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SIX MONTHLY SUBSIDENCE IMPACT REPORT

Tahmoor North, Western Domain Longwalls West 1 – West 4

1 April 2021 – 20 October 2021

Report 4 – November 2021

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Document Control

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Executive Summary

This report is the fourth six-monthly report to be submitted since the commencement of extraction of Longwall West 1 (LW W1), in accordance with the requirements of the Longwall West 1 and West 2 (LW W1-W2) Extraction Plan and the Longwall West 3 and West 4 (LW W3-W4) Extraction Plan. The reporting period of this report is from 1 April 2021 to 20 October 2021.

LW W1 extraction was completed on 6 November 2020, and Longwall West 2 (LW W2) extraction was completed on 17 June 2021. Longwall West 3 (LW W3) commenced extraction on 13 September 2021. As of 20 October 2021, 295 metres of LW W3 had been extracted.

During the reporting period, observed subsidence along the centreline of LW W2 is greater than LWW1 but current trends indicate that observed subsidence will be less than predicted subsidence and no trends of definitive valley closure have been evident.

There were seven (7) environmental aspects that were associated with Trigger Action Response Plans (TARPs) triggers, as well as a number of impacts to roads and built structures that required remediation. All triggers have been reviewed by the Environmental Response Group / Structural Response Group / specialist to determine if any further action is required. These TARP triggers included:

- Pool Water Level TARP – Levels 2 and 3 triggered due to pool water level reduction in Cedar Creek (pool CR14) and Stonequarry Creek (pool SG2). As the changes are relatively small and likely to be related to the prevailing below average rainfall conditions in combination with a slight increase in losing conditions, no further actions were undertaken. Tahmoor Coal is reporting on pool water level on a 3-monthly basis to DPIE;
- Groundwater Quality TARP – Levels 2, 3 and 4 triggered due to water quality results exceeding trigger levels, including lithium at P13C, Strontium at GW105228 and Barium at GW115860. The Lithium trigger level at P13C was questioned due to its conservative and very sensitive nature to any increase in Lithium concentration, and was revised in August 2021. No further actions were undertaken;
- Groundwater Bore Level TARP – Levels 2, 3 and 4 triggered during the reporting period, however a trend in groundwater recovery was evident. This Level 4 TARP trigger is a continuation of the TARP notification to DPIE on 30 December 2020. Groundwater bore level will continue to be monitored in accordance with the LW W3-W4 Water Management Plan, and Tahmoor Coal will continue to provide 3-monthly reports to DPIE for surface water and groundwater;
- Shallow Groundwater Pressures TARP – Levels 2 and 4 triggered during the reporting period, however a trend in groundwater recovery was evident. This Level 4 TARP trigger is a continuation of the TARP notification to DPIE on 30 December 2020. Groundwater bore level will continue to be monitored in accordance with the LW W3-W4 Water Management Plan, and Tahmoor Coal will continue to provide 3-monthly reports to DPIE for surface water and groundwater;
- Deep Groundwater Pressures TARP – Levels 2 and 3 triggered during the reporting period. Groundwater monitoring will continue under the existing monitoring program;

- Aquatic Ecology TARP – Level 2 Trigger for reduction in family richness of macroinvertebrates and OE50 score at Site MC8 (Matthews Creek). As these changes are most likely attributed to natural variation, no further actions are required;
- Historical Heritage TARP – Level 3 Trigger for impacts to sandstone culvert at 88.400 km and 88.980 km. These impacts included cracking and minor spalling. Tahmoor Coal is currently seeking expert advice from a heritage stonemason regarding remediation of the sandstone blocks, and remediation will be undertaken after the full effects of LW W3-W4 have been completed; and
- Main Southern Railway TARP – Blue Trigger at Ballast Top Subway (86.838 km) due to minor closure across the abutments of the structure related to a continuation of pre-existing conditions. As these impacts were unlikely to be mining induced, the trigger level was increased.

During the reporting period, there was one exceedance of environmental performance measures or indicators, as adopted from DA 67/98 Modification 5 or the LW W1-W2 Extraction Plan Approval conditions. Cracking on sandstone culverts at 88.400 km and 88.980 km resulted in exceedance of subsidence performance indicators for 'other Aboriginal and heritage sites'. DPIE and Heritage NSW were notified of this exceedance on 21 September 2021. Tahmoor Coal will complete remediation after the full effects of LW W3-W4 have been completed.

Table of Contents

List of Figures

List of Tables

1 Introduction

This Six-Monthly Subsidence Impact Report fulfils the reporting requirement of the Extraction Plan approved for Longwall West 1 and West 2 (LW W1-W2) and Longwall West 3 and West 4 (LW W3-W4) and covers the period of 1 April 2021 to 20 October 2021.

This report provides the Secretary of NSW Department of Planning, Industry and Environment (DPIE) with a summary of subsidence and environment monitoring results, subsidence impacts and management actions undertaken during the reporting period.

In addition, this report forms part of the three-monthly reporting for surface water and groundwater following an investigation of Level 4 TARP triggers relating to depressurisation of groundwater aquifers. This reporting requirement was requested by DPIE following the notification of these TARP triggers. This report includes a review and interpretation of monitoring data, assessment against performance measures and performance indicators for surface water and groundwater, and any recommendations in relation to ongoing monitoring or corrective actions (refer to **Section 4.2, Appendix B,** and **Appendix C**).

1.1 Background

Tahmoor Coal Mine (Tahmoor Mine) is an underground coal mine located approximately 80 kilometres (km) south-west of Sydney between the towns of Tahmoor and Bargo, New South Wales (NSW) (refer to **Figure 1-1**). Tahmoor Mine produces up to three million tonnes of Run of Mine coal per annum from the Bulli Coal Seam. Tahmoor Mine produces a primary hard coking coal product and a secondary higher ash coking coal product that are used predominantly for coke manufacture for steel production. Product coal is transported via rail to Port Kembla for Australian domestic customers and export customers.

Tahmoor Mine has been operated by Tahmoor Coal Pty Ltd (Tahmoor Coal) since Tahmoor Mine commenced in 1979 using bord and pillar mining methods, and via longwall mining methods since 1987. Tahmoor Coal is a wholly owned entity within the SIMEC Mining Division of the GFG Alliance group.

Tahmoor Coal has previously mined 34 longwalls to the north and west of Tahmoor Mine's current pit top location. The current mining area, the 'Western Domain', is located north-west of the Main Southern Rail between the townships of Thirlmere and Picton (**Figure 1-1**). The Western Domain is within the Tahmoor North mining area and is within Mining Lease (ML) 1376 and ML 1539.

Extraction Plan approval for the first two longwalls in the Western Domain (LW W1-W2) was granted by DPIE on 8 November 2019. Tahmoor Coal subsequently prepared an Extraction Plan for the next two longwalls in the Western Domain (LW W3-W4)**.** Extraction Plan approval was granted by DPIE on 13 September 2021. A copy of both Project Approvals is available on the Tahmoor Coal website (http://www.simec.com/mining/tahmoor-coking-coal-operations/). The Study Areas for both extraction plans are provided in **Figure 1-2** and **Figure 1-3**.

Longwall West 1 (LW W1) was the first longwall to be extracted in the Western Domain and was completed on 6 November 2020. The extraction of Longwall West 2 (LW W2) commenced on 7 December 2020 and was completed on 17 June 2021. Longwall West 3 (LW W3) commenced on 13 September 2021 and as of 20 October 2021, 295 metres of LW W3 had been extracted. The active subsidence area of LW W3 for 17 October 2021 (259.1 m extracted) is illustrated in **Figure 1-4**.

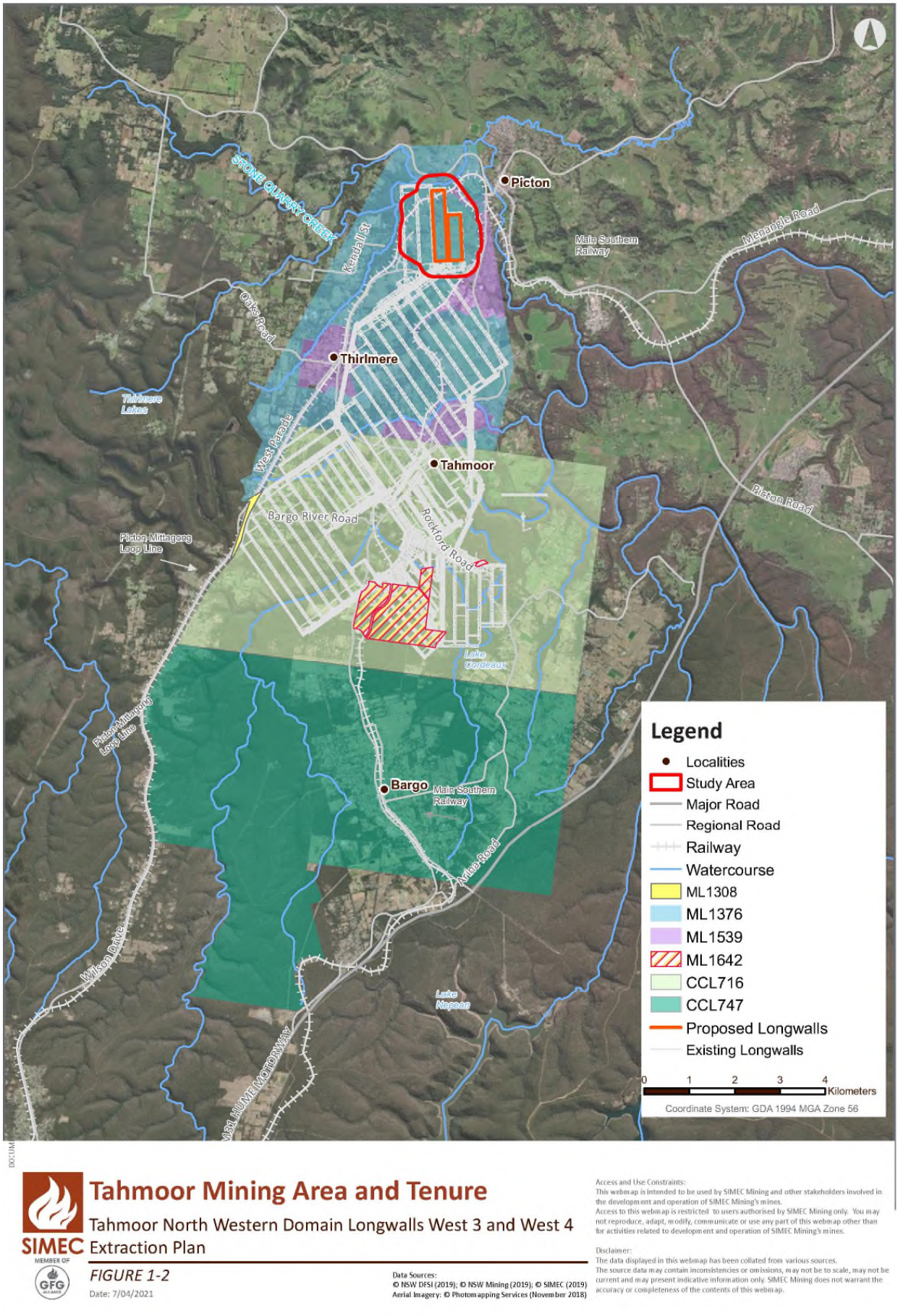

Figure 1-1 Tahmoor Mine Area and Tenure (source: LW W3-W4 Extraction Plan)

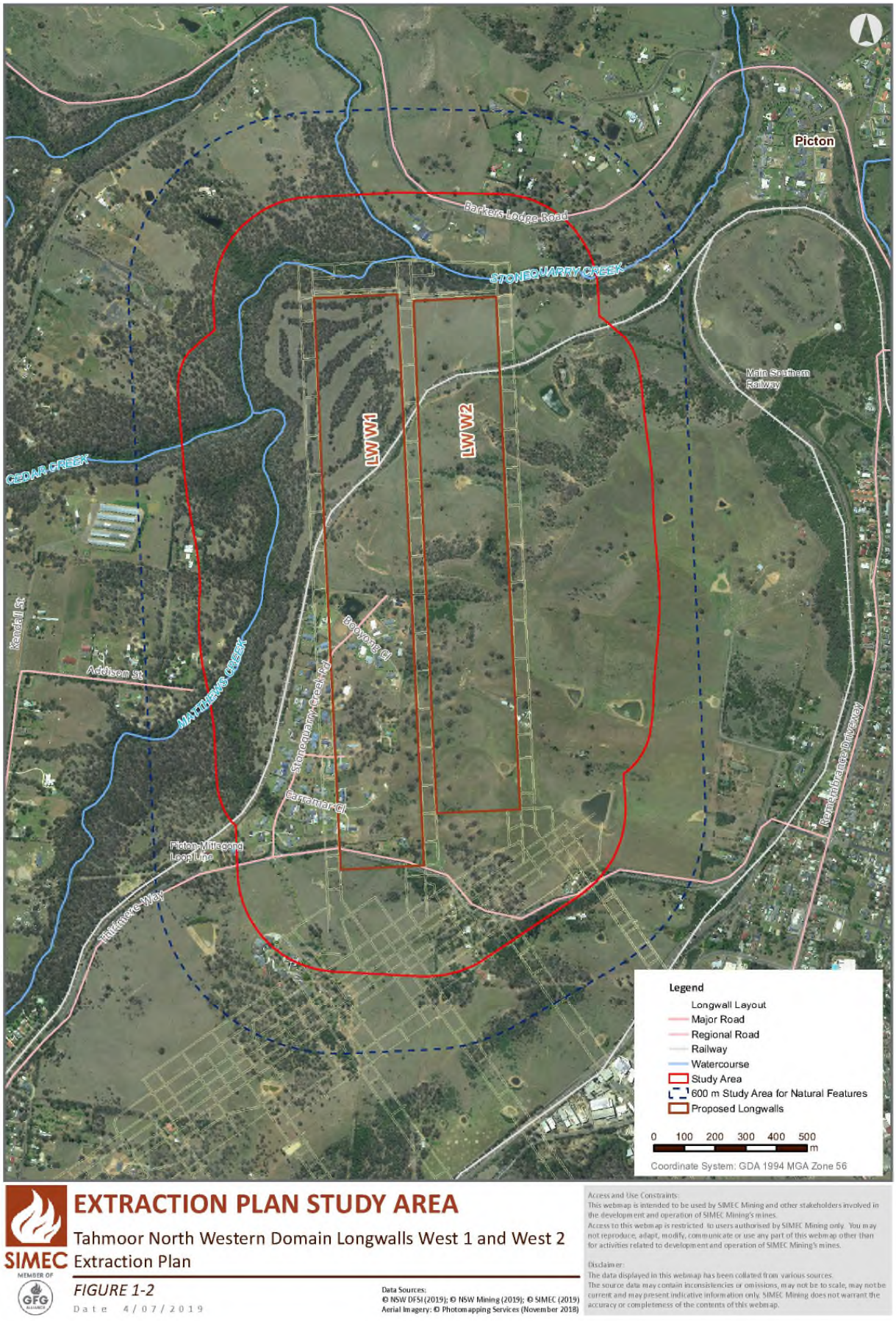

Figure 1-2 LW W1-W2 Extraction Plan Study Area (source: LW W1-W2 Extraction Plan)

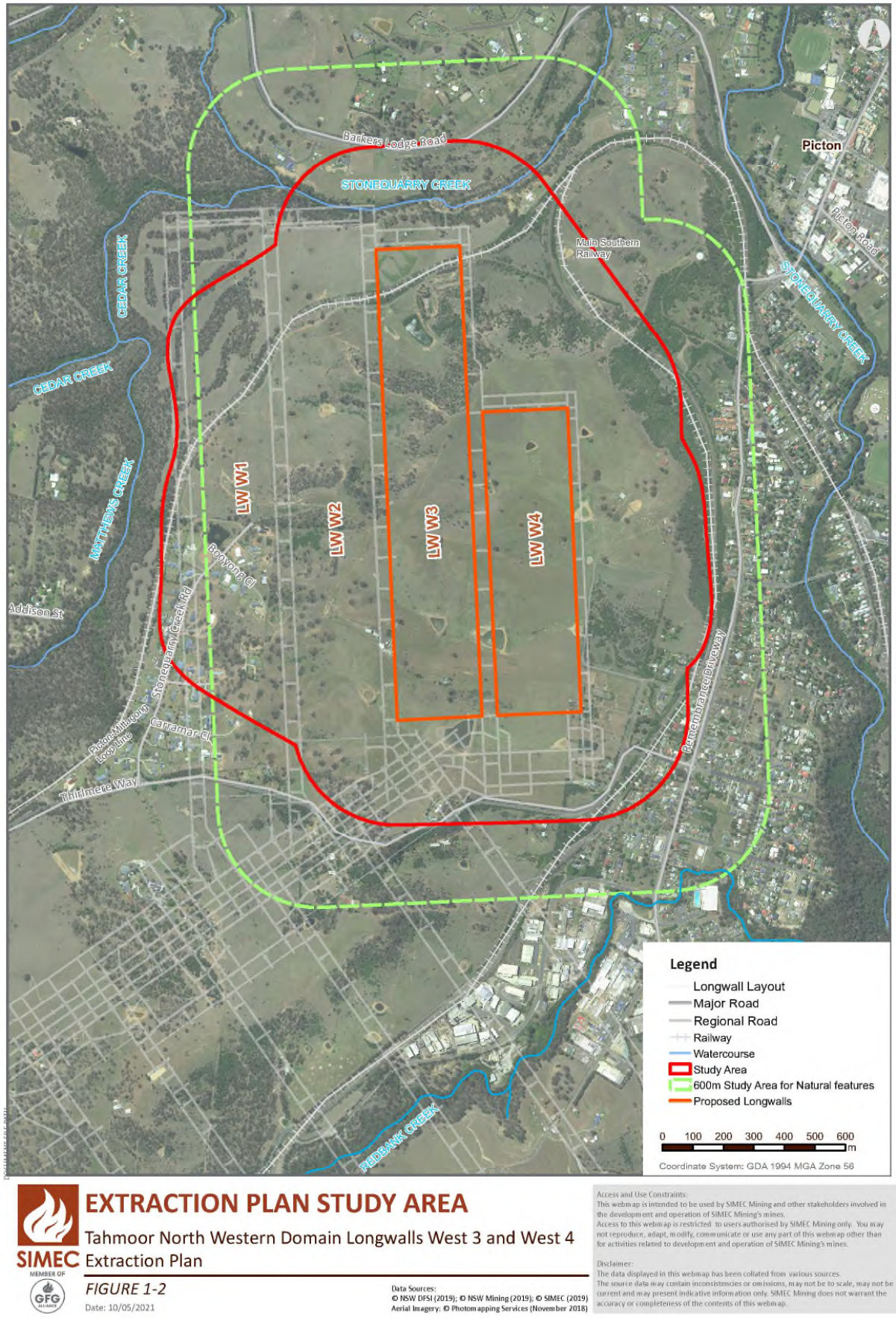

Figure 1-3 LW W3-W4 Extraction Plan Study Area (source: LW W3-W4 Extraction Plan)

Figure 1-4 LW W3 Zone of Active Subsidence for 17 October 2021

1.2 Purpose

The purpose of this report is to address the requirements for six-monthly reporting on impacts and environmental monitoring results associated with the extraction of LW W1-W4. These requirements are outlined in Section 6.1.4 of the LW W1-W2 Extraction Plan and **Section 6.1.4** of the LW W3-W4 Extraction Plan, which are derived from the Section 6 of the DPIE *Draft Guidelines for the Preparation of Extraction Plans V5* (DPE, 2015).

The requirements for this report are listed in **Table 1-1** below, together with the cross-reference where the requirements are addressed in this report.

Table 1-1 Six Monthly Subsidence Impact Report Requirements

Requirement No.	Requirement Description (as per Section 6.1.2 of the LW W1-W2 Extraction Plan and Section 6.1.2 of the LW W3-W4 Extraction Plan)	Section Addressed
1	A comprehensive summary of all impacts, including a revised characterisation according to the relevant TARP(s);	Section 2.1
2	Any proposed actions resulting from triggers being met in the TARP, or other actions;	Section 2.2
3	An assessment of compliance with all relevant performance measures and indicators; and	Section 3
4	A comprehensive summary of all quantitative and qualitative environmental monitoring results, including landscape monitoring, water quality data, water flow and level data, piezometer readings.	Section 4

This report will be distributed to the stakeholders listed in **Section 5.4**.

1.3 Scope

The Tahmoor Coal Environmental Management Structure, according to the LW W3-W4 Extraction Plan, is shown in **Figure 1-5**.

The Extraction Plan Study Areas for LW W1-W2 and LW W3-W4 are defined as the surface area that is likely to be affected by the extraction of LW W1-W2 and LW W3-W4 from the Bulli Coal Seam. These Study Areas have been calculated by combining the areas bound by the following limits:

- The predicted limit of vertical subsidence, taken as the 20 millimetre (mm) subsidence contour resulting from the extraction of LW W1-W2 and LW W3-W4; and
- A 35^{o} angle of draw line from the limit of proposed extraction for LW W1-W2 and LW W3-W4.

The Study Areas are illustrated in **Figure 1-2** and **Figure 1-3**.

As part of the LW W1-W2 Extraction Plan and LW W3-W4 Extraction Plan, a set of management plans were prepared to manage particular environment or built features with the LW W1-W2 Study Area and the LW W3-W4 Study Area, which consists of the following:

- Water Management Plan;
- Land Management Plan;
- Biodiversity Management Plan;
- Heritage Management Plan;

- Built Features Management Plan, with a number of sub-plans to manage potential environmental consequences to infrastructure and specific building structures as a result of secondary extraction; and
- Public Safety Management Plan.

The overall framework for subsidence monitoring and management of impacts of the LW W1-W2 Extraction Plan and the LW W3-W4 Extraction Plan is provided in the relevant Subsidence Monitoring Programs.

It is noted that the management requirements for public safety are covered in the Built Features Management Plan and the Land Management Plan.

Monitoring of environmental and built features has been completed by Tahmoor Coal and its consultants in accordance with management plans listed above.

This report is the fourth six-monthly report to be submitted since the commencement of extraction of LW W1, in accordance with the requirements of the LW W1-W2 Extraction Plan and the LW W3-W4 Extraction Plan. The reporting period of this report is from 1 April 2021 to 20 October 2021.

Table 1-2 summarises the monitoring and reporting completed during the reporting period, as well as the timeframe of data reviewed for each monitoring component.

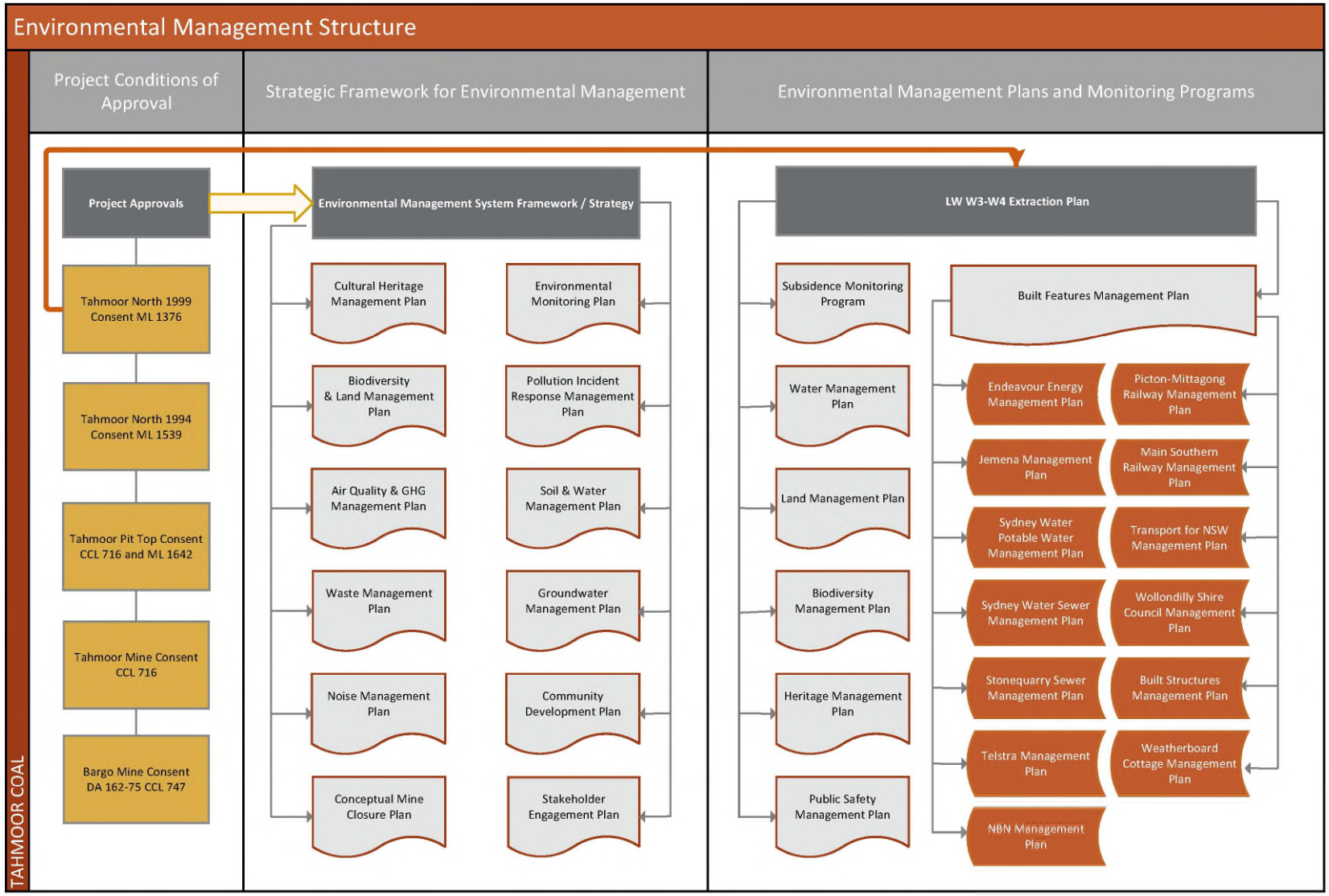

Figure 1-5 Overview of Environmental Management Structure for Tahmoor Coal (source: LW W3-W4 Extraction Plan)

Table 1-2 Monitoring and Reports Reviewed for this Reporting Period

Management Plan	Aspect	Feature	Monitoring Completed By	Monitoring Reported by	Monitoring Reports Completed during this Reporting Period	Reporting Frequency	Reference
Subsidence Monitoring Program	Subsidence	General subsidence	• SMEC • Building Inspection Service • Comms Network Solutions	Mine Subsidence Engineering Consultants (MSEC)	Subsidence Monitoring Reports for LW W2 (End of Panel Report, Report #28) and LW W3 (Latest Report, Report #3) reviewing data collected from 22 April 2021 to 20 October 2021.	Weekly	Appendix A (referenced reports only)
Water Management Plan	Surface Water	Stonequarry Creek flow	• WaterNSW	• Hydro Engineering and Consulting (HEC)	Surface Water Monitoring Report reviewing data collected from 1 April to 30 September 2021.	Monthly, summarised in a 6-monthly report	Appendix B
		Pool water level	• Hydrometric Consulting Service (HCS)				
		Stream water quality					
		Natural drainage behaviour	• GeoTerra • Brienan Environment and Safety	• GeoTerra • Brienan Environment and Safety	Creek Monitoring Reports reviewing data collected from 19 April 2021 to 28 June 2021 for Longwall West 2, and 23 September to 27 October 2021 for Longwall West 3.	Monthly	(Available on request)
	Groundwater	Groundwater quality	• GeoTerra	• SLR	Groundwater Monitoring Report reviewing data collected from 1 May 2021 to 31 October 2021.	Monthly, summarised in a 6-monthly report	Appendix C
		Groundwater bore level	• GeoTerra				
		Shallow groundwater pressures					
		Deep groundwater pressures	• Groundwater Exploration Services				
		Groundwater Inflow	• GeoTerra		Included in 6-monthly Groundwater Monitoring Report reviewing data collected from 1 May 2021 to 31 October 2021.	6-Monthly	

Land Management Plan	Landscape	Cliff lines	• Douglas Partners	• Douglas Partners	Geotechnical Monitoring Reports reviewing data collected from 21 April 2021 to 1 November 2021.	Monthly	(Available on request)
		Steep Slopes					
		Surface cracking (excluding railway corridor)					
		Dams					
		Dams	• Bloor Rail • Newcastle Geotechnical	• MSEC • Bloor Rail • Newcastle Geotechnical	Picton-Mittagong Loop Line (PMLL) Weekly Detailed Reports for LW W2 (Report #21-31) and LW W3 (Report #1-6) reviewing data collected from 21 April 2021 to 19 October 2021.	Weekly	Appendix F (referenced reports only)
		Dams	• Building Inspection Service (BIS)	• BIS	Dam inspection reports reviewing data collected from 23 April 2021 to 21 October 2021.	Weekly	(Available on request)
	Agricultural Land	Agricultural Land	• Tahmoor Coal • BIS	• BIS	Agricultural Subsidence Monitoring Reports reviewing data collected from 27 April 2021 to 29 October 2021.	Monthly	(Available on request)
Biodiversity Management Plan	Aquatic Ecology	Macroinvertebrates	• Niche	• Niche	Aquatic Ecology Monitoring Report for Autumn 2021. Preliminary Aquatic Ecology Monitoring Report for Spring 2021.	Six Monthly	Appendix D
	Terrestrial Ecology	Amphibians	• Niche	• Niche	Terrestrial Ecology Monitoring Report for Autumn 2021.	Six Monthly	(Available on request)
		Riparian Vegetation					
Heritage Management Plan	Aboriginal heritage	Rock shelters	• GeoTerra	• GeoTerra	Creek Monitoring Reports reviewing data collected from 19 April 2021 to 28 June 2021 for Longwall West 2.	Monthly	(Available on request)
			• EMM Consulting	• EMM Consulting	LW W2 End of Panel Report for Aboriginal Heritage.	Once after LW W2 Extraction completed.	Appendix E

		Grinding Grooves	• SMEC	• MSEC	Subsidence Monitoring Reports for LW W2 (End of Panel Report, Report #28) and LW W3 (Latest Report, Report #3) reviewing data collected from 22 April 2021 to 20 October 2021.	Weekly	Appendix A
			• EMM Consulting	• EMM Consulting	LW W2 End of Panel Report for Aboriginal Heritage.	Once after LW W2 Extraction completed.	Appendix E
	Historical heritage	Railway culverts	• Newcastle Geotechnical	• Newcastle Geotechnical	Picton-Mittagong Loop Line (PMLL) Weekly Detailed Reports for LW W2 (Report #21-31) and LW W3 (Report #1-6) reviewing data collected from 21 April 2021 to 19 October 2021.	Weekly	Appendix F (referenced reports only)
			• EMM Consulting	• EMM Consulting	LW W2 End of Panel Report for Historical Heritage.	Once after LW W2 Extraction completed.	Appendix E
Built Features Management Plan	Built Features	Electricity Infrastructure	• SMEC • BIS • Comms Network Solutions	• MSEC	Subsidence Monitoring Reports for LW W2 (End of Panel Report, Report #28) and LW W3 (Latest Report, Report #3) reviewing data collected from 22 April 2021 to 20 October 2021.	Weekly	Appendix A (referenced reports only)
		Gas Infrastructure					
		Potable Water					
		Sewerage Infrastructure					
		Telecommunications					
		Local roads, bridges and culverts					
		Built Structures					
		Picton-Mittagong Loop Line	• Southern rail Services • Bloor Rail	• MSEC	PMLL Weekly Status Reports for LW W2 (Report #21-32) and LW W3 (Report #1-6) reviewing data collected from 21 April 2021 to 19 October 2021.	Weekly	(Available on request)

		Roads and Maritime Services (RMS) Infrastructure	• SMEC • Southern Rail Services • BIS	• MSEC	RMS Status Reports for LW W2 and LW W3 reviewing data collected from 21 April 2021 to 7 October 2021.	Monthly	(Available on request)
		Main Southern Railway (MSR)	• SMEC • Southern rail Services • Bloor Rail • BIS • Comms Network Solutions • Newcastle Geotech	• MSEC	MSR Weekly Status Reports for LW W2 (Report #21-39) and LW W3 (Report #1-6) reviewing data collected from 21 April 2021 to 19 October 2021.	Weekly	Appendix G (referenced reports only)
		Queen Victoria Memorial Home (QVMH)	• Veris • ENRS	• MSEC	QVMH Status Reports 1-3 for LW W2 reviewing data collected from 18 May 2021 to 1 July 2021.	Weekly (till end of LW W2)	(Available on request)
		Mill Hill	• SMEC • BIS	• MSEC	Mill Hill Status Report 1 for LW W2 reviewing data collected from 30 June 2021 to 14 July 2021.	Weekly (till end of LW W2)	(Available on request)

2 Overview of Impacts and Actions

2.1 Summary of Impacts

This section provides a comprehensive summary of all impacts during the reporting period, including a revised characterisation according to the relevant Trigger Action Response Plan (TARP)(s) (if required).

