yancoal operates. Applications for CSP partnerships are formally received once per funding year. MTW considers and supports applications for local donations and sponsorships that have a clear community benefit and are aligned with the CSP guidelines.

The COVID-19 pandemic caused disruption to many events. Some MTW Community Support Program (CSP) events being supported in 2020 postponed their timing into 2021 due to COVID-19. The following organizations are those which postponed their timing into 2021 due to COVID-19:

- Westpac Rescue Helicopter Service – Hunter Valley Mining Charity Rugby League Competition 2020 (COVID-19 – Support held for event in March 2021 – but cancelled due to inclement weather).
- Newcastle & Hunter Combined Schools ANZAC Service – 2020 Singleton ANZAC Service (COVID-19 –April 2021)
- Singleton Business Chamber – 2020 Hunter Coal Festival (COVID19 – Support held for event – planned for October 2022)
- Rotary Club of Singleton on Hunter – 2020 Singleton Art Prize (COVID19 – July 2021)

- Singleton Theatrical Society – 2020 Annual Musical (COVID19 – June 2021)
- University of Newcastle – Upper Hunter Science and Engineering Challenge (COVID19 – June 2021)

The 2021 round of applications were advertised in September-October 2020 and closed 6 November 2020. There were 14 applications received. The following 7 organizations were supported in 2021 through the CSP:

- Branxton Tennis Club – Tennis court resurfacing and new nets
- PCYC Singleton – Electronic scoreboard
- Singleton Council – Christmas on John Street 2021
- Singleton Fire Brigade Social Club – Santa's lolly run
- Singleton Neighbourhood Centre – Garden Project
- St Catherine's Catholic College – Bush tucker garden
- Westpac Rescue Helicopter Service – Hunter Valley Mining Charity Rugby League Day 2021 (COVID – postponed to September 2022.

The 2022 round of applications were advertised in September-October 2021 and closed 5 November 2021. There were 15 applications received. The following organisations are being supported in 2022 through the CSP.

- University of Newcastle – Upper Hunter Science and Engineering Challenge
- Life Education NSW - Covid Recovery – Health & Wellbeing program for children in the Singleton LGA.
- Samaritans Foundation – Diocese of Newcastle - Christmas lunch in Singleton 2022.
- Singleton Business Chamber - 2022 Singleton Business Excellence Awards
- Singleton Council - 2022 Singleton Business Excellence Awards
- Singleton Council - Christmas on John Street 2022
- Singleton Golf Club Lady Members – Christmas on John Street 2022
- Singleton Fire Brigade Social Club – Singleton Lolly Run 2022
- Singleton Rugby Club Ltd - First Aid Kit Equipment Upgrade
- Northern Agriculture Association Inc (NAA) – Singleton Show & Camp Draft 2022
- Singleton Theatrical Society - 2022 Musical – Mamma Mia
- Rotary Club of Singleton on Hunter – 2022 Singleton Art Prize

For information on the Yancoal Community Support Program please visit our website at www.mtwcoal.com.au or email mtw.csp@yancoal.com.au.

9 INDEPENDENT ENVIRONMENTAL AUDIT

There was no Independent Environmental Audit completed during the reporting period. An update of progress against the Action Plan developed in response to the 2020 Independent Environmental Audit is included in **Appendix 10**. The next MTW Independent Environmental Audit is due in 2023.

The environmental audit report and MTW's response to recommendations are available in full on the company website (https://www.mtwcoal.com.au/page/environment/environmental-reports-studies-and-audits/).

10 INCIDENTS AND NON-COMPLIANCE

A summary of the environmental incidents reported during 2021 are provided in **Table 10.1** below

TABLE 10.1 ENVIRONMENTAL INCIDENT SUMMARY 2021

Date	Incident Details	Follow up Actions
4 January 2021	Discharge from four boundary dams at Warkworth (Dam 46N, Dam 52N, Dam 53N, Dam SSD09) and a mine water dam at Mount Thorley Operations (Dam 1S) as a result of a greater than design rainfall event. A total of 79.4mm of rainfall was recorded during the incident period from 18 March to 23 March 2021. Notifications to the relevant regulatory authorities was undertaken, in accordance with the MTW Pollution Incident Response Management Plan (PIRMP).	Investigation undertaken by MTW into both discharges. MTW submitted an incident report to EPA and DPE associated with the discharge event. Dewatering of Dam 46N, 52N, 53N and 1S continued throughout the duration and post the rainfall event to the sites mine water management system to dewater both dams to their lowest operating levels. Water management improvements completed: • Pumping infrastructure upgrade from Dam 1S. • Water diversion analysis to reduce rehabilitation catchment water reporting to Dams 3S, 2S, 1S. Sediment dam concept at MTO to be progressed. WMP updated to reflect this. • Drainage improvement works to eliminate mine water entering dam 46N.
19 March 2021	Discharge from three boundary dams at Warkworth (Dam 53N, 54N and 55N) and a mine water dam at Mount Thorley Operations (Dam 1S) as a result of a greater than design rainfall event. A total of 175.2mm of rainfall was recorded during the incident period from 18 March to 23 March 2021. Notifications to the relevant regulatory authorities was undertaken, in accordance with the MTW Pollution Incident Response Management Plan (PIRMP).	Investigation undertaken by MTW into both discharges. MTW submitted an incident report to EPA and DPE associated with the discharge event. Dewatering of Dam 54N, 53N, 55N and 1S continued throughout the duration and post the rainfall event to the sites mine water management system to dewater both dams to their lowest operating levels. Water management improvements completed as part of the January discharge incident for Dam 1S: • Pumping infrastructure upgrade from Dam 1S. • Water diversion analysis to reduce rehabilitation catchment water reporting to Dams 3S, 2S, 1S. Sediment dam concept at MTO to be

Date	Incident Details	Follow up Actions
		progressed. WMP updated to reflect this.
12 November 2021	Discharge from two boundary dams at Warkworth (Dam 54N and Dam 53N) as a result of a greater than design rainfall event. A total of 110.6mm of rainfall was recorded during the incident period from 10 November to 12 November 2021. Notifications to the relevant regulatory authorities was undertaken, in accordance with the MTW Pollution Incident Response Management Plan (PIRMP).	Investigation undertaken by MTW into discharges. MTW submitted an incident report to EPA and DPE associated with the discharge event. Dewatering of Dam 54N and Dam 53N continued throughout the duration and post the rainfall event to the sites mine water management system to dewater both dams to their lowest operating levels. Water samples were collected from monitoring sites during the event and analysis results obtained.
26 November 2021	Discharge from a boundary dams at Warkworth (Dam 53N) as a result of a greater than design rainfall event. A total of 84mm of rainfall was recorded during the incident period from 20 November to 26 November 2021. Notifications to the relevant regulatory authorities was undertaken, in accordance with the MTW Pollution Incident Response Management Plan (PIRMP).	Investigation undertaken by MTW into discharge. MTW submitted an incident report to EPA and DPE associated with the discharge event. Dewatering of Dam 53N continued throughout the duration and post the rainfall event to the sites mine water management system to dewater both dams to their lowest operating levels. Water samples were collected from monitoring sites during the event and analysis results obtained.

11 ACTIVITIES TO BE COMPLETED IN THE NEXT REPORTING PERIOD

Yancoal will endeavour to carry out the following activities during the 2021 reporting period at Mount Thorley Warkworth, as outlined in **Table 11.1**.

TABLE 11.1 PROPOSED ACTIVITIES FOR 2022 REPORTING PERIOD

ID	Performance Area	Activities Proposed
1	Noise	• Maintain and continue sound power level testing of attenuated fleet; • Continue undertaking noise management and monitoring actions in accordance with the MTW Noise Management Plan • Undertake quarterly comparison of real time and external noise monitoring to validate real time monitoring results. • Integrate an additional Environmental Noise Compass (ENC) into MTW's real time noise monitoring network. Note: the additional ENC will replace the existing noise monitor at that location
2	Blasting	• Review and revise the MTW Blast Management Plan for operational changes at MTW. • Implementation of a real time model, which will use real time meteorological data from weather stations throughout the Hunter Valley to better determine the effect of possible overpressure enhancement (real time model in development)
3	Air Quality	• Continue undertaking air quality management and monitoring actions in accordance with the MTW Air Quality Management Plan

ID	Performance Area	Activities Proposed
4	Aboriginal Cultural Heritage	• Ongoing Aboriginal archaeological and cultural heritage management activities will occur in 2022 in accordance with current management plans, to inform ongoing land management and development planning. This will include planning for the relocation of the Site M grinding grooves from the Putty Road Storage facility to the WBACHCA & the salvage of those Aboriginal artefact sites located within the AHMP Area in areas required for mine development. Condition monitoring of those sites peripheral to authorised disturbance areas will be conducted annually to ensure operational compliance with the AHMP. • Conservation Agreements for the Wollombi Brook and Loders Creek Aboriginal Cultural Heritage Conservation Areas will be progressed in 2022. • Relocation of the three cultural scar trees from the active mining area will be undertaken in consultation with the relevant stakeholders. • The WBACHCA PMIG meetings are planned to continue where required during the 2022 reporting period to begin actioning the WBACHCA plan of implementation.
5	Historic Heritage	• Implementing the MTW complex-wide HHMP developed in accordance with the conditions of the Warkworth & Mount Thorley Development Consents, which will guide the management of historic heritage. • MTW has engaged a contractor to undertake quarterly grounds maintenance at Springwood and Red Brick historic heritage houses. • Treatment of the cat claw creeper vine will be continue during the 2022 reporting period at Springwood followed by a structural building inspection. • Replacing window and door sheeting and any loose roofing is planned for completion at the Red Brick house during the 2022 reporting period. • Track maintenance into the RAAF Mess Hall is planned for completion during the 2022 reporting period to allow access for future works. During the 2022 reporting period tree lopping, asbestos removal and a structural building inspection are targeted for completion.

ID	Performance Area	Activities Proposed
6	Water	• Improving the general capacity of the site's water resources via construction and/or upgrades of approved tailings storage and water storage facilities (NOOP and Loders Pit TSF). • Implementation of actions/recommendations from the annual groundwater review. • Develop an action plan to address the findings of the annual stream health assessment for Loders Creek. • Construct rehab diversion and sediment basin as shown in the WMP to reduce catchment area reporting to dam 3S, 2S, 1S. • Install additional boundary dam monitoring equipment on the Mount Thorley mine water dams. • Update the operational site water balance and model.
7	Rehabilitation	• The rehabilitation monitoring programme will continue in 2022 for native vegetation rehabilitation areas. The monitoring program will be varied to align with changes to MOP performance criteria in the new format Rehabilitation Management Plan. • Weed spraying (boom and spot spraying), cut and paint and weed wiping will be conducted in establishing rehabilitation areas as required to control both noxious and environmental weeds that are likely to impact on successful rehabilitation being achieved. It is planned that 35ha of new rehabilitation will be undertaken at MTW during 2022. • Habitat augmentation measures, such as the construction of habitat ponds and the placement of salvaged logs in rehabilitation areas. • Surface water will be managed on Tailings Dam 2 with the aim to increase the strength of the tailings surface. Capping activities will continue on areas of the Tailings Dam 2 surface that allow for the safe placement of material, following ongoing geotechnical investigations. • Capping of the Interim TSF will continue during 2022 using breaker rock from the South CHPP as the initial capping layer.

ID	Performance Area	Activities Proposed
8	Biodiversity Management	• Planting works will continue to restore Warkworth Sands Woodland and Central Hunter Grey Box – Ironbark Woodland in the Northern and Southern BAs. Supplementary planting to re-establish the cleared land in the Yellow Box – Grey Box – Red Gum Grassy Woodland to a Box Gum Grassy Woodland community and increase the suitability of habitat for the Regent Honeyeater in the River Oak riparian woodland will continue at the Goulburn River Biodiversity Area. • Conservation management actions will be undertaken across the BAs in 2022 in accordance with the Offset Management Plans, these will include weed management in autumn and spring. Vertebrate pest management including 1080 ground baiting program to target wild dogs and foxes scheduled for autumn and spring across all BAs. 1080 baiting targeting feral pigs at the Goulburn River BA and a noisy miner control in the regent honeyeater breeding area at the Goulburn River BA. Thermal ground shooting programs at Putty, Condon View, Bowditch and Goulburn River. Habitat Restoration Monitoring and Bird Assemblage Monitoring will be undertaken in 2022. Rapid Condition Assessments, Overall Fuel Load Assessments and property inspections will be undertaken across all BAs. The hazard reduction burn for North Rothbury will be undertaken if conditions are within the parameters of the approved burn plan. Waste removal will be undertaken at the Seven Oaks BAs. Infrastructure improvement including fence repairs and track maintenance will be undertaken as required. • Progress the securing of biodiversity offset areas using the methods detailed in the relevant state and federal biodiversity approvals.
9	Community Engagement	• Continued operation of the Community Consultation Committee. • Implementation of the MTW Social Impact Management Plan (which outlines specific and general stakeholder engagement and consultation requirements).
10	Community Development	• Implementation of the Yancoal Community Support Program (CSP) during 2022. The CSP program provides an opportunity for multiple site or group-wide investment in larger, long-term, capacity building projects that make a positive difference. Focus areas include health, social and community, environment, education and training. • Continued funding and participation as a committee representative for the MTW Voluntary Planning Agreement to progress sustainable community projects in the local area.

Appendix 1:

Compliance Noise Monitoring Data



Compliance Noise Monitoring Data

Yancoal Mt Thorley Warkworth

2021

1.0 Noise

Routine attended noise monitoring is carried out in accordance with the MTW Noise Management Plan. The purpose of the noise surveys is to quantify and describe the acoustic environment around the site and compare results with specified limits. Attended noise monitoring locations are displayed in **Figure 1**.

1.1 Attended Noise Monitoring Results

Monthly attended monitoring was conducted at receiver locations surrounding MTW in 2021. All measurements complied with the relevant criteria. Results are detailed in **Table 1** to **Table 4.**

1.1.1 WML Noise Assessment

Compliance assessments undertaken against the WML noise criteria are presented in **Tables 1** and **2**.

Table 1: $L_{Aeq,\ 15\ minute}$ Warkworth Impact Assessment Criteria – 2021

Location	Date and Time	Wind Speed (m/s)	Stability Class	Criterion dB(A)	Criterion Applies?[1]	WML L_{Aeq} dB[2,3,4]	Exceedance[3,5]
Bulga RFS	14/01/2021 22:59	4.2	D	37	No	<25	NA
Bulga Village	14/01/2021 22:14	3.1	E	38	No	29	NA
Gouldsville	14/01/2021 21:23	1.7	F	38	Yes	IA	Nil
Inlet Rd	14/01/2021 21:26	1.7	F	37	Yes	IA	Nil
Inlet Rd West	14/01/2021 21:01	1.2	F	35	Yes	IA	Nil
Long Point	14/01/2021 21:00	1.2	F	35	Yes	IA	Nil
South Bulga	14/01/2021 23:22	5.7	D	35	No	IA	NA
Wambo Road	14/01/2021 21:50	2.1	F	38	No	IA	NA
Bulga RFS	17/02/2021 22:47	3.5	D	37	No	IA	NA
Bulga Village	17/02/2021 22:08	4.1	D	38	No	<25	NA
Gouldsville	17/02/2021 21:33	3.5	D	38	No	29	NA
Inlet Rd	17/02/2021 21:21	3.6	D	37	No	25	NA
Inlet Rd West	17/02/2021 21:00	3.6	D	35	No	29	NA
Long Point	17/02/2021 21:07	3.6	D	35	No	IA	NA
South Bulga	17/02/2021 23:35	3.8	D	35	No	IA	NA
Wambo Road	17/02/2021 21:45	3.5	D	38	No	33	NA
Bulga RFS	16/03/2021 0:19	2.0	E	37	Yes	IA	Nil
Bulga Village	15/03/2021 23:34	2.2	D	38	Yes	33	Nil
Gouldsville	15/03/2021 21:29	1.8	E	38	Yes	<30	Nil
Inlet Rd	15/03/2021 21:42	2	E	37	Yes	33	Nil
Inlet Rd West	15/03/2021 21:12	1.7	F	35	Yes	30	Nil
Long Point	15/03/2021 21:05	2.1	F	35	No	IA	NA
South Bulga	16/03/2021 1:05	2.4	D	35	Yes	IA	Nil
Wambo Road	15/03/2021 22:11	1.9	F	38	Yes	38	Nil
Bulga RFS	21/04/2021 23:11	2.1	D	37	Yes	36	Nil
Bulga Village	21/04/2021 22:27	2.3	D	38	Yes	33	Nil
Gouldsville	21/04/2021 21:25	1.4	E	38	Yes	IA	Nil

Location	Date and Time	Wind Speed (m/s)	Stability Class	Criterion dB(A)	Criterion Applies?[1]	WML L_{Aeq} dB[2,3,4]	Exceedance[3,5]
Inlet Rd	21/04/2021 21:31	1.4	E	37	Yes	31	Nil
Inlet Rd West	21/04/2021 21:00	0.7	F	35	Yes	28	Nil
Long Point	21/04/2021 21:03	0.7	F	35	Yes	IA	Nil
South Bulga	21/04/2021 23:36	1.9	F	35	Yes	30	Nil
Wambo Road	21/04/2021 22:02	1.6	E	38	Yes	33	Nil
Bulga RFS	18/05/2021 0:04	2.3	D	37	Yes	NM	Nil
Bulga Village	17/05/2021 23:18	1.9	D	38	Yes	IA	Nil
Gouldsville	17/05/2021 21:25	0.4	F	38	Yes	IA	Nil
Inlet Rd	17/05/2021 21:29	0.4	F	37	Yes	33	Nil
Inlet Rd West	17/05/2021 21:00	1.2	E	35	Yes	32	Nil
Long Point	17/05/2021 21:03	1.2	E	35	Yes	IA	Nil
South Bulga	18/05/2021 0:26	2.6	E	35	Yes	IA	Nil
Wambo Road	17/05/2021 21:57	1.1	F	38	Yes	34	Nil
Bulga RFS	1/06/2021 23:10	0.8	F	37	Yes	<30	Nil
Bulga Village	1/06/2021 22:25	1.8	D	38	Yes	32	Nil
Gouldsville	1/06/2021 21:38	2	E	38	Yes	IA	Nil
Inlet Rd	1/06/2021 21:36	2	E	37	Yes	32	Nil
Inlet Rd West	1/06/2021 21:15	1.8	E	35	Yes	25	Nil
Long Point	1/06/2021 21:13	1.8	E	35	Yes	IA	Nil
South Bulga	1/06/2021 23:50	1	F	35	Yes	28	Nil
Wambo Road	1/06/2021 22:02	2.4	D	38	Yes	30	Nil
Bulga RFS	23/07/2021 1:19	0.9	E	37	Yes	36	Nil
Bulga Village	23/07/2021 0:19	1.1	D	38	Yes	37	Nil
Gouldsville	22/07/2021 21:22	2.1	E	38	Yes	IA	Nil
Inlet Rd	22/07/2021 21:40	2.1	D	37	Yes	35	Nil
Inlet Rd West	22/07/2021 21:10	2.2	D	35	Yes	28	Nil
Long Point	22/07/2021 21:00	2	E	35	Yes	IA	Nil
South Bulga	23/07/2021 0:53	1	F	35	Yes	IA	Nil
Wambo Road	22/07/2021 22:08	1.5	F	38	Yes	38	Nil
Bulga RFS	11/08/2021 0:00	1.4	E	37	Yes	35	Nil
Bulga Village	10/08/2021 23:16	1	D	38	Yes	31	Nil
Gouldsville	10/08/2021 21:24	0.5	F	38	Yes	IA	Nil
Inlet Rd	10/08/2021 21:23	0.5	F	37	Yes	25	Nil
Inlet Rd West	10/08/2021 21:00	1.5	E	35	Yes	<20	Nil
Long Point	10/08/2021 21:00	1.5	E	35	Yes	IA	Nil
South Bulga	11/08/2021 0:18	1.7	D	35	Yes	32	Nil
Wambo Road	10/08/2021 21:48	0.4	F	38	Yes	<25	Nil
Bulga RFS	7/09/2021 22:51	1.7	F	37	Yes	IA	Nil
Bulga Village	7/09/2021 22:11	1.3	F	38	Yes	IA	Nil
Gouldsville	7/09/2021 21:27	3	D	38	Yes	29	Nil
Inlet Rd	7/09/2021 21:22	2.5	D	37	Yes	NM	Nil

Location	Date and Time	Wind Speed (m/s)	Stability Class	Criterion dB(A)	Criterion Applies?[1]	WML L_{Aeq} dB[2,3,4]	Exceedance[3,5]
Inlet Rd West	7/09/2021 21:00	2.9	E	35	Yes	IA	Nil
Long Point	7/09/2021 21:01	2.9	E	35	Yes	27	Nil
South Bulga	7/09/2021 23:38	1.7	E	35	Yes	IA	Nil
Wambo Road	7/09/2021 21:49	2.7	D	38	Yes	IA	Nil
Bulga RFS	21/10/2021 22:55	2.8	D	37	Yes	<25	Nil
Bulga Village	21/10/2021 21:48	2.9	D	38	Yes	29	Nil
Gouldsville	21/10/2021 21:22	3.1	D	38	Yes	<20	NA
Inlet Rd	21/10/2021 21:24	3.1	D	38	Yes	30	NA
Inlet Rd West	21/10/2021 21:00	3	D	35	Yes	25	Nil
Long Point	21/10/2021 21:00	3	D	35	Yes	IA	Nil
South Bulga	21/10/2021 23:18	3.2	D	35	Yes	IA	NA
Wambo Road	21/10/2021 22:10	3.2	D	38	Yes	31	NA
Bulga RFS	23/11/2021 23:03	2.6	F	37	No	IA	NA
Bulga Village	23/11/2021 22:06	3.2	E	38	No	<25	NA
Gouldsville	23/11/2021 21:23	3.5	E	38	No	<30	NA
Inlet Rd	23/11/2021 21:22	3.8	E	38	No	<25	NA
Inlet Rd West	23/11/2021 21:01	3.8	E	35	No	IA	NA
Long Point	23/11/2021 21:00	3.8	E	35	No	IA	NA
South Bulga	23/11/2021 23:23	2.8	F	35	No	IA	NA
Wambo Road	23/11/2021 21:44	3.3	E	38	No	<25	NA
Bulga RFS	20/12/2021 22:53	0.2	F	37	Yes	30	Nil
Bulga Village	20/12/2021 22:14	1	F	38	Yes	28	Nil
Gouldsville	20/12/2021 21:28	2.3	F	38	No	<25	NA
Inlet Rd	20/12/2021 21:23	2.3	F	37	No	35	NA
Inlet Rd West	20/12/2021 21:00	1.1	F	35	Yes	32	Nil
Long Point	20/12/2021 21:05	1.1	F	35	Yes	IA	Nil
South Bulga	20/12/2021 23:33	0.2	D	35	Yes	IA	Nil
Wambo Road	20/12/2021 21:50	2.4	D	38	Yes	37	Nil

Notes:

1. Noise criteria apply during all meteorological conditions except the following: during periods of rain or hail; average wind speed at microphone height exceeds 5 m/s; wind speeds greater than 3 m/s measured at 10 metres above ground level; stability category F temperature inversion conditions and wind speeds greater than 2m/s at 10m above ground level; or stability category G temperature inversion conditions. Criterion may or may not apply due to rounding of meteorological data values;

2. Site-only LAeq,15minute attributed to WML, including modifying factors if applicable;

3. Bold results in red indicate exceedances of relevant criteria;

4. IA denotes 'Inaudible'; and

5. NA in exceedance column means atmospheric conditions outside conditions specified in development consent and so criterion is not applicable.

Table 2: $L_{A1,\ 1\ minute}$ Warkworth - Impact Assessment Criteria – 2021

Location	Date and Time	Wind Speed (m/s)	Stability Class	Criterion dB(A)	Criterion Applies?[1]	WML $L_{A1,\ 1min}$ dB[2,3,4]	Exceedance[3,5]
Bulga RFS	14/01/2021 22:59	4.2	D	47	No	<25	NA
Bulga Village	14/01/2021 22:14	3.1	E	48	No	33	NA
Gouldsville	14/01/2021 21:23	1.7	F	48	Yes	IA	Nil
Inlet Rd	14/01/2021 21:26	1.7	F	47	Yes	IA	Nil
Inlet Rd West	14/01/2021 21:01	1.2	F	45	Yes	IA	Nil
Long Point	14/01/2021 21:00	1.2	F	45	Yes	IA	Nil
South Bulga	14/01/2021 23:22	5.7	D	45	No	IA	NA
Wambo Road	14/01/2021 21:50	2.1	F	48	No	IA	NA
Bulga RFS	17/02/2021 22:47	3.5	D	47	No	IA	NA
Bulga Village	17/02/2021 22:08	4.1	D	48	No	<25	NA
Gouldsville	17/02/2021 21:33	3.5	D	48	No	33	NA
Inlet Rd	17/02/2021 21:21	3.6	D	47	No	30	NA
Inlet Rd West	17/02/2021 21:00	3.6	D	45	No	37	NA
Long Point	17/02/2021 21:07	3.6	D	45	No	IA	NA
South Bulga	17/02/2021 23:35	3.8	D	45	No	IA	NA
Wambo Road	17/02/2021 21:45	3.5	D	48	No	39	NA
Bulga RFS	16/03/2021 0:19	2	E	47	Yes	IA	Nil
Bulga Village	15/03/2021 23:34	2.2	D	48	Yes	45	Nil
Gouldsville	15/03/2021 21:29	1.8	E	48	Yes	<30	Nil
Inlet Rd	15/03/2021 21:42	2	E	47	Yes	39	Nil
Inlet Rd West	15/03/2021 21:12	1.7	F	45	Yes	34	Nil
Long Point	15/03/2021 21:05	2.1	F	45	No	IA	NA
South Bulga	16/03/2021 1:05	2.4	D	45	Yes	IA	Nil
Wambo Road	15/03/2021 22:11	1.9	F	48	Yes	42	Nil
Bulga RFS	21/04/2021 23:11	2.1	D	47	Yes	40	Nil
Bulga Village	21/04/2021 22:27	2.3	D	48	Yes	37	Nil
Gouldsville	21/04/2021 21:25	1.4	E	48	Yes	IA	Nil
Inlet Rd	21/04/2021 21:31	1.4	E	47	Yes	39	Nil
Inlet Rd West	21/04/2021 21:00	0.7	F	45	Yes	36	Nil
Long Point	21/04/2021 21:03	0.7	F	45	Yes	IA	Nil
South Bulga	21/04/2021 23:36	1.9	F	45	Yes	40	Nil
Wambo Road	21/04/2021 22:02	1.6	E	48	Yes	35	Nil
Bulga RFS	18/05/2021 0:04	2.3	D	47	Yes	NM	Nil
Bulga Village	17/05/2021 23:18	1.9	D	48	Yes	IA	Nil
Gouldsville	17/05/2021 21:25	0.4	F	48	Yes	IA	Nil
Inlet Rd	17/05/2021 21:29	0.4	F	47	Yes	38	Nil

Location	Date and Time	Wind Speed (m/s)	Stability Class	Criterion dB(A)	Criterion Applies?[1]	WML $L_{A1, 1min}$ dB[2,3,4]	Exceedance[3,5]
Inlet Rd West	17/05/2021 21:00	1.2	E	45	Yes	39	Nil
Long Point	17/05/2021 21:03	1.2	E	45	Yes	IA	Nil
South Bulga	18/05/2021 0:26	2.6	E	45	Yes	IA	Nil
Wambo Road	17/05/2021 21:57	1.1	F	48	Yes	37	Nil
Bulga RFS	1/06/2021 23:10	0.8	F	47	Yes	<30	Nil
Bulga Village	1/06/2021 22:25	1.8	D	48	Yes	35	Nil
Gouldsville	1/06/2021 21:38	2	E	48	Yes	IA	Nil
Inlet Rd	1/06/2021 21:36	2	E	47	Yes	34	Nil
Inlet Rd West	1/06/2021 21:15	1.8	E	45	Yes	30	Nil
Long Point	1/06/2021 21:13	1.8	E	45	Yes	IA	Nil
South Bulga	1/06/2021 23:50	1	F	45	Yes	30	Nil
Wambo Road	1/06/2021 22:02	2.4	D	48	Yes	32	Nil
Bulga RFS	23/07/2021 1:19	0.9	E	47	Yes	40	Nil
Bulga Village	23/07/2021 0:19	1.1	D	48	Yes	40	Nil
Gouldsville	22/07/2021 21:22	2.1	E	48	Yes	IA	Nil
Inlet Rd	22/07/2021 21:40	2.1	D	47	Yes	38	Nil
Inlet Rd West	22/07/2021 21:10	2.2	D	45	Yes	<30	Nil
Long Point	22/07/2021 21:00	2	E	45	Yes	IA	Nil
South Bulga	23/07/2021 0:53	1	F	45	Yes	IA	Nil
Wambo Road	22/07/2021 22:08	1.5	F	48	Yes	42	Nil
Bulga RFS	11/08/2021 0:00	1.4	E	47	Yes	45	Nil
Bulga Village	10/08/2021 23:16	1	D	48	Yes	35	Nil
Gouldsville	10/08/2021 21:24	0.5	F	48	Yes	IA	Nil
Inlet Rd	10/08/2021 21:23	0.5	F	47	Yes	30	Nil
Inlet Rd West	10/08/2021 21:00	1.5	E	45	Yes	<20	Nil
Long Point	10/08/2021 21:00	1.5	E	45	Yes	IA	Nil
South Bulga	11/08/2021 0:18	1.7	D	45	Yes	40	Nil
Wambo Road	10/08/2021 21:48	0.4	F	48	Yes	35	Nil
Bulga RFS	7/09/2021 22:51	1.7	F	47	Yes	IA	Nil
Bulga Village	7/09/2021 22:11	1.3	F	48	Yes	IA	Nil
Gouldsville	7/09/2021 21:27	3	D	48	Yes	32	Nil
Inlet Rd	7/09/2021 21:22	2.5	D	47	Yes	NM	Nil
Inlet Rd West	7/09/2021 21:00	2.9	E	45	Yes	IA	Nil
Long Point	7/09/2021 21:01	2.9	E	45	Yes	28	Nil
South Bulga	7/09/2021 23:38	1.7	E	45	Yes	IA	Nil
Wambo Road	7/09/2021 21:49	2.7	D	48	Yes	IA	Nil
Bulga RFS	21/10/2021 22:55	2.8	D	47	Yes	<30	Nil

Location	Date and Time	Wind Speed (m/s)	Stability Class	Criterion dB(A)	Criterion Applies?[1]	WML $L_{A1, 1min}$ dB[2,3,4]	Exceedance[3,5]
Bulga Village	21/10/2021 21:48	2.9	D	48	Yes	35	Nil
Gouldsville	21/10/2021 21:22	3.1	D	48	Yes	<20	NA
Inlet Rd	21/10/2021 21:24	3.1	D	47	Yes	33	NA
Inlet Rd West	21/10/2021 21:00	3	D	45	Yes	28	Nil
Long Point	21/10/2021 21:00	3	D	45	Yes	IA	Nil
South Bulga	21/10/2021 23:18	3.2	D	45	Yes	IA	NA
Wambo Road	21/10/2021 22:10	3.1	D	48	Yes	34	NA
Bulga RFS	23/11/2021 23:03	2.6	F	47	No	IA	NA
Bulga Village	23/11/2021 22:06	3.2	E	48	No	27	NA
Gouldsville	23/11/2021 21:23	3.5	E	48	No	35	NA
Inlet Rd	23/11/2021 21:22	3.8	E	47	No	<25	NA
Inlet Rd West	23/11/2021 21:01	3.8	E	45	No	IA	NA
Long Point	23/11/2021 21:00	3.8	E	45	No	IA	NA
South Bulga	23/11/2021 23:23	2.8	F	45	No	IA	NA
Wambo Road	23/11/2021 21:44	3.3	E	48	No	29	NA
Bulga RFS	20/12/2021 22:53	0.2	F	47	Yes	35	Nil
Bulga Village	20/12/2021 22:14	1	F	48	Yes	30	Nil
Gouldsville	20/12/2021 21:28	2.3	F	48	No	<25	NA
Inlet Rd	20/12/2021 21:23	2.3	F	47	No	39	NA
Inlet Rd West	20/12/2021 21:00	1.1	F	45	Yes	37	Nil
Long Point	20/12/2021 21:05	1.1	F	45	Yes	IA	Nil
South Bulga	20/12/2021 23:33	0.2	D	45	Yes	IA	Nil
Wambo Road	20/12/2021 21:50	2.4	D	48	Yes	39	Nil

Notes:

1. Noise criteria apply during all meteorological conditions except the following: during periods of rain or hail; average wind speed at microphone height exceeds 5 m/s; wind speeds greater than 3 m/s measured at 10 metres above ground level; stability category F temperature inversion conditions and wind speeds greater than 2m/s at 10m above ground level; or stability category G temperature inversion conditions. Criterion may or may not apply due to rounding of meteorological data values;

2. Site-only LA1,1minute attributed to WML;

3. Bold results in red indicate exceedances of relevant criteria;

4. IA denotes 'Inaudible'; and

5. NA in exceedance column means atmospheric conditions outside conditions specified in development consent and so criterion is not applicable

1.1.2 MTO Noise Assessment

Compliance assessments undertaken against the MTO noise criteria are presented in **Table 3** and **4**.

Table 3: $L_{Aeq,\ 15minute}$ Mount Thorley - Impact Assessment Criteria – 2021

Location	Date and Time	Wind Speed (m/s)	Stability Class	Criterion dB	Criterion Applies?[1]	MTO L_{Aeq} dB[2,3,4]	Exceedance[3,5]
Bulga RFS	14/01/2021 22:59	4.2	D	37	No	IA	NA
Bulga Village	14/01/2021 22:14	3.1	E	38	No	IA	NA
Gouldsville	14/01/2021 21:23	1.7	F	35	Yes	IA	Nil
Inlet Rd	14/01/2021 21:26	1.7	F	37	Yes	IA	Nil
Inlet Rd West	14/01/2021 21:01	1.2	F	35	Yes	IA	Nil
Long Point	14/01/2021 21:00	1.2	F	35	Yes	IA	Nil
South Bulga	14/01/2021 23:22	5.7	D	36	No	IA	NA
Wambo Road	14/01/2021 21:50	2.1	F	38	No	IA	NA
Bulga RFS	17/02/2021 22:47	3.5	D	37	No	<30	NA
Bulga Village	17/02/2021 22:08	4.1	D	38	No	30	NA
Gouldsville	17/02/2021 21:33	3.5	D	35	No	IA	NA
Inlet Rd	17/02/2021 21:21	3.6	D	37	No	29	NA
Inlet Rd West	17/02/2021 21:00	3.6	D	35	No	25	NA
Long Point	17/02/2021 21:07	3.6	D	35	No	IA	NA
South Bulga	17/02/2021 23:35	3.8	D	36	No	IA	NA
Wambo Road	17/02/2021 21:45	3.5	D	38	No	33	NA
Bulga RFS	16/03/2021 0:19	2.0	E	37	Yes	IA	Nil
Bulga Village	15/03/2021 23:34	2.2	D	38	Yes	IA	Nil
Gouldsville	15/03/2021 21:29	1.8	E	35	Yes	IA	Nil
Inlet Rd	15/03/2021 21:42	2	E	37	Yes	IA	Nil
Inlet Rd West	15/03/2021 21:12	1.7	F	35	Yes	IA	Nil
Long Point	15/03/2021 21:05	2.1	F	35	No	IA	NA
South Bulga	16/03/2021 1:05	2.4	D	36	Yes	IA	Nil
Wambo Road	15/03/2021 22:11	1.9	F	38	Yes	IA	Nil
Bulga RFS	21/04/2021 23:11	2.1	D	37	Yes	<30	Nil
Bulga Village	21/04/2021 22:27	2.3	D	38	Yes	IA	Nil
Gouldsville	21/04/2021 21:25	1.4	E	35	Yes	IA	Nil
Inlet Rd	21/04/2021 21:31	1.4	E	37	Yes	IA	Nil
Inlet Rd West	21/04/2021 21:00	0.7	F	35	Yes	IA	Nil
Long Point	21/04/2021 21:03	0.7	F	35	Yes	IA	Nil

Location	Date and Time	Wind Speed (m/s)	Stability Class	Criterion dB	Criterion Applies?[1]	MTO L_{Aeq} dB[2,3,4]	Exceedance[3,5]
South Bulga	21/04/2021 23:36	1.9	F	36	Yes	IA	Nil
Wambo Road	21/04/2021 22:02	1.6	E	38	Yes	IA	Nil
Bulga RFS	18/05/2021 0:04	2.3	D	37	Yes	IA	Nil
Bulga Village	17/05/2021 23:18	1.9	D	38	Yes	IA	Nil
Gouldsville	17/05/2021 21:25	0.4	F	35	Yes	IA	Nil
Inlet Rd	17/05/2021 21:29	0.4	F	37	Yes	IA	Nil
Inlet Rd West	17/05/2021 21:00	1.2	E	35	Yes	IA	Nil
Long Point	17/05/2021 21:03	1.2	E	35	Yes	IA	Nil
South Bulga	18/05/2021 0:26	2.6	E	36	Yes	IA	Nil
Wambo Road	17/05/2021 21:57	1.1	F	38	Yes	IA	Nil
Bulga RFS	1/06/2021 23:10	0.8	F	37	Yes	<30	Nil
Bulga Village	1/06/2021 22:25	1.8	D	38	Yes	IA	Nil
Gouldsville	1/06/2021 21:38	2	E	35	Yes	IA	Nil
Inlet Rd	1/06/2021 21:36	2	E	37	Yes	IA	Nil
Inlet Rd West	1/06/2021 21:15	1.8	E	35	Yes	IA	Nil
Long Point	1/06/2021 21:13	1.8	E	35	Yes	IA	Nil
South Bulga	1/06/2021 23:50	1	F	36	Yes	IA	Nil
Wambo Road	1/06/2021 22:02	2.4	D	38	Yes	IA	Nil
Bulga RFS	23/07/2021 1:19	0.9	E	37	Yes	NM	Nil
Bulga Village	23/07/2021 0:19	1.1	D	38	Yes	IA	Nil
Gouldsville	22/07/2021 21:22	2.1	E	35	Yes	IA	Nil
Inlet Rd	22/07/2021 21:40	2.1	D	37	Yes	IA	Nil
Inlet Rd West	22/07/2021 21:10	2.2	D	35	Yes	IA	Nil
Long Point	22/07/2021 21:00	2	E	35	Yes	IA	Nil
South Bulga	23/07/2021 0:53	1	F	36	Yes	35	Nil
Wambo Road	22/07/2021 22:08	1.5	F	38	Yes	IA	Nil
Bulga RFS	11/08/2021 0:00	1.4	E	37	Yes	IA	Nil
Bulga Village	10/08/2021 23:16	1	D	38	Yes	IA	Nil
Gouldsville	10/08/2021 21:24	0.5	F	35	Yes	IA	Nil
Inlet Rd	10/08/2021 21:23	0.5	F	37	Yes	IA	Nil
Inlet Rd West	10/08/2021 21:00	1.5	E	35	Yes	<20	Nil
Long Point	10/08/2021 21:00	1.5	E	35	Yes	IA	Nil
South Bulga	11/08/2021 0:18	1.7	D	36	Yes	IA	Nil
Wambo Road	10/08/2021 21:48	0.4	F	38	Yes	IA	Nil
Bulga RFS	7/09/2021 22:51	1.7	F	37	Yes	NM	Nil
Bulga Village	7/09/2021 22:11	1.3	F	38	Yes	IA	Nil

Location	Date and Time	Wind Speed (m/s)	Stability Class	Criterion dB	Criterion Applies?[1]	MTO L_{Aeq} dB[2,3,4]	Exceedance[3,5]
Gouldsville	7/09/2021 21:27	3	D	35	Yes	IA	Nil
Inlet Rd	7/09/2021 21:22	2.5	D	37	Yes	IA	Nil
Inlet Rd West	7/09/2021 21:00	2.9	E	35	Yes	IA	Nil
Long Point	7/09/2021 21:01	2.9	E	35	Yes	IA	Nil
South Bulga	7/09/2021 23:38	1.7	E	36	Yes	32	Nil
Wambo Road	7/09/2021 21:49	2.7	D	38	Yes	NM	Nil
Bulga RFS	21/10/2021 22:55	2.8	D	37	Yes	32	Nil
Bulga Village	21/10/2021 21:48	2.9	D	38	Yes	<25	Nil
Gouldsville	21/10/2021 21:22	3.1	D	35	Yes	IA	NA
Inlet Rd	21/10/2021 21:24	3.1	D	37	Yes	IA	NA
Inlet Rd West	21/10/2021 21:00	3	D	35	Yes	IA	Nil
Long Point	21/10/2021 21:00	3	D	35	Yes	IA	Nil
South Bulga	21/10/2021 23:18	3.2	D	36	Yes	31	NA
Wambo Road	21/10/2021 22:10	3.2	D	38	Yes	IA	NA
Bulga RFS	23/11/2021 23:03	2.6	F	37	Yes	33	NA
Bulga Village	23/11/2021 22:06	3.2	E	38	Yes	IA	NA
Gouldsville	23/11/2021 21:23	3.5	E	35	Yes	IA	NA
Inlet Rd	23/11/2021 21:22	3.8	E	37	Yes	<25	NA
Inlet Rd West	23/11/2021 21:01	3.8	E	35	Yes	<20	NA
Long Point	23/11/2021 21:00	3.8	E	35	Yes	IA	NA
South Bulga	23/11/2021 23:23	2.8	F	36	Yes	<25	NA
Wambo Road	23/11/2021 21:44	3.3	E	38	Yes	IA	NA
Bulga RFS	20/12/2021 22:53	0.2	F	37	Yes	NM	Nil
Bulga Village	20/12/2021 22:14	1	F	38	Yes	28	Nil
Gouldsville	20/12/2021 21:28	2.3	F	35	No	IA	NA
Inlet Rd	20/12/2021 21:23	2.3	F	37	No	30	NA
Inlet Rd West	20/12/2021 21:00	1.1	F	35	Yes	IA	Nil
Long Point	20/12/2021 21:05	1.1	F	35	Yes	IA	Nil
South Bulga	20/12/2021 23:33	0.2	D	36	Yes	25	Nil
Wambo Road	20/12/2021 21:50	2.4	D	38	Yes	IA	Nil

Notes:

1. Noise criteria apply during all meteorological conditions except the following: during periods of rain or hail; average wind speed at microphone height exceeds 5 m/s; wind speeds greater than 3 m/s measured at 10 metres above ground level; stability category F temperature inversion conditions and wind speeds greater than 2m/s at 10m above ground level; or stability category G temperature inversion conditions. Criterion may or may not apply due to rounding of meteorological data values;

2. Site-only LAeq,15minute attributed to MTO, including modifying factors if applicable;

3. Bold results in red indicate exceedances of relevant criteria;

4. IA denotes 'Inaudible'; and

5. NA in exceedance column means atmospheric conditions outside conditions specified in development consent and so criterion is not applicable.

Table 4: $L_{A1, 1Minute}$ Mount Thorley - Impact Assessment Criteria – 2021

Location	Date and Time	Wind Speed (m/s)	Stability Class	Criterion dB	Criterion Applies?[1]	MTO $L_{A1, 1min}$ dB[2,3,4]	Exceedance[3,5]
Bulga RFS	14/01/2021 22:59	4.2	D	47	No	IA	NA
Bulga Village	14/01/2021 22:14	3.1	E	48	No	IA	NA
Gouldsville	14/01/2021 21:23	1.7	F	45	Yes	IA	Nil
Inlet Rd	14/01/2021 21:26	1.7	F	47	Yes	IA	Nil
Inlet Rd West	14/01/2021 21:01	1.2	F	45	Yes	IA	Nil
Long Point	14/01/2021 21:00	1.2	F	45	Yes	IA	Nil
South Bulga	14/01/2021 23:22	5.7	D	46	No	IA	NA
Wambo Road	14/01/2021 21:50	2.1	F	48	No	IA	NA
Bulga RFS	17/02/2021 22:47	3.5	D	47	No	<30	NA
Bulga Village	17/02/2021 22:08	4.1	D	48	No	33	NA
Gouldsville	17/02/2021 21:33	3.5	D	45	No	IA	NA
Inlet Rd	17/02/2021 21:21	3.6	D	47	No	36	NA
Inlet Rd West	17/02/2021 21:00	3.6	D	45	No	<30	NA
Long Point	17/02/2021 21:07	3.6	D	45	No	IA	NA
South Bulga	17/02/2021 23:35	3.8	D	46	No	IA	NA
Wambo Road	17/02/2021 21:45	3.5	D	48	No	35	NA
Bulga RFS	16/03/2021 0:19	2.0	E	47	Yes	IA	Nil
Bulga Village	15/03/2021 23:34	2.2	D	48	Yes	IA	Nil
Gouldsville	15/03/2021 21:29	1.8	E	45	Yes	IA	Nil
Inlet Rd	15/03/2021 21:42	2	E	47	Yes	IA	Nil
Inlet Rd West	15/03/2021 21:12	1.7	F	45	Yes	IA	Nil
Long Point	15/03/2021 21:05	2.1	F	45	No	IA	NA
South Bulga	16/03/2021 1:05	2.4	D	46	Yes	IA	Nil
Wambo Road	15/03/2021 22:11	1.9	F	48	Yes	IA	Nil
Bulga RFS	21/04/2021 23:11	2.1	D	47	Yes	33	Nil
Bulga Village	21/04/2021 22:27	2.3	D	48	Yes	IA	Nil
Gouldsville	21/04/2021 21:25	1.4	E	45	Yes	IA	Nil
Inlet Rd	21/04/2021 21:31	1.4	E	47	Yes	IA	Nil
Inlet Rd West	21/04/2021 21:00	0.7	F	45	Yes	IA	Nil
Long Point	21/04/2021 21:03	0.7	F	45	Yes	IA	Nil
South Bulga	21/04/2021 23:36	1.9	F	46	Yes	IA	Nil
Wambo Road	21/04/2021 22:02	1.6	E	48	Yes	IA	Nil
Bulga RFS	18/05/2021 0:04	2.3	D	47	Yes	IA	Nil
Bulga Village	17/05/2021 23:18	1.9	D	48	Yes	IA	Nil

Location	Date and Time	Wind Speed (m/s)	Stability Class	Criterion dB	Criterion Applies?[1]	MTO $L_{A1, 1min}$ dB[2,3,4]	Exceedance[3,5]
Gouldsville	17/05/2021 21:25	0.4	F	45	Yes	IA	Nil
Inlet Rd	17/05/2021 21:29	0.4	F	47	Yes	IA	Nil
Inlet Rd West	17/05/2021 21:00	1.2	E	45	Yes	IA	Nil
Long Point	17/05/2021 21:03	1.2	E	45	Yes	IA	Nil
South Bulga	18/05/2021 0:26	2.6	E	46	Yes	IA	Nil
Wambo Road	17/05/2021 21:57	1.1	F	48	Yes	IA	Nil
Bulga RFS	1/06/2021 23:10	0.8	F	47	Yes	<30	Nil
Bulga Village	1/06/2021 22:25	1.8	D	48	Yes	IA	Nil
Gouldsville	1/06/2021 21:38	2	E	45	Yes	IA	Nil
Inlet Rd	1/06/2021 21:36	2	E	47	Yes	IA	Nil
Inlet Rd West	1/06/2021 21:15	1.8	E	45	Yes	IA	Nil
Long Point	1/06/2021 21:13	1.8	E	45	Yes	IA	Nil
South Bulga	1/06/2021 23:50	1	F	46	Yes	IA	Nil
Wambo Road	1/06/2021 22:02	2.4	D	48	Yes	IA	Nil
Bulga RFS	23/07/2021 1:19	0.9	E	47	Yes	NM	Nil
Bulga Village	23/07/2021 0:19	1.1	D	48	Yes	IA	Nil
Gouldsville	22/07/2021 21:22	2.1	E	45	Yes	IA	Nil
Inlet Rd	22/07/2021 21:40	2.1	D	47	Yes	IA	Nil
Inlet Rd West	22/07/2021 21:10	2.2	D	45	Yes	IA	Nil
Long Point	22/07/2021 21:00	2	E	45	Yes	IA	Nil
South Bulga	23/07/2021 0:53	1	F	46	Yes	37	Nil
Wambo Road	22/07/2021 22:08	1.5	F	48	Yes	IA	Nil
Bulga RFS	11/08/2021 0:00	1.4	E	47	Yes	IA	Nil
Bulga Village	10/08/2021 23:16	1	D	48	Yes	IA	Nil
Gouldsville	10/08/2021 21:24	0.5	F	45	Yes	IA	Nil
Inlet Rd	10/08/2021 21:23	0.5	F	47	Yes	IA	Nil
Inlet Rd West	10/08/2021 21:00	1.5	E	45	Yes	25	Nil
Long Point	10/08/2021 21:00	1.5	E	45	Yes	IA	Nil
South Bulga	11/08/2021 0:18	1.7	D	46	Yes	IA	Nil
Wambo Road	10/08/2021 21:48	0.4	F	48	Yes	IA	Nil
Bulga RFS	7/09/2021 22:51	1.7	F	47	Yes	NM	Nil
Bulga Village	7/09/2021 22:11	1.3	F	48	Yes	IA	Nil
Gouldsville	7/09/2021 21:27	3	D	45	Yes	IA	Nil
Inlet Rd	7/09/2021 21:22	2.5	D	47	Yes	IA	Nil
Inlet Rd West	7/09/2021 21:00	2.9	E	45	Yes	IA	Nil
Long Point	7/09/2021 21:01	2.9	E	45	Yes	IA	Nil

Location	Date and Time	Wind Speed (m/s)	Stability Class	Criterion dB	Criterion Applies?[1]	MTO $L_{A1, 1min}$ dB[2,3,4]	Exceedance[3,5]
South Bulga	7/09/2021 23:38	1.7	E	46	Yes	42	Nil
Wambo Road	7/09/2021 21:49	2.7	D	48	Yes	NM	Nil
Bulga RFS	21/10/2021 22:55	2.8	D	47	Yes	36	Nil
Bulga Village	21/10/2021 21:48	2.9	D	48	Yes	<30	Nil
Gouldsville	21/10/2021 21:22	3.1	D	45	Yes	IA	NA
Inlet Rd	21/10/2021 21:24	3.1	D	47	Yes	IA	NA
Inlet Rd West	21/10/2021 21:00	3	D	45	Yes	IA	Nil
Long Point	21/10/2021 21:00	3	D	45	Yes	IA	Nil
South Bulga	21/10/2021 23:18	3.1	D	46	Yes	36	Nil
Wambo Road	21/10/2021 22:10	3.2	D	48	Yes	IA	NA
Bulga RFS	23/11/2021 23:03	2.6	F	47	Yes	39	NA
Bulga Village	23/11/2021 22:06	3.2	E	48	Yes	IA	NA
Gouldsville	23/11/2021 21:23	3.5	E	45	Yes	IA	NA
Inlet Rd	23/11/2021 21:22	3.8	E	47	Yes	<25	NA
Inlet Rd West	23/11/2021 21:01	3.8	E	45	Yes	<20	NA
Long Point	23/11/2021 21:00	3.8	E	45	Yes	IA	NA
South Bulga	23/11/2021 23:23	2.8	F	46	Yes	27	NA
Wambo Road	23/11/2021 21:44	3.3	E	48	Yes	IA	NA
Bulga RFS	20/12/2021 22:53	0.2	F	47	Yes	NM	Nil
Bulga Village	20/12/2021 22:14	1	F	48	Yes	31	Nil
Gouldsville	20/12/2021 21:28	2.3	F	45	No	IA	NA
Inlet Rd	20/12/2021 21:23	2.3	F	47	No	30	NA
Inlet Rd West	20/12/2021 21:00	1.1	F	45	Yes	IA	Nil
Long Point	20/12/2021 21:05	1.1	F	45	Yes	IA	Nil
South Bulga	20/12/2021 23:33	0.2	D	46	Yes	30	Nil
Wambo Road	20/12/2021 21:50	2.4	D	48	Yes	IA	Nil

Notes

1. Noise criteria apply during all meteorological conditions except the following: during periods of rain or hail; average wind speed at microphone height exceeds 5 m/s; wind speeds greater than 3 m/s measured at 10 metres above ground level; stability category F temperature inversion conditions and wind speeds greater than 2m/s at 10m above ground level; or stability category G temperature inversion conditions. Criterion may or may not apply due to rounding of meteorological data values;

2. Site-only LA1,1minute attributed to MTO;

3. Bold results in red indicate exceedances of relevant criteria;

4. IA denotes 'Inaudible'; and

5. NA in exceedance column means atmospheric conditions outside conditions specified in development consent and so criterion is not applicable.

1.1.3 Low Frequency Assessment

In accordance with the requirements of the EPA's Noise Policy for Industry (NPfI), the applicability of the low frequency modification factor corrections has been assessed. There were no noise measurements taken during the reporting period which required the penalty to be applied. The WML assessment for low frequency noise is shown in **Table 5** and the MTO assessment for low frequency noise is shown in **Table 6**.

Table 5: Warkworth Low Frequency Noise Assessment –2021

Location	Date and Time	Measured WML LAeq dB[1]	Criterion Applies?	Intermittency Modifying Factor?	Tonality Modifying Factor?	Frequency of Tonality[2]	Low-frequency Modifying Factor?	Maximum Exceedance of Reference Spectrum [2,3]	Penalty dB[3]	Exceedance
Bulga RFS	14/01/2021 22:59	<25	NA	No	No	NA	No	NA	Nil	NA
Bulga Village	14/01/2021 22:14	29	NA	No	No	NA	No	NA	Nil	NA
Gouldsville	14/01/2021 21:23	IA	Nil	No	No	NA	No	NA	Nil	NA
Inlet Rd	14/01/2021 21:26	IA	Nil	No	No	NA	No	NA	Nil	NA
Inlet Rd West	14/01/2021 21:01	IA	Nil	No	No	NA	No	NA	Nil	NA
Long Point	14/01/2021 21:00	IA	Nil	No	No	NA	No	NA	Nil	NA
South Bulga	14/01/2021 23:22	IA	NA	No	No	NA	No	NA	Nil	NA
Wambo Road	14/01/2021 21:50	IA	NA	No	No	NA	No	NA	Nil	NA
Bulga RFS	17/02/2021 22:47	IA	No	No	No	NA	No	NA	Nil	NA
Bulga Village	17/02/2021 22:08	<25	No	No	No	NA	No	NA	Nil	NA
Gouldsville	17/02/2021 21:33	29	No	No	No	NA	No	NA	Nil	NA
Inlet Rd	17/02/2021 21:21	25	No	No	No	NA	No	NA	Nil	NA
Inlet Rd West	17/02/2021 21:00	29	No	No	No	NA	No	NA	Nil	NA
Long Point	17/02/2021 21:07	IA	No	No	No	NA	No	NA	Nil	NA
South Bulga	17/02/2021 23:35	IA	No	No	No	NA	No	NA	Nil	NA
Wambo Road	17/02/2021 21:45	33	No	No	No	NA	No	NA	Nil	NA

Location	Date and Time	Measured WML LAeq dB[1]	Criterion Applies?	Intermittency Modifying Factor?	Tonality Modifying Factor?	Frequency of Tonality[2]	Low-frequency Modifying Factor?	Maximum Exceedance of Reference Spectrum [2,3]	Penalty dB[3]	Exceedance
Bulga RFS	16/03/2021 0:19	IA	Yes	No	No	NA	No	NA	Nil	NA
Bulga Village	15/03/2021 23:34	31	Yes	No	No	NA	Yes	**2 dB @ 80 Hz**	**2**	NA
Gouldsville	15/03/2021 21:29	<30	Yes	No	No	NA	No	NA	Nil	NA
Inlet Rd	15/03/2021 21:42	33	Yes	No	No	NA	No	NA	Nil	NA
Inlet Rd West	15/03/2021 21:12	30	Yes	No	No	NA	No	NA	Nil	NA
Long Point	15/03/2021 21:05	IA	No	No	No	NA	No	NA	Nil	NA
South Bulga	16/03/2021 1:05	IA	Yes	No	No	NA	No	NA	Nil	NA
Wambo Road	15/03/2021 22:11	36	Yes	No	No	NA	Yes	**2 dB @ 80 Hz**	**2**	NA
Bulga RFS	21/04/2021 23:11	36	Yes	No	No	NA	No	NA	Nil	NA
Bulga Village	21/04/2021 22:27	33	Yes	No	No	NA	No	NA	Nil	NA
Gouldsville	21/04/2021 21:25	IA	Yes	No	No	NA	No	NA	Nil	NA
Inlet Rd	21/04/2021 21:31	31	Yes	No	No	NA	No	NA	Nil	NA
Inlet Rd West	21/04/2021 21:00	28	Yes	No	No	NA	No	NA	Nil	NA
Long Point	21/04/2021 21:03	IA	Yes	No	No	NA	No	NA	Nil	NA
South Bulga	21/04/2021 23:36	30	Yes	No	No	NA	No	NA	Nil	NA
Wambo Road	21/04/2021 22:02	33	Yes	No	No	NA	No	NA	Nil	NA
Bulga RFS	18/05/2021 0:04	NM	Yes	No	No	NA	No	NA	Nil	NA
Bulga Village	17/05/2021 23:18	IA	Yes	No	No	NA	No	NA	Nil	NA
Gouldsville	17/05/2021 21:25	IA	Yes	No	No	NA	No	NA	Nil	NA
Inlet Rd	17/05/2021 21:29	33	Yes	No	No	NA	No	NA	Nil	NA
Inlet Rd West	17/05/2021 21:00	32	Yes	No	No	NA	No	NA	Nil	NA
Long Point	17/05/2021 21:03	IA	Yes	No	No	NA	No	NA	Nil	NA

Location	Date and Time	Measured WML LAeq dB[1]	Criterion Applies?	Intermittency Modifying Factor?	Tonality Modifying Factor?	Frequency of Tonality[2]	Low-frequency Modifying Factor?	Maximum Exceedance of Reference Spectrum [2,3]	Penalty dB[3]	Exceedance
South Bulga	18/05/2021 0:26	IA	Yes	No	No	NA	No	NA	Nil	NA
Wambo Road	17/05/2021 21:57	34	Yes	No	No	NA	No	NA	Nil	NA
Bulga RFS	1/06/2021 23:10	<30	Yes	No	No	NA	No	NA	Nil	NA
Bulga Village	1/06/2021 22:25	32	Yes	No	No	NA	No	NA	Nil	NA
Gouldsville	1/06/2021 21:38	IA	Yes	No	No	NA	No	NA	Nil	NA
Inlet Rd	1/06/2021 21:36	32	Yes	No	No	NA	No	NA	Nil	NA
Inlet Rd West	1/06/2021 21:15	25	Yes	No	No	NA	No	NA	Nil	NA
Long Point	1/06/2021 21:13	IA	Yes	No	No	NA	No	NA	Nil	NA
South Bulga	1/06/2021 23:50	28	Yes	No	No	NA	No	NA	Nil	NA
Wambo Road	1/06/2021 22:02	30	Yes	No	No	NA	No	NA	Nil	NA
Bulga RFS	23/07/2021 1:19	36	Yes	No	No	NA	No	NA	Nil	NA
Bulga Village	23/07/2021 0:19	35	Yes	No	No	NA	Yes	**1dB @ 80Hz**	**2**	NA
Gouldsville	22/07/2021 21:22	IA	Yes	No	No	NA	No	NA	Nil	NA
Inlet Rd	22/07/2021 21:40	35	Yes	No	No	NA	No	NA	Nil	NA
Inlet Rd West	22/07/2021 21:10	28	Yes	No	No	NA	No	NA	Nil	NA
Long Point	22/07/2021 21:00	IA	Yes	No	No	NA	No	NA	Nil	NA
South Bulga	23/07/2021 0:53	IA	Yes	No	No	NA	No	NA	Nil	NA
Wambo Road	22/07/2021 22:08	38	Yes	No	No	NA	No	NA	Nil	NA
Bulga RFS	11/08/2021 0:00	35	Yes	No	No	NA	No	NA	Nil	NA
Bulga Village	10/08/2021 23:16	31	Yes	No	No	NA	No	NA	Nil	NA
Gouldsville	10/08/2021 21:24	IA	Yes	No	No	NA	No	NA	Nil	NA
Inlet Rd	10/08/2021 21:23	25	Yes	No	No	NA	No	NA	Nil	NA

Location	Date and Time	Measured WML LAeq dB[1]	Criterion Applies?	Intermittency Modifying Factor?	Tonality Modifying Factor?	Frequency of Tonality[2]	Low-frequency Modifying Factor?	Maximum Exceedance of Reference Spectrum [2,3]	Penalty dB[3]	Exceedance
Inlet Rd West	10/08/2021 21:00	<20	Yes	No	No	NA	No	NA	Nil	NA
Long Point	10/08/2021 21:00	IA	Yes	No	No	NA	No	NA	Nil	NA
South Bulga	11/08/2021 0:18	32	Yes	No	No	NA	No	NA	Nil	NA
Wambo Road	10/08/2021 21:48	<25	Yes	No	No	NA	No	NA	Nil	NA
Bulga RFS	7/09/2021 22:51	IA	Yes	No	No	NA	No	NA	Nil	NA
Bulga Village	7/09/2021 22:11	IA	Yes	No	No	NA	No	NA	Nil	NA
Gouldsville	7/09/2021 21:27	29	Yes	No	No	NA	No	NA	Nil	NA
Inlet Rd	7/09/2021 21:22	NM	Yes	No	No	NA	No	NA	Nil	NA
Inlet Rd West	7/09/2021 21:00	IA	Yes	No	No	NA	No	NA	Nil	NA
Long Point	7/09/2021 21:01	27	Yes	No	No	NA	No	NA	Nil	NA
South Bulga	7/09/2021 23:38	IA	Yes	No	No	NA	No	NA	Nil	NA
Wambo Road	7/09/2021 21:49	IA	Yes	No	No	NA	No	NA	Nil	NA
Bulga RFS	21/10/2021 22:55	<25	Yes	No	No	NA	No	NA	Nil	NA
Bulga Village	21/10/2021 21:48	29	Yes	No	No	NA	No	NA	Nil	NA
Gouldsville	21/10/2021 21:22	<20	No	No	No	NA	No	NA	Nil	NA
Inlet Rd	21/10/2021 21:24	30	No	No	No	NA	No	NA	Nil	NA
Inlet Rd West	21/10/2021 21:00	25	Yes	No	No	NA	No	NA	Nil	NA
Long Point	21/10/2021 21:00	IA	Yes	No	No	NA	No	NA	Nil	NA
South Bulga	21/10/2021 23:18	IA	No	No	No	NA	No	NA	Nil	NA
Wambo Road	21/10/2021 22:10	31	No	No	No	NA	No	NA	Nil	NA
Bulga RFS	23/11/2021 23:03	IA	No	No	No	NA	No	NA	Nil	NA
Bulga Village	23/11/2021 22:06	<25	No	No	No	NA	No	NA	Nil	NA

Location	Date and Time	Measured WML LAeq dB[1]	Criterion Applies?	Intermittency Modifying Factor?	Tonality Modifying Factor?	Frequency of Tonality[2]	Low-frequency Modifying Factor?	Maximum Exceedance of Reference Spectrum [2,3]	Penalty dB[3]	Exceedance
Gouldsville	23/11/2021 21:23	<30	No	No	No	NA	No	NA	Nil	NA
Inlet Rd	23/11/2021 21:22	<25	No	No	No	NA	No	NA	Nil	NA
Inlet Rd West	23/11/2021 21:01	IA	No	No	No	NA	No	NA	Nil	NA
Long Point	23/11/2021 21:00	IA	No	No	No	NA	No	NA	Nil	NA
South Bulga	23/11/2021 23:23	IA	No	No	No	NA	No	NA	Nil	NA
Wambo Road	23/11/2021 21:44	<25	No	No	No	NA	No	NA	Nil	NA
Bulga RFS	20/12/2021 22:53	30	Yes	No	No	NA	No	NA	Nil	NA
Bulga Village	20/12/2021 22:14	28	Yes	No	No	NA	No	NA	Nil	NA
Gouldsville	20/12/2021 21:28	<25	No	No	No	NA	No	NA	Nil	NA
Inlet Rd	20/12/2021 21:23	35	No	No	No	NA	No	NA	Nil	NA
Inlet Rd West	20/12/2021 21:00	32	Yes	No	No	NA	No	NA	Nil	NA
Long Point	20/12/2021 21:05	IA	Yes	No	No	NA	No	NA	Nil	NA
South Bulga	20/12/2021 23:33	IA	Yes	No	No	NA	No	NA	Nil	NA
Wambo Road	20/12/2021 21:50	35	Yes	No	No	NA	Yes	**1dB @ 80Hz**	**2**	NA

Notes:
1. IA denotes 'Inaudible';
2. NA denotes 'Not Applicable'; and
3. Bold results indicate that application of NPfI modifying factor/s is required.

Table 6: Mount Thorley Operations Low Frequency Noise Assessment – 2021

Location	Date and Time	Measured WML LAeq dB[1]	Criterion Applies?	Intermittency Modifying Factor?	Tonality Modifying Factor?	Frequency of Tonality[2]	Low-frequency Modifying Factor?	Maximum Exceedance of Reference Spectrum [2,3]	Penalty dB[3]	Exceedance
Bulga RFS	14/01/2021 22:59	IA	NA	No	No	NA	No	NA	Nil	NA
Bulga Village	14/01/2021 22:14	IA	NA	No	No	NA	No	NA	Nil	NA

Location	Date and Time	Measured WML LAeq dB[1]	Criterion Applies?	Intermittency Modifying Factor?	Tonality Modifying Factor?	Frequency of Tonality[2]	Low-frequency Modifying Factor?	Maximum Exceedance of Reference Spectrum [2,3]	Penalty dB[3]	Exceedance
Gouldsville	14/01/2021 21:23	IA	Nil	No	No	NA	No	NA	Nil	NA
Inlet Rd	14/01/2021 21:26	IA	Nil	No	No	NA	No	NA	Nil	NA
Inlet Rd West	14/01/2021 21:01	IA	Nil	No	No	NA	No	NA	Nil	NA
Long Point	14/01/2021 21:00	IA	Nil	No	No	NA	No	NA	Nil	NA
South Bulga	14/01/2021 23:22	IA	NA	No	No	NA	No	NA	Nil	NA
Wambo Road	14/01/2021 21:50	IA	NA	No	No	NA	No	NA	Nil	NA
Bulga RFS	17/02/2021 22:47	<30	No	No	No	NA	No	NA	Nil	NA
Bulga Village	17/02/2021 22:08	30	No	No	No	NA	No	NA	Nil	NA
Gouldsville	17/02/2021 21:33	IA	No	No	No	NA	No	NA	Nil	NA
Inlet Rd	17/02/2021 21:21	29	No	No	No	NA	No	NA	Nil	NA
Inlet Rd West	17/02/2021 21:00	25	No	No	No	NA	No	NA	Nil	NA
Long Point	17/02/2021 21:07	IA	No	No	No	NA	No	NA	Nil	NA
South Bulga	17/02/2021 23:35	IA	No	No	No	NA	No	NA	Nil	NA
Wambo Road	17/02/2021 21:45	33	No	No	No	NA	No	NA	Nil	NA
Bulga RFS	16/03/2021 0:19	IA	Yes	No	No	NA	No	NA	Nil	NA
Bulga Village	15/03/2021 23:34	IA	Yes	No	No	NA	No	NA	Nil	NA
Gouldsville	15/03/2021 21:29	IA	Yes	No	No	NA	No	NA	Nil	NA
Inlet Rd	15/03/2021 21:42	IA	Yes	No	No	NA	No	NA	Nil	NA
Inlet Rd West	15/03/2021 21:12	IA	Yes	No	No	NA	No	NA	Nil	NA
Long Point	15/03/2021 21:05	IA	No	No	No	NA	No	NA	Nil	NA
South Bulga	16/03/2021 1:05	IA	Yes	No	No	NA	No	NA	Nil	NA
Wambo Road	15/03/2021 22:11	IA	Yes	No	No	NA	No	NA	Nil	NA

Location	Date and Time	Measured WML LAeq dB[1]	Criterion Applies?	Intermittency Modifying Factor?	Tonality Modifying Factor?	Frequency of Tonality[2]	Low-frequency Modifying Factor?	Maximum Exceedance of Reference Spectrum [2,3]	Penalty dB[3]	Exceedance
Bulga RFS	21/04/2021 23:11	<30	Yes	No	No	NA	No	NA	Nil	NA
Bulga Village	21/04/2021 22:27	IA	Yes	No	No	NA	No	NA	Nil	NA
Gouldsville	21/04/2021 21:25	IA	Yes	No	No	NA	No	NA	Nil	NA
Inlet Rd	21/04/2021 21:31	IA	Yes	No	No	NA	No	NA	Nil	NA
Inlet Rd West	21/04/2021 21:00	IA	Yes	No	No	NA	No	NA	Nil	NA
Long Point	21/04/2021 21:03	IA	Yes	No	No	NA	No	NA	Nil	NA
South Bulga	21/04/2021 23:36	IA	Yes	No	No	NA	No	NA	Nil	NA
Wambo Road	21/04/2021 22:02	IA	Yes	No	No	NA	No	NA	Nil	NA
Bulga RFS	18/05/2021 0:04	IA	Yes	No	No	NA	No	NA	Nil	NA
Bulga Village	17/05/2021 23:18	IA	Yes	No	No	NA	No	NA	Nil	NA
Gouldsville	17/05/2021 21:25	IA	Yes	No	No	NA	No	NA	Nil	NA
Inlet Rd	17/05/2021 21:29	IA	Yes	No	No	NA	No	NA	Nil	NA
Inlet Rd West	17/05/2021 21:00	IA	Yes	No	No	NA	No	NA	Nil	NA
Long Point	17/05/2021 21:03	IA	Yes	No	No	NA	No	NA	Nil	NA
South Bulga	18/05/2021 0:26	IA	Yes	No	No	NA	No	NA	Nil	NA
Wambo Road	17/05/2021 21:57	IA	Yes	No	No	NA	No	NA	Nil	NA
Bulga RFS	1/06/2021 23:10	<30	Yes	No	No	NA	No	NA	Nil	NA
Bulga Village	1/06/2021 22:25	IA	Yes	No	No	NA	No	NA	Nil	NA
Gouldsville	1/06/2021 21:38	IA	Yes	No	No	NA	No	NA	Nil	NA
Inlet Rd	1/06/2021 21:36	IA	Yes	No	No	NA	No	NA	Nil	NA
Inlet Rd West	1/06/2021 21:15	IA	Yes	No	No	NA	No	NA	Nil	NA
Long Point	1/06/2021 21:13	IA	Yes	No	No	NA	No	NA	Nil	NA

Location	Date and Time	Measured WML LAeq dB[1]	Criterion Applies?	Intermittency Modifying Factor?	Tonality Modifying Factor?	Frequency of Tonality[2]	Low-frequency Modifying Factor?	Maximum Exceedance of Reference Spectrum [2,3]	Penalty dB[3]	Exceedance
South Bulga	1/06/2021 23:50	IA	Yes	No	No	NA	No	NA	Nil	NA
Wambo Road	1/06/2021 22:02	IA	Yes	No	No	NA	No	NA	Nil	NA
Bulga RFS	23/07/2021 1:19	NM	Yes	No	No	NA	No	NA	Nil	NA
Bulga Village	23/07/2021 0:19	IA	Yes	No	No	NA	No	NA	Nil	NA
Gouldsville	22/07/2021 21:22	IA	Yes	No	No	NA	No	NA	Nil	NA
Inlet Rd	22/07/2021 21:40	IA	Yes	No	No	NA	No	NA	Nil	NA
Inlet Rd West	22/07/2021 21:10	IA	Yes	No	No	NA	No	NA	Nil	NA
Long Point	22/07/2021 21:00	IA	Yes	No	No	NA	No	NA	Nil	NA
South Bulga	23/07/2021 0:53	35	Yes	No	No	NA	No	NA	Nil	NA
Wambo Road	22/07/2021 22:08	IA	Yes	No	No	NA	No	NA	Nil	NA
Bulga RFS	11/08/2021 0:00	IA	Yes	No	No	NA	No	NA	Nil	NA
Bulga Village	10/08/2021 23:16	IA	Yes	No	No	NA	No	NA	Nil	NA
Gouldsville	10/08/2021 21:24	IA	Yes	No	No	NA	No	NA	Nil	NA
Inlet Rd	10/08/2021 21:23	IA	Yes	No	No	NA	No	NA	Nil	NA
Inlet Rd West	10/08/2021 21:00	<20	Yes	No	No	NA	No	NA	Nil	NA
Long Point	10/08/2021 21:00	IA	Yes	No	No	NA	No	NA	Nil	NA
South Bulga	11/08/2021 0:18	IA	Yes	No	No	NA	No	NA	Nil	NA
Wambo Road	10/08/2021 21:48	IA	Yes	No	No	NA	No	NA	Nil	NA
Bulga RFS	7/09/2021 22:51	NM	Yes	No	No	NA	No	NA	Nil	NA
Bulga Village	7/09/2021 22:11	IA	Yes	No	No	NA	No	NA	Nil	NA
Gouldsville	7/09/2021 21:27	IA	Yes	No	No	NA	No	NA	Nil	NA
Inlet Rd	7/09/2021 21:22	IA	Yes	No	No	NA	No	NA	Nil	NA

Location	Date and Time	Measured WML LAeq dB[1]	Criterion Applies?	Intermittency Modifying Factor?	Tonality Modifying Factor?	Frequency of Tonality[2]	Low-frequency Modifying Factor?	Maximum Exceedance of Reference Spectrum [2,3]	Penalty dB[3]	Exceedance
Inlet Rd West	7/09/2021 21:00	IA	Yes	No	No	NA	No	NA	Nil	NA
Long Point	7/09/2021 21:01	IA	Yes	No	No	NA	No	NA	Nil	NA
South Bulga	7/09/2021 23:38	32	Yes	No	No	NA	No	NA	Nil	NA
Wambo Road	7/09/2021 21:49	NM	Yes	No	No	NA	No	NA	Nil	NA
Bulga RFS	21/10/2021 22:55	32	Yes	No	No	NA	No	NA	Nil	NA
Bulga Village	21/10/2021 21:48	<25	Yes	No	No	NA	No	NA	Nil	NA
Gouldsville	21/10/2021 21:22	IA	No	No	No	NA	No	NA	Nil	NA
Inlet Rd	21/10/2021 21:24	IA	No	No	No	NA	No	NA	Nil	NA
Inlet Rd West	21/10/2021 21:00	IA	Yes	No	No	NA	No	NA	Nil	NA
Long Point	21/10/2021 21:00	IA	Yes	No	No	NA	No	NA	Nil	NA
South Bulga	21/10/2021 23:18	31	No	No	No	NA	No	NA	Nil	NA
Wambo Road	21/10/2021 22:10	IA	No	No	No	NA	No	NA	Nil	NA
Bulga RFS	23/11/2021 23:03	33	Yes	No	No	NA	No	NA	Nil	NA
Bulga Village	23/11/2021 22:06	IA	Yes	No	No	NA	No	NA	Nil	NA
Gouldsville	23/11/2021 21:23	IA	No	No	No	NA	No	NA	Nil	NA
Inlet Rd	23/11/2021 21:22	<25	No	No	No	NA	No	NA	Nil	NA
Inlet Rd West	23/11/2021 21:01	<20	Yes	No	No	NA	No	NA	Nil	NA
Long Point	23/11/2021 21:00	IA	Yes	No	No	NA	No	NA	Nil	NA
South Bulga	23/11/2021 23:23	<25	No	No	No	NA	No	NA	Nil	NA
Wambo Road	23/11/2021 21:44	IA	No	No	No	NA	No	NA	Nil	NA
Bulga RFS	20/12/2021 22:53	NM	Yes	No	No	NA	No	NA	Nil	NA
Bulga Village	20/12/2021 22:14	28	Yes	No	No	NA	No	NA	Nil	NA

Location	Date and Time	Measured WML LAeq dB[1]	Criterion Applies?	Intermittency Modifying Factor?	Tonality Modifying Factor?	Frequency of Tonality[2]	Low-frequency Modifying Factor?	Maximum Exceedance of Reference Spectrum [2,3]	Penalty dB[3]	Exceedance
Gouldsville	20/12/2021 21:28	IA	No	No	No	NA	No	NA	Nil	NA
Inlet Rd	20/12/2021 21:23	30	No	No	No	NA	No	NA	Nil	NA
Inlet Rd West	20/12/2021 21:00	IA	Yes	No	No	NA	No	NA	Nil	NA
Long Point	20/12/2021 21:05	IA	Yes	No	No	NA	No	NA	Nil	NA
South Bulga	20/12/2021 23:33	25	Yes	No	No	NA	No	NA	Nil	NA
Wambo Road	20/12/2021 21:50	IA	Yes	No	No	NA	No	NA	Nil	NA

Notes:
1. IA denotes 'Inaudible';
2. NA denotes 'not applicable'; and
3. Bold results indicate that application of NPfI modifying factor/s is required.

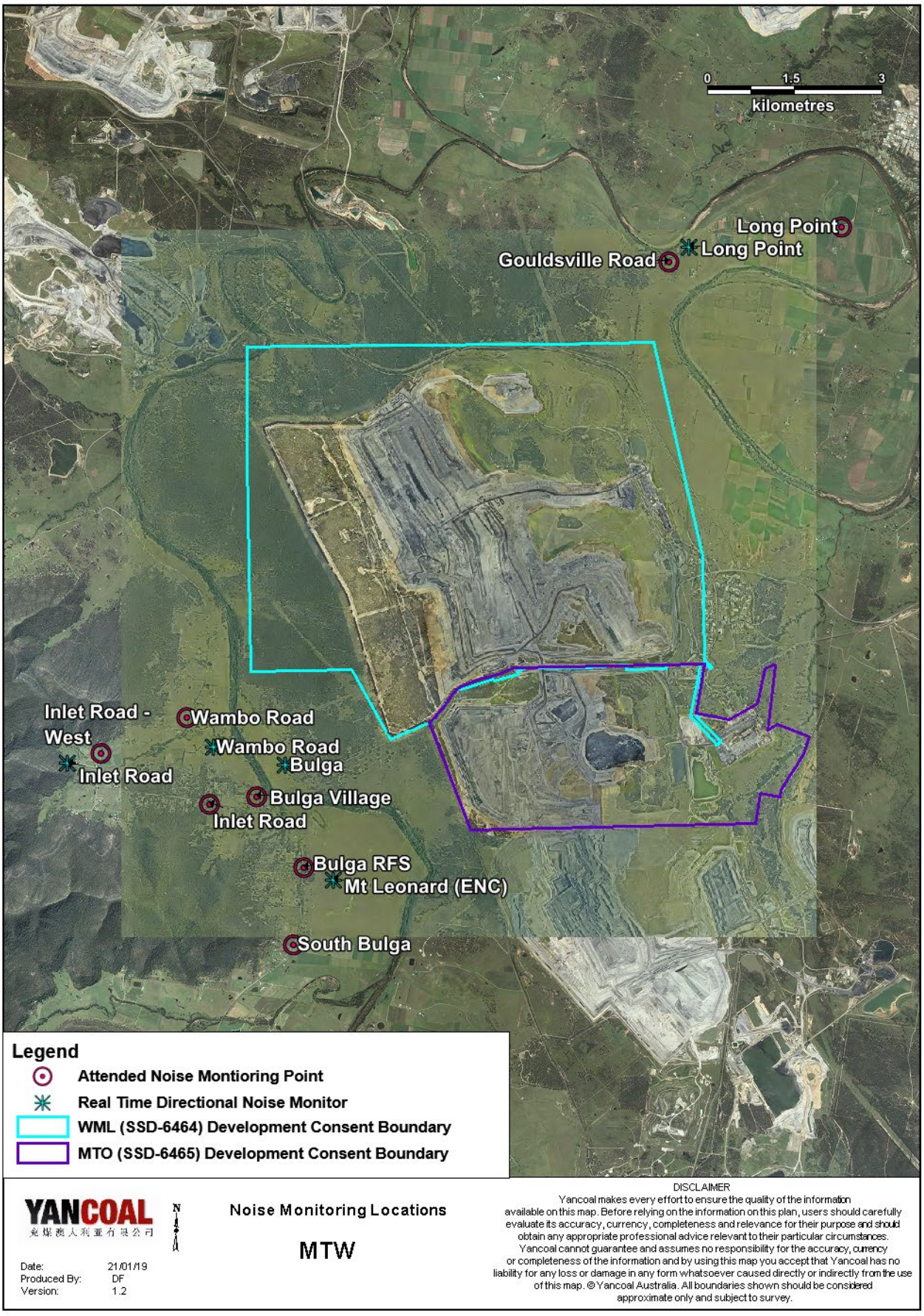


Figure 1: Noise Monitoring Location Plan

Appendix 2:

Aboriginal Heritage Management Plan Compliance Inspection Report

Mount Thorley Warkworth

Aboriginal Heritage Management Plan 2021 Compliance Audit Inspection

Report prepared for

Yancoal Australia, Mount Thorley Warkworth



November 2021

Joel Deacon

ARROW HERITAGE SOLUTIONS

Introduction

Yancoal Australia (Yancoal) manage the Mount Thorley Warkworth (MTW) mining complex located in the Hunter Valley, approximately 8km south-west of Singleton. Approval for the continuation & expansion of the mine was granted on 26th November 2015 under two separate project approvals: the Warkworth Continuation Project Approval (SSD-6464) & the Mount Thorley Operations Project Approval (SSD-6465).

Pursuant to Condition 43 of the Warkworth Continuation Project Approval, & Condition 28 of the Mount Thorley Operations Project Approval, Yancoal developed a MTW Aboriginal Heritage Management Plan (AHMP) to cover both mining operations, which was approved by the Department of Planning & Environment on 29th May 2017. This AHMP sets out the principles, processes & measures through which Aboriginal cultural heritage (ACH) will be managed within the AHMP Area. This includes a commitment (Provision 24) to conduct annual AHMP compliance inspections with members of the Aboriginal community, through the auspices of the MTW Aboriginal Cultural Heritage Working Group (CHWG), throughout the life of operations. The purpose of the compliance inspections is to afford the Aboriginal stakeholders & MTW:

- the opportunity to visit mine operations and mine areas to inspect the operational compliance with AHMP provisions & Ground Disturbance Permit procedures;
- to inspect and monitor the condition and management of various sites over time; and
- to review the effectiveness and performance of AHMP provisions in the management of cultural heritage at the mine.

These compliance inspections are conducted at least annually. Due to the number of ACH sites within the AHMP area & the time required to inspect all sites, it is not feasible to inspect every site during the same field trip. Therefore, a regular, rolling program of compliance inspections has been implemented that will visit all sites at each location periodically. A record will be kept of each compliance inspection so that it can be ensured that each site is inspected regularly.

Proposed Activity and Project Brief

The compliance inspections involved the following elements:

- Fifty-three (53) ACH site locations were visited and AHMP compliance inspection proformas were completed for each noting evidence of compliance and non-compliance with AHMP provisions, recommendations on modifications and improvements to management provisions, and recommendations on corrective actions; and
- A photographic record was completed for the inspected ACH sites.

Timing & Personnel

The 2021 MTW AHMP compliance inspection program was conducted on Tuesday and Wednesday 2/3 November 2021. The personnel involved in these inspections were:

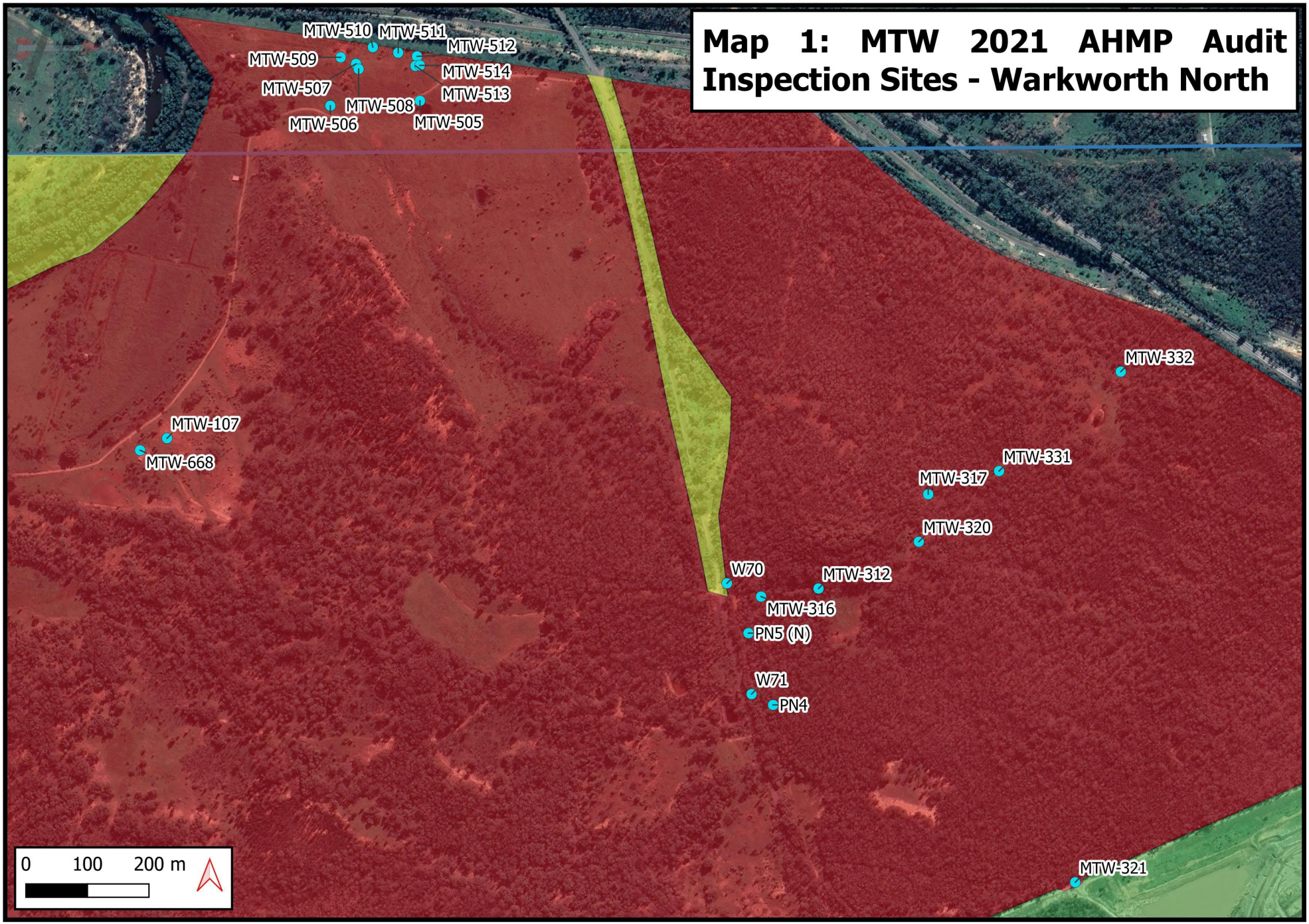
Name	Position/Organisation
Joel Deacon	Archaeologist, Arrow Heritage Solutions
Joshua van Bezouwen	Environment and Community Coordinator, MTW
Christine Paul	CHWG representative
Arthur Fletcher	CHWG representative

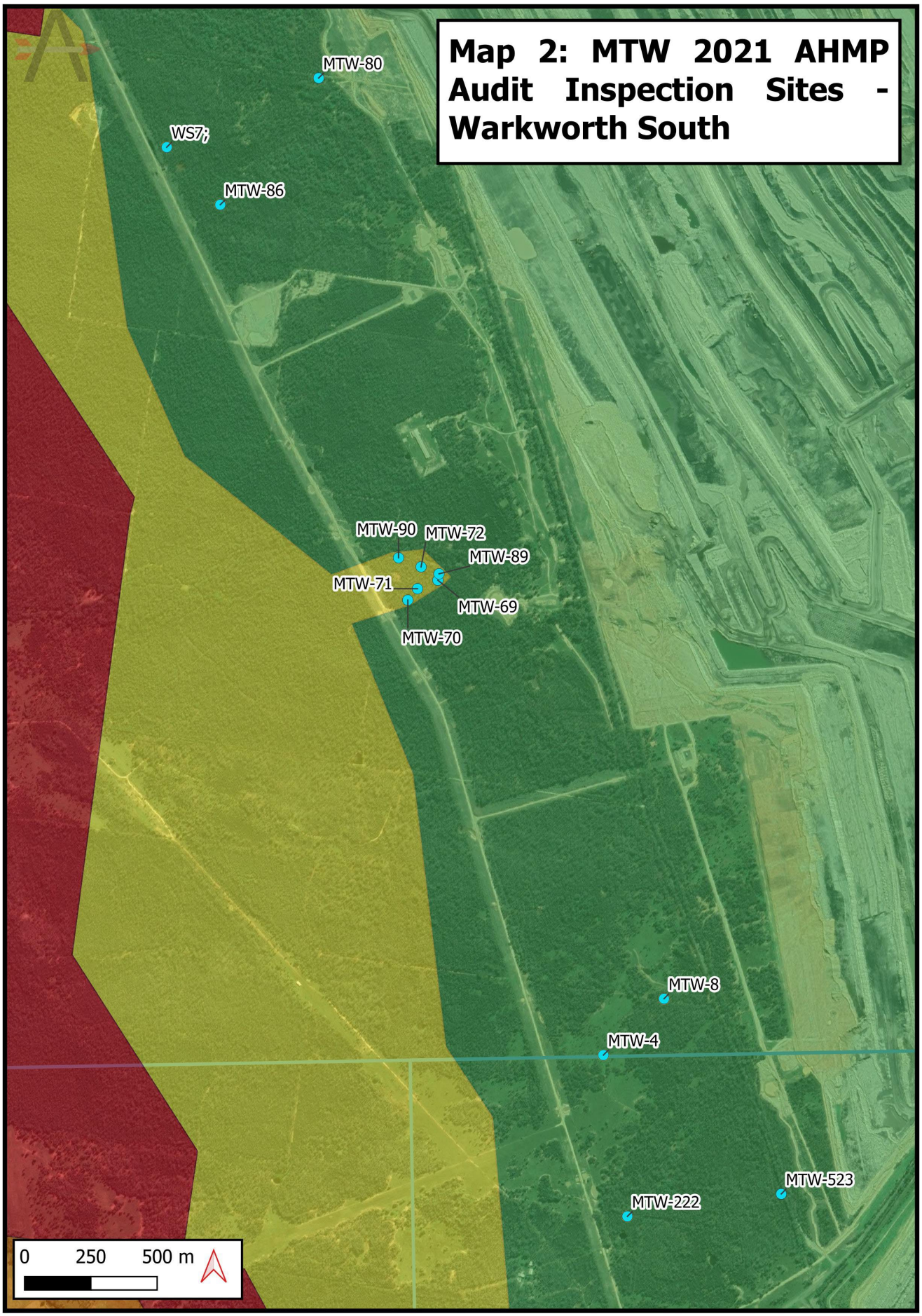
Arrow Heritage Solutions were engaged as independent heritage consultants to conduct the AHMP compliance inspections, and Joel Deacon acted as technical advisor and author of this report. MTW's Environment and Communities Co-ordinator Joshua van Bezouwen arranged the compliance inspection programs and escorted the field team. CHWG representatives from Aboriginal Native Title Consultants and Wonn1 participated in the field work program.

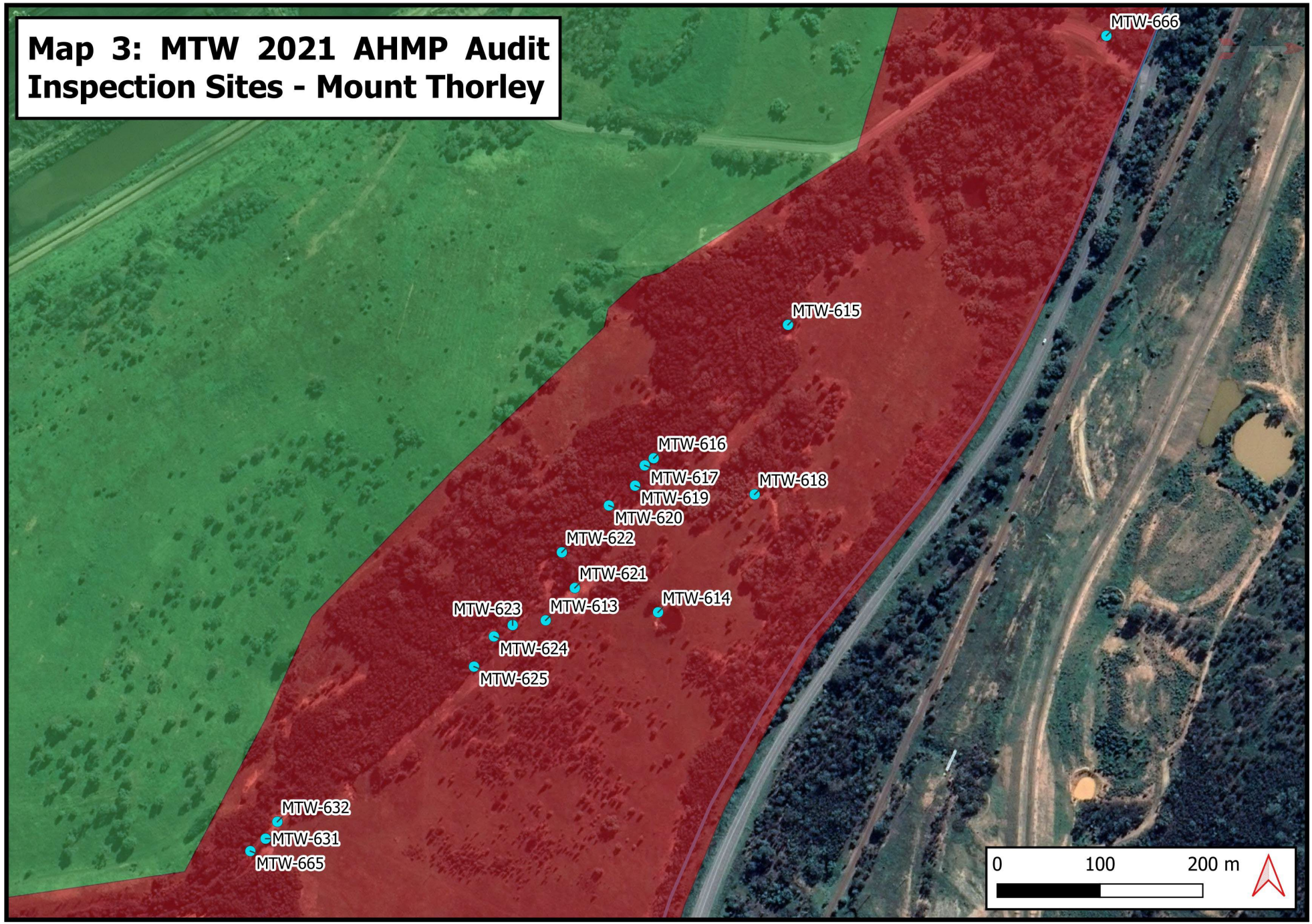
MTW AHMP Compliance Inspection

A total of 53 ACH sites were inspected across both the Warkworth and the Mount Thorley operations (see Maps 1, 2 and 3). The areas at Warkworth were selected for inspection as they were either located adjacent to current development areas or alongside regular tracks that are being frequently accessed. A sample of sites from within the Wollombi Brook ACH Conservation Area (WBACHCA) were also inspected to ensure they were being managed effectively and not subject to any natural disturbance, such as erosion. At Mount Thorley, ACH sites were inspected within the Loder Creek Aboriginal Cultural Heritage Conservation Area (LCACHCA) to ensure they were also being managed effectively.

In addition, a recent project area at Mt Thorley was also inspected to ensure that ACH site protection requirements were fully considered and completed in the course of ground disturbing works.


Map 1: MTW 2021 AHMP Audit Inspection Sites - Warkworth North
MTW-510
MTW-511
MTW-512
MTW-509
MTW-514
MTW-507
MTW-513
MTW-508
MTW-506
MTW-505
MTW-332
MTW-107
MTW-668
MTW-331
MTW-317
MTW-320
W70
MTW-312
MTW-316
PN5 (N)
W71
PN4
MTW-321
0
100
200 m


Map 2: MTW 2021 AHMP Audit Inspection Sites - Warkworth South
MTW-80
WS7;
MTW-86
MTW-90
MTW-72
MTW-89
MTW-71
MTW-69
MTW-70
MTW-8
MTW-4
MTW-523
MTW-222
0
250
500 m


Map 3: MTW 2021 AHMP Audit
Inspection Sites - Mount Thorley
MTW-666
MTW-615
MTW-616
MTW-617
MTW-618
MTW-619
MTW-620
MTW-622
MTW-621
MTW-623
MTW-613
MTW-614
MTW-624
MTW-625
MTW-632
MTW-631
MTW-665
0
100
200 m

Results

Table 1 shows the results of the 2021 MTW compliance inspection and summarises the information recorded on the individual proforma inspection sheets. Using a mobile mapper pre-loaded with the GIS co-ordinates for each ACH site, the field team travelled to each location and attempted to re-locate each site. Sometimes this was not possible due to poor ground surface visibility, a result which in itself was not overly significant as long as it was determined that the vicinity had not been disturbed. The presence and condition of barricading or fencing was noted, as well as the presence and nature of various potential site disturbing factors (e.g. erosion, animal, human). Pertinent observations of each site were made if necessary, and, based on information provided for all the above factors, management recommendations were discussed and agreed by the field team for each site.

Site Name	Date	Mine	Site re-identified?	Site intact?	Site fenced/ barricaded?	Fencing/ barricading intact?	Natural erosion	Livestock damage	Human disturbance	Animal disturbance	Pests & weeds	General observations	Management recommendations
MTW-107	2/11/21	WML	No	Yes	Yes	No	Some	No	Old track	No	No	Track edges formerly barricaded	Rebarricade sites to keep people on track
MTW-222	2/11/21	MTO	Yes	Yes	Yes	Yes	No	No	No	No	No		
MTW-312	2/11/21	WML	Yes	Yes	Yes	Yes	No	No	No	No	No	Track has been re-routed to avoid site	
MTW-316	2/11/21	WML	Yes	Yes	Yes	Yes	No	No	No	No	No		
MTW-317	2/11/21	WML	No	Yes	No	-	No	No	No	No	Prickly pear		
MTW-320	2/11/21	WML	No	Yes	Yes	No	No	No	No	No	No	Is on old track	Close track and barricade at this point
MTW-321	2/11/21	WML	Yes	Yes	Yes	Yes	No	No	No	No	No	In good condition	
MTW-331	2/11/21	WML	No	Yes	No	-	No	No	No	No	No		-
MTW-332	2/11/21	WML	No	Yes	Yes	No	No	No	No	No	No	Track edges formerly barricaded	Rebarricade sites to keep people on track
MTW-4	2/11/21	WML	No	Yes	Yes	Yes	No	No	No	No	No	Track has been diverted to avoid site	
MTW-505	3/11/21	WML	Yes	Yes	Yes	Yes	No	No	No	No	No		
MTW-506	3/11/21	WML	Yes	Yes	Yes	Yes	No	No	No	No	No	Artefacts noted outside of fence	Rebarricade along track edge
MTW-507	3/11/21	WML	Yes	Yes	Yes	Yes	No	No	No	No	No	Artefacts noted outside of fence	Extend barricading to tree planting area
MTW-508	3/11/21	WML	Yes	Yes	No	-	No	No	No	No	No		
MTW-509	3/11/21	WML	Yes	Yes	Yes	Yes	Yes	No	No	No	No		Extend barricading along track
MTW-510	3/11/21	WML	No	Yes	Yes	Yes	No	No	No	No	No	Artefacts noted outside of fence	Rebarricade along track edge
MTW-511	3/11/21	WML	No	Yes	No	-	No	No	No	No	No		Barricade nearby track edge
MTW-512	3/11/21	WML	Yes	Yes	No	-	No	No	No	No	No		
MTW-513	3/11/21	WML	Yes	Yes	Yes	Yes	No	No	No	No	No		
MTW-514	3/11/21	WML	Yes	Yes	Yes	Yes	No	No	No	No	No		
MTW-523	3/11/21	MTO	Yes	Yes	Yes	Yes	No	No	No	No	No		Tree to be salvaged as per current ToR
MTW-613	3/11/21	MTO	No	Yes	Yes	Yes	No	No	No	No	No		
MTW-614	3/11/21	MTO	Yes	Yes	No	-	No	No	Dam construction	No	No		
MTW-615	3/11/21	MTO	Yes	Yes	No	-	No	No	No	No	No	More extensive than first recorded	
MTW-616	3/11/21	MTO	No	Yes	No	-	No	No	No	No	No		
MTW-617	3/11/21	MTO	Yes	Yes	No	-	No	No	No	No	No		
MTW-618	2/11/21	MTO	No	Yes	Yes	Yes	Severe near track	No	Old track	No	No		Investigate erosion control measures
MTW-619	3/11/21	MTO	Yes	Yes	No	-	No	No	No	No	No		

Site Name	Date	Mine	Site re-identified?	Site intact?	Site fenced/ barricaded?	Fencing/ barricading intact?	Natural erosion	Livestock damage	Human disturbance	Animal disturbance	Pests & weeds	General observations	Management recommendations
MTW-620	3/11/21	MTO	Yes	Yes	No	-	No	No	No	No	No		
MTW-621	3/11/21	MTO	Yes	Yes	Yes	Yes	No	No	Old track	No	No		
MTW-622	3/11/21	MTO	Yes	Yes	No	-	No	No	No	No	No		
MTW-623	3/11/21	MTO	Yes	Yes	No	-	No	No	No	No	No		
MTW-624	3/11/21	MTO	Yes	Yes	No	-	No	No	No	No	No		
MTW-625	3/11/21	MTO	Yes	Yes	No	-	No	No	No	No	No		
MTW-631	3/11/21	MTO	Yes	Yes	No	-	severe	No	No	No	No		Investigate erosion control measures
MTW-632	3/11/21	MTO	Yes	Yes	No	-	severe	No	No	No	No		Investigate erosion control measures
MTW-665	3/11/21	MTO	Yes	Yes	No	-	severe	No	No	No	No		Investigate erosion control measures
MTW-6*6	3/11/21	MTO	Yes	Yes	No	-	No	No	On fence-line	No	No	Located just behind MTO CHPP road fence	
MTW-668	3/11/21	MTO	No	Yes	Yes	Yes	No	No	Under collapsed shed	No	No		Rebarricade when shed is removed – monitor removal
MTW-69	2/11/21	WML	Yes	Yes	Yes	Yes	No	No	No	No	No		
MTW-70	2/11/21	WML	Yes	Yes	Yes	Yes	No	No	No	No	termites	Tree has been burnt and has termites	
MTW-71	2/11/21	WML	Yes	Yes	Yes	Yes	No	No	No	No	No		
MTW-72	2/11/21	WML	No	Yes	Yes	Yes	No	No	No	No	No		
MTW-8	2/11/21	WML	Yes	Yes	Yes	Yes	No	No	No	No	No		Tree to be salvaged as per current ToR
MTW-80	2/11/21	WML	Yes	Yes	Yes	Yes	No	No	No	No	No		Tree to be salvaged as per current ToR
MTW-86	2/11/21	WML	No	Yes	Yes	Yes	No	No	No	No	No		
MTW-89	3/11/21	WML	Yes	Yes	Yes	Yes	Some wash	No	No	No	No		
MTW-90	2/11/21	WML	No	Yes	Yes	Yes	No	No	Old track	No	No		
PN4	2/11/21	WML	No	Yes	Yes	No	No	No	No	No	No		Rebarricade
PN5 (N)	2/11/21	WML	No	Yes	Yes	No	No	No	No	No	No		Rebarricade site to keep people on track
W70	2/11/21	WML	Yes	No	Yes	No	Yes	No	On track	No	No	Artefacts washing onto track	Rebarricade site to keep people on track
W71	2/11/21	WML	No	Yes	Yes	No	Yes	No	No	No	No		Rebarricade site to keep people on track
WS7	2/11/21	WML	No	Yes	Yes	Yes	No	No	No	No	No		

Table 1: Results of 2021 MTW AHMP Compliance Inspection

Aboriginal Site Management Recommendations

All ACH site locations visited during the AHMP compliance inspection were found to be intact with no recent damage or unauthorised disturbance noted, however, natural erosion processes were noted at some sites. Not all ACH sites were able to be re-identified, but this was due to thick vegetation cover obscuring the ground surface rather than due to inadvertent destruction. Management recommendations were provided for the majority of the ACH sites visited during the 2021 compliance inspection. These recommendations are described below.

Install or reinstall/repair barricade, wire and/or signage

Sites: MTW-107, 320, 332, 506, 507, 509, 510, 511, PN4, PN5 (N), W70 and W71



Example of dilapidated barricading (at MTW-320)

Most of the barricading at these ACH sites, although visible to some extent, was generally in a state of disrepair. The barricading for these sites is recommended around the site itself or along the edges of tracks in order to keep vehicles on these tracks where the actual extent of the site is large or unclear. In some cases, barricading is recommended to be extended due to additional artefacts being found outside of existing barricading. The specific recommendations for each site is noted in Table 1 above. Barricading should consist of hi-vis string line and signage delineating the area as an ACH site to be avoided.

Monitor shed removal and re-barricade

Sites: MTW-668

This site consists of a broken jar of artefacts that were discovered in a dilapidated farm shed that has since collapsed. The artefacts were likely collected by a former land-owner and deposited in the jar many years ago. Nearby structures have been removed, however, this particular shed was not touched because of the presence of the artefacts.

In order to complete the clean up of this area, it is recommended that the shed be removed, by hand where possible (especially in the vicinity of the artefacts), and the process monitored by a representative of the CHWG. Once the shed is removed and the artefacts reidentified, barricading can be erected around the site, which is located within the WBACHCA and cannot, therefore, be salvaged under the terms of the current management plans.



Star pickets indicate location of artefacts at MTW-668 underneath collapsed shed

Investigate erosion control measures

Sites: MTW-618, 631, 632, 665

These four ACH sites are located within the LCACHCA and are currently being affected by erosion. MTW-618 is located adjacent to a vehicle crossing on the banks of an eroding gully, the effects of which have been exacerbated by traffic. As this crossing is now to steep for continued use, the closing of this track should allow vegetation to regenerate and stabilise the bank. The remaining three sites are located on the bank of Loder Creek, where deeply incised erosion channelling is occurring, which is having the effect of washing artefacts away or covering them with sediment.



Severe erosion at MTW-632

As more sites further upstream have been identified during past audits as suffering the same erosion effects, rather than a site by site approach, it is suggested that a holistic environmental remediation plan be developed and implemented for the LCACHCA, with input from the CHWG and their assistance sought in its implementation. As no disturbance approval is currently in place for ACH sites within the LCACHCA, approval should be sought from Heritage NSW to allow the temporary removal of artefacts from remediation areas and their replacement once revegetation has been established and erosion has ceased.

Remove and relocate scarred trees

Sites: MTW-8; 80; 523

These three scarred trees are located within the approved future mining area at MTW and have been assessed by an arborist regarding the best method of removal and relocation. These scarred trees have also been visited by RAPs during this compliance inspection and during other inspections and assessments. A removal and relocation plan has been developed by MTW and the salvage of these trees is planned for 2022, with representatives of the CHWG to be involved.



Scarred tree MTW-8



Scarred tree MTW-523



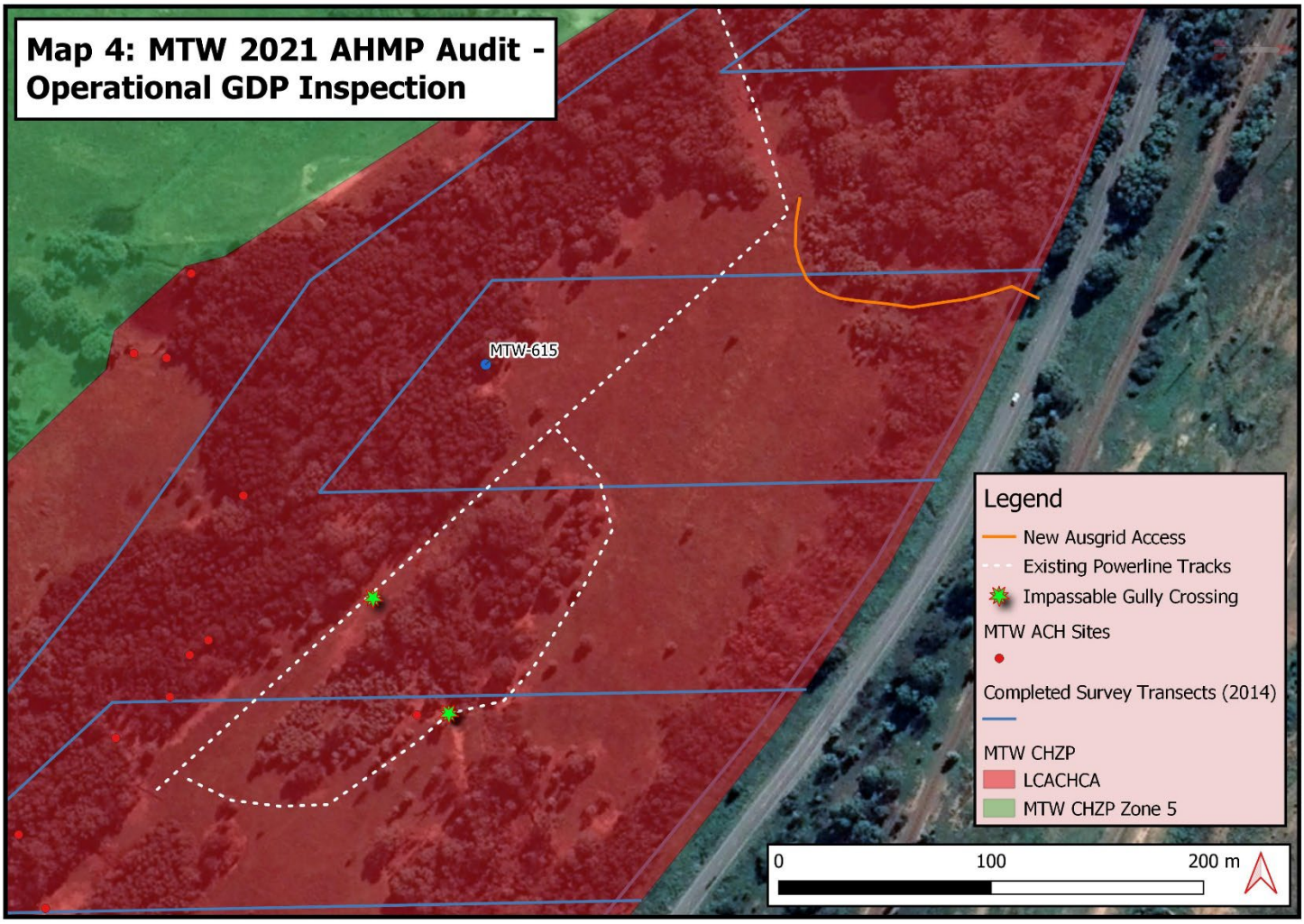
Scarred tree MTW-80

Ground Disturbance Audit Check

Aside from affording CHWG representatives with an opportunity to visit mining operations and monitor the condition of ACH sites, another intention of the compliance inspections is to provide the opportunity to inspect the operational compliance with AHMP provisions and GDP procedures. To this end, an inspection was made of a new route required by Ausgrid to access an existing powerline, that had been processed through the GDP procedure.

This access route measured c.150m in length and was designed to minimise vegetation disturbance and avoid impacts on any ACH sites. It runs west from Broke Rd to link up with an existing powerline track (see map below). This new access is required by Ausgrid as the former access to this part of the powerline has been closed due to erosion in a drainage gully, with remediation earthworks to the former access likely to cause impacts to previously recorded ACH sites.

The entire area has been subject to previous ACH assessments, most recently in September 2014 when comprehensive pedestrian transects were conducted by archaeologists and representatives of the CHWG. The nearest recorded ACH site (MTW-615 – an isolated mudstone flake) is located 150m to the south-west of the new access route.



Results of Audit Inspection

The field team inspected the new access route and confirmed the results of the 2014 ACH assessment. No ACH objects or sites were located on the new access route. The nearest ACH site – MTW-615 – was inspected and successfully relocated. In terms of the overall management of ACH in this area, it was agreed that the installation of this new track, which does not disturb any ACH sites, would be preferable to the potential remediation of the existing powerline track and the subsequent disturbance of previously recorded cultural material.

Conclusions and Recommendations

The 2021 AHMP compliance inspection has been conducted as per the procedures outlined in the AHMP. No unauthorised site disturbances or AHMP non-compliances were observed during the inspection, and no issues were raised by the CHWG representatives present. A number of recommendations have been made to enhance or assist with the management of ACH at MTW:

1. **Install or reinstall/repair barricading at, or in the vicinity of, ACH sites MTW-107, 320, 332, 506, 507, 509, 510, 511, PN4, PN5 (N), W70 and W71;**
2. **Representative/s of the CHWG to monitor the removal of the shed, if required, on top of ACH site MTW-668 and rebarricade;**
3. **Explore erosion remediation measures within the LCACHCA, especially in the vicinity of ACH sites MTW-618, 631, 632, 665; and**
4. **With the participation of representatives of the CHWG, an archaeologist and an arborist team, remove and relocate scarred trees MTW-8, 80 and 523, considering the Wollombi Brook ACH Conservation Area as a relocation destination.**

Appendix 3:

Historic Heritage Management Plan Compliance Inspection Report

Mount Thorley Warkworth Historic Heritage Management Plan 2021 Compliance Audit Inspection

Report prepared for

Yancoal Australia, Mount Thorley Warkworth



March 2022

Joel Deacon

ARROW HERITAGE SOLUTIONS

Introduction

Yancoal Australia (Yancoal) manage the Mount Thorley Warkworth (MTW) mining complex located in the Hunter Valley, approximately 8km south-west of Singleton. Approval for the continuation & expansion of the mine was granted on 26 November 2015 under two separate project approvals: the Warkworth Continuation Project Approval (SSD-6464) & the Mount Thorley Operations Project Approval (SSD-6465).

Pursuant to Condition 46 of the Warkworth Continuation Project Approval, Yancoal have developed an MTW Historic Heritage Management Plan (HHMP) that covers the whole MTW mining complex. The MTW HHMP was approved by the Department of Planning & Environment on 11 October 2017 and sets out the principles, processes & measures through which historic heritage will be managed within the HHMP Area. This includes the commitment (Provision 19) to conduct annual HHMP compliance inspections with members of the community through the auspices of the Community Heritage Advisory Group (CHAG). The purpose of the HHMP compliance inspections is to:

a. inspect areas and sites to assess compliance with the provisions of the HHMP;
b. inspect and monitor the condition and management of various sites; and
c. review the effectiveness and performance of the HHMP provisions in the management of historic heritage at MTW.

Proposed Activity and Project Brief

The following historic sites within the MTW HHMP area (shown on the map below) are to be inspected to assess compliance with actions listed in the HHMP and specific Conservation Management Plans (CMP). A detailed photographic record for each site was also collated to add to the previous photographic data:

- Former RAAF Base Bulga Mess Hall
- Springwood Homestead
- Mount Thorley Brick Farm House


Historic Heritage Sites Inspected
2021 MTW HHMP Compliance Audit
Springwood Homestead
Mount Thorley Red Brick House
Former RAAF Base Bulga Mess Hall
1 0 1 2 3 4 km
Legend
HHMP Audit Sites
Warkworth Continuation DC Boundary
MTW Mining Leases

Timing & Personnel

The 2021 MTW HHMP compliance inspection was conducted on Thursday 18 November 2021. The personnel involved in this inspection were:

Name	Position/Organisation
Joel Deacon	Archaeologist, Arrow Heritage Solutions
Drew Williams	Environment and Community Coordinator, MTW
Lyn MacBain	CHAG representative

Arrow Heritage Solutions were engaged as independent heritage consultants to conduct the HHMP compliance inspection, and Joel Deacon acted as technical advisor and author of this report. MTW's Environment and Community Coordinator arranged the compliance inspection program and escorted the field team. Lyn MacBain participated in the inspection as a representative of the CHAG forum.

