# Tahmoor South Project

## Longwall S7A Modification Report (SSD 8445 Mod 3)

Prepared for Tahmoor Coal Pty Ltd

May 2024

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## Longwall S7A Modification Report (SSD 8445 Mod 3)

Tahmoor Coal Pty Ltd

E230438 RP#7

May 2024

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| V1 | 20 May 2024 | James Wearne | Nicole Armit | Submission to DPHI |
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| | | | | |

Approved by

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20 May 2024

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# Executive Summary

## ES1 Introduction

Tahmoor Coal Pty Ltd (Tahmoor Coal) owns and operates the Tahmoor Mine, an underground coal mine approximately 80 kilometres (km) south-west of Sydney and 50 km north-west of Wollongong and Port Kembla in the Southern Coalfields of New South Wales (NSW).

## ES2 Proposed modification

Tahmoor Coal is seeking to modify SSD 8445 (Mod 3) under Section 4.55(2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to authorise:

- an additional longwall panel (LW S7A) to the approved A series longwall panel layout (modified layout)
- removal of restrictions imposed by Condition A6 of SSD 8445 on the requirement for mining to be completed within 10 years following the commencement of second workings in the Tahmoor South mining area
- an increase in the maximum volume of run of mine (ROM) coal authorised by Condition A11(b) of SSD 8445 that can be extracted and processed on site, from 33 million tonnes per annum (Mtpa) to 35 Mtpa.

LW S7A has been included in the mine plan following a revision of the geological interpretation of the location of the Central Fault, which is located to the south-west of the Tahmoor South Project area. The inclusion of LW S7A will extend mining beyond October 2032 (the current date by which mining operations are required to cease) by approximately nine months, with all approved and proposed mining operations to still be completed by 31 December 2033, as also stipulated in condition A6. Tahmoor Coal seeks to remove the restriction imposed by condition A6 of SSD 8445 for mining operations to be completed within 10 years from the commencement of second workings undertaken under SSD 8445, to enable sufficient time for LW S7A to be extracted.

Additionally, the extraction of LW S7A will add approximately 2 Mt of coal to the total volume of coal extracted over the life of the mine. Tahmoor Coal therefore seeks to increase the maximum volume of coal authorised to be extracted over the life of the development from 33 Mt to 35 Mt.

## ES3 Impact assessment

### ES3.1 Subsidence

The maximum predicted subsidence parameters within the study area, based on the modified layout with LW S7A included, are similar to those based on the current approved layout. This is because predicted maximum subsidence due to the extraction of the B series longwalls is greater than the A series and the addition of LW S7A does not influence maximum subsidence predictions associated with the B series of longwalls.

The potential subsidence impact to all identified natural features and built infrastructure as a result of the modification has been assessed to be manageable and can be controlled by the preparation and implementation of extraction plans and associated subsidence management plans, many of which have been successfully implemented during previous mining at Tahmoor Mine.

### ES3.2 Aboriginal cultural heritage

The proposed additional longwall is considered to have limited impact to the Aboriginal cultural heritage sites identified within the study area, as the sites are located on the edge of the predicted 20 millimetre (mm) incremental subsidence contour associated with LW S7A.

## ES3.3 Biodiversity

No significant impacts are predicted on biodiversity values as a result of the modification.

No surface disturbance or vegetation clearing is required to support the modification. The potential for vegetation to be impacted as a result of subsidence is considered negligible. As the modification will result in prescribed impacts only, of which an assessment of such impacts on candidate species has been assessed as low, no species credits species will be required to be offset as part of the modification.

The Biodiversity Assessment Method Calculator (BAM-C) has generated six ecosystem credits for the modification; however, this is an error and function of the necessary approach adopted for the preparation of the Biodiversity Development Assessment Report (BDAR), as described in further detail in Section 6.2.4iii. Consequently, no ecosystem credits are required for the modification. Further, as the modification will result in prescribed impacts only, of which an assessment of such impacts on candidate species has been assessed as low, no species credits species will be required to be offset as part of the modification.

## ES3.4 Surface water

Impacts to surface water quality and quantity are anticipated to be negligible. The current surface water monitoring program for Tahmoor South is considered comprehensive and sufficient to enable potential surface water impacts associated with the proposed modification to be appropriately identified. In accordance with the existing Tahmoor South Water Management Plan, if the modification is approved the site water balance model would continue to be updated and verified on a regular basis to maintain the model as a reliable tool for assessing the effectiveness of the site water management system.

## ES3.5 Groundwater

Predicted impacts on groundwater drawdown and baseflow losses from streams remain generally consistent with impacts presented in the Tahmoor South Project Amendment Report (AECOM 2020 and Hydrosimulations 2020) and the Second Amendment Report (EMM 2020). Predicted maximum drawdown due to LW S7A extraction in the water table is <20 metres (m) in the immediate vicinity of LW S7A and reduces to <5 m across much of the Tahmoor South footprint. Impacts to groundwater dependent ecosystems (Thirlmere Lakes) as a result of the modification are predicted to be negligible. While thirteen privately owned groundwater bores are predicted to experience drawdown of greater than 2 m due to the extraction of LW S7A, these bores are all already expected to experience drawdown greater than 2 m as a result of currently approved mining operations and are therefore already subject to 'make good' provisions.

The existing groundwater monitoring network is considered to be suitable for monitoring of potential incremental impacts due to the extraction of LW S7A, and no additional monitoring is therefore required. The existing Tahmoor South Groundwater Management Plan (GWMP) and Tahmoor South Water Management Plan (WMP) will continue to be implemented for the life of the Project. The management plans will be reviewed, and updated where required, prior to the extraction of LW S7A.

## ES3.6 Water licensing

Mining associated with the addition of LW S7A is predicted to take water from the Sydney Basin Nepean Groundwater Source (Nepean Management Zone 2) and Maldon Weir Water Source. Sufficient entitlement is held within the Sydney Basin Nepean Groundwater Source (Nepean Management Zone 2) to account for active take from both the approved Project and LW S7A. Based on the groundwater modelling undertaken by SLR (2024) used to estimate water licensing requirements, Tahmoor Coal may require additional entitlement in the Sydney Basin Nepean Groundwater Source (Nepean Management Zone 2) to account for passive take of groundwater inflows currently occurring into inactive mining areas.

If the predicted passive take groundwater volumes are required to be licensed, an additional entitlement of up to 1,217 ML is predicted to be required by the 2033-34 water year.

A detailed analysis of water licensing opportunities and water trading markets has identified that there is sufficient market depth within the water trading market to secure additional entitlement or allocation if required in the future.

Sufficient surface water entitlement is held by Tahmoor Coal to account for the predicted surface water take associated with the proposed modification in the Maldon Weir Water Source.

Surface water and groundwater monitoring is undertaken at Tahmoor Mine to assist in the ongoing review of the conceptual understanding and compliance reporting of water take. Monitoring results are used to inform groundwater modelling estimates of inflows into the mine workings as well as river leakage and baseflow reduction.

If the water take estimates are revised in the future to exceed the entitlement held by Tahmoor Coal in any water source, additional water entitlement or allocation in the relevant water sources will be traded with existing licence holders.

### ES3.7 Greenhouse gas

Scope 1 and 2 greenhouse gas emissions (GHG) for the life of the Project were calculated to be 14,285,834 Mt $CO_2$-e. It is estimated that the modification represents approximately 6% to 7% of total life of mine GHG emissions or 1,000,008 Mt$CO_2$-e. The updated annual average Scope 1 GHG emissions predicted from Tahmoor South (1,387,264 t $CO_2$-e) is less than that anticipated for Tahmoor South as originally approved under SSD 8445, which is 1,609,187 t $CO_2$-e. This is due to lower gas content being experienced, and predicted to be experienced, in the Tahmoor South Project area compared to what was assumed in the GHG predictions for the original Tahmoor South Project as approved by SSD 8445.

The annual average GHG emissions (Scope 1 and 2) generated by the Project are estimated to represent 1.08% of total GHG emissions for NSW and 0.31% of total GHG emissions for Australia.

## ES4 Modification justification and conclusion

The addition of LW S7A to the A series of approved longwalls will not substantially change the approved activities authorised by SSD 8445. Further, the modification proposes to remove the restriction imposed by condition A6 of SSD 8445 for mining operations to be completed within 10 years from the commencement of second workings under SSD 8445, however, all approved and proposed mining operations under Mod 3 will still be completed by 31 December 2033, as also stipulated in condition A6. Therefore, the modified development will remain substantially the same development for which consent was originally granted, and the proposed modification can be considered under Section 4.55 of the EP&A Act.

The addition of LW S7A to the mine plan will improve the resource recovery from Tahmoor South of high-quality coking coal that is required for steel production. This high-quality coking coal will be supplied through an existing operating mine, using existing infrastructure for coal handling and processing. The proposed modification will extend local employment and investment, and will provide additional royalties from the mine, for an additional nine months.

The proposed modification represents an efficient approach to extracting available high-quality coking coal within the existing mining leases held by Tahmoor Coal. This is consistent with the obligations of Tahmoor Coal under the NSW *Mining Act 1992* to optimise resource recovery in an efficient and sustainable manner.

The proposed modification will not require any additional surface infrastructure and will not change the existing disturbance footprint, the maximum annual ROM coal approved to be extracted, or the maximum annual volume of coal approved to be transported from the site. All impacts associated with the modified activities have been assessed to be negligible and generally consistent with those impacts previously assessed and approved. The modification therefore will not result in significant residual environmental or social impacts. All impacts associated with the modification can be controlled by the preparation and implementation of extraction plans and subsidence management plans, many of which have been successfully implemented during previous mining at Tahmoor Mine.

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# 1 Introduction

## 1.1 Background

Tahmoor Coal Pty Ltd (Tahmoor Coal) owns and operates the Tahmoor Mine, an underground coal mine approximately 80 kilometres (km) south-west of Sydney and 50 km north-west of Wollongong and Port Kembla in the Southern Coalfields of New South Wales (NSW). Tahmoor Mine is within the Wollondilly and Wingecarribee local government areas (LGAs) (refer to Figure 1.1).

Tahmoor Mine operates in accordance with State significant development consent (SSD 8445), which was granted on 23 April 2021 by the NSW Independent Planning Commission (IPC) for the Tahmoor South Project (the Project). Development consent SSD 8445 permits extraction (via longwall mining methods) and processing of up to 4 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal from the Bulli Seam until 31 December 2033, or until 10 years from the commencement of second workings (October 2032), whichever is the sooner. The approved longwalls authorised by SSD 8445 are situated in the Tahmoor South Domain as shown on Figure 1.2, and include an A series of longwall panels (Longwalls South 1A-6A (LW S1A-S6A)) and a B series of longwall panels (Longwalls South 1B-6B (LW S1B-S6B)). Longwall extraction under the Project's development consent commenced on 18 October 2022. Tahmoor Coal is currently extracting coal from LW S3A.

Development consent SSD 8445 has been modified on two occasions:

- Modification 1 (Mod 1) was granted on 19 July 2022 and authorised an extension of time, until 31 December 2023, for the new water treatment plant to be commissioned.
- Modification 2 (Mod 2) was granted on 13 June 2023 and authorised the transfer of brine from the water treatment plant to the underground workings for storage.

## 1.2 Proposed modification overview

Tahmoor Coal is seeking to modify SSD 8445 (Mod 3) under Section 4.55(2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to authorise:

- an additional longwall panel (LW S7A) to the approved A series longwall panel layout (modified layout)
- removal of restrictions imposed by Condition A6 of SSD 8445 on the requirement for mining to be completed within 10 years following the commencement of second workings in the Tahmoor South mining area
- an increase in the maximum volume of ROM coal authorised by Condition A11(b) of SSD 8445 that can be extracted and processed on site from 33 Mtpa to 35 Mtpa.

Further details on the proposed modification are presented in Chapter 3.

## 1.3 Purpose of this report

This modification report has been prepared by EMM Consulting Pty Limited (EMM) on behalf of Tahmoor Coal with relevant technical specialist input where required to support the modification application. It describes the proposed modification, the statutory and strategic context to the proposal, summarises the impact assessments that have been undertaken and recommends mitigation measures to address residual impacts.

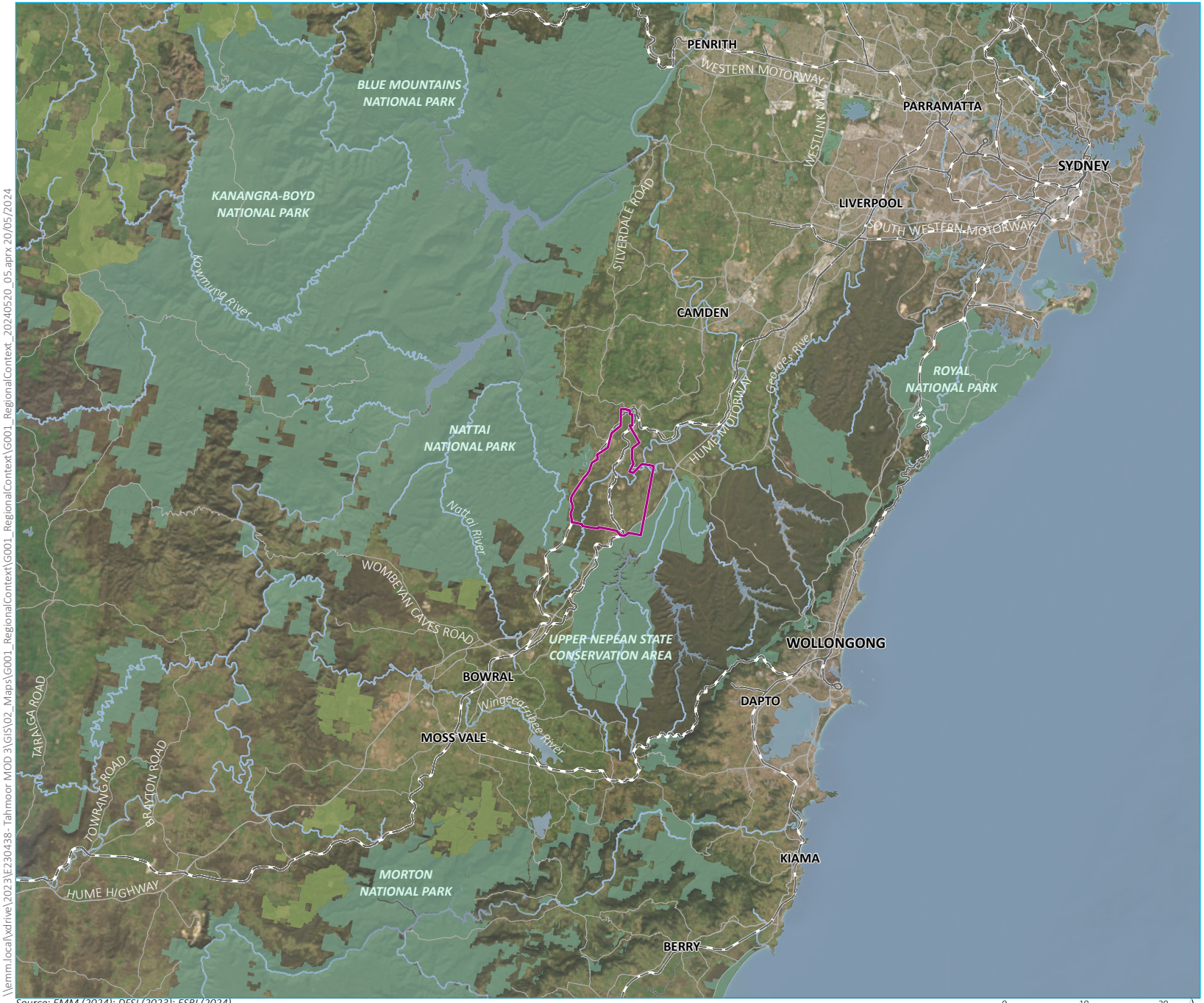
This modification report has been prepared in accordance with *State significant development guidelines – preparing a modification report* (DPIE 2022) and the requirements of the Environmental Planning and Assessment Regulation 2021 (EP&A Regulation).

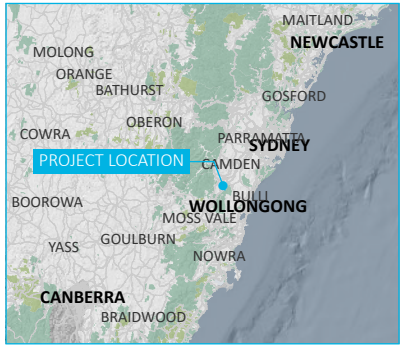
## 1.4 Applicant details

Tahmoor Coal supplies high-quality coking and high-ash coking coal to Australian and international markets, trading as Tahmoor Coal Pty Ltd within the SIMEC Mining Division (SIMEC) of the GFG Alliance. The applicants' details are summarised in Table 1.1.

**Table 1.1 Applicant details**

| Specifications | Detail |
|---|---|
| Applicant | Tahmoor Coal Pty Ltd |
| Site address | 2975 Remembrance Drive, Bargo NSW 2574 |
| Postal address | PO Box 100, Tahmoor NSW 2573 |
| ABN | 97 067 663 968 |
| Contact | Charlie Wheatley<br>Email: Charlie.Wheatley@simecgfg.com |




KEY

Tahmoor South project area (SSD 8445)

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody
- NPWS reserve
- State forest

Source: EMM (2024); DFSI (2023); ESRI (2024)

0 10 20 km

GDA 1994 NSW Lambert

N

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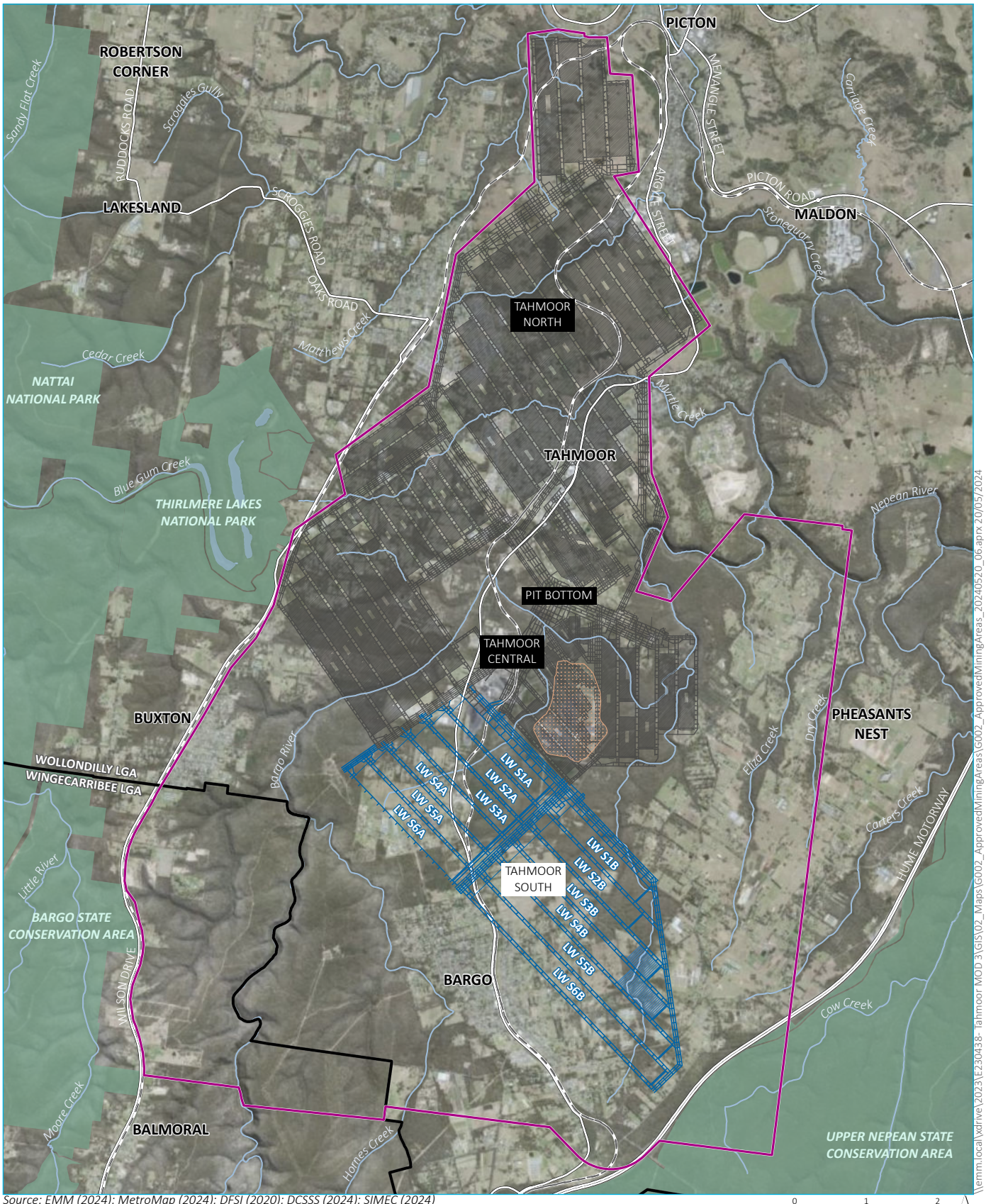
# Regional locality

Tahmoor South Project
SSD 8445 Modification 3
Figure 1.1

EMM
creating opportunities




Source: EMM (2024); MetroMap (2024); DFSI (2020); DCSSS (2024); SIMEC (2024)

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0 1 2 km
GDA 1994 MGA Zone 56

N

KEY

- Tahmoor South project area (SSD 8445)
- Extraction subject to secondary approval
- Existing underground working
- Tahmoor South approved mine working
- Approved reject emplacement area footprint

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody
- NPWS reserve
- Local government area

Existing and approved mining areas

Tahmoor South Project
SSD 8445 Modification 3
Figure 1.2

EMM
creating opportunities

# 2 Strategic context

## 2.1 Southern coalfields

The Southern Coalfield has historically been a major source of high-quality hard coking coal used for steel making, for both domestic and international markets. Coal mining has been carried out in the southern coalfield for around 200 years, contributing to the development of mining towns throughout the Illawarra region and the Southern Highlands.

The coal seams of the southern coalfield underlie the Upper Nepean and Woronora catchments which supply water to the Greater Sydney region. The major dams, reservoirs and canals used for water supply are surrounded by Special Areas, managed by WaterNSW, within which access and certain types of activities are restricted to protect water quality and maintain ecological integrity.

The unique nature of this coal resource within NSW makes it a very important contributor to the local, regional and NSW economies. The close proximity of the Southern Coalfield to the coast and the Port Kembla Coal Terminal (PKCT) is a major factor supporting export of coal from the region.

Coal from Tahmoor Mine is supplied to both domestic customers and international markets through the PKCT.

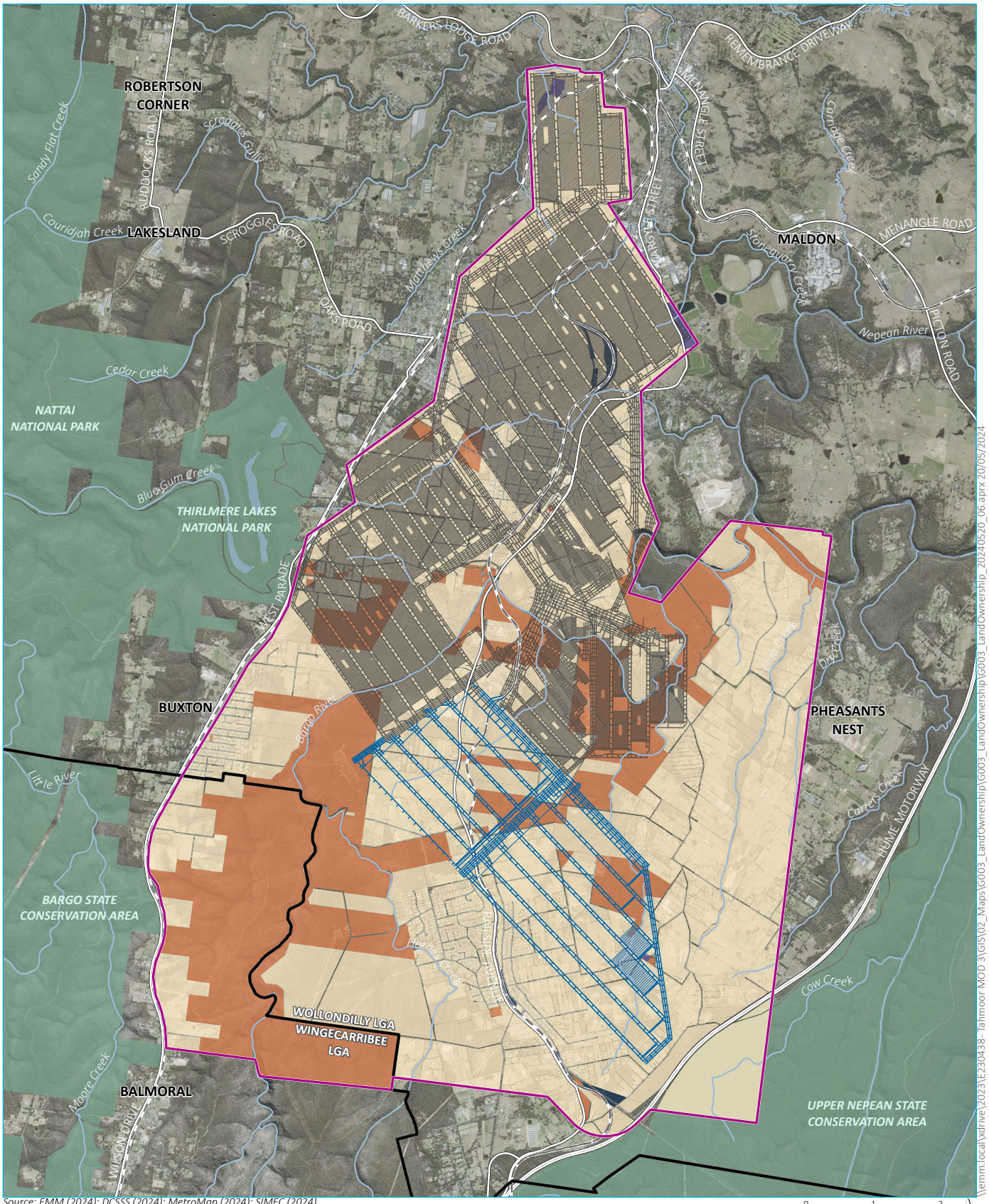
## 2.2 Land use and ownership

Land use in the region is characterised by a mix of residential, rural residential, agriculture, vacant Crown land and conservation areas.

The region includes the Upper Nepean State Conservation Area (SCA), the Bargo River SCA, Nattai National Park, Thirlmere Lakes National Park and Blue Mountains National Park. The three national parks form part of the Greater Blue Mountains World Heritage Area. The Project area does not extend into any of the above listed national parks or the Bargo River SCA (as shown on Figure 1.2). While the south-eastern corner of the Project area extends into the Upper Nepean SCA, no works associated with the Tahmoor Mine, such as longwall panels or any surface infrastructure, extend into the SCA.

Key infrastructure in the Project area includes the Main Southern Railway, which extends through the Project area and supports passenger and freight services between Sydney and Melbourne, and the M31 Hume Highway to the east of the Project area.

Land ownership within the Project area is shown on Figure 2.1. The modification does not propose any changes to the schedule of lands provided as Appendix 1 to the Development Consent.




Source: EMM (2024); DCSSS (2024); MetroMap (2024); SIMEC (2024)

0 1 2 km
GDA 1994 MGA Zone 56

N

KEY

- Tahmoor South project area (SSD 8445)
- Existing underground working
- Tahmoor South approved mine working
- Extraction subject to secondary approval

Land ownership

- Crown
- Freehold
- Local Government Authority
- NSW Government

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody
- NPWS reserve
- Local government area

# Land ownership

Tahmoor South Project
SSD 8445 Modification 3
Figure 2.1

EMM
creating opportunities

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## 2.3 Coal demand

Australia is the largest exporter of coking coal, with Australian coking coal exports accounting for over half of the global coking coal supply (Office of the Chief Economist (OCE) 2023). Australian coal therefore plays a critical part in meeting the global demand for metallurgical coal.

Demand for coking coal remains strong, with the OCE's latest *Resources and Energy Quarterly* (December 2023) reporting that world metallurgical coal trade is forecast to increase from 312 Mt in 2022 to 318 Mt by 2025, led by rising demand in India. India's demand for steel is expected to continue to grow, driven by the manufacturing and construction sectors. India is rapidly expanding its domestic steel production capacity and aims to double crude steel production capacity by 2030. Approximately 75% of coal produced from the Tahmoor Mine is sold to the export market.

## 2.4 Policy context

### 2.4.1 Strategic Statement on Coal Exploration and Mining

In June 2020, the NSW Government released the *Strategic Statement on Coal Exploration and Mining in NSW* (Strategic Statement). The key objective of the Strategic Statement is to provide greater certainty to explorers, investors, industry stakeholders and communities about the future of coal mining in the state to 2050.

The statement recognises the significance of coal to NSW, indicating that the industry provides over 22,000 direct jobs and around 89,000 indirect jobs. In 2018–2019, royalties from coal generated around $2 billion in government revenue.

At the time of its approval, the Project was considered to align with the objectives of the strategic statement. The proposed modification will enable the Project to operate for an additional nine months longer than originally anticipated; and extract approximately 2 million tonnes (Mt) of additional high quality coking coal, which will attract further royalties to the State and be used to fund the NSW economy.

### 2.4.2 Wollondilly 2040

Wollondilly 2040 is Wollondilly Council's local strategic planning statement (LSPS).

The LSPS details the land use planning vision for the Wollondilly LGA over the next 20 years. It recognises that there are significant mineral resources in the LGA and that primary industries are essential to the area's economy. The LSPS states that "Bargo is constrained by the need to protect State significant mineral resources and is unsuitable for expansion and further intensification until mining activity is complete".

The proposed modification will not impact the growth and future expansion within the Wollondilly LGA as extraction of the additional longwall will remain within the existing mining leases, with all mining in the Tahmoor South Domain to still be completed by 31 December 2033. As such, the extraction of LW S7A will not impact on the future land use opportunities for development beyond this date previously considered by the Project.

# 3 Description of the modification

## 3.1 Overview

The key aspects of the approved operations authorised by SSD 8445, as modified, include:

- continued mining using longwall mining methods in the Bulli Seam within CCL 747 and CCL 716
- extraction of up to 4 Mtpa of ROM coal with up to 33 Mt of ROM coal extracted over the life of the Project
- continued use of the surface and ancillary infrastructure and services at the surface facilities area
- continued coal processing at the Tahmoor coal handling and preparation plant (CHPP)
- continued transportation of product coal by rail to PKCT and to Newcastle using the existing rail load out, rail loop and rail infrastructure
- transportation of up to 200,000 tonnes per annum (tpa) of either product coal or reject material via road
- construction of a new upcast ventilation shaft (TSC1) and downcast ventilation shaft (TSC2), south of the reject emplacement area (REA)
- upgrades to the existing surface facilities, amenities, equipment and infrastructure to accommodate the extension of mining
- disposal of brine from the site water treatment plant to within the Tahmoor North underground mine workings
- transfer of mine water from Tahmoor South to Tahmoor North underground workings for temporary storage
- progressive rehabilitation and mine closure activities.

Tahmoor Coal is seeking to modify SSD 8445 under Section 4.55(2) of the EP&A Act to authorise:

- an additional longwall panel (LW S7A) to the approved longwall layout (modified layout)
- removal of restrictions imposed by Condition A6 on the requirement for mining to be completed within 10 years following the commencement of second workings in the Tahmoor South mining area
- an increase in the maximum volume of ROM coal authorised by Condition A11(b) of SSD 8445 that can be extracted and processed on site from 33 Mtpa to 35 Mtpa.

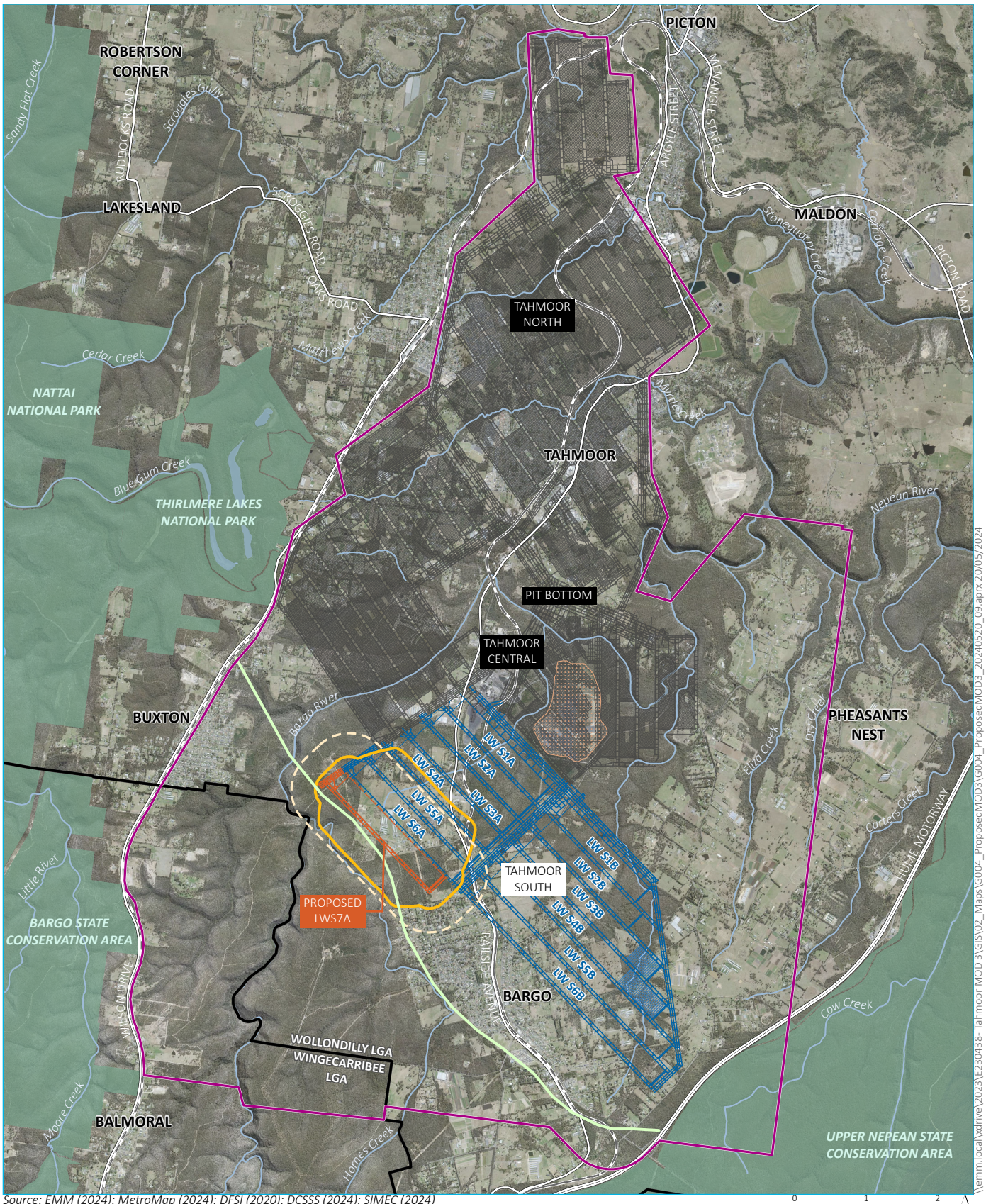
A summary of the approved Project and proposed modifications is provided in Table 3.1 and illustrated in Figure 3.1.

## Table 3.1 Proposed modification summary table

| Element | Approved project | Project with proposed Mod 3 |
|---|---|---|
| Project area | The Project area is illustrated in Figure 1.1 and Figure 1.2. | No change. |
| Mining areas | As shown on Figure 1.2. | Include mining of LW S7A as shown in Figure 3.1. |
| Extraction and processing rate | Up to 4 Mtpa of ROM coal per annum.<br>33 Mt of ROM coal over the life of the Project. | No change to annual extraction limit.<br>Increase in life of mine ROM coal extraction limit from 33 Mt to 35 Mt. |
| Mine life | Until 31 December 2033, or until 10 years from the commencement of second workings, whichever is the sooner. | Mining operations carried out until 31 December 2033.<br>Remove restriction 'or until 10 years from the commencement of second workings, whichever is the sooner' from condition A6. |
| Mining method | Longwall mining method. | No change. |
| Coal reject management | Continued use of the existing REA, where reject material may be emplaced up to a maximum height of RL 320 metres (m). | No change. |
| Transportation by rail | A maximum of 4 laden trains may leave the site in any 24-hour period. | No change. |
| Transportation by road | A maximum of 200,000 tonnes (t) per annum of material (including ROM coal, product coal, and coal reject material) may be transported to and from the site by road, at a rate of:<br>• 3,000 t per day<br>• 16 truck movements per hour<br>• 158 truck movements in total per day. | No change. |
| Mine water management | Mine water is collected in underground sumps and pumped from the mine to the existing water management system at the surface facilities area.<br>Treated mine water is reused underground or for other non-potable uses or discharged via the existing LDP1 to Tea Tree Hollow. | No change. |
| Disposal of brine | Transfer of brine from the water treatment plant underground for storage in the Western Domain mining area. | Continued transfer of brine from the water treatment plant for duration of additional mining. |

## Table 3.1 Proposed modification summary table

| Element | Approved project | Project with proposed Mod 3 |
|---|---|---|
| Operating hours | Underground mining operations:<br>• 24 hours a day, 7 days a week.<br>Road transportation:<br>• between 7.00 am to 6.00 pm Monday to Saturday.<br>Construction activities at the surface facilities site and ventilation shaft site:<br>• between 7.00 am to 6.00 pm Monday to Friday<br>• 8.00 am to 1.00 pm Saturday<br>• no construction activities on Sundays or public holidays unless the Planning Secretary agrees otherwise.<br>Drilling activities at the ventilation shaft sites may be undertaken 24 hours a day, 7 days a week. | No change. |
| Rehabilitation | • Progressive rehabilitation.<br>• Final rehabilitation and closure in accordance with a Rehabilitation Strategy and Rehabilitation Management Plan. | No change. |
| Workforce | Ongoing employment for approximately 400 full time equivalent (FTE) employees. | No change. |




Source: EMM (2024); MetroMap (2024); DFSI (2020); DCSSS (2024); SIMEC (2024)

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KEY

- Tahmoor South project area (SSD 8445)
- LW S7A study area
- Extraction subject to secondary approval
- Offset boundary (600m)
- Approved reject emplacement area footprint
- Existing underground working
- Tahmoor South approved mine working
- Proposed LWS7A

Existing environment

- Rail line
- Major road
- Central fault
- Named watercourse
- Named waterbody
- NPWS reserve
- Local government area

Proposed modification

Tahmoor South Project
SSD 8445 Modification 3
Figure 3.1

EMM
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## 3.2 Longwall S7A

Development consent SSD 8445 permits longwall mining of six panels within an 'A-series' and six panels within a 'B-series' of longwalls. A modified layout comprising the approval longwalls with the addition of a new longwall (LW S7A) to the A series longwalls is sought. The proposed LW S7A is within the existing Project area.

LW S7A will extract coal between a minimum extraction height of 2.1 metres (m) and a maximum extraction height of 2.5 m. Further details of the proposed LW S7A dimensions are summarised in Table 3.2.

**Table 3.2 Longwall S7A dimensions**

| Longwall ID | Overall void length including installation heading (m) | Overall void width including first workings (m) | Overall tailgate chain pillar width (m) |
|---|---|---|---|
| S7A | 1918 | 285 | 36 |

LW S7A has been included in the mine plan following a revision of the geological interpretation of the location of the Central Fault, which is located to the south-west of the Project area (refer Figure 3.1).

For the purposes of this modification application, a study area has been defined as the zone where the predicted subsidence effects, based on the modified layout, are different to those predicted based on the approved layout. The study area is shown in Figure 3.1, and has been based on the following parameters:

- 35° angle of draw line around LW S7A, based on the modified layout
- the limit where the predicted incremental vertical subsidence due to the extraction of LW S7A on the tailgate (eastern side) of the panel is greater than 20 millimetres (mm)
- the limit where the predicted incremental total subsidence due to the extraction of LW S1A to LW S7A on the maingate (western side) of the panel is greater than 20 mm.

A larger subsidence study area (refer to Figure 3.1) for natural features has also been defined as 600 m from LW S7A.

## 3.3 Life of mine

Condition A6 of SSD 8445 states:

> Mining operations may only be carried out on the site until 31 December 2033, or until 10 years from the commencement of second workings, whichever is the sooner.

The Tahmoor South second workings commenced under SSD 8445 in October 2022. As a result, in accordance with condition A6 of SSD 8445, mining operations must be completed by October 2032.

The inclusion of LW S7A will extend mining beyond October 2032 by approximately nine months, with all approved and proposed mining operations to still be completed by 31 December 2033, as also stipulated in condition A6.

Tahmoor Coal seeks to remove the restriction imposed by condition A6 of SSD 8445 for mining operations to be completed within 10 years from the commencement of second workings undertaken under SSD 8445, to enable sufficient time for LW S7A to be extracted.

Extraction of LW S7A is scheduled to be completed prior to mining moving to the B-series panels. It is anticipated extraction of LW S7A will commence in January 2027 and be completed in September 2027.

## 3.4 ROM extraction

Condition A11(b) of SSD 8445 authorises a maximum of 33 Mt of ROM coal to be extracted and processed on site over the life of the development. The extraction of LW S7A will add approximately 2 Mt of coal to the total volume of coal extracted over the life of the mine.

Tahmoor Coal therefore seeks to increase the maximum volume of coal authorised to be extracted over the life of the development from 33 Mt to 35 Mt.

## 3.5 Reject management

The additional 2 Mt of ROM coal extracted from LW S7A will produce an associated 0.6 Mt of reject material.

This reject material is proposed to be stored within the existing footprint and approved heights of Tahmoor Coal's existing REA.

# 4 Statutory context

## 4.1 Permissibility

The approved Project area is located within both the Wingecarribee and Wollondilly LGAs which are covered by the:

- *Wollondilly Local Environmental Plan (LEP) 2011* (Wollondilly LEP)
- *Wingecarribee Local Environmental Plan 2010* (Wingecarribee LEP).

The Project area includes land zoned under the Wollondilly LEP as:

- B2 – Local Centre
- B5 – Business Development
- C2 – Environmental Conservation
- C3 – Environmental Management
- C4 – Environmental Living
- IN2 – Light Industrial
- R2 – Low Density Residential
- R3 – Medium Density Residential
- R5 – Large Lot Residential
- RE1 – Public Recreation
- RE2 – Private Recreation
- RU1 – Primary Production
- RU2 – Rural Landscape
- RU4 – Primary Production Small Lots
- SP2 – Infrastructure

The Project area includes land zoned under the Wingecarribee LEP as:

- C2 – Environmental Conservation
- C3 – Environmental Management
- RU4 - Primary Production Small Lots.

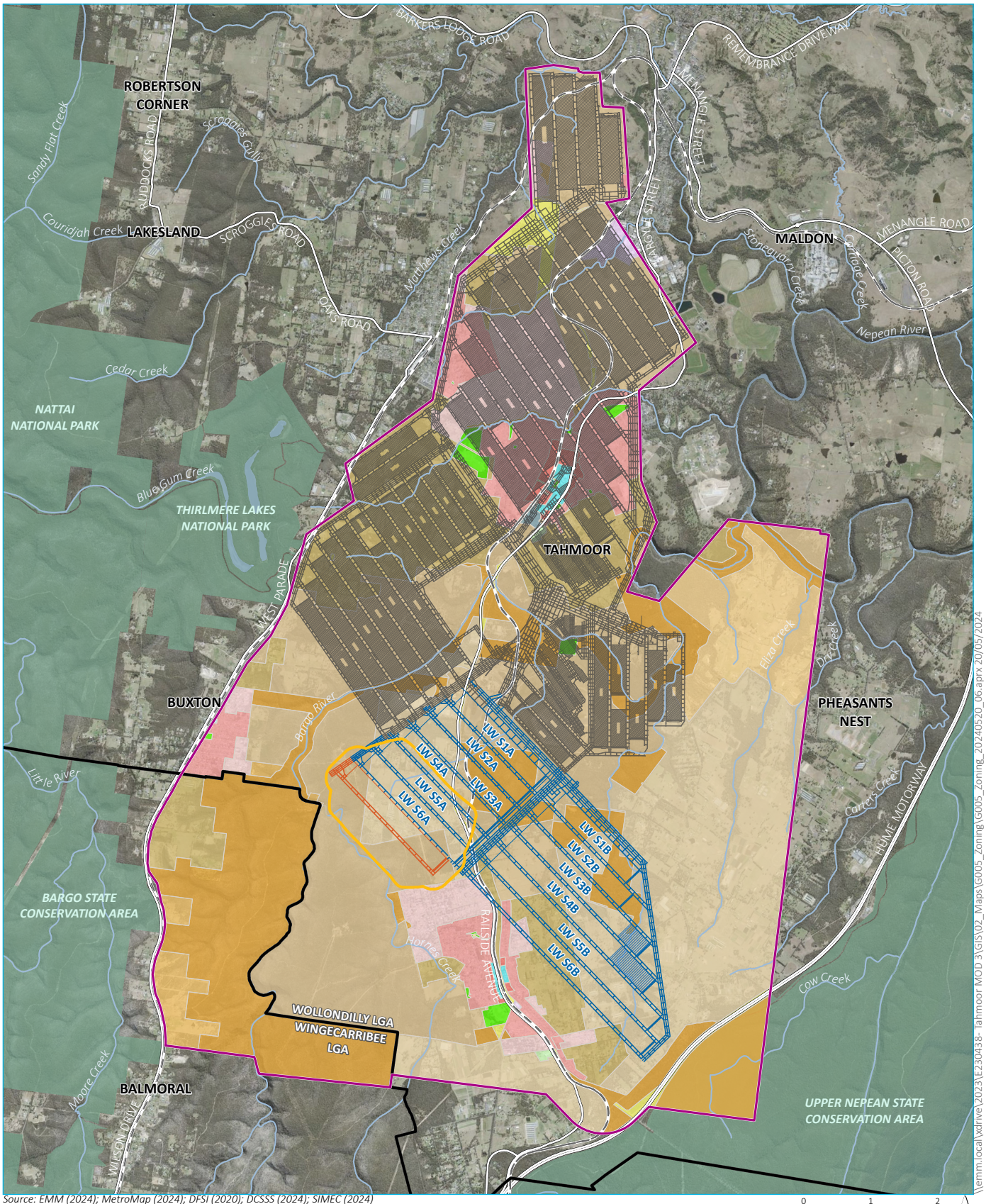
Land zoning within the Project area is shown on Figure 4.1.

The study area for the proposed longwall panel S7A falls entirely within the Wollondilly LGA on land zoned:

- C2 – Environmental Conservation
- R5 – Large Lot Residential
- RU1 – Primary Production
- RU2 – Rural Landscape
- RU4 – Primary Production Small Lots.

The proposed modification constitutes development that is ordinarily permitted with consent in some land use zones, whilst being prohibited in other zones under the Wollondilly LEP. Pursuant to Section 2.6 of the State Environmental Planning Policy (Resources and Energy) 2021 (Resources and Energy SEPP), in the case of an inconsistency between the Resources and Energy SEPP and any other environmental planning instrument, the provisions in the Resources and Energy SEPP (subject to limited exceptions) will prevail.

The proposed modification is considered 'mining' pursuant to Section 2.2(2) of the Resources and Energy SEPP. In accordance with Section 2.9(1)(a) of the Resources and Energy SEPP, underground mining activities are permissible with consent on any land. As such, the provisions of the Resources and Energy SEPP will prevail, and accordingly, the Minister, or delegate, would not be precluded from granting approval under section 4.38 of the EP&A Act for Mod 3 in respect of those parts of the study area land where mining is prohibited under the Wollondilly and Wingecarribee LEPs.




Source: EMM (2024); MetroMap (2024); DFSI (2020); DCSSS (2024); SIMEC (2024)

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KEY

- Tahmoor South project area (SSD 8445)
- LW S7A Study area
- Proposed LWS7A
- Existing underground working
- Tahmoor South approved mine working
- Extraction subject to secondary approval

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody
- NPWS reserve
- Local government area

Land zone

- B1 | Neighbourhood Centre
- B2 | Local Centre
- B5 | Business Development
- C1 | National Parks and Nature Reserves
- C2 | Environmental Conservation
- C3 | Environmental Management
- C4 | Environmental Living
- IN2 | Light Industrial
- R2 | Low Density Residential
- R3 | Medium Density Residential
- R5 | Large Lot Residential
- RE1 | Public Recreation
- RE2 | Private Recreation
- RU1 | Primary Production
- RU2 | Rural Landscape
- RU4 | Primary Production Small Lots
- SP2 | Infrastructure

# Land zoning

Tahmoor South Project
SSD 8445 Modification 3
Figure 4.1

EMM
creating opportunities

## 4.2 Commonwealth legislation

### 4.2.1 Commonwealth Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) aims to protect matters of national environmental significance (MNES). If an action will, or is likely to, have a significant impact on any MNES, it is deemed to be a controlled action and requires approval from the Commonwealth Minister for the Environment. Tahmoor Coal operates in accordance with approval issued under the EPBC Act 2017/8084, which was granted by the Commonwealth Minister for the Environment on 1 October 2021.

There is no additional surface infrastructure required to support the modification, and assessments completed to support the modification (refer Section 6.2 and Section 6.6) have determined that the modification is unlikely to have a significant residual impact on any MNES listed under the EPBC Act.

Consequently, Tahmoor Coal is satisfied that modification does not require referral to the Department of Climate Change, Energy, the Environment and Water (DCCEEW). However, in accordance with Condition 30 of EPBC 2017/8084, DCCEEW has been notified of the proposed changes to the Project.

### 4.2.2 National Greenhouse and Energy Reporting Act 2007

The *National Greenhouse and Energy Reporting Act 2007* (NGER Act) establishes a national framework and reporting scheme for Australian corporations to report greenhouse gas (GHG) emissions, reductions, removals and offsets, energy consumption and production. The National Greenhouse and Energy Reporting (NGER) scheme is a single national framework for reporting information about GHG emissions, energy production and energy consumption.

Facilities or corporations must report under the NGERs scheme if they emit GHG emissions or produce/consume energy at or above the following thresholds:

- greater than 25 kilotonnes (kt) GHG emissions (as $CO_2$-e) or produced/consume greater than 100 terajoules (TJ) of energy (facility level)
- greater than 125 kt of GHG emissions (as $CO_2$-e) or produce/consume greater that 500 terajoules (TJ) of energy (corporate level).

Tahmoor Coal currently reports annual GHG emissions under the NGER scheme.

## 4.3 NSW legislation

### 4.3.1 Environmental Planning and Assessment Act 1979

Tahmoor Coal proposes to modify SSD 8445 under Section 4.55(2) of the EP&A Act.

Under Section 4.55(2) of the EP&A Act, a consent authority may modify an SSD development consent provided the development to which the consent as modified relates is substantially the same as the development for which the consent was originally granted. Compliance of the proposed modification with the requirements of Section 4.55(2) is provided in Table 4.1.

**Table 4.1 Compliance with Section 4.55(2) requirements**

| Section 4.55(2) requirement | | Comment |
|---|---|---|
| (2) | **Other modifications**<br>A consent authority may, on application being made by the applicant or any other person entitled to act on a consent granted by the consent authority and subject to and in accordance with the regulations, modify the consent if: | |
| (a) | it is satisfied that the development to which the consent as modified relates is substantially the same development as the development for which consent was originally granted and before that consent as originally granted was modified (if at all), and | The proposed modification is for an extension of underground mining and is located within the existing approved Project area as authorised by SSD 8445. The addition of LW S7A to the A series of approved longwalls will not substantially change the approved activities authorised by SSD 8445. The proposed modification will not require any additional surface infrastructure or result in changes to the existing coal handling, processing and transport activities.<br>Further, in relation to the life of the Project, the modification proposes to remove the restriction imposed by condition A6 of SSD 8445 for mining operations to be completed within 10 years from the commencement of second workings under SSD 8445. However, all approved and proposed mining operations under Mod 3 will still be completed by 31 December 2033, as also stipulated in condition A6.<br>Therefore, the modified development will remain substantially the same development for which consent was originally granted, and the proposed modification can be considered under Section 4.55 of the EP&A Act. |
| (b) | it has consulted with the relevant Minister, public authority or approval body (within the meaning of Division 4.8) in respect of a condition imposed as a requirement of a concurrence to the consent or in accordance with the general terms of an approval proposed to be granted by the approval body and that Minister, authority or body has not, within 21 days after being consulted, objected to the modification of that consent, and | Tahmoor Coal has consulted with the NSW Department of Planning, Housing and Infrastructure (DPHI) as part of the preparation of this modification report. DPHI confirmed that the appropriate approval pathway for the modification is under Section 4.55(2) of the EP&A Act. Further information about this consultation is provided in Chapter 5. The modification will not require any new mining leases or variations to the current EPL. |
| (c) | it has notified the application in accordance with—<br>(i) the regulations, if the regulations so require, or<br>(ii) a development control plan, if the consent authority is a council that has made a development control plan that requires the notification or advertising of applications for modification of a development consent, and | Section 106 of the NSW EP&A Regulation relates to the notification requirements for 4.55(2) modifications. Notice of the application must be published in a local newspaper by DPHI. DPHI must also cause notice of the proposed modification to be given to each person who made a submission in relation to the original development application. |

### Table 4.1 Compliance with Section 4.55(2) requirements

| Section 4.55(2) requirement | | Comment |
|---|---|---|
| (d) | it has considered any submissions made concerning the proposed modification within the period prescribed by the regulations or provided by the development control plan, as the case may be. | Any submissions made concerning Mod 3 will be reviewed by DPHI and forwarded to Tahmoor Coal to consider and respond to via a submissions report. |

Modification applications under Section 4.55(2) are required to take into consideration the relevant matters referred to in Section 4.15 of the EP&A Act. These matters and where they are addressed in this modification report are detailed in Table 4.2.

### Table 4.2 EP&A Act Section 4.15(1) matters for consideration

| Section 4.15(1) matter for consideration | | Where addressed |
|---|---|---|
| (a) | the provisions of: | |
| (i) | any environmental planning instrument; and | Relevant planning instruments are addressed in Section 4.1 (Wollondilly and Wingecarribee LEPs, and the Resources and Energy SEPP). |
| (ii) | any proposed instrument that is or has been the subject of public consultation under this Act and that has been notified to the consent authority (unless the Planning Secretary has notified the consent authority that the making of the proposed instrument has been deferred definitely or has not been approved); and | There are no proposed instruments relevant to the modification. |
| (iii) | any development control plan; and | Wollondilly Development Control Plan 2016 and Wingecarribee Development Control Plans are relevant to the Project area noting Mod 3 is permitted under the Resources and Energy SEPP. |
| (iv) | any planning agreement that has been entered into under section 7.4, or any draft planning agreement that a developer has offered to enter into under Section 7.4; and | Tahmoor Coal entered into a voluntary planning agreement (VPA) with Wollondilly Shire Council for the Project on 8 December 2022. The modification does not change anything with respect to the VPA. Predicted impacts from the modification are considered to be negligible and will remain within the extent of existing mining leases. |
| (v) | the regulations (to the extent that they prescribe matters for the purposes of this paragraph) that apply to the land to which the development application relates; | The requirements of the EP&A Regulation are addressed in Section 4.3.2 |
| (b) | the likely impacts of the development, including environmental impacts on both the natural and built environments, and social and economic impacts in the locality; | This modification report and accompanying appendices and technical assessments comprehensively describe the likely impacts of the modification. |
| (c) | the sustainability of the site for the development; | It is considered that the site is suitable for the proposed activities as it has been approved under previous development consents for mining activities. The suitability of the site and its location is further addressed in Chapter 2. |

**Table 4.2 EP&A Act Section 4.15(1) matters for consideration**

| Section 4.15(1) matter for consideration | | Where addressed |
|---|---|---|
| (d) | any submissions made in accordance with this Act or the regulations; | The consent authority must satisfy itself on compliance with this obligation.<br>This modification report will be placed on public exhibition for a minimum of 14 days by DPHI and submissions will be sought from local and State government agencies and the community. Any submissions received by DPHI will be reviewed and forwarded to Tahmoor Coal to consider and respond to (via a submissions report). |
| (e) | the public interest | To assist the consent authority in determining whether Mod 3 is in the public interest, this modification report includes a detailed justification (Chapter 7), taking into consideration the potential environmental impacts of the proposed modification and the suitability of site. DPHI will also be required to consider all submissions received during the public exhibition of the modification report. |

### 4.3.2 NSW Environmental Planning and Assessment Regulation 2021

Section 100 of the EP&A Regulation lists the information required in a development consent application under Section 4.55(2) of the EP&A Act. Table 4.3 describes where this information is provided.

No land within the Project area is mapped as Biophysical Agricultural Land (BSAL) on the Strategic Agricultural Land Map. A site verification certificate was approved for the Project on 29 October 2018, confirming that the relevant parts of the proposal were not located on land mapped as BSAL. Further, no new mining leases are required for the modification.