A summary of monitoring results for relevant TARP's is given in **Table 2-3**. Triggers that were activated are denoted in **Table 2-3** with colours defined in **Table 2-1** and **Table 2-2**. A full list of TARPs for environmental features that are applicable is provided in Appendix D of the LW W1-W2 Extraction Plan and Appendix D of the LW W3-W4 Extraction Plan.

Table 2-1 Risk Levels for Environmental Feature TARPs

Risk Level	Trigger Description
Level 1	Normal – Operations within predicted impacts.
Level 2	Within Prediction - Operations within predicted impacts but exceeds or potentially exceeds predictions.
Level 3	Almost Exceeds Prediction - Operations within predicted impacts but are likely to almost exceed predictions.
Level 4*	Exceeds Prediction - Operations exceed predicted impact.

Note: * Level 4 is only used in the Water Management Plan TARPs.

Table 2-2 Trigger Levels for Railway Features (applicable to Picton-Mittagong Loop Line and Main Southern Railway features)

Trigger Level	Trigger Description
Green	Observations within predictions. Operate as normal.
Blue	Observations outside predictions but within operating tolerance. Investigate cause. Some action may be required to prevent operating restrictions.
Yellow	Restrictions on operations. Action required. Appropriate speed restriction applied until altered to Green or Blue level.
Red	Stop trains until altered to Green or Blue level.

As all results during this report period are consistent with the current TARPs, a revision of the TARPs for environmental features is not considered necessary at this point in time.

Table 2-3 Summary of TARP Triggers for the Current Reporting Period

Aspect	Feature	Corresponding Management Plan and TARP	April 2021	May 2021	June 2021	July 2021	August 2021	September 2021	October 2021
Surface Water	Stonequarry Creek flow	Water Management Plan - Downstream reduction in catchment flow rate in Stonequarry Creek at Picton Gauging Station (GS212053)	NA - Assessment unable to be completed due to invalidation of current model calibration.[1]	NA - Assessment unable to be completed due to invalidation of current model calibration.[1]	NA - Assessment unable to be completed due to invalidation of current model calibration.[1]	NA - Assessment unable to be completed due to invalidation of current model calibration.[1]	NA - Assessment unable to be completed due to invalidation of current model calibration.[1]	NA - Assessment unable to be completed due to invalidation of current model calibration.[1]	NA - Assessment unable to be completed due to invalidation of current model calibration.[1]
	Pool water level	Water Management Plan - Impact to pool water level	No pool water level triggers occurred.	LEVEL 2 TRIGGERED[2] Surface water level triggers occurred at monitoring site SG (pool SG2) between 20 May 2021 – 23 August 2021.	LEVEL 2 TRIGGERED[2] Surface water level triggers occurred at monitoring site SG (pool SG2) between 20 May 2021 – 23 August 2021.	LEVEL 2 TRIGGERED[2] Surface water level triggers occurred at: • Monitoring site SG (pool SG2) between 20 May 2021 – 23 August 2021. • Monitoring site CB (pool CR14) between 20-24 July 2021 and 27 July – 4 August 2021	LEVEL 2 TRIGGERED[2] Surface water level triggers occurred at: • Monitoring site SG (pool SG2) between 20 May 2021 – 23 August 2021. • Monitoring site CB (pool CR14) between 27 July – 4 August 2021 and 6-24 August 2021.	LEVEL 2 TRIGGERED[3] Surface water level triggers occurred at: • Monitoring site SG (pool SG2) between 1-30 September 2021. • Monitoring site CB (pool CR14) between 9-12 September 2021. LEVEL 3 TRIGGERED[4] Surface water level triggers occurred at monitoring site CB (pool CR14) between 13-30 September 2021.	NA - Monitoring data for October 2021 to be summarised in next report.
	Stream water quality	Water Management Plan - Stream water quality impact	No surface water quality triggers occurred.	No surface water quality triggers occurred.	No surface water quality triggers occurred.	No surface water quality triggers occurred.	No surface water quality triggers occurred.	No surface water quality triggers occurred.	NA - Monitoring data for October 2021 to be summarised in next report.
	Natural drainage behaviour	Water Management Plan - Impact to pool level, natural drainage behaviour or overland connected flow	No impacts to natural drainage behaviour observed.	No impacts to natural drainage behaviour observed.	No impacts to natural drainage behaviour observed.	NR - No monitoring required this month.	NR - No monitoring required this month.	No impacts to natural drainage behaviour observed.	No impacts to natural drainage behaviour observed.
	Flood levels	Water Management Plan - Impact to flood levels	NR - Flood modelling required after completion of LW W4.	NR - Flood modelling required after completion of LW W4.	NR - Flood modelling required after completion of LW W4.	NR - Flood modelling required after completion of LW W4.	NR - Flood modelling required after completion of LW W4.	NR - Flood modelling required after completion of LW W4.	NR - Flood modelling required after completion of LW W4.
Groundwater	Groundwater quality	Water Management Plan – Groundwater quality at monitoring bores and private groundwater bores	POTENTIAL LEVEL 4 TRIGGERED[5] Groundwater quality triggers occurred in P13C (Li). LEVEL 2 TRIGGERED[7] Groundwater quality triggers occurred in GW105546 (Li).	POTENTIAL LEVEL 4 TRIGGERED[5] Groundwater quality triggers occurred in P13C (Li). LEVEL 2 TRIGGERED[7] Groundwater quality triggers occurred in P12A (pH), P12C (pH), P13C (Cu), P14A (Cu, Al), P14B (Al), P16A (Li), P16B (Fe), P17 (Al).	POTENTIAL LEVEL 4 TRIGGERED[5] Groundwater quality triggers occurred in P13C (Li). LEVEL 2 TRIGGERED[7] Groundwater quality triggers occurred in P12C (pH), P13A (Cu), P13C (Zn), P14B (Al), P14C (Zn), P14D (Zn, Ba), P16A (Zn), P16B (Fe, Zn), P16C (Zn), P17 (Al).	POTENTIAL LEVEL 4 TRIGGERED[5] Groundwater quality triggers occurred in P13C (Li). LEVEL 2 TRIGGERED[7] Groundwater quality triggers occurred in P12A (pH), P14A (Al), P16B (Fe, Mn, Sr), GW104090 (EC), GW105467 (Ba), GW105228 (Sr), GW072402 (Al), GW115860 (EC, Ba).	LEVEL 2 TRIGGERED[7] Groundwater quality triggers occurred in P14A (Al), P16B (Fe, Sr).	LEVEL 2 TRIGGERED[8] Groundwater quality triggers occurred in P12A (Li), P12B (Li), P14A (Al, Li), P16A (Li), P16B (Fe, Li).	LEVEL 3 TRIGGERED[6] Groundwater quality triggers occurred in GW105228 (Sr) and GW115860 (Ba). LEVEL 2 TRIGGERED[8] Groundwater quality triggers occurred in P12A (Fe), P12B (pH, Al), P12C (EC, Mn, Zn), P13C (Li), P15A (Sr), P15B (Sr), P15C (Fe, Sr), P15D (Fe, Sr), P16B (Fe, Zn), GW115860 (EC, Mn, Zn).

Aspect	Feature	Corresponding Management Plan and TARP	April 2021	May 2021	June 2021	July 2021	August 2021	September 2021	October 2021
	Groundwater bore level	Water Management Plan – Groundwater levels at monitoring bores and private groundwater bores	LEVEL 4 TRIGGERED[9] Water level trigger occurred at piezometers P12C, P13C, P16B and P16C.	LEVEL 4 TRIGGERED[9] Water level trigger occurred at piezometers P12C, P13C, P16B and P16C.	LEVEL 4 TRIGGERED[9] Water level trigger occurred at piezometers P12C, P13C, P16B and P16C.	LEVEL 4 TRIGGERED[9] Water level trigger occurred at piezometers P12C, P16B and P16C. LEVEL 2 TRIGGERED[11] Water level trigger occurred at piezometer P13C and GW105467.	LEVEL 4 TRIGGERED[9] Water level trigger occurred at piezometers P12C, P16B and P16C.	LEVEL 3 TRIGGERED[10] Water level trigger occurred at piezometers P12C and P16C. LEVEL 2 TRIGGERED[12] Water level trigger occurred at piezometers P13C and P16B.	LEVEL 3 TRIGGERED[10] Water level trigger occurred at piezometer P12C and P16C. LEVEL 2 TRIGGERED[12] Water level trigger occurred at piezometer P16B.
	Shallow groundwater pressures	Water Management Plan – Shallow groundwater pressures at VMPs TNC036, TNC040, and TNC034	LEVEL 4 TRIGGERED[13] Depressurisation trigger occurred at TNC36 (intakes 65, 97 and 169 mbgl) and WD01.	LEVEL 3 TRIGGERED[13] Depressurisation trigger occurred at TNC36 (intakes 65, 97 and 169 mbgl).	LEVEL 4 TRIGGERED[13] Depressurisation trigger occurred at TNC36 (intakes 65, 97 and 169 mbgl).	LEVEL 4 TRIGGERED[13] Depressurisation trigger occurred at TNC36 (intakes 97 and 169 mbgl). LEVEL 2 TRIGGERED[15] Depressurisation trigger occurred at TNC36 (intake 65 mbgl).	LEVEL 4 TRIGGERED[13] Depressurisation trigger occurred at TNC36 (intakes 97 and 169 mbgl).	LEVEL 4 TRIGGERED[14] Depressurisation trigger occurred at TNC36 (intake 97 mbgl). LEVEL 2 TRIGGERED[16] Depressurisation trigger occurred at TNC36 (intake 169 mbgl).	LEVEL 4 TRIGGERED[14] Depressurisation trigger occurred at TNC36 (intake 97 mbgl). LEVEL 2 TRIGGERED[16] Depressurisation trigger occurred at TNC36 (intake 169 mbgl).
	Deep groundwater pressures	Water Management Plan – Deep groundwater pressures at VMPs TNC036, TNC040, and TNC043	LEVEL 3 TRIGGERED[17] Depressurisation trigger occurred at TNC36 (intakes 214). LEVEL 2 TRIGGERED[18] Depressurisation triggers occurred in TNC36 (intake 412.5).	LEVEL 2 TRIGGERED[18] Depressurisation triggers occurred in TNC36 (intake 214 and 412.5).	LEVEL 2 TRIGGERED[18] Depressurisation triggers occurred in TNC36 (intake 214 and 412.5).	LEVEL 2 TRIGGERED[18] Depressurisation triggers occurred in TNC36 (intake 214 and 412.5).	LEVEL 2 TRIGGERED[18] Depressurisation triggers occurred in TNC36 (intake 214 and 412.5).	LEVEL 2 TRIGGERED[19] Depressurisation triggers occurred in TNC36 (intake 214 and 412.5).	LEVEL 2 TRIGGERED[19] Depressurisation triggers occurred in TNC36 (intake 214 and 412.5).
Landscape	Cliff lines	Land Management Plan – Cliff line damage or instability	NR - No cliffs within the active subsidence zone this month.	NR - No cliffs within the active subsidence zone this month.	NR - No cliffs within the active subsidence zone this month.	NR - No monitoring required this month.	NR - No monitoring required this month.	NR - No monitoring required for LW W3.	NR - No monitoring required for LW W3.
	Steep Slopes	Land Management Plan – Steep slope damage or instability	No signs of cracking or movement on steep slopes near structures in the areas inspected that could be attributed to mine subsidence.	No signs of cracking or movement on steep slopes near structures in the areas inspected that could be attributed to mine subsidence.	No signs of cracking or movement on steep slopes near structures in the areas inspected that could be attributed to mine subsidence.	NR - No monitoring required this month.	NR - No monitoring required this month.	No signs of cracking or movement on steep slopes near structures in the areas inspected that could be attributed to mine subsidence.	No signs of cracking or movement on steep slopes near structures in the areas inspected that could be attributed to mine subsidence.
	Surface cracking	Land Management Plan – Surface cracking (excluding railway corridor)	No signs of change in the areas inspected that could be attributed to mine subsidence.	No signs of change in the areas inspected that could be attributed to mine subsidence.	No signs of change in the areas inspected that could be attributed to mine subsidence.	NR - No monitoring required this month.	NR - No monitoring required this month.	No signs of change in the areas inspected that could be attributed to mine subsidence.	No signs of change in the areas inspected that could be attributed to mine subsidence.
	Dams (monthly)	Water Management Plan – Impacts to dams	No signs of change to farm dams inspected that could be attributed to mine subsidence.	No signs of change to farm dams inspected that could be attributed to mine subsidence.	No signs of change to farm dams inspected that could be attributed to mine subsidence.	NR - No monitoring required this month.	NR - No monitoring required this month.	No signs of change to farm dams inspected that could be attributed to mine subsidence.	No signs of change to farm dams inspected that could be attributed to mine subsidence.
	Dams (weekly)	Water Management Plan – Impacts to dams	No signs of change to farm dams inspected that could be attributed to mine subsidence.	No signs of change to farm dams inspected that could be attributed to mine subsidence.	No signs of change to farm dams inspected that could be attributed to mine subsidence.	No signs of change to farm dams inspected that could be attributed to mine subsidence.	NR - No monitoring required this month.	No signs of change to farm dams inspected that could be attributed to mine subsidence.	No signs of change to farm dams inspected that could be attributed to mine subsidence.
Agricultural Land	Agricultural Land	Land Management Plan – Agricultural land	No signs of change since baseline at sites inspected.	No signs of change since baseline at sites inspected	No signs of change since baseline at sites inspected	NR - No monitoring required this month.	NR - No monitoring required this month.	No signs of change since baseline at sites inspected	No signs of change since baseline at sites inspected

Aspect	Feature	Corresponding Management Plan and TARP	April 2021	May 2021	June 2021	July 2021	August 2021	September 2021	October 2021
Aquatic Ecology	Macroinvertebrates	Biodiversity Management Plan – Decline or significant negative change in macroinvertebrate indicators.	LEVEL 2 TRIGGERED[20] Decreased family richness at Site MC8 were observed, as supported by statistical analysis. Monitoring macroinvertebrate indicators at all other sites were within range of baseline data as supported by statistical analysis.	NR - Monitoring next required in Spring 2021.	NR - Monitoring next required in Spring 2021.	NR - Monitoring next required in Spring 2021.	NR - Monitoring next required in Spring 2021.	NR - Monitoring next required in Spring 2021.	Monitoring macroinvertebrate indicators are within range of baseline data as supported by statistical analysis.
		Biodiversity Management Plan – Reduction in aquatic habitat through loss of pools or associated reduction in water quality (AURIVAS habitat assessment)	Monitoring macroinvertebrate indicators are within range of baseline data as supported by statistical analysis.	NR - Monitoring next required in Spring 2021.	NR - Monitoring next required in Spring 2021.	NR - Monitoring next required in Spring 2021.	NR - Monitoring next required in Spring 2021.	NR - Monitoring next required in Spring 2021.	Monitoring macroinvertebrate indicators are within range of baseline data as supported by statistical analysis.
Terrestrial Ecology	Amphibians	Biodiversity Management Plan – Decline in amphibian populations within watercourses of the Study Area	Monitoring indicates amphibian population parameters are predominantly within a reasonable range of baseline data as supported by statistical analysis (Autumn 2021 results).	NR - Monitoring next required in Spring 2021.	NR - Monitoring next required in Spring 2021.	NR - Monitoring next required in Spring 2021.	NR - Monitoring next required in Spring 2021.	NR - Monitoring next required in Spring 2021.	NA - Monitoring data for Spring 2021 to be summarised in next report.
	Riparian Vegetation	Biodiversity Management Plan – Dieback of riparian vegetation within watercourses of the Study Area	Monitoring indicates riparian vegetation parameters are predominantly within a reasonable range of baseline data as supported by statistical analysis (Autumn 2021 results).	NR - Monitoring next required in Spring 2021.	NR - Monitoring next required in Spring 2021.	NR - Monitoring next required in Spring 2021.	NR - Monitoring next required in Spring 2021.	NR - Monitoring next required in Spring 2021.	NA - Monitoring data for Spring 2021 to be summarised in next report.
Aboriginal Heritage	Rock shelters and grinding grooves	Heritage Management Plan – Aboriginal heritage	No subsidence related rock face cracking or spalling. No signs of change at SR17 (grinding groove site).	No subsidence related rock face cracking or spalling. No signs of change at SR17 (grinding groove site).	No subsidence related rock face cracking or spalling. No signs of change at SR17 (grinding groove site).	NR - No monitoring required this month.	End of Panel Monitoring confirmed no impacts to rock shelters, grinding groove site or modified tree.	No signs of change at SR17 (grinding groove site).	No signs of change at SR17 (grinding groove site).
Historical Heritage	Railway Culverts	Heritage Management Plan – Historical heritage (culverts only)	LEVEL 2 TRIGGERED[23] Increased width of cracking noted in sandstone culvert at 88.400 km and 88.980 km.	No signs of change to culverts inspected.	No signs of change to culverts inspected.	No signs of change to culverts inspected.	LEVEL 3 TRIGGERED[21] End of Panel Monitoring confirmed cracking and spalling at sandstone culverts at 88.980 km and 88.400 km exceeds prediction.	NR - No monitoring required this month.	LEVEL 3 TRIGGERED[22] Slight increases of crack widths noted at 88.400 km, however no impact on structural integrity of the culvert. No signs of change to all other culverts inspected. Inspection of culvert at 88.980 km not required.
Built Features	Picton-Mittagong Loop Line	Picton-Mittagong Railway Management Plan	Results are within survey tolerance. Visual inspections did not identify any issues.	Results are within survey tolerance. Visual inspections did not identify any issues.	Results are within survey tolerance. Visual inspections did not identify any issues.	Results are within survey tolerance. Visual inspections did not identify any issues.	NR - No monitoring required this month.	Results are within survey tolerance. Visual inspections did not identify any issues.	Results are within survey tolerance. Visual inspections did not identify any issues.
	Main Southern Railway	Main Southern Railway Management Plan	BLUE TRIGGER Minor changes across the abutments of Ballast Top Subway (86.838 km).	BLUE TRIGGER Minor changes across the abutments of Ballast Top Subway (86.838 km).	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.

Aspect	Feature	Corresponding Management Plan and TARP	April 2021	May 2021	June 2021	July 2021	August 2021	September 2021	October 2021
	Electricity Infrastructure	Endeavour Energy Management Plan	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	NR - No monitoring required this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.
	Gas Infrastructure	Jemena Management Plan	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	NR - No monitoring required this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.
	Potable Water	Sydney Water Potable Water Management Plan	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	NR - No monitoring required this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.
	Sewerage Infrastructure	Stonequarry Creek Sewer Management Plan	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	NR - No monitoring required this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.
	Telecommunications	Telstra Management Plan	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	NR - No monitoring required this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.
		NBN Co Management Plan	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	NR - No monitoring required this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.
	Local roads, bridges and culverts	Wollondilly Shire Council Management Plan	**Impacts to kerb and road surface on Stonequarry Creek Road (Report 28).**	**Impacts to kerb on Stonequarry Creek Road (Report 28).**	**Impact to kerb on Carramar Close (Report 28)**	No impacts observed in areas monitored this month.	NR - No monitoring required this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.
	Built Structures	Built Structures Management Plan	**Impacts to houses on Stonequarry Creek Road and Booyong Close (Report 28).**	**Impacts to houses on Stonequarry Creek Road and Booyong Close (Report 28).**	**Impacts to house on Booyong Close (Report 28).**	No impacts observed in areas monitored this month.	NR - No monitoring required this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.
	RMS Infrastructure	RMS management Plan	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	NR - No monitoring required this month.	NR - No monitoring required this month.	NR - No monitoring required this month.	NR - No monitoring required this month.	No impacts observed in areas monitored this month.
	Queen Victoria Memorial Home (QVMH)	QVMH Management Plan	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	NR - No monitoring required this month.	NR - No monitoring required for LW W3.	NR - No monitoring required for LW W3.
	Mill Hill	Mill Hill Management Plan	NR - No monitoring required this month.	NR - No monitoring required this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	NR - No monitoring required this month.	NR - No monitoring required for LW W3.	NR - No monitoring required for LW W3.

Notes:

NR – Monitoring not required this month.

NA – Monitoring data not available as monitoring not completed this month.

[1] Stonequarry Creek flow assessment unable to be completed due to invalidation of current model calibration as a result of revision of the rating curve for Stonequarry Creek at Picton (GS 212053) in July 2020 and change of streamflow records from December 2015.

[2] Level 2 TARP for pool water level (LW W1-W2 Water Management Plan): The recorded water level has dropped below the previously recorded minimum level (for more than one 24 hour period for automated pool water level) AND the above has occurred at one of the upstream pools (beyond mining effects) AND visual monitoring of pools has not noted any mining related impacts.

[3] Level 2 TARP for pool water level (LW W3-W4 Water Management Plan): The recorded water level has declined below the recorded baseline minimum level (for more than one 24 hour period for automated pool water level) AND the above has occurred at one of the upstream pools (beyond mining effects).

[4] Level 3 TARP for pool water level (LW W3-W4 Water Management Plan): The recorded water level has declined, although not atypical, below the recorded baseline minimum level (for more than one 24 hour period for automated pool water level) AND The above has not occurred at one of the upstream pools (beyond mining effects).

[5] Level 4 TARP for groundwater quality (LW W1-W2 Water Management Plan): Medium to long term increase in salinity and / or metals or a change in pH outside of baseline variability with the effect persisting for greater than 3 months or after a significant rainfall recharge event AND the reduction in water quality is determined not to be controlled by climatic or anthropogenic factors.

[6] Level 3 TARP for groundwater quality (LW W3-W4 Water Management Plan): Short term increase (<3 months) in salinity and/or metals or change in pH outside of baseline variability. The effect persists after a significant rainfall recharge event AND/OR the change in water quality is determined not to be controlled by climatic or anthropogenic factors.

[7] Level 2 TARP for groundwater quality (LW W1-W2 Water Management Plan): Short term increase (<3 months) in salinity and/or metals, or change in pH outside of baseline variability. The effect does not persist after a significant rainfall recharge event AND/OR a similar trent or response has been noted at other monitored bores or private groundwater bores.

[8] Level 2 TARP for groundwater quality (LW W3-W4 Water Management Plan): Short term increase (<3 months) in salinity and/or metals, or change in pH outside of baseline variability. The effect does not persist after a significant rainfall recharge event. AND/OR a similar trend or response has been noted at other monitored bores or private groundwater bores.

[9] Level 4 TARP for groundwater bore level (LW W1-W2 Water Management Plan): Greater than 2 m water level reduction for a period greater than 3 months AND water level (for a specific depressurisation even) does not return to within 1 m of the pre 'event' level (or trend occurring prior to the 'event') after 6 months of the 'event' AND the reduction in water level in determined not to be controlled by climatic or anthropogenic factors.

[10] Level 3 TARP for groundwater bore level (LW W3-W4 Water Management Plan): Water level declines below the water level of TARP Significance Level 3 (calculated as the average of TARP Significance Level 2 and Level 4) following the commencement of extraction at LW W1 (and LW W2, W3 and W4) AND the reduction in water level is determined not to be controlled by climatic or external anthropogenic factors.

[11] Level 2 TARP for groundwater bore level (LW W1-W2 Water Management Plan): Up to 2 m water level reduction over a period of up to 3 months following the commencement of extraction of LW W1. Groundwater level rise in response to significant rainfall recharge event is observed AND/OR the reduction in water level is determined to be controlled by climatic factors or local bore usage for private water supply bores.

[12] Level 2 TARP for groundwater bore level (LW W3-W4 Water Management Plan): Greater than 2 m water level reduction following the commencement of extraction at LW W1 (and LW W2, W3, W4) AND the reduction in water level is determined not to be controlled by climatic or external anthropogenic factors.

[13] Level 4 TARP for shallow groundwater pressures (LW W1-W2 Water Management Plan): Greater than 5 m water level reduction in VWP intakes located at or above (i.e. shallower than) 200 m depth for a period greater than 3 months AND water level (for a specific depressurisation event) does not return to within 5 m of the pre 'event' level (or trend occurring prior to the 'event') after 6 months of the 'event' in VWP intakes located at or above 200 m depth AND the reduction in water level is determined not to be controlled by climatic or anthropogenic factors.

[14] Level 4 TARP for shallow groundwater pressures (LW W3-W4 Water Management Plan): Water level reduction greater than the maximum modelled drawdown following the commencement of extraction at LW W1 (and LW W2, W3 and W4) AND the reduction in water level is determined not to be controlled by climatic or anthropogenic factors.

[15] Level 2 TARP for shallow groundwater pressures (LW W1-W2 Water Management Plan): Up to 5 m water level reduction in VWP intakes located at or above (i.e. shallower than) 200 m depth over a period of up to 3 months following the commencement of extraction at LW W1. Groundwater level rise in response to significant rainfall recharge event is observed AND/OR the reduction in water level is determined to be controlled by climatic factors.

[16] Level 2 TARP for shallow groundwater pressures (LW W3-W4 Water Management Plan): Greater than 5 m water level reduction in VWP intakes located at or above (i.e. shallower than 200 m depth) following the commencement of extraction at LW W1 (and LW W2, W3 and W4) AND the reduction in water level is determined not to be controlled by climatic or external anthropogenic factors.

[17] Level 3 TARP for deep groundwater pressures (LW W1-W2 Water Management Plan): Calculated or observed drawdown (based on 2009 – 2015 baseline data) for VWP intakes below 200 m depth (excluding those within the Bulli Coal Seam) exceeds predicted (modelled) drawdown by 30 m for a period of 6 months or more.