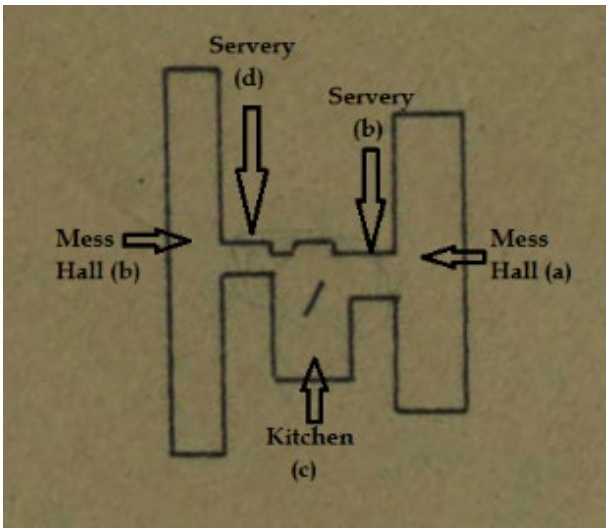
Former RAAF Base Bulga Mess Hall

Following the Japanese attack on Pearl Harbour in December 1941, plans were approved to expand existing RAAF bases and establish new ones, including a number of sites in the Hunter Valley. Bulga was identified as a potential site for an operational base and the area was officially taken over by the RAAF on 12 June 1942 for use as a relief landing strip. By July 1943 the site was completed, including the kitchen and mess hall, however, by January 1944 the use of the site was limited due to the decreasing threat of attack. A 1946 condition report noted this building as deteriorating. In January 1953, the building was noted as missing a few sheets of iron and windows.

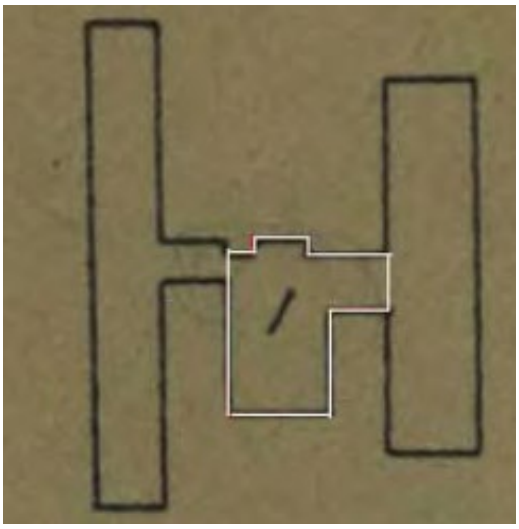
The building sits in the former camp area west of the north-south runway. It was originally irregular in plan comprising a central kitchen area measuring 13.4 x 8.8m, with long rectangular mess halls to the east and west, connected by a servery on either side. The remnant structure today comprises the kitchen building and the foundation of one of the serveries (see below).

The remnant building is "L" shaped in plan with brick and concrete footings. During the original assessment conducted by ERM in November 2012 (which informed the CMP) the building was noted as being in poor condition with trees physically impacting on the building fabric, and some minor settlement issues resulting in cracking and failing brickwork. The western section

of the building was the most intact part, retaining the original timber frame, corrugated asbestos cement roof sheeting and walls clad with corrugated iron sheeting.



Original layout of building



Remaining structure

The building is currently structurally unsound, with a number of timber elements either missing or in a deteriorated state. Corrugated asbestos roof sheeting is also missing in some places, and damaged and in poor condition where it remains. Much of the corrugated iron sheeting is corroded. Brickwork is also cracking in a number of locations resulting in significant movement outward, loss of mortar and loss of bricks along the southern and eastern elevations.



View to mess from south-east (2012)



Remnant kitchen area (2012)

As a result, a number of structural recommendations were outlined by ERM in the CMP developed for the site in 2012. These recommendations were not intended to return the building to a serviceable state, rather they sought to do the minimum required to allow safe access to the building to prevent significant damage, and also allow safe access for asbestos removal and internal inspection of the building in the short to medium term.

CMP Requirements

Short to medium term structural recommendations included:

a) **Remove fallen tree branch.** The tree branch impacting on the roof of the building should be removed, using an external mobile elevated platform or boom lift;
b) **Temporary propping.** The building should be temporarily propped and supported as per Bligh Tanner plans SK 1.0 A and SK 2.0 A (contained within the CMP) to allow for safe access into the building and more detailed inspection of the structure.
c) **Asbestos Removal.** Asbestos removal should be completed by a licensed asbestos removal specialist, include the roof sheeting, all asbestos dust and fibres, and loose fragments that are known to exist in the remaining area.
d) **Stabilise framework and replace roof.** Any structural roof members that are destabilized once the roof sheeting is removed are to be secured as required. Side walls which lose stiffness once the roof sheeting has been removed are to be propped temporarily until the new roof has been replaced.
e) **Archaeological clean-up.** Asbestos removal and clean-up should be supervised by a historical archaeologist to ensure any identified items of significance are retained.
f) **Further building inspection.** A structural engineer should complete a building inspection to identify structural repairs and stability requirements with four weeks of the building being cleaned up and decontaminated from asbestos.

Following the internal inspection of the building noted in (f) above, further advice may be provided regarding further recommendations, which, due to the lack of integrity of the building, are unlikely to be directed at restoration, but more towards retaining the remnant structure in a safe environment and reducing further deterioration. Repair drawings have been provided in the CMP to remedy any major cracking in the brickwork or where sections of brickwork have either partially collapsed or broken away from the wall.

Photographic Comparison 2012; 2018; 2020 (Mar); 2020 (Dec); 2021

During the inspection of the Former RAAF Base Bulga Mess Hall for this report, a number of photographs were taken from the same angles and of the same features as were taken during the ERM 2012 assessment and archival recording as well as during the 2018, March 2020 and December 2020 HHMP compliance inspections. These photographs provide a visual baseline condition assessment of the building, and also allow a comparative analysis of the deterioration, or maintenance, levels over the last six to nine years. These photographs are set out below, along with comments pertinent to management recommendations.

2012	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	
	**East elevation** **2012-18:** no discernible change – note fallen branch from tree on western side. **2018-20 (Mar):** no discernible change – fallen branch has moved. **Mar 2020 – Dec 2020:** no discernible change. **Dec 2020 – 2021:** no discernible change.

2012	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	**South-east elevation** **2012-18:** evidence of increased bow to southern wall. **2018-20 (Mar):** bow in wall appears to have increased. **Mar 2020 – Dec 2020:** bow in wall continues to increase. **Dec 2020 – 2021:** gap in bowing has increased.
	

2012	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	**South elevation** **2012-18:** evidence of increased bow to southern wall and missing panel above entry. **2018-20 (Mar):** increased bow to southern wall. **Mar 2020 – Dec 2020:** increased bowing on southern wall. **Dec 2020-2021:** gap in bowing has increased.
	

2012	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	
	**<u>West elevation</u>** **2012-18:** shows deterioration of roofing members above open kitchen area and leaning north wall, and further collapse of asbestos roof due to fallen dead tree. **2018-20 (Mar):** top of north wall now collapsed, further damage to roof with branch now fallen to ground. **Mar 2020 – Dec 2020:** no discernible change. **Dec 2020-2021:** northern wall on near side of chimney has detached from exposed western beam.

2012	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	**North elevation** **2012-18:** no discernible change. **2018-20 (Mar):** top of north wall now collapsed. **Mar 2020 – Dec 2020:** no discernible change. **Dec 2020-2021:** no discernible change.
	

2012	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	**Concrete and brick foundation at east side of building** **2012-18:** difficult to discern change. **2018-20 (Mar):** no discernible change. **Mar 2020 – Dec 2020:** no discernible change. **Dec 2020-2021:** difficult to discern change.
	

2012	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	
	**<u>Grease trap at south end of building</u>** **2012-18:** shows bow to south wall. **2018-20 (Mar):** shows increased bow to south wall. **Mar 2020 – Dec 2020:** shows increasing bowing of south wall, and example of new termite monitoring system in bottom right of picture. **Dec 2020-2021:** shows increasing bowing of south wall.

2012	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	
	**<u>Storage area at south end of building</u>** **2012-18:** further slight collapse of storage area. **2018-20 (Mar):** shows loosening of corrugated iron wall sheeting due to bowing in wall. **Mar 2020 – Dec 2020:** no discernible change. **Dec 2020-2021:** no discernible change.

2012	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	
	**Windows and entry at west elevation** **2012-18:** shows large trunk/branch portions of tree collapsed on roof, which has destroyed roof ventilator. **2018-20 (Mar):** shows majority of branches fallen from roof, leaving increased damage to sheeting. **Mar 2020 – Dec 2020:** no discernible change. **Dec 2020-2021:** no discernible change.

2012	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	**Timber window detail, west elevation** **2012-18:** no discernible change. **2018-20 (Mar):** no discernible change. **Mar 2020 – Dec 2020:** no discernible change. **Dec 2020-2021:** no discernible change.
	

2012	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	
	**<u>Showing cylindrical ventilator and damage to roof, view from west</u>** **2012-18:** shows significant roof damage from fallen dead tree, including to ventilator. **2018-20 (Mar):** shows increased damage to roof edge sheeting from fallen branch. **Mar 2020 – Dec 2020:** no discernible change. **Dec 2020-2021:** deterioration of left window frame.

2012	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	
	**Detail of north-west elevation** **2012-18:** shows increased collapse over open kitchen area, as well as new damage to brick foundation at north-west corner. **2018-20 (Mar):** shows fallen top of north wall plus increased (animal?) damage to brick foundation at north-western corner. **Mar 2020 – Dec 2020:** no discernible change. **Dec 2020 – 2021**: detachment of north wall from western beam

2012	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	
	**<u>Showing interior damage at kitchen at north end of building</u>** **2012-18:** shows increased collapse over and accumulation of debris within open kitchen area. Note also severe lean to north wall. Stove doors have become unhinged. **2018-20 (Mar):** shows collapsed top of north wall and collapse of remaining full cross-beam. Stove now obscured by collapsed north wall. **Mar 2020 – Dec 2020:** no discernible change. **Dec 2020 – 2021:** no discernible change.

2012	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	
	**<u>View to interior of south end of building, view from east</u>** **2012-18:** shows increased collapse over open kitchen area. **2018-20 (Mar):** shows further minor deterioration of asbestos panelling. **Mar 2020 – Dec 2020:** no discernible change. **Dec 2020 – 2021:** no discernible change.

2012	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	
	**Showing west interior space** **2012-18:** no discernible change. **2018-20 (Mar):** no discernible change. **Mar 2020 – Dec 2020:** no discernible change. **Dec 2020 – 2021**: no discernible change.

2012	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	
	**<u>Damaged brick foundation at south-east corner (south view)</u>** **2012-18:** no discernible increase to cracked brick foundation. **2018-20 (Mar):** further cracking of foundation (to left of shot) and some slumping of corner bricks. **Mar 2020 – Dec 2020:** some slight potential further movement in cracked section (also note termite management system in bottom right hand corner of photograph. **Dec 2020 – 2021**: no discernible change.

2012	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	**Detail of damaged brick foundation (east view)** **2012-18:** some further collapse of concrete/cement above brick foundation. **2018-20 (Mar):** some slumping outwards of corner brick foundation. **Mar 2020 – Dec 2020:** no discernible change. **Dec 2020 – 2021**: movement and setting of internal concrete piece.
	

2012	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	**View to interior of building, looking north from south entry** **2012-18:** no discernible change. **2018-20 (Mar):** no discernible interior change, but shows collapsed north wall. **Mar 2020 – Dec 2020:** no discernible change. **Dec 2020 – 2021**: no discernible change.
	

2012	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	**Showing interior of building, viewed from north-west corner** **2012-18:** shows collapsed roofing members above open kitchen area and accumulation of debris. **2018-20 (Mar):** shows additional collapsed roofing member. **Mar 2020 – Dec 2020:** no discernible change. **Dec 2020 – 2021**: no discernible change.
	

The comparative photographs above show the changes at the building over the past nine years. Although no substantial changes were noted between the current and the last inspection, no structural maintenance has occurred either. During this time it can be expected that the underlying causes of deterioration, such as the degeneration of wooden framework and metal panelling, and animal burrowing underneath the structure has continued. Therefore, the more significant changes and priority actions identified during the last inspection remain of importance and, if anything, their need of remediation has increased in urgency. Previous recommendations remain valid and the key issues remain:

- Damaged roof sheeting and roofing members, as well as increasing structural instability of bowing southern wall;
- Due to the complete collapse of remaining roofing members over the open kitchen area the top portion of the northern wall has now failed and fallen inside the building footprint. This northern wall has now detached from remnant roofing and west wall members;
- Deterioration of window panelling; and
- Increased damage to brick foundation in north-west corner, and new slumping of south-east foundation corner.

A termite management regime was implemented around the site prior to the 2020 annual inspection. The inspection points remain intact and these should continue to be monitored and any evidence of termite activity treated as soon as possible.

Recommendations

High Priority Actions

1. If not already conducted, have an asbestos expert assess and develop a clean up and disposal plan to deal with both the broken fragments and intact asbestos sheeting;
2. Remove any remaining tree branches from the roof. In addition, to prevent similar damage in the future, serious consideration should be given to removing or lopping those trees that are located close enough to the building that they may cause damage if they fall or drop large branches;

High Priority Actions to Follow Actions 1 & 2

3. Pending the results of the asbestos assessment, the building and surrounds should be thoroughly cleaned of asbestos and other rubbish material. An archaeologist should be present to collect any items of historic importance or that relate to the original fabric of the building. This should also include the removal, repair and curation of items such

as window frames and panels before their total deterioration. All such items can can be stored inside the building and potentially re-used during further stabilization programs;

4. Pending the results of the asbestos assessment, any parts of the building framework, such as roofing members of walls should be stabilized and propped, using the CMP Bligh Tanner plans as a guide;
5. A structural engineer should then inspect the building before any further works are commenced to make further recommendations on stability requirements and structural repairs. These further works should aim to reduce the likelihood and extent of any further deterioration at the site rather than seek to rebuild or renovate as it is unlikely that there would be any valid or appropriate option to re-use the site; and

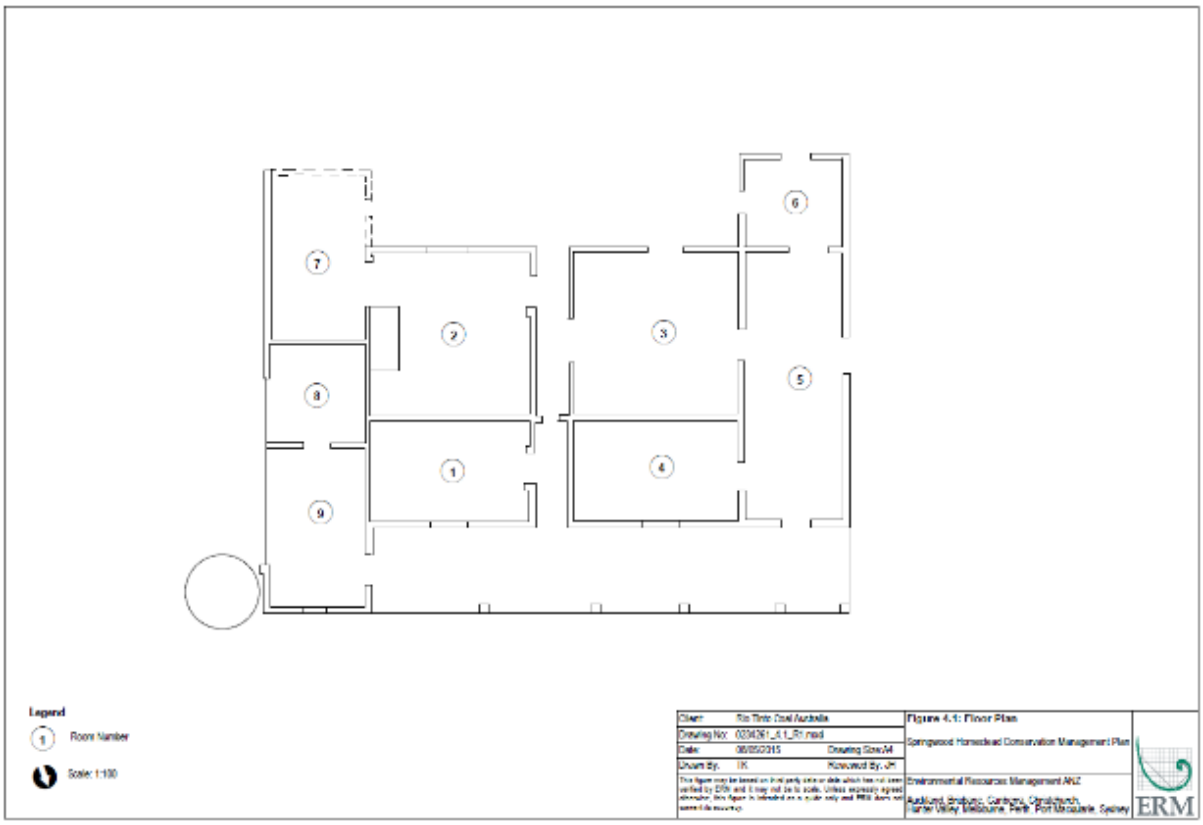
Ongoing

6. Continue with the recently implemented termite monitoring regime.

Springwood Homestead

Based on historical research, Springwood Homestead is likely to have been constructed c.1860 and displays many characteristics of late Old Colonial Georgian and Victorian Georgian architecture, including an original shingle broken-backed roof, fanlights or transom lights, panelled doors and under-roof verandahs. The homestead is low-set, constructed in vertical timber slabs and built around a four room square core, as shown in the plan below (taken from ERM's 2015 CMP).

Given that Springwood Homestead is timber framed and in direct contact with the ground, it is remarkable that it is still standing and in a generally stable condition, with most roof rafters appearing to be still in place. Although the building fabric is generally intact there are a number of areas where the level of structural damage to the roof, wall and flooring members is high. The majority of the damage has occurred from termites and fungal decay, resulting in localised collapse of outer external walls and roof structures. Recently, vandalism has also been an issue, with many vertical timber slabs having been pilfered. Within the CMP developed for the site by ERM in 2015, a number of stabilisation measures have been recommended that will assist to reduce the extent of damage, however a return to a habitable state is not planned.



Springwood Homestead plan



Springwood Homestead in 2012

CMP Recommendations

Although many recommendations are made within the CMP, the more important management measures have been incorporated within a conservation works schedule that covers the following issues:

- Drainage and weatherproofing;
- Vegetation;
- Termites and vermin;
- Building fabric; and
- Structural capacity and wind loads.

The works schedule prioritises the required conservation works and are presented with technical specifications from a structural engineer. Those measures that attend to the buildings structural integrity are the focus of the schedule.

High Priority

a) Remove debris from roof using a cherry picker or similar;
b) Remove tree from eastern elevation and stabilize building in this location;
c) Remove vine from eastern wall using combination of pruning and herbicide;
d) Remove tree from south-west corner and stabilize building in this location;
e) Prune all overhanging branches and maintain regular maintenance program; and
f) Reinstate southern verandah and roof to match northern elevation.

Moderate to Low Priority

g) Place treated plywood sheeting over door openings;
h) Prune trees, spray weeds and slash grass;
i) Clean up of site surrounds, overseen by archaeologist;
j) Clean up of building interior, overseen by archaeologist;
k) Refix loose ceiling boards, retaining evidence of fabric if unable to fix;
l) Refix loose and dislodged slabs and plates; and
m) Place treated plywood sheeting over openings and undertake repairs to windows.

Photographic Comparison 2012; 2018; 2020 (Mar); 2020 (Dec); 2021

During the inspection of Springwood Homestead for this report, a number of photographs were taken from the same angles and of the same features as were taken during the 2018 and March 2020 HHMP compliance inspections, and the ERM 2014 assessment that informed the 2015 CMP. These photographs provide a visual baseline condition assessment of the building, and also allow a comparative analysis of the changes over the last six to eight years. These photographs are set out below, along with comments pertinent to management recommendations.

2014	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	**Eastern elevation** **2014-8:** no discernible change. **2018-20 (Mar):** roof slumping appears to have increased. **Mar 2020-Dec 2020:** heavy leaf litter on roof persists. Positively, vegetation clearing surrounding the house is occurring regularly. **Dec 2020 – 2021:** tree growth and associated leaf litter/structural impacts increasing.
	

2014	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	**Southern elevation** **2014-8:** vertical timber slabs have been removed from southern wall. **2018-20 (Mar):** possible deterioration of shingles at roof edge, and missing panels from above back door. **Mar 2020-Dec 2020:** no discernible change. **Dec 2020 – 2021:** no discernible change.
	

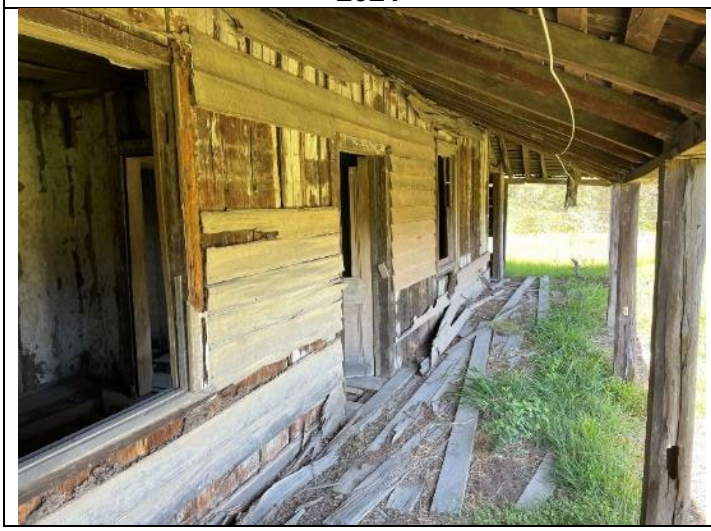
2014	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	**Southern elevation doorway** **2014-8:** door has been removed. **2018-20 (Mar):** no discernible change. **Mar 2020-Dec 2020:** no discernible change. **Dec 2020 – 2021:** no discernible change.
	

2014	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	
	**<u>South-eastern corner</u>** **2014-8:** vertical slabs have been removed causing further collapse of roof. **2018-20 (Mar):** further deterioration of eastern wall. **Mar 2020-Dec 2020:** heavy leaf litter on roof persists. **Dec 2020 – 2021:** heavy leaf litter on roof persists.

2014	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	
	**<u>Eastern side</u>** **2014-8:** debris has been cleaned and stored and a weed removal program conducted. The house area has also been fenced. **2018-20 (Mar):** further deterioration of eastern wall and regrowth of weeds. **Mar 2020-Dec 2020:** no discernible change. **Dec 2020 – 2021:** no discernible change.

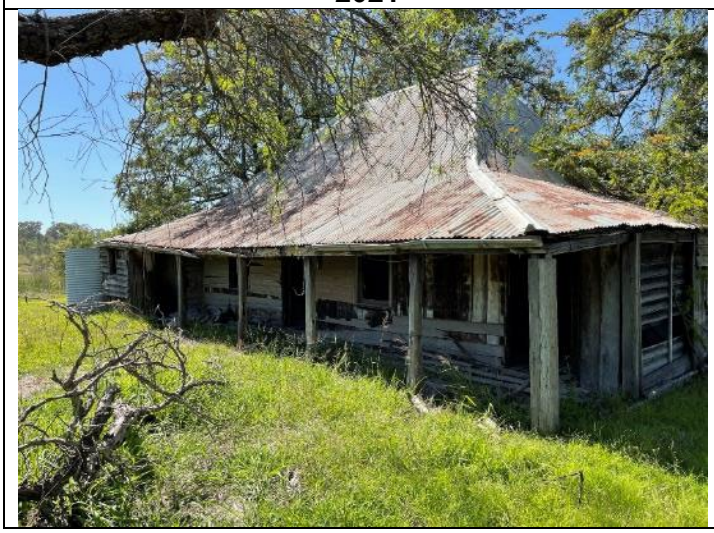
2014	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	
	**Room 2 interior** **2014-8:** increased debris caused by removal of southern wall. **2018-20 (Mar):** no discernible change. **Mar 2020-Dec 2020:** no discernible change. **Dec 2020 – 2021:** no discernible change.

2014	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	**South-west corner** **2014-8:** shows removal of vertical slabs from southern wall. **2018-20 (Mar):** no discernible change. **Mar 2020-Dec 2020:** no discernible change. **Dec 2020 – 2021:** furniture in far room collapsed.
	

2014	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	
	**Northern elevation** **2014-8:** further deterioration of weatherboard panelling. **2018-20 (Mar):** no discernible change, though termite activity present. **Mar 2020-Dec 2020:** grass/weed growth encroaching over verandah floor. **Dec 2020 – 2021:** increased grass encroachment.

2014	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	
	**<u>South-east corner</u>** **2014-8:** shows removal of vertical slabs from southern wall, and some from eastern wall, and further collapse of roof. **2018-20 (Mar):** further roof slumping and deterioration of eastern wall. **Mar 2020-Dec 2020:** no discernible change. **Dec 2020 – 2021:** further deterioration of eastern wall.

2014	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	**Eastern elevation** **2014-8:** possible further collapse of crossbeam and guttering. **2018-20 (Mar):** tree continues to impact eastern roof line. **Mar 2020-Dec 2020:** increased impact on roofline by tree branches. **Dec 2020 – 2021:** tree continues to impact eastern side.
	

2014	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	**Northern elevation** **2014-8:** slumping of verandah along edge beam. **2018-20 (Mar):** no discernible change. **Mar 2020-Dec 2020:** grass/weed growth encroaching over verandah floor. **Dec 2020 – 2021:** no discernible change.
	

2014	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	
	**<u>View of south-west corner from south</u>** **2014-8:** shows removal of vertical slabs from southern wall as well as some increase in vegetation growth. **2018-20 (Mar):** no discernible change but continuing vegetation impacts. **Mar 2020-Dec 2020:** Apparent increased vine growth. **Dec 2020 – 2021:** continued impacts on south-west corner.

The comparative photographs above show the changes at the building over the past eight years. Although no great change was noted between the current and the last inspection, no structural maintenance has occurred either. During this time it can be expected that the underlying causes of deterioration, such as the degeneration of wooden framework, impacts caused by adjacent trees and the effects of weather entering the unsealed building has continued. Therefore, the more significant changes and priority actions identified during the last inspection remain of importance and, if anything, their need of remediation has increased in urgency. Previous recommendations remain valid and the key issues remain:

- The removal of all of the vertical timber slabs from the southern wall continue to have a negative impact on the structural integrity of this side of the building, allowing weather and the associated adverse impacts into the building; and
- The continued growth of trees and vines are also having impacts on structural stability in the south-western corner and along the eastern roof line;

It should be noted, however, that a termite management regime has been implemented around the site, which is a positive action and will assist in the arrest of the deterioration of the wooden aspects of the building. Also, a vegetation management regime is in place that sees regular maintenance within the fenced compound.

Recommendations

Management recommendations have been prioritised as high or moderate importance, and high priority recommendations should be actioned as soon as possible, after which the conservation works schedule within the CMP can be re-evaluated and amended by a structural engineer prior to further works being commenced.

High Priority

1. Remove the trees and vines currently impacting the building at the eastern elevation and south-west corner and treat to prevent regrowth. Coincident with this removal, acrow props should be installed where appropriate, i.e. where the trees themselves have been supporting the building structure, and as per the structural engineer's instructions at Annex B of the CMP;
2. Once vegetation has been removed, clean all debris from the roof and prune (or consider the removal of) all other trees in close vicinity of the building with potential to drop leaf/branch litter on roof;

3. Clear the surroundings of the building of rubbish, overgrowth and weeds in the accompaniment of an archaeologist to ensure any items of historical relevance are salvaged and stored within the homestead; and
4. Due to the damage caused by the removal of the vertical slabs, once the items above are complete, a structural engineer should then re-inspect the building before any further works are commenced to make further recommendations on stability requirements and structural repairs.

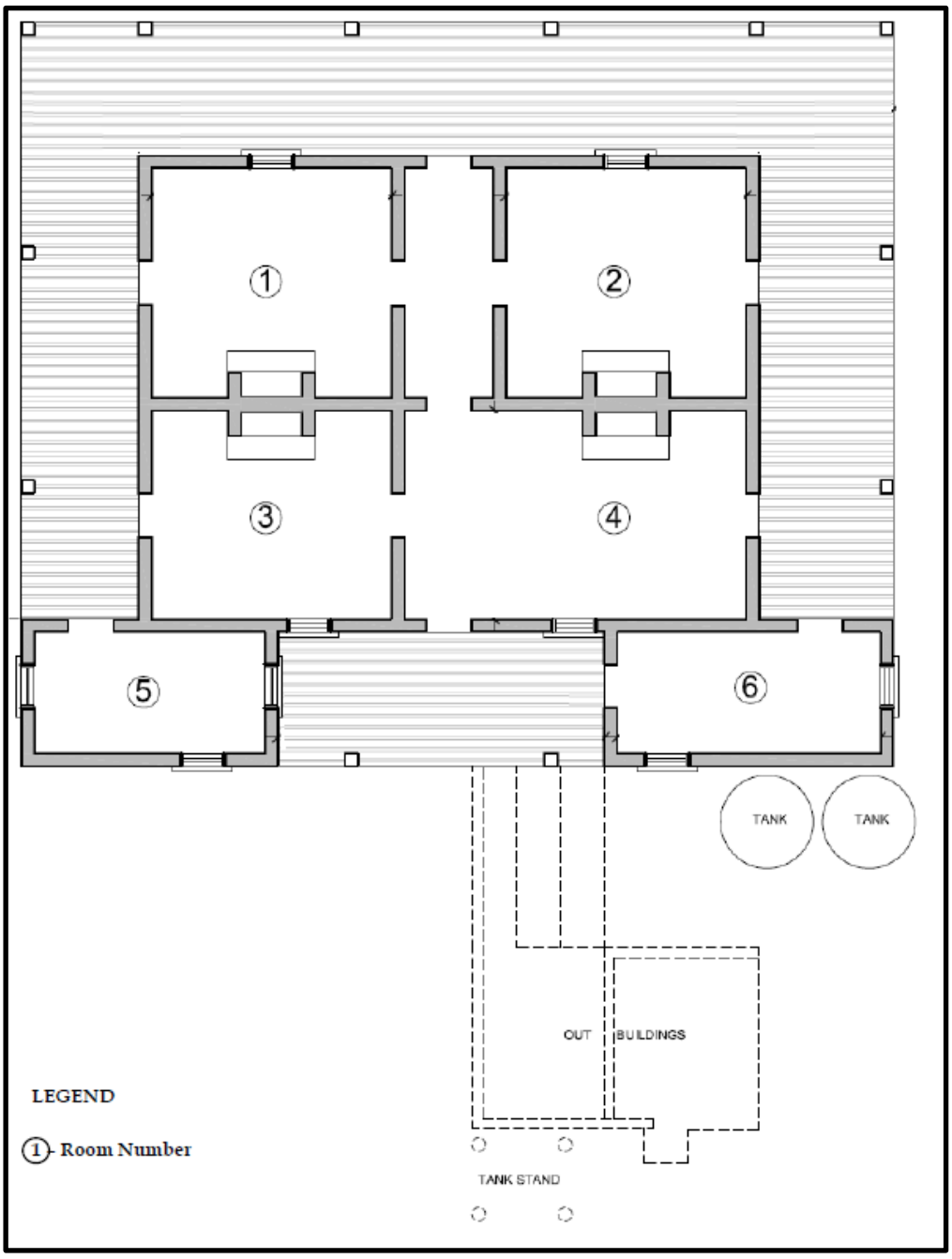
Moderate Priority

Once the high priority recommendations have been attended to, the structural engineer may recommend different or additional measures than originally put forward. Notwithstanding these, the following moderate priority measures are recommended to attain compliance with the CMP and enhance the condition of the homestead:

1. Due to their propensity to harbour termites and transfer infestation to the building, remove all peppercorn trees from around the building;
2. Future condition inspections should photograph the building using the photograph views and locations presented above so that any changes to the building can be documented in subsequent inspections;
3. Maintain the regular vegetation maintenance program;
4. Pending structural engineer's advice, reinstate southern wall, verandah and roof to match northern elevation.
5. Pending reconstruction of southern wall, place treated plywood sheeting over door and window openings;
6. Clean up of building interior, overseen by archaeologist;
7. Pending structural engineer's advice, refix loose ceiling boards and loose and dislodged wall slabs and plates, retaining evidence of fabric if unable to fix;
8. Ensure the minor recommendations and 'policies' listed throughout Section 7 of the CMP are considered in the future management of the homestead;
9. Give consideration to an archaeological excavation and research program at the site, with possible community involvement, to explore the areas of archaeological potential identified in the CMP; and
10. Maintain the termite and pest control regime at the building.

Mount Thorley Brick Farm House

The Mount Thorley Brick Farm House is located off the Golden Highway opposite the MTW coal handling and preparation plant, c.10km south-west of Singleton. The portion of land on which the house sits was purchased by Eliza Glass in 1870 and the physical attributes of the house, which display characteristics of Victorian Georgian architecture, suggest that it was constructed during the following decade. The building is roughly square in plan, with four principal rooms flanking a central hallway.



Floor plan of Mount Thorley Brick Farm House, north up (from ERM 2015 CMP)

The masonry structure of the building is sound, however, it was noted as being in poor physical condition in 2015 (when a CMP was developed for the site by ERM), with a collapsed verandah roof, missing or loose roof sheeting, missing or collapsed verandah posts, and floorboards and areas affected by termites. The conservation works schedule within the CMP considered the following issues at Mount Thorley Brick Farm House:

- Drainage and weather-proofing;
- Asbestos;
- Vegetation;
- Termites and vermin;
- Building fabric; and
- Structural capacity and wind loads.

Recommendations were made within the CMP's conservation works schedule to address the elements above, a number of which have completed by the proponent. These works included:

- Removal and safe storage of verandah;
- Initial vegetation clearing;
- Sheeting and sealing of all window and door openings;
- Clean up of scattered debris surrounding building; and
- Repair of loose roof sheeting and patching of holes.

Monitoring and maintenance of these repaired items is an ongoing requirement to ensure they provide continual protection to the building.

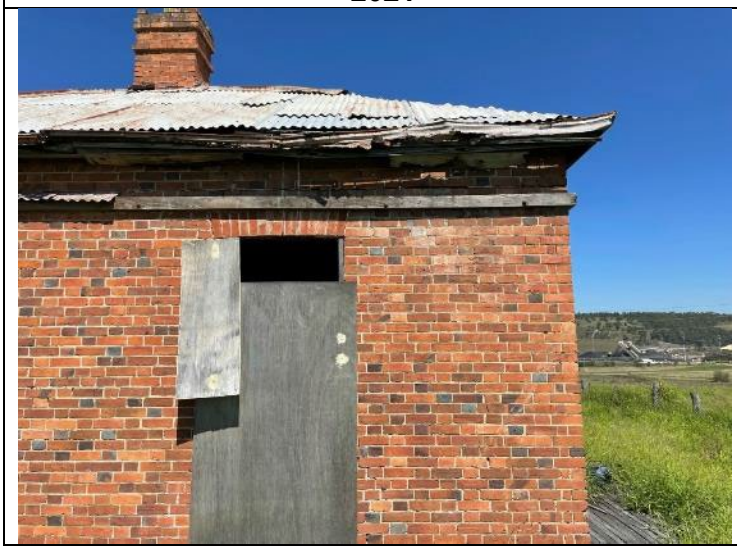


Mount Thorley Brick Farm House (2012)

Photographic Comparison 2012; 2018; 2020 (Mar); 2020 (Dec); 2021

During the inspection of the Mount Thorley Brick Farm House for this report, a number of photographs were taken from the same angles and of the same features as were taken during previous HHMP compliance inspections as well as the ERM 2015 assessment that informed the CMP. These photographs provide a visual baseline condition assessment of the building, and also allow a comparative analysis of the changes over the last seven years. These photographs are set out below, along with comments pertinent to management recommendations.

2015	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	**View of north-west side** **2015-8:** verandah removed and stored inside building, vegetation has been managed **2018-20 (Mar):** vegetation has regrown around building **Mar 2020-Dec 2020:** vegetation again under control, panel above boarded door requires refixing. **Dec 2020 – 2021:** vegetation requires management and loose boards re-affixing.
	

2015	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	**<u>View of north-west roof corner (focus on damaged roof)</u>**
	**2015-8:** roofing sheets have been replaced and holes patched **2018-20 (Mar):** some minor roof holes and lifted sheeting noted **Mar 2020-Dec 2020:** some verandah flashing fallen, panel above door requires refixing. **Dec 2020 – 2021:** panel above door requires re-affixing and guttering remains in disrepair.

2015	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	**View of door and window panelling** **2015-8:** sheeting installed on all openings, however some repair required **2018-20 (Mar):** no discernible change **Mar 2020-Dec 2020:** Front door panel requires reinstallation. **Dec 2020 – 2021:** front door panel remains broken.
	

2015	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	**View of door and window panelling** **2015-8:** sheeting installed on all openings, however some repair required **2018-20 (Mar):** some repair of panelling required **Mar 2020-Dec 2020:** Broken panel remains unrepaired **Dec 2020 – 2021:** broken panel remains unrepaired.
	

2015	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	
	**<u>View of rear of building (view south)</u>** **2015-8:** debris has been cleared and stacked **2018-20 (Mar):** vegetation has regrown around building and stacked debris **Mar 2020-Dec 2020:** vegetation cleared and debris restacked **Dec 2020 – 2021:** vegetation management required.

2015	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	**View of rear of building (view north)** **2015-8:** debris has been cleared and stacked **2018-20 (Mar):** vegetation has regrown around building and stacked debris **Mar 2020-Dec 2020:** vegetation cleared and debris restacked **Dec 2020 – 2021:** vegetation regrown.
	

2015	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	
	**<u>View of eastern verandah (focus on verandah floor)</u>** **2015-8:** posts and sheeting removed, damaged boards remain exposed **2018-20 (Mar):** damaged boards remain and vegetation growth throughout **Mar 2020-Dec 2020:** damaged boards remain and vegetation growth throughout **Dec 2020 – 2021:** verandah floor remains dilapidated and grass growth throughout.

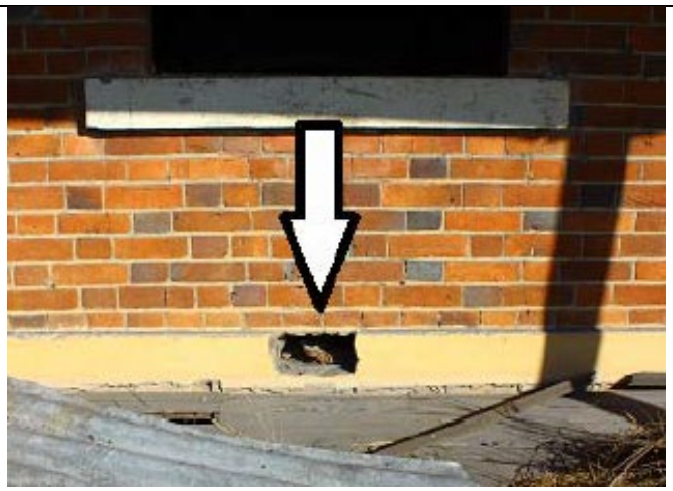
2015	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	**View of rear of building (focus on roof)**
	**2015-8:** skillion roof, guttering and rafters have collapsed; main roof holes repaired **2018-20 (Mar):** no discernible change **Mar 2020-Dec 2020:** some minor holes in roofing require repair **Dec 2020 – 2021:** minor roofing holes remain.

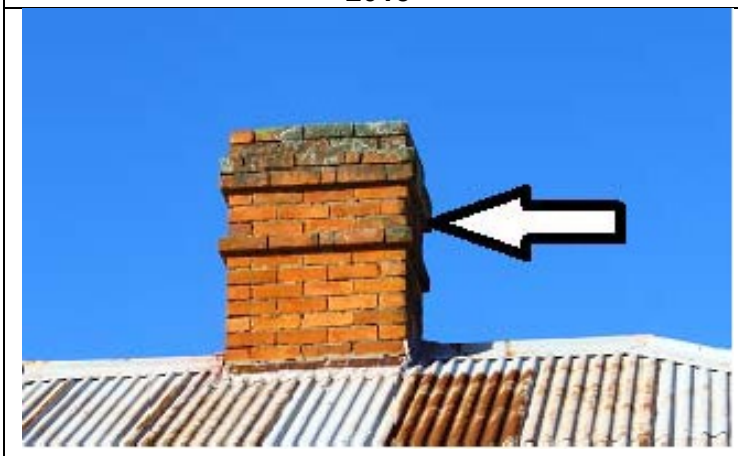
2015	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	
	**<u>View of north-east of building</u>** **2015-8:** wall element has collapsed (bricks stacked under window); roof framing, sheeting and guttering has collapsed **2018-20 (Mar):** no discernible change **Mar 2020-Dec 2020:** no discernible change **Dec 2020 – 2021:** rafter collapse from above window.

2015	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	
	**<u>View of north-east corner of building (focus wall below window)</u>** **2015-8:** bricks from roof above stacked in front of required repointing, window sheeting removed **2018-20 (Mar):** no discernible change **Mar 2020-Dec 2020:** repointing requirements remain **Dec 2020 – 2021:** repointing requirements remain.

2015	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	
	**<u>View of south-east of building (focus on top of wall)</u>** **2015-8:** no discernible change **2018-20 (Mar):** no discernible change **Mar 2020-Dec 2020:** no discernible change **Dec 2020 – 2021:** repointing requirements remain.

2015	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	
	**<u>View of eastern verandah (focus on dwarf wall wall)</u>** **2015-8:** debris cleared from verandah, no change to dwarf wall **2018-20 (Mar):** no discernible change **Mar 2020-Dec 2020:** cracking to wall evident **Dec 2020 – 2021:** remains in disrepair.

2015	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	**View of ventilation grilles** **2015-8:** grilles not replaced **2018-20 (Mar):** no discernible change **Mar 2020-Dec 2020:** grilles remain open **Dec 2020 – 2021:** grilles remain open.
	

2015	2018
	
2020 (Mar)	**2020 (Dec)**
	
2021	
	**<u>View of southern chimney</u>** **2015-8:** no discernible change **2018-20 (Mar):** no discernible change **Mar 2020-Dec 2020:** no discernible change **Dec 2020 – 2021:** repointing requirements remain.

The comparative photographs above show the changes at the building over the past seven years. As with the other two buildings, although no great change was noted between the current and the last inspection, no structural maintenance has occurred either. During this time it can be expected that the underlying causes of deterioration, such as the degeneration of wooden framework and the effects of weather entering through unsealed sections has continued. Therefore, the more significant changes and priority actions identified during the last inspection remain of importance and, if anything, their need of remediation has increased in urgency. Previous recommendations remain valid and the key issues remain:

- Considerable damage and exposure to the rear of the building;
- Loose, damaged and removed window and door sheeting;
- Some new roof holes and loose sheeting; and
- Reinstatement of vegetation management regime.

It should be noted, however, that a termite management regime has been implemented around the site, which is a positive action and will assist in the arrest of the deterioration of the wooden aspects of the building.

Recommendations

While many of the high and moderate priority recommended actions within the CMP conservation works schedule have been completed in the past, the 2020 inspection has identified that some items need renewed attention. The recommendations outlined below are required to minimise the risk of further deterioration in the building structure.

High Priority

1. Replace any damaged plywood door/window coverings and ensure all coverings are tightly attached;
2. Patch fix any new damage to roofing sheets;
3. If any asbestos or fibrous cement sheeting remains at the property, engage an asbestos removalist to remove as required;
4. Reinstate the vegetation management program;

Moderate Priority

5. Check that all debris surrounding the house has been removed. If this has not occurred, remove all debris, ensuring an archaeologist is on hand to identify and catalogue any early architectural fittings or rare pieces of joinery that should be retained for future restoration purposes;

6. Reinstall verandah, including verandah decking and northern brick dwarf wall, re-using original material where possible, as per recommendations M5, M6 and L1 in the CMP conservation works schedule;
7. As the roof above Room 6 has collapsed, salvage any reusable masonry or timber and set aside within room. Engage a structural engineer to advise on feasibility of reconstructing the roof. (NB. Recommendation M9 in the CMP conservation works schedule erroneously refers to Room 5 rather than Room 6 as shown in the photograph);
8. Replace gutters around the house to match existing materials and ogee profile. Install new down-pipes and ensure they are discharging away from the building.
9. Repoint mortar joints with lime based mortar on brickwork below Room 6 eastern elevation window sill, on northern wall of room 5 and all chimneys;
10. Install new ventilation grilles to existing ground level openings; and
11. Maintain the termite and pest control regime at the building.

Conclusion

Up to ten years has now elapsed since the preparation of the CMPs for the three historic heritage buildings reviewed during this inspection. Although some important conservation measures have been implemented over the last decade, other recommended management actions remain incomplete, with the urgency surrounding their attention only increasing year on year. The following actions are considered imperative to prevent irreparable damage to the buildings and, once complete, will provide a solid foundation from which to tackle the remaining issues.

Former RAAF Base Bulga Mess Hall

1. If not already conducted, have an asbestos expert assess and develop a clean up and disposal plan to deal with both the broken fragments and intact asbestos sheeting;
2. Remove any remaining tree branches from the roof and consider removing or lopping those trees that are located close enough to the building that they may cause damage if they fall or drop large branches;

Springwood Homestead

3. Remove the trees and vines currently impacting the building at the eastern elevation and south-west corner and treat to prevent regrowth. Coincident with this removal, acrow props should be installed where appropriate, i.e. where the trees themselves have been supporting the building structure, and as per the structural engineer's instructions at Annex B of the CMP;
4. Once vegetation has been removed, clean all debris from the roof and prune (or consider the removal of) all other trees in close vicinity of the building with potential to drop leaf/branch litter on roof;
5. Due to the damage caused by the removal of the vertical slabs, once the items above are complete, a structural engineer should then re-inspect the building before any further works are commenced to make further recommendations on stability requirements and structural repairs.

Mount Thorley Brick Farm House

6. Replace any damaged plywood door/window coverings and ensure all coverings are tightly attached;
7. Patch fix any new damage to roofing sheets;
8. If any asbestos or fibrous cement sheeting remains at the property, engage an asbestos removalist to remove as required.

Appendix 4:

Annual Stream Health and Stability Report

2021 STREAM HEALTH AND STABILITY REPORT

Mount Thorley Warkworth

Mount Thorley Warkworth
PO Box 267, Singleton NSW 2330 Australia

SLR Ref: 630.30119.00100-R01
Version No: -v0.2
December 2021

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Mount Thorley Warkworth (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
630.30119.00100-R01-v0.2	01/12/2021	Stephane Peignelin / Samuel McDonald	Duncan Barnes	Duncan Barnes

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APPENDICES

Appendix A Rapid Appraisal of Riparian Conditions
Appendix B CSIRO Ephemeral Stream Assessment Database

1 Introduction

SLR Consulting Australia Pty Ltd (SLR) was initially engaged in December 2017 by Bulga Surface Operations (BSO) and Mount Thorley Warkworth (MTW) to conduct channel stability and stream health monitoring of creeks adjacent to the mine sites. An integrated channel monitoring program was developed as both mines discharge into the same drainage lines (e.g. Loders Creek). Since 2020 the monitoring program includes channel stability and stream health assessments at MTW only. It also includes a visual inspection of Loders Creek from the Hunter River to the MTW discharge point to identify any areas of increased erosion.

SLR has carried out the 2018, 2019, 2020 and 2021 annual channel stability and stream health monitoring to identify any changes to the creeks including any new erosion features in accordance with regulatory requirements. This report has been specifically prepared for the MTW monitoring points and should be read in conjunction with the 2017, 2018, 2019 and 2020 reports for better understanding.

MTW has advised there have been 703.4ML discharged from the MTW discharge point between January and November 2021. There has been 736 mm of rainfall recorded within the on-site rainfall gauge for the period January to Mid-November 2021. In comparison, the Bureau of Meteorology shows 843 mm of rainfall recorded at Singleton (Singleton Defence AWS 61430) for the same period. Overall, this round of monitoring was subjected to a wetter year than the previous rounds of monitoring and that was reflected by an increase in vegetation growth.

2 METHODOLOGY

In accordance with the accepted scope of works the following procedure was undertaken at each monitoring site:

1. Documenting locations and dimensions of significant erosive or depositional features;
2. Photographs upstream, downstream and at both banks;
3. Rating the site with the Ephemeral Stream Assessment protocol developed by the CSIRO to assess the erosional state of the creek at the monitoring location (a measure of channel stability);
4. Rating the site with the Rapid Appraisal of Riparian Condition protocol developed by Land & Water Australia. This assesses the ecological condition of riparian habitats using indicators that reflect functional aspects of the physical, community and landscape features of the riparian zone (a measure of stream health); and
5. Taking measurements of the channel cross-sections (transects) for comparison purposes for any future monitoring.

2.1 Rapid Appraisal of Riparian Condition (RARC)

The RARC is an assessment method incorporating indicators of geophysical and biological properties and processes which are likely to provide reliable estimates of ecological condition in riverine ecosystems (Land & Water Australia, 2005). The RARC index is made up of five sub-indices, each with a number of indicator variables which can be seen in **Table 1** below.

Table 1 Summary table of indicators, functions and components assessed in the RARC (Land and Water Australia, 2005)

Functions of the riparian zone at different levels of organisation	Components of the riparian ecosystem that perform those functions	Indicators of the functions used in the RARC
Physical:		
Reduction of erosion of banks	Roots, ground cover	Vegetation cover*
Sediment trapping	Roots, fallen logs, ground cover	Canopy cover, fallen logs, ground cover vegetation, leaf litter cover
Controlling stream microclimate/ discharge/water temperatures	Riparian forest	Canopy cover
Filtering of nutrients from upslope	Vegetation, leaf litter	Ground cover vegetation, leaf litter cover
Community:		
Provision of organic matter to aquatic food chains	Vegetation	Vegetation cover*, leaf litter cover
Retention of plant propagules	Fallen logs, leaf litter	Fallen logs, leaf litter cover
Maintenance of plant diversity	Regeneration of dominant species, presence of important species, dominance of natives *versus* exotics	Native canopy and shrub regeneration, grazing damage to regeneration, reeds, native vegetation cover*
Provision of habitat for aquatic and terrestrial fauna	Fallen logs, leaf litter, standing dead trees/hollows, riparian forest, habitat complexity	Fallen logs, leaf litter cover, standing dead trees, hollows, vegetation cover*, number of vegetation layers
Landscape:		
Provision of biological connections in the landscape	Riparian forest (cover, width, connectedness)	Vegetation cover*, width of riparian vegetation, longitudinal continuity of riparian vegetation, proximity to other habitat
Provision of refuge in droughts	Riparian forest	Vegetation cover*

* Vegetation cover = canopy, understorey and ground cover

In accordance with previous annual stream health surveys undertaken at the site, classifications have been assigned based on the total score as assessed by the RARC methodology. It is useful to compare this total score over time to see how the biodiversity and functionality of the riparian zone is progressing at each of the monitoring points. **Table 2** below outlines these classifications.

Table 2 Summary RARC Classification System

RARC Total Score	Classification
40-50	Excellent
35-39	Good

RARC Total Score	Classification
30-34	Average
25-29	Poor
<25	Very Poor

2.2 CSIRO Ephemeral Stream Assessment

The CSIRO *Ephemeral Stream Assessment* procedures (CSIRO, date unknown) were used to assess the channel stability of Loders Creek in the vicinity of the MTW Mine. The assessment uses four main classes of indicators to evaluate the degree of stream-bed condition:

1. The type and condition of the vegetation present, if any;
2. The shape and profile of the drainage line and type of materials on the drainage line floor;
3. The nature of the drainage line wall materials; and
4. The nature of the stream bank bordering flats and/or slopes and regulation of lateral flow into the drainage line.

The indicators produce a rating based on a scoring system, and the combined total of the indicators rank each location from very actively eroding through to very stable as shown in **Table 3.** This enables an assessment to be made as to whether the section of creek has changed since previous rounds of annual monitoring.

Table 3 Classification of different drainage line states (CSIRO)

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

Activity Rating (%)	Classification	Discussion of Classification
< 50	Very Active	Drainage line is very actively eroding and immediate remedial actions are required. It is important to classify if erosion is caused primarily by upstream flows, lateral flows or unstable wall materials so that appropriate rehabilitation can be carried out.

Table Source: CSIRO Ephemeral Stream Assessment (CSIRO, date unknown)

2.3 Transects at Monitoring Points

Transect data is collected at the monitoring points to provide a representation of the drainage line profile. The transect assessment allows for simple identification of any deposition of sediments within the channel bed or scouring of the banks by comparison with profile measurements on a yearly basis.

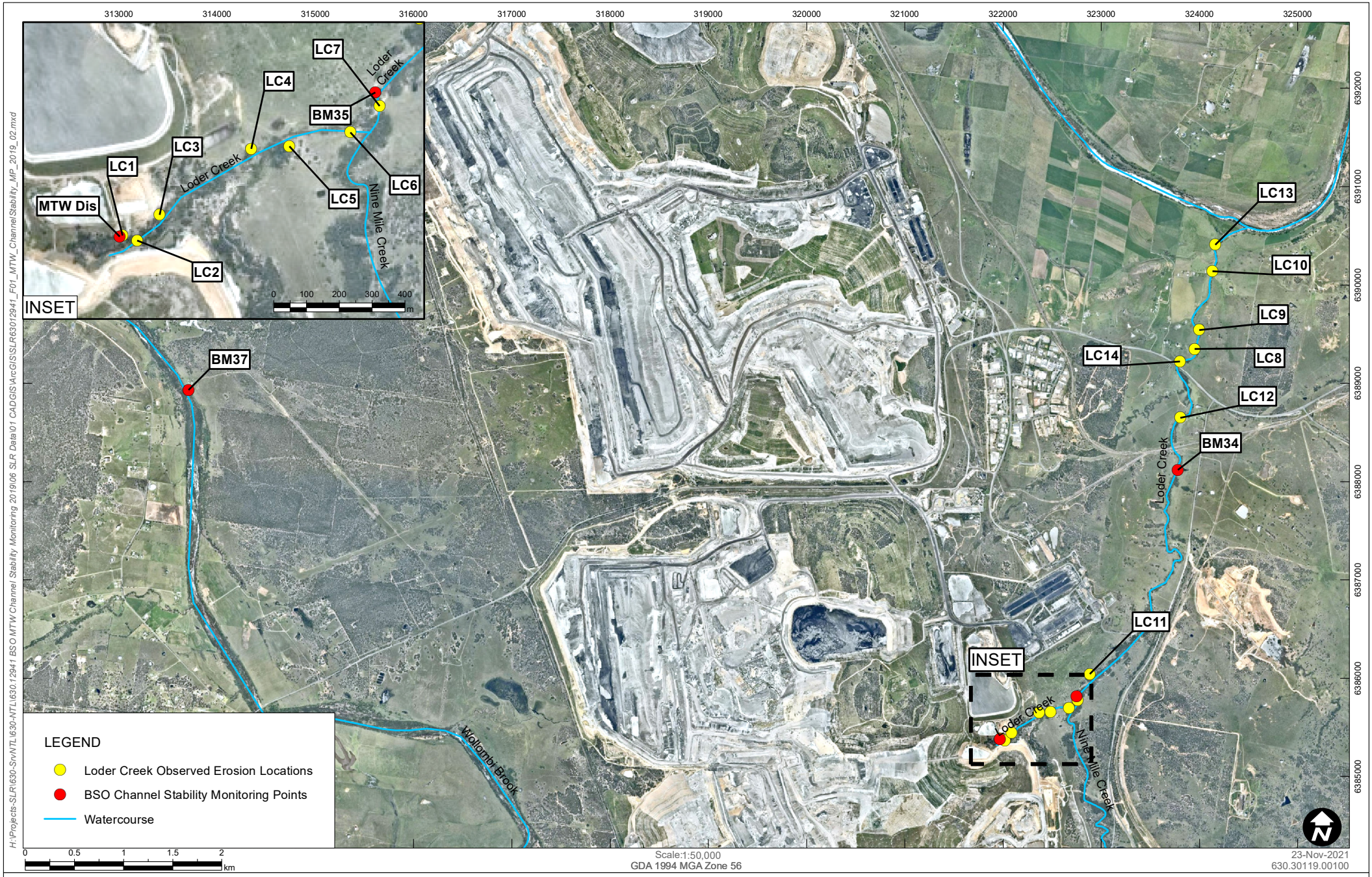
The transect assessment is undertaken by extending a tape measure laterally across the drainage line to two permanently fixed posts which are located within the riparian zone. A survey staff is then used to measure the vertical distance between the tape and the ground surface at approximately 0.5 m increments or at points which capture any sudden changes in channel geometry (e.g. steep channel banks).

2.4 Visual Assessment of Loders Creek

A visual inspection of Loders Creek from the Hunter River to the MTW discharge point was undertaken to identify any areas of increased erosion. Where erosion was observed within this reach of Loders Creek the following were recorded:

- Documented locations and dimensions of notable erosive or depositional features;
- Photos so that comparisons could be made in future surveys; and
- Rating the site with the *Ephemeral Stream Assessment* protocol developed by the CSIRO to assess the erosional state of the creek at the monitoring location.

Any visible changes that occurred since the preceding inspection were documented with a comparison to the photos taken during the previous surveys.



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MTW Channel Stability Monitoring Points - 2021

FIGURE 1

3 Results

3.1 Channel Stability / Stream Health Monitoring Site Results

3.1.1 MTW Discharge Point (321966 E 6385379 N)

This monitoring point is located at the Mount Thorley discharge point (MTW Dis). This section of creek was upgraded in 2018 and now includes rock armouring of the creek bed as well as jute mesh and seeding of both banks. Overall, this location shows similar conditions to the previous monitoring cycle.

The banks are characterised by patches of scattered eucalypts with Bull Oak (*Allocasuarina luehmannii*) and Swamp Oak (*Casuarina glauca*) dominating the canopy. The understorey is sparse consisting mainly of Acacia shrubs scattered on the bank. The key change observed was an increase in groundcover on either side of the rock armoured area likely due to favourable growing conditions which have been experienced throughout the year. While there was an increase in exotic grass, regeneration of canopy species was observed especially in areas covered with jute mesh around the rock armouring. It should be noted while there is still very little diversity in either canopy or groundcover species the diversity of canopy and groundcover species appears to be increasing.

Both banks of the creek contain an almost continuous band of riparian vegetation in widths less than 40m wide, with the exception of the cleared area where the discharge construction works occurred. Exotic grass and bare soil (mine workings and vehicle tracks) surround riparian vegetation. Debris such as leaf litter and fallen logs are evident as well as standing dead trees. As there was significant water in the creek at the time of monitoring it is likely that some fallen logs were hidden by the water. Linkage to larger areas of native vegetation is absent. The channel of the creek line contained dense native *Juncus* spp.

RARC Stream Health Assessment Classification – **Average**

CSIRO Ephemeral Stream Assessment Classification – **Potentially Stabilising**

Photos taken at the established photo points for this monitoring point are shown in Plate 1 to Plate 4.



Plate 1 Right Bank



Plate 2 Upstream



Plate 3 Downstream



Plate 4 Left Bank

No transect data was recorded at this location during the 2021 monitoring due to the water depth within the creek at the time of the inspection.

Transect data from previous monitoring rounds are presented on **Figure 2** below.

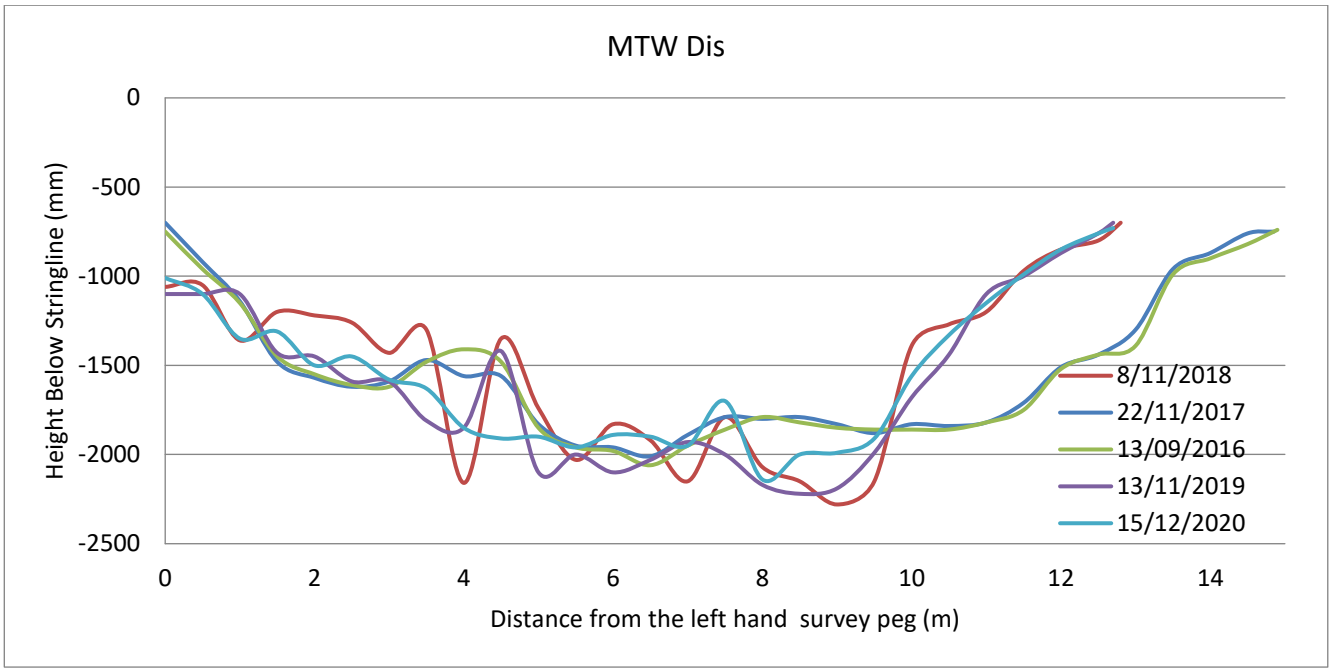


Figure 2 MTW Dis Transect Results

3.1.2 BM35 (322746 E 6385819 N)

The channel at this location was observed to have a good coverage of long grass across the bed. The left bank also appears stable with good grass coverage. The right bank contains some lateral erosion (approximately 0.5m high) at the top of the bank. The lateral erosion is forming some rill/gully erosion down this bank, however the rest of the right bank appears to be stable with good grass coverage. Overall, this location shows similar conditions to the previous monitoring cycle.

The creek banks are characterised by Swamp Oak (*Casuarina glauca*) with scattered eucalypts upslope. Both banks of the creek contained an almost continuous band of riparian vegetation in widths mostly around 15m wide with one patch downstream extending to 40m wide. The understory consisted of weeds including Paddy's Lucerne and Rhodes Grass. Exotic pastures surrounded riparian vegetation and linkage to other areas of native vegetation was absent. The channel of the creek line contained dense native *Typha* spp. with exotic grasses. Regenerating canopy tree (mostly *Casuarina glauca*) species were abundant.

Minimal noticeable changes were observed since the last monitoring period. A significant number of hoof prints were identified at the water line with evidence of some vegetation being trampled. As with many of the other sites *Typha* spp showed evidence of the recent high-water levels with a number of the plants showing signs of being flattened by the high-water levels. Some lantana growth was observed higher up on the banks.

RARC Stream Health Assessment Classification – **Poor**

CSIRO Ephemeral Stream Assessment Classification – **Active**

Photos taken at the established photo points for this monitoring point are shown in Plates 5 to 9.



Plate 5 Right Bank



Plate 6 Upstream



Plate 7 Downstream



Plate 8 Left Bank



Plate 9 Erosion (top of right bank)

For the purpose of monitoring any changes of the creek, a creek line transect was established. The transect is shown in **Figure 3** and was taken from left to right looking downstream. Results from the 2021 monitoring suggest that no significant scouring has occurred on the banks or creek bed since the previous monitoring cycles.

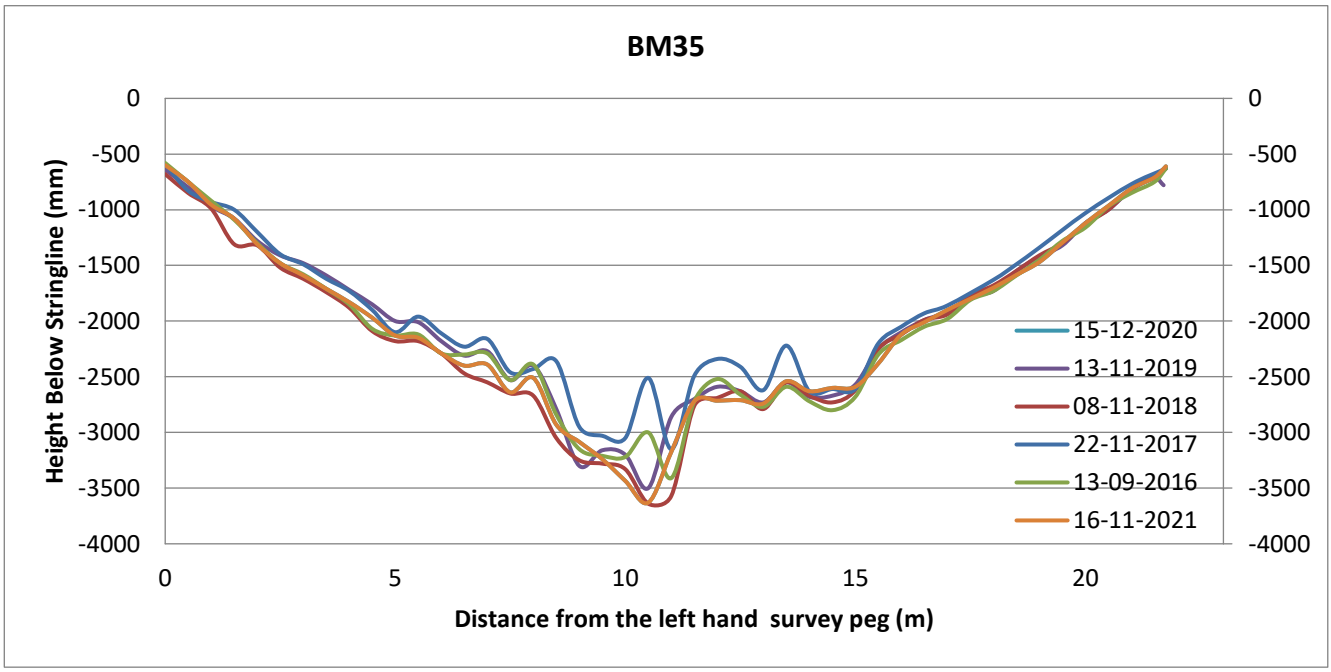


Figure 3 BM35 Transect Results

3.1.3 BM34 (323779 E 6388119 N)

The creek bed at this monitoring point is covered by reeds and is stable. Both the left and right banks have good grass coverage and appear to be stable with gentle-moderate slopes. The creek upstream and downstream of the monitoring point also appears to be stable. The creek has a very slight meander at this monitoring point. Overall, this location has remained the same as the previous monitoring cycle conditions.

The banks were characterised by dense Swamp Oak (*Casuarina glauca*), tall River Oak *(Casuarina cunninghamia)* with scattered eucalypts. The creek is congested with *Juncus spp* and *Phragmites australis.* The understory contained high levels of weed infestation. Paddy's Lucerne and in particular African Boxthorn were abundant below the canopy particularly upstream of the monitoring point. Native Weeping Grass (*Microlaena stipoides*) was present in small patches beneath the denser canopy areas. Both banks of the creek contained an almost continuous band of riparian vegetation in widths less than 30m wide.

Exotic pastures surrounded riparian vegetation and linkage to other areas of native vegetation was absent. Some lantana patches were observed. Regenerating canopy tree (mostly *Casuarina glauca*) species were abundant. Monitoring generally revealed vegetation growth since the last monitoring period especially in the stream bed where *Juncus spp* and *Phragmites australis* has continued to grow during favourable climatic conditions. However overall, there was very little observable change in vegetation structure.

RARC Stream Health Assessment Classification – **Average**

CSIRO Ephemeral Stream Assessment Classification – **Stable**

Photos taken at the established photo points for this monitoring point are shown in Plates 10 to 13.



Plate 10 Right Bank



Plate 11 Upstream



Plate 12 Downstream



Plate 13 Left Bank

No transect data was recorded at this location during the 2021 monitoring due to the water depth within the creek at the time of the inspection.

Transect data from previous monitoring rounds are presented on **Figure 4** below.

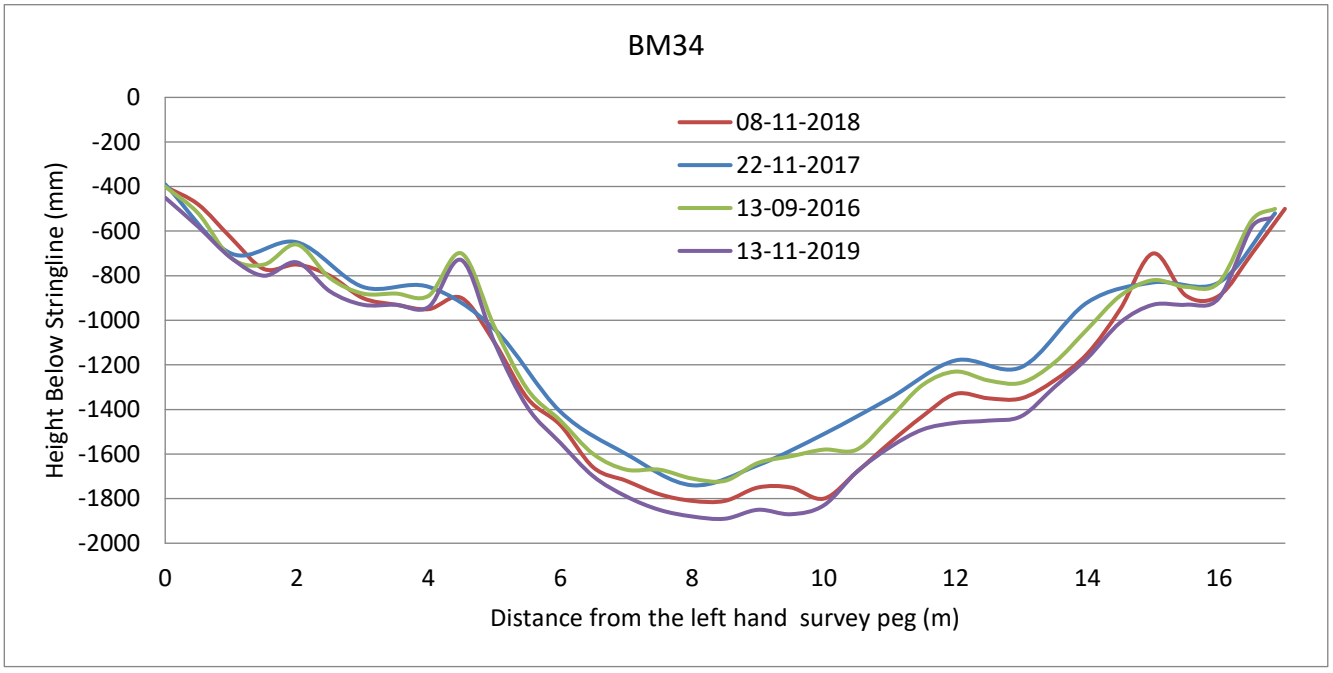


Figure 4 BM34 Transect Results

3.1.4 BM37 (313709 E 6388933 N)

Monitoring point BM37 is the only monitoring point that is located on Wollombi Brook. Wollombi Brook is a large tributary of the Hunter River, with channel widths ranging from 10m to 60m. Generally, Wollombi Brook has flowing water in it except during extreme drought periods. Water was observed to be flowing at the time of the inspection. Both the left and right banks appeared to be generally stable with both banks containing trees. The right bank is steeper than the left bank with a moderate slope and a height of approximately 2m. A pipe outlet exists immediately downstream of the monitoring point on the eastern bank and has scoured out the bank slightly with some exposed moderately dispersive soils (approximately 0.3m high). Some wombat holes were also observed on the eastern bank. Overall, this location has remained similar to the previous monitoring cycle conditions.

At sample site BM37, only the eastern side of Wollombi Brook was surveyed, as the width and depth of the stream prevented transects extending across the full width of the stream. Riparian vegetation along a 280 m reach of the stream was surveyed, with four parallel transects established across the riparian zone upstream and downstream of the sample site (marker point). Generally, only a thin band (of between 5m to 15m in width) of native riparian forest exists along the banks of the stream. The innermost parts of the riparian zone, extending over a series of steep terraced banks, comprise of a narrow band of modified open forest of mainly Swamp Oak (*Casuarina glauca*), River Oak (*Casuarina cunninghamiana*) and occasional Cabbage Gum *Eucalyptus amplifolia*. The lower bank edges contain patches of dense reeds, including *Typha orientalis*, *Phragmites australis* and the exotic *Juncus acutus*. Patches of Parramatta Green Wattle *Acacia parramattensis*, as well as juvenile (or early mature) eucalypts and casuarinas, form a mid-canopy in places; however, generally the vegetation lacks a shrub layer. Leaf litter, as well as exotic grasses and herbs, dominates the ground layer, with common species being Paddy's Lucerne *Sida rhombifolia*, Panic Veldt Grass *Ehrharta erecta* and Common Sowthistle *Sonchus oleraceus*. The native Weeping Grass (*Microlaena stipoides*) occurs occasionally in shaded bank areas.

Upslope of this vegetation, extending to the outer parts of the riparian zone, the forest canopy gives way to cleared land comprising with exotic pasture grass, supporting a range of common exotic grasses and herbs, including African Lovegrass *Eragrostis curvula*, Narrow-leafed Carpet Grass *Axonopus fissifolius*, Couch *Cynodon dactylon* and several other species. It should be noted that a large portion of the bank was submerged during the monitoring event. A minor increase in groundcover was observed on the bank including increased density of *Typha orientalis* and Sowthistle *Sonchus oleraceus.* The canopy layer appeared to be similar to the previous monitoring event.

RARC Stream Health Assessment Classification – **Poor**

CSIRO Ephemeral Stream Assessment Classification – **Potentially Stabilising**

Photos taken at the established photo points for this monitoring point are shown in Plates 14 to 19.



Plate 14 Right Bank



Plate 15 Upstream



Plate 16 Downstream



Plate 17 Left Bank



Plate 18 Erosion



Plate 19 Erosion

3.2 Loders Creek Erosion Visual Assessment

3.2.1 LC1 (321974 E 6385382 N)

The erosion at LC1 has been remediated as part of upgrade work on the Mount Thorley discharge point in 2018. The works undertaken at this erosion site included rock armouring of the creek bed as well as jute mesh and seeding of both banks. Overall, this location has improved greatly and is now considered stable.

CSIRO Ephemeral Stream Assessment Classification – **Stable**

Photos taken at the established photo points for this monitoring point are shown in Plates 20 to 23.



Plate 20 Right Bank



Plate 21 Upstream



Plate 22 Downstream



Plate 23 Left Bank

3.2.2 LC2 (322019 E 6385367 N)

The erosion observed at LC2 included a steep near vertical section of exposed dispersive material (approximately 2m high) on the right bank. This area appeared to be actively eroding including some areas immediately downstream. The erosion at this monitoring location appears to be similar to what was observed in the 2018 survey. A tree was observed to have fallen over at this section of the exposed creek bank. The creek bed and left bank appear to be stable at this location.

CSIRO Ephemeral Stream Assessment Classification – **Active**

Photos taken at the established photo points for this monitoring point are shown in Plates 24 to 26.



Plate 24 Upstream



Plate 25 Downstream



Plate 26 Erosion

3.2.3 LC3 (322087 E 6385446 N)

This location is positioned at a small channel entry point to Loders Creek (on the left bank). The channel appears to be stable, however the confluence point has some significant erosion with some slight undercutting and tunnelling of the dispersive soil. Overall, this monitoring location appears to have worsened since the previous monitoring cycle.

CSIRO Ephemeral Stream Assessment Classification – **Very Active**

Photos taken at the established photo points for this monitoring point are shown in Plates 27 to 30.



Plate 27 Upstream



Plate 28 Downstream



Plate 29 Erosion



Plate 30 Tunnel Erosion

3.2.4 LC4 (322367 E 6385647 N)

LC4 is located on the left bank in an inlet to Loder Creek. It appears that vegetation at this location has been maintained within the powerline easement. The near vertical left bank on the outside of the creek meander is about 4-5m high and has some exposed dispersive material (approximately 1m high) near the top of the bank however this erosion has shown signs of potentially stabilising. The right bank is much flatter and appears to be stable, as does the creek bed. Overall, this monitoring location has shown similar conditions to the previous monitoring cycle.

CSIRO Ephemeral Stream Assessment Classification – **Potentially Stabilising**

Photos taken at the established photo points for this monitoring point are shown in Plates 31 to 33.



Plate 31 Right Bank



Plate 32 Left Bank



Plate 33 Downstream

3.2.5 LC5 (322484 E 6385655 N)

LC5 is located in a historic diversion of Loders Creek. The erosion observed at LC5 included erosion extending up the right bank approximately 20-30m. The area has 0.5-1.0m high steep exposed walls surrounding 5m of exposed soil. The creek bed and left bank appear to be stable. Overall, this monitoring location has shown similar conditions to the previous monitoring cycle.

CSIRO Ephemeral Stream Assessment Classification – **Active**

Photos taken at the established photo points for this monitoring point are shown in Plates 34 to 37.



Plate 34 Right Bank



Plate 35 Upstream



Plate 36 Downstream



Plate 37 Erosion (top of right bank)

3.2.6 LC6 (322670 E 6385697 N)

The erosion observed at LC6 included significant lateral erosion near the top of the right bank. This erosion was approximately 1m high with an alluvial fan extending approximately 2m from the near vertical bank. The rest of the right bank appears to be stable as does the creek bed and the left bank. Overall, this monitoring location appears to have worsened since the previous monitoring cycle. The active erosion appears to be primarily the result of a historic disturbance of the top of the right bank which has exposed the highly dispersive soils at this location.

CSIRO Ephemeral Stream Assessment Classification – **Active**

Photos taken at the established photo points for this monitoring point are shown in Plates 38 to 40.



Plate 38 Right Bank



Plate 39 Erosion



Plate 40 Erosion

3.2.7 LC7 (322759 E 6385778 N)

The erosion observed at LC7 included an area of active erosion of a steep batter comprising exposed dispersive clay material (approximately 0.8m high) on the right bank, however this erosion is not laterally extensive. The erosion appears to have been caused by lateral flow across the bare banks in the area. The right bank appears to be stable downslope of the eroded area, as does the creek bed and the left bank. Overall, this monitoring location has shown similar conditions to the previous monitoring cycle.

CSIRO Ephemeral Stream Assessment Classification – **Active**

Photos taken at the established photo points for this monitoring point are shown in Plates 41 to 43.



Plate 41 Right Bank



Plate 42 Upstream



Plate 43 Erosion

3.2.8 LC8 (323948 E 6389351 N)

The erosion observed at LC8 included significant erosion of the left bank (approximately 1m high with the overall bank at approximately 2.5m high) at a location with a slight meander in the creek. The erosion has some minor undercutting with a section of vertical banks partly stabilised by tree roots. Vegetation growth at this location appears to have increased since the last round of monitoring. This is most likely linked to the alluvial nature of the soil as well as the excessive rainfall observed in the region in the last few months. Trees at this location are at risk of falling over due to loss of support. The creek bed and right bank appear to be stable. Overall, this monitoring location has shown similar conditions to the previous monitoring cycle.

CSIRO Ephemeral Stream Assessment Classification – **Potentially Stabilising**

Photos taken at the established photo points for this monitoring point are shown in Plates 44 to 47.



Plate 44 Right Bank



Plate 45 Upstream



Plate 46 Downstream



Plate 47 Left Bank

3.2.9 LC9 (323996 E 6389540 N)

The erosion observed at LC9 included some loss of exposed slightly dispersive material on the right bank which may have been caused by livestock in the area. This bank is about 2m high and has about 0.8m of exposed soil. The area appears to be stabilising and this round of monitoring has shown an increase in vegetation growth. This is most likely linked to the excessive rainfall observed in the region in the last few months. The creek bed and the left bank appear to be stable. Overall, this monitoring location has shown similar conditions to the previous monitoring cycle.

CSIRO Ephemeral Stream Assessment Classification – **Potentially Stabilising**

Photos taken at the established photo points for this monitoring point are shown in Plates 48 to 51.



Plate 48 Right Bank



Plate 49 Upstream



Plate 50 Downstream



Plate 51 Left Bank

3.2.10 LC10 (324131 E 6390142 N)

The erosion observed at LC10 is located immediately downstream of a concrete lined chute. The soil is alluvial and non-dispersive. The erosion has been created from scouring of the right bank during large flow events with the upstream chute increasing the velocity of the water to this downstream section of channel. This scouring has exposed some roots of some of the trees that line the creek bank. The creek has steep slopes on both banks (approximately 3m high) and was observed flowing at the time of monitoring. The creek is generally stable upstream and downstream except for some cattle tracks immediately upstream on the right bank. Overall, this monitoring location has shown similar conditions to the previous monitoring cycle.

CSIRO Ephemeral Stream Assessment Classification – **Active**

Photos taken at the established photo points for this monitoring point are shown in Plates 52 to 55.



Plate 52 Right Bank



Plate 53 Upstream



Plate 54 Downstream



Plate 55 Left Bank

3.2.11 LC11 (322881 E 6386043 N)

The erosion observed at LC11 includes some significant tunnelling and active erosion on the left bank with exposed vertical dispersive soil. Potential causes for this erosion include wombat holes as well as the presence of a contour bank overflow (which is located immediately upslope of the erosion). Trees were observed on both banks and creek bed. The creek bed and the right bank both show stable conditions. Overall, this monitoring location has shown similar conditions to the previous monitoring cycle.

CSIRO Ephemeral Stream Assessment Classification – **Active**

Photos taken at the established photo points for this monitoring point are shown in Plates 56 to 59.



Plate 56 Upstream



Plate 57 Right Bank



Plate 58 Erosion



Plate 59 Erosion

3.2.12 LC12 (323802 E 6388650 N)

The erosion observed at LC12 includes some erosion (approximately 2m high) on the left bank. It is likely that this erosion was at least partially caused by a fallen tree at the monitoring point location. The 2021 monitoring cycle shows this erosion partially vegetated. This is most likely linked to the excessive rainfall observed in the region in the last few months. The left bank at the monitoring point is significantly higher than the right bank. The creek bed and the right bank both show stable conditions.

CSIRO Ephemeral Stream Assessment Classification – **Potentially Stabilising**

Photos taken at the established photo points for this monitoring point are shown in Plates 60 to 63.



Plate 60 Right Bank



Plate 61 Upstream



Plate 62 Downstream



Plate 63 Left Bank

3.2.13 LC13 (324160 E 6390408 N)

LC13 includes some erosion extending for approximately 5m on the steep left bank with exposed soil which doesn't appear to be highly dispersive. This erosion was most likely caused by livestock tracks observed upstream and downstream of the monitoring location or a localised slope failure. Other than more vegetation as a result of continuous rainfall in the region, this monitoring location has shown similar conditions to the previous monitoring cycle.

CSIRO Ephemeral Stream Assessment Classification – **Potentially Stabilising**

Photos taken at the established photo points for this monitoring point are shown in Plates 64 to 67.



Plate 64 Right Bank



Plate 65 Upstream



Plate 66 Downstream



Plate 67 Left Bank

3.2.14 LC14 (323800 E 6389222 N)

LC14 includes some erosion extending for approximately 3m on the steep left bank with exposed soil which doesn't appear to be highly dispersive. This erosion was most likely caused by livestock tracks. Immediately downstream of this location slight undercutting vertical walls are present on the left bank.

CSIRO Ephemeral Stream Assessment Classification – **Active**

Photos taken at the established photo points for this monitoring point are shown in Plates 68 to 71.



Plate 68 Right Bank



Plate 69 Upstream



Plate 70 Downstream



Plate 71 Left Bank

4 Summary of Results

Site	RARC Stream Heath Assessment Classification					CSIRO Ephemeral Stream Assessment Classification					Primary Cause of Erosion
	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	
MTW Dis	Poor	Poor	Poor	Average	Average	Active	Potentially Stabilising	Potentially Stabilising	Potentially Stabilising	Potentially Stabilising	Lateral Inflows
BM35	Poor	Poor	Poor	Poor	Poor	Active	Active	Active	Active	Active	Unstable Wall Materials
BM34	Poor	Poor	Average	Average	Average	Very Stable	Stable	Stable	Stable	Stable	NA
BM37	Average	Poor	Poor	Poor	Poor	Stable	Stable	Potentially Stabilising	Potentially Stabilising	Potentially Stabilising	NA
LC1	NA	NA	NA	NA	NA	Active	Stable	Stable	Stable	Stable	NA
LC2	NA	NA	NA	NA	NA	Active	Active	Active	Active	Active	Unstable Wall Materials
LC3	NA	NA	NA	NA	NA	Very Active	Very Active	Very Active	Very Active	Very Active	Upstream Flows
LC4	NA	NA	NA	NA	NA	Potentially Stabilising	Potentially Stabilising	Potentially Stabilising	Potentially Stabilising	Potentially Stabilising	Unstable Wall Materials
LC5	NA	NA	NA	NA	NA	Potentially Stabilising	Active	Active	Active	Active	Unstable Wall Materials
LC6	NA	NA	NA	NA	NA	Active	Active	Active	Active	Active	Unstable Wall Materials
LC7	NA	NA	NA	NA	NA	Active	Active	Active	Active	Active	Lateral Inflows

Site	RARC Stream Heath Assessment Classification					CSIRO Ephemeral Stream Assessment Classification					Primary Cause of Erosion
	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	
LC8	NA	NA	NA	NA	NA	Potentially Stabilising	Potentially Stabilising	Potentially Stabilising	Potentially Stabilising	Potentially Stabilising	Upstream Flows
LC9	NA	NA	NA	NA	NA	Potentially Stabilising	Potentially Stabilising	Potentially Stabilising	Potentially Stabilising	Potentially Stabilising	Unstable Wall Materials
LC10	NA	NA	NA	NA	NA	Potentially Stabilising	Active	Potentially Stabilising	Active	Active	Upstream Flows
LC11	NA	NA	NA	NA	NA	Active	Active	Active	Active	Active	Wombat Activity, Contour Bank Overflows
LC12	NA	NA	NA	NA	NA	Active	Active	Potentially Stabilising	Potentially Stabilising	Potentially Stabilising	Fallen Tree
LC13	NA	NA	NA	NA	NA	Active	Active	Active	Potentially Stabilising	Potentially Stabilising	Livestock Tracks
LC14	NA	NA	NA	NA	NA	NA	NA	NA	NA	Active	Livestock Tracks

5 Conclusion and Recommendations

This round of monitoring was subjected to a wetter year than the previous rounds of monitoring and that was reflected by an increase in vegetation growth. MTW advised that there has been 703.43ML discharged from the MTW discharge point between January and November 2021. There has been 736 mm of rainfall recorded within the on-site rainfall gauge for the period January to Mid-November 2021. In comparison, the Bureau of Meteorology shows 843 mm of rainfall recorded at Singleton (Singleton Defence AWS 61430) for the same period.

The results of this monitoring survey indicate that both stream health and channel stability fluctuate over different sections of Loders Creek. The survey identified that some sections of Loders Creek are currently eroding and are vulnerable to further erosion with areas of significant erosion observed. These areas are generally associated with exposed dispersive sub-soils, which hamper vegetation establishment by the development of a hard surface crust when the soil is dry, and the 'melting' nature of the soil when wet.

The survey identified that the majority of Loders Creek displayed stable environments. Generally, the monitoring identified that the creeks have not significantly changed from what was observed during the 2020 survey. Many sections of the creek experience active erosion as a result of natural influences as well as the increased rainfall experienced in the region since 2020. An additional erosion point LC14 was identified during the 2021 survey. This erosion was most likely caused by cattle grazing in the area.

The RARC stream health assessment identified that the monitoring points on Loders Creek were classified as poor to average. The single monitoring point on Wollombi Brook (BM37) was classed as poor with little change observed since monitoring in 2019 with the exception of groundcover growth as a result of good growing conditions. While the recent high-water levels across all creeks and streams flattened vegetation within the creek including native grasses and reeds it is unlikely the vegetation will be impacted over the longer term. Due to the consistent rainfall over the previous year a noticeable increase in vegetation mass (both natives and weeds) was identified across all sites.

It is recommended that MTW adopt a risk-based approach to determine whether mitigation measures and/or improvement works are required at the monitoring points where erosion was observed. Different remediation measures may be utilised depending on the type of erosion that has occurred (as listed in **Section 4**).

For example, erosion caused by lateral flows and unstable wall materials may be remediated by re-grading the batter slope (as required) to a maximum gradient of 3(H):1(V), ripping the soil and then seeding with a suitable vegetation species. Gypsum may also be used as a soil ameliorant and applied at a rate of 1kg/m^2. Bunding may also be used to control upslope lateral flows. Creek erosion caused by the shear stresses associated with the upstream flows may be remediated using armouring of the creek bed / banks (i.e. rock, jute mesh, erosion blanket etc), as was observed to have been implemented by MTW at location MTW Discharge Point during the 2018 survey.

6 References

Land & Water Australia (2005), Rapid Appraisal Of Riparian Condition – Version Two (River and Riparian Technical Guideline No. 4a)

Commonwealth Scientific and Research Organisation (CSIRO) (date unknown) - Ephemeral Stream Assessment, date accessed 14/09/09,

http://www.cse.csiro.au/research/ras/efa/resources/ephemeraldrainagelineassessment.pdf

APPENDIX A

Rapid Appraisal of Riparian Conditions

Rapid Appraisal of Riparian Condition

Site Number: BM34

Site: Loaders Creek **GPS start:** see figure

Date: 16-11-2021 **Observer:** SM **GPS end:**

Longitudinal continuity of riparian canopy vegetation (>5m wide)

Map	Score
	4

0 = <50%, 1 = 50-64%, 2 = 65-79%, 3 = 80-94%, 4 = ≥95% vegetated bank;

with ½ point subtracted for each significant discontinuity (>50m long)

Width of riparian canopy vegetation

Transect	Channel Width (CW)	Vegetation Width (VW)	Score
1	6	25	3
2	6	20	3
3	6	15	2
4	6	15	2
Average			2.5

Channel ≤10m wide: 0 = VW <5m, 1 = VW 5-9m , 2 = VW 10-19m, 3 = VW 20-39m, 4 = VW ≥40m

Channel >10m wide: 0 = VW/CW <0.5, 1 = VW/CW 0.5-0.9, 2 = VW/CW 1-1.9, 3 = VW/CW 2-3.9, 4 = VW/CW ≥4

Proximity

Score
2

Nearest patch of native vegetation >10ha:

0 = >1km, 1 = 200m-1km, 2 = contiguous,

3 = contiguous with patch >50ha

Vegetation cover: Canopy >5m, Understorey 1-5m, Ground cover <1m

Transect	Canopy	Native canopy	Understorey	Native understorey	Ground cover	Native ground cover	# layers
1	2	2	2	0	3	2	3
2	1	1	2	0	3	2	3
3	3	3	2	0	3	2	3
4	3	3	2	0	2	2	3
Average	2.25	2.25	2	0	2.75	2	3

Canopy and ground cover: 0 = none, 1 = 1-30%, 2 = 31-60%, 3 = >60%

Understorey cover: 0 = none, 1 = 1-5%, 2 = 6-30%, 3 = >30%

Debris

Transect	Leaf litter	Native leaf litter	Standing dead trees	Hollow-bearing trees	Fallen logs
1	3	3	1	0	1
2	2	2	2	0	1
3	1	1	1	0	1
4	1	1	0	0	1
Average	1.75	1.75	1	0	1

Leaf litter & native leaf litter cover: 0 = none, 1 = 1-30%, 2 = 31-60%, 3 = >60%

Standing dead trees (>20cm dbh) & hollow-bearing trees: 0 = absent, 1 = present

Fallen logs (>10cm diameter): 0 = none, 1 = small quantities, 2 = abundant

Features

Transect	Native canopy species regeneration	Native understorey regeneration	Large native tussock grasses	Reeds
1	1	1	2	2
2	1	1	2	2
3	1	1	2	2
4	1	1	2	2
Average	1	1	2	2

Regeneration <1m tall: 0 = none, 1 = scattered, and 2 = abundant, with ½ point subtracted for grazing damage

Reeds & large tussock grasses: 0 = none, 1 = scattered, and 2 = abundant

Calculation of scores

Site Number:	BM34

Longitudinal continuity of riparian canopy vegetation

Score
4

Width of riparian canopy vegetation

Average	2.5

Proximity

Score
2

Vegetation cover

	Canopy	Native canopy	Understorey	Native understorey	Ground cover	Native ground cover	# layers
Average	2.25	2.5	2	0	2.75	2	3

Debris

	Leaf litter	Native leaf litter	Standing dead trees	Hollow-bearing trees	Fallen logs
Average	1	1	0	0	0

Features

	Native canopy species regeneration	Native understorey regeneration	Large native tussock grasses	Reeds
Average	1	1	1	2

TOTALS

Site:	Habitat	Cover	Natives	Debris	Features	**Total**
(out of)	11	12	9	10	8	50
	8.5	10	4.5	2	5	30

Rapid Appraisal of Riparian Condition

Site Number: BM35

Site: Loaders Creek **GPS start:** See figure

Date: 16-11-2021 **Observer:** SM **GPS end:**

Longitudinal continuity of riparian canopy vegetation (>5m wide)

Map	Score
	3

0 = <50%, 1 = 50-64%, 2 = 65-79%, 3 = 80-94%, 4 = ≥95% vegetated bank;

with ½ point subtracted for each significant discontinuity (>50m long)

Width of riparian canopy vegetation

Transect	Channel Width (CW)	Vegetation Width (VW)	Score
1	5	18	2
2	5	25	3
3	5	30	3
4	5	60	4
Average			3

Channel ≤10m wide: 0 = VW <5m, 1 = VW 5-9m , 2 = VW 10-19m, 3 = VW 20-39m, 4 = VW ≥40m

Channel >10m wide: 0 = VW/CW <0.5, 1 = VW/CW 0.5-0.9, 2 = VW/CW 1-1.9, 3 = VW/CW 2-3.9, 4 = VW/CW ≥4

Proximity

Score
1

Nearest patch of native vegetation >10ha:

0 = >1km, 1 = 200m-1km, 2 = contiguous,

3 = contiguous with patch >50ha

Vegetation cover: Canopy >5m, Understorey 1-5m, Ground cover <1m

Transect	Canopy	Native canopy	Understorey	Native understorey	Ground cover	Native ground cover	# layers
1	2	2	2	0	3	0	3
2	3	3	2	0	3	0	3
3	3	3	2	0	3	0	3
4	3	3	2	0	2	0	3
Average	2.75	2.75	2	0	2.75	0	3

Canopy and ground cover: 0 = none, 1 = 1-30%, 2 = 31-60%, 3 = >60%

Understorey cover: 0 = none, 1 = 1-5%, 2 = 6-30%, 3 = >30%

Debris

Transect	Leaf litter	Native leaf litter	Standing dead trees	Hollow-bearing trees	Fallen logs
1	3	3	1	0	1
2	3	3	1	0	1
3	3	3	1	0	1
4	3	3	0	0	1
Average	3	3	0.75	0	1

Leaf litter & native leaf litter cover: 0 = none, 1 = 1-30%, 2 = 31-60%, 3 = >60%

Standing dead trees (>20cm dbh) & hollow-bearing trees: 0 = absent, 1 = present

Fallen logs (>10cm diameter): 0 = none, 1 = small quantities, 2 = abundant

Features

Transect	Native canopy species regeneration	Native understorey regeneration	Large native tussock grasses	Reeds
1	1	1	2	2
2	1	1	2	2
3	1	1	2	2
4	1	1	2	2
Average	1	1	2	2

Regeneration <1m tall: 0 = none, 1 = scattered, and 2 = abundant, with ½ point subtracted for grazing damage

Reeds & large tussock grasses: 0 = none, 1 = scattered, and 2 = abundant

Calculation of scores

Site Number:	BCC01

Longitudinal continuity of riparian canopy vegetation

Score
3

Width of riparian canopy vegetation

Average	3

Proximity

Score
1

Vegetation cover

	Canopy	Native canopy	Understorey	Native understorey	Ground cover	Native ground cover	# layers
Average	2.25	2.25	2	0	2	0	3

Debris

	Leaf litter	Native leaf litter	Standing dead trees	Hollow-bearing trees	Fallen logs
Average	3	3	0	0	0

Features

	Native canopy species regeneration	Native understorey regeneration	Large native tussock grasses	Reeds
Average	1	1	1	2

TOTALS

Site:	Habitat	Cover	Natives	Debris	Features	**Total**
(out of)	11	12	9	10	8	50
	7	9.25	2.25	6	5	29.5

Rapid Appraisal of Riparian Condition

Site Number:	BM37

Site:	Wollomi Brook			GPS start:	See figure
Date:	16-11-2021	Observer:	SM	GPS end:	

Longitudinal continuity of riparian canopy vegetation (>5m wide)

Map	Score
	3

0 = <50%, 1 = 50-64%, 2 = 65-79%, 3 = 80-94%, 4 = ≥95% vegetated bank;

with ½ point subtracted for each significant discontinuity (>50m long)

Width of riparian canopy vegetation

Transect	Channel Width (CW)	Vegetation Width (VW)	Score
1	20	15	1
2	10	17	2
3	20	20	4
4	10	35	3
Average			2.5

Channel ≤10m wide: 0 = VW <5m, 1 = VW 5-9m , 2 = VW 10-19m, 3 = VW 20-39m, 4 = VW ≥40m

Channel >10m wide: 0 = VW/CW <0.5, 1 = VW/CW 0.5-0.9, 2 = VW/CW 1-1.9, 3 = VW/CW 2-3.9, 4 = VW/CW ≥4

Proximity

Score
2

Nearest patch of native vegetation >10ha:

0 = >1km, 1 = 200m-1km, 2 = contiguous,

3 = contiguous with patch >50ha

Vegetation cover: Canopy >5m, Understorey 1-5m, Ground cover <1m

Transect	Canopy	Native canopy	Understorey	Native understorey	Ground cover	Native ground cover	# layers
1	2	2	2	1	3	1	3
2	3	3	2	1	3	1	3
3	3	3	2	1	3	1	3
4	3	3	2	1	2	1	3
Average	2.75	2.75	2	1	2.75	1	3

Canopy and ground cover: 0 = none, 1 = 1-30%, 2 = 31-60%, 3 = >60%

Understorey cover: 0 = none, 1 = 1-5%, 2 = 6-30%, 3 = >30%

Debris

Transect	Leaf litter	Native leaf litter	Standing dead trees	Hollow-bearing trees	Fallen logs
1	3	3	1	0	0
2	2	2	1	0	0
3	2	2	1	0	1
4	2	2	0	0	1
Average	2.25	2.25	0.75	0	0.5

Leaf litter & native leaf litter cover: 0 = none, 1 = 1-30%, 2 = 31-60%, 3 = >60%

Standing dead trees (>20cm dbh) & hollow-bearing trees: 0 = absent, 1 = present

Fallen logs (>10cm diameter): 0 = none, 1 = small quantities, 2 = abundant

Features

Transect	Native canopy species regeneration	Native understorey regeneration	Large native tussock grasses	Reeds
1	0	0	1	2
2	0	0	1	2
3	0	0	1	2
4	0	0	1	2
Average	0	0	1	2

Regeneration <1m tall: 0 = none, 1 = scattered, and 2 = abundant, with ½ point subtracted for grazing damage

Reeds & large tussock grasses: 0 = none, 1 = scattered, and 2 = abundant

Calculation of scores

Site Number:	BM37

Longitudinal continuity of riparian canopy vegetation

Score
3

Width of riparian canopy vegetation

Average	2.5

Proximity

Score
2

Vegetation cover

	Canopy	Native canopy	Understorey	Native understorey	Ground cover	Native ground cover	# layers
Average	2	2	2	1	3	1	3

Debris

	Leaf litter	Native leaf litter	Standing dead trees	Hollow-bearing trees	Fallen logs
Average	2	2	0	0	0.5

Features

	Native canopy species regeneration	Native understorey regeneration	Large native tussock grasses	Reeds
Average	0	0	1	2

TOTALS

Site:	Habitat	Cover	Natives	Debris	Features	**Total**
(out of)	11	12	9	10	8	50
	7.5	10	4	4.5	3	29

Rapid Appraisal of Riparian Condition

Site Number:	MTW DIS

Site:	**Mount Thorley Discharge**			**GPS start:**	**See figure**
Date:	**16-11-2021**	**Observer:**	**SM**	**GPS end:**	

Longitudinal continuity of riparian canopy vegetation (>5m wide)

Map	Score
	2

0 = <50%, 1 = 50-64%, 2 = 65-79%, 3 = 80-94%, 4 = ≥95% vegetated bank;

with ½ point subtracted for each significant discontinuity (>50m long)

Width of riparian canopy vegetation

Transect	Channel Width (CW)	Vegetation Width (VW)	Score
1	3	75	4
2	3	15	2
3	5	45	4
4	7	55	4
Average			3.5

Channel ≤10m wide: 0 = VW <5m, 1 = VW 5-9m , 2 = VW 10-19m, 3 = VW 20-39m, 4 = VW ≥40m

Channel >10m wide: 0 = VW/CW <0.5, 1 = VW/CW 0.5-0.9, 2 = VW/CW 1-1.9, 3 = VW/CW 2-3.9, 4 = VW/CW ≥4

Proximity

Score
1

Nearest patch of native vegetation >10ha:

0 = >1km, 1 = 200m-1km, 2 = contiguous,

3 = contiguous with patch >50ha

Vegetation cover: Canopy >5m, Understorey 1-5m, Ground cover <1m

Transect	Canopy	Native canopy	Understorey	Native understorey	Ground cover	Native ground cover	# layers
1	2	2	1	1	2	1	3
2	3	3	0	0	2	1	3
3	2	2	1	1	3	1	3
4	3	3	1	1	2	1	3
Average	2.5	2.5	0.75	0.75	2.25	1	3

Canopy and ground cover: 0 = none, 1 = 1-30%, 2 = 31-60%, 3 = >60%

Understorey cover: 0 = none, 1 = 1-5%, 2 = 6-30%, 3 = >30%

Debris

Transect	Leaf litter	Native leaf litter	Standing dead trees	Hollow-bearing trees	Fallen logs
1	3	3	1	0	1
2	3	3	1	0	1
3	3	3	1	0	1
4	3	3	0	0	1
Average	3	3	0.75	0	1

Leaf litter & native leaf litter cover: 0 = none, 1 = 1-30%, 2 = 31-60%, 3 = >60%

Standing dead trees (>20cm dbh) & hollow-bearing trees: 0 = absent, 1 = present

Fallen logs (>10cm diameter): 0 = none, 1 = small quantities, 2 = abundant

Features

Transect	Native canopy species regeneration	Native understorey regeneration	Large native tussock grasses	Reeds
1	1	0	1	2
2	1	0	1	2
3	1	0	1	2
4	1	0	1	2
Average	1	0	1	2

Regeneration <1m tall: 0 = none, 1 = scattered, and 2 = abundant, with ½ point subtracted for grazing damage

Reeds & large tussock grasses: 0 = none, 1 = scattered, and 2 = abundant

Calculation of scores

Site Number:	MTO DIS

Longitudinal continuity of riparian canopy vegetation

Score
2

Width of riparian canopy vegetation

Average	3.5

Proximity

Score
1

Vegetation cover

	Canopy	Native canopy	Understorey	Native understorey	Ground cover	Native ground cover	# layers
Average	2.5	2.25	0.75	0.75	2.25	1	3

Debris

	Leaf litter	Native leaf litter	Standing dead trees	Hollow-bearing trees	Fallen logs
Average	3	3	0.75	0	1

Features

	Native canopy species regeneration	Native understorey regeneration	Large native tussock grasses	Reeds
Average	1	0	1	2

TOTALS

Site:	Habitat	Cover	Natives	Debris	Features	**Total**
(out of)	11	12	9	10	8	50
	6.5	8.5	4	7.75	4	30.75

APPENDIX B

CSIRO Ephemeral Stream Assessment Database

MTW CSIRO Ephemeral Stream Assessment Database

Site Number	Distance US/DS from Survey Peg (m)	Date of Monitoring	Nov-18	Nov-19	Dec-20	Nov-21
		Assessor	SLR	SLR	SLR	SLR
		Channel Characteristic	Rating	Rating	Rating	Rating
LC1	0m (At Survey Peg)	Vegetation on D/L Floor	3	3	3	3
		Vegetation on D/L Walls	3	3	3	3
		Shape of D/L Cross-Section	3	3	3	3
		Longitudinal Morphology	3	3	3	3
		Particle Size of Materials on Floor	1	1	1	1
		Nature of D/L Wall Materials	3	3	3	3
		Nature and Shape of Bank Edge	4	4	4	4
		Nature of Lateral Flow Regulation	3	3	3	3
		Sum of Ratings	**23**	**23**	**23**	**23**
		Activity Rating	**72**	**72**	**72**	**72**
		Classification	**Stable**	**Stable**	**Stable**	**Stable**
LC2	0m (At Survey Peg)	Vegetation on D/L Floor	3	3	3	3
		Vegetation on D/L Walls	1	1	1	1
		Shape of D/L Cross-Section	2	2	2	2
		Longitudinal Morphology	2	2	2	2
		Particle Size of Materials on Floor	1	1	1	1
		Nature of D/L Wall Materials	1	1	1	1
		Nature and Shape of Bank Edge	4	4	4	4
		Nature of Lateral Flow Regulation	4	4	4	4
		Sum of Ratings	**18**	**18**	**18**	**18**
		Activity Rating	**56**	**56**	**56**	**56**
		Classification	**Active**	**Active**	**Active**	**Active**
LC3	0m (At Survey Peg)	Vegetation on D/L Floor	3	3	3	3
		Vegetation on D/L Walls	1	1	1	1
		Shape of D/L Cross-Section	2	1	1	1
		Longitudinal Morphology	2	1	1	1
		Particle Size of Materials on Floor	1	1	1	1
		Nature of D/L Wall Materials	1	1	1	1
		Nature and Shape of Bank Edge	3	3	3	3
		Nature of Lateral Flow Regulation	2	2	2	2
		Sum of Ratings	**15**	**13**	**13**	**13**
		Activity Rating	**47**	**41**	**41**	**41**
		Classification	**Very Active**	**Very Active**	**Very Active**	**Very Active**
LC4	0m (At Survey Peg)	Vegetation on D/L Floor	3	3	3	3
		Vegetation on D/L Walls	3	3	3	3
		Shape of D/L Cross-Section	3	2	3	2
		Longitudinal Morphology	3	3	3	3
		Particle Size of Materials on Floor	1	1	1	1
		Nature of D/L Wall Materials	1	1	1	1
		Nature and Shape of Bank Edge	4	4	4	4
		Nature of Lateral Flow Regulation	4	4	4	4
		Sum of Ratings	**22**	**21**	**22**	**21**
		Activity Rating	**69**	**66**	**69**	**66**
		Classification	**Potentially Stabilising**	**Potentially Stabilising**	**Potentially Stabilising**	**Potentially Stabilising**
LC5	0m (At Survey Peg)	Vegetation on D/L Floor	3	3	3	3
		Vegetation on D/L Walls	2	2	2	2
		Shape of D/L Cross-Section	2	2	2	2
		Longitudinal Morphology	2	2	2	2
		Particle Size of Materials on Floor	1	1	1	1
		Nature of D/L Wall Materials	2	2	2	2
		Nature and Shape of Bank Edge	3	3	3	3
		Nature of Lateral Flow Regulation	4	4	4	4
		Sum of Ratings	**19**	**19**	**19**	**19**
		Activity Rating	**59**	**59**	**59**	**59**
		Classification	**Active**	**Active**	**Active**	**Active**
LC6	0m (At Survey Peg)	Vegetation on D/L Floor	3	3	3	3
		Vegetation on D/L Walls	2	2	2	2
		Shape of D/L Cross-Section	2	2	2	2
		Longitudinal Morphology	2	2	2	2
		Particle Size of Materials on Floor	1	1	1	1
		Nature of D/L Wall Materials	1	1	1	1

MTW CSIRO Ephemeral Stream Assessment Database

Site Number	Distance US/DS from Survey Peg (m)	Date of Monitoring	Nov-18	Nov-19	Dec-20	Nov-21
		Assessor	SLR	SLR	SLR	SLR
		Channel Characteristic	Rating	Rating	Rating	Rating
		Nature and Shape of Bank Edge	3	3	3	3
		Nature of Lateral Flow Regulation	3	3	3	3
		Sum of Ratings	**17**	**17**	**17**	**17**
		Activity Rating	**53**	**53**	**53**	**53**
		Classification	**Active**	**Active**	**Active**	**Active**
		Vegetation on D/L Floor	3	3	3	3
		Vegetation on D/L Walls	1	1	1	1
		Shape of D/L Cross-Section	2	2	2	2
		Longitudinal Morphology	2	2	2	2
		Particle Size of Materials on Floor	1	1	1	1
LC7	0m (At Survey Peg)	Nature of D/L Wall Materials	2	2	2	2
		Nature and Shape of Bank Edge	4	4	4	4
		Nature of Lateral Flow Regulation	2	2	2	2
		Sum of Ratings	**17**	**17**	**17**	**17**
		Activity Rating	**53**	**53**	**53**	**53**
		Classification	**Active**	**Active**	**Active**	**Active**
		Vegetation on D/L Floor	2	2	2	2
		Vegetation on D/L Walls	1	1	3	3
		Shape of D/L Cross-Section	3	3	3	3
		Longitudinal Morphology	3	3	3	3
		Particle Size of Materials on Floor	1	1	1	1
LC8	0m (At Survey Peg)	Nature of D/L Wall Materials	2	2	2	2
		Nature and Shape of Bank Edge	4	4	4	4
		Nature of Lateral Flow Regulation	4	4	4	4
		Sum of Ratings	**20**	**20**	**22**	**22**
		Activity Rating	**63**	**63**	**69**	**69**
		Classification	**Potentially Stabilising**	**Potentially Stabilising**	**Potentially Stabilising**	**Potentially Stabilising**
		Vegetation on D/L Floor	3	3	3	3
		Vegetation on D/L Walls	3	3	3	3
		Shape of D/L Cross-Section	3	3	3	3
		Longitudinal Morphology	2	2	2	2
		Particle Size of Materials on Floor	1	1	1	1
LC9	0m (At Survey Peg)	Nature of D/L Wall Materials	3	2	2	2
		Nature and Shape of Bank Edge	3	4	3	3
		Nature of Lateral Flow Regulation	4	4	4	4
		Sum of Ratings	**22**	**22**	**21**	**21**
		Activity Rating	**69**	**69**	**66**	**66**
		Classification	**Potentially Stabilising**	**Potentially Stabilising**	**Potentially Stabilising**	**Potentially Stabilising**
		Vegetation on D/L Floor	1	1	1	1
		Vegetation on D/L Walls	1	1	1	1
		Shape of D/L Cross-Section	2	2	2	2
		Longitudinal Morphology	2	1	2	2
		Particle Size of Materials on Floor	1	3	1	1
LC10	0m (At Survey Peg)	Nature of D/L Wall Materials	4	4	4	4
		Nature and Shape of Bank Edge	4	4	4	4
		Nature of Lateral Flow Regulation	4	4	4	4
		Sum of Ratings	**19**	**20**	**19**	**19**
		Activity Rating	**59**	**63**	**59**	**59**
		Classification	**Active**	**Potentially Stabilising**	**Active**	**Active**
		Vegetation on D/L Floor	3	2	2	2
		Vegetation on D/L Walls	1	2	2	2
		Shape of D/L Cross-Section	2	3	3	3
		Longitudinal Morphology	2	2	2	2
		Particle Size of Materials on Floor	1	1	1	1
LC11	0m (At Survey Peg)	Nature of D/L Wall Materials	1	2	2	2
		Nature and Shape of Bank Edge	3	3	3	3
		Nature of Lateral Flow Regulation	4	4	4	4
		Sum of Ratings	**17**	**19**	**19**	**19**
		Activity Rating	**53**	**59**	**59**	**59**
		Classification	**Active**	**Active**	**Active**	**Active**
		Vegetation on D/L Floor	2	2	2	2

MTW CSIRO Ephemeral Stream Assessment Database

Site Number	Distance US/DS from Survey Peg (m)	Date of Monitoring / Assessor / Channel Characteristic	Nov-18 SLR Rating	Nov-19 SLR Rating	Dec-20 SLR Rating	Nov-21 SLR Rating
LC12	0m (At Survey Peg)	Vegetation on D/L Walls	2	2	3	3
		Shape of D/L Cross-Section	3	3	3	3
		Longitudinal Morphology	2	3	2	2
		Particle Size of Materials on Floor	1	1	1	1
		Nature of D/L Wall Materials	2	2	2	2
		Nature and Shape of Bank Edge	3	3	3	3
		Nature of Lateral Flow Regulation	4	4	4	4
		Sum of Ratings	**19**	**20**	**20**	**20**
		Activity Rating	**59**	**63**	**63**	**63**
		Classification	**Active**	**Potentially Stabilising**	**Potentially Stabilising**	**Potentially Stabilising**
LC13	0m (At Survey Peg)	Vegetation on D/L Floor	1	1	1	1
		Vegetation on D/L Walls	2	1	2	2
		Shape of D/L Cross-Section	3	2	3	3
		Longitudinal Morphology	2	2	2	2
		Particle Size of Materials on Floor	1	1	1	1
		Nature of D/L Wall Materials	2	3	3	3
		Nature and Shape of Bank Edge	4	4	4	4
		Nature of Lateral Flow Regulation	4	4	4	4
		Sum of Ratings	**19**	**18**	**20**	**20**
		Activity Rating	**59**	**56**	**63**	**63**
		Classification	**Active**	**Active**	**Potentially Stabilising**	**Potentially Stabilising**
LC14	0m (At Survey Peg)	Vegetation on D/L Floor	n/a	n/a	n/a	2
		Vegetation on D/L Walls				3
		Shape of D/L Cross-Section				2
		Longitudinal Morphology				2
		Particle Size of Materials on Floor				1
		Nature of D/L Wall Materials				1
		Nature and Shape of Bank Edge				4
		Nature of Lateral Flow Regulation				4
		Sum of Ratings	**0**	**0**	**0**	**19**
		Activity Rating	**0**	**0**	**0**	**59**
		Classification	**No Assessment Undertaken**	**No Assessment Undertaken**	**No Assessment Undertaken**	**Active**
MTW Dis	0m (At Survey Peg)	Vegetation on D/L Floor	1	1	1	1
		Vegetation on D/L Walls	2	2	2	2
		Shape of D/L Cross-Section	3	3	3	3
		Longitudinal Morphology	2	2	2	2
		Particle Size of Materials on Floor	3	3	3	3
		Nature of D/L Wall Materials	3	3	3	3
		Nature and Shape of Bank Edge	4	4	4	4
		Nature of Lateral Flow Regulation	2	2	2	2
		Sum of Ratings	**20**	**20**	**20**	**20**
		Activity Rating	**63**	**63**	**63**	**63**
		Classification	**Potentially Stabilising**	**Potentially Stabilising**	**Potentially Stabilising**	**Potentially Stabilising**
BM34	0m (At Survey Peg)	Vegetation on D/L Floor	3	3	3	3
		Vegetation on D/L Walls	3	3	3	3
		Shape of D/L Cross-Section	5	5	5	5
		Longitudinal Morphology	3	3	3	3
		Particle Size of Materials on Floor	1	1	1	1
		Nature of D/L Wall Materials	3	3	3	3
		Nature and Shape of Bank Edge	3	3	3	3
		Nature of Lateral Flow Regulation	4	4	4	4
		Sum of Ratings	**25**	**25**	**25**	**25**
		Activity Rating	**78**	**78**	**78**	**78**
		Classification	**Stable**	**Stable**	**Stable**	**Stable**
BM35	0m (At Survey Peg)	Vegetation on D/L Floor	3	3	3	3
		Vegetation on D/L Walls	2	2	2	2
		Shape of D/L Cross-Section	2	2	2	2
		Longitudinal Morphology	2	2	2	2
		Particle Size of Materials on Floor	1	1	1	1
		Nature of D/L Wall Materials	2	2	2	2
		Nature and Shape of Bank Edge	3	3	3	3

MTW CSIRO Ephemeral Stream Assessment Database

Site Number	Distance US/DS from Survey Peg (m)	Date of Monitoring	Nov-18	Nov-19	Dec-20	Nov-21
		Assessor	SLR	SLR	SLR	SLR
		Channel Characteristic	Rating	Rating	Rating	Rating
		Nature of Lateral Flow Regulation	3	3	3	3
		Sum of Ratings	**18**	**18**	**18**	**18**
		Activity Rating	**56**	**56**	**56**	**56**
		Classification	**Active**	**Active**	**Active**	**Active**
BM37	0m (At Survey Peg)	Vegetation on D/L Floor	1	1	1	1
		Vegetation on D/L Walls	3	3	3	3
		Shape of D/L Cross-Section	4	4	3	3
		Longitudinal Morphology	3	3	4	4
		Particle Size of Materials on Floor	1	1	1	1
		Nature of D/L Wall Materials	3	2	2	2
		Nature and Shape of Bank Edge	4	4	4	4
		Nature of Lateral Flow Regulation	4	4	4	4
		Sum of Ratings	**23**	**22**	**22**	**22**
		Activity Rating	**72**	**69**	**69**	**69**
		Classification	**Stable**	**Potentially Stabilising**	**Potentially Stabilising**	**Potentially Stabilising**

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Appendix 5:

Annual Ground Water Review Report

Australasian Groundwater & Environmental Consultants

Report on

Mount Thorley Warkworth Annual Groundwater Monitoring Review 2021

Prepared for
Yancoal Australia Ltd

Project No. MTW5003.001
March 2022

ageconsultants.com.au

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Mount Thorley Warkworth Annual Groundwater Monitoring Review 2021

1 Introduction

Yancoal Australia Ltd (Yancoal) operate the Mount Thorley and Warkworth Mines (MTW) as an amalgamated complex known as MTW, which is located 15 km south-west of Singleton in the Hunter Valley Region of NSW. The mine consists of two separate open cut mining pits operated and owned by Yancoal, accessing a series of coal seams within the Permian Wittingham Coal Measures.