**Table 4.3 EP&A Regulation Section 100 information requirements**

| Section 100 information requirements | | Where addressed |
|---|---|---|
| (1)(a) | the name and address of the applicant | Section 1.4 |
| (1)(b) | a description of the development that will be carried out under the development consent | Chapter 3 |
| (1)(c) | the address and folio identifier of the land on which the development will be carried out | |
| (1)(d) | a description of the modification to the development consent, including the name, number and date of plans that have changed, to enable the consent authority to compare the development with the development originally approved | Chapter 3 |
| (1)(e) | whether the modification is intended to—<br>(i) merely correct a minor error, misdescription or miscalculation, or<br>(ii) have another effect specified in the modification application | Section 4.3.1 |
| (1)(f) | a description of the expected impacts of the modification | Chapter 6 |
| (1)(g) | an undertaking that the modified development will remain substantially the same as the development originally approved | Section 4.3.1 |
| (1)(h) | for a modification application that is accompanied by a biodiversity development assessment report—the biodiversity credits information | Section 6.2 |

### Table 4.3 EP&A Regulation Section 100 information requirements

| Section 100 information requirements | | Where addressed |
|---|---|---|
| (1)(i) | if the applicant is not the owner of the land—a statement that the owner consents to the making of the modification application | In accordance with Section 98(3) of the EP&A Regulation, the consent of the owner of the land is not required for a modification application for public notification development. A notice of the modification application will be published in a newspaper circulating in the area in which the development will be carried out no later than 14 days after the modification application is made. |
| (1)(j) | whether the modification application is being made to—<br>(i) the Court under the Act, section 4.55, or<br>(ii) the consent authority under the Act, section 4.56. | Not applicable |
| (2) | Subsection (1)(i) does not apply if the consent of the owner is not required under section 98. | Landowner consent is not required pursuant to Section 98(3) of the EP&A Regulation. |

### 4.3.3 Other relevant NSW State legislation and environmental planning instruments

**Table 4.4 Other relevant NSW State Legislation**

| NSW legislation or EPIs | Comment |
|---|---|
| *Protection of the Environment Operations Act 1997* | Tahmoor Mine is a 'premised-based scheduled activity' under Schedule 1 of the *Protection of the Environment Operations Act 1997* (POEO Act). Tahmoor Mine operates under EPL 1389. EPL 1389 licenses Tahmoor Mine for:<br>• Coal works: >2,000,000–5,000,000 t annual handing capacity.<br>• Mining for coal: >2,000,000–3,500,000 t annual production capacity.<br>• Sewage treatment processing by small plants: 0–20 megalitres (ML) annual maximum volume of discharge.<br>No changes to EPL 1389 are required as a result of this modification. |
| *Mining Act 1992* | The *Mining Act 1992* (Mining Act) encourages and facilitates the discovery and development of mineral resources in NSW, while encouraging ecologically sustainable development. Tahmoor Mine operates under Consolidated Coal Lease 716 and 747 and Mining Lease 1376, 1308, 1539, and 1642. No new mining leases are required to support the proposed modification. Proposed LW S7A is within CCL 747.<br>A Rehabilitation Management Plan for the Tahmoor Mine has been prepared in accordance with the Mining Regulation 2016 requirements and Condition B60 of the SSD 8445 development consent. |
| *NSW Biodiversity Conservation Act 2016* | Under the NSW *Biodiversity Conservation Act 2016* (BC Act), impacts to biodiversity are assessed and, if required, offset in accordance with the clearing thresholds prescribed by the Biodiversity Conservation Regulation 2017.<br>An assessment of impacts to biodiversity has been prepared and provided as Appendix C. Impacts to biodiversity are summarised in Section 6.2. |
| *NSW National Parks and Wildlife Act 1974* | Aboriginal objects and places are protected in NSW under Part 6 of the NSW *National Parks and Wildlife Act 1974* (NPW Act).<br>An assessment of impacts of the proposed modification to Aboriginal objects and places has been prepared and provided as Appendix D. Impacts to Aboriginal objects and places are summarised in Section 6.3.<br>A small portion of the Upper Nepean State Conservation Area (SCA), is located within the Project area; however, the proposed modification will not result in any impacts to this SCA. |
| *Climate Change (Net Zero Future) Act 2023* | The *Climate Change (Net Zero Future) Act 2023* commits the NSW government to effective action on climate change to ensure a sustainable and fair future for the people, economy and environment of NSW. It legislates guiding principles for action to address climate change that consider the impacts, opportunities and need for action in NSW including emissions reduction targets for NSW being:<br>• 50% reduction on 2005 levels by 2030<br>• 70% reduction on 2005 levels by 2035<br>• Net zero by 2050.<br>An assessment of the proposed modification's contributions to greenhouse gas emissions is outlined in Section 6.8 and Appendix I. |
| *Heritage Act 1977* | The *Heritage Act 1977* is designed to protect historic heritage items. No items of historic heritage are located within the study area. The Wellers Road overbridge (Listing LEP #I40) and Picton Weir (Listing No: I41) are located outside the study area. Subsidence predictions and assessment of potential impacts from subsidence for these two sites are considered in Section 6.1.4 and Appendix B. |

### Table 4.4 Other relevant NSW State Legislation

| NSW legislation or EPIs | Comment |
|---|---|
| *Native Title (New South Wales) Act 1994* | The *Native Title Act 1994* provides for the recognition and protection of Native Title rights in Australia.<br>The *Native Title Act 1994* provides a mechanism to determine whether Native Title exists and identify the rights and interests that comprise that Native Title. The process is designed to ensure that Indigenous people who claim to have an interest in a parcel of land have the opportunity to express this interest formally, and to negotiate with the Government and the applicant about the proposed grant or renewal of a mining tenement, or consent to access Native Title land.<br>The Mining Act must be administered in accordance with the *Native Title Act 1994*. The primary effect of the *Native Title Act 1994* on exploration and mining approvals is to provide Native Title parties with 'Rights to Negotiate' about the grant and some renewals by Governments of exploration and mining titles.<br>The *Native Title Act 1994*, where applicable, would be complied with in relation to the renewal of any necessary mining tenements for the mine. No new mining leases are required to support the proposed modification. |
| *Crown Land Management Act 2016* | Crown road reserves exists within the study area for LW S7A as shown on Figure 2.1. No impacts to Crown road reserves as a result of the proposed modification are anticipated.<br>All Crown roads within a mining lease (with sub-surface rights only) must be subject to a section 81 consent under the Mining Act where surface activities are proposed. No surface activities within Crown roads are proposed by the modification.<br>DPHI Crown Lands has been consulted with in relation to this modification application (refer to Chapter 5). |
| *Waste Avoidance and Resource Recovery Act 2001* | All wastes produced by the modified activities will continue to be classified, stored and handled in accordance with the *Waste Classification Guidelines – Part 1: Classifying Waste* (EPA 2014). |
| *Work Health and Safety (Mines and Petroleum Sites) Act 2013* | The NSW *Work Health and Safety (Mines and Petroleum Sites) Act 2013* (WHS Mines and Petroleum Act) aims to assist in securing and promoting the health, safety and welfare of people at work at coal operations.<br>Tahmoor Coal hold all necessary approvals and operations will continue to be regulated under the provisions of the WHS Mines and Petroleum Act. |
| *Fisheries Management Act 1994* | The NSW *Fisheries Management Act 1994* (FM Act) contains provisions for the conservation of fish stocks, key fish habitat, biodiversity, threatened species, populations and ecological communities.<br>The modification will not impact any threatened aquatic species, populations, communities, habitats and key fish habitats. |

### Table 4.4 Other relevant NSW State Legislation

| NSW legislation or EPIs | Comment |
|---|---|
| *Water Management Act 2000* | The *Water Management Act 2000* (WM Act) regulates the use and interference with surface water (streams, creeks, rivers, etc.) and groundwater in NSW. The main tool in the WM Act for managing the state's water resources are water sharing plans (WSPs).<br>The following WSPs, extraction management units (EMUs) and water sources are relevant to the project.<br>• Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2023:<br>– Upper Nepean and Upstream Warragamba EMU:<br>▪ Stonequarry Creek Water Source – contains rules relating to surface water take from Redbank Creek<br>▪ Maldon Weir Water Source – contains rules relating to surface water take from Teatree, Bargo, Hornes, Dogtrap and Myrtle creeks<br>• Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2023:<br>– Sydney Basin Nepean Groundwater Source, Nepean Management Zone 2 – contains the rules relating to groundwater extraction from the fractured rock aquifer at the project site.<br>Pursuant to Section 60I(2) of the WM Act, mining projects are required to hold a water access licence (WAL) authorising the take of water in the course of carrying out a mining activity.<br>Tahmoor Coal holds WALs authorising the take of water. WALs and required considerations of impacts to water resources under the WM Act are further detailed within Section 6.7. |
| *Roads Act 1993* | Under section 138 of the NSW *Roads Act 1993* (Roads Act), any works that impact on a road requires approval of the relevant road authority. Road works are not proposed as part of the modification. |
| State Environmental Planning Policy (Resilience and Hazards) 2021 | The State Environmental Planning Policy (Resilience and Hazards) 2021 (Resilience and Hazards SEPP) aims to promote the remediation of contaminated land for the purpose of reducing the risk of harm to human health or any other aspect of the environment. The modification will not require any additional surface infrastructure or result in any change to existing surface infrastructure. Consequently, no further contamination assessment is required to support the modification application. |
| State Environmental Planning Policy (Biodiversity and Conservation) 2021 | State Environmental Planning Policy (Biodiversity and Conservation) 2021 aims to protect and conserve biodiversity, including ecosystems and habitats which encompass the Sydney drink water catchments. Although a small portion in the south-east corner of the Project area falls within the Metropolitan Special Area associated with Sydney's drinking water catchments, no mining or surface infrastructure extends into the MSA and no impacts to the MSA are anticipated. |

## 4.4 Other relevant policies

### 4.4.1 The Safeguard Mechanism

#### i Overview

The Safeguard Mechanism is the Australian Government's policy for reducing GHG emissions at Australia's largest industrial facilities and is enacted through the NGER Act and other legislation. The Safeguard Mechanism was first legislated in 2014 and has been in place since 2016. It was reformed in 2023 to ensure that the facilities it covers will contribute to meeting the targets.

There are currently around 220 Safeguard Facilities across the mining, manufacturing, transport, oil, gas and waste sectors. These facilities produce around 28% of Australia's GHG emissions. The Safeguard Mechanism sets legislated limits—known as baselines—on the GHG emissions of these facilities. These baselines will decrease on a trajectory that is consistent with achieving Australia's GHG emission-reduction targets of 43% below 2005 levels by 2030 and net zero by 2050. The baselines will decrease gradually from 1 July 2023. The decline rate will be set at 4.9 per cent each year to 2030.

In general terms, the Safeguard Mechanism applies to facilities with Scope 1 emissions of more than 100,000 t of $CO_2$-e per year.

It is acknowledged that the Safeguard Mechanism provides minimum requirements for the highest emitting facilities, but does not preclude the need for NSW Environment Protection Authority (EPA) and the consent authority to properly understand the potential GHG impacts of proposed new or significantly modified developments, and to ensure that all proponents are adequately avoiding, minimising and managing their GHG emissions over all stages of the development.

#### ii Application to the modification

Tahmoor Mine is, and will continue to be, a designated large facility as defined by the Commonwealth NGER Act. The Safeguard Mechanism, including the recently commenced reforms, therefore applies to Tahmoor Mine. Tahmoor Coal have implemented a range of measures to manage, and abate GHG emissions from the Tahmoor Mine. These measures will continue to be implemented for the life of the Project. In addition to existing measures, and in accordance with the SSD 8445 conditions of consent, Tahmoor Coal have continued to investigate viable technology options to control mine emissions. Further information on the measures implemented by Tahmoor Coal to manage and abate GHG emissions from the Tahmoor Mine, and ongoing investigations into abatement technologies, is presented in Section 6.8.

### 4.4.2 NSW Aquifer Interference Policy

The NSW Aquifer Interference Policy (AIP) (DPI 2012) sets out the role and requirements of the Minister administering the WM Act in the water licensing and assessment processes for aquifer interference activities. The WM Act defines an aquifer interference activity as an activity involving any of the following:

- penetration of an aquifer
- interference with water in an aquifer
- obstruction of the flow of water in an aquifer
- taking of water from an aquifer in the course of carrying out mining, or any other activity prescribed by the regulations, or

- disposal of water taken from an aquifer in the course of carrying out mining, or any other activity prescribed by the regulations.

The AIP (DPI 2012) specifically refers to 'take' that is 'required to allow for the effective and safe operation of an activity, for example dewatering to allow mining', regardless of whether the take will be used. The take, use and incidental interception of groundwater must be licensed. The AIP states that, unless specifically exempt, a water access licence (WAL) is required under the WM Act where any act by a person carrying out an aquifer interference activity causes:

- the removal of water from a water source
- the movement of water from one part of an aquifer to another part of an aquifer
- the movement of water from one water source to another water source, such as:
    - from an aquifer to an adjacent aquifer
    - from an aquifer to a river/lake, or
    - from a river/lake to an aquifer.

The AIP specifies that the project licensing requirement should consider adjacent and overlying water sources. Should the project cause water to inflow and subsequently take from an adjacent water source, a licence for that volume is required from that adjacent water source. Consideration of the water licencing requirements for the modification and overall Project are presented in Section 6.7.

Additionally, the AIP specifies 'minimal harm considerations' for highly and less productive aquifers, while also defining thresholds for water table and groundwater pressure drawdown, and changes in groundwater and surface water quality. There are separate minimal impact considerations for:

- "Highly productive" groundwater
- "Less productive" groundwater
- "Water supply" works
- "High Priority" Groundwater Dependent Ecosystems (GDEs)
- "High Priority" Culturally significant sites.

The AIP categorises groundwater source productivity (highly productive or less productive) based on characteristics of salinity and aquifer yield. Tahmoor Mine undermines the 'Highly Productive' Hawkesbury Sandstone aquifer. Further information on the assessment of the modification against the AIP is presented in Section 6.6.

# 5 Engagement

In preparing this modification report, consultation was undertaken in accordance with the requirements set out in the *Undertaking Engagement Guidelines for State Significant Projects* (SSD Engagement Guidelines) (DPIE 2022).

## 5.1 Government agencies and council

A summary of engagement with government agencies undertaken relating to the proposed modification is provided in Table 5.1.

**Table 5.1 Government agency consultation**

| Agency | Date | Method | Description | Outcome |
|---|---|---|---|---|
| DPHI | 21 July 2023 | Letter | Correspondence providing an overview of the proposed modification and seeking feedback on assessment approach and approval pathway. | Request for scoping meeting. |
| | 10 August 2023 | Scoping meeting | Discuss proposed modification and assessment approach with DPHI. | DPHI requested Tahmoor Coal ensure consultation is completed with BCS regarding vegetation at REA and ensure engagement with stakeholders and the community is covered off well. |
| | 17 August 2023 | Letter | DPHI scoping response. | DPHI confirmed assessment pathway under Section 4.55(2) of the EP&A Act. Additional requirements for consideration in the modification report to include:<br>• potential noise, air quality and visual impacts associated with changes to the reject emplacement area<br>• a detailed justification for the proposed modification<br>• evidence of consultation with relevant agencies and the community, including detail of how any issues raised have been addressed by the modification. |
| NSW Department of Climate Change, Energy, the Environment and Water (NSW DCCEEW) - – Biodiversity Conservation and Science Group (BCS) | 18 July 2023 | Meeting | Background and overview of existing operations and proposed modification. Feedback sought on proposed BDAR approach. | BCS noted a dominant focus of their review will be on prescribed impacts, especially water bodies, water quality and hydrological processes; and caves, crevices, cliffs, rocks and other geological features of significance (and these impacts to frogs, bats and snake threatened species, etc.). The focus of BCS review would also include adaptive management for any uncertain biodiversity impacts. |

**Table 5.1 Government agency consultation**

| Agency | Date | Method | Description | Outcome |
|---|---|---|---|---|
| | 19 July 2023 | Email | Correspondence from NSW DCCEEW providing guidance on the Biodiversity Development Assessment Report (BDAR) assessment requirements. | BCS noted:<br>• The BDAR will need to align with the Biodiversity Assessment Method (BAM 2020).<br>• The BDAR will need to use the revised Plant Community Type (PCT) classification for the NSW coastal and tablelands bioregions as in Bionet Vegetation Classification (note: relevant existing plot data might be used in Plot to PCT Assignment Tool).<br>• The BDAR will need to include the threatened species associations with the PCT as in Bionet Threatened Biodiversity Data Collection (TBDC).<br>• BDAR to consider if any newly listed threatened species or ecological communities need to be assessed.<br>BCS noted they expect to see assessment in the BDAR of any direct/indirect impacts to native vegetation (albeit restored native vegetation) associated with proposed works at the REA and noted a streamlined assessment as per BAM 2020 Appendix D could be an option for planted native vegetation). |
| | 24 July 2023 | Email | Further clarifications on BDAR assessment approach sought from NSW DCCEEW. | |

**Table 5.1 Government agency consultation**

| Agency | Date | Method | Description | Outcome |
|---|---|---|---|---|
| | 25 July 2023 | Email | Clarifications on BDAR assessment approach provided by NSW DCCEEW. | BCS noted that they would accept in the BDAR:<br>• Vegetation of the subject site to be based off regional mapping, with some validation within publicly accessible areas.<br>• All PCTs within the study area are assumed to be at benchmark condition. Therefore, no need for BAM plot collection as assuming best condition.<br>• PCTs and benchmark entered into BAM-C to generate species list.<br>• All threatened flora species are assumed to be present within the study area as it will not be possible to survey to the guidelines, nor are experts available.<br>• All threatened fauna species are assumed to be present within the study area as it will not be possible to survey to the guidelines, nor are experts available.<br>BCS requested access to all reports, including subsidence predictions and specialist assessment used to assess prescribed impacts to biodiversity. |
| | 3 March 2024 | Meeting | Discuss BDAR and approach prior to submission. | BCD to provide dieback on BDAR approach given credit liability calculations using BAM-C calculator. |
| | 10 April 2024 | Email | Feedback from BCD on options to progress with BDAR submission. | Three options identified being:<br>• Apply credits as per BAM-C outcomes.<br>• Seek DPHI apply/extinguish credit liability through consent conditions.<br>• Seek a BDAR Waiver. |
| DPHI – Crown Land | 22 April 2024 | Letter | Background and overview of proposed modification. | Receipt of the correspondence was noted by DPHI Crown Land on 22 April 2024. No issues were raised in relation to the proposed modification. |
| Wollondilly Council | 31 October 2023 | Meeting | Meeting with Council outlining the proposed modification. | No issues raised. |

**Table 5.1 Government agency consultation**

| Agency | Date | Method | Description | Outcome |
|---|---|---|---|---|
| Commonwealth DCCEEW | 21 August 2023 | Letter | Notification of proposed modification. | |
| | 12 January 2024 | Phone call | Discussion with Commonwealth DCCEEW regarding proposed modification. | DECCW requested confirmation of any requirements to refer the modification under the EPBC Act. |
| | 12 January 2024 | Email | Confirmation of position that Tahmoor has determined the modification does not require a referral to the Commonwealth DCCEEW under the EPBC Act. | No further response received. |

## 5.2 Community

### 5.2.1 Tahmoor Coal Community Consultative Committee

The Tahmoor Coal Community Consultative Committee (TCCCC) provides a forum for open discussion between representatives of Tahmoor Mine, the community, WSC and other stakeholders on issues directly relating to the mine's operations, environmental performance and community relations. The TCCCC is independently chaired, and membership consists of up to seven representatives from the local area, who meet on a quarterly basis.

Correspondence was emailed to the TCCCC on 7 December 2023 notifying the TCCCC members of the proposed modification, with information presented to the TCCCC members on the same day. Questions were asked during the meeting if there will be further mine plan modifications in the future. Tahmoor Coal advised the TCCCC that opportunities to recover available coal resources from within the existing mining leases was ongoing. A subsequent TCCCC meeting was held on 7 March 2024 with an update on the modification application and associated environmental assessment process was provided. Minutes of TCCCC meetings are available on the Tahmoor Mine website (https://www.tahmoorcolliery.com.au/community/tcccc-meeting-minutes/).

### 5.2.2 Landowners

Consultation undertaken with landowners within and surrounding the study area is summarised in Table 5.2.

**Table 5.2 Summary of community engagement activities**

| Date | Engagement | Outcome |
|---|---|---|
| 1 November 2023 | Door-knocked and letterbox dropped letter and information pack to all residents within the LW S7A study area. | One resident in Yarran Road expressed their dissatisfaction with the proposed modification but stated "there is nothing we can do about it" and "it is what it is".<br>One resident phoned and requested a call back regarding longwall S7A. Call returned on two occasions and messages left, however no further contact received. |
| 5 December 2023 | Community newsletter #9 with frequently asked questions was letterboxed dropped to all A series study area residents and emailed to all Tahmoor South residents who have registered for newsletter communications. | |
| 23 February 2024 | Community newsletter #10 was letterboxed dropped to all A series study area residents and emailed to all Tahmoor South residents who have registered for newsletter communications. | No concerns or questions received. |

## 5.3 Aboriginal stakeholders

Aboriginal consultation for the proposed modification was undertaken in accordance with the procedures set out in the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW 2010). These guidelines identify a five-stage process.

1. Pre-notification – identification of the Aboriginal individuals and/or communities relevant to the study area by contacting several state government agencies.

2. Notification – contacting all Aboriginal individuals and/or communities identified in Stage 1 to determine their interest in being consulted during the modification application. This includes direct communication and the placement of advertisements in local media seeking further expressions of interest from Aboriginal individuals and/or communities that may have been missed through Stage 1. Those Aboriginal individuals and/or communities that wish to be consulted become a 'registered' Aboriginal party (RAP).

3. Presentation of project information/assessment methodology – briefing RAPs about the modification and scope of any Aboriginal heritage assessment and investigations. This is usually undertaken through written correspondence, but can include meetings, and may undergo several iterations through the modification as the nature of the assessment changes (e.g. surface ground-truthing may lead to a requirement for test excavations).

4. Impacts and mitigation strategies – discussion of potential impacts to cultural materials and mitigation options with the RAPs prior to developing the Aboriginal Cultural Heritage Assessment (ACHA). This is often undertaken either onsite at the end of any field program and/or as part of Stage 4.

5. Report review – the RAPs are provided an opportunity to review and comment upon the draft ACHA, to contribute input into the overall findings, significance and management of cultural heritage.

The consultation process for this modification had two aims:

- to comply with the mandated consultation procedures to obtain input on the ACHA process
- to identify cultural places and intangible values that may be affected by the modification.

Twenty organisations and/or individuals registered an interest in the consultation process for the modification (Table 5.3). The RAPs include several local Aboriginal organisations and/or individuals based in Tahmoor and/or immediate surrounds, as well as a smaller proportion that are based in Sydney but have ancestral connections to the region.

**Table 5.3 List of registered Aboriginal parties for the modification**

| Organisation | Contact |
|---|---|
| Tharawal Local Aboriginal Lands Council | Julie Dannevig |
| Didge Ngunawal Clan | Lillie Carroll |
| Konanggo ACHS | Robert Young |
| Pamela Young | Pamela Young |
| RAW Cultural Healing | Raymond Weatherill |
| Thomas Dahlstrom | Thomas Dahlstrom |

### Table 5.3 List of registered Aboriginal parties for the modification

| Organisation | Contact |
|---|---|
| Mundawari Heritage Consultants | Dean Delponte |
| A1 Indigenous Services | Carolyn Hickey |
| Cubbitch Barta Native Title Aboriginal Claimants | Glenda Chalker |
| Clive Freeman | Clive Freeman |
| Butucarbin Aboriginal Corporation | Jennifer Beale |
| Kamilaroi Yanktjatjara Working Group | Phil Khan |
| Barraby Cultrual Services | Lee Field |
| Yurrandali | Bo Field |
| *Name Withheld* | |
| Mura Culture Service | Phillip Carroll |
| Guntawang Aboriginal Resources Incorporated | Wendy Morgan |
| D'harawal Traditional Descendants and Knowledge Holders Circle | Gawaian Bodkin-Andrews |
| Wori Wooilywa | Daniel Chalker |
| Murra Bidgee Mullangari Aboriginal Corporation | Ryan Johnson |

Table 5.4 provides a summary of the main steps undertaken to conform with Heritage NSW guidelines.

### Table 5.4 Summary of Aboriginal consultation undertaken for the modification

| Consultation stage | Description | Date initiated | Date completed |
|---|---|---|---|
| 1 | Government Agency Pre-Notification | 1 November 2023 | 20 November 2023 |
| | Advertisement in *The District Reporter* | 17 November 2023 | 17 November 2023 |
| | Notification and registration of potential Aboriginal stakeholders | 17 November 2023 | 1 December 2023 |
| | Advising Heritage NSW and Tharawal LALC of RAPs | 11 December 2023 | 11 December 2023 |
| 2/3 | Presentation of information about the proposed modification; and gathering information about cultural significance | 5 December 2023 | 2 January 2024 |
| | Field survey | 19 February 2024 | 21 February 2024 |
| 4/5 | Review of draft ACHA report | 19 March 2023 | 16 April 2024 |

# 6 Assessment of impacts

This chapter provides a summary of the predicted impacts of the proposed modification.

## 6.1 Subsidence

### 6.1.1 Introduction

Subsidence predictions and impact assessment was prepared by Mine Subsidence Engineering Consultants (MSEC) for the modification. The assessment reviewed the conceptual mine plan and mining method to make subsidence predictions for the modification and to identify potential subsidence-related impacts, effects and environmental consequences to natural and built features within and near to the proposed longwall mining area. A copy of the subsidence predictions and impact assessment is provided as Appendix B.

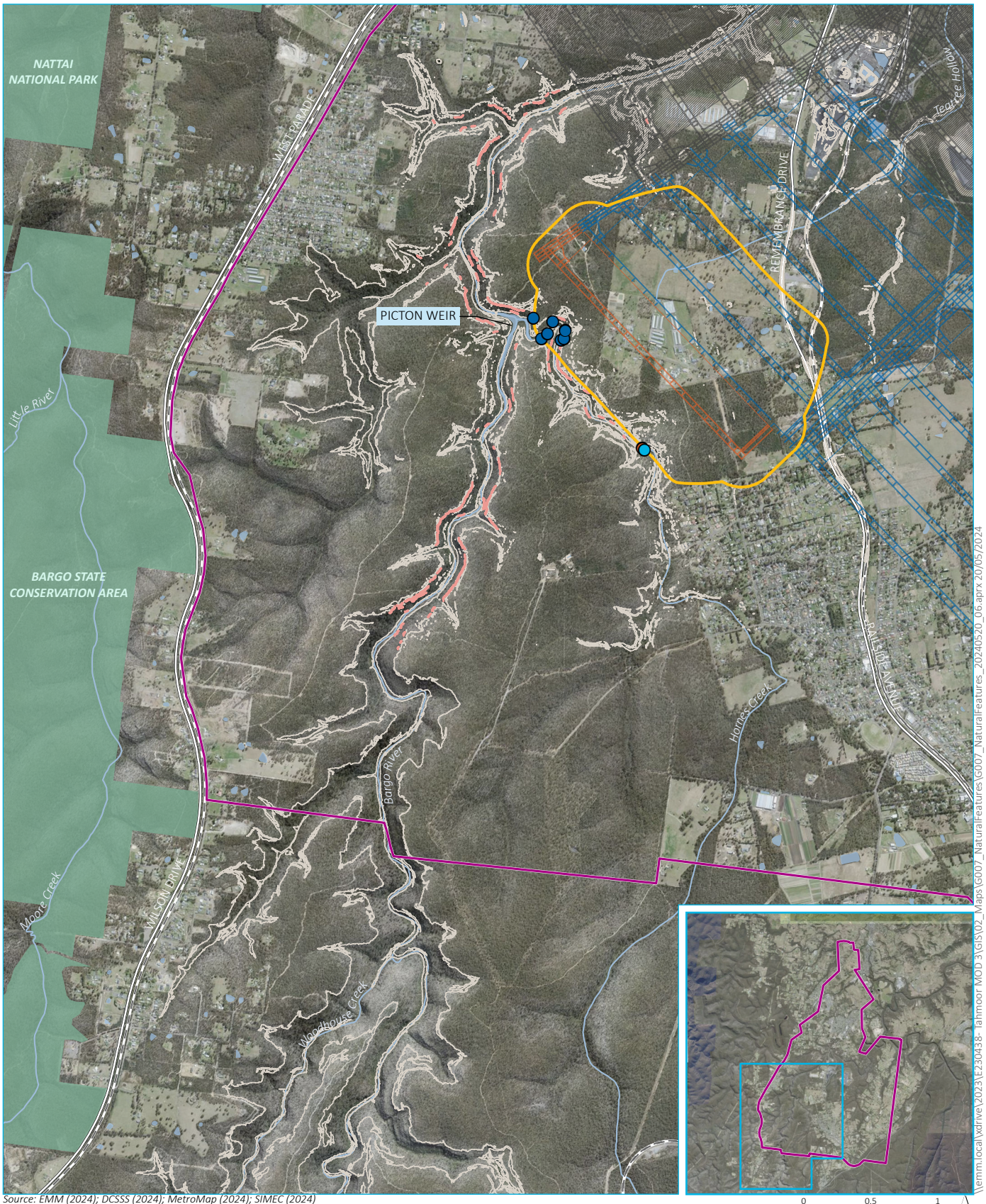
### 6.1.2 Existing environment

Tahmoor Coal is currently extracting LW S3A within the A series of longwall panels, in accordance with the approved extraction plan (approved by DPHI on 20 September 2023).

Surface features that are located within 600 m of LW S7A, which will experience valley-related effects and could be sensitive to these effects, were also included in the assessment, and include:

- natural features, including Bargo River at the confluence with Hornes Creek; Hornes Creek, Teatree Hollow and its tributaries; cliffs and steep slopes
- built features, including the Main Southern Railway; local roads Yarran Road and parts of Caloola Road, Wellers Road, Elvy Street and Remembrance Drive; powerlines, telecommunication cables, gas pipelines, potable water pipelines and sewer pipelines; Picton Weir; farm dams; commercial and residential properties; and items of heritage significance.

The key natural and built features within the study area and summarised in the sections below and illustrated in detail in the subsidence predictions and impact assessment provided as Appendix B.




Source: EMM (2024); DCSSS (2024); MetroMap (2024); SIMEC (2024)

0 0.5 1 km
GDA 1994 MGA Zone 56

N

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## KEY

- Tahmoor South project area (SSD 8445)
- LW S7A study area
- Existing underground working
- Tahmoor South approved mine working
- Proposed LWS7A

Aboriginal cultural heritage site

- Grinding groove
- Isolated find
- Rock shelter

Existing environment

- Rail line
- Major road
- Cliffs
- Steep Slopes
- Named watercourse
- Waterbody
- NPWS reserve

# Natural features within study area

Tahmoor South Project
SSD 8445 Modification 3
Figure 6.1

EMM
creating opportunities

*Source: EMM (2024); MetroMap (2024); DFSI (2020); DCSSS (2024); SIMEC (2024)*

0 250 500 m
GDA 1994 MGA Zone 56

N

\\emm.local\xdrive\2023\E230438- Tahmoor MOD 3\GIS\02_Maps\G006_BuiltFeatures\G006_BuiltFeatures_20240520_06.aprx 20/05/2024

KEY

- LW S7A study area
- Proposed LWS7A
- Existing underground working
- Tahmoor South approved mine working

Utility

- Sewer infrastructure
- Water main
- Gas pipeline
- Electrical infrastructure
- Telecommunications infrastructure

Built features

- Commercial
- Dam
- House
- Pool
- Public utility
- Rural
- Tank

Existing environment

- Rail line
- Major road
- Minor road
- Named watercourse
- Named waterbody

# Built features within the LW S7A study area

Tahmoor South Project
SSD 8445 Modification 3
Figure 6.2

EMM
creating opportunities

### i Natural features

#### a Watercourses

**Bargo River**

The Bargo River commences north of Colo Vale near the townships of Hill Top and Yerrinbool, flowing generally towards the north and to the west of the Bargo township. The Bargo River then flows to the west and north of the Tahmoor South longwalls before draining into the Nepean River approximately 4.9 km north-east of LW S1A.

While the Bargo River is outside of the study area, a short 200 m long section of the river at the confluence with Hornes Creek is within the 600 m subsidence study area as shown in Figure 6.1. This 200 m long section commences from the Picton Weir and continues up to the confluence of Hornes Creek and slightly around the bend in the Bargo River.

The 200 m long section is wholly within the stored waters behind the Picton Weir. With exception of periods of prolonged drought, the bedrock is usually under water. The bedrock is covered with sediments that have been washed down the Bargo River and Hornes Creek. The rest of the Bargo River is outside the 600 m subsidence study area. The closest distance between the Bargo River and LW S7A is approximately 520 m.

**Hornes Creek**

Hornes Creek commences west of the township of Bargo and flows generally towards the north-west before draining into the Bargo River. The catchment of Hornes Creek is to the south-southwest of longwall panels S1A-S6A.

The catchment area of Hornes Creek is approximately 19.3 $km^2$, comprising predominantly of bushland, rural-residential areas and residential areas associated with the Bargo township. Hornes Creek is a fourth order stream within the study area.

The downstream section of Hornes Creek meanders inside and outside of the study area and the majority of the downstream section is located inside the 600 m subsidence study area as shown in Figure 6.1.

The closest distance between Hornes Creek and LW S7A is approximately 330 m at a sharp bend. Upstream of the bend, the distance between Hornes Creek and LW S7A is between 470 m and 620 m.

Water levels in the downstream section of Hornes Creek are controlled by the Picton Weir. Hornes Creek is generally inundated with stored water, but the stored water recedes during periods of prolonged dry weather.

**Teatree Hollow and tributaries**

The sections of Teatree Hollow and its tributaries within the subsidence study area are ephemeral first or second order drainage lines having shallow incisions into the natural surface soils. The catchment area is above LW S7A in predominantly grazing land, with stream flow captured by a number of farm dams.

Further information on the hydrology of the study area is presented in Section 6.5.

#### b Cliffs

For the purposes of the subsidence assessment, a cliff has been defined as a continuous rockface having a maximum height greater than 10 m, a minimum length of 20 m and a minimum slope of 2 in 1. The locations of cliffs within the study area are shown on Figure 6.1. A total of 19 cliffs are within the 600 m subsidence study area, five of which are within the study area.

The cliffs are located within the Hawkesbury Sandstone along the Bargo River and Hornes Creek, at distances of between 275 m and 600 m from LW S7A.

### c Steep slopes

For the purposes of the subsidence assessment, a steep slope has been defined as an area of land having a gradient greater than 1 in 3 (or 33% or 18.3°). The locations of the steep slopes within the study area are shown in Figure 6.1.

The steep slopes within the study area can be broadly categorised as:

a) steep slopes on the sides of valleys

b) batters of road and railway embankments and cuttings

c) slopes on farm dams.

The steep slopes on the sides of valleys are predominantly found in Hawkesbury Sandstone and consist of a mixture of cliffs and rock outcrops, which are stable at vertical to overhanging, and screed slopes with rocky soils and loose rock fragments. The majority of slopes are stabilised, to some extent, by natural vegetation.

### d Heritage sites

Six Aboriginal heritage rockshelter sites are located within the study area. One grinding groove site is located within 10 m, but outside, of the study area boundary. All sites are constrained to the outcropping Hawkesbury Sandstone bordering Hornes Creek.

Further details on the Aboriginal heritage of the study area are presented in Section 6.3 and Appendix D.

## ii Built features

### a Picton weir

The Picton Weir is located on the Bargo River just downstream of the confluence with Hornes Creek. The Picton Weir was constructed in the late 19th century, and it was built to provide water to the surrounding townships. It is now heavily silted and is no longer used for water supply. Water retained by the weir is released at its base through a seized open valve and outlet pipe. The Picton Weir is approximately 605 m from LW S7A at its closest point.

### b Main Southern Railway

The Main Southern Railway is a key national transport route that carries substantial freight and passenger services between Sydney and Melbourne. The Main Southern Railway is leased by the Australian Rail Track Corporation (ARTC), who is responsible for maintaining the track. As shown on Figure 6.2, the proposed LW S7A is not located directly beneath the Main Southern Railway; however, approximately 500 m of the track, including two railway culverts, is within the study area. The closest distance between the Main Southern Railway and the proposed LW S7A is approximately 400 m. A small cutting associated with the Main South Railway, which is up to 2 m high in competent sandstone rock, is located within the study area. Wellers Road Overbridge is approximately 540 m from LW S7A.

### c Roads

Sections of four local roads are within the study area, as shown in Figure 6.2. The entire length of Yarran Road and sections of Caloola Road, Remembrance Drive, and Wellers Road at Elvy Street are all located within the study area. These local roads are maintained by Wollondilly Shire Council. There are three road drainage culverts within the study area, one under Caloola Road and two under Remembrance Drive in the vicinity of Yarran Road, although none of these are located directly over LW S7A.

### d Services infrastructure

**Electrical services infrastructure**

Electrical infrastructure within the study area comprises 11 kV and low voltage powerlines which are located across the area, generally following the alignment of Yarran Road, Caloola Road and Remembrance Drive, or the Main Southern Railway. The powerlines generally comprise aerial copper cables supported on timber poles, but there are also some sections of direct buried cables. The powerlines are owned and operated by Endeavour Energy.

**Telecommunications infrastructure**

Telecommunications infrastructure within the study area comprises optical fibre cables and copper cables which are owned by Telstra, the National Broadband Network (NBN) and TPG. The optical fibre cables are direct buried or buried in conduit. There is an NBN telecommunications tower and adjacent shed located at No. 3166 Remembrance Drive, with access from Yarran Road. The tower and shed are located directly above LW S6A.

**Gas infrastructure**

Gas infrastructure within the study area is owned by Jemena and comprises a 150 mm diameter steel main which generally follows the alignment of Remembrance Drive, and a short section of 50 mm nylon pipeline alongside Wellers Road, on the southern boundary of the study area. The gas main along Remembrance Drive crosses LW S1A-S5A but does not cross directly above LW S7A. The nylon gas pipeline alongside Wellers Road also does not cross directly above LW S7A.

**Potable water infrastructure**

The water pipelines within the study area are owned and operated by Sydney Water. The potable water infrastructure includes a cast iron cement lined (CICL) 450 mm diameter watermain which follows the alignment of Remembrance Drive, before crossing beneath the Main Southern Railway just north of Yarran Road and following Great Southern Road. 100 mm and 200 mm diameter ductile iron cement lined (DICL) water pipelines are located along Caloola Road, Yarran Road and along a short section Remembrance Drive to the south of the railway crossing. The types of pipelines within the study area are mainly DICL and CICL, with short sections of steel cement lined (SCL) beneath road crossings.

**Sewer infrastructure**

The sewer infrastructure within the study area is owned and operated by Sydney Water and comprises a 180 mm diameter pressure main along Remembrance Drive. The sewer pressure main crosses LW S1A-S5A but does not cross directly above LW S7A. The sewerage system was designed to accommodate mine subsidence movements and consists of polyethylene pipelines.

### e Rural structures

There are 276 rural structures which have been identified on private properties within the study area, of which 48 structures (17%) will be mined directly beneath by the proposed LW S7A. The rural structures include sheds, garages, carports, gazebos, pergolas, greenhouses, shade structures and other non-residential structures.

### f Tanks

Tanks include both septic tanks and potable water storage tanks, which comprise inground and above ground tanks of concrete or steel or polyethylene construction. There are 67 tanks which have been identified within the study area, of which:

- 16 are directly above LW S7A
- 27 are located directly above the approved longwalls (LW S1A to LW S6A)

- 24 tanks will not be directly mined beneath by the approved longwalls or proposed LW S7A.

#### g Farm dams

There are 20 farm dams (Structure Type D) which have been identified within the study area. The dams are typically of earthen construction and have been established by localised cut and fill operations within the natural streams. The farm dams are generally shallow, with the dam wall heights generally being less than 3 m.

Only one of these dams is directly above proposed LW S7A. This dam is identified as BYR_095_d01 (MSEC 2024) and is 43 m in length with an area 1,003 $m^2$. All other 19 dams will experience some subsidence movements due to the extraction of the approved longwalls (LW S1A to LW S6A).

#### h Commercial and business establishments

A total of 29 structures are within the study area that are used for commercial or business purposes by three different establishments. These are Bargo Valley Produce, Ingham Turkey Farm and the Canine Country Club and Cattery. The structures are all on properties along Yarran Road and 26 of the 29 structures (90 %) will be directly mined beneath by LW S7A.

#### i Swimming pools

There are 13 swimming pools within the study area. Three swimming pools are directly above LW S7A, eight pools are directly above the approved longwalls (LW S1A to LWS 6A) and two pools will not be directly mined beneath.

#### j Houses

There are 62 houses that have been identified within the study area with 11 houses located directly above the proposed LW S7A. 38 houses are located above previously approved longwalls within the study area.

### 6.1.3 Subsidence predictions

The Incremental Profile Method was used by MSEC for the subsidence assessment, consistent with the approach previously used to predict the conventional subsidence parameters resulting from the extraction of the approved LW S1A-S6A.

A summary of the maximum predicted values of incremental conventional subsidence, tilt and curvature due to the extraction of LW S1A-S6A under the approved layout and LW S7A is provided in Table 6.1. The predicted tilts provided in this table are the maxima after the completion of each longwall. The predicted curvatures are the maxima at any time during or after the extraction of each of the longwalls.

**Table 6.1 Maximum predicted incremental conventional subsidence, tilt and curvature resulting from the extraction of LW S1A-S7A**

| Layout | Maximum predicted incremental conventional subsidence (mm) | Maximum predicted incremental conventional tilt (mm/m) | Maximum predicted incremental conventional hogging curvature ($km^{-1}$) | Maximum predicted incremental conventional sagging curvature ($km^{-1}$) |
|---|---|---|---|---|
| **Approved Layout** | | | | |
| Longwall S1A | 800 | 7.0 | 0.08 | 0.22 |
| Longwall S2A | 950 | 7.5 | 0.08 | 0.22 |
| Longwall S3A | 950 | 8.0 | 0.09 | 0.22 |

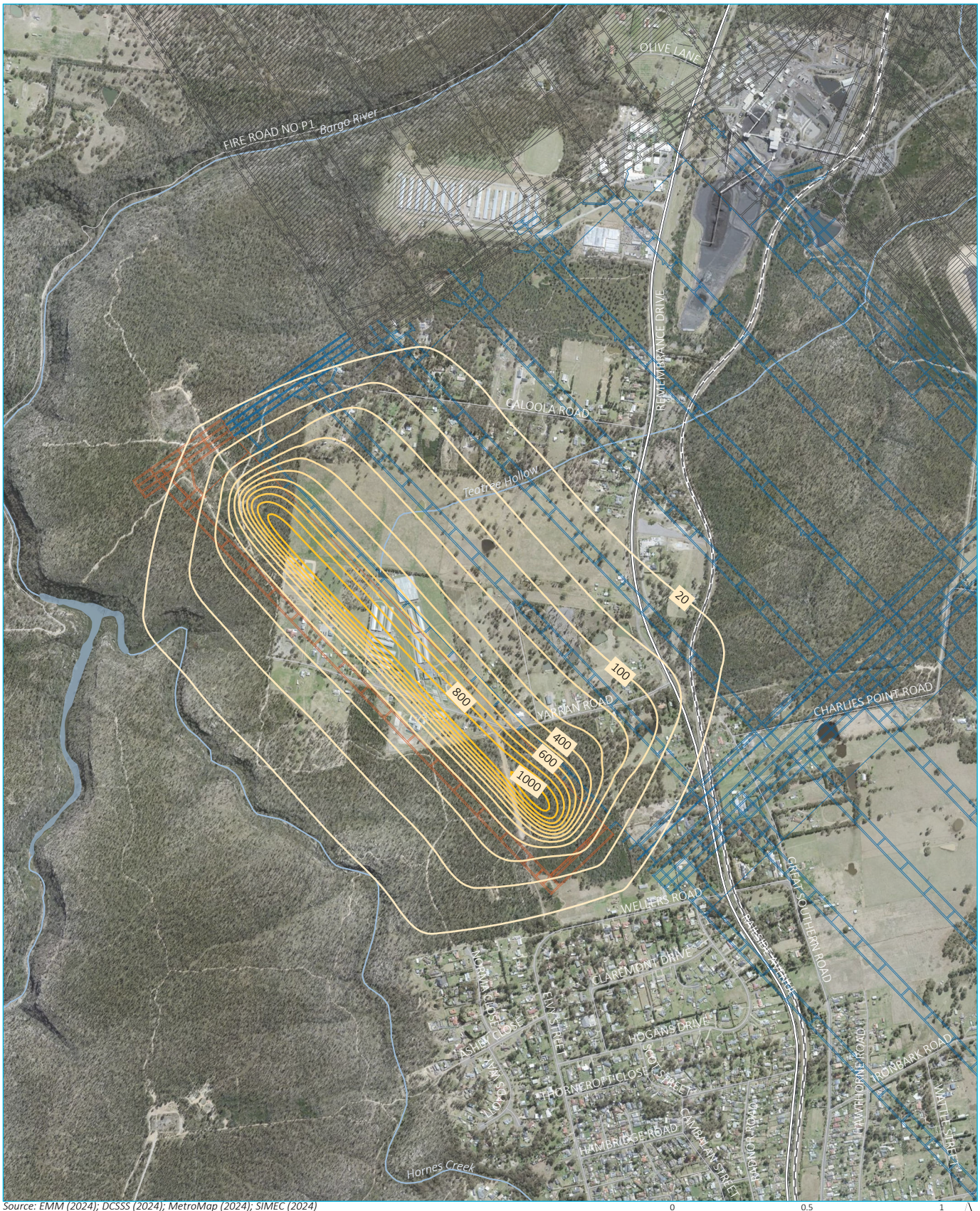
**Table 6.1 Maximum predicted incremental conventional subsidence, tilt and curvature resulting from the extraction of LW S1A-S7A**

| Layout | Maximum predicted incremental conventional subsidence (mm) | Maximum predicted incremental conventional tilt (mm/m) | Maximum predicted incremental conventional hogging curvature ($km^{-1}$) | Maximum predicted incremental conventional sagging curvature ($km^{-1}$) |
|---|---|---|---|---|
| Longwall S4A | 950 | 8.0 | 0.09 | 0.22 |
| Longwall S5A | 950 | 8.0 | 0.10 | 0.22 |
| Longwall S6A | 975 | 8.3 | 0.09 | 0.23 |
| **Modified layout** | | | | |
| Longwall S7A | 1,050 | 8.9 | 0.10 | 0.24 |

As shown in Table 6.1, the predicted maximum incremental subsidence parameters associated the modified layout are similar to those based on the approved layout. The differences in the predicted maximum parameters due to the proposed modification are not considered to be significant.

The predicted maximum incremental subsidence due to the proposed extraction of LW S7A is located above the commencing end of the panel. This is because planned extraction heights are greatest in this location.

A summary of the maximum predicted total conventional subsidence, tilt and curvature, based on the approved and modified layouts are provided in Table 6.2. The values in this table are the maxima anywhere above the longwalls, and at any time during or after extraction of the longwalls.




Source: EMM (2024); DCSSS (2024); MetroMap (2024); SIMEC (2024)

0 0.5 1 km

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KEY

Existing underground working
Tahmoor South approved mine working
Proposed LWS7A

Existing environment

Rail line
Major road
Minor road
Named watercourse
Named waterbody

Incremental subsidence contour (mm)

20
50
100
200
300
400
500
600
700
800
900
1000

# Incremental subsidence prediction contours for LW S7A

Tahmoor South Project
SSD 8445 Modification 3
Figure 6.3

EMM
creating opportunities

**Table 6.2 Maximum predicted total conventional subsidence, tilt and curvature resulting from the extraction of longwalls S1A to S7A**

| Layout | Maximum predicted total conventional subsidence (mm) | Maximum predicted total conventional tilt (mm/m) | Maximum predicted total hogging curvature ($km^{-1}$) | Maximum predicted total sagging curvature ($km^{-1}$) |
|---|---|---|---|---|
| **Approved layout** | | | | |
| After longwall S6A | 1,350 | 9.5 | 0.14 | 0.24 |
| After longwall S6B | 1,600 | 10.5 | 0.18 | 0.28 |
| **Modified layout** | | | | |
| After longwall S7A | 1,400 | 10.0 | 0.14 | 0.25 |
| After longwall S6B | 1,600 | 10.5 | 0.18 | 0.28 |

When comparing maximum predicted total subsidence parameters for the A series longwalls, it can be seen that the addition of LW S7A is predicted to result in a small increase in maximum total subsidence but negligible change in predicted maximum tilt and curvature.

There is negligible change to the maximum predicted total subsidence predictions when comparing the approved layout to the modified layout. This is because predicted maximum subsidence due to the extraction of the B series longwalls is greater than the A series and the addition of LW S7A does not influence maximum subsidence predictions associated with the B series of longwalls.

### 6.1.4 Subsidence impacts

A summary of the predicted maximum subsidence, subsidence impacts, and proposed monitoring and management measures for each of the natural and built features within the study area is provided in Table 6.3. Further detailed assessments and predictions for individual features are provided in the MSEC subsidence assessment provided as Appendix B.

## Table 6.3 Maximum subsidence predictions and impact assessment for natural and built features

| Feature | Subsidence prediction Maximum predicted incremental | Subsidence prediction Maximum predicted total | Impact assessment | Monitoring and management |
|---|---|---|---|---|
| **Natural features** | | | | |
| Bargo River | • <20 mm vertical<br>• 20 mm upsidence<br>• 20 mm closure | • <20 mm vertical<br>• 30 mm upsidence<br>• 20 mm closure | Mining could potentially result in increased ponding where mining induced tilts oppose and exceed the existing stream gradients. However, the predicted change of grade due to LW S7A is negligible, and the resulting impacts are also considered to be negligible.<br>There is a long history of mining beneath the Bargo River. While there have been mining induced impacts in the past, these impacts were directly related to sections of the river which were located directly over the longwall panel, and the impacts were self-remediated through the transport of sediment in the river.<br>The likelihood of fracturing and flow diversion reduces significantly the further the extraction occurs from the river. Therefore, the location of LW S7A is unlikely to result in any significant change to flow or fracturing within the Bargo River.<br>Further information on impacts to watercourses is presented in Section 6.5. | Two global navigation satellite system (GNSS) units have been installed near the tops of the Bargo River valley across the Picton Weir. The units have continuously monitored changes during mining since the commencement of LW S1A.<br>Prior to the commencement of LW S2A, additional GNSS units were installed along Hornes Creek, which will also provide relevant monitoring information for monitoring changes and potential impacts along the Bargo River.<br>Tahmoor Coal will continue to monitor changes in the Bargo River during the extraction of proposed LW S7A. This monitoring will be detailed in the Subsidence Monitoring Plan and Water Management Plan prepared as part of the Extraction Plan required to be approved prior to the commencement of mining in LW S7A. |

**Table 6.3 Maximum subsidence predictions and impact assessment for natural and built features**

| Feature | Subsidence prediction Maximum predicted incremental | Subsidence prediction Maximum predicted total | Impact assessment | Monitoring and management |
|---|---|---|---|---|
| Hornes Creek | Section with water levels controlled by Picton Weir:<br>• 30 mm vertical<br>• 50 mm upsidence<br>• 130 mm closure<br><br>Section with water levels controlled by rockbars:<br>• 20 mm vertical<br>• 30 mm upsidence<br>• 60 mm closure | Section with water levels controlled by Picton Weir:<br>• 40 mm vertical<br>• 80 mm upsidence<br>• 150 mm closure<br><br>Section with water levels controlled by rockbars:<br>• 25 mm vertical<br>• 45 mm upsidence<br>• 70 mm closure | The proposed modification may lead to increased ponding and bed scouring within Hornes Creek where the mining-induced tilts oppose and are greater than the natural stream gradients that exist before mining.<br>Mining can also potentially result in an increased likelihood of scouring of the stream beds in the locations where the mining induced tilts considerably increase the natural stream gradients that exist before mining.<br>The section of Hornes Creek downstream of Pool HC-16 is 300 m from LW S7A and would be unlikely to experience fracturing, based on previous experience at Tahmoor Mine.<br>The likelihood of impacts on surface flow is considered low given that water levels are controlled by the Picton Weir.<br>Gas emissions may occur and become visible in the stored water behind the Picton Weir as a result of the proposed extraction of the longwalls. Where these gas releases occur into the water column there is insufficient time for any substantial amount of gas to dissolve into the water. The majority of the gas is released into the atmosphere and is unlikely to have an adverse impact on water quality.<br>Further information on impacts to watercourses is presented in Section 6.5. | Six GNSS units are installed along the tops of Hornes Creek in pairs across the valley to monitor subsidence along Hornes Creek.<br>This monitoring program will continue and will be detailed in the Subsidence Monitoring Plan and Water Management Plan prepared as part of the Extraction Plan required to be approved prior to the commencement of mining in LW S7A. The Water Management Plan will detail the specific management and monitoring that would be undertaken to assess if mining has resulted in impacts to Hornes Creek. |

**Table 6.3 Maximum subsidence predictions and impact assessment for natural and built features**

| Feature | Subsidence prediction Maximum predicted incremental | Subsidence prediction Maximum predicted total | Impact assessment | Monitoring and management |
|---|---|---|---|---|
| Teatree Hollow and tributaries | Teatree Hollow Creek:<br>• 925 mm vertical<br>• 90 mm upsidence<br>• 50 mm closure<br>Tributary to Teatree Hollow Creek:<br>• <20 mm vertical<br>• <20 mm upsidence<br>• <20 mm closure | Teatree Hollow Creek:<br>• 1,400 mm vertical<br>• 400 mm upsidence<br>• 275 mm closure<br>Tributary to Teatree Hollow Creek:<br>• 1,350 mm vertical<br>• 450 mm upsidence<br>• 375 mm closure<br>*Note: downstream sections of Teatree Hollow have been previously mined beneath by LW1 and LW2 at Tahmoor Mine. The maximum predicted parameters provided above table include those resulting from the extraction of these earlier longwalls.* | Teatree Hollow and its tributaries will be directly mined beneath by LW S7A. Previous assessments show that fracturing and surface flow diversions are possible (i.e. in some of these locations, the fracturing could impact the holding capacity of the standing pools, particularly those located directly above the proposed longwall. However, it is unlikely that there would be any net loss of water from the catchment.<br>Mining can also potentially result in an increased likelihood of scouring of the stream beds in the locations where the mining induced tilts considerably increase the natural stream gradients that exist before mining.<br>Minor increases to flood levels are predicted in areas subject to flooding under existing conditions above LW S3A at Caloola Road and LW S5A at Yarran Road. The addition of LW S7A will not materially change the results of the flood study, though the extent of impacts increases further upstream to include the headwaters of two first order sections in the catchment.<br>As LW S7A is proposed directly beneath the headwaters of first order tributaries, any gas emissions that occur will release into the atmosphere and is unlikely to have an adverse impact on water quality.<br>Further information on impacts to watercourses is presented in Section 6.5. | No additional mitigation measures are proposed to manage impacts at Teatree Hollow and its tributaries.<br>Tahmoor Coal will prepare a Water Management Plan as part of the Extraction Plan required to be approved prior to the commencement of mining in LW S7A. The Water Management Plan will detail the specific management and monitoring that would be undertaken to assess if mining has resulted in impacts to Teatree Hollow and its tributaries. |

## Table 6.3 Maximum subsidence predictions and impact assessment for natural and built features

| Feature | Subsidence prediction Maximum predicted incremental | Subsidence prediction Maximum predicted total | Impact assessment | Monitoring and management |
|---|---|---|---|---|
| Cliffs | • 60 mm vertical<br>• <0.5 mm/m tilt<br>• <0.01 $km^{-1}$ hogging curvature<br>• <0.01 $km^{-1}$ sagging curvature | | No cliffs will be directly undermined. It is difficult to predict with great accuracy that the cliffs will not be impacted, given there are natural erosion and instability inherent in cliff systems.<br>The likelihood of mining induced instability has been measured at other sites (including other sections of Tahmoor Mine, Appin Colliery and Tower Colliery) where longwall mining has taken place close to cliffs. There have been no recorded cliff instabilities outside of longwall mining extraction areas in the Southern Coalfield. Based on this data, and the distance of the cliffs from the panel, it would be unlikely that the extraction of LW S7A would result in significant cliff instability.<br>The cliffs are in an area that is very difficult for the public to access. In the very unlikely event that an isolated rock fall occurs, the likelihood of a rock fall affecting public safety is assessed to be low. | Tahmoor Coal has developed a Land Management Plan for managing potential impacts on cliffs during the mining of LWs S1A–S6A. The management plan includes:<br>• identification of all structures, dams and roads that are in close proximity to cliffs<br>• site investigation of cliffs by a qualified geotechnical engineer<br>• baseline mapping of cliffs to measure face area<br>• monitoring, including ground survey and visual inspections<br>• erection of warning signs and consultation with landowners if impacts are observed.<br>Tahmoor Coal will update the LW S1A-S6A Land Management Plan to include management of potential impacts on cliffs due to the extraction of LW S7A. |

**Table 6.3 Maximum subsidence predictions and impact assessment for natural and built features**

| Feature | Subsidence prediction Maximum predicted incremental | Subsidence prediction Maximum predicted total | Impact assessment | Monitoring and management |
|---|---|---|---|---|
| Steep slopes | • <20 mm vertical<br>• 20 mm upsidence<br>• 20 mm closure | • <20 mm vertical<br>• 30 mm upsidence<br>• 20 mm closure | Potential impacts on steep slopes would generally result from the movement of soils, causing tension cracks to appear at the tops of the slopes and compression ridges to form at the bottoms of the slopes. These movements are consistent with observations of upsidence and closure of creek valleys where compression is developed at the bottoms of the valleys and tension is developed at the tops of the valleys. If tension cracks were left untreated it is possible that soil erosion could occur.<br>While in most cases impacts to slopes are likely to consist of surface cracking, there remains a low probability of large-scale slope slippage. The probability is assessed to be very low for slopes that will not be directly mined beneath by the longwalls. Experience indicates that the probability of mining induced large-scale slippages is low due to the substantial depths of cover within the study area.<br>There are no structures or roads along natural steep slopes within the study area. | Tahmoor Coal has developed a Land Management Plan for managing potential impacts on steep slopes during the mining of LW S1A-S6A. The management plan includes:<br>• identification of all structures, dams and roads that are in close proximity to cliffs<br>• site investigation of cliffs by a qualified geotechnical engineer<br>• baseline mapping of cliffs to measure face area<br>• monitoring, including ground survey and visual inspections<br>• erection of warning signs and consultation with landowners if impacts are observed.<br>Tahmoor Coal will update the LW S1A-S6A Land Management Plan to include management of potential impacts on steep slopes due to the extraction of LW S7A. |
| Heritage sites | | • 50 mm vertical<br>• <0.5 mm/m tilt<br>• <0.01 $km^{-1}$ hogging<br>• <0.01 $km^{-1}$ sagging curvature<br>Grinding grooves:<br>• 45 mm upsidence<br>• 65 mm closure | Six Aboriginal rockshelter sites have been recorded within the study area and one grinding groove site located within 10 m of the study area boundary. All sites are constrained to the outcropping Hawkesbury Sandstone bordering Hornes Creek.<br>Further information on impacts to Aboriginal heritage is presented in Section 6.3. | Tahmoor will update its existing LW S1A-S6A Heritage Management Plan to include details of monitoring that will be undertaken during and following the extraction of LW S7A and any management measures that will be implemented to manage the potential for impacts to heritage sites. |

## Table 6.3 Maximum subsidence predictions and impact assessment for natural and built features

| Feature | Subsidence prediction Maximum predicted incremental | Subsidence prediction Maximum predicted total | Impact assessment | Monitoring and management |
|---|---|---|---|---|
| **Built features** | | | | |
| Main Southern Railway | • 40 mm vertical<br>• <0.05 mm/m tilt<br>• <0.01 $km^{-1}$ hogging curvature<br>• <0.01 $km^{-1}$ sagging curvature | • 1,400 mm vertical<br>• 0.85 mm/m tilt<br>• 0.10 $km^{-1}$ hogging curvature<br>• 0.20 $km^{-1}$ sagging curvature | The Main Sothern Railway is predicted to experience minor additional subsidence movements due to the proposed extraction of LW S7A. The addition of LW S7A does not materially change the impact assessment though the potential for impacts increases slightly within the study area.<br>With an appropriate management plan in place, it is considered that the Main Southern Railway will remain safe and serviceable at all times during and after the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred. | Tahmoor Coal has extensive experience mining under and in the vicinity of the Main Southern Railway over a number of years and managing the interaction of longwall mining with the railway in collaboration with ARTC. Tahmoor Coal and ARTC have developed a detailed risk management plan for managing potential mine subsidence impacts on the Main Southern Railway due to the extraction of LW S1A-S6A. The LW S1A-S6A Railway Management Plan will be updated to include potential impacts from LW S7A. |