[18] Level 2 TARP for deep groundwater pressures (LW W1-W2 Water Management Plan): Calculated or observed drawdown (based on 2009 – 2015 baseline data) for VWP intakes below 200 m depth (excluding those within the Bulli Coal Seam) is within 30 m of predicted (modelled) drawdown.

[19] Level 2 TARP for deep groundwater pressures (LW W3-W4 Water Management Plan): Calculated or observed drawdown (based on 2009 – 2015 baseline data) for VWP intakes below 200 m depth (excluding those within the Bulli Coal Seam) is within 30 m of predicted (modelled) drawdown.

[20] Level 2 TARP for decline or significant negative change in macroinvertebrate indicators (LW W1-W2 Biodiversity Management Plan): One or more macroinvertebrate indicators are not within range of baseline data as supported by statistical analysis AND one or both of the following:

- Subsidence monitoring program identifies potential for impact to watercourse parameters associated with aquatic habitat areas compared to baseline (e.g. cracking).
- Surface monitoring program identifies potential impacts to hydrology / water quality parameters compared to baseline.

[21] Level 3 TARP for historical heritage (LW W1-W2 Heritage Management Plan): Historical heritage site monitoring indicates environmental consequences exceeds predictions.

[22] Level 3 TARP for historical heritage (LW W3-W4 Heritage Management Plan): Historical heritage site monitoring indicates environmental consequences to heritage site(s).

[23] Level 2 TARP for historical heritage (LW W1-W2 Heritage Management Plan): Historical heritage site monitoring indicates no detectable environmental consequences.

2.2 Summary of Actions

During the reporting period, there were seven (7) environmental aspects that were associated with TARP triggers, as well as a number of impacts to roads and built structures that required remediation. This section provides a summary of actions resulting from triggers being met in the TARPs, as well as required remediation actions. All triggers have been reviewed by the Environmental Response Group / Structural Response Group / specialist to determine if any further action is required.

2.2.1 Pool Water Level TARPs – Level 2 and Level 3 Triggers for Pool Water Level Reduction

Background

The following TARP triggers occurred during the current reporting period for water level (refer **Appendix B**):

- Monitoring Site SG – Level 2 TARP triggers occurred at pool SG2 (Stonequarry Creek) and pool CR14 (Cedar Creek) between May to September 2021; and
- Monitoring Site CB – Level 2 TARP triggers occurred at pool CR14 (Cedar Creek) between July to September 2021, and a Level 3 TARP trigger occurred in September 2021.

Further discussion of these triggers is provided in the Surface Water Review (refer **Appendix B**).

Pool CR14

The water level records for monitoring site CB (pool CR14) in Cedar Creek indicate that the water level declined below the baseline minimum by a maximum of 11 mm between 20 and 24 July, 21 mm between 27 July and 4 August, 28 mm between 6 and 24 August 2021, 4 mm for short periods on 2 and 3 September, 13 mm between 9 September and 12 September and 22 mm between 13 and 30 September (refer **Appendix B**). The water level was recorded slightly below the baseline minimum at the end of the review period (5 mm below). During the periods of water level decline the water level remained above the previously recorded minimum and did not decline atypically.

For the periods 20 to 24 July, 27 July to 4 August, 6 to 24 August and 9 to 12 September 2021, a Level 2 TARP significance in relation to pool water level decline at monitoring site CB has been derived in accordance with the LW W1-W2 Water Management Plan.

In accordance with the LW W3-W4 Water Management Plan, a Level 3 TARP significance in relation to pool water level decline at monitoring site CB has been derived for the period 13 to 30 September 2021. Although a Level 3 TARP significance has been derived for this period, the water level decline was relatively small (22 mm below the baseline minimum) and likely related to the prevailing below average rainfall conditions in combination with the prevailing losing conditions at monitoring site CB during this period (**Appendix B**).

In August and September 2021, the groundwater levels recorded at relevant groundwater monitoring sites remained stable although below the baseline level. This suggests that inferred losing conditions at monitoring site CB are likely to have persisted for the period 1 August to 30 September 2021 (**Appendix B**).

Pool SG2

From late May to late August 2021, there was a declining trend in the water level during a period of below average rainfall. The water level declined below the previously recorded minimum by a maximum of 53 mm between 20 May and 23 August. The water level then rose in response to a rainfall event in late August and declined to a historical minimum on 12 September before rising slightly again towards the end of the review period.

Water level records for sites further downstream of monitoring site SG in Stonequarry Creek (i.e. monitoring sites SE, SA, SB) indicate that the water level did not decline below the baseline or previously recorded minimum during the review period. As such, there is no indication of a mining related effect on pool water level in the reach of Stonequarry Creek within or upstream of the Investigative Area.

Visual inspection records and site photographs indicate that the pool at site SG contains substantial vegetative debris, including weeds/reeds and has heavily vegetated soil banks. It is likely that surface flow at monitoring site SG passes beneath the shallow cobble/boulder mound control and/or infiltrates into the heavily vegetated soil banks resulting in a decline in pool water level which appears inconsistent with water level records for all other monitored pools. As such, a Level 2 TARP significance in relation to pool water level decline at reference site SG was derived for the periods 20 May to 23 August 2021 and 1 September to 30 September 2021.

Actions Completed

The following actions have been completed in light of the Level 2 and Level 3 TARP triggers (primarily for the exceedances at Site CB) during this reporting period:

- Continue monthly review of data – ongoing monthly groundwater result analysis and reporting is completed;
- Convene Tahmoor Coal Environmental Response Group to review response – completed on a monthly basis, including the discussion of any pool water level TARP triggers;
- Review relevant surface water level, groundwater level and streamflow data to assess comparative trends – completed as part of the first 3-monthly Monitoring Report for surface water and groundwater (HEC, 2021). The assessment for the period 1 April to 31 July 2021 identified that although an increase in groundwater levels had been recorded since completion of LW W2, the groundwater levels had not returned to baseline levels. As such, it was inferred that losing conditions (surface water discharge to the groundwater system) were prevailing at monitoring site CB and that further surface water level decline may occur during periods of below average rainfall (HEC, 2021);
- Review manual water level measurements for additional monitoring sites to identify potential spatial trends in water level decline – completed as part of the Surface Water Review (**Appendix B**). Review of the water level measurements for monitoring sites in Cedar Creek downstream of monitoring site CB, namely monitoring sites CC, CD, CE and CG, indicate that the water level at these sites remained above the baseline minimum during the period 13 to 30 September 2021. As such, there is no indication that there has been a wide-spread effect on surface water levels in the downstream reach of Cedar Creek; and

- Consider increasing download and review of data frequency to fortnightly for sites where Level 3 has been reached – considered as part of the Surface Water Review (**Appendix B**). An increase in the frequency of data download and review is not considered to be required at this stage. Monthly download and review of surface monitoring data will continue to be conducted. Should a Level 4 trigger exceedance occur in the future, further action will be taken in accordance with the LW W3-W4 Water Management Plan.

Tahmoor Coal have been providing quarterly (3-monthly) monitoring reports for surface water and groundwater as per the request by DPIE on 25 June 2021. This report will form the second 3-monthly monitoring report. These reports include a review and interpretation of monitoring data, assessment against performance measures and performance indicators for surface water and groundwater, and any recommendations in relation to ongoing monitoring or corrective actions.

Proposed Actions

The current monitoring program will continue in accordance with the LW W3-W4 Water Monitoring Plan, and the next 3-monthly Monitoring Report will be provided to DPIE in February 2022.

2.2.2 Groundwater Quality TARP – Level 2, 3 and 4 Triggers for Groundwater Quality

Background

The following TARP triggers occurred during the current reporting period for groundwater quality:

- P13C - 'Potential' Level 4 TARP trigger for Lithium from April to July 2021;
- GW105228 – Level 3 TARP trigger for Strontium in October 2021; and
- GW115860 - Level 3 TARP trigger for Barium in October 2021.

A number of Level 2 TARP triggers occurred for groundwater quality (refer to **Table 2-3**) however these triggers do not require further discussion.

Further discussion of these triggers is provided in the Groundwater Six-Month Report (refer **Appendix C**).

Lithium at P13C

Lithium (Li) concentrations at P13C showed fluctuating behaviour with an overall increasing trend developing since April 2021. As of August 2021, dissolved Li recorded above the trigger level for the eight consecutive months, and concentrations in the reporting period reached 0.044 mg/L on 29 September 2021.

The proposed trigger level for Li at P13C has been noted to conservative and very sensitive to any increase in Li concentration. The baseline data for Li at P13C was collected during the NSW drought (2017-2020) with relatively low background levels (0.010 mg/L to 0.012 mg/L) compared to the other nested piezometer P13A and P13B, resulting in a lower trigger level at P13C (0.015 mg/L) than the trigger level for P13A and P13B (0.03mg/L and 0.04 mg/L, respectively). In addition, while no Australian wide guideline figure exists, in the USA the Environmental Protection Agency (EPA) estimated a limit of 0.70 mg/L (Water Research Centre), which is 21 times higher than the maximum Li concentrations recorded at P13C in July 2021.

The increasing trend in dissolved Li concentrations at P13C was likely attributed to the intense rainfall in early 2020 and 2021 that may be the cause of a naturally occurring source of Li being flushed through and down the profile and is likely to decline gradually over time. The on-going groundwater level recovery in P13C, following depressurisation in 2020 could also contributed to this observed increase and may have re-mobilised a local natural source of Li in the Hawkesbury Sandstone.

Hence, the consecutive exceedances observed during the reporting period were potentially a result of variation in the natural groundwater conditions rather than mining related where a 'potential' TARP Level 4 was reported between April 2021 and August 2021.

Private bores

GW105228 had three consecutive exceedances of dissolved strontium that triggered a TARP Level 2 in February through to the July 2021. A TARP level 3 is applied in October 2021 with concentrations being marginally above the trigger level at 0.17 mg/L (trigger is at 0.15 mg/L). Monitoring for metal concentrations in these standpipes commenced by GeoTerra towards the end of 2020, so the available historical data is limited and therefore the exceedances are likely due to background concentrations of strontium in the aquifer surrounding this bore being higher than the trigger level assigned.

GW115860 had two consecutive exceedances of dissolved barium that triggered a TARP Level 2 in July and Level 3 in October 2021. Monitoring for metal concentrations in these standpipes commenced by GeoTerra towards the end of 2020, so the available historical data is limited and therefore the exceedances are likely due to background concentrations of barium in the aquifer surrounding this bore being higher than the trigger level assigned.

The higher concentrations in barium and strontium at bores GW115860 and GW105228 could be linked to hard water, with both bores showing level of CaCO3 greater than 60mg/L and up to 175mg/L in October 2021. Groundwater in GW115860 is frequently pumped and likely to draw down water in GW105228. High transmissivities were also reported due to the quick rate of drawdown and recovery at those locations (pers. comm GeoTerra) meaning that groundwater flows well between these two bores. Fouling of pumping, irrigation and distribution equipment in waters could explain hard water in GW115860 and influence metal concentration (i.e. barium, strontium) in GW105228 (i.e. via groundwater connectivity). Exceedances in barium and strontium concentrations at those sites could potentially be due to pumping operations/material or be natural rather than a mining effect.

Actions Completed

In response to the exceedances for this reporting period, the following actions were completed:

- Ongoing review of water quality data – ongoing monthly groundwater result analysis and reporting is completed;
- Convene Tahmoor Coal Environmental Response Group to review response – completed on a monthly basis, including the discussion of any groundwater triggers; and
- Response as defined by the Environmental Response Group – review of P13C lithium trigger level recommended by the ERG and completed in August 2021.

In August 2021, SLR revised the trigger level for dissolved Li concentrations at P13C which was assessed too conservative to account for wetter conditions throughout 2021 (i.e. exceptional floods in April 2021). The revision was in line with trigger levels at P13A and P13B to 0.034 mg/L from the previous lower trigger level of 0.015 mg/L.

Since the revision of the lithium trigger level in August 2021 to 0.034 mg/L, lithium at P13C was within the TARP Level 1 until the last reading in September 2021 where the TARP Level 2 trigger was exceeded but remain within TARP Level 1 for the shallow groundwater in P13A and P13B. P13C was decommissioned in October 2021. At the sampling round before decommissioning (October) only lithium exceeded the TARP Level 2 (i.e. by 0.01 mg/L above the trigger level) with all other metal parameters being within the TARP Level 1.

Proposed Actions

The current monitoring program will continue in accordance with the LW W3-W4 Water Monitoring Plan.

2.2.3 Groundwater Bore Level TARP – Level 2, 3 and 4 Triggers for Open Standpipe Piezometer Groundwater Levels

Background

During this reporting period, a number of groundwater intakes in open standpipe piezometers (OSPs) have recorded reduced water level elevation below the baseline range. This was noted in the following OSP intakes (refer to **Appendix C**):

- P12C – Level 4 TARP trigger from April to August 2021, and a Level 3 TARP trigger in September and October 2021;
- P13C – Level 4 TARP trigger from April to June 2021, a Level 2 TARP trigger in July 2021 and September 2021;
- P16B – Level 4 TARP trigger from April to August 2021, and a Level 2 TARP trigger in September and October 2021;
- P16C – Level 4 TARP trigger from April to August 2021, and a Level 3 TARP trigger in September and October 2021; and
- GW105467 - Level 2 TARP trigger in July 2021.

During the reporting period, a period of groundwater recovery was identified in the mid Hawkesbury Sandstone aquifer at the open standpipes P12C, P13C, P16B and P16C. The groundwater recovery is associated with the completion of LW W1 and LW W2, and wetter condition in February and March 2021 gradual recovery of groundwater levels was noted.

This trend of groundwater recovery was evident particularly in P13C during the reporting period. The level 4 TARP trigger for P13C was reduced to a Level 2 TARP trigger in July, and further reduction to Level 1 in August 2021. A Level 2 TARP trigger was associated with P13C in September 2021 in accordance with the LW W3-W4 Water Management Plan TARP, however this TARP was noted to be more conservative than the LW W1-W2 Water Management Plan TARP. The change to the LW W3-W4 Water Management Plan TARP also resulted in a reduction of TARP level triggers for P12C, P16B and P16C.

Since January 2021 the bore yield at GW105467 has declined from 0.67 L/s to 0.38 L/s in July 2021. A TARP Level 2 was applied at GW105467 as the lowest groundwater yield during the baseline period was 0.47 L/s in March 2019 and during the severe NSW drought. This bore is not actively used for groundwater extraction and no site access was possible in October 2021.

Actions Completed

On 30 December 2020, Level 4 TARP triggers for the reduced water level elevations at P13C, P16B, P16C and TNC036 were notified to DPIE and NRAR. This reduction was attributed to mining induced depressurisation of deeper groundwater aquifer, however this also correlated to a reduction in rainfall recharge events. The Level 4 TARP triggers observed during this reporting period are a continuation of the trend as previously notified.

In light of the Level 4 TARP triggers, Tahmoor Coal have been providing quarterly (3-monthly) monitoring reports for surface water and groundwater as per the request by DPIE on 25 June 2021. This report will form the second 3-monthly monitoring report. These reports include a review and interpretation of monitoring data, assessment against performance measures and performance indicators for surface water and groundwater, and any recommendations in relation to ongoing monitoring or corrective actions.

The following actions have been completed in light of the Level 2 and Level 3 TARP triggers during this reporting period:

- Ongoing review of water level data and consideration of mining and external stresses – ongoing monthly groundwater result analysis and reporting completed;
- Convene Tahmoor Coal Environmental Response Group to review response – completed on a monthly basis, including the discussion of any groundwater level TARP triggers;
- Review relevant surface water level, groundwater level and streamflow data to assess comparative trends – completed as part of the first 3-monthly Monitoring Report for surface water and groundwater (HEC, 2021). This report found that surface water level decline occurred during periods of notable groundwater level decline when losing conditions are inferred to prevail (HEC, 2021); and
- Compare against base case and deterministic model scenarios – completed as part of the Groundwater Report (refer to Section 6 of **Appendix C**).

Proposed Actions

Groundwater monitoring will continue under the existing monitoring program, and the next 3-monthly Monitoring Report will be provided to DPIE in February 2022.

2.2.4 Shallow Groundwater Pressures TARP – Level 2 and 4 Triggers for Shallow Vibrating Wire Piezometer Groundwater Pressure

Background

During this reporting period, a number of groundwater intakes in shallow (<200 mbgl) Vibrating Wire Piezometers (VWPs) have recorded a trend of depressurisation below the baseline range. This trend has been noted in the following VWP intakes (refer to **Appendix C**):

- TNC036 intake 65 mbgl – Level 4 TARP trigger from April to June 2021, and a Level 2 TARP trigger in July 2021;
- TNC036 intake 97 mbgl – Level 4 TARP trigger from April to October 2021; and
- TNC036 intake 169 mbgl – Level 4 TARP trigger from April to August 2021, and a Level 2 TARP trigger in September and October 2021.

During the reporting period, a period of groundwater recovery was identified in the mid Hawkesbury Sandstone aquifer at TNC036 in the three upper instruments HBSS-65m, HBSS-97m and BGSS-169m. The groundwater recovery is associated with the completion of LW W1 and LW W2, and wetter condition in February toMarch 2021 gradual recovery of groundwater levels was noted.

Groundwater recovery has been evident at TNC036 (HBSS-65m), which was reduced from a Level 4 TARP trigger to a Level 2 TARP trigger in July 2021, and to Level 1 in August 2021. The change to the LW W3-W4 Water Management Plan TARP resulted in a reduction of TARP level trigger for TNC036 intake BGSS-169m. TNC036 intake 97 mbgl remained at a Level 4 TARP trigger for the entire reporting period, however it is expected that this intake will recover to a Level 3 in the next review period (refer to **Appendix C**).

Actions Completed

On 30 December 2020, Level 4 TARP triggers for the reduced water level elevations at P13C, P16B, P16C and TNC036 were notified to DPIE and NRAR. This reduction was attributed to mining induced depressurisation of deeper groundwater aquifer, however this also correlated to a reduction in rainfall recharge events. The Level 4 TARP triggers observed during this reporting period are a continuation of the trend as previously notified.

In light of the Level 4 TARP triggers, Tahmoor Coal have been providing quarterly (3-monthly) monitoring reports for surface water and groundwater as per the request by DPIE on 25 June 2021. This report will form the second 3-monthly monitoring report. These reports include a review and interpretation of monitoring data, assessment against performance measures and performance indicators for surface water and groundwater, and any recommendations in relation to ongoing monitoring or corrective actions.

The following actions have been completed in light of the Level 2 TARP triggers during this reporting period:

- Ongoing review of water level data – ongoing monthly groundwater result analysis and reporting completed; and
- Convene Tahmoor Coal Environmental Response Group to review response – completed on a monthly basis, including the discussion of any groundwater TARP triggers.

Proposed Actions

Groundwater monitoring will continue under the existing monitoring program, and the next 3-monthly Monitoring Report will be provided to DPIE in February 2022.

2.2.5 Deep Groundwater Pressures TARP – Level 2 and 3 Triggers for Deep Vibrating Wire Piezometer Groundwater Pressure

Background

During this reporting period, groundwater intakes in deep (>200 mbgl) VWPs have recorded a trend of depressurisation below the baseline range. These trends have been noted in the following VWP intakes (refer to **Appendix C**):

- TNC036 intake 214 mbgl – Level 3 TARP trigger in April 2021, and Level 2 TARP triggered in May to October 2021; and
- TNC036 intake 412.5 mbgl – Level 2 TARP trigger from April to October 2021.

Actions Completed

The following actions have been completed in light of the Level 2 and Level 3 TARP triggers during this reporting period:

- Ongoing review of water level data – ongoing monthly groundwater result analysis and reporting completed; and
- Convene Tahmoor Coal Environmental Response Group to review response – completed on a monthly basis, including the discussion of any groundwater TARP triggers.

Proposed Actions

Groundwater monitoring will continue under the existing monitoring program.

2.2.6 Aquatic Ecology TARP – Level 2 Trigger for Reduction in Family Richness of Macroinvertebrates and OE50 score at Site MC8

Background

Macroinvertebrate sampling in the Autumn 2021 season identified that there was a decrease in family richness and OE50 score at aquatic ecological monitoring Site MC8 on Matthews Creek compared to pre-mining results (refer to Aquatic Ecology Monitoring Report in **Appendix D**). This impact to aquatic ecology in combination with potential impacts to hydrology within the LW W2 Study Area resulted in the triggering of a Level 2 TARP trigger for aquatic biodiversity in April 2021.

It is noted, however, that the hydrological impacts were observed downstream of Site MC8, and there was no water quality, hydrology or visual evidence to support hydrological impact at Site MC8 specifically. Even though Site MC8 showed a change in family richness and reduction in AUSRIVAS OE50 score, to date these associated ecological impacts have not been observed outside what is considered natural variation. As such the 'within prediction' assessment is considered conservative.

This Level 2 TARP trigger was not identified in the previous Six-Monthly Subsidence Impact Report as at the time of reporting only a preliminary ecological report focusing on AUSRIVAS results had been required. The decrease in family richness was later noted following the completion of statistical analysis and the provision of the full report.

Actions Completed

Following the identification of this TARP trigger for aquatic ecology, the following actions were completed:

- Review and confirm monitoring data, cross check aquatic biodiversity monitoring data against other related environmental data (e.g. control sites and benchmark data) and subsidence monitoring upon identification of the potential trigger. This action was completed as part of the Aquatic Ecology Monitoring Report (refer **Appendix D**) through comparison of data to control sites and baselines data as well reviewing surface water and visual subsidence monitoring results.
- Undertake further investigations as appropriate to confirm the potential issues and analyse data with the aim of determining whether the exceedance is likely to be mining related. This action was completed as part of the Aquatic Ecology Monitoring Report (refer **Appendix D**) through consideration of the results in light of visual monitoring and surface water monitoring results and as well dedicated surface water study.

- Assess need for any increase to monitoring frequency or additional monitoring where relevant. This action was completed as part of the Aquatic Ecology Monitoring Report (refer **Appendix D**) and it was considered that changes to the ecological monitoring program is not deemed necessary at this point in time.
- Convene Tahmoor Coal Environmental Response Group to review response – meeting held on 13 July 2021 discussed the recent findings and the actions completed to date. The meeting also identified that there are no requirements to add new sites or increase monitoring frequency.

Proposed Actions

The current monitoring program will continue in accordance with the LW W3-W4 Biodiversity Monitoring Plan.

2.2.7 Historical Heritage TARP – Level 3 Trigger for Sandstone Culvert Impacts

Background

Visual inspections during the previous reporting period noted the development of a number of minor cracks on sandstone culverts along the Picton-Mittagong Loop Line. Slight increase in crack dimension has occurred during this monitoring period, with particular focus on the sandstone culverts at 88.400 km and 88.980 km. These changes have included:

- Sandstone culvert at 88.400 km:
  - Upside headwall – slight increase in crack width from 7 mm to 8 mm at crest with outward movement around the headwall and wingwall increased from 8 mm to 9 mm relative to the culvert barrel (LW W3 PMLL Detailed Monitoring Report 4, **Appendix F**).
  - Downside headwall – slight increase in crack width from 8 mm to 9 mm at crest and 5 mm to 6 mm mid-height (LW W3 PMLL Detailed Monitoring Report 4, **Appendix F**).
- Sandstone culvert at 88.980 km:
  - Minor separation and circumferential cracking of the sandstone block arch obvert predominantly along mortar bed indicative of outward rotation of the headwall up to 5 mm with some associated spalling of sandstone block facing (LW W2 PMLL Detailed Monitoring Report 29, **Appendix F**).
  - Vertical crack along mortar up to 5 mm at city side junction between wingwall and headwall with outward rotation of the wingwall up to 5 mm (LW W2 PMLL Detailed Monitoring Report 29, **Appendix F**).

Changes at the culvert at 88.400 km were noted in the LW W3 PMLL Detailed Monitoring Report 4 (**Appendix F**) and are illustrated in **Figure 2-1**. No further movement was noted during the reporting period.

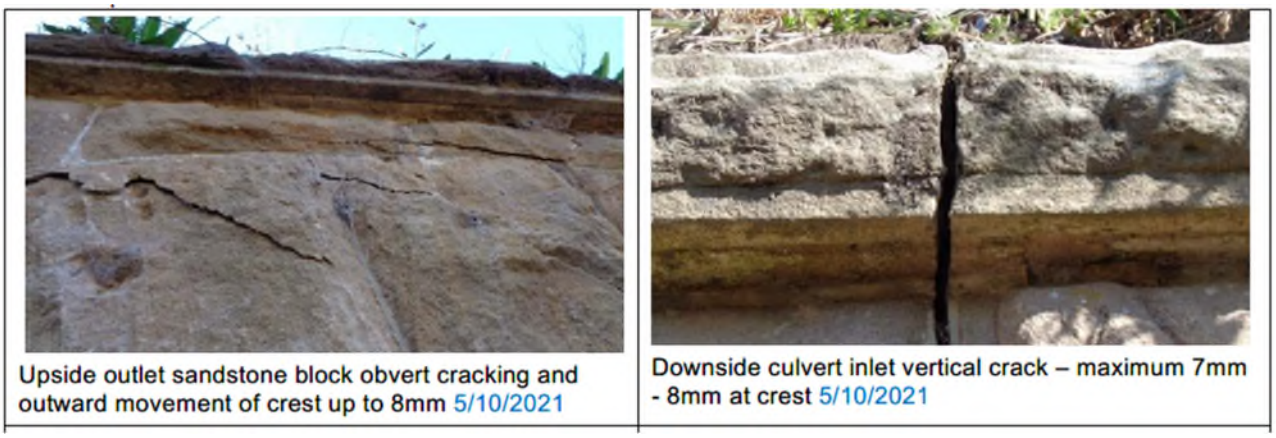

Figure 2-1 Cracking at culvert 88.44 km (source: LW W3 PMLL Detailed Monitoring Report 4, **Appendix F**).

Changes at the culvert at 88.980 km were noted in the LW W2 PMLL Detailed Monitoring Report 29 (**Appendix F**) and are illustrated in **Figure 2-2**. No further monitoring has been completed during the reporting period.

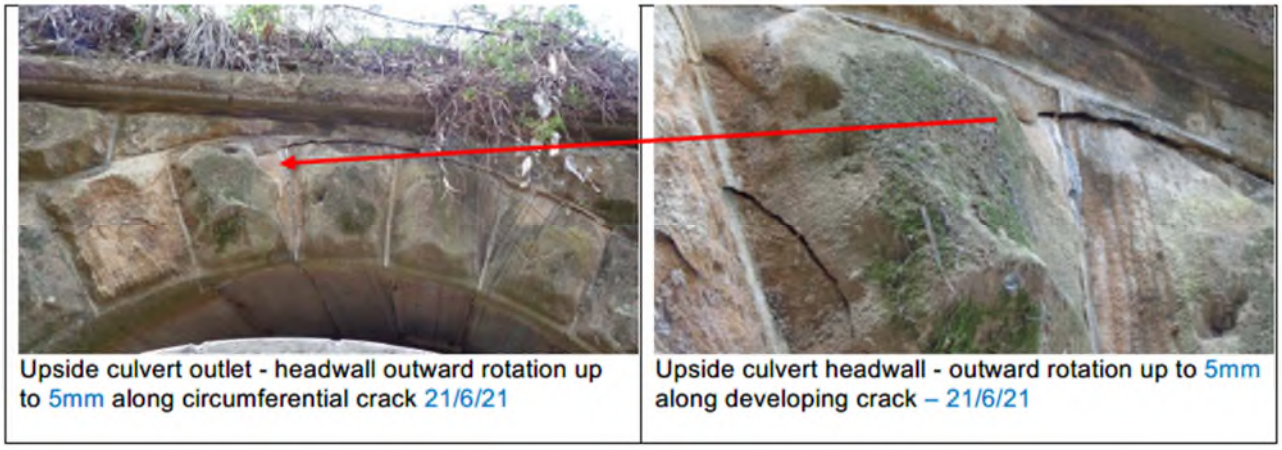

Figure 2-2 Cracking at culvert 88.980 km (source: LW W2 PMLL Detailed Monitoring Report 29, **Appendix F**).

Cracking and spalling of the sandstone blocks at the two culverts developed gradually in March and April 2021. These impacts started as very minor hairline mortar cracks before gradually increasing in width and outward displacement as mining occurred.

Tahmoor Coal requested EMM to determine if this impact to culvert 88.400 km had triggered the Historical Heritage TARP under the LW W1-W2 Heritage Management Plan. EMM notified Tahmoor Coal on 25 April 2021 that the observed impacts to the culvert constituted a Level 2 TARP trigger. EMM justified that as the cracks were in the mortar joints and not impacting the structural integrity of the culvert, the impacts to heritage values were considered negligible. In addition, as the culvert was then outside the zone of active subsidence, any further impacts were considered unlikely and the culvert stable. Therefore, in accordance with the Heritage Management Plan, continued monitoring by structural engineers during extraction of LW W2 was considered appropriate, followed by a review of the culvert at the end of LW W2 extraction by a heritage consultant.

Ongoing monitoring and reporting were completed until 21 June 2021, during which time slight development of impacts were observed and reported for both culverts. However, as the culverts were considered stable and previous heritage advice indicated that the impacts to culvert 88.400 km (the culvert with the greater level of impact) constituted a Level 2 TARP trigger, inspection of the culverts by a heritage consultant was scheduled for the end of LW W2 extraction. LW W2 extraction was completed on 17 June 2021 and the end of panel inspection by a heritage consultant (Pamela Chauvel from EMM) was completed on the 25 August 2021. The draft Historical Heritage End of Panel Report was provided to Tahmoor Coal on 14 September 2021, which identified that a Level 3 TARP trigger for historical heritage had been triggered.