Whilst MTW is operated in an amalgamated manner, the Mount Thorley and Warkworth Mines currently have separate conditions of approval issued by the NSW Department of Planning, Industry and Environment. The Development Consents (Warkworth: SSD-6464, Mount Thorley: SSD-6465) for both mines include conditions that require environmental monitoring data be collected at each mine, with this data being reviewed and reported in an Annual Review document.

Yancoal have commissioned Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) to review groundwater monitoring data collected at MTW during 2021 and provide the results in an Annual Review.

1.1 Scope

This report is a review of groundwater monitoring data collected during the one-year monitoring period 1 January 2021 to 31 December 2021. Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) were commissioned by MTW to undertake the following scope of work:

- review alluvial and rock aquifer groundwater levels and quality;
- update relevant groundwater monitoring hydrographs;
- discuss how groundwater levels respond to rainfall and mining over the reporting period;
- discuss groundwater chemistry trend analyses;
- identify any changes/observations made during the past 12 months;
- identify exceedances of trigger criteria outlined in the approved the Water Management Plan (WMP; Water Management Plan Mount Thorley Warkworth version 5.1, dated 15 November 2021);
- assess the adequacy of the existing monitoring bore network and monitoring program; and
- provide recommendations if necessary.

2 Physical setting

2.1 Climate and rainfall

Long-term rainfall data covering the period 2007 – 2021 were obtained from MTWs Charlton Ridge weather station and are summarised in Table 2.1.

The total annual rainfall recorded at MTW for 2021 was 979.6 mm. March was the wettest month, with 236.6 mm of recorded rain, and May the driest with 8.4 mm of rain recorded. A comparison of the total annual 2021 rainfall (979.6 mm) at MTW with the longer-term 2007 to 2021 average (668.3 mm) illustrates an above average rainfall trend for the year.

Table 2.1

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
MTW monthly Total Rainfall (mm) 2021	106.0	89.4	236.6	20.8	8.4	53.0	23.0	41.2	20.6	82.2	227.4	71.0	979.6
MTW long-term average monthly Total Rainfall (mm) 2007-2021	72.0	85.8	85.9	46.5	27.3	64.5	23.0	27.9	34.6	42.8	80.3	77.7	668.3

Historical rainfall was contextualised using the Cumulative Rainfall Departure (CRD) method (Figure 2.1). This method is a summation of the monthly departure of rainfall from the long-term average monthly rainfall. A rising trend in the CRD plot indicates periods of above average rainfall, whilst a falling slope indicates periods when rainfall is below average.

The CRD (Figure 2.1) has displayed an increasing trend throughout 2020 and 2021, following drought conditions from early 2017 to late 2019.

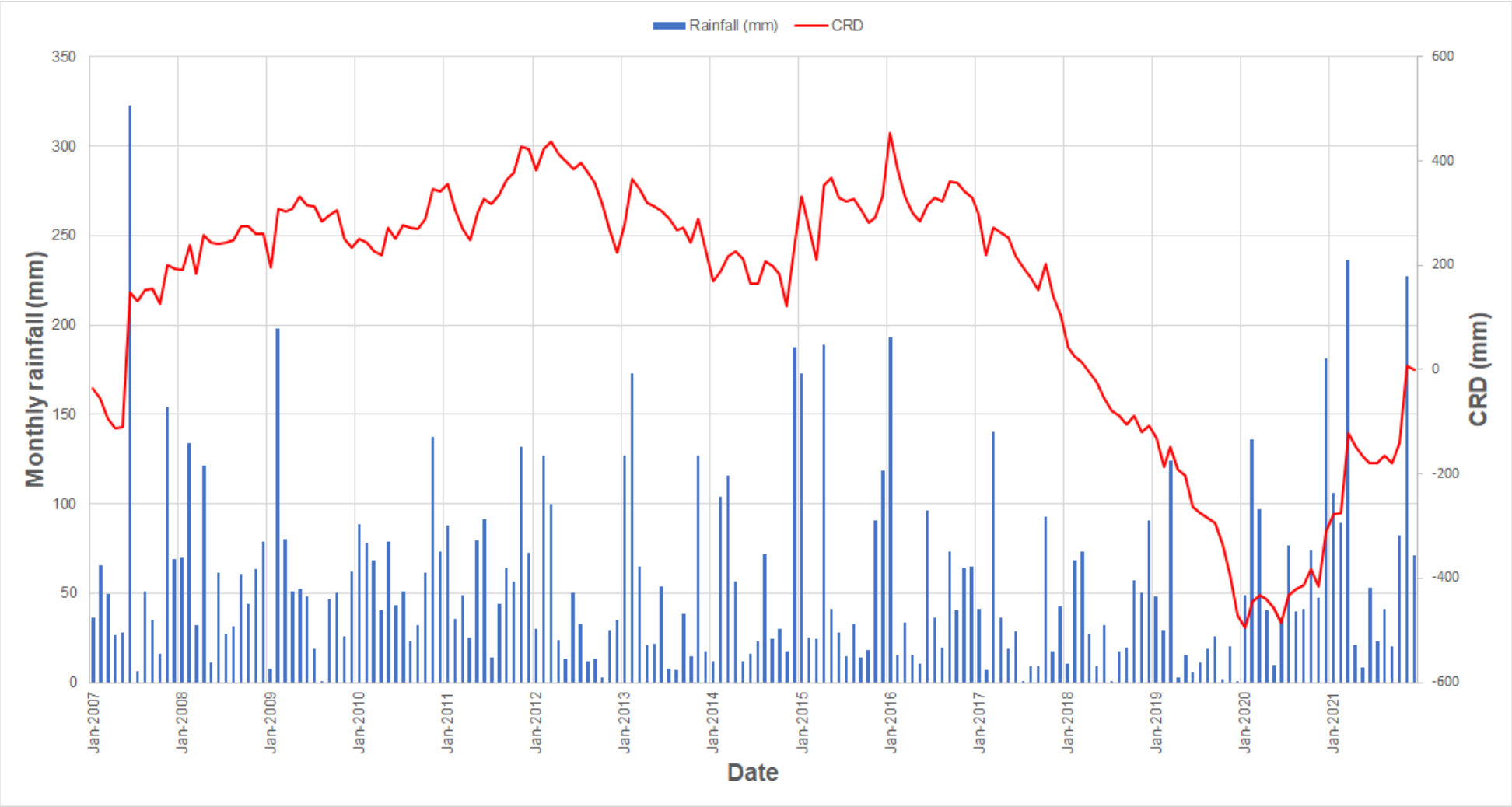


Figure 2.1 Cumulative rainfall departure (2007 to 2021) for MTW Charlton Ridge weather station

2.2 Surface water

MTW is bound by Wollombi Brook to the east and Hunter River to the north and north-east. Real time stream flow data was collected from Wollombi Brook at Warkworth (210004), Hunter River at Maison Dieu (210128) and Hunter River at Long Point (210134) from January 2016 to December 2021 (Figure 2.2).



Figure 2.2 Surface water levels

Excepting short term fluctuations following heavy rainfall events, surface water levels were relatively stable in both the Wollombi Brook and Hunter River in 2021. Hunter River is regulated at Glenbawn Dam with daily releases to maintain flow and environmental quality. Wollombi Brook has held water since January 2020, following an extended period with no flow. Increased flow in Wollombi Brook aligns with an incline in CRD recorded since January 2020.

2.3 Geology

MTW is located within the Hunter Coalfield in the Sydney Basin, that is a Permian-Triassic age sedimentary basin situated in the southern section of the Sydney-Gunnedah-Bowen Basin. The Sydney Basin's north-eastern extents are constrained by the New England Fold Belt and constrained by the Lachlan Fold Belt towards the south and west. The New England Fold Belt's periphery is distinguished by the Hunter-Mooki Thrust, defined by a progression of reverse faults alternated by mid-carboniferous rocks and Permian Sydney Basin strata.

The main stratigraphic units (Figure 2.3) occurring in the vicinity of the Project Area and the dominant lithology within each are:

- Quaternary alluvium– unconsolidated clays, silts, sands, and gravels mainly associated with Wollombi Brook to the west and Hunter River to the east of MTW;
- Warkworth sands – aeolian sand dunes unconformably overlying the Wittingham Coal Measures towards the north east of the Project area;
- Permian age Wittingham Coal Measures including the Jerry Plains and Vane sub-groups comprising multiple coal seams with intervening claystones, siltstones, sandstones, and conglomerates.

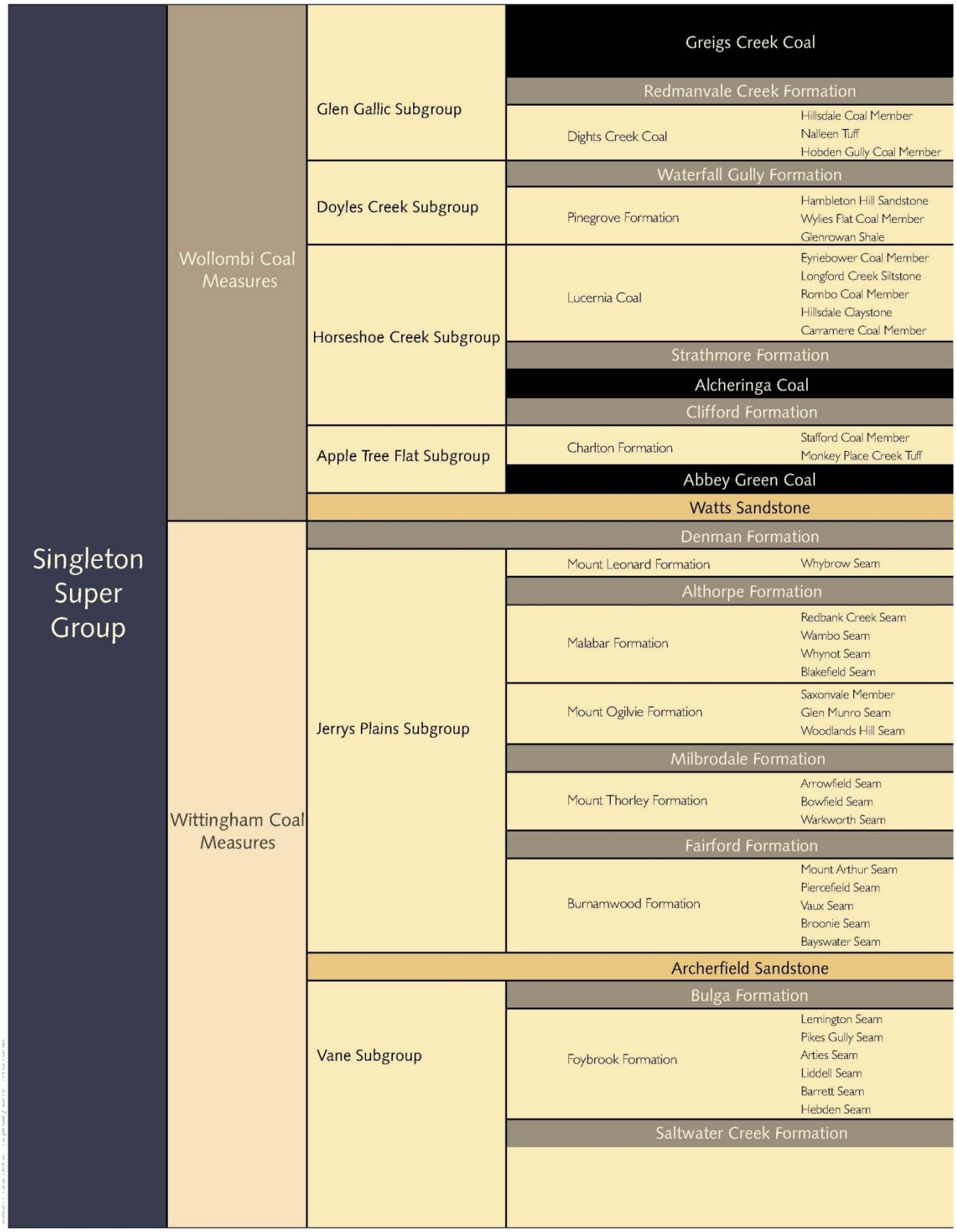


Figure 2.3 Stratigraphic column

3 Groundwater monitoring network

An updated WMP for MTW received approval 15 November 2021 (Yancoal 2021). The WMP contains a Groundwater Management Plan (Section 8 of the WMP), which outlines the groundwater monitoring network (Figure 3.1) and water quality triggers (Table 3.1).

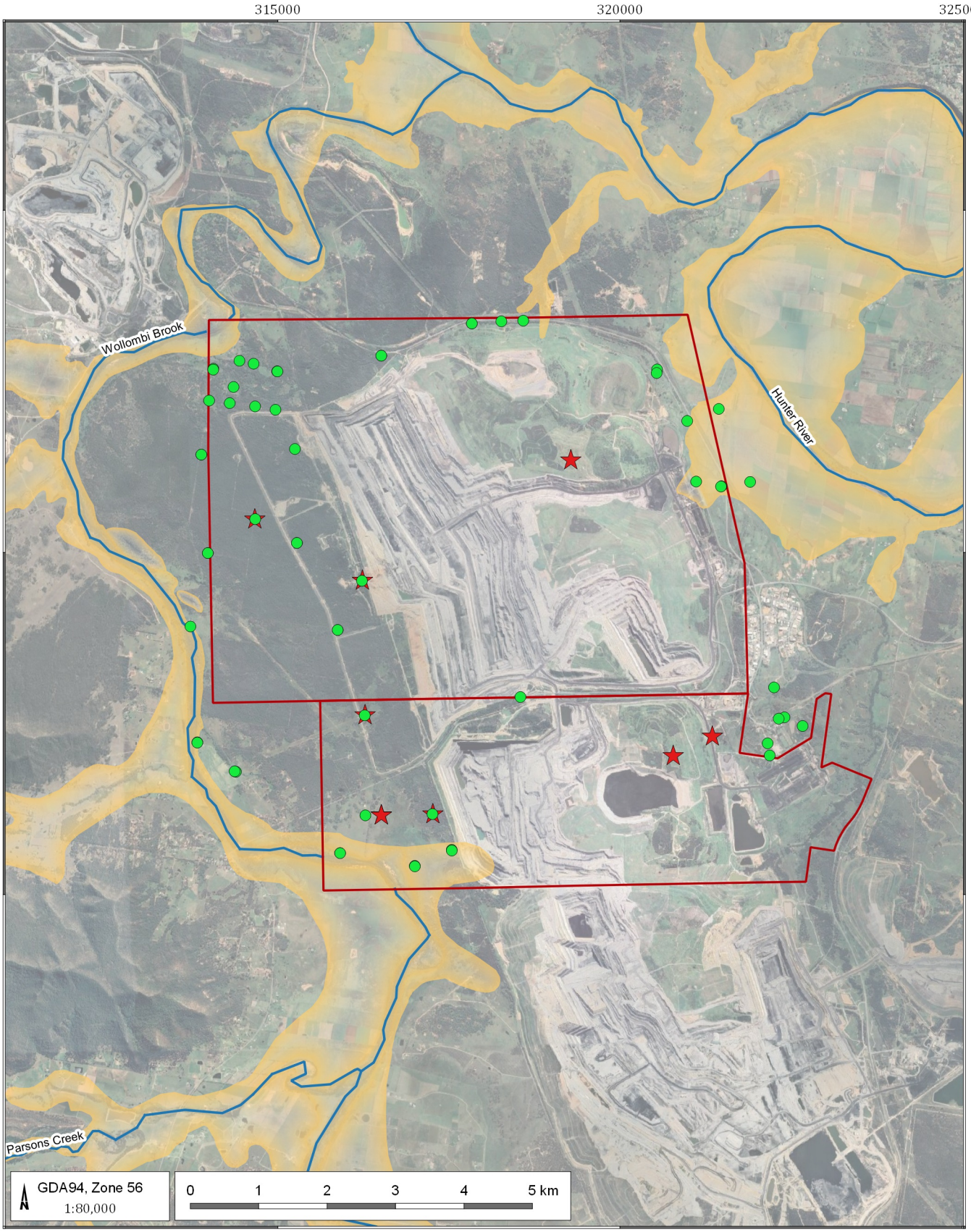
The groundwater monitoring network comprises a total of 70 monitoring sites comprised of 60 monitoring bores and 10 Vibrating Wire Piezometer (VWP) installations which require quarterly groundwater level, pH and Electrical Conductivity (EC) monitoring and annual comprehensive lab analysis. Appendix A contains a list of the known details for each monitoring sites, as well as the monitoring plan reproduced from the WMP. The bores target alluvial aquifers (Wollombi Brook and Hunter River) as well as coal seams and interburden units within the Permian coal measures sequence. The coal seams currently mined at Warkworth Mine include the Redbank Creek, Wambo, Whynot, Blakefield, Glen Munro, Woodlands Hill, Arrowfield, Bowfield, Warkworth and Mt Arthur Seams. Currently approved mining at Mt Thorley targets seams down to the Woodlands Hill.

VWP installations comprise pressure sensors grouted within each borehole and are used for monitoring of piezometric head.

At each monitoring bore site, groundwater levels, EC and pH are measured in the field on a quarterly basis. A groundwater sample is also collected from each monitoring bore annually and analysed by an offsite laboratory for:

- total dissolved solids (TDS);
- major ions – Ca, Mg, Na, K, Cl, SO_4(or S);
- total alkalinity, bicarbonate alkalinity, carbonate alkalinity, hydroxide alkalinity; and
- trace elements - Al, As, B, Cd, Cu, Hg, Ni, Pb, Se, Zn (plus Mo, V and Cr for selected bores).

In November 2021 AGE recommended MTW install two monitoring bores (PZ10a and PZ11a) and two VWP installations (PZ10b and PZ11b) to monitor potential mining related impacts to surface water and groundwater aquifers nearby MTW. The groundwater monitoring installations are designed to fill spatial data gaps in MTWs groundwater monitoring network. The monitoring bores will be installed into the Wollombi Brook alluvium to monitor groundwater level and quality. The VWPs will monitor pressure head in the Blakefield, Woodlands Hill, Bowfield and Mt Arthur coal seams.



LEGEND

- Monitoring bore
- VWP
- Major water courses
- MTW Leases
- Quaternary Alluvium

MTW Annual groundwater monitoring review 2021 (MTW5003.001)

Groundwater monitoring network

AGE

DATE 10/03/2022

FIGURE No: **3.1**

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Source: LiDAR DEM - © Department Finance, Services and Innovation.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:\Projects\MTW5003.001.MTW_Annual_Groundwater_Monitoring_Review_2021\3_GIS\Workspaces\001_Deliverable1\MTW5003. monitoring locations.qgs

3.1 Trigger values

The WMP outlines trigger values for groundwater EC and pH in Hunter River Alluvium, Wollombi Brook Alluvium, Aeolian Warkworth Sands, shallow overburden and various coal seams. Trigger limits are applied to bores with a sufficient baseline dataset. The triggers apply and are calculated for groups of bores installed within the same geological unit and utilise percentiles of the available data to trigger further investigation. Three consecutive measurements falling outside the 5th and 95th percentile for pH triggers further investigation, whilst three consecutive results above the 95th percentile for EC require investigation. Groundwater quality triggers are summarised in Table 3.1.

The WMP provides a methodology to investigate samples that exceed the triggers for pH and EC. The WMP requires that '*in the event that a water quality measurement exceeds a predetermined trigger value, exceedances will be recorded and MTW will initiate a site-specific investigation if':*

- *professional judgement determines that the single deviation or a developing trend could result in environmental harm; or*
- *three consecutive measurements of EC or pH exceed trigger values.*

The investigation will:

- *determine the source and risk of impact on downstream water quality.*
- *determine the need for and extent of contingency measures.*
- *communicate outcomes to senior management.*
- *be reported in the Annual Review.*

Whilst the WMP does not specify a trigger for groundwater levels it does require an annual review of '*depressurisation of coal measures and alluvium by a suitably qualified hydrogeologist.'*

Table 3.1 Groundwater quality trigger levels

Sample Point	Target Seam	Electrical Conductivity	pH	
		95th	5th	95th
OH786	Hunter River Alluvium	1551	6.9	7.7
OH787	Hunter River Alluvium	19351	7.2	7.7
OH942	Hunter River Alluvium	25400	6.5	6.8
OH943	Hunter River Alluvium	8395	7.1	7.6
OH788	Hunter River Alluvium	13480	6.9	7.9
PZ8S	Wollombi Brook Alluvium	15190	6.5	7
PZ9S	Wollombi Brook Alluvium	16197	6.8	7
PZ7S	Aeolian Warkworth Sands	1747	6.7	7.5
GW9706 GW9707 GW9708 GW9709 GW98MTCL1 GW98MTCL2 OH1127	Bayswater	22982	6.6	7.5
OH1125(3)	Bowfield Seam	14600	6.6	6.9
OH1122(1) WOH2139A OH1125(1)	Blakefield	14825	6.6	8
WOH2153A WOH2154A WOH2155A WOH2156A	Redbank	15482	7	7.9

Sample Point	Target Seam	Electrical Conductivity	pH	
		95th	5th	95th
MTD614P MTD616P MTD605P PZ7D MBW02 MB15MTW01D MB15MTW02D MB15MTW03 PZ8D PZ9D	Shallow Overburden	17516	6.7	8
OH1137 OH1126 OH1121	Vaux	17740	6.7	7.2
WD622P WOH2153B WOH2154B WOH2155B MBW04 WOH2156B	Wambo	14114	6.9	7.8
WD625P	Woodlands Hill	12483	6.9	7.3
OH1138(2) OH1138(1)	Warkworth	19872	5.9	6.9
WOH2141A	Whynot	10689	7.5	7.8

3.2 Sampling methods

The WMP states that groundwater monitoring will be undertaken "*in accordance with AS 5667.1:-1998, Guidance on the Design of Sampling Programs, Sampling Techniques and the Preservation and Handling of Samples and AS 5667.11-1998, Guidance on Sampling of Groundwaters*".

A review of field sheet data indicate that quarterly groundwater samples were collected as grab samples or following purging in all bores. A Waterra pump was used to purge WOH2153B (in August) and OH1127 (in December). No other information on purged volumes or equipment used for purging/sampling was made available.

4 Water licensing

Groundwater licenses held for MTW are outlined in Table 4.1.

Table 4.1 Summary of licenses held by MTW

Licence No.	DWE Reference	Share Component (ML)	Location/Purpose
10543	20AL201239	1009	Zone 2B: Hunter River from Wollombi Brook junction to Oakhampton Rail Bridge
963	20AL201242	243	Warkworth farm - Hunter River pump (Zone 2B)
971	20AL201258	270	Warkworth farm - Hunter River pump (Zone 2B)
1008	20AL201341	243	Warkworth farm - Hunter River pump (Zone 2B)
995	20AL201302	243	Anndale farm – Hunter River pump (Zone 2B)
1009	20AL201343	435	Anndale farm – Hunter River pump (Zone 2B)
19022	20AL209903	60	Sandy Hollow Creek (Unregulated river – Singleton Water Source)
18558	20AL208627	50	Lower Wollombi Brook Water Source
18469	20AL20858	245	Lower Wollombi Brook Water Source
40464	20AL218784	180	Mt Thorley Excavation; North Coast Fractured and Porous Rock Groundwater Sources
40465	20AL218785	750	Warkworth Excavation; North Coast Fractured and Porous Rock Groundwater Sources

Note: Water licence details obtained from the approved WMP (15 November 2021).

5 Groundwater monitoring results

Groundwater level measurements provided by Yancoal were used to prepare hydrographs for each monitoring point. The groundwater levels were also plotted along with the CRD to determine if trends in water levels were related to climatic factors or other influences. The CRD shows monthly rainfall trends compared with long term averages. An increase trend in the CRD indicates periods of above average rainfall, whilst a declining trend indicates below average rainfall. Where recharge occurs from rainfall, groundwater levels are often correlated with the CRD. This comparison can be used to 'screen out' climatic trends and determine where other factors such as mining are influencing groundwater levels.

Appendix C contains the hydrographs generated for each bore and compared to modelled predictions. The hydrographs include long term data preceding the 2021 reporting year to ensure long term trends are identified and considered. Appendix B contains groundwater level hydrographs with the bores grouped according to geological unit. These figures also show the pH and EC measured for each bore (with a trigger applied) to allow water levels and water quality trends to be compared and determine if they are interrelated.

The groundwater level trends observed within the monitoring network depend on the location and geological units screened and long-term trends can therefore be grouped into:

- Western down-dip depressurisation zone – monitoring bores in Permian coal measures to the west and 'down-dip' of the mining area that are recording depressurisation due to mining operations, as predicted by groundwater modelling.
- Eastern up-dip coal measures and alluvium – bores to the east of the mining area within Hunter River alluvium and Bayswater coal seam that are 'up-dip' of mining and are responding only to climatic influences.
- Wollombi Brook alluvium – bores within the Wollombi Brook alluvium that have a varied response, suggesting localised impact where mining is close to the flood plain and no impact where mining is more distant.
- Warkworth Sands – bores within the perched aquifer of the Warkworth Sands, which is located in elevated areas, generally do not respond to mining.

The sections below discuss water level and quality trends within each of these zones. Samples collected that exceeded the nominated triggers values are also discussed.

5.1 Western down-dip depressurisation zone

A number of numerical models to simulate groundwater flow at MTW have been developed (within EIS reports from 2002, 2009 and 2014). The most recent updated to the model was conducted by AGE (2015) which updated the model developed for the 2014 EIS. All numerical models developed have consistently predicted mining will depressurise groundwater within the coal measures down-dip and west of the mining area. The models predict the zone of depressurised Permian bedrock will extend under the Wollombi Brook alluvium, but the alluvium water level will be largely unaffected. Groundwater monitoring generally confirms this conclusion with a general loss of water pressure and level occurring in many of the monitoring sites installed within Permian bedrock to the west of the mining area.

The measured decline in water levels is not as uniform as predicted by groundwater modelling due to heterogeneities within the groundwater systems. The sections below discuss the water level and quality data collected from the bores grouped together for trigger levels. Water level and quality graphs for each group of bores are included within Appendix B.

5.1.1 Redbank Creek coal seam bores

There are four bores (WOH2153A, WOH2154A, WOH2155A and WOH2156A) within this group located west and down-dip of the mine (Figure B1). The data for these bores indicate:

- A long-term declining trend in groundwater levels as predicted by groundwater modelling.
- Excepting an increase during the May monitoring period in WOH2154A, WOH2155A and WOH2156A, groundwater levels within Redbank Creek coal seam bores have declined throughout 2021. This slight increase in groundwater level in May correlates with above average rainfall in the region, signified by a sharply inclining CRD trend.
- Groundwater pH was relatively stable in Redbank Creek coal seam bores during the 2021 monitoring period. Fluctuations are attributed to natural variation as they do not exceed prescribed trigger criteria. The exception to this is WOH2156A, which recorded a pH value below the lower prescribed trigger in February. This exceedance did not require investigation under the WMP as it was a single exceedance only.
- Groundwater EC values recorded in Redbank Creek coal seams bores were stable during the 2021 monitoring period. All EC values were below the established trigger value during the monitoring period.

5.1.2 Wambo coal seam bores

There are six bores (WD622P, WOH2153B, WOH2154B, WOH2155B, WOH2156B and MBW04) within the Wambo coal seam group, west and down-dip of the mine (Figure B2). The data for these bores indicate:

- A long-term declining trend in groundwater levels in WD622P. The remaining Wambo coal seam bores are relatively stable;
- Groundwater level in Wambo Creek coal seam bores were generally stable during the 2021 monitoring period. WOH2153B and WOH2155B recorded slight decreases in groundwater levels in the May and August monitoring periods, before returning to similar levels recorded at the start of the year in November. WOH2154B groundwater level varied in 2021, increasing and decreasing throughout the year. Excepting stable groundwater levels in February and May, long-term declining trend in WD622P continued toward the end of the monitoring period;
- Groundwater pH in Wambo coal seam monitoring bores varied in the 2021 monitoring period. Two consecutive pH exceedances were recorded in WOH2154B in February and May, before declining below the 95th percentile trigger in August and November. WD622P recorded a pH exceedance in the February monitoring period, recording pH within the established trigger criteria for the remainder of 2021.
- Groundwater EC values recorded in Wambo coal seam bores in 2021 were relatively stable. The exception to this being WOH2154B and WOH2155B in which EC trended upwards throughout the year. Excepting an EC exceedance in WD622P in February, Wambo coal seam monitoring bores were below established trigger criteria during the monitoring period.

5.1.3 Blakefield coal seam bores

There are three bores (OH1122(1), OH1125(1) and WOH2139A) within this group, downdip of the Warkworth mining area (Figure B3). The data indicate:

- A long-term declining trend in groundwater levels in WOH2139A. In recent years groundwater levels in the remaining Blakefield coal seam bores is relatively stable.
- Groundwater levels in OH1122(1) and OH1125(1) were stable in the 2021 monitoring period. WOH2139A recorded decreased groundwater levels each quarter during the monitoring period. The continued decline in WOH2139A, during periods of significant rainfall, shown with an inclining CRD trend; is evidence that WOH2139A is affected by mining impacts.
- WOH2139A recorded three pH exceedances in 2021, in February, May, October and November. Historically pH in WOH2139A has exceeded the upper trigger criteria. Trigger criteria for pH for Blakefield coal seam bores were amended in November 2021 and mid-2020 to attempt to reconcile these exceedances. Groundwater pH in OH1122(1) and OH1125(1) were stable throughout the monitoring period. Monitoring bore OH1125(1) recorded pH on the lower prescribed trigger in each of the four monitoring periods in 2021. No exceedances were recorded.
- Groundwater EC in monitoring bores OH1122(1) and OH1125(1) trend downward during the monitoring period. The downward trend is likely due to above average rainfall recorded in the region in 2021, evident by an inclining CRD trend. Groundwater EC in WOH2139A recorded a sharp decrease in May, before returning to similar EC values in October and November that were recorded in February. No EC exceedance were recorded in Blakefield coal seam monitoring bores during the 2021 monitoring period.

5.1.4 Bowfield coal seam bores

There is one bore (OH1125(3)) installed within this group to the north of Warkworth mine (Figure B4). The data for this bore indicate:

- Long-term groundwater levels in OH1125(3) are weakly correlated to the CRD trend.
- Groundwater level in Bowfield coal seam monitoring bore OH1125(3) increased sharply in the first half of 2021, correlating closely to an inclining CRD trend, before decreasing rapidly in the September monitoring period. No groundwater level data has been recorded since September 2021.
- Groundwater pH in the Bowfield coal seam bore were stable during the 2021 monitoring period. No pH exceedances were recorded in 2021.
- Groundwater EC values in OH1125(3) decreased slightly throughout the recent monitoring period. No groundwater EC exceedances were recorded in 2021.

5.1.5 Whynot coal seam bore

There is one monitoring bore (WOH2141A) installed within this group to the north of Warkworth mine (Figure B5). The data for this bore indicate:

- Long-term data show a declining groundwater level in WOH2141A. This decline in groundwater level aligns with modelled predictions.
- Groundwater level in Whynot coal seam bore WOH2141A decreased during the 2021 monitoring period. Groundwater levels initially increased in March, following significant rainfall in the region, as indicated by a sharply inclining CRD trend, which decreased thereafter.
- Two instances of groundwater pH were recorded on the upper trigger criteria in 2021 in WOH2141A. This is likely due to the pH trigger range being extremely narrow for this bore. No pH exceedances were recorded in WOH2141A during the 2021 monitoring period.
- Excepting an increase in November, groundwater EC values in WOH2141A decreased during the 2021 monitoring period. No EC exceedances were recorded in 2021.

5.1.6 Woodlands Hill coal seam bore

There is one monitoring bore (WD625P) installed within the Woodlands Hill coal seam to the west of MTW (Figure B6). The data for this bore indicate:

- Long-term gradually declining trend in groundwater level.
- Groundwater level increased slightly during the 2021 monitoring period.
- Groundwater pH fluctuated during the monitoring period. One 5th percentile trigger pH exceedance was recorded during August. The pH trigger values in WD625P are extremely narrow. This is likely the cause of the trigger exceedance as pH values are generally within historic ranges.
- Groundwater EC in WD625P were stable during the 2021 monitoring period. No EC exceedances were recorded in 2021.

5.1.7 Shallow overburden underlying Wollombi Brook alluvium bores

There are six bores installed within shallow overburden material underlying the Wollombi Brook alluvium (PZ8D, PZ9D, MB15MTW01D, MB15MTW02D and MB15MTW03) and Warkworth Sands (PZ7D) to the west of the Warkworth and Mt Thorley mines (Figure B7 and B8). The bores are paired with shallow bores monitoring the overlying alluvial and aeolian sediments. The data for these bores indicate:

- Long-term groundwater level data indicate that shallow overburden monitoring bores underlying Wollombi Brook alluvium and Warkworth Sands exhibit a delayed response to rainfall recharge.
- Groundwater level in shallow overburden monitoring bores underlying the Wollombi Brook alluvium and Warkworth Sands increased gradually during the 2021 monitoring period. The exception being PZ9D in which groundwater level was generally stable. PZ8D recorded decreased groundwater level in June and September; increasing in December. Minimal interaction between the Wollombi Brook alluvium and the shallow overburden is evident as no significant groundwater level changes occur during periods of increased rainfall in the region which can be correlated with increased groundwater levels in the alluvium.
- Monitoring bores underlying the Wollombi Brook alluvium and Warkworth Sands recorded varied pH in 2021. PZ7D recorded a sharp increase in pH in May, decreasing and stabilising thereafter. Three consecutive 95th percentile groundwater pH exceedances were recorded in PZ7D in 2021 (May, August and November). No investigation into these exceedances were undertaken by MTW. Similarly, to PZ7D, MB15MTW01D recorded an increase in pH in May, decreasing and stabilising thereafter. Four pH exceedances were recorded in MB15MTW01D during the 2021 monitoring period. Values for pH in MB15MTW01D were recorded below the 5th percentile trigger criteria consistently since November 2018. Excepting an increase in June in PZ9D, MB15MTW03 and PZ9D recorded declining pH during the 2021 monitoring period. A single 5th percentile pH exceedance was recorded in PZ9D in April and MB15MTW03 in November. Generally stable groundwater pH data were recorded in PZ8D and MB15MTW02D during 2021.
- Excepting MB15MTW01D in which EC fluctuated, groundwater EC in shallow overburden monitoring bores underlying Wollombi Brook alluvium and Warkworth Sands were stable during the 2021 monitoring period.

Historically, pH in PZ7D has been high, exceeding the upper prescribed trigger in September 2016; and recording pH values close to the upper trigger value in January and December 2016 and March 2017. Values for pH recorded recently have exceeded the prescribed upper trigger by pH 0.4 (August) and pH 0.2 (November). These increased pH values in PZ7D do not change the beneficial use category of the water as defined in the ANZECC/ARMCANZ guidelines (ANZECC, 2000).

5.1.8 Shallow overburden bores

There are four bores (MBW02, MTD614P, MTD605P and MTD616P) installed within the shallow overburden to the west of MTW, and east of the Wollombi Brook alluvium (Figure B7 and B8). The data for these bores indicate:

- Long-term groundwater level data indicate stable groundwater levels in shallow overburden monitoring bores east of the Wollombi Brook alluvium.
- Excepting MTD616P which increased gradually, groundwater levels in shallow overburden bores east of Wollombi Brook alluvium were stable during the 2021 monitoring period.

- Groundwater pH fluctuated in shallow overburden monitoring bores in the 2021 monitoring period. Excepting three lower prescribed trigger exceedances in MTD616P (February, May and November), groundwater pH values were within prescribed trigger criteria during 2021. Exceedances for pH recorded in MTD616P are within the lower bounds of historic ranges. Despite this, the WMP requires a site-specific investigation be initiated.
- Groundwater EC in shallow overburden monitoring bores east of Wollombi Brook alluvium were generally stable during the monitoring period. The exception to this being MTD616P which decreased throughout the year. MTD605P recorded two 95th percentile EC exceedances during the 2021 monitoring period (May and November). EC exceedances in MTD605P have generally been recorded within historic ranges.

5.2 Eastern up-dip coal measures and alluvium

A network of monitoring bores is present to the east of the MTW mining area. This network includes bores screened within the Hunter River alluvium and also bores screened within the Bayswater seam underlying the alluvium. The sections below discuss the monitoring results for each of these bores.

5.2.1 Hunter River alluvium bores

There are six bores (OH786, OH787, OH788, OH942, OH943 and OH944) located to the east of the Warkworth mining area screened within the Hunter River alluvium (Figure B9 to B14). The monitoring data for these bores indicate:

- Excepting OH786 in which groundwater level has fluctuated, long-term groundwater levels in Hunter River alluvial monitoring bores have been stable.
- Groundwater levels in Hunter River alluvial bores were stable during the 2021 monitoring period; the exception being OH786 which recorded fluctuating groundwater levels. Monitoring bore OH944 was dry throughout 2021.
- Groundwater pH values in Hunter River alluvial monitoring bores were relatively stable during 2021. The exception being OH786 and OH787 which recorded decreases in June before increasing in September, stabilising thereafter. OH788 recorded a 5th percentile pH trigger exceedance in September, returning pH values within the trigger criteria thereafter. No other pH exceedances were recorded in Hunter River alluvial bores during the 2021 monitoring period.
- Groundwater EC in Hunter River alluvial bores were relatively stable during 2021, decreasing slightly in December. The exception to this was OH786, which recorded increasing EC values throughout the monitoring period. EC exceedances were recorded in three monitoring bores in 2021; OH787 (three exceedances); OH788 (two exceedances); and OH943 (two exceedances). 95th percentile trigger values were updated in November for OH787 and OH788. EC values in both bores decreased below the trigger criteria in December. Exceedances in OH787 and OH788 are generally recorded within historic ranges. EC in OH943 increased significantly between early 2019 and 2021. EC in OH943 should be closely monitored in 2022.

5.2.2 Bayswater coal seam bores

The Bayswater seam is the basal coal seam within the Jerry's Plains subgroup. Mining at MTW does not remove the Bayswater seam, and therefore it is representative of the 'under-burden' bedrock sequence within the pit floor. There are seven bores (GW9706, GW9707, GW9708, GW9709, GW98MTCL1, GW98MTCL2 and OH1127) within the Bayswater group (Figure B15), with the monitoring data indicating:

- Long-term groundwater levels are stable within Bayswater coal seam monitoring bores;
- Groundwater levels in Bayswater coal seam monitoring bores were generally stable during the 2021 monitoring period;
- Groundwater pH values varied in Bayswater coal seam monitoring bores during the monitoring period. On pH exceedance was recorded in 2021; GW98MTCL2 in June, increasing but remaining within the trigger criteria thereafter; and
- Groundwater EC values in Bayswater coal seam bores showed a slightly declining or stable trend in 2021. The exception to this was GW9708, which recorded an increase in EC during December. No groundwater EC exceedances were recorded during the 2021 monitoring period.

5.2.3 Warkworth coal seam bores

There are two nested bores (OH1138 (1) and OH1138 (2)) within this group located to the north of Warkworth Mine (Figure B16). The data for these bores indicate:

- Long-term groundwater levels in Warkworth coal seam bores are weakly correlated to the CRD trend.
- Groundwater levels in Warkworth coal seam monitoring bores increased gradually throughout the 2021 monitoring period. This slight increase in groundwater level corelates with a sharp inclining CRD trend.
- Groundwater pH values were stable in both Warkworth coal seam bores throughout the 2021 monitoring period. OH1138(1) exceeded the lower prescribed trigger value six times during 2021. In November 2021 the 5th percentile trigger value was decreased to pH 5.9. This decrease in lower pH trigger should reduce the amount of exceedances in the future. OH1138(2) recorded stable pH throughout the monitoring period. Fluctuations are attributed to natural variation as they do not exceed the trigger criteria.
- Ground water EC values in Warkworth coal seam monitoring bores generally trended downward in 2021. EC increased in monitoring bore OH1138(1) between May and October, decreasing sharply in the December monitoring period. No groundwater EC exceedances were recorded in the 2021 monitoring period.

5.2.4 Vaux coal seam bores

There are three bores (OH1121, OH1126 and OH1137) installed within the Vaux seam group that surround the Warkworth Mine to the north and east (Figure B17). The data for these bores indicate:

- Excepting OH1121 which has been stable, long-term groundwater levels in Vaux coal seam monitoring bores have been decreasing.
- Groundwater levels in Vaux coal seam monitoring bores increased in 2021. This increase weakly correlates with an inclining CRD trend recorded during the monitoring period.
- Groundwater pH in OH1121 exceeded the prescribed upper trigger value both times it was sampled in 2021. In November 2021 the 95th percentile trigger value was increased. Values for pH in OH1126 fluctuated throughout the 2021 monitoring period, exceeding the lower prescribed trigger on two occasions. OH1137 recorded stable groundwater pH readings in the two occasions it was sampled. No pH exceedances were recorded in OH1137 in 2021.
- Except for OH1126, which recorded increasing EC values during the first three samples, groundwater EC values in Vaux coal seam monitoring bores decreased throughout the year. Excepting OH1137 which recorded a single EC exceedance, no groundwater EC exceedances were recorded during the 2021 monitoring period.

5.3 Wollombi Brook Alluvium bores

Two bores (PZ8S and PZ9S) are installed within the Wollombi Brook alluvium. The bores are located in proximity to the Mt Thorley Mine Loders Pit, where the Wollombi Brook alluvium encroaches on this location (Figure B18 and B19). The data for these bores indicate:

- Long-term trends indicate that Wollombi Brook alluvial groundwater levels strongly correlate with climatic trends;
- Groundwater level in PZ8S increased throughout the 2021 monitoring period, correlating strongly with the CRD trend and displaying no mining related impacts. Excepting a decrease in June 2021, groundwater level in PZ9S has been relatively stable since June 2020;
- Only one pH reading was recorded in PZ9S during 2021 (December) due to insufficient water in the bore. No pH exceedances were recorded during the 2021 monitoring period; and
- Groundwater EC values were stable in PZ8S, with a decrease in December, during the 2021 monitoring period. One EC value was recorded in PZ9S in 2021. No EC exceedances were recorded during the 2021 monitoring period.

5.4 Warkworth Sands bore

A single monitoring bore (PZ7S) is installed at the foot-slopes of the Warkworth Sands Woodland (Figure B20). The dataset for this bore indicate:

- Long-term groundwater level data indicate PZ7S is weakly correlated with climatic conditions.
- Groundwater level in PZ7S increased during the 2021 monitoring period, this is likely due to increased rainfall in the region in 2020 and 2021, as indicated by an increasing CRD.
- Excepting a slight increase in May, groundwater pH values were stable in PZ7S during the year. No pH exceedances were recorded during the 2021 monitoring period.
- Groundwater EC in PZ7S increased between May and August, decreasing in November. EC exceeded the upper exceedance criteria in August. No investigation was undertaken as consecutive exceedances were not recorded.

5.5 Additional bores

Groundwater level, pH and EC trends in monitoring bores outlined in the WMP but without water quality trigger values are outlined in this section.

5.5.1 Wollombi Brook alluvium bores

Three additional monitoring bores (MB15MTW01S, MB15MTW02S and MBW01) are installed into the Wollombi Brook alluvium (Figure B21). Data in these bores has been collected since August 2017. No trigger values are established for these bores. The data indicate:

- Long-term groundwater levels correlate with the CRD.
- Groundwater level in additional Wollombi Brook alluvial bores were relatively stable during the 2021 monitoring period. The exception to this was MBW01 which recorded an increase in groundwater levels. This increase can be attributed to above average rainfall in the region during the year.
- Groundwater pH in additional Wollombi Brook alluvial monitoring bores were stable during the 2021 monitoring period.
- Excepting MBW01 which increased slightly, groundwater EC values in additional Wollombi Brook alluvial monitoring bores were stable during the 2021 monitoring period.

5.5.2 Warkworth Sands bores

Eight additional monitoring bores (MB15MTW04, MB15MTW05, MB15MTW06, MB15MTW07, MB15MTW08, MB15MTW09, MB15MTW10 and MB15MTW11) are installed into the Warkworth Sands (Figure B22). MB15MTW04, MB15MTW05, MB15MTW07, MB15MTW08, MB15MTW10 and MB15MTW11 were dry for the entire monitoring period. The dataset for these bores indicate:

- Groundwater level in MB15MTW06 decreased during the 2021 monitoring period. MB15MTW09 recorded a single groundwater level in 2021, during November monitoring.
- Groundwater pH in MB15MTW06 increased in May, decreasing gradually throughout the remainder of the 2021 monitoring period. A single pH reading was taken in MB15MTW09 during 2021.
- All four groundwater EC values recorded in MB15MTW06 were below 200 µS/cm, indicating the groundwater is extremely fresh. A single EC reading was taken in MB15MTW09 during 2021.

5.5.3 Whybrow coal seam bore

A single monitoring bore (MBW03) is installed in the Whybrow coal seam (Figure B23). No groundwater quality triggers are assigned to this bore. The dataset indicate the following:

- Long-term groundwater levels correlate strongly with climatic conditions as indicated by changes in groundwater level closely aligning with the CRD. Groundwater level in MBW03 increased in the 2021 monitoring period.
- Groundwater pH values in MBW03 were relatively stable during the 2021 monitoring period.
- Excepting a sharp decrease February, groundwater EC values in MBW03 were stable in 2021.

5.5.4 MBW6A

No survey coordinates or bore construction details are available for MBW6A (Figure B24). Groundwater level and EC data has been recorded consistently since September 2017. The dataset indicate:

- Long-term groundwater level trend increased until November 2019, decreasing gradually thereafter. It is likely that MBW06A is impacted by mining, as indicated by declining groundwater levels during periods of increased rainfall experience since January 2020.
- Groundwater pH in MBW6A decreased slightly during the 2021 monitoring period.
- Groundwater EC increased slightly during 2021. All EC values were recorded below 775 µS/cm indicating the groundwater in MBW6A is fresh and likely screened in alluvium or Warkworth Sands.

5.6 VWP pressure heads

VWP pressure head data collected in during the 2021 monitoring period was graphed with historic data. VWP figures presented graphically in Appendix D. The following observations can be noted for 2021:

- VWP pressure head in WD609A sensor at 110 m (spoil) (Figure D1) continued to trend downward in 2021.
- Pressure head in VWP WD615 sensor at 133 (Piercefield) (Figure D2) has been relatively stable since its installation in 2013. Pressure head in the sensor at 255 m, installed into the Baywater coal seam has been increasing gradually since September 2018, following a declining trend since 2013. Pressure head in the deeper Bayswater seam was initially higher than the shallower Piercefield seam indicating that an upward hydraulic gradient was present in the Bayswater seam before depressurisation due to mining.
- VWP pressure heads in WD625 (Figure D3) were relatively stable during the 2021 monitoring period. The exception being the sensor at 441 m (Bayswater) which has recorded a steadily declining groundwater level since mid-2020.
- Excepting in the sensor at 54 m (Wambo) in which pressure head has gradually decreased since July 2020, pressure heads in WD622 (Figure D4) were stable during 2021. No data is available from September 2015 to July 2020 to due a malfunctioning logger.
- Pressure heads in MTD613 (Figure D5) have decreased slightly during the 2021 monitoring period. The exception to this being the sensor at 42 m installed in the Whybrow coal seam which increased. Pressure head in the sensor at 446 m (Bayswater) is higher than the sensors at 215 m (Woodlands Hill), 343 m (Mt Arthur) and 378 m (Vaux) indicating that the Bayswater seam hasn't been depressurised.
- Pressure head in MTD616 sensor at 384 m (Broonie/Bayswater) (Figure D6) have increased since April 2020. No data is available from early January 2021, this is likely due to malfunctioning logger and should be investigated during the next monitoring period.
- Excepting the sensor at 58 m (Overburden) and 100 m (Whybrow) which increased slightly, pressure heads in MTD605 (Figure D7) decreased during 2021. Sensors at 429 m (Vaux) and 502 m (Bayswater) have higher pressure heads than the shallower sensors at 215 m (Blakefield) and 368 m (Mt Arthur). This indicated an upward hydraulic gradient in the deeper seams. No data is available for the Vaux seam sensor since 2019. An inspection should be conducted on the VWP cable wire/connections to ensure a loose wire isn't the reason for the loss of data.
- Pressure heads in sensors at 64 m (Whybrow) and 191 m (Glen Munro) in MTD614 (Figure D8) were stable during the 2021 monitoring period. No data has been recorded in the sensor at 383 m (Vaux) since June 2016. Data in sensors at 342 m (Mt Arthur) and 453 m (Bowfield) has been erroneous since they were installed. This is likely due to the sensors being damaged during the installation process. Periodically data is recorded in these sensors, however, the pressure readings fluctuate significantly between each reading.
- Pressure heads in VWP MTD518 (Figure D9) have decreased during the 2021 monitoring period. The exception being the sensor at 358 m, installed in the Wambo coal seam, which has repressurised rapidly since June 2021.
- PZ1 calibration factors weren't available. Calibration factors should be located so that PZ1 can be reviewed in the next Annual Review.

6 Model verification

Observed groundwater level data and numerical groundwater model predictions (AGE, 2015) have been graphed in Appendix C. Review of the data indicate that observed groundwater level trends generally correlate with 2021 modelled predictions. However, at multiple monitoring locations observed and modelled groundwater levels don't align, these are discussed below:

- Observed groundwater levels in Redbank seam monitoring bores have trended downward since 2011. The observed downward trend is more rapid than model predictions, particularly in WOH2153A and WOH2154A in which modelled groundwater levels are generally stable.
- Observed groundwater levels in Wambo seam monitoring bores are slightly lower than predictions. The exception being WOH2156B in which observed data indicate relatively stable groundwater levels in recent years, with the model predicting a sightly declining groundwater level trend.
- Observed groundwater levels in WOH2139A (Blakefield seam) have been trending downward since 2011, correlating closely with modelled predictions. Predicted groundwater level in the remaining Blakefield coal seam bores are significantly lower than observed levels. This is especially evident in OH1122(1) in which observed groundwater levels are >35 m higher than model predictions.
- A weak correlation between observed and predicted groundwater level trends in Bowfield monitoring bore OH1125(3) is evident. Observed data show a fluctuating groundwater level, whilst modelled predictions indicate a gradually declining groundwater level from 2015 to 2021.
- Observed level data in Warkworth seam bore OH1138(1) strongly correlates with model predictions. Observed groundwater levels in OH1138(2) is higher than predictions.
- Excepting OH1121 in which observed groundwater levels have consistently been below modelled predictions, observed groundwater levels in Vaux seam monitoring bores are above predictions. OH1126 has recorded decreasing groundwater levels since 2016; predicted levels are stable during this time. Observed groundwater levels in OH1126 are >8 m above predicted levels in 2021.
- Observed groundwater level in shallow overburden monitoring bores correlate strongly with predictions. The exception being PZ9D, which has remained relatively stable since 2016. Modelled groundwater levels show a declining trend.
- Like modelled predictions, groundwater level in Hunter River alluvial bores have remained stable in recent years. However, observed levels in OH787and OH788 are lower than predictions.
- Observed groundwater levels in Bayswater coal seam bores generally align with predicted levels. The exceptions GW9709, in which observed groundwater levels are below predictions; and GW98MTCL2 in which observed groundwater levels are higher than modelled predictions (>10 m).
- Groundwater levels in Wollombi Brook alluvium monitoring bores strongly correlate with predictions.
- Observed groundwater levels in Warkworth Sands bore PZ7S are approximately 5 m lower than predictions.

7 Summary

A summary of the findings of this report are as follows:

- Groundwater level in coal seams in the Western down-dip depressurised zone generally declined or remained stable during the 2021 monitoring period. The exception being OH1125(3) in the Bowfield coal seam which increased until-mid 2021 before declining rapidly in September.
- Excepting PZ9D which was stable, groundwater level in shallow overburden monitoring bores underlying the Wollombi Brook alluvium and Warkworth Sands increased gradually during the 2021 monitoring period. Minimal interaction between the Wollombi Brook alluvium and the shallow overburden is evident.
- Groundwater level in coal seams eastward and up-dip of mining recorded variable results during 2021. Bayswater monitoring bores were stable, whilst groundwater levels in Vaux seam bores increased during the monitoring period.
- Groundwater level in Hunter River alluvial bores were stable during 2021. The exception being OH786 which recorded fluctuating groundwater levels. Monitoring bore OH944 was dry throughout the 2021 monitoring period.
- Groundwater level in Wollombi Brook Alluvium monitoring bores increased or remained stable during the year. Groundwater level in PZ8S increased throughout the 2021 monitoring period, correlating strongly with the CRD, indicating no mining related impacts. Excepting a decrease in June, groundwater level in PZ9S has been relatively stable since June 2020.
- Groundwater level in Warkworth Sands monitoring bore PZ7S increased during the 2021 monitoring period, this is likely due to increased rainfall in the region in 2020 and 2021, indicated by an increasing CRD.
- Various pH trigger exceedances were recorded in bores in the Western depressurized zone; Wambo seam bores WOH2154B (in February and May) and WD622P (in February); Blakefield seam bore WOH2139A (in February, May, October and November) and Woodlands Hill seam bore WD625P (in August).
- Multiple pH exceedances were recorded in shallow overburden monitoring bores underlying Wollombi Brook Alluvium and Warkworth Sands. These include three consecutive trigger exceedances in PZ7D (in May, August and November), four consecutive exceedances in MB15MTW01D (February, May, August and November), PZ9D (in April) and MB15MTW03 (in November). No exceedance investigation was undertaken for these bores in 2021.
- Three pH exceedances were recorded in shallow overburden monitoring bore MTD616P (in February, May and November). Two groundwater EC exceedances were recorded in shallow overburden monitoring bore MTD605P (in May and November).
- Two bores eastward and up-dip of mining at MTW recorded pH trigger exceedances during the 2021 monitoring period. These were Bayswater coal seam bore GW98MTCL2 (in June) and Warkworth seam bore OH1138(1) (in January, February, March, April, June and August).
- One pH exceedance was recorded in Hunter River Alluvium bore OH788 (in September) during 2021. Several EC exceedances were also record in Hunter River alluvial bores, OH787 (in April, June and September), OH788 (in June and September) and OH943 (September and December).
- Wollombi Brook Alluvium bore PZ7S recorded a single EC trigger exceedance (in August) during the 2021 monitoring period. No investigation was undertaken as consecutive exceedances were not recorded.
- VWP sensors installed into the Bayswater coal seam recorded varied results during the 2021 monitoring period. Sensor in WD625, MTD616 and MTD605 recorded decreasing pressure heads throughout the year; pressure heads in WD615 and MTD613 increased. Pressure head in the Bayswater seam at WD622 was stable during 2021.
- VWP pressure head in sensors installed into the Mt Arthur coal seam decreased during the 2021 monitoring period. The exception being sensors in WD625 and WD622 in which pressure head was stable throughout 2021. Data in MTD614 Mt Arthur sensor is erroneous and should be inspected.
- Sensors installed into Woodlands Hill coal seam recorded decreasing or stable pressure heads during the 2021 monitoring period.
- Excepting the sensor in MTD518 in which pressure head increased, Wambo coal seam VWP sensor pressure heads decreased throughout the year.

- VWP pressure heads recorded in Vaux coal seam VWP sensors varied in 2021. Sensors installed in WD625 and WD622 were stable, whilst, sensors installed in MTD616 and MTD605 decreased during the monitoring period. The sensor in MTD614 has recorded erroneous data and should be inspected.
- Whybrow coal seam VWP sensor pressure heads increased during the 2021 monitoring period. The exception being the sensor at MTD614 which recorded stable pressure head during the year.
- VWP pressure heads in the Glen Munro seam (at MTD614) and Piercefield seam (at WD615) were stable during the 2021 monitoring period. Blakefield seam sensor at MTD605 recorded decreasing pressure head throughout the year. MTD614 sensor in Bowfield seam recorded erroneous data and should be inspected.
- Observed groundwater level trends generally correlate with modelled predictions. The exceptions being Blakefield seam bore OH1122(1) in which observed groundwater levels are >35m higher than model predictions, a weak correlation between modelled and observed level data in Bowfield seam monitoring bores and GW98MTCL2 with differences between observed data and modelled data >10 m. There is no modelled data for bores constructed after 2015.

8 Recommendations

Based on the findings of this report the following recommendations have been made:

- calibration factors for VWP PZ1 should be determined so that pressure head trends can be discussed in future annual reviews;
- cable/wire connections to VWP logger boxes should be inspected at VWP MTD616 (sensor at 383 m) and MTD605 (sensor at 429 m) to determine if erroneous data is due to a poor connection;
- Mount Arthur and Vaux seam VWP sensor cables should be inspected in MTD614 for damage to determine if erroneous data is due to a poor connection to the logger;
- pH trigger exceedance investigations should be undertaken for WOH2139A, PZ7D, OH1138(1) and OH787 as they recorded three consecutive pH exceedances in 2021; and
- the groundwater model should be updated to incorporate newly constructed monitoring installations and to better model existing monitoring installations.

9 References

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Appendix A

Summary of groundwater monitoring program

Sample Point	Easting	Northing	Top of casing elevation (mAHD)	Bore depth (m)	Target Seam	Water Level	EC	pH	Compre-hensive Analysis
OH786	320542	6392674	55.7	7.1	Hunter River Alluvium	Q	Q	Q	A
OH787	320982	6391921	50	12.1	Hunter River Alluvium	Q	Q	Q	A*
OH788	321482	6390967	45.4	22.1	Hunter River Alluvium	Q	Q	Q	A
OH942	320536	6392622	55.8	13.2	Hunter River Alluvium	Q	Q	Q	A*
OH943	321476	6390963	45	9.9	Hunter River Alluvium	Q	Q	Q	A
OH944	321113	6391035	47.9	8.2	Hunter River Alluvium	Q	Q	Q	A
OH1121	321902	6391030	45.6	20.3	Vaux	Q	Q	Q	A
OH1122(1)	318545	6387886	100.6	49.6	Blakefield	Q	Q	Q	A*
OH1125(1)	316511	6392875	86.2	40	Blakefield	Q	Q	Q	A*
OH1125(3)	316511	6392875	86.2	62.7	Bowfield	Q	Q	Q	A*
OH1126	318586	6393387	64.5	52.5	Vaux	Q	Q	Q	A
OH1127	321444	6392097	51.2	29	Bayswater	Q	Q	Q	A
OH1137	318266	6393377	67.9	17.8	Vaux	Q	Q	Q	A
OH1138(1)	317835	6393346	70.7	24.8	Warkworth	Q	Q	Q	A
OH1138(2)	317835	6393346	70.7	42.8	Warkworth	Q	Q	Q	A
WOH2139A	315249	6391511	91.7	96	Blakefield	Q	Q	Q	A*
WOH2153A	313881	6391429	68.3	42.6	Redbank	Q	Q	Q	A
WOH2153B	313881	6391429	68.3	62.4	Wambo	Q	Q	Q	A
WOH2154A	313976	6389990	68.9	69.4	Redbank	Q	Q	Q	A
WOH2154B	313976	6389990	68.9	98	Wambo	Q	Q	Q	A
WOH2155A	315278	6390138	74.6	46	Redbank	Q	Q	Q	A
WOH2155B	315278	6390138	74.6	73.1	Wambo	Q	Q	Q	A
WOH2156A	315874	6388866	80.4	31.5	Redbank	Q	Q	Q	A
WOH2156B	315874	6388866	80.4	80.1	Wambo	Q	Q	Q	A
WOH2141A	314989	6392647	91.6	45.6	Whynot	Q	Q	Q	A
PZ7D	314057	6392684	58.4	30.5	Shallow overburden	Q	Q	Q	A
PZ7S	314055	6392671	58.4	11.1	Aeolian Warkworth Sands	Q	Q	Q	A

Sample Point	Easting	Northing	Top of casing elevation (mAHD)	Bore depth (m)	Target Seam	Water Level	EC	pH	Compre-hensive Analysis
PZ8D	317001	6385418	65.8	37	Shallow overburden	Q	Q	Q	A
PZ8S	317002	6385411	65.8	-	Wollombi Brook Alluvium	Q	Q	Q	A
PZ9D	317541	6385652	65.5	24	Shallow overburden	Q	Q	Q	A
PZ9S	317542	6385642	65.4	6.9	Wollombi Brook Alluvium	Q	Q	Q	A
GW9706	322404	6387589	64.2	21.2	Bayswater	Q	Q	Q	A
GW9707	322319	6387569	63.9	21	Bayswater	Q	Q	Q	A
GW9708	322158	6387209	73.1	29.6	Bayswater	Q	Q	Q	A
GW9709	322251	6388026	60.3	21	Bayswater	Q	Q	Q	A
GW98 MTCL1	322188	6387032	77.8	19.7	Bayswater	Q	Q	Q	A
GW98 MTCL2	322669	6387462	79.5	27.6	Bayswater	Q	Q	Q	A
PZ1(VWP)	321350	6387310	72.1	41 42	Mt Arthur (Shallow) Mt Arthur (Deep)	Q	-	-	-
WD609A (VWP)	318803	63922	129.9	110	Spoil	Q	-	-	-
WD615 (VWP)	319281	6391347	160	133 225	Piercefield Bayswater	Q	- -	- -	- -
WD625 (VWP)	314663	6390483	76.4	217 354 375 441	Woodlands Hill Mt Arthur Vaux Bayswater	Q	-	-	-
WD625P	314669	6390487	76.4	31	Woodlands Hill	Q	Q	Q	A
WD622 (VWP)	316236	6389588	84.5	54 165 314 334 408	Wambo Woodlands Hill Mt Arthur Vaux Bayswater	Q	-	-	-
WD622P	316229	6389585	84.5	55	Wambo	Q	Q	Q	A

Sample Point	Easting	Northing	Top of casing elevation (mAHD)	Bore depth (m)	Target Seam	Water Level	EC	pH	Compre-hensive Analysis
MTD616 (VWP)	316274	6387621	77.7	42	Whybrow	Q	-	-	-
				109	Wambo				
				215	Woodlands Hill				
				343	Mt Arthur				
				378	Vaux				
				446	Bayswater				
MTD616P	316269	6387618	77.8	29	Shallow overburden	Q	Q	Q	A
MTD613 (VWP)	320778	6387025	150.5	384	Broonie/Bayswater	Q	-	-	-
MTD605 (VWP)	316512	6386159	77.1	58	Overburden	Q	-	-	-
				100	Whybrow				
				149	Interburden				
				215	Blakefield				
				368	Mt Arthur				
				429	Vaux				
				502	Bayswater				
MTD605P	316279	6386156	77.4	42	Shallow overburden	Q	Q	Q	A
MTD614 (VWP)	317265	6386174	72.4	64	Whybrow	Q	-	-	-
				191	Glen Munro				
				342	Mt Arthur				
				383	Vaux				
				453	Bowfield				
MTD614P	317259	6386175	72.6	30	Shallow overburden	Q	Q	Q	A
MTD518 (VWP)	316512	6386156	80	-	Mt Arthur	Q	-	-	-
				-	Blakefield/Woodlands Hill		-	-	-
				-	Wambo		-	-	-
MB15 MTW01S	315909	6385605	-	-	Wollombi Brook Alluvium	Q	Q	Q	A
MB15 MTW01D	315910	6385604	-	-	Shallow overburden	Q	Q	Q	A
MB15 MTW02S	313823	6387224	-	-	Wollombi Brook Alluvium	Q	Q	Q	A

Sample Point	Easting	Northing	Top of casing elevation (mAHD)	Bore depth (m)	Target Seam	Water Level	EC	pH	Compre-hensive Analysis
MB15 MTW02D	313823	6387219	-		Shallow overburden	Q	Q	Q	A
MB15 MTW03	313722	6388917	-	22.7	Shallow overburden	Q	Q	Q	A
MB15 MTW04	314993	6392645	-	6.5	Warkworth Sands	Q	Q	Q	A
MB15 MTW05	314645	6392758	-	6.9	Warkworth Sands	Q	Q	Q	A
MB15 MTW06	314438	6392801	-	6.9	Warkworth Sands	Q	Q	Q	A
MB15 MTW07	314965	6392085	-	6.8	Warkworth Sands	Q	Q	Q	A
MB15 MTW08	314296	6392182	-	6.8	Warkworth Sands	Q	Q	Q	A
MB15 MTW09	313995	6392219	-	3.1	Warkworth Sands	Q	Q	Q	A
MB15 MTW10	314667	6392134	-	3.7	Warkworth Sands	Q	Q	Q	A
MB15 MTW11	314352	6392417	-	6.9	Warkworth Sands	Q	Q	Q	A
MBW01	314379	6386796	62.4	11	Wollimbi Brook Alluvium	Q	Q	Q	A
MBW02	314373	6386798	62.6	60.4	Shallow overburden	Q	Q	Q	A
MBW03	314387	6386794	62.4	84.2	Whybrow seam	Q	Q	Q	A
MBW04	314368	6386800	62.4	162	Wambo	Q	Q	Q	A
MBW6A						Q	Q	Q	A

Notes: Comprehensive analysis includes major ions TDS, Al, As, B, Ca, Cd, Cl, (CO3), Cu, Hg, K, Mg, Na, Ni, Pb, Se, SO4 (or S), Zn Total Alkalinity, Bicarbonate Alkalinity, Carbonate Alkalinity, Hydroxide Alkalinity.

* = Comprehensive analysis also includes: Mo, V and Cr.

(VWP) denotes vibrating wire piezometer.

Q – Quarterly.

A – Annual.

Appendix B

Groundwater level and quality graphs

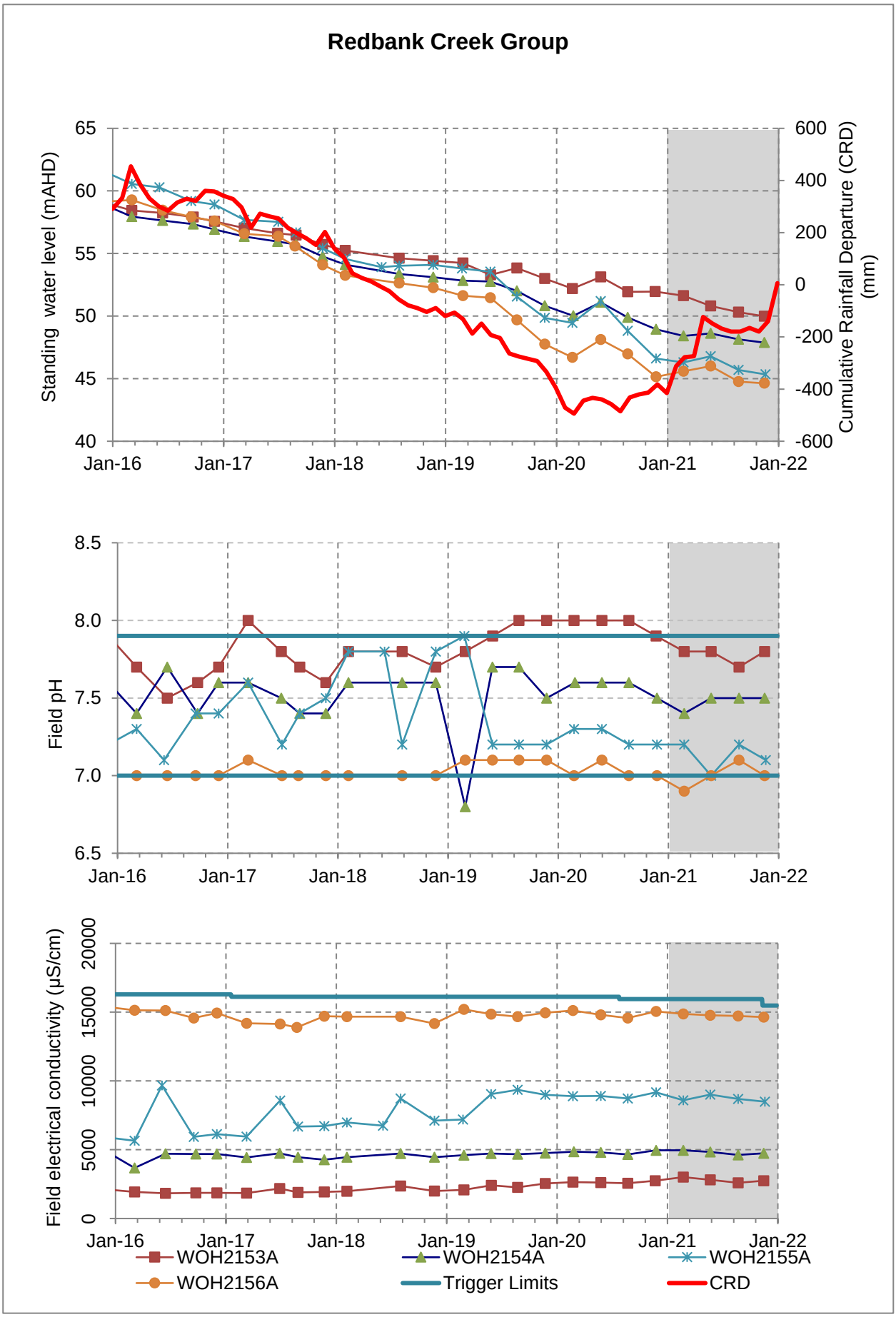


Figure B 1 Redbank Creek seam bores GWL, pH and EC trends

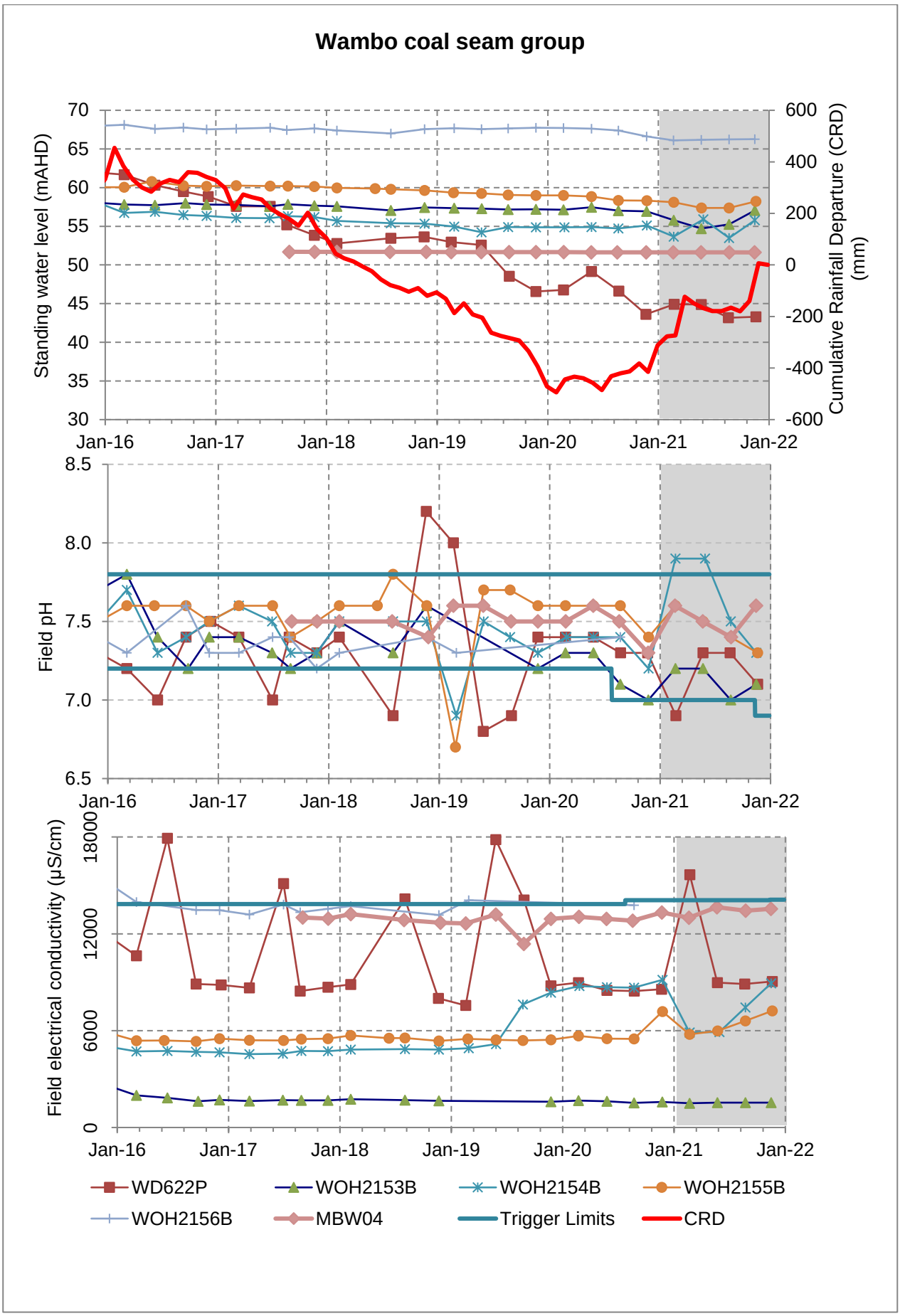


Figure B 2 Wambo coal seam bores GWL, pH and EC trends

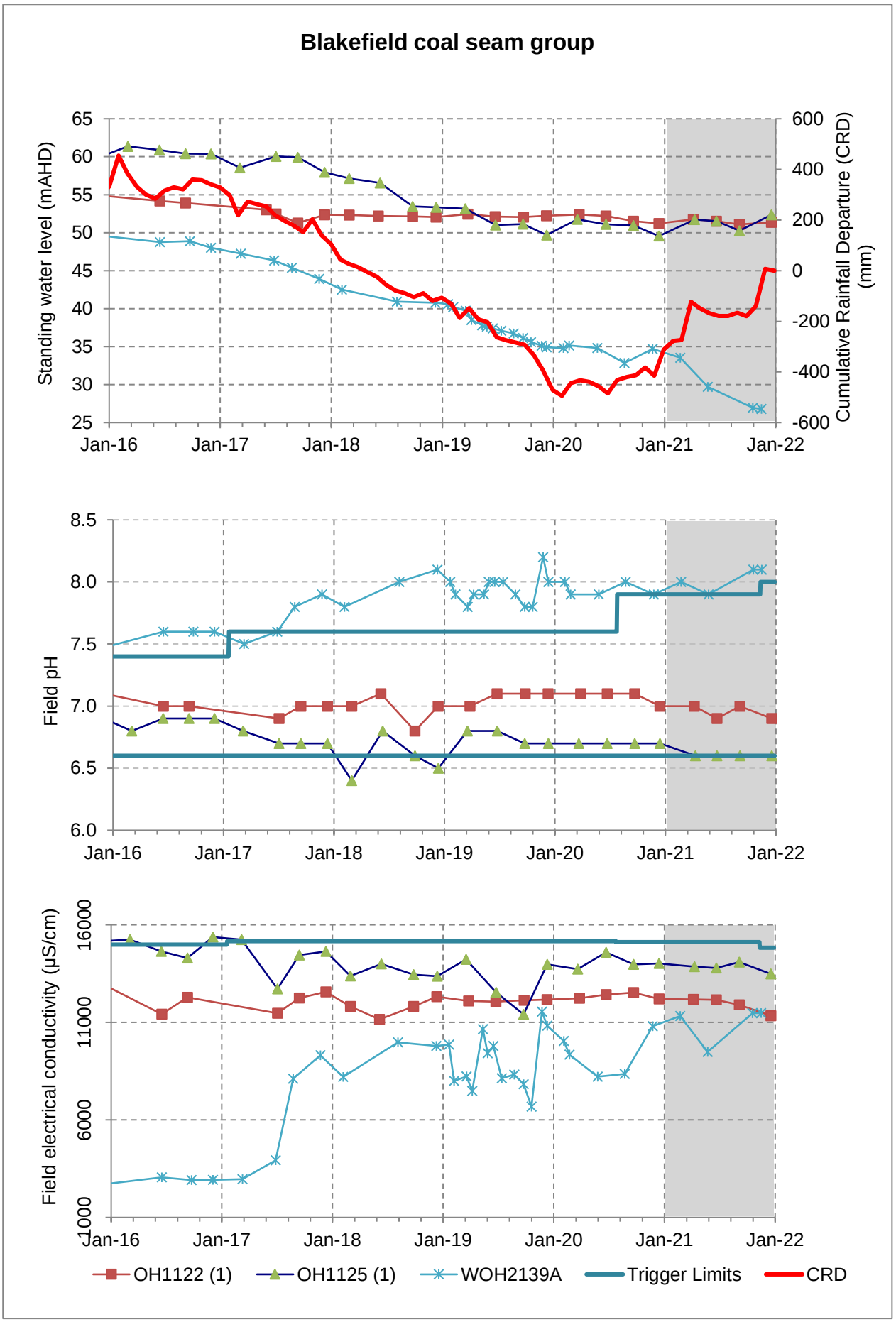


Figure B 3 Blakefield coal seam bores GWL, pH and EC trends

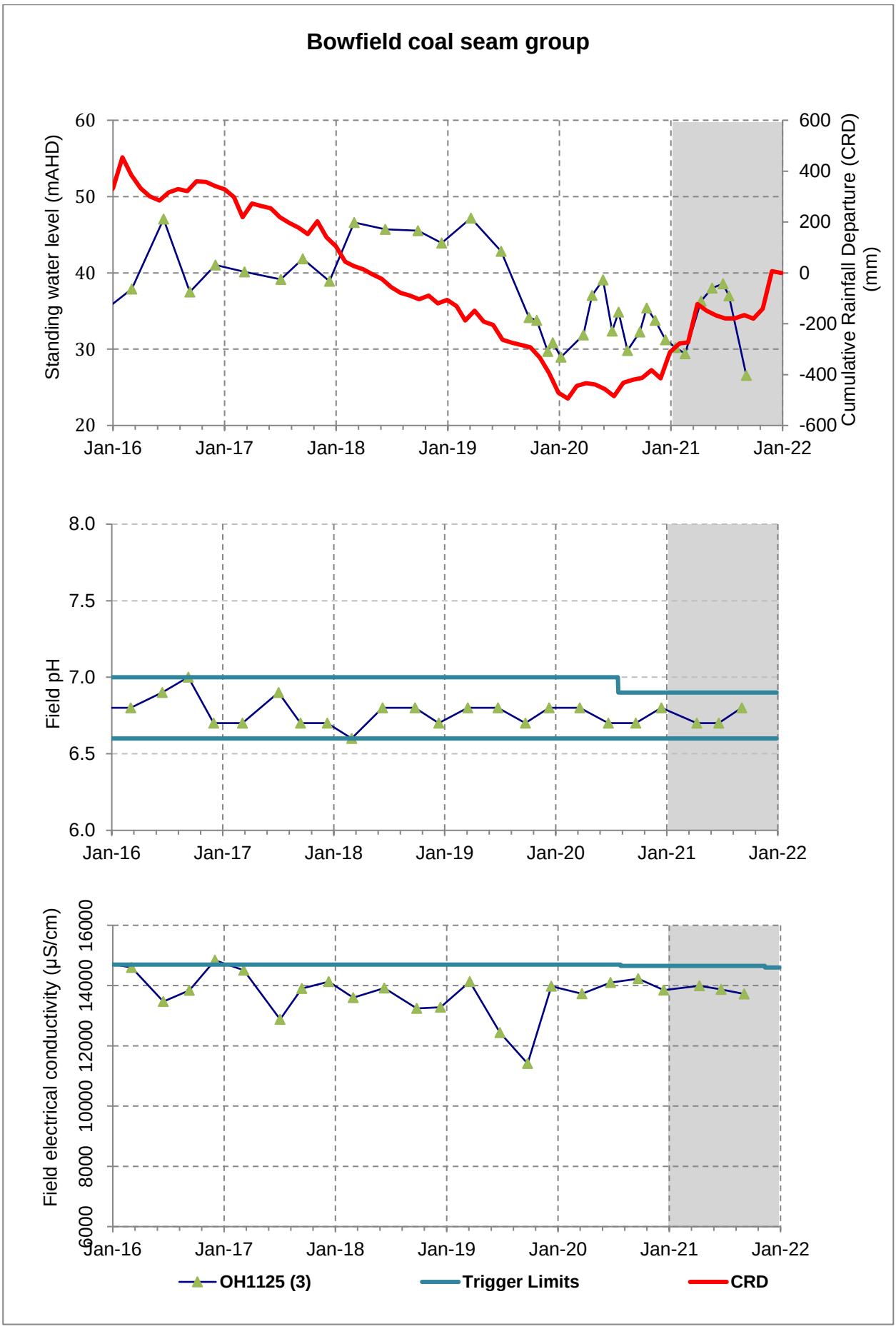


Figure B 4 Bowfield coal seam bores GWL, pH and EC trends

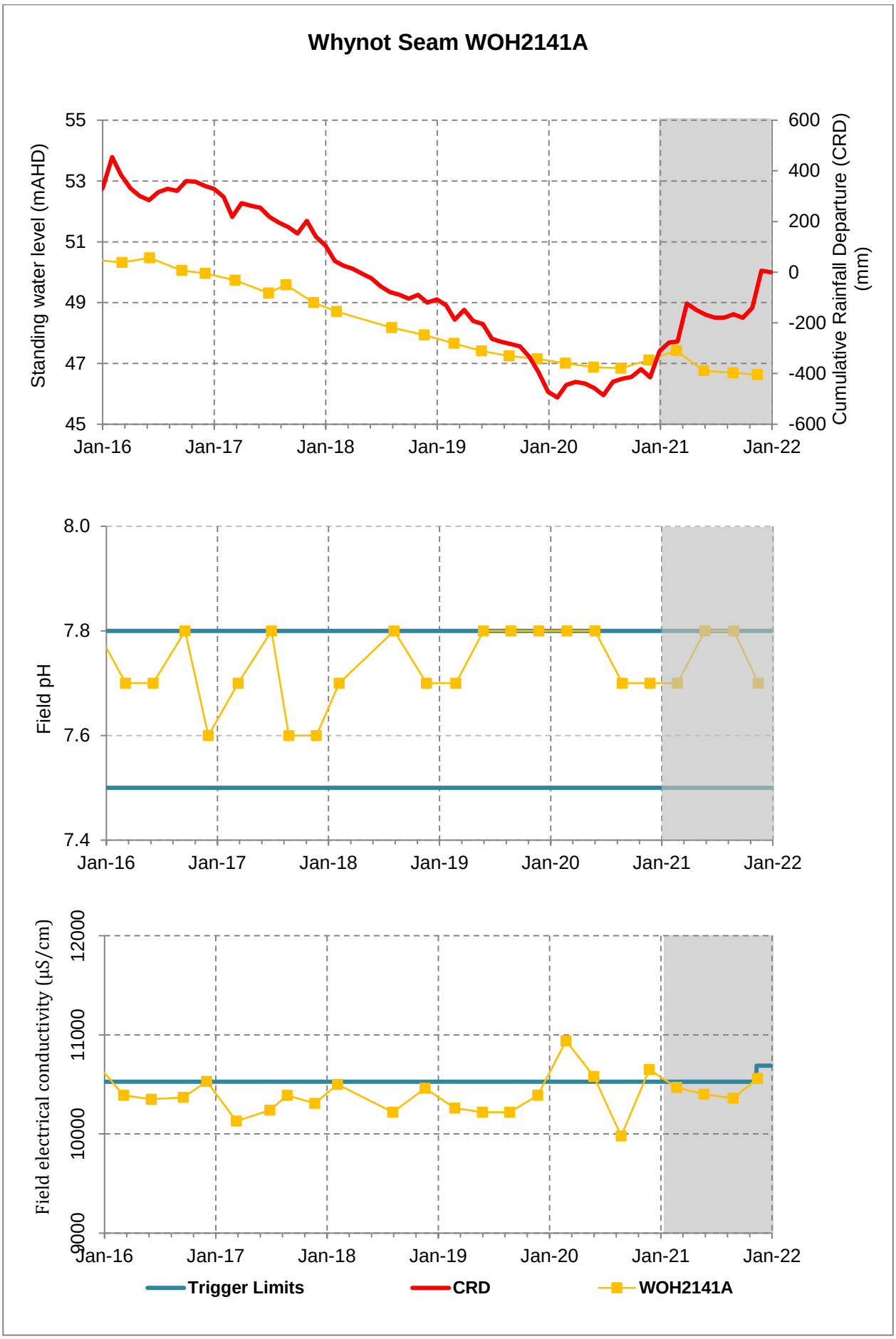


Figure B 5 Whynot coal seam bores GWL, pH and EC trends

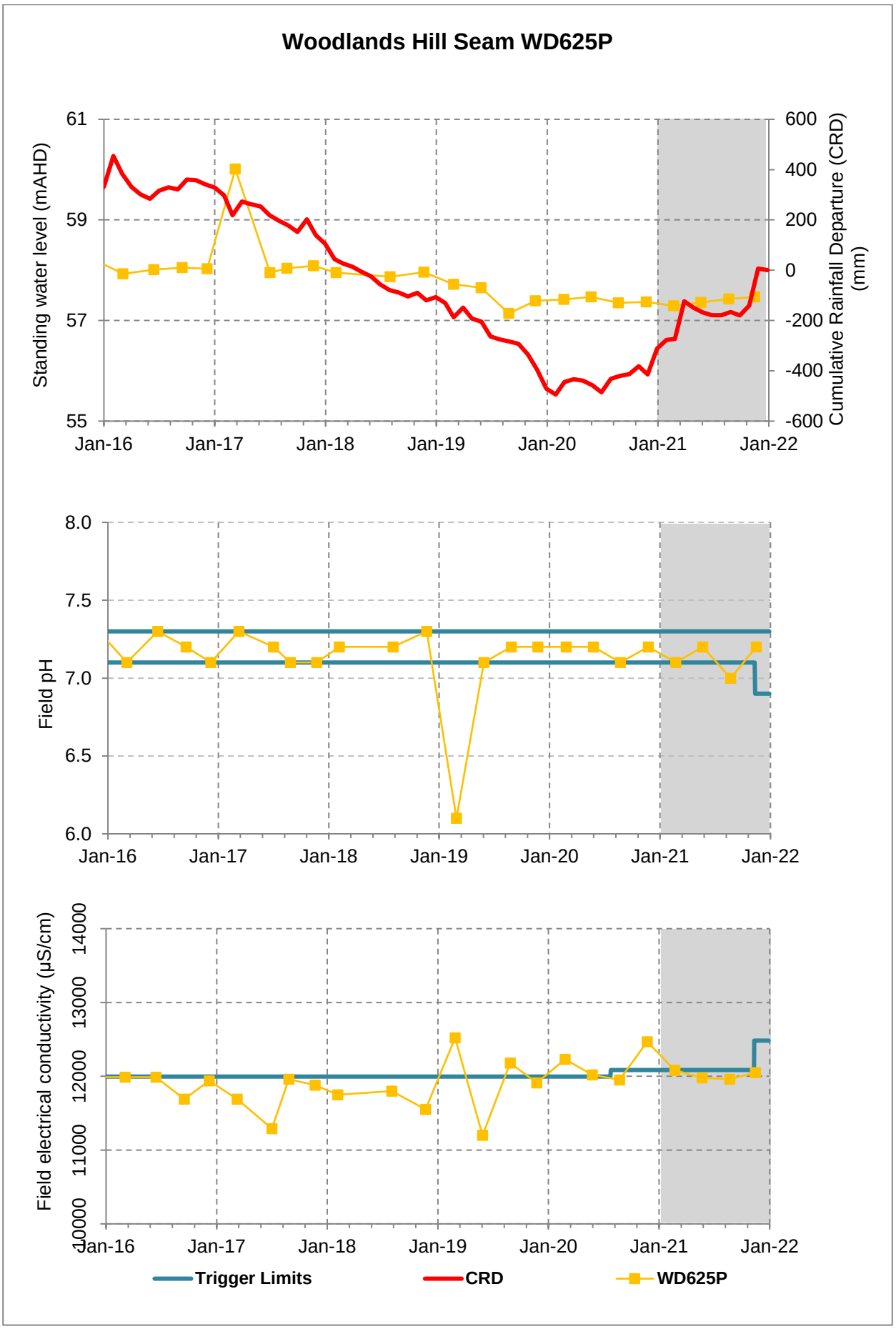


Figure B 6 Woodlands Hill coal seam bores GWL, pH and EC trends

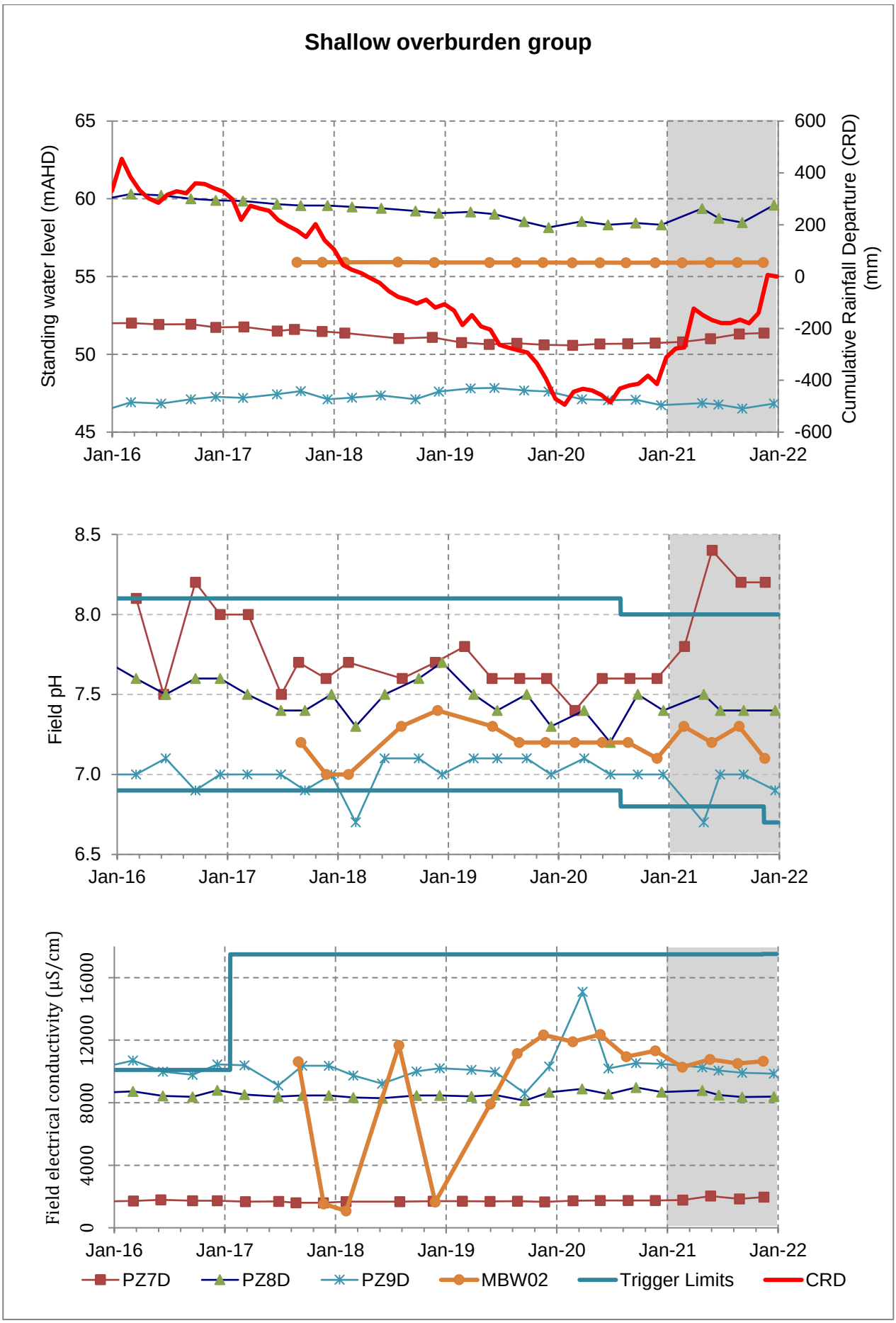


Figure B 7 Shallow overburden bores GWL, pH and EC trends (1)

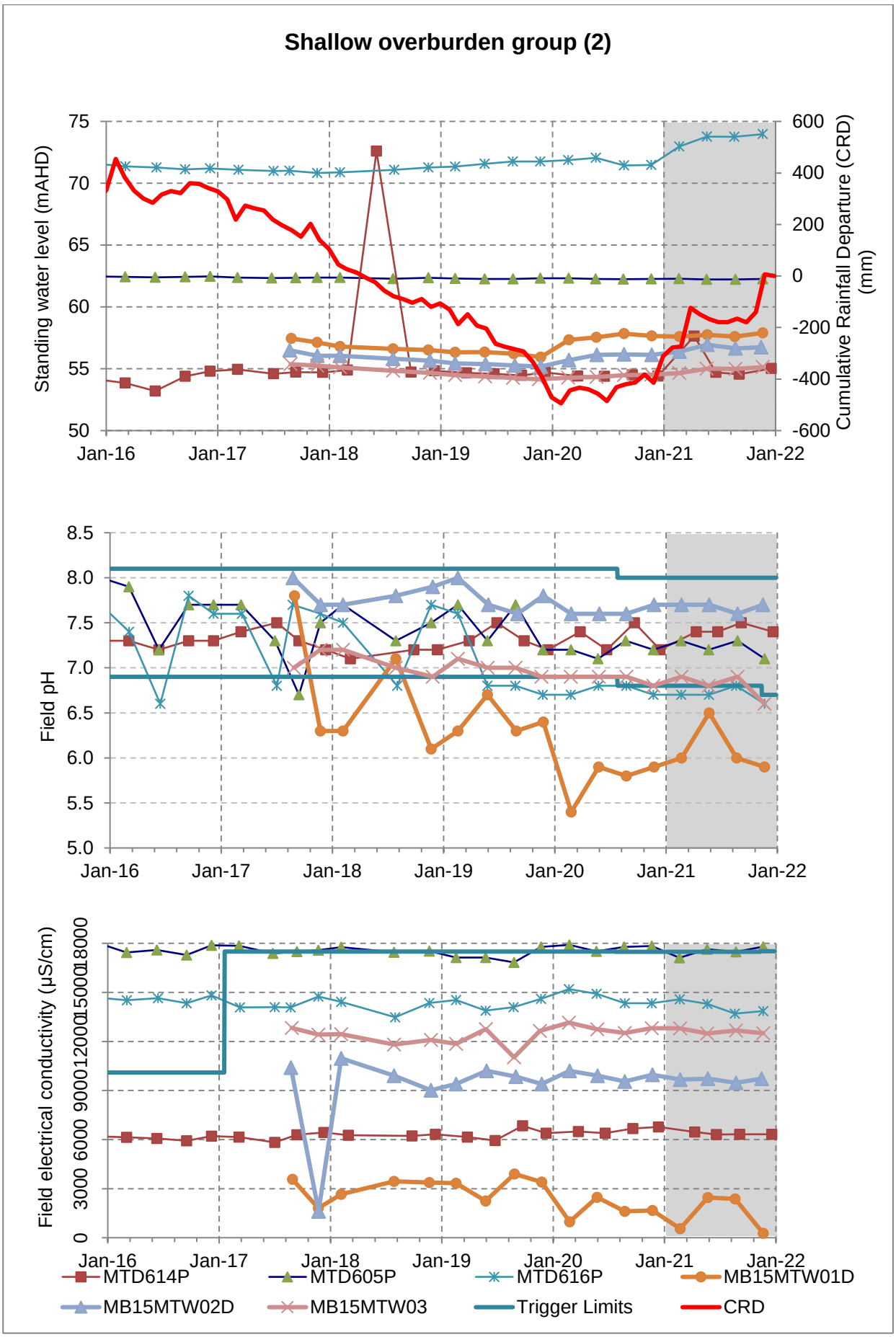


Figure B 8 Shallow overburden bores GWL, pH and EC trends (2)