**Table 6.3 Maximum subsidence predictions and impact assessment for natural and built features**

| Feature | Subsidence prediction Maximum predicted incremental | Subsidence prediction Maximum predicted total | Impact assessment | Monitoring and management |
|---|---|---|---|---|
| Roads | Yarran Road<br>• 950 mm vertical<br>• 3.5 mm/m tilt along alignment<br>• 7.0 mm/m tilt across alignment<br>• 0.04 $km^{-1}$ hogging curvature<br>• <0.05 $km^{-1}$ sagging curvature<br>Caloola Road<br>• 60 mm vertical<br>• <0.5 mm/m tilt along alignment<br>• <0.5 mm/m tilt across alignment<br>• <0.01 $km^{-1}$ hogging curvature<br>• <0.01 $km^{-1}$ sagging curvature<br>Remembrance Drive<br>• 60 mm vertical<br>• <0.5 mm/m tilt along alignment<br>• <0.5 mm/m tilt across alignment<br>• <0.01 $km^{-1}$ hogging curvature<br>• <0.01 $km^{-1}$ sagging curvature | Yarran Road<br>• 1,350 mm vertical<br>• 6.5 mm/m tilt along alignment<br>• 7.5 mm/m tilt across alignment<br>• 0.10 $km^{-1}$ hogging curvature<br>• 0.20 $km^{-1}$ sagging curvature<br>Caloola Road<br>• 1,400 mm vertical<br>• 6.5 mm/m tilt along alignment<br>• 6.5 mm/m tilt across alignment<br>• 0.12 $km^{-1}$ hogging curvature<br>• 0.20 $km^{-1}$ sagging curvature<br>Remembrance Drive<br>• 1,400 mm vertical<br>• 7.0 mm/m tilt along alignment<br>• 5.0 mm/m tilt across alignment<br>• 0.13 $km^{-1}$ hogging curvature<br>• 0.25 $km^{-1}$ sagging curvature | LWs 22–32 and LWs W1–W3 at Tahmoor Mine have mined directly beneath 28 km of local roads and a total of 54 impact sites have been observed. The observed rate of impact on the local roads equates to an average of one impact for every 520 m of pavement. In most cases, the impacts were relatively minor and were remediated by locally resurfacing the pavements.<br>The most severe impacts were located where substantial non-conventional movements had developed.<br>The addition of LW S7A does not materially change this assessment, though the extent of impacts increases further west along Yarran Road.<br>With an appropriate management plan in place, it is considered that the local roads will remain safe and serviceable at all times during and after the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred. | Tahmoor Coal and Wollondilly Shire Council have implemented extensive measures to manage potential impacts on local roads and the associated structures due to the extraction of LW S1A-S6A, in accordance with a Subsidence Management Plan for this specific infrastructure.<br>This plan will be updated to include potential impacts due to the extraction of LW S7A. |

## Table 6.3 Maximum subsidence predictions and impact assessment for natural and built features

| Feature | Subsidence prediction Maximum predicted incremental | Subsidence prediction Maximum predicted total | Impact assessment | Monitoring and management |
|---|---|---|---|---|
| Powerlines | As per subsidence predictions for roads | | 11 kV powerlines are directly above LW S7A. These therefore could experience the full range of predicted subsidence movements due to extraction of the longwall. The predicted profiles of conventional subsidence, tilt and curvature along the powerlines following the alignment of local roads are as predicted for these roads themselves.<br>There is extensive experience of mining directly beneath electrical infrastructure in the Southern Coalfield which demonstrates that impacts can be managed with the implementation of suitable management strategies. In all cases the electrical infrastructure has remained in safe and serviceable condition and have been remediated using normal maintenance techniques.<br>The addition of LW S7A does not materially change this assessment, though the extent of impacts increases further west along Yarran Road.<br>With an appropriate management plan in place, it is considered that the electrical infrastructure will remain safe and serviceable at all times during and after the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred. | Tahmoor Coal and Endeavour Energy have implemented extensive measures to manage potential impacts on electrical infrastructure due to the extraction of LW S1A-S6A, in accordance with a Subsidence Management Plan for this specific infrastructure. This plan will be updated to include potential impacts due to the extraction of LW S7A. |

**Table 6.3 Maximum subsidence predictions and impact assessment for natural and built features**

| Feature | Subsidence prediction Maximum predicted incremental | Subsidence prediction Maximum predicted total | Impact assessment | Monitoring and management |
|---|---|---|---|---|
| Telecommunications infrastructure | Optical fibre and copper cables:<br>• Predictions as per the Main Southern Railway and roads themselves<br>Shed<br>• 175 mm vertical<br>• 1.0 mm/m tilt<br>• 0.01 $km^{-1}$ hogging curvature<br>• <0.01 $km^{-1}$ sagging curvature<br>Tower<br>• 175 mm vertical<br>• 1.0 mm/m tilt<br>• 0.01 $km^{-1}$ hogging curvature<br>• <0.01 $km^{-1}$ sagging curvature | Optical fibre and copper cables:<br>• Predictions as per the Main Southern Railway and roads themselves<br>Shed<br>• 1,050 mm vertical<br>• 3.5 mm/m tilt<br>• 0.05 $km^{-1}$ hogging curvature<br>• 0.21 $km^{-1}$ sagging curvature<br>Tower<br>• 1,050 mm vertical<br>• 3.5 mm/m tilt<br>• 0.05 $km^{-1}$ hogging curvature<br>• <0.22 $km^{-1}$ sagging curvature | The NBN telecommunications tower is expected to experience some additional subsidence movements during the extraction of proposed LW S7A. These are not likely to affect the structural integrity of the tower, although predicted tilts of 3.5 mm/m, while small, may affect the operation of the antennae on top of the structure.<br>With appropriate management plans in place, it is considered that the telecommunications infrastructure will remain safe and serviceable at all times during and after the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred. | Tahmoor Coal has developed multiple Subsidence Management Plans as part of the Extraction Plan for LW S1A-S6A in consultation with Telstra, NBN and TPG to manage potential impacts on the telecommunications infrastructure. These plans will be updated to include potential impacts due to the extraction of LW S7A. |

**Table 6.3 Maximum subsidence predictions and impact assessment for natural and built features**

| Feature | Subsidence prediction Maximum predicted incremental | Subsidence prediction Maximum predicted total | Impact assessment | Monitoring and management |
|---|---|---|---|---|
| Gas infrastructure | Jemena gas main<br>• 50 mm vertical<br>• <0.5 mm/m tilt<br>• <0.01 $km^{-1}$ hogging curvature<br>• <0.01 $km^{-1}$ sagging curvature | Jemena gas main<br>• 1,400 mm vertical<br>• 7.5 mm/m tilt<br>• 0.12 $km^{-1}$ hogging curvature<br>• 0.21 $km^{-1}$ sagging curvature | The steel gas main along Remembrance Drive would be expected to experience only small additional subsidence movements due to LW S7A following extraction of LW S1A-S6A.The nylon gas pipeline alongside Wellers Road is predicted to experience less than 20 mm of subsidence.<br>There is extensive experience of mining directly beneath nylon gas pipelines above LWs 22–32 where no impacts were experienced.<br>Based on the subsidence predictions and past experiences observed, it is unlikely that the nylon gas pipeline along Wellers Road will experience adverse impacts due to the extraction of the proposed LW S7A.<br>With an appropriate management plan in place, it is considered that the gas infrastructure will remain safe and serviceable at all times during and after the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred. | Tahmoor Coal has developed a Subsidence Management Plan for gas infrastructure in consultation with Jemena to manage potential impacts on local gas infrastructure due to the extraction of LW S1A-S2A. Tahmoor Coal and Jemena are currently developing an updated Subsidence Management Plan to manage potential impacts on local gas infrastructure due to the extraction of LW S3A-S6A. This plan will be updated to include potential impacts due to the extraction of LW S7A. |

## Table 6.3 Maximum subsidence predictions and impact assessment for natural and built features

| Feature | Subsidence prediction Maximum predicted incremental | Subsidence prediction Maximum predicted total | Impact assessment | Monitoring and management |
|---|---|---|---|---|
| Potable water infrastructure | As per subsidence predictions for roads | | The predicted profiles of conventional subsidence, tilt and curvature along the water pipelines following the alignment of local roads are as predicted for these roads themselves. Any additional subsidence movements due to extraction of LW S7A are slight when compared to the Approved Layout, and the locations of the predicted maxima do not change along these powerline alignments.<br>With an appropriate management plan in place, it is considered that the potable water infrastructure will remain safe and serviceable at all times during and after the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred. | Tahmoor Coal and Sydney Water have implemented extensive measures to manage potential impacts on potable water infrastructure due to the extraction of LW S1A-S6A, in accordance with a Subsidence Management Plan for this specific infrastructure. This plan will be updated to include potential impacts due to the extraction of LW S7A. |
| Sewer infrastructure | As per subsidence predictions for Remembrance Drive | | Any additional subsidence movements due to extraction of LW S7A are slight when compared to the Approved Layout, and the locations of the predicted maxima do not change along these powerline alignments. With an appropriate management plan in place, it is considered that the sewer infrastructure will remain safe and serviceable at all times during and after the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred. | Tahmoor Coal and Sydney Water have implemented extensive measures to manage potential impacts on the sewer infrastructure due to the extraction of LW S1A-S6A, in accordance with a Subsidence Management Plan for this specific infrastructure. This plan will be updated to include potential impacts due to the extraction of LW S7A. |

**Table 6.3 Maximum subsidence predictions and impact assessment for natural and built features**

| Feature | Subsidence prediction Maximum predicted incremental | Subsidence prediction Maximum predicted total | Impact assessment | Monitoring and management |
|---|---|---|---|---|
| Picton weir | • <20 mm vertical<br>• <20 mm upsidence<br>• <20 mm closure | • <20 mm vertical<br>• 20 mm upsidence<br>• <20 mm closure | The weir is located outside the predicted limit of subsidence and is, therefore, predicted to experience negligible conventional subsidence movements.<br>However, it is noted that LW S7A is proposed to be extracted up to but stop short of the weir, while the analyses include sites where previously extracted longwalls had mined past them. The analyses, therefore, are expected to provide a conservative assessment. | Tahmoor Coal has developed a Subsidence Management Plan to manage the potential for impacts to the Picton Weir due to the extraction of LW S1A-S6A. This plan will be updated to include potential impacts due to the extraction of LW S7A.<br>Tahmoor Coal is currently implementing monitoring and management measures to ensure Picton Weir remains safe throughout the mining period. The management measures include a combination of:<br>• Mitigation or strengthening measures prior to mining.<br>• Installation of a monitoring system, which includes, among other things:<br>– GNSS monitoring at both ends of the Picton Weir.<br>– GNSS monitoring at a location between LW S1A-S7A and the Picton Weir.<br>– GNSS monitoring at three pairs across Hornes Creek.<br>– Survey marks on rockfaces on both sides of the Picton Weir.<br>– Survey marks on the Picton Weir.<br>– Photogrammetric survey of shape of dam wall and surrounding rockfaces on both sides of the Picton Weir.<br>– Vertical inclinometers in boreholes at both ends of the Picton Weir.<br>– Groundwater level monitoring in vertical inclinometers.<br>– Water level monitoring upstream of Picton Weir.<br>– Detailed visual inspection of Picton Weir and surrounding rockfaces by UAV.<br>– Visual inspections during mining.<br>• Implementation of planned responses if triggered by monitoring and inspections. |

**Table 6.3 Maximum subsidence predictions and impact assessment for natural and built features**

| Feature | Subsidence prediction Maximum predicted incremental | Subsidence prediction Maximum predicted total | Impact assessment | Monitoring and management |
|---|---|---|---|---|
| Rural structures | • 950 mm vertical<br>• 8 mm/m tilt<br>• 0.09 $km^{-1}$ hogging curvature<br>• 0.22 $km^{-1}$ sagging curvature | • 13,500 mm vertical<br>• 8.5 mm/m tilt<br>• 0.12 $km^{-1}$ hogging curvature<br>• 0.23 $km^{-1}$ sagging curvature | It is expected that the rural structures within the study area would remain safe and serviceable during the mining period, provided that they are in sound existing condition. The risk of impact is clearly greater if the structures are in poor existing condition, though the chances of there being a public safety risk remains very low. A number of rural structures which were in poor existing condition have been directly mined beneath and these structures have not experienced impacts during mining. | Tahmoor Coal has developed a Subsidence Management Plan for built structures to manage potential impacts to farm buildings during the mining of LW S1A-S6A that provides for identification of buildings in poor pre-mining condition that are hazardous or may become hazardous due to mining, and monitoring of structures during active subsidence.<br>If impacts occur, the structure will be repaired in accordance with the *Coal Mine Subsidence Compensation Act 2017*.<br>The Subsidence Management Plan will be updated to include potential impacts due to the extraction of LW S7A. |

**Table 6.3 Maximum subsidence predictions and impact assessment for natural and built features**

| Feature | Subsidence prediction Maximum predicted incremental | Subsidence prediction Maximum predicted total | Impact assessment | Monitoring and management |
|---|---|---|---|---|
| Tanks | • 950 mm vertical<br>• 8 mm/m tilt<br>• 0.09 $km^{-1}$ hogging curvature<br>• 0.22 $km^{-1}$ sagging curvature | • 1,350 mm vertical<br>• 8.5 mm/m tilt<br>• 0.12 $km^{-1}$ hogging curvature<br>• 0.23 $km^{-1}$ sagging curvature | Tilt can potentially affect the serviceability of tanks by altering the water levels in the tanks, which can in turn affect the minimum level of water which can be released from the outlets. The maximum predicted conventional tilt for the tanks within the study area is 8.5 mm/m. The predicted changes in grade are small and unlikely, therefore, to result in any adverse impacts on the serviceability of the tanks.<br>The tanks are typically constructed above ground level and, therefore, are unlikely to experience the curvatures and ground strains resulting from the extraction of the proposed longwalls. It is possible that any buried water pipelines associated with the tanks within the study area could be impacted by the ground strains, if they are anchored by the tanks, or by other structures in the ground.<br>Any impacts are expected to be of a minor nature, including leaking pipe joints, and could be easily repaired. With these remedial measures in place, it would be unlikely that there would be any adverse impacts on the pipelines associated with the tanks.<br>With an appropriate management plan in place, it is considered that tanks can be maintained at all times due to the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred. | Tahmoor Coal has developed a Subsidence Management Plan for built structures to manage potential impacts to tanks during the mining of LW S1A-S6A. The management plan provides for identification of tanks in poor pre-mining condition that are hazardous or may become hazardous due to mining, and monitoring of structures during active subsidence. If impacts occur, the structure will be repaired in accordance with the *Coal Mine Subsidence Compensation Act 2017*.<br>The Subsidence Management Plan will be updated to include potential impacts due to the extraction of LW S7A. |

**Table 6.3 Maximum subsidence predictions and impact assessment for natural and built features**

| Feature | Subsidence prediction Maximum predicted incremental | Subsidence prediction Maximum predicted total | Impact assessment | Monitoring and management |
|---|---|---|---|---|
| Farm dams | • 950 mm vertical<br>• 8 mm/m tilt<br>• 0.06 $km^{-1}$ hogging curvature<br>• 0.21 $km^{-1}$ sagging curvature | • 1,375 mm vertical<br>• 8.5 mm/m tilt<br>• 0.1 $km^{-1}$ hogging curvature<br>• 0.23 $km^{-1}$ sagging curvature | The maximum predicted final tilt for the farm dams is 8.5 mm/m. Mining induced tilts can affect the water levels around the perimeters of farm dams, with the freeboard increasing on one side, and decreasing on the other. Tilt can potentially reduce the storage capacity of farm dams, by causing them to overflow, or can affect the stability of the dam walls. it would still be expected that the rates of impact on the farm dams would be very low and could be managed with the implementation of suitable management strategies.<br>With an appropriate management plan in place, it is considered that dams can be maintained at all times due to the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred. | Tahmoor Coal has developed a Subsidence Management Plan for built structures to manage potential impacts to farm dams during the mining of LW S1A-S6A. The management plan includes an assessment of potential environmental or safety consequences as a result of dam breach. The management plan provides for visual monitoring of dams immediately prior to and after active subsidence at each dam.<br>If impacts occur to the dams, Tahmoor Coal will supply water to the landowner on a temporary basis until the dam is repaired in accordance with the *Coal Mine Subsidence Compensation Act 2017*.<br>The Subsidence Management Plan will be updated to include potential impacts due to the extraction of LW S7A. |

**Table 6.3 Maximum subsidence predictions and impact assessment for natural and built features**

| Feature | Subsidence prediction Maximum predicted incremental | Subsidence prediction Maximum predicted total | Impact assessment | Monitoring and management |
|---|---|---|---|---|
| Commercial and business establishments | • 950 mm vertical<br>• 8 mm/m tilt<br>• 0.09 $km^{-1}$ hogging curvature<br>• 0.21 $km^{-1}$ sagging curvature | • 1,100 mm vertical<br>• 8.5 mm/m tilt<br>• 0.12 $km^{-1}$ hogging curvature<br>• 0.22 $km^{-1}$ sagging curvature | Tahmoor Coal has previously developed and acted in accordance with risk management plans to successfully manage potential impacts to industrial, commercial and business establishments during the mining of LWs 22–32, including a turkey processing plant, a large shopping centre, horticultural businesses, industrial and commercial establishments and a variety of shops. Each business is unique in terms of the structures on the property and the activities that are conducted on each property.<br>With an appropriate management plan in place, it is considered that commercial and business establishments can be maintained at all times due to the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred. | Tahmoor Coal has committed to developing individual subsidence management plans in consultation with the owners of each business that are predicted to experience more than 20 mm of subsidence due to the extraction of LW S5A-S6A. The subsidence management plans will be extended to include the extraction of the proposed LW S7A.<br>The management strategy for each business will include:<br>• Consultation with the owner of each business.<br>• Pre-mining hazard identification inspection of each structure by structural engineer.<br>• Identification and assessment of potential impacts to the operation of each business and safety of workers and the general public.<br>• Consideration of mitigation measures to reduce risk prior to the commencement of subsidence movements.<br>• Consideration of appropriate monitoring measures.<br>• Consideration of appropriate triggered responses during mining.<br>• Development of an agreed detailed subsidence management plan between Tahmoor Coal and the owners of each business.<br>Each management plan would be reviewed periodically by Tahmoor Coal and the owners of each business. |

**Table 6.3 Maximum subsidence predictions and impact assessment for natural and built features**

| Feature | Subsidence prediction Maximum predicted incremental | Subsidence prediction Maximum predicted total | Impact assessment | Monitoring and management |
|---|---|---|---|---|
| Swimming pools | • 900 mm vertical<br>• 8 mm/m tilt<br>• 0.09 $km^{-1}$ hogging curvature<br>• 0.19 $km^{-1}$ sagging curvature | • 1,300 mm vertical<br>• 8.5 mm/m tilt<br>• 0.09 $km^{-1}$ hogging curvature<br>• 0.23 $km^{-1}$ sagging curvature | Mining-induced tilts are more noticeable in pools than other structures due to the presence of the water line and the small gap to the edge coping, particularly when the pool lining has been tiled. Skimmer boxes are also susceptible of being lifted above the water line due to mining tilt.<br>The Australian Standard AS2783-1992 (*Use of reinforced concrete for small swimming pools*) requires that pools be constructed level ± 15 mm from one end to the other. This represents a tilt of approximately 3 mm/m for pools that are 10 m in length. Australian Standard AS/NZS 1839:1994 (*Swimming pools –Pre-moulded fibre-reinforced plastics – Installation*) also requires that pools be constructed with a tilt of 3 mm/m or less.<br>There are a total of 13 pools within the study area. Of these, there are 3 pools (i.e. 23% of the total) which are predicted to experience final tilts of 3 mm/m or less, at the completion of the proposed longwalls, which is similar to or less than the Australian Standard. It is expected that the rate of impact on the pools within the study area would be similar, but, slightly greater than those previously experienced at Tahmoor North. With an appropriate management plan in place, it is considered that pools and pool fences can be maintained at all times due to the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non- conventional movements occurred. | Tahmoor Coal has developed a Subsidence Management Plan for built structures to manage potential impacts to swimming pools during the mining of LW S1A-S6A. This includes a pre-mining inspection of pools, pool fences and gates and measurement of levels around the pools.<br>The Subsidence Management Plan will be updated to include potential impacts due to the extraction of LW S7A.<br>Impacts to the pools would be repaired or, if required the pool would be replaced in accordance with the *Coal Mine Subsidence Compensation Act 2017*. |

**Table 6.3 Maximum subsidence predictions and impact assessment for natural and built features**

| Feature | Subsidence prediction Maximum predicted incremental | Subsidence prediction Maximum predicted total | Impact assessment | Monitoring and management |
|---|---|---|---|---|
| Houses | • 950 mm vertical<br>• 8 mm/m tilt<br>• 0.09 $km^{-1}$ hogging curvature<br>• 0.22 km-1 sagging curvature | • 1,400 mm vertical<br>• 8.5 mm/m tilt<br>• 0.1 $km^{-1}$ hogging curvature<br>• 0.23 $km^{-1}$ sagging curvature | The predicted maximum tilts are less than 7 mm/m at 53 of the houses within the study area (i.e. 85% of the total) at the completion of mining. It is expected that only minor serviceability impacts would occur at these houses, as the result of tilt, which could be remediated using normal building techniques.<br>The maximum predicted tilt for the houses is 8.5 mm/m (i.e. 0.85%, or 1 in 118). A total of nine houses (i.e. 15% of the total) are predicted to experience tilts greater than 7 mm/m. The potential for serviceability impacts is greater for these houses. In some cases, more substantial remediation measures may be required, such as relevelling of the building structure.<br>It is expected that, in all cases, the houses within the study area will remain in safe and serviceable conditions as the result of the mining induced tilts as tilts by themselves rarely impact on the stability of building structures at the levels that are predicted to occur. The maximum predicted curvatures for the houses within the study area are 0.10 $km^{-1}$ hogging and 0.23 $km^{-1}$ sagging, which represent minimum radii of curvature of 10.5 km and 4.3 km, respectively. The range of predicted curvatures for the houses within the study area are less than those observed above previously extracted longwalls at Tahmoor Mine.<br>With appropriate management plans in place, it is considered that the houses will remain safe and serviceable at all times due to the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non- conventional movements occurred. | Tahmoor Coal has developed a Subsidence Management Plan for built structures to manage potential impacts to houses during the mining of LW S1A-S6A. This plan will extend to all houses potentially impacted by the extraction of LW S7A. The following process will be implemented:<br>1. Regular consultation, cooperation and coordination with the community before, during and after mining. This includes letters and door knocking to all residents of structures that will soon be affected by subsidence. The letters offer a free pre-mining inspection and hazard identification inspection by a structural engineer.<br>2. Site-specific investigations, where they are necessary and appropriate, into the conditions of buildings and associated structures and their surrounding environment (where access is allowed).<br>3. Implementation of pre-mining mitigation measures following inspections by the geotechnical engineer and the structural engineer, in consultation and agreement with the landowner.<br>4. Surveys and inspections during mining within the active subsidence area structural engineer (where access is allowed by the landowner) to properties with structures that have been specifically targeted on the basis that may be more sensitive to mine subsidence movements. |

### 6.1.5 Management and mitigation

The predicted subsidence impacts, effects and environmental consequences associated with LW S7A are materially the same as previously approved for Tahmoor South. The minor increase in subsidence predictions does not change the existing risk profile previously assessed and approved for the Project.

The overall findings of the assessment completed by MSEC determined that the levels of impact, and damage to all identified natural features and built infrastructure are manageable and can be controlled by the preparation and implementation of extraction plans and subsidence management plans, many of which have been successfully implemented during previous mining at Tahmoor Mine. These management plans are developed in consultation with the owners of infrastructure and are approved by relevant government agencies.

Subsidence impacts will be managed through the implementation of effective management measures which will include:

- a detailed pre-mining assessment of the potential impacts of surface infrastructure in the event that increased subsidence occurs
- monitoring of subsidence movements above and beyond the proposed mining footprint, including across the projected location of the Central Fault on the surface
- monitoring of the condition of surface infrastructure during and after the mining period
- implementation of planned early intervention measures to further protect the safety and serviceability of surface infrastructure based on pre-determined trigger levels based on monitoring data.

### 6.1.6 Conclusion

The maximum predicted subsidence parameters within the study area, based on the modified layout with LW S7A included, are similar to those based on the current approved layout. The potential for impacts has been assessed based on the predicted subsidence movements, consultation with infrastructure owners and experiences gained during the extraction of previous longwalls at Tahmoor Mine and more broadly from experiences during the extraction of previous longwalls at similar depths of cover at nearby mines in the Southern Coalfield.

The overall findings of the assessments undertaken by MSEC are that the levels of impact and damage to all identified natural features and built infrastructure are manageable and can be controlled by the preparation and implementation of subsidence management plans (as part of an Extraction Plan), many of which have been successfully implemented during previous mining at Tahmoor Mine. These management plans are developed in consultation with the owners of infrastructure and are approved by relevant government agencies.

Recommended management measures generally include monitoring of ground movements and the condition of surface features. Some mitigation measures are recommended to mitigate or avoid the risk of serious consequences should impacts occur to some critical surface features.

## 6.2 Biodiversity

### 6.2.1 Introduction

A Biodiversity Development Assessment Report (BDAR) was prepared by Niche Environment and Heritage (Niche) to support the modification application. A copy of the BDAR is provided as Appendix C with the outcomes summarised in the sections below.

The BDAR was prepared in accordance with the Biodiversity Assessment Methodology (BAM) (DPIE 2020). Given the nature of the modification (i.e. prescribed impacts only, as discussed in Section 6.2.3iii), no direct and indirect impacts are expected.

As such, a deviation to the BAM was adopted as part of the BDAR and the field assessment did not include:

- collection of floristic and habitat data from BAM plots
- targeted, or seasonal, surveys for any flora and/or fauna candidate species.

As an alternative the following approach was discussed with BCS, and accepted, as outlined in Chapter 5.

- Vegetation mapping of the study area was reviewed and publicly available areas of the study area ground-truthed and validated by rapid data points (RPD).
- Validated Plant Community Types (PCTs) were entered in the BAM-Calculator (BAM-C) at benchmark condition i.e. 100 for each attribute.
- All predicted and candidate species generated by the BAM-C to be assumed present.
- Concentrate any threatened flora and fauna survey (not in accordance with BAM survey guidelines) to those areas that may be potentially impacted by subsidence (e.g. riparian zones and cliff lines).
- Candidate species known to utilise those areas that may be potentially impacted by subsidence (e.g. riparian zones and cliff lines) were the focus of the impact assessment.

### 6.2.2 Existing environment

#### i Vegetation communities and condition

Native vegetation extent within the study area was mapped by Niche using the NSW State Vegetation Type Map (SVTM) (DPE 2022), and data collected from 33 RDPs from across the study area during field surveys undertaken over several days in September 2023.

235.96 ha of native woody vegetation was mapped across the study area. Vegetation was assessed as aligning with six PCTs as summarised in Table 6.4. Areas within the study area that are not native vegetation include roads, access roads, buildings and dams, and those grassland areas that occur in association with the semi-rural properties present and are dominated by exotic groundcover species.

**Table 6.4 PCTs identified within the study area**

| PCT ID | PCT name | Area (ha) |
|---|---|---|
| 0 | Non-Native | 106.31 |
| 3598 | Woronora Plateau Scribbly Gum Woodland | 20.49 |
| 3611 | Nattai Plateau Bloodwood-Peppermint Forest | 1.62 |
| 3614 | Southern Highlands Sandstone Peppermint Forest | 2.72 |
| 3616 | Sydney Hinterland Grey Gum Transition Forest | 24.14 |
| 3618 | Sydney Hinterland Sandflat Peppermint Forest | 1.27 |
| 3619 | Sydney Hinterland Enriched Sandstone Bloodwood Forest | 185.72 |
| Total | | 342.27 |

None of the PCTs present in the study area align to any Threatened Ecological Communities (TECs) listed under the BC Act or EPBC Act.

Given the nature of the modification (i.e. prescribed impact only), and as no plot data was collected, PCTs were not refined to multiple condition classes. Instead, each PCT was considered to be present at benchmark condition for input into the BAM-C.

*Source: EMM (2024); SIMEC (2024); Niche (2024); DCSSS (2024); Metro Map (2024)*

0 250 500 m

GDA 1994 MGA Zone 56

N

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KEY

- Study area
- Existing underground working
- Tahmoor South approved mine working
- Proposed LWS7A

Existing environment

- Rail line
- Major road
- Minor road
- Named watercourse
- Waterbody

Plant Community Type

- 0 | Non native vegetation
- 3579 | Blue Mountains Scribbly Gum Swamp Woodland
- 3598 | Woronora Plateau Scribbly Gum Woodland
- 3611 | Nattai Plateau Bloodwood-Peppermint Forest
- 3614 | Southern Highlands Sandstone Peppermint Forest
- 3616 | Sydney Hinterland Grey Gum Transition Forest
- 3618 | Sydney Hinterland Sandflat Peppermint Forest
- 3619 | Sydney Hinterland Enriched Sandstone Bloodwood Forest

# PCTs identified within the study area

Tahmoor South Project
SSD 8445 Modification 3
Figure 6.4

EMM creating opportunities

### ii Flora

No targeted flora surveys were conducted as part of the assessment given the nature of the modification (i.e. prescribed impacts only). Rather, the BAM-C tool (using benchmark condition for mapped PCTs) was used to identify candidate species credit species and predicted ecosystem credit species known or predicted to occur within the study area.

A total of 35 threatened flora species and four threatened flora populations were identified from the BAM-C and are summarised in Table 6.5. Two flora candidate species and four populations listed in Table 6.5 were excluded from further assessment due to geographic limitations, as listed below:

- *Acacia gordonii*
- *Acacia prominens*
- *Grevillea parviflora subsp. supplicans*
- *Marsdenia viridiflora subsp. viridiflora*
- *Pomaderris prunifolia*
- *Wahlenbergia multicaulis.*

Of the 33 flora candidate species retained for further assessment, only two species were considered to be potentially impacted by subsidence due to their closer association with creeklines and riparian vegetation, making them more susceptible to subsidence related changes to watercourse and associated flows. These two species are:

- Woronora Beard-heath (*Leucopogon exolasius*)
- Brown Pomaderris (*Pomaderris brunnea*).

## Table 6.5 Predicted flora species credit species

| Common name | Scientific name | Listing status | | Species retained for further assessment? | Reason for exclusion from further assessment | Further assessment required? |
|---|---|---|---|---|---|---|
| | | BC Act | EPBC Act | | | |
| Bynoe's Wattle | *Acacia bynoeana* | E | V | Yes | | No |
| Flockton Wattle | *Acacia flocktoniae* | V | V | Yes | | No |
| | *Acacia gordonii* | E | E | No | Geographic limitations. Study area does not occur north of the Great Western Highway. | No |
| Gosford Wattle, Hurstville and Kogarah Local Government Areas (LGAs) | *Acacia prominens* | EP | | No | Geographic limitations. Study area not within the Hurstville and Kogarah LGAs. | No |
| Downy Wattle | *Acacia pubescens* | V | V | Yes | | No |
| Netted Bottle Brush | *Callistemon linearifolius* | V | | Yes | | No |
| Dwarf Kerrawang | *Commersonia prostrata* | E | | Yes | | No |
| | *Darwinia biflora* | V | | Yes | | No |
| | *Darwinia peduncularis* | V | | Yes | | No |
| | *Deyeuxia appressa* | E | E | Yes | | No |
| | *Dillwynia tenuifolia* | V | | Yes | | No |
| | *Epacris purpurascens var. purpurascens* | V | | Yes | | No |
| Camfield's Stringybark | *Eucalyptus camfieldii* | V | V | Yes | | No |
| Bauer's Midge Orchid | *Genoplesium baueri* | E | E | Yes | | No |
| Juniper-leaved Grevillea | *Grevillea juniperina subsp. juniperina* | V | | Yes | | No |

## Table 6.5 Predicted flora species credit species

| Common name | Scientific name | Listing status | | Species retained for further assessment? | Reason for exclusion from further assessment | Further assessment required? |
|---|---|---|---|---|---|---|
| | | BC Act | EPBC Act | | | |
| Small-flower Grevillea | *Grevillea parviflora subsp. parviflora* | V | V | Yes | | No |
| | *Grevillea parviflora subsp. supplicans* | E | | No | Geographic limitations. Study area does not occur north of the Great Western Highway. | No |
| | *Gyrostemon thesioides* | E | | Yes | | No |
| | *Hibbertia fumana* | CE | | Yes | | No |
| | *Hibbertia puberula* | E | | Yes | | No |
| | *Hibbertia superans* | E | | Yes | | No |
| | *Lasiopetalum joyceae* | V | V | Yes | | No |
| Woronora Beard-heath | *Leucopogon exolasius* | V | V | Yes | | Yes |
| | *Leucopogon fletcheri subsp. fletcheri* | E | | Yes | | No |
| Marsdenia viridiflora R. Br. subsp. Viridiflora population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith LGAs | *Marsdenia viridiflora subsp. viridiflora* | EP | | No | Geographic limitations. Study area not within the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith LGAs. | No |
| Deane's Paperbark | *Melaleuca deanei* | V | V | Yes | | No |
| Bargo Geebung | *Persoonia bargoensis* | E | V | Yes | | No |
| Mittagong Geebung | *Persoonia glaucescens* | E | V | Yes | | No |

## Table 6.5 Predicted flora species credit species

| Common name | Scientific name | Listing status | | Species retained for further assessment? | Reason for exclusion from further assessment | Further assessment required? |
|---|---|---|---|---|---|---|
| | | BC Act | EPBC Act | | | |
| Hairy Geebung | *Persoonia hirsuta* | E | E | Yes | | No |
| Nodding Geebung | *Persoonia nutans* | E | E | Yes | | No |
| | *Pimelea curviflora var. curviflora* | V | V | Yes | | No |
| Brown Pomaderris | *Pomaderris brunnea* | E | V | Yes | | Yes |
| P. prunifolia in the Parramatta, Auburn, Strathfield and Bankstown LGAs | *Pomaderris prunifolia* | EP | | No | Geographic limitations. Study area not within the Parramatta, Auburn, Strathfield and Bankstown LGAs. | No |
| Sydney Plains Greenhood | *Pterostylis saxicola* | E | E | Yes | | No |
| | *Pultenaea parviflora* | E | V | Yes | | No |
| Eastern Australian Underground Orchid | *Rhizanthella slateri* | V | E | Yes | | No |
| | *Tetratheca glandulosa* | V | | Yes | | No |
| Tadgell's Bluebell in the Auburn, Bankstown, Baulkham Hills, Canterbury, Hornsby, Parramatta and Strathfield LGAs | *Wahlenbergia multicauli* | EP | | No | Geographic limitations. Study area not within the Auburn, Bankstown, Baulkham Hills, Canterbury, Hornsby, Parramatta and Strathfield LGAs. | No |
| | *Zieria involucrata* | E | V | Yes | | No |

### iii Fauna

No targeted fauna surveys were conducted as part of the BDAR, as agreed with BCS. A brief habitat assessment was completed during field surveys conducted in September 2023 which involved opportunistically recording key fauna habitat features. Where possible, bat habitat features (e.g. caves, overhangs, escarpments, outcrops, crevices, boulder piles) were inspected to determine potential suitability for roosting bats. Areas within the study area that would be potentially impacted by subsidence and a likely habitat requirement for threatened species (e.g. riparian zones and cliff lines/rock outcrops) were a key focus of field investigations.

A total of 28 threatened flora species and one threatened fauna population were identified from the BAM-C as potential candidate threatened flora species (Table 6.6). Four fauna candidate species and one threatened fauna population listed in Table 6.6 were excluded from further assessment due to geographic limitations. Fauna species excluded from further assessment included:

- Regent Honeyeater (*Anthochaera phrygia*)
- Gang-gang Cockatoo (*Callocephalon fimbriatum)* - endangered population in the Hornsby and Ku-ring-gai Local Government Areas
- Swift Parrot (*Lathamus discolor*)
- Broad-billed Sandpiper (*Limicola falcinellus*)
- Grey-headed Flying-fox (*Pteropus poliocephalus*).

Of the 24 candidate fauna species retained for further assessment, only six species are considered to potentially be impacted by subsidence being:

- Large-eared Pied Bat (*Chalinolobus dwyeri*)
- Giant Burrowing Frog (*Heleioporus australiacus*)
- Broad-headed Snake (*Hoplocephalus bungaroides*)
- Little Bent-winged Bat (*Miniopterus australis*)
- Large Bent-winged Bat (*Miniopterus orianae oceanensis*)
- Red-crowned Toadlet (*Pseudophryne australis*).

## Table 6.6 Predicted fauna species credit species

| Common name | Scientific name | Listing status | | Species retained for further assessment? | Reason for exclusion from further assessment | Further assessment required? |
|---|---|---|---|---|---|---|
| | | BC Act | EPBC Act | | | |
| Regent Honeyeater | *Anthochaera phrygia* | E | CE | Yes | Habitat constraints. Study area not within the Important Habitat Map for the species. | No |
| Bush Stone-curlew | *Burhinus grallarius* | E | | Yes | | No |
| Gang-gang Cockatoo | *Callocephalon fimbriatum* | V | E | Yes | | No |
| Gang-gang Cockatoo population in the Hornsby and Ku-ring-gai LGAs | | EP | | No | Geographic limitations. Study area not within the Hornsby and Ku-ring-gai LGAs. | No |
| Glossy Black-Cockatoo | *Calyptorhynchus lathami lathami* | V | V | Yes | | No |
| Eastern Pygmy-possum | *Cercartetus nanus* | V | | Yes | | No |
| Large-eared Pied Bat | *Chalinolobus dwyeri* | V | V | Yes | | Yes |
| White-bellied Sea-Eagle | *Haliaeetus leucogaster* | V | | Yes | | No |
| Giant Burrowing Frog | *Heleioporus australiacus* | V | V | Yes | | Yes |
| Little Eagle | *Hieraaetus morphnoides* | V | | Yes | | No |
| Broad-headed Snake | *Hoplocephalus bungaroides* | E | E | Yes | | Yes |
| Swift Parrot | *Lathamus discolor* | E | CE | No | Habitat constraints. Study area not within the Important Habitat Map for the species. | No |
| Broad-billed Sandpiper | *Limicola falcinellus* | | V | No | Habitat constraints. Study area not within the Important Habitat Map for the species, and lacks suitable habitat. | No |
| Square-tailed Kite | *Lophoictinia isura* | V | | Yes | | No |

## Table 6.6 Predicted fauna species credit species

| Common name | Scientific name | Listing status | | Species retained for further assessment? | Reason for exclusion from further assessment | Further assessment required? |
|---|---|---|---|---|---|---|
| | | BC Act | EPBC Act | | | |
| Cumberland Plain Land Snail | *Meridolum corneovirens* | E | | Yes | | No |
| Little Bent-winged Bat | *Miniopterus australis* | V | | Yes | | Yes |
| Large Bent-winged Bat | *Miniopterus orianae oceanensis* | V | | Yes | | Yes |
| Southern Myotis | *Myotis macropus* | V | | Yes | | No |
| Barking Owl | *Ninox connivens* | V | | Yes | | No |
| Powerful Owl | *Ninox strenua* | V | | Yes | | No |
| Eastern Osprey | *Pandion cristatus* | V | | Yes | | No |
| Southern Greater Glider | *Petauroides volans* | | V | Yes | | No |
| Squirrel Glider | *Petaurus norfolcensis* | V | | Yes | | No |
| Koala | *Phascolarctos cinereus* | V | E | Yes | | No |
| Dural Land Snail | *Pommerhelix duralensis* | E | E | Yes | | No |
| Red-crowned Toadlet | *Pseudophryne australis* | V | | Yes | | Yes |
| Grey-headed Flying-fox | *Pteropus poliocephalus* | V | V | Yes | Habitat constraints. No breeding camps were observed, nor are any known to occur, within the study area. | No |
| Masked Owl | *Tyto novaehollandiae* | V | | Yes | | No |
| Sooty Owl | *Tyto tenebricosa* | V | | Yes | | No |

The total area of suitable habitat within the study area for each flora and fauna species identified in Table 6.5 and Table 6.6 as requiring further assessment is summarised in Table 6.7.

**Table 6.7 Habitat for species identified/assumed as present within the study area**

| Common name | Scientific name | Extent of suitable habitat (ha) |
|---|---|---|
| Woronora Beardheath | *Woronora Beardheath* | 231.97 |
| Brown Pomaderris | *Pomaderris brunnea* | 212.58 |
| Large-eared Pied Bat | *Chalinolobus dwyeri* | 235.96 |
| Giant Burrowing Frog | *Heleioporus australiacus* | 232.19 |
| Broadheaded Snake | *Hoplocephalus Bungaroides* | 12 |
| Little Bentwinged Bat | *Miniopterus australis* | 12 |
| Large Bentwinged Bat | *Miniopterus orianae oceanensis* | 235.96 |
| Red-crowned Toadlet | *Pseudophryne australis* | 95.01 |

### 6.2.3 Impact assessment

#### i Direct impacts

The proposed modification is limited to underground mining activities. No surface disturbance of vegetation (native and non-native) removal is required. Therefore, the modification will not result in any direct impacts to biodiversity.

#### ii Indirect impacts

As the proposed modification is limited to underground mining activities with no surface disturbance or vegetation removal required, the modification will not result in any indirect impacts to biodiversity.

#### iii Prescribed impacts

Prescribed biodiversity impacts are impacts on biodiversity values in addition to, or instead of, impacts from clearing vegetation and/or loss of habitat. A summary of the predicted impacts that the proposed modification may have on natural surface features sensitive to subsidence, and the associated potential impacts to biodiversity, are presented in the sections below.

#### a Karst, caves, crevices, cliffs, rocks or other geological features of significance

Cliffs and rock features are present within the western portion of the study area. These features are adjacent to Hornes Creek which intersects the western limit of the study area. Five cliffs were identified within the study area. These cliffs and rocky features are typical habitat for many threatened reptiles, either as nesting or foraging habitat, and may also provide roosting habitat for threatened bats.

While the proposed modification involves longwall mining, it does not involve mining directly beneath any identified cliffs, as shown in Figure 6.1 (refer to Section 1). Mining beneath cliff lines is known to result in instabilities, slippages and creature surface fissures. Previous knowledge of longwall mining in the Southern Coalfield has determined that longwall mining that does not occur directly underneath a cliff face is highly unlikely to result in slippages and rock falls (MSEC 2024). Any threatened fauna that may be inhabiting the cliffs and rock faces are therefore unlikely to be adversely affected by the proposed modification.

### b Human-made structures

Human-made structures have been identified within the central and eastern portion of the study area. These structures have the potential to provide nesting and roosting habitat for species of threatened microbats.

The proposed modification will not result in direct physical impacts to human-made structures. Threatened species which may be inhabiting human-made structures within the study area are therefore unlikely to be impacted.

### c Non-native vegetation

Areas of non-native vegetation exist within the study area in the form of modified pastures and introduced weeds. These areas may be utilised by threatened species as foraging or roosting habitat. Threatened owl species, such as Masked Owl, are known to utilise open fields as foraging habitat.

Non-native vegetation will not be removed or modified as a result of this modification. Threatened species which are inhabiting areas of non-native vegetation within the study area are unlikely to be impacted.

### d Habitat connectivity

The study area incorporates large areas of intact native vegetation, providing connectivity with habitat within the study area to areas of high-quality habitat north and west of the study area. The proposed modification does not require the removal of vegetation; however, MSEC (2024) acknowledged that gas emissions may occur as a result of the longwall mining. Gas emissions may result in localised vegetation dieback which could reduce the extent of the canopy and vegetation cover. The frequency of gas emissions has been noted as very low and is unlikely to reduce vegetation cover to an extent in which habitat connectivity is compromised or modified. The risk of gas emissions as a result of the modification are consistent with the current approved mine plan. As such, connectivity is unlikely to be impacted by the modification and the risk of impacts are consistent with those previously assessed and approved.

### e Waterbodies, water quality and hydrological processes

There are several waterways within the study area, including:

- Bargo River
- Hornes Creek
- Teatree Hollow and tributaries
- numerous farm dams.

These waterbodies are likely utilised as drinking water and foraging habitat by threatened species, such as koalas, microbats, and woodland birds.

The proposed modification will involve longwall mining which may disrupt watery quality and hydrogeological processes. This includes reducing water quality, flow of surface water, scouring and desiccation due to mining-induced tilting. Subsequently, this could have negative impacts for threatened fauna inhabiting the impacted waterbodies, or utilising the waterway as a water source. However, it has been identified that any impacts to waterbodies and geological processes will be minimal to negligible. Therefore, any threatened fauna associated the waterbodies or hydrological processes which may experience minor impacts are unlikely to be adversely affected.

#### f Vehicle strikes

The proposed modification will not increase the volume of traffic above the land surface. As such, no threatened or protected fauna will be impacted by this prescribed impact.

#### iv Impacts to matters of national environmental significance

The following MNES species are assumed present within the study area.

- Threatened flora species
  - Woronora Beard-heath
  - Brown Pomaderris
- Threatened fauna species
  - Broad-headed Snake
  - Large-pied eared bat
  - Giant Burrowing Frog.

An EPBC Act Significant Impact Criteria Assessment for these species has been prepared and presented in the BDAR (Appendix C). The assessments concluded that the proposed modification is not likely to result in a significant impact on any of these EPBC Act listed species.

### 6.2.4 Management and mitigation

#### i Avoidance

The proposed modification utilises the existing pit top facilities and avoids the requirement to establish new surface facilities to support the extraction of LW S7A. As such, the proposed modification does not require any surface disturbance or vegetation clearing.

#### ii Environmental management system and plans

Tahmoor Coal has developed and implements an Environmental Management System (EMS) for the Tahmoor Mine, which includes a series of environmental management plans (EMPs) that outline the mitigation and management programs for key environmental aspects at the mine. Operations at Tahmoor Mine will continue to be managed in accordance with the EMS and associated EMPs. The existing Biodiversity Management Plan (BMP) for the LW S1A-S6A Extraction Plan (which also includes a Subsidence Monitoring Plan and Trigger Action Response Plan/s) will be revised and updated to incorporate the outcomes of the assessments prepared to support this modification. The trigger action response plans (TARPs) within the BMP provide an adaptive management framework to monitor and respond to uncertain or difficult to measure impacts, such as prescribed impacts to biodiversity values, including amphibian populations, riparian vegetation, threatened species and threatened populations, potentially impacted by the modification.

No additional measures to mitigate and manage potential impacts to biodiversity are considered necessary.

#### iii Offsets

Given no surface disturbance and vegetation clearing is required to support the modification, and the potential for vegetation to be impacted as a result of subsidence is considered negligible, no biodiversity offsets are required for the modification. However, while no areas of vegetation will be directly impacted by the modification, to generate potential candidate species the BAM-C does not allow for '0 ha' to be entered. As such, the smallest area permitted to be entered in the BAM-C, 0.01 ha, was used as detailed in the BDAR provided as Appendix C. This in turn has calculated a total of six ecosystem credits to be offset, one for each PCT as follows:

- 3598 – 1 credit
- 3611 – 1 credit
- 3614 – 1 credit
- 3616 – 1 credit
- 3618 – 1 credit
- 3619 – 1 credit.

This is an error and function of the necessary approach adopted for the preparation of the BDAR. The total ecosystem credits to be offset for the modification should be zero. Consequently, no ecosystem credits are required for the modification.

Further, as the modification will result in prescribed impacts only, of which an assessment of such impacts on candidate species has been assessed as low, no species credits species will be required to be offset as part of the modification.

### 6.2.5 Conclusion

The proposed modification is limited to underground mining activities. No surface disturbance of vegetation (native and non-native) removal is required, and therefore the modification will not result in any direct impacts to biodiversity. No biodiversity offsets are required to mitigate any residual impacts of the modification.

## 6.3 Aboriginal cultural heritage

### 6.3.1 Introduction

An ACHA (EMM 2024a) has been prepared for the modification and assesses the potential impacts on cultural heritage sites and values. A copy of the ACHA is provided as Appendix D. The ACHA was prepared in accordance with the following NSW government guidelines:

- *Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW* (OEH, 2011)
- *Aboriginal Cultural Heritage Consultation Requirements for Proponents* (DECCW 2010)
- *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (DECCW 2010).

### 6.3.2 Existing environment

#### i Overview

The study area is situated on the south-western edge of the Sydney Basin. It is located within a semi-rural setting, characterised by rolling hills within valleys that have been cleared for pastoral grazing and that borders onto sandstone scarp features and incised stream channels to the west.

The majority of the study area comprises gently undulating hills and plateaus, sloping gently to the east and becoming more steeply incised and rugged to the west of the study area beside Hornes Creek.

The highest potential for Aboriginal archaeological sites is constrained to outcropping Hawkesbury Sandstone bordering Hornes Creek in the west of the study area, which is suitable for the occurrence of Aboriginal grinding grooves, rock shelters (including those with art), rock engravings and modified rock pools.

Uncleared vegetation within the riparian corridor in the east of the study area may contain culturally modified trees.

#### ii AHIMS data

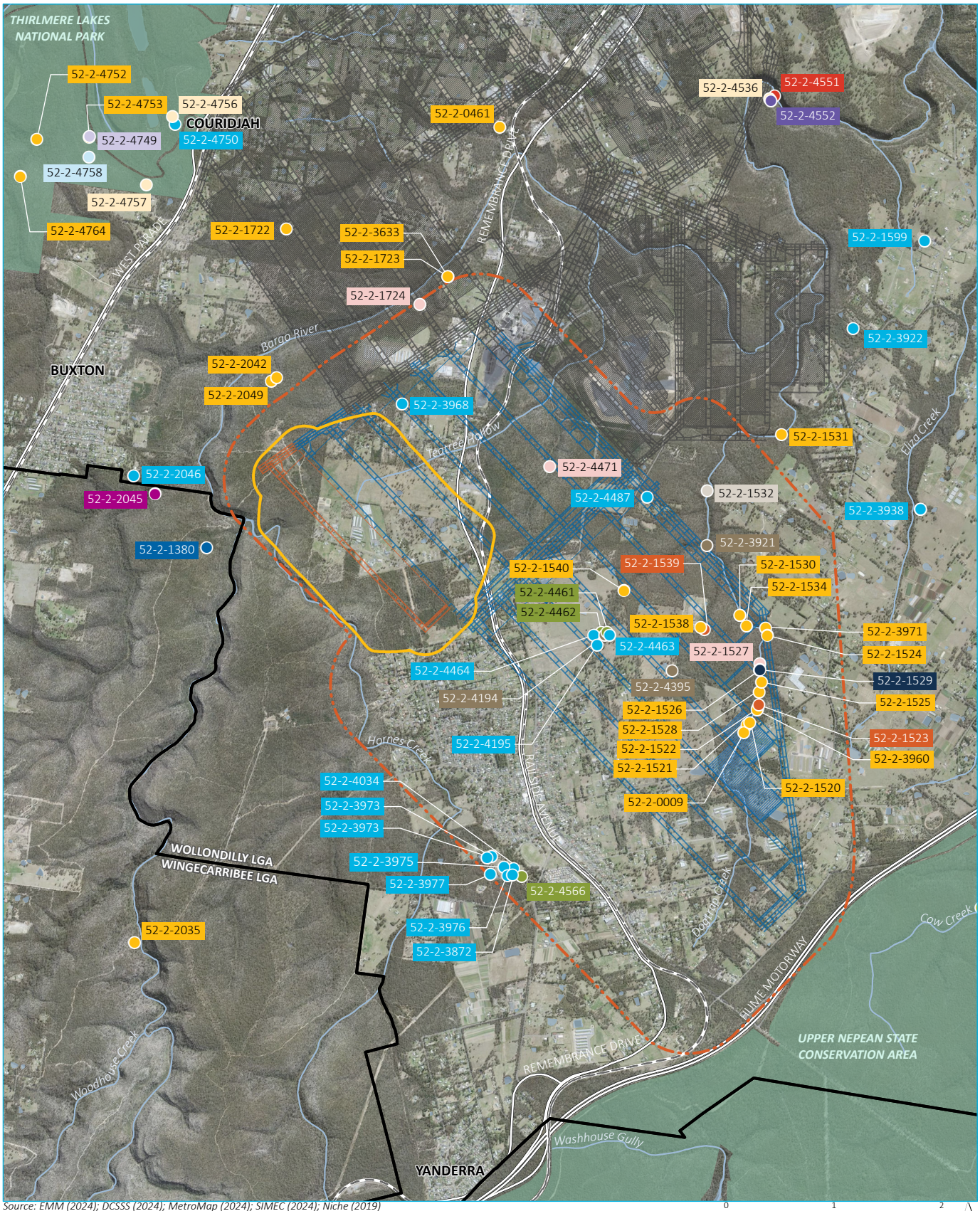
A search of the Aboriginal Heritage Information Management System (AHIMS) was conducted on 18 January 2024 for the area between longitudes 150.5131 and 150.6367 and latitudes -34.3021 and -34.2311. A total of 85 registered sites were identified (Figure 6.5), of which no sites were registered within the study area. The most common site types within the search area are rockshelter sites (n=49) and artefact sites including isolated finds and artefact scatters (n=21). In addition, there are four grinding grooves sites, three areas of potential archaeological deposit (PAD), two culturally modified trees, a rock engraving, an open art site and an open camp site. There are also three restricted sites. Rockshelters and grinding groove sites are confined to watercourses and their adjacent scarp landforms. Most open artefact sites are identified on gentle slopes in proximity to watercourses.

**Table 6.8 AHIMS site search results**

| Site Type | Count |
|---|---|
| Open Art Site | 1 |
| Artefact | 21 |
| Culturally Modified Tree | 2 |
| Grinding Groove | 4 |

### Table 6.8 AHIMS site search results

| Site Type | Count |
|---|---|
| Open Camp Site | 1 |
| PAD | 3 |
| Restricted | 3 |
| Rock Engraving | 1 |
| Rockshelter | 49 |
| **Total** | **85** |




Source: EMM (2024); DCSSS (2024); MetroMap (2024); SIMEC (2024); Niche (2019)

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KEY

- ACHA study area (indicative) (Niche 2019)
- Study area
- Extraction subject to secondary approval
- Existing underground working
- Tahmoor South approved mine working
- Proposed LWS7A

Existing environment

- Rail line
- Major road
- Named watercourse
- Waterbody
- NPWS reserve
- Local government area

AHIMS (by site type)

- Art Site
- Artefact
- Culturally Modified Tree
- Grinding Groove
- Open Camp Site
- PAD
- Restricted
- Rock Engraving
- Selter with PAD
- Shelter with Art
- Shelter with Art and Deposit
- Shelter with Art and Grinding Grooves
- Shelter with Art and PAD
- Shelter with Art and Stone Arrangement
- Shelter with Deposit
- Shelter with PAD
- Shleter with Art

# Existing AHIMS sites in and around study area

Tahmoor South Project
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Figure 6.5

EMM creating opportunities

### 6.3.3 Field surveys

EMM conducted the archaeological field survey over two days with the assistance of a RAP site officer on 19 and 21 February 2024.

The focus of the survey sampling strategy was to characterise the archaeological landscape of the study area for sandstone-type sites. This focus was directly linked to accounting for Aboriginal sites that have the potential to be harmed by modification related subsidence impacts, which in this instance are Aboriginal rockshelters, art sites and grinding groove sites.

Nine new sites not listed on AHIMS were identified during the archaeological field survey, comprising six within the study area and three that are just outside the study area. Table 6.9 provides a description of each of these sites and their location is shown on Figure 6.6.

In summary:

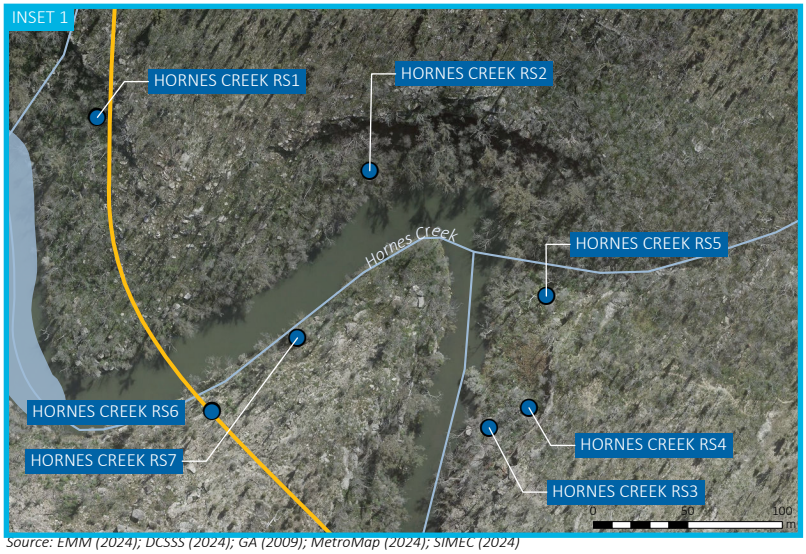
- Seven newly identified rockshelters were recorded (six within the study area); six contained a potential archaeological deposit (PAD), and three contained artefacts.
- No rockshelters with art were identified although indeterminate charcoal markings were observed on the walls of two shelters.
- One grinding groove site was identified on a rockbar within Hornes Creek outside the study area.
- One isolated find was identified on a fire track outside the study area.
- No trees of sufficient age to retain culturally modified scars were observed within the study area.

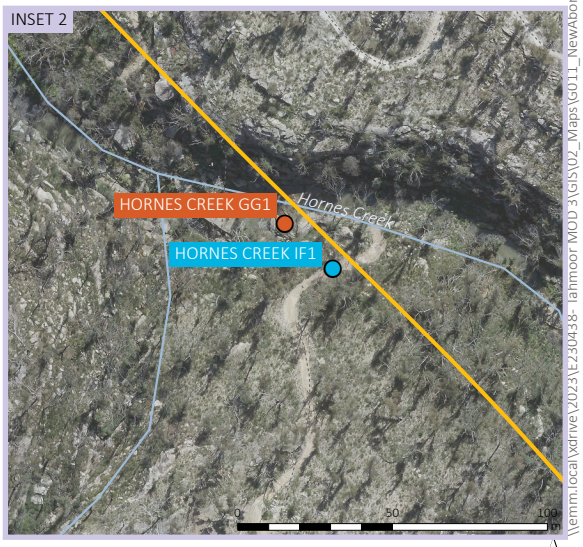
**Table 6.9 New Aboriginal sites identified during survey in the study area**

| AHIMS number | Site name | Site type | Description | Landform |
|---|---|---|---|---|
| **Sites within the study area** | | | | |
| 52-2-4975 | Hornes Creek RS2 | Rockshelter with deposit and artefacts | High, shallow rockshelter with deposit and artefacts. Overhang extends for approximately 80 m along the upper scarp. Artefacts were identified under the dripline within a 1 $m^2$ area. Artefacts included a mudstone flake, a quartz flake piece and a silcrete flake. | Upper scarp |
| 52-2-4976 | Hornes Creek RS3 | Rockshelter with deposit | Cavernous, open shelter facing west on the upper scarp. Rockshelter has a rock platform base overlaid with 10–20 cm depth of sandy PAD and a large area of PAD below the drip line. | Upper scarp |
| 52-2-4977 | Hornes Creek RS4 | Rockshelter with deposit and artefact | Large, west facing rockshelter with good amenity and area of PAD (6 x 4 m). Charcoal graffiti and disturbance from recent campfires in the shelter. Indeterminate charcoal markings, partly covered in lichen may represent earlier artworks. One silcrete debitage flake. | Upper scarp |
| 52-2-4978 | Hornes Creek RS5 | Rockshelter | Low shelter (1.7 m high) charcoal graffiti and some indeterminate charcoal markings. No PAD. | Upper scarp |
| 52-2-4982 | Hornes Creek RS6 | Rockshelter with deposit and artefact | Large rockshelter formed by cavernous weathering, facing north above Hornes Creek. A small micro-debitage mudstone flake was found within the dripline. The shelter contains an area of PAD approximately 6 x 3 m. | Upper scarp |

### Table 6.9 New Aboriginal sites identified during survey in the study area

| AHIMS number | Site name | Site type | Description | Landform |
|---|---|---|---|---|
| 52-2-4981 | Hornes Creek RS7 | Rockshelter with deposit | Small rockshelter with PAD (approximately 1 x 3 m) beside Hornes Creek. | Footslope |
| **Sites outside the study area** | | | | |
| 52-2-4980 | Hornes Creek GG1 | Grinding grooves | Narrow grinding grooves, possibly from spear sharpening, located on a sandstone platform in Hornes Creek. The grooves (n=7) are oriented north – south. The deepest groove is approximately 5 mm deep, 130 mm long and 15 mm wide. | Creek (4th order) |
| 52-2-4974 | Hornes Creek RS1 | Rockshelter with deposit | West facing rockshelter near the confluence of Hornes Creek and the Bargo River. Shelter is quite shallow with a rock base and a limited area of PAD. | Upper scarp |
| 52-2-4979 | Hornes Creek IF1 | Isolated find | Grey silcrete horseshoe core (33 mm). Multidirectional flaking has removed all cortex. Located on a fire trail, amongst gravel, leading down to Hornes Creek. | Hillslope |




Source: EMM (2024); DCSSS (2024); GA (2009); MetroMap (2024); SIMEC (2024)

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GDA 1994 MGA Zone 56

N

## KEY

- Study area
- Existing underground working
- Tahmoor South approved mine working
- Proposed LWS7A

Site location

- Grinding groove
- Isolated find
- Rock shelter

Existing environment

- Rail line
- Major road
- Minor road
- Watercourse/drainage line
- Waterbody

# New recorded Aboriginal heritage sites

Tahmoor South Project
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Figure 6.6

EMM
creating opportunities

### 6.3.4 Significance assessment

Cultural significance is outlined in Article 1.2 of the *Burra Charter* - the best practise document for managing cultural heritage – as 'aesthetic, historic, scientific, social or spiritual value for past, present or future generations' (ICOMOS 2013). These values are reiterated in the NSW guidelines, which determines cultural significance of a place can be assessed by identifying the values that are present across the subject area and assessing what is important and why (OEH 2011).