Actions Completed

Following the identification of this TARP trigger for historical heritage at culverts 88.400 km and 88.980 km, the following actions were completed:

- The Draft EMM Historical Heritage End of Panel report was provided to ERG on 14 September which informed that the impacts at culverts 88.400 km and 88.980 km had triggered a Level 3 TARP Trigger in accordance with the LW W1-W2 Heritage Management Plan;
- MSEC was requested to provide a report summarising subsidence predictions and observations relating to the culverts. This report was provided on 16 September 2021, and included a review of mine design/predictions against mine criteria, and confirmation that the culverts were predicted to experience negligible additional subsidence due to future longwall extraction in the Western Domain;
- Finalisation of the Historical Heritage End of Panel report provided to Tahmoor Coal on 17 September 2021 (refer to **Appendix E**);
- Tahmoor Coal commenced seeking further expert advice from a heritage stonemason regarding remediation of the sandstone structures (10 September 2021). Initial advice received from EMM indicated that repairs should be completed after the full effect of LW W3-W4 have been completed. To do so earlier may cause greater damage at the new filling joint and then be harder to repair; and
- Tahmoor Coal notified DPIE and Heritage NSW of the trigger via the NSW Major Projects Planning Portal on 21 September 2021.

Proposed Actions

As per the relevant Historical Heritage TARP, the following actions will be completed:

- Continue monitoring and management of sites in accordance with the LW W3-W4 Heritage Management Plan. The Picton Mittagong Loop Line Management Plan for LW W3-W4 was prepared in consultation with Transport Heritage NSW and the Tahmoor Coal Rail Management Group. Monitoring of the two culverts in accordance with this management plan have been adopted in the LW W3-W4 Heritage Management Plan;
- Tahmoor Coal is seeking further expert advice from a heritage stonemason regarding remediation of the sandstone; and
- Remediation will be undertaken after the full effects of LW W3-W4 have been completed.

2.2.8 Main Southern Railway TARP – Blue Trigger at Ballast Top Subway (86.838 km)

Background

On 12 April 2021, local 3D survey of the Ballast Top Subway (86.838 km) noted minor changes across the abutments of the structure. This change entailed additional closure between the abutment wall on the Upside where movements have been previously observed after rain events. This change triggering a blue TARP trigger, which continued into May 2021 (refer to MSR Status Reports 21-24; **Appendix G**).

Actions Completed

A structural inspection was conducted on 28 April 2021, which confirmed that further movement of the abutment had occurred due to rain events and were not subsidence related. The trigger level was increased to 20 mm, as recommended by the Structural Engineer.

Proposed Actions

Visual inspection of the location will continue under the existing monitoring program.

2.2.9 Impacts to Built Structures and Local Roads

Background

A number of impacts to local roads and built structures occurred during the reporting period as a result of subsidence from LW W2 extraction. These impacts are focused within the Stonequarry Estate and can be summarised as:

- Impacts to kerb and road surface on Stonequarry Creek Road (April and May 2021);
- Impacts to houses on Stonequarry Creek Road (April and May 2021);
- Impacts to houses on Booyong Close (April to July 2021); and
- Impacts to kerb on Carramar Close (June 2021).

Actions Completed

Where appropriate, Tahmoor Coal has completed temporary repairs to roads and built structures within the Stonequarry Estate. All residential impacts have been referred to SA NSW.

Proposed Actions

Visual inspection of the roads and structures will continue under the existing monitoring program, and repair of damages and interaction with SA NSW will also continue as required.

3 Assessment of Environmental Performance

This section provides an assessment of compliance with all relevant performance measures and indicators.

3.1 Environmental Performance Measures and Indicators

The following development consents include subsidence impact performance measures as conditions for the extraction of LW W1-W2 and LW W3-W4:

- DA 67/98 Modification 5:
  - Condition 13A – Performance Measures for Natural and Heritage Features;
  - Condition 13E – Performance Measures for Built Features;
- LW W1-W2 Extraction Plan Approval:
  - Condition 1 – Performance Measures for Stonequarry Creek, Cedar Creek and Matthews Creek;
- LW W3-W4 Extraction Plan Approval:
  - Condition 1 – Performance Measures for Stonequarry Creek, Cedar Creek and Matthews Creek.

The subsidence impact performance measures were adopted as part of the LW W1-W2 Extraction Plan and associated management plans, as well as the LW W3-W4 Extraction Plan and associated management plans. To assist in defining the performance measures, each measure has been assigned subsidence performance indicator(s).

These performance measures and indicators are provided in **Table 3-1**, as well as an assessment of performance.

Table 3-1 Assessment of Environmental Performance

Feature	Subsidence Performance Measure	Subsidence Performance Indicator	Subsidence Performance Measure Exceeded?	Section Discussed
Water Management				
Stonequarry Creek, Cedar Creek and Matthews Creek (LW W1-W2 Extraction Plan Approval)	No subsidence impact or environmental consequence greater than minor*	This performance indicator will be considered to be exceeded if mining-induced fracturing in a rockbar or stream bed results in a reduction in pool water level below historically recorded water levels, taking into account rainfall and observations during the baseline monitoring period, for: • More than 10% of pools located within the 600 m Study Area for Natural Features; and/or • Pool SR17.	**No**	Sections 4.2.2 and 4.2.3
	No connective cracking between the surface, or the base of the alluvium, and the underground workings.	This performance indicator will be considered to be exceeded if analysis of inflow data suggests high correlation to rainfall events and significant departure from recent groundwater model predictions. This would be supported by analysis of pre- and post-mining goaf centreline bore data.	**No** *Note: Post-mining goaf centreline bore data not yet available.*	Section 4.2.8
Public Safety (DA 67/98 Condition 13E)	Negligible additional risk**.	Flooding This performance indicator will be considered to be exceeded if subsidence results in the post-mining 1% AEP flood level being above the floor level of one or more dwelling.	**No** *Note: LW W3-W4 mining is still in progression, and therefore post-mining flood modelling has not been completed.*	Not applicable
Land Management				
Public Safety (DA 67/98 Condition 13E)	Negligible additional risk**.	Landscape Features This performance indicator will be considered to be triggered if subsidence impacts to landscape features result in the collapse of cliffs, rock outcrops or steep slopes in proximity to members of the public.	**No**.	Section 4.3.1 and 4.3.2

Biodiversity Management				
Threatened species, threatened populations, or endangered ecological communities (DA 67/98 Condition 13A)	Negligible environmental consequences**.	This performance indicator will be considered to be triggered if: • Changes in macroinvertebrate and stream health indicators are statistically significant; • If visual assessment of aquatic habitat identifies mining subsidence induced impacts. • Statistically significant changes in amphibian diversity is detected toward baseline attributed to mining, as detected during amphibian monitoring; and/or • Statistically significant changes in riparian vegetation is detected toward baseline attributed to mining, as detected during riparian monitoring.	**No**	Section 4.4.1 and 4.4.2
Heritage Management				
Heritage sites (DA 67/98 Condition 13A)	Negligible subsidence impacts or environmental consequences**.	<u>Isolated finds/artefact scatters (AHIMS items)</u> No performance indicators are currently established as impacts are predicted to be negligible.	**No** *Note: The LW W1-W2 Heritage Management Plan and LW W3-W4 Heritage Management Plan assessed the probability of impacts to isolated finds / artefact scatters from the proposed longwall mining as very unlikely. Impacts to open sites, such as artefact scatters, are limited to cracking in the surface soils which is unlikely to affect the artefacts. Therefore monitoring of these sites have not been included in the monitoring program.*	Not applicable

		Scarred tree (AHIMS item) This performance indicator will be considered to be triggered if: • subsidence monitoring identifies a perceptible tilt increase that places the tree at risk of falling; and/or • subsidence monitoring identifies a perceptible cracking in the tree unrelated to natural weathering or trauma damage	**No** *Note: The LW W1-W2 Heritage Management Plan and LW W3-W4 Heritage Management Plan assessed the probability of impacts to the scarred tree from the proposed longwall mining as very unlikely.* *Impacts to open sites, such as the scarred trees, are limited to cracking in the surface soils which is unlikely to affect the item. Therefore monitoring of this item has not been included in the monitoring program.*	Not applicable
		Grinding grooves (AHIMS item) This performance indicator will be considered to be triggered if: • subsidence monitoring identifies visible perceptible impacts such as subsidence induced cracking; and • these subsidence impacts result in impacts to the heritage values of the site.	**No**	Section 4.5.1
		Rockshelters (AHIMS items) This performance indicator will be considered to be triggered if: • subsidence monitoring identifies visible perceptible change, e.g. rockfall, cracking, or toppling within rockshelters; and • these subsidence impacts result in impacts to the heritage values of the sites.	**No** *Note: These items are relevant to LW W1-W2 only.*	Section 4.5.1

	Negligible loss of heritage value**.	<u>Queen Victoria Memorial Hospital (local heritage significance)</u> This performance indicator will be considered to be triggered if subsidence monitoring identifies cracking of external brick work or other physical impacts to the historical heritage values of the building, measurable tilt and internal damage, or cracks in foundations.	**No**	Section 4.5.2 and 4.6
		<u>Mill Hill, Miller's House and archaeological relics (local heritage significance)</u> This performance indicator will be considered to be triggered if subsidence monitoring identifies damage to external cladding or internal finishes.	**No**	Section 4.5.2 and 4.6
		<u>Harmony House archaeological site (local heritage significance)</u> No performance indicators are currently established as impacts are predicted to be negligible. However, if the pre-mining assessment identifies that the cistern is located within the Study Area, this may need to be re-evaluated.	**No** *Note: The LW W1-W2 Heritage Management Plan assessed the probability of impacts to this heritage item from the proposed longwall mining as very unlikely. Therefore monitoring of this site has not been included in the monitoring program.*	Not applicable
		<u>Rural landscape – Thirlmere Way (local heritage significance)</u> No performance indicators are currently established as impacts are predicted to be negligible.	**No** *Note: The LW W1-W2 Heritage Management Plan assessed the probability of impacts to this heritage item from the proposed longwall mining as very unlikely. Therefore monitoring of this site has not been included in the monitoring program.*	Not applicable

Other Aboriginal and heritage sites (DA 67/98 Condition 13A)	Negligible subsidence impacts or environmental consequences**.	<u>Sandstone culverts (local heritage significance)</u> This performance indicator will be considered to be triggered if subsidence monitoring identifies visible perceptible impacts such as subsidence induced cracking, exfoliation, block movement or block fall.	**Yes** Cracking on sandstone culverts at 88.400 km and 88.980 km resulted in exceedance of subsidence performance indicators. DPIE and Heritage NSW were notified of this exceedance on 21 September 2021. Tahmoor Coal will complete remediation after the full effects of LW W3-W4 have been completed.	Sections 2.2.7, 4.5.2 and 4.6
		<u>Brick culverts (local heritage significance)</u> This performance indicator will be considered to be triggered if subsidence monitoring identifies visible perceptible impacts such as subsidence induced cracking, exfoliation, brick movement or brick fall.	**No**	Section 4.5.2 and 4.6
Built Feature Management				
Key Public Infrastructure: • Main Southern Railway; • Picton-Mittagong Loop Line; and • Electricity transmission lines and towers. (DA 67/98 Condition 13E)	Always safe and serviceable.	None allocated.	**No**	Section 4.6
	Damage that does not affect safety or serviceability must be fully repairable, and must be fully repaired.	None allocated.	**No**	Section 4.6
Other Infrastructure: • Electricity distribution lines, poles and associated towers; • Unsealed roads and road culverts, fire trails, fences and other built features; and • Other public infrastructure. (DA 67/98 Condition 13E)	Always safe.	None allocated.	**No**	Section 4.6
	Serviceability should be maintained wherever practicable.	None allocated.		
	Loss of serviceability must be fully compensated.	None allocated.		
	Damage must be fully repairable, and must be fully repaired or else replaced or fully compensated.	None allocated.	**No**	Section 4.6

Privately-owned residences (DA 67/98 Condition 13E)	Always safe.	None allocated.	**No**	Section 4.6
	Serviceability should be maintained wherever practicable.	None allocated.		
	Loss of serviceability must be fully compensated.	None allocated.		
	Damage must be fully repairable, and must be fully repaired or else replaced or fully compensated.	None allocated.	**No**	Section 4.6
Other privately-owned built features and improvements, including farm dams, swimming pools, tennis courts, roads, tracks and fences (DA 67/98 Condition 13E)	Always safe.	None allocated.	**No**	Section 4.6
	Serviceability should be maintained wherever practicable.	None allocated.		
	Loss of serviceability must be fully compensated.	None allocated.		
	Damage must be fully repairable, and must be fully repaired or else replaced or fully compensated.	None allocated.	**No**	Section 4.6
Public Safety (DA 67/98 Condition 13E)	Negligible additional risk**.	None allocated.	**No**	Section 4.6
Mine workings				
First workings (DA 67/98 Condition 13A)	To remain long term stable and non-subsiding.	None allocated.	**No**	Not applicable
Second workings (DA 67/98 Condition 13A)	To be carried out only within the approved mine plan, in accordance with an approved Extraction Plan.	None allocated.	**No**	Not applicable

NOTES:

* minor is defined as *not very large, important or serious* by DPIE.

** For the purpose of this Extraction Plan and associated documents, 'negligible' is defined as being 'so small and insignificant as to not be worth considering'. A negligible impact is viewed with regards to a long term context, causing little or no impact. If a short-term impact causes a greater than negligible impact, the impact can still be considered negligible if the impacts are of a limited duration and are considered negligible when considered over the long term.

4 Summary of Environmental Monitoring Results

This section provides a comprehensive summary of all quantitative and qualitative environmental monitoring results.

4.1 Subsidence Monitoring

During the reporting period, the LW W1-W2 Subsidence Monitoring Program and LW W3-W4 Subsidence Monitoring Program have been implemented to monitor subsidence impacts within the Study Area. The details of the Subsidence Monitoring Program are illustrated in **Figure 4-1** and **Figure 4-2**. The Subsidence Monitoring Program includes eighteen (18) Global Navigation Satellite System (GNSS) units measuring absolute horizontal and vertical positions in real time installed directly above and adjacent to LW W2-W4.

A summary of all surveys and inspections completed during the reporting period is provided in Figure A and Table 1 of the MSEC1149 LW W2 Subsidence Monitoring Report 28 and MSEC1204 LW W3 Subsidence Monitoring Report 3 (refer **Appendix A**). A weekly review of the subsidence survey results during the reporting period has been completed by Tahmoor Coal and MSEC.

As of 20 October 2021 (the end of this reporting period), 295 m of LW W3 had been extracted and extraction of LW W2 has been completed. The active subsidence area of LW W3 for 17 October 2021 is illustrated in **Figure 1-4**.

Table 4-1 summarises the maximum observed ground movements within the active subsidence zone at the start and end of this reporting period. During the reporting period, a maximum of 578 mm of vertical subsidence relating to the extraction of LW W2 has been recorded along the LW W1-W2 crossline survey.

Table 4-1 Subsidence Monitoring Observations for the start and end of this Reporting Period (source: MSEC, Subsidence Monitoring Reports 28 (LW W2) and 3 (LW W3), Appendix A)

	Report 28 (MSEC1149)		**Report 3 (MSEC1204)**	
General Information				
Monitoring Period	15/06/2021 – 12/09/2021		14/10/2021 – 20/10/2021	
Length of extraction	LW W2 completed		295 m (LW W3)	
Distance travelled by longwall since previous report	LW W2 completed (end of panel report)		66 m in the week	
Observed Ground Movement Parameters	**Maximum Observed Total**	**Location**	**Maximum Observed Total**	**Location**
Subsidence (mm)	578	LW W1-W2 Crossline	556	PMLL
Tilt (mm/m)	3.6	LW W1-W2 Crossline & Stonequarry Creek Road	3.5	PMLL
Hogging Curvature (km^{-1})	0.24	LW W1-W2 Crossline	0.13	PMLL
Sagging Curvature (km^{-1})	-0.18	LW W1-W2 Crossline	-0.13	PMLL
Tensile Strain (mm/m)	1.2	PMLL	1.1	PMLL
Compressive Strain (mm/m)	-4.7	PMLL	-1.7	PMLL
Subsidence since previous survey (mm)	10 mm	PMLL	38 mm	LW W3 Centreline & PMLL

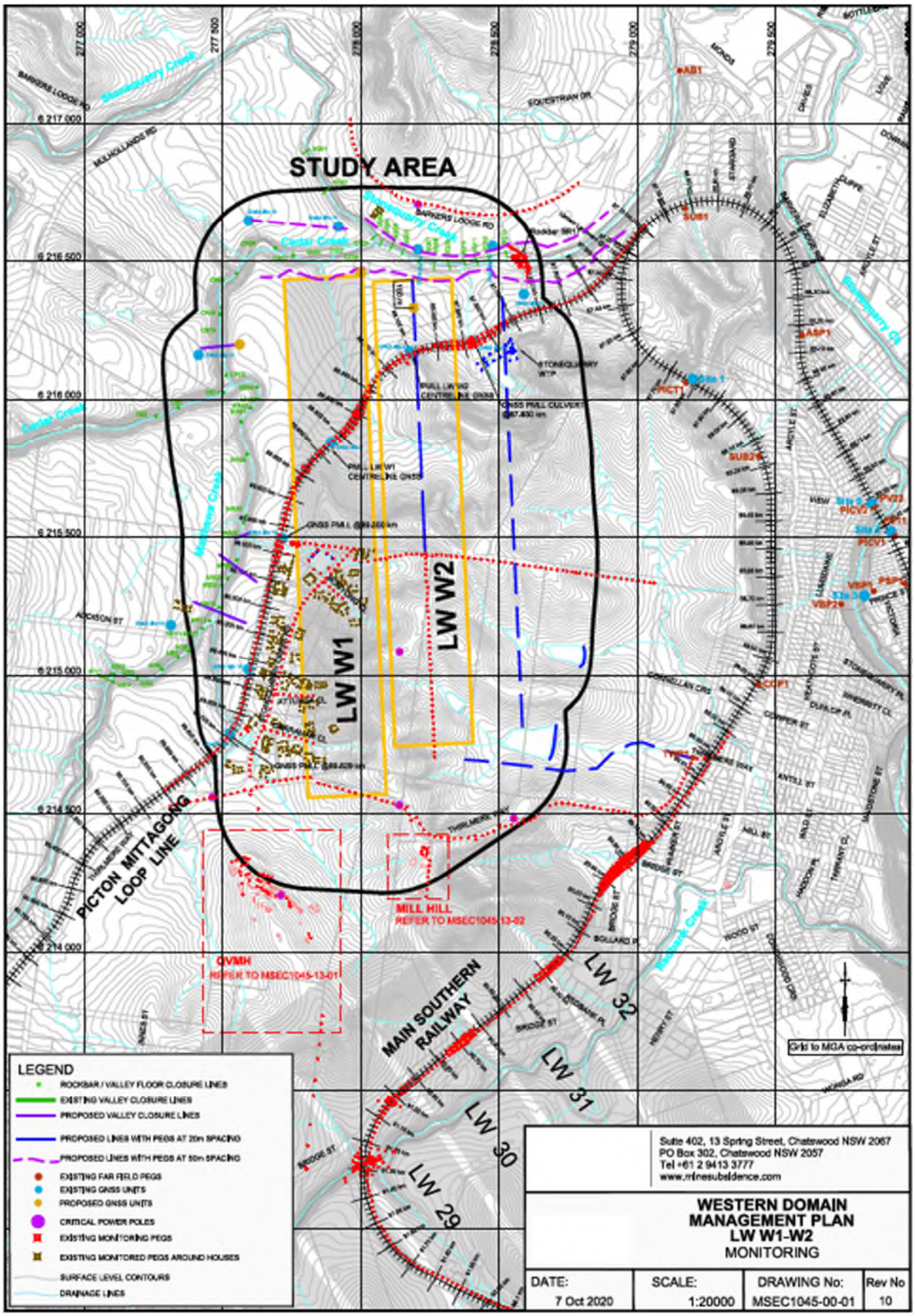

Figure 4-1 LW W1-W2 Subsidence Monitoring Program (source: LW W1-W2 Subsidence Monitoring Program)

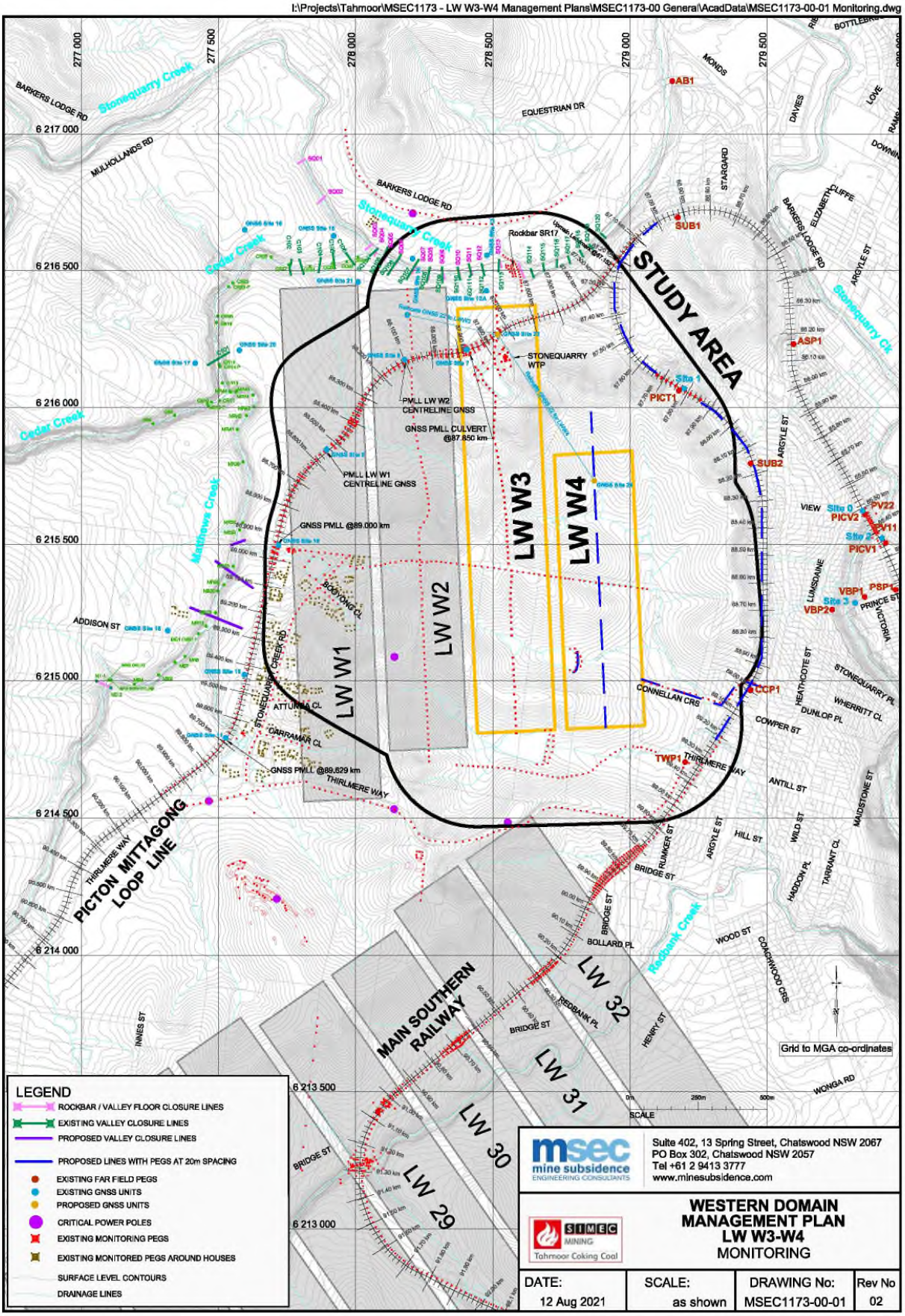

Figure 4-2 LW W3-W4 Subsidence Monitoring Program (source: LW W3-W4 Subsidence Monitoring Program)

4.1.1 Ground Survey Results

LW W2 Subsidence Observations

The development of subsidence on the LW W2 centreline and PMLL GNSS at 88.100 km is illustrated in **Figure 4-3**. Observations of subsidence development shows that the magnitude of vertical subsidence is greater than observed above LW W1, however current trends indicate that observed subsidence will be less than predicted subsidence.

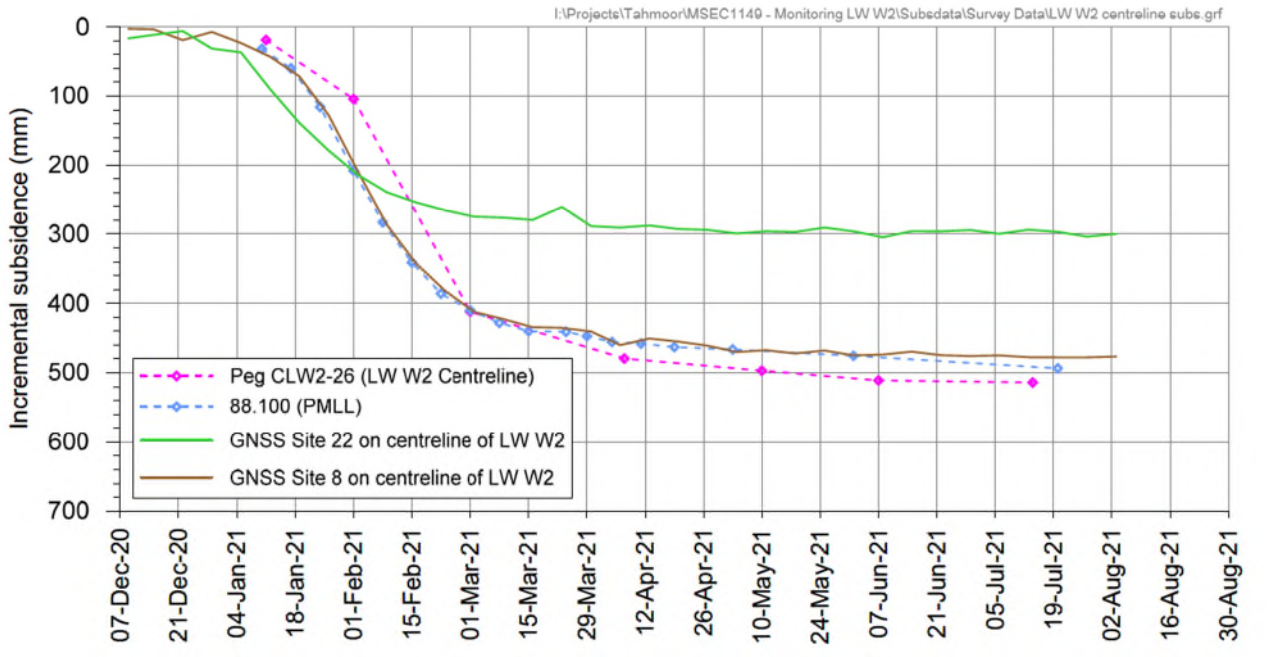

Figure 4-3 Development of subsidence along centreline of LW W2 (source: MSEC, Subsidence Monitoring Report 28, Appendix A)

LW W2 passed beneath the Picton to Mittagong Loop line at 88.13km on 12/01/2021. A final survey of the railway for LW W2 was conducted on 20 July 2021, which identified some minor issues. At the culvert at 88.400 km, an 8 mm wide crack in the vertical mortar joint at the Down side headwall and a 7 mm wide crack in a mortar joint at the Up side headwall were observed. Minor spalling of sandstone was also noted and a minor outward movement up to 8 mm of the headwall and wingwall relative to the culvert. Compressive strains have developed at 88.400 km to the side of the culvert, within the embankment fill, with minor changes observed in the final month of monitoring.

The first surveys within the Stonequarry Estate were conducted on 11 March 2021. Additional subsidence (up to 60 mm) was measured in the Estate since the final survey for LW W1. In the final survey for LW W2 on 14 July, very minor to minor changes in ground strain were observed in the Estate. Small compressive strains are developing in the active subsidence zone, and some minor impacts to roads and built structures have been noted in the Stonequarry Estate during the current monitoring period (refer to **Table 2-3** for more details).

A comparison between assessed and observed impacts to surface features is summarised in Table 3 of the MSEC Subsidence Monitoring Report 28 for LW W2 (refer to **Appendix A**).

LW W3 Subsidence Observations

The development of subsidence at pegs and GNSS units located on the LW W3 centreline that have been mined directly beneath by LW W3 are illustrated in **Figure 4-4**. This figure shows that subsidence currently observed along the centreline of LW W3 (represented by GNSS unit 23 is tracking with predictions and is currently greater than observations along the centreline of LW W2 at a similar stage of mining It is noted that the length of extraction of LW W3 has not yet reached a sufficient length for subsidence to fully develop above the longwall panel.