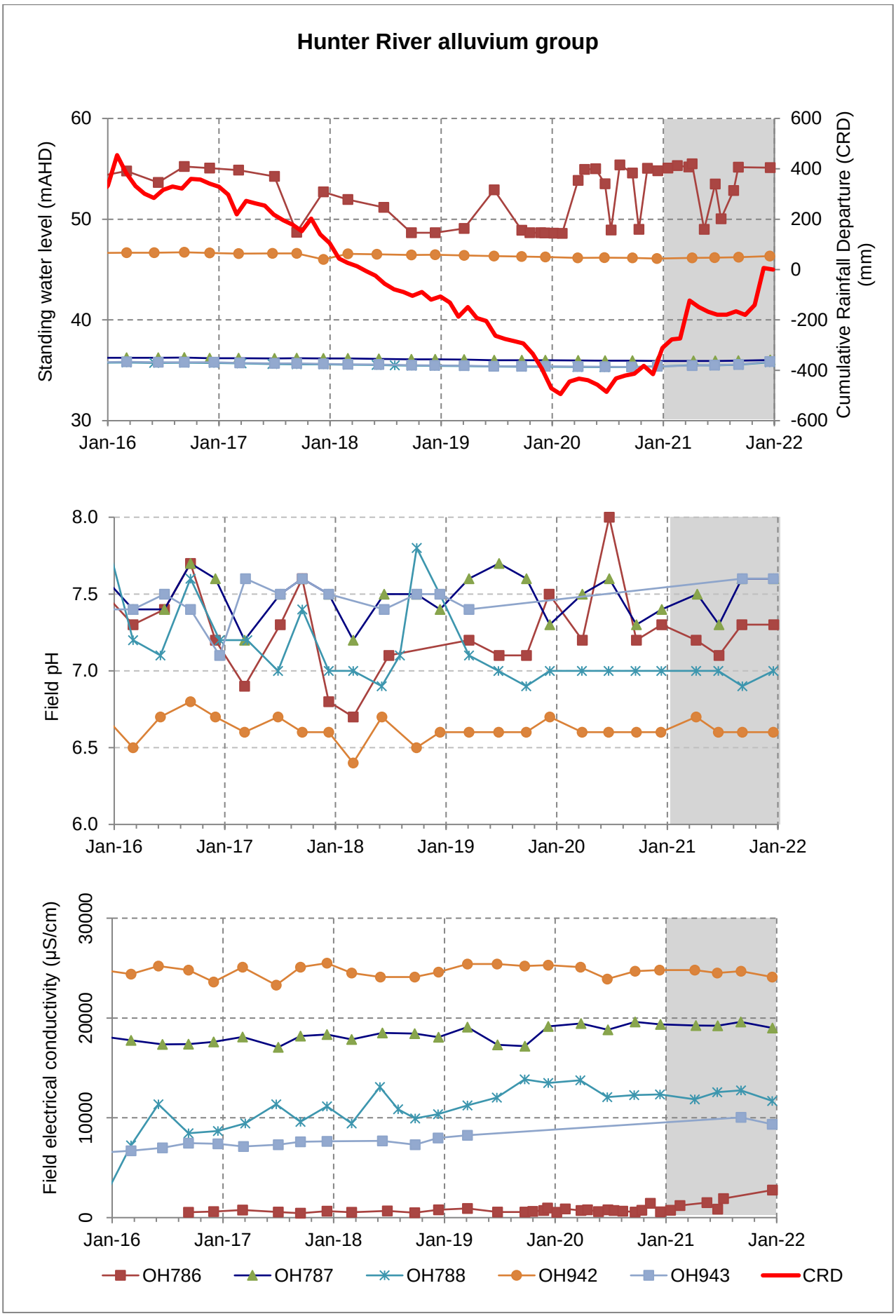


Figure B 9 Hunter River Alluvium bores GWL, pH and EC trends

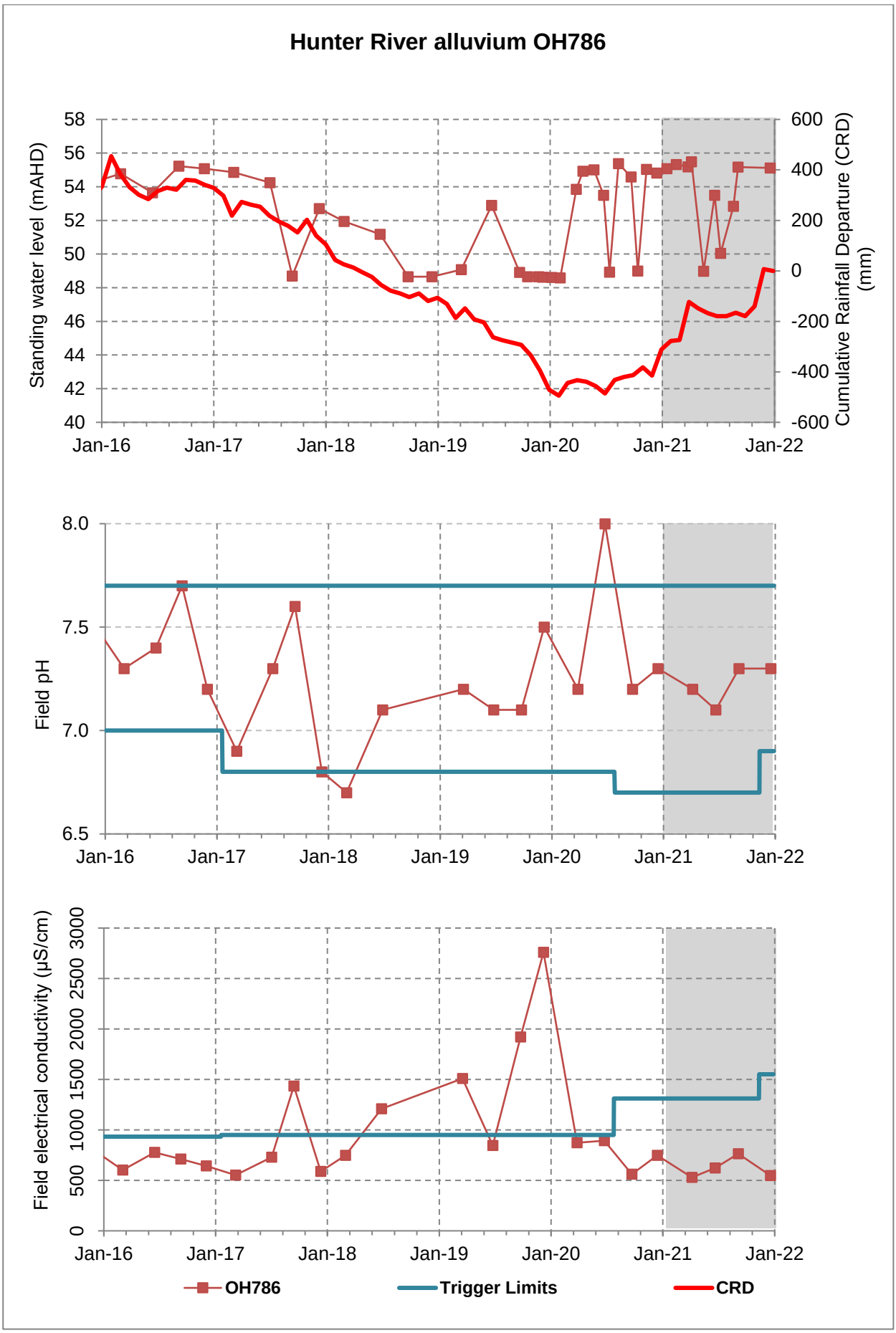


Figure B 10 Hunter River bore OH786 GWL, pH and EC trends

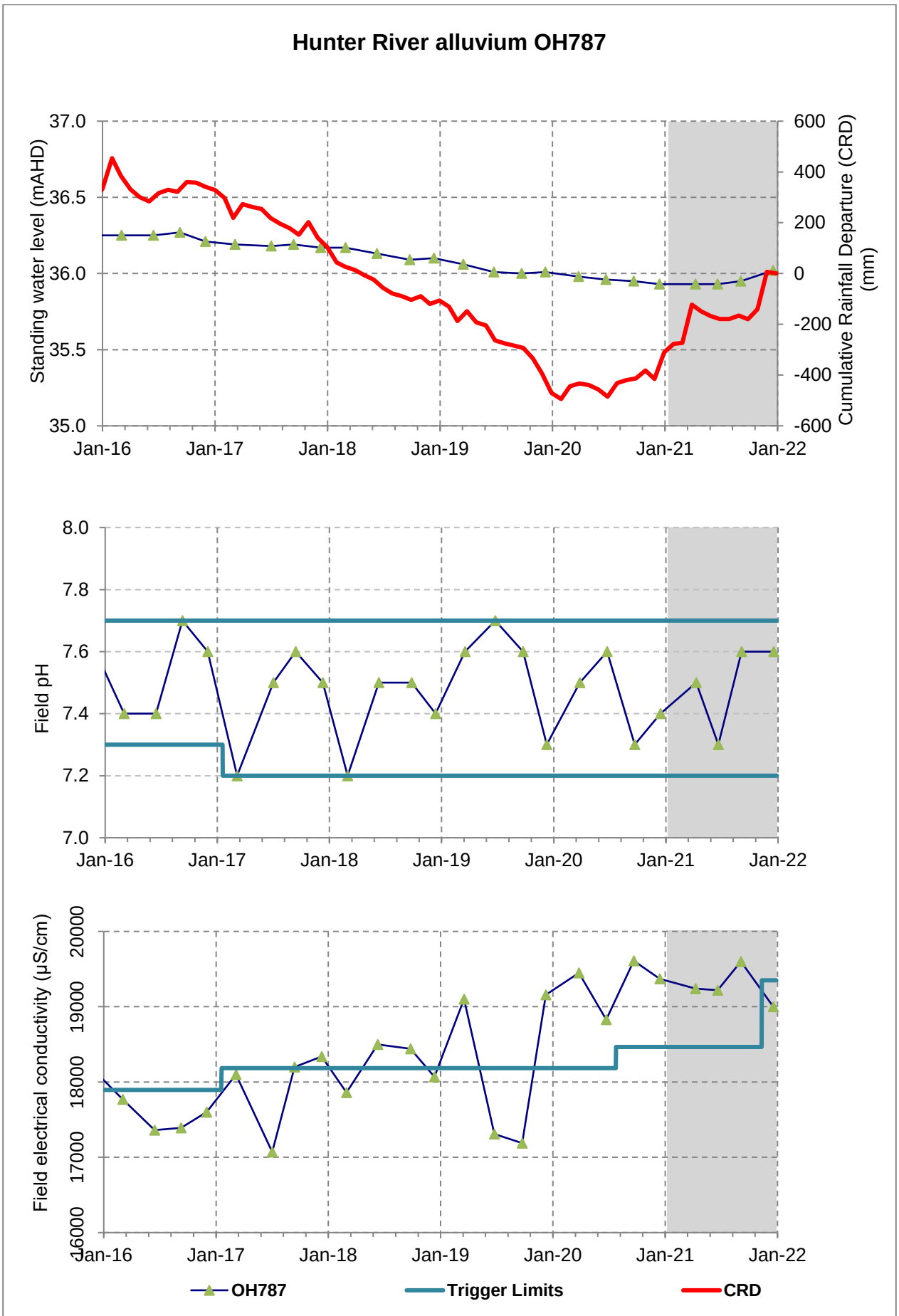


Figure B 11 Hunter River bore OH787 GWL, pH and EC trends

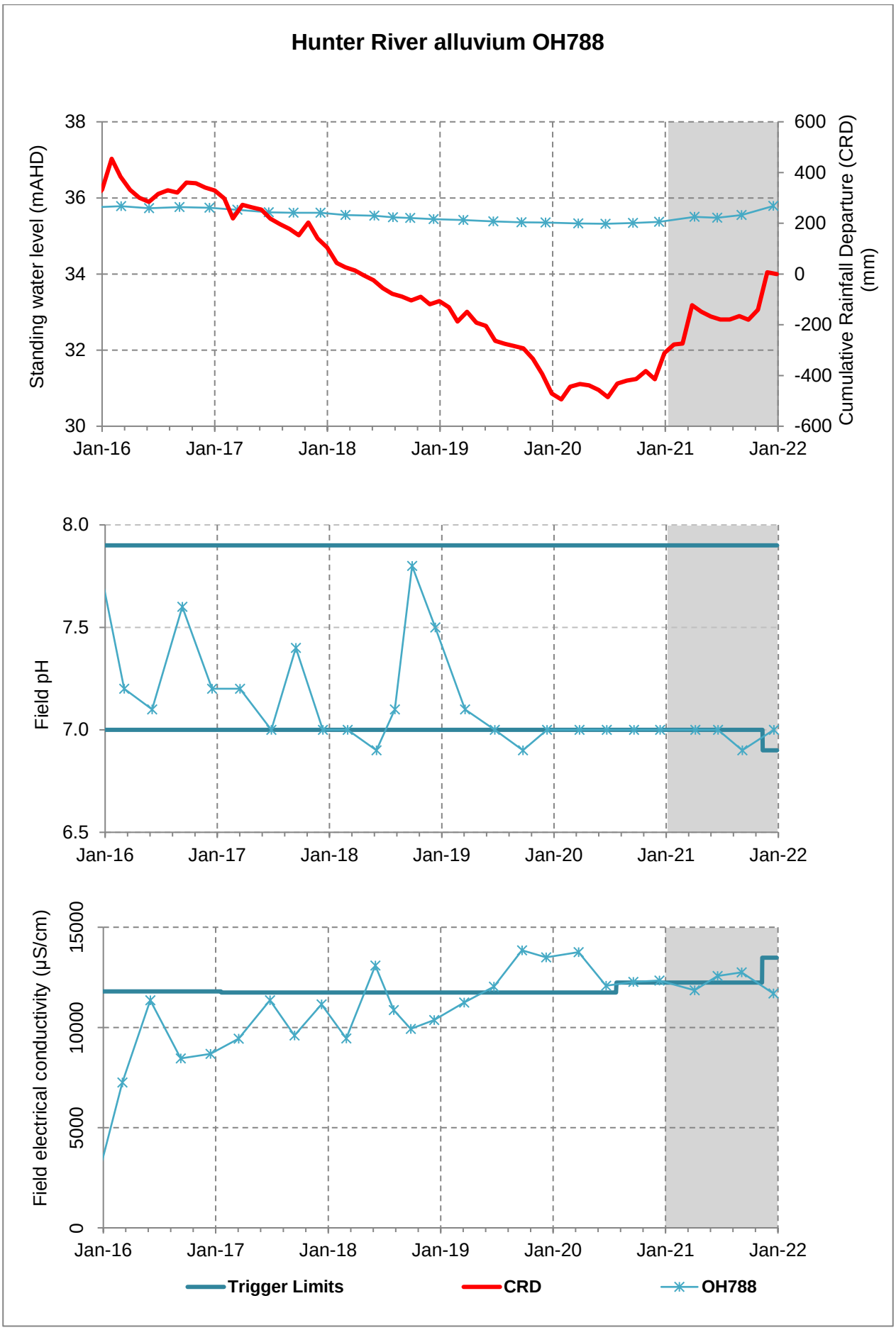


Figure B 12 Hunter River bore OH788 GWL, pH and EC trends

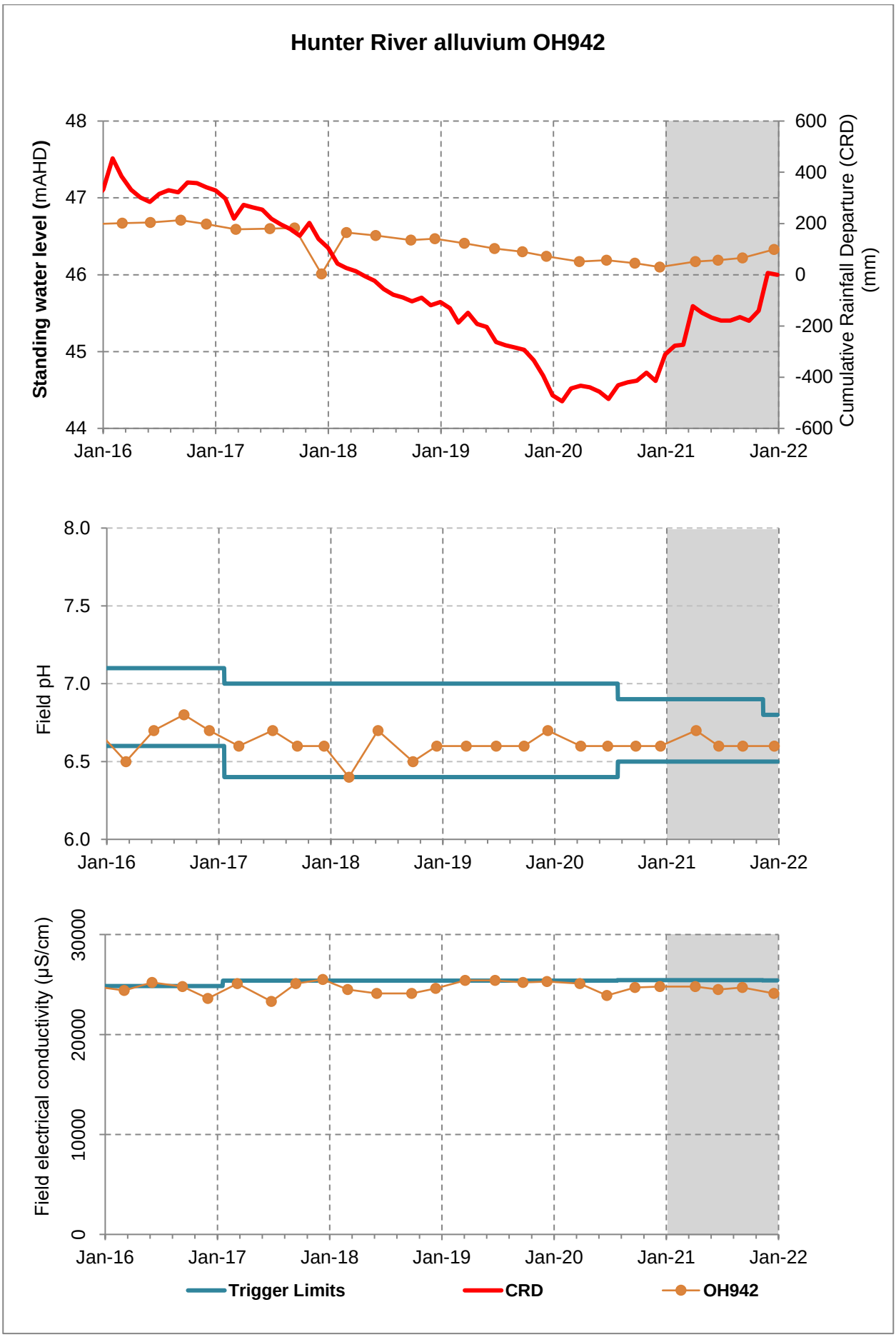


Figure B 13 Hunter River bore OH942 GWL, pH and EC trends

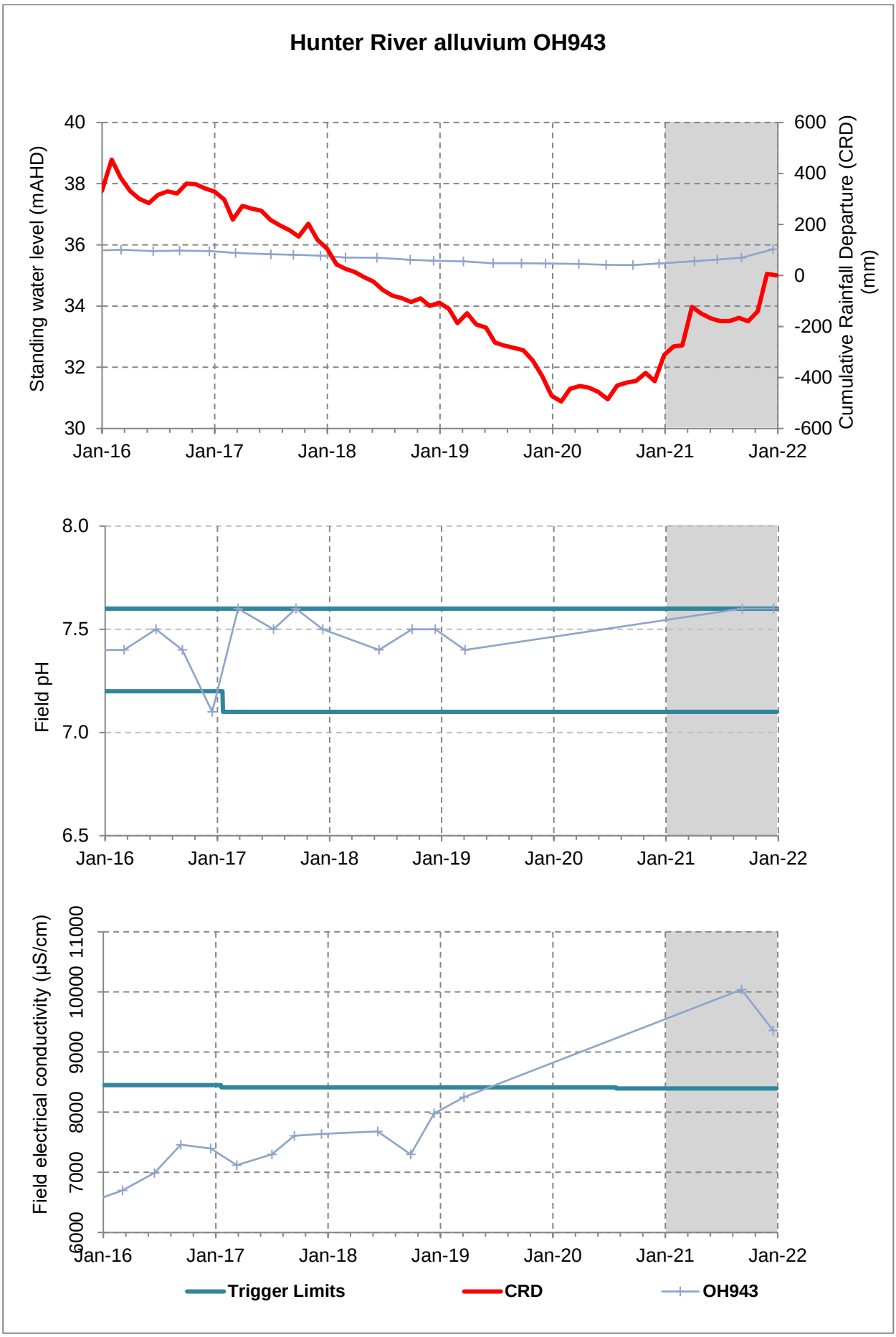


Figure B 14 Hunter River bore OH943 GWL, pH and EC trends

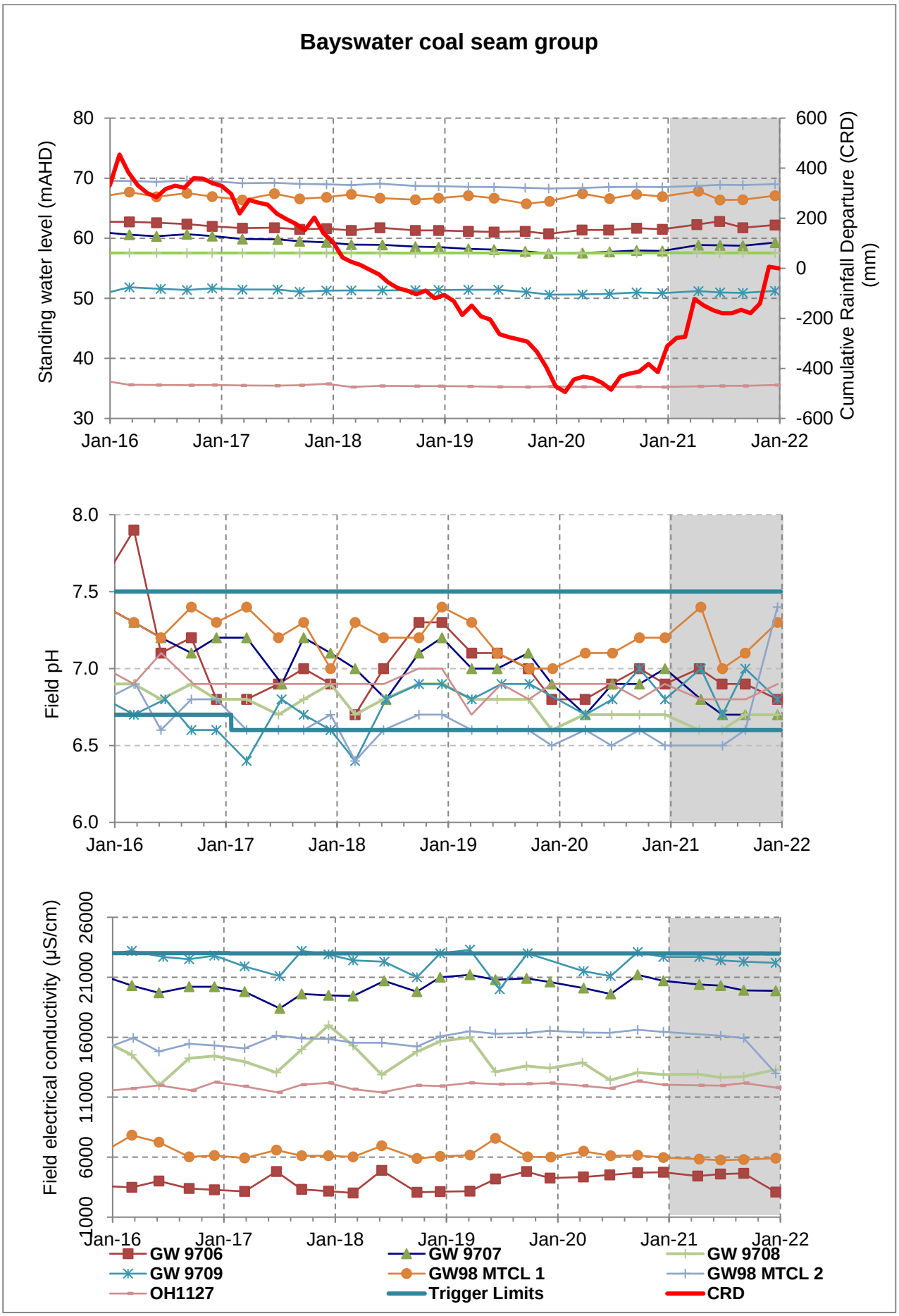


Figure B 15 Bayswater coal seam bores GWL, pH and EC trends

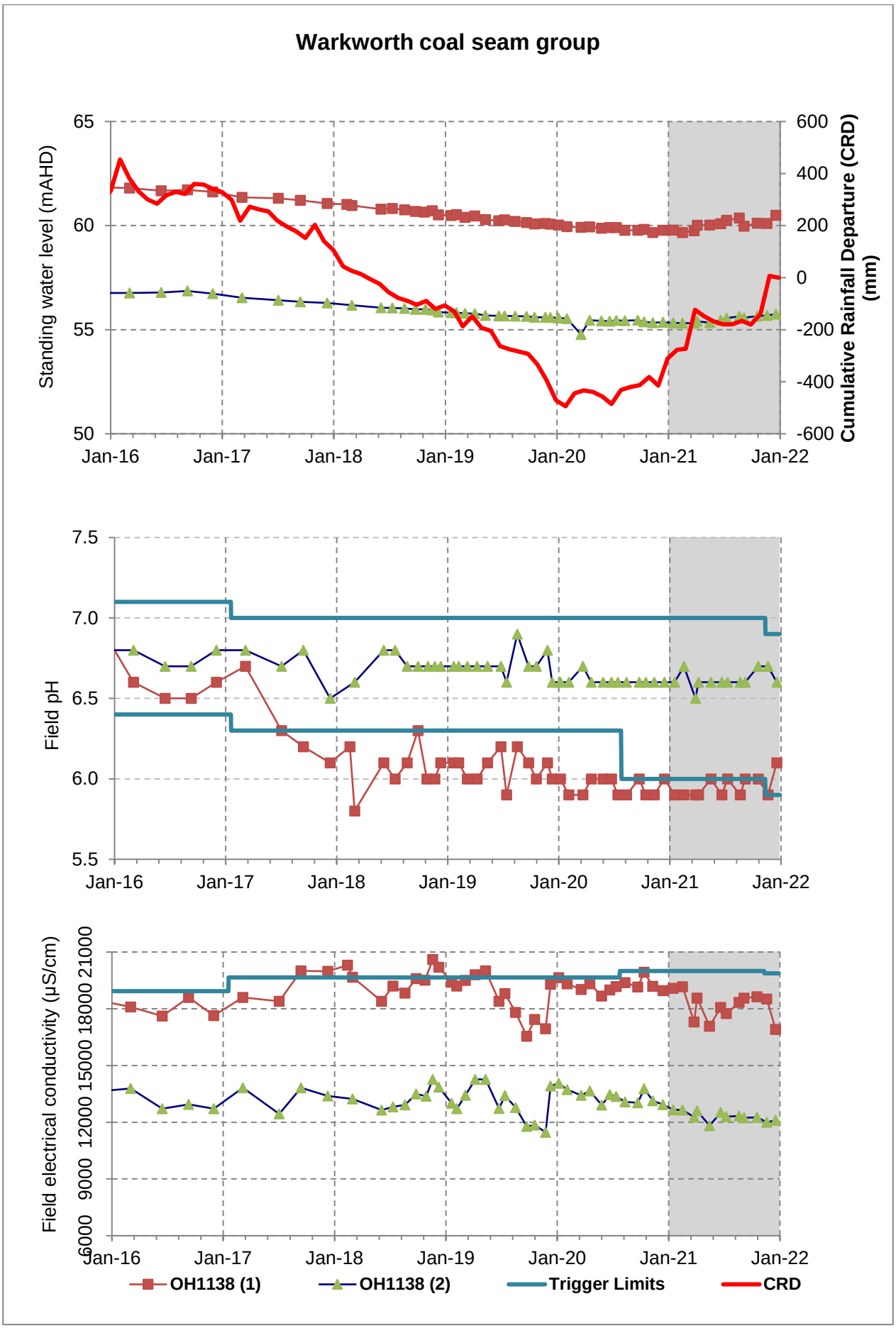


Figure B 16 Warkworth coal seam bores GWL, pH and EC trends

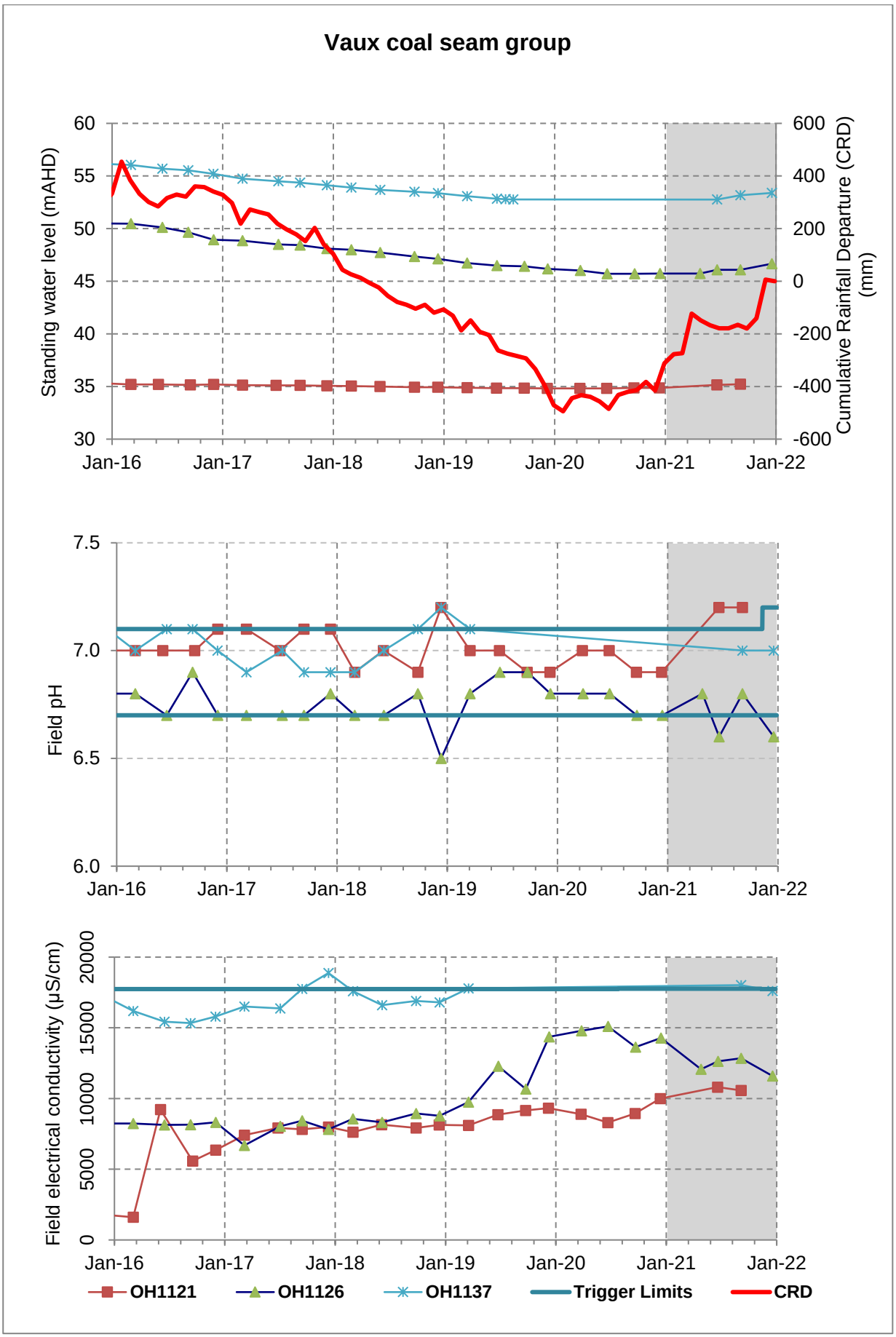


Figure B 17 Vaux coal seam bores GWL, pH and EC trends

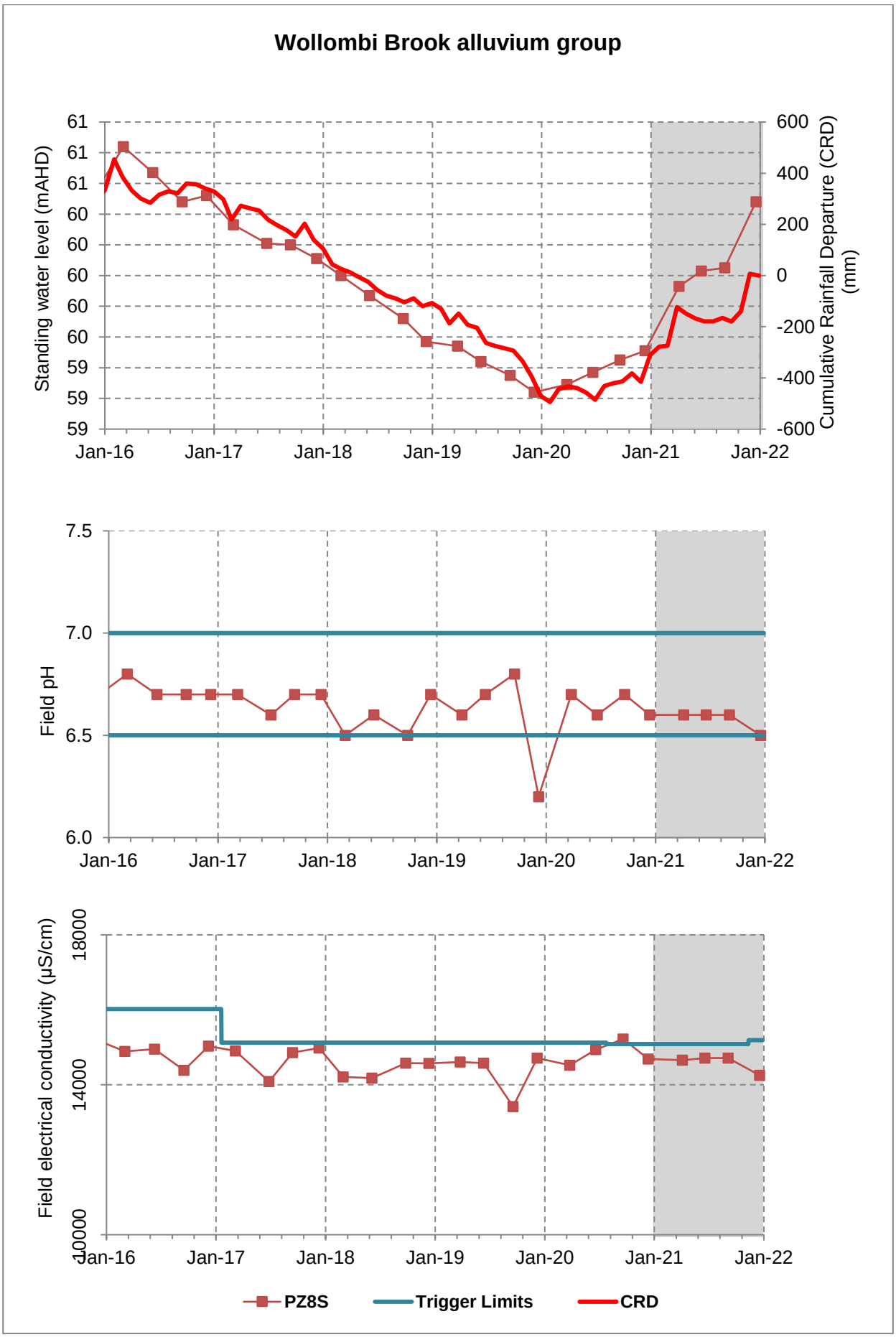


Figure B 18 Wollombi Brook Alluvium bore PZ8S GWL, pH and EC trends

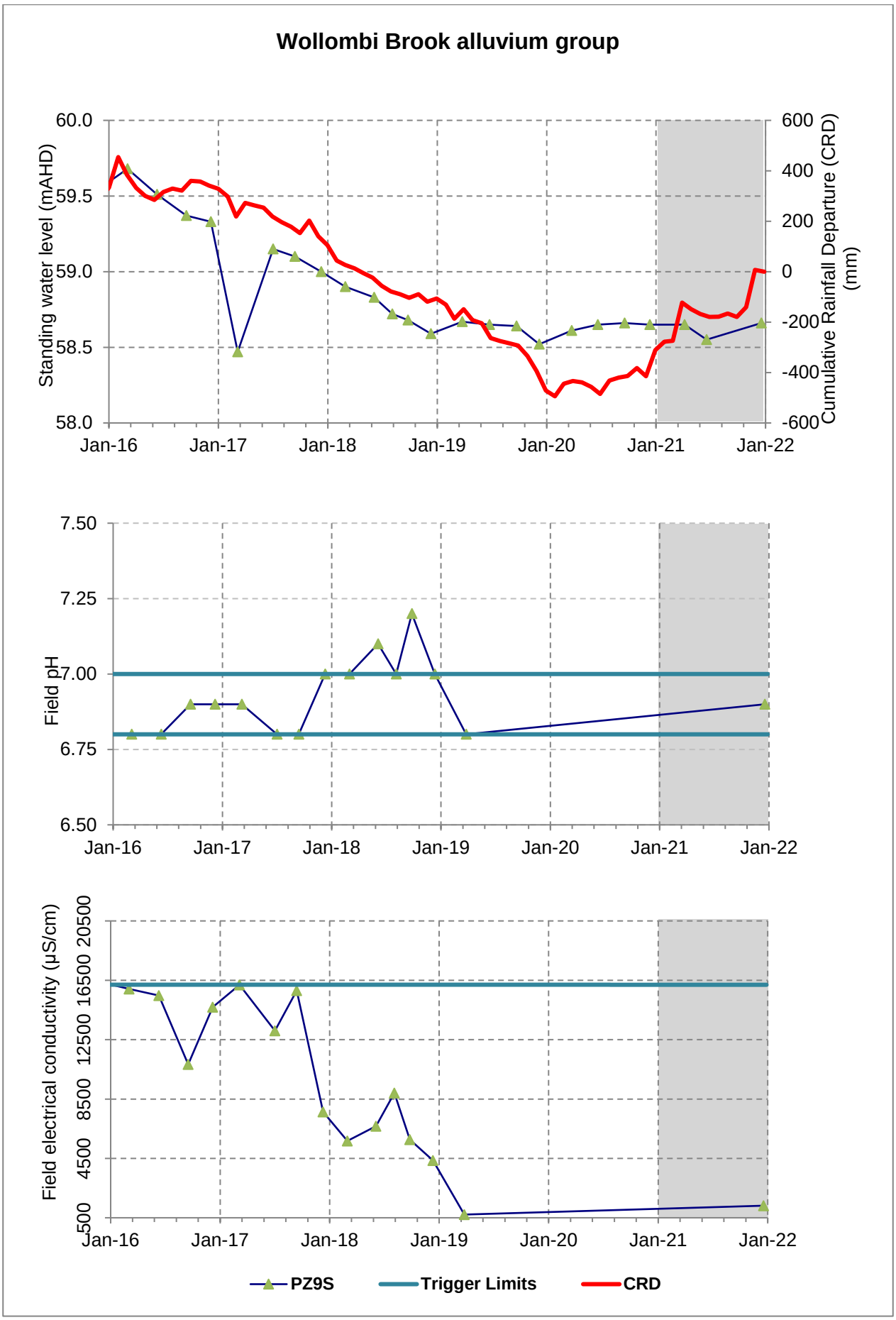


Figure B 19 Wollombi Brook Alluvium bore PZ9S GWL, pH and EC trends

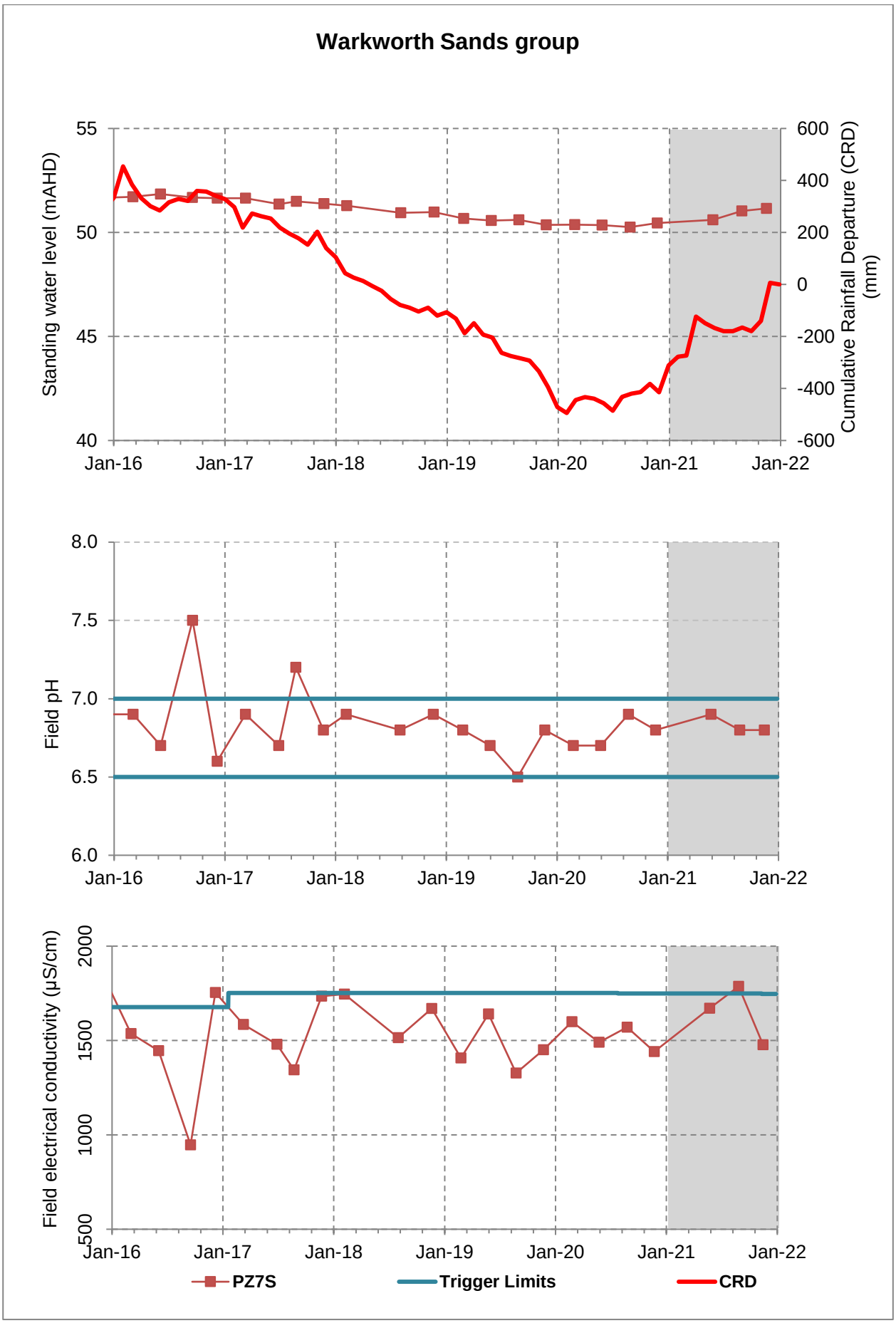


Figure B 20 Warkworth Sands bore PZ7S GWL, pH and EC trends

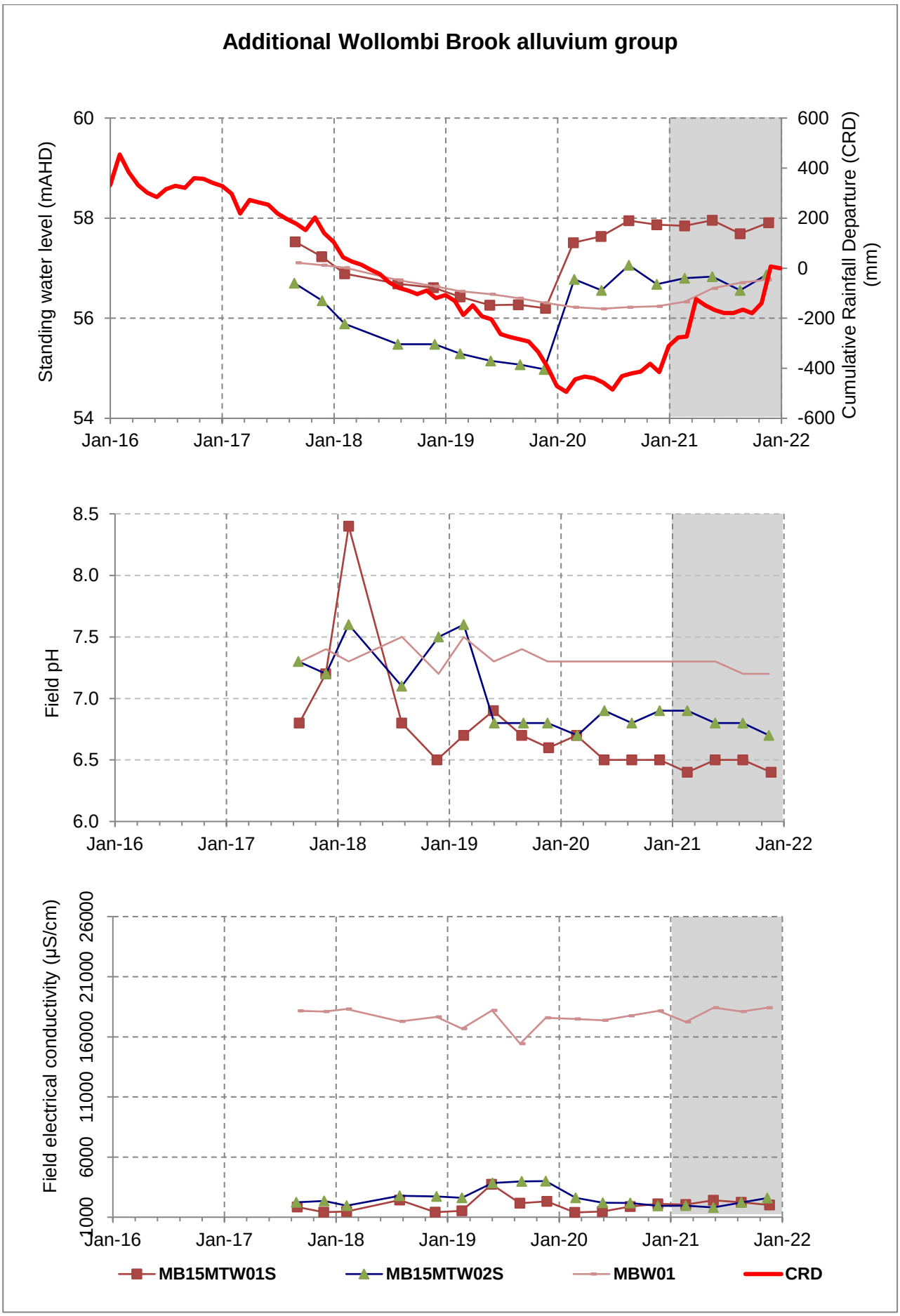


Figure B 21 Additional Wollombi Brook Alluvium bores GWL, pH and EC trends

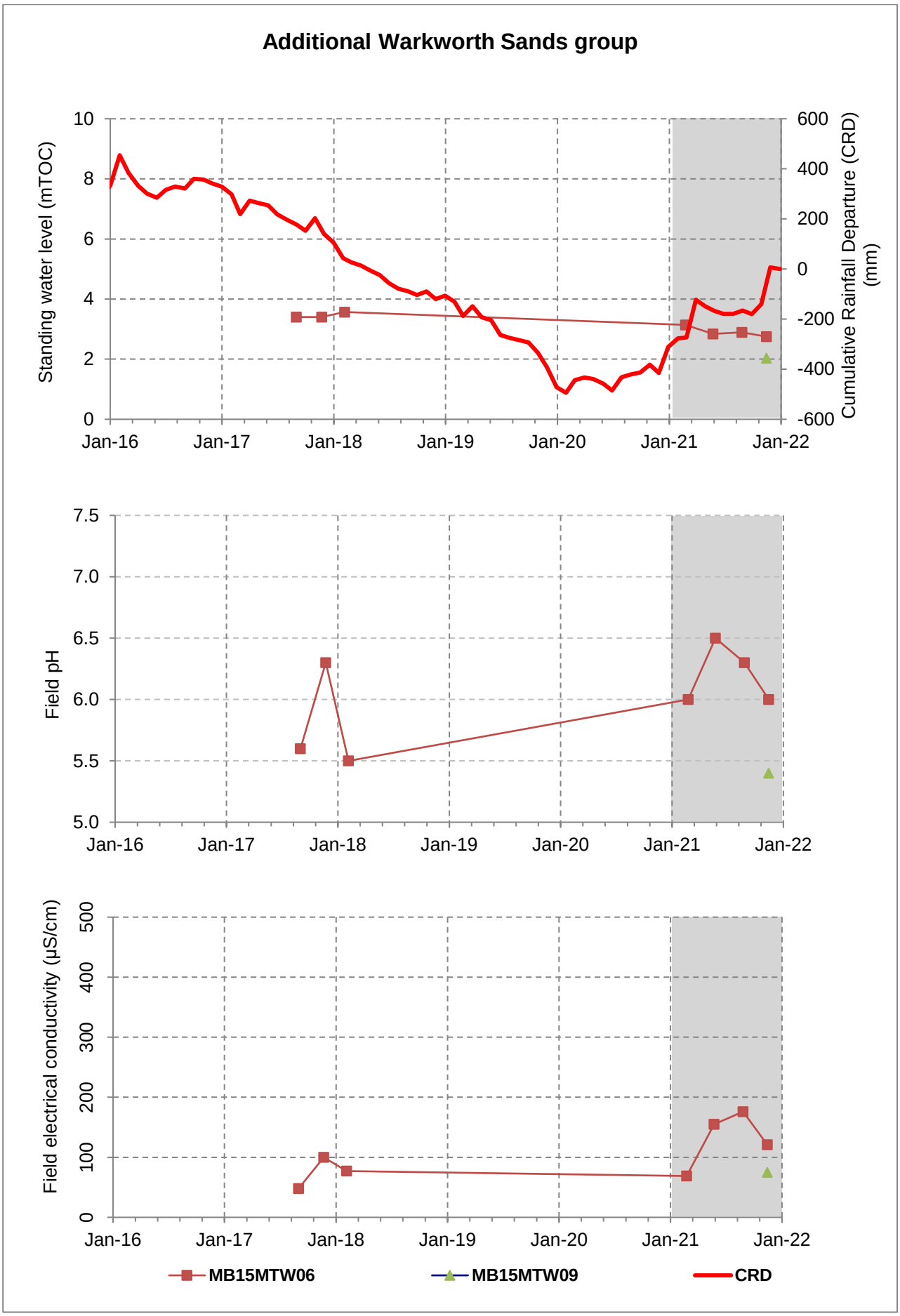


Figure B 22 Additional Warkworth Sands bores GWL, pH and EC trends



Figure B 23 Whybrow coal seam bores GWL, pH and EC trends

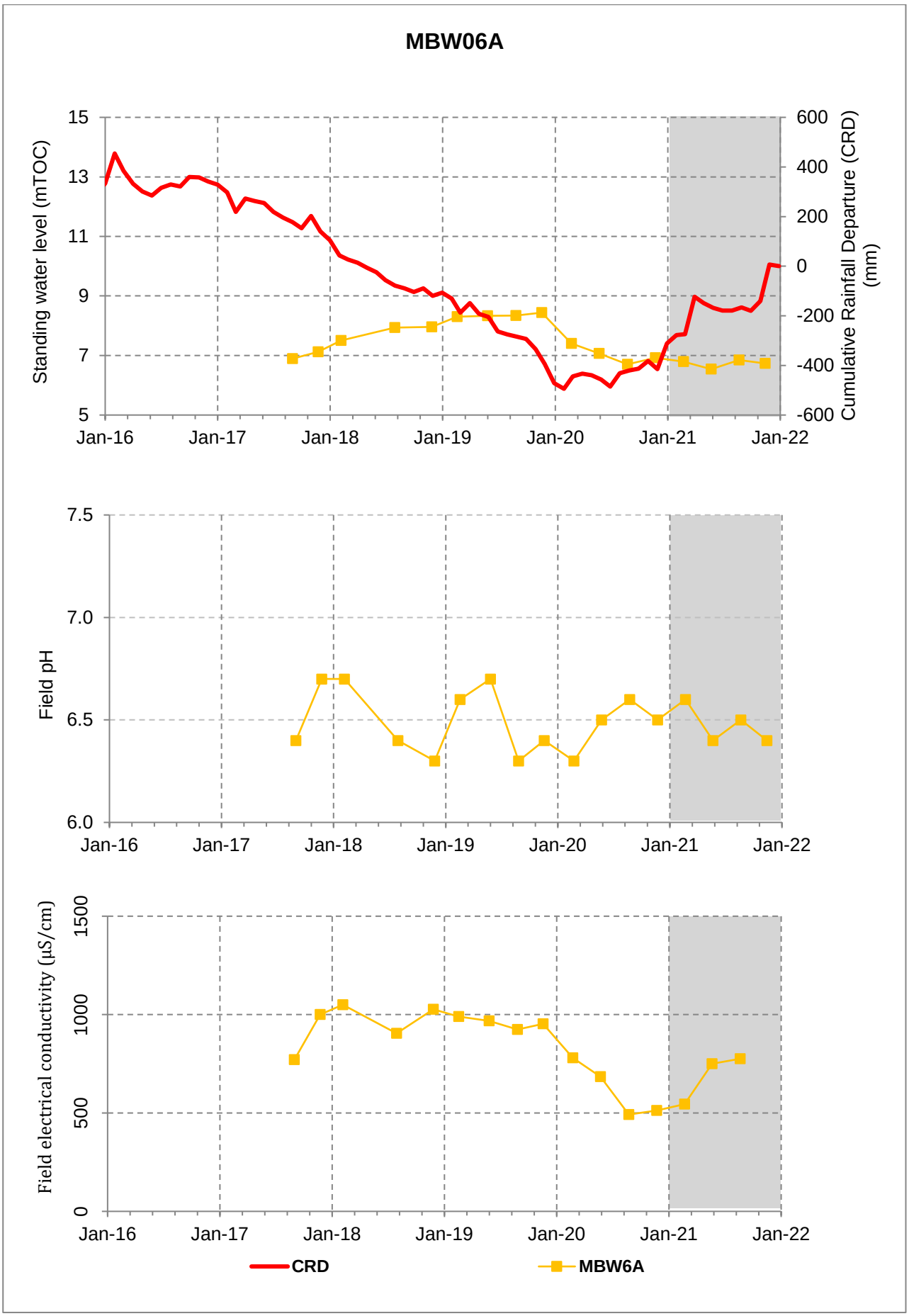
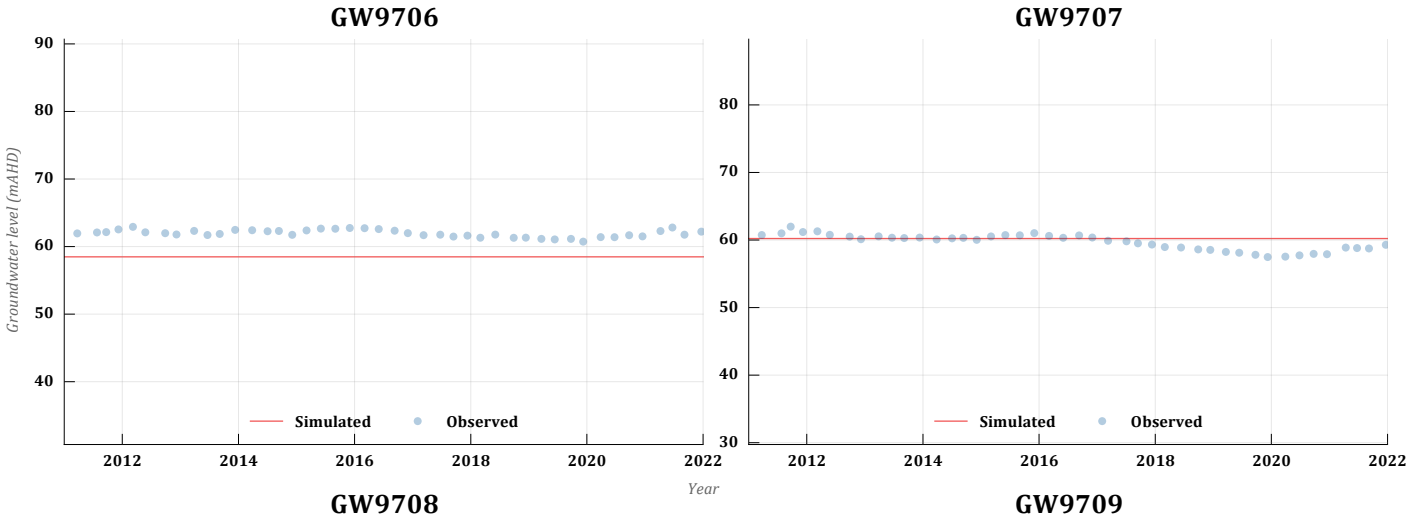


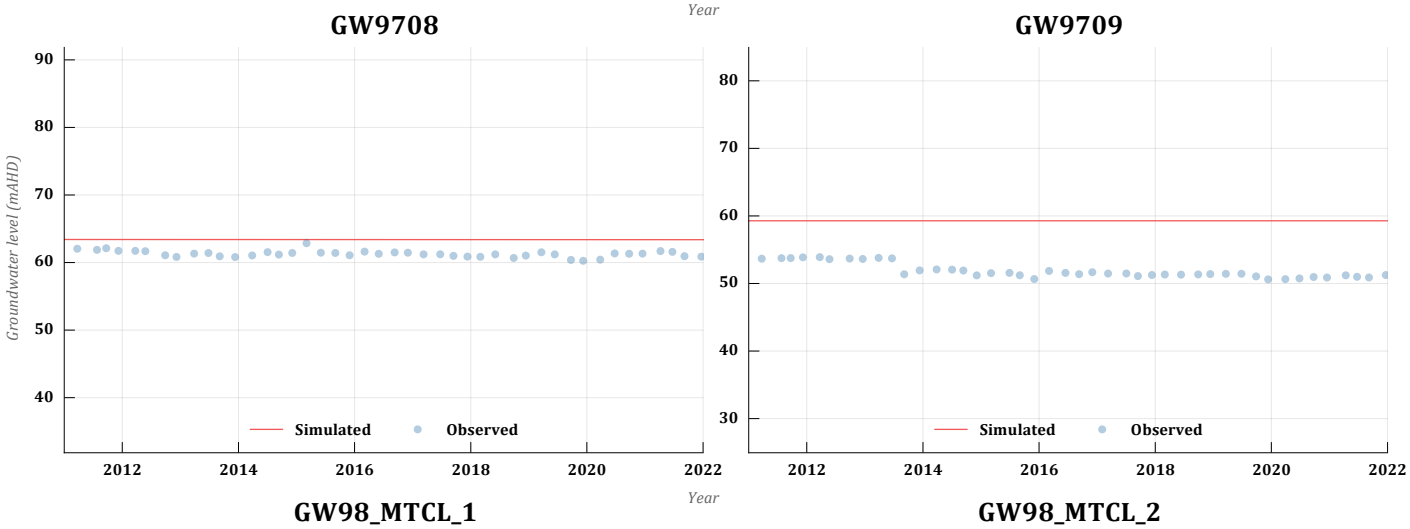
Figure B 24 MBW6A GWL, pH and EC trends

Appendix C

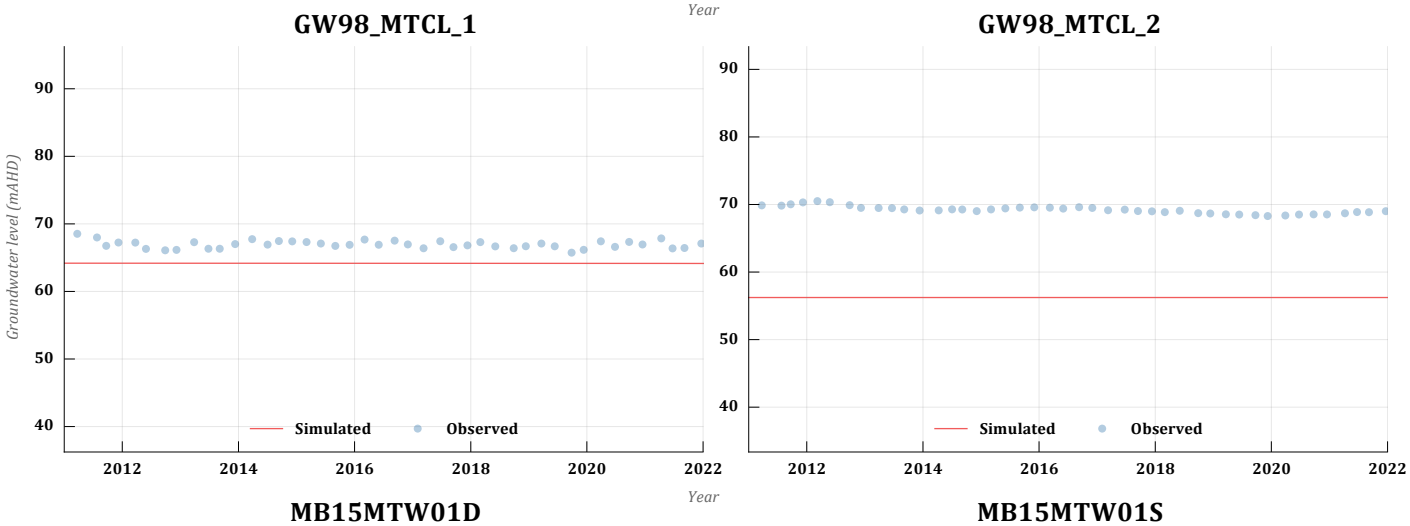
Model verification graphs


GW9706
Groundwater level (mAHD)
90
80
70
60
50
40
Simulated
Observed
2012
2014
2016
2018
2020
2022
Year

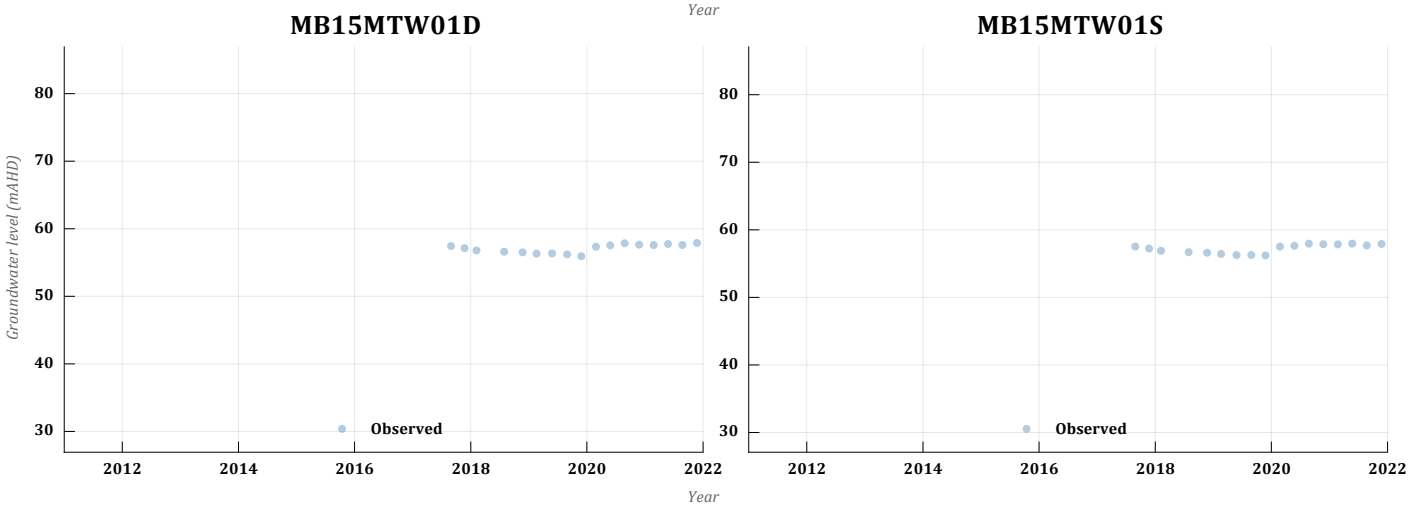
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Simulated
Observed
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2014
2016
2018
2020
2022


GW9708
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Simulated
Observed
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2014
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2018
2020
2022
Year

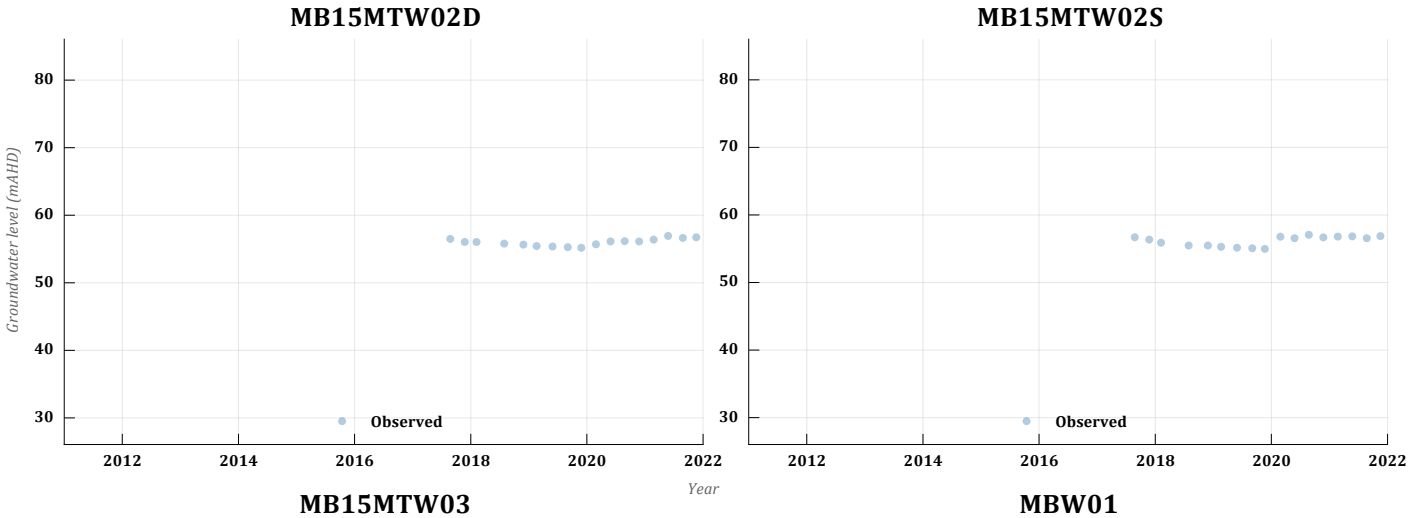
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2020
2022

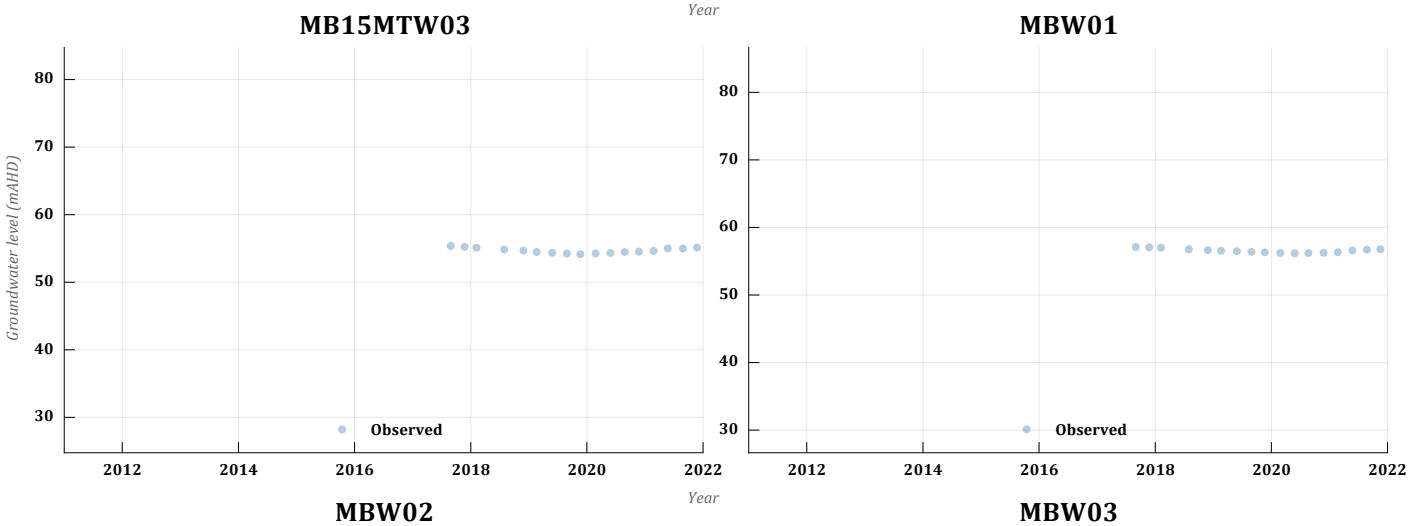

GW98_MTCL_1
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Simulated
Observed
2012
2014
2016
2018
2020
2022
Year

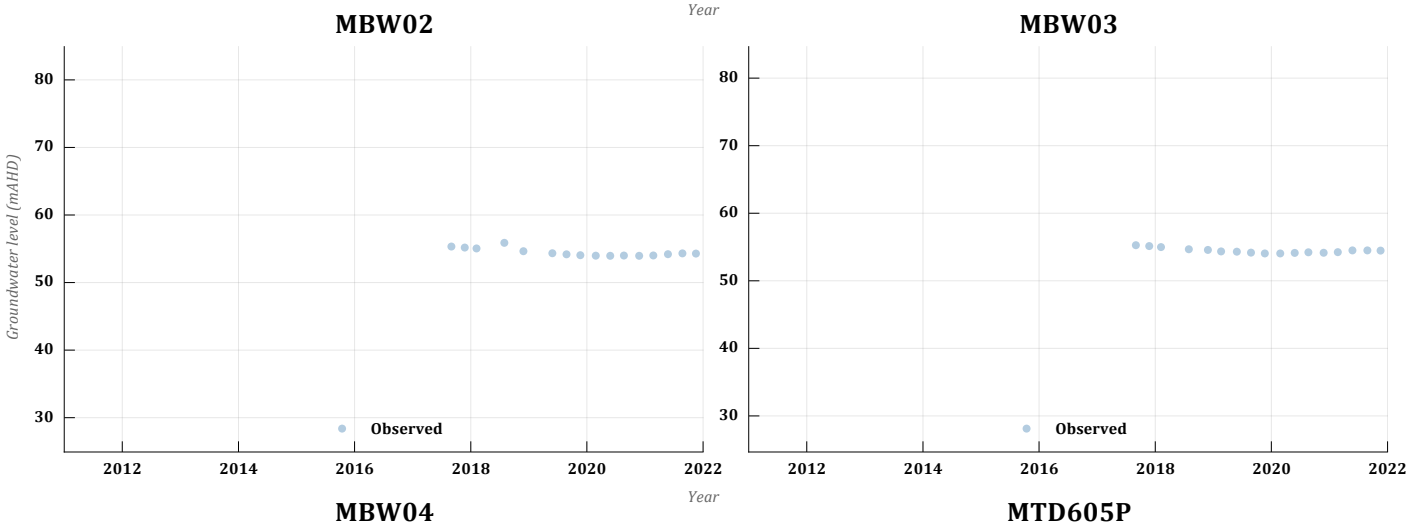
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Observed
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2020
2022

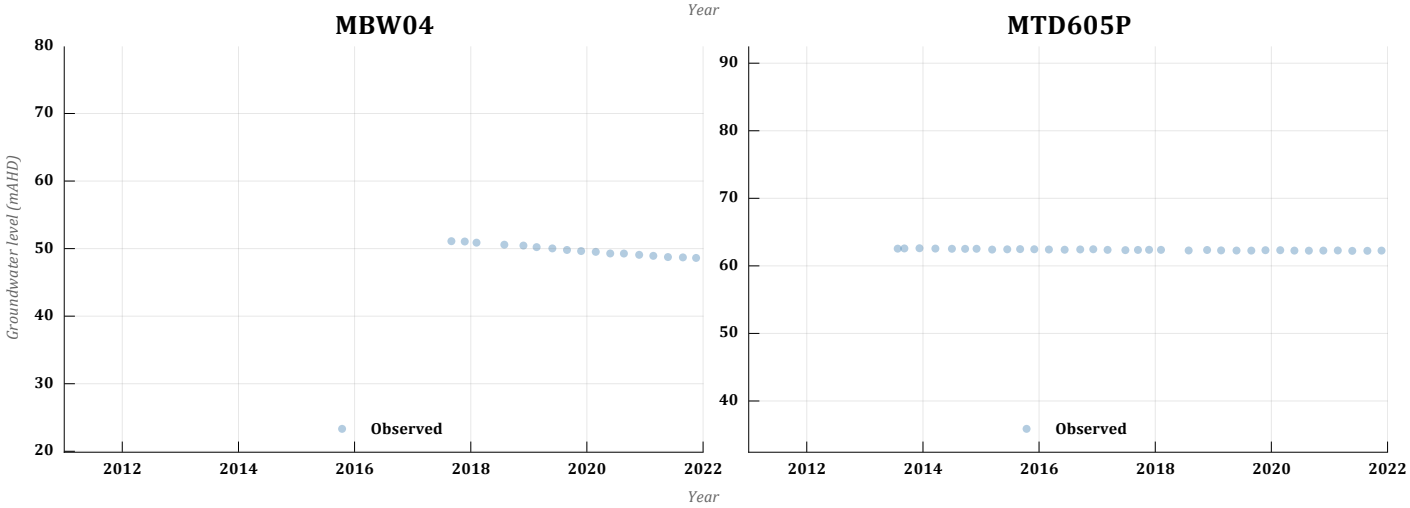

MB15MTW01D
Groundwater level (mAHD)
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Observed
2012
2014
2016
2018
2020
2022
Year

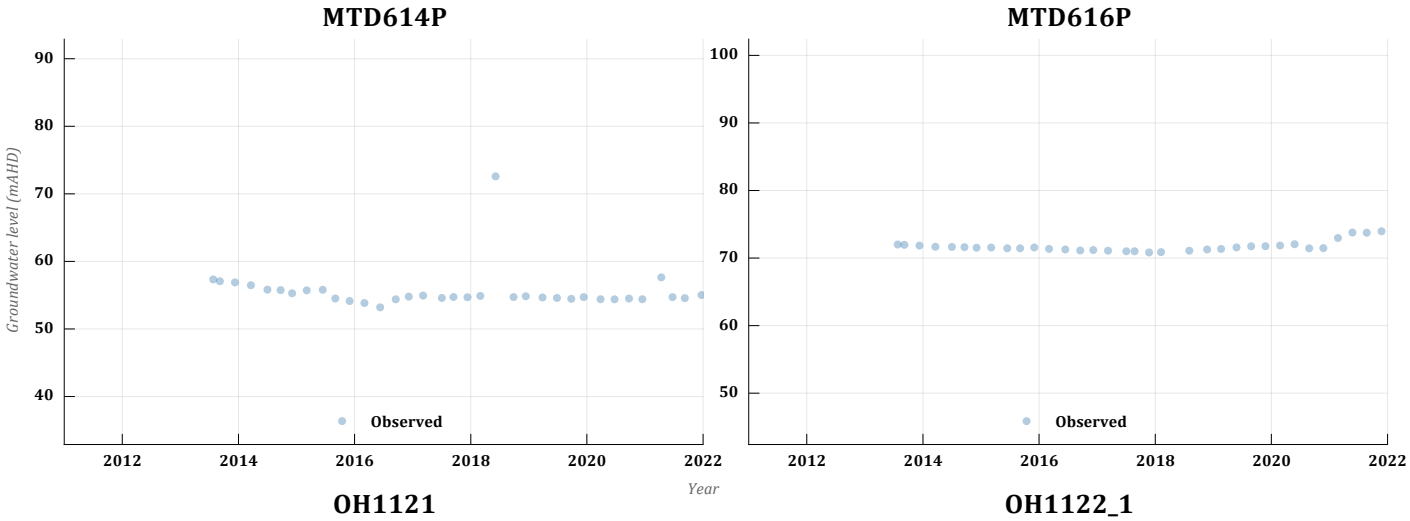
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2020
2022


MB15MTW02D
MB15MTW02S
Groundwater level (mAHD)
Observed
Year

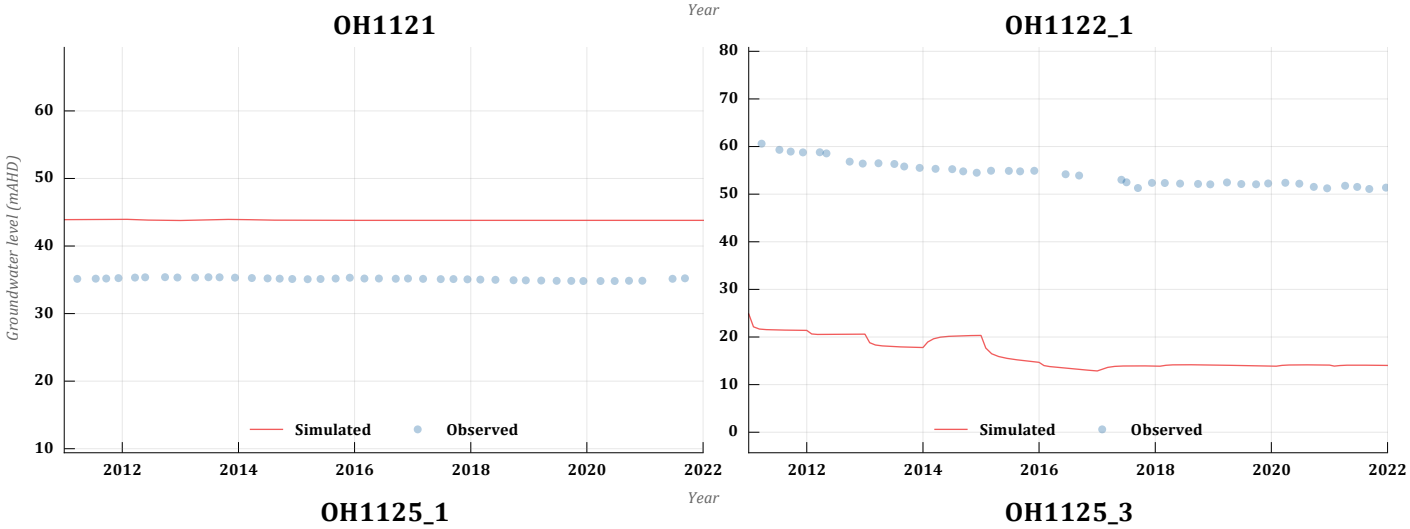

MB15MTW03
MBW01
Groundwater level (mAHD)
Observed
Year


MBW02
MBW03
Groundwater level (mAHD)
Observed
Year

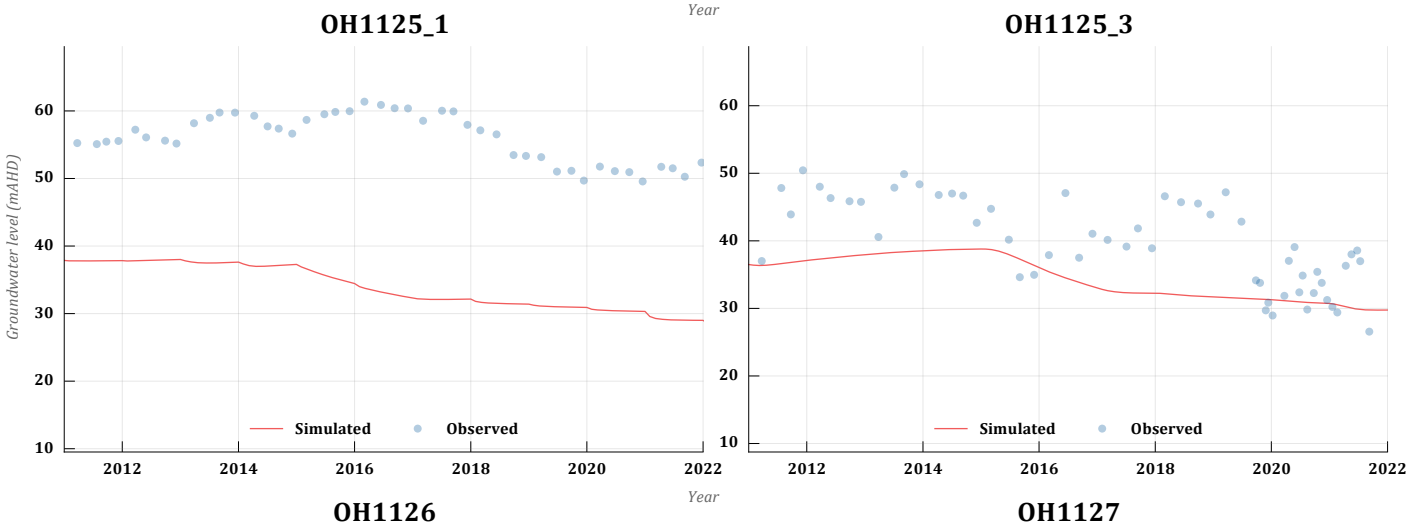

MBW04
MTD605P
Groundwater level (mAHD)
Observed
Year


MTD614P
Groundwater level (mAHD)
Observed
2012
2014
2016
2018
2020
2022

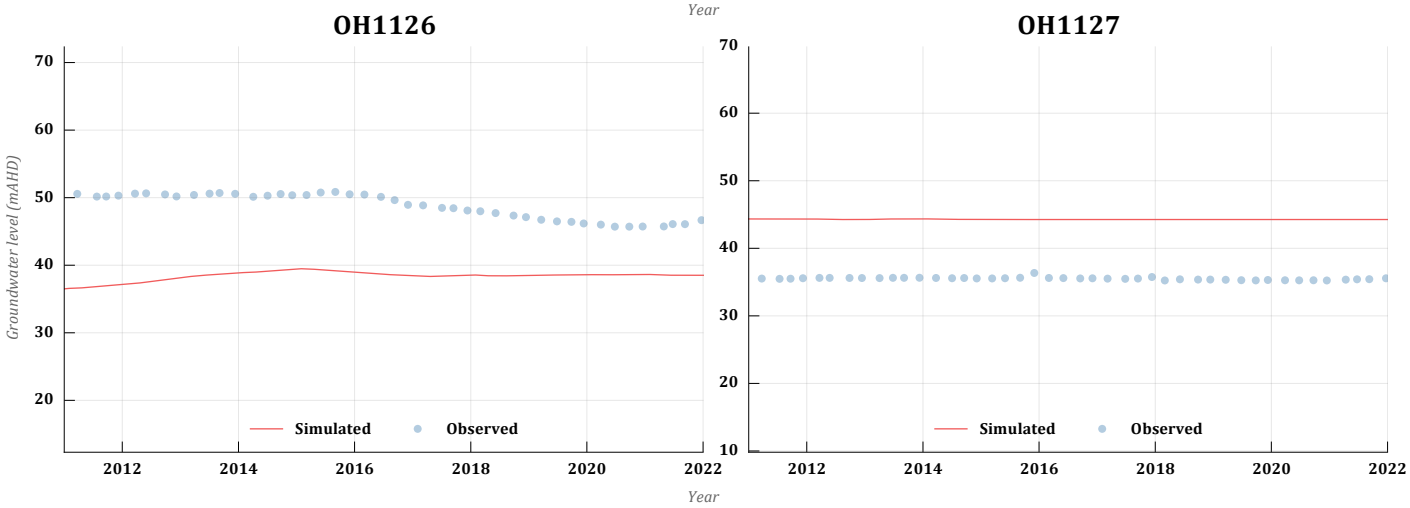
MTD616P
Observed
2012
2014
2016
2018
2020
2022


OH1121
Groundwater level (mAHD)
Simulated
Observed
Year
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2014
2016
2018
2020
2022

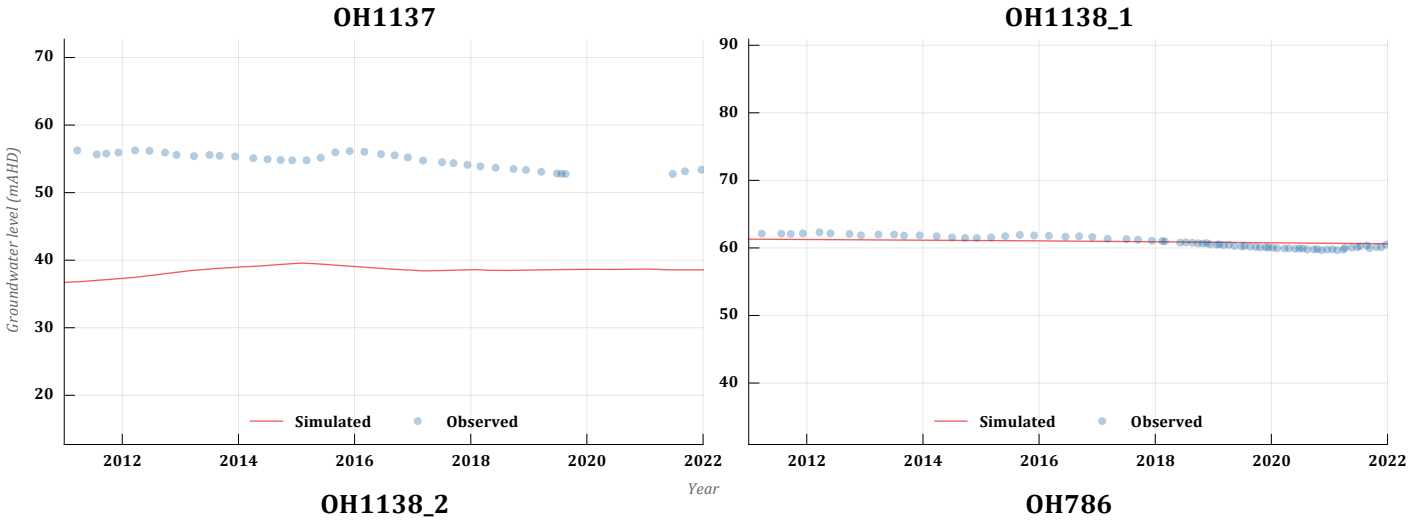
OH1122_1
Simulated
Observed
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2022


OH1125_1
Groundwater level (mAHD)
Simulated
Observed
Year
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2014
2016
2018
2020
2022

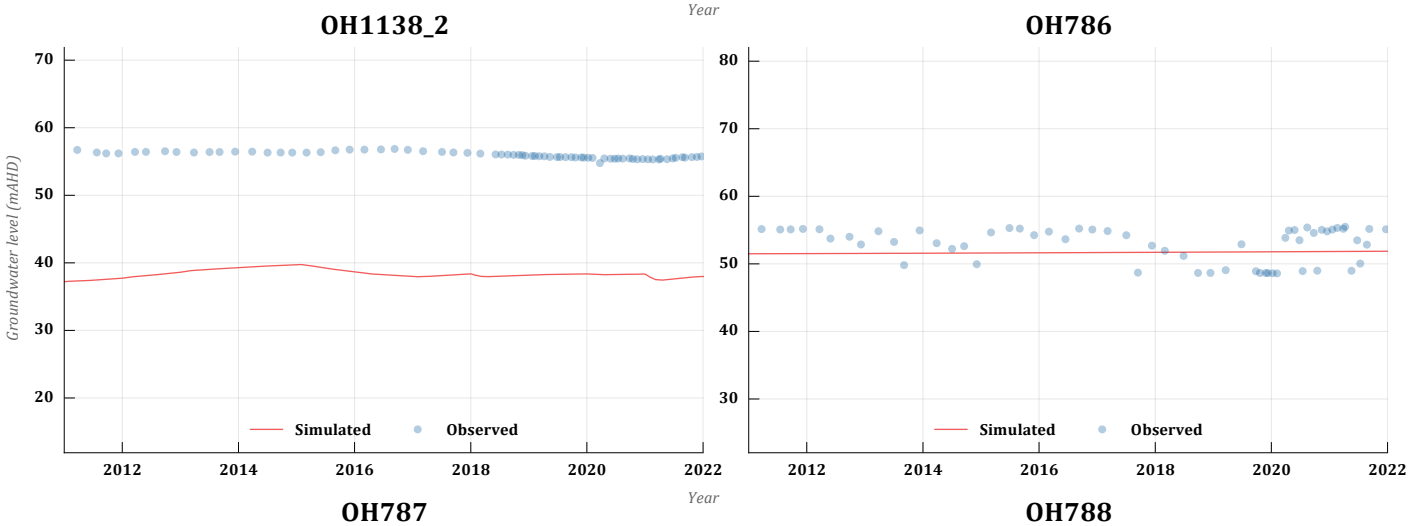
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Groundwater level (mAHD)
Simulated
Observed
Year
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2018
2020
2022

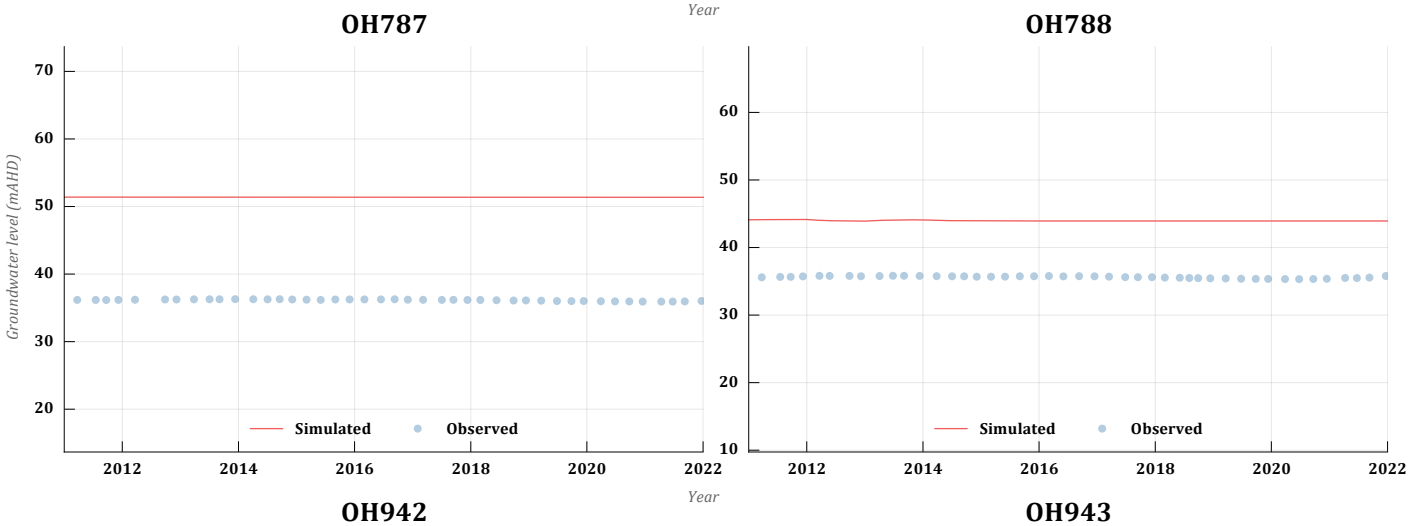
OH1127
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Observed
2012
2014
2016
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2020
2022


OH1137
Groundwater level (mAHD)
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Simulated
Observed
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2016
2018
2020
2022
Year

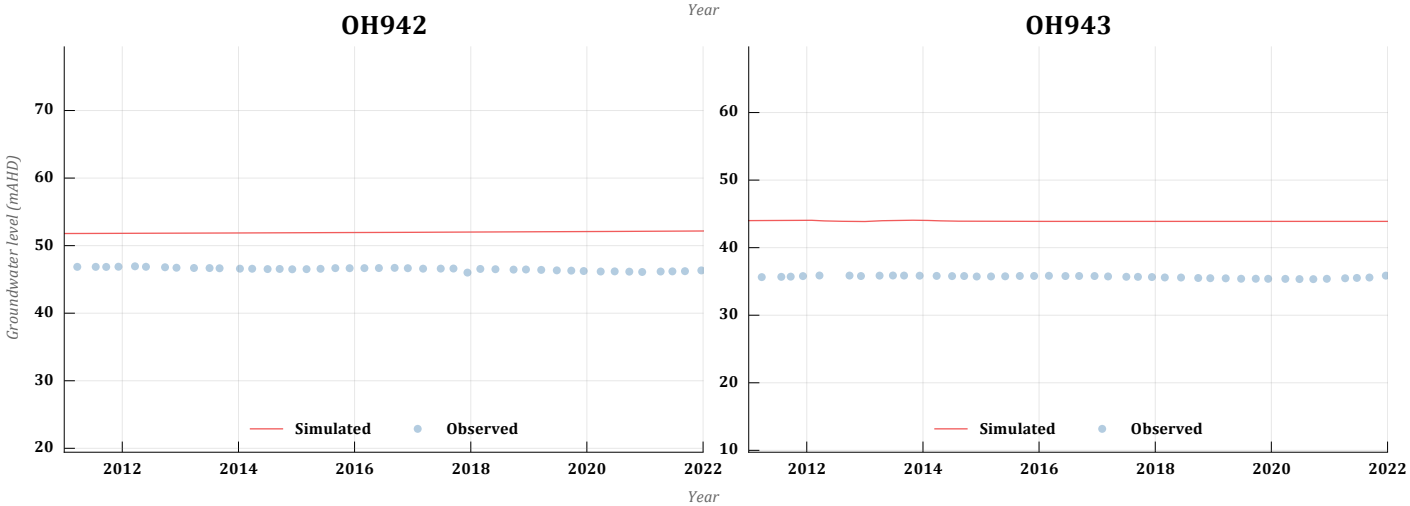
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Simulated
Observed
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2014
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2020
2022


OH1138_2
Groundwater level (mAHD)
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Simulated
Observed
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2016
2018
2020
2022
Year

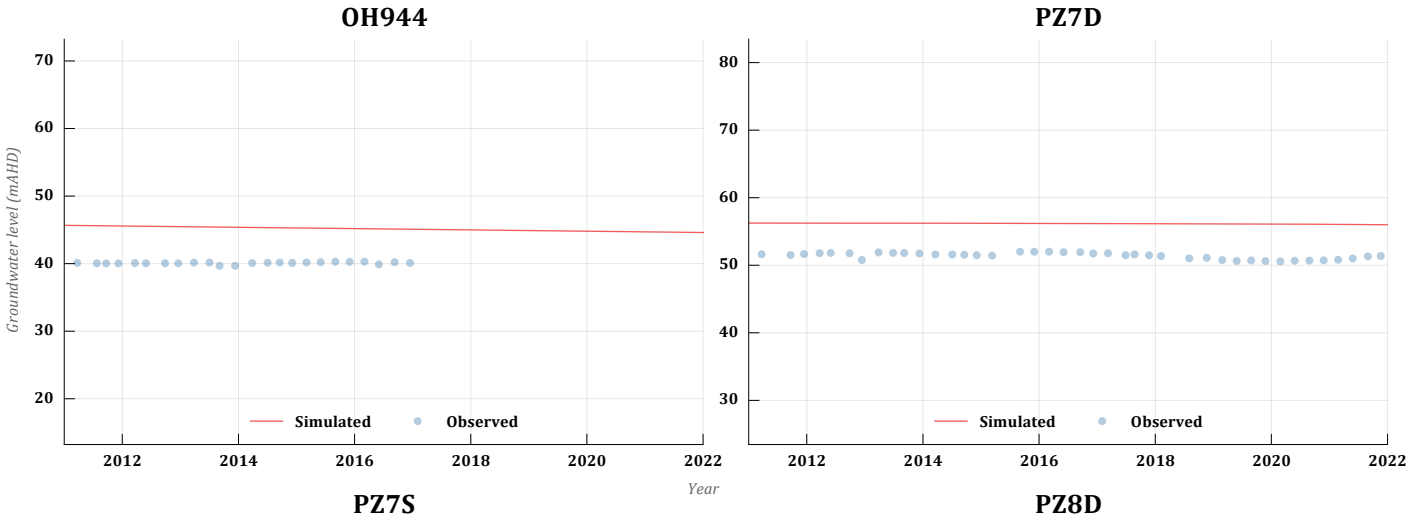
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Simulated
Observed
2012
2014
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2018
2020
2022


OH787
Groundwater level (mAHD)
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60
50
40
30
20
Simulated
Observed
2012
2014
2016
2018
2020
2022
Year

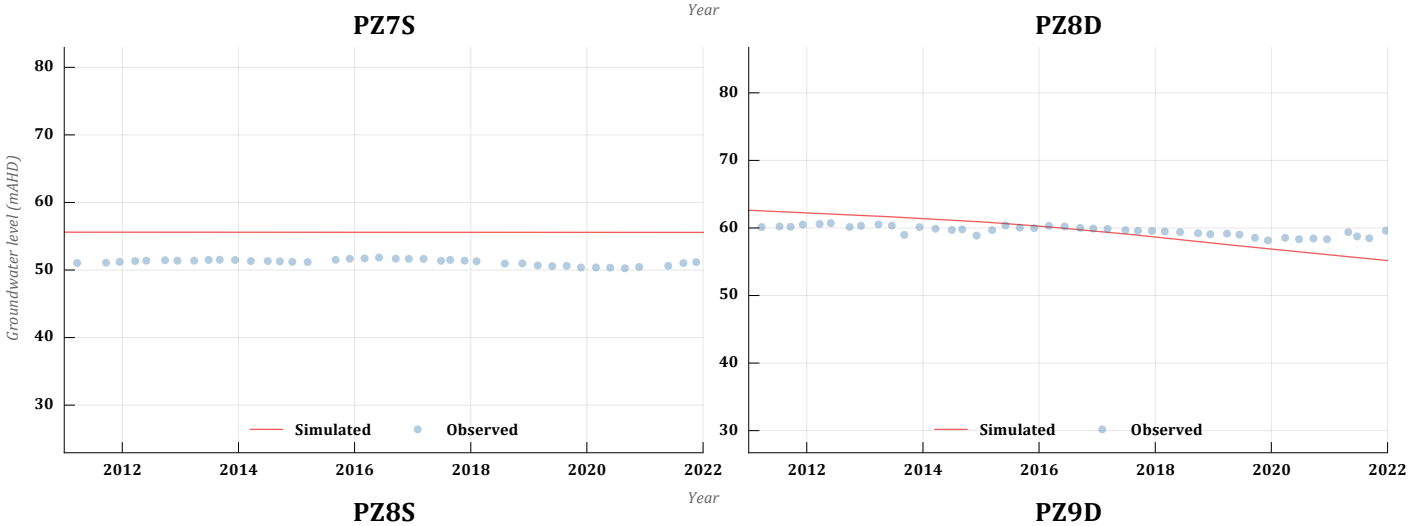
OH788
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30
20
10
Simulated
Observed
2012
2014
2016
2018
2020
2022


OH942
Groundwater level (mAHD)
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60
50
40
30
20
Simulated
Observed
2012
2014
2016
2018
2020
2022
Year

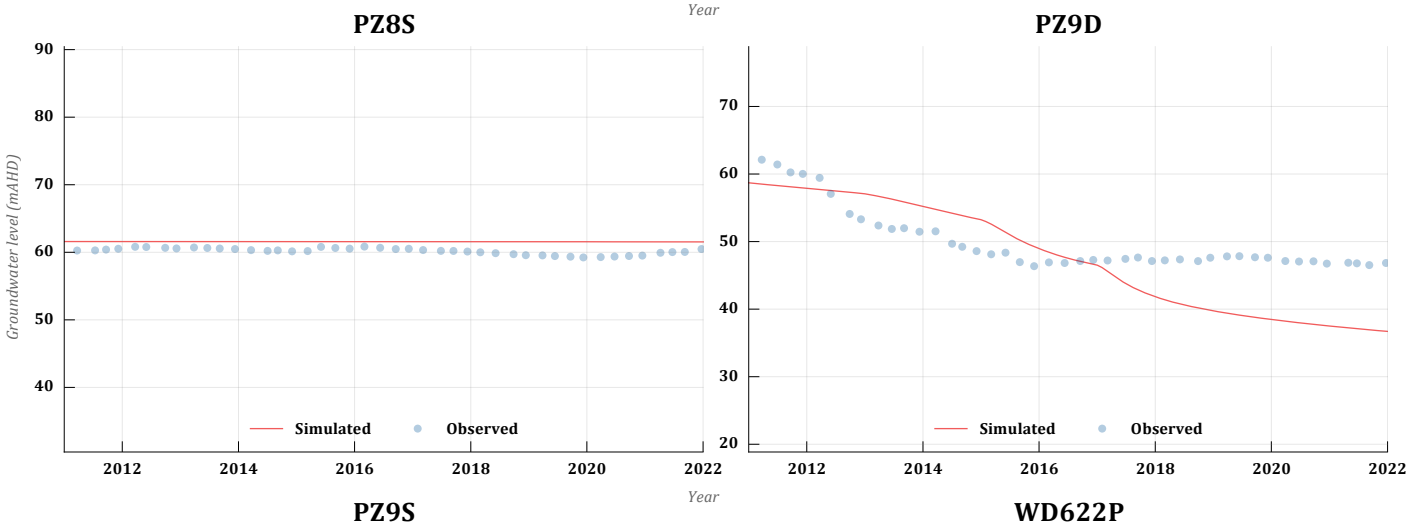
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Simulated
Observed
2012
2014
2016
2018
2020
2022


OH944
Groundwater level (mAHD)
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50
40
30
20
Simulated
Observed
2012
2014
2016
2018
2020
2022
Year

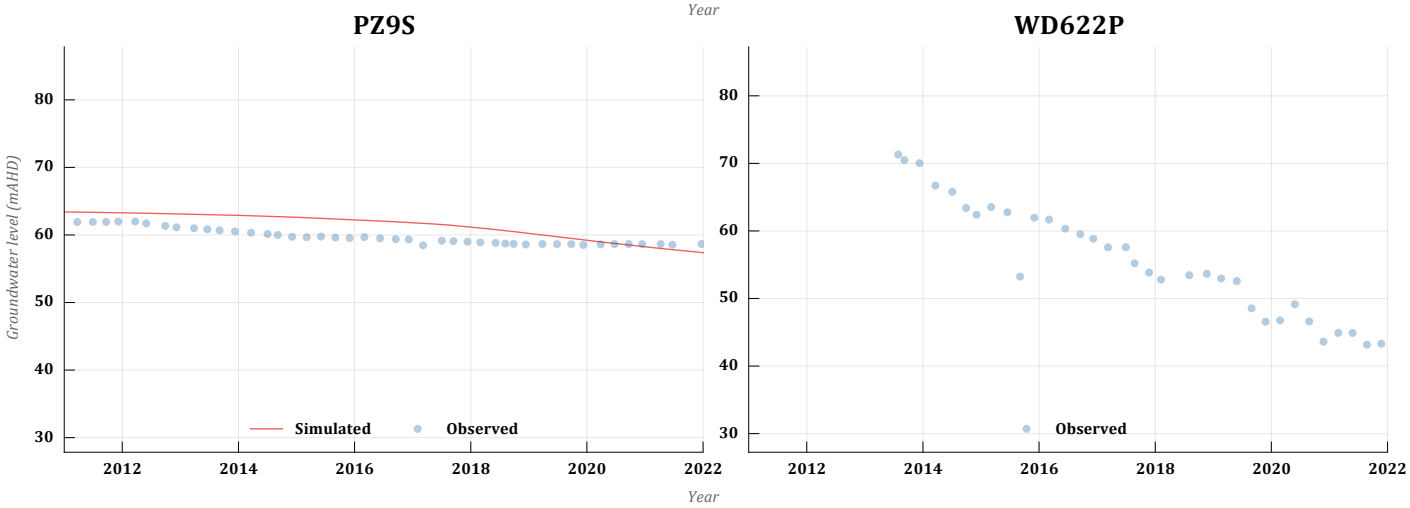
PZ7D
Groundwater level (mAHD)
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50
40
30
Simulated
Observed
2012
2014
2016
2018
2020
2022
Year


PZ7S
Groundwater level (mAHD)
80
70
60
50
40
30
Simulated
Observed
2012
2014
2016
2018
2020
2022
Year

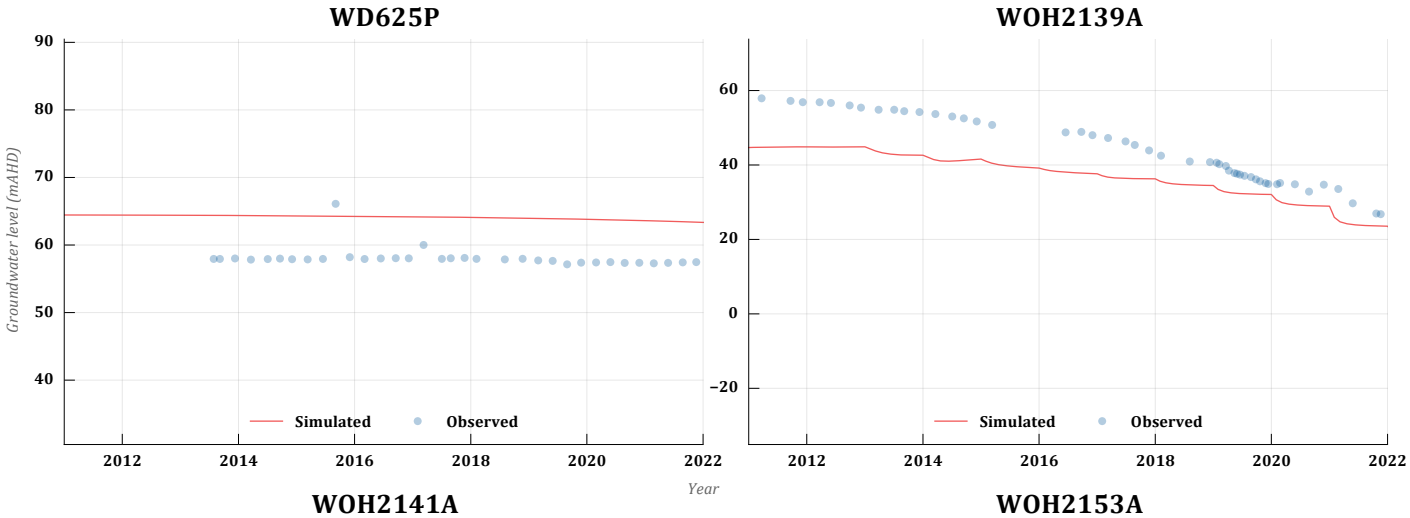
PZ8D
Groundwater level (mAHD)
80
70
60
50
40
30
Simulated
Observed
2012
2014
2016
2018
2020
2022
Year

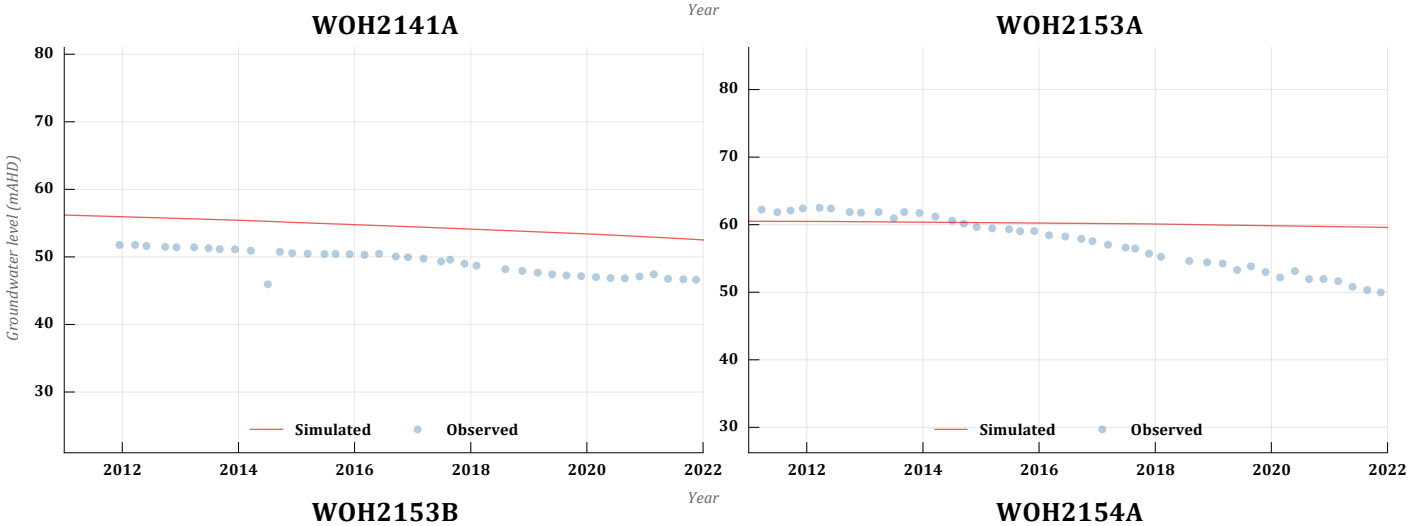

PZ8S
Groundwater level (mAHD)
90
80
70
60
50
40
Simulated
Observed
2012
2014
2016
2018
2020
2022
Year

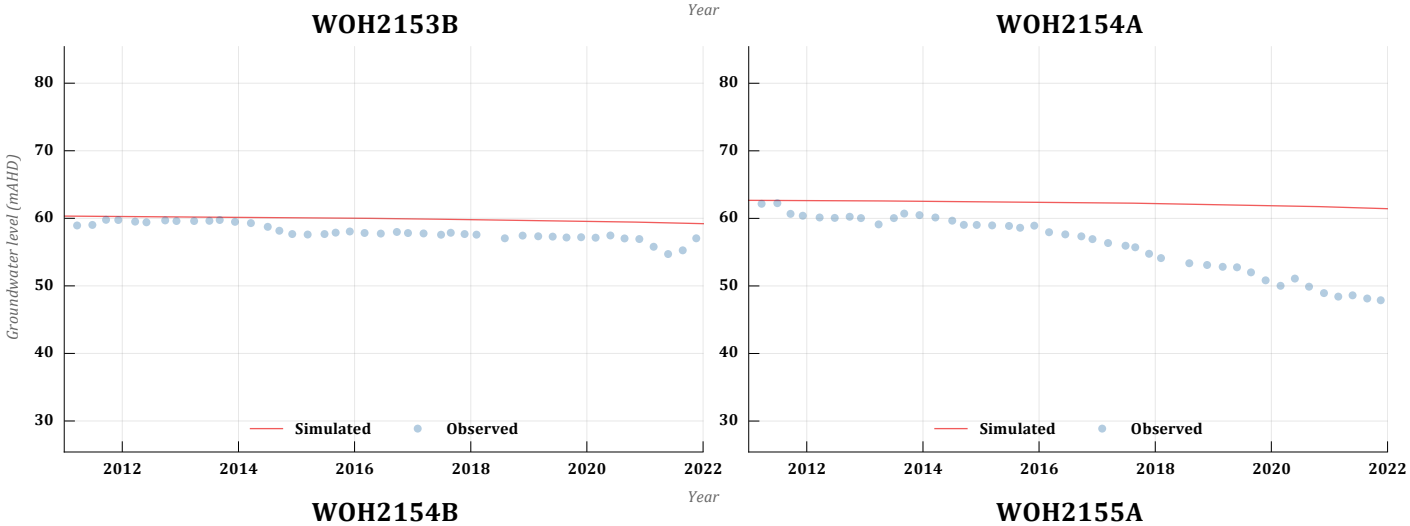
PZ9D
Groundwater level (mAHD)
70
60
50
40
30
20
Simulated
Observed
2012
2014
2016
2018
2020
2022
Year

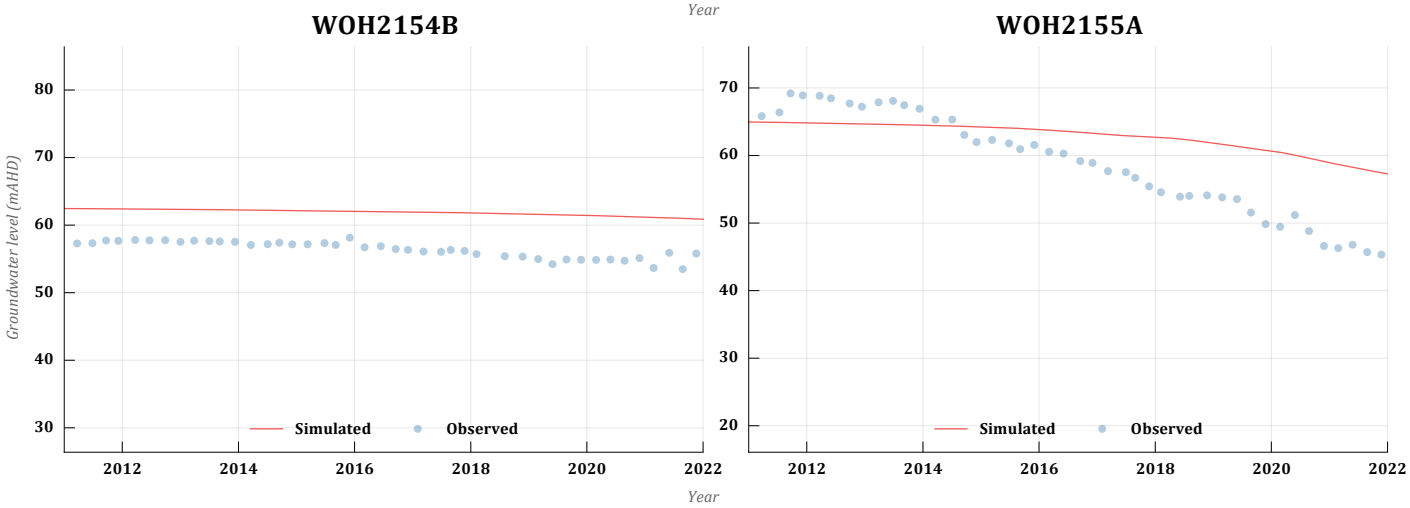

PZ9S
Groundwater level (mAHD)
80
70
60
50
40
30
Simulated
Observed
2012
2014
2016
2018
2020
2022
Year

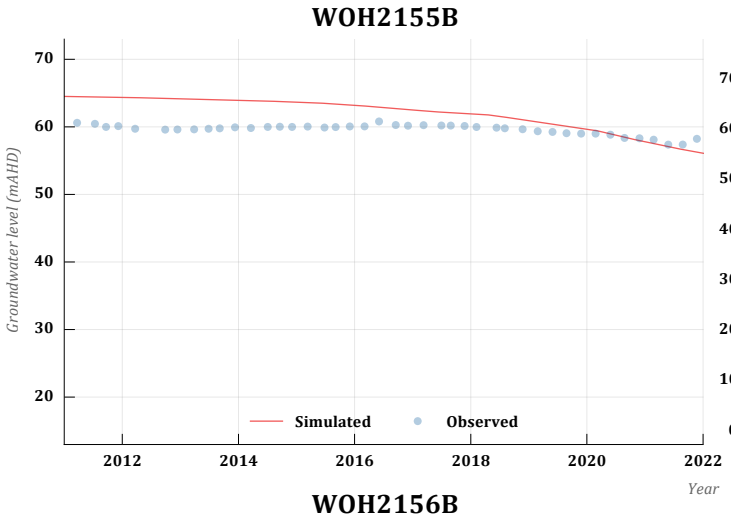
WD622P
Groundwater level (mAHD)
80
70
60
50
40
30
Observed
2012
2014
2016
2018
2020
2022
Year

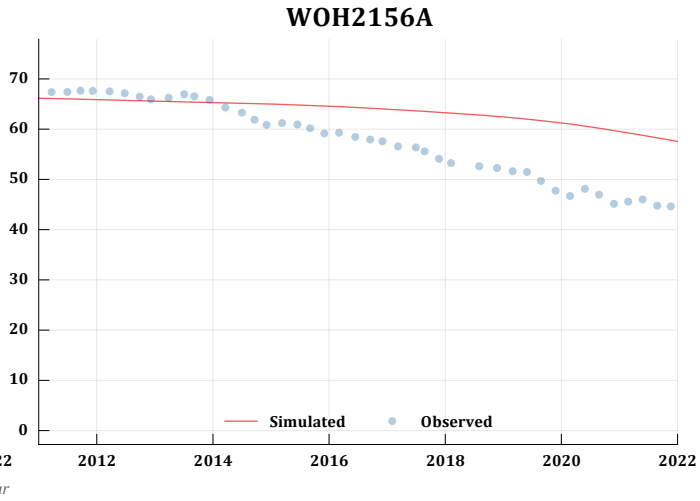

WD625P
WOH2139A
Groundwater level (mAHD)
Simulated
Observed
2012
2014
2016
2018
2020
2022
Year

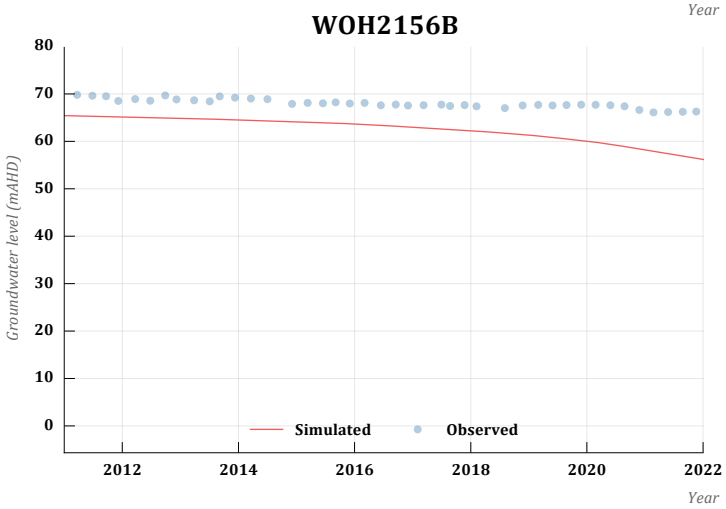

WOH2141A
WOH2153A
Groundwater level (mAHD)
Simulated
Observed
2012
2014
2016
2018
2020
2022
Year


WOH2153B
WOH2154A
Groundwater level (mAHD)
Simulated
Observed
2012
2014
2016
2018
2020
2022
Year


WOH2154B
WOH2155A
Groundwater level (mAHD)
Simulated
Observed
2012
2014
2016
2018
2020
2022
Year


WOH2155B
Groundwater level (mAHD)
70
60
50
40
30
20
Simulated
Observed
2012
2014
2016
2018
2020
2022
Year


WOH2156A
70
60
50
40
30
20
10
0
Simulated
Observed
2012
2014
2016
2018
2020
2022


WOH2156B
Groundwater level (mAHD)
80
70
60
50
40
30
20
10
0
Simulated
Observed
2012
2014
2016
2018
2020
2022
Year