The criteria adopted for assessing cultural significance are summarised in Table 6.10. The results of the cultural significance assessment for the nine sites identified within and in the vicinity of the study area are presented in Table 6.11.

**Table 6.10 Summary of criteria used to assess the cultural significance (OEH 2011)**

| Criterion | Definition |
|---|---|
| **Social value**—Does the place have a strong or special association with a particular community or cultural group for social, cultural or spiritual reasons? | Social (or cultural) value refers to the spiritual, traditional, historical or contemporary associations and attachments the place or area has for Aboriginal people. Social or cultural value is how people express their connection with a place and the meaning that place has for them.<br>Social or cultural value can only be identified through consultation with Aboriginal people. |
| **Historic value**—Is the place important to the cultural or natural history of the local area and/or region and/or state? | Historic value refers to the association of a place with a historically important person, event, phase or activity. Historic places do not always have physical evidence of their historical importance (such as structures, planted vegetation or landscape modifications). They may have 'shared' historic values with other (non-Aboriginal) communities. |
| **Scientific (archaeological) value**—Does the place have potential to yield information that will contribute to an understanding of the cultural or natural history of the local area and/or region and/or state? | Scientific (archaeological) value refers to the importance of a landscape, area, place or object because of its rarity, representativeness and the extent to which it may contribute to further understanding and information.<br>Information about scientific values is gathered through archaeological investigation undertaken in this report. |
| **Aesthetic value**—Is the place important in demonstrating aesthetic characteristics in the local, regional, and/or State environment? | Aesthetic value refers to the sensory, scenic, architectural and creative aspects of the place. It is often linked with social value, and can consider form, scale, colour, texture and material of the fabric or landscape, and the smell and sounds associated with the place and its use. This value is only relevant to archaeological sites on only rare occasions, such as rockshelters that contain art, or culturally modified trees in prominent positions, etc. |

**Table 6.11 Significance of Aboriginal site identified during survey**

| AHIMS number | Site name | Site type | Significance | | | | |
|---|---|---|---|---|---|---|---|
| | | | Scientific | Aesthetic | Historical | Cultural | Overall |
| **Sites within the study area** | | | | | | | |
| 52-2-4975 | Hornes Creek RS2 | Rockshelter with deposit and artefacts | M | M | | M | Moderate |
| 52-2-4976 | Hornes Creek RS3 | Rockshelter with deposit | L | L | | L | Low |
| 52-2-4977 | Hornes Creek RS4 | Rockshelter with deposit and artefact | M | M | | M | Moderate |
| 52-2-4978 | Hornes Creek RS5 | Rockshelter | L | L | | L | Low |
| 52-2-4982 | Hornes Creek RS6 | Rockshelter with deposit and artefact | M | M | | M | Moderate |
| 52-2-4981 | Hornes Creek RS7 | Rockshelter with deposit | L | L | | L | Low |
| **Sites outside the study area** | | | | | | | |
| 52-2-4980 | Hornes Creek GG1 | Grinding grooves | H | H | H | H | High |
| 52-2-4974 | Hornes Creek RS1 | Rockshelter with deposit | L | L | L | L | Low |
| 52-2-4979 | Hornes Creek IF1 | Isolated find | L | L | L | L | Low |

### 6.3.5 Impact assessment

There are six rockshelters with PAD and/or artefacts recorded within the study area. One grinding groove site was recorded within 10 m of the study area boundary. Longwall mining causes subsidence at the ground surface resulting in tensile and compressive strains. Streams and valleys are the natural surface features most sensitive to subsidence movements. Axe grinding groove sites and rockshelters are located along the valleys of streams and therefore could experience valley related movements of upsidence and valley closure movements. Archaeological sites which are most susceptible to subsidence-induced damage are rockshelters generally associated with cliff lines (DoP 2008). Fracturing has historically been observed in the Southern Coalfield, with more significant fracturing tending to occur near the bases of rivers, creeks and valleys, as the result of valley related movements (MSEC 2019).

Subsidence predictions for each Aboriginal heritage site are provided in Table 6.12. While some movement is predicted to occur, the overall likelihood of this movement causing an impact on the newly recorded Aboriginal sites is considered low (MSEC 2024).

The cliffs which contain the newly recorded rockshelters are considered unlikely to experience any major instabilities due to the proposed extraction of LW S7A as the proposed modification does not involve mining directly beneath any identified cliffs within the study area. Hornes Creek GG1 is located on a flat sandstone slab and the grinding grooves are not located across natural joints of the rock. The likelihood of fracturing occurring at Hornes Creek GG1 is also considered low and in the unlikely event that it occurs, the fractures are expected to be minor and isolated (MSEC 2024).

Overall, the proposed longwall is considered to have low risk of impact to the cultural sites identified within the study area as the sites are located on the edge of the predicted 20 mm incremental contour after LW S7A.

A summary of the predicted probability of impact from the extraction of LW S7A on each Aboriginal site is presented in Table 6.13.

## Table 6.12 Subsidence predictions for Aboriginal heritage sites (MSEC 2024)

| AHIMS | Site name | Site type | Significance assessment | Location in relation to LW S7A | Total Subsidence (mm) | Maximum tilt (mm/m) | Total hogging curvature (1/km) | Total sagging curvature (1/km) | Total upsidence (mm) | Total closure |
|---|---|---|---|---|---|---|---|---|---|---|
| 52-2-4975 | Hornes Creek RS2 | Rockshelter with deposit and artefacts | Moderate | ~300 m south west | 40 | <0.5 | <0.01 | <0.01 | - | - |
| 52-2-4976 | Hornes Creek RS3 | Rockshelter with deposit | Low | ~350 m south west | 40 | <0.5 | <0.01 | <0.01 | - | - |
| 52-2-4977 | Hornes Creek RS4 | Rockshelter with deposit and artefact | Moderate | ~350 m south west | 40 | <0.5 | <0.01 | <0.01 | - | - |
| 52-2-4978 | Hornes Creek RS5 | Rockshelter | Low | ~300 m south west | 50 | <0.5 | <0.01 | <0.01 | - | - |
| 42-2-4982 | Hornes Creek RS6 | Rockshelter with deposit and artefact | Moderate | ~400 m south west | 20 | <0.5 | <0.01 | <0.01 | - | - |
| 52-2-4981 | Hornes Creek RS7 | Rockshelter with deposit | Low | ~350 m south west | 30 | <0.5 | <0.01 | <0.01 | - | - |
| 52-2-4980 | Hornes Creek GG1 | Grinding grooves | High | ~400 m south west | 20 | <0.5 | <0.01 | <0.01 | 45 | 65 |

**Table 6.13 Impact assessment of Aboriginal heritage sites in or within 10 m of the study area**

| AHIMS | Site name | Type of potential harm | Degree of potential harm | Consequence of potential harm |
|---|---|---|---|---|
| 52-2-4975 | Hornes Creek RS2 | Indirect | Partial | Partial loss of value |
| 52-2-4976 | Hornes Creek RS3 | Indirect | Partial | Partial loss of value |
| 52-2-4977 | Hornes Creek RS4 | Indirect | Partial | Partial loss of value |
| 52-2-4978 | Hornes Creek RS5 | Indirect | Partial | Partial loss of value |
| 42-2-4982 | Hornes Creek RS6 | Indirect | Partial | Partial loss of value |
| 52-2-4981 | Hornes Creek RS7 | Indirect | Partial | Partial loss of value |
| 52-2-4980 | Hornes Creek GG1 | Indirect | Partial | Partial loss of value |

### 6.3.6 Management and mitigation

A subsidence monitoring program will be implemented to monitor the subsidence impacts and environmental consequences of subsidence effects during extraction of LW S7A on all rockshelter and grinding groove sites identified in and immediately adjacent to the study area. This monitoring program will be preceded by a detailed recording of the sites in order to assess their current condition. The existing Heritage Management Plan (HMP) for LW S1A-S6A will be updated to include the newly recorded Aboriginal sites with specific management measures for pre-mining recording, additional investigation (if required), a monitoring program, and integration into the TARP in the event of observed impacts. Project RAPs will continue to be consulted throughout the life of the Project.

### 6.3.7 Conclusion

Six Aboriginal heritage rockshelter sites have been identified within the study area for LW S7A.

The proposed longwall is considered to have a low potential for impact to the cultural sites identified, as the sites are located on the edge of the predicted 20 mm incremental contour associated with LW S7A. In addition, no surface disturbance activities are proposed as part of the modification, and therefore no direct impacts from any surface disturbance will occur.

## 6.4 Geomorphological assessments

### 6.4.1 Introduction

A geomorphology assessment was prepared by Fluvial Systems Pty Ltd (Fluvial System) to update baseline geomorphological attributes of reaches of Hornes Creek and Bargo River, relevant to the study area, originally conducted in 2013 as part of the Project; and assess the risks to geomorphic stream form and process associated with changes due to subsidence associated with the extraction of LW S7A. A copy of the geomorphology assessment is provided as Appendix E, with key outcomes summarised in the sections below.

### 6.4.2 Existing environment

The study area is in a region characterised by generally weakly developed soils on sandstone and shale. Some of the soils are highly susceptible to erosion by concentrated water flow. This would be expected of weakly developed soils in steep environments.

The streams of the study area comprise Hornes Creek and Bargo River which are both eroded into rocky gorges, plus six small headwater streams that are tributaries of these watercourses. A field survey was undertaken to characterise the geomorphology of the study area and was a repeat of a survey undertaken in 2013. The lengths of Hornes Creek and Bargo River within the study area were walked in their entirety, with the survey focussing on pools, knickpoints and bedrock featured that were large relative to the channel size. Characterisation of the geomorphology of the study area was approached at the landscape and stream reach/point scales. Streams were classified according to Strahler stream order and geomorphological type, and geomorphic features of the streams were measured in the field at the reach/point-scale.

The gorges associated with Hornes Creek and Bargo River are rimmed by cliffs of various lengths and heights, with densely vegetated talus slopes below the cliffs. These cliffs, and the talus slopes below them, appeared to be relatively stable. The geomorphological features within the study area are generally:

- cliffs
- streams, with pools, knickpoints
- steep slopes.

Being bedrock controlled, the streams of the study area are naturally resistant to geomorphic change. Most streams are in a stable, close to natural geomorphic condition. The streams have been affected by loss of trees in the riparian zone because of a severe bushfire in 2019/20 followed by a sequence of large floods in 2021 and 2022. The streams are also characterised by the presence of ferruginous suspended colloids. The survey noted widespread ferruginous colloids along Hornes Creek upstream of site 31 located at chainage 1,260 m. The downstream 740 m of the creek was clear of ferruginous colloids, iron precipitates and iron staining. Bargo River had high concentrations of ferruginous colloids in the water and iron precipitates and iron staining on the bed material. Water in the large, deep, shaded pool immediately downstream of Picton Weir, and water within the weir pool itself, was clear of ferruginous colloids. These factors do not have strong implications for geomorphic condition, but they could have relevance for ecological condition.

The field survey found that differences in knickpoint height (being a local steep fall in channel bed elevation) between the 2013 and 2023 surveys were within measurement error. Pool dimensions varied between the 2013 and 2023 surveys, most within measurement error. Some of the differences could have been related to the lower flow rate that occurred during the 2023 survey, possibly affecting the perception of pool boundaries.

The assessment also noted a clear difference in condition of the P1 Fire Trail. In 2023 the trail became impassable a short distance from Tahmoor due to fallen trees. Closer to Picton Weir, the trail was affected by occasional slumping and scouring by local runoff from small tributaries. More extensive damage in the form of surface stripping was also apparent. This damage appeared to have been caused by inundation and scour of the trail by large flood flows.

The results of the comparison assessment of 2013 and 2019 for cliffline geomorphic values are summarised in Table 6.14.

**Table 6.14 Geomorphic comparison between 2013 and 2019 data**

| Cliff class (as classified in 2013 study) | N (cliff polygons) | Change in average elevation between 2013 and 2019 (m) | | | | |
|---|---|---|---|---|---|---|
| | | Maximum | 10th percentile | 50th percentile | 90th percentile | Minimum |
| 1. Cliffs >=10 m high, all lengths | 42 | 3.8 | 1.8 | 0.0 | -2.9 | -9.7 |
| 1a. Cliffs >=10 m high a nd >=20 m long | 16 | 3.8 | 2.4 | 0.3 | -3.5 | -9.7 |
| 1b. Cliffs >=10 m high and <20 m long | 26 | 2.9 | 1.4 | -0.1 | -2.8 | -5.3 |
| 2. Minor cliffs 5–<10 m high, all lengths | 208 | 4.9 | 2.8 | 0.3 | -2.5 | -35.0 |
| 3. Rock faces 3–5 m high, all lengths | 695 | 6.8 | 2.1 | 0.1 | -2.0 | -9.9 |

Notes: A negative difference would suggest cliff collapse within cliff polygons. A positive difference must represent error. Elevation differences between 2013 and 2019 data at individual pixels within polygons were greater than statistics based on average differences between all pixels within polygons, as provided in this table.

### 6.4.3 Impact assessment

Subsidence has the potential to impact on geomorphological processes and forms in the study area. Subsidence effects such as rockbar and pool bedrock fracturing, and changes to the channel bed slopes could result in geomorphic responses that would constitute an environmental impact with possible implications for environmental values. However, given the resilient and resistant steam type found in the study area, and the distance of the streams from significant mine subsidence related processes, subsidence poses a negligible risk to stream geomorphology.

The streams in the study area are all confined by valleys, with beds and banks controlled by bedrock or hard regolith. The likelihood of a change of alignment is rare. If such an event were to occur it would only be in small headwater streams, so the consequence would be minor.

The proposed mining is not expected to present a significant risk to change in geomorphic character of the streams. Any changes that do occur would be expected to recover quickly because the streams are resilient and in generally good geomorphic condition (i.e. essentially natural with intact form and process).

### 6.4.4 Management and mitigation

Given that negligible impacts are predicted, specific management approaches to mitigating possible future impacts are not warranted for this modification.

In regard to monitoring, permanent reference points for regular photographic recording were established in the 2013 survey, and the present survey attempted to repeat the 2013 survey. This proved difficult in some locations due to high relief terrain and tall trees impairing GPS signal, and access difficulties.

Tahmoor Coal has nevertheless committed to further monitoring using this method and photographic survey. Photographs will be assessed and reported on by a geomorphologist. The geomorphic response to subsidence is likely to be slow, and therefore an area-wide re-survey and reporting of stream geomorphological condition will be undertaken following the extraction of LW S7A currently anticipated to be in 2027 or within 5 years should extraction of LW S7A not be completed by this time.

### 6.4.5 Conclusion

The proposed addition of LW S7A is not expected to present a significant risk to change in geomorphic character of the streams in the study area. Notwithstanding, Tahmoor Coal will continue to monitor stream condition via photographic survey.

## 6.5 Surface water

### 6.5.1 Introduction

A surface water impact assessment (SWIA) was prepared by ATC Williams Pty Ltd (ATCW) to support the Modification Report. The SWIA is provided as Appendix F with the key outcomes from the SWIA summarised in the sections below.

### 6.5.2 Existing environment

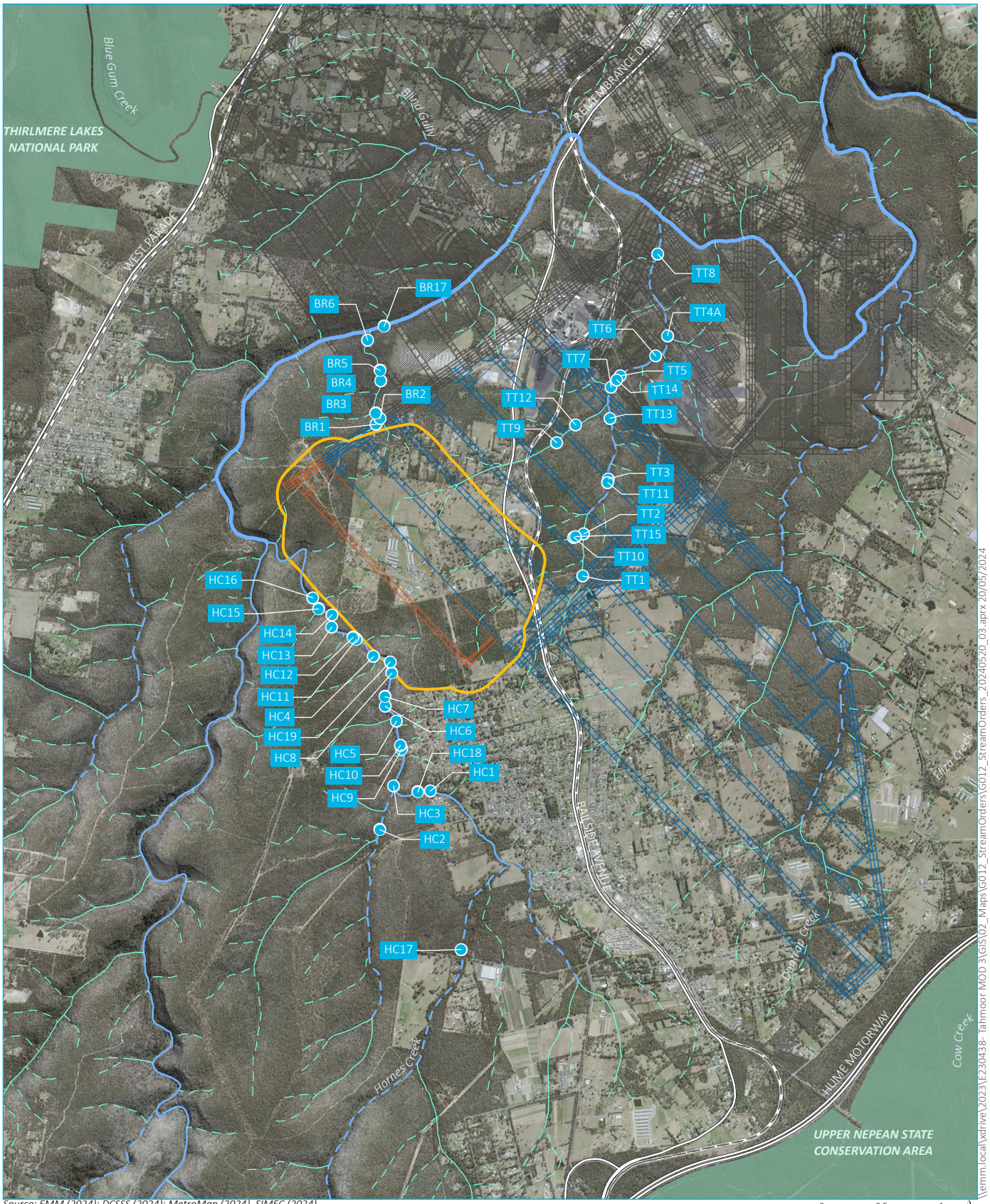
#### i Surface water catchments

The study area is located predominantly within the Teatree Hollow catchment which is a sub-catchment of the Bargo River. Small portions of the study area are also located within the Hornes Creek and Bargo River catchments.

The Dogtrap Creek catchment, which overlies the approved B series longwalls, is located to the east of the study area. Teatree Hollow, Dogtrap Creek and the Bargo River catchment have, to varying degrees, experienced subsidence-related effects due to historical mining operations at the Tahmoor Mine.

The confluence of the Bargo River and the Nepean River is approximately 9 km downstream of the Tahmoor Mine. The Nepean River flows into the Warragamba River near Wallacia at which point it is referred to as the Hawkesbury-Nepean River.

The stream order of Teatree Hollow, Teatree Hollow tributary, Hornes Creek, the Bargo River and the Bargo River tributary within and adjacent to the study area is shown in Figure 6.7. The locations of pools in Teatree Hollow, Teatree Hollow tributary, Hornes Creek and the Bargo River tributary within and adjacent to the study area are also shown in Figure 6.7.

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*Source: EMM (2024); DCSSS (2024); MetroMap (2024), SIMEC (2024)*

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## KEY

- Study area
- Existing underground working
- Tahmoor South approved mine working
- Proposed LWS7A
- Mapped pool

Strahler stream order

- 1st order
- 2nd order
- 3rd order
- 4th order
- 5th order

Existing environment

- Rail line
- Major road
- Minor road
- NPWS reserve

# Stream orders and mapped pools

Tahmoor South Project
SSD 8445 Modification 3
Figure 6.7

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### ii Water management system

The Tahmoor Mine water management system has been designed to:

- appropriately manage runoff from disturbed areas associated with the Tahmoor Mine
- increase to a practical maximum the capture and reuse of mine water and disturbed area runoff to meet operational demands
- increase to a practical maximum on-site water recycling and reuse
- reduce the capture and use of undisturbed area runoff
- reduce the use of make-up water from external sources
- manage risks to the receiving environment and downstream water users.

A schematic representation of the Tahmoor Mine water management system is shown in Figure 6.8.

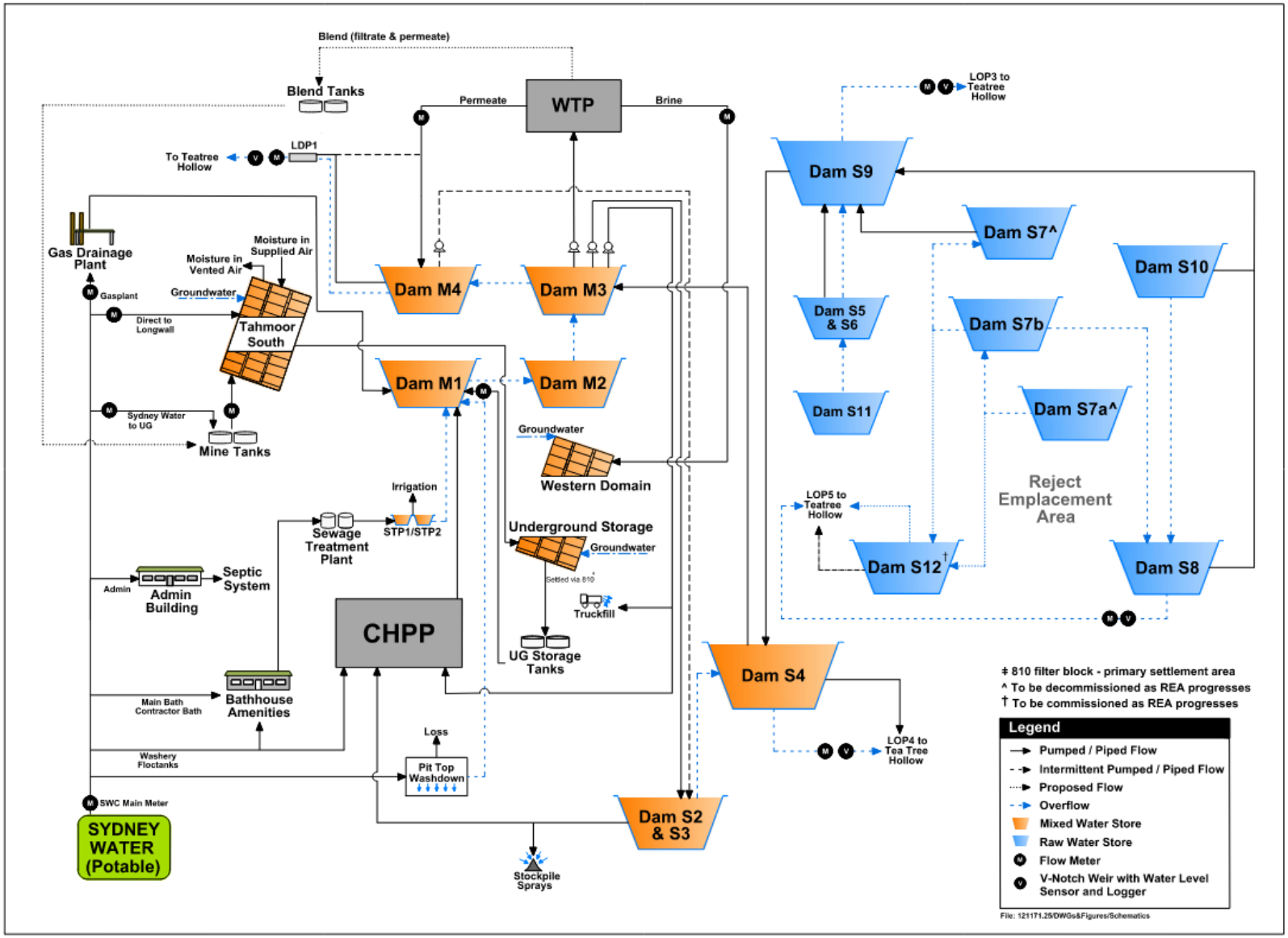



**Figure 6.8** **Tahmoor Mine water management system overview**

### a EPL 1389

In accordance with EPL 1389, Tahmoor Coal is licensed to discharge from one licensed discharge point (LDP1) and three licensed overflow points (LOPs) as summarised in Table 6.15.

**Table 6.15 Tahmoor Mine LDPs and LOPs**

| Discharge / Overflow point | Type of discharge point | Location description | Discharge limit |
|---|---|---|---|
| LDP1 | Discharge to waters<br>Discharge quality monitoring<br>Volume monitoring | Main water discharge - discharge drain located downstream of the final mine water treatment dam (dam M4) | 15,500 kilolitres per day during low rainfall conditions<br>Unlimited during wet weather conditions*† |
| LOP3 | Discharge to waters | Overflow from sediment dam S9 | Not specified |
| LOP4 | | Overflow from sediment dam S4 | |
| LOP5 | | Overflow from sediment dam S8 | |

* Defined as more than 10 mm rainfall within a 24-hour period.

† Provided that all practical measures are taken to reduce potential water quality impacts.

The current interim water quality limits for discharge to LDP1 are listed in Table 6.16. New limits for the constituents listed in Table 6.16 will be defined, in collaboration with the NSW EPA, once sufficient monitoring data is available from the recently commissioned Water Treatment Plant (WTP).

**Table 6.16 EPL 1389 licensed Discharge Point 1 water quality limits**

| Constituent | Discharge limit |
|---|---|
| Aluminium (µg/L) | 110 |
| Arsenic (µg/L) | 200 |
| Barium (µg/L) | 6,440 |
| Copper (µg/L) | 5 |
| Electrical Conductivity (µS/cm) | 2,600 |
| Enterococci (colony forming units per 100 mL) | 1,700 |
| Nickel (µg/L) | 200 |
| Total Nitrogen (mg/L) | 8 |
| pH | 6.5-9 |
| Total Suspended Solids (mg/L) | 30 |
| Turbidity (NTU) | 150 |
| Zinc (µg/L) | 300 |

### b Water treatment plant

In accordance with Condition B30 of SSD 8445, a WTP was commissioned in late 2023 at Tahmoor Mine. Under normal operations, the WTP treats up to 3 megalitres per day (ML/d) of water from dam M3. Dependent on the stored water volume of dam M3, the operating capacity of the WTP may be increased to 6 ML/d with a maximum of 7.2 ML/d able to be treated.

The WTP has been designed to operate with a recovery rate of up to 95% (i.e. 95% permeate, 5% brine). The contract water quality requirements of the WTP are listed in Table 6.17.

**Table 6.17 WTP permeate water quality contract requirements**

| Parameter | Units | Water quality requirements |
|---|---|---|
| pH | - | 6.5–8.0 |
| Oil and grease | mg/L | <5 |
| Electrical Conductivity | µS/cm | <300 |
| Bicarbonate Alkalinity as CaCO3 | mg/L | <150 |
| Dissolved Aluminium | mg/L | <0.03 |
| Dissolved Arsenic | mg/L | <0.024 |
| Dissolved Barium | mg/L | <0.2 |
| Dissolved Copper | mg/L | <0.0011 |
| Total Manganese | mg/L | <0.2 |
| Dissolved Nickel | mg/L | <0.011 |
| Dissolved Zinc | mg/L | <0.008 |
| Total Iron | mg/L | <0.2 |
| Total Nitrogen | mg/L | <0.25 |

In future, Tahmoor Coal intend to utilise WTP permeate supply in lieu of Sydney Water supply for underground mine purposes. At present, permeate from the WTP discharges to Teatree Hollow via LDP1. When the WTP is operating at full capacity, WTP permeate would be transferred either directly to LDP1 or to LDP1 via dam M4.

### c Brine Disposal

The WTP will produce a brine by-product. Modification 2 of SSD 8445 authorises the storage of the brine from the WTP in the historical workings of the Tahmoor Mine Western Domain. As a contingency for when brine is unable to be pumped underground for storage, for example during maintenance periods of pumping infrastructure, the WTP will have four brine storage tanks that can store up to 46 kilolitres (kL) of brine each, equating to a maximum storage capacity of 184 kL of brine at any given time. The proposed modification will extend the timeframe over which brine storage will be required to occur.

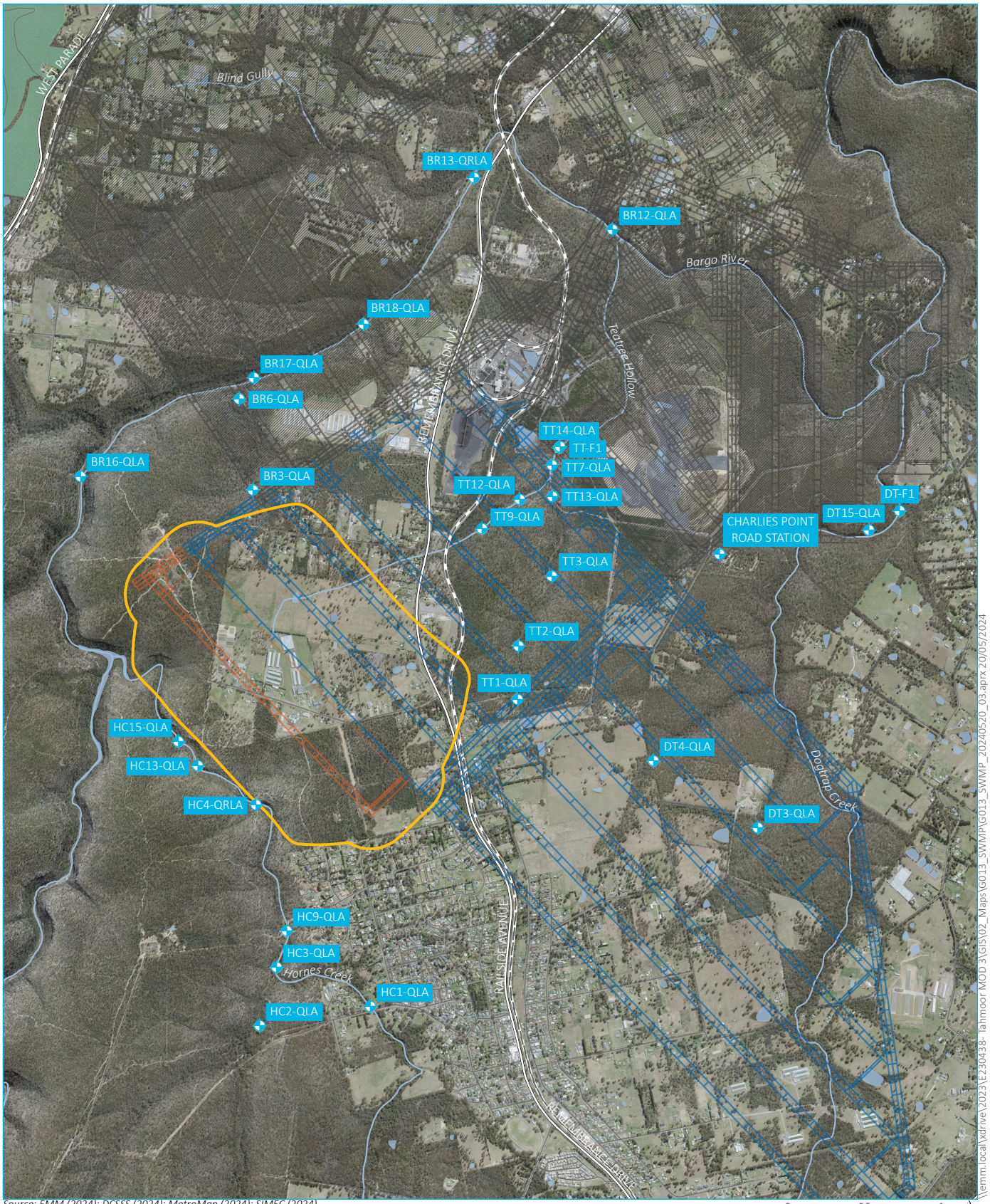
## iii Surface water monitoring program

A comprehensive surface water monitoring program has been implemented for Tahmoor South comprising:

- streamflow monitoring

- surface water quality monitoring
- pool water level monitoring
- monitoring of physical features and natural behaviour of pools and reaches
- morphology and channel stability monitoring.

The surface water monitoring program and channel morphology monitoring sites relevant to the study area are illustrated on Figure 6.9 and Figure 6.10 respectively.




Source: EMM (2024); DCSSS (2024); MetroMap (2024); SIMEC (2024)

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## KEY

- Study area
- Existing underground working
- Tahmoor South approved mine working
- Proposed LWS7A
- Surface water monitoring site

Existing environment

- Rail line
- Major road
- Minor road
- Named watercourse
- Waterbody
- NPWS reserve

# Tahmoor Mine surface water monitoring program

Tahmoor South Project
SSD 8445 Modification 3
Figure 6.9

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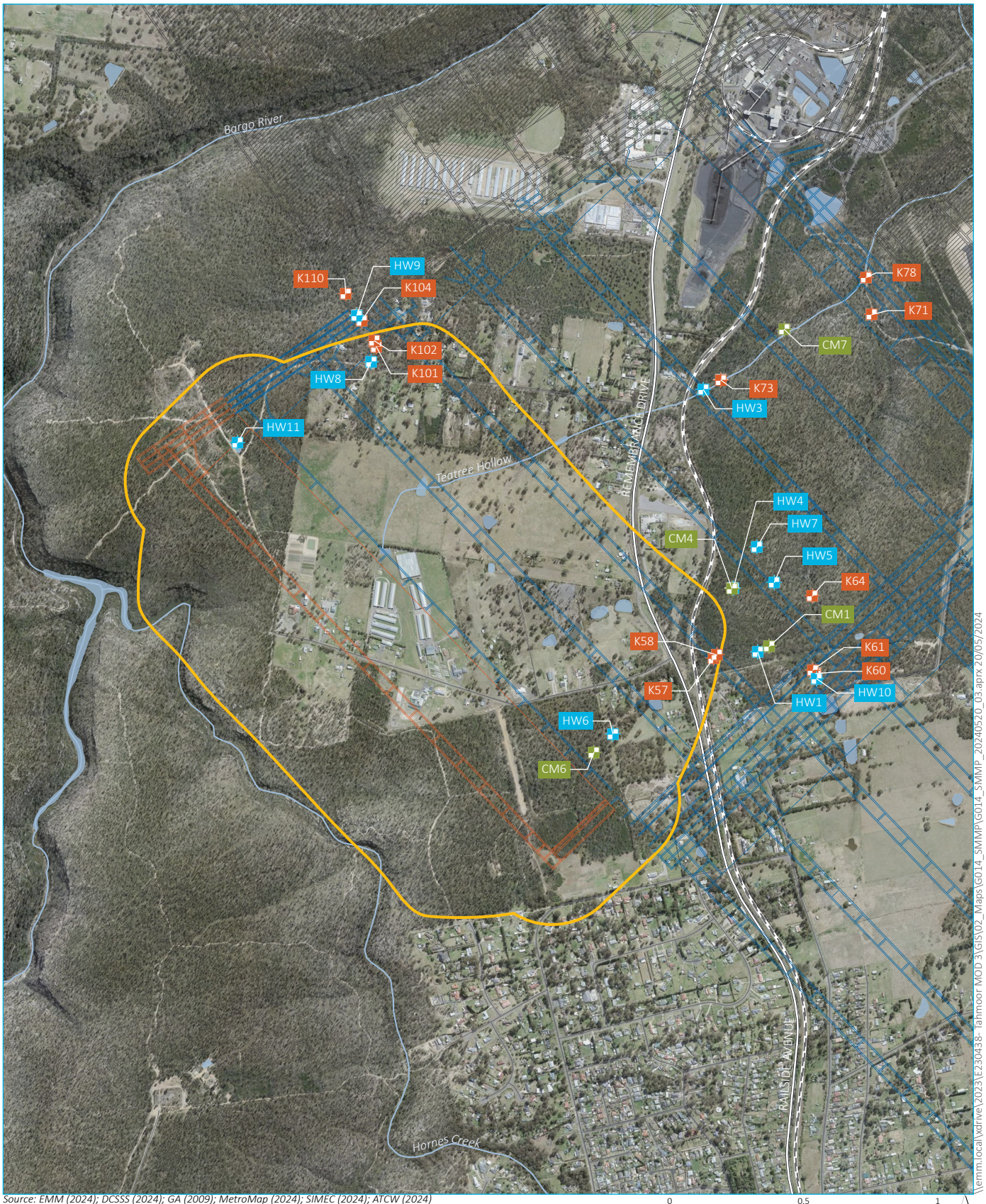


Source: EMM (2024); DCSSS (2024); GA (2009); MetroMap (2024); SIMEC (2024); ATCW (2024)

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KEY

- Study area
- Existing underground working
- Tahmoor South approved mine working
- Proposed LWS7A
- Channel morphology site
- Kickpoint site
- Headwater site

Existing environment

- Rail line
- Major road
- Minor road
- Named watercourse
- Waterbody

# Tahmoor Mine stream morphology monitoring program

Tahmoor South Project
SSD 8445 Modification 3
Figure 6.10

EMM
creating opportunities

### 6.5.3 Water and salt balance

Due to the proposed extension of timing for mining activities and to take into consideration mine water inflows into LW S7A and updated groundwater model inflow predictions, the water and salt balance model for Tahmoor Mine has been updated to assess the potential impacts on the capacity of the current water management system.

The water and salt balance model simulates all the inflows, outflows, transfers and changes in storage of water on-site at each model time step (i.e. 8-hourly basis).

The simulated average annual total system inflows and outflows over the proposed Project life (31 December 2033) are summarised in Table 6.18. The results presented in Table 6.18 indicate that Sydney Water supply is predicted to comprise the largest proportion of total site water inflows while discharge to LDP1 is predicted to comprise the largest proportion of total site water outflows.

It is noted that Tahmoor Coal intend to blend permeate with feed water for underground mine usage. This would reduce both the Sydney Water demand and the rate of permeate discharge to LDP1.

**Table 6.18 Simulated average annual water balance results**

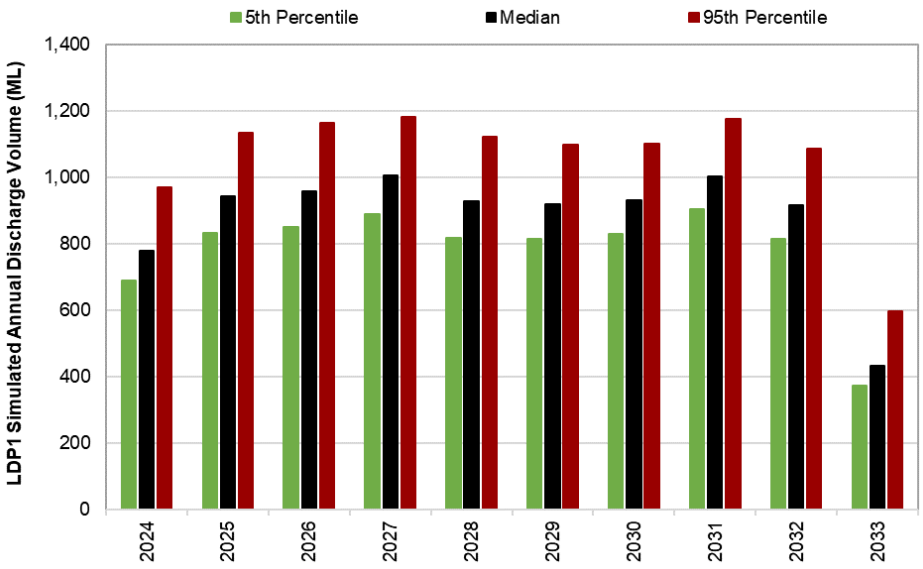
| Description | Volume (ML/annum) | Percentage of total inflows / outflows |
|---|---|---|
| **Inflows** | | |
| Rainfall runoff | 392 | 24% |
| Sydney water supply | 783 | 20% |
| Groundwater inflow to underground mine | 323 | 48% |
| Ventilation moisture (In) | 131 | 8% |
| **Total inflows** | **1,629** | |
| **Outflows** | | |
| Evaporation | 39 | 2% |
| Discharge via LDP1 | 953 | 59% |
| Release via LOPs | 188 | 12% |
| CHPP make-up water supply | 32 | 2% |
| Haul Road dust suppression | 10 | 1% |
| Stockpile sprays (dust suppression) | 73 | 4% |
| Pit top washdown water, sealing washdown, office supply | 39 | 2% |
| Ventilation moisture (Out) | 245 | 15% |
| Brine | 48 | 3% |
| **Total outflows** | **1,627** | |

#### i LDP discharges

Simulated annual volumes of water discharged via LDP1 over the proposed Project life (31 December 2023), comprising overflow from dam M4, controlled release from dam M4 and permeate release direct from the WTP, are shown in Figure 6.11.

The results presented in Figure 6.11 illustrate that discharge via LDP1 to Teatree Hollow is predicted to peak in 2031 at 1,175 ML based on the 95th percentile results and 1,003 ML based on the median results. The 95th percentile predicted peak annual discharge volume equates to an average of 3.2 ML/d discharged via LDP1 in that year. On average, discharge to LDP1 is predicted at 953 ML/annum or 2.6 ML/d.

For the majority of time, the EC of discharge to LDP1 is predicted at less than 350 µS/cm based on the model realizations equating to the median and 95th percentile total rainfall. Few exceedances of 350 µS/cm were predicted to occur during simulated periods of overflow from dam M4.

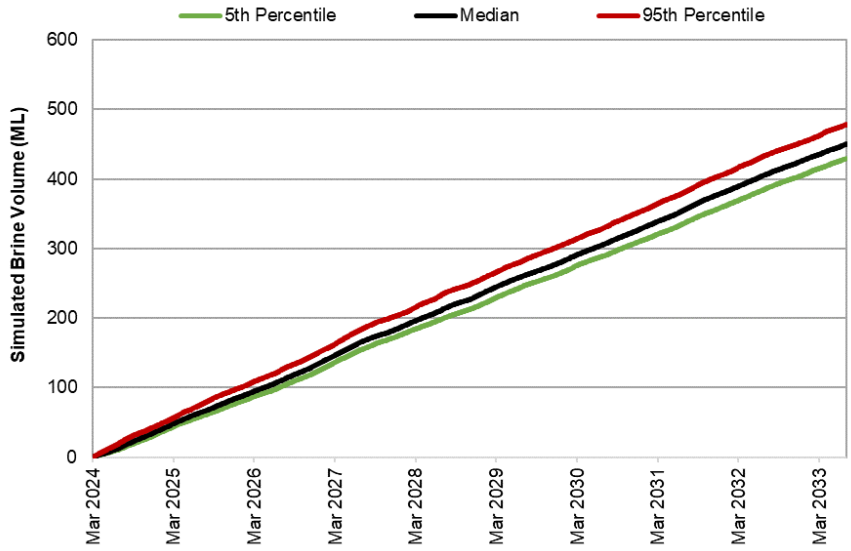



Source – ATCW 2024

**Figure 6.11 Simulated annual release and overflow via LDP1**

### ii Brine production

Figure 6.12 presents the predicted cumulative volume of brine produced from the WTP over the proposed Project life (31 December 2033) based on the 5th percentile, median and 95th percentile model results.




Source – ATCW 2024

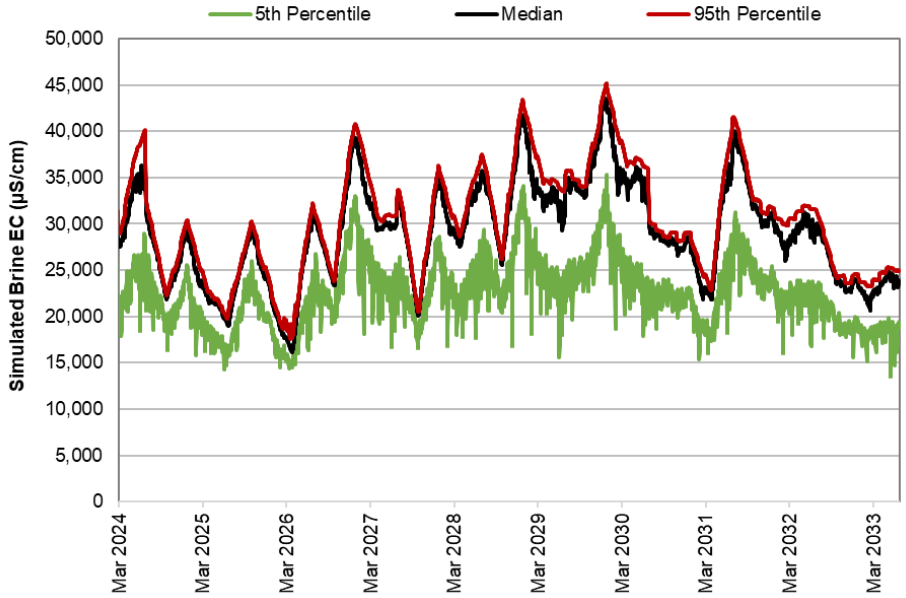
**Figure 6.12 Simulated produced brine volume**

The results presented in Figure 6.12 indicate that approximately 478 ML of brine is predicted to be produced over the Project life (up to 31 December 2033) based on the 95th percentile model results.

This is less than the corresponding Modification 2 predicted stored brine volume of 690 ML (ATCW 2022). The difference in predicted brine volume is related to lower groundwater inflow rates predicted based on the revised numerical groundwater model as compared to that predicted for Modification 2.

#### iii Predicted Stored Salt Mass and Salinity Concentration

Figure 6.13 presents the predicted brine EC based on the 5th percentile, median and 95th percentile model results. The predicted brine EC is dependent on the predicted feed water EC.




Source – ATCW 2024

**Figure 6.13 Simulated brine salinity**

The results presented in Figure 6.13 indicate that the brine EC is predicted to range between 17,000 microsiemens per centimetre (µS/cm) and 45,000 µS/cm based on the median and 95th percentile model results.

### 6.5.4 Impact assessment

#### i Subsidence effects

The maximum predicted values of total vertical subsidence, upsidence and closure for the Bargo River, Hornes Creek, Teatree Hollow and Teatree Hollow tributary are presented Table 6.19. The predictions after LW S6A are based on the approved Project while the predictions after LW S7A reflect the proposed modification.

### Table 6.19 Maximum predicted total vertical subsidence, upsidence and closure

| Watercourse | Longwall | Maximum predicted total vertical subsidence (mm) | Maximum predicted total upsidence (mm) | Maximum predicted total closure (mm) |
|---|---|---|---|---|
| Bargo River | After LW S6A | <20 | <20 | <20 |
| | After LW S7A | <20 | 30 | 20 |
| Hornes Creek | After LW S6A | <20 | <20 | <20 |
| | After LW S7A (downstream of pool HC16) | 40 | 80 | 150 |
| | After LW S7A (upstream of pool HC16) | 25 | 45 | 70 |
| Teatree Hollow | After LW S6A | 1,400* | 400* | 275* |
| | After LW S7A | 1,400* | 400* | 275* |
| Teatree Hollow Tributary | After LW S6A | 1,350 | 450 | 375 |
| | After LW S7A | 1,350 | 450 | 375 |

*Note: downstream sections of Teatree Hollow have been previously mined beneath by LW1 and LW2 at the Tahmoor Mine. The maximum predicted parameters provided in the above table include those resulting from the extraction of these earlier longwalls.

As shown in Table 6.19, the maximum total vertical subsidence, upsidence and closure at Teatree Hollow and Teatree Hollow tributary is not predicted to increase as a result of mining of LW S7A.

A slight increase in the Bargo River maximum total upsidence and closure is predicted after LW S7A in comparison to that predicted after LW S6A. A maximum total closure of 150 mm is predicted at Hornes Creek downstream of pool HC16 after mining of LW S7A. Upstream of pool HC16, a maximum total closure of 70 mm is predicted after mining of LW S7A.

#### ii Potential impacts to water quantity

Potential impacts to water quantity associated with the modification, include:

- changes in pool water level and streamflow characteristics due to subsidence induced fracturing and tilt
- reduction in baseflow rates and change in low flow regime
- change in flood regime of watercourses and local tributary gullies
- change in overland flow behaviour
- increased flows due to controlled release and storage overflow.

#### a Potential impact to pool water level and streamflow due to subsidence induced fracturing

**Bargo River**

The minimum distance from the centreline of the Bargo River to LW S7A is 520 m. The maximum total upsidence and closure associated with mining of LW S7A are predicted to be low, 30 mm and 20 mm respectively. Given the distance of the Bargo River from LW S7A and the low predictions of total upsidence and closure, it is considered very unlikely that surface fractures would develop in the Bargo River (MSEC 2024).

In the unlikely event that subsidence movements result in opening of existing fractures in the Bargo River downstream of Picton Weir, the high sediment load discharged at times from the Picton Weir may be sufficient to fill widened fractures in the base of the Bargo River (MSEC 2024).

Given the resilient and resistant stream type found in the Study Area, and the distance of the streams from significant mine subsidence related processes, subsidence was considered to pose a negligible risk to stream geomorphology. Any changes that do occur would be expected to recover quickly because the streams are resilient and in generally good geomorphic condition (i.e. essentially natural with intact form and process) (Gippel 2024).

**Hornes Creek**

The minimum distance from the centreline of Hornes Creek to LW S7A, downstream of pool HC16, is 330 m. It is noted that this section of Hornes Creek is influenced by backwater effects from Picton Weir. The minimum distance from the centreline of Hornes Creek to LW S7A, upstream of pool HC16, is 360 m.

As Hornes Creek is not proposed to be directly mined beneath, the risk of surface fracturing is considered to be low. In the unlikely event that fracturing occurs, the fractures are expected to be minor and isolated (MSEC 2024). Any changes that do occur would be expected to recover quickly because the streams are resilient and in generally good geomorphic condition (i.e. essentially natural with intact form and process) (Gippel 2024).

Transport of sediment from upstream Hornes Creek may be sufficient to fill the isolated fractures, thereby reducing the volume of diverted surface flow. Additionally, backwater effects from Picton Weir may be sufficient to maintain water levels in the vicinity of pool HC16.

**Teatree Hollow and Teatree Hollow Tributary**

The upper reaches of Teatree Hollow tributary overlie LW S7A. Consistent with information presented in the Tahmoor South Project EIS, where Teatree Hollow and Teatree Hollow tributary are directly undermined, fracturing of sandstone bedrock and subsequent diversion of surface flow may occur.

However, it is noted that the channel of Teatree Hollow tributary is ill-defined in the upper reaches; characterised by a low relief landscape, with a dominant bed material of mud (cohesive clay/silt/sand) and notable grass coverage (Gippel 2013). Accordingly, while surface fracturing may occur above LW S7A, there is potential for the transported cohesive clay/silt/sand to infill surface fractures and reduce the potential for surface flow diversion.

Should diversion of surface flow occur in the upper reaches of Teatree Hollow tributary, it is expected that the volume of diverted surface flow would be low given the limited catchment area of Teatree Hollow tributary overlying LW S7A. Additionally, as per observations to date following mining of LW S1A to S2A, it is expected that diverted surface flow would re-emerge further downstream in Teatree Hollow tributary or Teatree Hollow.

As the maximum total subsidence, upsidence and closure at Teatree Hollow and Teatree Hollow tributary are not expected to increase following mining of LW S7A in comparison to mining of LW S1A to LW S6A, it is envisaged that impacts to pool water level and streamflow would be consistent with that detailed in the Project EIS, Amendment Report and Second Amendment Report.

### b Potential impact to baseflow and low flow regime

Baseflow reduction predictions have been provided for the following:

- Incremental effects – incremental increase in baseflow reduction associated with mining of LW S7A as compared to the approved Tahmoor South operations.
- Cumulative mining effects – cumulative baseflow reduction associated with the approved Project, the proposed modification and regional mining activities as compared to the ‘no mining’ scenario.

The maximum incremental and cumulative baseflow reduction predictions during the Project life are presented in Table 6.20 for relevant watercourses in comparison to the baseflow reduction predictions presented in the Tahmoor South Project Amendment Report.

**Table 6.20 Baseflow reduction predictions**

| Watercourse | Monitoring site | Baseflow reduction predictions (ML/d) | | |
|---|---|---|---|---|
| | | Incremental maximum (LW S7A) - modification | Cumulative maximum – Modification[1] | Cumulative maximum – EIS[2] |
| Teatree Hollow | TT8-QLa | 0.0019 | 0.0167 | 0.088 |
| Bargo River | BR13-QRLa | 0.0017 | 0.033 | 0.175 |
| Hornes Creek | HC9-QLa | 0 | 0.0018 | 0.001 |
| Dogtrap Creek | DT-F1 | 0.003 | 0.018 | 0.133 |

Notes:

1. Source: SLR (2024).
2. Source: Hydrosimulations (2020).

The data presented in Table 6.20 show that, with the exception of Hornes Creek, the predicted baseflow reduction associated with cumulative mining effects is not expected to be greater than that presented in Hydrosimulations (2020). A slight increase in baseflow reduction associated with cumulative mining effects is predicted for Hornes Creek based on the revised numerical groundwater modelling conducted for the modification.

The predicted reduction in baseflow contribution to Hornes Creek and the Bargo River is considered negligible and would likely be indiscernible from natural fluctuations in streamflow at these locations. Compliance with the performance criteria for Hornes Creek and Bargo River, as outlined in the Tahmoor South Project conditions of consent, is expected to be maintained as a result of the modification.

### c Predicted impact to flood regime – Teatree Hollow

Vertical subsidence and tilt associated with mining of LW S7A is predicted to affect a small portion only of the catchment of the Bargo River and Hornes Creek, with subsidence effects predicted to be low. As such, increases in the flood extent of the Bargo River and Hornes Creek are not expected to occur as a result of mining of LW S7A.

As subsidence effects are predicted to be more extensive in the Teatree Hollow catchment, a flood study has been conducted to assess the cumulative influence of mining-induced subsidence associated with LW S1A-S7A on the flood extent of Teatree Hollow and Teatree Hollow tributary. The full Flood study is provided as Appendix C to the SWIA provided as Appendix F.

The flood study was conducted to assess the potential cumulative impacts of the longwall layout and associated subsidence predictions on flooding of land within and adjacent to LW S1A-S7A.

The hydraulic model results for the 1% AEP flood event indicate that overbank flooding is predicted to occur under existing conditions at:

- areas upstream of the culverts beneath Remembrance Drive and Caloola Road
- the corridor between Remembrance Driveway and the railway embankment to the east of Caloola Road
- a portion of the Main South Railway Line adjacent to Teatree Hollow

- to the west of Remembrance Driveway overlying LW S5A.

Further downstream, inundation is limited to the main channel areas.

The findings of the flood study for are generally consistent with those presented in the Tahmoor South Amendment Report and there is negligible change as a result of the extraction of LW S7A.

#### d Potential impact to overland flow

Negligible change in gradient is predicted to occur to the Bargo River tributary or in the catchment of Hornes Creek.

The maximum predicted incremental tilt associated with mining of LW S7A is 8.9 mm/m and the maximum predicted total tilt after mining of LW S1A-S7A is 10 mm/m (MSEC 2024). Based on the natural gradient of the surface overlying LW S7A and the predicted post-subsidence topography associated with mining of LW S1A-S7A, subsidence effects are estimated to result in a 0.3% increase in surface gradient overlying LW S7A. While minor changes to the natural drainage behaviour may occur in some locations, the predicted increase in gradient is considered negligible and unlikely to result in significant impacts to overland flow or channel morphology.

#### e Potential impact to Teatree Hollow – Discharge to LDP1

As stated in Section 6.5.3, discharge to LDP1 is predicted at 953 ML/annum or 2.6 ML/d on average. The predicted average daily discharge rate of 2.6 ML/d is only slightly greater than the average daily discharge recorded in 2023 (2.4 ML/d). As such, impacts to streamflow in Teatree Hollow downstream of LDP1 are not predicted to occur as a result of the proposed modification.

#### f Potential impacts to water supply

A total reduction in Teatree Hollow streamflow of 19.2 ML was estimated for the period of January to December 2023 due to effects associated with mining of LW S1A-S2A. It is considered that the estimated streamflow reduction is largely reflective of effects associated with upstream fracturing; however, may also comprise baseflow reduction. While streamflow reduction may increase as mining of Tahmoor South progresses, it is expected that majority of the streamflow diverted via the subsurface fracture network would re-emerge downstream. It is also considered that mining of LW S7A is unlikely to result in impacts to Teatree Hollow streamflow downstream of pool TT7 in excess of that expected to occur as a result of mining of LW S1A-S6A.

### iii Potential impacts to water quality

#### a Subsidence induced fracturing and flow diversion

Flushing of freshly exposed fractures in sandstone bedrock has the potential to liberate contaminants resulting in localised and transient increases in water quality constituents. Additionally, significant reductions in pool water level and associated transformation processes occurring in stored sediments has the potential to result in intermittent changes in pool water quality characteristics. Subsidence induced fracturing may also increase the extent and prevalence of ferruginous deposition (iron staining).

While it is anticipated that intermittent, episodic increases in specific constituents will continue to occur in Teatree Hollow and Teatree Hollow tributary during mining of LW S1A-S7A, it is not expected that mining of LW S7A would substantially increase this effect. It is considered that the potential for flushing of freshly exposed sandstone bedrock fractures and associated liberation of contaminants or increased iron staining is low in the upper reaches of the Teatree Hollow tributary overlying LW S7A.