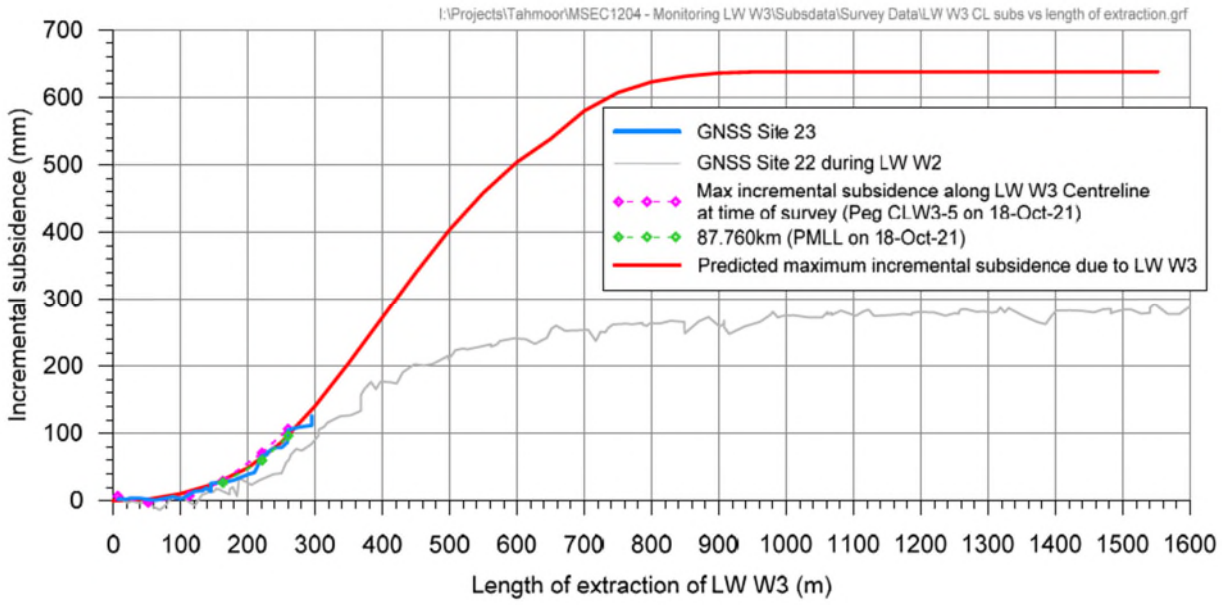

Figure 4-4 Development of subsidence along centreline of LW W3 (source: MSEC, Subsidence Monitoring Report 3, Appendix A)

Monthly and weekly surveys have commenced for the Picton to Mittagong Loop Line and the Main Southern Railway, and a maximum of 96 mm of vertical subsidence has been measured along the PMLL railway during LW W3. No issues have been identified by visual inspections at this early stage on either railway line.

A comparison between assessed and observed impacts to surface features is summarised in Table 2 of the MSEC Subsidence Monitoring Report 3 (refer to **Appendix A**).

4.1.2 GNSS Monitoring Observations

Some trends can be seen in the results of the observed GNSS movements with the closest GNSS units generally moving towards the extracted panel as expected. Results from all GNSS units, including incremental horizontal movements, are presented in the MSEC Subsidence Monitoring Reports (refer **Appendix A**).

Changes in horizontal distances between GNSS units stationed near each other and on opposite sides of a waterway as a result of the extraction of LW W2 and LW W3 are shown in **Figure 4-5**.

Site 12 and Site 13 are located across Stonequarry Creek at Rockbar SR17. As previously reported, Site 12 appeared to have been affected by the heavy rainfall event between 7 and 9 February 2020, resulting in swelling of clay soils around the unit and movement of the sensor. If the movements during the week after the wet weather event on 7 and 9 February 2020 are removed from the results, the resultant movements at Site 12 would be similar in magnitude to the movements measured at Site 13.

Site 13 moved south more than Site 12, resulting in closure of approximately 20 mm since the commencement of LW W2. Very little change is, however, measured across the rockbar itself and rates of change have reduced. Site 12 was observed to rise in height in response to the heavy rainfall event in late March. Site 12 has now been relocated to a new site where the unit is mounted on sandstone. The site is named Site 12a.

Sites 14 and 22 are located across Stonequarry Creek to the north of LW W2. The units moved towards each other by approximately 10 mm during early January, but have since moved apart approximately 60 mm as the longwall face moved away to the south. Rates of change are reducing.

During LW W3 extraction, only minor changes have been observed between the GNSS units.

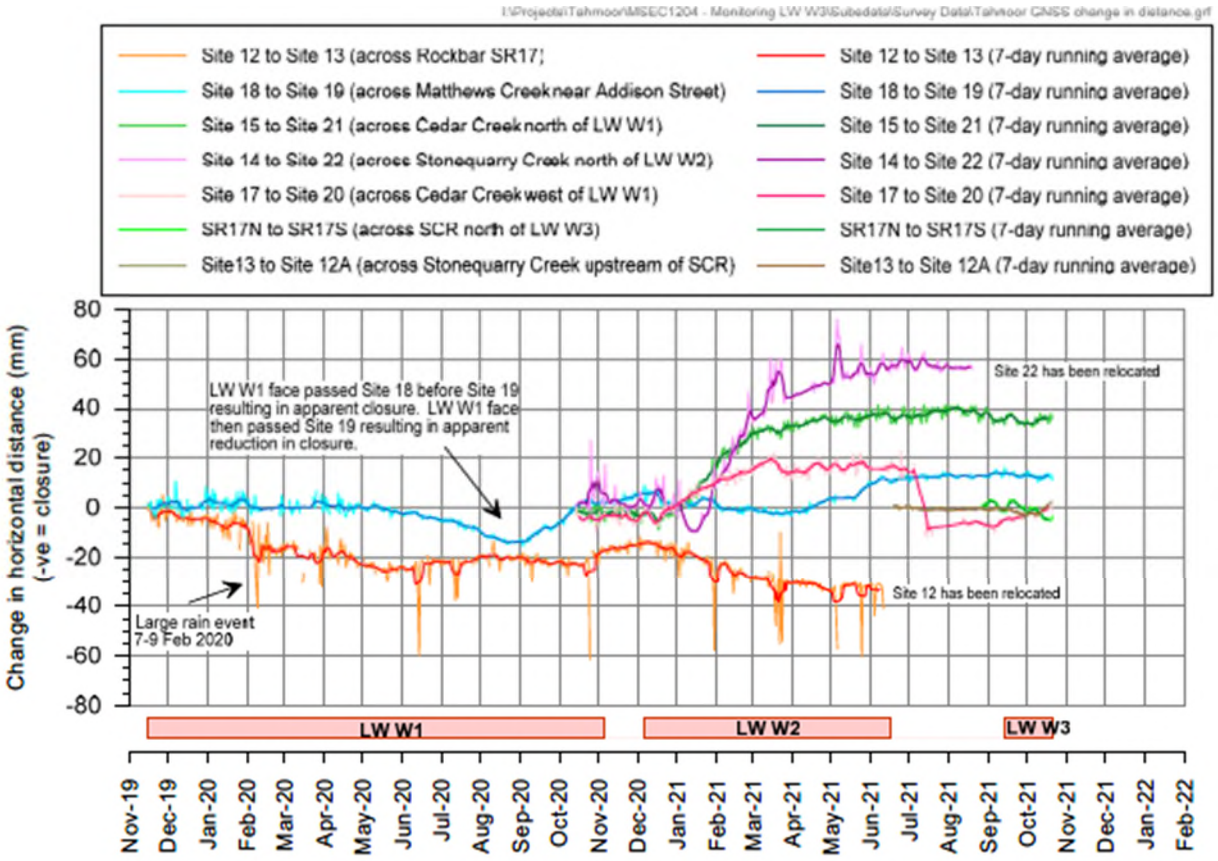

Figure 4-5 Observed changes in horizontal distances between GNSS units during LW W2 and LW W3 extraction (source: MSEC, Subsidence Monitoring Report 3, Appendix A).

4.1.3 Valley Closure in Creeks

Survey marks installed across rockbars in Stonequarry Creek, Cedar Creek and Matthews Creek prior to the commencement of LW W1 are illustrated in **Figure 4-1** and **Figure 4-2**.

Along Stonequarry Creek, the last survey for LW W2 movements was completed on 31 August 2021 and observed small changes in closure at SQ104 and SQ105, with rates of change appearing to be slowing. In contrast, measured changes in distance between GNSS units across Cedar and Stonequarry Creeks have measured a gradual ground extension. The most recent survey for the measurement of LW W3 movements was completed on 20 October 2021, and observed small changes including minor closure developing across SQ104, SQ105, SQ106 and SQ107.

The last survey for LW W2 movements at Rockbar SR17 was completed on 30 August, which observed minor changes in horizonal distances both along and across the rockbar. These observations were also noted during the most recent survey for LW W3 movements on 21 October.

Surveys across the newly installed closure marks on Cedar Creek completed on 30 August indicated that minor changes had occurred. Further survey of these marks during the extraction of LW W3 has recorded a measurable change is distance between the valley closure survey sites (C101-1 and C101-2).

The most recent survey of Matthews Creek for LW W2 impacts was completed on 1 September 2021, which observed minor changes. Further survey on 6 October also observed minor changes.

4.2 Water Monitoring

The LW W1-W2 Water Management Plan and LW W3-W4 Water Management Plan were prepared to manage the potential environmental consequences of LW W1-W2 and LW W3-W4 extraction on surface water and groundwater systems in accordance with Condition 13H(vii)I of DA 67/98.

During this reporting period, the LW W1-W2 Water Management Plan and the LW W3-W4 Water Management Plan have been implemented to monitor the following surface water and groundwater systems:

- Surface Water:
  - Flow, pool water level and surface water quality monitored for Stone quarry Creek, Cedar Creek and Matthews Creek – monitoring data reviewed and reported by Hydro Engineering & Consulting (refer to **Appendix B** for referenced reports);
  - Creek monitoring for natural drainage behaviour – visual inspections and reporting by GeoTerra and Brienan Environment and Safety;
- Groundwater:
  - Shallow groundwater levels, quality and pressures, and deep groundwater levels / pressures – monitoring data reviewed and reported by SLR (refer to **Appendix C** for Six Monthly Report); and
  - Mine water intake – data for this reporting period reviewed and reported by SLR (refer to **Appendix C** for Six Monthly Report).

Performance against all Water Management Plan TARPs for the reporting period are summarised in **Table 2-3**. The following sections summarise the observations made during the reporting period for each surface water and groundwater category.

4.2.1 Stonequarry Creek Flow

In accordance with the LW W1-W2 Water Management Plan, the downstream reduction in catchment flow rate recorded at the WaterNSW gauging station Stonequarry Creek at Picton (GS212053) was to be assessed. The assessment method relied on a calibrated streamflow model which enabled comparison of modelled and monitored streamflow rates. The locations of GS212053 is illustrated in **Figure 4-6**.

The rating curve for Stonequarry Creek at Picton (GS212053) was revised by WaterNSW in July and November 2020 and, as such, the streamflow records for the site have changed thereby invalidating the previous model calibration. Despite attempts to recalibrate the streamflow model, challenges were encountered due to the limitations of the gauging station at Stonequarry Creek at Picton (GS212053), the limitations of catchment rainfall records, water extraction from Stonequarry Creek catchment and the inability to adequately match the monitored and modelled flows. As such, the assessment method, and subsequently assessment of trigger exceedances in relation to catchment flow rate in Stonequarry Creek at Picton, have been discontinued.

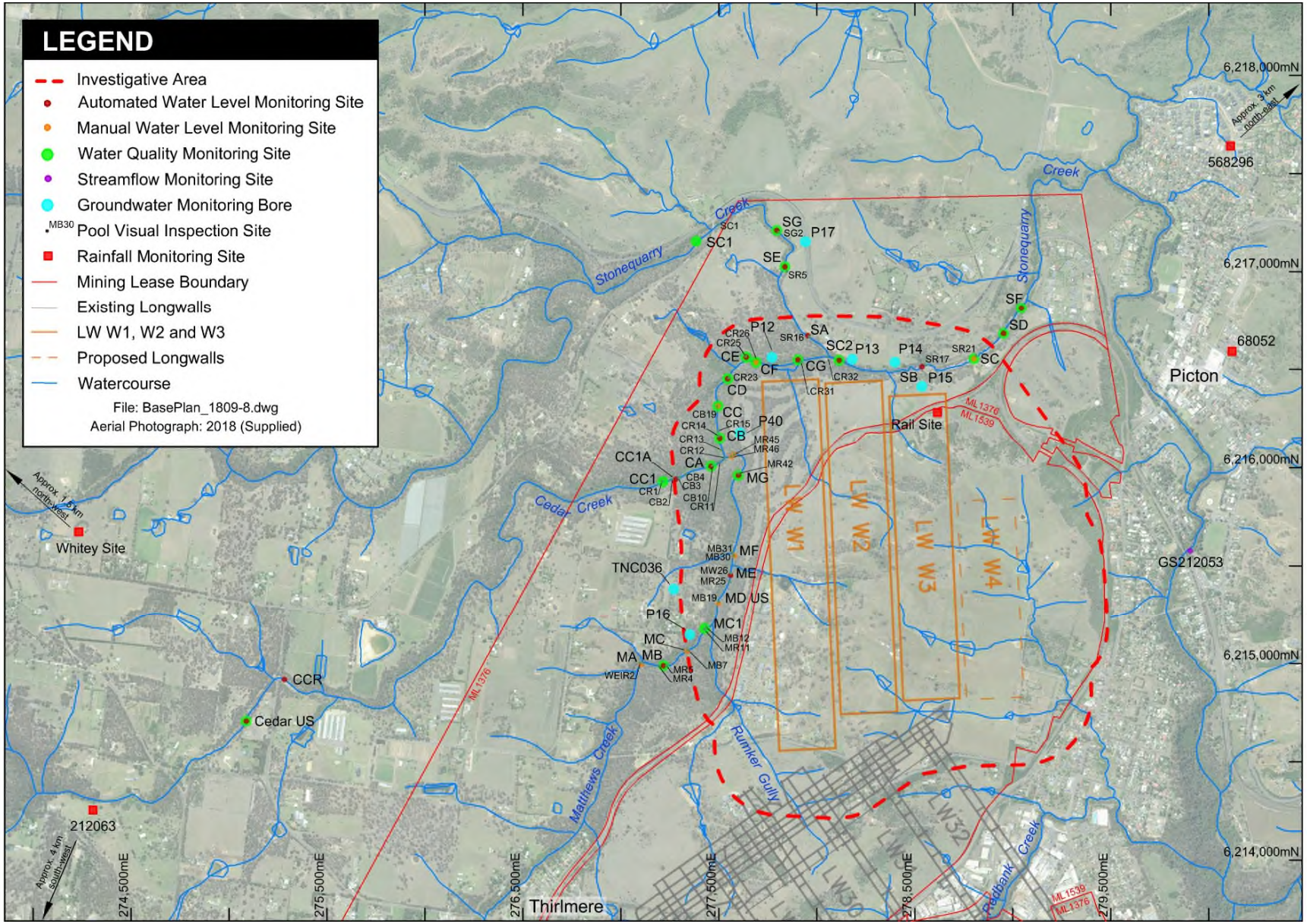

Figure 4-6 LW W1-W4 Surface Water Monitoring Locations (source: HEC, Surface Water Review, Appendix B)

4.2.2 Pool Water Level

Surface water level data has been recorded at the pool monitoring sites on Matthews Creek, Cedar Creek and Stonequarry Creek as shown in **Figure 4-6**. Continuous surface water level data has been recorded at three pool monitoring sites on Matthews Creek, eight monitoring sites on Cedar Creek and seven monitoring sites on Stonequarry Creek. Manual water level measurements have also been undertaken monthly at the sites shown in **Figure 4-6**.

During the reporting period, most monitoring sites on Matthews Creek, Stonequarry Creek, and Cedar Creek water levels remained above minimum baseline levels and/or consistent with baseline conditions. The water level records for monitoring site CD (Pool CR23) declined to just below the baseline minimum for a brief period in late April and again in late August. More notable declined in water level were noted at monitoring sites CB and SG during the reporting period, which are discussed below.

Charts illustrating monitored pool water level hydrographs for pools on Matthews Creek, Cedar Creek and Stonequarry Creek are presented in Charts A1-25 in Attachment A of the Surface Water Monitoring Report (refer to **Appendix B**).

Monitoring site CB

The water level records for monitoring site CB (pool CR14) in Cedar Creek indicated that water level declined below the baseline minimum for parts of July, August and September with a maximum of 28 mm decline below the baseline minimum recorded on 21 August. The water level was recorded slightly below the baseline minimum at the end of the review period (5 mm below). During the periods of water level decline the water level remained above the previously recorded minimum and did not decline atypically (refer to **Appendix B**).

For the periods 20 to 24 July, 27 July to 4 August, 6 to 24 August and 9 to 12 September 2021, a Level 2 TARP significance in relation to pool water level decline at monitoring site CB has been derived in accordance with the LW W1-W2 WMP. In accordance with the LW W3-W4 Water Management Plan, a Level 3 TARP significance in relation to pool water level decline at monitoring site CB has been derived for the period 13 to 30 September 2021. It should be noted that the water level decline was relatively small (22 mm below the baseline minimum) and likely related to the prevailing below average rainfall conditions in combination with a slight increase in losing conditions at monitoring site CB during this period (refer to **Appendix B**).

Monitoring site SG

Water level at monitoring site SG (pool SG2) indicated a declining trend in water level associated with below average rainfall from 20 May to 23 August 2021. Water level declined by a maximum of 53 mm below the previously recorded minimum. The water level then rose in response to a rainfall event in late August and declined to a historical minimum on 12 September before rising slightly again towards the end of the review period (refer to **Appendix B**).

Based on the groundwater level records for P17 and P13, it has been inferred that the pool at monitoring site SG was likely gaining from the groundwater system during the review period, with groundwater recharge to the stream inferred to increase at a similar magnitude to baseline conditions during the review period. Water level records for sites further downstream of monitoring site SG in Stonequarry Creek (i.e. monitoring sites SE, SA, SB) indicate that the water level did not decline below the baseline or previously recorded minimum during the review period. As such, there is no indication of a mining related effect on pool water level in the reach of Stonequarry Creek within or upstream of the Investigative Area.

Visual inspection records and site photographs indicate that the pool appears to be controlled by a shallow cobble/boulder mound. It is likely that surface flow at monitoring site SG passes beneath the shallow cobble/boulder mound control and/or infiltrates into the heavily vegetated soil banks resulting in a decline in pool water level which appears inconsistent with water level records for all other monitored pools. As such, a Level 2 TARP significance in relation to pool water level decline at reference site SG has been derived for the periods 20 May to 23 August 2021 and 1 September to 30 September 2021.

4.2.3 Natural Drainage Behaviour

Visual and photographic surveys for subsidence impacts on creeks have been completed monthly for all monitoring pools on Stonequarry Creek, Cedar Creek and Matthews Creek within the active subsidence zone of LW W2 and LW W3, with additional monitoring conducted fortnightly on pool monitoring sites CA, CB, CC1A, MR45 and MR46 from January 2021 until the end of LW W2 mining. The purpose of these surveys is to note whether change has occurred to pool level, drainage or overland flow, and to assist in determining if any change can be attributed to mining impacts. Surveys are carried out to identify rock bar and/or stream base cracking, gas release, or increased iron precipitation.

Creek monitoring locations are illustrated on **Figure 4-7**, and a summary of creek observations for the reporting period is provided in **Table 4-2**.

During the reporting period, pool water level and overland connective flow was influenced by rainfall events in March 2021 and resulting catchment base-flow recharge. Some minor iron oxyhydroxide precipitation was observed in pools within all creeks, however these levels did not exceed pre-Longwall West 1 baseline levels.

Up to the end of this reporting period, there have been no creek bed cracking evident in Cedar Creek, Matthews Creek or Stonequarry Creek.

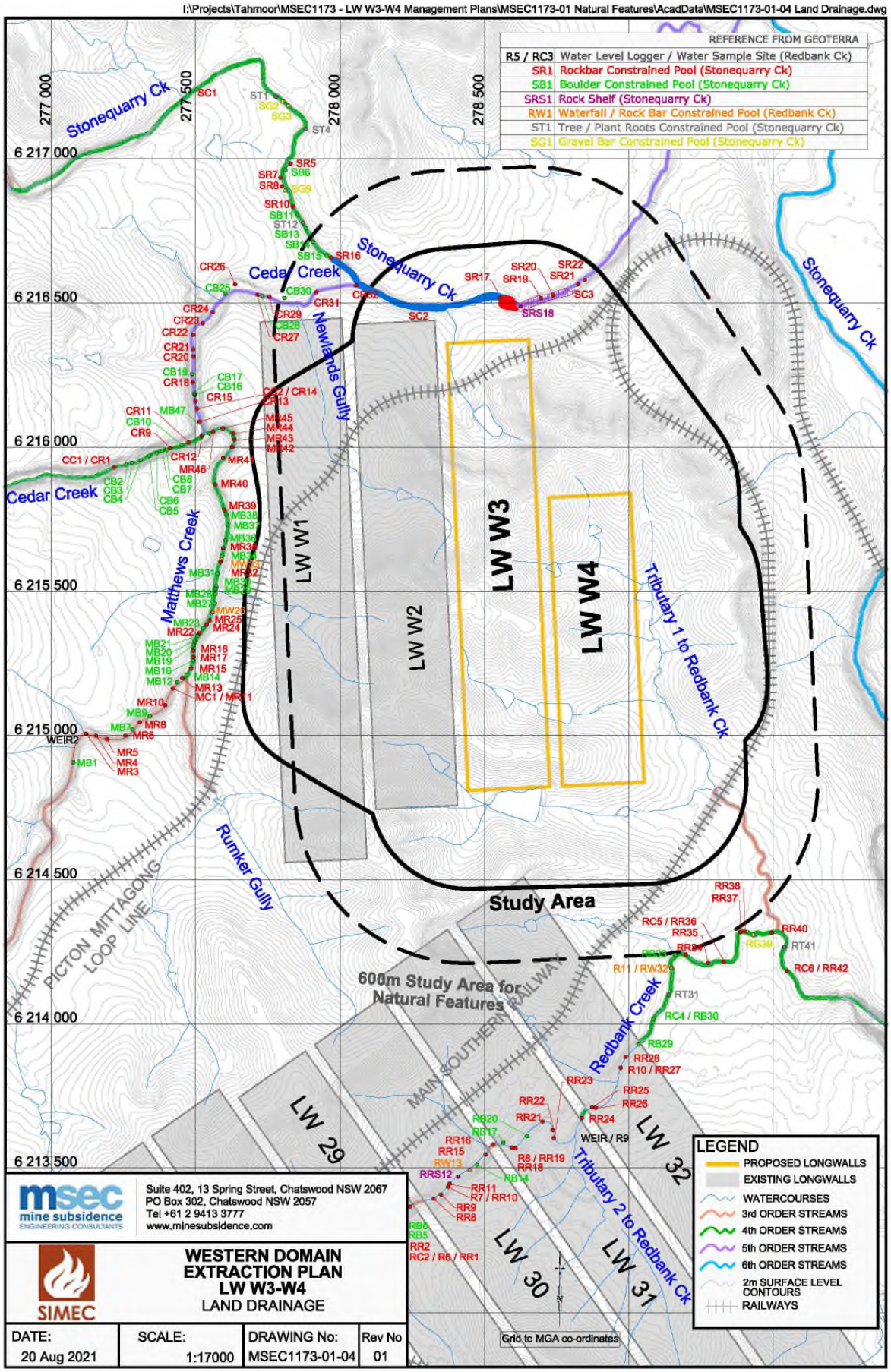

Figure 4-7 LW W3-W4 Creek Monitoring Locations (source: MSEC, 2021; LW W3-W4 Subsidence Predictions and Impact Assessment Report)

Table 4-2 Creek Monitoring Observations for the Reporting Period

	April Report 19th & 28th April 2021	May Report 10th & 17th May 2021	June Report 21st & 28th June 2021	September Report 23rd Sep & 1st October 2021	October Report 18th & 27th October 2021
Stonequarry Creek					
Observations of individual pool water level and flow	• No observable mining induced related impacts such as reduction in pool level or connective overland flow.	• No observable mining induced related impacts such as reduction in pool level or connective overland flow.	• No observable mining induced related impacts such as reduction in pool level or connective overland flow.	• No observable mining induced related impacts such as reduction in pool level or connective overland flow.	• No observable mining induced related impacts such as reduction in pool level or connective overland flow.
Surface cracking	No surface cracking was reported during the review period.				
Iron hydroxide precipitation	• No increase in iron hydroxide precipitation observed.	• No increase in iron hydroxide precipitation observed.	• No increase in iron hydroxide precipitation observed.	• Extensive iron hydroxide precipitation observed downstream of site SC1, however did not exceed pre-Longwall West 1 baseline levels.	• Extensive iron hydroxide precipitation observed at pools SR16 and SR20, however did not exceed pre-Longwall West 1 baseline levels.
Gas Releases	No gas releases were observed in pools on Cedar Creek.				
Cedar Creek					
Observations of individual pool water level and flow	• Pool levels elevated and overland connective flow observed following recent significant rain event.	• Pool levels elevated and overland connective flow observed following recent significant rain event.	• "Normal" pool levels and stream flow observed.	• "Normal" pool levels and stream flow observed.	• "Normal" pool levels and stream flow observed.
Surface cracking	No surface cracking was reported during the review period.				
Iron hydroxide precipitation	• No increase in iron hydroxide precipitation observed.	• No increase in iron hydroxide precipitation observed.	• Minor iron oxy-hydroxide precipitation noted at pools CR12, CR13, CR22, CR27, CB28 and CR29. However, this level was attributed to a higher proportional groundwater baseflow contribution to the stream flow, rather than mining impacts.	• Minor iron oxy-hydroxide precipitation noted at pools CB7, CR11/12, CR14, CR25 CR29 and CB30. However, this level did not exceed pre-Longwall West 1 baseline levels.	• Minor iron oxy-hydroxide precipitation noted at pools CB7, CR11/12, CR14, CR25 CR29 and CB30. However, this level did not exceed pre-Longwall West 1 baseline levels.
Gas Releases	No gas releases were observed in pools on Cedar Creek.				

	April Report 19th & 28th April 2021	May Report 10th & 17th May 2021	June Report 21st & 28th June 2021	September Report 23rd Sep & 1st October 2021	October Report 18th & 27th October 2021
Matthews Creek					
Observations of individual pool water level and flow	• Most pools elevated and overland connective flow observed following rain event. • Pools MB20-MB23 and MB38 had no overland flows.	• Pools elevated and overland connective flow observed following rain event.	• "Normal" pool levels and stream flow observed at most sites. • Pools MB20-MB23 and MB38 dry or very low.	• "Normal" pool levels and stream flow observed at most sites.	• "Normal" pool levels and stream flow observed at most sites.
Surface cracking	No surface cracking was reported during the review period.				
Iron hydroxide precipitation	• No increase in iron hydroxide precipitation observed.	• No increase in iron hydroxide precipitation observed.	• No increase in iron hydroxide precipitation observed.	• Minor iron oxy-hydroxide precipitation noted at pools MR32, however did not exceed pre-Longwall West 1 baseline levels.	• Minor iron oxy-hydroxide precipitation noted at pools MR32, however did not exceed pre-Longwall West 1 baseline levels.
Gas Releases	None observed.				

4.2.4 Surface Water Quality

Surface water quality data has been recorded at the following sites (refer to **Figure 4-6**):

- Cedar Creek: Cedar US, CC1, CA, CB, CC, CD, CE, CF, CG;
- Matthews Creek: MC1, MB, MG; and
- Stonequarry Creek: SC1, SC2, SC, SD, SE, SF, SG.

Field analyses are undertaken for pH, electrical conductivity (EC), dissolved oxygen, temperature and oxidation reduction potential. Laboratory analyses are undertaken for pH, EC, total dissolved solids (TDS), alkalinity, sulphate, chloride, calcium, magnesium, sodium, potassium, fluoride, nitrate+nitrite, total kjeldahl nitrogen, phosphorus and the following total and dissolved metals: aluminium, arsenic, barium, copper, lead, lithium, manganese, nickel, selenium, strontium, zinc and iron.

A summary of observations for the reporting period is provided in **Table 4-3**.

Charts illustrating water quality results for monitored pools on Matthews Creek, Cedar Creek and Stonequarry Creek are presented in Charts B1-11 in Appendix B of the Surface Water Review (refer to **Appendix B**).

To date, there has been negligible evidence of an influence of mining LW W1, LW W2 or LW W3 on surface water quality in Matthews Creek, Cedar Creek or Stonequarry Creek. The water quality characteristics of monitoring sites following commencement of mining LW W1, LW W2, and LW W3 have been consistent with baseline conditions and / or consistent with reference site conditions.

Although isolated occurrences of elevated water quality constituents were recorded at some monitoring sites on Matthews Creek, Cedar Creek and Stonequarry Creek during the period 1 April to September 2021, the elevated levels were either not in excess of baseline conditions or were also elevated at an upstream reference site.