Appendix D

VWP figures

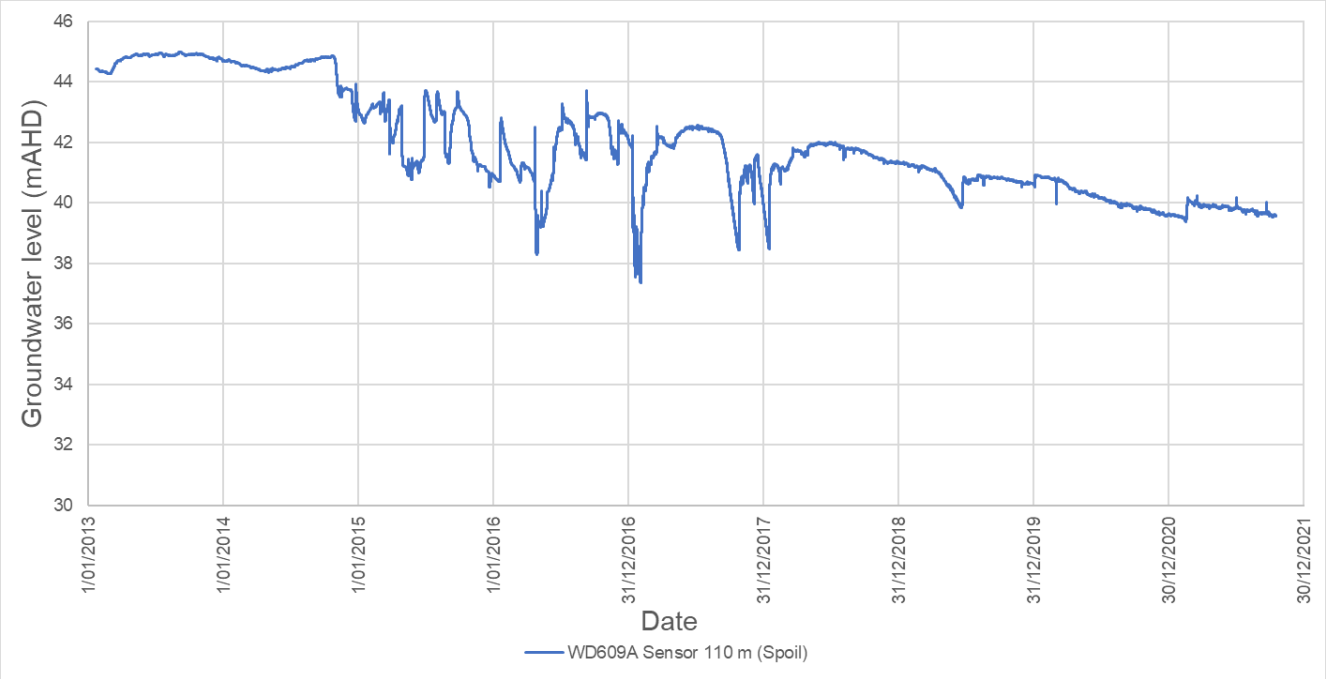


Figure D 1 VWP WD609A pressure head

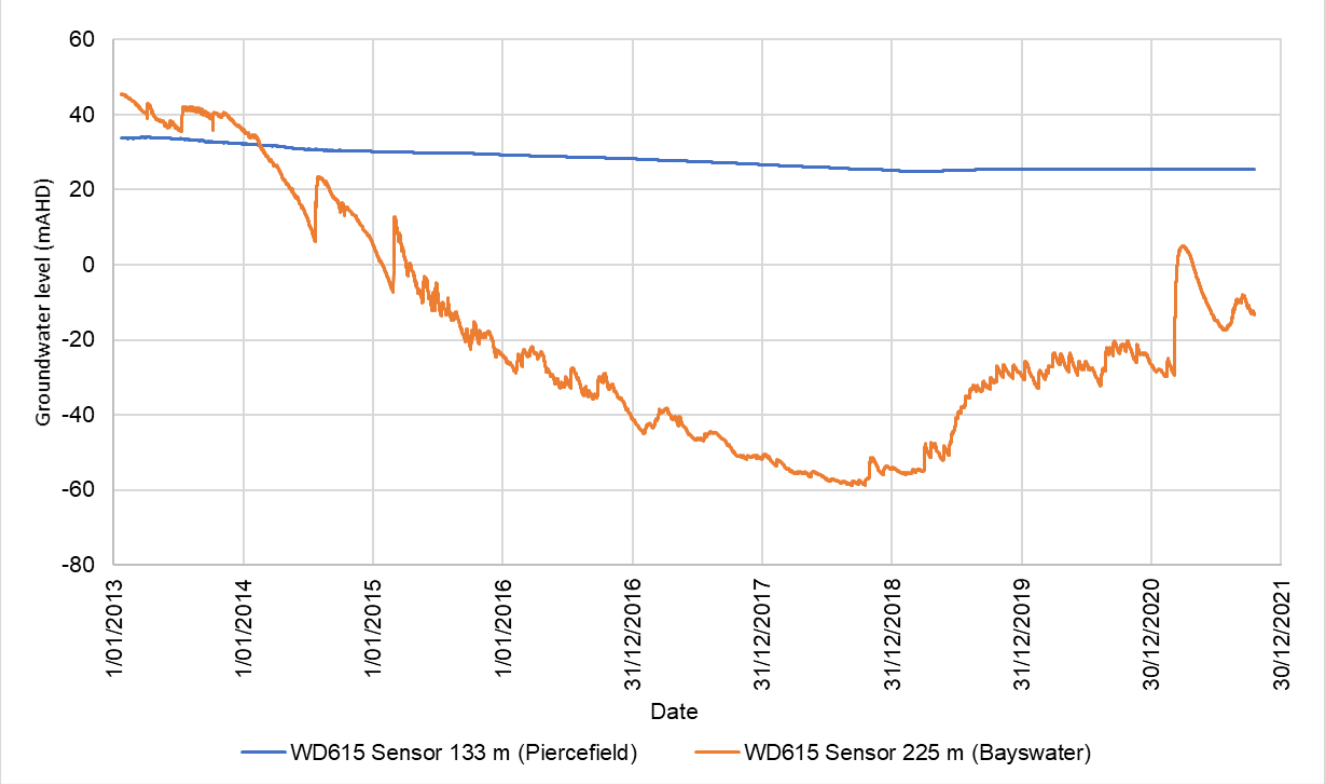


Figure D 2 VWP WD615 pressure heads

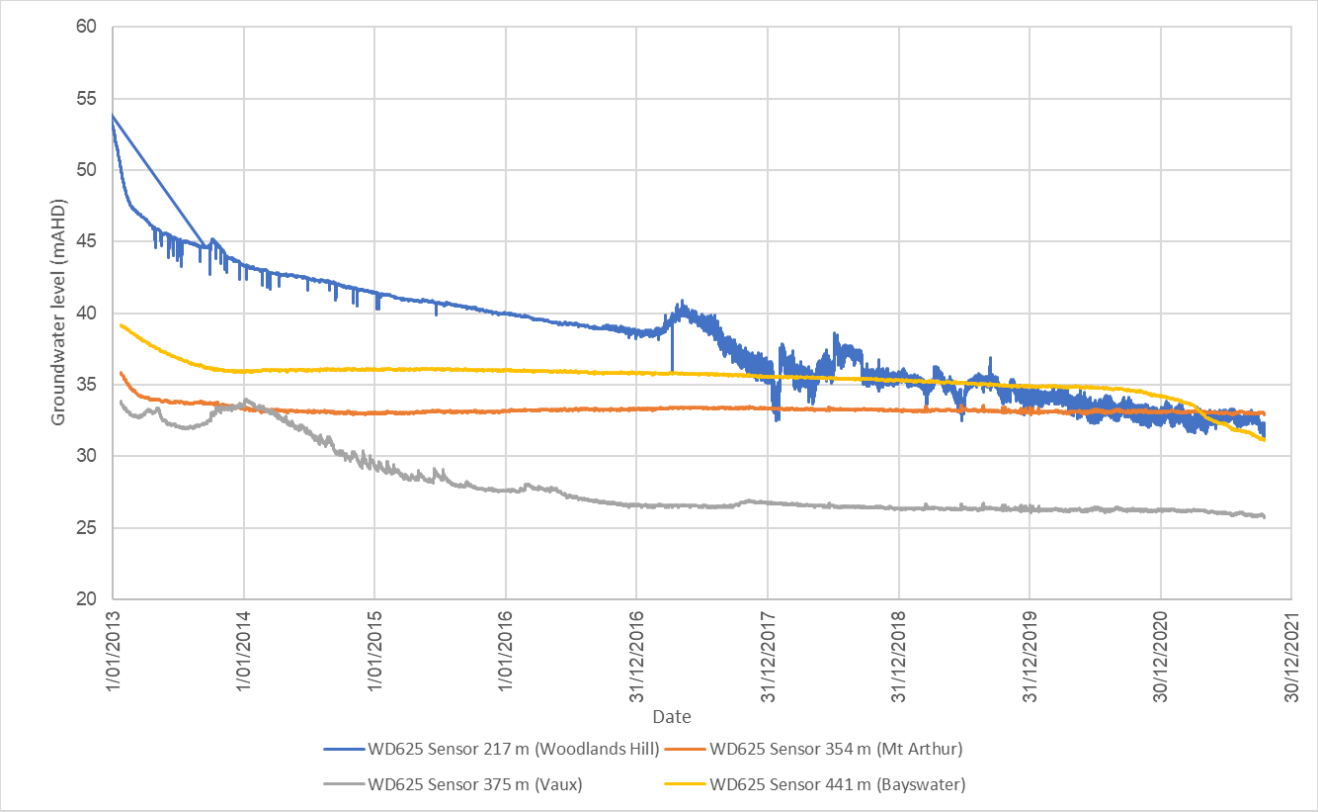


Figure D 3 VWP WD625 pressure heads

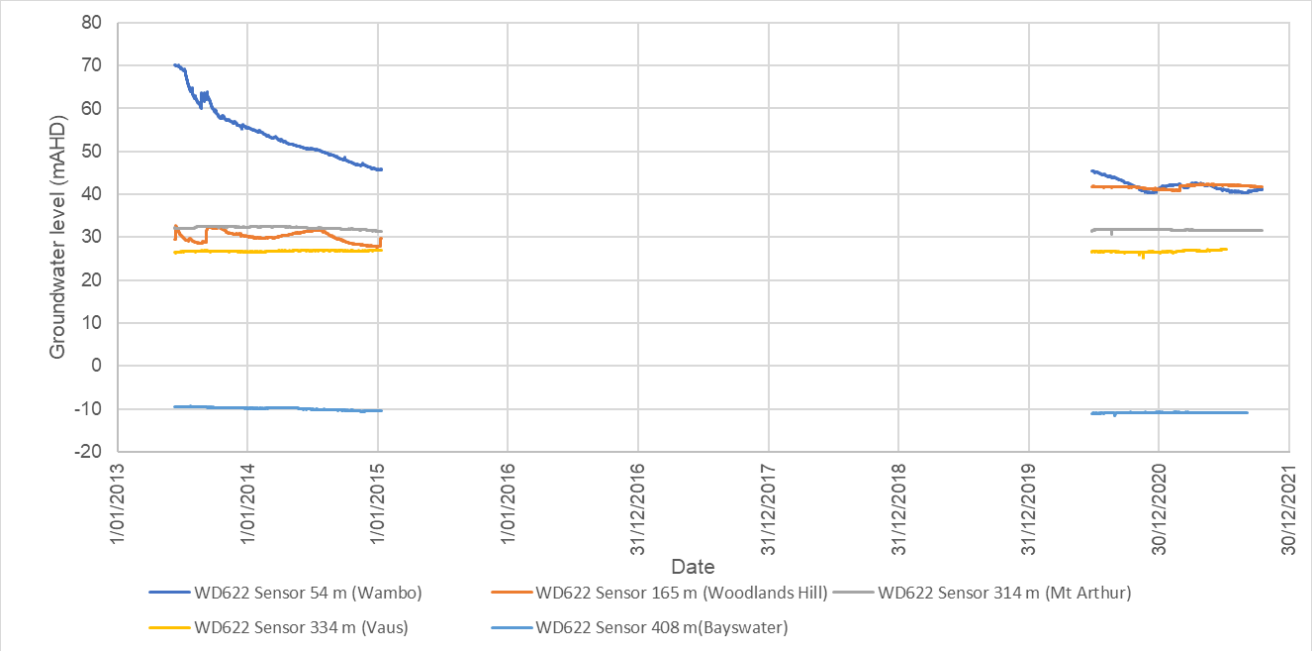


Figure D 4 VWP WD622 pressure heads

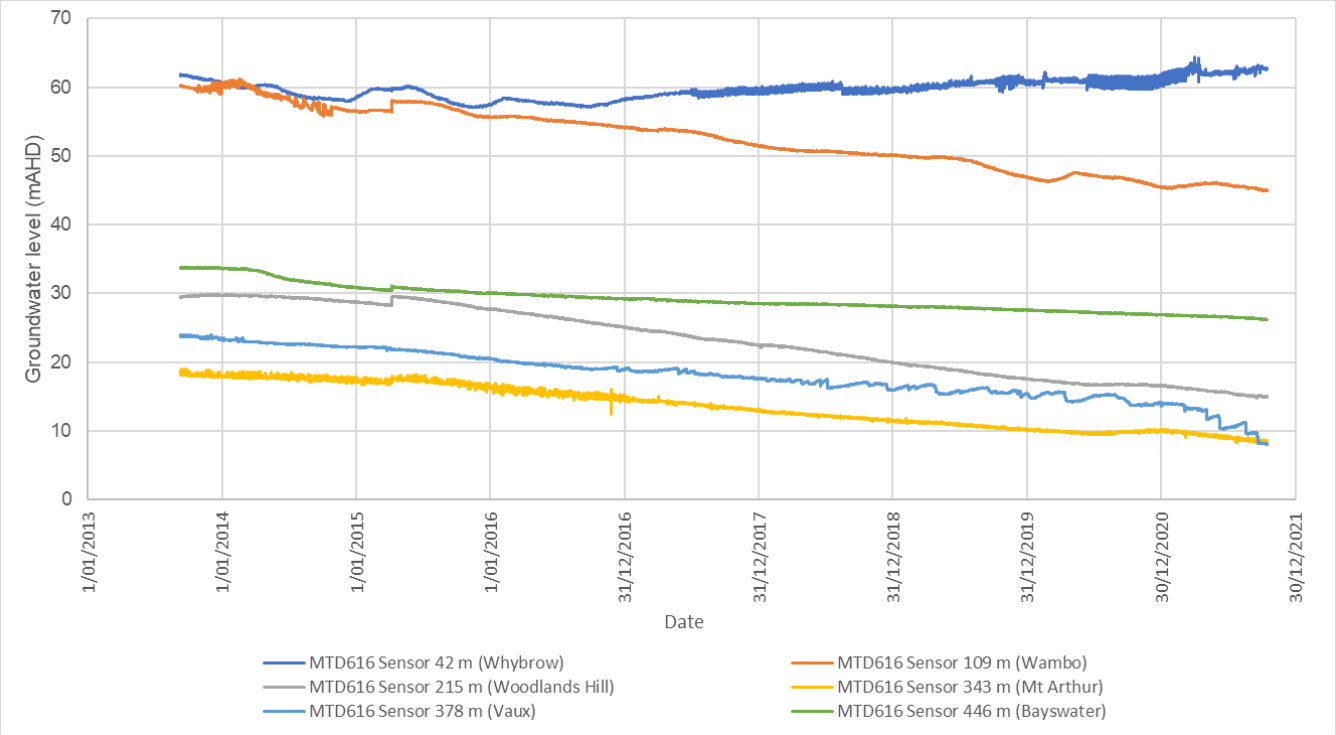


Figure D 5 VWP MTD616 pressure heads

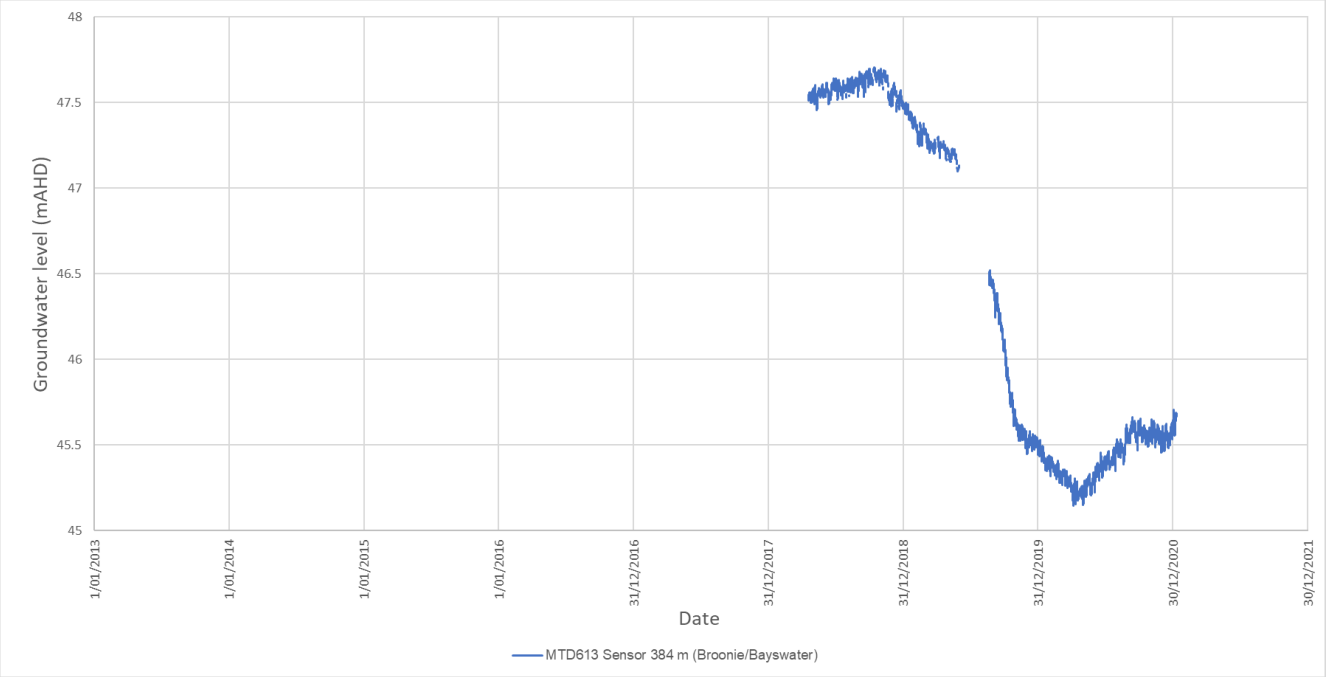


Figure D 6 VWP MTD613 pressure heads

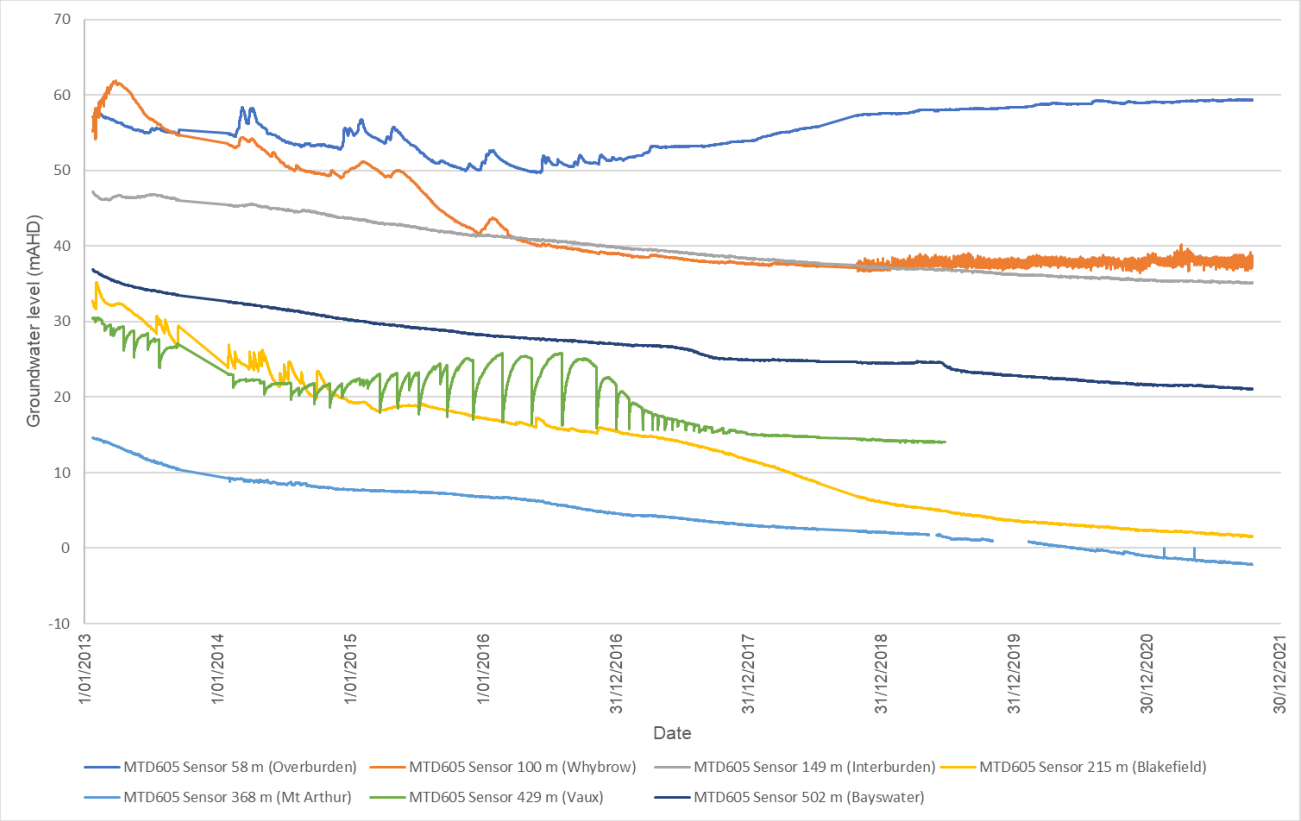


Figure D 7 VWP MTD605 pressure heads

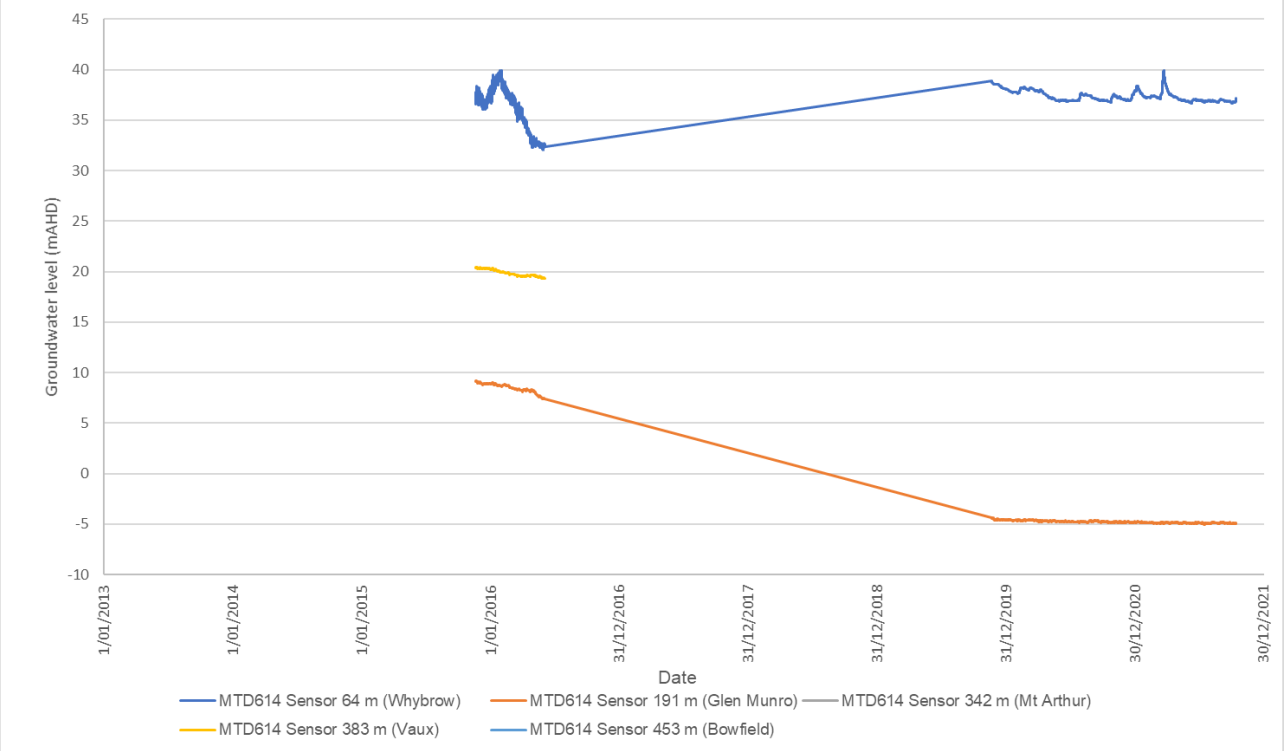


Figure D 8 VWP MTD614 pressure heads

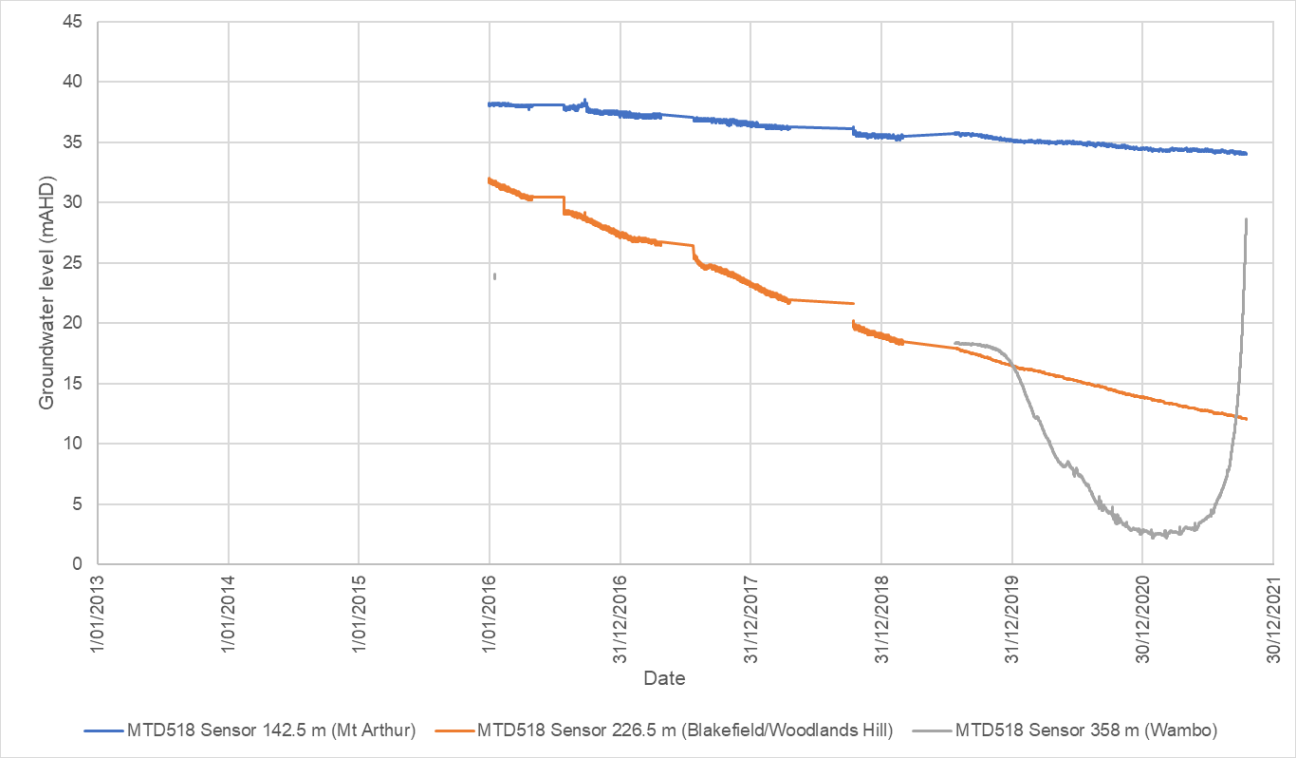


Figure D 9 VWP MTD518 pressure heads

Appendix E

Annual groundwater quality laboratory results

Sample Point	Target Seam	Date	Time	pH Field	EC Field (uS/cm (25TRef))	Water Temp (Deg C)	RL Standing Water Level (m)	TDS - Total (mg/l)	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3	Acidity as CaCO3	SO4 - Total (mg/l)	Cl- (mg/l)	Ca - Total (mg/l)	Mg - Total (mg/l)	Na - Total (mg/l)	K - Total (mg/l)	Al - Total (mg/l)	As - Total (mg/l)	Cd - Total (mg/l)	Cu - Total (mg/l)	Pb - Total (mg/l)	Ni - Total (mg/l)	Se (mg/l)	Zn - Total (mg/l)	B (mg/l)	Hg - Total (mg/l)	Mo (mg/l)	V (mg/l)	Cr (mg/l)	Total anions	Total Cations	Ionic Balance
OH786	Hunter River Alluvium	24/06/2021	1:25:00 PM	7.1	622	19.9	53.49	423	<1	<1	104	104		43	105	17	14	88	5	11.9	0.004	0.0002	0.025	0.018	0.022	<0.01	0.77	<0.05	<0.0001				5.94	5.96	0.18
OH787	Hunter River Alluvium	24/06/2021	1:10:00 PM	7.3	19220	20.1	35.93	12500	<1	<1	1460	1460	28	374	5760	122	285	4070	30	0.19	<0.001	<0.0001	<0.001	<0.001	0.008	<0.01	0.018	0.1	<0.0001	0.003	<0.01	0.002	199	207	1.94
OH788	Hunter River Alluvium	22/06/2021	12:00:00 PM	7	12570	20.3	35.48	7430	<1	<1	1440	1440		373	3510	112	262	2440	44	0.02	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.005	0.08	<0.0001				136	134	0.42
OH942	Hunter River Alluvium	22/06/2021	1:00:00 PM	6.6	24500	21.1	46.19	14500	<1	<1	766	766		970	7710	203	714	4480	40	0.95	<0.001	<0.0001	<0.001	<0.001	0.004	<0.01	<0.005	0.06	0.0003	<0.001	<0.01	0.005	253	265	2.28
OH943	Hunter River Alluvium	22/06/2021	12:10:00 PM				35.52																												
OH944	Hunter River Alluvium	22/06/2021	11:50:00 AM				no RL provided																												
OH1121	Vaux	23/06/2021	12:10:00 PM	7.2	10810	20.1	35.15	6560	<1	<1	1200	1200		589	2850	135	154	2160	19	0.06	0.002	<0.0001	<0.001	<0.001	0.002	<0.01	<0.005	0.06	<0.0001				117	114	1.21
OH1122(1)	Blakefield	24/06/2021	8:30:00 AM	6.9	12150	19.3	51.52	7520	<1	<1	1500	1500		641	3270	136	376	2160	36	4.18	0.004	<0.0001	0.638	0.047	0.066	<0.01	0.756	0.11	<0.0001	0.003	0.02	0.025	136	133	1.1
OH1125(1)	Blakefield	24/06/2021	9:45:00 AM	6.6	13780	20.7	51.51	9460	<1	<1	991	991	121	808	4110	357	561	2020	26	0.12	<0.001	<0.0001	<0.001	0.002	0.006	<0.01	0.025	0.07	<0.0001	<0.001	<0.01	<0.001	152	152	0.01
OH1125(3)	Bowfield Seam	24/06/2021	10:30:00 AM	6.7	13870	20.7	38.57	9720	<1	<1	976	976	109	780	4060	379	555	1990	26	0.47	<0.001	<0.0001	0.003	0.007	0.008	<0.01	0.142	0.08	<0.0001	<0.001	<0.01	0.002	150	152	0.51
OH1126	Vaux	24/06/2021	12:20:00 PM	6.6	12640	21.3	46.09	8400	<1	<1	952	952	83	806	3550	138	289	2350	27	56.4	0.018	0.001	0.351	0.078	0.112	<0.01	0.464	0.12	0.0002				136	134	0.88
OH1127	Bayswater	23/06/2021	11:20:00 AM	6.8	11970	20.4	35.41	7530	<1	<1	2220	2220		<1	3100	162	134	2430	18	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.005	0.13	<0.0001				132	125	2.54
OH1137	Vaux	24/06/2021	12:10:00 PM				no RL provided																												
OH1138(1)	Warkworth	24/06/2021	11:15:00 AM	5.9	18070	20.3	60.09	12800	<1	<1	281	281		426	5990	188	688	2650	59	3.76	0.002	0.0007	0.003	0.004	0.021	<0.01	0.028	<0.05	0.0009				183	183	0.18
OH1138(2)	Warkworth	24/06/2021	11:40:00 AM	6.6	12520	20.6	55.46	9390	<1	<1	782	782		577	3800	535	420	1600	22	0.22	0.001	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.005	<0.05	<0.0001				135	131	1.28
WOH2139A	Blakefield	22/10/2021	8:55:00 AM	8.1	11470	22.2	26.96	5330	<1	23	1020	1050		3	3110	17	8	2370	9	1.3	0.001	<0.0001	0.006	0.006	0.003	<0.01	0.081	0.15	<0.0001	0.003	<0.01	0.002	109	105	1.85
WOH2153A	Redbank	26/08/2021	12:45:00 PM	7.7	2600	20.2	50.32	1680	<1	<1	1230	1230		18	242	4	3	609	4	0.26	0.001	<0.0001	<0.001	<0.001	<0.001	<0.01	0.016	0.17	<0.0001				31.8	27	8.06
WOH2153B	Wambo	26/08/2021	1:00:00 PM	7	1545	19.7	55.26	1300	<1	<1	573	573		41	198	22	19	311	6	113	0.01	0.0002	0.076	0.194	0.057	0.02	0.308	0.16	<0.0001				17.9	16.3	4.51
WOH2154A	Redbank	26/08/2021	11:10:00 AM	7.5	4620	20	48.14	2780	<1	<1	1080	1080		120	886	6	4	972	6	0.23	<0.001	<0.0001	<0.001	<0.001	0.001	<0.01	0.023	0.14	<0.0001				49.1	43.1	6.52
WOH2154B	Wambo	26/08/2021	11:35:00 AM	7.5	7440	20.1	53.49	4360	<1	<1	1170	1170		153	1520	59	95	1400	13	14.4	0.003	<0.0001	0.003	0.011	0.006	<0.01	0.051	0.16	<0.0001				69.4	72	1.8
WOH2155A	Redbank	26/08/2021	9:35:00 AM	7.2	8690	19.7	45.7	5360	<1	<1	1030	1030		733	1960	47	79	1710	14	0.47	<0.001	<0.0001	0.002	0.005	0.001	<0.01	0.056	0.13	<0.0001				91.1	83.6	4.32
WOH2155B	Wambo	26/08/2021	10:05:00 AM	7.4	6610	19.5	57.38	4190	<1	23	1190	1210		335	1230	44	35	1410	9	41	0.007	0.0001	0.019	0.13	0.01	0.01	0.095	0.2	<0.0001				65.8	66.6	0.6
WOH2156A	Redbank	26/08/2021	8:40:00 AM	7.1	14730	19.8	44.77	9730	<1	<1	1360	1360		1050	3990	140	220	2810	24	0.08	<0.001	0.0002	0.003	<0.001	0.002	<0.01	0.021	0.15	<0.0001				162	148	4.41
WOH2156B	Wambo	26/08/2021	8:35:00 AM				66.23																												
WOH2141A	Whynot	30/08/2021	10:55:00 AM	7.8	10360	20.9	46.69	6250	<1	<1	1310	1310		<1	2890	29	20	2150	8	0.11	0.001	<0.0001	0.004	<0.001	0.001	<0.01	0.046	0.17	<0.0001				108	96.8	5.32
PZ7D	Shallow overburden	30/08/2021	9:05:00 AM	8.2	1854	19.3	51.31	1160	<1	43	690	733		6	231	6	6	408	3	0.14	<0.001	<0.0001	0.01	0.002	0.001	<0.01	0.017	0.14	<0.0001				21.3	18.6	6.69
PZ7S	Aeolian Warkworth Sands	30/08/2021	8:55:00 AM	6.8	1787	18.6	51.03	1110	<1	<1	553	553		24	293	69	49	230	8	6.8	0.005	<0.0001	0.184	0.009	0.011	<0.01	0.041	0.06	<0.0001				19.8	17.7	5.68
PZ8D	Shallow overburden	23/06/2021	1:05:00 PM	7.4	8490	19.4	58.75	5260	<1	<1	1920	1920		39	1760	35	35	1920	12	0.5	0.002	<0.0001	0.005	0.009	0.009	<0.01	0.021	0.2	<0.0001				88.8	88.4	0.21
PZ8S	Wollombi Brook Alluvium	22/06/2021	8:10:00 AM	6.6	14710	19.7	60.03	9260	<1	<1	706	706		558	4440	144	289	2700	12	0.04	0.001	<0.0001	0.008	<0.001	0.008	<0.01	0.059	<0.05	<0.0001				151	149	0.75
PZ9D	Shallow overburden	22/06/2021	9:10:00 AM	7	10060	19.4	46.78	6220	<1	<1	1050	1050		424	2800	212	275	1660	27	1.52	0.052	0.0002	0.156	0.026	0.041	<0.01	0.254	0.08	<0.0001				109	106	1.25
PZ9S	Wollombi Brook Alluvium	22/06/2021	9:05:00 AM				58.55																												
GW9706	Bayswater	22/06/2021	9:35:00 AM	6.9	4600	20.3	62.82	3070	<1	<1	568	568		928	688	120	91	820	13	0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.005	0.14	<0.0001				50.1	49.5	0.6
GW9707	Bayswater	23/06/2021	10:25:00 AM	6.7	20300	18.8	58.81	16800	<1	<1	594	594		5440	4510	550	678	3570	20	0.3	<0.001	0.0002	0.009	0.002	0.011	<0.01	0.015	0.39	<0.0001				252	239	2.71
GW9708	Bayswater	22/06/2021	11:00:00 AM	6.6	12640	21.6	61.58	10800	<1	<1	723	723		5190	1570	512	454	2260	23	0.02	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.005	0.26	<0.0001				167	162	1.52
GW9709	Bayswater	23/06/2021	11:00:00 AM	6.7	22400	18.9	50.99	19100	<1	<1	885	885		6440	5020	601	786	4200	22	0.75	0.001	<0.0001	0.003	0.004	0.023	<0.01	0.015	0.3	<0.0001				293	278	2.7
GW98MTCL1	Bayswater	23/06/2021	10:40:00 AM	7	5750	20.2	66.37	3710	<1	<1	968	968		894	837	56	80	1160	16	0.06	<0.001	0.0002	<0.001	<0.001	0.001	0.01	<0.005	0.15	<0.0001				61.6	60.2	1.08
GW98MTCL2	Bayswater	23/06/2021	8:25:00 AM	6.5	16130	19.7	68.88	13200	<1	<1	712	712		4380	3580	602	546	2740	39	0.02	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.005	0.19	<0.0001				206	195	2.8
WD625P	Woodlands Hill	26/08/2021	12:25:00 PM	7	11960	19.6	57.43	6450	<1	<1	1430	1430		241	3330	123	199	2280	14	0.07	<0.001	<0.0001	<0.001	<0.001	0.003	<0.01	0.012	0.16	<0.0001				128	122	2.19
WD622P	Wambo	24/08/2021	12:40:00 PM	7.3	8890	20	43.17	5950	<1	<1	1360	1360		126	2540	61	97	1960	16	0.21	0.004	<0.0001	0.001	0.001	0.002	<0.01	0.024	0.14	<0.0001				101	96.7	2.4
MTD616P	Shallow overburden	23/08/2021	1:00:00 PM	6.8	13700	20.9	73.75	8760	<1	<1	1460	1460		446	4360	146	328	2480	46	0.04	<0.001	<0.0001	0.004	<0.001	0.04	<0.01	<0.005	0.16	<0.0001				161	143	5.94
MTD605P	Shallow overburden	27/08/2021	8:25:00 AM	7.3	17480	20.6	62.23	11500	<1	<1	2360	2360		967	4600	45	27	4210	13	0.02	0.001	<0.0001	<0.001	<0.001	0.002	<0.01	<0.005	0.26	<0.0001				197	188	2.37
MTD614P	Shallow overburden	23/06/2021	1:30:00 PM	7.4	6310	19.5	54.71	3840	<1	<1	1770	1770		103	1140	66	140	1280	12	0.29	0.005	<0.0001	0.002	0.015	0.012	<0.01	0.038	0.1	<0.0001				69.7	70.8	0.81
MB15MTW01S	Wollombi Brook Alluvium	23/08/2021	9:35:00 AM	6.5	2240	21	57.688	1340	<1	<1	41	41		65	703	61	55	266	9	<0.01	0.003	<0.0001	<0.001	<0.001	0.008	<0.01	<0.005	<0.05	<0.0001				22	19.4	6.36
MB15MTW01D	Shallow overburden	24/08/2021	1:00:00 PM	6	2370	18.4	57.593	1520	<1	<1	23	23		64	762	63	60	285	8	0.55	<0.001	<0.0001	0.012	0.002	0.062	<0.01	0.08	<0.05	<0.0001				23.3	20.7	5.92
MB15MTW02S	Wollombi Brook Alluvium	23/08/2021	11:00:00 AM	6.8	2220	19.9	56.56	1230	<1	<1	190	190		30	637	36	28	346	5	<0.01	0.002	<0.0001	<0.001	<0.001	0.011	<0.01	0.005	<0.05	<0.0001				22.4	19.3	7.46
MB15MTW02D	Shallow overburden	27/08/2021	11:45:00 AM	7.6	9470	19	56.641	5810	<1	34	2410	2450		<1	2620	44	40	2220	9	0.02	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.01	0.013	0.2	<0.0001				123	102	9.14
MB15MTW03	Shallow overburden	27/08/2021	11:00:00 AM	6.9	12670	19.6	54.987	7890	<1	<1	1100	1100		348	3650	236	226	2330	20	0.17	<0.001	<0.0001	<0.001	<0.001	0.002	<0.01	<0.005	0.11	<0.0001				132	132	0.02
MB15MTW04	Warkworth Sands	30/08/2021	10:40:00 AM				dry																												
MB15MTW05	Warkworth Sands	30/08/2021	10:30:00 AM				dry																												
MB15MTW06	Warkworth Sands	30/08/2021	9:45:00 AM	6.3	176	17.8	no RL provided	109	<1	<1	59	59		6	21	6	2	24	3	0.25	0.002	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.005	<0.05	<0.0001				1.9	1.69	
MB15MTW07	Warkworth Sands	23/08/2021	12:40:00 PM				dry																												
MB15MTW08	Warkworth Sands	23/08/2021	12:20:00 PM				dry																												
MB15MTW09	Warkworth Sands	23/08/2021	12:15:00 PM				dry																												
MB15MTW10	Warkworth Sands	23/08/2021	12:30:00 PM				dry																												
MB15MTW11	Warkworth Sands	30/08/2021	11:20:00 AM				dry																												
MBW01	Alluvium	24/08/2021	11:30:00 AM	7.2	18100	18.5	56.71	11200	<1	<1	1560	1560		439	5720	59	240	3740	26	6.02	0.004	<0.0001	0.008	0.004	0.05	<0.01	0.012	0.08	<0.0001				202	186	4.03
MBW02	Shallow overburden	24/08/2021	10:45:00 AM	7.3	10510	19.8	54.32	6490	<1	<1	2060	2060		<1	2800	46	35	2320	17	0.08	<0.001	<0.0001	<0.001	<0.001	0.006	<0.01	<0.005	0.14	<0.0001				120	106	6.01
MBW03	Whybrow seam	27/08/2021	12:10:00 PM	7.3	10250	20.1	54.5	6740	<1	<1	2880	2880		<1	1920	35	12	2580	18	2.88	0.003	<0.0001	0.002	0.007	<0.001	<0.01	0.01	0.16	<0.0001				112	115	1.64
MBW04	Wambo	27/08/2021	12:30:00 PM	7.4	13440	22.5	48.7	8280	<1	<1	2050	2050		241	3600	75	105	2880	23	1.42	0.001	<0.0001	0.002	0.001	0.002	<0.01	0.018	0.11	<0.0001				148	138	3.25
MBW6A		24/08/2021	12:20:00 PM	6.5	775	19.7	no RL provided	548	<1	<1	123	123		40	161	10	12	123	3	3.26	0.001	<0.0001	0.004	0.003	0.03	<0.01	0.009	0.08	<0.0001				7.83	7.28	3.7

Appendix 6:

Rehabilitation Monitoring Report

2021 Ecological Monitoring Report

Report prepared on behalf of Yancoal
Mount Thorley Warkworth Complex

29 March 2022

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1.0 Introduction

Mount Thorley - Warkworth Complex (MTW) is an open cut coal mine located approximately 10 kilometres south-west of Singleton, in the NSW Hunter Valley. This report satisfies the annual ecological reporting requirements as specified in the Minong Operations Plan (MOP) and consent conditions (SSD 9526). The objective of the monitoring program is to measure the progress of the rehabilitation against Performance Criteria and to monitor ecological change in the offset areas, in relation to vegetation condition and variations in abundance of weed/pest species. This report was prepared by Tasman Willis of Emergent Ecology on behalf of Dendra Systems Ltd.

2.0 Methods

The methodology for the 2021 Ecological Monitoring Program was consistent with previous years monitoring effort, as outlined in the MOP and Monitoring Methodology (AECOM 2012). The 2021 monitoring program targeted 69 sites, including:

- six Grey Box-Ironbark Woodland reference sites;
- 32 previously established Woodland – EEC rehabilitation sites;
- 26 newly established Woodland – EEC rehabilitation sites; and
- five previously established Woodland – Other rehabilitation sites.

All rehabilitation sites were in the Ecosystem and Landuse Establishment Phase, as outlined in the MOP. The location of the rehabilitation monitoring sites are shown in **Figure 1**, reference sites in **Figure 2** and details of each site are provided in **Appendix 1**.

Field surveys for the Ecological Monitoring Program were undertaken over 14 days from 18th October to 5th December and 3rd to 10th January. The weather was mild (20 to 35 degrees Celsius) with light to moderate winds and moderate to heavy rainfall.

2.1 Site Layout

Site layout involved a 20m by 50m plot, with a nested 20m by 20m plot, and includes a 50m transect running through the plot, as shown in **Figure 3**. Monitoring methods undertaken within each plot and transect are outlined in **Section 2.2**. Permanent markers (metal star pickets) were placed at either end of the 50m transect to identify the plots. Photo monitoring included three photos from the start of the transect; one along the length of the transect and two photos looking either way diagonally across the 20m by 20m plot.

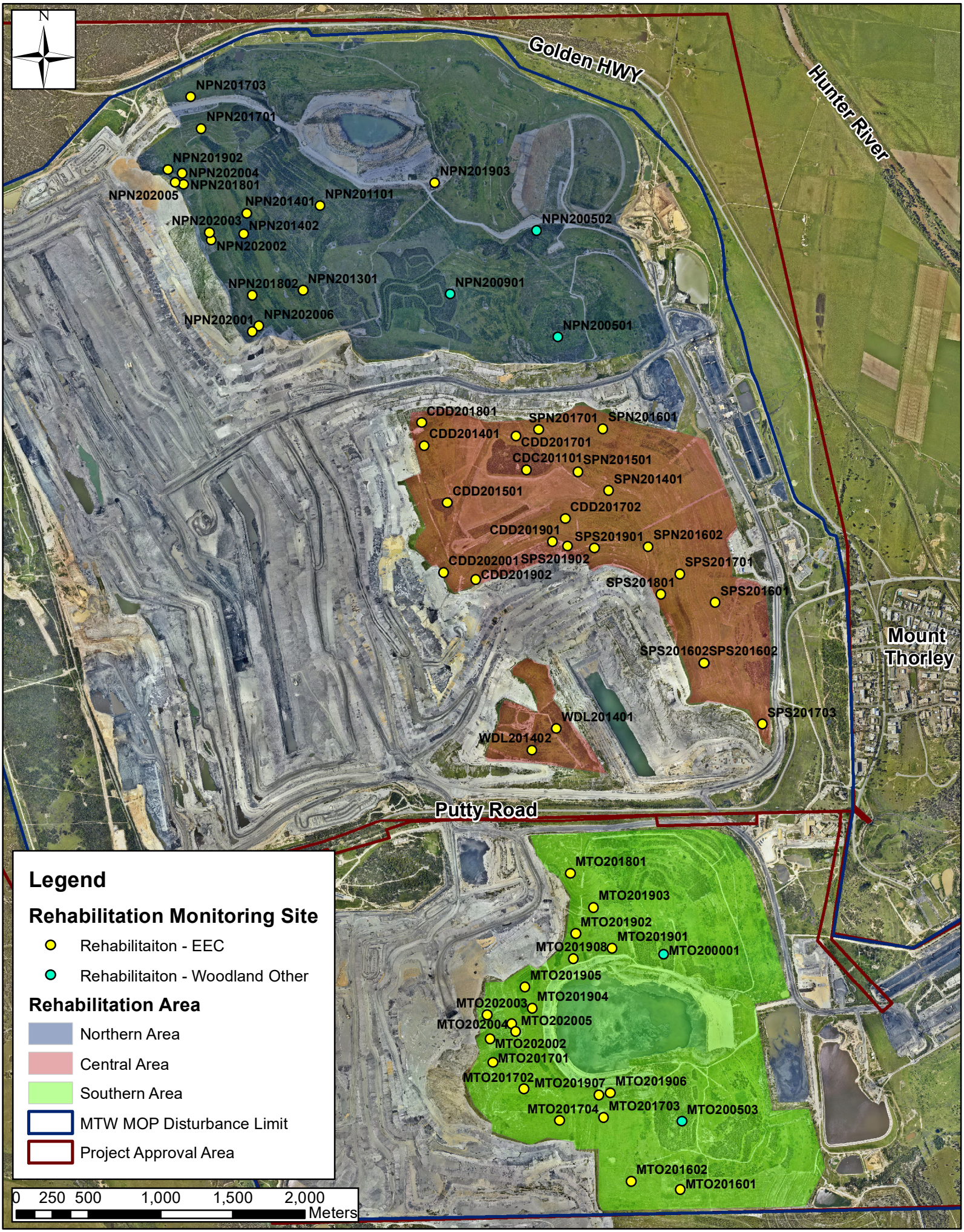


Figure 1. Location of Rehabilitation Monitoring Sites



Figure 2.2. Location of Reference Monitoring Sites

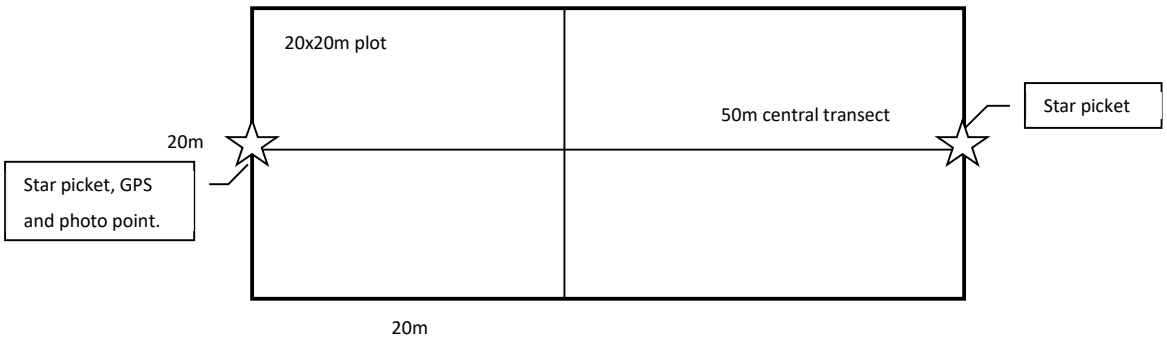


Figure 3 Monitoring Plot Layout

2.2 BAM Vegetation Sampling

Biobanking Assessment Methodology (BAM) vegetation sampling compares the results of the monitoring program to a standard vegetation classification, developed in accordance with the BAM Methodology (DECCW 2014). BAM vegetation sampling was undertaken at each of the 69 flora monitoring sites and involved measuring the following components:

Native plant species richness: total number of species recorded in a 20m x 20m plot. The plot was systematically traversed, and the number of indigenous vascular plant species were counted. All species were recorded to ensure the vegetation community is trending towards the target plant community type (PCT);

Native over-storey: percent foliage cover at 10 points along a 50m transect. Native over-storey is the tallest woody stratum present (including emergents) that is 1m and higher and includes all species native to New South Wales;

Native mid-storey cover: percent foliage cover within the 20m x 20m plot. The mid-storey contains all vegetation between the over-storey stratum and 1m in height and includes all species native to New South Wales;

Native ground cover: percent foliage cover within the 20m x 20m plot for grasses, shrubs and other (such as herbs and forbs). The ground stratum contains all native vegetation below 1m in height and includes all species native to New South Wales;

Exotic plant cover: percent foliage cover within the 20m x 20m plot;

No. of trees with hollows: total no. of hollow trees within the 50m x 20m plot;

Total length of fallen logs: total length of logs at least 10cm diameter and at least 0.5m long within a 50m x 20m plot; and

Regeneration: measured as the proportion of over-storey species present at the site that are regenerating (i.e. with DBH < 5cm) within the entire zone. For example, if there are three tree species present at the site but only one of these species is regenerating, then the value is 0.33.

2.3 Additional Features Recorded

Additional features were recorded to allow direct comparison to the Performance Criteria for Rehabilitation - EEC and Rehabilitation - Woodland Other. The following features were recorded at each site.

2.3.1 Native Canopy Development

Canopy development was measured by:

- density of tree species;
- native tree/shrub/groundcover species diversity; and
- average diameter at breast height (DBH).

These features are described below:

Density of tree species was measured by counting all individual trees within one metre either side of the 50-metre central transect of each plot, this was then converted to stems per hectare. The following species we considered trees for the purpose of this assessment, in line with previous years surveys:

- hickory wattle (*Acacia implexa*);
- cooba (*Acacia salicina*);
- bulloak (*Allocasuarina leumannii*); and
- Eucalypt species (including *Eucalyptus*, *Corymbia* and *Angophora* spp.).

Tree/shrub/groundcover diversity was measured through BAM sampling. Each species was allocated a growth form. Diversity was the sum of species for each growth form at a site.

The average DBH was determined by measuring the DBH of all tree stems greater than 5cm within the 50m by 20m plot.

2.4 Landscape Function Analysis

Landscape Function Analysis (LFA) is a technique used to monitor the health of landscapes, particularly in areas of disturbance. LFA uses simple visual assessment of both physical and biological landscape components (mostly in relation to surface hydrology), that can be readily replicated in order to determine changes to the landscape within a site and develop value limits, over time, for specific landscape components. The LFA methodology has been developed in accordance with Tongway and Hindley (2004).

Landscape Function Analysis (LFA) was undertaken at all monitoring sites in 2021. LFA methodology involves collecting data, along a 50m transect on a decline slope, at a coarse scale (landscape organisation) and fine scale (soil surface assessment). Ground cover types (patches and inter-patches) are identified along each transect.

The landscape organisation index is the proportion of the length of patch (i.e. stable structures such as vegetation) to the total length of the transect. For example, if the transect is an entire patch (i.e. a continuous grassland), the index would score 100. In comparison, a totally bare (interpatch) transect would score a value of 0 (zero). A landscape with high functionality has high retention of vital resources such as water, topsoil and organic matter, whereas low functionality implies that some of these resources are vulnerable to loss from the system.

To determine the soil surface assessment, approximately five replicates of each ground cover type along the transect (patch and interpatch) are recorded using the eleven key soil surface assessment indicators, being:

1. rain splash protection;
2. perennial vegetation cover;
3. litter cover, origin and degree of decomposition;
4. cryptogam cover;
5. crust brokenness;
6. erosion features;
7. deposited materials;
8. micro topography;
9. surface resistance to erosion;
10. soil texture, and
11. slaking characteristics.

The data collected from the above soil surface assessment indicators were entered into the LFA Excel spreadsheet template. The spreadsheet calculates values for stability, infiltration and nutrient functions (critical measures) of each site. Values are presented as percentages of the maximum available score of each critical measure with 100 representing the highest possible score.

It should be noted that LFA does not automatically classify a site as being in either good, moderate or poor condition. The significance of the numerical values comes from comparing disturbed sites with reference sites and developing a value range for each critical measure at each site. Values generated do not provide the functional state, this is dependent upon the ecosystem being assessed (i.e. a stability value less than 20 may represent a dysfunctional grassland but may represent a functional woodland).

2.5 Soil Assessment

Two methods of soil assessment were undertaken as part of the 2021 monitoring program: being soil composition and microbial assessment. Soil composition was undertaken at each of the 69 flora monitoring sites and microbial assessment was undertaken at each of the six reference sites, four sites from the northern area and four sites from the central area.

Soil composition sampling involved collecting a sub sample, from five to ten centimetre depth, every ten meters along the 50 metre transect of the plot, resulting is five sub-samples. Sub-samples were mixed homogenously in a bucket and bagged (250-500 grams), labelled and stored at five degrees Celsius until sent to Environmental Analysis Laboratory for testing. Soil composition samples were analysed for:

- pH;
- Electrical Conductivity;
- Soil Phosphorous
- Organic Matter;
- Cation Exchange Capacity
- Exchangable Sodium %
- Calcium Magnesium Ratio;

The microbial assessment involved collecting a second sample in the same methodology as soil composition, however the samples were stored at -15° Celsius. Samples were sent to Microbial Laboratories Australia to measure microbial activity, soil basal respiration and soil microbial biomass carbon.

3.0 Results and Discussion

The results of the field surveys, and relevant discussion points, are provided in the following sections. The results of the photo monitoring are provided in **Appendix 2** and a full list of flora species is provided in **Appendix 3**.

Monitoring sites have been grouped by area to compare results more easily between sites; these include the northern, central and southern areas, as shown on **Figure 1**. The Target PCT for rehabilitation sites monitoring in 2021 was identified as PCT1603: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter. This community conforms to the Central Hunter Grey Box-Ironbark Woodland Endangered Ecological Community, listed under the *Biodiversity Conservation Act 2016*.

3.1 Biobanking Assessment Methodology Vegetation Sampling

The monitoring methodology specified in the MOP required a Site Value score to be provided for each site monitored. Due to the methodology being developed in 2014, and several updates since then, the online calculator to determine a Site Value score is not available. As an alternative, a colour coded system has been developed to visually represent the condition of the rehabilitation compared to the benchmark and reference site values for each feature, shown in **Table 3.1**. Cells that are green have achieved, or exceeded, the benchmark value/Performance Criteria. Cells that are blue have not achieved the benchmark value/Performance Criteria however are trending towards the target PCT. Cells that are orange or red did not achieve the benchmark value/Performance Criteria standard in 2021 and require either management actions or time to develop to achieve the target PCT.

Table 3.1. Benchmark Colour Code

	Value is 100% of the reference/BAM value (target has been achieved or exceeded)
	Value is ± 50% to 99% of the reference/BAM value (target has not been met, however trending towards target)
	Value is ± 25-49% that of the reference/BAM value (target not yet achieved)
	Value is ± 0-24% that of the reference/BAM value (target not yet achieved)

The results of the BAM vegetation sampling are provided in **Table 3.2**, **3.3** and **3.4**. Benchmark values from the reference sites and Performance Criteria from Table 36

of the MOP (Ecosystem and Landuse Sustainability) have been provided to assess the progress of the rehabilitation.

3.1.1 Northern Area Rehabilitation

The northern area occurs north from the haul road to North Pit to the northern limit of the Disturbance Area. The NPN sites are located in this area. **Table 3.2** provides the BAM vegetation sampling results for the northern area.

Table 3.2. Northern Area BAM Vegetation Sampling Results

Attribute	MOP	Avg. Ref.	Monitoring Sites																	
			NPN 2005 01*	NPN 2005 02*	NPN 2009 01*	NPN 2011 01	NPN 2013 01	NPN 2014 01	NPN 2014 02	NPN 2017 01	NPN 2017 03	NPN 2018 01	NPN 2018 02	NPN 2019 02	NPN 2019 03	NPN 2020 01	NPN 2020 02	NPN 2020 03	NPN 2020 04	NPN 2020 05	NPN 2020 06
Nat. Sp Rich	21 to 41	47	26	26	32	23	26	33	21	35	30	38	24	59	37	23	28	17	37	39	27
Nat. Canopy (%)	15-50	14	14	16	40	7	0	22	17	0	0	0	0	4.5	0	0	0	0	0	0	0
Nat. mid (%)	5 to 60	14	7.4	34.2	5.8	48.2	32.2	39.6	31.1	13.6	2.6	35.4	14.2	20.2	1.8	0.5	3.2	0.4	1.2	1.4	14.6
Nat. GC grass (%)	5-50	35	89	39.3	14.6	8.3	16.8	4.6	18.3	58.6	65.6	9.4	57.1	52.3	14.7	27	40.2	7.5	24.6	31.5	21.5
Nat. GC shrub (%)	5 to 10	2	5	5	2	5	2	0	5	30	20	10	5	5	1	1	1	0	1	5	1
Nat. GC other (%)	5-40	7	1.5	1	1	3.5	1.6	1	10.6	26.1	8.2	1.3	0.4	2.3	0.5	10.3	0.4	2.8	1.2	0.5	5.2
Weed cover (%)	5-33	1	12	32.4	1.4	78.7	59.6	48.9	33.7	64.7	18.5	36.4	59.3	10.1	8.1	5.9	41.9	85.9	20.8	7.2	60.9
No. hollow trees	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total length of fallen logs	5	15	0	0	0	0	0	0	0	6	4	0	10	0	0	0	0	0	0	0	0
Regeneration	0.5 -1	1	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

*Woodland – Other rehabilitation site; GC – Ground Cover.

The reference sites were generally in good condition and no evidence of direct impacted as a result of mining activities. No evidence of disease or die-back was recorded at the reference sites. A minor cover of high threat exotic (HTE) species was recorded at all reference sites, including creeping pear (*Opuntia husifusum*) and prickly pear (*Opuntia stricta*). Although these species were

at a low cover, management should be undertaken to ensure these species cover does not increase. Fireweed (*Senecio madagascariensis*) and cobblers peg (*Bidens pilosa*) were recorded at the reference sites in low abundance and therefore no management actions are currently required to target these species. Further discussion on HTE species is provided in **Section 3.2**.

The rehabilitation in the northern area generally provided a good diversity of native species and good native ground cover. This is a good indicator of resilience and the ability of these sites to progress towards the target vegetation community. Appropriate weed management of exotic grassland species and appropriate cover in the shrub and canopy layer will allow these sites to develop towards the target vegetation community.

The recently established sites (established from 2017 to 2020) provided poor canopy and shrub cover and low cover of native herbs, as expected in early-stage rehabilitation. However, a good diversity of species from all stratum were recorded at these sites. NPN200501, NPN200502, NPN200901, NPN201101, NPN201401 and NPN201402 provide good canopy cover and good succession of shrubs in the ground cover. NPN201301 is dominated by shrub species and provided a low abundance of canopy species. Remote sensing data shows that trees covered 13 percent of the area (182 hectares), shrubs covered 17 percent and grass covered 65 percent. The canopy species present (spotted gum (*Corymbia maculata*)) was at a reasonable density for an open woodland however this area will not progress towards the target Grey Box-Ironbark Woodland without infill planting of target canopy species and reduction of cover of Mudgee wattle (*Acacia spectabilis*). This area is currently trending towards a Spotted-Ironbark Woodland, if the Mudgee wattle does not continue to regenerate to a similar density.

Cover of native grasses in the northern area were mostly in range of the MOP Performance Criteria. Site NPN201401 provided a slightly lower cover of native grasses and ground cover shrubs/other. This is likely to be due to the dense cover of shrubs and exotic grasses at this site. Appropriate management of exotic grass species will assist in developing the native grass layer. Management recommendations are provided in **Section 3.6**.

Native ground cover - other (e.g. herbs, ferns, sedges, rushes) was generally low at rehabilitation and reference sites. Sites NPN201402, NPN201701NPN201703 and NPN202001 achieved the MOP Performance Criteria value for this attribute. Herbs, ferns, sedges and rushes typically develop later in the succession of an ecosystem, in a highly disturbed landform. Appropriate management of exotic grass species will assist in colonisation of native ground cover - other.

Weed cover was within the MOP Performance Criteria at most rehabilitation sites. Sites NPN201101, NPN201301, NPN201701, NPN201802, NPN202003 and NPN202006 provided a high cover of weed species. **Section 3.2** provides details of specific weeds for each site and management recommendations. Number of trees with hollows, total length of fallen timber and regeneration was typically low at all sites, as expected from early-stage rehabilitation. Fallen timber was observed throughout the rehabilitation area however much of this did not occur within the plots. Results of the remote sensing shows limited cover of fallen logs throughout the area.

3.1.2 Central Area Rehabilitation

The central area occurs from south of the haul road to North Pit to the Putty Road. The sites in this area include CDC, CDD, SPN, SPS and WDL. **Table 3.3** provides the BAM vegetation sampling results for the central area.

Table 3.3. Central Area BAM Vegetation Sampling Results

Attribute	MOP	Avg. Ref.	Monitoring Sites																						
			CDC201101	CDD201401	CDD201501	CDD201701	CDD201702	CDD201801	CDD201901	CDD201902	CDD202001	SPN201401	SPN201501	SPN201601	SPN201602	SPN201701	SPS201601	SPS201602	SPS201701	SPS201703	SPS201801	SPS201901	SPS2021902	WDL201401	WDL201402
Nat. Sp Rich	21 to 41	47	35	15	20	22	18	35	24	33	15	16	18	29	33	23	15	18	27	17	2	14	35	25	16
Nat. Canopy (%)	15-50	14	17	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6.5	0
Nat. mid (%)	5 to 60	14	12.4	0.3	37	3.2	0.2	5.4	0.5	0.8	0.2	0.7	4.5	0.6	7.8	0.7	0.3	0.3	4.8	0.3	0	0.1	0.8	22.1	6.1
Nat. GC grass (%)	5-50	35	21.2	5	19.1	22.6	23	44.7	47.5	22.8	26	16.6	11.1	37.2	18.4	22.2	15.6	22	36.1	31.6	5	16	28.8	17	17.1
Nat. GC shrub (%)	5 to 10	2	5	1	5	1	0	0.5	1	1	0	0	2	1	2	5	0	1	0.5	0.1	0	0	2	5	1

Attribute	MOP	Avg. Ref.	Monitoring Sites																						
			CD C20 1101	CD D201 4 01	CD D20 1501	CD D20 1701	CD D20 170 2	CD D20 1801	CD D20 1901	CD D20 190 2	CD D20 200 1	SP N 201 401	SP N20 1501	SP N20 1601	SP N20 160 2	SP N20 1701	SPS 201 601	SPS 201 602	SPS 201 7 01	SPS 2017 03	SPS 201 8 01	SPS 201 9 01	SPS 2021 902	WD L201 401	WD L201 402
Nat GC other (%)	5-40	7	3.9	1.4	2.2	0.2	7	3.2	1.5	1	0.5	6	0.5	9.8	4.2	5.7	5.4	3.2	1.6	5.3	0.1	10.4	1.1	8.4	7.2
Weed (%)	5-33	1	13	92.6	4.3	68.7	53.3	31.2	9.8	46.8	33.3	84	75.2	37.1	39.9	56.1	83.1	63.1	13.4	6.5	90.5	85.6	38.3	19.7	52.6
No. hollow trees	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
fallen logs (m)	5	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0
Regen	0.5-1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

GC – Ground Cover.

Species richness was moderate to low throughout the central area due to the abundance of exotic grass species. As the canopy and shrub layer mature the exotic pasture species should reduce in most areas, however control of exotic pasture species and infill planting is required. Approximately half the sites did not achieve the MOP Performance Criteria for native species richness and Site SPS201801 has an extremely low native species richness score with only two native species recorded within the plot. Significant effort is required in this area to achieve the target vegetation community. Long-term options to transition from exotic pasture to native woodland is provided in **Section 3.6**. Remote sensing data shows that trees covered three percent of the area (196 hectare), shrubs covered six percent and grass covered 86 percent.

All sites, except CDC201101, provided a low cover of native canopy and most sites provided low native shrub cover with a high density of exotic pasture species. Older rehabilitation to the north (CDC201101 and CDD201501) and south (WDL201401) provided a moderate to dense canopy and shrub layer. Scattered trees and shrubs occur throughout the central area however management of exotic pasture species is required to progress toward the target vegetation community, refer to **Section 3.6** for management recommendations.

The central area provided good to moderate native ground cover (grasses, shrubs and other) for all sites; this shows good potential resilience following control of exotic grass species. Weed cover was generally moderate throughout with 11 sites' (48%) having greater than 50 percent cover of exotic species. HTE species and control methods are provided in **Section 3.2**. Hollows, fallen logs and regeneration of canopy species is low at all sites, except SPS201801 which provided an abundance of fallen timber. Fallen logs should be placed strategically across the landscape to provide a corridor for native species movement.

3.1.3 Southern Area Rehabilitation

The southern area occurs from south of the Putty Road to the southern limit of the Disturbance Area. The MTO sites are included within this area. **Table 3.4** provides the BAM vegetation sampling results for the southern area.

Table 3.4. Southern Area BAM Vegetation Sampling Results

Attribute	MOP	Avg. Ref.	Monitoring Sites																				
			MTO 200001*	MTO 200503*	MTO 201601	MTO 201602	MTO 201701	MTO 201702	MTO 201703	MTO 201704	MTO 201801	MTO 201901	MTO 201902	MTO 201903	MTO 201904	MTO 201905	MTO 201906	MTO 201907	MTO 201908	MTO 202002	MTO 202003	MTO2020004	MTO 202005
Nat. Sp Rich	21 to 41	47	19	27	9	39	14	9	9	15	30	45	31	44	29	38	21	33	36	38	19	15	30
Nat. Canopy (%)	15-50	14	15	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nat. mid (%)	5 to 60	14	1.2	0.2	0	2.9	1.6	0.1	0	1	1	20.3	11.7	9	1.6	8.8	0.3	0.9	3.3	6.6	0.2	0.3	1.1
Nat GC grass (%)	5-50	35	50.2	51.1	31.1	49.1	48	38	47	65	52.7	36	40.1	31.6	32.7	31.2	36	41.9	31.9	72.3	71.1	95.1	70.1
Nat GCr shrub (%)	5 to 10	2	5	1	0	5	0	0	0.5	0	1	5	5	5	1	2	1	0	0	5	0	0.1	3
Nat GC other (%)	5-40	7	5.3	1.1	0.3	1.6	9.1	15.7	5	3.9	1.2	3.2	0.8	2.1	0.5	0.8	0.8	1	1	1.8	3.3	2.1	0.3
Weed plant (%)	5-33	1	22.2	22.2	33.1	25.2	30.8	46.2	19.6	11.1	35.7	23.5	57.1	28.1	26.7	34.1	52.5	22.5	22.9	6	12	17.6	15.9
No. hollow trees	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fallen logs (m)	5	15	0	6	0	10	0	2	18	12	0	0	0	0	0	10	10	4	5	0	0	0	0
Regeneration	0.5 -1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

GC – Ground Cover.

Most of the southern area provided moderate to high native species richness with two sites (MTO201901 and MTO201903) exceeding the benchmark value. Both of these sites were established in 2019 and provided a good cover of native shrubs and groundcover. The canopy cover was low at these sites which is expected in early-stage rehabilitation. Both sites provided a moderate abundance of canopy species and moderate cover of weed species.

Sites MTO201601, MTO201702 and MTO201703 provided moderate to low native species richness, canopy cover, shrub cover, ground cover shrubs and high cover of weed species. These sites occur on relatively flat terrain, likely resulting in higher ground moisture content which is ideal conditions for weed species. Weed cover was moderate throughout with two sites (10%) having greater than 50 percent cover of exotic species. The area around these sites will require management of exotic pasture species progress towards the target vegetation community. Refer to **Section 3.2.2** for control methods and **Section 3.6** for a long-term plan to progress towards a native vegetation community.

Native canopy cover was low throughout the southern area which is expected in early-stage rehabilitation. Sites MTO200001 and MTO200503 are targeted at Woodland – Other and provide a good canopy cover of local and non-local canopy species. Native mid-story cover was generally low throughout, as expected in early-stage rehabilitation. Sites MTO201901, MTO201902, MTO201903 and MTO201905 provide a good cover of canopy and shrub species within the mid-story layer. Remote sensing data shows that trees covered six percent of the area (159 hectares), shrubs covered two percent and grass covered 88 percent. These sites are progressing well towards the target vegetation community for canopy, shrub and native grass cover, however continued weed control is required to progress towards the target vegetation community.

Native ground cover – grasses was high at all sites in the southern area, with all sites achieving the MOP Performance Criteria value. A total of eight sites exceeded the benchmark value for native ground cover – grasses, four of which were over 70 percent cover. It is unlikely that high native grass cover will suppress the regeneration of canopy, shrub and ground cover – other. Further monitoring will determine if management action is required.

Hollow logs and regeneration of canopy species is low, as expected in early-stage rehabilitation. Fallen log cover was adequate throughout the area with seven sites exceeding the benchmark value. The fallen logs occur as a corridor from the south to the north, around the tailings dam. As new rehabilitation is established north-west of the tailings dam, fallen timber should be placed to provide a refuge corridor for native fauna. Pest control will be required to prevent the colonisation of pest species, such as rabbits and foxes.

3.2 Native/Exotic Flora Composition

A total of 245 plant species were recorded across all monitoring sites in 2021, including 174 native species and 71 weed species. The most speciose family was Poaceae with 50 species recorded, followed by Fabaceae (including subf. Faboideae (peaflowers) and subf. Mimosoideae (wattles)) with 42 species and Asteraceae with 33 species. The following section outlines the native and weed species composition at the monitoring sites. A complete flora list is provided in **Appendix 2**.

Weed species provide a significant barrier to the establishment woodland communities within mine rehabilitation. The Performance Criteria states that weed species should be comparable to reference sites or baseline survey. Weed species can be categorised as;

- **High Threat Exotic (HTE)**: pose a threat to the integrity of the target vegetation community and requires active control; and
- **Exotic**: generally require minimal to no active control and does not pose a significant threat to the development of the target vegetation community.

The below figures have been developed for management purposes to provide an indication of the abundance of high priority weeds at each site; **Figure 4** is the northern area; **Figure 5** is the central area and **Figure 6** is the southern area. It should be acknowledged that weeds will occur in any newly created ecosystem and therefore priorities need to be developed to control the risks to establishing the target vegetation community.

The below figures provide a visual representation of the total number of native and weed species recorded at all monitoring sites in 2021. Native species are shown in green, Exotic species (such as scarlet pimpernel, plantain and sow thistle) are shown in orange and HTE species (such as prickly pear, galenia, Rhodes grass and kikuyu) are shown in red. Note that HTE grass species (such as Rhodes grass and green panic) recorded in Rehabilitation – Woodland were considered Exotic, due to these species not being a limiting factor to achieve the target vegetation community as defined in the Performance Criteria.

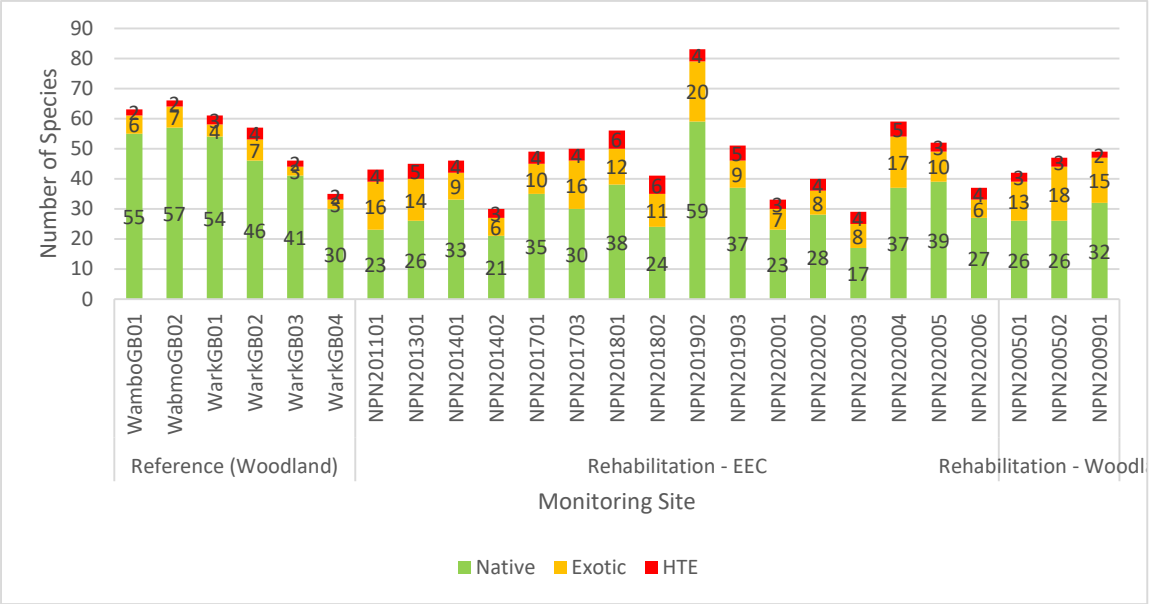


Figure 4 Northern Area Native and Weed Species Composition

The abundance of native species at the woodland reference sites ranges from 30 to 57 HTE species abundance ranges from two to four species. The Rehabilitation sites in the northern area range from 17 to 59 native species and two to six HTE species, showing good potential resilience and a trend towards the target vegetation community. Site NPN201902 exceeded the reference sites for abundance of native species and is within range of HTE species. This site is progressing well towards the target vegetation community, particularly considering it was established in 2019. Management recommendations to improve the abundance and cover of native flora species at the woodland rehabilitation sites are provided in **Section 3.6** and control methods for HTE **Section 3.2.2**.

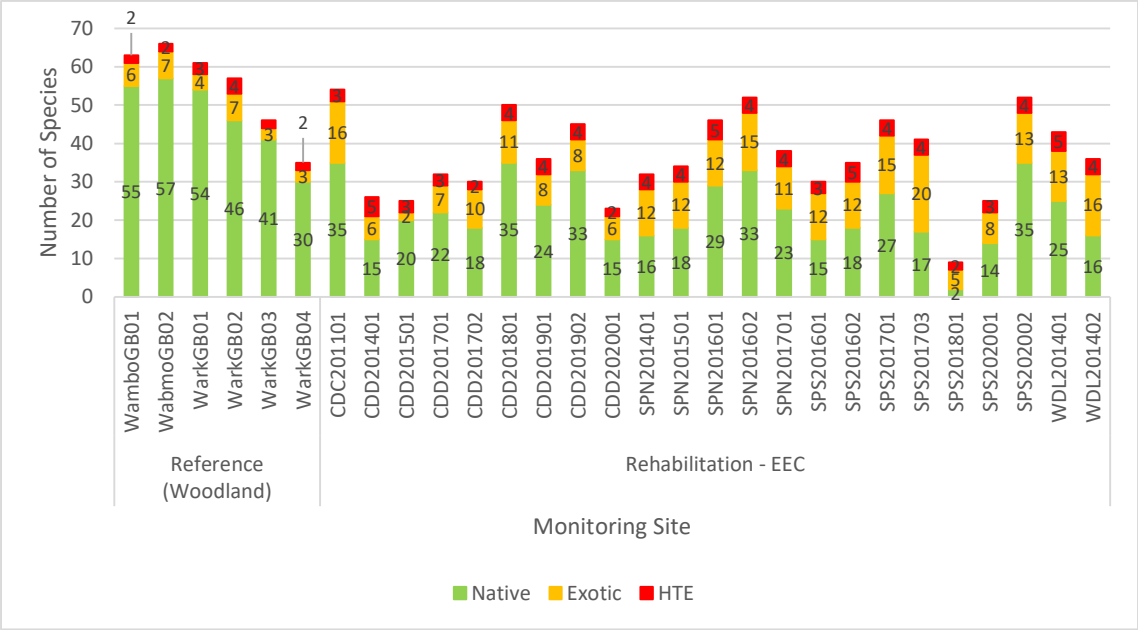


Figure 5 Central Area Native and Weed Species Composition

The Rehabilitation sites in the central area range from two to 35 native species and two to five HTE species. Site SPN201801 provided a poor abundance native species with only two species recorded. The central area has a high cover of exotic grass species which is suppressing the establishment of the target vegetation communities. Management recommendations to improve the abundance and cover of native flora species is provided in **Section 3.6** and control methods for HTE **Section 3.2.2**.

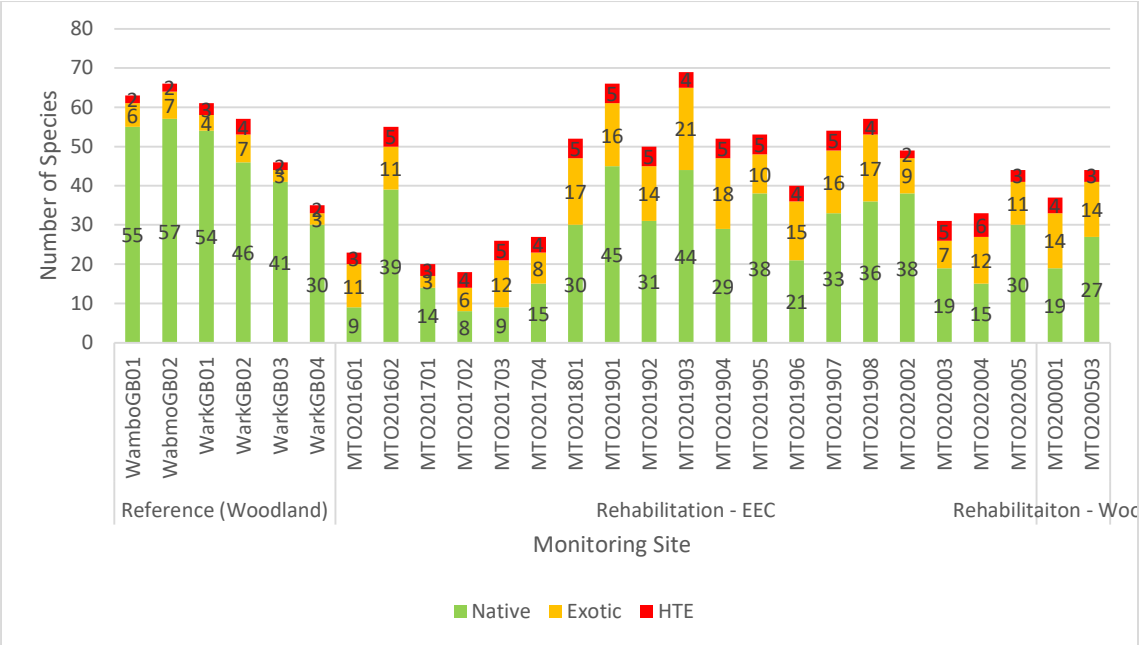


Figure 6 Southern Area Native and Weed Species Composition

The Rehabilitation sites in the southern area range from eight to 45 native species and two to six HTE species. The rehabilitation to the south and south-west of the tailings dam provides a low abundance of native species. As previously discussed, these sites occur on relatively flat terrain resulting with high ground moisture, which is beneficial to the occurrence of exotic species. The northern and western region of the southern area is progressing relatively well towards the target vegetation communities, however further control of HTE weed species is required to assist the development. Management recommendations to improve the abundance and cover of native flora species at the woodland rehabilitation sites are provided in **Section 3.6** and control methods for HTE **Section 3.2.2**.

3.2.1 Abundance of High Threat Exotic and Invasive Species

High Threat Exotic (HTE) weed species pose a significant threat to development of the target vegetation community. HTE weed species reduce the resilience of a community following disturbance and can be a limit to achieving Performance Criteria.

The MOP Performance Criteria provides different targets for weed species cover in each Secondary Domain; being five to 33 percent weed cover in Rehabilitation – EEC, less than ten percent cover of HTE species (excluding pasture species) in Rehabilitation – Woodland Other and less than 20 percent HTE species (excluding pasture species) in Rehabilitation - Grassland.

Table 3.5. Percent Foliage Cover of High Threat Exotic Species Recorded within the Reference Sites

Scientific Name	Common Name	Monitoring Site					
		Wam 01	Wam 02	War 01	War 02	War 03	War 04
Bidens pilosa var. *pilosa*	cobblers pegs			0.1	0.1		
Senecio madagascariensis	fireweed	0.1	0.1	0.1	0.1	0.1	0.1
Opuntia aurantiaca	tiger pear				0.1		0.1
Opuntia humifusum	creeping pear	0.1	0.1	0.1	0.1	0.1	
Lantana camara	lantana			0.1			
Total		**0.2**	**0.2**	**0.4**	**0.4**	**0.2**	**0.2**

Although all HTE species (OEH 2022) were considered in the Native/Exotic Flora Composition figures in **Section 3.2**, cobbler's peg (*Bidens pilosa*) and fireweed (*Senecio madagascariensis*) are not included in the discussions below as these species were not dominant and did not pose a threat to the establishment of the target vegetation community in 2021. Exotic pasture species were not assessed as HTE in the five Rehabilitation – Woodland Other plots due to the MOP not specifying grass species needing to be native for this Domain. Additional species have been added to the table due to their invasive nature and ability to suppress the establishment of the target vegetation community. The colour code in the following tables is a similar method to the benchmark colour code in **Table 3.1**.

Table 3.6 provides the foliage cover of HTE and invasive species in the northern area (NPN sites). The three Rehabilitation - Woodland Other sites are progressing well towards the Performance Criteria in the MOP with a low abundance of HTE or invasive species. Site NPN200502 requires control of galenia (*Galenia pubescens*) to achieve the Performance Criteria in the MOP.

Several of the early phase rehabilitation sites, to the west of the northern area, are progressing well with low cover of HTE or invasive species. However, Rhodes grass (*Chloris gayana*) is dominating several sites throughout the northern area and will need to be controlled to achieve the Performance Criteria in the MOP. **Section 3.6** provides management actions to assist in controlling invasive species and progressing the rehabilitation area towards the target vegetation community.

Three sites (NPN201101, NPN201901 and NPN202003) have greater than 50 percent cover of HTE and/or invasive weed species. A specific action plan for these areas may need to be developed if native species show to be in decline.

A low abundance of African olive (*Olea europaea*) and African boxthorn (*Lycium ferocissimum*) was recorded at site NPN200502. Prickly/creeping pear was observed at NPN201301, NPN201401, NPN201801 and NPN201802. These species should be targeted to ensure they do not establish elsewhere in the rehabilitation area.

Table 3.7 provides the foliage cover of HTE and invasive species in the central area (CDC, CDD, SPN and SPS sites). In general, the central area is dominated by exotic perennial grass species, including Rhodes grass (*Chloris gayana*), green panic (*Megathyrsus maximus*) and African lovegrass (*Erogrostis curvula*). Ten sites within the central area have 50 percent or greater cover of HTE and/or invasive species. A trial to develop the soil profile through establishing a dense ground cover was undertaken in this area. This trial, and potentially the topsoil applied, has resulted in a high cover of exotic perennial grass species. This method is no longer being undertaken at MTW and measures to progress the rehabilitation to the target vegetation community are being developed. **Section 3.6** provides management actions to assist in controlling invasive species and progressing the rehabilitation area towards the target vegetation community.

Sites CDC201101, CDD201501, CDD2001801, CDD201901, SPS201701 and SPS201703 provided cover of ten percent or less HTE species. These sites are more likely to have the ability to progress to the target vegetation community and MOP Performance Criteria, however continued weed control is required to progress towards the target vegetation community.

Table 3.8 provides the foliage cover for HTE and invasive species in the southern area (MTO sites). The two Rehabilitation - Woodland Other sites (MTO200001 and MTO200503) are progressing well towards the Performance Criteria in the MOP with a low abundance of HTE and invasive weed species. Galenia (*Galenia pubescens*) was recorded at two of the woodland sites. This species has the ability to suppress establishing native species and therefore should be targeted in these areas.

The southern area is providing a moderate to high cover of exotic perennial grasses, including Rhodes grass (*Chloris gayana*), green panic (*Megathyrsus maximus*) and African lovegrass (*Erogrostis curvula*). All sites within the southern area provide less than 50 percent cover of HTE and/or invasive species. The trial into developing the soil profile through establishing a dense ground cover was also undertaken in the area close to the boundary with Bulga Coal. This trial, and potentially the topsoil applied, has resulted in the high cover of exotic perennial grass species. This method is no longer being undertaken at MTW and measures to progress the rehabilitation to the target vegetation community are being developed. **Section 3.6** provides management actions to assist in controlling invasive species and progressing the rehabilitation area towards the target vegetation community.

A low abundance of African olive (*Olea europaea*), African boxthorn (*Lycium ferocissimum*) and lantana (*Lantana camara*) was recorded at sites MTO201908 and MTO200503, with low cover of African boxthorn (*Lycium ferocissimum*) also recorded at MTO201801 and MTO201906. These species should be targeted to ensure they do not establish elsewhere in the rehabilitation area.

Table 3.6. Percent Foliage Cover of High Threat Exotic Species Recorded within the Northern Area and Invasive

Scientific Name	Common Name	Monitoring Sites (Percent Foliage Cover)																	
		NPN 200501*	NPN 200502*	NPN 200901*	NPN 201101	NPN 201301	NPN 201401	NPN 201402	NPN 201701	NPN 201703	NPN 201801	NPN 201802	NPN 201902	NPN 201903	NPN 202001	NPN 202002	NPN 202003	NPN 202004	NPN 202005	NPN 202006
Galenia pubescens	galenia	1	10	0.1	5	5	5		20	0.1	5	3	0.2	5		0.1	0.1	3		0.1
Bidens pilosa var. *pilosa*	cobblers pegs	0.1	0.1+	0.1	0.1		0.1	0.1	1	5+	0.1	0.1	0.1		0.1			0.1		
Senecio madagascariensis	fireweed	0.1	0.1+		0.1	0.1	0.1	0.1	0.1	0.1+	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Opuntia humifusum	creeping pear					0.1														
Opuntia stricta	prickly pear					0.1		0.1			0.1	0.1								
Cenchrus clandestinus	kikuyu													0.1						
Chloris gayana	Rhodes grass	30+	15+		20	40	40		20	0.1	10	2	1	1	5	30	75	10	5	60
Eragrostis curvula	African lovegrass	15+	20+	0.1+							0.1	0.2		1		1	5	1	0.2	0.1
Megathyrsus maximus #	green panic	30+		10+	50		2	30		5		1	0.1			0.1				
Acacia saligna #	golden wreath wattle	3+	5+	0.1+	0.2							0.1		0.1					0.1	
Eucalyptus cladocalyx #	sugar gum	7+	15+																	
Olea europaea #	African olive		0.1																	
Lycium ferocissimum #	African boxthorn		0.1																	
MOP Rehab EEC: 5-33% MOP Rehab Woodland: <10%		1.2	10.2	0.2	75.4	45.3	47.2	30.3	41.1	10.3	15.4	6.6	1.5	7.3	5.2	31.3	80.2	14.2	5.4	60.3

* Indicates a Rehabilitation – Woodland Other site.

+ indicates a species removed from the calculation in the table due to not being a threat to the establishment of the target vegetation community.

indicates an invasive exotic species not listed as a HTE species (OEH 2022).

Table 3.7. Percent Foliage Cover of High Threat Exotic Species Recorded within the Central Area and Invasive

Scientific Name	Common Name	Monitoring Sites																			
		CDC 201101	CDD 201401	CDD 201501	CDD 201701	CDD 201702	CDD 201801	CDD 201901	CDD D201902	CDD D202001	SPN 201401	SPN 201501	SPN 201601	SPN 201602	SPN 201701	SPS 201601	SPS 201602	SPS 201701	SPS 201703	SPS 201801	SPS 201901	SPS 201902
Galenia pubescens	galenia	0.5	20	0.1	3	10	0.1	2	10	3	8	4	20	5	30	5	5	0.1	0.1	0.1	20	10
Bidens pilosa	cobblers pegs	0.1	0.1				0.1				0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.1			
Senecio madagascariensis	Fire weed	0.1	0.1	0.1	0.1			0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1			0.1
Cenchrus clandestinu	kikuyu																2					
Chloris gayana	Rhodes grass		50	3	60	40	5	5	10	20	10	5	2	25	5		20	1	2	20	5	15
Eragrostis curvula	African lovegrass		5				5	1	5				1								5	5
Megathyrsus maximus #	green panic	5	15						1	5	60	60	5	5	15	70	30	5	1	70	50	2
Acacia podalyriifolia #	Queensland silver wattle				0.1																	
Acacia saligna #	golden wreath wattle		2								4					2	3		0.1		0.1	0.1
Lantana camara #	lantana																	0.1				
MOP/Reference Target 5-33%		5.7	92.2	3.2	63.2	50	10.2	8.1	26.1	28	82.2	69.2	28.2	35.2	50.2	77.2	60.2	6.8	3.4	90.1	80.1	32.2

* Indicates a Rehabilitation – Woodland Other site.

+ indicates a species removed from the calculation in the table due to not being a threat to the establishment of the target vegetation community.

indicates an invasive exotic species not listed as a HTE species (OEH 2022).

Table 3.8. Percent Foliage Cover of High Threat Exotic Species Recorded within the Southern Area and Invasive

Scientific Name	Common Name	Monitoring Sites																			
		MTO 200001*	MTO 200503*	MTO 201601	MTO 201602	MTO 201701	MTO 201702	MTO 201703	MTO 201704	MTO 201801	MTO 201901	MTO 201902	MTO 201903	MTO 201904	MTO 201905	MTO 201906	MTO 201907	MTO 201908	MTO 202002	MTO2 02003	MTO2 02004	MTO 202005
Galenia pubescens var. *pubescens*	galenia	0.1	2		20	10	20	5		5	5	15		2	2	1	1	3		0.1	0.1	0.5
Bidens pilosa var. *pilosa*	cobblers pegs	5+	0.1	30+	0.1		0.1	0.1	0.1	0.5	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	
Senecio madagascariensis	fireweed	0.1		0.1	0.1	0.1	0.1	2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Xanthium occidentale	nagoora burr			0.1																		
Opuntia aurantiaca	tiger pear	0.1	0.1																			
Cenchrus clandestinus	kikuyu													0.1							0.1	
Chloris gayana	Rhodes grass		1+		1	20	25	5	10	1	8	20	20	2	20	40	5	5	3	10	10	2
Eragrostis curvula	African lovegrass	3+	2+		1			1	0.1	2	3	1	0.5		1		3			0.1	1	
Megathyrsus maximus #	green panic	1+								1	0.5	0.5		5		5		3				2
Acacia saligna #	golden wreath wattle		0.1+				0.5	0.1				3	0.1	3			0.1	2				0.1
Eucalyptus cladocalyx #	sugar gum	10+	15+																			
Lycium ferocissimum #	African boxthorn	0.1	0.1							0.1						0.1						
Lantana camara #	lantana	0.1	0.1																			
MOP Rehab EEC: 5-33% MOP Rehab Woodland: <10%		0.5	2.4	0.2	22.2	22.2	45.7	13.2	10.3	9.7	16.7	39.7	20.8	12.3	23.2	46.3	9.3	13.2	3.1	10.4	11.4	4.7

* Indicates a Rehabilitation – Woodland Other site.
+ indicates a species removed from the calculation in the table due to not being a threat to the establishment of the target vegetation community.
indicates an invasive exotic species not listed as a HTE species (OEH 2022).

3.2.2 HTE and Invasive Species Control Methods

Table 3.9 provides control methods for HTE and invasive species. All weed control activities should be undertaken in accordance with the NSW Weed Control Manual (DPI 2018) and Australian Government off label permit (PER9907) where relevant.

Table 3.9. Control Methods for High Threat Exotic and Invasive Weed Species

Species	Common Name	Habit/Risk	Control Mechanism
Galenia pubescens	Galenia	Densely spreading aggressive prostrate herb forming large mats which can suppress the regeneration of other species.	Spray unit (Grazon), cut and paint (Glyphosate) in sensitive areas.
Carthamus lanatus	Saffron Thistle	Rapidly dispersing prickly herb. Typically dominates grassland areas.	Brush-cut/slash at early flowering. Spray rosettes late winter (Glyphosate). Typically reduces cover under a moderate to dense canopy.
Opuntia spp.	Prickly Pear, Creeping Pear	Succulent plant forming dense clumps across the landscape when left uncontrolled.	Spray unit (Grazon)
Acacia spp., *Olea* sp., *Lycium* sp.,	Wattles, African Olive, African Boxthorn	Low tree forming dense thickets which suppress the regeneration of other species. Potential allelopathic effect (chemical suppression released from plant). Rapid germination following fire.	Cut and paint (Glyphosate), spray unit with Grazon, mulch.
Lantana camara	Lantana	Low shrub forming dense thickets which suppress the regeneration of other species.	Cut and paint (Glyphosate), spray unit with Grazon, mulch.
Cestrum nocturnum	Lady-of-the-night	Low tree forming dense thickets.	Cut and paint (Glyphosate).
Xanthium occidentale	Noogoora Burr	Erect annual herb forming dense thicket. Rapidly	Spray unit with Grazon

Species	Common Name	Habit/Risk	Control Mechanism
		spreads and supresses native vegetation.	
Introduced Grasses	Variety of species	Dense aggressive grasses which can suppress regenerating species and plantings.	Spray unit (Glyphosate). Typically reduces cover under a moderate to dense canopy.

3.3 Additional Performance Criteria Monitoring

The following section outlines the results of the additional monitoring methods targeted at addressing the requirements of Ecosystem and Landuse Establishment in Table 35 of the MOP.

3.3.1 Tree Stem Density

The MOP defines the stem density requirements of Ecosystem and Landuse Establishment for woodland and EEC rehabilitation to be between 250 to 3,150 stems per hectare. The below figures show the results of the 2021 monitoring for tree stem density.

Figure 7 shows half the sites in the northern area provide a low value of tree stem density. These sites are scattered throughout the northern area. Native species richness and cover values for NPN200501, NPN201402 and sites established from 2017 to 2020 are adequate for the successional stage of rehabilitation with no further recommendations to manage tree stem density. Although the stem density was low along the transect, the stem density in the general area was adequate for woodland rehabilitation. Remote sensing data shows the tree stem density (as cover) in the northern area to be 12 percent cover. Although the tree stem density is low, tree/tall shrub species are scattered throughout the northern area with potential to provide woodland connectivity. Further monitoring is required to determine if trees/shrubs planting is required.

Site NPN202001 and NPN202006 provided higher than MOP values for canopy stem count however the native species richness and cover were moderate to high and therefore no action is currently required. If further monitoring identifies a reduction of native species richness, mulching/thinning should be considered.

Sites NPN201101, NPN201301 and NPN201401 provided a low tree stem density and low native species richness and cover. These sites are dominated by a dense cover of local and non-local native shrub species (up to 50 percent cover) and low tree cover. The density of the shrub layer is likely to have contributed to the lack of tree

cover. The shrub layer is likely to die-back over the next five to eight years due to these species being relatively short lived and therefore no management control is recommended. If further monitoring identifies a reduction of native species richness, planting of tree and shrub species should be considered.

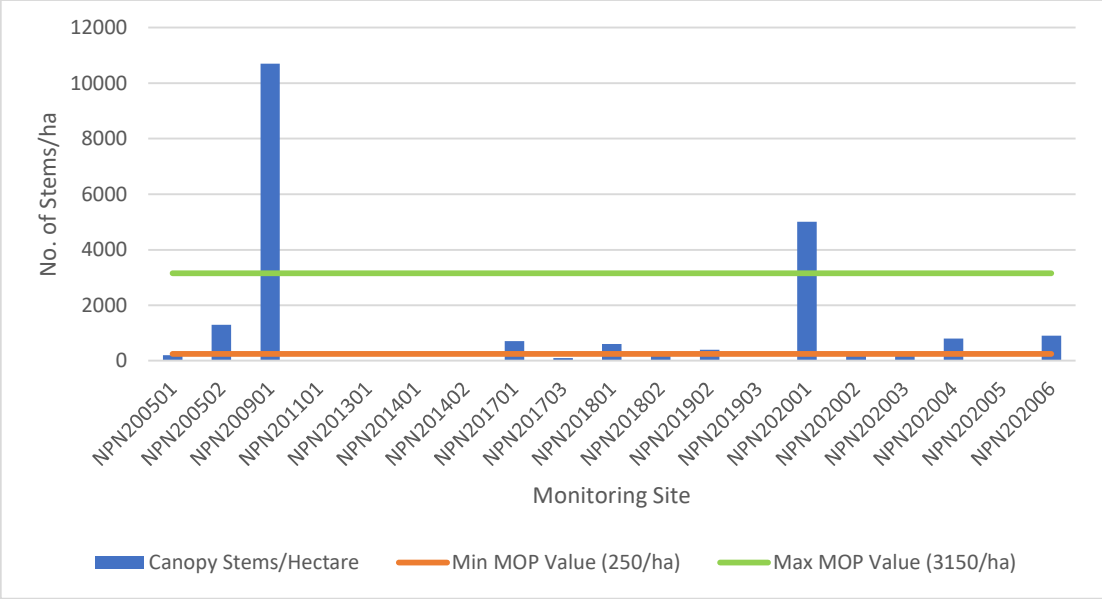


Figure 7 Tree Stem Density in the Northern Area

Figure 8 shows the results of the tree stem density in the central area. A total of 17 sites (74%) in the central area provided a low tree stem density score, based on the plot methodology. Remote sensing data shows the tree stem density in the central area to be three percent cover. As discuss previously, a trial into developing the soil profile was undertaken in this area. This has slowed the development of canopy and shrub species and resulted in a dominance of exotic grass species. **Section 3.6** provides management actions to assist in controlling invasive species and progressing the rehabilitation area towards the target vegetation community.

CDC201101, CDD201501, CDD201901 and WDL201401 provide tree stem density values within range of the MOP Performance Criteria. These sites generally provide moderate to good species richness and cover. Site CDD201501 has a dominance of shrub species (37%) which may need to be managed to ensure appropriate development of canopy and groundcover species. No management actions are recommended at this stage however further monitoring should assess species richness and cover of canopy and groundcover species to determine if action is required.

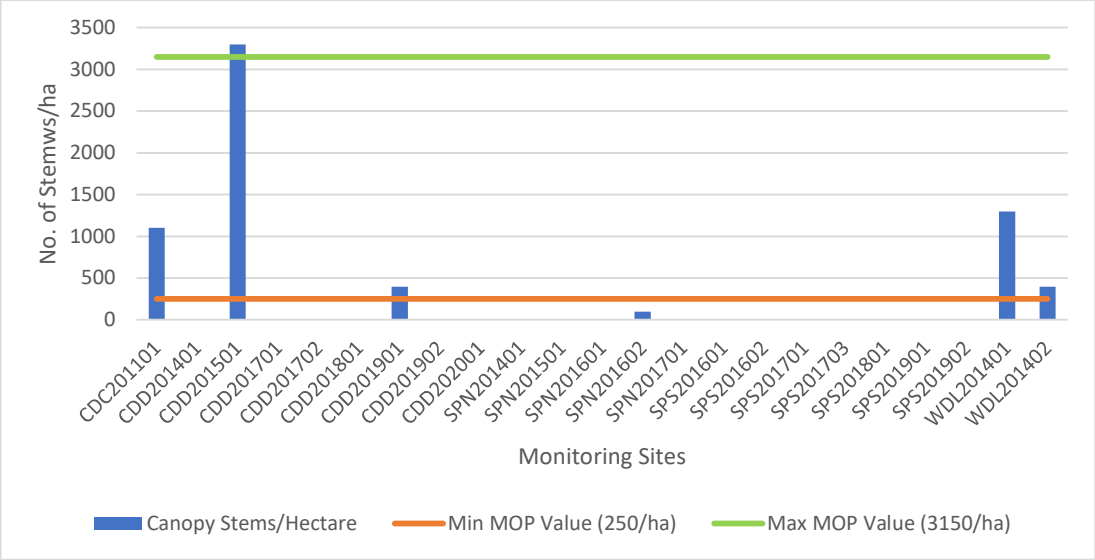


Figure 8 Tree Stem Density in the Central Area

Figure 9 provides the results of the tree stem density in the southern area. Half of the sites in the southern area provide a low value of tree stem density. Remote sensing data shows the tree stem density in the central area to be six percent cover. These sites also generally show low to moderate species richness and mid storey cover and high cover of weed species (mostly exotic grass species). Remote sensing data shows the tree stem density in the southern area to be six percent cover. Planting of trees and shrubs will be required to assist in progressing this area towards the target vegetation community. **Section 3.6** provides management recommendations to progress the area from an exotic dominated grassland towards the target vegetation community.

The cover of native grass species is high at all sites in the southern area, indicating good potential resilience.

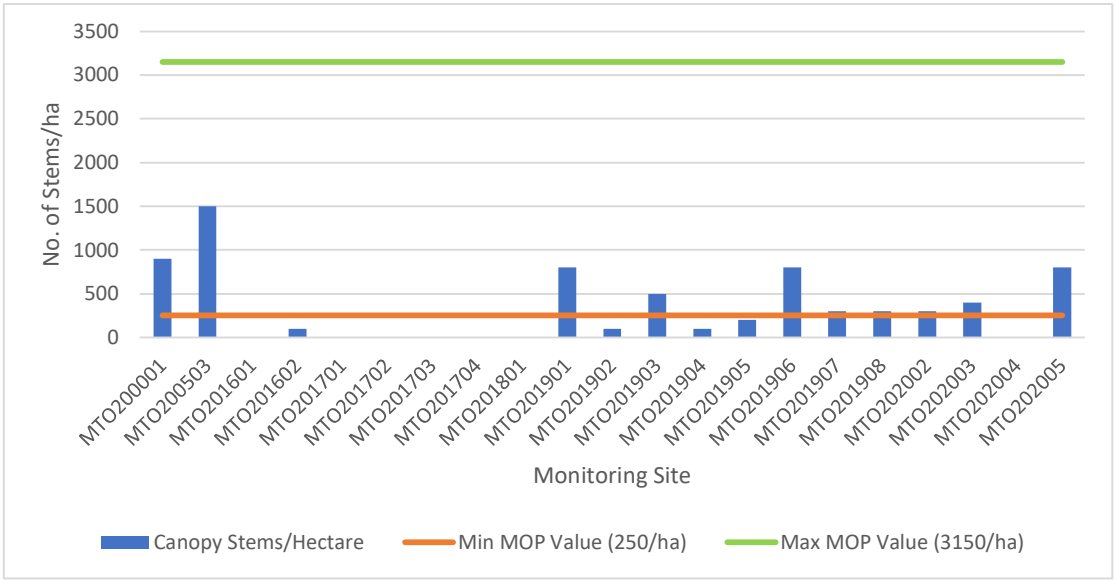


Figure 9 Tree Stem Density in the Southern Area

3.3.2 Tree/Shrub Diversity

Figures 10 and **11** show the tree and shrub diversity at each site in the northern area. All sites have achieved the minimum MOP tree diversity score and all sites except NPN202003 have achieved the minimum MOP shrub diversity score. This is evidence that the northern area has good potential resilience and is likely to recover well following disturbance, such as intense weed control.

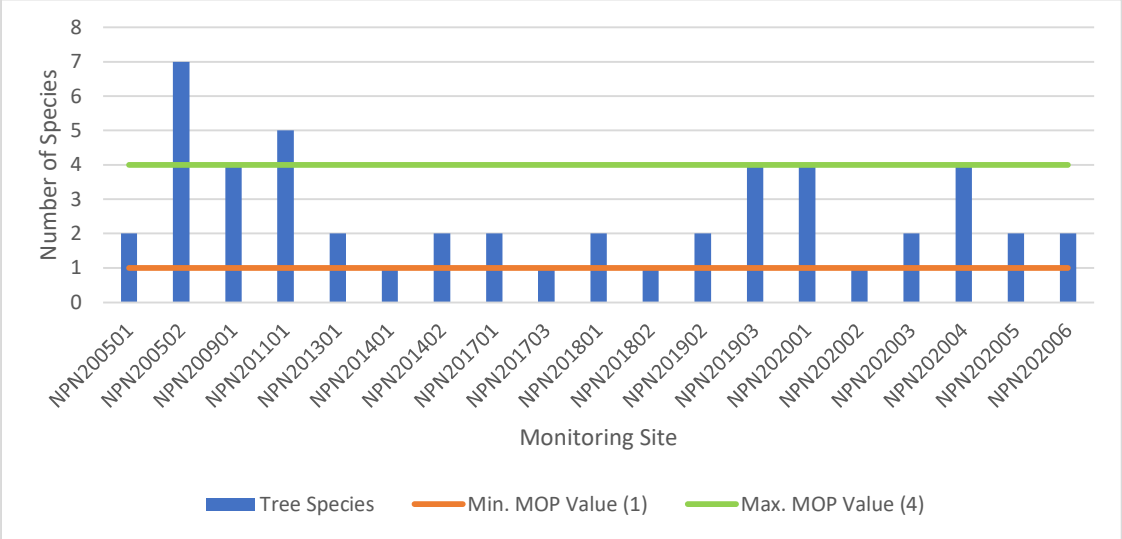


Figure 10 Tree Diversity per Site in the Northern Area

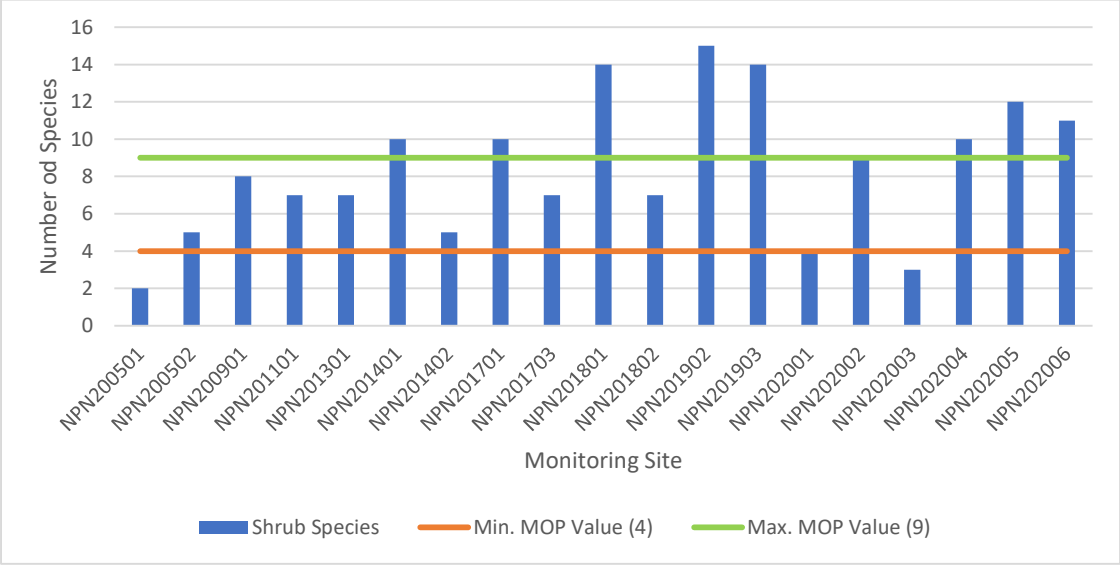


Figure 11 Shrub Diversity per Site in the Northern Area

Figures 12 and **13** show the tree and shrub diversity at each site in the central area. Most sites in the central area have achieved the minimum MOP tree diversity score. Site CDD201702, SPN201501, SPS101601 and SPS201801 recorded no canopy species in the plot and remote sensing showed no canopy species in the surrounding areas.

Half of the central area sites achieved minimum MOP shrub diversity score. These sites were scattered throughout the central area. Sites CDD201702, SPS201601 and SPS201801 provided values lower than the MOP limits for tree and shrub species richness. These sites are not trending towards the target vegetation community and will require additional planting and weed control.

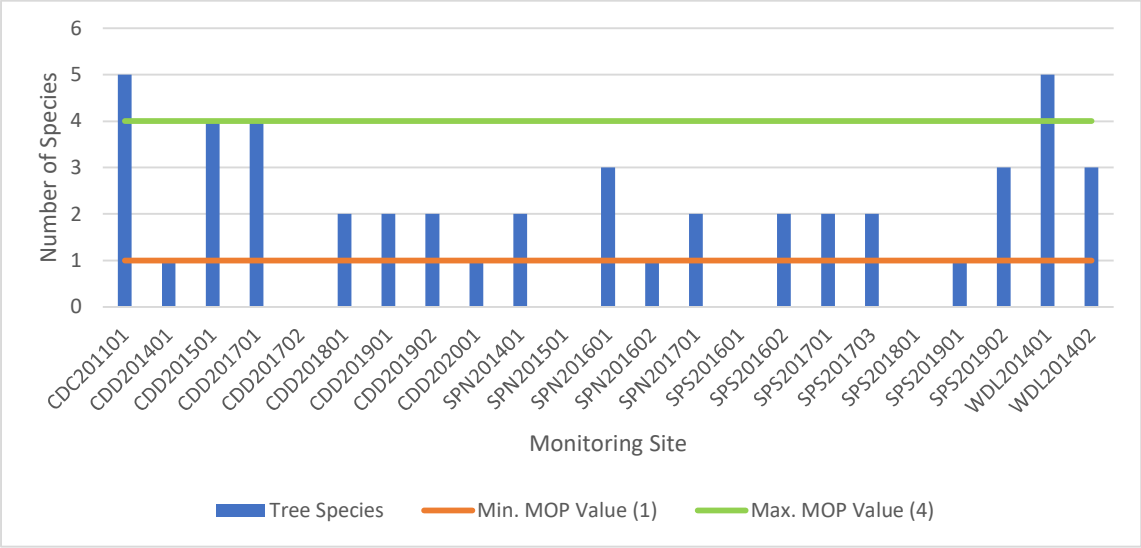


Figure 12 Tree Diversity per Site in the Central Area

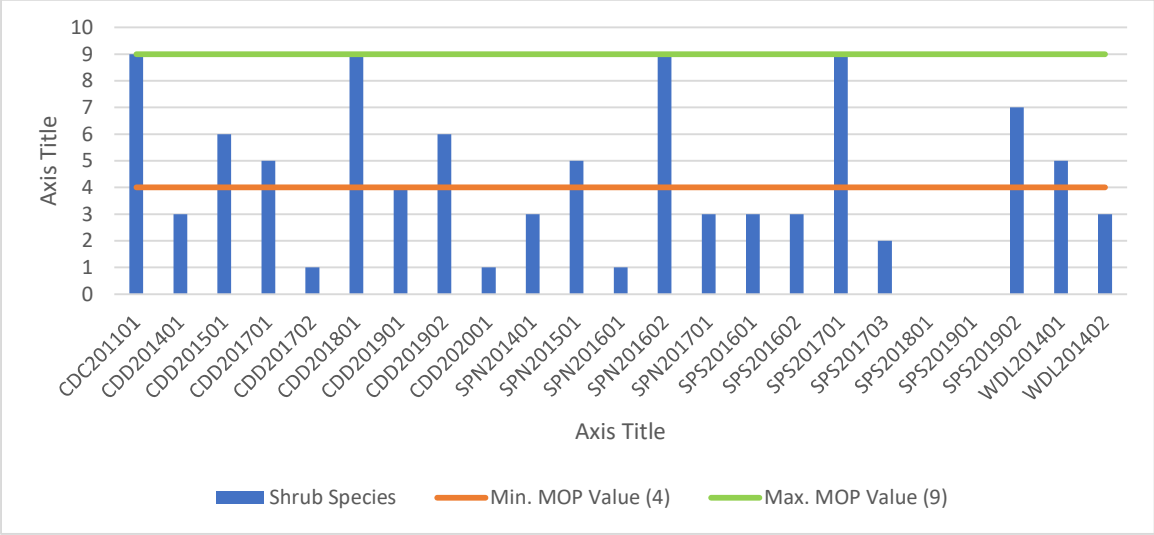


Figure 13 Shrub Diversity per Site in the Central Area

Figures 14 and **15** show the tree and shrub diversity at each site in the southern area. Most sites in the southern area have achieved the minimum MOP tree diversity score. Site MTO201702, MTO201703 and MTO202004 recorded no canopy species in the plot and remote sensing shows no canopy species surrounding these

sites. These areas are in early phase establishment and further monitoring is required to determine if infill planting is required.

Half of the southern area sites achieved the minimum MOP tree diversity score. These sites occurred to the south and west of the tailings dam. Sites MTO200001, MTO201702, MTO201703 and MTO202004 also provided values lower than the MOP limits for tree and shrub species richness. These sites are not currently trending towards the target vegetation community and will require additional planting and weed control.

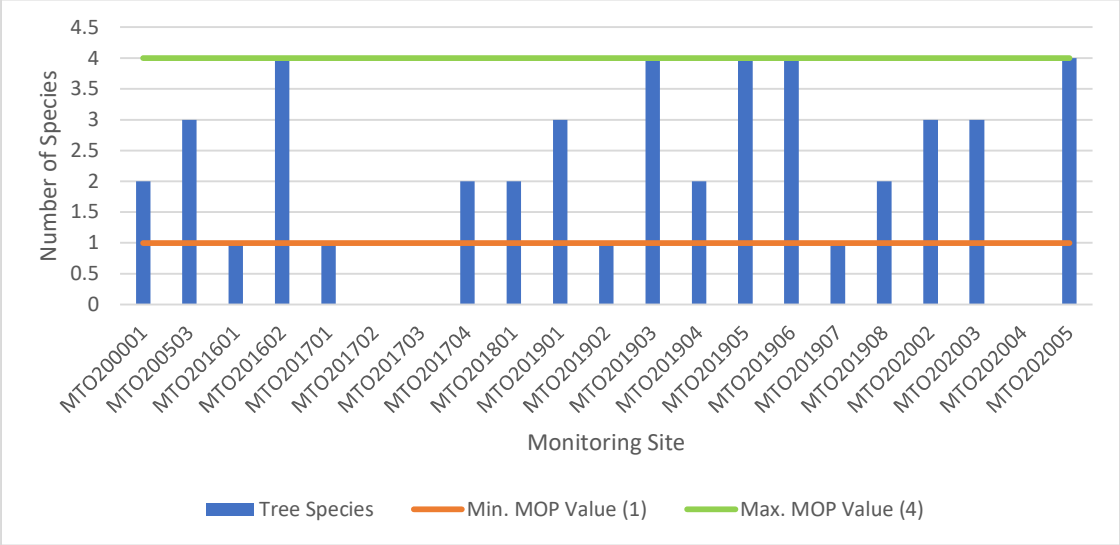


Figure 14 Tree Diversity per Site in the Southern Area

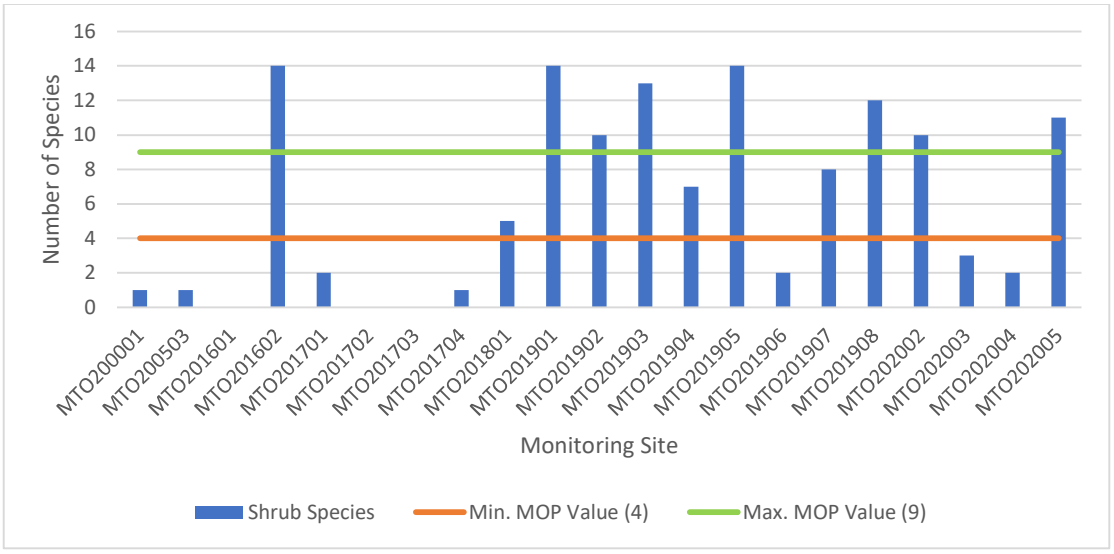


Figure 15 Shrub Diversity per Site in the Southern Area

3.3.3 Understorey Diversity

Understorey diversity is a measure in the Performance Criteria and trigger action response plan (TARP) in the MOP. Understorey species diversity (combination of grasses and other groundcover) is a measure in the TARP and the limit is based on the results from the reference sites, as specified in the TARP. The grass species diversity is a measure in the Performance Criteria and the limit is stated in the Performance Criteria. The below figures show both understorey and grass species diversity, and includes the minimum limits as specified the TARP/MOP.

Figure 16 provides the understorey and grass species diversity for the northern area. Most of the sites in the northern area did not achieve the understorey diversity of the reference sites. The species richness and cover from the BAM vegetation sampling indicates the northern area is generally progressing towards the target vegetation community, however the exotic grass cover is high and needs to be managed.

All sites, except NPN200501, achieve the grass species diversity minimum value from the Performance Criteria. This indicates the northern area has potential to progress towards the target vegetation community. Exotic grass cover is high throughout and needs to be managed to assist the progression of native species.

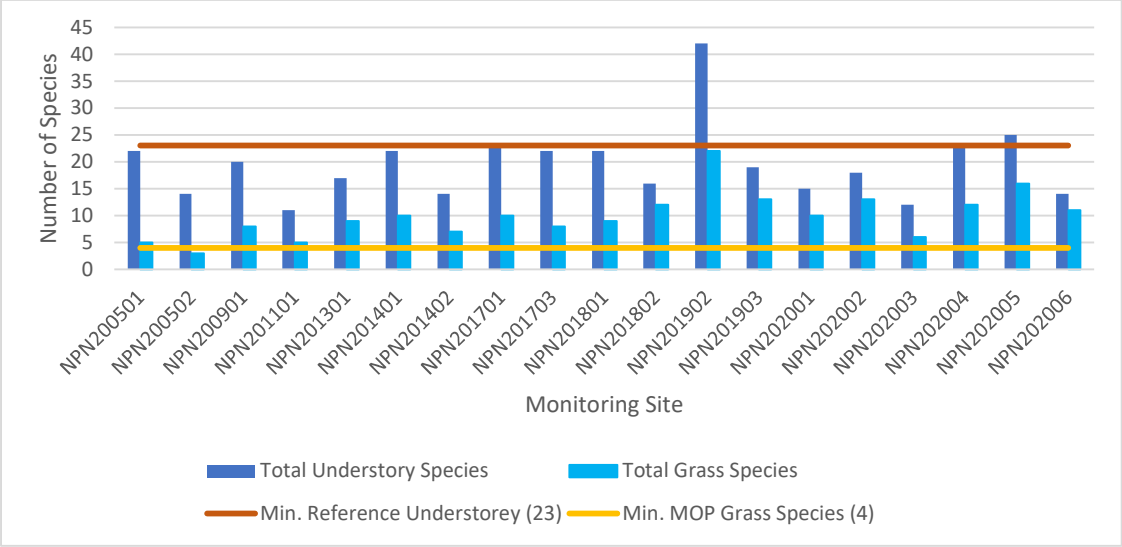


Figure 16 Understorey and Grass Species Diversity in the Northern Area

Figure 17 provides the understorey and grass species diversity for the northern area. A total of four of the 23 sites (17%) in the central area achieved the understorey diversity of the reference sites. This is to be expected in early phase restoration; however, some sites were established as early as 2011, 2014 and 2015 and are still providing low to moderate understorey species diversity. These sites have a dense canopy and mid-storey layer which is likely to suppress the establishment of understorey species. The wattle species (*Acacia* spp.) within these areas are likely

to die-back in the next five to eight years, due to the species being a relatively short-lived pioneer species, and therefore no management action is recommended. Exotic grass cover dominates the central area and will need to be managed to assist in the development of the target vegetation community.

All sites, except CDD201401 and SPS201801, achieve the grass species diversity minimum value from the Performance Criteria. This indicates the southern area has potential to progress towards the target vegetation community however, exotic grass cover is high throughout and needs to be managed to assist the progression of native species.

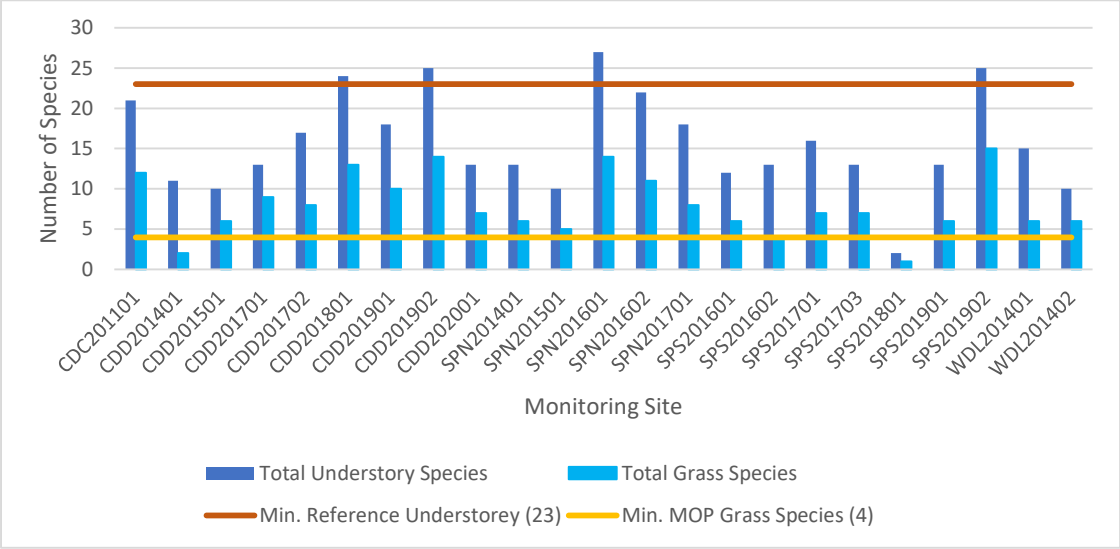


Figure 17 Understorey and Grass Species Diversity in the Central Area

Figure 18 provides the understorey and grass species diversity for the southern area. A total of seven of the 21 sites (33%) in the southern area achieved the understorey diversity of the reference sites. All sites, except CDD201401 and SPS201801, achieve the grass species diversity minimum value from the Performance Criteria. This indicates the southern area has potential to progress towards the target vegetation community. Exotic grass cover is high throughout and needs to be managed to assist the progression of native species.

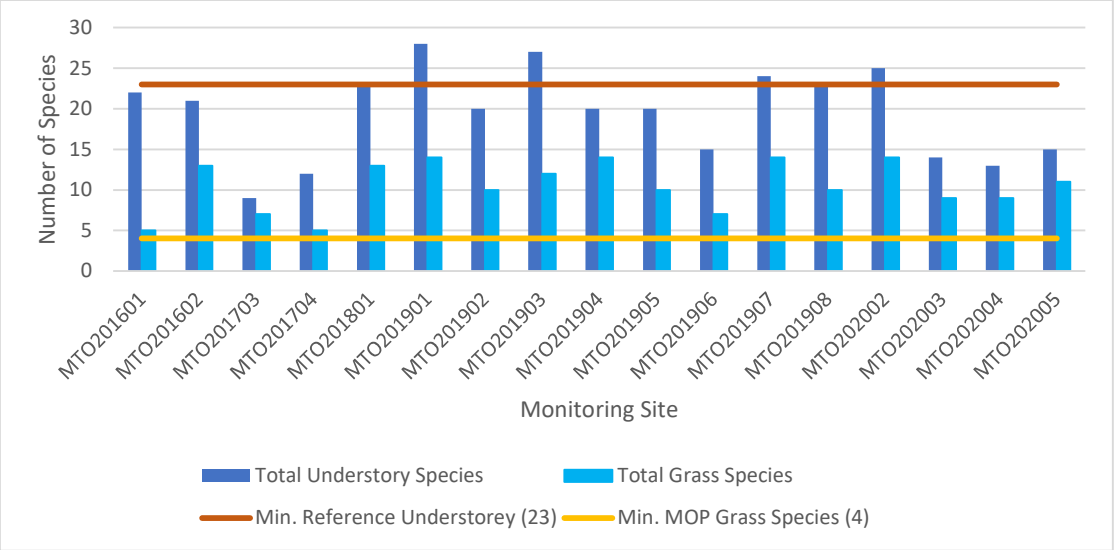


Figure 18 Understorey and Grass Species Diversity in the Southern Area

3.3.4 Assessment of Seed Mix

Germination rates of target native species was moderate to high at most sites. Seed mixes from 2014 to 2020 range from 58 species to 88 species in a seed mix. Each annual seeding program typically adds additional locally collected grass and ground cover species from offset areas and bufferland to the seed mix ordered. This section provides an analysis of species from the seed mix that were recorded commonly across the sites and species that were not recorded at any sites.

Table 3.10 shows the species from the seed mix that were commonly recorded across the sites. These species have good germination rates which should be considered when planning seed rates.

Table 3.10 Commonly Recorded Species from the Seed Mix

Acacia amblygona	*Atriplex semibaccata*	*Enchylaena tomentosa*
Acacia cultriformis	*Calotis lappulacea*	*Eucalyptus crebra*
Acacia decora	*Capillipedium spicigerum*	*Eucalyptus moluccana*
Acacia falcata	*Daviesia genistifolia*	*Hardenbergia violacea*
Acacia implexa	*Dodonaea viscosa subsp. cuneata*	
Acacia parvipinnula	*Einadia hastata*	*Indigofera australis*
Acacia salicina	*Einadia nutans*	*Myoporum montanum*
Acacia spectabilis	*Eromophylla debilis*	*Solanum cinereum*

Table 3.11 shows the species that were not recorded at any sites in 2021. Species such as *B. spinosa*, *Dianella* spp., *N. macrocarpa* and *P. linearis* are known to be difficult to germinate in nursery conditions and therefore expected to have poor germination success in mine rehabilitation. Other species may occur at low rates within the rehabilitation, or the seed rate could be increased to improve the abundance of germination in the rehabilitation. Consideration of seed cost and if the species is characteristic for the target Grey Box-Ironbark Woodland should be considered.

A. leuhmanii (Bulloak) should be sown at a low rate as this species can dominate disturbed area. *B. spinosa* , *N. macrocarpa* (native olive) and *C. endlicheri* (black cypress pine) may be more successful as a planting once the canopy and shrub layer mature.

Table 3.11. Species not recorded at Sites from the Seed Mix

Acacia brownii	*Dianella spp*	*Pandorea pandorana*
*Allocasuarina leuhmanii**	*Gahnia aspera*	*Persoonia linearis*
*Angophora floribunda**	*Imperata cylindrica*	*Podolepis neglecta*
*Brachychiton populneus**	*Kunzea ambigua*	
*Bursaria spinosa**	*Notelaea macrocarpa**	
*Callitris endlicheri**	*Leucopogon juniperinus*	

*indicates species listed as characteristic in the final determination for Central Hunter Grey Box-Ironbark Woodland.

3.4 Landscape Function Analysis

Landscape function analysis (LFA) provides a visual method of measuring soil function based on characteristics which generate scores to reflect the overall stability, nutrient function, and infiltration of the soil. The landscape organisation index provides a measure of bare ground and ground with cover at each monitoring site.

Appendix 1 provides the LFA site features, including slope angle, bearing and soil texture type. In general, the reference sites ranged in slope from one to six degree slopes, bearing of north and south and soil texture of sandy loam soils. The northern and central area ranged in slope from zero to 12 degrees, bearing in all directions and soil texture of sandy loam. The southern area ranged in slope from zero to ten degrees, bearing in all directions and soil texture of sandy loam.

3.4.1 Landscape Organisation Index

The landscape organization index is the proportion of the length of patch to the total length of the transect. As an example, a totally bare transect would have an index of 0, or if it was all patch (*e.g.*, a sward) the index would be 1 (Tongway and Hindley 2004). A patch is an area where valuable resources such as soil and leaf litter tend to accumulate (such as perennial grass, herbs and shrubs) whereas an interpatch is where resources are transported away (such as bare ground).

A summary of the LOI values at each transect are provided in **Figures 19**, **20** and **21**. This shows that 47 rehabilitation sites (75%) achieved the MOP Performance Criteria minimum LOI index of 0.84, indicating good ground cover with few areas of potential runoff (bare earth/inter-patches). This data indicates that these sites provide good soil stability and accumulation of organic matter, resulting in good development of the soil profile. The sites with low LOI recorded a high cover of annual grasses and were generally on flat terrain, therefore no action is required.