#### b Contamination of surface waters associated with gas emissions

When sediments are disturbed by mining related subsidence effects, methane derived naturally may be released more rapidly in surface water systems (NSW Department of Planning 2008). Should mining of LW S7A result in gas emissions occurring in local watercourses, it is considered unlikely that impacts to vegetation would occur.

#### c Water quality effects associated with discharge to LDP1

As stated in Section 6.5.3, for the majority of time, the EC of discharges to LDP1 is predicted to be less than 350 µS/cm. Few exceedances of 350 µS/cm were predicted to occur during simulated periods of overflow from dam M4.

The predicted EC of discharge to LDP1 is generally within the range of EC values recorded at upstream monitoring sites in Teatree Hollow and, for the majority of time, expected to be less than the ANZECC & ARMCANZ (2000) default guideline value for the protection of slightly disturbed aquatic ecosystems in upland rivers in NSW. As such, it is considered that the modification would result in a negligible impact to the water quality of Teatree Hollow downstream of Teatree Hollow.

#### d Water quality effects associated with underground brine storage

The storage of brine in existing underground workings at Tahmoor Mine, as approved by Mod 2, will continue for the additional mine life proposed by Mod 3. Consistent with the findings of the surface and groundwater assessments for Mod 2, the storage of brine in underground historical workings is not predicted to result in an impact to environmental receptors. The contaminant transport model predictions presented in SLR (2024) indicate that solutes associated with the stored brine may migrate upwards following recovery of groundwater levels in the vicinity of the historical Tahmoor Western Domain. However, the predicted concentrations of constituents migrating to the middle and upper Hawkesbury Sandstone are considered unlikely to represent a risk to environmental receptors including overlying surface water systems (SLR 2024).

#### iv Potential impacts to water management

The outcomes of the water and salt balance modelling, discussed in Section 6.5.3, demonstrates that the existing water management system is adequate to continue to manage the Project's water management requirements and no changes are required to accommodate the extraction of LW S7A.

### 6.5.5 Management and mitigation

Water management at the Tahmoor Mine is undertaken in accordance with SSD 8445 and EPL 1389. Tahmoor Coal operates in accordance with an approved LW S1A-S6A Extraction Plan Water Management Plan (EP WMP, Tahmoor Coal 2023) and the Tahmoor South Water Management Plan (Tahmoor Coal 2022).

The LW S1A-S6A Extraction Plan Water Management details the surface water monitoring program, impact assessment criteria and TARPs pertaining to Teatree Hollow, Teatree Hollow tributary, Hornes Creek, the Bargo River and the Bargo River tributary.

The current surface water monitoring program for the Project is considered comprehensive and sufficient to enable potential surface water impacts associated with the proposed modification to be appropriately identified. In addition, the TARPs detailed in the EP WMP define appropriate actions and responses necessary to be implemented in the event of a potential impact to surface water systems relevant to the modification.

In accordance with the Tahmoor South WMP, the site water balance model will continue to be updated and verified on a regular basis to maintain the model as a reliable tool for assessing the effectiveness of the site water management system.

Both the LW S1A-S6A EP WMP and Tahmoor South WMP will be reviewed and updated where necessary should the modification be approved, and prior to the commencement of extraction of LW S7A.

### 6.5.6 Conclusion

The impacts relating water quality, quantity and flooding as a result of the modification will remain substantially the same to those already approved for Tahmoor South. The updated site water balance demonstrates that the addition of LW S7A will not require any additional surface water management measures, and that the existing water management system will remain appropriate for the site.

## 6.6 Groundwater

### 6.6.1 Introduction

To facilitate the assessment of potential impacts from the proposed modification to groundwater resources, a groundwater impact assessment has been prepared by SLR Consulting Australia (SLR). The groundwater impact assessment was supported by an update to the Tahmoor Mine numerical groundwater model. The groundwater impact assessment and model update report is presented in Appendix G with key outcomes summarised in the sections below.

### 6.6.2 Geological and hydrogeological setting

Tahmoor Mine is situated within the Southern Coalfield in the sedimentary Sydney Basin (UOW 2012). Table 6.21 describes the regional stratigraphic sequence, with the hydrogeological characteristics of these units both regionally, and as they pertain to the study area, summarised below. A hydrogeological conceptualisation cross-section is provided as Figure 6.14.

**Table 6.21 Regional stratigraphic profile**

| Period | Stratigraphic unit | | Description |
|---|---|---|---|
| Quaternary | Alluvium and colluvium and other sediments in floodplains, alluvial fans, and high terraces (Qal, Tal, Qs) | | Alluvial and residual deposits comprising quartz and lithic fluvial sand, silt and clay. |
| Triassic | Wianamatta Group | Camden Sub-group | Dark green and black shales with thin graywacke-type sandstone lenses. Calcareous graywacke-type sandstone and black mudstones and silty shales with sideritic mudstone bands. |
| | | Liverpool Sub-group: Bringelly Shale (Rwb), Minchinbury Sandstone and Ashfield Shale (Rwa) | |
| | Hawkesbury Sandstone (Rh) | | Consists of thickly bedded or massive quartzose sandstone (with grey shale lenses up to several metres thick). |
| | Narrabeen Group | Newport Formation | Interbedded grey shales and sandstones. |
| | | Garie Formation | Cream to brown, massive, characteristically oolitic claystone. |
| | | Bald Hill Claystone | Brownish-red coloured “chocolate shale”, a lithologically stable unit. |
| | | Bulgo Sandstone | Strong, thickly bedded, medium to coarse grained lithic sandstone with occasional beds of conglomerate or shale. |
| | | Stanwell Park Claystone | Greenish-grey mudstones and sandstones. |
| | | Scarborough Sandstone | Mainly of thickly bedded sandstone with shale and sandy shale lenses up to several metres thick. |
| | | Wombarra Claystone | Similar properties to the Stanwell Park Claystone. |
| | | Coal Cliff Sandstone | Basal shales and mudstones that are contiguous with the underlying Bulli Coal seam. Absent in much of the Tahmoor area. |

**Table 6.21 Regional stratigraphic profile**

| Period | Stratigraphic unit | Description |
|---|---|---|
| Permian | Illawarra Coal Measures | Interbedded shales, mudstones, lithic sandstones and coals, including the:<br>• Bulli coal seam (2–4 m thick)<br>• Eckersley Formation, including the Balgownie Seam (5–10 m below Bulli Coal seam), Loddon Sandstone and Lawrence Sandstone<br>• Wongawilli Coal seam (8–10 m thick)<br>• Kembla Sandstone. |
| | Shoalhaven Group | |

### i Alluvium

Generally, there is limited extent of surficial alluvium in this region, with no occurrences in the vicinity of the Study Area. However, regionally, small areas of alluvium exist along Stonequarry Creek (located north of mining operations) and near Blue Gum Creek and Thirlmere Lakes alluvium at Thirlmere Lakes (located beyond the Study Area). The limited extent of the alluvium does not constitute it as a significant regional groundwater resource. It has isolated and localised flow regimes.

The primary mechanism for recharge to the alluvium is via direct rainfall infiltration. Discharge occurs via loss through evapotranspiration. Interaction with surface water features allows both recharge and discharge dependent on the hydraulic profile between the surface water and groundwater features, which is variable across the alluvium.

### ii Wianamatta group

The Wianamatta Group, composed of carbonaceous shales, overlies the Hawkesbury Sandstone and outcrops to the north of Tahmoor Mine. The Wianamatta Group formation predominantly has poor permeability and water quality, and therefore is not considered a major groundwater resource in the area and does not occur above or near the study area. The shales can lead to the development of springs in areas near the contact with the Hawkesbury Sandstone; however, no significant springs have been mapped or located in the vicinity of the Tahmoor Mine.

### iii Hawkesbury sandstone

The Hawkesbury Sandstone is present beneath the Wianamatta Group and alluvium, except for where it may have been eroded away along valleys to expose the underlying Narrabeen Group (HydroSimulations 2018). In the study area, Triassic Hawkesbury Sandstone dominates the outcrop area and it is also the dominant outcropping stratigraphic unit more regionally. The Hawkesbury Sandstone is the primary aquifer around Tahmoor Mine and the study area, and falls within the Sydney Basin Nepean Sandstone Groundwater Source classified as being ‘Highly Productive’ by the NSW Government based on considerations of bore yield and groundwater quality.

This unit forms a porous rock aquifer of moderate resource potential, tending to higher resource potential in areas where secondary porosity (jointing and fracturing) is more developed. Shallow groundwater levels in the Hawkesbury Sandstone constitute the water table aquifer. Typical depth to groundwater in the study area is approximately 40 to 50 metres below ground level (mbgl). Waterways in the region are typically incised into the Hawkesbury Sandstone, with the Bargo River being the most significant in the region. Groundwater flow is typically commensurate with topography and surface drainage, flowing from south-west to north-east.

### iv Narrabeen group

The Narrabeen Group is present across the Tahmoor Mine site beneath the Hawkesbury Sandstone. The unit consists of a sequence of interbedded sandstone, claystone, and siltstone. Locally, the main units are the Bald Hill Claystone, which is approximately 10 m thick (varying from approximately 2–30 m across the Tahmoor mining lease), and the Bulgo Sandstone which is a thick (140–220 m) sandstone/siltstone sequence. The Bulgo Sandstone, Stanwell Park Claystone and Wombarra Claystone are considered aquitards.

### v Illawarra coal measures

The Illawarra Coal Measures are present across the Tahmoor Mine site beneath the Narrabeen Group. The formation contains the units of primary economic interest in the Sydney Basin, and consist of interbedded sandstones, shale and coal seams with a total thickness of approximately 200–300 m.

The Bulli and Wongawilli coal seams are the main deposits of economic significance in this region. The Bulli coal seam is targeted by Tahmoor Coal. The Illawarra Coal Measures are not targeted for groundwater use due to depth to the hydrostratigraphic unit and the poor quality.

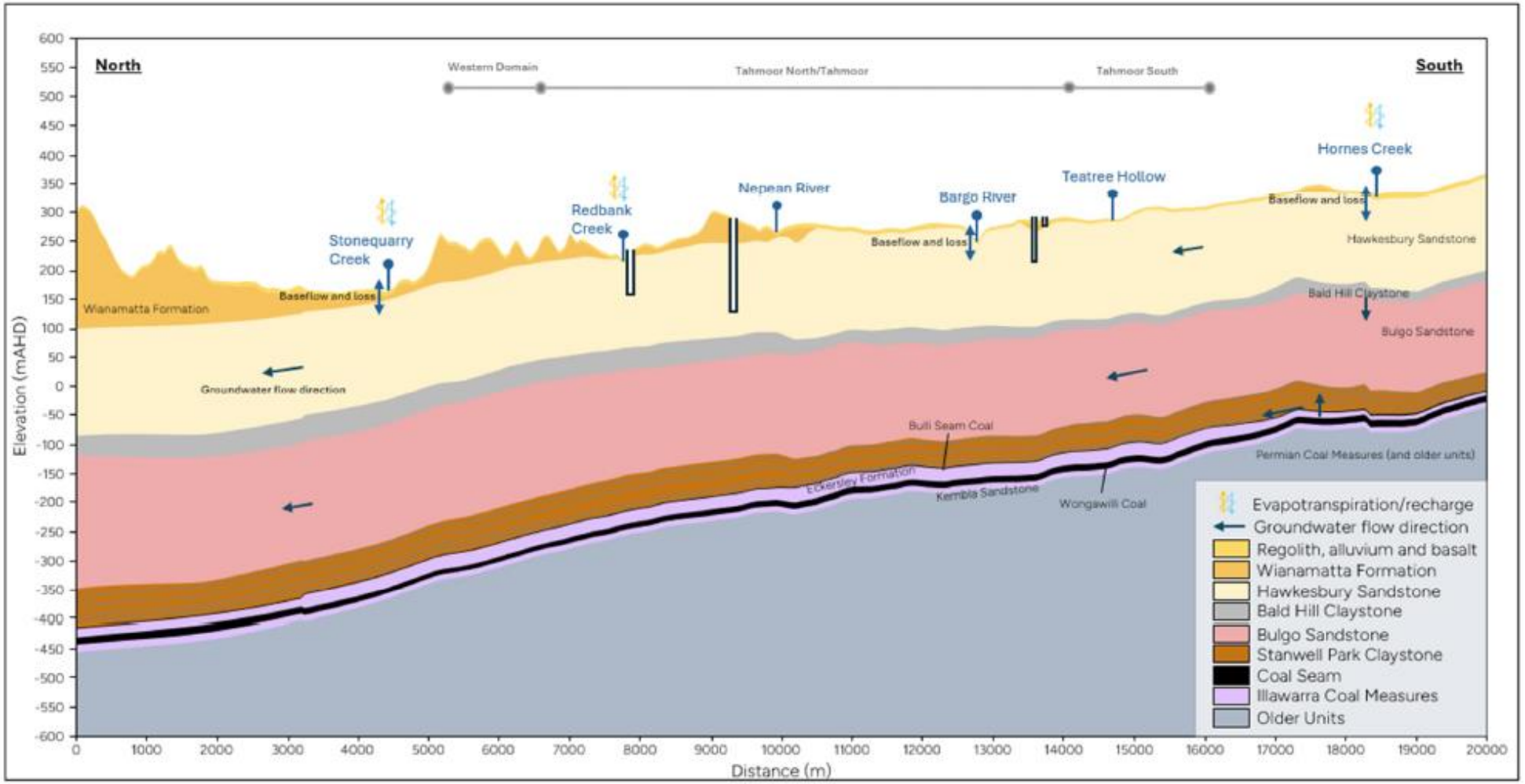



**Figure 6.14 Hydrogeological conceptualisation cross-section**

### 6.6.3 Groundwater receptors

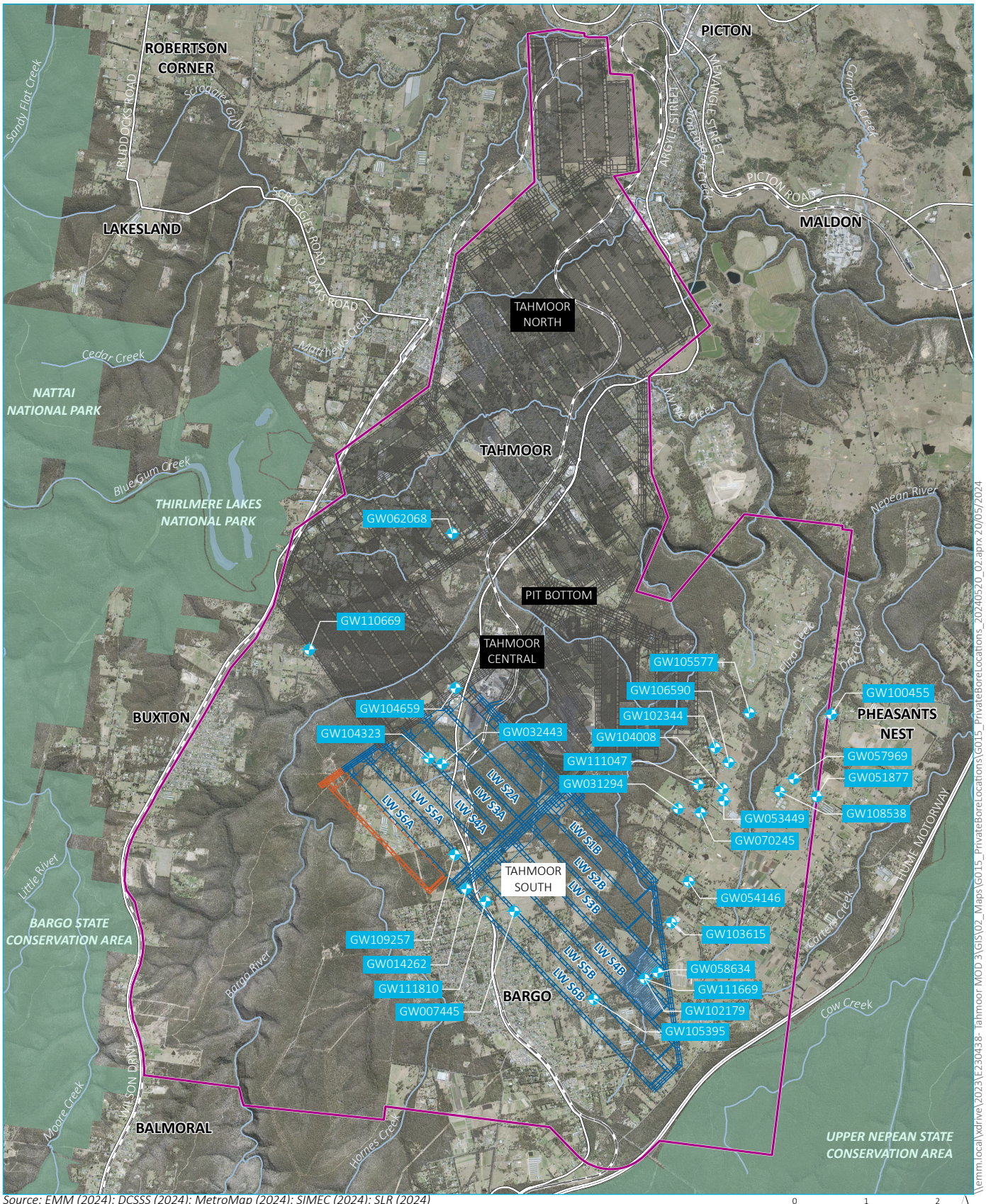
#### i Groundwater Dependent Ecosystems

The Thirlmere Lakes are the closest 'High Priority' Groundwater Dependent Ecosystem (GDE) to Tahmoor Mine, located 3.5 km from the study area. The Thirlmere Lakes is a group of five waterways in the Greater Blue Mountains World Heritage Area:

- Lake Gandangarra
- Lake Werri Berri
- Lake Couridjah
- Lake Baraba
- Lake Nerrigorang.

#### ii Groundwater Users

The Hawkesbury Sandstone is a productive aquifer utilised by landholders for subsidiary water supply. A review of the NSW government's online database to identify registered groundwater bores locally to the study area identified approximately 50 bores. The location of these bores is presented in Figure 6.15.




Source: EMM (2024); DCSSS (2024); MetroMap (2024); SIMEC (2024); SLR (2024)

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0 1 2 km
GDA 1994 MGA Zone 56

N

KEY

- Tahmoor South project area (SSD 8445)
- Extraction subject to secondary approval
- Existing underground working
- Tahmoor South approved mine working
- Proposed LWS7A
- Private bore location

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody
- NPWS reserve

Private bore locations

Tahmoor South Project
SSD 8445 Modification 3
Figure 6.15

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### 6.6.4 Groundwater modelling

#### i Numerical groundwater model

SLR were commissioned by Tahmoor Coal in 2021 to undertake a groundwater model rebuild for the Tahmoor Mine, as required by the Project's conditions of consent (SSD 8445). To facilitate the assessment of potential impacts from the proposed modification, Tahmoor Coal engaged SLR to update the numerical groundwater model and run predictive scenarios. A model update was required to simulate the additional mining of LW S7A. The model was also updated to reflect the latest conceptual model updates.

An independent third-party review of the model design was completed by Brian Barnett. Comments were addressed, and the model design accepted by the independent reviewer.

Transient predictive models were developed for three model scenarios:

- Null mining – No mining simulated at Tahmoor or surrounding mines.
- Approved – All currently approved mining at Tahmoor and all approved and foreseeable mining at surrounding mines.
- Modification 3 (MOD3) – All approved and foreseeable mining including the proposed LW S7A.

#### ii Contaminant transport model

The addition of LW S7A to the Tahmoor South mine plan will add an additional approximate 9 months to the mine life and will therefore extend the time in which brine is transferred to underground workings for storage (as approved by MOD2). To assess the impact of ongoing brine storage and disposal in the underground workings of the Western Domain, a contaminant transport simulation was preformed using the transport functionality in MODLOW USG - Transport.

Two scenarios were simulated for this assessment:

- Approved conditions: Based on the approved mining flow model, which includes approved injection rates for brine. Approved total dissolved solid (TDS) concentration at injections point were added for the transport simulation.
- MOD3: Based on the MOD3 mining flow model, which includes the additional mining of LW S7A and modified injection rate for brine. Estimated TDS concentration at injections points were added for the transport simulation.

It is noted that the estimated TDS is greater for the MOD3 scenario based on updated site monitoring data, but the total volume deposited is predicted to be less. The difference in predicted brine volume is related to lower groundwater inflow rates predicted based on the revised numerical groundwater model as compared to that predicted for Modification 2. The total mass of salt deposited is thus slightly less for the MOD3 scenario when compared with the approved scenario (Table 6.22).

**Table 6.22 Brine disposal details**

| Model | Brine storage period start | Brine storage period end | Daily average brine disposal rate (ML/d) | Total brine disposal (ML) | Brine TDS (mg/L) | Total brine disposal mass (t) |
|---|---|---|---|---|---|---|
| Approved | Jan 2024 | Sep 2032 | 0.21 | 690 | 16,770 | 11,200 |
| MOD3 | Jan 2024 | Jul 2033 | 0.14 | 474 | 21,985 | 10,420 |

### 6.6.5 Impact assessment

#### i Predicted maximum incremental drawdowns

The process of mining reduces groundwater levels and pressures in surrounding geological units. The extent of the zone affected is dependent on the properties of the aquifers/aquitards and is referred to as the zone of depressurisation in a confined aquifer and zone of drawdown within unconfined aquifers, including the water table.

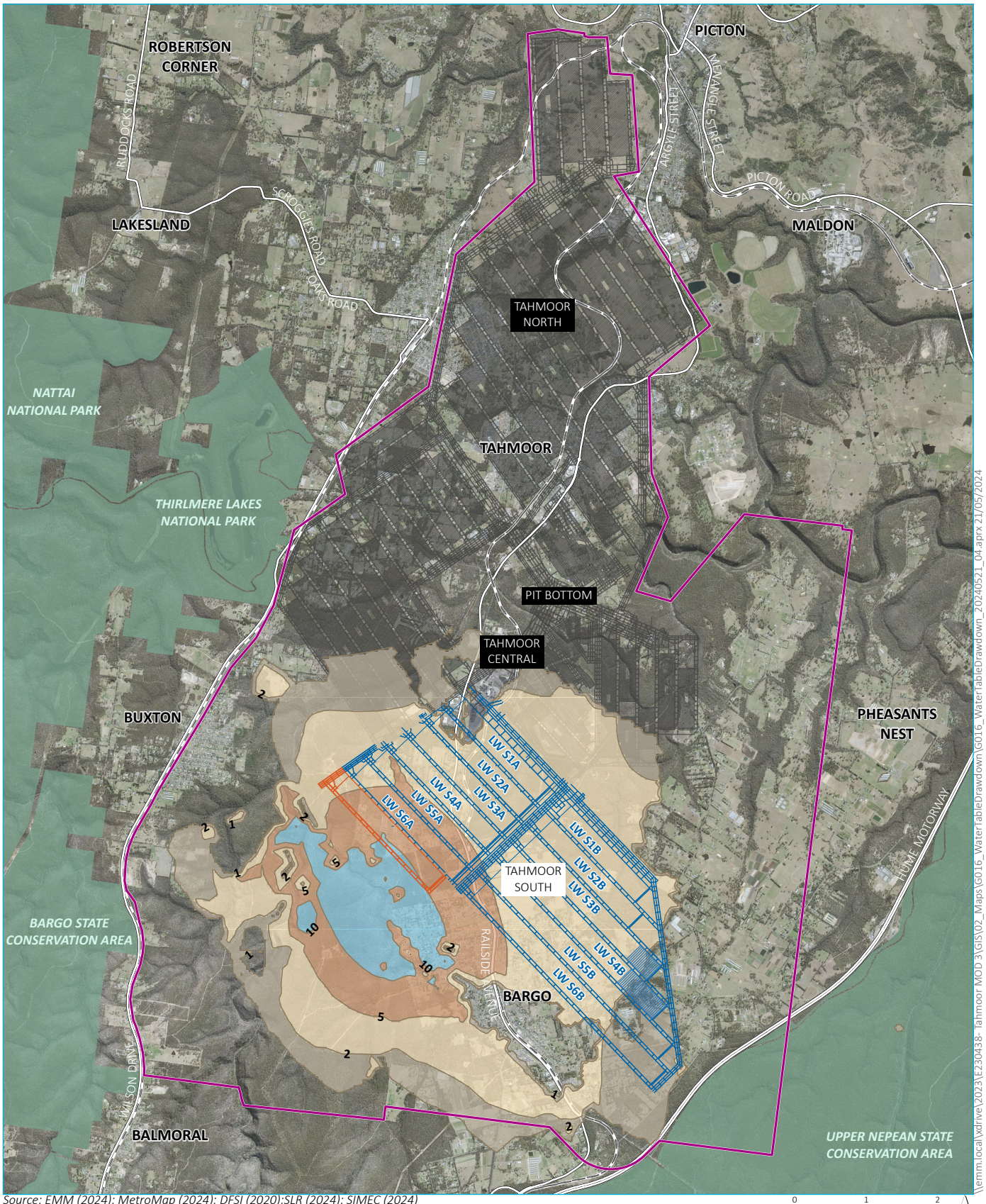
Depressurisation and drawdown are greatest at the working coalface and reduces with distance from the mine.

Maximum incremental drawdown due to LW S7A extraction was obtained by comparing the maximum drawdown for the approved scenario (i.e. maximum difference in groundwater levels between the approved scenario and the null scenario) and the MOD3 scenario (i.e. maximum difference in groundwater levels between the MOD3 scenario and the null scenario).

Predicted maximum drawdown due to LW S7A extraction (incremental drawdown) is presented in Figure 6.16, Figure 6.17 and Figure 6.18. Figure 6.16 shows the predicted maximum water table drawdown due to LW S7A extraction. The water table has been selected because it is the groundwater system that is connected to most environmental (surface) features. The maximum water table drawdown is <20 m in the immediate vicinity of LW S7A and reduces to <5 m across much of the Tahmoor South footprint. The maximum 1 m drawdown contour line is contained with the mining leases.

Figure 6.17 shows the predicted maximum drawdown in the lower Hawkesbury Sandstone, which is the source of much of the local groundwater extraction by bores. Figure 6.17 shows the maximum drawdown will extend radially from the LW S7A footprint. As shown the predicted drawdown in the Hawkesbury Sandstone is similar in extent to the water table drawdown and are mostly contained within the mining leases.

Figure 6.18 shows the extent of the maximum predicted 10 m depressurisation contour associated with LW S7A, which is approximately 2 km to the south and 2 km to the east of LW S7A. The figure shows the maximum extent to the west of the panels in that area. The cone of depression is predicted to be steepest around the mine area.




*Source: EMM (2024); MetroMap (2024); DFSI (2020);SLR (2024); SIMEC (2024)*

0 1 2 km
GDA 1994 MGA Zone 56

N

KEY

- Tahmoor South project area (SSD 8445)
- Extraction subject to secondary approval
- Existing underground working
- Tahmoor South approved mine working
- Proposed LWS7A

Existing environment

- Rail line
- Major road
- NPWS reserve

- Drawdown contour (m)

Drawdown (m)

- 1-2
- 2-5
- 5-10
- 10-20
- 20-50

# Predicted maximum incremental water table drawdown

Tahmoor South Project
SSD 8445 Modification 3
Figure 6.16

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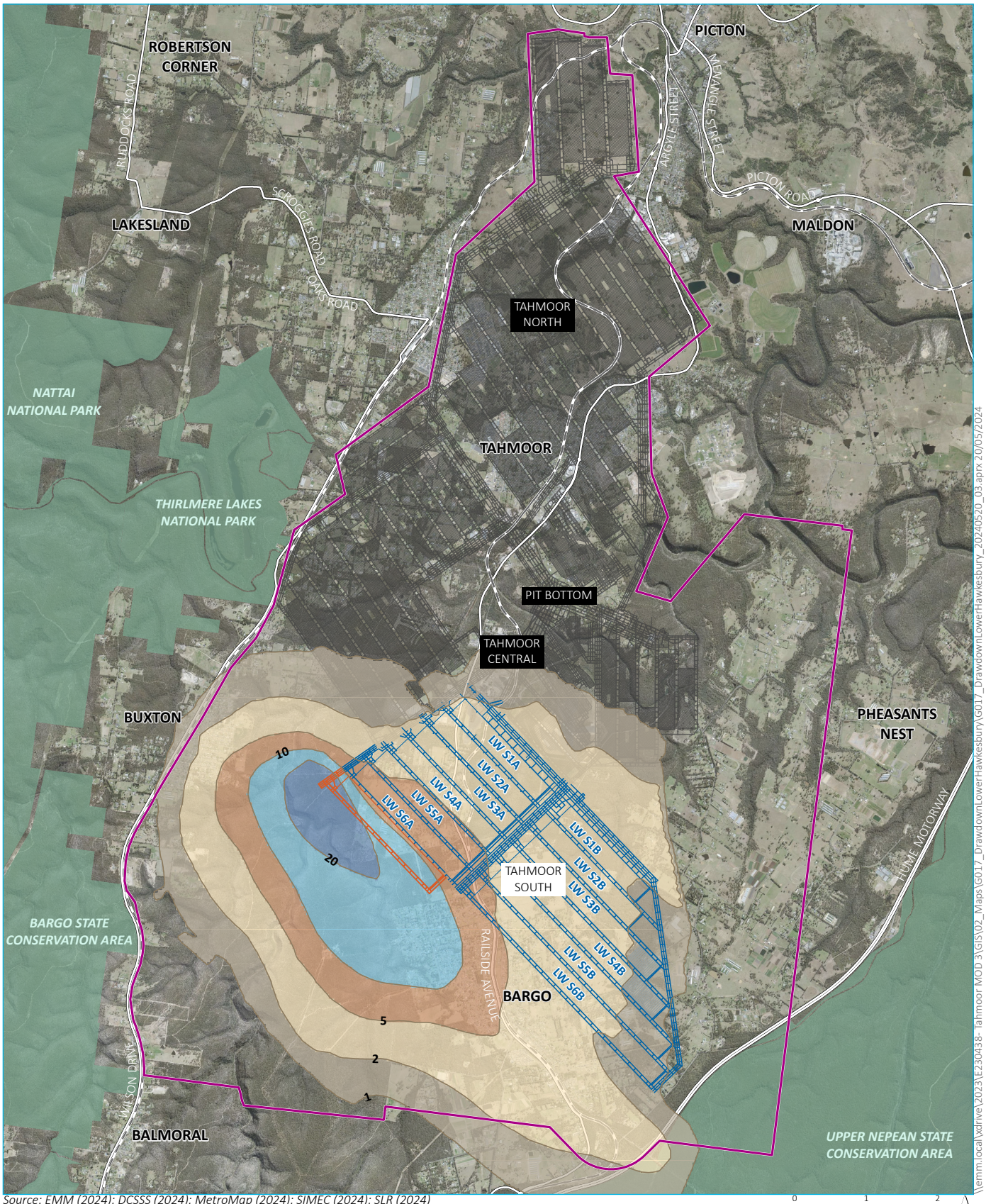


*Source: EMM (2024); DCSSS (2024); MetroMap (2024); SIMEC (2024); SLR (2024)*

0 1 2 km

GDA 1994 MGA Zone 56

N

KEY

- Tahmoor South project area (SSD 8445)
- Extraction subject to secondary approval
- Existing underground working
- Tahmoor South approved mine working
- Proposed LWS7A

Existing environment

- Rail line
- Major road
- NPWS reserve

- Drawdown contour (m)

Drawdown (m)

- 1-2
- 2-5
- 5-10
- 10-20
- 20-50

# Predicted maximum incremental drawdown in Lower Hawkesbury Sandstone

Tahmoor South Project
SSD 8445 Modification 3
Figure 6.17

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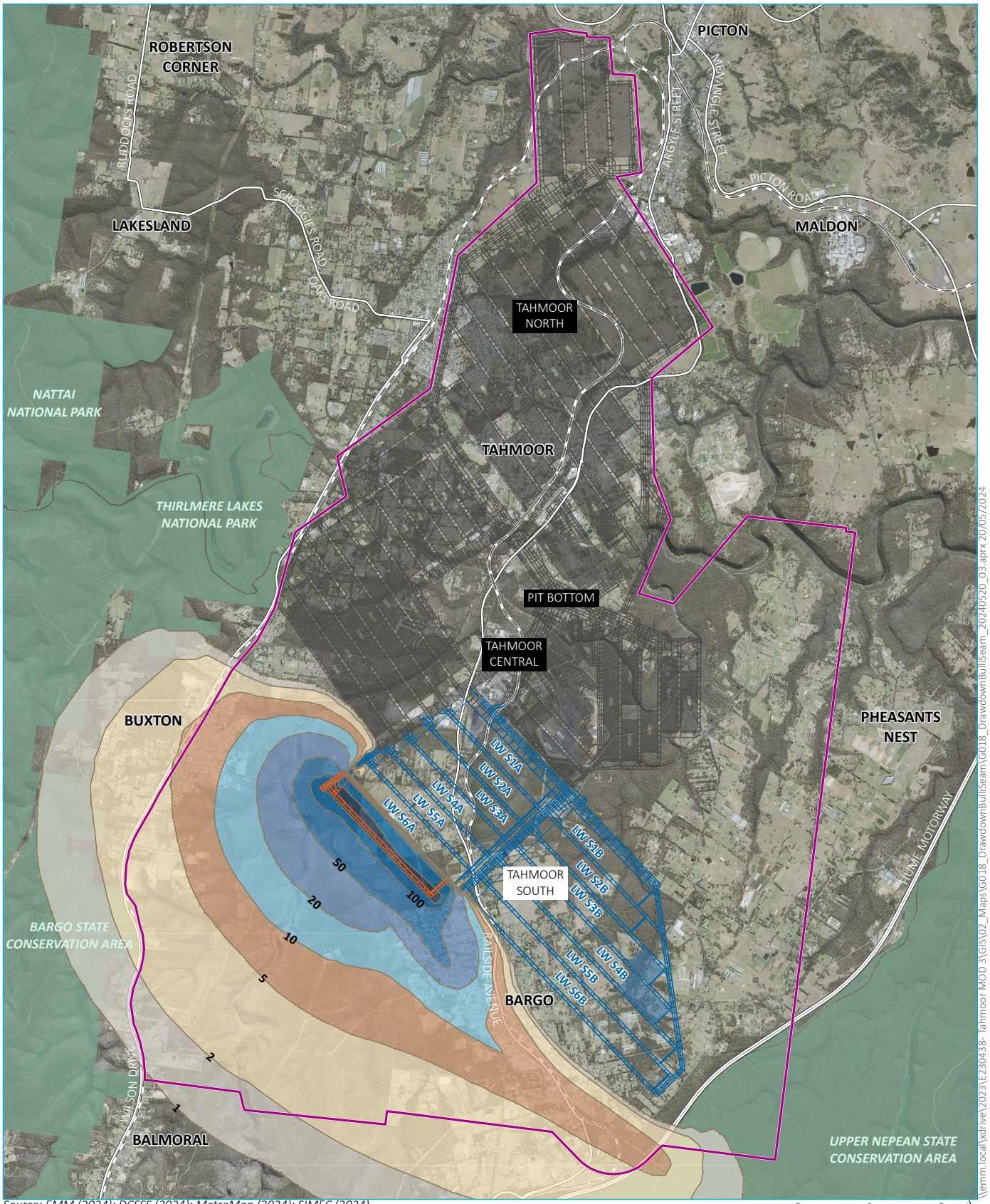


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*Source: EMM (2024); DCSSS (2024); MetroMap (2024); SIMEC (2024)*

0 1 2 km
GDA 1994 MGA Zone 56

N

KEY

- Tahmoor South project area (SSD 8445)
- Extraction subject to secondary approval
- Existing underground working
- Tahmoor South approved mine working
- Proposed LWS7A

Existing environment

- Rail line
- Major road
- NPWS reserve

- Drawdown contour (m)

Drawdown (m)

- 1-2
- 2-5
- 5-10
- 10-20
- 20-50
- 50-100
- 100-200
- 200-300

Predicted maximum incremental drawdown in Bulli Seam

Tahmoor South Project
SSD 8445 Modification 3
Figure 6.18

EMM
creating opportunities

### ii Groundwater interception

The predicted inflows to the Tahmoor South workings for the A series of longwalls (LW S1A-S7A) are presented in Figure 6.19. As shown, cumulative inflows to underground operations from the A series of longwalls are predicted to reach a maximum peak of 0.88 ML/d at the beginning of 2027. Inflow rates increase and decrease gradually from 2024 until the cessation of mining for the A series, currently anticipated to be in Oct 2027, where inflows reach a steady rate of approximately 0.10 ML/d.

The incremental inflow rate due to LW S7A starts as LW S7A becomes operational, which is anticipated to be in approximately the beginning of 2027. As shown, incremental inflows to underground operations are predicted to reach a maximum peak of 0.81 ML/d at this time. Therefore, with a cumulative peak of 0.88 ML/d, LW S7A increases inflows by up to 0.07 ML/d. It is estimated that the incremental inflow reaches a steady state rate of 0.05 ML/d.

Table 6.23 presents the groundwater take predictions for the approved Project and the incremental contribution from LW S7A.

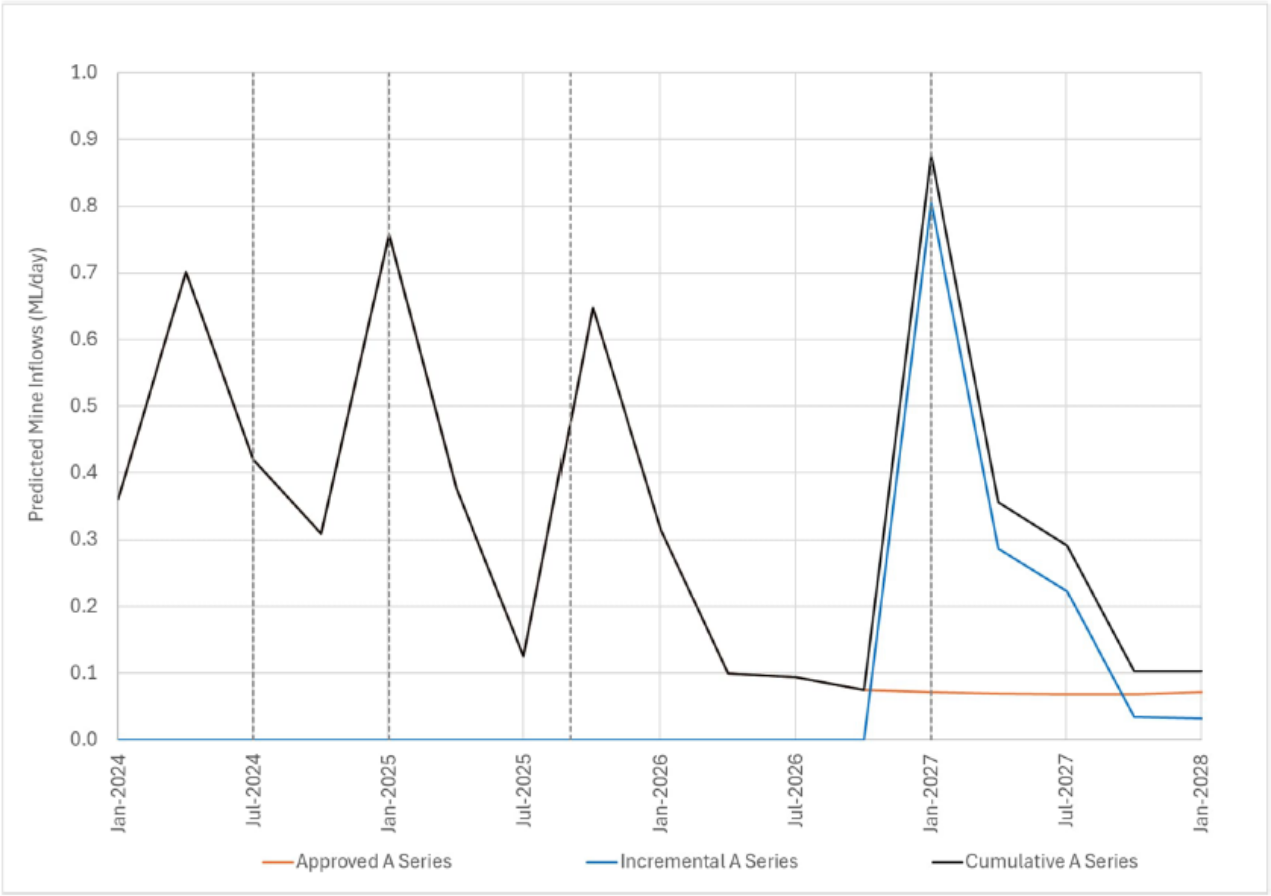


**Figure 6.19 Predicted mine pit inflows for longwall series A (approved, incremental (LWS 7A only), and cumulative)**

**Table 6.23 Predicted groundwater take from active mining at Tahmoor South (SLR 2024)**

| Water year | LW S7A (ML/year) | Total groundwater take (ML) |
|---|---|---|
| 2024-2025 | 0 | 301 |
| 2025-2026 | 0 | 208 |
| 2026-2027 | 100 | 405 |
| 2027-2028 | 29 | 298 |
| 2028-2029 | 11 | 396 |
| 2029-2030 | 13 | 389 |
| 2030-2031 | 16 | 290 |
| 2031-2032 | 18 | 401 |
| 2032-2033 | 19 | 276 |

### iii Baseflow loss

Mining activities resulting in a reduction in water levels and/or pressures, can result in a change in gradient between the aquifer and the watercourse, which may reduce the rate at which baseflow occurs or induce additional leakage via increased hydraulic gradients. This effect can be amplified in areas above longwall panels, where surface cracking may increase the permeability of the stream bed and the near-surface strata.

The predicted change in baseflow due to LW S7A extraction was calculated by comparing the net river flow in the MOD3 scenario against the approved scenario. The cumulative loss of baseflow was calculated by comparing the MOD3 scenario against the null scenario (i.e. no mining scenario).

Table 6.24 presents a summary of the predicted maximum baseflow loss at several creeks directly related to the LW S7A extraction. Overall, the model predicts insignificant change in baseflow due to LW S7A extraction. The impact in ML/d represents the maximum baseflow impact from any time in the predictive run. The sub-catchments most affected by the Tahmoor South mining operation are predicted to be Dogtrap Creek (0.003 ML/day loss in baseflow).

Table 6.24 shows the predicted cumulative baseflow losses due to mining in the A series with the addition of LWS 7A. A shown, the additional baseflow loss due to LWS 7A compared to the approved layout is negligible in the majority of watercourses. However, some incremental increases are predicted to be occur (between 0.002–0.003 ML/d), with the largest being in the following watercourses:

- Dogtrap creek, at around 0.003 ML/d representing 17% of the cumulative (approved A-series plus LWS 7A) baseflow loss.
- Teatree Hollow, at around 0.002 ML/d representing 10% of the cumulative (approved A-series plus LWS 7A) baseflow loss.
- Bargo River, at around 0.002 ML/d representing 6% of the cumulative (approved A-series plus LWS 7A) baseflow loss.

### Table 6.24 Maximum predicted baseflow impacts in local watercourses

| Watercourse | Site used for assessment | LW7A extraction impact (ML/d) | Cumulative impact (ML/d) |
|---|---|---|---|
| Eliza Creek | SW-18 | <0.001 | 0.015 |
| Carters Creek | SW-23 | <0.001 | 0.01 |
| Dogtrap Creek | SW-15 | 0.003 | 0.018 |
| Teatree Hollow | SW-22 | 0.002 | 0.02 |
| Cow Creek | SW-24 | <0.001 | 0.003 |
| Stonequarry Creek* | 212053 | -0.002 | 0.025 |
| Bargo River | SW-1 | <0.001 | 0.014 |
| Bargo River | SW-13 | 0.002 | 0.034 |
| Bargo River | SW-14 | 0.002 | 0.056 |
| Hornes Creek | SW-9 | 0 | 0.002 |
| Nepean River | SW-21 | <0.001 | 0.144 |
| Matthews Creek | | <0.001 | 0.01 |
| Cedar Creek | | <0.001 | 0.003 |
| Redbank Creek | | <0.001 | 0.007 |
| Avon River | | <0.001 | 0.02 |
| Cordeaux River | | <0.001 | 0.05 |
| Rumker Gully | | <0.001 | <0.001 |
| Myrtle Creek | | <0.001 | 0.02 |
| Dry Creek | | <0.001 | 0.006 |

*Stonequarry Creek is shown as negative due to a slight increase in baseflow during the recovery period.

## iv Impacts to groundwater dependent systems

### a Predicted potential change in lake-aquifer interaction at Thirlmere Lakes

Declines in groundwater levels due to mining can result in changes in the groundwater-surface water interaction between the lake system and the local groundwater system.

The model did not predict drawdown >1 m to extend to the Thirlmere Lakes as a result of LW S7A extraction. Therefore, negligible changes (<0.001 ML/d) in the lake leakages to the groundwater system are predicted (Table 6.25). This is consistent with the conclusions of the groundwater assessment for the Tahmoor South Project.

**Table 6.25 Predicted change in lake leakage due to mining**

| Lake | LW7A extraction impact (ML/d) | LW7A extraction impact (% change from approved scenario) | Cumulative impact (ML/d) |
|---|---|---|---|
| Gandangarra | <0.001 | < 1% | 0.06 |
| Baraba | <0.001 | < 1% | <0.001 |
| Nerrigorang | <0.001 | -2%* | 0.05 |
| Werri Berri | 0.001 | < 1% | 0.07 |
| Couridjah | <0.001 | < 1% | 0.02 |

Note: * Negative number means that on average (and including the full recovery period), there is a decrease in lake leakage (i.e. more groundwater flowing to the lake, likely due to increased fracturing around the region.

### b Influence on alluvium

The main alluvial resource in the area includes alluvium associated with Thirlmere Lakes. No drawdown >1 m is predicted in the Thirlmere Lakes alluvium in response to LW S7A extraction. The incremental impact on the alluvium baseflow is estimated at 0.0026 ML/d, which represent a negligible change (0.3%) from the approved scenario.

The loss of flow in alluvium due to the cumulative mining scenario was calculated by comparing the alluvial flows between the null scenario and LW S7A scenario. The maximum loss of flow in the Thirlmere Lakes alluvium is predicted to be 0.18 ML/d which is likely due to the mining activities in Tahmoor North and the Western Domain.

### v Predicted drawdown in private bores

Table 6.26 presents a list of the bores identified in the Project bore census (CES 2022) and presents the simulated drawdown impact at each. The drawdown values in Table 6.27 are the maximum impact at any given point in time in the predictive model.

As shown in Table 6.26, there are 13 bores with maximum predicted drawdown of greater than 2 m due to LW S7A extraction. However, these bores are already predicted to experience greater than 2 m drawdown as a result of approved operations. Therefore, the proposed MOD3 will not result in any additional bores experiencing a drawdown of greater than 2 m.

**Table 6.26 Modelled maximum impact on private groundwater bores**

| Bore | Easting | Northing | LW7A extraction impact (m) | Cumulative mining impact (m) |
|---|---|---|---|---|
| GW109257 | 276603.8 | 6205057.0 | 7.74 | 31.78 |
| GW032443 | 276427.0 | 6206329.0 | 3.97 | 30.88 |
| GW104323 | 276241.6 | 6206412.0 | 3.95 | 22.23 |
| GW014262 | 276764.0 | 6204587.0 | 7.74 | 28.69 |
| GW111810 | 277035.4 | 6204405.0 | 6.51 | 32.65 |
| GW104659 | 276616.0 | 6207392.0 | <2 | 26.77 |

**Table 6.26 Modelled maximum impact on private groundwater bores**

| Bore | Easting | Northing | LW7A extraction impact (m) | Cumulative mining impact (m) |
|---|---|---|---|---|
| GW007445 | 277437.0 | 6204264.0 | 5.38 | 33.10 |
| GW103615 | 279634.6 | 6204110.0 | 3.17 | 23.25 |
| GW110669 | 274570.4 | 6207928.0 | 2.88 | 25.74 |
| GW058634 | 279446.1 | 6203408.0 | 3.08 | 24.09 |
| GW111669 | 279262.7 | 6203321.0 | 3.16 | 24.21 |
| GW102179 | 279262.7 | 6203321.0 | 3.01 | 36.13 |
| GW105395 | 278546.8 | 6203033.0 | 3.90 | 25.52 |
| GW111047 | 280015.0 | 6206037.0 | <2 | 7.04 |
| GW031294 | 279732.0 | 6205706.0 | <2 | 6.78 |
| GW070245 | 280043.3 | 6205645.0 | <2 | 6.10 |
| GW102344 | 280250.8 | 6206554.0 | <2 | 6.36 |
| GW053449 | 280369.0 | 6205813.0 | <2 | 5.82 |
| GW104008 | 280359.0 | 6205978.0 | <2 | 5.90 |
| GW106590 | 280442.0 | 6206344.0 | <2 | 6.15 |
| GW054146 | 279879.6 | 6204679.0 | <2 | 5.29 |
| GW105577 | 280728.0 | 6207041.0 | <2 | 4.25 |
| GW108538 | 281155.0 | 6205941.0 | <2 | 4.53 |
| GW062068 | 276572.8 | 6209556.0 | 6.14 | 30.37 |
| GW057969 | 281351.1 | 6206122.0 | <2 | 4.24 |
| GW051877 | 281673.0 | 6205875.0 | <2 | 4.12 |
| GW100455 | 281877.0 | 6207020.0 | <2 | 3.16 |

### vi Solute transport modelling

Solutes from the storage of brine in the Western Domain are likely to migrate upward following groundwater recovery and the development of an upward hydraulic gradient between the mine and the water table. Preferential pathways for solute migration are the goaf areas of the Western Domain and the eastern fault lines. The model predicts that solutes at concentrations of potential concern may reach the lower Hawkesbury Sandstone but will remain near the mine boundary, primarily within the Western Domain and the eastern fault lines area. Solutes reaching the middle and upper Hawkesbury Sandstone were assessed to be too low in concentration to present a risk to environmental receptors.

The solute transport modelling outcomes presented in the groundwater impact assessment (SLR 2024) are consistent with those assessed and approved as part of Tahmoor Mod 2. There is no change in impacts or risk of impacts associated with this modification as a result of the ongoing storage of brine in the underground workings.

As discussed in Section 4.4.2, the NSW AIP, as it pertains specifically to groundwater quality for Highly Productive Fractured Aquifers, requires the following minimal impact considerations:

- Any change to the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.
- If condition 1 is not met, then appropriate studies will need to demonstrate to the Ministers satisfaction that the change in groundwater quality will not prevent the long-term viability of the groundwater dependent ecosystem significant site or affected water supply work.

The groundwater modelling indicates that after 550 years post mining, the salinity plume will only be present directly above the Western Domain and the eastern fault lines area, in concentration <200 milligrams per litre (mg/L) in the lower Hawkesbury Sandstone, whilst in the upper (outcropping) Hawkesbury Sandstone the maximum incremental TDS in the Hawkesbury Sandstone will be less than 10 mg/L. Consequently, there will be no discernible change in the beneficial use of the groundwater. The predicted changes in the upper Hawkesbury Sandstone are within the natural variations experienced at monitoring bores within the Western Domain.

In layer 1 of the model (regolith, alluvium and basalt), which is associated with rivers and creeks bed, simulated concentrations are also less than 10 mg/L, thus the impacts to waterways are predicted to be negligible.

There are no private bores located in areas where the maximum incremental TDS is predicted to be >10 mg/L.

### 6.6.6 Management and mitigation

#### i Groundwater monitoring

A targeted groundwater monitoring network has been developed and approved for the current approved operations at Tahmoor South and consists of a series of multi-level Vibrating Wire Piezometers (VWPs), open standpipes (OSPs) and private bores. The monitoring network is suitable for monitoring potential impacts from the incremental impacts due to the extraction of LW S7A, and no additional monitoring is required.

#### ii Groundwater management plan

The Tahmoor South Groundwater Management Plan (GWMP) and Tahmoor South Water Management Plan (WMP) are designed in accordance with the consent conditions of SSD 8445 and provide for adaptive and ongoing management of the groundwater. These management plans will continue to be implemented for the life of the Project. The management plans will be reviewed, and updated where required, prior to the extraction of LW S7A.

## 6.7 Water licensing

### 6.7.1 Introduction

As a component of the modification application, EMM were engaged to undertake a water licensing review to:

- outline the existing water entitlements held by Tahmoor Coal
- summarise the water take predictions for the Tahmoor mining operation based on the surface water and groundwater assessments for the Modification 3 project
- identify and outline the pathway to secure the necessary water licence entitlements required for the Modification 3 project.

A copy of the review is provided as Appendix F with key outcomes summarised below.

### 6.7.2 Existing licences and approvals

A summary of the existing WALs held by Tahmoor Coal is provided in Table 6.27 and their associated approvals are provided in Appendix H.

## Table 6.27 Summary of existing water access licences

| Licence | Category | Entitlement (units) | Tenure type | Water sharing plan | Water source | Management zone | Nominated works | Comments / purpose |
|---|---|---|---|---|---|---|---|---|
| WAL25777 | Unregulated river | 5 | Continuing | Greater Metropolitan Region Unregulated River Water Sources 2023 | Maldon Weir | – | 10WA103026 | |
| WAL43572 | Unregulated river | 16 | Continuing | | Stonequarry Creek | – | 10MW119329 | |
| WAL43656 | Unregulated river | 25 | Continuing | | Maldon Weir | – | 10MW119329 | |
| | | 11 | Temporary trade | | | | | Trade reference - SWC839757 |
| WAL44608 | Unregulated river | 9 | Continuing | | Stonequarry Creek | – | 10MW119329 | |
| WAL43658 | Unregulated river | 0 | Continuing | | Stonequarry Creek | – | 10MW119329 | |
| WAL43631 | Unregulated river | 0 | Continuing | | Little River | – | 10MW119329 | |
| WAL43655 | Unregulated river | 0 | Continuing | | Maguires Crossing | – | 10MW119329 | |
| WAL43657 | Unregulated river | 0 | Continuing | | Upper Nepean Rivers | Pheasants Nest Weir to Nepean Dam Management Zone | 10MW119329 | |
| WAL43659 | Unregulated river | 0 | Continuing | | Upper Nepean Rivers | Upper Nepean Rivers Management Zone | 10MW119329 | |
| WAL36442 | Aquifer | 1,642 | Continuing | Greater Metropolitan Region Groundwater Sources 2023 | Sydney Basin Nepean Groundwater Source | Nepean Management Zone 2 | 10WA118745 | |

## Table 6.28 Summary of existing approvals

| Approval number | Approval kind | Expiry date | Associated WAL | Work description | Use purpose | Location | Comments |
|---|---|---|---|---|---|---|---|
| 10WA118745 | Water supply works | 30/6/2025 | WAL36442 | Three bores for groundwater extraction | – | Lot 162, DP 1054184 | Mine dewatering |
| 10WA103026 | Water supply works | 24/9/2024 | WAL25777 | Diversion Works – pumps, Pumping plant | – | Lot 42, DP 751250 | |
| 10MW119329 | Miscellaneous works approval | 20/8/2120 | WAL43572, WAL43656, WAL44608, SWC839757, WAL43658, WAL43631, WAL43655, WAL43657, WAL43659 | Project elements as described within SSD8445 | – | Project area associated with SSD8445 | |

### 6.7.3 Water requirements and entitlements

Tahmoor Coal is required to licence surface water and groundwater that is directly taken for use or where groundwater take results in induced flow from the surface water source to an underlying groundwater source as a result of groundwater drawdown in accordance with the WM Act and AIP. Activities associated with the take of water at Tahmoor Mine and potentially requiring licensing have been identified as:

- pit top operation, including the interception of surface water runoff by the water management system
- underground mining, including:
  - dewatering of mine workings
  - reduction in streamflow due to general lowering of groundwater the table which reduces baseflow contribution
  - induced leakage from surface water sources to underlying groundwater
  - subsidence-induced cracking, which may result in the diversion of surface flow into underlying groundwater systems.

#### i Inflows to mine workings

Groundwater inflows into the active underground mine workings (Tahmoor South) will be directed to the surface to allow mining to occur, and then recycled and reused for mining operations. Groundwater inflows also occur to inactive areas of completed underground mining which are being allowed to fill (Tahmoor North) – this is referred to as passive take. The hydrogeological model predicts that inflows to areas of underground mine workings will occur for a number of years following the end of mining, until the groundwater system reaches equilibrium (SLR 2024).

Groundwater take associated with inflows into the active and inactive underground mine workings occurs from the Nepean Management Zone 2 of the Sydney Basin Nepean Groundwater Source. Groundwater inflow to active mine workings within Tahmoor South are predicted to have generally reduced in the most recent modelling revisions completed for the project compared to the previous predictions.

The groundwater take required to be licensed predicted by hydrogeological modelling is presented in Table 6.29 for the proposed project, total active underground mine workings (Tahmoor South, including proposed project), total passive take (Tahmoor North) and the total predicted take (all Tahmoor operations, including proposed project). The active underground mining operations are expected to be complete by the 2033-34 water year.

**Table 6.29 Predicted groundwater take from mining operations at Tahmoor Mine (SLR 2024)**

| Water year | For LW S7A mining (ML) | Total active groundwater take (ML) | Total passive groundwater take (ML) | Total groundwater inflow to underground areas (ML) |
|---|---|---|---|---|
| 2024-2025 | 0 | 301 | 2,251 | 2,551 |
| 2025-2026 | 0 | 208 | 2,111 | 2,318 |
| 2026-2027 | 100 | 405 | 1,917 | 2,322 |
| 2027-2028 | 29 | 298 | 1,789 | 2,087 |
| 2028-2029 | 11 | 396 | 1,571 | 1,967 |

## Table 6.29 Predicted groundwater take from mining operations at Tahmoor Mine (SLR 2024)

| Water year | For LW S7A mining (ML) | Total active groundwater take (ML) | Total passive groundwater take (ML) | Total groundwater inflow to underground areas (ML) |
|---|---|---|---|---|
| 2029-2030 | 13 | 389 | 1,502 | 1,892 |
| 2030-2031 | 16 | 290 | 1,453 | 1,742 |
| 2031-2032 | 18 | 401 | 1,213 | 1,615 |
| 2032-2033 | 19 | 276 | 1,971 | 2,247 |
| 2033-2034 | 0 | 0 | 2,858 | 2,858 |
| 2034-2035 | 0 | 0 | 2,357 | 2,357 |
| 2035-2036 | 0 | 0 | 1,882 | 1,882 |
| 2036-2037 | 0 | 0 | 1,608 | 1,608 |
| 2037-2038 | 0 | 0 | 1,471 | 1,471 |
| 2038-2039 | 0 | 0 | 1,349 | 1,349 |
| 2039-2040 | 0 | 0 | 1,249 | 1,249 |
| 2040-2041 | 0 | 0 | 1,229 | 1,229 |
| 2041-2042 | 0 | 0 | 1,004 | 1,004 |
| 2042-2043 | 0 | 0 | 292 | 292 |
| 2043-2044 | 0 | 0 | 50 | 50 |
| 2044-2045 | 0 | 0 | 44 | 44 |
| 2045-2046 | 0 | 0 | 42 | 42 |
| 2046-2047 | 0 | 0 | 40 | 40 |
| 2047-2048 | 0 | 0 | 37 | 37 |
| 2048-2049 | 0 | 0 | 32 | 32 |
| 2049-2050 | 0 | 0 | 29 | 29 |
| 2050-2051 | 0 | 0 | 25 | 25 |
| 2051-2052 | 0 | 0 | 29 | 29 |
| 2052-2053 | 0 | 0 | 24 | 24 |
| 2053-2054 | 0 | 0 | 25 | 25 |
| 2054-2055 | 0 | 0 | 22 | 22 |
| 2055-2056 | 0 | 0 | 19 | 19 |
| 2056-2057 | 0 | 0 | 16 | 16 |
| 2057-2058 | 0 | 0 | 16 | 16 |
| 2058-2081 | 0 | 0 | <15 | <15 |

### ii Changes to adjacent water sources

The take of water associated with the underground workings results in:

- direct take from of mine workings located within Nepean Management Zone 2
- minor throughflow from the adjacent groundwater zone, Nepean Management Zone 1
- leakage from overlying surface water systems.