Table 4-3 Summary of Notable Results for Key Water Quality Parameters for the Reporting Period

Parameter	Matthews Creek	Cedar Creek	Stonequarry Creek
pH	The field pH values indicate near neutral to slightly alkaline pH conditions for the duration of the review period, consistent with baseline values.	The field pH values indicate near neutral to slightly alkaline pH conditions for the duration of the review period, consistent with baseline values.	The field pH values indicate near neutral to slightly alkaline pH conditions for the duration of the review period, consistent with baseline values.
Electrical Conductivity	Field EC values were consistent with baseline values for the duration of the review period (less than 332 µS/cm at all sites).	Field EC values were consistent with baseline values for the duration of the review period (less than 475 µS/cm at all sites).	Field EC values were consistent with baseline values for the duration of the review period (less than 760 µS/cm at all sites).
Dissolved Aluminium	Dissolved aluminium concentrations were generally lower in comparison to the previous six-month period and were consistent with baseline values. A slightly elevated dissolved aluminium concentration of 0.07 mg/L was recorded at monitoring site MC1 in June. For the remainder of the review period and for all other monitoring sites in Matthews Creek, dissolved aluminium concentrations were equal to or below 0.03 mg/L.	Dissolved aluminium concentrations were generally lower in comparison to the previous six-month period and were consistent with baseline values. For the duration of the review period and for all monitoring sites in Cedar Creek, dissolved aluminium concentrations were equal to or below 0.03 mg/L.	Dissolved aluminium concentrations were lower in comparison to the previous six-month period and were consistent with baseline values. For the duration of the review period the dissolved aluminium concentrations were equal to or below the limit of detection at all sites in Stonequarry Creek (0.01 mg/L).
Dissolved Iron	Dissolved iron concentrations recorded at each monitoring site were equal to or less than 1.8 mg/L for the duration of the review period and consistent with baseline values.	Dissolved iron concentrations recorded at each monitoring site were equal to or less than 0.61 mg/L and consistent with baseline values.	Dissolved iron concentrations recorded at each monitoring site were equal to or less than 0.57 mg/L and consistent with baseline values.
Dissolved Manganese	Dissolved manganese concentrations were less than 0.04 mg/L at all sites during the review period and consistent with baseline values.	The dissolved manganese concentration recorded in September at reference site Cedar US was slightly elevated (0.67 mg/L) compared with the remainder of the review period, although was consistent with baseline values. Dissolved manganese concentrations recorded at all other sites for the duration of the review period were less than 0.21 mg/L and consistent with baseline values.	Dissolved manganese concentrations were less than or equal to 0.25 mg/L at all sites and consistent with baseline values.
Dissolved Nickel	Dissolved nickel concentrations were less than 0.002 mg/L at all sites during the review period and consistent with baseline values.	Dissolved nickel concentrations were less than 0.004 mg/L at all sites during the review period and consistent with baseline values.	Dissolved nickel concentrations were less than 0.002 mg/L at all sites during the review period and consistent with baseline values.

Parameter	Matthews Creek	Cedar Creek	Stonequarry Creek
Dissolved Zinc	Dissolved zinc concentrations were low (equal to or less than 0.005 mg/L) at all sites and consistent with baseline values.	Dissolved zinc concentrations were equal to or less than 0.026 mg/L at all sites and consistent with baseline values.	Dissolved zinc concentrations were less than 0.014 mg/L at all sites during the review period and consistent with baseline values.
Sulphate	An increasing trend in sulphate concentrations was recorded at all sites between April and September although the values were consistent with baseline concentrations (equal to or less than 12 mg/L at all sites during the review period).	An increasing trend in sulphate concentrations was recorded at all sites between April and September although the values were consistent with baseline concentrations (equal to or less than 10 mg/L at all sites during the review period).	An increasing trend in sulphate concentrations was recorded at all sites between April and September although the values were consistent with baseline concentrations (equal to or less than 19 mg/L at all sites during the review period).

4.2.5 Groundwater Quality

A total of 17 open standpipe piezometers (OSPs) have been installed at six locations in the Western Domain – P12 to P17. A number of private groundwater bores also form part of the groundwater monitoring program for LW W1-W2 and LW W3-W4. The locations of these groundwater bores are illustrated in **Figure 4-8**.

Further detail on the above groundwater quality triggers, including graphs showing progressive groundwater quality results for pH, electrical conductivity (EC) and selected metals, are provided in the SLR Groundwater Six-month Review (refer to **Appendix C**). Further detail and discussion of TARP triggers for groundwater quality are also discussed in **Section 2.2.2**.

Electrical conductivity and pH

During this reporting period, all EC measurements from the Tahmoor standpipes are within the Level 1 TARP criteria except the last monitoring round in October where standpipes P12C showed an exceedance of the EC TARP Level 2 trigger. In addition, private bores GW104090 and GW115860 showed a TARP Level 2 EC trigger exceedance in the July monitoring round, with GW115860 also showing an exceedance in October 2021.

Three monitoring sites have triggered pH trigger levels within this six-monthly monitoring period. P12A and P12B has triggered the upper pH trigger limit whilst P12C has triggered the lower pH trigger limit.

The recovery in groundwater levels at the deeper of the open standpipe is accompanied with a stable pH and EC across the Western Domain. Further monitoring is required at site P12 following the recent rise in pH and EC in October 2021. No significant change in pH and EC is recorded for the shallow groundwater, with all results within TARP Level 1 for this reporting period.

Metal concentrations

The following metal triggers were exceeded over the six-monthly monitoring period in the respective bores (**Appendix C**):

- Iron (Fe) – P12A (October), P15D (October), and P16B (all months);
- Copper (Cu) – P13A (June), P13C (May), and P14A (May);
- Zinc (Zn) – P13C, P14C, P14D, P16A, P16B, and P16C (all exceedances in June), P12C (October), P16B (October), GW115860 (October);
- Aluminium (Al) – P12B (October), P14A (May, July, October), P14B (May, June), P17 (May, June, July, and August), and GW072402 (July);

- Lithium (Li) – P12A, P12B, P14A, P16B (all September), P13C (May, June, July and October), P16A (May and September), and GW115860 (October);
- Barium (Ba) – P14D (June), GW115860 (July and October) and GW105467 (July);
- Strontium – P15A, P15B, P15C, P15D (all October), P16B (July and August) and GW105228 (July); and
- Manganese – P12C (October), P16B (July), GW15860 (October).

Most of the exceedances in metal concentrations reported during the review period are short-term increase (less than three months).

Metal concentration exceedances (TARP Level 2) that remain active as of October 2021 included Fe (P12A P15C and D, P16B), Al (P12B), Mn (P12C, P16B), Zn (P16B), Li (P13C), Sr (P15C, D). Exceedances in Fe at P16B are likely due to iron staining in the bore (previously observed during bore census conducted by GeoTerra in 2019).

The shallowest open standpipes at the Western Domain show no signs of depressurisation due to mining (less than 1 m) but show short-term fluctuation (less than 3 months) in Li (P12A, P14A, P16A), Al (P14A, P17), Cu (P13A, P14A), Zn (P16A) and Sr (P15A) and returning to non-exceedance levels as of October 2021 (except for P15A (Sr)).

Single exceedances in metal concentrations have been recorded in some private bores during the reporting period. There are no clear trends in metal concentrations that may be linked to mining operations. Metal concentration exceedances (TARP Level 2) remain active as of October 2021 for Mn, Zn and Ba (GW115860).

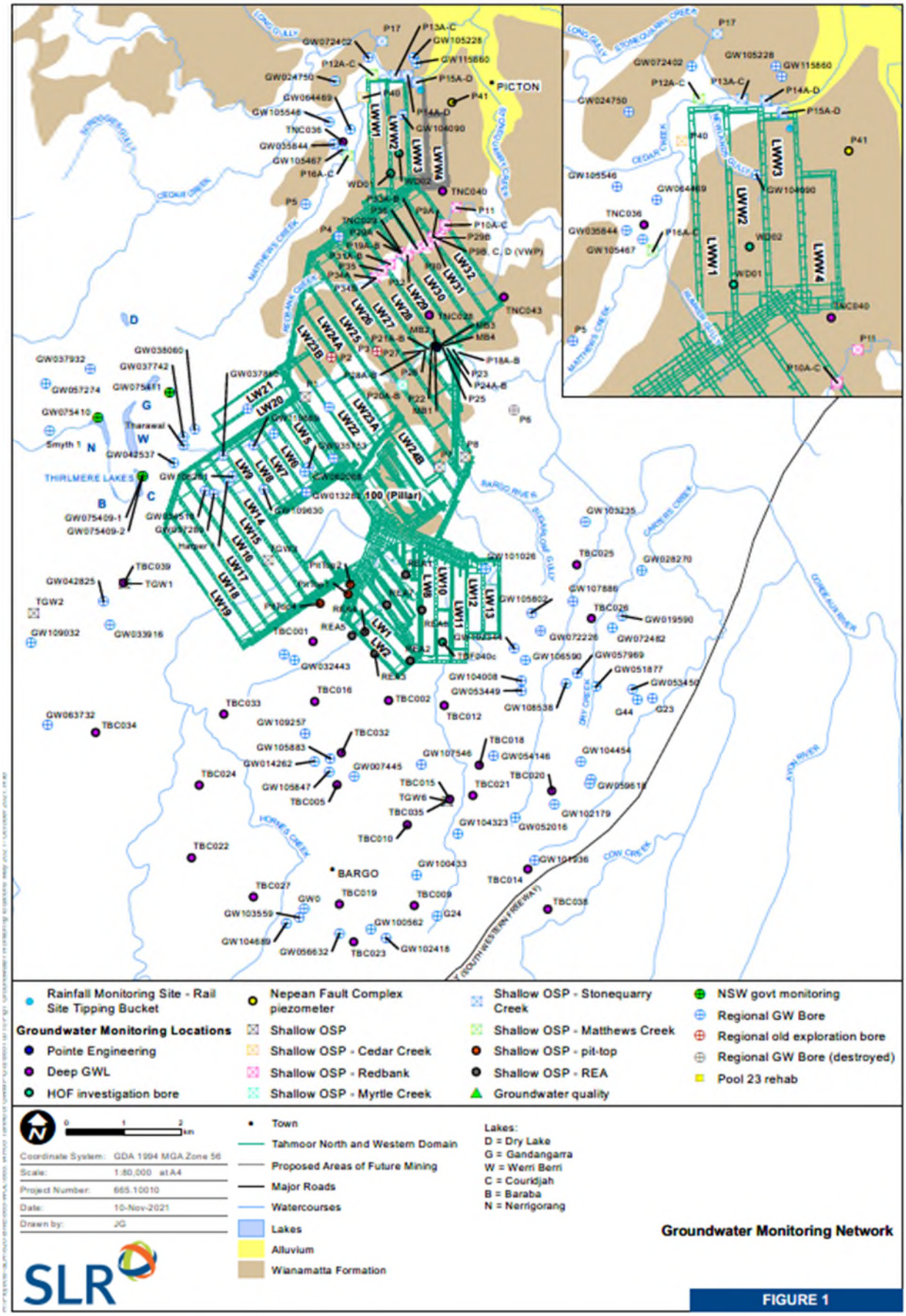

Figure 4-8 LW W1-W4 Groundwater Monitoring Bores (source: Groundwater Six-Month Review, SLR; Appendix C)

4.2.6 Groundwater Bore Levels

A total of 17 OSPs have been installed at six locations in the Western Domain – P12 to P17. A number of private groundwater bores also form part of the groundwater monitoring program for LW W1-W2 and LW W3-W4. The locations of these groundwater bores are illustrated in **Figure 4-8**.

Further detail on the below groundwater level triggers, including graphs showing progressive groundwater levels, are provided in the SLR Groundwater Six-month Review (refer to **Appendix C**). Further detail and discussion of TARP triggers for groundwater level are also discussed in **Section 2.2.3**.

Monitoring bores

The following groundwater bore level exceedances occurred during the six-monthly monitoring period in the respective bores (**Appendix C**):

- TARP Level 4 at the shallow open standpipe P13C during May and June, with a reduction in TARP to Level 2 in July and to Level 1 in August 2021 as groundwater levels recovered. In September 2021, a TARP Level 2 applies due to change in TARP level;
- TARP Level 4 at the shallow open standpipe P16B between May and August 2021, with a reduction in TARP to Level 2 in September 2021 and October 2021 as groundwater levels recovered;
- TARP Level 4 at the shallow open standpipes P16C between May and August 2021, with a reduction in TARP to Level 3 in September 2021 and October 2021;
- TARP Level 4 at the shallow VWP sensors at TNC036 (HBSS-65m) in May and June, with a reduction in TARP to Level 2 in July and Level 1 from August 2021 to October 2021 as groundwater levels recovered;
- TARP Level 4 at the shallow VWP sensors at TNC036 (HBSS-97m) across the whole reporting period;
- TARP Level 4 at the shallow VWP sensors at TNC036 (BGSS-169m) from May to August 2021, with a reduction to TARP Level 2 from September 2021 as groundwater levels recovered; and
- TARP Level 2 at the two deep VWP sensors at TNC036 (BGSS-214m and BGSS-412.5m) throughout the six-monthly reporting period.

All other groundwater monitoring sites remained within TARP Level 1 across the reporting period.

A period of groundwater recovery was identified in the mid Hawkesbury Sandstone aquifer at the open standpipes P12C, P13C, P16B and P16C. Groundwater recovery at site P14 (i.e. to a lesser extent) is also observed. The groundwater recovery is associated with the completion of LW W1 and LW W2, and wetter condition in February and March 2021.

The groundwater recovery started in April 2021 at monitoring sites north of the LW W1-W2 (i.e. P12, P13) while recovery started in June 2021 at site adjacent to LW W1-W2 (i.e. P16 and TNC036). The difference in timing could be associated with fracturing of the strata due to valley closure along the western side of LW W1 (i.e. increase in porosity hence storage leading to take more time to recover). Re-pressurisation of the lower Hawkesbury Sandstone (i.e. P12C and P13C) is suggested with the hydraulic gradient reversing from downward to upward in July 2021. The rate in groundwater recovery slowdown from July and August 2021 and water levels are stable by early September 2021.

Medium-term impact on shallow groundwater levels is identified at site P16A and P17 with groundwater levels remaining respectively 0.6m and 0.2m below baseline level. It is considered that the partial recovery in groundwater level could incur potential on-going reduction in baseflow (i.e site CB) but water levels at P40 (i.e closest monitoring site to CB) show water levels in the upper strata being within creek level/slightly above pool water level. This implies that hydrogeological conditions near CB (i.e surface water and groundwater interactions) is near/within pre-mining conditions.

The early part of LW W3 extraction throughout September and October 2021 had no significant effects on shallow and deep groundwater across the Western Domain. However, a consistent and minor decline was observed at site P14 and P15 (ranging from 0.4 m to 0.8 m) and assessed to be associated with the commencement of LW W3. No effects on surface water and groundwater interaction were observed at rockbar SR17 due to LW W3. As of October 2021, all groundwater levels remain within the TARP Level 1.

Private bores

From available information, there is no depressurisation identified at private bores with available groundwater levels and therefore no groundwater level exceedances are recorded at these locations. Some degree of drawdown is identified at GW72402, however this is unlikely due to mining.

4.2.7 Groundwater Pressures

Four VWP arrays have been installed at locations TNC36, TNC40, TNC43 and WD01 (refer to **Figure 4-8**).

Further detail on the below groundwater level triggers, including graphs showing progressive groundwater levels, are provided in the SLR Groundwater Six-month Review (refer to **Appendix C**). Further detail and discussion of TARP triggers for groundwater level are also discussed in **Section 2.2.4** and **Section 2.2.5**.

Shallow VWPs

In November 2020, a TARP Level 4 Significance Level was attributed to TNC036 (HBSS-65m, HBSS-97m and BGSS-169m) due to a greater than 5 m depressurisation over a period of six months. Between December 2020 and June 2021, water levels in HBSS-65m recorded a reduction greater than 5 m due to the passage of both LW W1 and LW W2, being within the Level 4 TARP criteria. Groundwater levels started to recover in June 2021 and by the end of July 2021, water levels in HBSS-65m increased above the TARP level 2 (i.e. 4.2 m below baseline level) and since August 2021 a TARP Level 1 applies.

As of September 2021, water levels in HBSS-97m remain just below the level for TARP Level 4 while it is expected to recover within the TARP Level 3 in the next review period. In HBSS-169m, the reduction to a TARP Level 2 occurred in September 2021 while groundwater levels continued to recover within the revised TARP Level 2.

Deep VWPs

Deeper strata at TNC036 (BGSS-214m) shows a reduction in depressurisation being stable as of October 2021 however there is still ongoing clear depressurisation in BUSM-412m (i.e. due to Tahmoor mine and regional mining). This is expected for deep strata near to a longwall, and depressurisation is within a magnitude that exceed the predicted modelled drawdown (+ 10-15 m of observed).

4.2.8 Mine Water Intake

Tahmoor Coal has a Groundwater Licence to extract 1642 ML/year of groundwater make from underground.

The inferred water make (groundwater that has seeped into the mine from the strata) is calculated from the difference between total mine inflows and total mine outflows. This calculation is assisted by input from flow meters installed on fresh water supply lines that pump water into the mine (mine inflow from Sydney Water supply to underground workings), and flow meters on three pipelines that extract water from underground (mine outflow). In addition, mine inflow and outflow also includes a measurement of water that enters and exits the mine through other means such as moisture in air vented in and out of the mine (water in vented air), and moisture in coal extracted from the mine.

SLR completed an analysis of water make for Tahmoor Mine recorded between 1 January 2009 to 19 October 2021 (**Appendix C**). Although this water make calculation does not just measure water make from the Western Domain, it provides an indication of the groundwater pumped out of the total Tahmoor Mine underground workings.

During the reporting period, a recent peak was recorded at marginally over 6 ML/day in March and April 2021 (**Figure 4-9**). Analysis of longwall extraction rate (in metres/day) versus inflow rate (ML/d or m^3/d) indicates that the consistently higher extraction rates that have been achieved in LW W1 and W2 are at least partly responsible for higher inflows. This is confirmed by the fact that once LW W2 was completed in June 2021 inflow reduced to 3-4 ML/d (i.e. inflow similar as prior LW W1) but then increased up to 5 ML/d in July 2021 throughout early August 2021 (i.e. probably pumping accounted for an earlier short-fall or in preparation of LW W3). Since the commencement of LW W3 and as of the end of the reporting period, the average inflows to the mine have been 4.2 ML/d, remaining below the average entitlement of 4.5 ML/d.

Other than the minor fault observed in the southern 'half' of LW W1 and LW W2, no other obvious geological structures have been noted as intersecting current longwalls. The faults on the north-eastern edge of LW W4 were mapped with major splays 1000 m from LW W4. Following this, investigations of the hydraulic properties within the lower fault zone were conducted within P41. The measured hydraulic properties within this zone were not abnormal and within those measured elsewhere at Tahmoor Mine. This would suggest that during extraction of LW W3 and LW W4 groundwater inflow to the mine is expected to stay within ranges previously observed and that no additional inflow to mine is likely to be driven from the faults mapped in the Nepean Fault Complex.

Since April 2021, there has been a general reduction in the inflow rates to the workings. Groundwater entitlement was not exceeded for the 2020-21 water year. Tahmoor Coal is currently in the process of actively seeking additional groundwater entitlement in accordance with the Tahmoor Coal Water Licencing Strategy as submitted to NRAR on 25 October 2021.

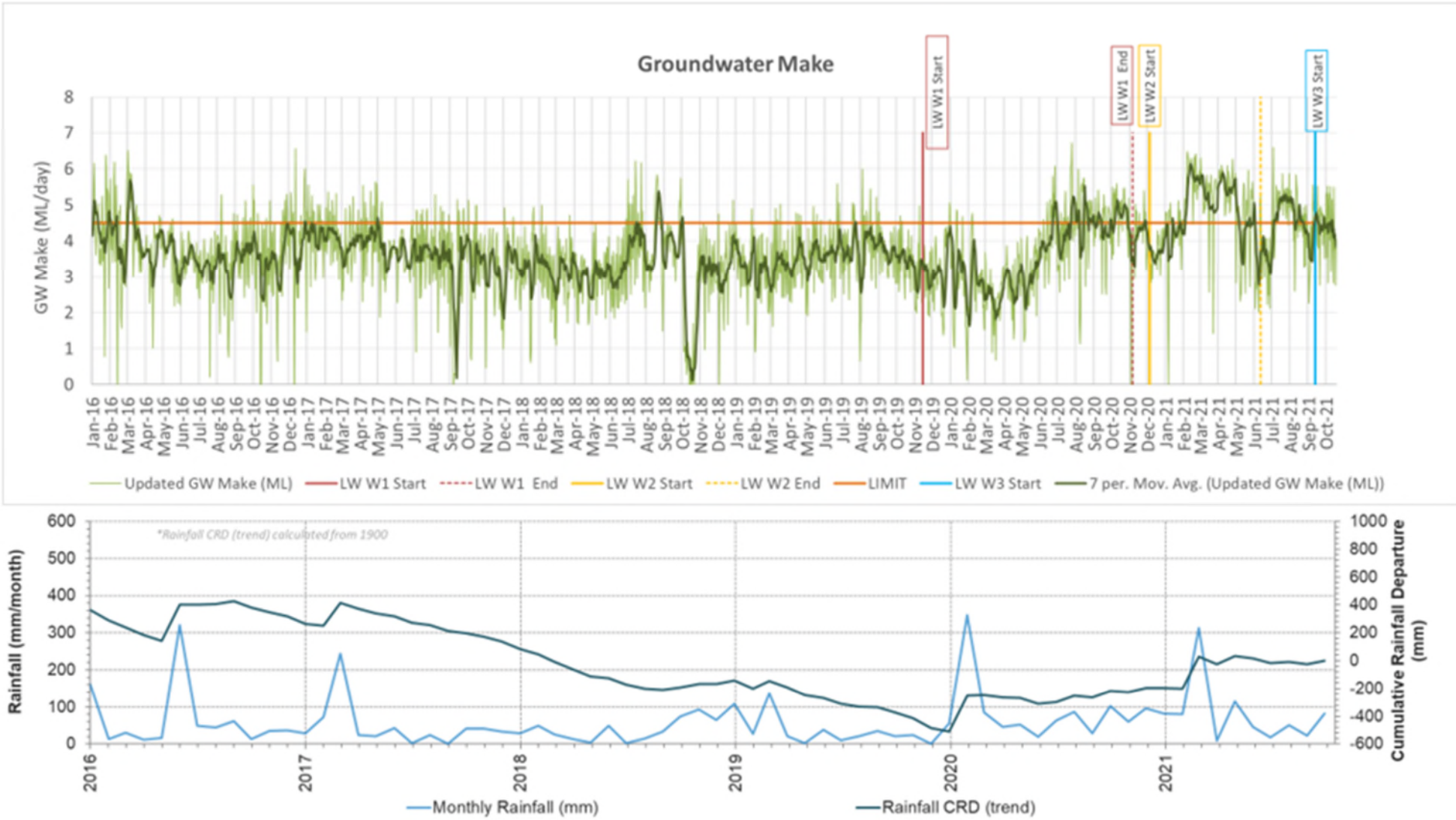

Figure 4-9 Historical record of inflows at Tahmoor Mine (source SLR, Groundwater Monitoring Report, Appendix C)

4.3 Land Monitoring

The LW W1-W2 Land Management Plan and LW W3-W4 Land Management Plan were prepared to manage the potential environmental consequences of LW W1-W2 and LW W3-W4 extraction on cliffs, rock outcrops, steep slopes, dams, agricultural land, and land in general in accordance with Condition 13H(vii)I of DA 67/98.

During this reporting period, the LW W1-W2 Land Management Plan and LW W3-W4 Land Management Plan have been implemented to monitor the following landscape features:

- Cliffs, rock outcrops, steep slopes, and dams – monthly visual inspections and reporting by geotechnical engineers from Douglas Partners;
- Stonequarry Sewage Treatment Plan retention basin (Dam FD7) – weekly visual inspections and reporting by Newcastle Geotechnical (referenced reports provided in **Appendix F**);
- Dams in active subsidence zone – weekly visual inspections and reporting by Building Inspection Services; and
- Agricultural land – monthly visual inspections and reporting by Building Inspection Service.

Performance against all Land Management Plan TARPs for the reporting period are summarised in **Table 2-3**. The following sections summarised the observations made during the reporting period for each landscape feature.

4.3.1 Cliffs and Rock Outcrops

Visual and photographic surveys for subsidence impacts on cliffs have been completed monthly for features within the LW W1-W2 active subsidence zone. The purpose of the surveys is to note any new instabilities in the cliff structures that have occurred since the commencement of LW W1-W2 mining, including freshly exposed rock face, debris scattered around the base of a cliff or overhang, and tension cracks. Surveys were completed by a walk through along the valley bed was conducted from Stonequarry Creek to the intersection of Cedar Creek and Matthew Creek.

The locations of cliffs and rock outcrops within the LW W1-W2 Study Area are illustrated in **Figure 4-10**.

During the reporting period, cliffs C03 to C09 along Cedar Creek and M01 and M02 along Matthews Creek were inspected, and there were no indications of recent rockfalls or signs of stress relief (tension cracking) along the sections of cliff monitored.

As there are no cliffs or rock outcrops within the LW W3-W4 Study Area (refer to **Figure 4-11**), no monitoring of these features has been completed during the extraction of LW W3.

4.3.2 Steep Slopes

Visual and photographic surveys for subsidence impacts on structures near steep slopes have been completed monthly for features within the LW W1-W2 active subsidence zone and LW W3-W4 active subsidence zone. The locations of steep slopes within the LW W1-W2 Study Area and LW W3-W4 Study Area are illustrated in **Figure 4-10** and **Figure 4-11**, respectively.

During the reporting period, structures located on Stonequarry Creek Road, Booyong Close, Attunga Close and Waste Water Treatment Plant (WWTP) were inspected. There were no signs of distress or changes in the areas inspected that could be attributed to mine subsidence.

4.3.3 Dams

Visual and photographic surveys for subsidence impacts on dams were completed on a weekly and monthly basis of dams within the LW W1-W2 active subsidence zone and LW W3-W4 active subsidence zone. The location of dams within the LW W1-W2 Study Area and LW W3-W4 Study Area are illustrated in **Figure 4-12** and **Figure 4-13**, respectively.

During the reporting period, the dams monitored were considered to be within the normal ranges as defined in the TARP for dams.

4.3.4 Agricultural Land

Visual and photographic surveys for subsidence impacts on agricultural land have been completed monthly at inspection points within the LW W1-W2 active subsidence zone and LW W3-W4 active subsidence zone. Inspections points were set up prior to the commencement of LW W1 mining and LW W3 mining to provide vantage of agricultural land within the LW W1-W2 Study Area and LW W3-W4 Study Area, respectively. The purpose of the surveys is to note whether change has occurred to agricultural land, and to assist in determining if any change can be attributed to mining impacts. Surveys noted the presence of erosion, condition of boundary and internal fencing components, paddock gate condition, out-building condition, paddock dam condition, presence of any surface slumping or cracking, and the presence of vegetation dieback.

Agricultural land identified within the LW W1-W2 Study Area and LW W3-W4 Study Area are illustrated on **Figure 4-14** and **Figure 4-15**, respectively.

During the reporting period, it was noted that seasonal changes had affected vegetation growth, however there were no observable changes to agricultural land in comparison to pre-mining baseline data.