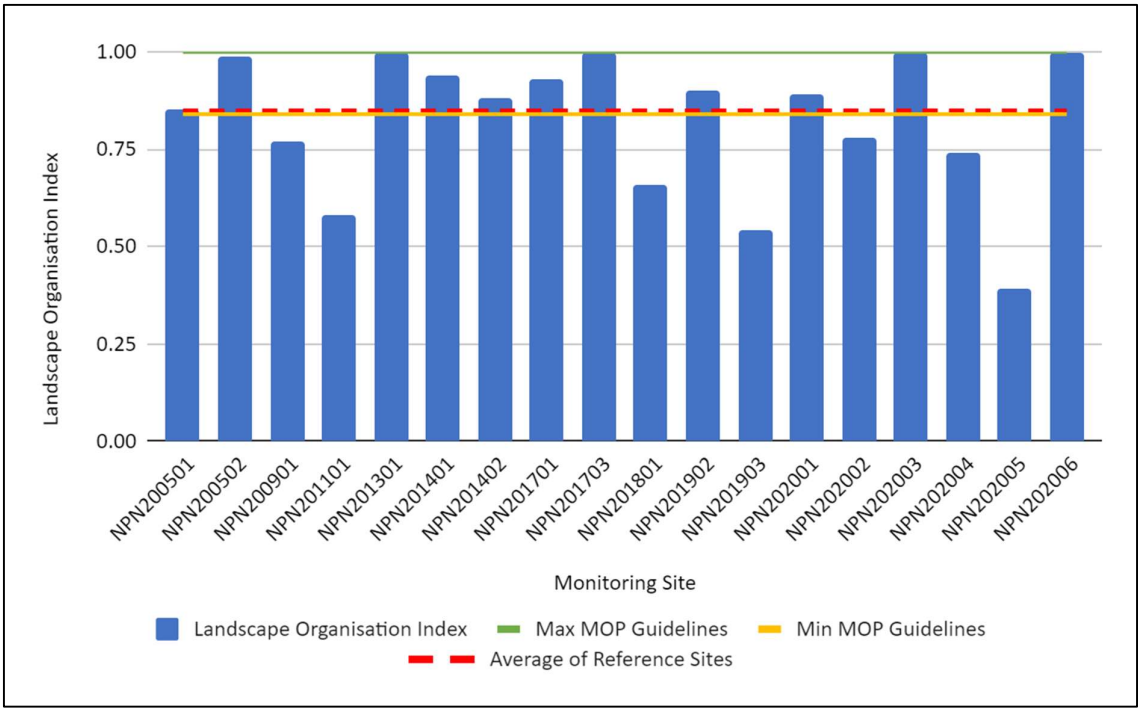


Figure 19 Landscape Organisation Index for Monitoring Sites in the Northern Area

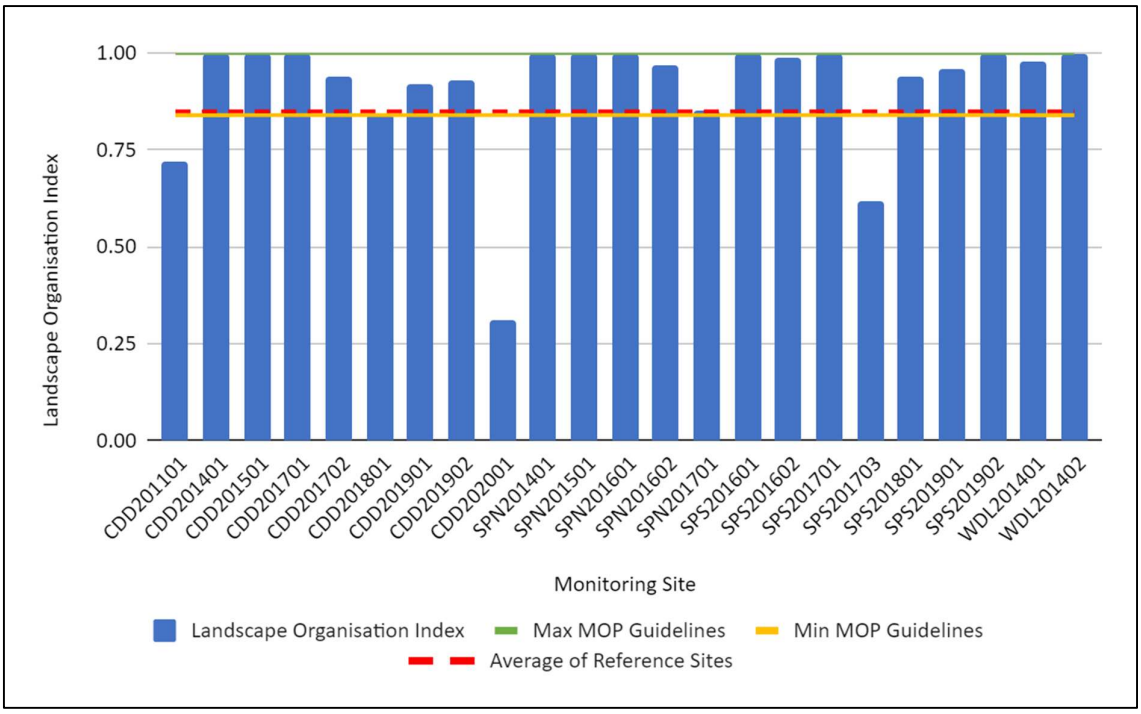


Figure 20 Landscape Organisation Index for Monitoring Sites in the Central Area

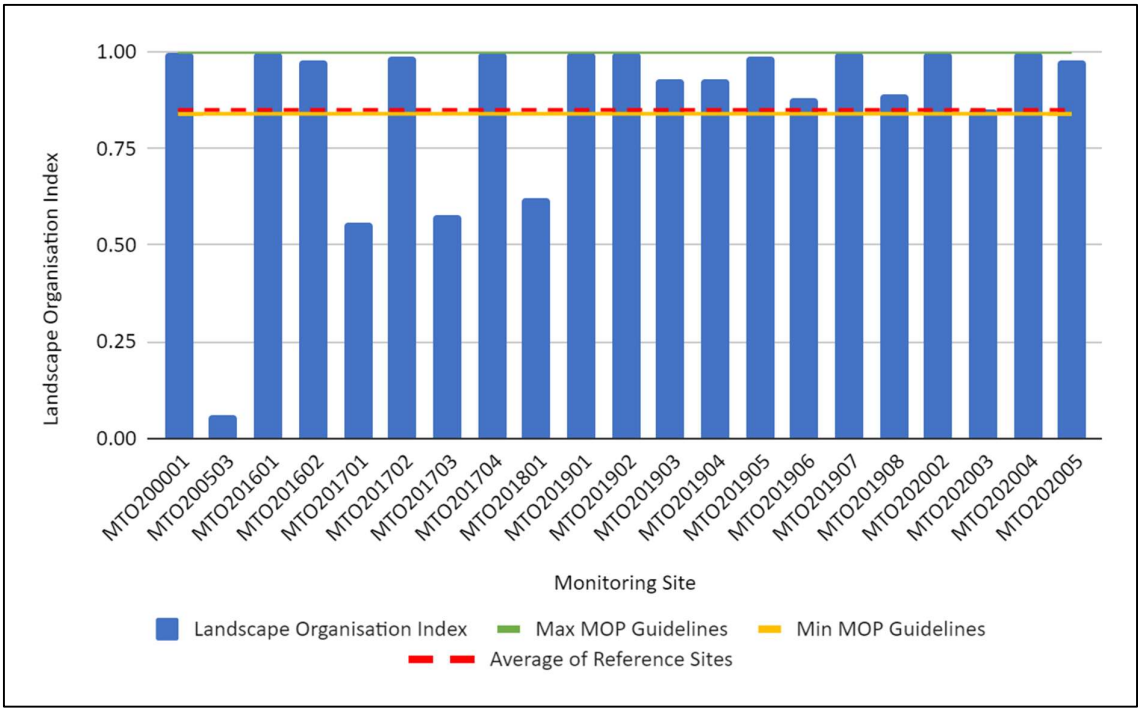


Figure 21 Landscape Organisation Index for Monitoring Sites in the Southern Area

3.4.2 Soil Stability

The indices (or score) for soil stability are collated from several attributes recorded in the Soil Stability Assessment. These include soil cover, litter cover, cryptogram cover, crust broken-ness, erosion type and severity, deposited materials, surface resistance to disturbance and the slake test.

A summary of the Soil Stability Indices at each transect is provided in **Figures 22**, **23** and **24**. This shows that all sites, except MTO201701, achieved the minimum MOP Performance Criteria for Stability of 53.9. Periods of high rainfall have led to an abundance and dense cover of grass and groundcover species, contributing to the overall soil stability in the rehabilitation sites. MTO201701 (**Figure 24**) was slightly below the Performance Criteria for Stability. However, this site occurs on relatively flat terrain and is dominated by annual grass species, therefore no action is required.

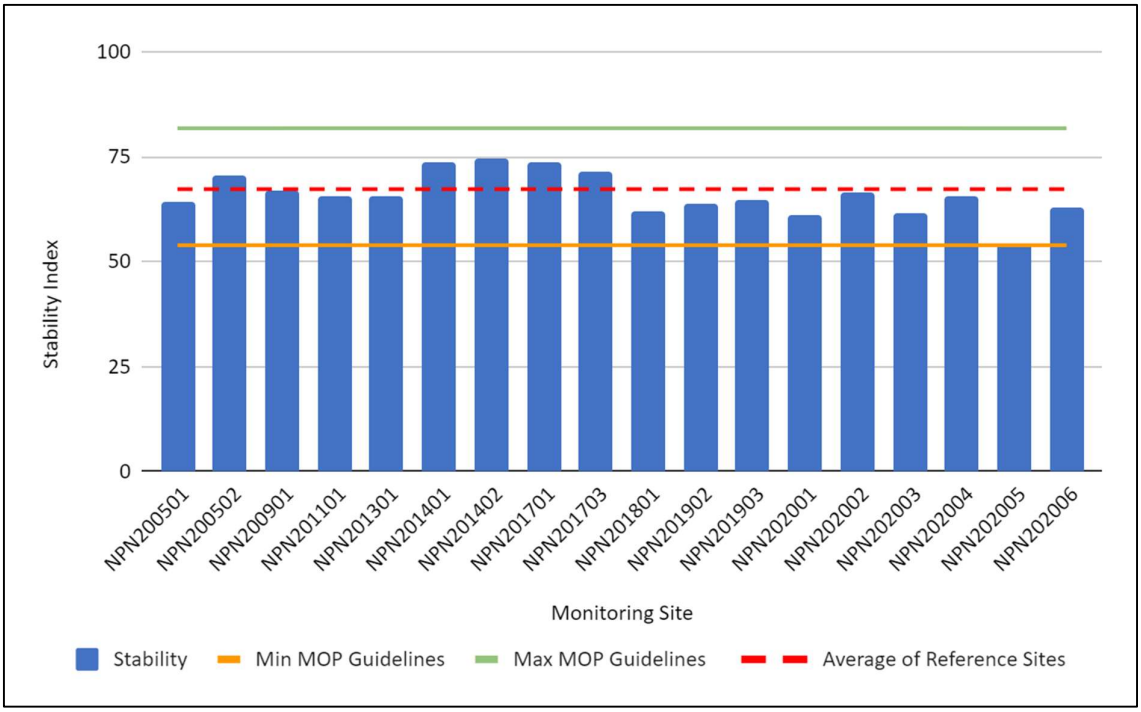


Figure 22 Stability Index Scores for Monitoring Sites in the Northern Area

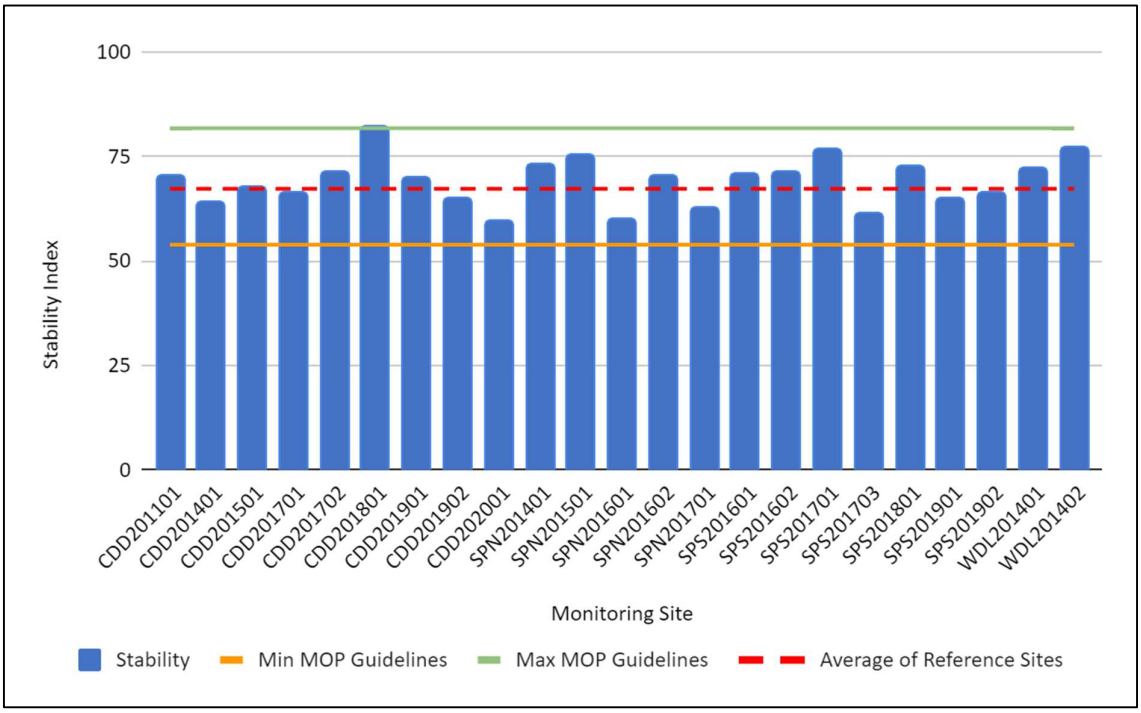


Figure 23 Stability Index Scores for Monitoring Sites in the Central Area

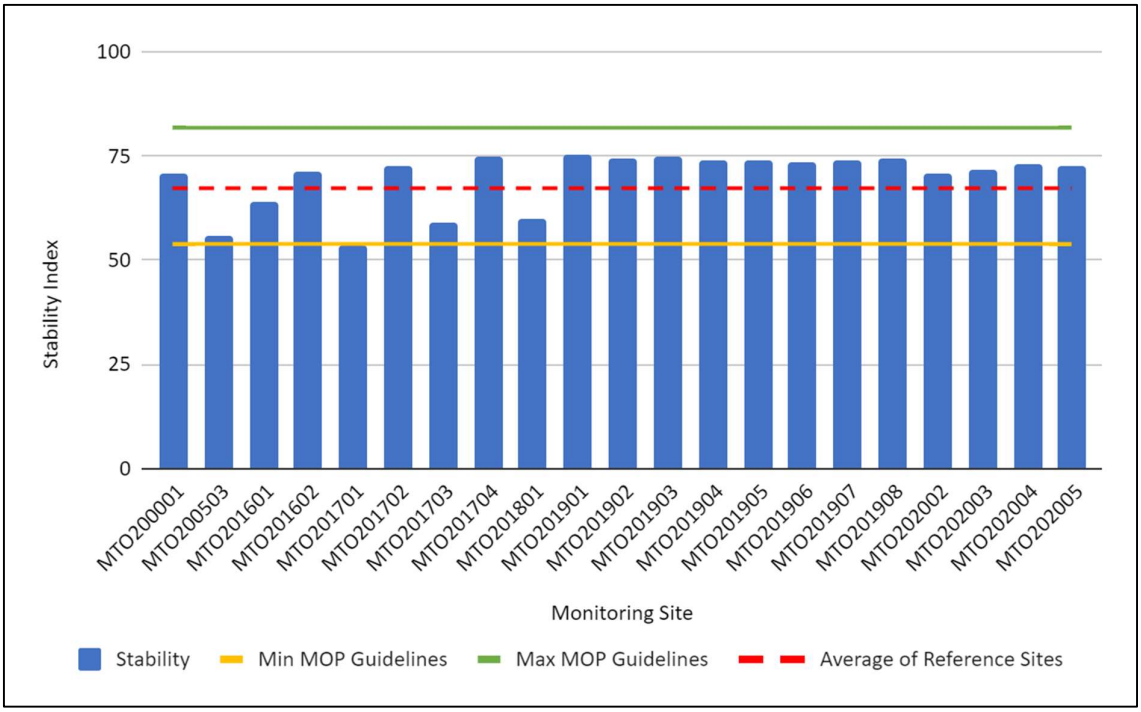


Figure 24 Stability Index Scores for Monitoring Sites in the Southern Area

3.4.3 Soil Infiltration

Soil infiltration assesses the basal grass/canopy cover, litter cover, soil surface roughness, slake test and soil texture, to account for the ability of these factors to contribute to infiltration of water into the soil.

The results of the Soil Infiltration values for each site are provided in **Figures 25**, **26** and **27**. These results show that 45 rehabilitation sites (71%) achieved the minimum MOP Performance Criteria for Soil Infiltration of 48.4. The sites with lower Infiltration scores provided lower perennial grass and litter cover and less surface roughness. A high cover of annual grasses was recorded at these sites, which is likely to increase the litter cover over time. Perennial grass and groundcover species are likely to establish over time and therefore no action is required.

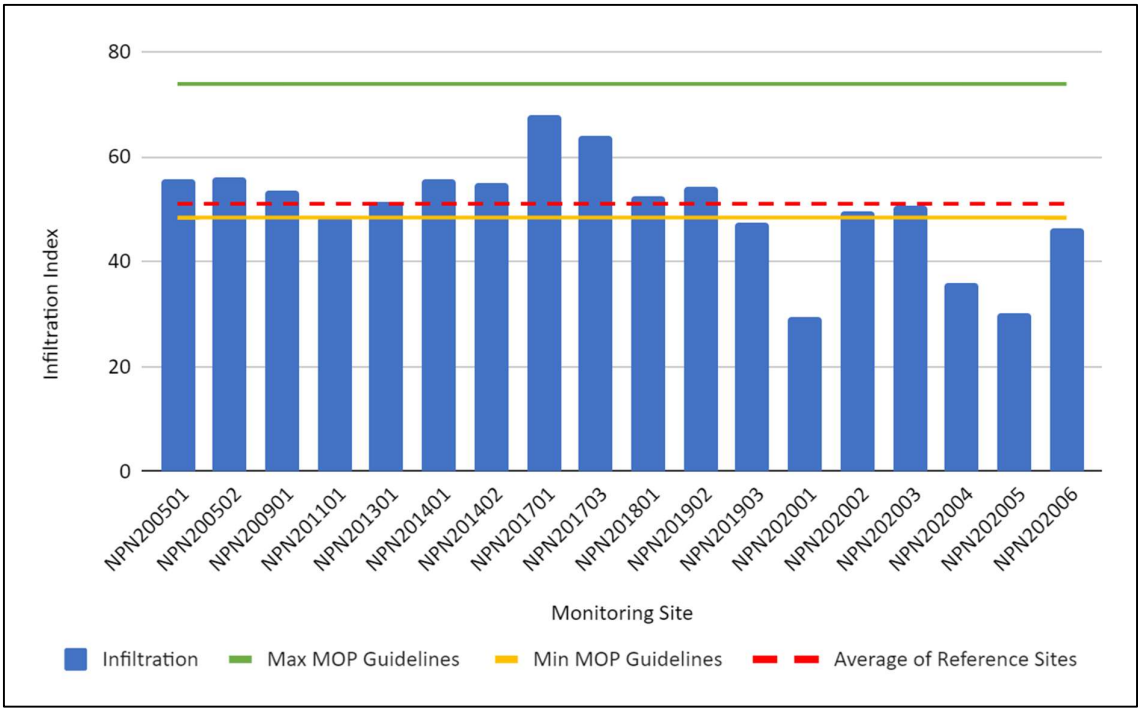


Figure 25 Infiltration Index Scores for Monitoring Sites in the Northern Area

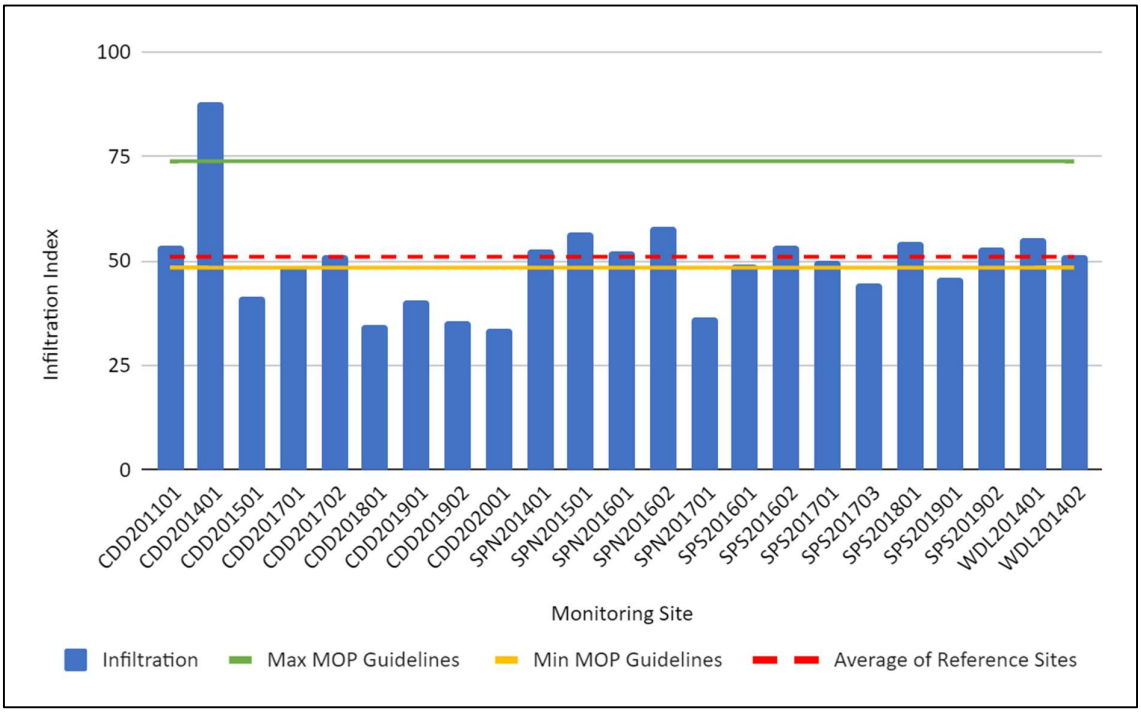


Figure 26 Infiltration Index Scores for Monitoring Sites in the Central Area

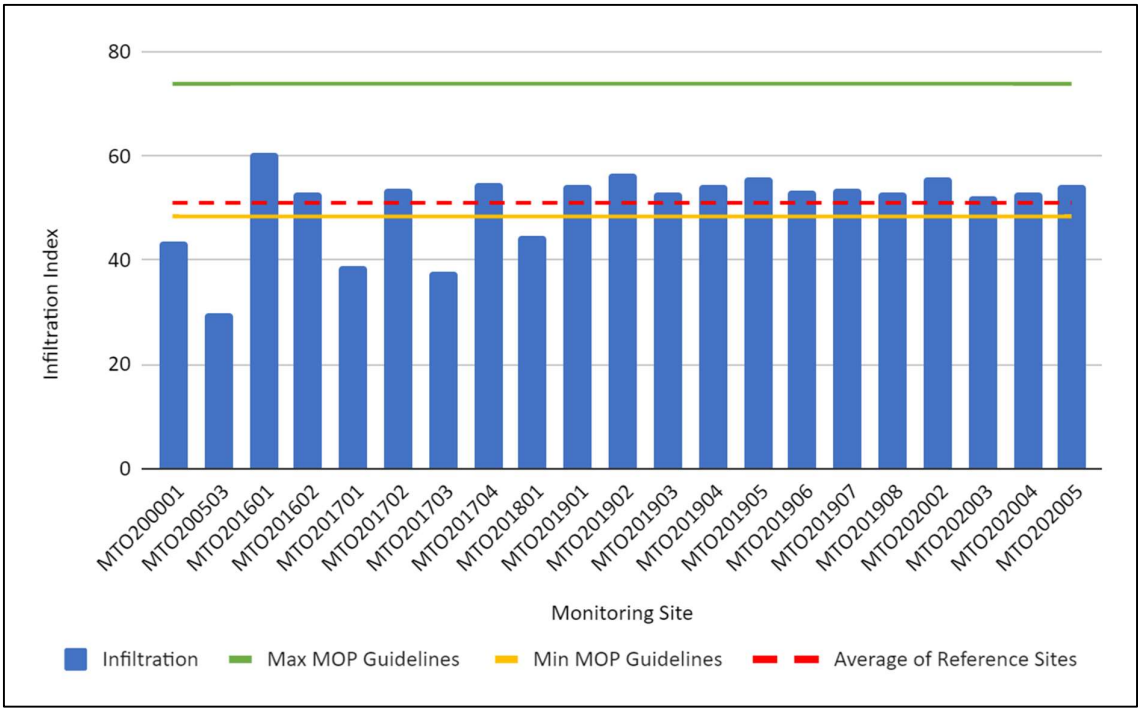


Figure 27 Infiltration index Scores for Monitoring Sites in the Southern Area

3.4.4 Soil Nutrients

Soil Nutrients, or the cycling of nutrients within the soil system, is assessed by basal cover of perennials, litter cover, cryptogram cover and soil surface roughness. The results of the Soil Nutrient values for each site are provided in **Figure 28**, **29** and **30**. These results show that 57 rehabilitation sites (90%) achieved the minimum MOP Performance Criteria for Soil Nutrients of 38.5.

The sites with lower Nutrient scores provided a lower leaf litter and perennial grass cover, no cryptogram (lichens, fungus and mosses etc) and low surface roughness. A high cover of annual grasses was recorded at these sites, which is likely to increase the litter cover over time. Perennial grass, groundcover and cryptogram cover are likely to develop over time and therefore no action is required.

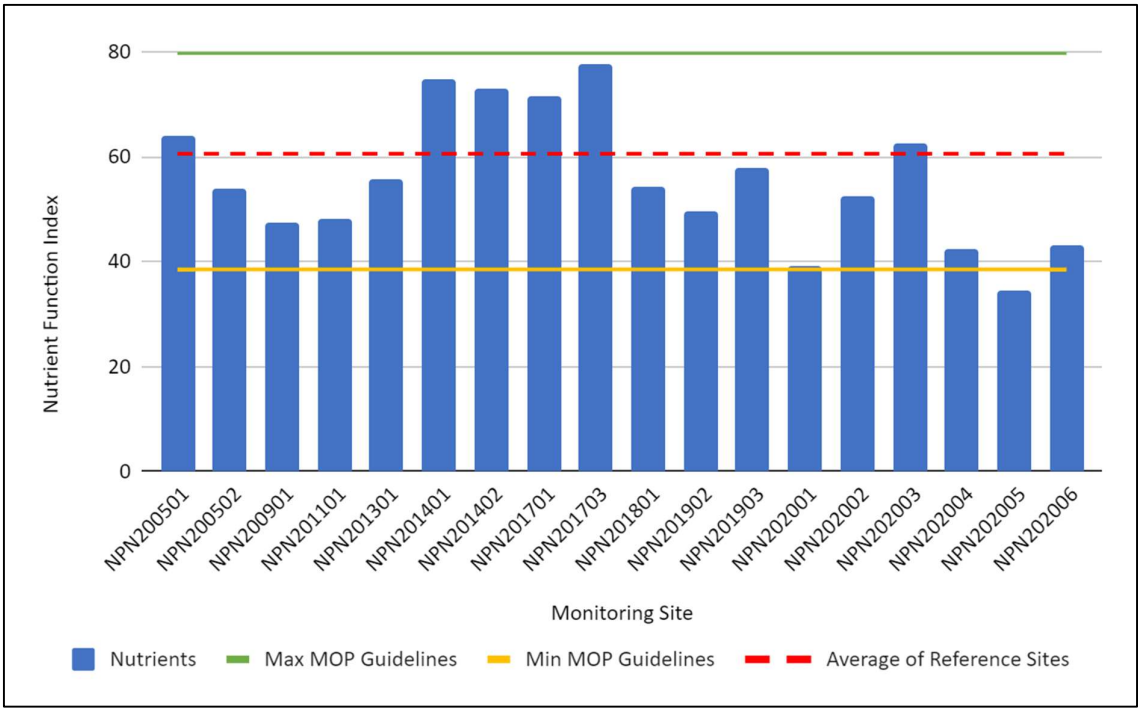


Figure 28 Nutrient Function Index Scores for Monitoring Sites in the Northern Area

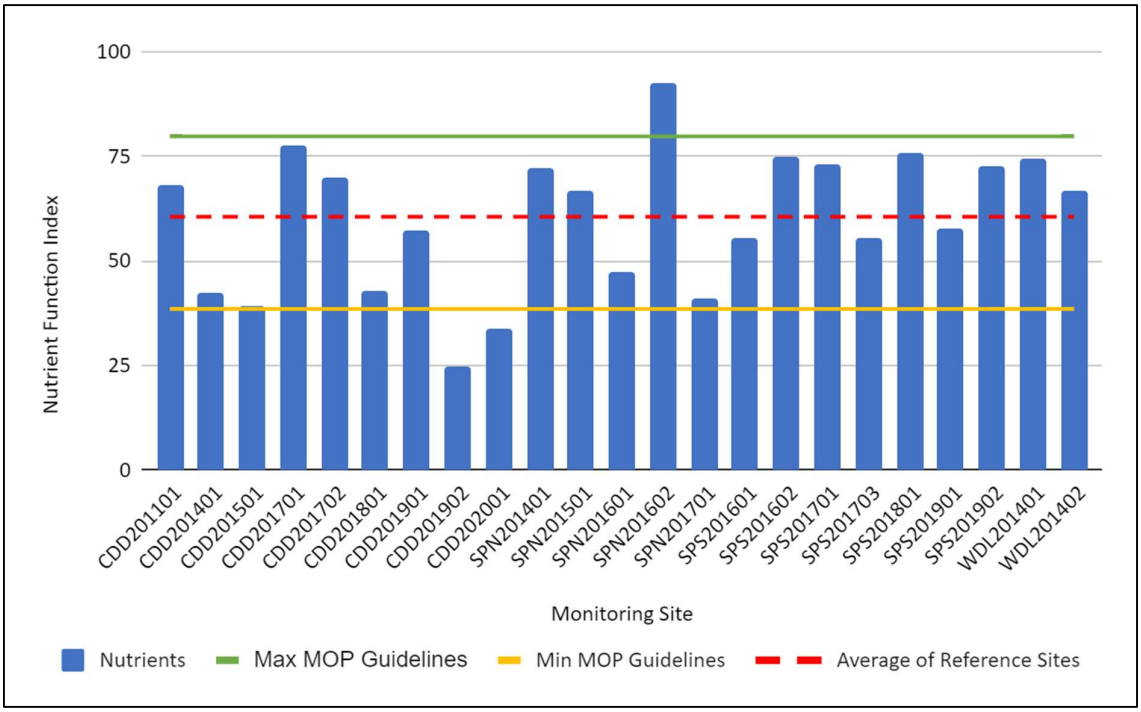


Figure 29 Nutrient Function index Scores for Monitoring Sites in the Central Area

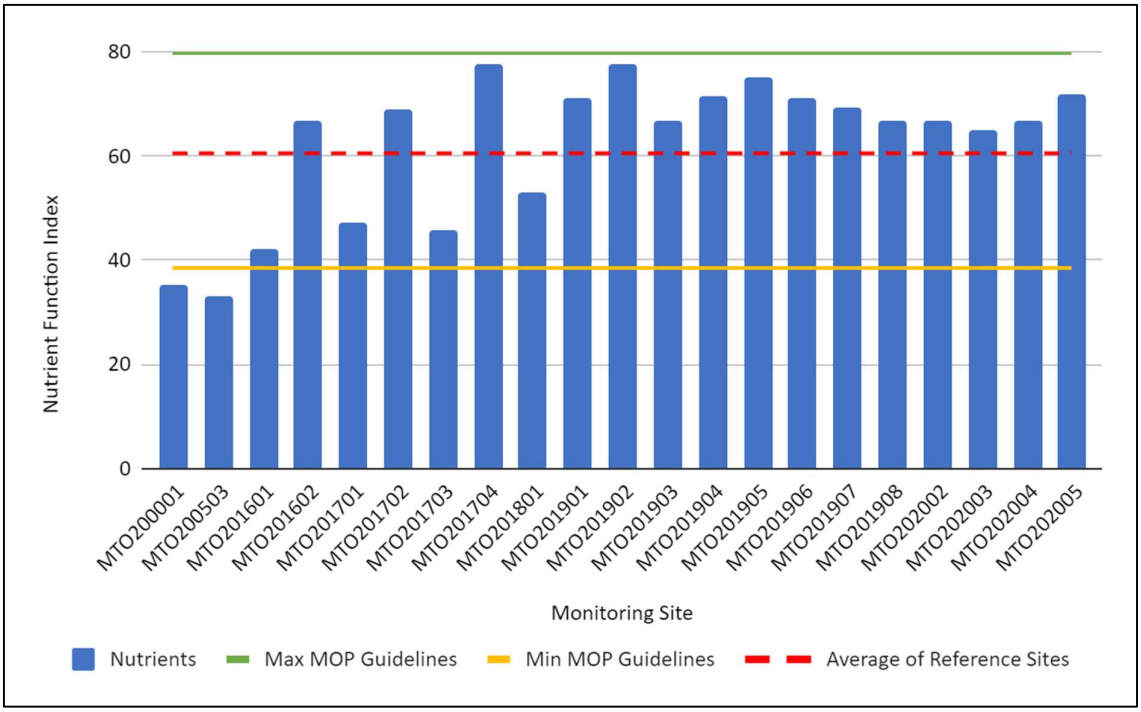


Figure 30 Nutrient Function index Scores for Monitoring Sites in the Central Area

3.5 Soil Assessment

The following section outlines the results of the soil assessment.

3.5.1 Soil Characterisation

The following section outlines the results of the soil characterisation assessment. Raw data tables from the soil assessment are provided in **Appendix 4**. Indicative guidelines provided in the tables have been developed from the MOP Performance Criteria and reference sites results. The results have been grouped by sites to the northern area (**Table 3.12**), central area (**Table 3.13**) and southern area (**Table 3.14**) for ease of comparison. The colour coded tables below follow the benchmark colour code provided in **Table 3**.

3.5.1.1 Northern Area

The soil assessment results for the northern area are generally in line with the MOP and reference site guidelines. The EC and organic carbon are within MOP and reference site guidelines at all sites. These are indicators of good soil health. The pH was slightly elevated at site NPN202001 and within limits at all other sites. Due to the minor elevated level at NPN202001, no further action is required.

Soil phosphorus levels were high at several sites. These sites generally provided a higher cover of weed species, as expected with high soil phosphorus. Additional weed control may be required at these sites. Ensure only low phosphorus soil ameliorants are applied to rehabilitation areas and do not apply fertiliser to the rehabilitation area. Excessively high phosphorus can result in stunted growth of plants, leaf distortions and delayed maturity. Evidence of poor plant growth/disease was not observed during the monitoring program and therefore no further action is required.

The cation exchange capacity (CEC) provides a measure of the soils ability to store nutrients. CEC is low at sites NPN201401, NPN201801, NPN202002, NPN202004 and NPN202006. There sites may result in slower plant growth however as the soil profile develops with increase litter and organic matter, plant growth should be acceptable for the target vegetation community. Evidence of poor plant growth/disease was not observed during the monitoring program and therefore no further action is required.

The exchangeable sodium percentage (ESP) measures the proportion of CEC occupied by sodium. Sites NPN201903, NPN202001 and NPN202002 provide high ESP indicating sodic soils at these locations. Natural rainfall over time should reduce the sodicity in the soil and therefore no further action is required.

The calcium magnesium ratio was higher than the MOP and reference site guidelines for sites NPN201301, NPN201801, NPN202003, NPN202004 and

NPN202006 however, these results are not excessively high from an agricultural perspective. These high calcium magnesium ratio levels do not typically inhibit growth. Site NPN201402 provided extremely high magnesium levels, which can inhibit the uptake of calcium and visually result in stunted growth and dark coloured vegetation. Evidence of poor plant growth/disease was not observed during the monitoring program and therefore no further action is required.

Table 3.12. Soil Assessment Results for Monitoring Sites in the Northern Area

Monitoring Site	pH	EC (dS/m)	Soil - P (Colwell - ppm)	Organic Matter (% OM)	(CEC) (cmol+/kg)	Exchangeable Sodium % (ESP)	Ca/Mg ratio
NPN200501	6.77	0.056	17	4.4	12	2.3	0.99
NPN200502	6.81	0.056	17	4.1	9.9	1.8	0.74
NPN200901	6.46	0.049	16	3.9	13	1.3	0.92
NPN201101	8.20	0.088	16	3.3	13	0.58	1.9
NPN201301	7.15	0.067	30	3.8	13	3.0	2.4
NPN201401	6.73	0.053	28	4.4	12	1.5	1.7
NPN201402	6.02	0.039	25	3.1	4.2	0.80	6.1
NPN201703	7.76	0.105	63	6.8	18	2.4	1.9
NPN201801	7.07	0.041	30	3.1	5.00	1.0	3.6
NPN201902	6.44	0.053	16	4.5	7.5	2.3	2.1
NPN201903	8.01	0.159	46	4.0	13	11	1.6
NPN202001	8.83	0.113	83	6.4	11	11	0.92
NPN202002	7.08	0.102	16	3.7	7.1	12	1.5
NPN202003	6.52	0.105	74	4.6	8.5	3.7	3.5
NPN202004	6.80	0.075	110	4.2	7.00	5.9	3.3
NPN202005	7.79	0.063	21	3.2	8.2	6.9	1.3
NPN201901	6.89	0.061	62	4.7	7.2	4.4	2.8
Reference Site Range	5.14-6.61	0.035-0.090	15-23	4.2-6.9	6.8-18	2.9-7.3	0.55-2.1
MOP Target Rage	5.5-8.5	<2	1.2-13	1.6-8.7	7.4-20.4	0.2-8.7	0.7-2.1

3.5.1.2 Central Area

The soil assessment results for the central area are generally in line with the MOP and reference site, with EC within limits at all sites. The organic carbon is high at several sites and CEC is slightly elevated at site SPS201601. These are indicators of good soil health and therefore have been allocated green, although they fall outside the MOP and reference site guidelines. The pH was slightly elevated at several sites however, due to the minor elevated level no further action is required.

The soil phosphorus levels were high at several sites, resulting in a higher cover of weed species, as expected. Additional weed control may be required at these sites. Ensure only low phosphorus soil ameliorants are applied to rehabilitation areas and do not apply fertiliser to the rehabilitation area. Excessively high phosphorus can result in stunted growth of plants, leaf distortions and delayed maturity. Evidence

of poor plant growth/disease was not observed during the monitoring program and therefore no further action is required.

The ESP is slightly elevated (sodic) at sites CDD201701, CDD201902, CDC202001, SPN201601, SPS201701, SPS201901, WDL201401 and high (highly sodic) at site CDD201901. Natural rainfall over time should reduce the sodicity in the soil. Evidence of poor plant growth/disease was not observed during the monitoring program and therefore no further action is required.

The calcium magnesium ratio indicates high magnesium at sites CDD201401, CDD201901, CDC201902, SPN201601 and SPN201501. These levels are unlikely to be high enough to impact growth. Evidence of poor plant growth/disease was not observed during the monitoring program and therefore no further action is required.

Table 3.13. Soil Assessment Results for Monitoring Sites in the Central Area

Monitoring Site	pH	EC (dS/m)	Soil - P (Colwell - ppm)	Organic Matter (% OM)	(CEC) (cmol+/kg)	Exchangeable Sodium % (ESP)	Ca/Mg ratio
CDD201101	6.54	0.053	15	4.2	12	5.1	0.94
CDD201401	7.80	0.096	68	8.6	18	2.8	2.6
CDD201501	8.67	0.107	20	9.1	12	1.0	1.5
CDD201701	7.85	0.137	20	3.4	11	13	1.2
CDD201702	7.62	0.119	49	4.3	11	7.9	2.0
CDD201801	7.98	0.125	47	14	18	6.5	1.7
CDD201901	9.10	0.251	133	9.4	15	17	3.1
CDD201902	7.73	0.182	75	6.0	14	11	2.6
CDD202001	7.77	0.124	81	5.6	13	9.2	1.5
SPN201401	8.19	0.093	21	5.4	15	3.1	1.2
SPN201501	8.00	0.133	110	11	20	1.8	3.7
SPN201601	7.75	0.129	36	6.5	17	7.2	2.3
SPN201701	7.95	0.140	43	5.5	13	10	2.0
SPS201601	8.69	0.176	24	11	23	9.8	0.87
SPS201602	7.48	0.319	36	4.9	19	4.4	2.0
SPS201701	8.10	0.090	34	5.7	11	7.8	2.1
SPS201703	8.57	0.117	20	5.2	13	6.5	1.1
SPS201801	8.29	0.098	22	7.8	16	2.6	1.9
SPS201901	9.00	0.163	43	5.1	14	15	2.1
SPS201902	7.27	0.069	55	4.0	8.3	6.1	1.9
WDL201401	7.63	0.185	39	6.3	16	15	1.1
WDL201402	7.70	0.096	35	7.9	16	2.2	1.4
Reference Site Range	5.14-6.61	0.035-0.090	15-23	4.2-6.9	6.8-18	2.9-7.3	0.55-2.1
MOP Target Range	5.5-8.5	<2	1.2-13.00	1.6-8.7	7.4-20.4	0.2-8.7	0.7-2.1

3.5.1.3 Southern Area

The soil assessment for the sites in the southern area show the results are generally in line with the MOP and reference site guidelines. The EC, organic carbon and CEC are within MOP and reference site guidelines at all sites. These are indicators of good soil health. The pH was slightly elevated at several sites however, due to the minor elevated level no further action is required.

Soil phosphorus levels were high at several sites. These sites generally provided a higher cover of weed species, as expected with high soil phosphorus. Additional weed control may be required at these sites. Ensure only low phosphorus soil ameliorants are applied to rehabilitation areas and do not apply fertiliser to the rehabilitation area. Excessively high phosphorus can result in stunted growth of plants, leaf distortions and delayed maturity. Evidence of poor plant growth/disease was not observed during the monitoring program and therefore no further action is required.

The ESP is slightly elevated (sodic) at sites MTO200503, MTO202004 and MTO201701 and high (highly sodic) at sites MTO201905, MTO201906, MTO202002, MTO202003 and MTO202005. Natural rainfall over time should reduce the sodicity in the soil. Evidence of poor plant growth/disease was not observed during the monitoring program and therefore no further action is required.

The calcium magnesium ratio indicates high magnesium at sites MTO201602, MTO201704, MTO201901, MTO201904, MTO202004, MTO201903 and very high for sites MTO201701 and MTO201702. Site MTO202005 had lower calcium magnesium ratio compared to the reference range. These levels are unlikely to be high/low enough to impact growth. Evidence of poor plant growth/disease was not observed during the monitoring program and therefore no further action is required.

Table 3.14. Soil Assessment Results for Monitoring Sites in the Southern Area

Monitoring Site	pH	EC (dS/m)	Soil - P (Colwell - ppm)	Organic Matter (% OM)	(CEC) (cmol+/kg)	Exchangeable Sodium % (ESP)	Ca/Mg ratio
MTO200001	6.80	0.062	26	3.2	9.8	6.8	0.76
MTO200503	7.38	0.238	16	2.1	12	9.3	0.95
MTO201601	7.00	0.299	31	5.9	13	8.5	2.0
MTO201908	7.85	0.071	21	6.4	7	6.7	2.2
MTO201701	9.17	0.277	79	11	18	14	4.6
MTO201702	8.46	0.161	87	8.0	18	7.2	4.7
MTO201703	8.92	0.122	25	5.6	14	5.7	1.9
MTO201704	7.37	0.066	26	3.9	10	4.1	3.1
MTO201801	7.16	0.069	17	4.8	11	4.4	1.4
MTO201901	7.09	0.116	77	5.4	13	5.3	2.3
MTO201902	7.18	0.066	65	5.5	11	3.3	1.9
MTO201903	6.42	0.117	79	4.6	7.0	1.0	3.3
MTO201904	7.85	0.070	22	6.3	12	1.0	2.6

Monitoring Site	pH	EC (dS/m)	Soil - P (Colwell - ppm)	Organic Matter (% OM)	(CEC) (cmol+/kg)	Exchangeable Sodium % (ESP)	Ca/Mg ratio
MTO201905	6.17	0.278	22	4.2	9.4	16	0.91
MTO201906	8.79	0.263	89	6.7	13	22	2.0
MTO201907	7.01	0.082	85	5.0	14	3.5	1.9
MTO201908	8.23	0.138	46	5.8	14	4.1	2.0
MTO202002	7.24	0.433	57	3.2	11	28	0.95
MTO202003	9.75	0.265	32	4.3	9.6	23	2.0
MTO202004	7.58	0.112	161	6.1	9.3	12	2.7
MTO202005	7.87	0.094	14	4.9	8.3	19	0.48
Reference Site Range	5.14-6.61	0.035-0.090	15-23	4.2-6.9	6.8-18	2.9-7.3	0.55-2.1
MOP Target Range	5.5-8.5	<2	1.2-13.00	1.6-8.7	7.4-20.4	0.2-8.7	0.7-2.1

3.5.2 Microbial Assessment

Microbial activity is an indicator of health of an ecosystem. If soil microbial health and activity is good, then the ecosystems will function efficiently, and plant growth is high. If microbial health and activity is poor, then ecosystem function will be limited and plant growth may reduce or fail.

Microbial soil assessment results for reference sites are provided in **Table 3.15**. Microbial activity, soil basal respiration and soil microbial biomass carbon at the analogue sites are generally in range of the guidelines; based on the Microbiology Laboratories Australia (MLA) guidelines for agriculture. Site WarkGB01 provided low microbial activity, soil basal respiration and soil microbial biomass. The vegetation at the site was in good health, with no notable die-back, insect attack or disease present. No action is required.

Table 3.15. Microbial Soil Assessment Results for Reference Sites

Parameter	Unit	Monitoring Site						Guideline
		WamboGB 01	WamboGB 02	WarkGB 01	WarkGB 02	WarkGB 03	WarkGB 04	
Microbial Activity Indicator		44.1	43.7	25	43.7	43.4	42.1	40-80
Soil Basal Respiration	Mg CO2/kg /day	394	391	232	391	388	378	300-680
Soil Microbial Biomass Carbon	Mg/kg	2358	2337	1482	2337	2332	2265	2000-400

Microbial soil assessment results for rehabilitation sites are provided in **Table 3.16**. Microbial activity, soil basal respiration and soil microbial biomass carbon for sites

CDD201401, NPN200901, NPN201101, NPN201301 and SPN201401 are within range of the guidelines. Sites CDD201101, CDD201501 and NPN200501 provided low microbial activity, soil basal respiration and soil microbial biomass. It is noted however that the values at these sites still exceeded the values at one of the reference sites WARKGB01. The vegetation at these sites was in good health, with no notable die-back, insect attack or disease present. Low soil basal respiration may be the result of compact soils however may be the result of low available carbon. No action is currently required.

Table 3.16. Microbial Soil Assessment Results for Rehabilitation Sites

Parameter	Unit	Monitoring Site								Guideline	Reference Site
		CDD 201101	CDD 201401	CDD 201501	NPN 200501	NPN 200901	NPN 201101	NPN 201301	SPN 201401		
Microbial Activity Indicator		36.2	68.7	25.3	31.4	60	63.6	63.7	53.2	40-80	25-44
Soil Basal Respiration	Mg CO2/kg/day	328	586	235	287	520	548	549	467	300-680	232-394
Soil Microbial Biomass Carbon	Mg/kg	1995	3484	1496	1774	3085	3249	3256	2771	2000-4000	1482-2358

3.6 Development of Native Woodland Ecosystems

Establishing a native ecosystem is a complicated process which relies on many factors for success. Often one technique will work during one season or climatic condition and not in another. No one technique or maintenance method will guarantee success in establishing a native ecosystem. Management measures must be adaptive and consider climatic and seasonal variations for all management actions. Regular monitoring of management actions is essential.

The below section provides indicative management actions to assist in the development of natural ecosystems. These management actions can be adapted for different vegetation types based on the occurrence of weed species and vegetation formations in which they occur. Specific areas are referenced as much as possible however the techniques can be adapted across the landscape.

3.6.1 Woodland EEC Area Dominated by Introduced Grasses

Woodland EEC rehabilitation areas dominated by introduced grass species include the western side of the northern area, most of the central area and the western side of the southern area. These areas are dominated by Rhodes grass, green panic and galenia. Native and introduced canopy and mid-storey species occur throughout these areas.

A long-term approach to management is required in these areas, including control of woody weeds and control of exotic pasture species. Woody weeds, such as golden wreath wattle and galenia, must be targeted and removed from these areas to establish a locally occurring vegetation community. Significant effort in removing these species has been undertaken to date however these species are persisting in these areas.

Management of the weed grasses will require the following:

1) the development of a native canopy, through tree planting (400-600 stems/ha),
2) potentially crash grazing once the canopy is mature enough (10-15 years, or canopy DBH of 10cm) and then,
3) introducing native understorey (including ground covers) where required.

These processes are described below.

1. Tree/tall shrub planting should occur in the autumn (April/May, following autumn rain) or early spring (September, following rain). Tree/tall shrub species should be targeted at a Grey Box-Ironbark Woodland. Trees/tall shrubs should be planted in areas where weed grass is not dominant. If this is not possible then ground preparation, such as spraying rip lines with Glyphosate, may be required. Trees should be monitored, and maintained, in early spring and autumn for two years or until the tree species are not at risk of being outcompeted by exotic grass species. If managed appropriately, canopy trees can provide sufficient shade to reduce the abundance of weed grasses. This, combined with crash grazing, can control weed grass species in a woodland ecosystem.

2. Crash grazing should occur as soon as canopy species are not at risk of being knocked over by livestock, typically 10-15 years or DBH of 10cm, depending on establishment rates, weather and growth medium. Crash grazing is running a moderate to high density of livestock over a short period of time, typically from August to October or when target exotic grasses are flowering. This will allow native grasses and herbs to grow and develop seed from October to April. Grazing needs to be monitored to maintain a ground cover, i.e. not over grazed. Over grazing will result in poor soil development and reduced diversity. An area of established trees/shrubs in the northern area (NPN201101) would currently be appropriate for crash grazing (in consultation with the regulatory authority). All other sites monitored in 2021 did not have trees mature enough to commence crash grazing. A grazing management plan should be developed for all area with potential for crash grazing.

3. The establishment of understorey and groundcover species should occur as soon as practical. Native understorey will establish best in areas where the canopy is 20-40 percent foliage cover. Thinning or tree planting may be

required to achieve an appropriate canopy cover. Where small areas of native species are persisting, the area should be fenced off from livestock and managed through weed spraying, where grazing occurs. These small areas will provide a more rapid colonisation of native species across an area rather than seeding, planting or translocating. Seeding, planting or translocation of groundcover species is an appropriate way of increasing the diversity of native groundcover and understorey species where they are not occurring. Many areas have poor soil development and therefore may require the application of organic material, such as mulch. This will need to be assessed prior to seeding, planting or translocation.

4.0 Direct Measures Against Performance Criteria

The following section compares the results of the ecological monitoring to the updated Performance Criteria outlined in the MOP: 1 July 2021 – 30 June 2023. All rehabilitation sites monitored in 2021 are in the Ecosystem and Land Use Establishment phase (Table 16 in the MOP) and therefore the reference sites have been compared to the same Performance Criteria phase.

4.1 Progress Towards Performance Criteria

Table 4.1 provides the performance of the 2021 ecological monitoring program against the Ecosystem and Landuse Establishment Performance Criteria from the MOP.

Table 4.1. Performance Against Performance Criteria

Objective	Performance Indicator	Performance Criteria	Northern Area (NA)	Central Area (CA)	Southern Area (SA)
All Domains					
Weeds are controlled to appropriate levels for the establishment and maintenance of selected vegetation species: • Recreating 1,027 ha grassland communities with a	Weeds are controlled to appropriate levels	The amount of weeds present is comparable to reference sites or baseline survey.	Weed cover was higher than reference sites at all sites. HTE grass species were the dominant weeds, including Rhodes grass and green panic. These species have the ability to suppress the regeneration of the target vegetation community. Section 3.6 provides management actions to assist in controlling invasive species and progressing the rehabilitation area towards the target vegetation community.		

Objective	Performance Indicator	Performance Criteria	Northern Area (NA)	Central Area (CA)	Southern Area (SA)
native component ; • Establishing approximately 632 ha of trees and shrubs over grassland areas; • Re-creating approximately 2,100 ha of EEC woodland communities.	Implementation of weed management measures.	Implementation of appropriate weed management measures which may include mechanical removal, application of approved herbicides and biological control.	Evidence of control was observed throughout. Observed targeted species included galenia, golden wreath wattle and small patches of exotic grass species. Establishment of a canopy and mid story species is an appropriate weed management measure.		
Rehabilitation Area					
Establishment and germination of selected vegetation species: • Establishing approximately 632 ha of trees and shrubs over grassland areas; • Re-creating approximately 2,100 ha of EEC woodland communities to a standard comparable to similar reference EEC communities.	Appropriate provenance rules and planting methods for tube stock planting	Woodland/grassland seed and tubestock supply will referentially be of local provenance. Seed and tubestock supplied from outside sources will be preferentially of Hunter provenance or from an area within NSW of similar climatic conditions to the Singleton area or as research defines. Tubestock is to be watered the day before and immediately prior to planting. Seedlings are hardened off before they are planted.	Seed and tubestock were of local provenance or from similar environments to the rehabilitation. Care should be taken not to let non-local provenance dominate the rehabilitation area, or it may not achieve the target vegetation community in areas targeted at EEC woodland. 2020 seed mix was generally appropriate for establishing a Grey Box-Ironbark Woodland. It is recommended to lower the rate of *Acacia* spp. in the seed mix		
	The vegetation is developing in structure and complexity comparable to that of the local remnant vegetation	Based on key physical, biological and chemical characteristics the LFA Stability Index provides an indication of the site's stability and that it is comparable to or trending towards that of analogue sites (%). Woodland: 53.9% to 81.8%.	95% of rehabilitation sites achieved the Woodland minimum criteria. MTO201701 provided a slightly lower score. No action required.		

Objective	Performance Indicator	Performance Criteria	Northern Area (NA)	Central Area (CA)	Southern Area (SA)
		Based on key physical, biological and chemical characteristics the LFA Infiltration Index provides an indication of the site's infiltration capacity and that it is comparable to or trending towards that of analogue sites (%). Woodland: 48.4% to 73.9%.	71% of rehabilitation sites achieved the Woodland minimum criteria. Sites with lower Infiltration scores provided lower perennial grass and litter cover and less surface roughness. A high cover of annual grasses was recorded at these sites, which is likely to increase the litter cover over time. Perennial grass and groundcover species are likely to establish over time and therefore no action is required.		
		Based on key physical, biological and chemical characteristics the LFA Nutrient Recycling Index provides an indication of the site's ability to recycle nutrients and that it is comparable to or trending towards that of analogue sites (%). Woodland: 38.5% to 79.8%.	90% of rehabilitation sites achieved the Woodland minimum criteria. sites with lower Nutrient scores provided a lower leaf litter and perennial grass cover, no cryptogram (lichens, fungus and mosses etc) and low surface roughness. A high cover of annual grasses was recorded at these sites, which is likely to increase the litter cover over time. Perennial grass, groundcover and cryptogram cover are likely to develop over time and therefore no action is required.		
		The Landscape Organisation Index provides a measure of the ability of the site to retain resources and that it is comparable to or trending towards that of analogue sites (%). Woodland: 0.84 to 1.00.	76% of rehabilitation sites achieved the Woodland minimum criteria. Sites with low LOI recorded a high cover of annual grasses and were generally on flat terrain. No action required.		
Habitat augmentation to provide additional habitat for threatened species.	Coarse woody debris (CWD) and rocks	Horizontal placement of hollow logs or small piles of timber and rocks are installed across the site creating cavities for habitat for small ground dwelling mammals and reptiles.	NPN sites 201701, 201703 and 201802 provide adequate fallen timber. All other sites had no	SPS201801 had 20m CWD, all other sites had none. Consider distributing CWD to other areas to	MTO sites 200501, 201602, 201703, 201704, 201905 to 201908 provide adequate fallen timber. Other

Objective	Performance Indicator	Performance Criteria	Northern Area (NA)	Central Area (CA)	Southern Area (SA)
			CWD. Consider adding CWD as a corridor from north-west to the south-east of the area.	create a corridor from north to the south of the area.	sites had low to no CDW. Site MTO201703 had an abundance of CDW, consider distributing to other areas to create a corridor from north to the south of the area.
	Drainage depression (frog ponds) creation providing riparian and aquatic habitat	Habitat is developed using common native rushes /sedges in unshaded locations, free from predatory fish, nearby grassland and sheltering sites of vegetation and rocks.	NPN sites 200502, 201101 and 202003 had ponding in contour drains. SPS202002 had ephemeral shallow ponding. No other sites had ponding.	CDD sites 201701 and 201801 had ephemeral shallow ponding. 201703 had ponding in a contour drain. No other sites had ponding.	MTO201601 had ephemeral shallow ponding. No other sites had ponding.
	Plant species selection	Plant species are used which create suitable habitat for woodland birds e.g., flaky bark, production of small and large sized woody debris, diversity of flowering time. Plant prickly species (e.g. Native boxthorn) that provide critical habitat for certain species.	Appropriate plant selection for woodland birds throughout, providing a diversity of structure and species. Good connectivity across throughout area.	Appropriate plant selection for woodland birds throughout. Currently poor connectivity due to early stage succession. Stepping stones of more mature vegetation in the north and WDL area.	Appropriate plant selection for woodland birds throughout, providing a diversity of structure and species. Good connectivity to the east. Poor connectivity to the west due to early stage succession.

Objective	Performance Indicator	Performance Criteria	Northern Area (NA)	Central Area (CA)	Southern Area (SA)
	Provide diversity of habitats to improve biodiversity	Create areas of open woodland where trees and shrubs are not planted too densely (create "patchiness") and provide relatively large patches of grassland with scattered trees. Create patchwork of dense thickets of shrubs.	Open woodland and grassland is developing to the east and north with dense shrubland and forest throughout. Several small water bodies occur throughout.	Grassland with scattered trees is developing along the eastern slope. Dense forest is developing in the north and shrubland is developing in the south. Several small water bodies occur throughout.	Open woodland is developing to the east providing connectivity through the area. Early stage regeneration in the west is providing low shrubland. Several small water bodies occur throughout.
Rehabilitation Areas - Woodland Other					
Establishing approximately 632 ha of trees over grassland areas, but not necessarily conforming to any particular vegetation community.	Establishing approximately 632 ha of trees over grassland areas, but not necessarily conforming to any particular vegetation community.	632 ha of trees over grassland established on rehabilitated mine lands.	Progressing well towards trees over grassland		
	The number of tree species comprising the vegetation community is comparable to that of analogue sites (no. species/area).	1 to 4 species within a 20m x 20m quadrat.	All sites achieved target	N/A	Both woodland – other sites achieved target.
	The number of grass species comprising the vegetation community is	4 to 9 species within a 20m x 20m quadrat.	Site NPN200502 was the only woodland – other	N/A	Both woodland – other sites achieved target.

Objective	Performance Indicator	Performance Criteria	Northern Area (NA)	Central Area (CA)	Southern Area (SA)
	comparable to that of analogue sites.		site not to achieve target however three species were recorded. No action required.		
	The density of trees is comparable to that of analogue sites (no./area).	250 to 3,150 stems per ha	NPN200501 did not achieve target, NPN200502 was within range of the target and NPN200901 had an extremely high count however provided high species diversity. No action required.	N/A	Both woodland – other sites achieved target.
	Species used are compatible with agricultural or native biodiversity conservation outcomes.	Species sown are based on those recommended species list from Table 39.	No woodland – other sites have been seeded. Existing sites are generally in accordance with Table 39 of the MOP.		
Rehabilitation Areas - Woodland EEC					
Establishment of 2,100 ha of Central Hunter Grey Box-Ironbark Woodland and / or Central Hunter Ironbark-Spotted Gum-Grey Box Forest on	Establishment of 2,100 ha of Central Hunter Grey Box-Ironbark Woodland and / or Central Hunter Ironbark-Spotted Gum-	2,100 ha of Central Hunter Grey Box-Ironbark Woodland and / or Central Hunter Ironbark-Spotted Gum- Grey Box Forest established on rehabilitated mine lands.	Management measures are in place to progress towards the target EEC's. Areas monitored in 2021 were in Ecosystem and Landuse Establishment phase. Management recommendations to progress towards the target vegetation community is provided in **Section 3.6**.		

Objective	Performance Indicator	Performance Criteria	Northern Area (NA)	Central Area (CA)	Southern Area (SA)
rehabilitated mine lands.	Grey Box Forest on rehabilitated mine lands.				
	The number of tree species comprising the vegetation community is comparable to that of analogue sites (no. species/area).	1 to 4 species within a 20m x 20m quadrat.	All sites achieved target	CDD201702, SPN201501, SPS201601 and SPS201801 did not achieve target. All other sites achieved target.	MTO sites 201702, 201703 and 202004 did not achieve target however canopy trees were observed in the surrounding area. No action required.
	The number of shrub species comprising the vegetation community is comparable to that of analogue sites (no. species/area).	4 to 9 species within a 20m x 20m quadrat.	Site NPN 202003 was the only site not to achieve target. This site is in early stage of establishment and therefore no action is currently required.	50% of the sites did not achieve target. Management recommendation to progress towards the target vegetation community is provided in **Section 3.6**.	42% of the sites did not achieve target. Management recommendation to progress towards the target vegetation community is provided in **Section 3.6**.
	The number of grass species comprising the vegetation community is comparable to that of analogue sites (no. species/area).	4 to 9 species within a 20m x 20m quadrat.	All sites, except NPN200501, achieve the grass species diversity minimum value. No action required.	All sites, except CDD201401 and SPS201801, achieve the grass species diversity minimum value. No action required.	All sites, except CDD201401 and SPS201801, achieve the grass species diversity minimum value. No action required.
	The number of subshrub species and understorey	10 to 20 species within a 20m x 20m quadrat.	Sites NPN202001 and NPN202003	35% of the sites did not achieve	29% of the sites did not achieve

Objective	Performance Indicator	Performance Criteria	Northern Area (NA)	Central Area (CA)	Southern Area (SA)
	species (other than grasses) comprising the vegetation community is comparable to that of analogue sites (no. species/area).		were the only sites not to achieve target, however they both had nine species. No action required.	the target. SPS201801 provided the lowest score of 1 species. Management recommendation to progress towards the target vegetation community is provided in **Section 3.6**.	target. MTO201703 provided the lowest value of two species. Management recommendation to progress towards the target vegetation community is provided in **Section 3.6**.
	The native plant species richness is within 50-100% or exceeds that of analogue sites (no. species/area).	13 to 41 species within a 20m x 20m quadrat.	75% of sites achieved target with NPN201902 exceeding the target. The other sites were only slightly below target. No action required.	35% of sites achieved target. Site SPS201801 only having two native species recorded. Management recommendation to progress towards the target vegetation community is provided in **Section 3.6**.	58% of sites achieved target. MTO sites 201601, 201702 and 201703 provided the lowest species richness values, of nine species. Management recommendation to progress towards the target vegetation community is provided in **Section 3.6**.
	The density of trees is comparable to that of analogue sites (no./area).	250 to 3,150 stems per ha	Half of the sites did not achieve target. NPN sites 200901 and 202001 provided	74% of sites did not achieve target due to dominance of grass and early	Half of the sites did not achieve target due to dominance of grass and early

Objective	Performance Indicator	Performance Criteria	Northern Area (NA)	Central Area (CA)	Southern Area (SA)
			extremely high density scores which may need to be managed if monitoring indicates a reduction of native species richness.	stage succession. Management recommendation to progress towards the target vegetation community is provided in **Section 3.6**.	stage succession on the western side. Management recommendation to progress towards the target vegetation community in exotic grassland areas is provided in **Section 3.6**. Further monitoring is required for sites established from 2017.
	Species used are compatible with agricultural or native biodiversity conservation outcomes.	Species sown are based on those recommended species list from Table 39.	The 2020 seed mix is generally in accordance with Table 39 of the MOP. It is recommended to lower the rate of *Acacia* spp. in the seed mix.		

4.2 Trigger Action Response Plan

Table 4.2 outlines relevant components of the monitoring program which triggered the Trigger Action Response Plan (TARP) in the MOP. Comments on how MTW have addressed the trigger and if action is required is provided, where possible.

Table 4.2. Elements of the Trigger Action Response Plan which Triggered a Response

Aspect/ Category	Item	Element	Trigger	Response	Northern Area	Central Area	Southern Area
Growth Medium Suitability	12	Chemical and Nutritional Properties	Soil properties atypical for the surrounding landscape &/or outside desirable ranges provided by the agricultural industry: Woodland Trigger Levels pH <5.5 or >8.5; Electrical Conductivity >2 dS/m; Phosphorous and Organic Carbon not within levels in analogue sites by Year 5; Cation Exchange Capacity, Exchangeable Sodium Percentage and Calcium/magnesium ratio not within levels in analogue sites by Year 2.	Engage a consultant to recommend appropriate soil/spoil amelioration. Undertake amelioration and revegetation in accordance with the consultant recommendations as required.	Soil results (**Section 3.5**) indicate the results are generally in line with agricultural industry. The pH, EC, organic matter and CEC were all generally within the MOP limits. Soil phosphorus, exchangeable sodium percentage and calcium magnesium ration were high at several sites. Evidence of poor plant growth/disease was not observed during the monitoring program and therefore no further action is required.		
Vegetation Establishment	14	Weed Levels	>10% cover of problematic weed species present in Ecosystem Establishment phase.	Engage land management contractor to control problematic weed using methods such as removal, biological control, herbicide application and slashing. Treatment of infestations as	Most of the rehabilitation area resulted in greater than 10 percent cover. Evidence if weed control was observed throughout the rehabilitation area. Weed cover was generally dominated by exotic pasture species and galenia. Occurrence and abundance of HTE weed species is provided in **Section 3.2**. **Section 3.6** provides recommendations on how to progress grass dominated areas to the target woodland vegetation community.		

Aspect/ Category	Item	Element	Trigger	Response	Northern Area	Central Area	Southern Area
				appropriate to the species. Conduct follow-up inspections to assess the effectiveness of weed management measures.			
	17	Understorey Species Diversity	Understorey species diversity atypical compared to analogue sites.	Tier 1 - An inspection of the site will be undertaken by a suitably trained person. Undertake remedial actions such as grazing, controlled burning, soil amelioration, reseeding and fertilising as required. Tier 2 - For widespread low understorey diversity review seed mix understorey species composition and seeding rates. Review monitoring results to determine rates of successful establishment for various understorey species in seed mixes.	The diversity at the analogue sites ranged from 23 – 45 species. **Section 3.3.3** shows the results of understorey species at each site. In general, the rehabilitation is performing poorly with only 13 sites in all areas achieving the minimal target of 23 species. The northern area provides moderate results with only three site (NPN201902) achieving lower target. Several sites are within range of the lower target, with an additional five sites having greater than 20 species. The central area provided moderate to poor results with four sites achieving the lower target and one site (SPS201801) only recording two native understorey species. The southern area provides moderate results with six sites achieving the lower target and an additional four sites at 20 species. Results of weed management activities were observed throughout the rehabilitation area. Continued weed management will assist in promoting understorey species diversity. **Section 3.6** provides recommendations on how to progress grass dominated areas to the target woodland vegetation community.		
	18	Tree and Shrub Species Diversity	Tree and shrub species diversity atypical compared to analogue sites	Tier 1 - An inspection of the site will be undertaken by a suitably trained person. Undertake remedial actions such as cultivation or spraying to reduce grass competition, reseeding and fertilising as	The tree and shrub diversity at the analogue sites ranged from 7 – 16 species. **Section 3.3.2** shows the results of tree and shrub species at each rehabilitation site. In general, the rehabilitation is performing well for the stage of establishment and historical practices. The northern area is performing well with most of the sites achieving the lower target. The central area is performing poorly with most sites below the lower target. The southern area is performing well in the 2019 and 2020 established rehabilitation however the older rehabilitation		

Aspect/ Category	Item	Element	Trigger	Response	Northern Area	Central Area	Southern Area
				required. Tier 2 - For widespread low tree and shrub diversity review seed mix tree/shrub species composition and seeding rates. Review monitoring results to determine rates of successful establishment for various tree/shrub species in seed mixes	is performing poorly. Continued weed management will assist in promoting understorey species diversity. Results of weed management activities were observed throughout the rehabilitation area. Continued weed management will assist in promoting understorey species diversity. No further action required at this stage.		
	19	Tree Density	Tree density is outside typical range for analogue sites.	Tier 1 - An inspection of the site will be undertaken by a suitably trained person. Undertake remedial actions such as cultivation or spraying to reduce grass competition, reseeding (for low density) and thinning (for high density) as required. Tier 2 - For widespread tree density outside analogue site ranges review seed mix tree species composition and seeding rates. Review monitoring results to determine rates of successful establishment for various tree species in seed mixes. Review seed bed preparation,	Tree density is provided is discussed in **Section 3.3.1**. Half the sites in the northern area provide a low value of tree stem density. Management recommendation to progress towards the target vegetation community is provided in **Section 3.6**.	Tree density is provided is discussed in **Section 3.3.1**. 74% of the sites provide a low value of tree stem density. Management recommendation to progress towards the target vegetation community is provided in **Section 3.6**.	Tree density is provided is discussed in **Section 3.3.1**. half the sites in the southern area provide a low value of tree stem density. Management recommendation to progress towards the target vegetation community is provided in **Section 3.6**.

Aspect/ Category	Item	Element	Trigger	Response	Northern Area	Central Area	Southern Area
				weed/grass control and sowing procedures.			
	20	Ground Cover	Total ground cover < 70% during Ecosystem Establishment phase.	Tier 1 - An inspection of the site will be undertaken by a suitably trained person. Undertake remedial actions such as soil amelioration, soil aeration, reseeding and fertilising as required. Tier 2 - For widespread low results for total ground cover review seasonal mixes and seeding rates.	All sites achieved target	All sites achieved target	MTO sites 202002, 202003, 202004 and 202005 did not achieve target however the dominant grasses were mostly native species. No action required.
	21	Tree Growth Rate	Average trunk diameter (dbh) of the tree population measuring growth rate is atypical compared to analogue sites.	Tier 1 - An inspection of the site will be undertaken by a suitably trained person. Undertake remedial actions such as soil amelioration and fertilising as required. Tier 2 - For widespread low results for tree growth rate review soil amelioration and preparation procedures.	The Analogue sites ranged from 18cm to 30cm DBH. All sites were in Ecosystem and Landuse establishment phase and therefore not within the DBH growth rate of the analogue sites at this stage. The largest DBH in rehabilitation were WDL201401 and CDC201101 at 8.5cm DBH, NPN201101 at 7cm DBH, CDD2015 at 6cm DBH and NPN201801 at 5cm DBH. All other sites were less than 5cm DBH. No action required.		
Fauna Recolonisation	25	Habitat – Fallen Logs	Total length of fallen logs in Woodland – EEC areas is <50% that of analogue sites.	Tier 1 - An inspection of the site will be undertaken by a suitably trained person. Undertake remedial actions such as introducing additional	Analogue sites ranged from 4m to 30m of fallen timber. NPN sites 201701, 201703 and 201802 achieved the	Analogue sites ranged from 4m to 30m of fallen timber. SPS201801 achieved the target with 20m	Analogue sites ranged from 4m to 30m of fallen timber. MTO sites 201602, 201702, 201703, 201704, 201905,

Aspect/ Category	Item	Element	Trigger	Response	Northern Area	Central Area	Southern Area
				fallen timber (consider pruning or thinning standing trees) as required. Tier 2 - For widespread low results for fallen logs review land management practices with a view to reducing loss of logs through regular bush fires or fire wood collection.	target. Fallen timber was not recorded at the other sites. Consider adding CWD as a corridor from north-west to the south-east of the area.	recorded. Fallen timber was not recorded at the other sites. Consider distributing CWD to other areas to create a corridor from north to the south of the area.	and 202001 achieved the target. Fallen timber was not recorded at the other sites. . Consider distributing CWD to other areas to create a corridor from north to the south of the area.
	26	Habitat-Hollows	Total length of hollows/ nesting sites in Woodland – EEC areas is <50% that of analogue sites.	An inspection of the site will be undertaken by a suitably trained person. Undertake remedial actions such as introducing stag trees or nest boxes as required.	The analogue sites ranged from no hollow trees to one hollow tree. The rehabilitation sites did not have any standing hollow trees. Nest boxes could be installed at CDC201101 and WDL201402. Woodland – other sites with potential to support nest boxes includes: NPN200501, NPN200502, MTO200001 and MTO200503.		
	27	Stability, Infiltration and Nutrient Cycling	LFA indices values for stability, infiltration, nutrient cycling or landscape organisation are trending away from the values of analogue sites.	Tier 1 - An inspection of the site will be undertaken by a suitably trained person. Undertake remedial actions such as soil amelioration, soil aeration, reseeding and fertilising as required. Tier 2 - For widespread negative trends for LFA indices review rehabilitation procedures related to soil amelioration and preparation.	LFA scores for LOI, stability, infiltration and nutrient are consistent with previous years, or slightly improved. Increased rainfall has led to slight improvements in LFA values. No action required.		

5.0 Summary of Recommendations

The following section provides a summary of recommendations from the 2021 monitoring program.

5.1 Weed Control

Section 3.2 identifies the extent and cover abundance of weed species in the rehabilitation area. Many of the weed species recorded did not pose a threat to the establishment of a local vegetation community however, the high threat exotic and invasive species identified in **Section 3.2.1** will require management to progress towards the target vegetation community. The following species are priorities in the described areas:

- Galenia control is required throughout the rehabilitation area with NPN200502 and NPN201701 providing the highest abundance in the northern area and several infestations occur in the central and southern area.
- African olive requires control at NPN200502, MTO20001 and MTO200503.
- African boxthorn requires control at NPN200502, MTO201801 and MTO201906.
- High density (>50% cover) of exotic grass species occurs at NPN201101, NPN202003, NPN202006 and throughout the central area. The southern area provided less than 50% cover however will require management to progress towards the target vegetation community.
- Prickly/creeping pear requires control at NPN201301, NPN201401, NPN201801 and NPN201802.
- All reference sites (except WarkGB04) require control of creeping/tiger pear. WarkGB01 requires control of lantana.

5.2 Soil Assessment

High phosphorus levels were recorded at several sites. Soil phosphorus cannot be reduced and does not leach from the soil. Ensure only low phosphorus soil ameliorants are applied to rehabilitation areas and do not apply fertiliser to the rehabilitation area. Excessively high phosphorus can result in stunted growth of plants, leaf distortions and delayed maturity.

A review of pH and soil phosphorus limits in the MOP Performance Criteria should be undertaken. The reference sites limits were lower for pH and higher for soil phosphorus. The MOP Performance Criteria should be broadened to include the values of the reference sites.

5.3 Development of Native Woodland Ecosystems

A management plan to progress areas of Rehabilitation – EEC, dominated by exotic grass species, towards the target vegetation community is provided in **Section 3.6**. These areas include the western part of the northern area, most of the central area and the western part of the southern area. Recommendations include:

- managing trees and tall shrubs to mature to 8cm DBH, and infill planting where required;
- crash grazing when trees and tall shrubs to mature to 8cm DBH; and
- seed, plant or translocate native groundcover species to increase ground cover biodiversity.

5.4 Increase Abundance of Fallen Timber

Fallen timber is scattered throughout the rehabilitation area however, some areas have a high abundance of fallen timber and other area lack any fallen timber resources. It is recommended to create a fallen timber corridor throughout the rehabilitation area. This will provide refuge for native animals as they colonise the rehabilitation area.

Sites NPN201701, NPN201703, NPN201802 and SPS201801 provided a high volume of fallen timber. These resources could be redistributed to other areas to create a refuge corridor through the rehabilitation area. This should be considered in newly established rehabilitation.

Pest control will be required to prevent the colonisation of pest species, such as rabbis, foxes and wild dogs.

5.5 Nest Box Installation

Nest box installation should be considered at sites NPN200501, NPN200502, CDC201101, WDL201402, MTO200001 and MTO200503. Nest box types to install include:

- Parrot;
- Glider;
- Treecreeper;
- Feathertail glider; and
- Micro-bat.

5.6 Assessment of Seed Mix

The 2020 seed mix was appropriate for establishing a Grey Box-Ironbark Woodland and is generally in accordance with Table 39 of the MOP. However, it is recommended to lower the rate of *Acacia* spp. in the seed mix due to the high cover of acacia species establishing.

6.0 Conclusion

The 2021 monitoring program targeted 58 Rehabilitation – EEC sites, five Rehabilitation – Woodland Other sites and six remnant Grey Box-Ironbark Woodland reference sites. In general, the reference sites were in good condition with a low weed cover. No direct impacts as a result of mining activities were observed at the reference sites.

The northern area generally provided good native species richness and good cover of native groundcover species. The western part provides areas dominated by local and non-local shrub species. These shrub species are likely to naturally die-back in the next five to eight years which should allow canopy species to establish – further monitoring is needed to determine if additional tree/shrub planting is required. Weed cover was high throughout, dominated by exotic perennial grass species. Fallen log and tree hollow resources were low throughout the area. The northern area is generally trending towards the target vegetation communities however, continued weed control of exotic perennial grasses is required to maintain species richness throughout the area.

The central area provided low species richness and cover, particularly on the eastern slope, with a high cover of exotic perennial grass species. Tree and shrub density was generally low, with poor tree/shrub connectivity through the area. A moderate density of native groundcover species indicates good potential resilience if intense weed control is undertaken. Fallen log and tree hollow resources were low throughout the area. In general, this area is not currently trending towards the target vegetation community and requires management action to progress. Two areas of established vegetation (CDC201101 and CDD201501) in the north of the central area provide a good cover and diversity of native vegetation. These areas are generally trending towards the target vegetation community however the mid-storey stem density at CDD201501 is high and may need to be thinned if monitoring indicates a reduction of native species richness.

The southern area provides a moderate native species richness at sites established since 2018 and Woodland Other rehabilitation. These sites also provided a good cover of native grass species and moderate abundance of fallen log resources. These sites have potential to progress towards the target vegetation community if weed control activities continue. Sites established in 2016 and 2017 provided low species richness and cover and poor availability of fallen log resources. Weed cover was high throughout, dominated by exotic perennial grass species and galenia. These sites are not trending towards the target vegetation community and will require management action to progress.

7.0 References

AECOM (2012). *Monitoring Methodology – Post-mined Lands*. Prepared for Coal and Allied Operations Pty Ltd.

DECCW (2014). *Draft Biobanking Assessment Methodology: Version 2*. NSW Department of Environment, Climate Change and Water, Sydney.

DPI 2018. *NSW Weed Control Handbook, NSW DPI Management Guide: Seventh Edition*. Department of Primary Industries, Sydney.

OEH (2022). Biodiversity Assessment Calculator High Threat Weed List download. NSW Office of Environment and Heritage web site. Accessed 10 February 2022, https://www.lmbc.nsw.gov.au/bamcalc.

Tongway, D. J. and Hindley, N. L. (2004). *Landscape Function Analysis: Methods for monitoring and assessing landscapes, with special reference to mine sites and rangelands*. CSIRO Sustainable Ecosystems, Canberra.

Appendix 1 - Monitoring Site Details

Appendix 1 – Monitoring Site Details

Appendix 1 provides details of the sites monitored in 2021. **Table 1** provides the LFA soil texture classes and **Table 2** provides the site details.

Table 1. LFA Soil Textures Classes

Texture	Class
Silty clay to heavy clay (very slow infiltration rate)	1
Sandy clay loam to sandy clay (slow Infiltration rate)	2
Sandy loam to silt loam (moderate infiltration rate)	3
Sandy to clayey sand (high infiltration rate	4

Table 2. 2021 Monitoring Site Details (GDA2020)

Site	Target PCT	Year Est.	Transect Start		Transect End		Slope (Degrees)	Aspect (Bearing)	Soil Texture Type
			Easting	Northing	Easting	Northing			
Reference Sites									
WamboBG01	GBIW	n/a	6392618	309194	6392661	309215	4	030	2
WamboGB02	GBIW	n/a	6391965	309539	6392010	309561	3	060	2
WarkGB01	GBIW	n/a	6392801	315553	6392824	315517	6	000	2
WarkGB02	GBIW	n/a	6387985	314002	6387939	313998	2	250	4
WarkGB03	GBIW	n/a	6386859	314917	6386864	314960	0.5	270	2
WarkGB04	GBIW	n/a	6386046	315336	6386087	315316	1	220	2
Northern Area									
NPN200501	Woodland	2005	319816	6391225	319842	6391183	2	130	2
NPN200502	Woodland	2005	319670	6391964	319716	6391981	3	060	2
NPN200901	Woodland	2009	319069	6391524	319027	6391535	1	080	2
NPN201101	GBIW	2011	318166	6392138	318190	6392183	4	030	3
NPN201301	GBIW	2013	318047	6391551	317995	6391519	0.5	230	3
NPN201401	GBIW	2014	317657	6392085	317623	6392119	0	000	2
NPN201402	GBIW	2014	317637	6391943	317665	6391985	1	210	2
NPN201701	GBIW	2017	317341	6392674	317334	6392719	10	340	2
NPN201703	GBIW	2017	317268	6392894	317259	6392938	12	340	3
NPN201801	GBIW	2018	317209	6392362	317213	6392407	4	350	3
NPN201802	GBIW	2018	317694	6391516	317735	6391541	12	040	4
NPN201902	GBIW	2019	317108	6392390	317059	6392384	7	230	3
NPN201903	GBIW	2019	318963	6392298	318935	6392260	8	210	2
NPN202001	GBIW	2020	317695	6391266	317663	6391303	1	270	3
NPN202002	GBIW	2020	317411	6391899	317368	6391877	8	240	3
NPN202003	GBIW	2020	317396	6391953	317346	6391958	8	240	3
NPN202004	GBIW	2020	317218	6392286	317251	6392246	10	140	2
NPN202005	GBIW	2020	317161	6392301	317126	6392337	8	280	3

Site	Target PCT	Year Est.	Transect Start		Transect End		Slope (Degrees)	Aspect (Bearing)	Soil Texture Type
			Easting	Northing	Easting	Northing			
NPN202006	GBIW	2019	317741	6391305	317694	6391320	1	300	3
Central Area									
CDC201101	GBIW	2011	319599	6390304	319552	6390312	2	120	2
CDD201401	GBIW	2014	318888	6390471	318942	6390460	0.5	090	3
CDD201501	GBIW	2015	319049	6390074	319081	6390034	1	110	2
CDD201701	GBIW	2017	319526	6390537	319512	6390491	0	000	2
CDD201702	GBIW	2017	319868	6389966	319879	6390013	4	000	2
CDD201801	GBIW	2018	318870	6390631	318843	6390676	1	280	3
CDD201901	GBIW	2020	319780	6389808	319762	6389760	0.5	200	2
CDD201902	GBIW	2020	319246	6389544	319209	6389575	10	300	3
CDD202001	GBIW	2020	319023	6389593	319059	6389616	8	060	2
SPN201401	GBIW	2014	320170	6390161	320185	6390197	10	000	2
SPN201501	GBIW	2015	319956	6390291	319984	6390332	9	020	2
SPN201601	GBIW	2016	320130	6390589	320158	6390630	9	000	2
SPN201602	GBIW	2016	320444	6389769	320494	6389775	8	070	2
SPN201701	GBIW	2017	319682	6390583	319693	6390634	10	345	3
SPS201601	GBIW	2016	320910	6389384	320949	6389413	10	050	2
SPS201602	GBIW	2016	320830	6388963	320879	6388975	6	070	2
SPS201701	GBIW	2017	320664	6389581	320717	6389580	10	080	2
SPS201703	GBIW	2017	321237	6388539	321288	6388542	10	080	2
SPS201801	GBIW	2018	320532	6389439	320580	6389441	11	070	2
SPS201901	GBIW	2020	320070	6389762	320082	6389715	12	155	2
SPS201902	GBIW	2020	319884	6389775	319932	6389787	3	070	2
WDL201401	GBIW	2017	319805	6388508	319849	6388526	6	080	2
WDL201402	GBIW	2017	319636	6388357	319624	6388309	8	180	2
Southern Area									
MTO200001	Woodland	2000	320551	6386940	320531	6386982	0	0	2
MTO200503	Woodland	2005	320678	6385782	320640	6385756	3	210	2
MTO201601	GBIW	2016	320667	6385308	320718	6385305	0.5	090	2

Site	Target PCT	Year Est.	Transect Start		Transect End		Slope (Degrees)	Aspect (Bearing)	Soil Texture Type
			Easting	Northing	Easting	Northing			
MTO201908	GBIW	2019	320326	6385366	320358	6385327	1	120	2
MTO201701	GBIW	2017	319366	6386190	319418	6386187	1	180	2
MTO201702	GBIW	2017	319581	6386006	319633	6386014	1	070	2
MTO201703	GBIW	2017	320133	6385806	320129	6385755	1	180	2
MTO201704	GBIW	2017	319829	6385785	319873	6385806	1	060	2
MTO201801	GBIW	2018	319904	6387502	319956	6387531	8	060	2
MTO201901	GBIW	2019	320193	6386985	320241	6386992	1	070	2
MTO201902	GBIW	2019	319940	6387086	319906	6387121	8	320	2
MTO201903	GBIW	2019	320064	6387268	320051	6387314	2	330	2
MTO201904	GBIW	2019	319639	6386566	319624	6386521	1	180	2
MTO201905	GBIW	2019	319589	6386716	319574	6386670	0.5	200	2
MTO201906	GBIW	2019	320182	6385979	320194	6385931	10	170	2
MTO201907	GBIW	2019	320102	6385966	320111	6385917	10	170	2
MTO201908	GBIW	2020	319926	6386913	319938	6386960	2	000	2
MTO202002	GBIW	2020	319346	6386354	319938	6386961	1	220	2
MTO202003	GBIW	2020	319326	6386521	319287	6386489	0.5	230	2
MTO202004	GBIW	2020	319499	6386459	319507	6386508	5	010	2
MTO202005	GBIW	2020	319525	6386407	319542	6386453	3	010	2

Appendix 2 - Monitoring Site Photos

Site NPN200501		
		
Site NPN200502		
		

Site NPN200901		
		
Site NPN201101		
		

Site NPN201301		
		
Site NPN201401		
		

Site NPN201402		
		
Site NPN201701		
		

Site NPN201703		
		
Site NPN201801		
		

Site NPN201802		
		
Site NPN202006		
		

Site NPN201902		
		
Site NPN201903		
		

Site NPN202001		
		
Site NPN202002		
		

Site NPN202003		
		
Site NPN202004		
		

Site NPN202005		
		
Site CDD201101		
		

Site CDD201401		
		
Site CDD201501		
		

Site CDD201701		
		
Site CDD201702		
		

Site CDD201801		
		
Site CDD201901		
		

Site CDD201902		
		
Site SPN201401		
		

Site SPN201501		
		
Site SPN201601		
		

Site SPN201602		
		
Site SPN201701		
		

Site SPS201601		
		
Site SPS201701		
		

Site SPS201703		
		
Site SPS201801		
		

Site SPS201901		
		
Site SPS201902		
		

Site WDL201401		
		
Site WDL201402		
		

Site MTO200001		
		
Site MTO200503		
		

Site MTO201601		
		
Site MTO201701		
		

Site MTO201702		
		
Site MTO201703		
		

Site MTO201704		
		
Site MTO201801		
		

Site MTO201901		
		
Site MTO201902		
		

Site MTO201903		
		
Site MTO201904		
		

Site MTO201905		
		
Site MTO201906		
		

Site MTO201907		
		
Site MTO201601		
		

Site MTO201908		
		
Site MTO202002		
		

Site MTO202003		
		
Site MTO202004		
		

Site MTO202005		
		
Site WAMBOGB01		
		

Site WAMBOGB02		
		
Site WARKGB01		
		

Site WARKGB02		
		
Site WARKGB03		
		

Site WARKGB04		
		

Appendix 3 - Flora Species List

Appendix 3 – Flora Species List

A full list of flora species recorded during the 2021 monitoring program is provided in the following tables: **Table 1** provides the northern area flora list; **Table 2** provides the central area flora list and **Table 3** provides the southern area flora list.

Table 1. Northern Area Flora List

Family	Scientific Name	Common Name	NPN 2005 01	NPN 2005 02	NPN 2009 01	NPN 2011 01	NPN 2013 01	NPN 2014 01	NPN 2014 02	NPN 2017 01	NPN 2017 03	NPN 2018 01	NPN 2018 02	NPN 2020 06	NPN 2019 02	NPN 2019 03	NPN 2020 01	NPN 2020 02	NPN 2020 03	NPN 2020 04	NPN 2020 05
Aiozaceae	*Galenia pubescens* var. *pubescens*	galenia	1	10	0.1	5	5	5		20	0.1	5	3	0.1	0.2	5		0.1	0.1	3	
Amaranthaceae	*Gomphrena celosioides*	gomphrena weed													0.1			0.1	0.1	0.1	
Apiaceae	*Cyclospermum leptophyllum*	slender celery	0.1				0.1					0.1									
Apocynaceae	*Gomphocarpus fruticosus*	narrow-leaved cotton bush	0.1		0.1	0.1				0.1	0.1	0.1			0.1					0.1	0.1
Asparagaceae	*Laxmannia gracilis*	slender wire lily													0.1						
Asparagaceae	*Lomandra longifolia*	spiny-headed mat-rush													0.1						
Asteraceae	*Aster subulatus*	wild aster									0.1	0.1			0.1	0.1					
Asteraceae	*Bidens pilosa* var. *pilosa*	cobblers pegs	0.1	0.1	0.1	0.1		0.1	0.1	1	5	0.1	0.1		0.1		0.1			0.1	
Asteraceae	*Bidens subalternans*	greater beggar's ticks					0.1		0.1		0.1				0.1				0.1		
Asteraceae	*Calotis lappulacea*	yellow burr-daisy	0.1	0.1						0.1	0.1	0.1	0.1								
Asteraceae	*Calotis cuneifolia*	purple burr-daisy		0.1				0.1	0.1			0.1	0.1		0.1						0.1
Asteraceae	*Calocephalus citreus*	lemon beauty-heads									0.1										

Family	Scientific Name	Common Name	NPN 2005 01	NPN 2005 02	NPN 2009 01	NPN 2011 01	NPN 2013 01	NPN 2014 01	NPN 2014 02	NPN 2017 01	NPN 2017 03	NPN 2018 01	NPN 2018 02	NPN 2020 06	NPN 2019 02	NPN 2019 03	NPN 2020 01	NPN 2020 02	NPN 2020 03	NPN 2020 04	NPN 2020 05
Asteraceae	*Cassinia quinquefaria*									0.1											
Asteraceae	*Chrysocephalum apiculatum*	yellow buttons	0.1																		
Asteraceae	*Cirsium vulgare*	spear thistle	0.1	0.1										0.1	0.1	0.1				0.1	0.1
Asteraceae	*Conyza bonariensis*	fleabane	0.1	1	0.1	0.1	0.1	0.1	0.1	3	0.1	0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.1
Asteraceae	*Gamochaeta americana*	cudweed	0.1			0.1	0.1														
Asteraceae	*Hypochaeris radicata*	flatweed																		0.1	
Asteraceae	*Lactuca serriola*	prickly lettuce												0.1	0.1		0.1			0.1	0.1
Asteraceae	*Olearia elliptica*	sticky daisy-bush		0.1	0.1			0.1													
Asteraceae	*Schkuhria pinnata*	dwarf marigold													0.1		0.1	0.1	0.1	0.1	0.1
Asteraceae	*Senecio madagascariensis*	fireweed	0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Asteraceae	*Sonchus oleraceus*	common sowthistle		0.1		0.1	0.1			0.1	0.1		0.1		0.1	0.1	0.1				
Asteraceae	*Tagetes minuta*	stinking Roger						0.1				0.1							0.1	0.1	0.1
Asteraceae	*Vittadinia cuneata*	fuzzweed									0.1										
Asteraceae	*Vittadinia muelleri*		0.1		0.1	0.1				0.2		0.1				0.1					
Asteraceae	*Vittadinia sulcata*	fuzzweed	0.1																		
Boraginaceae	*Heliotrope amplexicaule*	blue heliotrope												0.1							
Brassicaceae	*Hirschfeldia incana*	hairy brassica	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1			0.1	0.1			0.1	
Brassicaceae	*Lepidium africanum*															0.1	0.1				
Cactaceae	*Opuntia humifusum*	creeping pear					0.1														
Cactaceae	*Opuntia stricta* var. *stricta*						0.1		0.1			0.1	0.1								

Family	Scientific Name	Common Name	NPN 2005 01	NPN 2005 02	NPN 2009 01	NPN 2011 01	NPN 2013 01	NPN 2014 01	NPN 2014 02	NPN 2017 01	NPN 2017 03	NPN 2018 01	NPN 2018 02	NPN 2020 06	NPN 2019 02	NPN 2019 03	NPN 2020 01	NPN 2020 02	NPN 2020 03	NPN 2020 04	NPN 2020 05
Campanulaceae	*Wahlenbergia communis*	tufted bluebell										0.1									
Campanulaceae	*Wahlenbergia gracilis*	sprawling bluebell			0.1		0.1								0.1						
Chenopodiaceae	*Atriplex semibiccata*	creeping saltbush					1			15	2			5	1	0.1	10		2	0.5	
Chenopodiaceae	*Chenopodium album*	fat hen																		0.1	
Chenopodiaceae	*Einadia hastata*	berry saltbush	0.1		0.1		0.1	0.2	10		0.1	0.1	0.1		0.1		0.1		0.5	0.1	
Chenopodiaceae	*Einadia nutans* subsp. *linifolia*	saltbush	0.2	0.1				0.1	0.1	0.1					0.1						
Chenopodiaceae	*Einadia nutans* subsp. *nutans*	climbing saltbush							0.1								0.1				
Chenopodiaceae	*Enchylaena tomentosa*	ruby saltbush	0.1	0.1				0.1	0.1	10	5	0.1			0.1	0.1	0.1	0.1	0.1	0.1	
Chenopodiaceae	*Maireana microphylla*										0.1				0.1						
Chenopodiaceae	*Sclerolaena birchii*															0.1					
Commelinaceae	*Commelina cyanea*	creeping Christian							0.1										0.1	0.1	
Convolvulaceae	*Convolvulus erubescens*	blushing bindweed	0.1		0.1					0.1	0.1										
Convolvulaceae	*Dichondra repens*	kidney weed	0.1	0.1	0.1	3	0.1	0.1		0.1	0.2	0.1			0.2			0.1			0.1
Convolvulaceae	*Evolvulus alsinoides*									0.1											
Cyperaceae	*Cyperus* sp.														0.1						0.1
Cyperaceae	*Cyperus gracilis*	slender flat-sedge	0.1		0.1		0.1	0.1		0.1					0.1					0.1	0.1
Cyperaceae	*Frimbristylis dichotoma*	common frindge-sedge													0.1						0.1
Euphorbiaceae	*Euphorbia drummondii*		0.1	0.1	0.1	0.1					0.1	0.1			0.1						
Fabaceae subf. Caesalpinioides	*Senna artemisioides* subsp. *zygophylla*							0.1													

Family	Scientific Name	Common Name	NPN 2005 01	NPN 2005 02	NPN 2009 01	NPN 2011 01	NPN 2013 01	NPN 2014 01	NPN 2014 02	NPN 2017 01	NPN 2017 03	NPN 2018 01	NPN 2018 02	NPN 2020 06	NPN 2019 02	NPN 2019 03	NPN 2020 01	NPN 2020 02	NPN 2020 03	NPN 2020 04	NPN 2020 05
Fabaceae subf. Faboideae	*Daviesia genistiflolia*	broom bitter pea											0.1	0.1	0.2	0.1				0.1	0.1
Fabaceae subf. Faboideae	*Daviesia ulicifolia*	gorse bitter pea														0.1		0.1			0.1
Fabaceae subf. Faboideae	*Glycine clandestina*	a love creeper																		0.1	
Fabaceae subf. Faboideae	*Glycine tabacina*	a love creeper	0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1		0.1			0.1		0.1	0.1
Fabaceae subf. Faboideae	*Hardenbergia violacea*	false sarsparilla				0.1		0.1		0.1		0.1		0.2	0.1	0.1		0.1	0.1	0.1	0.1
Fabaceae subf. Faboideae	*Jacksonia scoparia*	dogwood													0.1	0.1					
Fabaceae subf. Faboideae	*Indigophera australis*	Australian indigo					0.1	0.1	0.1			1		0.2	1	0.2	0.1	0.2	0.1	0.1	0.1
Fabaceae subf. Faboideae	*Lotus australis*	Australian trefoil								0.1	0.1	0.1									0.1
Fabaceae subf. Faboideae	*Maekawaea rhytidophylla*	trefoil					0.1	0.1													
Fabaceae subf. Faboideae	*Podolobium ilicifolium*	prickly shaggy pea														0.1					
Fabaceae subf. Faboideae	*Pultenaea spinosa*														0.1	0.1					
Fabaceae subf. Faboideae	*Trifolium campestre*	hop clover				0.1															
Fabaceae subf. Mimosoideae	*Acacia amblygona*	fan-leaf wattle	0.1	2	0.1	0.1	1	5		5	1	2	2	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1
Fabaceae subf.	*Acacia binervia*	coastal myall						15	15												

Family	Scientific Name	Common Name	NPN 2005 01	NPN 2005 02	NPN 2009 01	NPN 2011 01	NPN 2013 01	NPN 2014 01	NPN 2014 02	NPN 2017 01	NPN 2017 03	NPN 2018 01	NPN 2018 02	NPN 2020 06	NPN 2019 02	NPN 2019 03	NPN 2020 01	NPN 2020 02	NPN 2020 03	NPN 2020 04	NPN 2020 05
Mimosoideae																					
Fabaceae subf. Mimosoideae	*Acacia leiocalyx*											0.1									
Fabaceae subf. Mimosoideae	*Acacia cultrifomis*	knife-leaf wattle			0.1	30	10	2	5	2	0.1	5		1	2	0.1	0.1	0.1		0.1	0.1
Fabaceae subf. Mimosoideae	*Acacia decora*	western silver wattle			0.1	5	15	15	10		0.1	1	3	0.1	2	0.1		0.1		0.1	0.1
Fabaceae subf. Mimosoideae	*Acacia decurrens*	black wattle												2	0.1						
Fabaceae subf. Mimosoideae	*Acacia elongata*											2		3		0.1		0.2		0.1	0.1
Fabaceae subf. Mimosoideae	*Acacia falcata*	sickle wattle			0.1		0.1	0.1		1	0.1	1		1	2	0.1		2		0.1	0.2
Fabaceae subf. Mimosoideae	*Acacia filicifolia*	fern-leaved wattle													5						
Fabaceae subf. Mimosoideae	*Acacia implexa*	hickory wattle	7	0.1	0.1	1	5	1	1	0.1		5	1	1	2					0.1	0.1
Fabaceae subf. Mimosoideae	*Acacia paradoxa*	kangaroo thorn					1					0.1			0.1	0.2				0.1	
Fabaceae subf. Mimosoideae	*Acacia parvipinnula*	silver stemmed wattle		30	5	2				0.1		5	0.1	5	5	0.2		0.1	0.1	0.1	0.1

Family	Scientific Name	Common Name	NPN 2005 01	NPN 2005 02	NPN 2009 01	NPN 2011 01	NPN 2013 01	NPN 2014 01	NPN 2014 02	NPN 2017 01	NPN 2017 03	NPN 2018 01	NPN 2018 02	NPN 2020 06	NPN 2019 02	NPN 2019 03	NPN 2020 01	NPN 2020 02	NPN 2020 03	NPN 2020 04	NPN 2020 05
Fabaceae subf. Mimosoideae	*Acacia rubida*											0.1									
Fabaceae subf. Mimosoideae	*Acacia salicina*	cooba	5	5		10	5	1	2	2	0.1	3				0.1			0.1	0.1	0.1
Fabaceae subf. Mimosoideae	*Acacia saligna*	golden wreath wattle	3	5	0.1	0.2							0.1		0.1					0.1	
Fabaceae subf. Mimosoideae	*Acacia spectabilis*	Mudgee wattle								3		10	5	1	0.1	0.1	0.1	0.1			
Fabaceae subf. Mimosoideae	*Acacia stricta*	hop wattle		1																	
Gentianaceae	*Centaurium tenuiflorum*		0.1	0.1		0.1	0.1						0.1		0.1			0.1		0.1	
Geraniaceae	*Geranium solanderi* var. *solanderi*	Austral cranesbill			0.1					0.1											
Linaceae	*Linum trigynum*	french flax			0.1		0.1														
Malvaceae	*Modiola caroliana*	red-flowered mallow			0.1	0.1	0.1			0.1	0.1	0.1	0.1								0.1
Malvaceae	*Sida corrugata*	corrugated sida	0.1		0.1																
Malvaceae	*Sida hackettiana*	spiked sida	0.1	0.1	0.1			0.1			0.1									0.1	
Malvaceae	*Sida rhombifolia*	Paddy's lucerne		0.1	0.1	0.1	0.1	0.1	0.1	10	1	0.1	2	0.1	0.1			0.1	0.1	0.1	
Malvaceae	*Sida spinosa*				0.1						0.1	0.1		0.1	0.1					0.1	
Myrtaceae	*Corymbia citriodora*	lemon-scented gum	7	0.1																	
Myrtaceae	*Corymbia maculata*	spotted gum		30	15	0.1	1		1			3	0.1	1	1	0.1	5	0.1	0.1	1	1

Family	Scientific Name	Common Name	NPN 2005 01	NPN 2005 02	NPN 2009 01	NPN 2011 01	NPN 2013 01	NPN 2014 01	NPN 2014 02	NPN 2017 01	NPN 2017 03	NPN 2018 01	NPN 2018 02	NPN 2020 06	NPN 2019 02	NPN 2019 03	NPN 2020 01	NPN 2020 02	NPN 2020 03	NPN 2020 04	NPN 2020 05
Myrtaceae	*Eucalyptus blakelyi*	Blakely's red gum															0.1				
Myrtaceae	*Eucalyptus cladocalyx*	sugar gum	7	15																	
Myrtaceae	*Eucalyptus crebra*	narrow-leaved ironbark		5	5	0.1									0.1	0.1	0.1			1	
Myrtaceae	*Eucalyptus fibrosa*	red ironbark		0.1		0.1															
Myrtaceae	*Eucalyptus moluccana*	grey box			10	5				1				0.1		0.1	0.1			0.1	
Myrtaceae	*Eucalyptus* sp.			0.1																	
Myrtaceae	*Eucalyptus tereticornis*	forest red gum		2	2																
Oleaceae	*Olea europaea* subsp. *cuspidata*	African olive		0.1																	
Oxalidaceae	*Oxalis perennans*	-	0.1	0.1		0.1	0.1	0.1			0.1		0.1		0.1						
Phyllanthaceae	*Phyllanthus hirtellus*	thyme spurge		0.1																	
Phytolaccaceae	*Phytolacca octandra*	inkweed									0.1										
Plantaginaceae	*Plantago lanceolata*	plantain		0.1	0.1	0.1											0.1				
Poacaeae	*Aristida ramosa*	purple wiregrass									0.1				1	1				0.1	2
Poaceae	*Austrostipa scabra*	speargrass	1				0.2	0.1					0.1								0.1
Poaceae	*Austrostipa verticillata*	slender bamboo grass					1	0.1	0.1							0.1					
Poaceae	*Avena sativa*	wild oats					3														
Poaceae	*Bothriochloa decipiens*	red grass			0.1	1	0.1	0.1		5		1			1	0.5		0.1			1
Poaceae	*Capillipedium spicigerum*	scented-top grass								0.2		0.1	5	0.2	5		2	2	1	2	1
Poaceae	*Cenchrus clandestinus*	kikuyu														0.1					
Poaceae	*Chloris gayana*	Rhodes grass	30	15		20	40	40		20	0.1	10	2	60	1	1	5	30	75	10	5

Family	Scientific Name	Common Name	NPN 2005 01	NPN 2005 02	NPN 2009 01	NPN 2011 01	NPN 2013 01	NPN 2014 01	NPN 2014 02	NPN 2017 01	NPN 2017 03	NPN 2018 01	NPN 2018 02	NPN 2020 06	NPN 2019 02	NPN 2019 03	NPN 2020 01	NPN 2020 02	NPN 2020 03	NPN 2020 04	NPN 2020 05
Poaceae	*Chloris truncata*	windmill grass	3				0.1		0.1	10	5		5	3	5	3	2	5		5	8
Poaceae	*Chloris ventricosa*	plump windmill grass	2						2		5	1	2	5	5	1	5	8	3	5	
Poaceae	*Chloris virgata*									0.1											0.5
Poaceae	*Cymbopogon refractus*	barbed-wire grass	5		0.2	0.2		1	1					0.1	4	0.1		2		1	1
Poaceae	*Cynodon dactylon*	common couch		0.1	1	5	10	1	10	30	40		15	1	1	3	5	5		0.1	0.2
Poaceae	*Dicanthium sericeum*	Queensland bluegrass			0.2	2	0.1	0.1		5	5	2	2	3	8		2	4	1	5	10
Poaceae	*Digitaria brownii*	cotton panic grass													1				0.5		
Poaceae	*Digitaria diffusa*	open summer-grass													0.1						
Poaceae	*Digitaria divaricatissima*	umbrella grass								0.1			5	3	5	0.2	5	2	1	1	3
Poaceae	*Echinochloa crus-galli*	banyard grass													1						
Poaceae	*Entolasia marginata*	bordered panic							5												
Poaceae	*Eragrostis brownii*	Brown's lovegrass											3		0.1						
Poaceae	*Eragrostis curvula*	African lovegrass	15	20	0.1							0.1	0.2	0.1		1		1	5	1	0.2
Poaceae	*Eragrostis elongata*	clustered lovegrass													0.1			5		0.2	0.1
Poaceae	*Eragrostis leptostachya*	paddock lovegrass			0.2				0.1				5	1	5		2				
Poaceae	*Eriochloa procera*	spring grass													0.1						
Poaceae	*Eriochloa pseudoacrotricha*	early spring grass	3		2		5	0.5		5	5	3	5	3	5		1	2		3	3
Poaceae	*Eulalia aurea*	silky browntop													0.1						0.1
Poaceae	*Megathyrsus maximus*	green panic	30		10	50		2	30		5		1		0.1			0.1			

Family	Scientific Name	Common Name	NPN 2005 01	NPN 2005 02	NPN 2009 01	NPN 2011 01	NPN 2013 01	NPN 2014 01	NPN 2014 02	NPN 2017 01	NPN 2017 03	NPN 2018 01	NPN 2018 02	NPN 2020 06	NPN 2019 02	NPN 2019 03	NPN 2020 01	NPN 2020 02	NPN 2020 03	NPN 2020 04	NPN 2020 05
Poaceae	*Melinis repens*	red natal grass		0.1	0.1	0.1						15			0.1	0.1			0.1	0.1	
Poaceae	*Panicum effusum*	hairy panic			0.1						0.5	2	5	2	0.2		2	3	1	2	
Poaceae	*Panicum simile*	two-colour panic														0.5					
Poaceae	*Paspalidium breviflorum*			2	0.5									0.2	1	0.1					
Poaceae	*Paspalum dilatatum*	paspalum								5	1			0.1	1	0.1		0.1			0.1
Poaceae	*Rytidosperma richardsonii*	wallaby grass						0.1								0.1		0.1		0.1	0.1
Poaceae	*Setaria parviflora*	setaria			0.1		10	1	3	5	5	5	50		5	0.1		10	5	5	1
Poaceae	*Setaria sphacelata*	South African pigeon grass		2																	
Poaceae	*Sporobolus creber*	slender rat's tail grass		0.1			0.1	1		3	5	0.1	5		4	5	1	2			1
Poaceae	*Themeda avenacea*	native oatgrass										0.1			0.1						
Poaceae	*Themeda triandra*	kangaroo grass				0.1	0.1	0.5		0.1		0.1			0.1	0.1					0.1
Portulacaceae	*Portulaca oleracea*	pigweed										0.1									
Primulaceae	*Lysimachia arvensis*	scarlet pimpernel		0.1	0.1	0.1				0.1	0.1	0.1	0.1								0.1
Proteaceae	*Grevillea montana*														0.1						
Proteaceae	*Hakea sericea*	needlebush										0.1			0.1			0.1			
Pteridaceae	*Cheilanthes sieberi*	rock fern		0.1					0.1												
Rubiaceae	*Aperula conferta*	common woodruff				0.1															
Rubiaceae	*Pomax umbellata*	pomax													0.1						
Sapindaceae	*Dodonaea viscosa* subsp. *cuneata*	wedge-leaf hop-bush			0.1	10		1		2	1	3	3								0.1

Family	Scientific Name	Common Name	NPN 2005 01	NPN 2005 02	NPN 2009 01	NPN 2011 01	NPN 2013 01	NPN 2014 01	NPN 2014 02	NPN 2017 01	NPN 2017 03	NPN 2018 01	NPN 2018 02	NPN 2020 06	NPN 2019 02	NPN 2019 03	NPN 2020 01	NPN 2020 02	NPN 2020 03	NPN 2020 04	NPN 2020 05
Scrophulariaceae	*Eremophila debilis*	winter apple	0.2	1	0.1			0.1			0.1				0.1					0.1	0.1
Scrophulariaceae	*Myoporum montanum*					0.1				0.2	0.1										
Solanaceae	*Lycium ferocissimum*	African boxthorn		0.1																	
Solanaceae	*Solanum cinereum*	narrawa burr	0.1					0.1		0.1	0.1			0.1		0.1	0.1		0.1	0.1	0.1
Solanaceae	*Solanum nigrum*	black-berry nightshade					0.1	0.1				0.1								0.1	
Thymelaeaceae	*Pimelia linifolia*	slender rice flower													0.1						
Verbenaceae	*Verbena bonariensis*	purple top	0.1	0.1	0.1	2	0.1	0.1		0.1	0.1				0.1						

Table 2. Central Area Flora List

Family	Scientific Name	Common Name	CDD2011011	CDD2014011	CDD2015011	CDD2017011	CDD2017021	CDD2018011	CDD2019011	CDD2019021	CDD2020011	SPN2014011	SPN2015011	SPN2016011	SPN2016021	SPN2017011	SPS2016011	SPS2016021	SPS2017011	SPS2017031	SPS2018011	SPS2019011	SPS2019021	WDL2014011	WDL2014021
Aiozaceae	*Galenia pubescens* var. *pubescens*	galenia	0.5	20	0.1	3	10	0.1	2	10	3	8	4	20	5	30	5	5	0.1	0.1	0.1	20	10	2	2
Amaranthaceae	*Gomphrena celosioides*	gomphrena weed				0.1																			
Apiaceae	*Cyclospermum leptophyllum*	slender celery					0.1																	0.1	
Apiaceae	*Foeniculum valgare*	fennel													0.1										
Apocynaceae	*Gomphocarpus fruticosus*	narrow-leaved cotton bush	0.1		0.1			0.1							0.1					0.1				0.1	
Asphodelaceae	*Asphodelus fistulosus*	onion weed						0.1								0.1									
Asteraceae	*Aster subulatus*	wild aster							0.1			0.1			0.1					0.1					0.1
Asteraceae	*Bidens pilosa* var. *pilosa*	cobblers pegs	0.1	0.1				0.1				0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.1				0.1	0.1
Asteraceae	*Bidens subalternans*	greater beggar's ticks					0.1					0.1					0.1								
Asteraceae	*Calotis lappulacea*	yellow burr-daisy					0.1	0.1						0.1	0.1	0.2									
Asteraceae	*Calotis cuneifolia*	purple burr-daisy										0.1		0.1		0.1									
Asteraceae	*Chrysocephalum apiculatum*	yellow buttons							0.1																
Asteraceae	*Cirsium vulgare*	spear thistle																0.1		0.1					0.1
Asteraceae	*Conyza bonariensis*	fleabane	0.1			0.1	0.1	0.1	0.1	0.1	0	0.5	0.1	0.1	0.5	0.1	0.1	0.1	0.1	0.1			0.1	0.1	0.1

Family	Scientific Name	Common Name	CD D20 110 1	CD D20 140 1	CD D20 150 1	CD D20 170 1	CD D20 170 2	CD D20 180 1	CD D20 190 1	CD D20 190 2	CD D20 200 1	SPN 201 401	SPN 201 501	SPN 201 601	SPN 201 602	SPN 201 701	SPS 201 601	SPS 201 602	SPS 201 701	SPS 201 703	SPS 201 801	SPS 201 901	SPS 201 902	WD L20 140 1	WD L20 140 2
Asteraceae	*Conyza* sp.																					0.1	0.1		
Asteraceae	*Gamochaeta americana*	cudweed	0.1																0.1						
Asteraceae	*Hypochaeris radicata*	flatweed																		0.1					
Asteraceae	*Lactuca serriola*	prickly lettuce																		0.1					0.1
Asteraceae	*Olearia elliptica*	sticky daisy-bush	0.1																						
Asteraceae	*Schkuhria pinnata*	dwarf marigold				0.1	0.1									0.1									
Asteraceae	*Senecio madagascariensis*	fireweed	0.1	0.1	0.1	0.1			0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1			0.1	0.1	0.1
Asteraceae	*Sonchus oleraceus*	common sowthistle	0.1	0.1		0.1	0.1							0.1	0.1	0.1	0.1		0.1	0.1	0.1			0.1	
Asteraceae	*Tagetes minuta*	stinking Roger					0.1						0.1						0.1				0.1		
Asteraceae	*Vittadinia cuneata*	fuzzweed	0.1	0.1			0.1	0.1					0.1					0.1	0.1						
Asteraceae	*Vittadinia muelleri*							0.1		0.1		0.1			0.1										
Asteraceae	*Vittadinia sulcata*	fuzzweed	0.1									0.1													
Brassicaceae	*Hirschfeldia incana*	hairy brassica	0.1									0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1			0.1	1
Brassicaceae	*Lepidium africanum*						0.5		0.1		0.1		0.1	0.1								0.1	0.1		
Chenopodiaceae	*Atriplex semibiccata*	creeping saltbush		0.5	0.1		1	2	0.1	0.2	0.1	5		1	1	5	5	2	1			5	0.2	1	5
Chenopodiaceae	*Chenopodium album*	fat hen									0.1														
Chenopodiaceae	*Einadia hastata*	berry saltbush		0.1	1			0.5	0.1	0.1	0.1	0.5	0.1	3	2	0.1						0.1	0.1	5	2
Chenopodiaceae	*Einadia nutans* subsp. *linifolia*	saltbush		0.1			0.1			0.1			0.1	3	0.1	0.1		0.1					0.1	1	

Family	Scientific Name	Common Name	CDD2011011	CDD2014011	CDD2015011	CDD2017011	CDD2017021	CDD2018011	CDD2019011	CDD2019021	CDD2020011	SPN2014011	SPN2015011	SPN2016011	SPN2016021	SPN2017011	SPS2016011	SPS2016021	SPS2017011	SPS2017031	SPS2018011	SPS2019011	SPS2019021	WDL2014011	WDL2014021
Chenopodiaceae	*Einadia nutans* subsp. *nutans*	climbing saltbush					0.5			0.1	0.1						0.1	0.1				0.1	0.1		
Chenopodiaceae	*Enchylaena tomentosa*	ruby saltbush		0.2	1		5	0.1	1	0.2	0.1				0.1	0.1		0.5	0.1		0.1	5	0.2	1	0.1
Chenopodiaceae	*Maireana microphylla*					0.1			0.1																
Chenopodiaceae	*Sclerolaena birchii*								0.1																
Commelinaceae	*Commelina cyanea*	creeping Christian																					0.1		
Convolvulaceae	*Convolvulus erubescens*	blushing bindweed								0.1				0.1	0.1			0.1	0.1						
Convolvulaceae	*Dichondra repens*	kidney weed	3					0.1				0.1		0.2	0.5		0.1	0.1		0.1		0.1		0.1	
Cyperaceae	*Cyperus* sp.								0.1	0.1															
Cyperaceae	*Cyperus gracilis*	slender flat-sedge				0.5				0.1				0.1	0.1	0.1	0.1		0.1	0.1			0.1		
Cyperaceae	*Frimbristylis dichotoma*	common frindge-sedge	0.1			0.1																			
Euphorbiaceae	*Euphorbia drummondii*																0.1			5					
Fabaceae subf. Caesalpinioides	*Senna artemisioides* subsp. *zygophylla*														0.1		0.1								
Fabaceae subf. Faboideae	*Daviesia genistiflolia*	broom bitter pea							0.1																
Fabaceae subf. Faboideae	*Dipogon lignosus*	dolichos pea																						2	
Fabaceae subf. Faboideae	*Glycine clandestina*	a love creeper					0.1																		