The Tahmoor Mine groundwater take comprises:

- inflow to the active mining areas (removal of water from the Sydney Basin Nepean Groundwater Source) and includes the reduction in groundwater available for baseflow contribution to surface water systems (reduced movement of water from the Sydney Basin Nepean Groundwater Source to streams).

The Tahmoor Mine surface water take comprises:

- increased river leakage, caused by the lowering of the groundwater table below the surface water level of the stream (take from the Maldon Water Source). Methodologies for estimating this take is further discussed in ATCW (2024) and SLR (2024).
- reduction in stream flow due to subsidence-induced surface cracking, which results in enhanced leakage from the stream into underlying groundwater systems (increased movement of water from the various surface water sources to the Sydney Basin Nepean Groundwater Source). Methodologies for estimating this take is further discussed in SLR (2024).

### iii Summary

Table 6.30 presents the maximum annual surface water and groundwater take associated with the proposed modification and the cumulative take associated with the entire Project, as presented by ATCW (2024) and SLR (2024).

**Table 6.30 Estimated maximum water take by water source (SLR 2024)**

| Water sharing plan | Water source | Management zone | Estimated maximum water take (ML/year)[1] | |
|---|---|---|---|---|
| | | | For LW S7A mining | Cumulative |
| Greater Metropolitan Region Groundwater Sources WSP | Sydney Basin Nepean Groundwater Source | Nepean Management Zone 2 | 100 | Active take – 405[2]<br>Passive take – 2,859[2] |
| Greater Metropolitan Region Unregulated River Water Sources WSP | Maldon Weir | – | 3 | 26 |

1. Estimated take has been rounded up to the nearest 1 ML.
2. The peak active groundwater take is expected to occur in 2026-2027. The peak groundwater inflow to the underground mining area is predicted to occur in 2033-2034 at the completion of mining, which will comprise entirely of passive take.

Table 6.31 provides a summary of Tahmoor Coal's secured entitlement, estimated maximum water take and additional entitlement requirements in each relevant water source.

Tahmoor Coal has currently secured water entitlement within the Sydney Basin Nepean Groundwater Source (Nepean Management Zone 2) and Maldon Weir Water Source. Based on the groundwater modelling undertaken by SLR (2024), Tahmoor Coal currently holds sufficient entitlement to account for all surface water take in water sources associated with the modification. Considering the predicted passive groundwater take volumes, Tahmoor Coal may require additional groundwater entitlement of up to 1,217 ML by the 2033-34 water year.

**Table 6.31 Summary of water licence requirements based on estimated maximum water take**

| Water sharing plan | Water source | Management zone | Entitlement held by Tahmoor Coal | Estimated maximum water take[1] | | Additional entitlement required |
|---|---|---|---|---|---|---|
| | | | | For LW S7A mining | Cumulative | |
| Greater Metropolitan Region Groundwater Sources WSP | Sydney Basin Nepean Groundwater Source | Nepean Management Zone 2 | 1,642 units | 100 ML/year | Active take – 405 ML/year<br>Passive take – 2,859 ML/year | 1,217 units |
| Greater Metropolitan Region Unregulated River Water Sources WSP | Maldon Weir | – | 30 units + 11 units leased | 3 ML/year | 26 ML/year | 0 units |

1. Estimated take has been rounded up to the nearest 1 ML.

### 6.7.4 Water access licensing opportunities

Water users are able to acquire new or additional water entitlement and/or allocation via a number of different pathways, for groundwater sources trading via the water trading market is the generally accepted pathway to securing entitlement or allocations. The options available for each water source depend on existing rights and the sustainability of the water source. A detailed analysis of water licensing opportunities and water trading markets has been undertaken and presented in Appendix H. This analysis indicates that there is sufficient market depth within the water trading market to secure additional entitlement or allocation if required in the future.

### 6.7.5 Conclusion

Mining associated with the addition of LW S7A is predicted to take water from the Sydney Basin Nepean Groundwater Source (Nepean Management Zone 2) and Maldon Weir Water Source. Sufficient entitlement is held within the Sydney Basin Nepean Groundwater Source (Nepean Management Zone 2) to account for active take from both the approved Project and LW S7A. Based on the groundwater modelling undertaken by SLR (2024) used to estimate water licensing requirements, Tahmoor Coal may require additional entitlement in the Sydney Basin Nepean Groundwater Source (Nepean Management Zone 2) to account for passive take of groundwater inflows currently occurring into inactive mining areas.

If the predicted passive take groundwater volumes are required to be licensed, an additional groundwater entitlement of up to 1,217 ML is predicted to be required by the 2033-34 water year.

Sufficient surface water entitlement is held by Tahmoor Coal to account for the predicted surface water take associated with the proposed modification in the Maldon Weir Water Source.

Surface water and groundwater monitoring is undertaken at Tahmoor Mine to assist in the ongoing review of the conceptual understanding and compliance reporting of water take. Monitoring results are used to inform groundwater modelling estimates of inflows into the mine workings as well as river leakage and baseflow reduction.

Within the Sydney Basin Nepean Groundwater Source (Nepean Management Zone 2), Tahmoor Coal currently holds 9% of the total share component held and requires an additional 7% of the remaining total share component in the management zone. Historical availability and usage of water in this water source indicates that much of the water is held in individual accounts and not actually used. Additionally, the water trading market in this water source is well established and liquid, representing few risks to the project in terms of securing sufficient entitlement and/or allocation to fulfil water licensing requirements.

If the water take estimates are revised in the future to exceed the entitlement held by Tahmoor Coal in any water source, additional water entitlement or allocation in the relevant water sources will be traded with existing licence holders.

## 6.8 Greenhouse gas

### 6.8.1 Introduction

A greenhouse gas (GHG) assessment has been prepared EMM (2024b) to support this modification report. The GHG assessment is provided as Appendix I with key outcomes summarised below.

### 6.8.2 Emissions sources

The estimation of GHG emissions for the modification was based on the *National Greenhouse Accounts Factors Workbook* (NGAF) (DCCEW 2023). The GHG emission sources included in the GHG assessment are listed in Table 6.32 and represent the most significant sources associated with the Project.

GHG emissions from the Project, including the proposed modification, have been estimated using the methodologies outlined in the NGAF, using fuel energy contents and Scope 1, 2 and 3 emission factors for fuel combustion, fugitive emissions from mining and post-mining sources, flaring of captured waste gas, electricity use, $SF_6$ consumption, diversion of waste mine gas to the third party owned Waste Coal Mine Gas Power Plant (WCMGPP), transportation of product coal to market and product coal combustion by end users.

**Table 6.32 Scope 1, 2 and 3 emission sources**

| Scope 1 | Scope 2 | Scope 3 |
|---|---|---|
| Direct emissions from fuel combustion (diesel). | Indirect emissions associated with the consumption of purchased electricity. | Indirect upstream emissions from the extraction, production and transport of diesel. |
| Direct emissions from fuel combustion (unleaded petrol). | - | Indirect upstream emissions from the extraction, production and transport of unleaded petrol. |
| Direct emissions from the use of oils and greases. | - | Indirect upstream emissions from the extraction, production and transport of oil and greases. |
| Direct emissions from flaring of mine waste gas | - | Indirect upstream emissions from electricity lost in delivery in the transmission and distribution network. |
| Emissions of mine ventilation air methane (VAM) from ventilation shafts. | - | Indirect downstream emissions from product coal combustion. |
| Fugitive emissions from stockpiled coal. | - | Indirect downstream emissions associated with product transportation (rail and shipping) |
| Direct emissions from the use of sulfur hexafluoride ($SF_6$). | - | Indirect downstream emissions associated with the combustion of captured waste gas by WCMGPP |

### 6.8.3 Activity data

The derived energy and fuel consumption rates by year are presented in Table 6.33. The derived gas extraction and flaring rates by year are presented in Table 6.34.

## Table 6.33 Projected energy and fuel consumption – life of mine

| Year | ROM coal (t) | Primary coking (t) | Secondary coking (t) | Electricity (kWh) | Diesel (L) | $SF_6$ (t) | Unleaded petrol (L) | Oils (L) | Lubricants (L) |
|---|---|---|---|---|---|---|---|---|---|
| FY24 | 2,518,066 | 1,470,094 | 72,137 | 116,198,211 | 1,343,172 | 392 | 3,472 | 163,812 | 211 |
| FY25 | 3,941,724 | 2,322,062 | 130,345 | 181,894,078 | 2,102,571 | 614 | 5,435 | 256,428 | 382 |
| FY26 | 3,600,134 | 2,149,464 | 145,133 | 166,131,101 | 1,920,362 | 561 | 4,964 | 234,206 | 425 |
| FY27 | 3,845,099 | 2,505,196 | 135,238 | 177,435,213 | 2,051,029 | 599 | 5,302 | 250,142 | 396 |
| FY28 | 3,186,803 | 2,220,649 | 127,190 | 147,057,629 | 1,699,885 | 496 | 4,394 | 207,317 | 373 |
| FY29 | 3,057,388 | 2,209,007 | 142,616 | 141,085,676 | 1,630,854 | 476 | 4,216 | 198,898 | 418 |
| FY30 | 2,668,377 | 1,943,613 | 165,210 | 123,134,448 | 1,423,350 | 416 | 3,679 | 173,591 | 484 |
| FY31 | 3,643,677 | 2,663,298 | 255,455 | 168,140,424 | 1,943,588 | 568 | 5,024 | 237,039 | 749 |
| FY32 | 3,411,562 | 2,449,670 | 256,479 | 157,429,316 | 1,819,775 | 531 | 4,704 | 221,939 | 752 |
| FY33 | 3,460,124 | 2,563,671 | 246,497 | 159,670,250 | 1,845,679 | 539 | 4,771 | 225,098 | 723 |
| **Total** | **33,332,955** | **22,496,724** | **1,676,301** | **1,538,176,346** | **17,780,264** | **5,193** | **45,962** | **2,168,471** | **4,915** |

## Table 6.34 Projected gas extraction, flaring and fugitive emissions – life of mine

| Year | ROM coal (t) | Coal seam gas captured for third part energy generation ($m^3$) | Flaring emissions (t $CO_2$-e) | Mine VAM emissions (t $CO_2$-e) | Post-mining activities (fugitives from stockpiles) (t $CO_2$-e) |
|---|---|---|---|---|---|
| FY24 | 2,518,066 | 20,434,278 | 57,820 | 938,188 | 47,843 |
| FY25 | 3,941,724 | 31,987,362 | 90,510 | 1,468,618 | 74,892 |
| FY26 | 3,600,134 | 29,215,331 | 82,666 | 1,341,347 | 68,402 |
| FY27 | 3,845,099 | 31,203,239 | 88,291 | 1,432,617 | 73,057 |
| FY28 | 3,186,803 | 25,861,125 | 73,175 | 1,187,347 | 60,549 |
| FY29 | 3,057,388 | 24,810,915 | 70,204 | 1,139,130 | 58,090 |
| FY30 | 2,668,377 | 21,654,065 | 61,271 | 994,191 | 50,699 |
| FY31 | 3,643,677 | 29,568,684 | 83,666 | 1,357,570 | 69,230 |
| FY32 | 3,411,562 | 27,685,060 | 78,336 | 1,271,089 | 64,819 |
| FY33 | 3,460,124 | 28,079,144 | 79,451 | 1,289,182 | 65,742 |
| **Total** | **33,332,955** | **270,499,203** | **765,389** | **12,419,279** | **633,323** |

### 6.8.4 Impact assessment

Calculated annual Scope 1 and 2 GHG emissions by source type over the life of the Project are presented Table 6.35, while calculated annual Scope 3 GHG emissions by source type are presented in Table 6.36. The life of mine emission totals and annual average emission totals by scope are presented in Table 6.37.

Notably, GHG emissions for the life of the mine have been updated compared to what was estimated and approved as part of SSD 8445 for Tahmoor South (and as listed in Appendix 1 of SSD 8445). The predicted Scope 1 and 2 emissions vary year on year due to updated estimates of ROM coal production (noting the volumes are within the approved maximum of up to 4 Mt/year), as well as due to updates in emission factors.

ROM coal extraction from LW S7A will represent 2 Mt of the total 35 Mt that will be extracted at Tahmoor South, equating to approximately 6% of total life of mine ROM coal extraction from the mine. Further, Tahmoor Coal estimate that the duration of mining of longwall S7A will represent approximately 7% of the total future mining duration for the life of the mine.

For the purpose of the GHG assessment, it has been assumed that 7% of total life of mine GHG emissions are associated with the modification. This approach assumes that fugitive emission generation, associated energy consumption (diesel consumption, electricity, etc.) are directly linear with ROM extraction rate, no matter where operations occur for in the mine.

## Table 6.35 Annual Scope 1 and 2 GHG emissions – life of mine

| Year | Annual Scope 1 emissions (t $CO_2$-e/year) | | | | | | | | Annual Scope 2 emissions (t $CO_2$-e/year) |
|---|---|---|---|---|---|---|---|---|---|
| | Diesel | Unleaded petrol | Oil and grease | Mine VAM | Flares | $SF_6$ | Post mining activities | Total | Electricity |
| FY24 | 3,640 | 8 | 88 | 938,188 | 57,820 | 392 | 47,843 | 1,047,979 | 68,557 |
| FY25 | 5,697 | 13 | 139 | 1,468,618 | 90,510 | 614 | 74,893 | 1,640,483 | 94,585 |
| FY26 | 5,204 | 12 | 127 | 1,341,347 | 82,666 | 561 | 68,403 | 1,498,318 | 64,791 |
| FY27 | 5,558 | 12 | 135 | 1,432,617 | 88,291 | 599 | 73,057 | 1,600,269 | 51,456 |
| FY28 | 4,606 | 10 | 112 | 1,187,347 | 73,175 | 496 | 60,549 | 1,326,297 | 41,176 |
| FY29 | 4,419 | 10 | 107 | 1,139,130 | 70,204 | 476 | 58,090 | 1,272,436 | 38,093 |
| FY30 | 3,857 | 9 | 94 | 994,191 | 61,271 | 416 | 50,699 | 1,110,536 | 23,396 |
| FY31 | 5,267 | 12 | 128 | 1,357,570 | 83,666 | 568 | 69,230 | 1,516,440 | 18,495 |
| FY32 | 4,931 | 11 | 120 | 1,271,089 | 78,336 | 531 | 64,820 | 1,419,838 | 9,446 |
| FY33 | 5,001 | 11 | 122 | 1,289,182 | 79,451 | 539 | 65,742 | 1,440,049 | 3,193 |
| **Total** | **48,180** | **107** | **1,172** | **12,419,279** | **765,389** | **5,193** | **633,326** | **13,872,645** | **413,189** |
| **Annual average** | **4,818** | **11** | **117** | **1,241,928** | **76,539** | **519** | **63,333** | **1,387,264** | **41,319** |

## Table 6.36 Annual Scope 3 GHG emissions – life of mine

| Year | Annual Scope 3 emissions (t $CO_2$-e/year) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Diesel | Unleaded petrol | Oil and grease | Electricity | Combustion of product coal by end user | Combustion of captured gas by third party | Product transport (Rail to Port Kembla) | Product transport (Shipping to Port of Dahej) | Total |
| FY24 | 897 | 8 | 115 | 4,648 | 4,257,945 | 43,757 | 5,143 | 74,937 | 4,387,449 |
| FY25 | 1,404 | 13 | 179 | 7,276 | 6,770,853 | 68,496 | 8,178 | 119,162 | 6,975,561 |
| FY26 | 1,282 | 12 | 164 | 4,984 | 6,335,153 | 62,561 | 7,651 | 111,494 | 6,523,301 |
| FY27 | 1,370 | 12 | 175 | 5,323 | 7,289,975 | 66,817 | 8,805 | 128,298 | 7,500,775 |
| FY28 | 1,135 | 10 | 145 | 2,941 | 6,482,148 | 55,378 | 7,829 | 114,081 | 6,663,668 |
| FY29 | 1,089 | 10 | 139 | 4,233 | 6,492,596 | 53,129 | 7,842 | 114,265 | 6,673,302 |
| FY30 | 950 | 9 | 122 | 1,231 | 5,822,251 | 46,369 | 7,032 | 102,467 | 5,980,431 |
| FY31 | 1,298 | 12 | 166 | 1,681 | 8,058,384 | 63,317 | 9,733 | 141,822 | 8,276,413 |
| FY32 | 1,215 | 11 | 156 | 1,574 | 7,471,406 | 59,284 | 9,024 | 131,491 | 7,674,161 |
| FY33 | 1,233 | 11 | 158 | 1,597 | 7,758,593 | 60,128 | 9,371 | 136,546 | 7,967,635 |
| **Total** | **11,873** | **107** | **1,518** | **35,488** | **66,739,305** | **579,236** | **80,607** | **1,174,563** | **68,622,697** |
| **Annual average** | **1,187** | **11** | **2,404** | **3,549** | **6,673,931** | **57,924** | **8,061** | **117,456** | **6,862,270** |

**Table 6.37 Estimated GHG emissions – life of mine**

| Source | Life of mine GHG emissions (t $CO_2$-e) by scope | | | |
|---|---|---|---|---|
| | Scope 1 | Scope 2 | Scope 3 | Total |
| Diesel combustion | 48,180 | - | 11,873 | 60,053 |
| Unleaded petrol combustion | 107 | - | 107 | 213 |
| Oil and grease consumption | 1,172 | - | 1,518 | 2,690 |
| $SF_6$ use | 5,193 | - | - | 5,193 |
| Mine VAM emissions | 12,419,279 | - | - | 12,419,279 |
| Flaring of captured gas | 765,389 | - | - | 765,389 |
| Post-mining | 633,326 | - | - | 633,326 |
| Electricity consumption | - | 413,189 | 24,041 | 351,453 |
| Combustion of captured gas by third party | - | - | 579,236 | 579,236 |
| Product transport (Rail to Port Kembla) | - | - | 80,607 | 80,607 |
| Product transport (Shipping to Port of Dahej) | - | - | 1,174,563 | 1,174,563 |
| Product coal combustion | - | - | 66,739,305 | 66,739,305 |
| **Total** | **13,872,645** | **413,189** | **68,622,697** | **82,908,530** |
| **Annual average** | **1,387,264** | **41,319** | **6,862,270** | **8,290,853** |
| **Modification total (7%)** | **971,085** | **28,923** | **4,803,589** | **5,803,597** |

The significance of mine emissions relative to State and National GHG emissions has been determined by comparing annual average GHG emissions against the most recent available total GHG emissions inventories (calendar year 2021) for NSW (132,049 kt $CO_2$-e) and Australia (464,770 kt $CO_2$-e). Notably, the updated annual average Scope 1 GHG emissions predicted from Tahmoor South (1,387,264 t $CO_2$-e) is less than that anticipated for Tahmoor South as approved under SSD 8445, which is 1,609,187 t $CO_2$-e. This is due to lower gas content being experienced, and predicted to be experienced, in the Tahmoor South Project area compared to what was assumed in the Project's GHG predictions for the original Tahmoor South Project as approved by SSD 8445.

The annual average GHG emissions (Scope 1 and 2) generated by the Project, as modified, are estimated to represent 1.08% of total GHG emissions for NSW and 0.31% of total GHG emissions for Australia.

It is estimated that the modification represents approximately 6%-7% of total life of mine GHG emissions.

### 6.8.5 Management and mitigation

The current and proposed GHG management measures to reduce Scope 1 and 2 emissions include:

- sealing off panels once mining activities are completed and are no longer required for future mining purposes, thus restricting fugitive $CH_4$ and $CO_2$ emissions
- continual $CH_4$ and $CO_2$ monitoring and detection
- maximising energy efficiency for run of mine operations including planning mine layout to minimise haul distances and therefore fuel use

- reducing fugitive $CH_4$ emissions using the following abatement measures:
  - flaring
  - $CH_4$ recycled through third party power generation (i.e. at the existing WCMGPP), when available
  - using ventilation control devices in sections of the mine not in use enabling them not to be ventilated (unless required for safety purposes)
- use of electric winder as the primary method of materials transport for the mine
- ensuring maintenance, calibration and record keeping is undertaken on the main ventilation shaft and fans, to allow calculations of greenhouse gas emissions
- tracking electricity bills and fuel usage
- installation of energy efficient technology where feasible
- engagement in projects related to reduction of GHG emissions, innovations and technologies
- internal company GHG emissions and energy consumption reduction targets.

Tahmoor Coal will continue to reduce Scope 3 emissions to the greatest extent possible by continuing to sell coal to customers with end users located in countries that are Parties to the Paris Agreement, or countries with equivalent domestic policies for reducing GHG emissions.

### i Gas drainage and capture

Gas drainage and capture are currently implemented at Tahmoor Mine and is an integral part of managing GHG emissions. Gas is drawn progressively from the coal seam ahead of longwall development (pre-mining) by vacuum and piped to the onsite gas plant located at the surface via the underground pipe network.

Gas management infrastructure at the mine consists of:

- Tahmoor Coal mine gas plant
- Tahmoor Coal mine gas plant vent
- Tahmoor Coal mine flare plant
- third party operated WCMGPP, when available.

The collected gas is tested for $CH_4$ concentration and is processed via one of the following options available at the mine:

- If the gas has sufficient $CH_4$ concentrations, it will be directed to the WCMGPP to be used in electricity generation.
- If the gas has insufficient $CH_4$ concentrations for electricity generation, or in circumstances where the WCMGPP is not operational, the gas is flared at the onsite flare plant.
- If the gas has insufficient $CH_4$ to be flared, it will be vented to the atmosphere via the gas vent stack at the gas plant.

Tahmoor Coal will continue to utilise the WCMGPP and gas flare plant and upgrade and/or replace them with additional or replacement plants as required.

### ii Ventilation air methane

Tahmoor Coal is committed to the ongoing management and reduction of GHG emissions generated by the mine. Tahmoor Coal monitors and reports GHG emissions and energy usage the under the NGER scheme.

GHG emissions from the mine are principally associated with mine VAM released from the underground workings via the upcast ventilation shaft.

The US-EPA (2019) identify that regenerative thermal oxidation (RTO) is the only commercially operational technology capable of using VAM as a primary fuel at $CH_4$ concentrations below 1.5%. Historical monitoring records of mine ventilation emissions recorded by Tahmoor Coal show that $CH_4$ content of VAM from the mine has been <0.5% since 2020. As operations have moved from Tahmoor North into Tahmoor South, the VAM concentration has decreased to the range of 0.16 to 0.35%. Forecast modelling indicates that the $CH_4$ concentration will be around this range as the mine progresses further to the south-west.

It is understood that the Newcastle Institute for Energy and Resources, a research branch of the University of Newcastle, has developed a 100-metre-long facility located in Western Sydney designed to test VAM abatement systems and components (such as capture ducts, mitigation measures and thermal oxidisers) under a variety of operating scenarios, including controlled $CH_4$ and coal dust explosions. A planned outcome of the testing is the development of technical and safety guidelines needed to deploy VAM abatement technologies across the sector.

Tahmoor Coal has committed to the ongoing investigation of viable technology options to control mine VAM emissions.

## 6.9 Other environmental and social aspects

Other environmental and social considerations not requiring further detailed assessment, along with current and proposed monitoring and management measures, are summarised in Table 6.38.

**Table 6.38 Other environmental and social aspects, impacts and management**

| Aspect | Assessment consideration | Management and mitigation |
|---|---|---|
| Air quality | The proposed modification will not increase the maximum annual ROM coal extraction rate or volume of coal processed and handled at the Tahmoor Mine surface facilities. No additional surface infrastructure is required to support the extraction of the additional LW S7A. All air quality impacts will remain consistent with those previously assessed and approved. | Air quality will continue to be monitored and managed in accordance with the existing approved Air Quality and Greenhouse Gas Management Plan (AQGMP).<br>No additional air quality management or mitigation measures are considered necessary as a result of the proposed modification. |
| Noise | The proposed modification will not require any additional surface infrastructure or equipment to support the extraction of the additional LW S7A. All air noise impacts will remain consistent with those previously assessed and approved.<br>Tahmoor Coal are currently implementing additional noise mitigation measures to achieve compliance with the noise criteria outlined in the SSD 8445 development consent. | Noise will continue to be monitored and managed in accordance with the existing approved Noise Management Plan.<br>No additional noise management or mitigation measures are considered necessary as a result of the proposed modification. |
| Historic heritage | No historic heritage sites are located within the study area. Two historic heritage sites listed on the State Heritage Register (Picton Wier and Wellers Road Overbridge) are located outside of the study area. Notwithstanding, impacts to these historic heritage sites have been assessed. No impacts to historic heritage sites as a result of the proposed modification are predicted. | The Heritage Management Plan prepared as part of the LW S1A-S6A Extraction Plan will be reviewed and updated should the modification be approved. No additional monitoring or management measures are considered necessary as a result of the proposed modification. |
| Visual | As the proposed modification does not involve any additional surface infrastructure or changes to existing approved surface facilities, the proposed modification will have no impacts on visual amenity. | Visual amenity will continue to be managed in accordance with the conditions of the SSD 8445 development consent. No additional visual monitoring or management measures are considered necessary as a result of the proposed modification. |
| Traffic | The proposed modification will not result in any increase in the current approved workforce numbers. No construction activities are proposed as a result of the modification. | Traffic impacts will continue to be monitored and managed in accordance with the existing approved Traffic Management Plan. No additional traffic monitoring or management measures are considered necessary as a result of the proposed modification. |
| Socio-economic | The modification will result in the extraction of an additional 2 Mt of resource that would otherwise be sterilised, and will provide ongoing employment opportunities for the existing workforce up until 31 December 2033. The additional coal extraction and continued employment will result in flow on benefits to the state, regional and local economies. | Social impacts from the ongoing operations at the Tahmoor Mine will continue to be monitored and managed in accordance with the existing approved Social Impact Management Plan. The community and landholders will continue to be engaged with through well-established communication processes and the TCCCC. No additional monitoring or mitigation measures to manage the social impacts of the Tahmoor Mine's operations are considered necessary as a result of the proposed modification. |

# 7 Justification and alternatives

## 7.1 Need for the modification

The addition of LW S7A to the mine plan improves the resource recovery of high-quality coking coal that is required for steel production. This high-quality coking coal will be supplied through an existing operating mine, using existing infrastructure for coal handling and processing. The proposed modification will extend local employment and investment, and will provide additional royalties from the mine, for an additional nine months.

## 7.2 Alternatives

### 7.2.1 Do nothing

The alternative option to the proposed modification is a 'do-nothing' approach. The 'do-nothing' approach would result in the sterilisation of approximately 2 Mt of high-quality coking coal and result in the associated flow on benefits, including royalties and continuing employment, not being realised.

### 7.2.2 Longwall design

During initial designs, Tahmoor Coal assessed LW S7A at a length consistent with the adjacent LW S6A panel. For this design, preliminary subsidence predictions identified the effects of subsidence would extend over a number of residential houses within the township of Bargo. As a result of the preliminary subsidence outcomes, the length of LW S7A was reduced by 130 m, resulting in a significant reduction in the number of houses within the study area that would be impacted by subsidence from the proposed extraction of LW S7A.

## 7.3 Justification

The proposed modification represents a sustainable and efficient approach to extracting available high-quality coking coal within the existing mining leases held by Tahmoor Coal. This is consistent with the obligations of Tahmoor Coal under the Mining Act to optimise resource recovery in an efficient and sustainable manner.

The proposed modification utilises existing mining infrastructure for coal handling and processing and will not require any additional surface infrastructure, changes to the existing disturbance footprints, increase to the maximum annual ROM coal approved to be extracted, or increase the maximum annual volume of coal approved to be transported from site. As expected therefore, and due to the relatively short timeframe the proposed modification will add to the life of Tahmoor South, the associated environmental and social impacts of the modification are substantially the same as that approved. Residual impacts will continue to be managed by the existing mitigation and management measures that are already well established at the Tahmoor Mine.

The proposed modification will enable Tahmoor South to operate for nine months longer than originally approved; and to extract approximately 2 Mt of additional high quality coking coal, which will attract further royalties to the State and be used to fund the NSW economy.

The proposed modification is consistent with the surrounding land uses in the area and aligns with the NSW Governments Strategic Statement on Coal Exploration and Mining in NSW.

# 8 Conclusion

Tahmoor Coal is seeking to modify SSD 8445 (Mod 3) under Section 4.55(2) of the EP&A Act to authorise:

- an additional longwall panel (LW S7A) to the approved A series longwall panel layout (modified layout)
- removal of restrictions imposed by Condition A6 of SSD 8445 on the requirement for mining to be completed within 10 years following the commencement of second workings in the Tahmoor South mining area
- an increase in the maximum volume of ROM coal authorised by Condition A11(b) of SSD 8445 that can be extracted and processed on site, from 33 Mtpa to 35 Mtpa.

The environmental and social impacts of the proposed modification have been assessed. The maximum predicted subsidence parameters within the study area, based on the modified layout with LW S7A included, are similar to those based on the current approved layout. This is because predicted maximum subsidence due to the extraction of the B series longwalls is greater than the A series and the addition of LW S7A does not influence maximum subsidence predictions associated with the B series of longwalls. Further, in relation to potential impacts on natural features and built infrastructure, all impacts are predicted to be negligible and generally consistent with those approved under SSD 8445. All subsidence related impacts associated with the modification can be effectively controlled by the preparation and implementation of extraction plans and subsidence management plans, many of which have been successfully implemented during previous mining at Tahmoor Mine.

Similarly, with regards to potential impacts on water resources, the impacts as a result of the modification will remain substantially the same to those already approved for Tahmoor South. The updated site water balance demonstrates that the addition of LW S7A will not require any additional surface water management measures, and that the existing water management system will remain appropriate for the site.

The proposed modification will utilise existing mining infrastructure for coal handling and processing and will not require any additional surface infrastructure, changes to the existing and approved disturbance footprint, increase in the maximum annual ROM coal approved to be extracted, or increase the maximum annual volume of coal approved to be transported from site.

No surface disturbance activities are therefore proposed as part of the modification, and no direct impacts from any surface disturbance activities will occur to identified heritage or biodiversity values. Similarly, all amenity related impacts, such as those relating to air quality, visual and noise, will remain consistent with those previously assessed and approved for Tahmoor South.

The proposed modification represents a sustainable and efficient approach to extract available high-quality coking coal within the existing mining leases held by Tahmoor Coal. This is consistent with the obligations of Tahmoor Coal under the Mining Act to optimise resource recovery in an efficient and sustainable manner.

The addition of LW S7A to the A series of approved longwalls will not substantially change the approved activities authorised by SSD 8445. Further, the modification proposes to remove the restriction imposed by condition A6 of SSD 8445 for mining operations to be completed within 10 years from the commencement of second workings under SSD 8445; however, all approved and proposed mining operations under Mod 3 will still be completed by 31 December 2033, as also stipulated in condition A6. Therefore, the modified development will remain substantially the same development for which consent was originally granted, and the proposed modification can be considered under Section 4.55 of the EP&A Act.

# Abbreviations

| | |
|---|---|
| Aquifer Interference Policy | AIP |
| *Biodiversity Conservation Act 2016* | BC Act |
| Cast Iron Cement Lined | CICL |
| Department of Climate Change, Energy, the Environment and Water | DCCEEW |
| Ductile Iron Cement Lined | DICL |
| EMM Consulting Pty Ltd | EMM |
| *Environment Protection and Biodiversity Conservation Act 1999* | EPBC Act |
| *Environmental Planning and Assessment Act 1979* | EP&A Act |
| *Environmental Planning and Assessment Regulation 2021* | EP&A Regulation |
| *Fisheries Management Act 1994* | FM Act |
| greenhouse gas | GHG |
| Independent Planning Commission | IPC |
| kilotonne | kt |
| local government area | LGA |
| local strategic planning statement | LSPS |
| metre | m |
| millimetre | Mm |
| million tonne | Mt |
| million tonnes per annum (Mtpa | Mtpa |
| Mine Subsidence Engineering Consultants | MSEC |
| *Mining Act 1992* | Mining Act |
| National Greenhouse and Energy Reporting | NGER |
| National Greenhouse and Energy Reporting Act 2007 | NGER Act |
| *National Parks and Wildlife Act 1974* | NPW Act |
| New South Wales | NSW |
| Port Kembla Coal Terminal | PKCT |
| potential archaeological deposit | PAD |
| *Protection of the Environment Operations Act 1997* | POEO Act |
| *Roads Act 1993* | Roads Act |
| run-of-mine | ROM |
| SIMEC Mining Division | SIMEC |
| State Conservation Area | SCA |

| | |
|---|---|
| State Environmental Planning Policy (Resources and Energy) 2021 | Resources and Energy SEPP |
| Steel Cement Lined | SCL |
| Tahmoor Coal Pty Ltd | Tahmoor Coal |
| Tahmoor Coal Community Consultative Committee | TCCCC |
| tonnes per annum | tpa |
| terajoules | Tj |
| *Water Management Act 2000* | WM Act |
| water sharing plan | WSP |
| water access licence | WAL |
| *Work Health and Safety (Mines and Petroleum Sites) Act 2013* | WHS Mines and Petroleum Act |

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# Appendix A
## Schedule of lands

EMM
creating opportunities

| Lot | Plan | Lot | Plan | Lot | Plan | Lot | Plan | Lot | Plan | Lot | Plan |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | DP736476 | 29 | DP253459 | 115 | DP1236902 | 1 | DP608204 | 432 | DP9278 | 60 | DP2444 |
| 234 | DP751250 | 27 | DP253459 | 116 | DP1236902 | 1 | DP792546 | 433 | DP9278 | 2 | DP625491 |
| 26 | DP777104 | 28 | DP253459 | 117 | DP1236902 | 4 | DP634020 | 430 | DP9278 | 2 | DP567155 |
| 11 | DP775465 | 101 | DP595343 | 118 | DP1236902 | 163 | DP7567 | 42 | DP709731 | 21 | DP2444 |
| 233 | DP751250 | 104 | DP703678 | 119 | DP1236902 | 78 | DP7567 | 571 | DP9278 | 1 | DP567155 |
| 25 | DP777104 | 7 | DP9636 | 120 | DP1236902 | 2 | DP608204 | 598 | DP829722 | 20 | DP2444 |
| 1 | DP244794 | 103 | DP703678 | 121 | DP1236902 | 164 | DP7567 | 570 | DP9278 | 65 | DP2444 |
| 1 | DP500116 | 368 | DP9278 | 122 | DP1236902 | 79 | DP7567 | 450 | DP9278 | 64 | DP2444 |
| 1 | DP86284 | 358 | DP9278 | 123 | DP1236902 | 589 | DP790976 | 600 | DP9278 | 19 | DP2444 |
| 94 | DP869494 | 367 | DP9278 | 124 | DP1236902 | 60 | DP7567 | 599 | DP829722 | 623 | DP775309 |
| 92 | DP869494 | 5 | DP24972 | 125 | DP1236902 | 48 | DP7567 | 449 | DP9278 | 22 | DP2444 |
| 1 | DP877585 | 6 | DP24972 | 126 | DP1236902 | 47 | DP7567 | 2 | DP622650 | 23 | DP2444 |
| 21 | DP881044 | 361 | DP9278 | 127 | DP1236902 | 61 | DP7567 | 12 | DP818651 | 21 | DP2444 |
| 22 | DP881044 | 3 | DP24972 | 128 | DP1236902 | 49 | DP7567 | 11 | DP818651 | 2 | DP618917 |
| 1 | DP180408 | 4 | DP24972 | 129 | DP1236902 | 62 | DP7567 | 5 | DP26499 | 59 | DP2444 |
| 202 | DP852816 | 102 | DP595343 | 130 | DP1236902 | 50 | DP7567 | 4 | DP26499 | 58 | DP2444 |
| 201 | DP852816 | 24 | DP253459 | 131 | DP1236902 | 63 | DP7567 | 6 | DP26499 | 27 | DP2444 |
| 192 | DP832091 | 23 | DP253459 | 132 | DP1236902 | 51 | DP7567 | 7 | DP26499 | 42 | DP979250 |
| 30 | DP832105 | 22 | DP253459 | 133 | DP1236902 | 57 | DP7567 | 8 | DP26499 | 1 | DP194839 |
| 190 | DP832091 | 21 | DP253459 | 134 | DP1236902 | 16 | DP7567 | 4 | DP374559 | 40 | DP979250 |
| 16 | DP250750 | 32 | DP253459 | 135 | DP1236902 | 55 | DP7567 | 46 | DP8982 | 64 | DP2444 |
| 12 | DP250750 | 20 | DP253459 | 136 | DP1236902 | 2 | DP586802 | 64 | DP8982 | 72 | DP2444 |
| 14 | DP250498 | 19 | DP253459 | 137 | DP1236902 | 1 | DP586802 | 67 | DP8982 | 14 | DP2444 |
| 13 | DP250498 | 33 | DP253459 | 138 | DP1236902 | 62 | DP616907 | 94 | DP8982 | 16 | DP1212867 |
| 1 | DP812618 | 18 | DP253459 | 139 | DP1236902 | 61 | DP616907 | 68 | DP8982 | 17 | DP1212867 |
| 2 | DP812618 | 17 | DP253459 | 140 | DP1236902 | 70 | DP7567 | 93 | DP8982 | 18 | DP1212867 |
| 3 | DP812618 | 34 | DP253459 | 141 | DP1236902 | 69 | DP7567 | 65 | DP8982 | 27 | DP658457 |
| 4 | DP812618 | 35 | DP255955 | 142 | DP1236902 | 71 | DP7567 | 66 | DP8982 | 26 | DP658456 |
| 1 | DP633251 | 3 | DP9636 | 143 | DP1236902 | 72 | DP7567 | 45 | DP8982 | 24 | DP658454 |
| 5 | DP250750 | 6 | DP9636 | 144 | DP1236902 | 84 | DP7567 | 44 | DP8982 | 44 | DP979250 |
| 18 | DP250498 | C | DP374621 | 145 | DP1236902 | 68 | DP7567 | 89 | DP8982 | 43 | DP979250 |
| 3 | DP255768 | 3 | DP599365 | 146 | DP1236902 | 85 | DP7567 | 72 | DP8982 | 45 | DP979250 |
| 9 | DP616757 | 2 | DP599365 | 147 | DP1236902 | 86 | DP7567 | 1 | DP573625 | 60 | DP979250 |
| 2 | DP255768 | 359 | DP9278 | 148 | DP1236902 | 9 | DP7567 | 86 | DP8982 | 41 | DP979250 |
| 1 | DP249449 | 360 | DP9278 | 149 | DP1236902 | 10 | DP7567 | 85 | DP8982 | 11 | DP2444 |
| 2 | DP249449 | 1 | DP570518 | 150 | DP1236902 | 11 | DP7567 | 84 | DP8982 | 1 | DP618917 |
| 20 | DP250498 | 13 | DP253459 | 151 | DP1236902 | 12 | DP7567 | 141 | DP8982 | 171 | DP715217 |
| 19 | DP250498 | 14 | DP253459 | 152 | DP1236902 | 13 | DP7567 | 142 | DP8982 | 172 | DP715217 |
| 5 | DP812618 | 15 | DP253459 | 153 | DP1236902 | 24 | DP7567 | 143 | DP8982 | 65 | DP2444 |
| 16 | DP250498 | 65 | DP10669 | 154 | DP1236902 | 98 | DP7567 | 144 | DP8982 | 11 | DP1212867 |
| 15 | DP250498 | 1 | DP623314 | 155 | DP1236902 | 99 | DP7567 | 436 | DP9278 | 12 | DP1212867 |
| 16 | DP12084 | 53 | DP10669 | 156 | DP1236902 | 116 | DP7567 | 437 | DP9278 | 13 | DP1212867 |
| 17 | DP12084 | 16 | DP253459 | 157 | DP1236902 | 135 | DP7567 | 106 | DP1236902 | 14 | DP1212867 |
| 20 | DP12084 | 52 | DP10669 | 158 | DP1236902 | 117 | DP7567 | 107 | DP1236902 | 15 | DP1212867 |
| 21 | DP12084 | 51 | DP10669 | 159 | DP1236902 | 100 | DP7567 | 108 | DP1236902 | 2 | DP263330 |
| 22 | DP12084 | 37 | DP255955 | 160 | DP1236902 | 118 | DP7567 | 56 | DP1236125 | 10 | DP583245 |
| 15 | DP12084 | 43 | DP255955 | 161 | DP1236902 | 101 | DP7567 | 57 | DP1236125 | 91 | DP703032 |
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| 19 | DP12084 | 57 | DP255955 | 163 | DP1236902 | 102 | DP7567 | 101 | DP1236902 | 8 | DP979250 |
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| Lot | Plan | Lot | Plan | Lot | Plan | Lot | Plan | Lot | Plan | Lot | Plan |
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| 2 | DP622888 | 5 | DP262074 | 130 | DP1248998 | 96 | DP7567 | 44 | DP1236125 | 3 | DP2339 |
| 33 | DP255689 | 4 | DP262074 | 131 | DP1248998 | 114 | DP7567 | 45 | DP1236125 | 4 | DP2339 |
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| 3 | DP264153 | 9 | DP262074 | 98 | DP13127 | 108 | DP1029577 | 16 | DP10196 | 2 | DP2339 |
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| 160 | DP10336 | 161 | DP10669 | 1 | DP579477 | 6 | DP11845 | 24 | DP1230557 | 21 | DP806833 |
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| 157 | DP10336 | 91 | DP10669 | 52 | DP1121566 | 3 | DP11845 | 27 | DP1230557 | 41 | DP255955 |
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| 111 | DP10336 | 124 | DP10669 | 22 | DP1211933 | 4 | DP12096 | 6 | DP1230557 | 11 | DP10669 |
| 1 | DP590177 | 108 | DP10669 |  | SP93175 | 3 | DP12096 | 7 | DP1230557 | 3930 | DP1217241 |
| 2 | DP590177 | 125 | DP10669 | 3 | DP562297 | 2 | DP12096 | 8 | DP1230557 | 3931 | DP1217241 |
| 109 | DP10336 | 107 | DP10669 | 2 | DP562297 | 1 | DP12096 | 9 | DP1230557 | 190 | DP950890 |
| 108 | DP10336 | 19 | DP262360 | 1 | DP122883 | 51 | DP866493 | 5 | DP245153 | 1 | DP1210340 |
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| 11 | DP10336 | 21 | DP262360 | 2 | DP16911 | 101 | DP1007374 | 18 | DP1239573 | 912 | DP1204255 |
| 112 | DP10336 | 20 | DP262360 | 111 | DP751270 | 53 | DP866493 | 19 | DP1239573 | 911 | DP1204255 |
| 167 | DP10336 | 13 | DP262360 |  | SP21810 | 20 | DP1022412 | 20 | DP1239573 | 51 | DP1191488 |
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| 108 | DP9024 | 4 | DP1004732 | 1 | DP262150 | 63 | DP2444 | 301 | DP1033743 | 40 | DP2444 |
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| Lot | Plan | Lot | Plan | Lot | Plan | Lot | Plan | Lot | Plan | Lot | Plan |
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| 111 | DP9024 | 5171 | DP1007684 | 1 | DP1111097 | 36 | DP791760 | 6 | DP7567 | 70 | DP2444 |
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| 36A | DP301449 | 501 | DP1009611 | 11 | DP1176003 | 39 | DP793915 | 30 | DP7567 | 10 | DP635048 |
| 40A | DP301449 | 1 | DP263330 | 10 | DP1176003 | 40 | DP793915 | 29 | DP7567 | 100 | DP703682 |
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| 41 | DP9024 | 300 | DP8982 | 3751 | DP1190005 | 21 | DP2444 | 31 | DP7567 | 61 | DP2444 |
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| 21 | DP12975 | 3381 | DP1012649 | | SP92158 | 1 | DP714233 | 1 | DP579559 | 2 | DP565368 |
| 20 | DP12975 | 295 | DP8982 | 6033 | DP1223897 | 1 | DP785738 | 126 | DP7567 | 7 | DP2339 |
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| 15 | DP12975 | 297 | DP8982 | 2 | DP1012780 | A | DP348761 | 8 | DP7567 | 9 | DP2339 |
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| 24 | DP634256 | 1464 | DP1015024 | 6 | DP244846 | 43 | DP2444 | 168 | DP8982 | 16 | DP245323 |
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| B | DP420110 | 249 | DP8982 | 503 | DP9278 | 367 | DP748183 | 261 | DP8982 | 13 | DP245323 |
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| B | DP87022 | 4812 | DP1014861 | 34 | DP261754 | 5 | DP22773 | 228 | DP8982 | 7 | DP245323 |
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| 14 | DP840952 | 2062 | DP1014538 | 36 | DP261754 | 2 | DP746989 | 264 | DP8982 | 10 | DP245323 |
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| Lot | Plan | Lot | Plan | Lot | Plan | Lot | Plan | Lot | Plan | Lot | Plan |
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| 69 | DP13127 | 131 | DP1001217 | 10 | DP244846 | 93 | DP2444 | 283 | DP8982 | 3 | DP247831 |
| 68 | DP13127 | 23 | DP1015681 | 8 | DP244846 | 94 | DP2444 | 275 | DP8982 | 5 | DP247831 |
| 13 | DP13127 | 87 | DP10669 | 9 | DP244846 | 95 | DP2444 | 284 | DP8982 | 11 | DP247831 |
| 11 | DP13127 | 88 | DP10669 | 12 | DP244846 | 85 | DP2444 | 274 | DP8982 | 7 | DP247831 |
| 10 | DP13127 | 841 | DP879630 | 15 | DP244846 | 81 | DP2444 | 285 | DP8982 | 12 | DP247831 |
| 18 | DP13116 | 86 | DP10669 | 16 | DP244846 | 82 | DP2444 | 273 | DP8982 | 13 | DP247831 |
| 17 | DP13116 | 853 | DP1015904 | 14 | DP244846 | 83 | DP2444 | 286 | DP8982 | 15 | DP2339 |
| 591 | DP774743 | 852 | DP1015904 | 17 | DP244846 | 84 | DP2444 | 470 | DP9278 | 101 | DP1170839 |
| 73 | DP13127 | 851 | DP1015904 | 507 | DP9278 | 86 | DP2444 | 469 | DP9278 | 102 | DP1170839 |
| 74 | DP13127 | 842 | DP879630 | 45 | DP261754 | 87 | DP2444 | 524 | DP9278 | 4 | DP1180702 |
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| 141 | DP13127 | 530 | DP746569 | 53 | DP792010 | 76 | DP2444 | 114 | DP8982 | 872 | DP1191842 |
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| 118 | DP13127 | 4 | DP1024499 |  | SP39840 | 68 | DP2444 | 166 | DP8982 | 153 | DP1162213 |
| 117 | DP13127 | 6 | DP1024499 | 511 | DP841700 | 57 | DP2444 | 164 | DP8982 | 151 | DP1162213 |
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| 10 | DP787777 | 212 | DP1027845 | 42 | DP787244 | 7 | DP2444 | 270 | DP8982 | 105 | DP1199149 |
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| 5 | DP785866 | 1 | DP550036 | 52 | DP856292 | 9 | DP2444 | 5 | DP1239574 | 107 | DP1199149 |
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| 168 | DP13127 | 6 | DP877774 | 21 | DP1051285 | 23 | DP791760 | 11 | DP1242373 | 2 | DP1213698 |
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| 193 | DP13127 | 288 | DP8982 | 34 | DP1215451 | 44 | DP793915 | 40 | DP2444 | 25 | DP1239050 |
| 194 | DP13127 | 2912 | DP1037812 | 33 | DP1215451 | 45 | DP793915 | 534 | DP633872 | 26 | DP1239050 |
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| 4 | DP255248 | 2 | DP1041252 | 4 | DP1215451 | 58 | DP2444 | 4 | DP870819 | 3928 | DP1217239 |
| 3 | DP255248 | A | DP372440 | 3 | DP1215451 | 59 | DP2444 | 3 | DP870819 | 201 | DP1246186 |
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| 22 | DP262281 | 103 | DP1040257 | 7 | DP1215451 | 68 | DP2444 | 12 | DP1018596 | 206 | DP1246186 |
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| 25 | DP787855 | 11 | DP28039 | 193 | DP8982 | 1 | DP1238384 | 31 | DP1267360 | 16 | DP1255136 |
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| 19 | DP787855 | 65 | DP13116 | 7 | DP244681 | 57 | DP1149670 | 6 | DP1267360 | 5 | DP1255136 |
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| 121 | DP10336 | 22 | DP626646 | 16 | DP1207547 | 16 | DP13821 | 1 | DP126552 | 57 | DP10669 |
| 122 | DP10336 | 1 | DP118809 | 17 | DP1207547 | 17 | DP13821 | 1 | DP338852 | 5811 | DP1203513 |
| 123 | DP10336 | 240 | DP8982 | 18 | DP1207547 | 18 | DP13821 | 100 | DP751271 | 5812 | DP1203513 |
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| 139 | DP10336 | 239 | DP8982 | 20 | DP1207547 | 20 | DP13821 | 350 | DP775873 | 5 | DP1010127 |
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| 214 | DP751250 | 35 | DP285800 | 18 | DP730919 | 3022 | DP737100 | 258 | DP8982 | 313 | DP8982 |
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| 8 | DP747237 | 7 | DP1132496 | 612 | DP1203889 | 2 | DP262287 | 2 | DP1128745 | 258 | DP10669 |
| 25 | DP791621 | 9 | DP1132496 | 611 | DP1203889 | 3 | DP262650 | 1 | DP1128745 | 164 | DP10669 |
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| 18 | DP807880 | 1 | DP1137978 | 22 | DP2339 | 1 | DP568282 | 991 | DP732012 | 17 | DP1217860 |
| 10 | DP801222 | 7308 | DP1141189 | 151 | DP873266 | 6 | DP262287 | 19 | DP834318 | 18 | DP1217860 |
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| Lot | Plan | Lot | Plan | Lot | Plan | Lot | Plan | Lot | Plan | Lot | Plan |
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# Appendix B
## Subsidence assessment

EMM
creating opportunities

mine subsidence ENGINEERING CONSULTANTS

SIMEC

SIMEC Mining:

# Tahmoor Coal – Modification 3 - Longwall S7A

The effects of the proposed addition of LW S7A
on previous subsidence predictions and impact assessments

## DOCUMENT REGISTER

| Revision | Description | Author | Checker | Date |
|---|---|---|---|---|
| A | Draft | DJK | | Nov-23 |
| B | Final | DJK | AH/CW | Mar-24 |
| | | | | |
| | | | | |
| | | | | |

Report produced to:- Support an application to extract Tahmoor LW S7A to be submitted to the Department of Planning and Environment.

Previous reports:- MSEC1192 (Revision A) – Tahmoor South Project – Extraction Plan for Longwalls S1A to S6A - Subsidence ground movement predictions and subsidence impact assessments for natural features and surface infrastructure (May 2022)

Background reports available at *www.minesubsidence.com*:

Introduction to Longwall Mining and Subsidence (Revision A)

General Discussion of Mine Subsidence Ground Movements (Revision A)

Mine Subsidence Damage to Building Structures (Revision A)

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Fig. A.09 Predicted profiles of conventional subsidence, tilt and curvature along Caloola Road resulting from the extraction of LWs S1A to S7A App. A
Fig. A.10 Predicted profiles of conventional subsidence, tilt and curvature along Remembrance Drive resulting from the extraction of LWs S1A to S7A App. A
Fig. A.11 Predicted profiles of vertical subsidence, tilt and curvature along Remembrance Drive and the 150mm steel gas main resulting from the extraction of LWs S1A to S7A App. A

**Drawings**

Drawings referred to in this report are included in Appendix B at the end of this report.

| ***Drawing No.*** | ***Description*** | ***Revision*** |
|---|---|---|
| MSEC1348-01 | General layout | A |
| MSEC1348-02 | Surface level contours | A |
| MSEC1348-03 | Bulli Seam roof contours | A |
| MSEC1348-04 | Bulli Seam depth of cover contours | A |
| MSEC1348-05 | Extraction height | A |
| MSEC1348-06 | Geological structures at Bulli Seam level | A |
| MSEC1348-07 | Natural features | A |
| MSEC1348-08 | Main Southern Railway | A |
| MSEC1348-09 | Surface infrastructure | A |
| MSEC1348-10 | Archaeological and Heritage sites | A |
| MSEC1348-11 | Built features | A |
| MSEC1348-12 | Predicted incremental subsidence due to LW S7A | A |
| MSEC1348-13 | Predicted total subsidence due to LW S1A to LW S7A | A |
| MSEC1348-14 | Predicted total subsidence due to LW S1A to LW S6B | A |
| MSEC1348-15 | Proposed Subsidence Monitoring Plan | A |

## 1.1. Background

Tahmoor Coal owns and operates Tahmoor Mine, an existing underground coal mine that is located approximately 80 km south-west of Sydney in the Southern Coalfield of NSW. Tahmoor Coal is a wholly owned entity within the SIMEC Mining Division of the GFG Alliance group.

Mine Subsidence Engineering Consultants (MSEC) was previously commissioned by Tahmoor Coal to undertake subsidence predictions and impact assessments for the proposed Longwalls 101A to 106B in the Tahmoor South Domain area at Tahmoor Mine (Tahmoor South Project). Report No. MSEC1123 was issued in support of the EIS for these longwalls. The Department of Planning, Industry and Environment, granted Tahmoor Coal development consent for the Tahmoor South Project on 23 April 2021. This consent has subsequently been modified twice (Mod 1 and Mod 2).

On 20 May 2022, Tahmoor Coal lodged an Extraction Plan Application for the extraction of LWs S1A to S6A. Mine Subsidence Engineering Consultants (MSEC) was previously commissioned by Tahmoor Coal to undertake subsidence predictions and impact assessments for the proposed Longwalls S1A to S6A in the Tahmoor South Domain area at Tahmoor Mine. Report No. MSEC1192 (Revision A) was issued during May 2022 in support of the Extraction Plan Application for these longwalls. The Department of Planning, Industry and Environment, granted Tahmoor Coal approval for extraction of LW S1A to S6A on 20 September 2022.

The longwall layout adopted in Report No. MSEC1192 is referred to as the *Approved Layout* in this report.

Tahmoor Coal is currently extracting LW S2A and proposes to extract an additional longwall panel, Longwall S7A (LW S7A) to the A series compared to *Approved Layout* adopted in Report No. MSEC1192. The proposed LW S7A represents the third modification to the development consent (Modification 3) and the proposed longwall layout including LW S7A is referred to as the *Modified Layout* in this report.

LW S7A has been included following a revision of the geological interpretation of the location of the Central Fault, which is located to the south west of the Tahmoor South Project. The commencing end of LW S7A has been shortened compared to LW S6A for the purposes of reducing the potential for subsidence effects on the urban area of Bargo township.

This subsidence report will support the Modification 3 application for the addition of LW S7A, which will be submitted to the Department of Planning and Environment. The location of LW S7A has been overlaid on an aerial photograph, as shown in Fig. 1.1.

## 1.2. Mining geometry

The locations of the longwalls in the Tahmoor South Domain are shown in Drawing No. MSEC1348-01, in Appendix B. The location of LW S7A based on the Modified Layout is shown in orange in this drawing.

A summary of the dimensions of LW S7A is provided in Table 1.1.

**Table 1.1 Dimensions of LW S7A based on the Modified Layout**

| Layout (Report No.) | Longwall | Overall void length including installation heading (m) | Overall void width including first workings (m) | Overall tailgate chain pillar width (m) |
|---|---|---|---|---|
| Modified Layout (MSEC1348) | LW S7A | 1,918 | 285 | 36 |

## 1.3. Surface and seam

The Tahmoor South Domain area at Tahmoor Mine is located between Tahmoor's surface facilities to the north and the township of Bargo to the south. The terrain directly above LW S7A is relatively flat such that the surface level above LW S7A varies between approximately 320 metres above Australian Height Datum (m AHD) and 350 m AHD. The surface level contours are shown in Drawing No. MSEC1348-02.

The seam roof contours are shown in Drawing No. MSEC1348-03. The Bulli Seam generally dips from the south-west towards the north-east with an average gradient of 5 % (i.e. 1 in 20) across the mining area.

The depth of cover contours are shown in Drawing No. MSEC1348-04. The depth of cover directly above LW S7A varies between approximately 375 m and 385 m.

The A series longwalls are approved to extract coal from the Bulli Seam. Tahmoor Coal has revised its forecast extraction heights since the previous predictions were provided in Report No. MSEC1192. The changes are generally minor for the A series longwall panels, in the range of 50 to 100 mm greater than previously forecast. Tahmoor Coal proposes to extract a minimum height of 2.1 metres and maximum extraction height of 2.6 metres within LW S7A, as shown in Drawing No. MSEC1348-05. The surface and seam levels across LW S1A to LW S7A are shown in Fig. 1.2.

**Fig. 1.1 Location of LW S7A overlaid on aerial photograph**

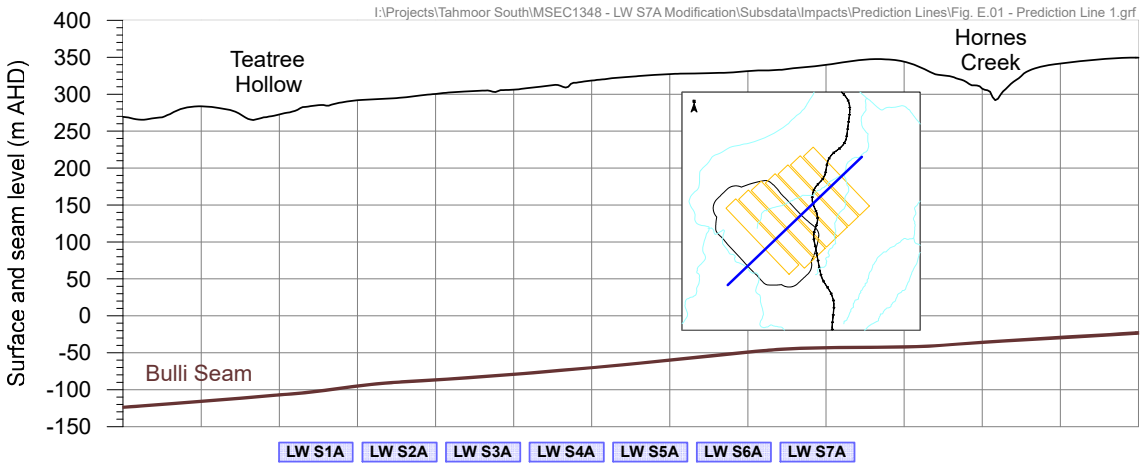



**Fig. 1.2 Surface and seam levels along the Prediction Line across LWs S1A to S7A**

## 2.1. Maximum predicted conventional subsidence effects

The Incremental Profile Method (IPM) was previously used to predict the conventional subsidence parameters resulting from the extraction of the approved LW S1A to S6A at Tahmoor, which were provided in Report No. MSEC1192.