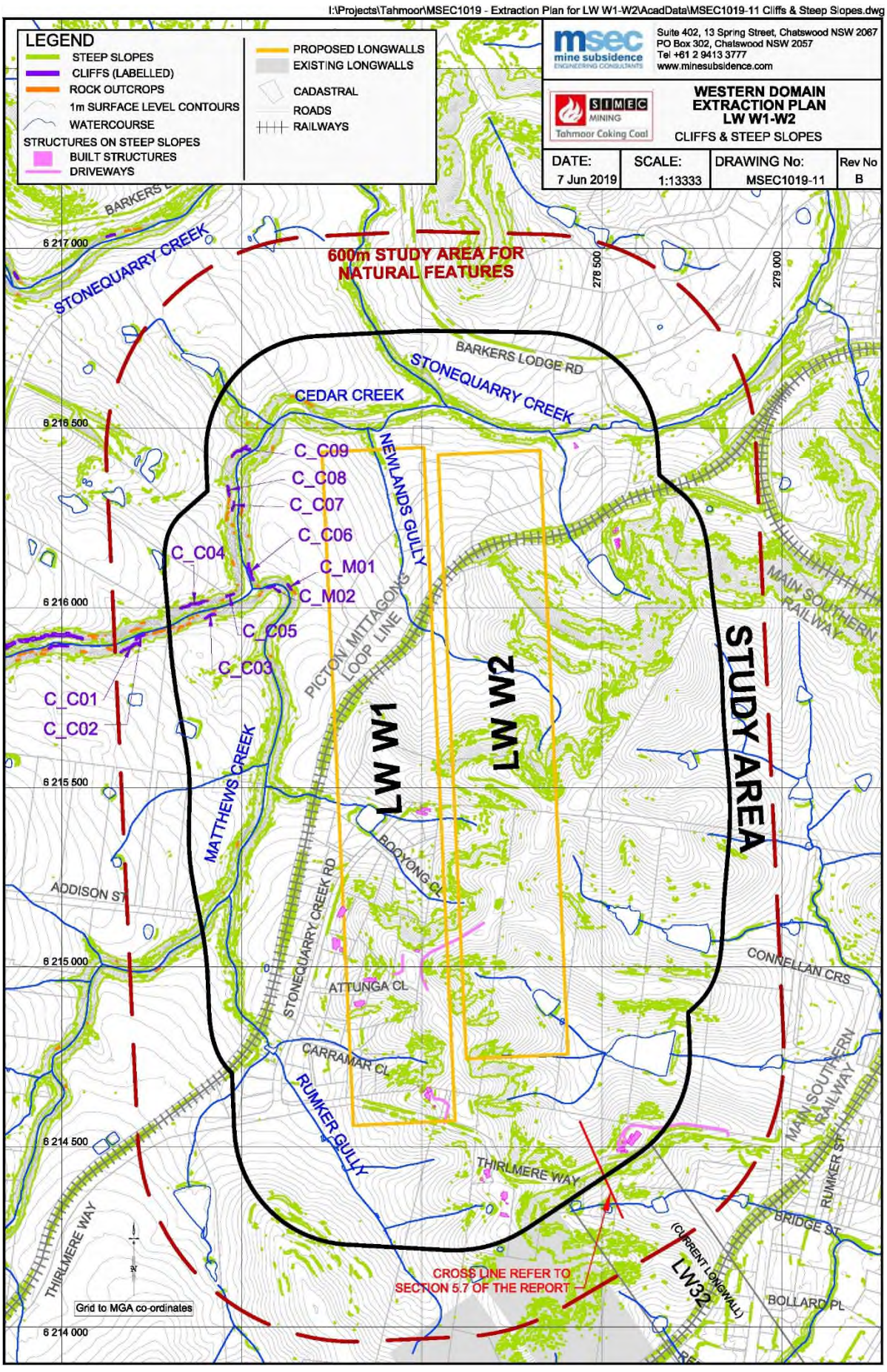

Figure 4-10 Cliffs, rock outcrops and steep slopes within the LW W1-W2 Study Area (source: LW W1-W2 Subsidence Predictions and Impact Assessment Report)

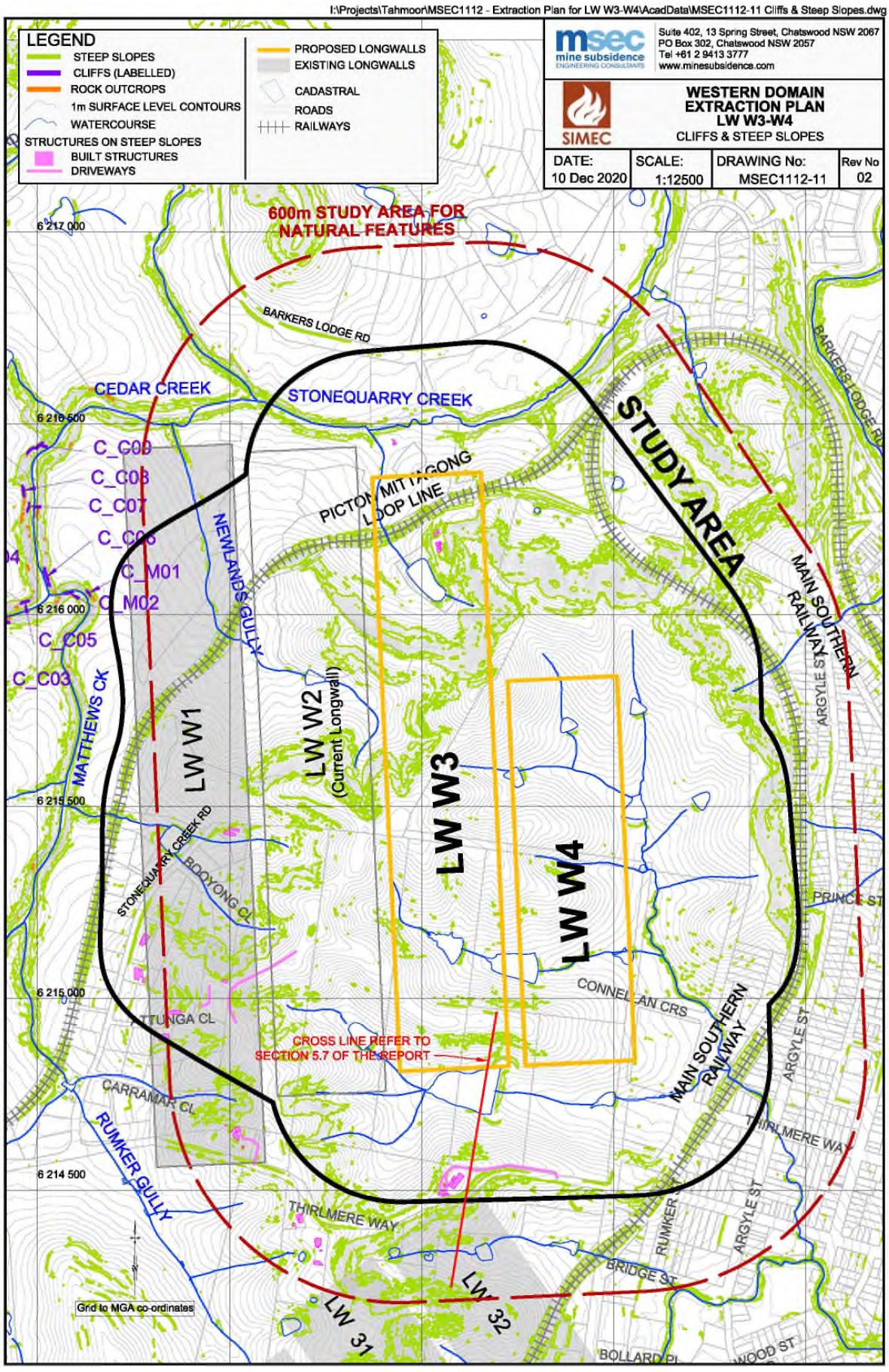

Figure 4-11 Cliffs, rock outcrops and steep slopes within the LW W3-W4 Study Area (source: LW W3-W4 Subsidence Predictions and Impact Assessment Report)

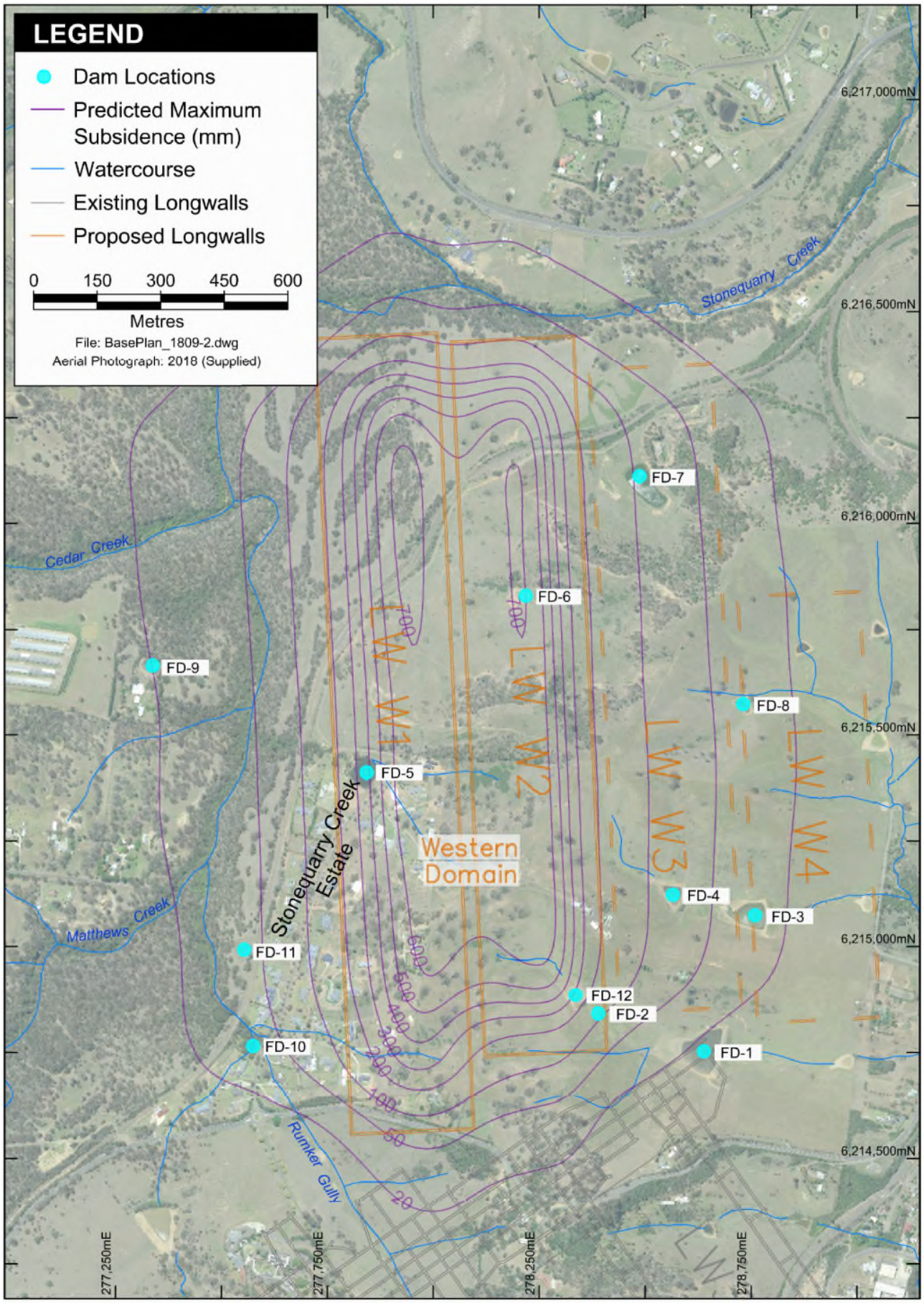

Figure 4-12 Dams within the LW W1-W2 Study Area (source: LW W1-W2 Water Management Plan)

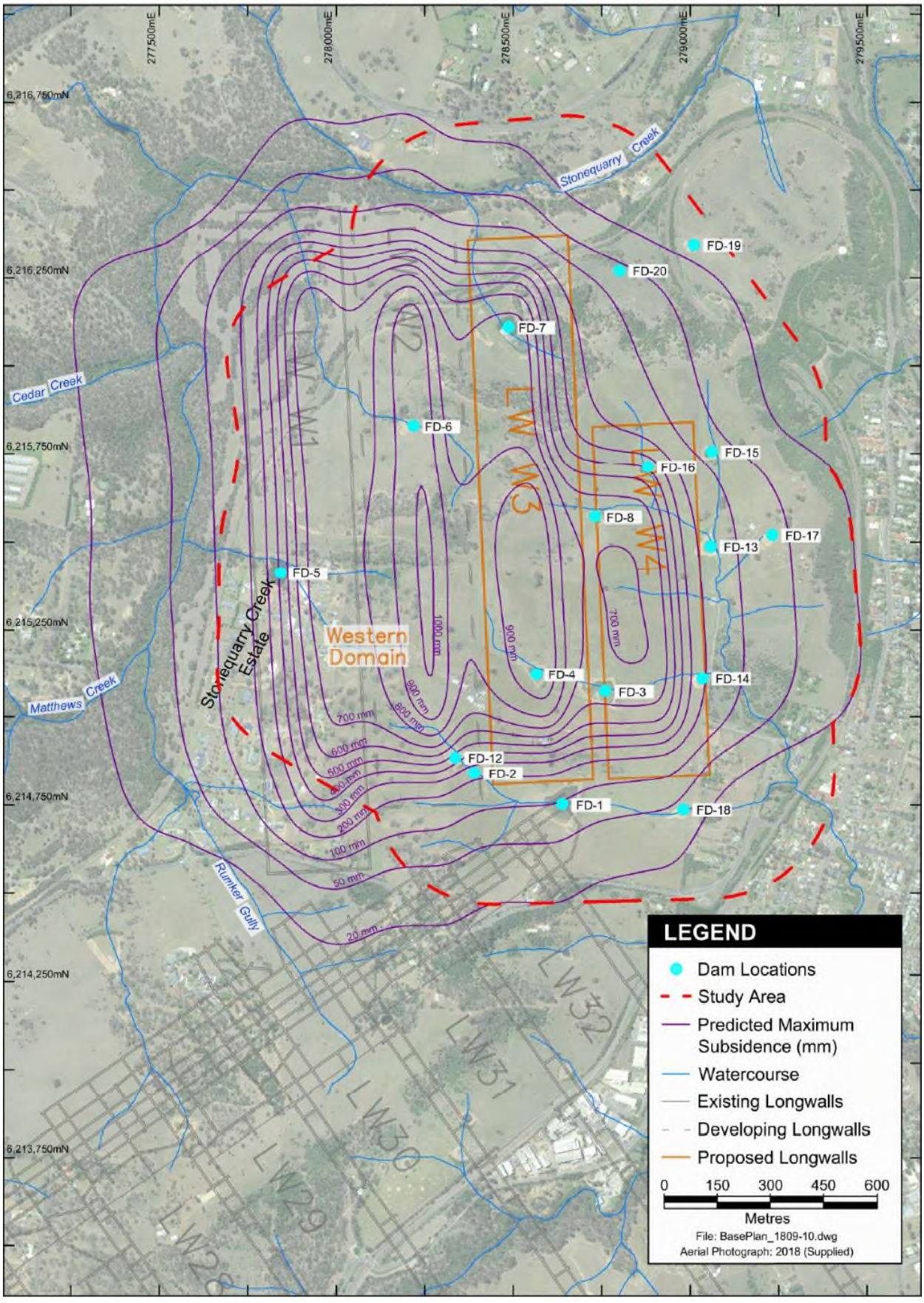

Figure 4-13 Dams within the LW W3-W4 Study Area (source: LW W3-W4 Water Management Plan)

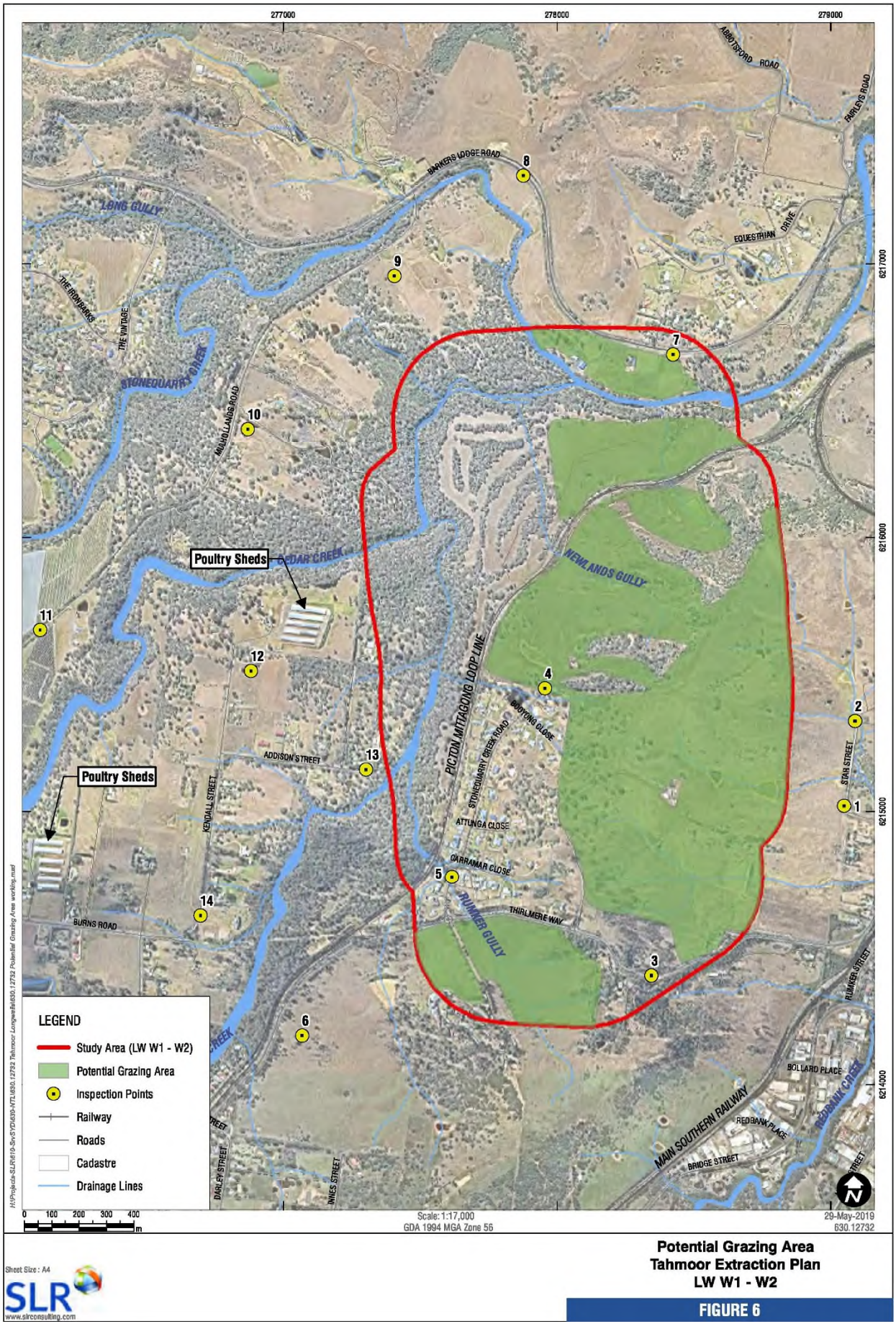

Figure 4-14 Agricultural land and inspection points within the LW W1-W2 Study Area (source: LW W1-W2 Land and Agricultural Resource Assessment)

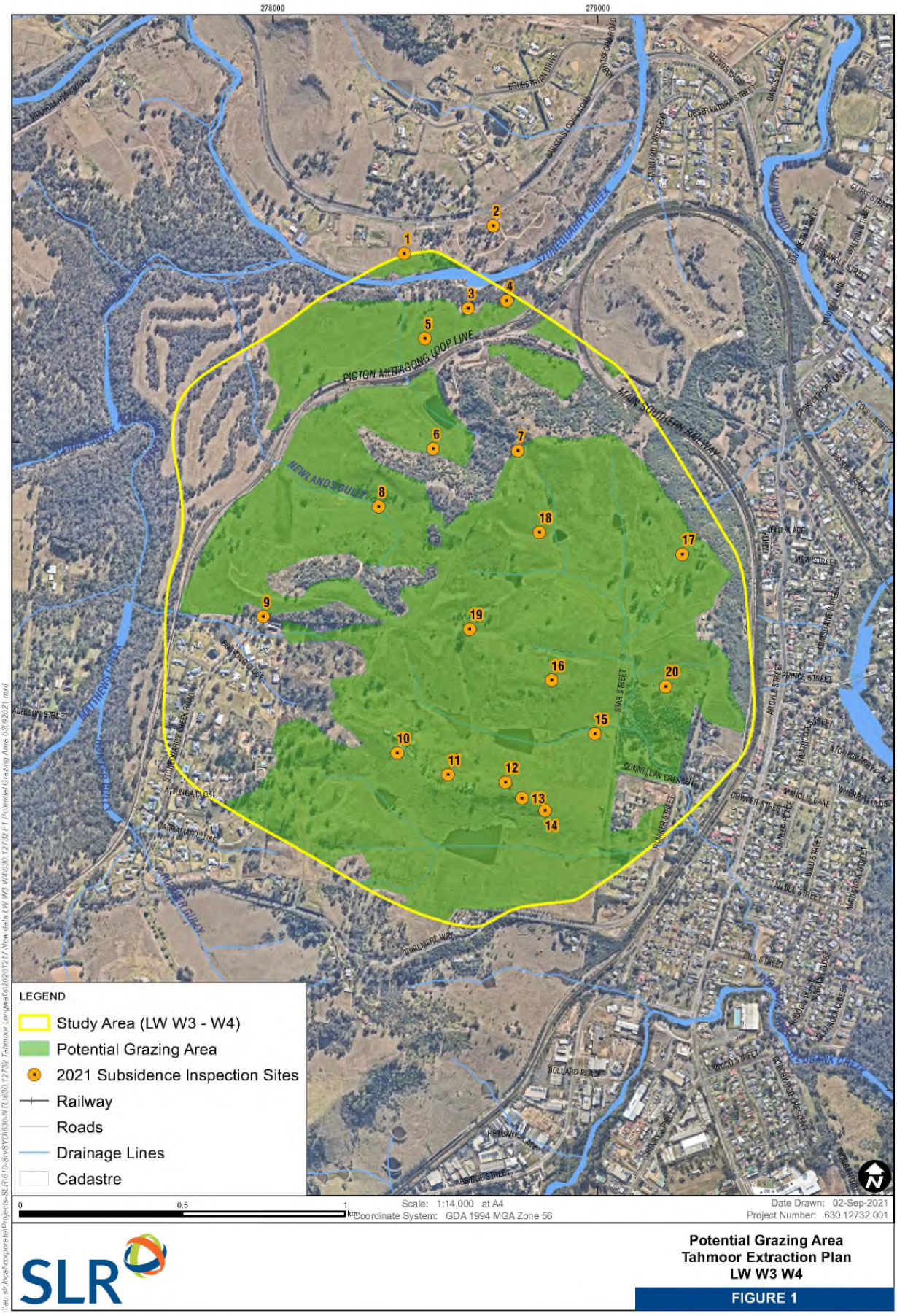

Figure 4-15 Agricultural land and inspection points within the LW W3-W4 Study Area (source: SLR Agricultural Subsidence Monitoring LW W3-W4 Report (SLR, 2021))

4.4 Biodiversity Monitoring

The LW W1-W2 Biodiversity Management Plan and LW W3-W4 Biodiversity Management Plan were prepared to manage the potential environmental consequences of LW W1-W2 and LW W3-W4 extraction on aquatic and terrestrial flora and fauna in accordance with Condition 13H(vii)(d) of DA 67/98.

During the reporting period, the LW W1-W2 Biodiversity Management Plan and LW W3-W4 Biodiversity Management Plan have been implemented to monitor ecology in the Study Area, as outlined below:

- Aquatic ecology – macroinvertebrate monitoring during Autumn 2021 by Niche Environment and Heritage; and
- Terrestrial ecology – amphibian and riparian vegetation monitoring during Autumn 2021 by Niche Environment and Heritage.

Performance against all Biodiversity Management Plan TARPs for the reporting period are summarised in **Table 2-3**. The following sections summarised the observations made during the reporting period.

4.4.1 Aquatic Ecology

Autumn 2021 Monitoring Results

The aquatic ecology monitoring program for LW W1-W2 and LW W3-W4 has been designed to monitor subsidence-induced impacts on aquatic ecology. The following survey methods have been completed during baseline and during mining monitoring sampling:

- Aquatic habitat assessment:
  - The Australian River Assessment System (AUSRIVAS);
  - Riparian Channel and Environment (RCE) Inventory;
- Macroinvertebrate survey:
  - AUSRIVAS macroinvertebrate sampling;
  - Quantitative benthic macroinvertebrate monitoring program;
- Water quality sampling.

The aquatic ecology monitoring program is primarily focused on macroinvertebrate monitoring regimes including AUSRIVAS and quantitative using Before After Control Impact (BACI) design. A total of fifteen locations were sampled within Stonequarry Creek, Cedar Creek and Matthews Creek comprised of seven impact sites and eight control sites (refer to **Appendix D**). The locations of monitoring sites are illustrated in **Figure 4-16**.

Aquatic monitoring for autumn 2021 was conducted by Niche Environment and Heritage in the week of 5 April 2021. The following results were observed for Autumn 2021 monitoring (refer **Appendix D** for further detail):

- There was aquatic habitat present at all sites in autumn 2021;
- All sites had similar riparian and channel condition prior to pre-mining sampling;
- Despite some minor water quality exceedances in electrical conductivity (EC) and acidity (pH), the water quality was comparable to that at control sites and pre-mining;
- Most AUSRIVAS scores in autumn 20201 were either comparable to or higher than scores observed pre-mining (scoring in Band A and Band B);
- Site MC8 had a lower Observed Expected (0E) 50 score compared to previous autumn results;

- Signal scores were low but comparable to pre-mining scores;
- Ephemeroptera Plecoptera Trichoptera (EPT) scores at all sites were similar to pre-mining surveys;
- Number of taxa were above or within the range of pre-mining results;
- The macroinvertebrate assemblages showed variability spatially (site level) and temporally (between surveys); and
- Site MC8 had statistically lower family richness in autumn 2021 compared to pre-mining results.

Considering the reduction in family richness and AUSRIVAS OE50 score at Site MC8 in conjunction with potential surface water impacts (water level) and visual observations of hydrology changes in the Study Area, a 'within prediction' or Level 2 TARP for aquatic biodiversity has been conservatively triggered. Further discussion of this TARP trigger is provided in **Section 2.2.6**.

Spring 2021 Monitoring Results

A letter report summarising AUSRIVAS results for Spring 2021 monitoring has been prepared by Niche Environment and Heritage. Although only AUSRIVAS monitoring results were provided in this letter report, enough information is available to interpret whether there have been any triggers in accordance with the TARP and to determine whether associated actions were required.

During Autumn 2021, it is unlikely that any Aquatic Ecology Biodiversity TARPs have been triggered. The following results were observed:

- Aquatic habitats were similar at most sites when compared to previous survey. At Site 4 (confluence of Cedar Creek and Stonequarry Creek) the waterway had been modified by the land holder to crease a creek crossing, resulting in the disturbance of bed and banks in Cedar Creek and the placement boulder placed in the waterway;
- AUSRIVAS results showed sites scoring in Band A, Band B and Band C; and
- Results indicated that there had been a reduction in stream health at most sites, which could be the result of seasonal/climatic variability. There have been no clear subsidence impacts that could relate this reduction to mining induced subsidence.

To date, there have been no observable mining subsidence related impacts to aquatic ecology of Cedar Creek, Matthews Creek or Stonequarry Creek.

4.4.2 Terrestrial Ecology

The terrestrial ecology monitoring program for LW W1-W2 and LW W3-W4 has been designed to monitor subsidence-induced impacts on terrestrial ecology including riparian vegetation and amphibian monitoring. The following survey methods have been completed during baseline and during mining monitoring sampling:

- Riparian vegetation monitoring involving floristic surveys within established vegetation monitoring plots;
- Amphibian monitoring along established transects:
  - Spotlighting;
  - Call provocation;
  - Listening for diagnostic frog calls; and
  - Tadpole identification.

In particular, two threatened frog species – the Giant Burrowing Frog (*Heleioporus australiacus*) and the Red-crowned Toadlet (*Pseudophryne australis*) – were targeted in the amphibian monitoring.

A total of eight locations were sampled within Stonequarry Creek, Cedar Creek and Matthews Creek comprised of three impact sites and five control sites. The locations of monitoring sites are illustrated in **Figure 4-17**.

Autumn 2021 Monitoring Results

Riparian vegetation monitoring for Autumn 2021 was conducted by Niche Environment and Heritage between 15-19 March 2021, and amphibian monitoring for Autumn 2021 was conducted between 8-10 March 2021. At the time of writing this report, Spring 2021 monitoring is yet to be completed. The results of this monitoring will be provided in the next report.

The following results were observed for Autumn 2021 monitoring:

Riparian monitoring:

- River-flat Eucalypt Forest, which is listed as an Endangered Ecological Community under the BC Act, was recorded at control Site 9, with a high level of weed infestation (147.4% cover across the combined growth forms, see Plate 25 Autumn 2021 Site 09 Plate 25);
- Floristic composition and vegetation cover average at each Site increased by 5 percent at the impact Sites and 29 percent at control Sites compared to pre-mining values, most likely due to increased rainfall across 2020 and early 2021;
- Impact Sites had a slightly lower mean species richness and percentage vegetation cover than control;
- Sites, although the exotic cover in the control Sites is relatively high at approximately 38 percent compared to nine percent at impact Sites;
- Anthropogenic influences were observed at Sites, particularly weeds and altered flow regimes; and
- Sites 7, 8 and 9 tended to have higher soil fertility and organic matter loads, which lead to higher species diversity and generally more exotic species. These Sites appeared to be more influenced by seasonal changes and stochastic flooding events (e.g., witnessed in 2020 and 2021) than Sites further up the catchment (Sites 4, 5, 6 and 10), which tended to be somewhat protected in deep gullies and canyons.

Amphibian monitoring:

- Frog detection rates were variable between before monitoring events and impact monitoring event 2021 for most Sites. There was a significant difference in species diversity between control Sites and impact Sites, with the reduction in control Sites. One control Site (Site 6) and impact Site (Site 4) had an increase in Stony Creek Frog (*Litoria lesueurii*) individuals. This may be due to the recent rainfall which likely triggered a breeding event at both Sites;
- The targeted threatened frog species were not detected. Six common frog species were detected during the monitoring event, which represents an otherwise normal assemblage that may be expected to be present in the Study Area under the current climatic conditions;
- The targeted threatened frog species appear not to be present in the Study Area, at least not in a population size that can be meaningfully monitored. While the study environment contains superficially suitable habitat, it is possible that these species would no longer be able to survive in the area due to a number of factors such as:
    - Absence of suitable non-breeding habitat for Giant Burrowing Frog at most monitoring Sites (due to heavy weed encroachment and erosion);

- Increased urban encroachment;
- Changes in hydrological flows, water quality and nutrient loads;
- Climatic variability;
- Predation pressures from two introduced predators: Eastern Gambusia (*Gambusia holbrooki*) and the Yabby (*Cherax destructor*), both of which were detected at all Sites;

- Frog detection rates were variable between monitoring events for most Sites, most likely due to the highly variable weather and climatic conditions across the survey periods. However, results show that there was a significant difference between control Sites and impact Sites (detection being greater at impact Sites).