Family	Scientific Name	Common Name	CD D20 110 1	CD D20 140 1	CD D20 150 1	CD D20 170 1	CD D20 170 2	CD D20 180 1	CD D20 190 1	CD D20 190 2	CD D20 200 1	SPN 201 401	SPN 201 501	SPN 201 601	SPN 201 602	SPN 201 701	SPS 201 601	SPS 201 602	SPS 201 701	SPS 201 703	SPS 201 801	SPS 201 901	SPS 201 902	WD L20 140 1	WD L20 140 2
Fabaceae subf. Faboideae	*Glycine tabacina*	a love creeper	0.5					0.1						0.1	0.1	0.1		0.1	0.1				0.1	0.1	
Fabaceae subf. Faboideae	*Hardenbergia violacea*	false sarsparilla		0.1	0.1																				
Fabaceae subf. Faboideae	*Indigophera australis*	Australian indigo	0.1							0.1					0.5			0.1	0.1	0.1			0.1		
Fabaceae subf. Faboideae	*Lotus australis*	Australian trefoil		0.1																					
Fabaceae subf. Faboideae	*Macroptilium lathyroides*	phasey bean												0.1											
Fabaceae subf. Faboideae	*Maekawaea rhytidophylla*	trefoil													0.1										
Fabaceae subf. Faboideae	*Medicago sativa*	lucerne										0.1													
Fabaceae subf. Faboideae	*Trifolium arvense*																			0.1					
Fabaceae subf. Faboideae	*Trifolium campestre*	hop clover																		0.1	0.1				
Fabaceae subf. Faboideae	*Trifolium repens*	white clover																		0.1					
Fabaceae subf. Mimosoideae	*Acacia amblygona*	fan-leaf wattle	1		1	1		1		0.1	0.1	0.1	1		1	0.1		0.1	2	0.1			0.1	4	0.1
Fabaceae subf. Mimosoideae	*Acacia cultrifomis*	knife-leaf wattle	3	0.1	5	0.1		2		0.1			1				0.1		0.1					2	3
Fabaceae subf.	*Acacia decora*	western silver wattle	1	0.1	1	1		1		0.1		0.1	1	0.5	2		0.1	0.1	0.1				0.1	5	3

Family	Scientific Name	Common Name	CD D20 110 1	CD D20 140 1	CD D20 150 1	CD D20 170 1	CD D20 170 2	CD D20 180 1	CD D20 190 1	CD D20 190 2	CD D20 200 1	SPN 201 401	SPN 201 501	SPN 201 601	SPN 201 602	SPN 201 701	SPS 201 601	SPS 201 602	SPS 201 701	SPS 201 703	SPS 201 801	SPS 201 901	SPS 201 902	WD L20 140 1	WD L20 140 2
Mimosoideae																									
Fabaceae subf. Mimosoideae	*Acacia falcata*	sickle wattle	0.1					0.2		0.1					1				0.1				0.1	0.1	
Fabaceae subf. Mimosoideae	*Acacia implexa*	hickory wattle	2		10			0.1							0.1				0.1					10	
Fabaceae subf. Mimosoideae	*Acacia paradoxa*	kangaroo thorn						0.1					0.5												
Fabaceae subf. Mimosoideae	*Acacia parvipinnula*	silver stemmed wattle			10				0.1	0.2													0.1		
Fabaceae subf. Mimosoideae	*Acacia podalyriifolia*	Queensland silver wattle				0.1																			
Fabaceae subf. Mimosoideae	*Acacia salicina*	cooba	1	0.1		0.1		0.5	0.1	0.1	0.1			1				0.1	0.1	0.1			0.1	0.1	
Fabaceae subf. Mimosoideae	*Acacia saligna*	golden wreath wattle		2								4					2	3		0.1		0.1	0.1		10
Fabaceae subf. Mimosoideae	*Acacia spectabilis*	Mudgee wattle	2		10	1	0.1	0.5							2				0.1				0.1		
Gentianaceae	*Centaurium tenuiflorum*		0.1			0.1						0.1	0.1				0.1	0.1	0.1	1					1
Geraniaceae	*Geranium solanderi* var. *solanderi*	Austral cranesbill	0.1	0.1				0.1						2			0.1		0.1	0.1					
Juncaceae	*Juncus usitatus*							0.1																	

Family	Scientific Name	Common Name	CDD2011011	CDD2014011	CDD2015011	CDD2017011	CDD2017021	CDD2018011	CDD2019011	CDD2019021	CDD2020011	SPN2014011	SPN2015011	SPN2016011	SPN2016021	SPN2017011	SPS2016011	SPS2016021	SPS2017011	SPS2017031	SPS2018011	SPS2019011	SPS2019021	WDL2014011	WDL2014021
Linaceae	*Linum marginale*	native flax		0.1		0.1						0.1													0.1
Linaceae	*Linum trigynum*	french flax	0.1																						
Lythraceae	*Lythrum hyssopifolia*	hyssop loosestrife																		0.1					
Malvaceae	*Modiola caroliana*	red-flowered mallow	0.1	0.1						0.1		0.1			0.1			0.1		0.1			0.1		
Malvaceae	*Sida corrugata*	corrugated sida	0.1										0.1	0.1				0.1							
Malvaceae	*Sida hackettiana*	spiked sida								0.1			0.1	0.1					0.1			0.1	0.2	0.1	
Malvaceae	*Sida rhombifolia*	Paddy's lucerne	0.1	0.1			0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.1		0.1		0.1	0.1
Malvaceae	*Sida spinosa*		0.1				0.1	0.1		0.2			0.1	0.1	0.1		0.1		0.1	0.1	0.1		0.1	0.1	0.1
Myrtaceae	*Angophora floribunda*																								0.1
Myrtaceae	*Corymbia maculata*	spotted gum	20		5	0.1		3	1						0.1	2				0.1		0.1	1	10	2
Myrtaceae	*Eucalyptus blakelyi*	Blakely's red gum														0.1									
Myrtaceae	*Eucalyptus crebra*	narrow-leaved ironbark	3		3								3						0.1					5	
Myrtaceae	*Eucalyptus dawsonii*	slatey gum				0.1							1		0.5									2	
Myrtaceae	*Eucalyptus fibrosa*	red ironbark	1		3																				
Myrtaceae	*Eucalyptus moluccana*	grey box	2		1	0.1				0.1			0.5					0.1					0.1	3	2
Oxalidaceae	*Oxalis perennans*	-	0.1	0.1								0.1	0.1	3	0.1			0.1	0.1			0.1			0.1
Plantaginaceae	*Plantago lanceolata*	plantain	0.1						0.1							0.1	0.1		0.1	0.1			0.1	0.1	0.5
Poacaeae	*Aristida ramosa*	purple wiregrass								0.1													0.1		
Poacaeae	*Austrostipa aristiglumis*	plains grass							0.1														0.1		

Family	Scientific Name	Common Name	CDD2011011	CDD2014011	CDD2015011	CDD2017011	CDD2017021	CDD2018011	CDD2019011	CDD2019021	CDD2020011	SPN2014011	SPN2015011	SPN2016011	SPN2016021	SPN2017011	SPS2016011	SPS2016021	SPS2017011	SPS2017031	SPS2018011	SPS2019011	SPS2019021	WDL2014011	WDL2014021
Poaceae	*Austrostipa scabra*	speargrass			5									3											
Poaceae	*Austrostipa verticillata*	slender bamboo grass												0.5		0.1									
Poaceae	*Bothriochloa decipiens*	red grass	2		1		0.5	1		0.1		0.1	2				0.1			0.5					2
Poaceae	*Capillipedium spicigerum*	scented-top grass	3			1	0.5	5		1			0.1	1	0.5				1	0.5			1		2
Poaceae	*Cenchrus clandestinus*	kikuyu																2							
Poaceae	*Chloris gayana*	Rhodes grass		50	3	60	40	5	5	10	20	10	5	2	25	5		20	1	2	20	5	15	2	20
Poaceae	*Chloris truncata*	windmill grass			10	2	5	2	5	3	5			1	3	2	0.2	10	3	5		3	2	2	
Poaceae	*Chloris ventricosa*	plump windmill grass	1			2	1	2	10	5	5			1		2			1	0.5		3	5	5	
Poaceae	*Chloris virgata*														0.1										
Poaceae	*Cymbopogon refractus*	barbed-wire grass							0.1														0.1		
Poaceae	*Cynodon dactylon*	common couch	2	2	1	5	5	3	5		5	5		5	5	5	5		15	10	5	3	5		5
Poaceae	*Dicanthium sericeum*	Queensland bluegrass	1			2		5	0.2	2	2	3	3	1	2	1		5	1	5		2	1	2	5
Poaceae	*Digitaria brownii*	cotton panic grass								1				0.1									1		
Poaceae	*Digitaria diffusa*	open summer-grass														1									
Poaceae	*Digitaria divaricatissima*	umbrella grass	1				1			1				5									0.2		
Poaceae	*Echinochloa esculenta*	Japanese millet							0.1																
Poaceae	*Eragrostis brownii*	Brown's lovegrass						5																	

Family	Scientific Name	Common Name	CDD2011 01	CDD2014 01	CDD2015 01	CDD2017 01	CDD2017 02	CDD2018 01	CDD2019 01	CDD2019 02	CDD2020 01	SPN2014 01	SPN2015 01	SPN2016 01	SPN2016 02	SPN2017 01	SPS2016 01	SPS2016 02	SPS2017 01	SPS2017 03	SPS2018 01	SPS2019 01	SPS2019 02	WDL2014 01	WDL2014 02
Poaceae	*Eragrostis curvula*	African lovegrass		5				5	1	5				1								5	5	0.1	
Poaceae	*Eragrostis elongata*	clustered lovegrass						0.5																	
Poaceae	*Eragrostis leptostachya*	paddock lovegrass	1			1			1														1		
Poaceae	*Eriochloa procera*	spring grass															5								
Poaceae	*Eriochloa pseudoacrotricha*	early spring grass	3	3		5	5	8	5	3	5	6	3	5	2	10	5	5	5	10		3	2	5	3
Poaceae	*Eulalia aurea*	silky browntop								0.1	1				0.1								0.1		
Poaceae	*Megathyrsus maximus*	green panic	5	15						1	5	60	60	5	5	15	70	30	5	1	70	50	2	2	10
Poaceae	*Melinis repens*	red natal grass			1					0.1															
Poaceae	*Panicum effusum*	hairy panic	2			1		3						1	0.5								0.1	1	
Poaceae	*Panicum simile*	two-colour panic							1	1	3														
Poaceae	*Paspalidium breviflorum*							5		0.1				10	2										
Poaceae	*Paspalum dilatatum*	paspalum	1					0.1	0.1	0.1													0.2		0.1
Poaceae	*Rytidosperma richardsonii*	wallaby grass	0.1																						
Poaceae	*Setaria parviflora*	setaria	5			5	2	20	1	20			5	5	3	5	5	2	5			5	5	10	5
Poaceae	*Sporobolus creber*	slender rat's tail grass	3		0.1	3	5	5	20	5		2	3	3	3	1	0.2	2	10			2	10	2	
Poaceae	*Themeda triandra*	kangaroo grass	2		2			0.1		0.2		0.5		0.5	0.1										0.1
Poaceae	*Urochloa panicoides*	urochloa grass									5														
Portulacaceae	*Portulaca oleracea*	pigweed									0.1														

Family	Scientific Name	Common Name	CDD2011011	CDD2014011	CDD2015011	CDD2017011	CDD2017021	CDD2018011	CDD2019011	CDD2019021	CDD2020011	SPN2014011	SPN2015011	SPN2016011	SPN2016021	SPN2017011	SPS2016011	SPS2016021	SPS2017011	SPS2017031	SPS2018011	SPS2019011	SPS2019021	WDL2014011	WDL2014021
Primulaceae	*Lysimachia arvensis*	scarlet pimpernel	0.1					0.1				0.1	0.1	0.1	0.1	0.1			0.1	0.5					
Sapindaceae	*Dodonaea viscosa* subsp. *cuneata*	wedge-leaf hop-bush	2			0.1		0.2	0.1			0.5	1		0.1	0.2			0.1				0.1		
Scrophulariaceae	*Eremophila debilis*	winter apple	1																					1	
Scrophulariaceae	*Myoporum montanum*							0.2	0.1						1	0.2			2						
Solanaceae	*Lycium ferocissimum*	African boxthorn						0.1																	
Solanaceae	*Solanum brownii*	violet nightshade														0.1									
Solanaceae	*Solanum cinereum*	narrawa burr	0.1	0.1			0.1	0.1	0.1	0.1	0.1			0.1		0.1			0.1	0.1		0.1	0.1		
Solanaceae	*Solanum nigrum*	black-berry nightshade					0.1	0.1					0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1			0.1	0.5	0.1
Verbenaceae	*Lantana camara*	lantana																	0.1					0.1	
Verbenaceae	*Verbena bonariensis*	purple top						0.1				0.5			0.1		0.1	0.1				0.1	0.1	0.1	2

Table 3. Southern Area Flora List

Family	Scientific Name	Common Name	MTO2000001	MTO2005003	MTO2016001	MTO2017001	MTO2017002	MTO2017003	MTO2017004	MTO2018001	MTO2019001	MTO2019002	MTO2019003	MTO2019004	MTO2019005	MTO2019006	MTO2019007	MTO2016002	MTO2019008	MTO2002002	MTO2002003	MTO2002004	MTO2002005
Aiozaceae	*Galenia pubescens* var. *pubescens*	galenia	0.1	2		10	20	5		5	5	15		2	2	1	1	20	3		0.1	0.1	0.5
Amaranthaceae	*Gomphrena celosioides*	gomphrena weed								0.1	0.1						0.1					0.1	
Apiaceae	*Cyclospermum leptophyllum*	slender celery			0.1					0.1							0.1						
Apocynaceae	*Gomphocarpus fruticosus*	narrow-leaved cotton bush		0.1					0.1		0.1		0.1		0.1	0.1	0.1	0.1				0.1	0.1
Asparagaceae	*Lomandra longifolia*	spiny-headed mat-rush													0.1								
Asteraceae	*Aster subulatus*	wild aster			0.1		0.1	0.1	0.1				0.1			0.1	0.1			0.2	0.1	0.1	
Asteraceae	*Bidens pilosa* var. *pilosa*	cobblers pegs	5	0.1	30		0.1	0.1	0.1	0.5	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	
Asteraceae	*Bidens subalternans*	greater beggar's ticks	0.1							0.5					0.1		0.1						
Asteraceae	*Calotis lappulacea*	yellow burr-daisy	0.1	0.1		0.1	0.5		0.1	0.1	0.1		0.1		0.1			0.1	0.1				
Asteraceae	*Calotis cuneifolia*	purple burr-daisy									0.1	0.1	0.5		0.1					0.1			0.1

Family	Scientific Name	Common Name	MTO2000001	MTO2005003	MTO2016001	MTO2017001	MTO2017002	MTO2017003	MTO2017004	MTO2018001	MTO2019001	MTO2019002	MTO2019003	MTO2019004	MTO2019005	MTO2019006	MTO2019007	MTO2016002	MTO2019008	MTO2002002	MTO2002003	MTO2002004	MTO2002005
Asteraceae	*Carthamus lanatus*	saffron thistle																0.1	0.1				
Asteraceae	*Cassinia quinquefaria*																	0.1					
Asteraceae	*Cassinia sifton*	sifton bush																0.1					
Asteraceae	*Cirsium vulgare*	spear thistle										0.1	0.1			0.1							
Asteraceae	*Conyza bonariensis*	fleabane	1	0.1	1	0.1	0.1	0.5	0.1	3	0.5	0.5	0.1	5	0.1	0.1	5	0.1	0.1	0.1	0.1	0.2	0.1
Asteraceae	*Conyza* sp.												0.1									0.1	
Asteraceae	*Euchiton involucratus*	star cudweed			0.1													0.1		0.1			0.1
Asteraceae	*Gamochaeta americana*	cudweed										0.1	0.1	0.1									
Asteraceae	*Lactuca serriola*	prickly lettuce									0.1		0.1			0.1			0.1				
Asteraceae	*Olearia elliptica*	sticky daisy-bush																0.1					
Asteraceae	*Ozothamnus diosmifolius*	white dogwood																0.1					
Asteraceae	*Schkuhria pinnata*	dwarf marigold			0.1							0.1	0.1				0.1			0.1		0.1	0.1
Asteraceae	*Senecio madagascariensis*	fireweed	0.1		0.1	0.1	0.1	2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Asteraceae	*Sonchus oleraceus*	common sowthistle						0.1			0.1			0.1					0.1	0.1			
Asteraceae	*Tagetes minuta*	stinking Roger	0.1							0.5	0.1	0.1	0.1	0.1		0.1	0.1		3				
Asteraceae	*Vittadinia cuneata*	fuzzweed		0.1																			
Asteraceae	*Vittadinia muelleri*		4	0.1							0.1		0.1					0.1					
Asteraceae	*Vittadinia sulcata*	fuzzweed			0.1													0.1					
Asteraceae	*Xanthium occidentale*	nagoora burr			0.1																		

Family	Scientific Name	Common Name	MTO2000001	MTO2005003	MTO2016001	MTO2017001	MTO2017002	MTO2017003	MTO2017004	MTO2018001	MTO2019001	MTO2019002	MTO2019003	MTO2019004	MTO2019005	MTO2019006	MTO2019007	MTO2016002	MTO2019008	MTO2020002	MTO2020003	MTO2020004	MTO2020005
Brassicaceae	*Hirschfeldia incana*	hairy brassica	0.1		1					0.1	0.1	0.1		0.1					0.1				
Brassicaceae	*Lepidium africanum*		0.1		0.1	0.5	0.1	0.1	0.1	0.1			0.1	0.1		0.1	0.1	0.1	0.1		0.1		
Cactaceae	*Opuntia aurantiaca*	tiger pear	0.1	0.1																			
Celastraceae	*Stackhousia viminea*	slender stackhousia								0.1			0.1										
Chenopodiaceae	*Atriplex semibiccata*	creeping saltbush				5	15	4	3		1					0.2	0.2	1		1	3	2	0.1
Chenopodiaceae	*Chenopodium album*	fat hen			0.1																0.1		
Chenopodiaceae	*Einadia hastata*	berry saltbush	0.1	0.1		2	0.1			0.1	0.1	0.1	0.1			0.1	0.1		0.1	0.1	0.1	0.1	
Chenopodiaceae	*Einadia nutans* subsp. *linifolia*	saltbush	0.1	0.1									0.2		0.1	0.1					0.1		
Chenopodiaceae	*Einadia nutans* subsp. *nutans*	climbing saltbush				1										0.1	0.1			0.1			
Chenopodiaceae	*Enchylaena tomentosa*	ruby saltbush	0.2	0.1		1	0.1	1	0.5		0.1	0.1	0.5	0.1	0.1	0.1		0.1		0.1	0.1		
Chenopodiaceae	*Maireana microphylla*															0.1							
Chenopodiaceae	*Sclerolaena muricata* var. *muricata*															0.1							
Commelinaceae	*Commelina cyanea*	creeping Christian		0.1							0.1												
Convolvulaceae	*Convolvulus erubescens*	blushing bindweed											0.1				0.1		0.1				

Family	Scientific Name	Common Name	MTO2000001	MTO2005003	MTO2016001	MTO2017001	MTO2017002	MTO2017003	MTO2017004	MTO2018001	MTO2019001	MTO2019002	MTO2019003	MTO2019004	MTO2019005	MTO2019006	MTO2019007	MTO2016002	MTO2019008	MTO2020002	MTO2020003	MTO2020004	MTO2020005
Convolvulaceae	*Dichondra repens*	kidney weed	0.1	0.1					0.1	0.5	1	0.1	0.1	0.1	0.1		0.1		0.1	0.1			
Cyperaceae	*Cyperus* sp.										0.1	0.1	0.1				0.1		0.1	0.1	0.1	0.1	
Cyperaceae	*Cyperus gracilis*	slender flat-sedge	0.1	0.1							0.1								0.1				
Cyperaceae	*Frimbristylis dichotoma*	common frindge-sedge								0.1	0.1		0.1		0.1				0.1	0.1			0.1
Euphorbiaceae	*Euphorbia drummondii*			0.1								0.1	0.1	0.1					0.1				
Fabaceae subf. Caesalpinioides	*Senna artemisioides* subsp. *zygophylla*									0.1													
Fabaceae subf. Faboideae	*Daviesia genistiflolia*	broom bitter pea									0.1	0.1	0.1	0.1	1			0.1		1			0.1
Fabaceae subf. Faboideae	*Glycine clandestina*	a love creeper								0.1									0.1				
Fabaceae subf. Faboideae	*Glycine tabacina*	a love creeper	0.1	0.1					0.1	0.1	0.1	0.1			0.1		0.1		0.1	0.1			
Fabaceae subf. Faboideae	*Hardenbergia violacea*	false sarsparilla									0.5	0.1	0.1	0.1	0.1			0.1	0.1	0.1			
Fabaceae	*Jacksonia scoparia*	dogwood													0.1								

Family	Scientific Name	Common Name	MTO2000001	MTO2005003	MTO2016001	MTO2017001	MTO2017002	MTO2017003	MTO2017004	MTO2018001	MTO2019001	MTO2019002	MTO2019003	MTO2019004	MTO2019005	MTO2019006	MTO2019007	MTO2016002	MTO2019008	MTO2002002	MTO2002003	MTO2002004	MTO2002005
subf. Faboideae																							
Fabaceae subf. Faboideae	*Indigophera australis*	Australian indigo									2	0.1	0.1	0.1	0.1		0.2	0.1	0.1	0.1		0.1	0.1
Fabaceae subf. Faboideae	*Lotus australis*	Australian trefoil															0.1		0.1				
Fabaceae subf. Faboideae	*Medicago sativa*	lucerne																		0.1		0.1	
Fabaceae subf. Faboideae	*Pultenaea spinosa*										0.1		0.1		0.1								
Fabaceae subf. Faboideae	*Trifolium campestre*	hop clover			0.1			0.1						0.1				0.1					
Fabaceae subf. Mimosoideae	*Acacia amblygona*	fan-leaf wattle								0.1	2	3	0.5	0.1	0.5			0.1	0.1	1		0.1	0.1
Fabaceae subf. Mimosoideae	*Acacia cultrifomis*	knife-leaf wattle				0.5			0.5	0.5	1	0.1	1	0.5	2		0.1	1	0.5	0.1			0.1

Family	Scientific Name	Common Name	MTO2000001	MTO2005003	MTO2016001	MTO2017001	MTO2017002	MTO2017003	MTO2017004	MTO2018001	MTO2019001	MTO2019002	MTO2019003	MTO2019004	MTO2019005	MTO2019006	MTO2019007	MTO2016002	MTO2019008	MTO2020002	MTO2020003	MTO2020004	MTO2020005
Fabaceae subf. Mimosoideae	*Acacia decora*	western silver wattle								0.1	1	0.1	0.2		0.1	0.1	0.1	0.5	0.1	0.1			0.1
Fabaceae subf. Mimosoideae	*Acacia decurrens*	black wattle		0.1																			0.1
Fabaceae subf. Mimosoideae	*Acacia elongata*										0.5	0.1	0.1		0.1				0.1	0.1			0.1
Fabaceae subf. Mimosoideae	*Acacia falcata*	sickle wattle									5	3	2	0.5	2		0.1	0.1	1	3			0.1
Fabaceae subf. Mimosoideae	*Acacia implexa*	hickory wattle	0.1								2	0.1	2		1		0.1	0.1	0.1	0.1			0.1
Fabaceae subf. Mimosoideae	*Acacia paradoxa*	kangaroo thorn									2	3	0.5		1				0.1				
Fabaceae subf. Mimo	*Acacia parvipinnula*	silver stemmed wattle								0.1	2	2	2	0.1	0.5		0.1	0.1	0.1	1	0.1		0.1

Family	Scientific Name	Common Name	MTO2000001	MTO2005003	MTO2016001	MTO2017001	MTO2017002	MTO2017003	MTO2017004	MTO2018001	MTO2019001	MTO2019002	MTO2019003	MTO2019004	MTO2019005	MTO2019006	MTO2019007	MTO2016002	MTO2019008	MTO2020002	MTO2020003	MTO2020004	MTO2020005
soideae																							
Fabaceae subf. Mimosoideae	*Acacia salicina*	cooba	0.1	0.1	0.1	0.1				0.5	0.5		0.1	0.1	0.1	0.1		0.1	0.1	0.1			0.1
Fabaceae subf. Mimosoideae	*Acacia saligna*	golden wreath wattle		0.1			0.5	0.1				3	0.1	3			0.1		2				0.1
Fabaceae subf. Mimosoideae	*Acacia spectabilis*	Mudgee wattle									1		0.2	0.1	0.2						0.1		0.1
Gentianaceae	*Centaurium tenuiflorum*				0.1		0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1		0.1		0.1	0.1			0.1
Geraniaceae	*Geranium solanderi* var. *solanderi*	Austral cranesbill							0.1														
Linaceae	*Linum trigynum*	french flax								0.1								0.1					
Malvaceae	*Malva parviflora*	small-flowered mallow								0.1													
Malvaceae	*Modiola caroliana*	red-flowered mallow		0.1					0.1					0.1			0.1						
Malvaceae	*Sida corrugata*	corrugated sida	0.5	0.1						0.1													
Malvaceae	*Sida hackettiana*	spiked sida										0.1	0.1		0.1		0.1		0.1				
Malvaceae	*Sida rhombifolia*	Paddy's lucerne	0.1				0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.1		0.1	0.1

Family	Scientific Name	Common Name	MTO2000001	MTO2005003	MTO2016001	MTO2017001	MTO2017002	MTO2017003	MTO2017004	MTO2018001	MTO2019001	MTO2019002	MTO2019003	MTO2019004	MTO2019005	MTO2019006	MTO2019007	MTO2016002	MTO2019008	MTO2020002	MTO2020003	MTO2020004	MTO2020005
Malvaceae	*Sida spinosa*							0.1			0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1		0.1	0.1
Myrtaceae	*Corymbia maculata*	spotted gum							2	0.1	2	0.5	0.2	0.1	0.1	2	0.2	2	1	0.1	0.1		0.5
Myrtaceae	*Eucalyptus cladocalyx*	sugar gum	10	15																			
Myrtaceae	*Eucalyptus crebra*	narrow-leaved ironbark		0.1					3				0.1			0.1		1			0.1		0.1
Myrtaceae	*Eucalyptus fibrosa*	red ironbark									0.1				0.1								
Myrtaceae	*Eucalyptus moluccana*	grey box	5										1		0.1	0.5		0.1		0.1	0.1		0.1
Myrtaceae	*Eucalyptus* sp.			2																			
Myrtaceae	*Melaleuca nodosa*	prickly-leaved paperbark											0.1										
Myrtaceae	*Melaleuca seiberi*																			0.1			
Oxalidaceae	*Oxalis perennans*	-	0.1	0.1	0.1					0.1	0.1		0.1	0.1			0.1	0.1	0.1				
Plantaginaceae	*Plantago lanceolata*	plantain		0.1				0.1	0.1		0.1		0.1		0.1	0.1		0.1	0.1				
Poaceae	*Aristida ramosa*	purple wiregrass		1							0.5		0.1	0.1			0.1		0.1				
Poaceae	*Austrostipa aristiglumis*	plains grass								0.1													
Poaceae	*Austrostipa scabra*	speargrass		5																			
Poaceae	*Austrostipa verticillata*	slender bamboo grass																2					
Poaceae	*Bothriochloa decipiens*	red grass									1		0.1	0.5			0.1	2		1			
Poaceae	*Capillipedium spicigerum*	scented-top grass						1		1	5	5	5	5	5		3	5	5	3		1	2
Poaceae	*Cenchrus clandestinus*	kikuyu												0.1								0.1	

Family	Scientific Name	Common Name	MTO2000001	MTO2005003	MTO2016001	MTO2017001	MTO2017002	MTO2017003	MTO2017004	MTO2018001	MTO2019001	MTO2019002	MTO2019003	MTO2019004	MTO2019005	MTO2019006	MTO2019007	MTO2016002	MTO2019008	MTO2020002	MTO2020003	MTO2020004	MTO2020005
Poaceae	*Chloris gayana*	Rhodes grass		1		20	25	5	10	1	8	20	20	2	20	40	5	1	5	3	10	10	2
Poaceae	*Chloris truncata*	windmill grass		5	20	5	8	20	20	10	5	5		5	1	5	5	5	5	10	20	5	5
Poaceae	*Chloris ventricosa*	plump windmill grass			0.1	3	5			10	5	5	5	4		10	10			20	20	5	5
Poaceae	*Cymbopogon refractus*	barbed-wire grass		2										0.2				2	0.5				2
Poaceae	*Cynodon dactylon*	common couch	5		5	5		5	10	5	3		5		5	5	5	3		5	5	70	40
Poaceae	*Dicanthium sericeum*	Queensland bluegrass			1			5	10	10	3	4	5	5	5	2	5	5	5	10	5	3	
Poaceae	*Digitaria brownii*	cotton panic grass															1					2	
Poaceae	*Digitaria divaricatissima*	umbrella grass								1	1	2	2	3	2		1	5	0.5	3	5		2
Poaceae	*Eragrostis brownii*	Brown's lovegrass		2											2					1			2
Poaceae	*Eragrostis curvula*	African lovegrass	3	2				1	0.1	2	3	1	0.5		1		3	1			0.1	1	
Poaceae	*Eragrostis leptostachya*	paddock lovegrass									1	3	5	0.5		4	1			5	5	2	2
Poaceae	*Eriochloa pseudoacrotricha*	early spring grass	40	20	5	20	20	10	5	10	5	5			1	5	5	5	5	5	5	5	5
Poaceae	*Eulalia aurea*	silky browntop											0.1										
Poaceae	*Megathyrsus maximus*	green panic	1							1	0.5	0.5		5		5			3				2
Poaceae	*Melinis repens*	red natal grass		1									0.5										
Poaceae	*Panicum effusum*	hairy panic		2				1		0.1	3	8	3	5	5			3	5	1			2
Poaceae	*Panicum simile*	two-colour panic															0.5				1	2	
Poaceae	*Paspalidium breviflorum*			5						0.2	1		1	0.1				2		3			

Family	Scientific Name	Common Name	MTO2000001	MTO2005003	MTO2016001	MTO2017001	MTO2017002	MTO2017003	MTO2017004	MTO2018001	MTO2019001	MTO2019002	MTO2019003	MTO2019004	MTO2019005	MTO2019006	MTO2019007	MTO2016002	MTO2019008	MTO2020002	MTO2020003	MTO2020004	MTO2020005
Poaceae	*Paspalum dilatatum*	paspalum											0.1		0.1				0.1		0.1	0.1	0.5
Poaceae	*Rytidosperma richardsonii*	wallaby grass	0.1	1						0.1				0.1				0.1					
Poaceae	*Setaria parviflora*	setaria	1					5		20	5	15	5	8	10	5	5	2	5	2	1	5	10
Poaceae	*Sporobolus creber*	slender rat's tail grass	5	8		15	5	5	20	5	2	2		4	3	5	5	10	5	5	5		3
Poaceae	*Themeda triandra*	kangaroo grass								0.1	0.2	1	0.1	0.2	2		0.1		0.5	0.1			
Portulacaceae	*Portulaca oleracea*	pigweed												0.1									
Primulaceae	*Lysimachia arvensis*	scarlet pimpernel		0.1				0.1	0.1	0.1				0.1		0.1			0.1				
Pteridaceae	*Cheilanthes distans*	bristly cloak fern	0.1																				
Rubiaceae	*Richardia stellaris*																						0.1
Sapindaceae	*Dodonaea viscosa* subsp. *cuneata*	wedge-leaf hop-bush									1				0.1		0.1	0.2	1				
Scrophulariaceae	*Eremophila debilis*	winter apple	1	0.1																			
Scrophulariaceae	*Myoporum montanum*					1					0.5					0.1		0.1					
Solanaceae	*Lycium ferocissimum*	African boxthorn	0.1	0.1						0.1						0.1							
Solanaceae	*Solanum cinereum*	narrawa burr	0.1			0.1	0.1		0.5	0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1			0.1	
Solanaceae	*Solanum nigrum*	black-berry nightshade			0.1	0.1				0.1	0.1	0.1	0.1	0.1		0.1					0.1	0.1	
Verbenaceae	*Lantana camara*	Lantana	0.1	0.1																			

Family	Scientific Name	Common Name	MTO2000001	MTO2005003	MTO2016001	MTO2017001	MTO2017002	MTO2017003	MTO2017004	MTO2018001	MTO2019001	MTO2019002	MTO2019003	MTO2019004	MTO2019005	MTO2019006	MTO2019007	MTO2016002	MTO2019008	MTO2002002	MTO2002003	MTO2002004	MTO2002005
Verbenaceae	*Verbena bonariensis*	purple top	0.1	0.1	0.1			0.1		1	0.1	1	0.1	0.1	0.1		2		0.1				

Appendix 4 - Soil Assessment Results and Microbiology Laboratories Australia

Appendix 4 – Soil Assessment Results

Appendix 4 provides the raw data from the soil assessment, analysed by Environmental Analysis Laboratory and Microbiology Laboratories Australia.

Environmental Analysis Laboratory

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AGRICULTURAL SOIL ANALYSIS REPORT

67 samples supplied by Dendra Systems Ltd on 16/02/2022. Lab Job No.M6226

Unit 2/5 John Street SINGLETON NSW 2330

			Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
		Sample ID:	WDL201401	SPS201703	CDD201901	SPS201701	CDD201902	CDD201101
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW
	Parameter	Method reference	M6226/1	M6226/2	M6226/3	M6226/4	M6226/5	M6226/6
	Soluble Calcium (mg/kg)	**Inhouse S10 - Morgan 1	777	922	1,855	946	1,119	555
	Soluble Magnesium (mg/kg)		519	579	341	327	334	433
	Soluble Potassium (mg/kg)		212	159	178	167	192	156
	Soluble Phosphorus (mg/kg)		3.4	4.1	15	2.9	6.8	1.1
	Phosphorus (mg/kg P)	**Rayment & Lyons 2011 - 9E2 (Bray 1)	10	6.9	52	8.3	23	1.8
		**Rayment & Lyons 2011 - 9B2 (Colwell)	39	20	133	34	75	15
		**Inhouse S3A (Bray 2)	121	32	215	52	90	5.7
	Nitrate Nitrogen (mg/kg N)	**Inhouse S37 (KCl)	2.5	0.11	0.32	1.1	0.74	0.39
	Ammonium Nitrogen (mg/kg N)		7.7	3.6	3.8	4.7	7.6	5.4
	Sulfur (mg/kg S)		21	7.8	20	2.0	37	3.5
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	7.63	8.57	9.10	8.10	7.73	6.54
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.185	0.117	0.251	0.090	0.182	0.053
	Estimated Organic Matter (% OM)	**Calculation: Total Carbon x 1.75	6.3	5.2	9.4	5.7	6.0	4.2
	Exchangeable Calcium	(cmol+/kg)	6.7	5.9	9.1	6.7	8.7	5.2
		(kg/ha)	2,986	2,636	4,087	3,008	3,900	2,328
		(mg/kg)	1,333	1,177	1,825	1,343	1,741	1,039
	Exchangeable Magnesium	(cmol+/kg)	5.8	5.3	2.9	3.2	3.3	5.5
		(kg/ha)	1,589	1,447	798	873	911	1,509
		(mg/kg)	709	646	356	390	407	674
	Exchangeable Potassium	(cmol+/kg)	0.92	0.59	0.56	0.63	0.78	0.82
		(kg/ha)	806	516	492	548	681	718
		(mg/kg)	360	230	220	245	304	320
	Exchangeable Sodium	(cmol+/kg)	2.4	0.82	2.6	0.89	1.6	0.62
		(kg/ha)	1,222	422	1,319	459	824	317
		(mg/kg)	546	188	589	205	368	141
	Exchangeable Aluminium	(cmol+/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		(kg/ha)	<1	<1	<1	<1	<1	1.6
		(mg/kg)	<1	<1	<1	<1	<1	<1
	Exchangeable Hydrogen	(cmol+/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		(kg/ha)	<1	<1	<1	<1	<1	<1
		(mg/kg)	<1	<1	<1	<1	<1	<1
	Effective Cation Exchange Capacity(ECEC) (cmol+/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	16	13	15	11	14	12
	Calcium (%)	**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	42	47	60	59	60	43
	Magnesium (%)		37	42	19	28	23	46
	Potassium (%)		5.8	4.7	3.7	5.5	5.4	6.7
	Sodium - ESP (%)		15	6.5	17	7.8	11	5.1
	Aluminium (%)		0.03	0.03	0.02	0.03	0.03	0.07
	Hydrogen (%)		0.00	0.00	0.00	0.00	0.00	0.00
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol+/kg)	1.1	1.1	3.1	2.1	2.6	0.94

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AGRICULTURAL SOIL ANALYSIS REPORT

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Unit 2/5 John Street SINGLETON NSW 2330

			Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
		Sample ID:	WDL201401	SPS201703	CDD201901	SPS201701	CDD201902	CDD201101
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW
	Parameter	Method reference	M6226/1	M6226/2	M6226/3	M6226/4	M6226/5	M6226/6
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	15	5.6	16	9.9	13	3.5
	Manganese (mg/kg)		3.4	2.9	1.4	5.2	9.7	9.5
	Iron (mg/kg)		80	20	42	45	59	83
	Copper (mg/kg)		2.6	1.4	5.2	1.7	1.9	1.1
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	0.28	0.20	0.56	0.28	0.40	0.41
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	33	25	31	26	33	58
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	3.6	3.0	5.4	3.3	3.4	2.4
	Total Nitrogen (%)		0.24	0.13	0.24	0.22	0.22	0.18
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	15	23	22	15	15	14
	Basic Texture	**Inhouse S65	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam
	Basic Colour		Brownish	Brownish	Brownish	Brownish	Brownish	Brownish
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	118	75	161	58	117	34

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwood.
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013, Schedule B(1) - Guideline on Investigation Levels for Soil and Groundw[illegible]5-A Background Ranges.

NATA WORLD RECOGNISED ACCREDITATION Accreditation No. 14960 Accredited for compliance with ISO/IEC 17025 - Testing

9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil results'.
10. Conversions for 1 cmol,/kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
11. Conversions to kg/ha = mg/kg x 2.24
12. The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
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AGRICULTURAL SOIL ANALYSIS REPORT

67 samples supplied by Dendra Systems Ltd on 16/02/2022. Lab Job No.M6226

Unit 2/5 John Street SINGLETON NSW 2330

			Sample 7	Sample 8	Sample 9	Sample 10	Sample 11	Sample 12
		Sample ID:	NPN201301	CDD202001	NPN201401	SPS201602	WDL201402	NPN201402
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW
	Parameter	Method reference	M6226/7	M6226/8	M6226/9	M6226/10	M6226/11	M6226/12
	Soluble Calcium (mg/kg)	**Inhouse S10 - Morgan 1	954	823	777	1,435	1,101	417
	Soluble Magnesium (mg/kg)		303	410	360	503	575	58
	Soluble Potassium (mg/kg)		178	189	164	227	196	43
	Soluble Phosphorus (mg/kg)		1.8	7.1	1.4	2.1	6.3	2.4
	Phosphorus (mg/kg P)	**Rayment & Lyons 2011 - 9E2 (Bray 1)	5.9	27	4.1	9.0	8.5	12
		**Rayment & Lyons 2011 - 9B2 (Colwell)	30	81	28	36	35	25
		**Inhouse S3A (Bray 2)	31	88	21	55	74	34
	Nitrate Nitrogen (mg/kg N)	**Inhouse S37 (KCl)	0.27	0.70	1.3	2.7	1.3	4.8
	Ammonium Nitrogen (mg/kg N)		5.3	4.8	5.4	6.7	6.7	3.4
	Sulfur (mg/kg S)		3.9	6.9	<1	68	4.8	3.7
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	7.15	7.77	6.73	7.48	7.70	6.02
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.067	0.124	0.053	0.319	0.096	0.039
	Estimated Organic Matter (% OM)	**Calculation: Total Carbon x 1.75	3.8	5.6	4.4	4.9	7.9	3.1
	Exchangeable Calcium (cmol+/kg)	Rayment & Lyons 2011 - 15D3(Ammonium Acetate)	8.1	6.6	6.9	12	8.7	3.2
	Exchangeable Calcium (kg/ha)		3,641	2,947	3,094	5,236	3,925	1,453
	Exchangeable Calcium (mg/kg)		1,626	1,315	1,381	2,337	1,752	649
	Exchangeable Magnesium (cmol+/kg)		3.3	4.4	4.1	5.7	6.2	0.53
	Exchangeable Magnesium (kg/ha)		908	1,196	1,103	1,554	1,686	145
	Exchangeable Magnesium (mg/kg)		406	534	493	694	753	65
	Exchangeable Potassium (cmol+/kg)		0.78	0.77	0.74	1.1	0.81	0.12
	Exchangeable Potassium (kg/ha)		680	671	646	935	709	<112
	Exchangeable Potassium (mg/kg)		304	300	288	417	316	<50
	Exchangeable Sodium (cmol+/kg)		0.37	1.2	0.18	0.84	0.35	<0.065
	Exchangeable Sodium (kg/ha)		193	612	94	433	179	<33
	Exchangeable Sodium (mg/kg)		86	273	42	193	80	<15
	Exchangeable Aluminium (cmol+/kg)	**Inhouse S37 (KCl)	<0.01	<0.01	<0.01	<0.01	0.01	0.01
	Exchangeable Aluminium (kg/ha)		<1	<1	1.2	1.8	2.2	2.2
	Exchangeable Aluminium (mg/kg)		<1	<1	<1	<1	1.0	<1
	Exchangeable Hydrogen (cmol+/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	<0.01	0.13	<0.01	<0.01	0.27
	Exchangeable Hydrogen (kg/ha)		<1	<1	2.8	<1	<1	6.1
	Exchangeable Hydrogen (mg/kg)		<1	<1	1.3	<1	<1	2.7
	Effective Cation Exchange Capacity(ECEC) (cmol+/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	13	13	12	19	16	4.2
	Calcium (%)	**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	64	51	57	60	54	77
	Magnesium (%)		26	34	34	30	38	13
	Potassium (%)		6.2	5.9	6.1	5.5	5.0	2.9
	Sodium - ESP (%)		3.0	9.2	1.5	4.4	2.2	0.80
	Aluminium (%)		0.03	0.03	0.05	0.05	0.07	0.26
	Hydrogen (%)		0.00	0.00	1.0	0.00	0.00	6.5
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol+/kg)	2.4	1.5	1.7	2.0	1.4	6.1

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Unit 2/5 John Street SINGLETON NSW 2330

			Sample 7	Sample 8	Sample 9	Sample 10	Sample 11	Sample 12
		Sample ID:	NPN201301	CDD202001	NPN201401	SPS201602	WDL201402	NPN201402
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW
	Parameter	Method reference	M6226/7	M6226/8	M6226/9	M6226/10	M6226/11	M6226/12
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	14	8.4	7.6	12	13	5.1
	Manganese (mg/kg)		6.7	4.0	5.5	6.2	8.0	7.2
	Iron (mg/kg)		78	62	76	38	45	53
	Copper (mg/kg)		2.6	2.3	2.1	1.9	2.3	0.49
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	0.38	0.47	0.43	0.31	0.24	0.30
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	42	31	49	27	25	14
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	2.2	3.2	2.5	2.8	4.5	1.8
	Total Nitrogen (%)		0.17	0.19	0.18	0.19	0.29	0.12
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	13	17	14	15	16	15
	Basic Texture	**Inhouse S65	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam
	Basic Colour		Brownish	Brownish	Brownish	Brownish	Brownish	Brownish
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	43	80	34	204	61	25

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013,

Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.

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Unit 2/5 John Street SINGLETON NSW 2330

			Sample 13	Sample 14	Sample 15	Sample 16	Sample 17	Sample 18
		Sample ID:	NPN200901	WARKGB01	NPN200501	CDD201401	WARKGB04	SPS201801
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW
	Parameter	Method reference	M6226/13	M6226/14	M6226/15	M6226/16	M6226/17	M6226/18
	Soluble Calcium (mg/kg)	**Inhouse S10 - Morgan 1	660	326	621	1,572	237	1,426
	Soluble Magnesium (mg/kg)		525	176	463	459	311	497
	Soluble Potassium (mg/kg)		121	88	142	204	90	187
	Soluble Phosphorus (mg/kg)		<1	<1	1.1	8.3	<1	4.8
	Phosphorus (mg/kg P)	**Rayment & Lyons 2011 - 9E2 (Bray 1)	1.5	1.9	1.5	22	3.7	7.2
		**Rayment & Lyons 2011 - 9B2 (Colwell)	16	17	17	68	18	22
		**Inhouse S3A (Bray 2)	8.0	2.8	6.0	179	9.7	109
	Nitrate Nitrogen (mg/kg N)	**Inhouse S37 (KCl)	0.86	0.31	0.26	1.1	<0.1	0.29
	Ammonium Nitrogen (mg/kg N)		7.5	9.9	8.7	6.9	5.2	4.9
	Sulfur (mg/kg S)		8.0	7.4	6.9	5.2	3.1	4.4
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	6.46	5.14	6.77	7.80	5.63	8.29
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.049	0.047	0.056	0.096	0.035	0.098
	Estimated Organic Matter (% OM)	**Calculation: Total Carbon x 1.75	3.9	4.2	4.4	8.6	4.3	7.8
	Exchangeable Calcium (cmol+/kg)	Rayment & Lyons 2011 - 15D3(Ammonium Acetate)	6.0	2.9	5.3	12	1.8	9.7
	Exchangeable Calcium (kg/ha)		2,678	1,285	2,357	5,250	811	4,371
	Exchangeable Calcium (mg/kg)		1,196	574	1,052	2,344	362	1,951
	Exchangeable Magnesium (cmol+/kg)		6.5	1.9	5.3	4.6	3.3	5.1
	Exchangeable Magnesium (kg/ha)		1,768	529	1,449	1,247	887	1,384
	Exchangeable Magnesium (mg/kg)		789	236	647	557	396	618
	Exchangeable Potassium (cmol+/kg)		0.61	0.44	0.66	0.81	0.37	0.74
	Exchangeable Potassium (kg/ha)		538	389	577	711	321	648
	Exchangeable Potassium (mg/kg)		240	174	258	317	143	289
	Exchangeable Sodium (cmol+/kg)		0.17	0.23	0.26	0.50	0.21	0.41
	Exchangeable Sodium (kg/ha)		90	118	136	257	107	212
	Exchangeable Sodium (mg/kg)		40	53	61	115	48	94
	Exchangeable Aluminium (cmol+/kg)	**Inhouse S37 (KCl)	<0.01	0.28	0.01	<0.01	0.13	<0.01
	Exchangeable Aluminium (kg/ha)		1.1	57	2.1	<1	27	1.1
	Exchangeable Aluminium (mg/kg)		<1	25	<1	<1	12	<1
	Exchangeable Hydrogen (cmol+/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.23	1.7	<0.01	<0.01	1.3	<0.01
	Exchangeable Hydrogen (kg/ha)		5.1	39	<1	<1	30	<1
	Exchangeable Hydrogen (mg/kg)		2.3	17	<1	<1	13	<1
	Effective Cation Exchange Capacity(ECEC) (cmol+/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	13	7.5	12	18	7.1	16
	Calcium (%)	**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	44	38	46	66	25	61
	Magnesium (%)		48	26	46	26	46	32
	Potassium (%)		4.6	5.9	5.7	4.6	5.1	4.6
	Sodium - ESP (%)		1.3	3.1	2.3	2.8	2.9	2.6
	Aluminium (%)		0.04	3.8	0.09	0.02	1.9	0.03
	Hydrogen (%)		1.7	23	0.00	0.00	19	0.00
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol+/kg)	0.92	1.5	0.99	2.6	0.55	1.9

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			Sample 13	Sample 14	Sample 15	Sample 16	Sample 17	Sample 18
		Sample ID:	NPN200901	WARKGB01	NPN200501	CDD201401	WARKGB04	SPS201801
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW
	Parameter	Method reference	M6226/13	M6226/14	M6226/15	M6226/16	M6226/17	M6226/18
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	5.0	2.2	1.7	27	1.4	19
	Manganese (mg/kg)		11	14	9.8	7.2	7.3	4.0
	Iron (mg/kg)		89	177	41	60	108	27
	Copper (mg/kg)		1.9	0.65	0.51	4.6	0.16	4.7
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	0.26	0.45	0.22	0.32	0.25	0.31
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	58	38	37	23	22	15
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	2.2	2.4	2.5	4.9	2.4	4.4
	Total Nitrogen (%)		0.15	0.17	0.19	0.37	0.16	0.23
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	15	15	14	13	15	20
	Basic Texture	**Inhouse S65	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam
	Basic Colour		Brownish	Brownish	Brownish	Brownish	Brownish	Brownish
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	32	30	36	61	23	63

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
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Unit 2/5 John Street SINGLETON NSW 2330

			Sample 19	Sample 20	Sample 21	Sample 22	Sample 23	Sample 24
		Sample ID:	SPS201901	NPN200502	SPS201902	SPN201401	CDD201501	CDD201801
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW
	Parameter	Method reference	M6226/19	M6226/20	M6226/21	M6226/22	M6226/23	M6226/24
	Soluble Calcium (mg/kg)	**Inhouse S10 - Morgan 1	1,268	467	596	980	1,147	1,370
	Soluble Magnesium (mg/kg)		385	500	246	571	464	570
	Soluble Potassium (mg/kg)		191	116	170	168	97	202
	Soluble Phosphorus (mg/kg)		2.3	<1	4.6	1.7	1.8	7.5
	Phosphorus (mg/kg P)	**Rayment & Lyons 2011 - 9E2 (Bray 1)	13	1.8	17	4.9	5.9	20
		**Rayment & Lyons 2011 - 9B2 (Colwell)	43	17	55	21	20	47
		**Inhouse S3A (Bray 2)	63	20	80	39	80	163
	Nitrate Nitrogen (mg/kg N)	**Inhouse S37 (KCl)	0.47	1.4	0.76	0.87	0.21	0.13
	Ammonium Nitrogen (mg/kg N)		5.5	8.9	5.0	5.5	6.4	7.7
	Sulfur (mg/kg S)		3.6	1.5	3.4	2.6	5.0	10
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	9.00	6.81	7.27	8.19	8.67	7.98
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.163	0.056	0.069	0.093	0.107	0.125
	Estimated Organic Matter (% OM)	**Calculation: Total Carbon x 1.75	5.1	4.1	4.0	5.4	9.1	14
	Exchangeable Calcium (cmol+/kg)	Rayment & Lyons 2011 - 15D3(Ammonium Acetate)	7.8	3.9	4.7	7.4	6.6	9.8
	Exchangeable Calcium (kg/ha)		3,504	1,771	2,113	3,326	2,976	4,393
	Exchangeable Calcium (mg/kg)		1,564	791	943	1,485	1,329	1,961
	Exchangeable Magnesium (cmol+/kg)		3.8	5.4	2.4	6.0	4.4	5.9
	Exchangeable Magnesium (kg/ha)		1,024	1,460	659	1,639	1,203	1,601
	Exchangeable Magnesium (mg/kg)		457	652	294	732	537	715
	Exchangeable Potassium (cmol+/kg)		0.74	0.44	0.62	0.68	0.33	0.87
	Exchangeable Potassium (kg/ha)		649	389	545	598	290	761
	Exchangeable Potassium (mg/kg)		290	174	243	267	130	340
	Exchangeable Sodium (cmol+/kg)		2.2	0.18	0.50	0.44	0.12	1.2
	Exchangeable Sodium (kg/ha)		1,123	95	257	229	61	596
	Exchangeable Sodium (mg/kg)		501	42	115	102	27	266
	Exchangeable Aluminium (cmol+/kg)	**Inhouse S37 (KCl)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Exchangeable Aluminium (kg/ha)		<1	<1	<1	<1	<1	<1
	Exchangeable Aluminium (mg/kg)		<1	<1	<1	<1	<1	<1
	Exchangeable Hydrogen (cmol+/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Exchangeable Hydrogen (kg/ha)		<1	<1	<1	<1	<1	<1
	Exchangeable Hydrogen (mg/kg)		<1	<1	<1	<1	<1	<1
	Effective Cation Exchange Capacity(ECEC) (cmol+/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	14	9.9	8.3	15	12	18
	Calcium (%)	**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	54	40	57	51	58	55
	Magnesium (%)		26	54	29	41	38	33
	Potassium (%)		5.1	4.5	7.5	4.7	2.9	4.9
	Sodium - ESP (%)		15	1.8	6.1	3.1	1.0	6.5
	Aluminium (%)		0.02	0.03	0.04	0.02	0.01	0.01
	Hydrogen (%)		0.00	0.00	0.00	0.00	0.00	0.00
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol+/kg)	2.1	0.74	1.9	1.2	1.5	1.7

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AGRICULTURAL SOIL ANALYSIS REPORT

67 samples supplied by Dendra Systems Ltd on 16/02/2022. Lab Job No.M6226

Unit 2/5 John Street SINGLETON NSW 2330

			Sample 19	Sample 20	Sample 21	Sample 22	Sample 23	Sample 24
		Sample ID:	SPS201901	NPN200502	SPS201902	SPN201401	CDD201501	CDD201801
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW
	Parameter	Method reference	M6226/19	M6226/20	M6226/21	M6226/22	M6226/23	M6226/24
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	8.1	3.8	7.1	9.2	7.7	51
	Manganese (mg/kg)		4.0	5.4	5.3	4.0	2.5	7.0
	Iron (mg/kg)		34	80	108	24	21	54
	Copper (mg/kg)		2.9	1.4	2.2	2.1	2.4	7.7
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	0.24	0.26	0.28	0.25	0.10	0.36
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	3.3	35	28	19	8.0	23
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	2.9	2.3	2.3	3.1	5.2	8.0
	Total Nitrogen (%)		0.15	0.15	0.19	0.20	0.20	0.37
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	19	16	12	15	26	22
	Basic Texture	**Inhouse S65	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam
	Basic Colour		Grey	Brownish	Brownish	Brownish	Grey	Brownish
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	104	36	44	60	69	80

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013,

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9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil re
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Unit 2/5 John Street SINGLETON NSW 2330

			Sample 25	Sample 26	Sample 27	Sample 28	Sample 29	Sample 30
		Sample ID:	CDD201701	SPN201501	NPN201801	NPN201703	NPN201101	SPN201701
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW
	Parameter	Method reference	M6226/25	M6226/26	M6226/27	M6226/28	M6226/29	M6226/30
	Soluble Calcium (mg/kg)	**Inhouse S10 - Morgan 1	647	2,755	528	1,487	1,130	1,024
	Soluble Magnesium (mg/kg)		398	479	116	567	454	379
	Soluble Potassium (mg/kg)		93	294	96	194	137	220
	Soluble Phosphorus (mg/kg)		1.1	19	5.1	13	1.2	10
	Phosphorus (mg/kg P)	**Rayment & Lyons 2011 - 9E2 (Bray 1)	2.0	40	11	25	1.4	15
		**Rayment & Lyons 2011 - 9B2 (Colwell)	20	110	30	63	16	43
		**Inhouse S3A (Bray 2)	11	367	48	177	29	91
	Nitrate Nitrogen (mg/kg N)	**Inhouse S37 (KCl)	0.49	1.3	1.7	0.59	0.90	3.2
	Ammonium Nitrogen (mg/kg N)		6.0	5.7	8.7	7.0	7.1	10.0
	Sulfur (mg/kg S)		19	6.0	2.8	6.7	7.1	4.4
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	7.85	8.00	7.07	7.67	8.20	7.95
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.137	0.133	0.041	0.105	0.088	0.140
	Estimated Organic Matter (% OM)	**Calculation: Total Carbon x 1.75	3.4	11	3.1	6.8	3.3	5.5
	Exchangeable Calcium (cmol+/kg)	Rayment & Lyons 2011 - 15D3(Ammonium Acetate)	5.2	15	3.7	11	8.0	7.1
	Exchangeable Calcium (kg/ha)		2,321	6,616	1,647	4,866	3,602	3,166
	Exchangeable Calcium (mg/kg)		1,036	2,953	735	2,172	1,608	1,413
	Exchangeable Magnesium (cmol+/kg)		4.3	3.9	1.0	5.8	4.3	3.5
	Exchangeable Magnesium (kg/ha)		1,173	1,072	281	1,580	1,168	955
	Exchangeable Magnesium (mg/kg)		524	479	126	706	522	426
	Exchangeable Potassium (cmol+/kg)		0.40	1.0	0.27	0.84	0.55	0.79
	Exchangeable Potassium (kg/ha)		351	916	237	732	483	688
	Exchangeable Potassium (mg/kg)		157	409	106	327	216	307
	Exchangeable Sodium (cmol+/kg)		1.5	0.35	<0.065	0.43	0.07	1.3
	Exchangeable Sodium (kg/ha)		786	182	<33	219	39	656
	Exchangeable Sodium (mg/kg)		351	81	<15	98	17	293
	Exchangeable Aluminium (cmol+/kg)	**Inhouse S37 (KCl)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Exchangeable Aluminium (kg/ha)		<1	<1	1.5	<1	<1	<1
	Exchangeable Aluminium (mg/kg)		<1	<1	<1	<1	<1	<1
	Exchangeable Hydrogen (cmol+/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Exchangeable Hydrogen (kg/ha)		<1	<1	<1	<1	<1	<1
	Exchangeable Hydrogen (mg/kg)		<1	<1	<1	<1	<1	<1
	Effective Cation Exchange Capacity(ECEC) (cmol+/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	11	20	5.0	18	13	13
	Calcium (%)	**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	45	73	73	61	62	56
	Magnesium (%)		38	20	21	32	33	28
	Potassium (%)		3.5	5.2	5.4	4.7	4.3	6.2
	Sodium - ESP (%)		13	1.8	1.0	2.4	0.58	10
	Aluminium (%)		0.02	0.02	0.14	0.01	0.01	0.02
	Hydrogen (%)		0.00	0.00	0.00	0.00	0.00	0.00
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol+/kg)	1.2	3.7	3.6	1.9	1.9	2.0

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Unit 2/5 John Street SINGLETON NSW 2330

			Sample 25	Sample 26	Sample 27	Sample 28	Sample 29	Sample 30
		Sample ID:	CDD201701	SPN201501	NPN201801	NPN201703	NPN201101	SPN201701
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW
	Parameter	Method reference	M6226/25	M6226/26	M6226/27	M6226/28	M6226/29	M6226/30
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	2.9	50	11	24	3.0	12
	Manganese (mg/kg)		5.7	4.2	5.4	9.3	5.7	5.2
	Iron (mg/kg)		56	58	26	75	16	57
	Copper (mg/kg)		1.0	7.0	1.7	3.4	1.2	1.4
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	0.22	0.35	0.20	0.38	0.17	0.32
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	20	26	23	29	23	36
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	1.9	6.5	1.8	3.9	1.9	3.1
	Total Nitrogen (%)		0.13	0.49	0.12	0.29	0.12	0.23
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	15	13	15	13	15	13
	Basic Texture	**Inhouse S65	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam
	Basic Colour		Brownish	Brownish	Brownish	Brownish	Brownish	Brownish
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	88	85	26	67	56	90

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
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Unit 2/5 John Street SINGLETON NSW 2330

Parameter	Method reference	Sample 31	Sample 32	Sample 33	Sample 34	Sample 35	Sample 36
Sample ID:		SPN201601	CDD201702	NPN202003	NPN202006	NPN202004	NPN201902
Crop:		Soil	Soil	Soil	Soil	Soil	Soil
Client:		Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW
		M6226/31	M6226/32	M6226/33	M6226/34	M6226/35	M6226/36
Soluble Calcium (mg/kg)	**Inhouse S10 - Morgan 1	1,322	637	755	610	638	571
Soluble Magnesium (mg/kg)		435	229	174	180	157	221
Soluble Potassium (mg/kg)		332	174	129	107	143	92
Soluble Phosphorus (mg/kg)		6.0	6.0	6.9	6.3	10	1.6
Phosphorus (mg/kg P)	**Rayment & Lyons 2011 - 9E2 (Bray 1)	9.2	17	32	22	42	2.1
	**Rayment & Lyons 2011 - 9B2 (Colwell)	36	49	74	62	110	16
	**Inhouse S3A (Bray 2)	57	82	133	107	170	8.0
Nitrate Nitrogen (mg/kg N)	**Inhouse S37 (KCl)	4.2	1.4	0.49	0.51	1.0	1.0
Ammonium Nitrogen (mg/kg N)		8.0	5.9	5.5	5.6	5.1	5.6
Sulfur (mg/kg S)		4.5	5.4	22	6.7	5.1	4.6
pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	7.75	7.62	6.52	6.89	6.80	6.44
Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.129	0.119	0.105	0.061	0.075	0.053
Estimated Organic Matter (% OM)	**Calculation: Total Carbon x 1.75	6.5	4.3	4.6	4.7	4.2	4.5
Exchangeable Calcium (cmol+/kg)	Rayment & Lyons 2011 - 15D3(Ammonium Acetate)	10	6.3	6.0	4.8	4.7	4.6
Exchangeable Calcium (kg/ha)		4,541	2,843	2,708	2,158	2,100	2,078
Exchangeable Calcium (mg/kg)		2,027	1,269	1,209	963	938	928
Exchangeable Magnesium (cmol+/kg)		4.4	3.2	1.7	1.7	1.4	2.2
Exchangeable Magnesium (kg/ha)		1,202	870	464	470	383	601
Exchangeable Magnesium (mg/kg)		537	388	207	210	171	268
Exchangeable Potassium (cmol+/kg)		1.4	0.88	0.49	0.33	0.45	0.33
Exchangeable Potassium (kg/ha)		1,260	775	425	290	395	287
Exchangeable Potassium (mg/kg)		562	346	190	129	176	128
Exchangeable Sodium (cmol+/kg)		1.2	0.90	0.32	0.31	0.41	0.17
Exchangeable Sodium (kg/ha)		636	462	164	161	212	89
Exchangeable Sodium (mg/kg)		284	206	73	72	95	40
Exchangeable Aluminium (cmol+/kg)	**Inhouse S37 (KCl)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Exchangeable Aluminium (kg/ha)		<1	<1	1.1	<1	1.1	1.3
Exchangeable Aluminium (mg/kg)		<1	<1	<1	<1	<1	<1
Exchangeable Hydrogen (cmol+/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	<0.01	<0.01	<0.01	<0.01	0.20
Exchangeable Hydrogen (kg/ha)		<1	<1	<1	<1	<1	4.5
Exchangeable Hydrogen (mg/kg)		<1	<1	<1	<1	<1	2.0
Effective Cation Exchange Capacity(ECEC) (cmol+/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	17	11	8.5	7.2	7.0	7.5
Calcium (%)	**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	59	56	71	67	67	61
Magnesium (%)		26	28	20	24	20	29
Potassium (%)		8.4	7.8	5.7	4.6	6.5	4.3
Sodium - ESP (%)		7.2	7.9	3.7	4.4	5.9	2.3
Aluminium (%)		0.02	0.02	0.06	0.05	0.08	0.09
Hydrogen (%)		0.00	0.00	0.00	0.00	0.00	2.7
Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol+/kg)	2.3	2.0	3.5	2.8	3.3	2.1

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			Sample 31	Sample 32	Sample 33	Sample 34	Sample 35	Sample 36
		Sample ID:	SPN201601	CDD201702	NPN202003	NPN202006	NPN202004	NPN201902
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW
	Parameter	Method reference	M6226/31	M6226/32	M6226/33	M6226/34	M6226/35	M6226/36
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	9.1	9.1	4.1	10	11	2.5
	Manganese (mg/kg)		10	4.5	2.5	5.7	3.4	18
	Iron (mg/kg)		42	53	68	95	131	91
	Copper (mg/kg)		1.4	1.6	1.2	2.7	3.0	1.0
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	0.43	0.27	0.45	0.41	0.33	0.37
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	43	29	36	25	25	32
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	3.7	2.4	2.6	2.7	2.4	2.6
	Total Nitrogen (%)		0.29	0.20	0.18	0.19	0.19	0.15
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	13	12	15	14	13	17
	Basic Texture	**Inhouse S65	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam
	Basic Colour		Brownish	Brownish	Brownish	Brownish	Brownish	Brownish
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	82	76	67	39	48	34

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
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Unit 2/5 John Street SINGLETON NSW 2330

			Sample 37	Sample 38	Sample 39	Sample 40	Sample 41	Sample 42
		Sample ID:	NPN202005	NPN202001	SPS201601	NPN202002	WOMBOGB02	WOMBOGB01
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW
	Parameter	Method reference	M6226/37	M6226/38	M6226/39	M6226/40	M6226/41	M6226/42
	Soluble Calcium (mg/kg)	**Inhouse S10 - Morgan 1	602	711	1,269	507	814	535
	Soluble Magnesium (mg/kg)		351	464	1,030	260	605	471
	Soluble Potassium (mg/kg)		96	158	207	102	187	154
	Soluble Phosphorus (mg/kg)		1.1	7.4	2.0	<1	1.7	1.4
	Phosphorus (mg/kg P)	**Rayment & Lyons 2011 - 9E2 (Bray 1)	2.5	41	3.3	2.2	2.0	2.8
		**Rayment & Lyons 2011 - 9B2 (Colwell)	21	83	24	16	15	17
		**Inhouse S3A (Bray 2)	16	179	60	13	3.5	5.0
	Nitrate Nitrogen (mg/kg N)	**Inhouse S37 (KCl)	0.61	0.45	1.1	0.53	1.4	1.2
	Ammonium Nitrogen (mg/kg N)		2.8	3.6	7.7	4.5	9.0	7.3
	Sulfur (mg/kg S)		2.2	12	6.3	9.9	3.3	3.2
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	7.79	8.83	8.69	7.08	6.61	6.02
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.063	0.113	0.176	0.102	0.077	0.082
	Estimated Organic Matter (% OM)	**Calculation: Total Carbon x 1.75	3.2	6.4	11	3.7	4.7	5.4
	Exchangeable Calcium (cmol+/kg)	Rayment & Lyons 2011 - 15D3(Ammonium Acetate)	4.2	4.5	9.1	3.5	8.2	5.3
	Exchangeable Calcium (kg/ha)		1,904	2,017	4,107	1,592	3,661	2,368
	Exchangeable Calcium (mg/kg)		850	900	1,834	711	1,634	1,057
	Exchangeable Magnesium (cmol+/kg)		3.3	4.9	10	2.3	7.7	5.6
	Exchangeable Magnesium (kg/ha)		899	1,333	2,857	633	2,097	1,537
	Exchangeable Magnesium (mg/kg)		402	595	1,275	282	936	686
	Exchangeable Potassium (cmol+/kg)		0.33	0.56	0.75	0.37	1.0	0.76
	Exchangeable Potassium (kg/ha)		290	491	661	320	880	662
	Exchangeable Potassium (mg/kg)		129	219	295	143	393	295
	Exchangeable Sodium (cmol+/kg)		0.58	1.3	2.2	0.83	0.77	0.60
	Exchangeable Sodium (kg/ha)		301	664	1,142	429	395	310
	Exchangeable Sodium (mg/kg)		134	296	510	191	176	138
	Exchangeable Aluminium (cmol+/kg)	**Inhouse S37 (KCl)	<0.01	<0.01	<0.01	<0.01	<0.01	0.02
	Exchangeable Aluminium (kg/ha)		<1	<1	<1	1.1	1.5	3.2
	Exchangeable Aluminium (mg/kg)		<1	<1	<1	<1	<1	1.4
	Exchangeable Hydrogen (cmol+/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	<0.01	<0.01	<0.01	<0.01	0.52
	Exchangeable Hydrogen (kg/ha)		<1	<1	<1	<1	<1	12
	Exchangeable Hydrogen (mg/kg)		<1	<1	<1	<1	<1	5.2
	Effective Cation Exchange Capacity(ECEC) (cmol+/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	8.5	11	23	7.1	18	13
	Calcium (%)	**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	50	40	40	50	46	41
	Magnesium (%)		39	44	46	33	44	44
	Potassium (%)		3.9	5.0	3.3	5.2	5.7	5.9
	Sodium - ESP (%)		6.9	11	9.8	12	4.3	4.7
	Aluminium (%)		0.03	0.02	0.02	0.08	0.04	0.12
	Hydrogen (%)		0.00	0.00	0.00	0.00	0.00	4.1
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol+/kg)	1.3	0.92	0.87	1.5	1.1	0.93

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AGRICULTURAL SOIL ANALYSIS REPORT

67 samples supplied by Dendra Systems Ltd on 16/02/2022. Lab Job No.M6226

Unit 2/5 John Street SINGLETON NSW 2330

			Sample 37	Sample 38	Sample 39	Sample 40	Sample 41	Sample 42
		Sample ID:	NPN202005	NPN202001	SPS201601	NPN202002	WOMBOGB02	WOMBOGB01
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW
	Parameter	Method reference	M6226/37	M6226/38	M6226/39	M6226/40	M6226/41	M6226/42
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	2.6	14	11	2.3	1.8	3.1
	Manganese (mg/kg)		6.4	1.1	3.1	6.0	14	20
	Iron (mg/kg)		31	30	34	99	61	103
	Copper (mg/kg)		0.56	5.1	3.3	0.76	0.68	0.91
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	0.21	0.30	0.33	0.42	0.60	0.67
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	26	13	13	31	48	51
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	1.8	3.7	6.3	2.1	2.7	3.1
	Total Nitrogen (%)		0.11	0.16	0.24	0.13	0.17	0.20
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	16	23	26	16	16	15
	Basic Texture	**Inhouse S65	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam
	Basic Colour		Brownish	Grey	Brownish	Brownish	Brownish	Brownish
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	40	72	112	65	49	52

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013,

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			Sample 43	Sample 44	Sample 45	Sample 46	Sample 47	Sample 48
		Sample ID:	WARKGB02	WARKGB03	MTO202004	MTO201907	MTW201906	MTO201602
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW
	Parameter	Method reference	M6226/43	M6226/44	M6226/45	M6226/46	M6226/47	M6226/48
	Soluble Calcium (mg/kg)	**Inhouse S10 - Morgan 1	439	253	654	883	931	652
	Soluble Magnesium (mg/kg)		177	281	214	378	326	212
	Soluble Potassium (mg/kg)		130	105	104	250	180	114
	Soluble Phosphorus (mg/kg)		1.5	1.9	10	7.3	14	3.0
	Phosphorus (mg/kg P)	**Rayment & Lyons 2011 - 9E2 (Bray 1)	2.2	2.3	50	27	42	6.4
		**Rayment & Lyons 2011 - 9B2 (Colwell)	23	16	161	85	89	21
		**Inhouse S3A (Bray 2)	4.2	4.7	221	127	194	27
	Nitrate Nitrogen (mg/kg N)	**Inhouse S37 (KCl)	5.9	0.54	2.3	3.9	9.5	3.7
	Ammonium Nitrogen (mg/kg N)		11	13	14	8.2	6.5	5.0
	Sulfur (mg/kg S)		3.3	8.6	22	7.1	52	4.8
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	5.88	5.55	7.58	7.01	8.79	7.85
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.056	0.090	0.122	0.082	0.263	0.071
	Estimated Organic Matter (% OM)	**Calculation: Total Carbon x 1.75	5.5	6.9	6.1	5.0	6.7	6.4
	Exchangeable Calcium (cmol+/kg)	Rayment & Lyons 2011 - 15D3(Ammonium Acetate)	3.6	2.1	5.7	7.9	6.3	4.2
	Exchangeable Calcium (kg/ha)		1,628	963	2,550	3,536	2,831	1,887
	Exchangeable Calcium (mg/kg)		727	430	1,138	1,578	1,264	842
	Exchangeable Magnesium (cmol+/kg)		1.7	3.0	2.1	4.2	3.2	1.9
	Exchangeable Magnesium (kg/ha)		471	809	574	1,137	873	518
	Exchangeable Magnesium (mg/kg)		210	361	256	508	390	231
	Exchangeable Potassium (cmol+/kg)		0.52	0.44	0.42	1.0	0.60	0.38
	Exchangeable Potassium (kg/ha)		457	385	366	904	523	334
	Exchangeable Potassium (mg/kg)		204	172	164	404	234	149
	Exchangeable Sodium (cmol+/kg)		0.21	0.55	1.1	0.47	2.8	0.47
	Exchangeable Sodium (kg/ha)		109	284	562	242	1,461	241
	Exchangeable Sodium (mg/kg)		49	127	251	108	652	108
	Exchangeable Aluminium (cmol+/kg)	**Inhouse S37 (KCl)	0.03	0.10	<0.01	<0.01	<0.01	<0.01
	Exchangeable Aluminium (kg/ha)		5.6	21	<1	<1	1.2	1.3
	Exchangeable Aluminium (mg/kg)		2.5	9.3	<1	<1	<1	<1
	Exchangeable Hydrogen (cmol+/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.67	1.3	<0.01	<0.01	<0.01	<0.01
	Exchangeable Hydrogen (kg/ha)		15	29	<1	<1	<1	<1
	Exchangeable Hydrogen (mg/kg)		6.7	13	<1	<1	<1	<1
	Effective Cation Exchange Capacity(ECEC) (cmol+/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	6.8	7.5	9.3	14	13	7.0
	Calcium (%)	**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	53	28	61	58	49	60
	Magnesium (%)		25	39	23	31	25	27
	Potassium (%)		7.7	5.8	4.5	7.6	4.6	5.5
	Sodium - ESP (%)		3.1	7.3	12	3.5	22	6.7
	Aluminium (%)		0.41	1.4	0.05	0.03	0.05	0.09
	Hydrogen (%)		9.8	17	0.00	0.00	0.00	0.00
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol+/kg)	2.1	0.72	2.7	1.9	2.0	2.2

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Unit 2/5 John Street SINGLETON NSW 2330

			Sample 43	Sample 44	Sample 45	Sample 46	Sample 47	Sample 48
		Sample ID:	WARKGB02	WARKGB03	MTO202004	MTO201907	MTW201906	MTO201602
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW
	Parameter	Method reference	M6226/43	M6226/44	M6226/45	M6226/46	M6226/47	M6226/48
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	3.5	2.1	17	12	20	2.9
	Manganese (mg/kg)		30	20	2.3	5.3	1.5	3.1
	Iron (mg/kg)		118	378	97	87	71	47
	Copper (mg/kg)		0.81	0.36	5.7	2.1	6.9	0.60
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	0.43	0.46	0.64	0.52	0.36	0.21
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	29	33	38	40	19	31
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	3.1	4.0	3.5	2.8	3.8	3.7
	Total Nitrogen (%)		0.22	0.25	0.23	0.22	0.20	0.14
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	14	16	15	13	19	26
	Basic Texture	**Inhouse S65	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam
	Basic Colour		Brownish	Brownish	Brownish	Brownish	Brownish	Brownish
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	36	58	78	53	168	45

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
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Unit 2/5 John Street SINGLETON NSW 2330

			Sample 49	Sample 50	Sample 51	Sample 52	Sample 53	Sample 54
		Sample ID:	MTO201901	MTO201904	MTO201701	MTO201703	MTO202003	MTO201702
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW
	Parameter	Method reference	M6226/49	M6226/50	M6226/51	M6226/52	M6226/53	M6226/54
	Soluble Calcium (mg/kg)	**Inhouse S10 - Morgan 1	920	1,018	2,236	1,568	921	2,093
	Soluble Magnesium (mg/kg)		323	308	310	486	262	319
	Soluble Potassium (mg/kg)		176	159	272	168	117	192
	Soluble Phosphorus (mg/kg)		5.5	1.6	9.2	3.5	1.1	25
	Phosphorus (mg/kg P)	**Rayment & Lyons 2011 - 9E2 (Bray 1)	21	4.5	26	6.9	11	31
		**Rayment & Lyons 2011 - 9B2 (Colwell)	77	22	79	25	32	87
		**Inhouse S3A (Bray 2)	75	24	229	52	103	244
	Nitrate Nitrogen (mg/kg N)	**Inhouse S37 (KCl)	1.4	1.9	1.1	0.64	1.6	2.4
	Ammonium Nitrogen (mg/kg N)		6.7	6.7	4.2	3.7	2.9	7.8
	Sulfur (mg/kg S)		11	8.2	31	4.4	52	13
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	7.09	7.85	9.17	8.92	9.75	8.46
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.116	0.070	0.277	0.122	0.265	0.161
	Estimated Organic Matter (% OM)	**Calculation: Total Carbon x 1.75	5.4	6.3	11	5.6	4.3	8.0
	Exchangeable Calcium (cmol+/kg)	Rayment & Lyons 2011 - 15D3(Ammonium Acetate)	7.7	8.0	12	8.5	4.7	13
	Exchangeable Calcium (kg/ha)		3,476	3,587	5,492	3,826	2,090	5,926
	Exchangeable Calcium (mg/kg)		1,552	1,601	2,452	1,708	933	2,645
	Exchangeable Magnesium (cmol+/kg)		3.4	3.0	2.6	4.4	2.3	2.8
	Exchangeable Magnesium (kg/ha)		929	822	719	1,197	631	771
	Exchangeable Magnesium (mg/kg)		415	367	321	534	282	344
	Exchangeable Potassium (cmol+/kg)		0.75	0.63	0.97	0.60	0.41	0.74
	Exchangeable Potassium (kg/ha)		656	553	848	526	363	648
	Exchangeable Potassium (mg/kg)		293	247	379	235	162	289
	Exchangeable Sodium (cmol+/kg)		0.66	0.12	2.5	0.82	2.2	1.3
	Exchangeable Sodium (kg/ha)		342	63	1,305	423	1,118	675
	Exchangeable Sodium (mg/kg)		153	28	583	189	499	301
	Exchangeable Aluminium (cmol+/kg)	**Inhouse S37 (KCl)	<0.01	<0.01	0.01	<0.01	<0.01	0.01
	Exchangeable Aluminium (kg/ha)		1.7	1.7	2.2	1.4	1.3	2.8
	Exchangeable Aluminium (mg/kg)		<1	<1	<1	<1	<1	1.2
	Exchangeable Hydrogen (cmol+/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Exchangeable Hydrogen (kg/ha)		<1	<1	<1	<1	<1	<1
	Exchangeable Hydrogen (mg/kg)		<1	<1	<1	<1	<1	<1
	Effective Cation Exchange Capacity(ECEC) (cmol+/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	13	12	18	14	9.6	18
	Calcium (%)	**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	62	68	67	59	49	73
	Magnesium (%)		27	26	14	31	24	16
	Potassium (%)		6.0	5.4	5.3	4.2	4.3	4.1
	Sodium - ESP (%)		5.3	1.0	14	5.7	23	7.2
	Aluminium (%)		0.07	0.07	0.06	0.05	0.07	0.08
	Hydrogen (%)		0.00	0.00	0.00	0.00	0.00	0.00
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol+/kg)	2.3	2.6	4.6	1.9	2.0	4.7

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		Sample ID:	MTO201901	MTO201904	MTO201701	MTO201703	MTO202003	MTO201702
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW
	Parameter	Method reference	M6226/49	M6226/50	M6226/51	M6226/52	M6226/53	M6226/54
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	10	3.6	22	6.0	7.9	18
	Manganese (mg/kg)		8.4	6.0	1.7	6.9	0.85	7.9
	Iron (mg/kg)		106	44	72	32	20	51
	Copper (mg/kg)		2.1	1.8	6.2	2.2	3.3	2.4
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	0.46	0.27	0.28	0.21	0.35	0.42
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	37	22	13	11	13	29
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	3.1	3.6	6.2	3.2	2.5	4.6
	Total Nitrogen (%)		0.20	0.17	0.29	0.16	0.09	0.38
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	15	21	21	20	28	12
	Basic Texture	**Inhouse S65	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam
	Basic Colour		Brownish	Brownish	Brownish	Brownish	Brownish	Brownish
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	75	45	177	78	169	103

Notes:

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			Sample 55	Sample 56	Sample 57	Sample 58	Sample 59	Sample 60
		Sample ID:	MTO201903	MTO201704	MTO201801	MTO201908	MTO200001	MTO201905
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW
	Parameter	Method reference	M6226/55	M6226/56	M6226/57	M6226/58	M6226/59	M6226/60
	Soluble Calcium (mg/kg)	**Inhouse S10 - Morgan 1	649	931	702	1,315	403	439
	Soluble Magnesium (mg/kg)		154	221	369	469	408	349
	Soluble Potassium (mg/kg)		168	156	243	190	74	89
	Soluble Phosphorus (mg/kg)		7.5	3.9	2.1	8.4	1.2	1.4
	Phosphorus (mg/kg P)	**Rayment & Lyons 2011 - 9E2 (Bray 1)	41	9.6	3.0	19	8.4	5.0
		**Rayment & Lyons 2011 - 9B2 (Colwell)	79	26	17	46	26	22
		**Inhouse S3A (Bray 2)	95	50	9.1	76	21	13
	Nitrate Nitrogen (mg/kg N)	**Inhouse S37 (KCl)	0.50	0.45	0.46	0.63	0.75	0.44
	Ammonium Nitrogen (mg/kg N)		8.7	6.3	5.1	4.5	4.9	6.8
	Sulfur (mg/kg S)		32	4.4	4.4	6.9	4.5	97
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	6.42	7.37	7.16	8.23	6.80	6.17
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.117	0.066	0.069	0.138	0.062	0.278
	Estimated Organic Matter (% OM)	**Calculation: Total Carbon x 1.75	4.6	3.9	4.8	5.8	3.2	4.2
	Exchangeable Calcium (cmol+/kg)	Rayment & Lyons 2011 - 15D3(Ammonium Acetate)	4.8	6.9	5.7	8.4	3.8	3.4
	Exchangeable Calcium (kg/ha)		2,133	3,090	2,580	3,789	1,701	1,522
	Exchangeable Calcium (mg/kg)		952	1,379	1,152	1,692	759	679
	Exchangeable Magnesium (cmol+/kg)		1.4	2.2	4.0	4.3	5.0	3.7
	Exchangeable Magnesium (kg/ha)		387	609	1,088	1,177	1,357	1,012
	Exchangeable Magnesium (mg/kg)		173	272	486	525	606	452
	Exchangeable Potassium (cmol+/kg)		0.62	0.60	1.0	0.73	0.37	0.40
	Exchangeable Potassium (kg/ha)		541	526	891	637	327	348
	Exchangeable Potassium (mg/kg)		241	235	398	284	146	156
	Exchangeable Sodium (cmol+/kg)		0.07	0.41	0.50	0.57	0.66	1.5
	Exchangeable Sodium (kg/ha)		38	212	255	296	342	775
	Exchangeable Sodium (mg/kg)		17	95	114	132	153	346
	Exchangeable Aluminium (cmol+/kg)	**Inhouse S37 (KCl)	0.02	<0.01	0.01	0.01	0.02	0.02
	Exchangeable Aluminium (kg/ha)		3.3	2.0	2.0	2.4	3.7	4.6
	Exchangeable Aluminium (mg/kg)		1.5	<1	<1	1.1	1.7	2.1
	Exchangeable Hydrogen (cmol+/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.15	<0.01	<0.01	<0.01	<0.01	0.41
	Exchangeable Hydrogen (kg/ha)		3.3	<1	<1	<1	<1	9.2
	Exchangeable Hydrogen (mg/kg)		1.5	<1	<1	<1	<1	4.1
	Effective Cation Exchange Capacity(ECEC) (cmol+/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	7.0	10	11	14	9.8	9.4
	Calcium (%)	**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	68	68	51	60	39	36
	Magnesium (%)		20	22	35	31	51	39
	Potassium (%)		8.8	5.9	9.0	5.2	3.8	4.2
	Sodium - ESP (%)		1.0	4.1	4.4	4.1	6.8	16
	Aluminium (%)		0.23	0.10	0.09	0.09	0.19	0.24
	Hydrogen (%)		2.1	0.00	0.00	0.00	0.00	4.3
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol+/kg)	3.3	3.1	1.4	2.0	0.76	0.91

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AGRICULTURAL SOIL ANALYSIS REPORT

67 samples supplied by Dendra Systems Ltd on 16/02/2022. Lab Job No.M6226

Unit 2/5 John Street SINGLETON NSW 2330

			Sample 55	Sample 56	Sample 57	Sample 58	Sample 59	Sample 60
		Sample ID:	MTO201903	MTO201704	MTO201801	MTO201908	MTO200001	MTO201905
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW
	Parameter	Method reference	M6226/55	M6226/56	M6226/57	M6226/58	M6226/59	M6226/60
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	6.5	12	3.6	6.1	7.7	2.4
	Manganese (mg/kg)		5.1	9.4	15	7.3	5.5	7.4
	Iron (mg/kg)		85	72	62	40	70	161
	Copper (mg/kg)		1.0	2.3	0.90	1.8	0.67	0.99
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	0.36	0.45	0.25	0.28	0.21	0.44
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	32	55	45	34	42	42
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	2.6	2.3	2.8	3.3	1.8	2.4
	Total Nitrogen (%)		0.16	0.15	0.20	0.21	0.11	0.12
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	17	15	14	16	17	19
	Basic Texture	**Inhouse S65	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam
	Basic Colour		Brownish	Brownish	Brownish	Brownish	Brownish	Brownish
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	75	42	44	88	40	178

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013,

Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.

9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil re
10. Conversions for 1 cmol+/kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
11. Conversions to kg/ha = mg/kg x 2.24
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Quality Checked: Kris Saville
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Unit 2/5 John Street SINGLETON NSW 2330

			Sample 61	Sample 62	Sample 63	Sample 64	Sample 65	Sample 66
		Sample ID:	MTO202005	MTO200503	MTO201601	MTO202002	MTO201902	NPN201903
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW
	Parameter	Method reference	M6226/61	M6226/62	M6226/63	M6226/64	M6226/65	M6226/66
	Soluble Calcium (mg/kg)	**Inhouse S10 - Morgan 1	291	645	900	521	832	823
	Soluble Magnesium (mg/kg)		379	467	340	381	323	336
	Soluble Potassium (mg/kg)		101	80	170	99	154	93
	Soluble Phosphorus (mg/kg)		<1	<1	2.2	3.8	5.1	4.5
	Phosphorus (mg/kg P)	**Rayment & Lyons 2011 - 9E2 (Bray 1)	1.9	3.0	7.3	20	19	18
		**Rayment & Lyons 2011 - 9B2 (Colwell)	14	16	31	57	65	46
		**Inhouse S3A (Bray 2)	45	7.1	41	50	74	80
	Nitrate Nitrogen (mg/kg N)	**Inhouse S37 (KCl)	0.57	0.44	1.4	0.65	0.44	0.45
	Ammonium Nitrogen (mg/kg N)		5.1	3.6	5.4	7.4	8.8	3.9
	Sulfur (mg/kg S)		20	57	72	96	6.5	15
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	7.87	7.38	7.00	7.24	7.18	8.01
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.094	0.238	0.299	0.433	0.066	0.159
	Estimated Organic Matter (% OM)	**Calculation: Total Carbon x 1.75	4.9	2.1	5.9	3.2	5.5	4.0
	Exchangeable Calcium (cmol+/kg)	Rayment & Lyons 2011 - 15D3(Ammonium Acetate)	2.0	5.0	7.4	3.7	6.3	6.8
	Exchangeable Calcium (kg/ha)		914	2,238	3,301	1,675	2,841	3,058
	Exchangeable Calcium (mg/kg)		408	999	1,474	748	1,268	1,365
	Exchangeable Magnesium (cmol+/kg)		4.3	5.3	3.6	3.9	3.3	4.4
	Exchangeable Magnesium (kg/ha)		1,160	1,435	983	1,073	896	1,187
	Exchangeable Magnesium (mg/kg)		518	641	439	479	400	530
	Exchangeable Potassium (cmol+/kg)		0.42	0.39	0.75	0.45	0.60	0.38
	Exchangeable Potassium (kg/ha)		368	345	660	395	522	334
	Exchangeable Potassium (mg/kg)		164	154	295	176	233	149
	Exchangeable Sodium (cmol+/kg)		1.5	1.1	1.1	3.1	0.34	1.5
	Exchangeable Sodium (kg/ha)		790	561	558	1,595	177	767
	Exchangeable Sodium (mg/kg)		353	251	249	712	79	342
	Exchangeable Aluminium (cmol+/kg)	**Inhouse S37 (KCl)	0.02	0.02	0.01	0.01	0.02	0.01
	Exchangeable Aluminium (kg/ha)		3.1	3.2	2.8	2.7	3.2	2.2
	Exchangeable Aluminium (mg/kg)		1.4	1.4	1.3	1.2	1.4	1.0
	Exchangeable Hydrogen (cmol+/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Exchangeable Hydrogen (kg/ha)		<1	<1	<1	<1	<1	<1
	Exchangeable Hydrogen (mg/kg)		<1	<1	<1	<1	<1	<1
	Effective Cation Exchange Capacity(ECEC) (cmol+/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	8.3	12	13	11	11	13
	Calcium (%)	**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	25	42	57	33	60	52
	Magnesium (%)		52	45	28	35	31	33
	Potassium (%)		5.1	3.3	5.9	4.0	5.6	2.9
	Sodium - ESP (%)		19	9.3	8.5	28	3.3	11
	Aluminium (%)		0.18	0.13	0.11	0.12	0.15	0.09
	Hydrogen (%)		0.00	0.00	0.00	0.00	0.00	0.00
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol+/kg)	0.48	0.95	2.0	0.95	1.9	1.6

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Unit 2/5 John Street SINGLETON NSW 2330

			Sample 61	Sample 62	Sample 63	Sample 64	Sample 65	Sample 66
		Sample ID:	MTO202005	MTO200503	MTO201601	MTO202002	MTO201902	NPN201903
		Crop:	Soil	Soil	Soil	Soil	Soil	Soil
		Client:	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW	Yancoal MTW
	Parameter	Method reference	M6226/61	M6226/62	M6226/63	M6226/64	M6226/65	M6226/66
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	6.4	0.71	6.2	3.8	8.1	7.7
	Manganese (mg/kg)		2.0	4.8	11	5.9	5.5	1.4
	Iron (mg/kg)		48	30	102	65	68	27
	Copper (mg/kg)		2.3	0.68	1.6	0.92	2.1	3.1
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	0.44	0.23	0.49	0.60	0.38	0.31
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	25	40	40	40	39	25
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	2.8	1.2	3.4	1.8	3.1	2.3
	Total Nitrogen (%)		0.11	0.07	0.20	0.13	0.18	0.11
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	25	17	17	14	17	20
	Basic Texture	**Inhouse S65	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam
	Basic Colour		Brownish	Brownish	Brownish	Brownish	Brownish	Brownish
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	60	153	191	277	42	102

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
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AGRICULTURAL SOIL ANALYSIS REPORT

67 samples supplied by Dendra Systems Ltd on 16/02/2022. Lab Job No.M6226

Analysis requested by Chris Lani. Your Job: Yancoal MTW

Unit 2/5 John Street SINGLETON NSW 2330

		Sample 67	*Heavy Soil*	*Medium Soil*	*Light Soil*	*Sandy Soil*
	Sample ID:	MTO202005				
	Crop:	Soil				
	Client:	Yancoal MTW	*Clay*	*Clay Loam*	*Loam*	*Loamy Sand*
	Parameter	**Method reference**	**M6226/67**	**Indicative guidelines - refer to Notes 6 and 8**		
	Soluble Calcium (mg/kg)		316	*1150*	*750*	*375*	*175*
	Soluble Magnesium (mg/kg)	**Inhouse S10 - Morgan 1	226	*160*	*105*	*60*	*25*
	Soluble Potassium (mg/kg)		81	*113*	*75*	*60*	*50*
	Soluble Phosphorus (mg/kg)		<1	*15*	*12*	*10*	*5.0*
	Phosphorus (mg/kg P)	**Rayment & Lyons 2011 - 9E2 (Bray 1)	1.9	*45 note 8*	*30 note 8*	*24 note 8*	*20 note 8*
		**Rayment & Lyons 2011 - 9B2 (Colwell)	15	*80*	*50*	*45*	*35*
		**Inhouse S3A (Bray 2)	15	*90 note 8*	*60 note 8*	*48 note 8*	*40 note 8*
	Nitrate Nitrogen (mg/kg N)		0.77	*15*	*13*	*10*	*10*
	Ammonium Nitrogen (mg/kg N)	**Inhouse S37 (KCl)	5.3	*20*	*18*	*15*	*12*
	Sulfur (mg/kg S)		4.5	*10.0*	*8.0*	*8.0*	*7.0*
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	7.53	*6.5*	*6.5*	*6.3*	*6.3*
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.044	*0.200*	*0.150*	*0.120*	*0.100*
	Estimated Organic Matter (% OM)	**Calculation: Total Carbon x 1.75	2.3	*> 5.5*	*>4 .5*	*> 3.5*	*> 2.5*
	Exchangeable Calcium (cmol+/kg)	Rayment & Lyons 2011 - 15D3(Ammonium Acetate)	2.1	*15.6*	*10.8*	*5.0*	*1.9*
	Exchangeable Calcium (kg/ha)		921	*7000*	*4816*	*2240*	*840*
	Exchangeable Calcium (mg/kg)		411	*3125*	*2150*	*1000*	*375*
	Exchangeable Magnesium (cmol+/kg)		2.1	*2.4*	*1.7*	*1.2*	*0.60*
	Exchangeable Magnesium (kg/ha)		571	*650*	*448*	*325*	*168*
	Exchangeable Magnesium (mg/kg)		255	*290*	*200*	*145*	*75*
	Exchangeable Potassium (cmol+/kg)		0.29	*0.60*	*0.50*	*0.40*	*0.30*
	Exchangeable Potassium (kg/ha)		251	*526*	*426*	*336*	*224*
	Exchangeable Potassium (mg/kg)		112	*235*	*190*	*150*	*100*
	Exchangeable Sodium (cmol+/kg)		0.54	*0.3*	*0.26*	*0.22*	*0.11*
	Exchangeable Sodium (kg/ha)		280	*155*	*134*	*113*	*57*
	Exchangeable Sodium (mg/kg)		125	*69*	*60*	*51*	*25*
	Exchangeable Aluminium (cmol+/kg)	**Inhouse S37 (KCl)	0.02	*0.6*	*0.5*	*0.4*	*0.2*
	Exchangeable Aluminium (kg/ha)		3.6	*121*	*101*	*73*	*30*
	Exchangeable Aluminium (mg/kg)		1.6	*54*	*45*	*32*	*14*
	Exchangeable Hydrogen (cmol+/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	*0.6*	*0.5*	*0.4*	*0.2*
	Exchangeable Hydrogen (kg/ha)		<1	*13*	*11*	*8*	*3*
	Exchangeable Hydrogen (mg/kg)		<1	*6*	*5*	*4*	*2*
	Effective Cation Exchange Capacity(ECEC) (cmol+/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	5.0	*20.1*	*14.3*	*7.8*	*3.3*
	Calcium (%)	**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	41	*77.6*	*75.7*	*65.6*	*57.4*
	Magnesium (%)		42	*11.9*	*11.9*	*15.7*	*18.1*
	Potassium (%)		5.7	*3.0*	*3.5*	*5.2*	*9.1*
	Sodium - ESP (%)		11	*1.5*	*1.8*	*2.9*	*3.3*
	Aluminium (%)		0.35	*6.0*	*7.1*	*10.5*	*12.1*
	Hydrogen (%)		0.00				
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol+/kg)	0.98	*6.5*	*6.4*	*4.2*	*3.2*

67 samples supplied by Dendra Systems Ltd on 16/02/2022. Lab Job No.M6226

Analysis requested by Chris Lani. Your Job: Yancoal MTW

Unit 2/5 John Street SINGLETON NSW 2330

			Sample 67	*Heavy Soil*	*Medium Soil*	*Light Soil*	*Sandy Soil*
		Sample ID:	MTO202005				
		Crop:	Soil				
		Client:	Yancoal MTW	*Clay*	*Clay Loam*	*Loam*	*Loamy Sand*
	Parameter	**Method reference**	**M6226/67**	**Indicative guidelines - refer to Notes 6 and 8**			
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	2.5	*6.0*	*5.0*	*4.0*	*3.0*
	Manganese (mg/kg)		1.8	*25*	*22*	*18*	*15*
	Iron (mg/kg)		49	*25*	*22*	*18*	*15*
	Copper (mg/kg)		0.99	*2.4*	*2.0*	*1.6*	*1.2*
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	0.22	*2.0*	*1.7*	*1.4*	*1.0*
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	25	*50*	*45*	*40*	*35*
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	1.3	*> 3.1*	*> 2.6*	*> 2.0*	*> 1.4*
	Total Nitrogen (%)		0.08	*> 0.30*	*> 0.25*	*> 0.20*	*> 0.15*
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	16	*10–12*	*10–12*	*10–12*	*10–12*
	Basic Texture	**Inhouse S65	Clay Loam	..	..	..	..
	Basic Colour		Brownish	..	..	..	..
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	28	..	..	..	..

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia*. CSIRO Publishing: Collingwo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013,

Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.

9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil re
10. Conversions for 1 cmol+/kg =
    230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
11. Conversions to kg/ha = mg/kg x 2.24
12. The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
13. ** NATA accreditation does not cover the performance of this service.
14. Analysis conducted between sample arrival date and reporting date.
15. This report is not to be reproduced except in full. Results only relate to the item tested.
16. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions
17. This report was issued on 09/03/2022.

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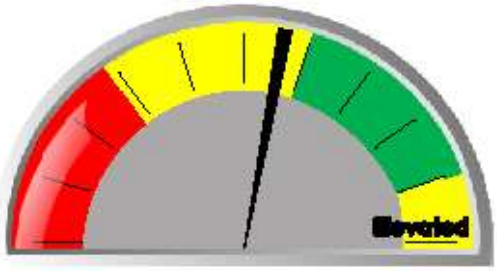
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MICROBE ACTIVITY WISE

V 15-2020

Customer name	Dendra Systems	**Date received**	16/02/2022
Client name	Chris	**Agent**	Microbiology Laboratories Australia
Sample name	WAMBO G801	**Advisor**	
Crop	Not Specified	**Authorised by**	
Date sampled	10/02/2022 **Ext. ID**	**Analysis no.**	3183-10-MAWS

Potential Microbial Activity Indicator



Data

Potential	Yours	Guide
Microbial Activity Indicator	44.1	80.0

Poor Fair Good

Potential		Yours	Guide
Soil Basal Respiration	mg CO_2/ kg/day	394	668
Soil Microbial Biomass Carbon	mg/kg	2,358	4,000

Key

Comments

The microbial activity in your sample was fair. However, it could be increased by adopting management practices that encourage microbial activity. If your soil is low in carbon consider the addition of organic based soil conditioners. If your soil is low in nitrogen consider the addition of N fertiliser. It is very important to take the C:N ratio of your soil into account when adding any fertilisers high in C or N. In most farmed soils it is good practice to aim for a C:N ratio of less than 20:1 (12:1 is optimal for most soils, but may not be practicable for some production systems). Avoid the addition of large amounts of high C fertiliser to soils low in N, and the addition of large amounts of high N fertiliser to soils low in C, as these practices can further deplete Total C and Total N, and microbial activity.

Explanations

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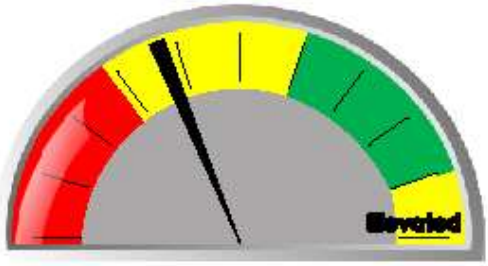
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MICROBE ACTIVITY WISE

V 15-2020

Customer name	Dendra Systems	**Date received**	16/02/2022
Client name	Chris	**Agent**	Microbiology Laboratories Australia
Sample name	WARK GB01	**Advisor**	
Crop	Not Specified	**Authorised by**	
Date sampled	10/02/2022 **Ext. ID**	**Analysis no.**	3183-8-MAWS

Potential Microbial Activity Indicator



Data

Potential	Yours	Guide
Microbial Activity Indicator	25.0	80.0

Poor Fair Good

Potential		Yours	Guide
Soil Basal Respiration	mg CO_2/ kg/day	232	668
Soil Microbial Biomass Carbon	mg/kg	1,482	4,000

Key

Comments

The microbial activity in your sample was fair to low. This could occur if microbial activity in your soil has been depleted due to a bare fallow, practices that deplete soil carbon (C) and/or nitrogen (N) or an extended dry period. It should be increased by adopting management practices that encourage microbial activity. If your soil is low in carbon consider the addition of organic based soil conditioners. If your soil is low in nitrogen consider the addition of N fertiliser. It is very important to take the C:N ratio of your soil into account when adding any fertilisers high in C or N. In most farmed soils it is good practice to aim for a C:N ratio of less than 20:1 (12:1 is optimal for most soils, but may not be practicable for some production systems). Avoid the addition of large amounts of high C fertiliser to soils low in N, and the addition of large amounts of high N fertiliser to soils low in C, as these practices can further deplete Total C and Total N, and microbial activity.

Explanations

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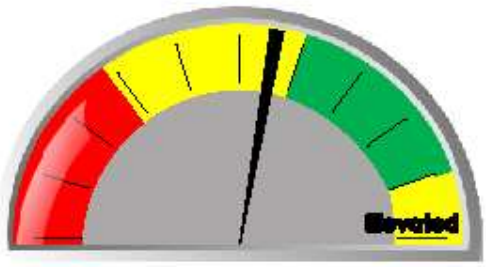
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MICROBE ACTIVITY WISE

V 15-2020

Customer name	Dendra Systems	**Date received**	16/02/2022
Client name	Chris	**Agent**	Microbiology Laboratories Australia
Sample name	WAMBO GB02	**Advisor**	
Crop	Not Specified	**Authorised by**	
Date sampled	10/02/2022 **Ext. ID**	**Analysis no.**	3183-7-MAWS

Potential Microbial Activity Indicator



Data

Potential	Yours	Guide
Microbial Activity Indicator	43.7	80.0

Poor Fair Good

Potential		Yours	Guide
Soil Basal Respiration	mg CO_2/ kg/day	391	668
Soil Microbial Biomass Carbon	mg/kg	2,337	4,000

Key

Comments

The microbial activity in your sample was fair. However, it could be increased by adopting management practices that encourage microbial activity. If your soil is low in carbon consider the addition of organic based soil conditioners. If your soil is low in nitrogen consider the addition of N fertiliser. It is very important to take the C:N ratio of your soil into account when adding any fertilisers high in C or N. In most farmed soils it is good practice to aim for a C:N ratio of less than 20:1 (12:1 is optimal for most soils, but may not be practicable for some production systems). Avoid the addition of large amounts of high C fertiliser to soils low in N, and the addition of large amounts of high N fertiliser to soils low in C, as these practices can further deplete Total C and Total N, and microbial activity.

Explanations

The Microbe Activity Wise test measures the activity of soil microbes directly from your sample. It measures the amount of carbon dioxide (CO_2 emitted by microbes to calculate Microbial Activity, Soil Basal Respiration (SBR) and Soil Microbial Biomass Carbon (C) (SMBC). Most soil microbes under aerobic conditions convert carbohydrates into energy and CO_2, which they emit as a waste product, just like animals, plants and humans. This is used to calculate the Microbial Activity Indicator based on known values for soils. Correlations published in scientific journals are used to calculate soil basal respiration (SBR, 0-24 day) and soil microbial biomass C (SMBC). Soil Basal Respiration is the normal, steady rate of respiration in a soil. Soil Microbial Biomass C is the amount of C held in the net microbial biomass. All three values reflect the quantity and quality of soil carbon, and other microbially assistive nutrients in the soil. Plants can use the CO_2 emitted by soil microbes to overcome the often limiting CO_2 in the air around crops. Having a good level of microbial activity in your soil not only helps soil processes, but can also help to improve crop growth. Always compare your results with a control sample. Guide values are included as a help, but because a large number of factors affect microbiology the guide levels may not be optimal for your specific conditions. Visit www.microbelabs.com.au for more information.

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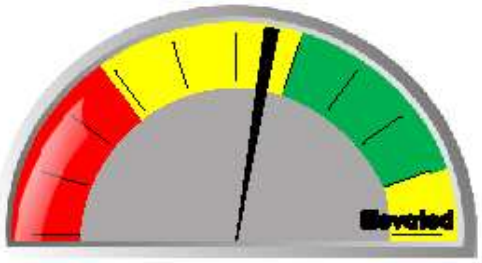
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MICROBE ACTIVITY WISE

V 15-2020

Customer name	Dendra Systems	**Date received**	16/02/2022
Client name	Chris	**Agent**	Microbiology Laboratories Australia
Sample name	WARK GB03	**Advisor**	
Crop	Not Specified	**Authorised by**	
Date sampled	10/02/2022 **Ext. ID**	**Analysis no.**	3183-6-MAWS

Potential Microbial Activity Indicator



Data

Potential	Yours	Guide
Microbial Activity Indicator	43.4	80.0

Poor Fair Good

Potential		Yours	Guide
Soil Basal Respiration	mg CO_2/ kg/day	388	668
Soil Microbial Biomass Carbon	mg/kg	2,322	4,000

Key

Comments

The microbial activity in your sample was fair. However, it could be increased by adopting management practices that encourage microbial activity. If your soil is low in carbon consider the addition of organic based soil conditioners. If your soil is low in nitrogen consider the addition of N fertiliser. It is very important to take the C:N ratio of your soil into account when adding any fertilisers high in C or N. In most farmed soils it is good practice to aim for a C:N ratio of less than 20:1 (12:1 is optimal for most soils, but may not be practicable for some production systems). Avoid the addition of large amounts of high C fertiliser to soils low in N, and the addition of large amounts of high N fertiliser to soils low in C, as these practices can further deplete Total C and Total N, and microbial activity.

Explanations

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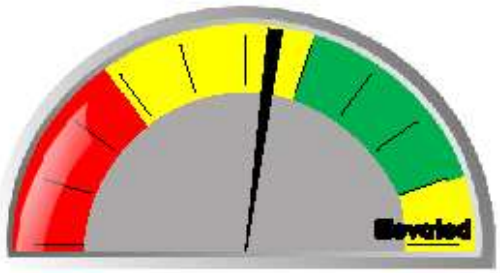
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MICROBE ACTIVITY WISE

V 15-2020

Customer name	Dendra Systems	**Date received**	16/02/2022
Client name	Chris	**Agent**	Microbiology Laboratories Australia
Sample name	WARK GB04	**Advisor**	
Crop	Not Specified	**Authorised by**	
Date sampled	10/02/2022 **Ext. ID**	**Analysis no.**	3183-4-MAWS

Potential Microbial Activity Indicator



Data

Potential	Yours	Guide
Microbial Activity Indicator	42.1	80.0

Poor Fair Good

Potential		Yours	Guide
Soil Basal Respiration	mg CO_2/ kg/day	378	668
Soil Microbial Biomass Carbon	mg/kg	2,265	4,000

Key

Comments

The microbial activity in your sample was fair. However, it could be increased by adopting management practices that encourage microbial activity. If your soil is low in carbon consider the addition of organic based soil conditioners. If your soil is low in nitrogen consider the addition of N fertiliser. It is very important to take the C:N ratio of your soil into account when adding any fertilisers high in C or N. In most farmed soils it is good practice to aim for a C:N ratio of less than 20:1 (12:1 is optimal for most soils, but may not be practicable for some production systems). Avoid the addition of large amounts of high C fertiliser to soils low in N, and the addition of large amounts of high N fertiliser to soils low in C, as these practices can further deplete Total C and Total N, and microbial activity.

Explanations

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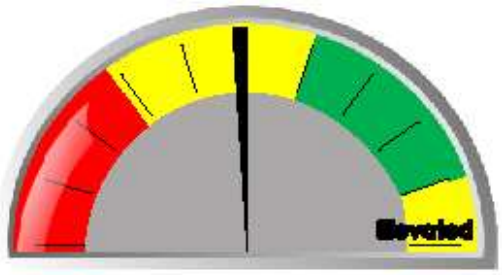
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MICROBE ACTIVITY WISE

V 15-2020

Customer name	Dendra Systems	**Date received**	16/02/2022
Client name	Chris	**Agent**	Microbiology Laboratories Australia
Sample name	CDD 201 101	**Advisor**	
Crop	Not Specified	**Authorised by**	
Date sampled	10/02/2022 **Ext. ID**	**Analysis no.**	3183-3-MAWS

Potential Microbial Activity Indicator



Data

Potential	Yours	Guide
Microbial Activity Indicator	36.2	80.0

Poor Fair Good

Key

Potential		Yours	Guide
Soil Basal Respiration	mg CO_2/ kg/day	328	668
Soil Microbial Biomass Carbon	mg/kg	1,995	4,000

Comments

The microbial activity in your sample was fair to low. This could occur if microbial activity in your soil has been depleted due to a bare fallow, practices that deplete soil carbon (C) and/or nitrogen (N) or an extended dry period. It should be increased by adopting management practices that encourage microbial activity. If your soil is low in carbon consider the addition of organic based soil conditioners. If your soil is low in nitrogen consider the addition of N fertiliser. It is very important to take the C:N ratio of your soil into account when adding any fertilisers high in C or N. In most farmed soils it is good practice to aim for a C:N ratio of less than 20:1 (12:1 is optimal for most soils, but may not be practicable for some production systems). Avoid the addition of large amounts of high C fertiliser to soils low in N, and the addition of large amounts of high N fertiliser to soils low in C, as these practices can further deplete Total C and Total N, and microbial activity.

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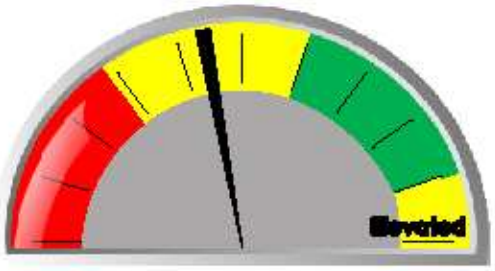
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MICROBE ACTIVITY WISE

V 15-2020

Customer name	Dendra Systems	**Date received**	16/02/2022
Client name	Chris	**Agent**	Microbiology Laboratories Australia
Sample name	NPN 200 501	**Advisor**	
Crop	Not Specified	**Authorised by**	
Date sampled	10/02/2022 **Ext. ID**	**Analysis no.**	3183-2-MAWS

Potential Microbial Activity Indicator



Data

Potential	Yours	Guide
Microbial Activity Indicator	31.4	80.0

Poor Fair Good

Potential		Yours	Guide
Soil Basal Respiration	mg CO_2/ kg/day	287	668
Soil Microbial Biomass Carbon	mg/kg	1,774	4,000

Key

Comments

The microbial activity in your sample was fair to low. This could occur if microbial activity in your soil has been depleted due to a bare fallow, practices that deplete soil carbon (C) and/or nitrogen (N) or an extended dry period. It should be increased by adopting management practices that encourage microbial activity. If your soil is low in carbon consider the addition of organic based soil conditioners. If your soil is low in nitrogen consider the addition of N fertiliser. It is very important to take the C:N ratio of your soil into account when adding any fertilisers high in C or N. In most farmed soils it is good practice to aim for a C:N ratio of less than 20:1 (12:1 is optimal for most soils, but may not be practicable for some production systems). Avoid the addition of large amounts of high C fertiliser to soils low in N, and the addition of large amounts of high N fertiliser to soils low in C, as these practices can further deplete Total C and Total N, and microbial activity.

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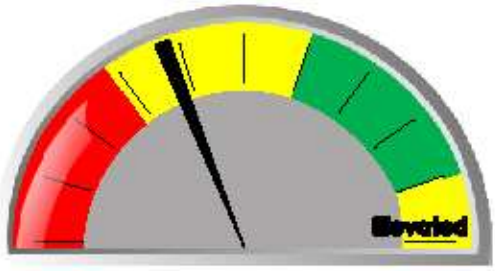
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MICROBE ACTIVITY WISE

V 15-2020

Customer name	Dendra Systems	**Date received**	16/02/2022
Client name	Chris	**Agent**	Microbiology Laboratories Australia
Sample name	CDD 201 501	**Advisor**	
Crop	Not Specified	**Authorised by**	
Date sampled	10/02/2022 **Ext. ID**	**Analysis no.**	3183-1-MAWS

Potential Microbial Activity Indicator



Data

Potential	Yours	Guide
Microbial Activity Indicator	25.3	80.0

Poor Fair Good

Potential		Yours	Guide
Soil Basal Respiration	mg CO_2/ kg/day	235	668
Soil Microbial Biomass Carbon	mg/kg	1,496	4,000

Key

Comments

The microbial activity in your sample was fair to low. This could occur if microbial activity in your soil has been depleted due to a bare fallow, practices that deplete soil carbon (C) and/or nitrogen (N) or an extended dry period. It should be increased by adopting management practices that encourage microbial activity. If your soil is low in carbon consider the addition of organic based soil conditioners. If your soil is low in nitrogen consider the addition of N fertiliser. It is very important to take the C:N ratio of your soil into account when adding any fertilisers high in C or N. In most farmed soils it is good practice to aim for a C:N ratio of less than 20:1 (12:1 is optimal for most soils, but may not be practicable for some production systems). Avoid the addition of large amounts of high C fertiliser to soils low in N, and the addition of large amounts of high N fertiliser to soils low in C, as these practices can further deplete Total C and Total N, and microbial activity.

Explanations

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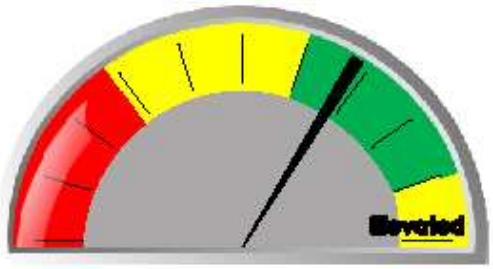
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MICROBE ACTIVITY WISE

V 15-2020

Customer name	Dendra Systems	**Date received**	14/01/2022
Client name	Chris	**Agent**	Microbiology Laboratories Australia
Sample name	NPN 200901	**Advisor**	
Crop	Not specified	**Authorised by**	
Date sampled	8/12/2021 **Ext. ID**	**Analysis no.**	3154-3-MAWS

Potential Microbial Activity Indicator



Data

Potential	Yours	Guide
Microbial Activity Indicator	60.0	80.0

Poor Fair Good

Potential		Yours	Guide
Soil Basal Respiration	mg CO_2/ kg/day	520	668
Soil Microbial Biomass Carbon	mg/kg	3,085	4,000

Key

Comments

The microbial activity in your sample was fair. However, it could be increased by adopting management practices that encourage microbial activity. If your soil is low in carbon consider the addition of organic based soil conditioners. If your soil is low in nitrogen consider the addition of N fertiliser. It is very important to take the C:N ratio of your soil into account when adding any fertilisers high in C or N. In most farmed soils it is good practice to aim for a C:N ratio of less than 20:1 (12:1 is optimal for most soils, but may not be practicable for some production systems). Avoid the addition of large amounts of high C fertiliser to soils low in N, and the addition of large amounts of high N fertiliser to soils low in C, as these practices can further deplete Total C and Total N, and microbial activity.

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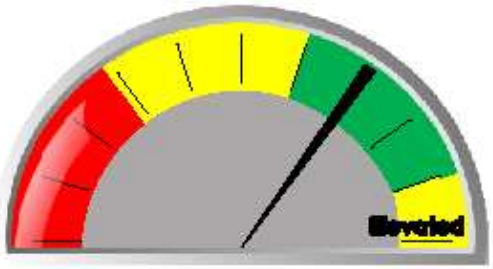
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MICROBE ACTIVITY WISE

V 15-2020

Customer name	Dendra Systems	**Date received**	14/01/2022
Client name	Chris	**Agent**	Microbiology Laboratories Australia
Sample name	NPN 201101	**Advisor**	
Crop	Not specified	**Authorised by**	
Date sampled	7/12/2021 **Ext. ID**	**Analysis no.**	3154-1-MAWS

Potential Microbial Activity Indicator



Data

Potential	Yours	Guide
Microbial Activity Indicator	63.6	80.0

Poor | Fair | Good

Potential		Yours	Guide
Soil Basal Respiration	mg CO_2/ kg/day	548	668
Soil Microbial Biomass Carbon	mg/kg	3,249	4,000

Key

Comments

The microbial activity in your sample was good. However, it could be increased by adopting management practices that encourage microbial activity. If your soil is low in carbon consider the addition of organic based soil conditioners. If your soil is low in nitrogen consider the addition of N fertiliser. It is very important to take the C:N ratio of your soil into account when adding any fertilisers high in C or N. In most farmed soils it is good practice to aim for a C:N ratio of less than 20:1 (12:1 is optimal for most soils, but may not be practicable for some production systems). Avoid the addition of large amounts of high C fertiliser to soils low in N, and the addition of large amounts of high N fertiliser to soils low in C, as these practices can deplete Total C and Total N, and microbial activity.