The Incremental Profile Method has also been used to predict the conventional subsidence parameters resulting from the extraction of LW S7A, based on the *Modified Layout.*

The predicted incremental subsidence contours due to the extraction of LW S7A, based on the *Modified Layout*, are shown in Drawing No. MSEC1348-12. The predicted total subsidence contours after the extraction of LW S7A, based on the *Modified Layout*, are shown in Drawing No. MSEC1348-13.

The predicted 20 mm incremental and total subsidence contour lines are shown in Drawing No. MSEC1348-01. The predicted total 20 mm subsidence contour line, based on the *Approved Layout*, is also shown in the drawing for comparison. Predicted profiles across LWs S1A to S7A are shown in Fig. A.01, which is included in Appendix A at the back of this report.

The predicted total subsidence contours for the Tahmoor South Project after the extraction of LW S6B, based on the *Modified Layout* is shown in Drawing No. MSEC1348-14. It is noted, however, that Tahmoor Coal has not finalised its mine design for the B series longwall panels. The layout for the B series longwall panels differ from the layout presented in the EIS (Report N. MSEC1123) because some panels have been shortened due to the realignment of the central mains.

The predictions for LWs S1A to S6B have been provided to illustrate the effect of Modification 3 on the whole Tahmoor South Project but the mine layout may change in future when the design for the B series panels is finalised.

A summary of the maximum predicted values of incremental conventional subsidence, tilt and curvature, due to the extraction of LWs S1A to S6A under the *Approved Layout* and LW S7A, based on the *Modified Layout*, is provided in Table 2.1. The predicted tilts provided in this table are the maxima after the completion of each longwall. The predicted curvatures are the maxima at any time during or after the extraction of each longwall.

**Table 2.1 Maximum predicted incremental conventional subsidence, tilt and curvature resulting from the extraction of LWs S1A to S7A**

| Longwall | Maximum predicted incremental conventional subsidence (mm) | Maximum predicted incremental conventional tilt (mm/m) | Maximum predicted incremental conventional hogging curvature ($km^{-1}$) | Maximum predicted incremental conventional sagging curvature ($km^{-1}$) |
|---|---|---|---|---|
| ***Approved Layout*** | | | | |
| LW S1A | 800 | 7.0 | 0.08 | 0.22 |
| LW S2A | 950 | 7.5 | 0.08 | 0.22 |
| LW S3A | 950 | 8.0 | 0.09 | 0.22 |
| LW S4A | 950 | 8.0 | 0.09 | 0.22 |
| LW S5A | 950 | 8.0 | 0.10 | 0.22 |
| LW S6A | 975 | 8.3 | 0.09 | 0.23 |
| ***Modified Layout*** | | | | |
| LW S7A | 1,050 | 8.9 | 0.10 | 0.24 |

It can be seen from the above table, that the predicted maxima, based on the *Modified Layout*, are similar to those based on the *Approved Layout*. The differences in the predicted maximum parameters due to the proposed modification are not considered to be significant.

As shown in Drawing No. MSEC1348-12, the maximum predicted incremental subsidence due to the proposed extraction of LW S7A is located above the commencing end of the panel. This is because planned extraction heights are greatest in this location. As shown in Fig. 1.1, the commencing end of LW S7A is located directly beneath open farmland.

A summary of the maximum predicted total conventional subsidence, tilt and curvature, based on the *Approved and Modified* Layout are provided in Table 2.2. The values in this table are the maxima anywhere above the longwalls, and at any time during or after extraction of the longwalls.

**Table 2.2 Maximum Predicted Total Conventional Subsidence, Tilt and Curvature resulting from the extraction of LWs S1A to S7A**

| Layout | Maximum Predicted Total Conventional Subsidence (mm) | Maximum Predicted Total Conventional Tilt (mm/m) | Maximum Predicted Total Hogging Curvature ($km^{-1}$) | Maximum Predicted Total Sagging Curvature ($km^{-1}$) |
|---|---|---|---|---|
| ***Approved Layout*** | | | | |
| After LW S6A | 1,350 | 9.5 | 0.14 | 0.24 |
| After LW S6B | 1,600 | 10.5 | 0.18 | 0.28 |
| ***Modified Layout*** | | | | |
| After LW S7A | 1,400 | 10.0 | 0.14 | 0.25 |
| After LW S6B | 1,600 | 10.5 | 0.18 | 0.28 |

When comparing maximum predicted total subsidence parameters for the A series longwalls, it can be seen that the addition of LW S7A is predicted to result in a small increase in maximum total subsidence but negligible change in predicted maximum tilt and curvature.

When comparing maximum predicted total subsidence parameters for the A and B series longwalls, it can be seen that there is negligible change to the predictions. This is because predicted maximum subsidence due to the extraction of the B series longwalls is greater than the A series.

## 2.2. Effect of revision of planned extraction heights

Tahmoor Coal has revised its forecast extraction heights since the previous predictions were provided in Report No. MSEC1192. The changes are generally minor for the A series longwall panels, in the range of 50 to 100 mm greater than previously forecast.

It is noted, however, that forecast extraction heights at the commencing end of LW S7A are greater than previously planned for LWs S1A to S6A, such that predicted maximum incremental subsidence due to the extraction of LW S7A is greater in this area. The planned extraction heights for the rest of the longwall panel are similar in magnitude compared to the rest of the A series longwalls and predicted incremental subsidence due to the mining of LW S7A is similar to the predictions for the rest of the A series longwalls, as demonstrated in Fig. A.01.

A comparison of predicted conventional subsidence due to the extraction of LWs S1A to S6A between the predictions that were previously provided in Report No. MSEC1192 and predictions based on revised extraction heights is shown in Fig. 2.1 and Table 2.3.

**Table 2.3 Comparison of Maximum Predicted Total Conventional Subsidence, Tilt and Curvature resulting from the extraction of LWs S1A to S6A due to revision of extraction heights**

| Layout | Maximum Predicted Total Conventional Subsidence (mm) | Maximum Predicted Total Conventional Tilt (mm/m) | Maximum Predicted Total Hogging Curvature ($km^{-1}$) | Maximum Predicted Total Sagging Curvature ($km^{-1}$) |
|---|---|---|---|---|
| ***Approved Layout (MSEC1192)*** | | | | |
| After LW S6A | 1,350 | 9.5 | 0.14 | 0.24 |
| ***Modified Layout with revised extraction heights*** | | | | |
| After LW S6A | 1,400 | 10.0 | 0.14 | 0.25 |

As shown in Fig. 2.1 and Table 2.3, the predicted increases in subsidence, tilt and curvature due to the revision in extraction height is relatively minor. The predictions do not materially change the assessment of potential impacts on natural and built features, nor our recommendations for managing potential impacts to natural and built features as previously provided in Report Nos. MSEC1123 (EIS) and MSEC1192 (Extraction Plan for LWs S1A to S6A).

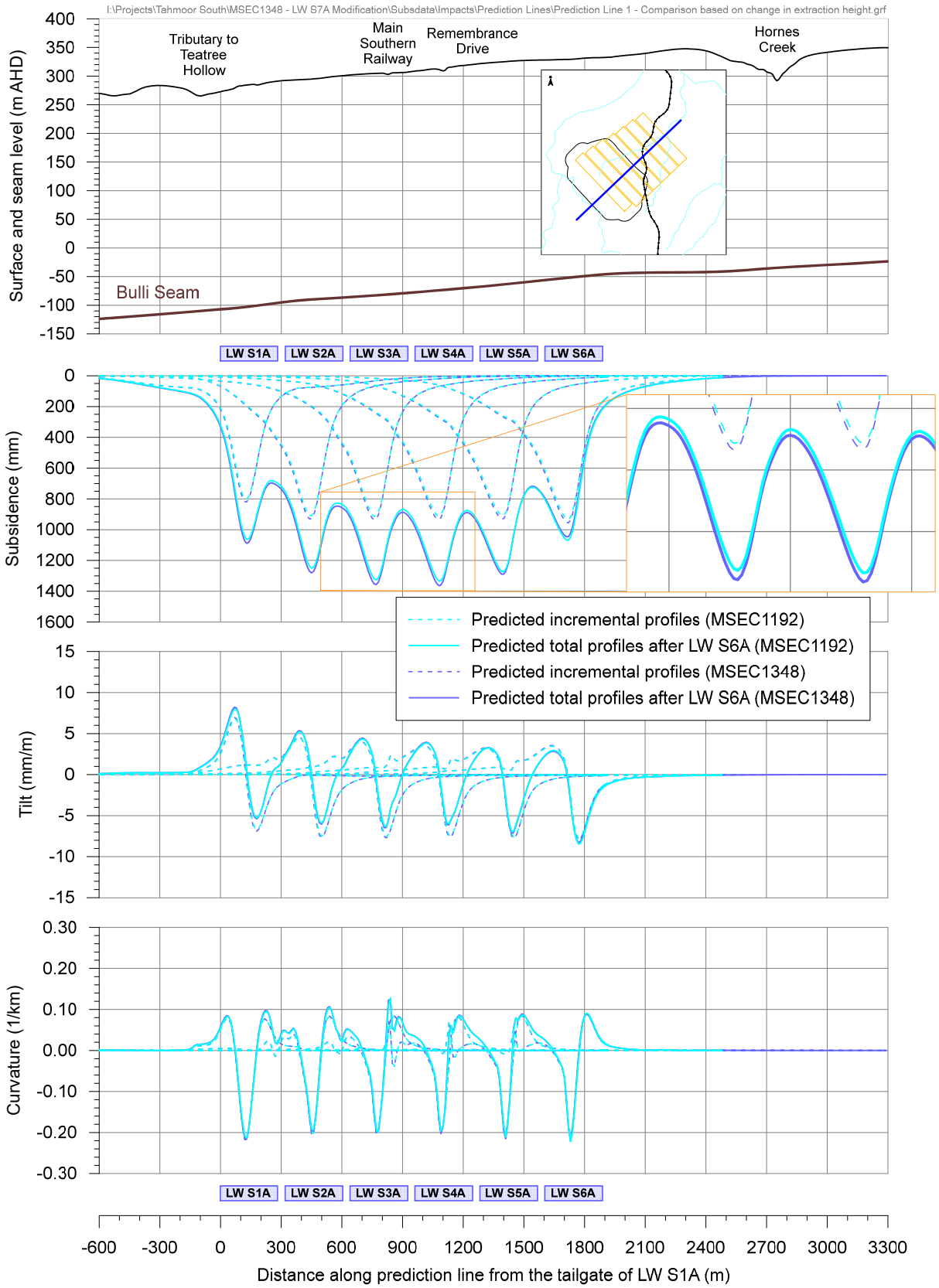



**Fig. 2.1 Predicted subsidence, tilt and curvature across LWs S1A to S7A**

For the purposes of providing clarity, this report will focus on predicted subsidence movements and potential impacts on natural and built features due to the addition of LW S7A only, rather than comment on the very minor changes in predicted movements due to the revised forecast of extraction heights within the broader mining domain of LW S1A to S6A.

## 2.3. Comparison between Observed and Predicted Subsidence during the mining of LWs S1A and S2A

Extensive monitoring has been undertaken by Tahmoor Coal during the mining of LWs S1A and S2A. Observed incremental subsidence due to the extraction of LWs S1A and LW S2A has correlated reasonably well with predictions, as shown in Fig. 2.2, Fig. 2.4 and Fig. 2.5.

Subsidence was observed to vary in magnitude along the centreline of LW S1A. Maximum subsidence was measured at Peg V51 on the V-Line, which is located between Teatree Hollow and the Tributary to Teatree Hollow. Observed subsidence was reduced in magnitude on the northern half of the longwall panel at the Main Southern Railway and Tahmoor Mine Site (Pier 2).

As shown in Fig. 2.2, observed subsidence at Peg V51 was slightly greater than predicted but within the accuracy of the prediction model of ± 15% (Reports Nos. MSEC1123 and MSEC1192). Observed subsidence at other locations above LW S1A was less than predicted.

As at January 2024, monitoring during the mining of LW S2A has measured subsidence movements developing within predictions, as shown in Fig. 2.3.

As recommended in Report No. MSEC1192, monitoring will be conducted during mining to compare observations with predictions. TC has extensive experience in successfully managing potential subsidence impacts on surface features, even when actual subsidence is substantially greater than the magnitudes that have been predicted above LW S7A. It is recommended that subsidence management plans be developed to manage potential impacts that could occur if greater than predicted subsidence occurs.

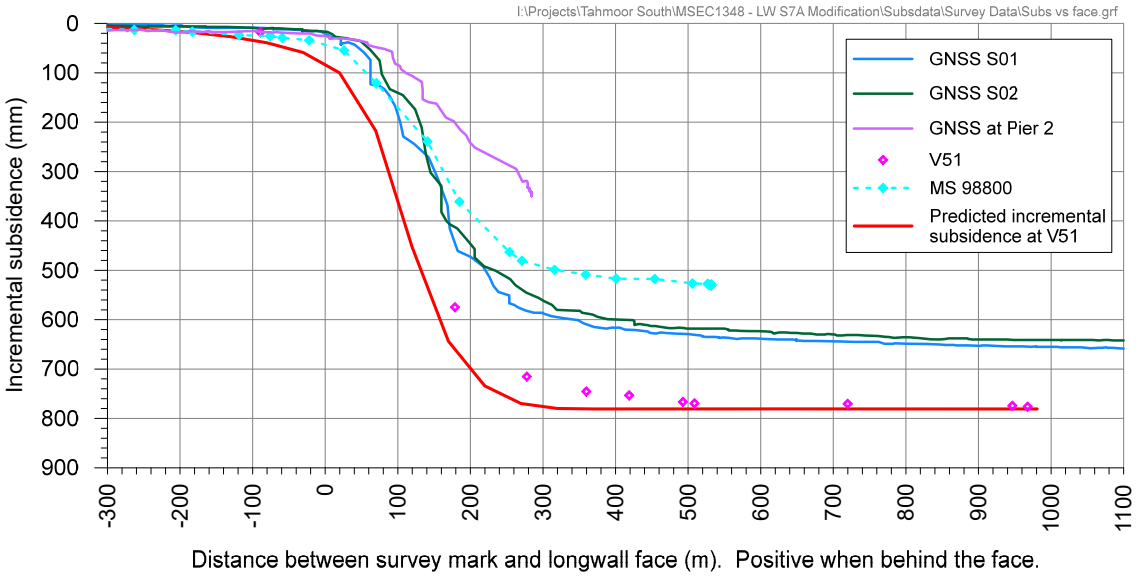



**Fig. 2.2 Comparison between predicted and observed subsidence above centreline of LW S1A**

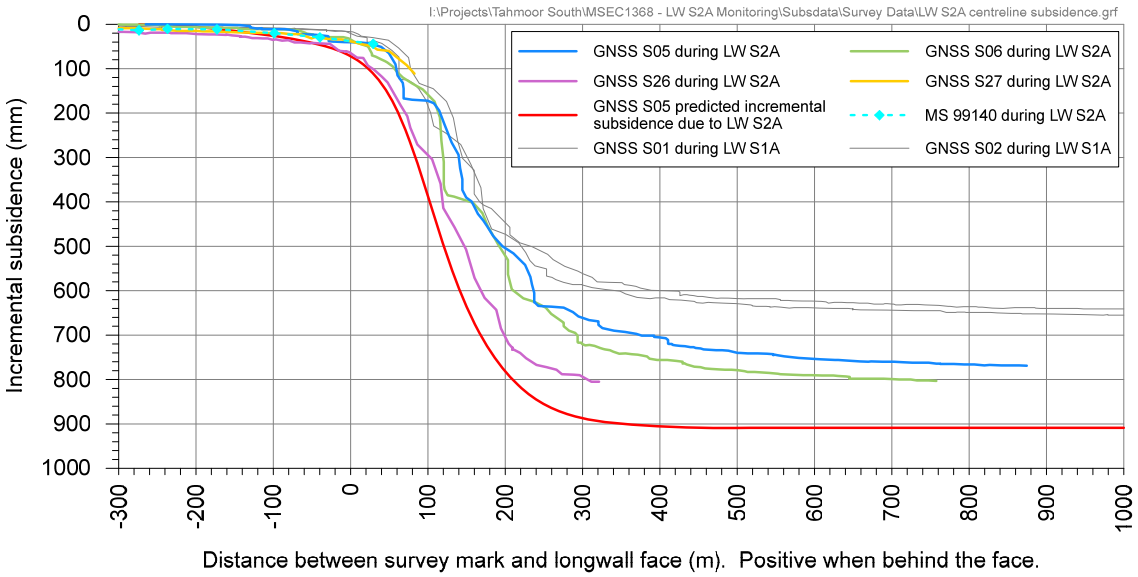



**Fig. 2.3 Comparison between predicted and observed subsidence above centreline of LW S2A**

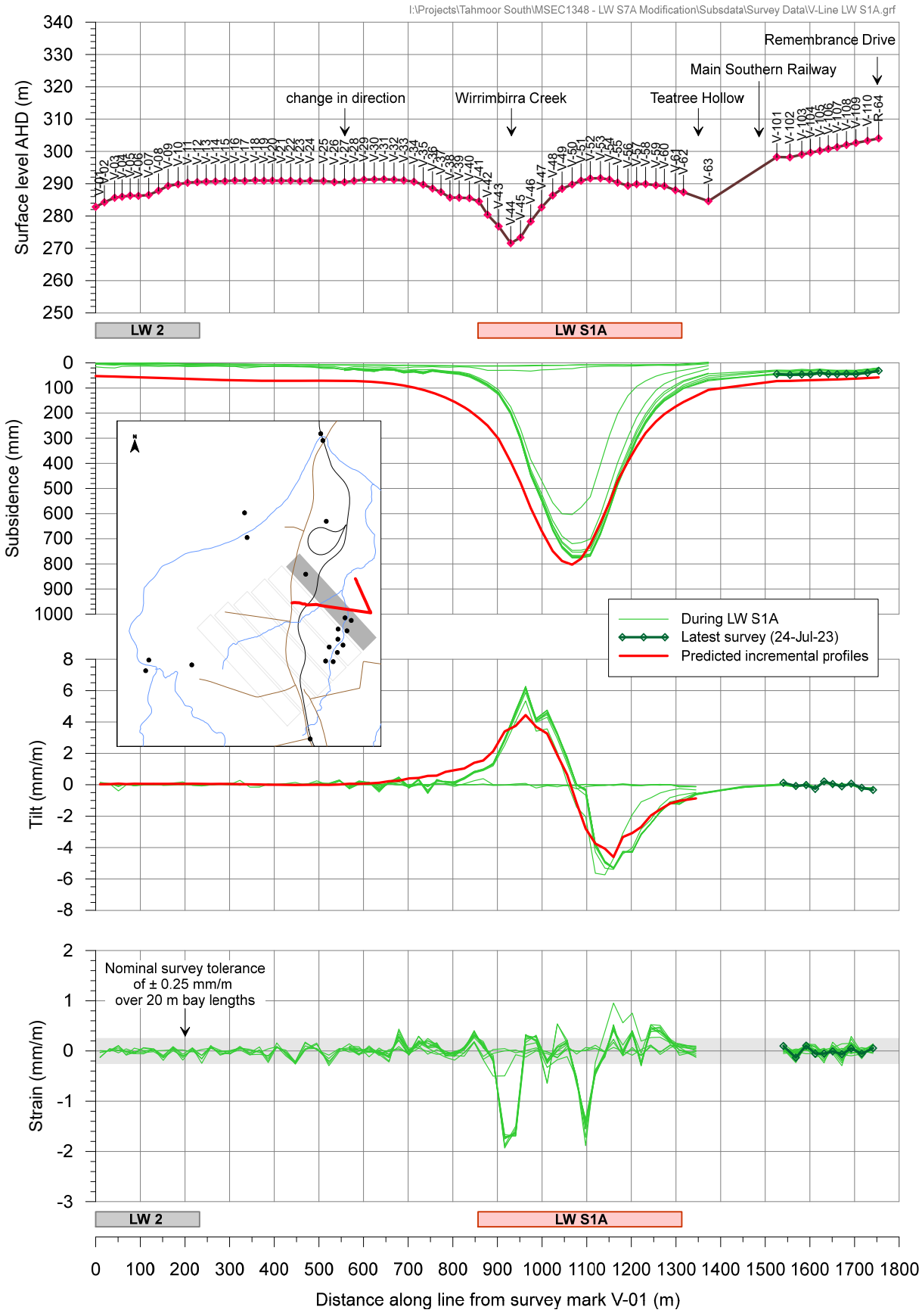



**Fig. 2.4 Observed subsidence along V Line during the mining of LW S1A**

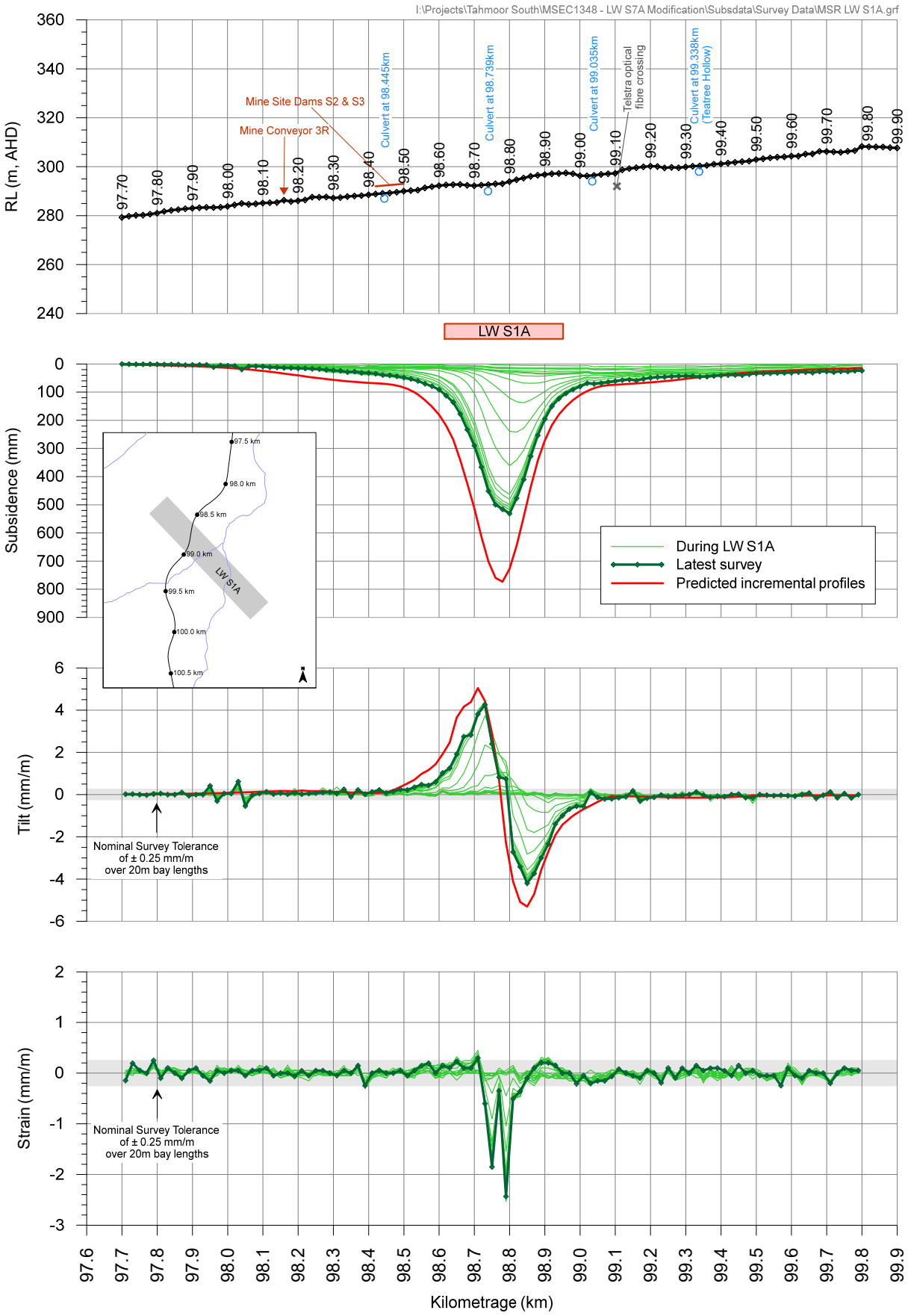



**Fig. 2.5 Observed subsidence along Main Southern Railway during the mining of LW S1A**

## 2.4. Potential for increased subsidence

As discussed in Report No. MSEC1123 (EIS), increased subsidence was observed above several previously extracted Longwalls, i.e. Longwall 8, Longwall 13, Longwall 24A and above the commencing ends of Longwalls 24A to 27 and above the commencing end of Longwall 32. Increased subsidence was also observed above the commencing end of LW W4.

The cause for the increased subsidence over Longwall 24A and above the commencing end of Longwall 25 was investigated by Strata Control Technology on behalf of Tahmoor Coal, (Gale and Sheppard, 2011). The investigations concluded that the increased subsidence is consistent with localised weathering of joint and bedding planes above a depressed water table adjacent to an incised gorge. The continued monitoring of the increased subsidence over Longwalls 26 and 27 confirmed that the extent of the increased subsidence reduced with increasing distance from the Bargo River Gorge and the northern end of a mapped fault echelon structure.

The observation above the commencing end of Longwall 32 and the commencing end of LW W4 has shown that increased subsidence has developed where mining has occurred close to other mapped first order fault echelon structures associated with the Nepean Fault.

It is worthwhile noting that Longwalls 10A, 10B, and 12 are also located near the Nepean Fault and the Bargo River and there was a reasonable correlation between observed and predicted subsidence along the available monitoring lines. Similarly, many longwalls have been extracted close to major river valleys and gorges and there were reasonable correlations between observed and predicted subsidence along all the available monitoring lines. Accordingly, it appears that the location of the zones of increased subsidence is linked to both the;

- close proximity to and the alignment of the Nepean Fault, and
- close proximity to the Bargo River Gorge, which is approximately 100 metres deep, which permitted groundwater flows to weather the joint and bedding plane properties of the surrounding strata.

The proposed LW S7A runs adjacent and approximately parallel to the Central Fault complex, which is located on the western side of the mining area. The Central Fault zone lies to the west and south of the proposed LW S7A, was described by MBGS (2013) as a normal fault trending northwest with vertical displacement up to 20 metres, east side up. This fault was identified in the 2D seismic lines and was also intercepted in one drill hole (JB06) where the Wongawilli Seam has been displaced. The Gordon Geotechniques (2013) report advised that this Central Fault zone was associated with a number of features including a change in Bulli Seam fluidity and thinning of the Balgownie to Bulli Seam interburden. The downstream part of Hornes Creek follows the surface expression of the Central Fault. Further analyses of exploration data has improved confidence in defining the location of the Central Fault, which has allowed Tahmoor Coal to propose extraction of LW S7A. Since the Extraction Plan of LW S1A to S6A was approved, Tahmoor Coal has also drilled boreholes on both ends of the Picton Weir. The fault was not observed by PSM (2023) during the geological field mapping and the boreholes did not intercept it.

It is possible that increased subsidence may develop above LW S7A but this is not certain for the following reasons:

- The Central Fault is less defined in the Tahmoor South area compared to the Nepean Fault in the Tahmoor North area, and
- The measured groundwater gradients in the Tahmoor South area are less than those measured near Longwalls 24A to 26.

If greater than predicted subsidence was to occur above the proposed longwalls, it is unlikely that the magnitude of this increased subsidence will be much greater than the predictions for the following reasons:

- Predicted maximum incremental subsidence is 1,150 mm, which represents approximately 45 % to 52 % of the proposed extraction height. Maximum observed incremental subsidence above Longwalls 24A to 27 was approximately 55 % of the extraction height.
- Predicted maximum total subsidence is 1,650 mm, which represents approximately 63 % of the proposed extraction height. Maximum observed total subsidence above Longwalls 24A to 27 was approximately 62 % of the extraction height.
- The higher levels of predicted subsidence at Tahmoor South are due to a combination of greater extraction heights and slightly shallower depths of cover. They are comparable to or just less than the observed increased subsidence above Longwalls 24A to 27 when expressed as a proportion of extraction height.
- In the cases of Longwalls 24A and 25, the observed maximum subsidence was greater than predictions by between 2 to 2.3 times. This was partly because the panels were the first and second in a series of longwalls where reduced subsidence would normally have been expected to develop. Increasing the predicted levels of subsidence by factors of 2 to 2.3 would result in subsidence much greater than the proposed extraction height, which is extremely unlikely to occur.

While the potential exists for increased subsidence to occur above LW S7A adjacent to the Central Fault, it is important to note that the potential impacts on surface infrastructure from this extra subsidence can be managed, as it was managed over Longwalls 24A to 27, Longwall 32 and Longwall W4, so that they remain safe and serviceable during and after the mining period with the implementation of effective management measures. When required, these measures would include;

- A detailed pre-mining assessment of the potential impacts on surface infrastructure in the event that increased subsidence occurs.
- Monitoring of subsidence movements above and beyond the proposed mining footprint, including across the projected location of the Central Fault on the surface.
- Monitoring of the condition of surface infrastructure during and after the mining period.
- Implementation of planned early intervention measures to further protect the safety and serviceability of surface infrastructure based on pre-determined trigger levels based on monitoring data.
- If increased subsidence were to occur during the mining of a proposed longwall, consideration of whether to continue mining future longwalls at the same commencing and/or finishing ends as proposed or make amendments to avoid future increased subsidence.

## 2.5. Predicted Strain

It is important to appreciate that the extraction of coal not only results in subsidence, but, it also induces horizontal ground movements and ground strains, and, unlike subsidence, which is measured vertically, it is important to appreciate that these parameters have both a magnitude and a direction. The magnitude of the measured ground strains can be sensitive to the ground distances over which they were measured, and, both the measured ground strains and horizontal movements are very sensitive to the direction in which they were measured. Hence, strain and horizontal movements are more complex, and they are more difficult to predict than subsidence, tilt and curvature.

The profiles of observed strain along monitoring lines, therefore, were often irregular in shape even when the profiles of observed subsidence, tilt and curvature were relatively smooth.

Early researchers noticed the similarity between the observed curvature and strain profiles and the similarity between the observed tilt and horizontal movement profiles. Hence, it was logical that the early strain prediction methods were based on linear relationships with predicted conventional curvature and the early horizontal ground movement prediction methods were based on linear relationships with predicted conventional tilt.

The locations that are predicted to experience hogging or convex curvature are expected to be net tensile strain zones and the locations that are predicted to experience sagging or concave curvature are expected to be net compressive strain zones and adopting a linear relationship between curvature and strain provided a reasonable prediction for the maximum conventional tensile and compressive strains.

In the Southern Coalfield, it was found that a curvature to conventional strain conversion factor of 15 provided a reasonable relationship between the maximum predicted curvatures and the maximum predicted conventional strains. Similarly, a tilt to conventional horizontal movement conversion factor of 15 was found to provide a reasonable relationship between the maximum predicted tilt and the maximum predicted conventional horizontal movement.

However, it was noticed that, whilst these correlations were reasonable for the maximum values of these parameters over some areas of the mined panels, they were not as reliable in many other areas, particularly in those locations that were beyond the edges of the mined panels that were near changes in geological conditions. It was also noted that survey tolerance and valley related movements can represent a high proportion of measured ground strains and horizontal displacements.

The limited accuracy of strain and horizontal movement predictions at locations away from the point of maximum strain and horizontal movement was discussed in later subsidence prediction reports where it was stated that the measured strains and horizontal ground movements at a point can vary considerably from the predicted conventional values. It was noted that the locations that were predicted to experience hogging or convex curvature experienced net tensile strain zones and the locations that were predicted to experience sagging or concave curvature experienced net compressive strain zones, but, it was highlighted that the observed strain and horizontal movement profiles along monitoring lines were irregular in shape, with an occasional spike, compared to the observed subsidence, tilt and curvature profiles which were relatively smooth. Hence, it was concluded that, whilst the prediction of vertical subsidence and tilt at a point could be carried out with reasonable accuracy and reliability, the prediction of mining-induced ground strains and horizontal movements at a point was far less accurate, especially when those predictions used linear conversion factors that were based on predicted conventional curvature and tilt.

Furthermore, the horizontal movement predictions at a point were rarely provided and the predictions of ground strains are usually provided based on statistical basis, as is detailed in Section 2.5.1.

However, strain is one of the most important parameters for assessing the likelihood of mine subsidence damage to natural features and built features on the surface. Recent research has resulted in some improved understanding and methods for predicting ground strains and relative horizontal movements in zones across mined panels at the surface, (Barbato, 2016, 2017). These new methods for predicting strain have been developed dependent on the mining geometry, surface topography, surface geology and the likelihood of irregular anomalous movements.

The predicted distribution of strains using this new method also provides guidance on the magnitudes of localised spikes and the likelihoods of exceeding strain thresholds based on previously measured ground monitoring data (Barbato et al., 2016 and 2017).

The reasons why ground strains and horizontal movements are more complex and difficult to predict than subsidence, tilt and curvature are partly associated with the observation that, while the strata has only one direction to move,( i.e. vertically downwards), it can be moved in two directions horizontally and it has been observed that the ground will move wherever it is easiest to go. Additionally, studies have noted that ground strains and horizontal movements are influenced/affected by many multiple factors and a complex interaction of many mechanisms, including the:

- magnitude of the vertical subsidence, tilt and the depth of cover;
- steepness and direction of the surface topography;
- steepness and direction of the seam dip;
- direction of mining in relation to both the surface and seam slope;
- geology, geomechanical properties and thicknesses of the near surface strata, as well as, all the overburden strata layers, the seam and the strata layers immediately under the seam;
- presence of geological faults, pre-existing natural joints and igneous intrusions;
- magnitude and principal direction of the in situ horizontal compressive stresses in the strata layers around the mined goaf and the surface strata layers;
- presence and proximity of previously extracted panels in the currently mined seam and previously extracted panels in other seams;
- behaviour of blocky sandstone environments where initial ground movements occur predominantly along pre-existing natural joints, the location of which would not be known;
- limited ability of opened joints to close fully during the following compression phases after the initial shearing and tensile movements;
- reversing component that seems to initially move surveyed surface pegs towards the longwall face as the face approaches and, then, after the face extracts under and away from this peg, the surface is moved back towards its initial position and often it is moved further past that position as it follows the mining face; and
- other contributing factors such as the degree of surface roughness and frictional resistance along the bedding planes, survey accuracy or survey tolerance (especially where the strains are of a low order of magnitude), the presence of groundwater flows along the bedding planes and its influence on the slippage along bedding planes, etc.

Nevertheless, it has been concluded that the curvature to conventional strain conversion factor and the tilt to horizontal movement conversion factor can be used to provide a reasonable indication of the maximum conventional strains and horizontal movements over extracted panels.

Using the maximum predicted conventional curvatures of 0.14 $km^{-1}$ hogging and 0.25 $km^{-1}$ sagging curvature and the conventional strain conversion factor of 15, the maximum predicted conventional strains for the proposed LWs S1A to S6A, are approximately 2.1 mm/m tensile and 3.8 mm/m compressive.

At specific points around the mined panels, however, there can be considerable variation from this linear curvature to conventional strain relationship, resulting from non-conventional movements and a wide range of scatter is observed between the predicted and observed strain profiles. When expressed as a percentage, observed strains can be many times greater than the predicted conventional strain for low magnitudes of curvature. In this report, therefore, MSEC has provided a statistical approach to predict observed strain and hence account for this variability, instead of just providing a single predicted conventional strain.

The range of potential strains above the proposed longwalls has been determined using monitoring data from the previously extracted longwalls at Tahmoor Mine, as well as from other nearby collieries, including Appin and West Cliff, where the regional geology and mining geometries are reasonably similar to that for the proposed longwalls. A summary of the monitoring lines that were used in the strain analysis is provided in Table 2.4 and Table 2.5 shows the mining geometry for the proposed longwalls.

**Table 2.4 Monitoring lines used in the strain analysis**

| Location | Monitoring Lines | Longwall Widths (m) | Depths of Cover (m) | Width-to-Depth Ratios | Extraction Heights (m) |
|---|---|---|---|---|---|
| Early longwall areas at Tahmoor Mine | 100-Line | 190 | 410 | 0.47 | 2.0 |
| | 200-Line | 190 | 410 | 0.46 | 1.9 |
| | 300-Line | 190 ~ 240 | 430 | 0.47 | 2.2 |
| | 800-Line | 235 | 420 | 0.56 | 2.1 |
| | 900-Line | 235 | 420 | 0.56 | 2.0 |
| | 1000-Line | 190 ~ 240 | 400 | 0.57 | 1.8 |
| Northern areas over Tahmoor | 40 monitoring lines located outside the area of '*increased subsidence*' | 285 | 425 ~ 470 *(440 average)* | 0.60 ~ 0.67 *(0.64 average)* | 1.7 ~ 2.3 *(2.1 average)* |
| Appin Area 3 | M-Line | 260 | 480 ~ 520 *(500 average)* | 0.50 ~ 0.54 *(0.52 average)* | 2.6 ~ 3.0 *(2.8 average)* |
| Appin Area 7 | HW2 East, HW2 West, ARTC and Moreton Park Road | 305 | 500 ~ 560 *(530 average)* | 0.54 ~ 0.61 *(0.58 average)* | 2.8 ~ 3.2 *(3.0 average)* |
| West Cliff Area 5 | B-Line | 305 | 490 ~ 530 *(510 average)* | 0.58 ~ 0.62 *(0.60 average)* | 2.4 ~ 3.0 *(2.6 average)* |

**Table 2.5 Mining geometry for the proposed LWs S1A to S7A**

| Location | Longwall Widths (m) | Depths of Cover (m) | Width-to-Depth Ratios | Extraction Heights (m) |
|---|---|---|---|---|
| LW S1A to LW S7A | 283-285 | 375 ~ 410 *(390 average)* | 0.69 ~ 0.76 *(0.73 average)* | 2.1 ~ 2.6 *(2.2 average)* |

It can be seen from the above tables, that the extraction heights for the LWs S1A and S6A and the proposed LW S7A vary between 2.1 metres and 2.6 metres, which are similar to those for the previously extracted longwalls at Tahmoor Mine, which varied between 1.7 metres and 2.3 metres, but is less on average than those for the previously extracted longwalls at Appin and West Cliff Collieries, which varied between 2.4 metres and 3.2 metres. That is, the extraction heights for the proposed longwalls are within the ranges of those for the previously extracted longwalls at Tahmoor, Appin and West Cliff Collieries.

The width-to-depth ratios for the proposed longwalls varies between 0.69 and 0.76, which are slightly greater than those for the previously extracted longwalls at Tahmoor, Appin and West Cliff Collieries, which varied between 0.46 and 0.67. Unfortunately, there is limited available ground monitoring data from previously extracted longwalls in the Southern Coalfield where the width-to-depth ratios are exactly similar to the proposed longwalls.

There is, however, extensive ground monitoring data available from previously extracted longwalls in the Newcastle, Hunter and Western Coalfields where the width-to-depth ratios were similar and much greater than those for the proposed longwalls. This data was not included in the strain analyses, since the overburden geology is different to that in the Southern Coalfield and since the width-to-depth ratios for the proposed longwalls are only slightly higher than the available Southern Coalfields data that has similar overburden geology.

A review of the available data from the Newcastle, Hunter and Western Coalfields indicates that the observed strains for previously extracted longwalls having width-to-depth ratios between 0.70 and 0.85, i.e. slightly greater when compared to the proposed amended longwalls, were on average, around 20 % to 40 % greater than the observed strains for previously extracted longwalls in the Newcastle, Hunter and Western Coalfields having width-to-depth ratios between 0.50 and 0.70, i.e. similar to Tahmoor North, Appin and West Cliff Collieries.

It could be expected, therefore, that the observed strains resulting from the extraction of the proposed longwalls would be, on average, around 20 % to 40 % greater than those previously experienced at Tahmoor, Appin and West Cliff Collieries and, hence, the predicted strains for the proposed longwalls have been determined from the analyses of strain from the previously extracted longwalls at Tahmoor, Appin and West Cliff Collieries, with the magnitudes increased by 20 % to 40 % to account for the higher width-to-depth ratios based on the observations from the Newcastle, Hunter and Western Coalfields.

The data used in the analysis of observed strains included those resulting from both conventional and non-conventional anomalous movements but did not include those resulting from valley related movements, which are addressed separately in this report. The strains resulting from damaged or disturbed survey marks have also been excluded.

A number of probability distribution functions were fitted to the empirical monitored strain data. It was found that a *Generalised Pareto Distribution (GPD)* provided a good fit to the raw strain data. Confidence levels have been determined from the empirical strain data using the fitted GPDs. In the cases where survey bays were measured multiple times during a longwall extraction, the maximum tensile strain and the maximum compressive strain were used in the analysis (i.e. single tensile strain and single compressive strain measurement per survey bay).

### 2.5.1. Analysis of strains measured in survey bays

For features that are in discrete locations, such as building structures, farm dams and archaeological sites, it is appropriate to assess the frequency of the observed maximum strains for individual survey bays.

***Predictions of strain above goaf***

The survey database has been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of the previous longwalls at Tahmoor, Appin and West Cliff Collieries, for survey bays that were located directly above goaf or the chain pillars that are located between the extracted longwalls, which has been referred to as "*above goaf*".

The histogram of the maximum observed total tensile and compressive strains measured in survey bays above goaf, for monitoring lines at Tahmoor, Appin Area and West Cliff Collieries, is provided in Fig. 2.6. The probability distribution functions, based on the fitted GPDs, have also been shown in this figure.

The 95 % confidence levels for the maximum total strains that the individual survey bays *above goaf* experienced at any time during mining at Tahmoor, Appin and West Cliff Collieries were 0.9 mm/m tensile and 1.6 mm/m compressive. The strains for the proposed longwalls are predicted to be 20 % to 40 % greater than those previously observed at these collieries and, therefore, it is expected that 95 % of the strains measured *above goaf* would be less than 1.3 mm/m tensile and 2.2 mm/m compressive.

The 99 % confidence levels for the maximum total strains that the individual survey bays *above goaf* experienced at any time during mining at Tahmoor, Appin and West Cliff Collieries were 1.4 mm/m tensile and 3.1 mm/m compressive. Similarly, it is expected that 99 % of the strains measured *above goaf* for the proposed longwalls would be less than 2.0 mm/m tensile and 4.3 mm/m compressive.

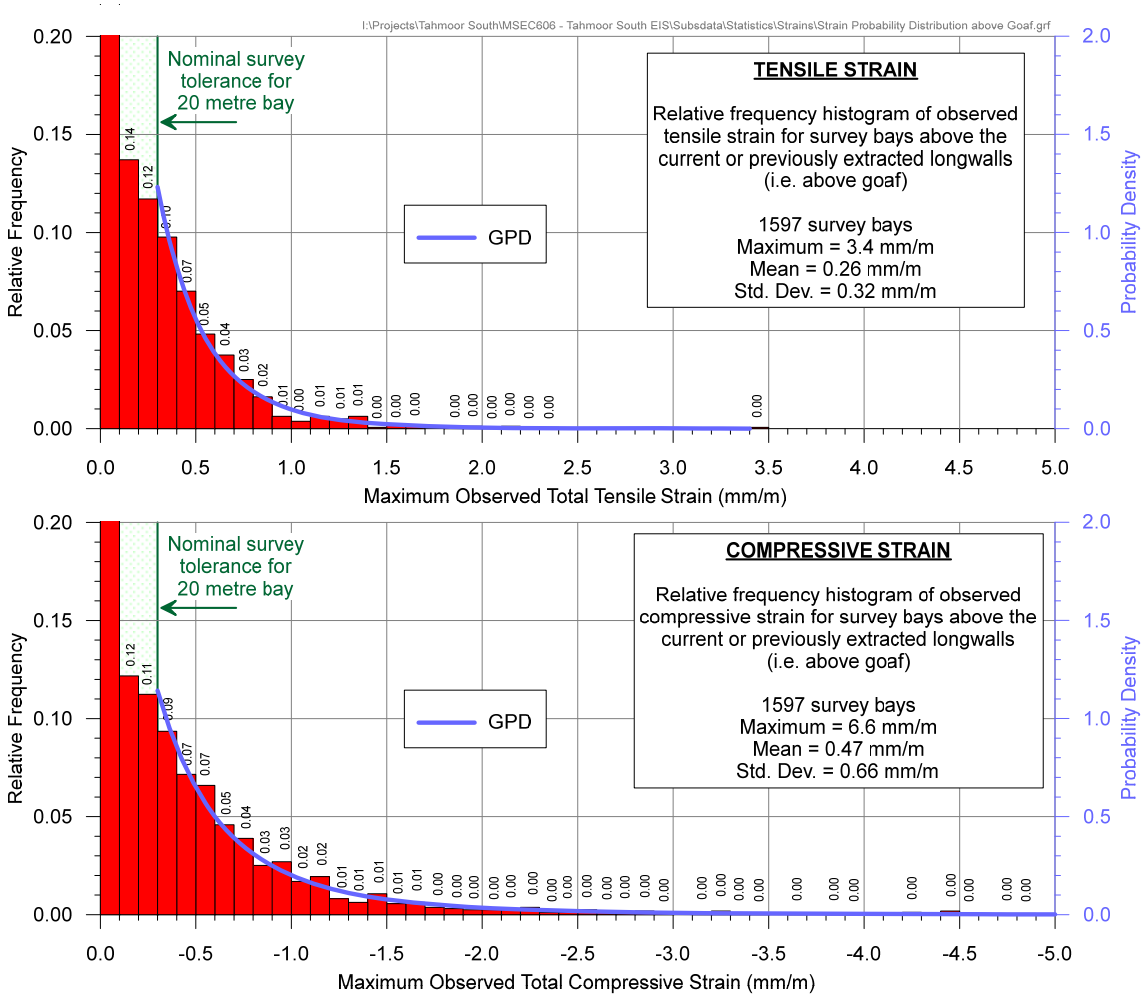



**Fig. 2.6 Distributions of the measured maximum tensile and compressive strains for surveys bays located *above goaf* at Tahmoor, Appin and West Cliff Collieries**

The histogram of the maximum observed total tensile and compressive strains measured in survey bays above goaf, for monitoring lines at Tahmoor, Appin Area and West Cliff Collieries, is provided in Fig. 2.7. The probability distribution functions, based on the fitted GPDs, have also been shown in this figure, along with the probability distribution function shown in Fig. 2.6 for comparison.

It can be seen that the observed strains above LW S1A have generally been less than previously observed at Tahmoor, Appin and West Cliff Collieries. LW S1A is, however, the first panel in the series and ground strains were predicted to be smaller above LW S1A than above future longwalls.

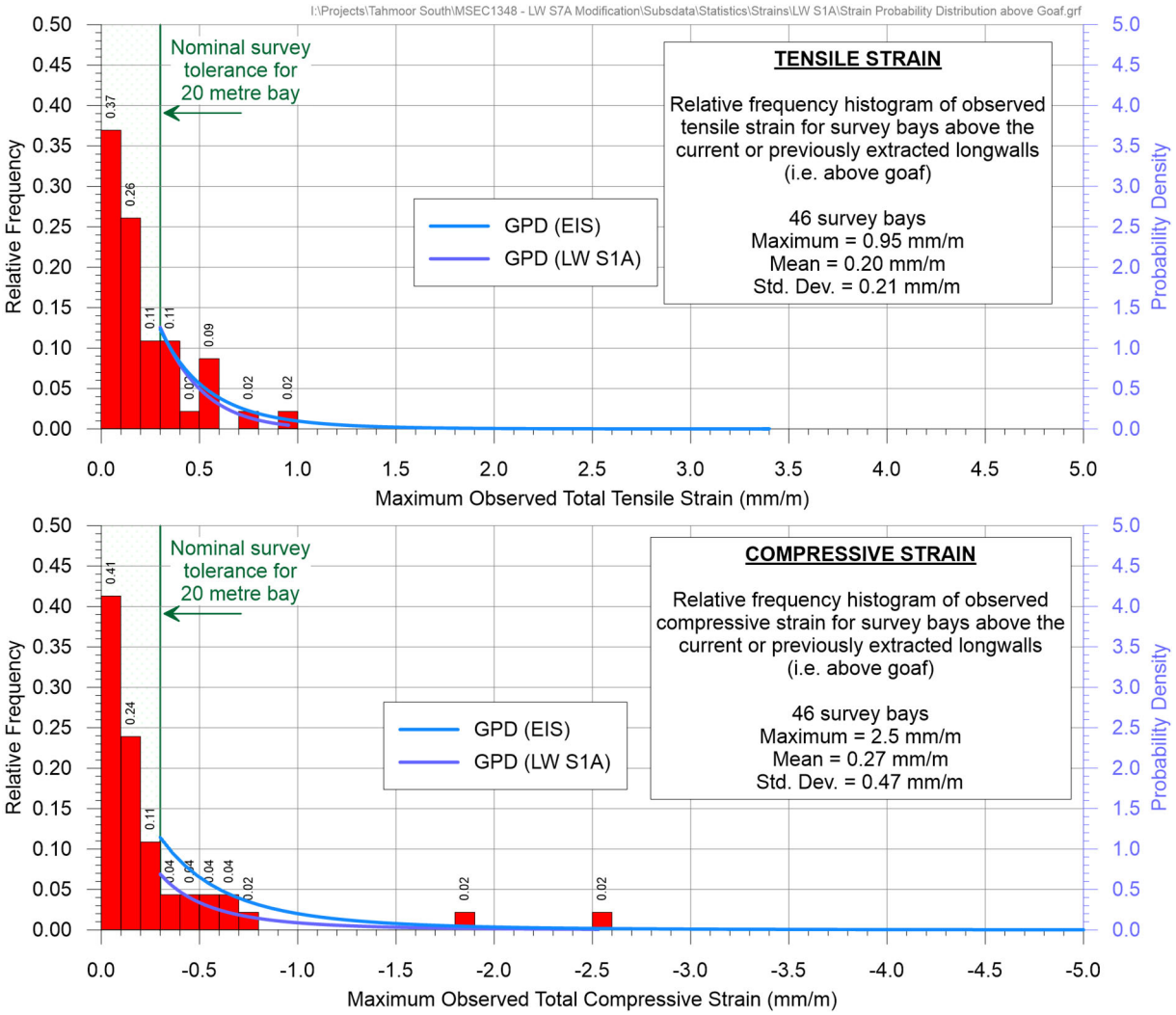



**Fig. 2.7 Distributions of the measured maximum tensile and compressive strains for surveys bays located *above goaf* at Tahmoor LW S1A**

***Predictions of strain above solid coal***

The survey database has also been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of the previous longwalls at Tahmoor, Appin and West Cliff Collieries, for survey bays that were located beyond the goaf edges of the mined panels and positioned on unmined areas of coal, i.e. outside panels but within 200 metres of the nearest longwall goaf edge, which has been referred to as "*above solid coal*".

The histogram of the maximum observed tensile and compressive strains measured in survey bays above solid coal, for monitoring lines at Tahmoor, Appin and West Cliff Collieries, is provided in Fig. 2.8. The probability distribution functions, based on the fitted GPDs, have also been shown in this figure.

The 95 % confidence levels for the maximum total strains that the individual survey bays *above solid coal* experienced at any time during mining at Tahmoor, Appin and West Cliff Collieries were 0.6 mm/m tensile and 0.5 mm/m compressive. The strains for the proposed longwalls are predicted to be 20 % to 40 % greater than those previously observed at these collieries and, therefore, it is expected that 95 % of the strains measured *above solid coal* would be less than 1.0 mm/m tensile and compressive.

The 99 % confidence levels for the maximum total strains that the individual survey bays *above solid coal* experienced at any time during mining at Tahmoor, Appin and West Cliff Collieries were 0.9 mm/m tensile and compressive. Similarly, it is expected that 99 % of the strains measured *above solid coal* adjacent to the proposed longwalls would be less than 1.5 mm/m tensile and compressive.

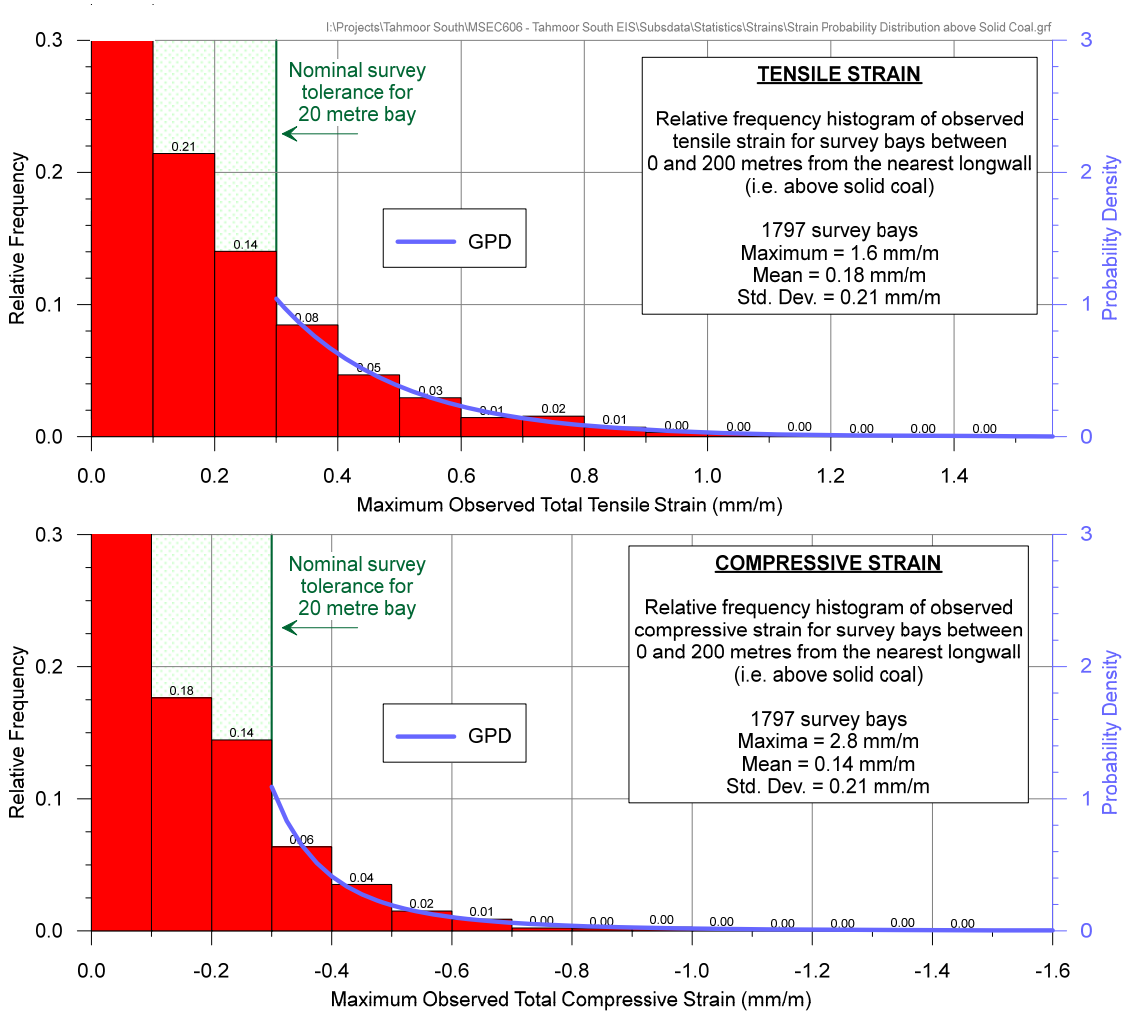



**Fig. 2.8 Distributions of the measured maximum tensile and compressive strains for survey bays located *above solid Coal* at Tahmoor, Appin and West Cliff Collieries**

The histogram of the maximum observed total tensile and compressive strains measured in survey bays above goaf, for monitoring lines at Tahmoor, Appin Area and West Cliff Collieries, is provided in Fig. 2.9. The probability distribution functions, based on the fitted GPDs, have also been shown in this figure, along with the probability distribution function shown in Fig. 2.8 for comparison.

The results include the observed non-conventional compressive ground strain of 2.0 mm/m that was observed between Pegs R47 and R48 to the side of LW S1A.

It can be seen that the observed strains adjacent to LW S1A have generally been less than previously observed at Tahmoor, Appin and West Cliff Collieries. The distribution in LW S1A is, however, the first panel in the series and ground strains were predicted to be smaller above LW S1A than above future longwalls.

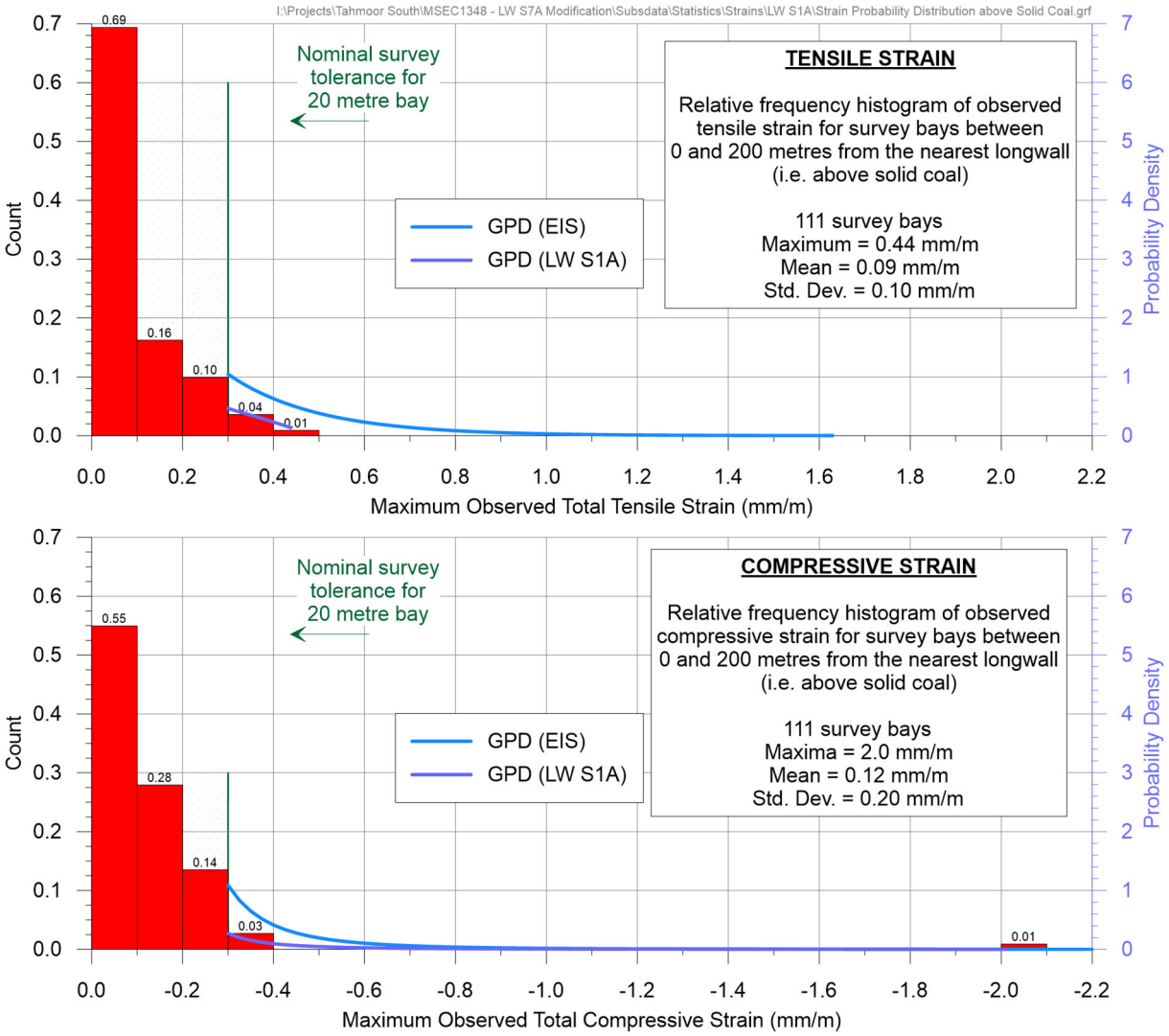



**Fig. 2.9 Distributions of the measured maximum tensile and compressive strains for surveys bays located *above solid coal* at Tahmoor LW S1A**

### 2.5.2. Analysis of strains measured along whole monitoring lines

For linear features such as roads, cables and pipelines, it is more appropriate to assess the frequency of the maximum observed strains along whole monitoring lines, rather than for individual survey bays. That is, an analysis of the maximum strains measured anywhere along the monitoring lines, regardless of where the strain actually occurs.