No thresholds within the TARP in the LW W1-W2 Biodiversity Management Plan have been triggered for Autumn 2021 monitoring, and therefore, no remedial management actions are required.

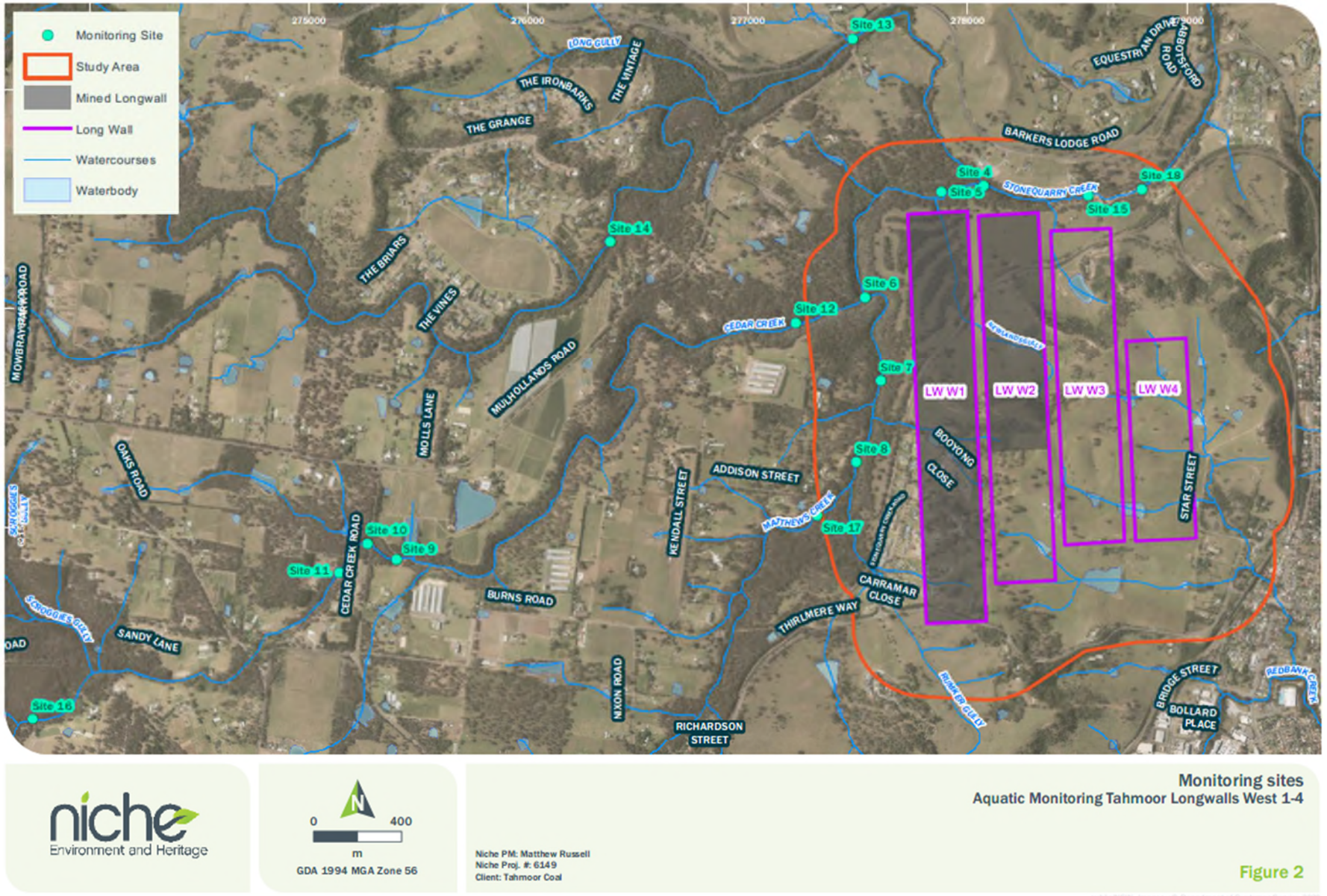

Figure 4-16 LW W1-W4 Aquatic Ecology Monitoring Locations (source: Niche, 2021a)

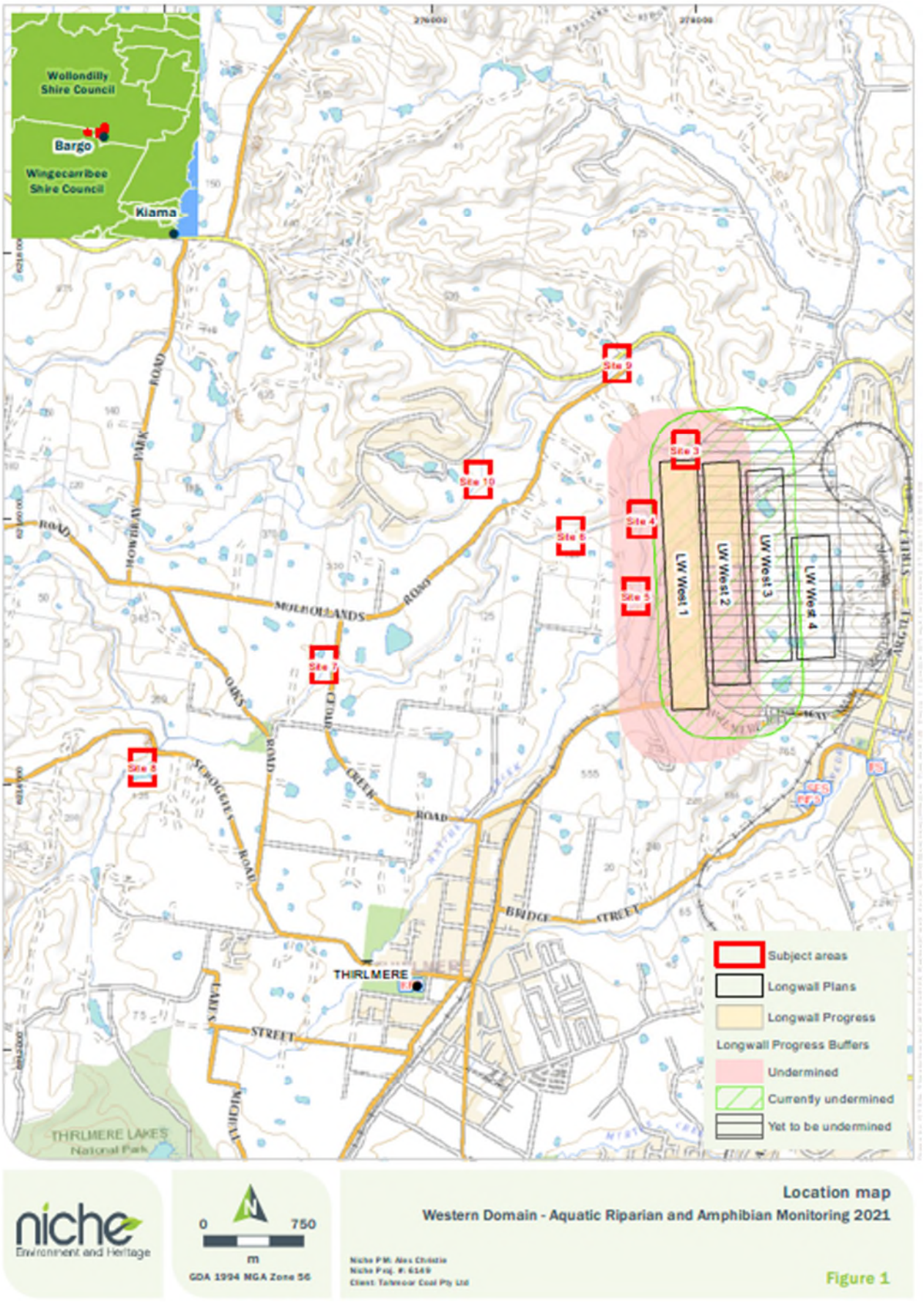

Figure 4-17 LW W1-W4 Terrestrial Ecology Monitoring Locations (source: Niche, 2021b)

4.5 Heritage Monitoring

The LW W1-W2 Heritage Management Plan and LW W3-W4 Heritage Management Plan were prepared to manage the potential environmental consequences of LW W1-W2 and LW W3-W4 extraction on Aboriginal heritage and historical heritage sites and values in accordance with Condition 13H(vii)(f) of DA 67/98.

During this reporting period, the LW W1-W2 Heritage Management Plan and LW W3-W4 Heritage Management Plan have been implemented to monitor subsidence impacts for the following heritage items:

- Aboriginal heritage:
  - Rock shelters – monthly external visual inspections of rock shelters by GeoTerra for LW W2;
  - Grinding grooves – monthly review of GNSS unit movements by MSEC (refer to **Appendix A** for referenced reports);
  - Rock shelters and grinding grooves – end of panel review of items by an EMM Archaeologist and a RAP representative (EMM, 2021a);
- Historical heritage:
  - Sandstone and brick culverts along the PMLL:
    - Weekly visual inspection by Newcastle Geotechnical (refer to **Appendix F**); and
    - End of panel review of items by an EMM Archaeologist (refer to **Appendix E**; EMM, 2021b).

Performance against all Heritage Management Plan TARPs for the reporting period are summarised in **Table 2-3**. The following sections summarised the observations made during the reporting period.

4.5.1 Aboriginal Heritage

An end of panel monitoring inspection was carried out by an EMM archaeologist and a RAP representative on 25 and 26 August 2021, and the findings of this inspection reported in an end of panel report (EMM, 2021a). The focus of the fieldwork was to conduct archaeological monitoring of Aboriginal sites associated with the underground coal mining of Longwall West 2 (LW W2) after completion of its panel extraction in the Tahmoor Mine Western Domain. The locations of Aboriginal heritage items within the Study Area of LW W1-W2 are illustrated in **Figure 4-18**.

In accordance with the subsidence monitoring program, the inspection relates to 25 Aboriginal sites including 17 rock shelters, one grinding groove site and one modified tree. The six open artefact sites do not require monitoring.

The grinding groove site (AHIMS #52-2-2068) has been monitored during LW W1-W2 extraction through the GNSS units and monthly ground surveys of rock bar during the period of active subsidence for the longwall. The rock shelters in the project area have been subject to monthly visual inspections by subsidence experts from a safe location during extraction. As a “safe location” does not allow physically entering each rock shelter, these prior inspections for rock shelters have been taken from a distance to observe toppling, cracking, or collapse of the cliff lines where the rock shelters occur. Overall, no subsidence related impacts have been observed to any of the Aboriginal sites inspected as part of the monitoring program.

During the end of panel inspection, no subsidence related impacts were observed to any of the Aboriginal sites inspected, and as such no additional management strategies are required.

4.5.2 Historical Heritage

EMM consultants completed an end of panel monitoring inspection on the 25 August 2021 focused on the five historical brick and sandstone culverts within the Study Area of LW W1-W2 (**Appendix E**). The locations of historical heritage items are illustrated in **Figure 4-19**.

During the extraction of LW W2, the culverts have been continuously monitored at weekly intervals by Mark Delaney, principal engineering geologist at Newcastle Geotech, as part of the subsidence monitoring program.

As discussed in **Section 2.2.7** of this report, visual inspections during the previous reporting period noted the development of a number of minor cracks on sandstone culverts along the Picton-Mittagong Loop Line. Slight increase in crack dimension have occurred during this monitoring period, with particular focus on the sandstone culverts at 88.400 km and 88.980 km.

The end of panel inspection confirmed that impacts to the two culverts had triggered a Level 3 TARP trigger for historical heritage in accordance with the LW W1-W2 Heritage Management Plan. A subsidence report for the two culverts completed by MSEC (**Appendix E**) included a review of mine design/predictions against mine criteria, and confirmation that the culverts were predicted to experience negligible additional subsidence due to future longwall extraction in the Western Domain.

Tahmoor Coal notified DPIE and Heritage NSW of the trigger via the NSW Major Projects Planning Portal on 21 September 2021. Remediation of the two culverts will be undertaken after the full effects of LW W3-W4 have been completed. Tahmoor Coal commenced seeking further expert advice from a heritage stonemason regarding remediation of the sandstone structures.

No other impacts to historical heritage were observed during this reporting period.

This information has been retracted
- For more information contact Tahmoor Coal

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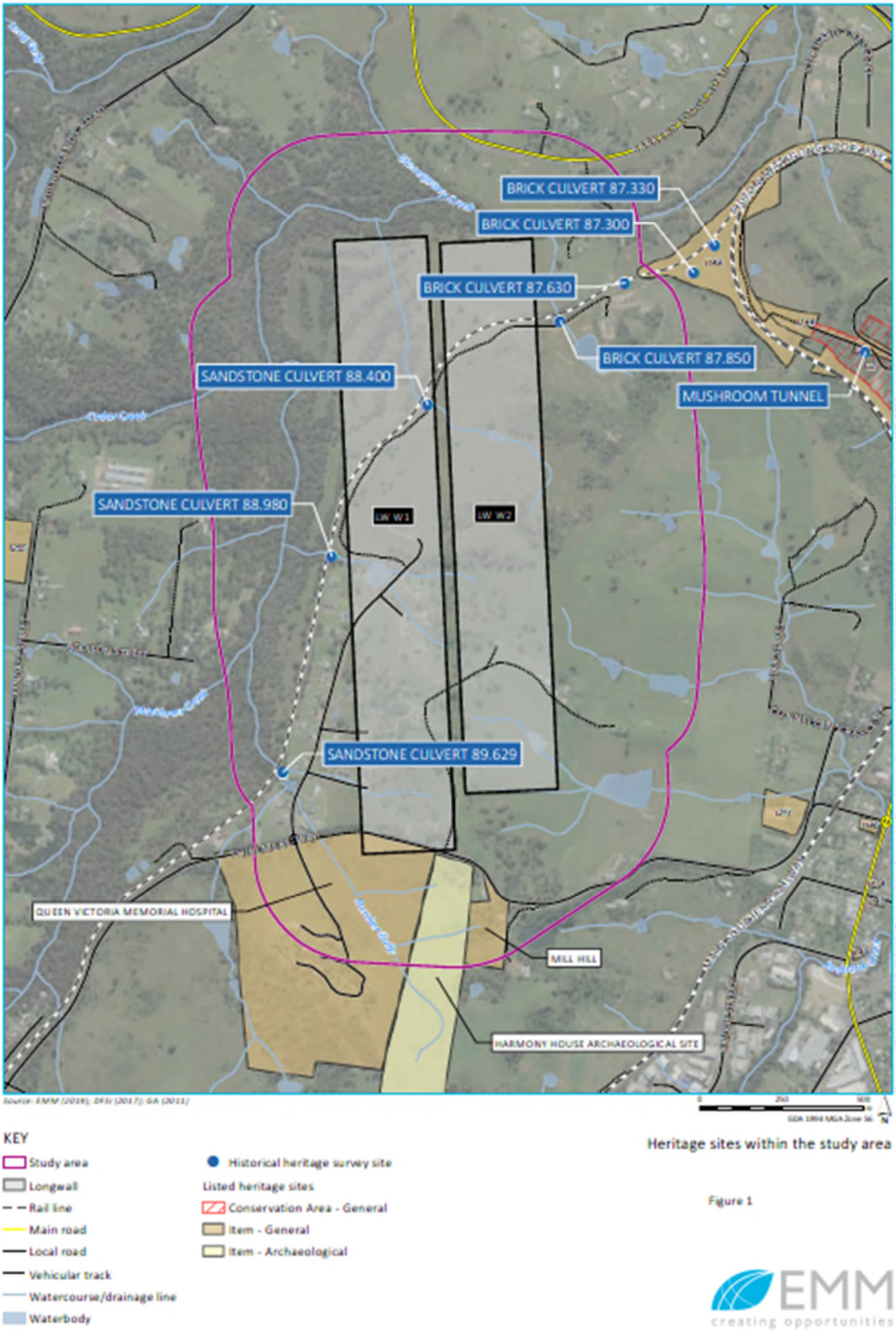

Figure 4-19 Historical Heritage Sites in the Study Area and Surrounds (Source EMM, 2021b)

4.6 Built Features Monitoring

The LW W1-W2 Built Features Management Plan and associated sub-plans and LW W3-W4 Built Features Management Plan and associated sub-plans were prepared to manage the potential environmental consequences of LW W1-W2 and LW W3-W4 extraction on built features in accordance with Condition 13H(vii)(b) of DA 67/98.

During this reporting period, the LW W1-W2 Subsidence Monitoring Program and the LW W3-W4 Subsidence Monitoring Program have been implemented to monitor subsidence impacts on infrastructure owned by Endeavour Energy (electrical infrastructure), Sydney Water (potable water infrastructure and sewer infrastructure), Bradcorp (sewer infrastructure), Jemena (gas infrastructure), Wollondilly Shire Council (roads, bridges and culverts), Telstra (telecommunications infrastructure), NBN (telecommunications infrastructure), ARTC (rail infrastructure), Transport Heritage NSW (rail infrastructure), Queen Victoria Memorial Home (historical building and nursing home), Mill Hill (historical building), Weatherboard House (historical building) and private property owners. The details of the Subsidence Monitoring Program are illustrated in **Figure 4-1** and **Figure 4-2**.

A weekly review of the subsidence survey results during the reporting period has been completed by MSEC (refer **Appendix A**). Monitoring observations for built infrastructure from the weekly and monthly reports, as well performance against all Infrastructure Management Plan TARPs for the reporting period have been summarised in **Table 2-3**.

A comparison between assessed and observed impacts to surface features is summarised in Table 3 of the MSEC LW W2 Subsidence Monitoring Report 28 and Table 2 of the MSEC LW W3 Subsidence Monitoring Report 3 (refer to **Appendix A**).

A number of impacts to local roads and built structures occurred during the reporting period as a result of subsidence from LW W2 extraction. These impacts are focused within the Stonequarry Estate and can be summarised as:

- Impacts to kerb and road surface on Stonequarry Creek Road (April and May 2021);
- Impacts to houses on Stonequarry Creek Road (April and May 2021);
- Impacts to houses on Booyong Close (April to July 2021); and
- Impacts to kerb on Carramar Close (June 2021).

Where possible, Tahmoor Coal has repaired damages to roads and built structures within the Stonequarry Estate in consultation with SA NSW where appropriate.

Impacts to rail infrastructure including the Main Southern Railway and the Picton to Mittagong Loop Line because of subsidence from LW W2 and LW W3 can be summarised as follows:

- Minor closure across the abutments of the Main Southern Railway Ballast Top Subway at 86.838 km (April 2021); and
- Cracking and spalling of the sandstone blocks at two culverts on the Picton Mittagong Loop Line (88.400 km and 88.980 km).

Closure at the Ballast Top Subway was reviewed by the RMG and investigated by Structural Engineer (John Matheson). It was determined that the movements were associated with rain events and not subsidence related. The trigger level was increased to 20 mm, and monitoring continues as per the rail subsidence management plans.

The two sandstone culverts that have been impacted by subsidence will continue to be monitored in accordance with the rail subsidence management plan. Following the full effects of LW W3-W4, the sandstone culverts will be remediated, in accordance with any advice received from a heritage stonemason (currently in consultation).

No other subsidence impacts to built features were observed during this reporting period.

4.7 Public Safety Monitoring

The LW W1-W2 Public Safety Management Plan and LW W3-W4 Public Safety Management Plan were prepared to manage the potential consequences as a result of LW W1-W2 and LW W3-W4 extraction on public safety within the Study Area in accordance with Condition 13H(vii)(g) of DA 67/98.

As noted in **Section 1.3** of this report, management requirements for public safety are covered in the Built Features Management Plan and the Land Management Plan. Monitoring of cliffs, rock outcrops and steep slopes and other landscape features has been conducted for the reporting period in accordance with the LW W1-W2 Land Management Plan and LW W3-W4 Land Management Plan (refer to **Section 4.3.1** for a summary of monitoring results). In addition, monitoring of infrastructure items has also been conducted for the reporting period in accordance with the LW W1-W2 Built Features Management Plan and LW W3-W4 Built Features Management Plan (refer to **Section 4.6** for a summary of monitoring results).

No subsidence impacts were identified during the reporting period that were considered to pose a risk to public safety.

5 Document Information

5.1 References

Department of Planning and Environment (DPE) (2015), Draft Guidelines for the Preparation of Extraction Plans V5.

EMM Consulting (2021a), Aboriginal heritage monitoring report: Tahmoor Mine Longwall West 2 (LW W2) End Of Panel Monitoring Inspection.

EMM Consulting (2021b), Historical heritage monitoring report: Tahmoor Mine Longwall West 2 (LW W2) End of Panel Monitoring Inspection).

HEC (2021), Tahmoor Mine LW W1-W2 Surface Water and Groundwater Review March to July 2021, report to Tahmoor Coal, 22 September 2021.

Mine Subsidence Engineering Consultants (MSEC) (2021), Tahmoor Coal – Longwalls W3 and W4, Subsidence Predictions and Impact Assessments for Natural and Built Features due to the Extraction of the Proposed Longwalls W3 and W4 in Support of the Extraction Plan Application. Prepared for Tahmoor Coal, March 2021, document MSEC1112.

Niche (2021a), Aquatic Ecology Monitoring Report 2017-2021, report to Tahmoor Coal, 25th June 2021.

Niche (2021b), Terrestrial Ecology Monitoring Report, Riparian vegetation and amphibian monitoring Autumn 2021, report to Tahmoor Coal, 23rd April 2021.

SLR (2021), Agricultural Subsidence Monitoring LW W3-W4, letter report to Tahmoor Coal, 26th August 2021, document 630.12953.001

Tahmoor Coal Documents:

- Extraction Plan LW W1-W2 Extraction Plan Main Document, TAH-HSEC-248
- Extraction Plan LW W1-W2 Water Management Plan, TAH-HSEC-244
- Extraction Plan LW W1-W2 Land Management Plan, TAH-HSEC-247
- Extraction Plan LW W1-W2 Biodiversity Management Plan, TAH-HSEC-246
- Extraction Plan LW W1-W2 Heritage Management Plan, TAH-HSEC-242
- Extraction Plan LW W1-W2 Built Features Management Plan, TAH-HSEC-249
- Extraction Plan LW W1-W2 Public Safety Management Plan, TAH-HSEC-250
- Extraction Plan LW W1-W2 Subsidence Monitoring Program, TAH-HSEC-249
- Extraction Plan LW W3-W4 Extraction Plan Main Document, TAH-HSEC-326
- Extraction Plan LW W3-W4 Water Management Plan, TAH-HSEC-328
- Extraction Plan LW W3-W4 Land Management Plan, TAH-HSEC-330
- Extraction Plan LW W3-W4 Biodiversity Management Plan, TAH-HSEC-325
- Extraction Plan LW W3-W4 Heritage Management Plan, TAH-HSEC-331
- Extraction Plan LW W3-W4 Stonequarry Creek Rockbar Management Plan, TAH-HSEC-352
- Extraction Plan LW W3-W4 Built Features Management Plan, TAH-HSEC-332
- Extraction Plan LW W3-W4 Public Safety Management Plan, TAH-HSEC-333
- Extraction Plan LW W3-W4 Subsidence Monitoring Program, TAH-HSEC-329

5.2 Glossary of Terms

Terms references to this document are provided below in **Table 5-1**.

Table 5-1 Glossary of Terms

Term	Definition
Active Subsidence Zone	The active subsidence zone for each longwall is defined by the area bounded by the predicted 20 mm subsidence contour for the active longwall and a distance of 150 m in front of the active longwall face and 450 m behind the active longwall face or following 500 m of longwall extraction.
Angle of draw	The angle of inclination from the vertical of the line connecting the goaf edge of the workings and the limit of subsidence (which is usually taken as 20 mm of subsidence)
Cliffs	Continuous rockfaces having minimum heights of 10 m, minimum lengths of 20 m and minimum slopes of 2 to 1, i.e. having minimum angles to the horizontal of 63°.
Closure	The reduction in the horizontal distance between the valley sides. The magnitude of closure, which is typically expressed in the units of mm, is the greatest reduction in distance between any two points on the opposing valley sides. It should be noted that the observed closure movement across a valley is the total movement resulting from various mechanisms, including conventional mining induced movements, valley closure movements, far-field effects, downhill movements and other possible strata mechanisms.
Longwall	A system of mining coal in which the seam is extracted on a broad front or long face using a coal shearer and the roof is supported by hydraulic roof supports.
Reporting period	15 November 2019 to 5 May 2020
Run of mine (ROM)	Raw coal production; the unprocessed mined coal that is conveyed to the CPP. ROM may consist of coal and rock.
Study Area	Study Area as defined in the LW W1-W2 Extraction Plan
Subsidence	The vertical movement of a point on the surface of the ground as it settles above an extracted panel, but, 'subsidence of the ground' in some references can include both a vertical and horizontal movement component. The vertical component of subsidence is measured by determining the change in surface level of a peg that is fixed in the ground before mining commenced and this vertical subsidence is usually expressed in units of mm. Sometimes the horizontal component of a peg's movement is not measured, but in these cases, the horizontal distances between a particular peg and the adjacent pegs are measured.
Subsidence impacts	The physical changes or damage to the fabric or structure of the ground, its surface and environmental features, or built structures that are caused by the subsidence effects. These impacts considerations can include tensile and shear cracking of the rock mass, localised buckling of strata, bed separation, rock falls, collapse of overhangs, failure of pillars, failure of pillar floors, dilation, slumping and also include subsidence depressions or troughs.

Term	Definition
Upsidence	Upsidence results from the dilation or buckling of near-surface strata at or near the base of the valley. The term uplift is used for the cases where the ground level is raised above the pre-mining level, i.e. when the upsidence is greater than the subsidence. The magnitude of upsidence, which is typically expressed in the units of mm, is the difference between the observed subsidence profile within the valley and the conventional subsidence profile which would have otherwise been expected in flat terrain.
Western Domain	Area to the north-west of the Main Southern Railway.

5.3 Abbreviations

Abbreviations used in this document are provided below in **Table 5-2**.

Table 5-2 Abbreviations

Abbreviation	Definition
AHIMS	Aboriginal Heritage Information System
ARTC	Australian Rail Track Corporation
AUSRIVAS	The Australian River Assessment System
BACI	Before After Control Impact design
BGSS	Bargo Sandstone
DA	Development Approval
DRNSW	Department of Regional NSW
DPE	NSW Department of Planning and Environment (now DPIE)
DPIE	NSW Department of Planning, Industry and Environment
EC	Electrical conductivity
ERG	Environmental Response Group
EPA	NSW Environment Protection Authority
EPT	Ephemeroptera Plecoptera Trichoptera scores
GFG	GFG Alliance
GNSS	Global Navigation Satellite System units
HBSS	Hawkesbury Sandstone
HEC	Hydro Engineering and Consulting
Km	Kilometres
Li	Lithium
LW W1	Longwall West 1
LW W1-W2	Longwalls West 1 to West 2
LW W3	Longwall West 3
LW W3-W4	Longwalls West 3 to West 4
LW W4	Longwall West 4
m	metres
mbgl	Metres below ground level
mg/L	Milligrams per litre

Abbreviation	Definition
ML	Mining Lease
mm	millimetre
MSEC	Mine Subsidence Engineering Consultants
NRAR	NSW Industry – Land & Water – Natural Resources Access Regulator – East
NSW	New South Wales
OE	Observed expected score
OSP	Open Standpipe Piezometers
pH	pH units
PMLL	Picton-Mittagong Loop Line railway
RCE	Riparian Channel and Environment Inventory
RMG	Rail Management Group
Tahmoor Coal	Tahmoor Coal Pty Ltd
Tahmoor Mine	Tahmoor Coal Mine
TARP	Trigger Action Response Plan
TCCO	Tahmoor Coking Coal Operations
VMP	Vibrating Wire Piezometer
WWTP	Waste water treatment plant

5.4 Document Distribution

This report and associated documents have been distributed according to **Table 5-3**.

Table 5-3 Distribution List for Six Monthly Subsidence Impact Report

Agency	Contact Person	Position	Electronic Copy
DPIE - Planning	Jessie Evans	Director – Resource Assessments	Jessie.evans@planning.nsw.gov.au
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DRNSW – Mining Exploration and Geoscience	(none assigned)	(none assigned)	resource.operations@planning.nsw.gov.au
DPRNSW – Resources Regulator – Mining Act Inspectorate	Greg Kininmonth	Manager Environmental Operations (Southern)	greg.kininmonth@planning.nsw.gov.au nswresourcesregulator@service-now.com

Agency	Contact Person	Position	Electronic Copy
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Subsidence Advisory NSW	Matthew Montgomery	Infrastructure Manager	matthew.montgomery@finance.nsw.gov.au
NRAR	Guy Ohandja	Manager Compliance Monitoring & Audit	guy.ohandja@nrar.nsw.gov.au
EPA	Andrew Couldridge	Senior Operations Officer - Metropolitan Illawarra	andrew.couldridge@epa.nsw.gov.au
TCCCC Committee Members	Documents sent to TCCCC Committee Members at private email addresses.		

Appendix A – Subsidence Monitoring Reports

Appendix B – Surface Water Monitoring Report

Appendix C – Groundwater Monitoring Report

Appendix D – Ecology Monitoring Report

Appendix E – Heritage Monitoring Report

Appendix F - Picton-Mittagong Loop Line Detailed Reports

Appendix G – Main Southern Railway Status Report