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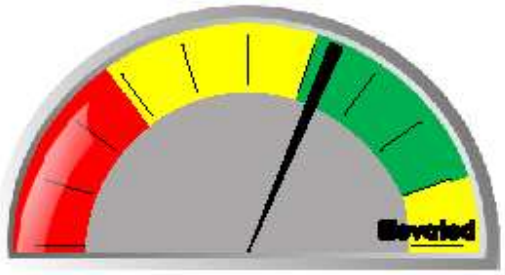
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MICROBE ACTIVITY WISE

V 15-2020

Customer name	Dendra Systems	**Date received**	16/02/2022
Client name	Chris	**Agent**	Microbiology Laboratories Australia
Sample name	SPN 201 401	**Advisor**	
Crop	Not Specified	**Authorised by**	
Date sampled	10/02/2022 **Ext. ID**	**Analysis no.**	3183-5-MAWS

Potential Microbial Activity Indicator



Data

Potential	Yours	Guide
Microbial Activity Indicator	53.2	80.0

Poor Fair Good

Potential		Yours	Guide
Soil Basal Respiration	mg CO_2/ kg/day	467	668
Soil Microbial Biomass Carbon	mg/kg	2,771	4,000

Key

Comments

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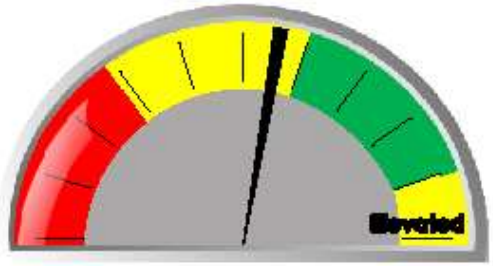
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MICROBE ACTIVITY WISE

V 15-2020

Customer name	Dendra Systems	**Date received**	16/02/2022
Client name	Chris	**Agent**	Microbiology Laboratories Australia
Sample name	WARK VB02	**Advisor**	
Crop	Not Specified	**Authorised by**	
Date sampled	10/02/2022 **Ext. ID**	**Analysis no.**	3183-9-MAWS

Potential Microbial Activity Indicator



Data

Potential	Yours	Guide
Microbial Activity Indicator	43.7	80.0

Poor Fair Good

Potential		Yours	Guide
Soil Basal Respiration	mg CO_2/ kg/day	391	668
Soil Microbial Biomass Carbon	mg/kg	2,337	4,000

Key

Comments

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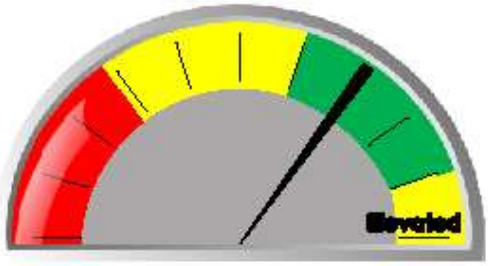
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MICROBE ACTIVITY WISE

V 15-2020

Customer name	Dendra Systems	**Date received**	14/01/2022
Client name	Chris	**Agent**	Microbiology Laboratories Australia
Sample name	NPN 201301	**Advisor**	
Crop	Not specified	**Authorised by**	
Date sampled	8/12/2021 **Ext. ID**	**Analysis no.**	3154-2-MAWS

Potential Microbial Activity Indicator



Data

Potential	Yours	Guide
Microbial Activity Indicator	63.7	80.0

Poor Fair Good

Potential		Yours	Guide
Soil Basal Respiration	mg CO_2/ kg/day	549	668
Soil Microbial Biomass Carbon	mg/kg	3,256	4,000

Key

Comments

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Appendix 7:

Annual Rehabilitation Report Summary Table

Annual Rehabilitation Report Form, Rehabilitation Maps and Rehabilitation Summary

Annual Rehabilitation Report Form – Mines
Year Ending: 2021
Mine: Mt Thorley Warkworth
Company: Yancoal Australia
Plans Attached:
Mt Thorley Warkworth – AER 2021
Approved Mining Operations Plan:
MTW MOP Extension to 02 July 2022 – Approval Date 30/11/2021
Total Area Covered by Mining Operations Plan:
MTW MOP – 6,185ha
Total Area Covered by Mining Lease for This Mine: 6,185ha

Table 1: Rehabilitation Progress 2021

Rehabilitation Activity Type	Domain Identifier	Primary Domain	Secondary Domain	Total Area Last Reported (ha)	Total Area to date (ha)
1.1 Active mining and infrastructure area, facilities, including roads and tracks	1A	Final Void	Final Void	397.4	439.8
	2C	Water Management Areas	Rehabilitation Area - Grassland	64.1	67.2
	2E	Water Management Areas	Rehabilitation Area - Woodland EEC	1.1	1.1
	3C	Infrastructure Area	Rehabilitation Area - Grassland	169.3	170.1
	3E	Infrastructure Area	Rehabilitation Area - Woodland EEC	0.1	0.1
	4C	Tailings Storage Facility	Rehabilitation Area - Grassland	37.1	37.1
	4D	Tailings Storage Facility	Rehabilitation Area - Woodland	75.5	75.5
	4E	Tailings Storage Facility	Rehabilitation Area - Woodland EEC	97.0	97.0
	5C	Overburden Emplacement Area	Rehabilitation Area - Grassland	184.9	191.0
	5D	Overburden Emplacement Area	Rehabilitation Area - Woodland	247.9	248.4

Rehabilitation Activity Type	Domain Identifier	Primary Domain	Secondary Domain	Total Area Last Reported (ha)	Total Area to date (ha)
	5E	Overburden Emplacement Area	Rehabilitation Area - Woodland EEC	1326.9	1274.2
	Total Active			2601.3	2601.5
1.2 Decommissioning	Total - Decommissioning			0.0	0.0
1.3 Landform Establishment	4C	Tailings Storage Facility	Rehabilitation Area - Grassland	0.0	0.0
	4E	Tailings Storage Facility	Rehabilitation Area - Woodland EEC	0.4	0.4
	5C	Overburden Emplacement Area	Rehabilitation Area - Grassland	1.4	2.1
	5D	Overburden Emplacement Area	Rehabilitation Area - Woodland	0.0	0.2
	5E	Overburden Emplacement Area	Rehabilitation Area - Woodland EEC	16.6	27.0
	Total - Landform Establishment			18.4	29.6
1.4 Growth Medium Development	2C	Water Management Areas	Rehabilitation Area - Grassland	4.0	3.9
	2E	Water Management Areas	Rehabilitation Area - Woodland EEC	0.0	0.0
	4E	Tailings Storage Facility	Rehabilitation Area - Woodland EEC	4.0	3.2
	5C	Overburden Emplacement Area	Rehabilitation Area - Grassland	16.1	3.7
	5D	Overburden Emplacement Area	Rehabilitation Area - Woodland	0.0	0.0
	5E	Overburden Emplacement Area	Rehabilitation Area - Woodland EEC	62.4	16.6
	Total - Growth Medium Development			86.5	27.4
1.5 Ecosystem and Land Use Establishment	1A	Final Void	Final Void	1.2	1.2
	2C	Water Management Areas	Rehabilitation Area - Grassland	4.9	1.9
	2E	Water Management Areas	Rehabilitation Area - Woodland EEC	3.30.0	0.0
	3C	Infrastructure Area	Rehabilitation Area - Grassland	5.5	4.8
	3D	Infrastructure Area	Rehabilitation Area - Woodland	0.3	0.3
	3E	Infrastructure Area	Rehabilitation Area - Woodland EEC	0.1	0.0
	4C	Tailings Storage Facility	Rehabilitation Area - Grassland	27.0	27.0
	4D	Tailings Storage Facility	Rehabilitation Area - Woodland	0.6	0.6
	4E	Tailings Storage Facility	Rehabilitation Area - Woodland EEC	35.4	36.2

Rehabilitation Activity Type	Domain Identifier	Primary Domain	Secondary Domain	Total Area Last Reported (ha)	Total Area to date (ha)
	5C	Overburden Emplacement Area	Rehabilitation Area - Grassland	418.3	429.3
	5D	Overburden Emplacement Area	Rehabilitation Area - Woodland	201.7	201.7
	5E	Overburden Emplacement Area	Rehabilitation Area - Woodland EEC	532.9	621.3
	Total - Ecosystem and Land Use Establishment			1227.9	1324.4
1.6 Ecosystem and Land Use Development	1A	Final Void	Final Void	0.0	0.0
	2C	Water Management Areas	Rehabilitation Area - Grassland	0.0	0.0
	2E	Water Management Areas	Rehabilitation Area - Woodland EEC	0.0	0.0
	3C	Infrastructure Area	Rehabilitation Area - Grassland	0.0	0.0
	3D	Infrastructure Area	Rehabilitation Area - Woodland	0.0	0.0
	3E	Infrastructure Area	Rehabilitation Area - Woodland EEC	0.0	0.0
	4C	Tailings Storage Facility	Rehabilitation Area - Grassland	0.0	0.0
	4D	Tailings Storage Facility	Rehabilitation Area - Woodland	0.0	0.0
	4E	Tailings Storage Facility	Rehabilitation Area - Woodland EEC	0.0	0.0
	5C	Overburden Emplacement Area	Rehabilitation Area - Grassland	0.0	0.0
	5D	Overburden Emplacement Area	Rehabilitation Area - Woodland	0.0	0.0
	5E	Overburden Emplacement Area	Rehabilitation Area - Woodland EEC	0.0	0.0
	Total - Ecosystem and Land Use Development			0.0	0.0
1.7 Rehabilitation Complete	Total - Rehabilitation Complete			0.0	0.0
1.8 Total Area Disturbed (items 1.1 to 1.7)	1A	Final Void	Final Void	398.6	441.0
	2C	Water Management Areas	Rehabilitation Area - Grassland	73.0	73.0
	2E	Water Management Areas	Rehabilitation Area - Woodland EEC	1.1	1.1
	3C	Infrastructure Area	Rehabilitation Area - Grassland	174.8	174.9
	3D	Infrastructure Area	Rehabilitation Area - Woodland	0.3	0.3
	3E	Infrastructure Area	Rehabilitation Area - Woodland EEC	0.2	0.2

Rehabilitation Activity Type	Domain Identifier	Primary Domain	Secondary Domain	Total Area Last Reported (ha)	Total Area to date (ha)
	4C	Tailings Storage Facility	Rehabilitation Area - Grassland	64.1	64.0
	4D	Tailings Storage Facility	Rehabilitation Area - Woodland	76.1	76.1
	4E	Tailings Storage Facility	Rehabilitation Area - Woodland EEC	136.8	136.8
	5C	Overburden Emplacement Area	Rehabilitation Area - Grassland	620.7	626.2
	5D	Overburden Emplacement Area	Rehabilitation Area - Woodland	449.6	450.3
	5E	Overburden Emplacement Area	Rehabilitation Area - Woodland EEC	1938.8	1939.1
	Total Footprint			3934.1	3982.9

Table 2: Soil Management and Erosion, 2021

Soil Stockpiling/ Use	Soil Used This Period (m3)	Soil Pre-stripped This Period (m3)	Stockpile Inventory to Date (m3)	Soil Stockpiled Last Report (m3)
	8,600	50,207	670,921*	666,929

2.2 Erosion Treatment	Total Area to Date (ha)	Total Area Last Report (ha)	Total Area This Report (ha)	Area Retreated This Period (ha)
Approx. area of sheet or gully erosion requiring reshaping topdressing and/or resowing	Not Available	6.0	7.8	0.0

** 37,615m3 of topsoil from TS-2010-01 and TS-2018-05 written off from topsoil inventory due to poor quality.*

Table 3: Weed Control

	Area (ha)
3.1 Approx. area adversely affected by weeds as of the date of this report	Not Available
3.2 Area treated for weed control during the period covered by the report	255.9
3.3 Give summary of control strategies used and verification by approval agency(s)	
Species targeted in rehabilitation areas during 2021 included: *Galenia pubescens*, Rhodes grass, green panic, *Acacia saligna*, mustard weed (Brassica), farmers friend (*Bidens pilosa*) and paddys lucerne (*Sida rhombifolia*). 117.4ha treated for weed control using boom spray or wick wiper treatment; 138.5ha treated for weed control using Quikspray units, backpack sprays, cut and paint or manual removal.	

Table 4: Management of Rehabilitation Areas

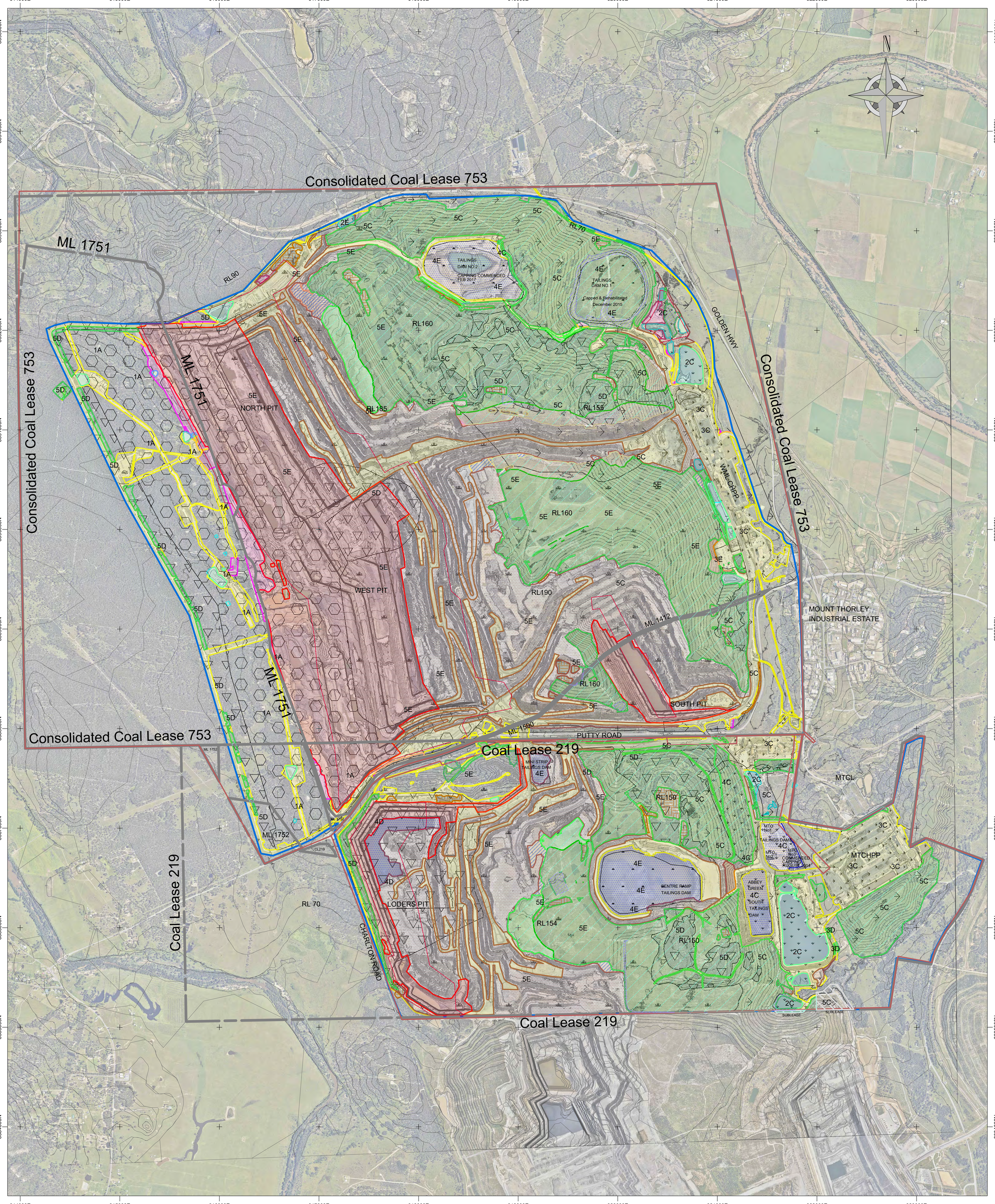
4.1 Area treated with maintenance fertiliser	4.8ha
4.2 Area treated by rotational grazing, cropping or slashing	0ha
Give Summary	NA

Table: 5 Variations to Rehabilitation Program

Has rehabilitation work proceeded generally in accordance with the conditions of an accepted Mining Operations Plan?	Yes
If not please cite any approval granted for variations, or briefly describe the seasonal conditions or other reasons for any changes and the nature of any changes which have been made.	NA

Table 6: Planned Operations During the Next Report Period

6.1 Area estimated to be disturbed	80.5ha
6.2 Area estimated to be rehabilitated	35ha



Mining Tenement
- Project Approval Area
- Sublease Boundary
- Area of disturbance
- Expected mining area - 2021

Rehabilitation Phases
- Ecosystem and Land Use Establishment
- Growth of medium development
- Landform establishment
- Lease Boundary
- 2021- 5m Contours (AHD)

Primary Domains
- 1 - Final Void
- 2 - Water Management Area
- 3 - Infrastructure Area
- 4 - Tailings Storage Facility
- 5 - Overburden Emplacement

Secondary Domains
- A - Final Void
- B - Water Management Area
- C - Rehabilitation Area- Grassland
- D - Rehabilitation Area- Woodland Other
- E - Rehabilitation Area- Woodland EEC

Note: For plan clarity only, black polygons have been used for primary & secondary domains. Plan has been labeled with text.

Aerial photo date: 31st December 2021
Co-ordinate grid datum: MGA 2020 Zone 56
Height datum: Australian Height Datum (AHD71)

AEMR 2021 Areas
- Active Mining
- Shaped Spoils
- Shaped Spoils >10°
- Unshaped Spoils
- Topsoil Stripped
- Topsoil Spread > 18°
- Topsoil Spread
- New Rehabilitation
- Temporary New Rehabilitation
- Rehabilitation
- Temporary Rehabilitation
- Infrastructure
- Infrastructure Tailings
- Water Structures
- Topsoil Stockpile
- Compost Spread

SCHEDULE OF ENDORSEMENTS

REF	DATE	DESCRIPTION/REFERENCES	SIGNED
Full Plan	29-03-2022	Mine surveying content depicted on the plan is sourced from RT 769	J.SHERRITT
Full Plan	29-03-2022	Domain boundaries supplied by others.	J.SHERRITT
Full Plan	29-03-2022	Disturbance limits supplied by others.	J.SHERRITT
Full Plan	29-03-2022	Mining tenement & lease boundaries supplied by others.	J.SHERRITT
Full Plan	29-03-2022	Expected mining areas supplied by others.	J.SHERRITT
Full Plan	29-03-2022	Rehabilitation data & phases supplied by others.	J.SHERRITT

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0m 100m 250m 500m 1000m 1500m 2000m

SCALE 1:12500

I, James Sherritt, Registered Mining Surveyor, No. 8626, certify that to the best of my knowledge and belief the survey information on this plan conforms to the accuracy and standards required by the Resources Regulator, Department of Regional New South Wales.

Registered Mining Surveyor

29/03/2022
Date

MOUNT THORLEY OPERATIONS / WARKWORTH MINING Ltd.

Annual Environmental Review Plan 2021

REDUCTION RATIO: 1 : 12,500 | A0

DRAWN BY: J. SHERRITT | DATE: 29/03/2022

APPROVED BY: B BAXTER

PLAN No. MTW-1162

Appendix 8:

Rehabilitation and Disturbance Summary

MTW Annual Review Appendix 6 – Rehabilitation Summary

Rehabilitation Site Name	Type	Coordinates (GDA2020)	Area (ha)	*Rehabilitation Summary*
TD2 SW Slope Spoil/Compost	Woodland	318,262.32 E 6,392,396.19 N	1.4	▪ The landform was constructed from a waste emplacement. ▪ The landform has been designed using a constant grade of approximately 10 degrees. The slope has a primarily westerly aspect. ▪ No water management structures were required on this slope due to short length of slope. ▪ Landform surface preparation comprised bulk shaping, deep ripping, rock raking, and removal of oversize rock material. ▪ No topsoil was added, spoil has been used as the growth medium. ▪ Soil ameliorants comprising recycled gypsum and Bettergrow Biomulch compost were applied at rates of 5t/ha and 90t/ha respectively. ▪ Growth medium preparation included ameliorant incorporation, rock picking and aerating as required ▪ The area was sown in August with Diverse Native Woodland at 15.7kg/ha. Non-flowable (grass) seed was spread onto the surface using a direct drill and then the flowable components of the seed mix were spread via an air-seeder mounted on the aerator implement. ▪ Selective weed control of *Galenia pubescens* and Rhodes Grass was undertaken after sowing when desirable native species and weed species had started to germinate.
MTO RL155 Spoil/Compost A	Woodland	319,124.64 E 6,386,005.75 N	15.8	▪ The landform was constructed from a waste emplacement. ▪ The landform has been designed using a geomorphological landform approach based on alluvial analogues. Typical slope of the landform is less than 10 degrees. The slope has a primarily easterly aspect. ▪ Drainage lines direct water to rock lined drains to the east. ▪ Landform surface preparation comprised bulk shaping, deep ripping, rock raking, and removal of oversize rock material. ▪ No topsoil was added, spoil has been used as the growth medium. ▪ Soil ameliorants comprising recycled gypsum and Bettergrow Biomulch compost were applied at rates of 5t/ha and 90t/ha respectively. ▪ Growth medium preparation included ameliorant incorporation, rock windrowing, rock picking, and aerating as required

Rehabilitation Site Name	Type	Coordinates (GDA2020)	Area (ha)	*Rehabilitation Summary*
				▪ The area was sown in August with Diverse Native Woodland at 15.7kg/ha. Non-flowable (grass) seed was spread onto the surface using a direct drill and then the flowable components of the seed mix were spread via an air-seeder mounted on the aerator implement.
TD1/TD2 Road	Grassland	319,346.18 E 6,391,949.58 N	1.3	▪ The landform was constructed from a waste emplacement. ▪ Light vehicle access road batters have been regraded to stable slopes of 10 to 14 degrees. The road batters have a primarily northerly and southerly aspect on either side of the road. ▪ No water management structures were required on this slope due to short length of slope. ▪ Landform surface preparation comprised minor shaping of road batters. ▪ Clay loam/sandy clay loam topsoil from existing topsoil stockpiles was spread at a nominal thickness of 100mm. ▪ Granulock Fertiliser compost was applied at a rate of 250kg/ha. ▪ The area was sown in August with an exotic pasture seed mix at a rate of 40kg/ha. Seed was spread via hand seeding due to small area.
NPS RL185 Spoil/Compost B	Woodland	317,364.11 E 6,391,624.38 N	15.8	▪ The landform was constructed from a waste emplacement. ▪ The landform has been designed using a geomorphological landform approach based on alluvial analogues. Typical slope of the landform is less than 10 degrees. The slope has a primarily westerly aspect. ▪ Drainage lines direct water to rock lined drains to the east. ▪ Landform surface preparation comprised bulk shaping, deep ripping, rock raking, and removal of oversize rock material. ▪ No topsoil was added, spoil has been used as the growth medium. ▪ Soil ameliorants comprising recycled gypsum and Bettergrow Biomulch compost were applied at rates of 5t/ha and 90t/ha respectively. ▪ Growth medium preparation included ameliorant incorporation, rock windrowing, rock picking, and aerating as required ▪ The area was sown in November with Diverse Native Woodland at 15.7kg/ha. Non-flowable (grass) seed was spread onto the surface using a direct drill and then the flowable components of the seed mix were spread via an air-seeder mounted on the aerator implement. ▪ Selective weed control commenced in December targeting emerging Rhodes Grass.

Rehabilitation Site Name	Type	Coordinates (GDA2020)	Area (ha)	*Rehabilitation Summary*
NPN RL185 Spoil/Compost	Woodland	317,147.15 E 6,392,105.52 N	4.2	▪ The landform was constructed from a waste emplacement. ▪ The landform has been designed using a geomorphological landform approach based on alluvial analogues. Typical slope of the landform is 10 to 14 degrees. The northern slope has a primarily northerly aspect and the southern slope has a primarily south-eastly aspect. ▪ Drainage lines direct water to rock lined drains to the east. ▪ Landform surface preparation comprised bulk shaping, deep ripping, rock raking, and removal of oversize rock material. ▪ No topsoil was added, spoil has been used as the growth medium. ▪ Soil ameliorants comprising recycled gypsum and Remondis compost were applied at rates of 5t/ha and 100t/ha respectively. ▪ Growth medium preparation included ameliorant incorporation, rock windrowing, rock picking, and aerating as required ▪ The area was sown in December with Diverse Native Woodland at 15.7kg/ha. Non-flowable (grass) seed was spread onto the surface using a direct drill and then the flowable components of the seed mix were spread via an air-seeder mounted on the aerator implement.
MTO RL155 Spoil/Compost B	Woodland	319,467.93 E 6,386,941.11 N	7.2	▪ The landform was constructed from a waste emplacement. ▪ The landform has been designed using a geomorphological landform approach based on alluvial analogues. The landform is flat in this area, no aspect. ▪ Area is flat and hence not requiring drainage controls. ▪ Landform surface preparation comprised bulk shaping, deep ripping, rock raking, and removal of oversize rock material. ▪ No topsoil was added, spoil has been used as the growth medium. ▪ Soil ameliorants comprising recycled gypsum and Remondis compost were applied at rates of 5t/ha and 100t/ha respectively ▪ Growth medium preparation included ameliorant incorporation, rock windrowing, rock picking, and aerating as required ▪ The area was sown in December with Diverse Native Woodland at 15.7kg/ha. Non-flowable (grass) seed was spread onto the surface using a direct drill and then the flowable components of the seed mix were spread via an air-seeder mounted on the aerator implement.



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N

MTW

MTW
Rehabilitation areas 2021

File: Rehab Areas 2021.wor
Rehab Areas 2021.PDF
Aerial Photo taken December 2021

Date:	24/03/2022
Produced By:	BB
Map Size:	A4 Portrait
Coordinate System:	MGA2020 Zone 56
Revision	01
Data Source	Various

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Appendix 9:

Local and Regional Biodiversity Areas Annual Compliance Reports



Local Biodiversity Areas

Annual Report 2021

3 May 2022

Annual report for the period from January to December 2021, for activities described in the Management Plans for all Local Warkworth Mining Limited offsets including:

- Southern Biodiversity Area (including the Putty Road Offset Area)
- Northern Biodiversity Area

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4.1 Bird assemblages monitoring 18
4.2 Habitat restoration monitoring 18
5 Progress in attaining Conservation Objectives against Key Performance Indicators 18
6 Adaptive Management 19

1 INTRODUCTION

This annual report is a requirement of the management plans for all Local Warkworth Mining Limited offsets for the 2021 reporting period (1 January 2021 to 31 December 2021).

The report provides a summary of the key management activities completed across the biodiversity offset located within the Southern (includes the Putty Road Offset Area) and Northern Biodiversity Areas (BAs).

The management plans describe the conservation management strategies and monitoring to achieve and measure improvement and protection of the offsets biodiversity values. It is a compliance requirement of the Commonwealth and NSW environmental approvals to implement the management plans.

The Local OMP (November 2014) was prepared to satisfy the consent requirements for the New South Wales (NSW) Warkworth Mine Development Approval (DA 300-9-2002i) and replaces the former *Flora and Fauna Management Plan* and *Warkworth Sands Woodland (WSW) Offset Area OMP*. In November 2015 the NSW Warkworth Continuation Project Approval (SSD-6464) was granted providing both NSW and Commonwealth approval for the same disturbance area. Phase 2 of the EPBC2009/5081 action also commenced on 16 February 2016. In response to the granting of these new approvals, new Management Plans for the Southern and Northern BA have been prepared to satisfy the Commonwealth approval EPBC2009/5081 and the NSW consent (SSD-6464), replacing both the Local and Putty Road OMPs.

The Biodiversity Offset Portal contains the supporting documentation for this report, including photo point monitoring. Access to the portal is restricted, relevant regulators have been provided with login details; please contact Mount Thorley Warkworth should you require assistance.

2 LOCATION AND LANDHOLDER DETAILS

The locations of the local BAs are shown in **Figure 1**, **Figure 2** and **Figure 3**, details are provided in **Table 1**.

Table 1 Local Biodiversity Areas

Biodiversity Area	Land Owner	Area (ha)	Offset Area (ha)	Location
Northern BA	Coal & Allied Operations Pty Ltd	344	341	Approximately 7km north of the Warkworth Mining Lease and in close proximity to the Hunter Valley Operations. Accessed via Comleroi Road.
Southern BA (including the Putty Road Offset)	Coal & Allied Operations Pty Ltd Miller Pohang Coal Company Pty Ltd Warkworth Mining Limited	1,023	986	Immediately west and north of Warkworth Mine. Intersected by Putty Road in the south, and Wallaby Scrub Road and the Golden Highway in the north.

Location of the Warkworth Mining Limited Biodiversity Areas

Annual Compliance Report

Figure 1

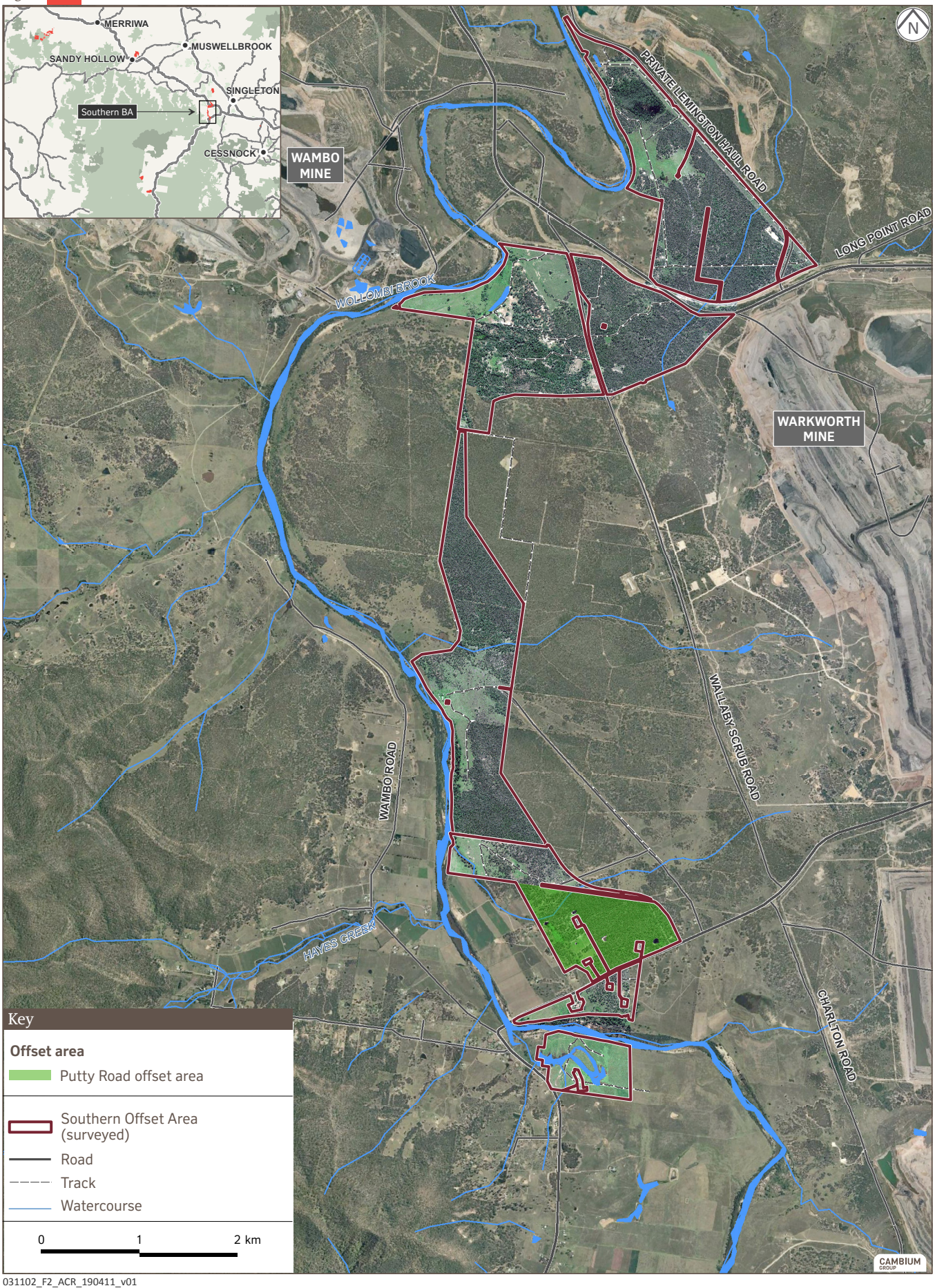


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Southern Biodiversity Area - Putty Road offset area

Annual Compliance Report

Figure 2

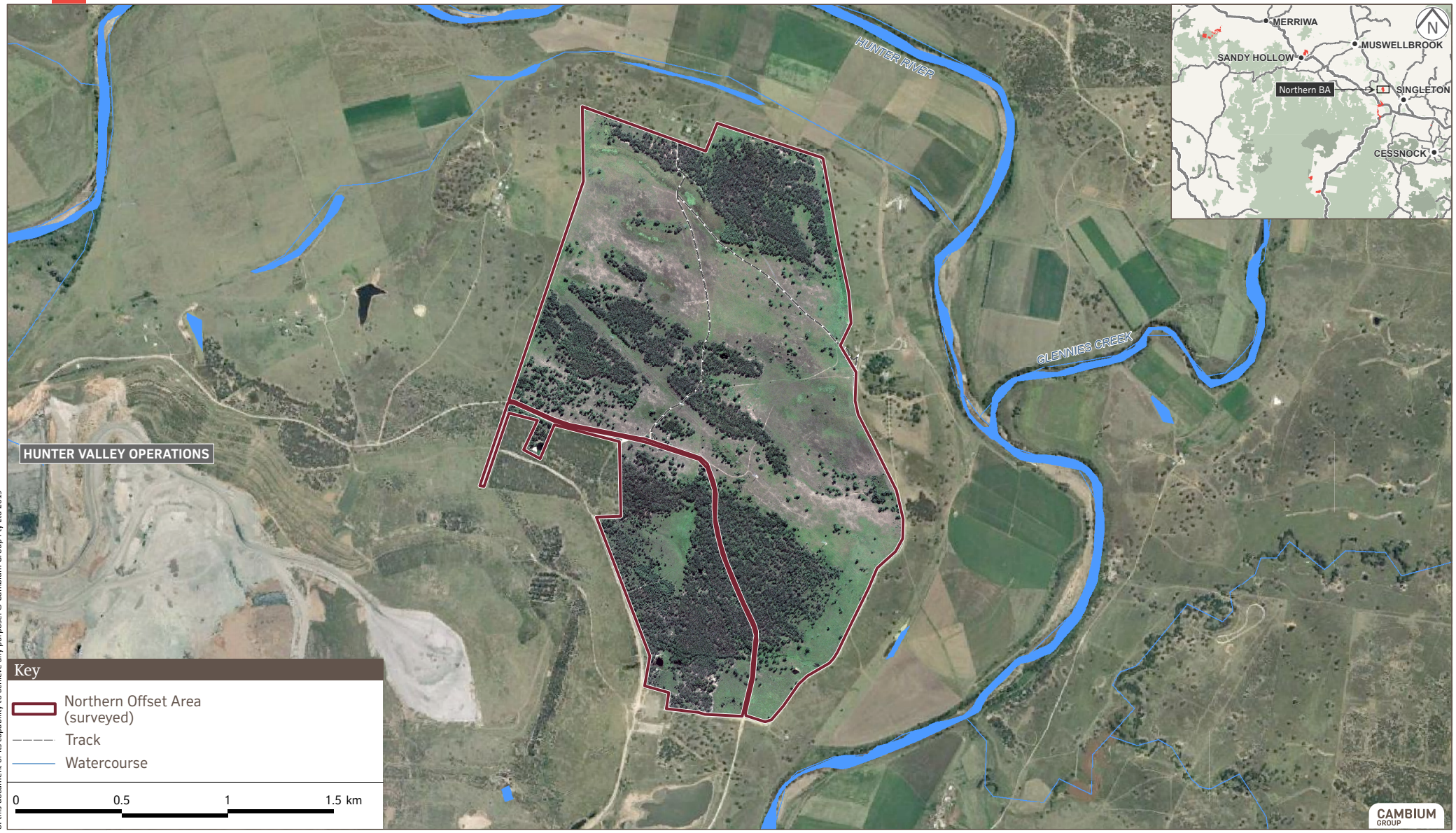


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Northern Biodiversity Area

Annual Compliance Report

Figure 3



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3 SUMMARY OF ACTIVITIES – 2021

Table 2 provides a summary of the activities undertaken during the reporting period (year 5) and the progress in attaining the Performance Criteria for the key Conservation Management Strategies in the management plans.

3.1 Summary of climatic conditions

Figure 4 and **Figure 5** show the monthly actual rainfall compared to the long-term average for the Northern BA and Southern BA for the reporting period. In 2021 rainfall was well above average for January, February, March, June, October and November with minimal rainfall in May. The Southern BA received 1,087mm of rainfall which was 551mm above the long-term average and the Northern BA received 1,083mm which was 527mm above the long-term average. The high rainfall was a significant factor in the survival of the Central Hunter Grey Box – Ironbark Woodland, River Oak Forest and Warkworth Sands Woodland tube stock planted from July to December 2021.

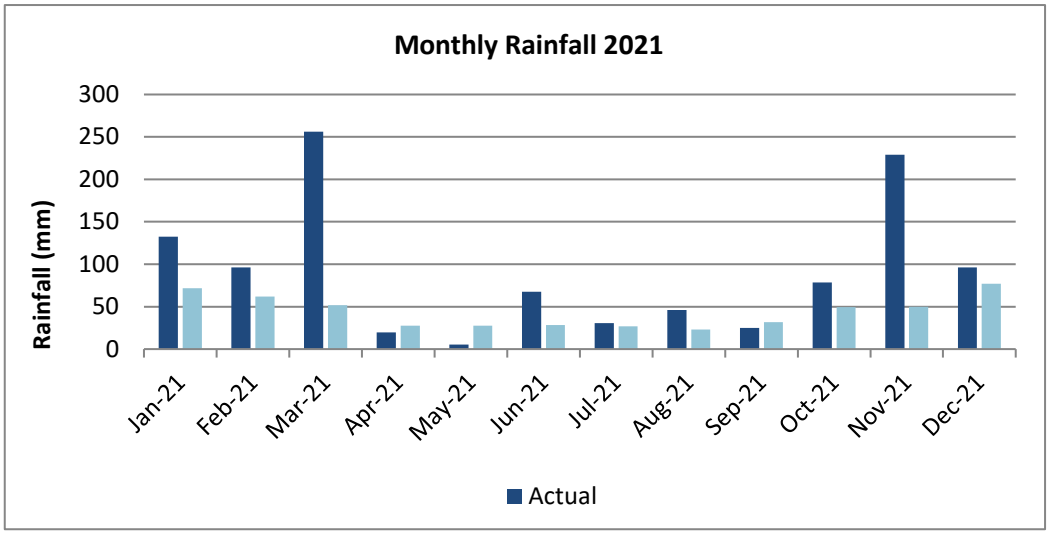


FIGURE 4 MONTHLY RAINFALL – NORTHERN BA

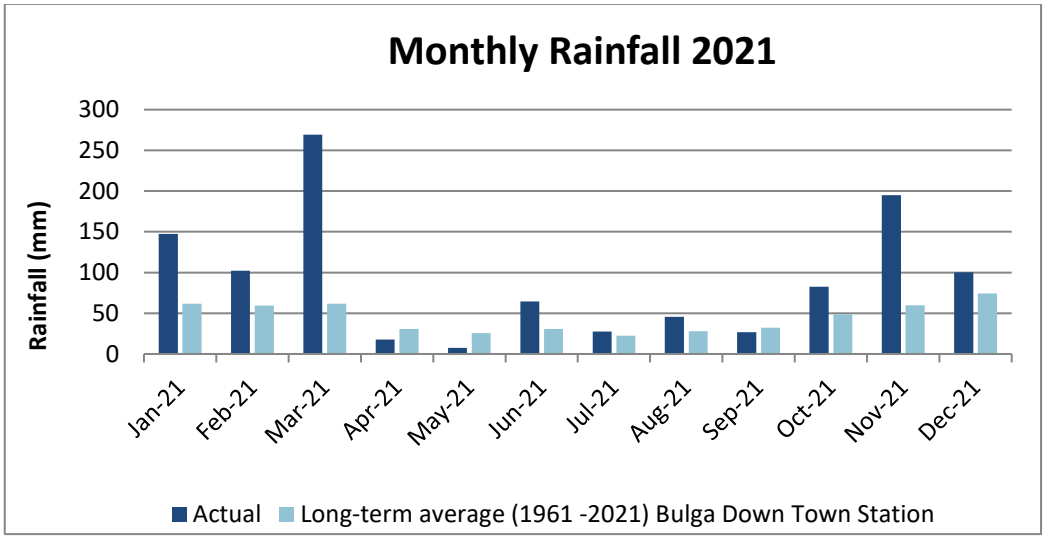


FIGURE 5 MONTHLY RAINFALL –SOUTHERN BA

Table 2 Summary of progress against Performance Criteria

Conservation Actions	Year 1 to Year 5 (2021 is Year 5)	Year 6 to Year 10	Completion Criteria	Actions 2022
ACTIVE RESTORATION				
Southern BA WSW planting (40ha)				
Performance Criteria	*Collection of seed. Plant propagation. Tubestock planted.* *Completed survival assessment.*	*Ecological monitoring completed*	*Ecological monitoring demonstrates a trajectory toward the reference site or the benchmark values for HU872 for all attributes measured over the three consecutive assessments (the average of all plots).*	
Activity / Progress	Seed collection and plant propagation was undertaken. In 2017 1ha of WSW tubestock was planted in the Southern BA. In 2018 14 ha of WSW Tubestock planted in the Southern BA including replanting the sand quarry and old orchard areas. In 2019 maintenance of planting areas was undertaken and included infill planting of over 9,000 tubestock. In 2020 maintenance of planting areas was undertaken and included infill planting of over 2,000 tubestock. Survival assessments were completed for all planting areas			Collect seed and propagate plants. Undertake survival assessments. Undertake Ecological monitoring. Undertake infill planting to restore Warkworth Sands Woodland in the Southern BA.

Conservation Actions	Year 1 to Year 5 (2021 is Year 5)	Year 6 to Year 10	Completion Criteria	Actions 2022
Southern BA CHGBIW planting (240ha)				
Performance Criteria	*Collection of seed. Plant propagation. Tubestock planted.* *Completed survival assessment.*	*Ecological monitoring completed.*	*Ecological monitoring demonstrates a trajectory toward the reference site or the NSW Biometric HU817 for all attributes measured over three consecutive assessments (the average of all plots).*	
Activity / Progress	Seed collection and plant propagation was undertaken. Restoration activities included tubestock planting of Central Hunter Grey Box – Ironbark Woodland in the Southern BA. In 2017, 89 ha of the Southern BA was planted with over 13,000 tubestock planted into rip lines. In 2018 118 ha of the Southern BA was planted with over 20,000 tubestock planted into rip lines. In 2019 maintenance of planting areas was undertaken and included infill planting of over 10,000 tubestock. In 2020 maintenance of planting areas was undertaken and included infill planting of over 3,800 tubestock. In 2021 maintenance of planting areas was undertaken and included infill planting of 9,000 tubestock. The site preparation for these sites included ripping by dozer and weed control. To mimic nature the tree species were planted at a spacing of 5 -10m and shrubs species planted in clumps as commonly found with understory species within this vegetation type. All plants were watered, fertilised and protected with a tree guard. Survival Assessments were completed for all planting areas.			Collect seed and propagate plants. Undertake survival assessments. Undertake Ecological monitoring. Undertake infill planting of Central Hunter Grey Box – Ironbark Woodland in the Southern BA.

Conservation Actions	Year 1 to Year 5 (2021 is Year 5)	Year 6 to Year 10	Completion Criteria	Actions 2022
Southern BA ROF planting (26ha)				
Performance Criteria	*Collection of seed. Plant propagation. Tubestock planted.* *Completed survival assessment.*		*Survival assessment greater than 70%*	
Activity / Progress	Seed collection and plant propagation was undertaken. Restoration activities included planting River Oak Forest in the Southern BA. In 2018, 11ha of the Southern BA was planted with over 2,000 tubestock planted into rip lines. In 2019 maintenance of planting areas was undertaken and included infill planting of over 800 tubestock. In 2020 maintenance of planting areas was undertaken and included infill planting of 3,200 tubestock. In 2021 maintenance of planting areas was undertaken and included infill planting of 4,000 tubestock. The site preparation for this site included ripping by dozer and weed control. To mimic nature the tree species were planted at a spacing of 5 -10m and shrubs species planted in clumps as commonly found with understory species within this vegetation type. All plants were watered, fertilised and protected with a tree guard. Survival Assessments were completed for all planting areas.			Collect seed and propagate plants. Undertake survival assessments. Undertake Ecological monitoring. Undertake infill planting of 11ha of River Oak Forest in the Southern BA.
Northern BA WSW planting (195ha)				
Performance Criteria	*Collection of seed. Plant propagation. Tubestock planted.* *Completed survival assessment.*	*Ecological monitoring completed.*	*Ecological monitoring demonstrates a trajectory toward the reference site or the benchmark values for HU872 for all attributes measured over three consecutive assessments (the average of all plots).*	

Conservation Actions	Year 1 to Year 5 (2021 is Year 5)	Year 6 to Year 10	Completion Criteria	Actions 2022
Activity / Progress	Seed collection and plant propagation was undertaken. Restoration activities included planting Warkworth Sands Woodland in the Northern BA. In 2014 work commenced to restore over 80 hectares of Warkworth Sands Woodland, this involved the planting of seedlings and the relocation of sand salvaged ahead of mining activities. In 2017, 10,800 tubestock were planted into 44 50x50m patches. Topsoil from ahead of mining operations at MTW was salvaged and hauled to the Biodiversity Area prior to planting commencing. In total Ten patches received 50mm of topsoil over the whole patch, two received 50mm of topsoil over half the patch, 12 received 25mm of topsoil over the patch and ten received no topsoil. Holes were dug for tubestock, either by hand or auger and all plants were watered, fertilised and protected with a tree guard. In 2018 maintenance of planting areas was undertaken and included infill planting of over 8,000 tubestock. In 2019 maintenance of planting areas was undertaken and included infill planting of over 3,000 tubestock. In 2020 planting progressed at the Northern BA with 9,112m³ of WSW sand stripped ahead of mining at MTW and hauled to the Northern Biodiversity Area. 5,480m³ of this WSW sand was spread into strips and seeded with native grasses to increase the groundcover diversity then planted with 4,500 tubestock In 2021 WSW planting progressed with 3,632 m³ of sand from ahead of mining at MTW spread into strips and seeded with native grasses then planted with 1,500 tubestock. Survival Assessments were completed for all planting areas A separate Ecological monitoring program was undertaken in 2021 to capture the WSW planting areas.			Collect seed and propagate plants. Undertake survival assessments Undertake Ecological monitoring. Spread topsoil from ahead of mining operations at MTW into the 2022 Northern BA planting strips. Undertake planting of 15ha of Warkworth Sands Woodland in the Northern BA

Conservation Actions	Year 1 to Year 5 (2021 is Year 5)	Year 6 to Year 10	Completion Criteria	Actions 2022
Northern BA CHGBIW planting (23ha)				
Performance Criteria	*Collection of seed. Plant propagation. Tubestock planted.* *Completed survival assessment.*	*Ecological monitoring completed.*	*Ecological monitoring demonstrates a trajectory toward the reference site or the NSW Biometric HU817 for all three attributes measured over three consecutive assessments (the average of all plots).*	
Activity / Progress	Restoration activities included tubestock planting of Central Hunter Grey Box – Ironbark Woodland in the Northern BA. In 2017, 6ha of the Northern BA was planted with 2,780 tubestock planted into rip lines. The site preparation for this site included ripping by dozer and weed control. To mimic nature the tree species were planted at a spacing of 5 -10m and shrubs species planted in clumps as commonly found with understory species within this vegetation type. All plants were watered, fertilised and protected with a tree guard. In 2018 maintenance of planting areas was undertaken and included infill planting. Survival Assessments were completed for all planting areas.			Undertake Ecological monitoring.

Conservation Actions	Year 1 to Year 5 (2021 is Year 5)	Year 6 to Year 10	Completion Criteria	Actions 2022
PASSIVE RESTORATION				
Weed control and monitoring				
Performance Criteria	*At least two weed control events each year for species listed in Table 14 of Management Plans and other weeds recorded from monitoring activities.* *All actions recorded in Annual Report.* *Complete Rapid Condition Assessment and Property Inspections.*	*At least one weed control event each year for species listed in Table 14 of Management Plans and other weeds recorded from monitoring activities.* *All actions recorded in Annual Report.* *Complete Rapid Condition Assessment and Property Inspections.*	*Ecological monitoring data indicates a trajectory for reduction in exotic plant cover over three consecutive assessments.*	
Activity / Progress	Weed contractor engaged to undertake weed control activities at the Northern and Southern BA throughout the year. In 2021weed control targeted the following species: African boxthorn *(Lycium ferocissimum),* African lovegrass *(Eragrostis curvulva), ,* Blue heliotrope *(Heliotropium amplexicaule),* Coolatai grass *(Cynodon dactylon),* Farmers *friends (Biden pilosa),*Galenia *(Galenia pubescens),* Green cestrum *(Cestrum parqui),* Lantana *(Lantana camara),* Mother of millions *(Bryophyllum delagonese),* Paterson's curse *(Echium plantagineum),* Prickly pear *(Opuntia stricta), Telegraph weed (Heterotheca grandiflora),* Tiger pear *(Optunia aurantiaca),* Whisky grass *(Andropogon virginicus) and* St Johns Wort *(Hypericum perforatum).* Rapid Condition Assessment and Property Inspections were completed in 2021.			Control noxious species and stop weeds spreading into previously un-infested areas. Undertake Rapid Condition Assessment. Undertake Property Inspections.

Conservation Actions	Year 1 to Year 5 (2021 is Year 5)	Year 6 to Year 10	Completion Criteria	Actions 2022
Pest control and monitoring				
Performance Criteria	*At least two control events each year for species listed in Table 20 of Management Plans, and any other species recorded from monitoring activities.* *Active participation in programme coordinated by HLLS, this may include local control actions.* *Complete biannual inspection and report all works completed and actions for next year.*	*At least one control events each year for species listed in Table 17 of Management Plans, and any other species recorded from monitoring activities.* *Active participation in programme coordinated by HLLS, this may include local control actions.* *Complete biannual inspection and report all works completed and actions for next year.*	*No observed vertebrate pest or damage.* *Ecological monitoring demonstrates a trajectory to benchmark values for all attributes measured over three consecutive assessments (the average of all plots).*	
Activity / Progress	In 2021 a vertebrate pest contractor was engaged to undertake programmes across the Southern and Northern BA. Three 1080 ground baiting programmes were undertaken targeting wild dogs and foxes in autumn, winter and spring. Biannual property inspections were undertaken in 2021.			Undertake vertebrate pest management including 1080 ground baiting programmes scheduled for autumn and spring to target wild dogs and foxes. Undertake Property Inspections.
Grazing				
Performance Criteria	*Grazing is conducted in accordance with the Management Plan.* *Boundary fences maintained.* *Complete Rapid Condition Assessment and Property Inspections.*			
Activity / Progress	No strategic grazing was undertaken in the BAs in 2021. Property Inspections and Rapid Condition Assessments were undertaken in 2021.			Undertake Property Inspections. Undertake Rapid Condition Assessment. Maintain boundary fences.

Conservation Actions	Year 1 to Year 5 (2021 is Year 5)	Year 6 to Year 10	Completion Criteria	Actions 2022
Bushfire Management Plan (BFMP), Ecological burn and monitoring				
Performance Criteria	*Actions implemented.* *Review and revise if required.* *Complete Rapid Condition Assessment and Property Inspections.*	*Actions implemented.* *Review and revise if required.* *Complete Rapid Condition Assessment and Property Inspections.* *Completed ecological fire management plan for MZ1, MZ3, MZ5, MZ7, MZ8 and MZ9.*	*All required actions of BFMP have been implemented.* *BFMP has been reviewed annually and revised if required.*	
Activity / Progress	BFMP reviewed. Firebreaks were slashed in 2021. Property Inspections and Rapid Condition Assessment were undertaken in 2021.			Review BFMP. Undertake Property Inspections. Undertake Rapid Condition Assessment. Undertake fuel load assessments. Slash firebreaks.
Infrastructure Improvements and monitoring				
Performance Criteria	*Completed GDP for all infrastructure improvement actions.* *Maintenance of tracks and fences completed at least every 3 years.* *Property Inspections undertaken.*			.
Activity / Progress	GDP completed for track maintenance at Southern BA in 2021. Boundary fences maintained and Property Inspections undertaken in 2021.			Maintain tracks and boundary fences. Undertake Property Inspections
Erosion monitoring inspections and reports				
Performance Criteria	*Complete Rapid Condition Assessment and Property Inspections*			
Activity / Progress	Rapid Condition Assessment and Property Inspections undertaken in 2021. No significant erosion issues identified at either BA			Undertake Rapid Condition Assessment. Undertake Property Inspections.

Conservation Actions	Year 1 to Year 5 (2021 is Year 5)	Year 6 to Year 10	Completion Criteria	Actions 2022
Dam conversion and rehabilitation and monitoring				
Performance Criteria	*Prepare dam conversion plan.* *Dam conversion complete and rehabilitation has stabilised the site.* *Property inspections.*	*Observed natural flow regime and no erosion.* *Property inspections.*	*All works completed.*	
Activity / Progress	Property inspections undertaken in 2021. Dam conversion plan prepared.			Implement actions from dam conversion plan. Undertake Property Inspections.
Natural Regeneration and monitoring				
Performance Criteria	Annual weed control, vertebrate pest and fire management actions implemented as per management plans. *Complete Rapid Condition Assessment and Property Inspections.*		*Ecological monitoring demonstrates a trajectory to benchmark values for all attributes measured over three consecutive assessments (the average of all plots).*	
Activity / Progress	All actions implemented in 2021 as per management plans. Rapid Condition Assessment and Property Inspections undertaken in 2021.			Undertake Property Inspections. Undertake Rapid Condition Assessment.
Controlled Activities				
Performance Criteria	*No reported incidents of prohibited actions undertaken Yancoal, contractors, consultants or other agents of Yancoal.* *Any clearing of vegetation reported in Annual Report.* *Signage and locks (where required) maintained.* *Complete risk assessment for any recreation activities.* *All occupants of residents compliant with requirements of the MP.* *No Cultural Heritage sites knowingly disturbed and any protective barricading maintained.* *Damaged and unwanted fences removed.* *All Property Inspections completed.*			

Conservation Actions	Year 1 to Year 5 (2021 is Year 5)	Year 6 to Year 10	Completion Criteria	Actions 2022
Activity / Progress	In 2017 trespassing and illegal tree clearing and timber getting within the Southern Biodiversity Area resulted in felling approximately 40 full sized trees and 100 small trees. This unauthorised activity was reported to both Department of Environment and Energy and Department of Planning and Environment in October 2017. Internal fences and waste were removed from the Southern BA areas to be planted in 2018 and sections of boundary fence at the Northern BA and Southern BA were repaired and replaced where needed. New Biodiversity Area signs were installed in 2017. Regular property inspections were undertaken. In 2021 there were no reported incidents or prohibited actions undertaken on the Biodiversity Areas.			Undertake Property Inspections.

4 MONITORING ACTIVITIES

The following table provides a summary of the monitoring activities undertaken as detailed in the MP. Monitoring reports and results are available on the Biodiversity Offset Portal.

Table 3 Monitoring Activity Summary

Monitoring	2021	Date/s	Completed by
Bird Assemblage	X	July – August 2020, next due July – August 2022	ANU Enterprise
Habitat Restoration	X	November 2021 additional monitoring plots at NBA, next due September – November 2022	Cumberland Plain Seeds
Rapid Condition Assessment	X	November 2021, next due September – November 2022	Advisor – Land Management
Property Inspection	X	April/November 2021, next due April/November 2022	Advisor – Land Management

4.1 Bird assemblages monitoring

Bird assemblage monitoring was not required to be undertaken during 2021. The results from the 2020 bird assemblage monitoring were presented in the 2020 Annual Report for Local Offsets.
The next bird assemblage monitoring is scheduled for July 2022.

4.2 Habitat restoration monitoring

Habitat restoration monitoring was not required to be undertaken during 2021. The results from the last round of habitat restoration monitoring conducted in 2020 were presented in the 2020 Annual Report for Local Offsets.
A separate monitoring program was undertaken across the Northern BA in Spring 2021 and included an additional eight transitional plots to capture the WSW planting activities undertaken between 2014 - 2021. The monitoring demonstrated that the woodland areas were near benchmark condition however the cleared grasslands still require substantial effort to decrease weed density and increase native species diversity and cover.
A combination of weed control, planting, seeding and soil translocation will all be required to improve vegetation condition.
The next habitat restoration monitoring is scheduled for September 2022.

5 PROGRESS IN ATTAINING CONSERVATION OBJECTIVES AGAINST KEY PERFORMANCE INDICATORS

The primary conservation objectives for the local offset areas (including the Putty Road Offset) are to:

- enhance biodiversity values across the BAs;
- protect the WSW Offset Area and Putty Road Offset Area under a legally binding conservation covenant;

- increase the condition of WSW and Ironbark EECs and observe a transition from grassland to woodland;

- enhance habitat and foraging opportunities for the woodland birds; and

- contribute to and enhance the existing network of protected vegetation within the Hunter Valley.

Table 2 indicates the progress in attainment of the long-term conservation objectives, the ecological monitoring data supports the continued implementation of the conservation management strategies.

6 ADAPTIVE MANAGEMENT

No new environmental risks have been identified during the reporting period.

Table 4 Local Offset Areas Biodiversity Values and Key Performance Indicators

Area	Biodiversity Value	Description and baseline metric	KPI	Progress comment
Southern BA	Ironbark Woodland	Total area: 446.7ha RCA Average Health rating 18/20 (MZ1)	Extent and condition of woodland over 10 years.	RCA results: 2014 – 18/20 2015 – 18/20 2016 – 18/20 2017 – 18.5/20 2018 – 18.5/20 2019 – 18/20 2020 – 17.5/20 2021 – 17.5/20 Area and health maintained.
	Ironbark Grassland	Total area: 258.4ha	Transition of grassland to woodland.	2021 monitoring supports continued implementation of the conservation management strategies.
	WSW	Total area: 137ha RCA Average Health rating 17.8/20 (MZ3)	Extent and condition of woodland over 10 years.	RCA results: 2014 – 16/20 2015 – 18/20 2016 – 17/20 2017 – 18/20 2018 – 19/20 2019 – 19/20 2020 – 17/20 2021 – 18.5/20 Area and health maintained.

	WS Grassland	Total area:40.3ha	Transition of grassland to woodland.	
	Hunter Lowland Red Gum Forest	Total area: 32.4ha RCA Average Health rating 18.6/20 (MZ5)	Extent and condition over 10 years.	RCA results: 2014 – 17/20 2015 – 19/20 2016 – 19/20 2017 – 19/20 2018 – 18.5/20 2019 – 18.5/20 2020 – 19/20 2021 - * *Sites were inaccessible due to flooding
	Fauna Habitat	Low potential habitat	Observe maintenance or increase habitat condition rating over 10 years	2021 monitoring supports continued implementation of the conservation management strategies.

Area	Biodiversity Value	Description and baseline metric	KPI	Progress comment
Northern BA	Ironbark Woodland	Total area: 103.6ha RCA Average Health rating 18.6/20 (MZ1)	Extent and condition of woodland over 10 years.	RCA results: 2014 – 18/20 2015 – 18.5/20 2016 – 19.5/20 2017 – 19.5/20 2018 – 18/20 2019 – 18/20 2020 – 19/20 2021 – 18/20 Area and health maintained.

Ironbark Grassland	Total area: 23.1ha	Transition of grassland to woodland.	
WSW	Total area: 19.5ha RCA Average Health rating 18.5/20 (MZ3)	Maintain woodland extent over 10 years.	RCA results: 2014 – 17.5/20 2015 – 18/20 2016 – 19/20 2017 – 19/20 2018 – 18.5/20 2019 – 18.5/20 2020 – 19/20 2021 – 18.5/20 Area and health maintained.
WS Grassland	Total area: 194.5	Transition of grassland to woodland	2021 monitoring supports continued implementation of the conservation management strategies.
Fauna Habitat		Observe maintenance or increase habitat condition rating over 10 years	2021 monitoring supports continued implementation of the conservation management strategies.



Regional Biodiversity Areas

Annual Report 2021

3 May 2022

Annual report for the period from January to December 2021, for activities described in the Management Plans for all regional Warkworth Mining Limited offsets including:

- Goulburn River Biodiversity Area
- Seven Oaks Biodiversity Area
- Bowditch Biodiversity Area
- Putty Biodiversity Area
- Condon View Biodiversity Area
- North Rothbury Biodiversity Area

Note that a portion of Condon View Biodiversity Area is an offset for Hunter Valley Operations to satisfy conditions of the Commonwealth approval EPBC 2016-760.

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1 INTRODUCTION

This annual report is a requirement of the Management Plans for all regional Warkworth Mining Limited offsets for the 2020 reporting period from 1 January through to 31 December 2021.

The annual report provides a summary of the key management activities completed across the biodiversity offsets located within the Goulburn River, Seven Oaks, Bowditch, Putty, Condon View and North Rothbury Biodiversity Areas (BAs).

The management plans describe the conservation management strategies and monitoring to achieve and measure improvement and protection of the offsets biodiversity values. It is a compliance requirement of the Commonwealth and NSW environmental approvals to implement the management plans.

The Regional Offset Management Plan (ROMP) was prepared to satisfy the consent requirements for the New South Wales (NSW) Hunter Valley Operations (HVO) South Project Approval (PA 06_0261) and the Warkworth Mine Commonwealth EPBC 2002/629 Approval. In November 2015, the NSW Warkworth Continuation Project Approval (SSD-6464) was granted providing both NSW and Commonwealth approval for the same disturbance area. Phase 2 of the EPBC2009/5081 action also commenced on 16 February 2016. In response to the granting of these new approvals, new Management Plans for the Bowditch and Goulburn River BA have been prepared to satisfy the Commonwealth approval EPBC2009/5081 and the NSW consent (SSD-6464), replacing the ROMP. On 10 October 2016 HVO was granted approval (EPBC2016/7604), The Condon View BA provides 168ha of suitable direct offset to be compliant with this approval. Management Plans have also been prepared and submitted for the new regional BAs: Seven Oaks, Putty, Condon View and North Rothbury.

The Biodiversity Offset Portal contains all the supporting documentation for this report, including photo point monitoring. Access to the portal is restricted, relevant regulators have been provided with login details; please contact Mount Thorley Warkworth should you require assistance.

2 LOCATION AND LANDHOLDER DETAILS

The locations of the regional BAs are shown in **Figure 1**, further details are provided in **Table 1**. The land is owned by Warkworth Mining Limited (WML). The Goulburn River and Condon View BAs are owned by Warkworth Mining Limited and have a portion of the total area designated as an offset for Hunter Valley Operations (HVO). Details of the Warkworth Offset and HVO Offset areas are in **Table 2 and Figure 1, 2 and 3**.

Table 1 Regional Biodiversity Areas

Biodiversity Area	Local Government Area	Land Owner	Area (ha)	Offset Area (ha)	Location
Goulburn River	Upper Hunter / Mid-Western	Warkworth Mining Limited	1,539	1,206	'The Rivers' 30km west of Merriwa, via Dulhunty Road, Comialla Road and Golden Hwy.
Bowditch	Muswellbrook	Warkworth Mining Limited	607	602	3km north of Sandy Hollow, 3450 Wybong Road, via Golden Hwy.
Seven Oaks	Mid-Western	Warkworth Mining Limited	521	519	35km west of Merriwa via Ulan Road, Summer Hill Road, Durridgerie Road and Smedes Road.
Condon View	Singleton	Warkworth Mining Limited	553	345	5km west of Putty via Box Tree Clearing Trail off Putty Valley Road.
Putty	Singleton	Warkworth Mining Limited	386	383	5km south of Putty via Box Gap Road.
North Rothbury	Cessnock	Warkworth Mining Limited	41	41	1km south of North Rothbury via Wine Country Drive.

Table 2 Goulburn River and Condon View Biodiversity Areas

Biodiversity Area	Land Owner	Area (ha)	Warkworth Offset Area (ha)	HVO Offset Area (ha)
Goulburn River	Warkworth Mining Limited	1,539	1,066	140
Condon View	Warkworth Mining Limited	553	345	168

Location of the Warkworth Mining Limited Biodiversity Areas

Annual Compliance Report

Figure 1

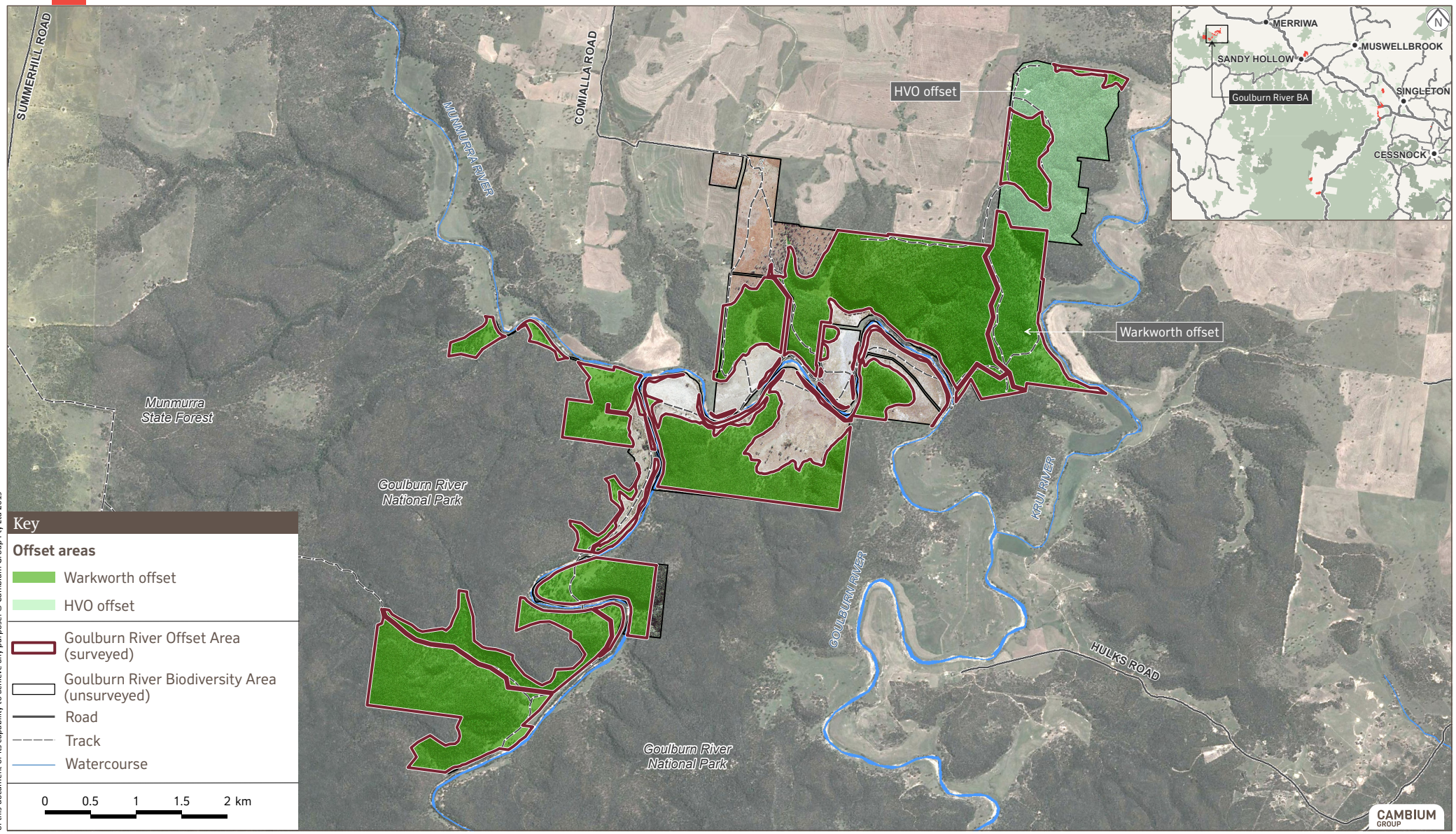


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Offset areas at the Goulburn River Biodiversity Area

Annual Compliance Report

Figure 2

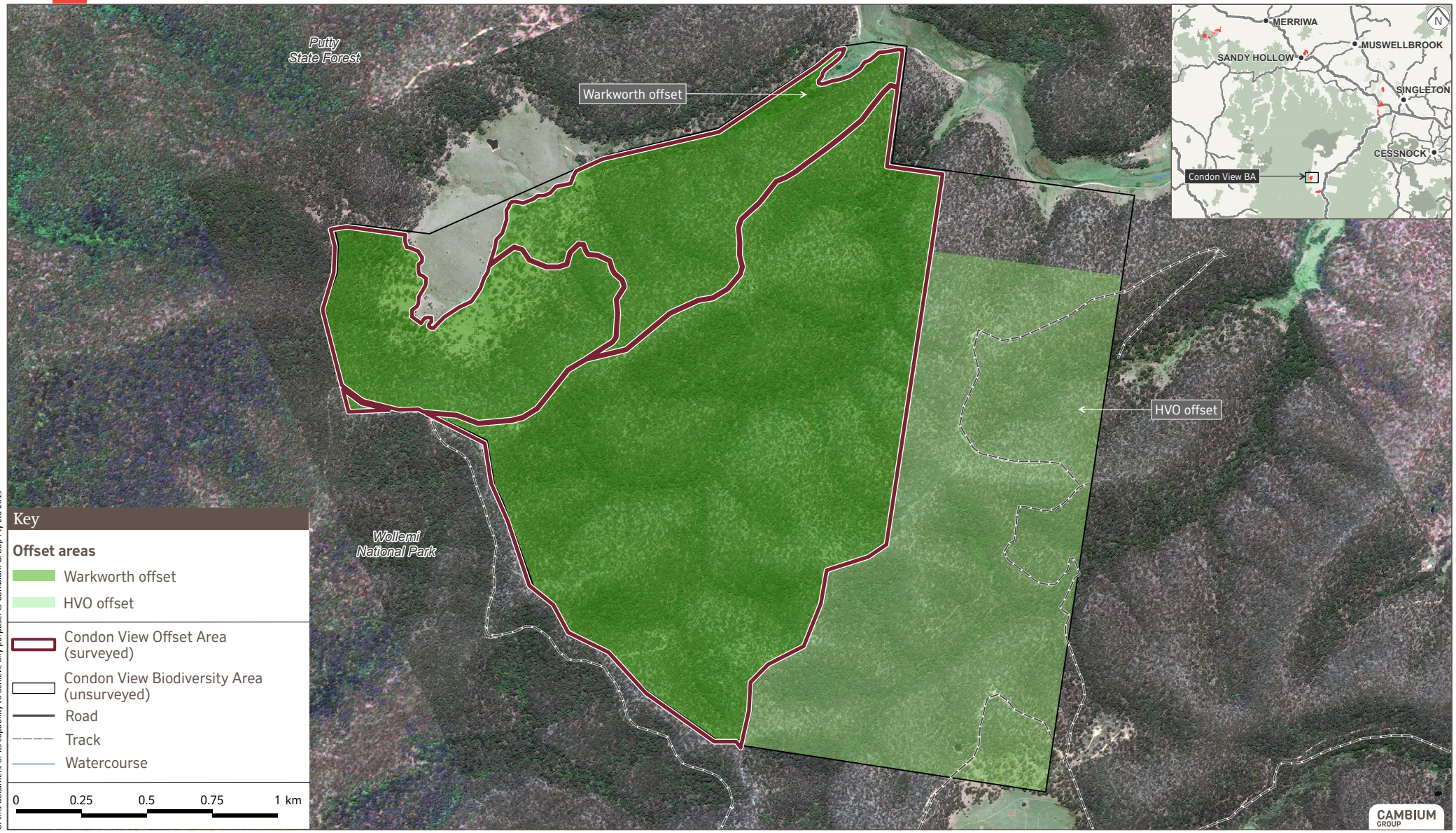


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Offset areas at the Condon View Biodiversity Area

Annual Compliance Report

Figure 3



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3 SUMMARY OF ACTIVITIES – 2021

Table 3 provides a summary of the activities undertaken during the reporting period (Year 5) and the progress in attaining the Performance Criteria for the key Conservation Management Strategies in the management plans.

3.1 Summary of climatic conditions

Figure 4 shows the monthly actual rainfall compared to the long-term average for the regional Biodiversity Areas for the reporting period. In 2021, rainfall was well above average in March and November. The Putty region received 892mm which was 209mm above the long-term average. North Rothbury received 982mm, 370mm above the long-term average. Sandy Hollow received 826mm which was 379mm above the long-term average and the Merriwa region received 908mm, 437mm above the long-term average.

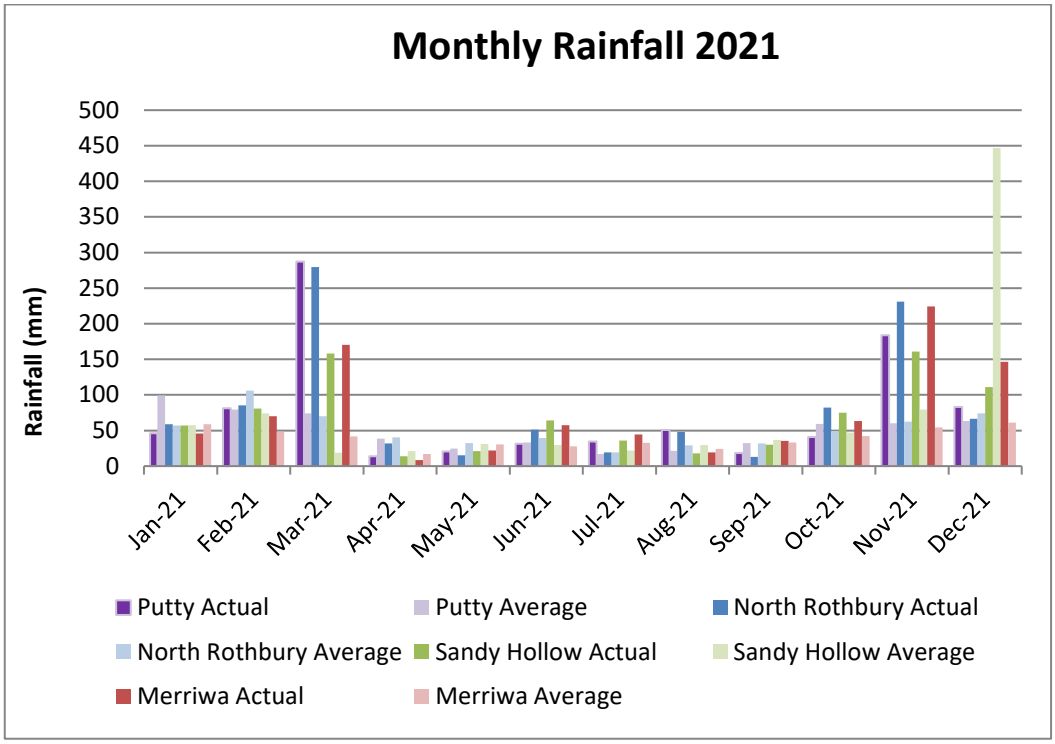


FIGURE 4 MONTHLY RAINFALL - 2021

Table 3 Summary of progress against Performance Criteria

Conservation Actions	Year 1 to Year 4	Year 5 to Year 10 (2021 is Year 5)	Completion Criteria	Actions 2022
ACTIVE RESTORATION				
Goulburn River BA Yellow Box – Grey Box – Red Gum grassy woodland (21.5ha) and River Oak riparian woodland (24.2ha)				
Performance Criteria	*Collection of seed. Plant propagation. Tubestock planted.* *Completed survival assessment.*		*Planting achieves above 70% survival.*	
Activity / Progress	Seed collection was undertaken at the Goulburn River BA in 2021. In 2019 17,000 tube stock was planted into 21.5ha of Yellow Box-Red Gum grassy woodland and 24.2ha of River Oak riparian woodland. The site preparation for these sites included ripping by dozer and weed control. To mimic nature the tree species were planted at a spacing of 5 -30m. All plants were watered, fertilised and protected with a tree guard. In 2020 maintenance of planting areas was undertaken and included infill planting of 12,000 tubestock. Survival assessments undertaken.	In 2021 maintenance of planting areas was undertaken and included infill planting of 12,000 tubestock into areas that could be accessed.		Collect seed and propagate plants. Undertake survival assessments. Undertake infill planting of 21.5ha of Yellow Box – Grey Box – Red Gum grassy woodland and 24.2ha of River Oak riparian woodland in the Goulburn River BA.
All Regional BAs				
Performance Criteria	*Review monitoring data to identify areas that require re-planting.* *If re-planting is identified, develop a re-establishment plan and implement within 12 months*			
Activity / Progress	No re-planting identified from ecological monitoring results/recommendations.			

Conservation Actions	Year 1 to Year 4	Year 5 to Year 10 (2021 is Year 5)	Completion Criteria	Actions 2022
PASSIVE RESTORATION				
Weed control and monitoring				
Performance Criteria	*At least two weed control events each year for species listed in Table 14 of Management Plans and other weeds recorded from monitoring activities.* *Complete Ecological Monitoring, Rapid Condition Assessment and Property Inspections.*	*At least one weed control event each year for species listed in Table 14 of Management Plans and other weeds recorded from monitoring activities.* *Complete Ecological Monitoring, Rapid Condition Assessment and Property Inspections.*	*Ecological monitoring data indicates a trajectory for reduction in exotic plant cover over three consecutive assessments.*	
Activity / Progress		Weed contractor engaged to undertake weed control activities across all Regional BAs throughout the year to control noxious species and stop weeds spreading into previously un-infested areas. In 2021 weed control targeted the following species Bathurst Burr *(Xanthium spinosum)*, Blackberry *(Rubus fruticosus)*, Blue heliotrope *(Heliotropium amplexicaule),* Bridal creeper *(Asparagus asparagoides),* Common Thorn-Apple *(Datura stramonium),* Farmers friends *(Bidens pilosa), Fireweed (Scenecio madagascariensis), Fleabane (Erigeron bonariensis),* Giant Parramatta grass *(Sporobolus fertilis)*, Great Mullein *(Verbascum Thapsus)*, ,Green cestrum *(Cestrum parqui),* Lantana *(Lantana camara),* Mallow *(Malva parviflora),* Mexican Poppy *(Argemone ochroleuca)*, Moth vine *(Araujia sericifera)*, Narrow leaf cotton bush (*Gomphocarpus fructicosus),* Paddy's lucene *(Sida rhombifolia),* Prickly pear (*Opuntia stricta*), Purple top *(Verbena bonariensis)*, Rhodes Grass *(Chloris gayana)*, Scotch thistle (*Onopordum acanthium),* St John's wort *(Hypericum perforatum),* Stinking roger *(Tangetes minuta),* Tiger pear (*Optunia aurantiaca),* Tree of heaven *(Ailanthus altissima), and* Variegated thistle *(Silybum marianum)*. Rapid Condition Assessment and Property Inspections were completed in 2021.		Control noxious species and stop weeds spreading into previously un-infested areas. Undertake Rapid Condition Assessment. Undertake Property Inspections. Undertake Ecological monitoring.

Conservation Actions	Year 1 to Year 4	Year 5 to Year 10 (2021 is Year 5)	Completion Criteria	Actions 2022
Pest control and monitoring				
Performance Criteria	*At least two control events each year for species listed in Management Plans, and any other species recorded from monitoring activities.* *All actions recorded in the Annual Report.* *Active participation in programme coordinated by HLLS, this may include local control actions.* *Complete Rapid Condition Assessment and Property Inspections.*	*At least one control event each year for species listed in Management Plans, and any other species recorded from monitoring activities.* *All actions recorded in the Annual Report.* *Active participation in programme coordinated by HLLS, this may include local control actions.* *Complete Rapid Condition Assessment and Property Inspections.*	*No observed vertebrate pest or damage.* *Ecological monitoring demonstrates a trajectory to benchmark values for all attributes measured over three consecutive assessments (the average of all plots).*	
Activity / Progress		In 2021 vertebrate pest contractors were engaged to undertake programmes across all Regional BAs. Two 1080 ground baiting programmes targeting wild dogs and foxes were undertaken in autumn and spring and was undertaken in conjunction with neighbouring landholders and HLLS where possible. A feral pig 1080 baiting and ground shooting programme was undertaken at the Goulburn River BA in March controlling 87 feral pigs. A Noisy Miner ground shoot was undertaken at the Goulburn River BA in August to assist the survivability of the Regent Honeyeater: 230 Noisy Miners controlled under Licence to Harm Protected Animals (Biodiversity Conservation Act 2016). This is the fifth consecutive year of the programme making this the longest running and most successful noisy miner management programme in the country. A ground shooting program was undertaken at the Goulburn River BA in August controlling 26 feral pigs. Participation in HLLS and NPWS aerial shooting programmes. Participation in HLLS Wild Dog Association programme. Shooting for other vertebrate pests was undertaken across the BAs. Rapid Condition Assessment and Property Inspections were completed in 2021.		Participate in HLLS Aerial Baiting/shooting programmes. Participate in HLLS Wild Dog Association programme. Undertake shooting, baiting and trapping programmes. Undertake a control programme for noisy miners in the Regent Honeyeater breeding area at GRBA Undertake a control programme for noisy miners at the Bowditch BA. Undertake Rapid Condition Assessment. Undertake Property Inspections. Undertake Ecological monitoring.

Conservation Actions	Year 1 to Year 4	Year 5 to Year 10 (2021 is Year 5)	Completion Criteria	Actions 2022
Grazing				
Performance Criteria	*Grazing is conducted in accordance with the Management Plan.* *Boundary fences maintained.* *Complete Rapid Condition Assessment and Property Inspections.*			
Activity / Progress	Cattle excluded from all BAs. Rapid Condition Assessment and Property Inspections were completed in 2021. Boundary fences repaired at North Rothbury, Putty and Bowditch BA. A new 470m section of boundary fence was installed at Putty BA. Rapid Condition Assessment and Property Inspections were completed in 2021.			Undertake Rapid Condition Assessment. Undertake Property Inspections.
Regional BA Bushfire Management Plan (BFMP) and monitoring				
Performance Criteria	*Actions implemented.* *Review and revise if required.* *Complete Rapid Condition Assessment and Property Inspections*	*Actions implemented.* *Review and revise if required.* *Complete Rapid Condition Assessment and Property Inspections.* *Completed ecological fire management plan.*	*All required actions of BFMP have been implemented.* *BFMP has been reviewed annually and revised if required.*	
Activity / Progress		No revision of the BFMP required. No FLA were undertaken during 2021 these have been scheduled for Q1 2022. A Hazard Reduction Burn for North Rothbury BA was approved however weather conditions were outside the prescribed limits, so the burn has been rescheduled for 2022. Slashing of fire breaks was undertaken at the Goulburn River BA. Rapid Condition Assessment and Property Inspections were completed in 2021.		Review BFMP. Implement a bushfire fuel hazard reduction programme. Undertake annual fuel load assessments on all Regional BAs. Undertake the Hazard Reduction Burn at North Rothbury BA. Undertake Rapid Condition Assessment. Undertake Property Inspections.
Erosion monitoring inspections and reports				
Performance Criteria	*Complete Rapid Condition Assessment and Property Inspections*			
Activity / Progress	No significant erosion issues identified during monitoring. Rapid Condition Assessment and Property Inspections were completed in 2021			Undertake Rapid Condition Assessment. Undertake Property Inspections.

Conservation Actions	Year 1 to Year 4	Year 5 to Year 10 (2021 is Year 5)	Completion Criteria	Actions 2022
Dam conversion and rehabilitation and monitoring				
Performance Criteria	*Prepare dam conversion plan.* *Dam conversion complete and rehabilitation has stabilised the site.* Property inspections.	*Observed natural flow regime and no erosion.* *Property inspections.*	*All works completed.*	
Activity / Progress		Property inspections undertaken in 2021. A dam conversion plan was prepared in 2021		Implement the dam conversion plan. Undertake Property Inspections. Undertake Ecological monitoring.
Natural Regeneration and monitoring				
Performance Criteria	*Annual weed control, vertebrate pest and fire management actions implemented as per management plans.* *Complete Rapid Condition Assessment and Property Inspections.*		*Ecological monitoring demonstrates a trajectory to benchmark values for all attributes measured over three consecutive assessments (the average of all plots).*	
Activity / Progress	Rapid Condition Assessment and Property Inspections undertaken in 2021. Actions implemented as per management plans – see above.			Implement actions as per Management plans. Undertake Rapid Condition Assessment. Undertake Property Inspections. Undertake Ecological monitoring.
Controlled Activities				
Performance Criteria	*No reported incidents of prohibited actions undertaken Yancoal, contractors, consultants or other agents of Yancoal.* *Any clearing of vegetation reported in Annual Report.* *Signage and locks (where required) maintained.* *Complete risk assessment for any recreation activities.* *All occupants of residents compliant with requirements of the MP.* *No Cultural Heritage sites knowingly disturbed and any protective barricading maintained.* *Damaged and unwanted fences removed.* *All Property Inspections completed.*			
Activity / Progress	No reported incidents of prohibited actions undertaken in 2021. Regular property inspections were undertaken in 2021.			Undertake Property Inspections.

4 MONITORING ACTIVITIES

The following table provides a summary of the monitoring activities undertaken as detailed in the management plans. Monitoring reports and results are available on the Biodiversity Offset Portal.

Table 4 Monitoring Activity Summary

Monitoring	2021	Date/s	Completed by
Bird Assemblage	X	July – August 2020, next due July – August 2022	ANU Enterprise
Habitat Restoration	X	November 2020, next due September – November 2022	SLR Consulting
Rapid Condition Assessment	X	November 2021 next due September – November 2022	Advisor – Land Management
Property Inspection	X	April/November 2021, next due April/November 2022	Rural and Environmental Management

4.1 Bird assemblages monitoring

Bird assemblage monitoring was not required to be undertaken during 2021. The results from the 2020 Bird Assemblage monitoring were presented in the 2020 Annual Report for Regional Offsets. The next Bird Assemblage monitoring is scheduled for July 2022.

4.2 Habitat restoration monitoring

Habitat Restoration monitoring was not required to be undertaken during 2021. The results from the last round of Habitat Restoration monitoring conducted in 2020 were presented in the 2020 Annual Report for Regional Offsets. The next Habitat Restoration monitoring is scheduled for September 2022.

5 PROGRESS IN ATTAINING CONSERVATION OBJECTIVES AGAINST KEY PERFORMANCE INDICATORS

The primary conservation objectives for the Regional BAs are to:

- enhance landscape connectivity within the surrounding landscape;
- improve fauna movement and flora dispersal opportunities within the surrounding landscape;
- increased condition and area of suitable habitats for threatened fauna species within protected reserves, specifically for the Regent Honeyeater and Swift Parrot;
- provide refuge and habitat for local fauna populations and transient species, particularly threatened species; and
- enhance network of protected vegetation within the Hunter Valley.

Table 3 details the progress in attainment of the long-term conservation objectives. The baseline data presented is from the first monitoring completed in 2014. The Rapid

Condition Assessment (RCA) monitoring results indicate that the vegetation and habitat health is being maintained in comparison to the baseline data **Table 5– Table 10**.

6 ADAPTIVE MANAGEMENT

No new environmental risks have been identified during the reporting period.

Table 5 Goulburn River BA: Biodiversity Values and KPIs

Biodiversity Value	Nested Conservation Value(s)	Description and baseline metric	KPI	Progress comment
Woodland (MZ2, MZ3, MZ4, MZ5 and MZ7)		Total area: 1,169ha RCA Average Health rating 17.5/20	Maintain or increase area, connectivity and habitat condition over 10 years	RCA Average health rating 2015 – 17/20 2016 – 17.1/20
	Fauna Habitat	Moderate potential habitat for Swift Parrot and Regent Honeyeater	improved habitat condition over 10 years	2017 – 17.1/20 2018 - 18.1/20 2019 – 18.4/20 2020 - *17.5/20 2021 - *17.4/20 Area and health maintained *Some sites were inaccessible due to high water levels in the Goulburn River.

Table 6 Bowditch BA: Biodiversity Values and KPIs

Biodiversity Value	Nested Conservation Value(s)	Description and baseline metric	KPI	Progress comment
Woodland (MZ1, MZ2 and MZ4)		Total area: 602ha RCA Average Health rating 17.9/20	Observed and measured increase or maintained RCA scores over 10 years	RCA Average Health rating 2015 – 18/20 2016 – 18.4/20
	Fauna Habitat	Moderate potential habitat for Swift Parrot and Regent Honeyeater	Maintain or increase the condition and extent of habitat and bird usage over 10 years	2017 – 17.1/20 2018 – 17.7/20 2019 – 17.7/20 2020 – 18.1/20 2021 – 18.3/20 Area and health maintained

Table 7 Seven Oaks BA: Biodiversity Values and KPIs

Biodiversity Value	Nested Conservation Value(s)	Description and baseline metric	KPI	Progress comment
Woodland (MZ3, MZ4 and MZ5)		Total area: 519ha RCA Average Health rating 17.8/20	Observe an increase in area, connectivity and habitat condition over 10 years	RCA Average Health rating 2016 – 18/20 2017 – 17.3/20
	Fauna Habitat	Moderate potential habitat for Swift Parrot and Regent Honeyeater	Maintain or increase the condition and extent of habitat and bird usage over 10 years	2018 – 17.6/20 2019 – 17.6/20 2020 - 18.2/20 2021 – 18.2/20 Area and health maintained

Table 8 Condon View BA: Biodiversity Values and KPIs

Biodiversity Value	Nested Conservation Value(s)	Description and baseline metric	KPI	Progress comment
Woodland (MZ2 and MZ4)		Total area: 515ha RCA Average Health rating 18.9/20	Maintain or increase area, connectivity and habitat condition over 10 years	RCA Average Health rating 2016 – 20/20 2017 – 18.2/20 2018 – 18.6/20 2019 – 18.6/20 2020 – 19/20 2021 – 19.3/20 Area and health maintained
	Fauna Habitat	Moderate potential habitat for Swift Parrot and Regent Honeyeater	Maintain or increase the condition and extent of habitat and bird usage over 10 years	

Table 9 Putty BA: Biodiversity Values and KPIs

Biodiversity Value	Nested Conservation Value(s)	Description and baseline metric	KPI	Progress comment
Woodland (MZ2, MZ3 and MZ4)		Total area: 383ha RCA Average Health rating 16.9/20	Observe an increase in area, connectivity and habitat condition over 10 years	RCA Average Health rating 2016 – 17.3/20 2017 – 17.6/20 2018 – 17.8/20 2019 – 15.6/20 2020 – 16.2/20 2021 – 16.8/20 (Bushfire in July and December 2019 reduced the health rating)
	Fauna Habitat	Moderate potential habitat for Swift Parrot and Regent Honeyeater	Maintain or increase the condition and extent of habitat and bird usage over 10 years	

Table 10 North Rothbury BA: Biodiversity Values and KPIs

Biodiversity Value	Nested Conservation Value(s)	Description and baseline metric	KPI	Progress comment
Woodland (MZ1 and MZ2)		Total area: 41ha RCA Average Health rating 18.6/20	Observe an increase in area, connectivity and habitat condition over 10 years	RCA Average Health rating 2016 – 18/20 2017 – 18.2/20 2018 – 19/20 2019 – 18.7/20 2020 – 19/20 2021 – 19/20 Area and health maintained
	Fauna Habitat	Moderate potential habitat for Swift Parrot and Regent Honeyeater	Maintain or increase the condition and extent of habitat and bird usage over 10 years	

Appendix 10:

IEA Action Status Table

Mount Thorley Warkworth Complex (SSD-6464 and SSD-6465) – Independent Environmental Audit 2020 – Progress with Audit Recommendations

NON-COMPLIANCE RECOMMENDATIONS AND RESPONSES			
Ref	**Non-Compliance**	**Hansen Bailey Recommendation**	**MTW Progress**
Previous IEA			
Table 6	Review process for documenting training records for training required by approvals. Implement process for documenting these training records as required.	No outstanding recommendations from previous IEA.	Review of process has been completed by MTW. Environmental training requirements of the approvals are incorporated into induction training materials. Records of training are maintained by MTW.
SSD 6464			
Sch 2 Cond 9	The application to surrender DA-300-9-2002-i has not been approved by DPIE. Email from DPIE dated 3/3/20 states that DPIE does not have capacity to complete the surrender and will complete in "the near future".	Follow up with DPIE to seek surrender notice.	MTW followed up progress with DPE during August 2020, and February 2021 and received a response from DPE 2 July 2021 requesting additional information required by subclauses 97(3) and (4) of the EP&A Regulation. MTW will follow up with DPE to progress surrender of the relevant consent during the 2022 Annual Review period.
Sch 3 Cond 8	Three blast non-compliances during the IEA period. Two blasts exceeded the blast criteria of 120 dBA (28/12/18, 4/4/19). One blast was an administrative non-compliance for failure to capture the blast at the monitor (5/7/18). A penalty notice was issued from DPIE for the blast exceedance occurring on the 4/4/19.	Implement continuous improvement practices with the aim to avoid any blast exceedances.	MTW has already reacted with modification to blast practices in relation to each on the non-compliances noted, including engaging external investigations, modifications to blast permissions pages, and installing an additional weather station to assist review. As a further measure of continuous improvement, MTW have continued working with stakeholders in the Hunter Valley in the 2021 reporting period to enable the implementation of a real time model, which will use real time meteorological data from weather stations throughout the Hunter Valley to better determine the effect of possible overpressure enhancement. Development of an MTW specific model is in its final stages of development, with testing and implementation expected to occur during the 2022 Annual Review period.
Sch 3 Cond 28	The condition requires retirement of the required biodiversity credits within 3 years of the development commencing (i.e. by 14 February 2019). Although correspondence with regulators has occurred regarding progress to date, including issues with changing biodiversity legislation, possible timelines to complete, and correspondence on impending administrative non-compliance with this condition, there is no evidence available that the timelines proposed for the retirement of biodiversity credits has been achieved. No formal extension to the 3 year timeframe can be granted by DPIE as the condition does not allow the Secretary to grant one.	At next modification consider to request amendment to condition to facilitate extension to time by adding "or with the agreement of the Secretary" after "approval" consistent with other contemporary approvals.	After consultation with DPE, MTW lodged a modification application to DPE on 5 May 2021 to address the biodiversity credit requirement (SSD-6464 MOD1). The modification application is in progress with DPE and will continue in the 2022 Annual Review period.
Sch 3 Cond 30	No evidence that offset areas listed in Table 12 have been secured under an in-perpetuity conservation mechanism in accordance with the relevant provisions of the *Threatened Species Conservation Act.*	Continue to progress long term security mechanism for ecology offset areas with relevant regulators.	After consultation with DPE, MTW lodged a modification application to DPE on 5 May 2021 to address the biodiversity credit requirement (SSD-6464 MOD1). The modification application is in progress with DPE and will continue in the 2022 Annual Review period.

NON-COMPLIANCE RECOMMENDATIONS AND RESPONSES			
Ref	**Non-Compliance**	**Hansen Bailey Recommendation**	**MTW Progress**
Sch 3 Cond 34	2017 audit confirmed it sighted evidence of consultation with neighbouring mines and OEH. OEH has not confirmed whether the Integrated Management Plan for the Warkworth Sands Woodland EEC is to their satisfaction.	Follow up with OEH to confirm that Integrated Management Plan for the Warkworth Sands Woodland EEC is to their satisfaction.	OEH has not approved this plan yet despite being submitted for approval within 12 months. Follow up with Biodiversity Conservation Division has occurred during April-May 2020 which indicated this item has moved up BCD priority list. MTW followed up with BCD on the status of the Integrated Management Plan for the Warkworth Sands Woodland EEC during site visit on 27 October 2020 with the intention to resolve during the 2020 Annual Review period, however no response has been received from BCD on approval of this plan. Further follow up required in the 2022 Annual Review period.
Sch 3 Cond 43(c)	The research program as part of the AHMP has not been progressed and was due to be implemented in August 2017.	Access to the sand bodies with HVO should be resolved. If access cannot be granted, discussions should occur with relevant regulators and modify the ACHMP to relocate the Research Program requirement. The Research Program on MTW should be progressed.	The main delay associated with this project has been the access arrangements for research areas that are not located on land owned/managed by Yancoal. Timing to resolve access issues for parts of the currently proposed program located on non-MTW owned land to understand if access may be granted: By 31 July 2022. Within 3 months of understanding land access position, MTW is proposing to consult with the relevant regulators and its registered Aboriginal parties (RAP's) regarding a revised scope of works for the research program which will be tailored for research areas that are currently located on land that is currently owned or is under agreement with MTW. This will allow for the program to proceed without further delays associated with legal agreements for access.
Sch 3 Cond 57	There were ongoing delays in the progression of rehabilitation areas identified by the Resources Regulator for which MTW received a Section 240 notice.	Complete undertaking actions described in Section 240 notice issued by the Resource Regulator. Actions are being processed as described in Appendix E.	Confirmation received from Resources Regulator on 24 January 2020 that the directions of section 240 notices NTCE0003219 and NTCE 0003168 had been satisfactorily addressed by the submission of the Emergent Ecology Report into rehabilitation progress at MTW. The requirements of subsequent section 240 notices NTCE0004831 and NTCE0004858 have been addressed through the submission of the MTW MOP Amendment C on 31 March 2020. MTW MOP Amendment C was approved by Resources Regulator on 24 November 2020.
SSD 6465			
Sch 3 Cond 27	No evidence that the Loders Creek Aboriginal Cultural Heritage Conservation Area has been entered into a Conservation Agreement.	Progress establishment of the Loders Creek Heritage Conservation Area Agreement with relevant regulators.	MTW has two Aboriginal Cultural Heritage Conservation Areas (ACHCA) to conserve under it's development consents – the Wollombi Brook ACHCA (WBACHCA), and the Loders Creek ACHCA (LCACHCA). MTW provided BCD (now Heritage NSW) with a draft Conservation Agreement for the WBACHCA in 2019, continued consultation during 2020 and 2021, provided an updated WBACHCA draft Conservation Agreement in August 2021, and an updated draft Conservation Agreements for LCACHCA and WBACHCA in December 2021.

NON-COMPLIANCE RECOMMENDATIONS AND RESPONSES			
Ref	**Non-Compliance**	**Hansen Bailey Recommendation**	**MTW Progress**
			MTW submitted signed conservation agreements for LCACHCA and WBACHCA on 22 February 2022, requesting execution by the relevant Minister,and continues to engage with Heritage NSW towards the completion and registering of the WBACHCA and LCACHCA conservation agreements in the 2022 Annual Review period.

CONTINUAL IMPROVEMENT RECOMMENDATIONS		
Ref	**Hansen Bailey Recommendation**	**MTW Progress**
SSD 6464		
Sch 3 Cond 6(d)	Recommend toolbox talk (or similar) distributed to relevant personnel in relation to reminder for need for sound suppression on mobile fleet.	MTW has distributed a toolbox talk on mobile fleet sound suppression to all site personnel.
Sch 3 Cond 7(e)	Undertake a regular comparison of real time monitoring as part of regular, external noise monitoring to validate real time monitoring results and discuss in Annual Review which is the intent of this condition. Recommend showing maximum monitored result from the three quarterly readings (LAeq 15 min) in all tables in section 6.5 of the Annual Reviews, instead of an average of the three. The link in the AR should also be updated to facilitate ease of finding detailed noise results to https://insite.yancoal.com.au/document-library/monthly-reporting-mtw.	MTW are undertaking a regular comparison of real time and external noise monitoring. This comparison was undertaken in quarter four 2020 and will be discussed in Annual Reviews going forward. MTW have shown maximum values in Table 6.5 of the 2020 Annual Review and in Annual Review's going forward and the link in the AR has also be updated to facilitate ease of finding detailed noise results, as recommended. No further action required.
Sch 3 Cond 16(c)	Add statement in Road Closure Management Plan at next update that occupancy licences are updated annually.	A statement has been included in the main text of the revised Blast Management Plan that occupancy licences will be included in Appendix D (Road Closure Management Plan) of the BMP as they are updated and that an update to the Road Occupancy Licences in Appendix D will not trigger submission of an updated BMP to DPE, but rather enable the current licences to be viewed. This revised Blast Management Plan was submitted for approval to DPE on 28 July 2020. After incorporating DPE feedback, the BMP was resubmitted for approval on 9 July 2021 and was approved on 20 July 2021. No further action required.
Sch 3 Cond 18(a)	Tenant and landowner on mine owned land be re-notified of any health risks associated with such exceedances in accordance with the notification requirements under schedule 4 of this consent; at least 5 yearly (i.e. 2020).	MTW has reviewed notification methods. For mine owned properties, each residential tenancy is renewed every 12 months with the Mine Dust and You Factsheet included with all new leases and lease renewals.
Sch 3 Cond 18(c)	MTW's TEOM's are located in positions that are representative of privately owned properties. The TEOM results should be utilised to calculate results for the closest tenant to be available should a regulator, tenant or landholder request this data.	MTW engaged an air quality consultant to clarify whether extrapolation from the air quality monitoring network data provided representative data to inform tenants of the particulate emissions at their residence or if additional monitoring was required. This engagement and review identified that in general the monitoring network was well positioned around the mine to adequately monitor particulate levels at occupied mine-owned residences. It was however recommended to install an additional PM10 monitor in the vicinity of one tenanted property to enable the provision of representative particulate data at that location. This additional PM10 monitor has been installed and the monitor is logging data.
Sch 3 Cond 19(c)	Ensure equipment downtime logging includes all environmental alerts.	Equipment downtime is currently categorised for "Dust" and "Environment". MTW have investigated the need for additional downtime categories in 2020 and although not deemed required, consider that it would be beneficial for increased clarity in reporting and for internal tracking purposes. MTW have implemented an additional "Noise" category in 2021. No further action required.
Sch 3 Cond 19(d)	Process to co-ordinate the air quality management on site with the air quality management at nearby mines (including the Mt Thorley, Bulga, Wambo and Hunter Valley Operations mines) to minimise any cumulative air quality impacts is formalised and included in next revision to AQMP as per condition Sch 3 Cond 20f below.	MTW has updated the inter-site communications protocol for environmental management within the AQMP, to minimise the cumulative air quality impacts with neighbouring mines and submitted to DPE for approval on 13 November 2020. After incorporating DPE feedback, the AQMP was resubmitted for approval on 9 July 2021 and was approved on 20 July 2021.
Sch 3 Cond 19(d)	Document protocols to minimise the cumulative air quality with neighbouring mines within the AQMP	MTW has updated the inter-site communications protocol for environmental management within the AQMP, to minimise the cumulative air quality impacts with neighbouring mines and has submitted to DPE for approval on 13 November 2020. After incorporating DPE feedback, the AQMP was resubmitted for approval on 9 July 2021 and was approved on 20 July 2021.

CONTINUAL IMPROVEMENT RECOMMENDATIONS		
Ref	**Hansen Bailey Recommendation**	**MTW Progress**
Sch 3 Cond 27(b)(ii)	Progress the SLR recommendations in the annual Stream Health and Channel Stability report.	MTW is committed to progressing the recommendations in the annual Stream Health and Channel Stability report regarding observed erosion near monitoring points. This will commence with a preliminary environmental constraints review (cultural heritage, ecology, works near watercourse) during the 2022 Annual Review period to inform the scope of any further works.
Sch 3 Cond 27(b)(iii)	The recommendations in the 2019 Annual Groundwater Review conducted by SLR Consulting should be progressed: • MTW changed its sampling methodology during the 2019 reporting period following recommendations in the 2018 review. It is recommended that a review of the trigger be undertaken in light of the revised sampling methodology. • Further investigation into the ground conditions, bore construction and loggers at PZ7S and PZ7D is recommended. • Grab samples have been taken for monitoring bores WOH1239A, WOH2141A, WOH2153A, WOH1254A, WOH2155A, WOH2156A, WD622P, MBW02 and MBW03 within the network. This approach is not in line with industry standards and may not provide a representative water quality sample. The justification for this methodology should be reviewed to determine if more suitable methods (i.e. full purge or low flow) can be applied. A review into the requirement of these bores for the collection of water quality data for the WMP should be undertaken. If it is found that the continued collection of water quality data is required from a bore and suitable sampling methods cannot be adopted, then bore rectification works should be considered. • A review of the construction details and lithological logs for each bore should be undertaken to confirm that each bore is targeting the Blakefield Seam." At the next Annual Groundwater Review, bore GW98MTCL2 is reviewed and discussed in the AR.	MTW has reviewed the triggers and submitted the changes in the 2020 Water Management Plan revision. After incorporating DPE feedback, the WMP was resubmitted for approval on 31 October 2021 and was approved on 15 November 2021. MTW engaged a consultant to conduct a review of the groundwater monitoring network in 2021 to help ensure all monitoring infrastructure at the site is fit for purpose. The review identified that a number of bores required field investigations to determine bore condition. In field investigations were undertaken for these bores in July 2021. A review of bore construction details and lithology was also undertaken and no issues with the bores targeting the Blakefield seem were identified. MTW's environmental monitoring contractor revised its sampling methodology in 2019, based on the recommendations of the 2018 Annual Groundwater Review. The methodology changed from grab samples for quarterly sampling to full pump or purge method prior to sampling wherever possible and to either point sampling or hydrasleeve sampling where required. Previously purging was generally only undertaken for comprehensive annual sampling. Note: Hydrasleeves are generally used for sampling if bores are too deep to pump effectively and their minimum diameter is 50mm. For bores which are too deep to pump and with a smaller diameter, the use of a point sampler allows a sample to be taken without too much disturbance of the water column. Purge and return is used when a bore's recharge rate is such that it would take a considerable time for re-charge to occur (i.e. day(s) and with some weeks) or if there is insufficient water in the bore to pump effectively. Pumping is used when the recharge rate is such that three bore volumes can be removed in a reasonable time (within 4 hours or so).
Sch 3 Cond 28	Adding a table to Section 4 of the Biodiversity MP summarising the specific ecosystem/species credit obligations and where they are being met across each offset property to confirm all credit obligations are being met by the offset package. At next modification, to ensure compliance, consider seeking to amend the mechanism as NSW Biodiversity Offsets Policy for Major Projects no longer applies (in this and subsequent relevant conditions).	After consultation with DPE, MTW lodged a modification application to DPE on 5 May 2021 to address the biodiversity credit requirement (SSD-6464 MOD1). The modification application is in progress with DPE and will continue in the 2022 Annual Review period.
Sch 3 Cond 32	Collect attributes as part of monitoring include additional measures such as stem classes and groundcovers. Given data is available, suggest adding some of these to the performance criteria or provide discussion on using data to aid in adaptive mgt e.g. stem class count threshold to aid in determining whether future thinning actions are required to increase vegetation in groundcover.	MTW added detail to the Trigger, Response and Action table in a draft update to the BMP by 13 November 2020. The updated BMP will be submitted post the determination of the biodiversity modification (SSD-6464 MOD1). In the meantime, monitoring is being undertaken to collect the attributes specified in the audit action.

CONTINUAL IMPROVEMENT RECOMMENDATIONS		
Ref	**Hansen Bailey Recommendation**	**MTW Progress**
Sch 3 Cond 36(e)	Implement the monitoring reports recommendations for the restoration of WSW and generally the Biodiversity Offset Area (BOA)s including: Habitat restoration monitoring for the southern and northern BOAs (Niche 2018). • A more finely detailed assessment of management zones (Warkworth Sands Grassland (Management Zones 2 and 4) be undertaken in order to target management works appropriately; • Direct seeding of grassland areas may be required; and • An assessment of the canopy recruitment at each transition site should be undertaken to determine if further planting or seeding is required. Vegetation and habitat monitoring for the Goulburn and Condon View BOAs (Niche 2016 and 2018). • Management intervention involving increased weed management should be considered to prevent weed incursions impacting on vegetation; and • F\or intensive management including intensive weed would be needed to assist in regeneration. Provide information relating to salinity in Biodiversity Management Plan or link to Plan where this is addressed.	Monitoring report recommendations to be implemented in monitoring period 2022 (2020 monitoring already completed). BMPs were updated to include salinity information by 13 November 2020.
Sch 3 Cond 39	Progress and complete conservation agreement relating to Wollombi Brook Aboriginal Cultural Heritage Conservation Area prior to entering the area beyond the "Proposed Initial Mining Area" west of Lot 1/2 DP 124545.	MTW has two Aboriginal Cultural Heritage Conservation Areas (ACHCA) to conserve under it's development consents – the Wollombi Brook ACHCA (WBACHCA), and the Loders Creek ACHCA (LCACHCA). MTW provided BCD (now Heritage NSW) with a draft Conservation Agreement for the WBACHCA in 2019, continued consultation during 2020 and 2021, provided an updated WBACHCA draft Conservation Agreement in August 2021, and an updated draft Conservation Agreements for LCACHCA and WBACHCA in December 2021. MTW submitted signed conservation agreements for LCACHCA and WBACHCA on 22 February 2022, requesting execution by the relevant Minister,and continues to engage with Heritage NSW towards the completion and registering of the WBACHCA and LCACHCA conservation agreements in the 2022 Annual Review period.
Sch 3 Cond 42	No reports were available for the first and second salvages (defined in Table A of **Appendix E**) were available at the time of this IEA. Recommend these are finalised asap and submitted to BCD to update AHIMS Register.	While formal salvage reports were not developed at the time of these salvages, MTW can confirm that the salvages were undertaken in accordance with the methodology outlined in the sites ACHMP. All salvage activities were undertaken in consultation with the CHWG. During the 2020 Annual Review period, MTW engaged a suitably qualified archaeologist to complete the salvage reports and ensured the site cards associated with the above-mentioned works were updated with AHIMS. No further action required.
Sch 3 Cond 43(b)	• Original GDP forms and spreadsheet are updated following field inspection by Environmental team to confirm that all GDPs actions are completed and signed off. • A requirement of the AHMP is for the long-term management of Aboriginal Objects. The objects are in storage at HVO. A new care agreement has been approved with OEH, 26 April 2019, and communicated to the Registered Aboriginal Parties in October 2019, however the objects are yet to be relocated. Recommend this is progressed.	During the 2020 Annual Review period, MTW relocated the Aboriginal Objects in accordance with the recent Care Agreement from OEH. No further action required.

CONTINUAL IMPROVEMENT RECOMMENDATIONS		
Ref	**Hansen Bailey Recommendation**	**MTW Progress**
Sch 3 Cond 46(d)	• Add labels for the RAAF Base Bulga, Great Northern Road, the Brickhouse and Springwood Homestead to figures in the HHMP at next review. • Action recommendations from '*Archaeological Investigations of the Former RAAF Base Bulga*' report dated March 2018 and report on in Annual Review. • Action recommendations from '*Mount Thorley Warkworth Historic Heritage Management Plan 2019 Compliance Audit Inspection'* in the next period and report on in Annual Review.	MTW will include the labels for the relevant historic heritage sites in the next review of the sites Historic Heritage Management Plan in 2022. MTW has developed a project schedule and budget to progress the recommendations outlined in the sites Historic Heritage Management Plan and each Conservation Management Plan for its known historic heritage sites during the 2021 and the 2022 Annual Review period.
Sch 3 Cond 52(a)	Amend internal Procedures and CRO Work Instruction to refer to revised '*Lighting and Management Leaders document'* and training rolled out to relevant personnel.	The *Lighting and Management - Leaders and Mining Supervisors* procedure is available on the MTW document control system for use at MTW. No further action required.
Sch 3 Cond 52(b)	Additional plantings designed and undertaken to reduce view at the third crossing into Mt Thorley.	MTW will review the location of this recommendation for additional plantings, and action if visual screening is deemed necessary. The location will be reviewed by 30 April 2022 and plantings completed during the 2022 Annual Review period.
Sch 3 Cond 56	Update rehabilitation procedures to include requirements of biosolids guidelines. Recommend fly ash and other waste conditions from EPL are also included. As per **Appendix F**, the current weed management controls on site is generally acceptable and in accordance with key guidelines. However, successfully management and tracking of improvement in these areas against performance and long term completion criteria may require more intensive control actions. Potential options for investigation may include: Additional trials areas and analysis of spoil compost Vs no compost VS topsoils in weed cover and density;	The requirements of Biosolids Guideline and requirements for other wastes listed in EPL will be added to rehabilitation procedures as required by 30 June 2022. Results from topsoil trials, where compost was not added to some plots, indicate that native vegetation establishment was better on plots where compost was not added. Procedures changed to apply low nutrient compost or no compost to rehabilitation areas that have been spread with topsoil. Additional trials will be conducted during 2022 to investigate the effects on native vegetation establishment/weed competition in spoil/compost areas with the use of different compost types. Experience to date indicates that higher nutrient composts perform better in spoil/compost applications where the spoil is low in nutrients and the weed seed load is low.
Sch 3 Cond 58(d)	The TARP is shown in Table 44 of the MOP, and does not clearly delineate between tier one and tier two trigger values, recommend this is amended to clarify. Within the MOP, it is also unclear how the rehabilitation of the site is integrated with the implementation of the biodiversity offset strategy, the next amendment should clarify this.	Completed 13 November 2020. MOP Amendment C Sections 5.2.2 and 9 updated to address this audit action. No further action required.
Sch 3 Cond 58(g)	Although the MOP is approved, no relevant level of mine closure strategy is included. Recommend this is undertaken and included at next Amendment.	Completed 13 November 2020. MOP Amendment C Section 1.6 updated to Include mine closure strategy items listed in Sch 3 Cond 58(g), which addresses this auit recommendation. No further action required.
Sch 4 Cond 2(a)	Tenants are advised of the potential health and amenity impacts associated with living on the land, and provided a copy of the NSW Health fact sheet regularly (e.g. five yearly).	MTW has reviewed notification methods. For mine owned properties, each residential tenancy is renewed every 12 months with the Mine Dust and You Factsheet included with all new leases and lease renewals.
Sch 5 Cond 1	As proposed, prepare a risk based environmental training program focusing on high priority areas. Program should be completed regularly as toolbox talks (or other preferred methods) and training recorded.	MTW undertakes environmental training for new starters and at induction and maintains records of that training. Additional role specific work instructions, Trigger Action Response Plans, or competency assessments have been developed for other areas (e.g. blast management plan, boundary dam management) to manage high priority areas.

CONTINUAL IMPROVEMENT RECOMMENDATIONS		
Ref	**Hansen Bailey Recommendation**	**MTW Progress**
Sch 5 Cond 9(d)	Northern Biodiversity Area The current weed management controls on site is generally acceptable and in accordance with key guidelines. However, successfully management and tracking of improvement in these areas against performance and long term completion criteria may require more intensive control actions. Potential options for investigation may include: • A digitised register of application area linked to proposed return frequency prior to consecutive seed set may further assist in medium to long term planning of weed control on site; • Trials of dedicated repeat control Vs non control to determine effort reward improvements; and • Trail areas of scalping, burning and or supplementary native seeding in BOAs with significant pasture and understorey weed infestations. To ensure year 15 performance targets of 75% survival and minimum number of tube stock are met, increased number of plantings are proposed. These additional plantings should reflect the survival rates for species diversity across each of the different structural layers of the WSW.	Scalping trials have been included in the 2020 planting strips at the NBA. Native grass seeding has also been included prior to tube stock planting at the NBA to increase species diversity in the groundcover. Increased number of planting are planned, draft BMP was updated to include this updated mapping by 13 November 2020. No further action required.
EPL 1376		
P1.3	Update Water and Land Table as follows: Location Description for Discharge to pipe (EPA Identification No. 24), is required by Special Condition E2, not E3. Include mine name where discharge of mine water will occur to**.**	This has been completed during a licence variation/licence review process and the the Water and Land table has been updated. There is no longer a Special Condition E2 in current licence.
O4	Inspection / maintenance forms required under this condition be updated to specifically refer to ponding (O4.3).	MTW has updated the sites effluent management system quarterly inspection checklist to include ponding. No further action required.