The histogram of maximum observed total tensile and compressive strains measured anywhere along the monitoring lines, at any time during or after the extraction of the previous longwalls at Tahmoor, Appin and West Cliff Collieries, is provided in Fig. 2.10.

It can be seen from Fig. 2.10, that 42 of the 52 monitoring lines (i.e. 92 % of the total) at Tahmoor, Appin and West Cliff Collieries had recorded maximum total tensile strains of 2.0 mm/m, or less. The strains for the proposed longwalls are predicted to be 20 % to 40 % greater than those previously observed at these collieries and, therefore, it is expected that 92 % of the monitoring lines above the proposed longwalls would experience maximum tensile strains of 3.0 mm/m, or less.

It can also be seen, that 45 of the 52 monitoring lines (i.e. 87 % of the total) at Tahmoor, Appin and West Cliff Collieries had recorded maximum total compressive strains of 4.0 mm/m, or less. The strains for the proposed longwalls are predicted to be 20 % to 40 % greater than those previously observed at these collieries and, therefore, it is expected that 87 % of the monitoring lines above the proposed longwalls would experience maximum compressive strains of 5.5 mm/m, or less.

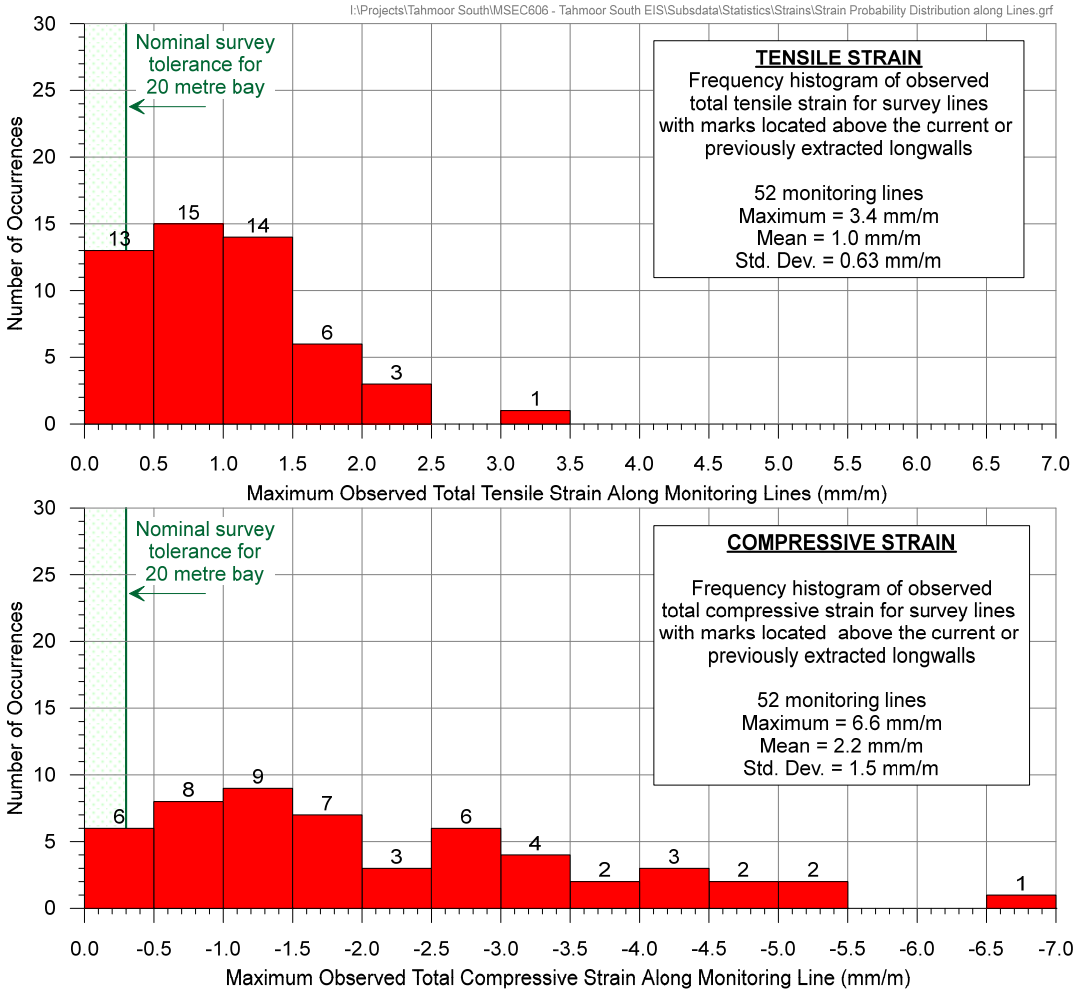



**Fig. 2.10 Distributions of measured maximum tensile and compressive strains anywhere along the monitoring lines at Tahmoor, Appin and West Cliff Collieries**

A statistical comparison of observed maximum strains along monitoring lines above LW S1A has not been conducted due to limited data. Two monitoring lines, the Main Southern Railway and Remembrance Drive recorded a maximum compressive strain of 2.5 mm/m and 2 mm/m, respectively.

### 2.5.3. Analysis of shear strains

Ground strain comprises two components, being normal strain and shear strain, which can be interrelated using a Mohr's Circle analysis. The magnitudes of the normal strain and shear strain components are, therefore, dependent on the orientation in which they are measured. The maximum normal strains (i.e. principal strains) are those in the direction where the corresponding shear strain is zero.

Normal strains along monitoring lines can be measured using 2D and 3D techniques, by taking the change in horizontal distance between two points on the ground and dividing by the original horizontal distance between them. This provides the magnitude of normal strain along the orientation of the monitoring line but, this strain may not necessarily be the maximum (i.e. principal) strain.

Shear deformations are more difficult to measure, as they are the relative horizontal movements perpendicular to the direction of measurement. However, 3D monitoring techniques provide data on the direction and the absolute displacement of survey marks and, therefore, the shear deformations perpendicular to the monitoring line can be determined. It is possible to gain an understanding of the shear strain along a monitoring line with repeat measurements, but, in accordance with rigorous definitions and the principles of continuum mechanics, (e.g. Jaeger, 1969), it is not possible to accurately determine

horizontal shear strains in any direction relative to the monitoring line using 3D monitoring data from a straight line of survey marks.

Shear deformations perpendicular to monitoring lines can be described using various parameters, including horizontal tilt, horizontal curvature, horizontal mid-ordinate deviation, angular distortion and shear index. In this report, horizontal mid-ordinate deviation has been used as the measure for shear deformation, which is defined as the differential horizontal movement of each survey mark, perpendicular to a line drawn between two adjacent survey marks.

The frequency distribution of the maximum total horizontal mid-ordinate deviations measured at survey marks above goaf, for previously extracted longwalls in the Southern Coalfield, is provided in Fig. 2.11. As the typical survey bay length was 20 metres, the calculated mid-ordinate deviations were over a chord length of 40 metres. The probability distribution function, based on the fitted GPD, has also been shown in this figure.

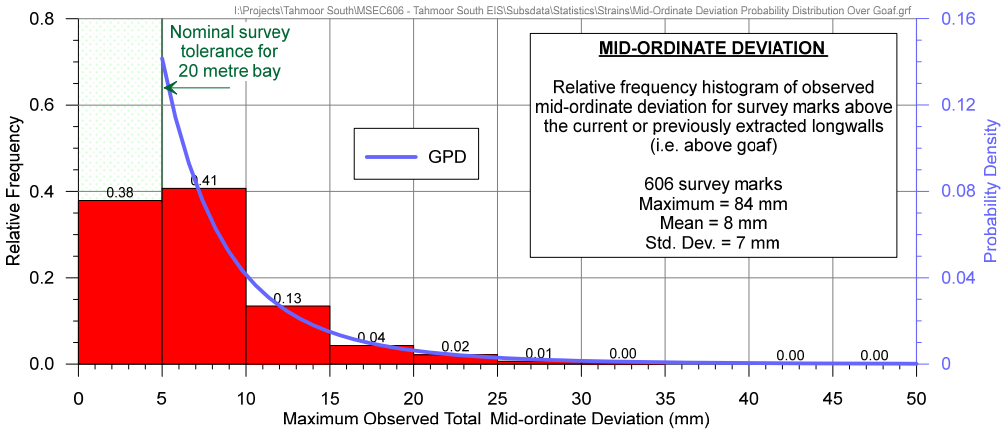



**Fig. 2.11 Distribution of measured maximum mid-ordinate deviation during the extraction of previous longwalls in the Southern Coalfield for marks located above goaf**

The 95 % and 99 % confidence levels for the maximum total horizontal mid-ordinate deviation that the individual survey marks located above goaf experienced at any time during mining were 20 mm and 35 mm, respectively. The shear deformations for the proposed longwalls are estimated to be 20 % to 40 % greater than those previously observed at Tahmoor, Appin and West Cliff Collieries and, therefore, it is expected that 95 % and 99 % of the horizontal mid-ordinate deviations measured above the proposed longwalls would be less than 30 mm and 50 mm, respectively.

A statistical comparison of observed maximum strains along monitoring lines above LW S1A has not been conducted due to limited data.

## 2.6. Predicted far-field horizontal movements

In addition to the conventional subsidence movements that have been predicted above and adjacent to the proposed LW S7A, far-field horizontal movements will also be experienced during the extraction of the proposed longwall.

The observed incremental far-field horizontal movements resulting from the extraction of incremental longwall panels, in any location above goaf, i.e. above the currently mined or previously mined panels, or above solid coal, i.e. unmined areas of coal, are provided in Fig. 2.12. The observed incremental far-field horizontal movements above solid coal only, i.e. outside the extents of extracted longwalls, are provided Fig. 2.13. The confidence levels, based on fitted *Generalised Pareto Distributions* (GPDs), have also been shown in these figures to illustrate the spread of the data. It can be seen from Fig. 2.12 and Fig. 2.13 that the magnitude of the observed far-field horizontal movements over solid unmined areas of coal are lower and more consistent than the observed far-field horizontal movements over previously extracted panels.

As successive longwalls within a series of longwalls are mined, the magnitudes of the incremental far-field horizontal movements decrease. This is possibly due to the fact that once the in-situ stresses within the strata have been redistributed around the collapsed zones above the first few extracted longwalls, the potential for further movement is reduced. The total far-field horizontal movement may be less, therefore, than the sum of the incremental far-field horizontal movements for the individual longwalls.

The predicted far-field horizontal movements resulting from the extraction of the proposed LW S7A are very small and could only be detected by precise surveys. Such movements tend to be bodily movements towards the extracted goaf area, and are accompanied by very low levels of strain, which are generally less than the order of survey tolerance (i.e. less than 0.3 mm/m). The potential impacts of differential far-field horizontal movements on the natural and built features within the vicinity of the proposed longwalls are not

expected to be measurable, with possibly the exception of the road and railway bridges and the Picton Weir, which are discussed in the impact assessments for these features in the following chapter.

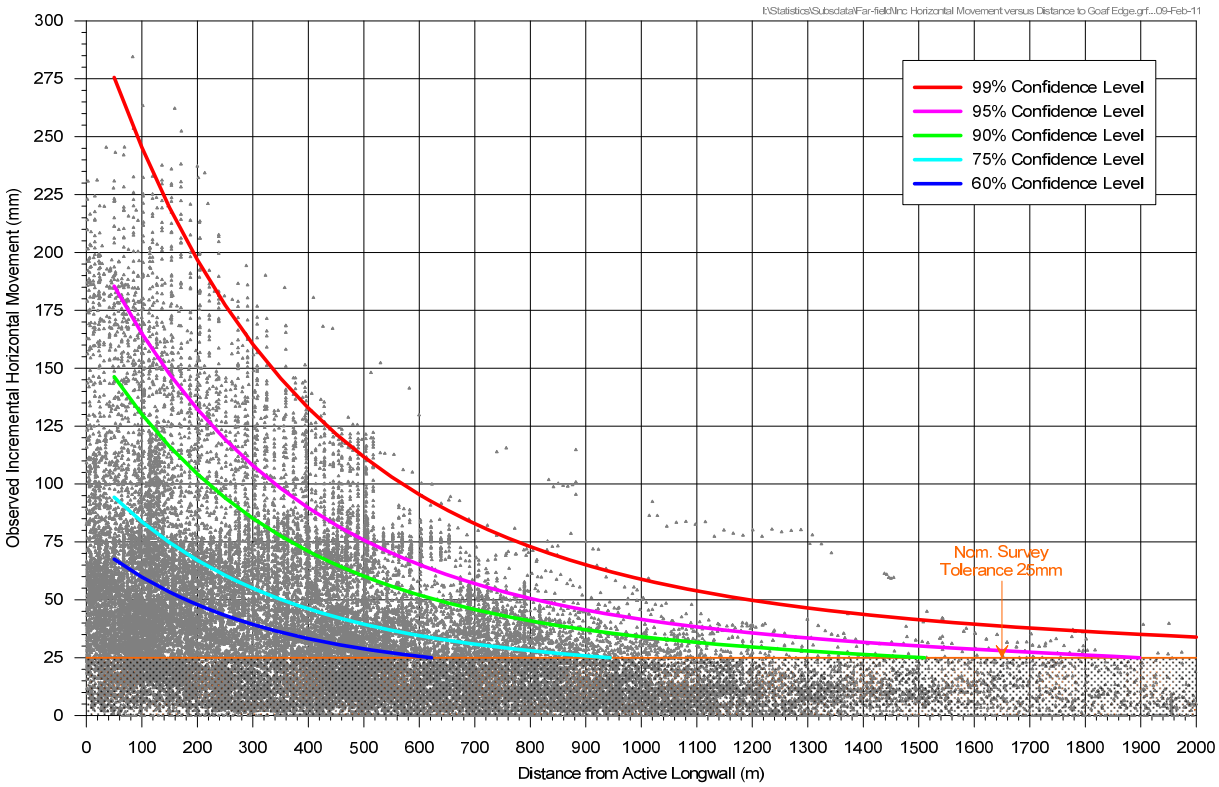



**Fig. 2.12 Observed incremental far-field horizontal movements above goaf or solid coal**

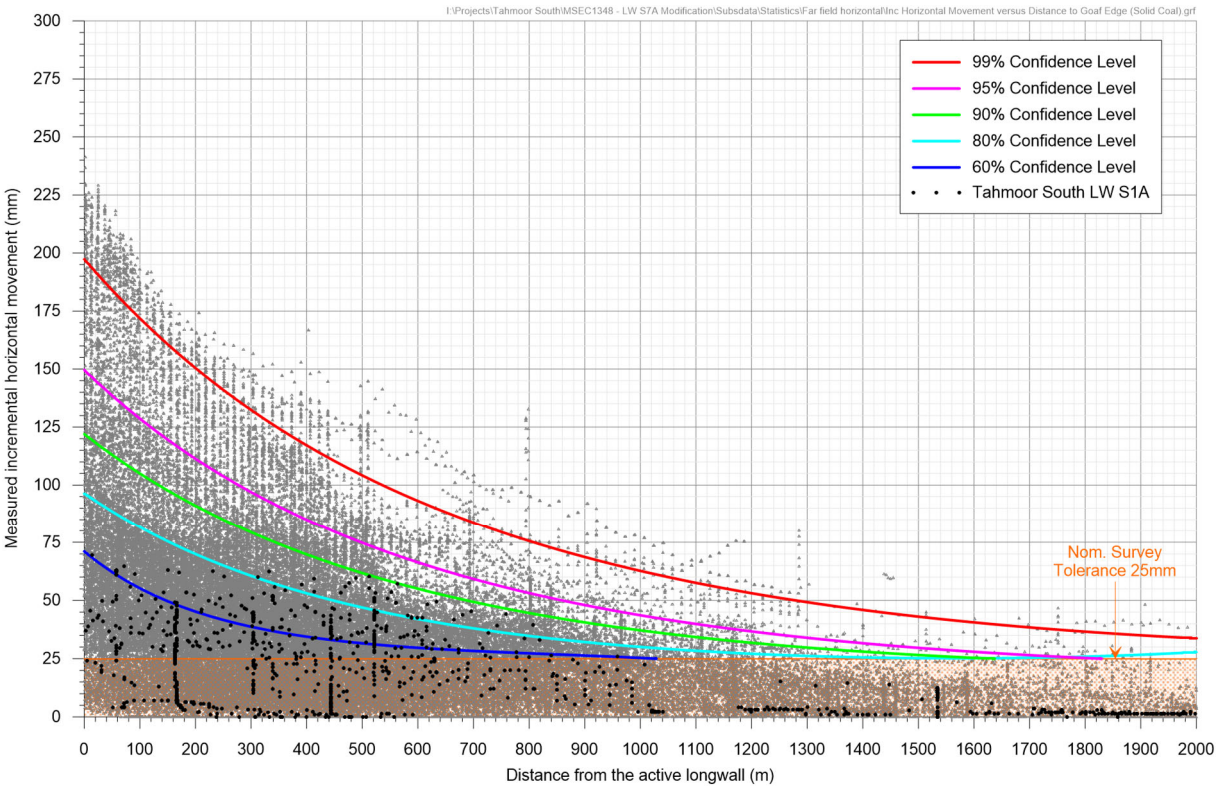



**Fig. 2.13 Observed incremental far-field horizontal movements above solid coal only**

A far field monitoring program was conducted by Tahmoor Coal during the extraction of LW S1A at key civil structures and along the Bargo River and Hornes Creek. The observed horizontal movements during the mining of LW S1A were within the normal range, as shown in Fig. 2.13.

## 3.1. The Study Area

The Study Area has been defined as the zone where the predicted subsidence effects, based on the *Modified Layout*, are different to those predicted based on the *Approved Layout*. The Study Area has been based on the following:

- 35° angle of draw line around LW S7A, based on the Modified Layout;
- The limit where the predicted incremental vertical subsidence due to the extraction of LW S7A on the tailgate (eastern side) of the panel is greater than 20 mm; and
- The limit where the predicted incremental total subsidence due to the extraction of LWs S1A to S7A on the maingate (western side) of the panel is greater than 20 mm.

The extent of the Study Area is shown in Drawing No. MSEC1348-01. Surface features that are located within 600 m of LW S7A, which will experience valley-related effects and could be sensitive to these effects, have also been included in the assessments provided in this report.

The natural and built features that are located within the Study Area are shown in Drawings Nos. MSEC1348-07 to MSEC1348-10. The surface features that have been included in the assessments provided in this report are:

- Bargo River at the confluence with Hornes Creek;
- Hornes Creek;
- Teatree Hollow and tributaries;
- Cliffs and steep slopes;
- Main Southern Railway;
- Local roads, specifically the whole of Yarran Road and parts of Caloola Road, Remembrance Drive and Wellers Road at Elvy Street;
- Powerlines, telecommunication infrastructure, gas pipelines, potable water pipelines and sewer pipelines;
- Picton Weir;
- Items of Heritage Significance;
- Farm dams;
- Commercial establishments; and
- Houses and other building structures.

The effects of the proposed LW S7A on the subsidence predictions and impact assessments for these features are provided in the following sections.

## 3.2. Bargo River

The location of the Bargo River is shown in Drawing No. MSEC1348-07. Descriptions, predictions and impact assessments for the river are provided in the following sections.

### 3.2.1. Description of the Bargo River

The Bargo River commences north of Colo Vale and near the townships of Hill Top and Yerrinbool and flows generally towards the north and to the west of the Bargo township. The Bargo River then flows to the west and north of the proposed Tahmoor South longwalls. The Bargo River ultimately drains into the Nepean River approximately 4.9 kilometres north-east of Longwall S1A.

While the Bargo River is located outside the Study Area, a short 200 metre long section of the Bargo River at the confluence with Hornes Creek is located within the 600m Study Area for Natural Features. The 200 metre long section commences from the Picton Weir and continues up to the confluence of Hornes Creek and slightly around the bend in the Bargo River. A photograph is shown in Fig. 3.1.

The 200 metre long section is located completely within the stored waters behind the Picton Weir. With exception of periods of prolonged drought, the bedrock is usually under water. The bedrock is covered with sediments that have been washed down the Bargo River and Hornes Creek.

The remainder of the Bargo River is outside the 600m Study Area for Natural Features. The closest distance between the Bargo River and LW S7A is approximately 520 metres.

A summary of the minimum distances between the river and the proposed longwalls is provided below in Table 3.1.

**Table 3.1 Minimum distances of the proposed longwalls from the Bargo River**

| Longwall | Minimum distance from the centreline of Bargo River (m) |
|---|---|
| LW S1A | 720 |
| LW S2A | 690 |
| LW S3A | 730 |
| LW S4A | 780 |
| LW S5A | 830 |
| LW S6A | 850 |
| LW S7A | 520 |

The section of Bargo River that is within the Study Area is a 5th order perennial stream as defined by the Strahler Stream Order Method.

The surface water flows in this section of the river are controlled by the Picton Weir (also called the Bargo Weir) with discharge regulated by a fixed discharge valve. The reservoir is emptied following extended dry periods, but it is quickly filled with the spillway overtopping following large storm events. The following article from the Picton Post, dated 1945, provides some background:

> *"The existing dam was built to T.W.L.912 in 1899, the lowest foundation being at R.L.887, which was a few feet below river bed level. In 1910 the wall was raised to T.W.L.920, giving a storage of 37 m.g."*
>
> *"During the recent drought the water level dropped considerably, and it was ascertained that the dam had silted up. It is understood that the silt level is approximately at R.L.904, which would leave an available storage, if this level were uniform, of 33 m.g. It is quite probable that the silt level in the upper reaches of storage is higher."*

The Weir was raised again in 1947 to its final height of RL1927 (Haigh, 1954). The water stored by the Picton Weir was initially used to supply the nearby communities. After pipes were laid from the much larger Nepean Dam, however, Bargo, Thirlmere, Picton and The Oaks were supplied water from the Nepean Dam (now through the Nepean Water Filtration Plant), and stored water from the Picton Weir was no longer used for town water supply.

Examples of fluctuations in water levels in the Bargo River are provided below:

- 13 November 2019 (Fig. 3.2) – Picton Weir was dry after an extended drought period, just prior to bushfires through the area in December 2019. It can be seen that water storage had receded such that very little surface water was visible upstream of the confluence with Hornes Creek. Alluvial sediments were visible in the aerial photograph, covering the bedrock.
- 18 February 2022 (Fig. 3.3) – Picton Weir was full and overtopping after substantial rain events. It can be seen that the whole section of Bargo River within the 600m Study Area for Natural Features was inundated with stored water.

The reports by Fluvial Systems (2013) and the Water Management Plan (Tahmoor Coal, 2023a) provide a detailed description of the river.

*Image courtesy EMM on 24 May 2022*

**Fig. 3.1 View of Bargo River and Picton Weir downstream of confluence with Hornes Creek**

*Image courtesy Nearmap*

**Fig. 3.2 Aerial photo of section of Bargo River within 600m Study Area on 13 November 2019**

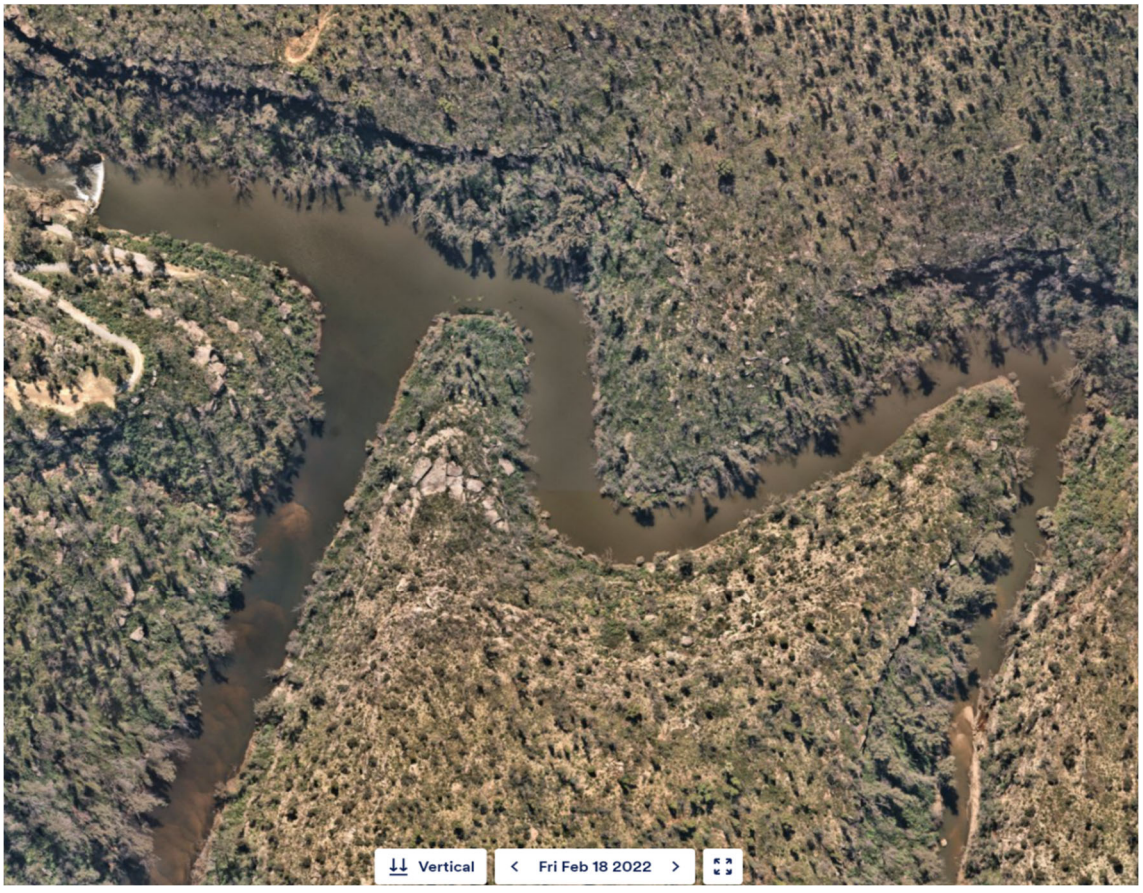



*Image courtesy Nearmap*

**Fig. 3.3 Aerial photo of section of Bargo River within 600m Study Area on 18 February 2022**

### 3.2.2. Predictions for the Bargo River

The predicted profiles of subsidence, upsidence and closure, using the IPM subsidence model and the 2002 ACARP valley closure prediction model, along the Bargo River and Hornes Creek are shown in Fig. A.02.

A summary of the maximum predicted values of incremental vertical subsidence, upsidence and closure for the Bargo River is provided Table 3.2 and the maximum predicted total values of vertical subsidence, upsidence and closure is provided in Table 3.3.

**Table 3.2 Maximum predicted incremental vertical subsidence, upsidence and closure for Bargo River**

| Layout | Longwall | Maximum predicted incremental vertical subsidence (mm) | Maximum predicted incremental upsidence (mm) | Maximum predicted incremental closure (mm) |
|---|---|---|---|---|
| Modified Layout | LW S7A | < 20 | 20 | 20 |

**Table 3.3 Maximum predicted total vertical subsidence, upsidence and closure for Bargo River**

| Layout | Longwall | Maximum predicted total vertical subsidence (mm) | Maximum predicted total upsidence (mm) | Maximum predicted total closure (mm) |
|---|---|---|---|---|
| Approved Layout | After LW S6A | < 20 | < 20 | < 20 |
| Modified Layout | After LW S7A | < 20 | 30 | 20 |

It can be seen that the predictions for the *Modified Layout* are slightly increased when compared to the predictions based on the *Approved Layout*, which is expected given that LW S7A is closer to the River. Further statistical analysis and discussion on predicted closure movements are provided in the following Section 3.3 of this report for Hornes Creek.

### 3.2.3. Potential impacts on the Bargo River

The impact assessments for the Bargo River within the 600m Study Area are provided in the following sections. The assessments provided in this report should be read in conjunction with the Water Management Plan (Tahmoor Coal, 2023a) and the Biodiversity Management Plan (Tahmoor Coal, 2023c), which assess the consequences of the impacts on surface water flows and ecology.

***Potential for increased levels of ponding, scouring or desiccation due to mining-induced tilt***

Mining can potentially result in increased levels of ponding in locations where the mining-induced tilts oppose and are greater than the natural stream gradients that exist before mining. Mining can also potentially result in an increased likelihood of scouring of the stream beds in the locations where the mining-induced tilts considerably increase the natural stream gradients that exist before mining.

In this case, the predicted changes in grade along the Bargo River due to the proposed extraction of LW S7A are negligible. The potential for impacts due to mining-induced changes in stream gradients is also irrelevant given that the section of Bargo River within the 600m Study Area is usually inundated with stored water.

***Potential for fracturing and surface water flow diversion in the stream***

There has been a long history of mining directly beneath or near the Bargo River at Tahmoor Mine. While impacts have occurred when various previously extracted longwalls were mined directly beneath the river, impacts have not been observed when mining has been undertaken more than 500 metres away from the river.

- Longwalls 8, 10 to 13 were mined between 1991 and 1994 directly beneath a 2.0 kilometre section of the Bargo River and directly beneath a 1.0 kilometre section of Dog Trap Creek.

  These were the first series of longwalls to be mined directly beneath the Bargo River at Tahmoor Mine. Very little monitoring of the river occurred during this time, although extensive protective works were undertaken at the Rockford Road Bridge, which was located over Longwall 12.

  Surface fracturing of exposed bedrock was observed near to the supporting piers of the Bridge following the extraction of Longwalls 12 and 13. Fractures were also observed in flute holes downstream of the bridge over the goaf edge of Longwall 13, which were first observed during the extraction of Longwall 12 (Holla and Barclay, 2000). The fractures were localised and did not

consistently run along the length of the river valley. They appeared to be the result of localised shearing and compressive buckling and some fractures were located where there was noticeable cross bedding within the river bed. There were no reports of impact to water flows along this section of river.

While surface fracturing is still visible in the flute holes that are located on a large, exposed rockbar, surface water diversion is not evident and large pools exist directly above the previously extracted longwalls, as Tahmoor Mine's licensed discharge has contributed a base flow to this section of the Bargo River.

**Fig. 3.4 Large pool in the Bargo River, located upstream of Rockford Road Bridge, directly above previously extracted Longwall 12**

Very little monitoring of the Dog Trap Creek occurred when Longwalls 12 and 13 mined directly beneath it, although extensive monitoring and works were undertaken at the small Road Bridge over Dog Trap Creek on Arina Road. No surface fractures are visible in the stream at the location, however, and pools are observed to exist. It is noted that this section of Dog Trap Creek contains plenty of sediment that could assist in the filling of fractures.

**Fig. 3.5 Ponded water in Dog Trap Creek near bridge over Arina Road above previously extracted Longwall 13**

- Longwalls 14 to 19 were mined between 1995 and 2002 directly beneath a 1.7 kilometre section of the Bargo River, downstream of Picton Weir. This section of river is located between 720 metres and 850 metres north-west of the proposed LWs S1A to S6A, as shown in Drawings No. MSEC1348-01 and MSEC1192-07.

  Limited monitoring indicated little impact on the River during the extraction of Longwalls 14 to 17. Fracturing was not observed on the surface, although many sections were concealed by alluvial and talus deposits.

  The first adverse impacts on the river were reported in January 2002, after the extraction of Longwall 18, when residents alerted Tahmoor Mine to reduced pool levels downstream of the mining area. At that time there was very little stored water in the Picton Weir due to low rainfalls and surface flows from the weir had reduced to a mere trickle. Inspections along the river indicated fracturing of rock shelves in the river bed and drainage of some shallow pools.

**Fig. 3.6 Immediately upstream of Picton Weir during period of prolonged dry weather – January 2002**

Detailed subsidence monitoring of survey pegs within the Bargo River over the centre of LW18 after LW18 was extracted, i.e. in October 2001 had indicated that total upsidence in the base of LW18 was 250 mm, the total valley closure was approximately 400 mm and the maximum measured valley closure strain was 15 mm/m.

The inspections in January 2002 found that the river had been drained directly above Longwall 18 and the length of drainage extended downstream for some distance beyond Longwall 14.

Shortly after this time a large rainfall event occurred, which filled the Weir and restored surface water flows along the River. A dry period followed and by July 2002 the Picton Weir was empty again and the extraction of Longwall 19 was completed. Inspections showed that surface flows ceased again, with the furthest drained pool from the longwalls being located 125 metres upstream of LW19. This coincided with the completion of this longwall.

Detailed subsidence monitoring of survey pegs within the Bargo River over the centre of LW18 after LW19 was extracted indicated that total upsidence in the base of LW18 was 450 mm, the total valley closure was approximately 700 mm and the maximum measured valley closure strain was 18 mm/m.

A further period of heavy rainfall occurred in February 2003 which then refilled the upstream sections of Picton Weir which then overtopped (see Fig. 3.7 and Fig. 3.8).

After this large storm, it was then observed that the water flows along the surface above the longwalls were progressively restored even during the following drier periods. It is believed that the high sediment load in the river, that was retained by the Picton Weir except when it is overtopped, had been washed down the river and filled in the mining induced fractures in the bedrock reducing the loss of surface water flows.

The extraction of Longwalls 14 to 19 also mined directly beneath small tributaries to the Bargo River. Fluvial Systems (2013) reports fracturing and surface flow diversions in two unnamed tributaries, which are located above previously extracted Longwalls 15 and 19. The stream channel beds in these tributaries were exposed bedrock.

**Fig. 3.7 Picton Weir 1st February 2003**

**Fig. 3.8 Picton Weir 24th February 2003**

- Previously extracted Longwall 24A was approximately 340 metres from the river at its closest point and Longwall 25 was approximately 510 metres from the river. Ground surveys measured very little vertical subsidence (less than 20 mm) and closure (less than 10 mm) occurred even though at this section of the river the gorge was 80 metres deep. Impacts to the river were not observed during the extraction of these longwalls.

With respect to streams or sections of streams located away from the proposed longwalls, the likelihood of fracturing and surface flow diversions reduces substantially compared to stream sections located directly above the proposed longwalls. The furthest known rockbar impact site where fracturing resulted in the diversion of surface water was at Pool F in the Waratah Rivulet that was being affected by a previously extracted longwall on one side and by the end of another longwall, i.e. the rockbar was located over solid unmined coal, but it was located in the corner between two longwalls. This site was located 160 metres to the side of one longwall and 230 metres from the approaching face of the active longwall. Surface water diversions have also been observed at three sites from the sides of longwalls at distances between 125 metres and 100 metres at the Bargo River, Waratah Rivulet and Native Dog Creek. Surface water diversion has only been observed at one site at Pool G1 in the Waratah Rivulet beyond the ends of the longwalls and in this case the closest distance was approximately 75 metres.

Minor and isolated fracturing could also occur outside the extents of the proposed longwalls. The furthest distance of an observed fracture from longwall mining at Appin Colliery was at the base of Broughtons Pass Weir, which was located approximately 415 metres from Appin Colliery Longwall 401. Another minor fracture was also recorded in the upper Cataract River, approximately 375 metres from Appin Colliery Longwall 301. This fracture occurred in a large rockbar, which was formed in thinly bedded sandstone, which had experienced movements from nearby previously extracted longwalls.

More recently, visual inspections along the Tributary to Teatree Hollow have identified a minor fracture that is located approximately 500 metres from LW S1A. The fracture was identified within a surface boulder upstream of Pool TT2. The boulder is wedged between two larger rocks on either side of the creek.

The above observations represent the furthest-most recorded fractures from longwall mining in the NSW Coalfields.

In the present case, the proposed LW S7A is located approximately 520 metres from the Bargo River at its closest point. The section of Bargo River within the 600 m Study Area is located within the stored waters behind the Picton Weir. Based on the previous experiences at Tahmoor Mine, it is very unlikely that the extraction of the proposed longwalls would result in adverse impacts on surface water flows in the river.

In the very unlikely event that surface fractures develop in the Bargo River due to the extraction of LW S7A, the fractures would likely not be detected as the bedrock is covered by alluvial sediment and frequently by stored water. Even if the predictions and impact assessments were exceeded, the likelihood of impacts on surface flow is considered extremely low given that water levels are controlled by the Picton Weir. Previously observed experiences have found that mining-induced sub-surface fracturing in this section of the Bargo River has been filled by sediment that is stored behind the Picton Weir, reducing the potential for impacts on surface water flows.

Further detailed discussions on the impacts and consequences of changes in the surface water flows are provided in the Water Management Plan (Tahmoor Coal, 2023a).

***Potential for Gas Emissions and Changes to Water Quality***

Gas emissions from the sandstone strata have been previously observed above and adjacent to mining areas in the Southern Coalfield, and some gas emissions have also been observed in water bores. Analyses of gas compositions indicate that the Bulli seam is not the direct and major source of the gas and that the most likely source is the Hawkesbury Sandstone (APCRC, 1997).

Gas emissions may occur and become visible in the stored water behind the Picton Weir as a result of the proposed extraction of the longwalls. Where these gas releases occur into the water column there is insufficient time for any substantial amount of gas to dissolve into the water. The majority of the gas is released into the atmosphere and is unlikely to have an adverse impact on water quality.

A description of potential water quality impacts and environmental consequences is presented in the Water Management Plan (Tahmoor Coal, 2023a) and the Biodiversity Management Plan (Tahmoor Coal, 2023c).

### 3.2.4. Management of potential impacts on the Bargo River

Tahmoor Coal has developed a Water Management Plan for LWs S1A to S6A to manage potential impacts on streams during the mining of longwalls, including the Bargo River. The management plan includes monitoring and triggered response plans. It includes monitoring of the required pre-mining conditions and data collection during mining. Monitoring typically continues for a period following mining.

The Water Management Plan will be updated to include LW S7A (Tahmoor Coal, 2023a).

Tahmoor Coal is currently monitoring ground movements at the Bargo River during the mining of LW S2A according to the Subsidence Monitoring Plan.

- Two GNSS have been installed near the tops of the Bargo River valley across the Picton Weir. The GNSS units have continuously monitored changes during mining since the commencement of LW S1A. While the GNSS units have measured minor horizontal movements, changes in horizontal distances between the units are less than 5 mm and within survey tolerance.
- Prior to the commencement of LW S2A, additional GNSS units have been installed along Hornes Creek, which will also provide relevant monitoring information for monitoring changes and potential impacts along the Bargo River.
- Two GNSS units have been installed across the Bargo River valley, directly above previously extracted LW 16. The GNSS units have continuously monitored changes during mining since the commencement of LW S1A. While the GNSS units have measured minor horizontal movements, changes in horizontal distances between the units are less than 5 mm and within survey tolerance.
- Tahmoor Coal installed ground surveys pegs across the Bargo River above previously extracted LWs 14B to 19. A re-survey after the completion of LW S1A on 6 November 2023 measured changes of ± 7 mm, which is considered to be within survey tolerance given the environment within which the pegs have been installed.

Tahmoor Coal will continue to monitor changes in the Bargo River during the extraction of proposed Tahmoor South longwalls, in accordance with the Subsidence Monitoring Plan and Water Management Plan.

## 3.3. Hornes Creek

The location of Hornes Creek is shown in Drawing No. MSEC1348-07. Descriptions, predictions and impact assessments for the creek are provided in the following sections.

### 3.3.1. Description of Hornes Creek

Hornes Creek commences west of the township of Bargo and flows generally towards the north-west before draining into the Bargo River. Hornes Creek catchment is located to the south-southwest of LW S1A-S6A. The catchment area of Hornes Creek is approximately 19.3 $km^2$ which comprises predominantly bushland, rural-residential area and residential area associated with the Bargo township (Tahmoor Coal, 2023a). Hornes Creek is a fourth order stream within the Study Area (Fluvial Systems, 2013).

The downstream section of Hornes Creek meanders inside and outside the Study Area and the majority of the downstream section is located inside the 600m Study Area for Natural Features, as shown in Drawing No. MSEC1348-07.

The closest distance between Hornes Creek and LW S7A is approximately 330 metres at a sharp bend and a photograph of the bend is shown in Fig. 3.9. Upstream of the bend, the distance between Hornes Creek and LW S7A is between 470 metres and 620 metres.

*Image courtesy EMM*

**Fig. 3.9 View of Hornes Creek at bend located closest to LW S7A**

Water levels in the downstream section of Hornes Creek are controlled by the Picton Weir. As discussed for the Bargo River in Section 3.2.1, Hornes Creek is generally inundated with stored water but the extent of stored water recedes during periods of prolonged dry weather.

Examples of fluctuations in water levels in Hornes Creek are provided below:

- 13 November 2019 (Fig. 3.2 and Fig. 3.10) – Picton Weir was dry after an extended drought period, just prior bushfires through the area in December 2019. It can be seen that water storage had receded such that very little surface water was visible upstream of the confluence with the Bargo River. Alluvial sediments were visible in the aerial photograph, covering the bedrock up to the upstream end of the storage area at Pool HC-16. Isolated pools were visible along the stream.
- 18 February 2022 (Fig. 3.3 and Fig. 3.11) – Picton Weir was full and overtopping after substantial rain events. It can be seen that the whole section of Bargo River within the 600m Study Area for Natural Features was inundated with stored water up to Pool HC-16.

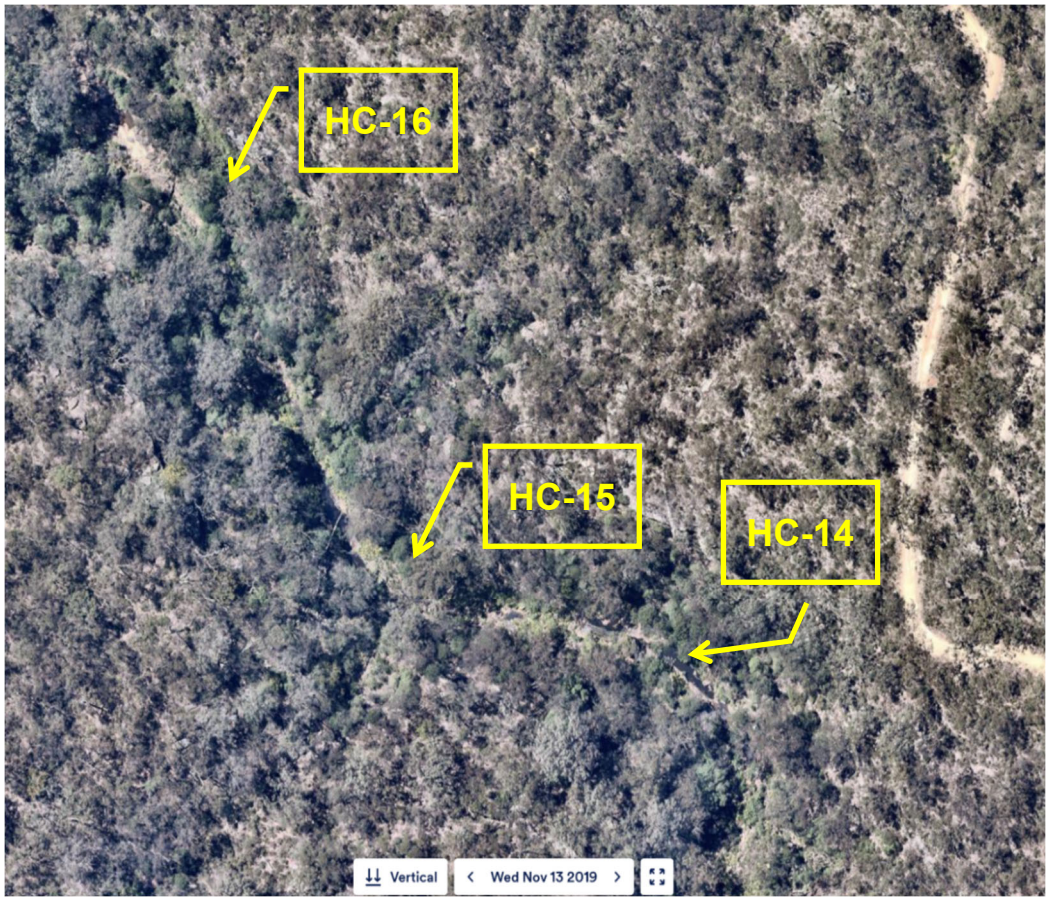



*Image courtesy Nearmap*

**Fig. 3.10 Aerial of photo of Hornes Creek near Pools HC-P14 to HC-P16 on 13 November 2019**

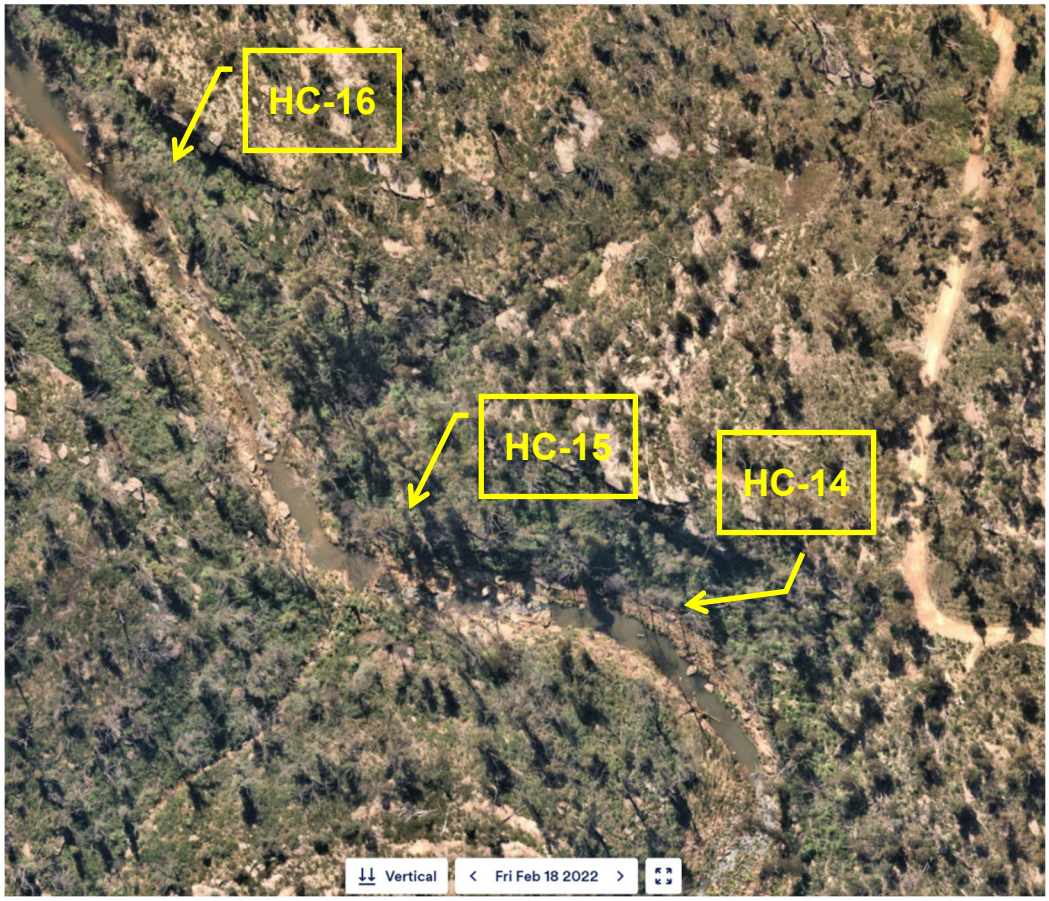



*Image courtesy Nearmap*

**Fig. 3.11 Aerial of photo of Hornes Creek near Pools HC-P14 to HC-P16 on 18 February 2022**

Upstream of Pool HC-16, Hornes Creek is comprised of a series of pools that are controlled by rockbars and boulders. Water flows are intermittent, with flowing water recorded on at least 81% of sampling occasions at all monitoring sites in Hornes Creek (Tahmoor Coal, 2023a). During periods of prolonged dry weather, however, the creek is dry with localised pools. A total of 9 pools (HC-08 to HC-16) are located within the 600m Study Area.

A photograph of Pool HC-09, which is closest to LW S7A is shown in Fig. 3.12.

*Image courtesy MNC consulting*

**Fig. 3.12 Hornes Creek Pool HC-P09 on 23 September 2023**

The reports by Fluvial Systems (2013) and the Water Management Plan (Tahmoor Coal, 2023a) provide a detailed description of Hornes Creek.

### 3.3.2. Predictions for Hornes Creek

The predicted profiles of subsidence, upsidence and closure, using the IPM subsidence model and the 2002 ACARP valley closure prediction model, along the Bargo River and Hornes Creek are shown in Fig. A.02.

A summary of the maximum predicted values of incremental vertical subsidence, upsidence and closure for Hornes Creek is provided in Table 3.4 and a summary of the maximum predicted values of total vertical subsidence, upsidence and closure for Hornes Creek is provided in Table 3.5.

**Table 3.4 Maximum predicted incremental vertical subsidence, upsidence and closure for Hornes Creek**

| Layout | Longwall | Maximum predicted incremental vertical subsidence (mm) | Maximum predicted incremental upsidence (mm) | Maximum predicted incremental closure (mm) |
|---|---|---|---|---|
| Modified Layout | LW S7A | | | |
| Section with water levels controlled by Picton Weir downstream from Pool HC-16 to confluence with Bargo River | | 30 | 50 | 130 |
| Section with water levels controlled by rockbars and boulders upstream from Pool HC-16 | | 20 | 30 | 60 |

**Table 3.5 Maximum predicted total vertical subsidence, upsidence and closure for Hornes Creek**

| Layout | Longwall | Maximum predicted total vertical subsidence (mm) | Maximum predicted total upsidence (mm) | Maximum predicted total closure (mm) |
|---|---|---|---|---|
| Approved Layout | After LW S6A | < 20 | 30 | < 20 |
| Modified Layout | After LW S7A | | | |
| Section with water levels controlled by Picton Weir downstream from Pool HC-16 to confluence with Bargo River | | 40 | 80 | 150 |
| Section with water levels controlled by rockbars and boulders upstream from Pool HC-16 | | 25 | 45 | 70 |

It can be seen that the predictions based on the *Modified Layout* are increased when compared to the predictions based on the *Approved Layout*, which is expected given that LW S7A is closer to Hornes Creek.

Maximum subsidence, closure and upsidence is located at the sharp bend in Hornes Creek, which is located closest to LW S7A. As shown in Fig. A.02, predicted movements reduce further upstream and downstream of the bend.

### 3.3.3. Statistical analyses of valley closure movements

Statistical analyses of previously measured valley closure in the Southern Coalfield have been conducted based on monitoring data from Tahmoor Colliery and nearby Appin and West Cliff Collieries, where depths of cover and extraction heights are similar to those proposed for LW S7A. The results are relevant for the proposed extraction of LW S7A adjacent to Hornes Creek and the Bargo River.

Observed incremental valley closure at sites located above solid, unmined coal, are shown relative to their distances from the maingate edges of previously extracted longwalls in Fig. 3.13. A total of 2390 measurements have been plotted, sorted into groups based on valley depths that are greater than or less than 40 metres. Where surveys were conducted on multiple occasions at a site during the extraction of a longwall, only the maximum measured incremental closure for each longwall has been plotted.

The confidence levels, based on fitted *Generalised Pareto Distributions* (GPDs), have also been shown in Fig. 3.13 to illustrate the spread of the data. The GPD and confidence levels have been calculated without filtering the data based on valley depths, nor the locations of the sites relative to the sides or ends of the longwalls.

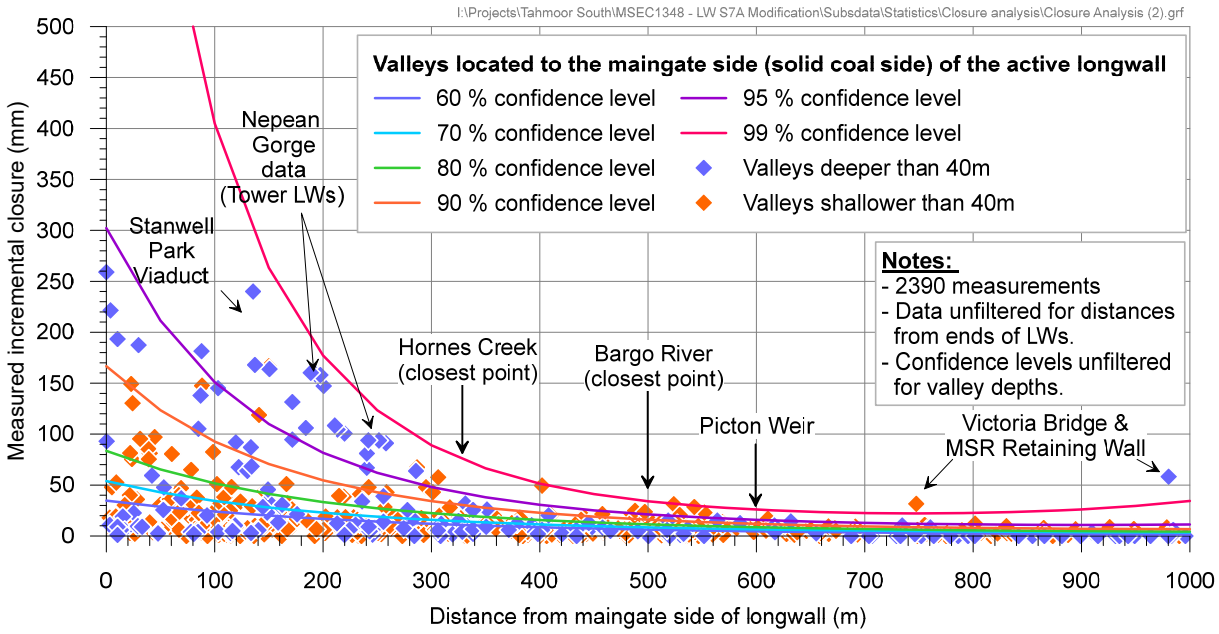



**Fig. 3.13 Observed incremental valley closure against distance from the maingate edge of the active longwall over solid, unmined coal**

It can be seen from Fig. 3.13 that observed valley closure increases as the distance of the sites to the extracted longwalls reduce, as expected. Given that predicted maximum incremental valley closure along Hornes Creek is 130 mm at a distance of 330 metres from the maingate edge of LW S7A, the statistical analyses also demonstrates that observed closure, when plotted against distance from the maingate edge, is generally less than predicted by the ACARP method.

The reason for the more conservative prediction by the ACARP method can be explained by the way in which the ACARP normalises the offset distances by dividing them by the sum of the longwall panel width and chain pillar width. The ACARP method of predicting valley closure relative to the transverse distance to the active longwall is shown in Fig. 3.14, with the latest available empirical data overlaid on the graph. It can be seen that upper bound prediction curves are conservative, though some outliers can be seen.

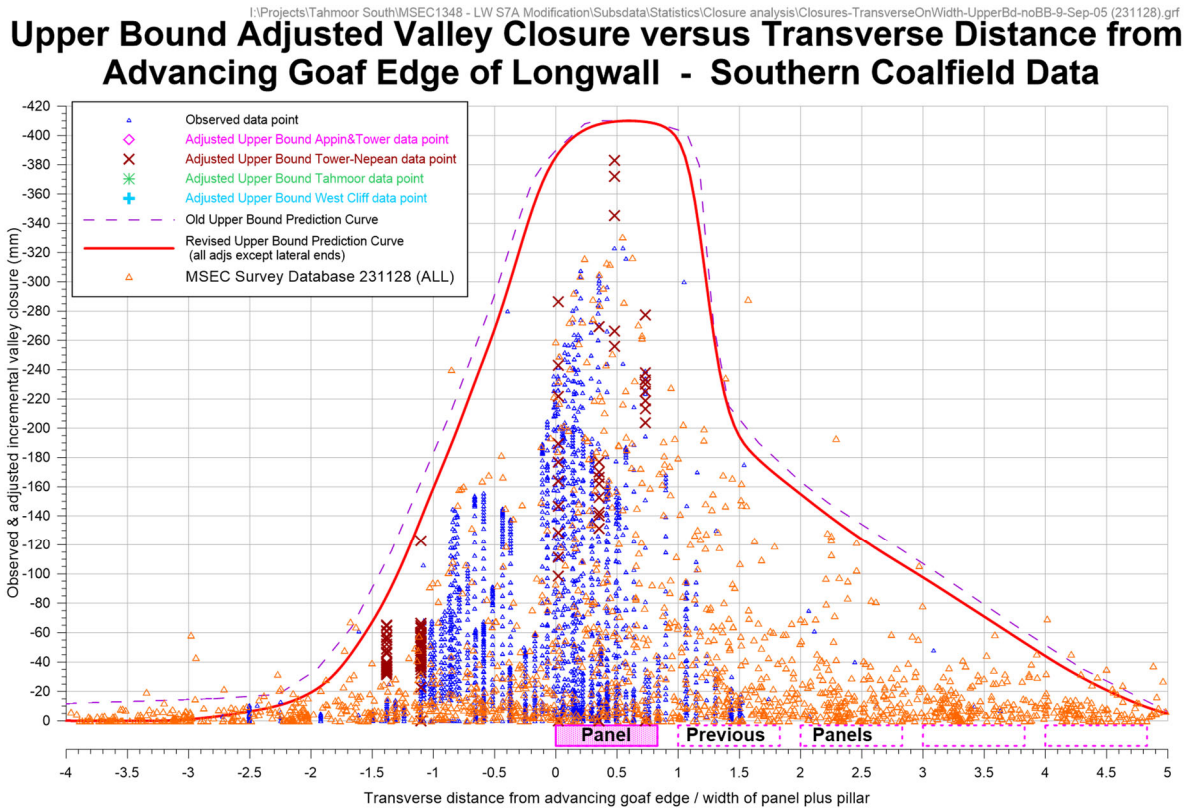



**Fig. 3.14 Observed incremental valley closure against normalised transverse distance from maingate edge of longwalls and ACARP prediction model**

The closest distance between Hornes Creek and LW S7A is approximately 330 metres at a sharp bend. The distance equates to an normalised distance of -1.03 in Fig. 3.14. The empirical data that influenced the shape of the prediction curve in the ACARP model was primarily based on surveys conducted across the Nepean Gorge during the extraction of longwalls at Tower Colliery, where the longwall panels were approximately 210 metres wide. When the data is plotted against distance only, as shown in Fig. 3.13, the Nepean Gorge data is located around 200 to 250 metres from the maingate edge. When the data is plotted against normalised distance, as shown in Fig. 3.14 and also in Fig. 3.15 below, the Nepean Gorge data is more applicable to the predictions at the closest point of Hornes Creek to LW S7A.

Similarly, measured incremental valley closure across the Stanwell Park Viaduct during mining at CoalCliff Colliery fits within the confidence level curves when plotted against distance in Fig. 3.13, but becomes an outlier when the distance is normalised due to the narrowness of the extracted panel.

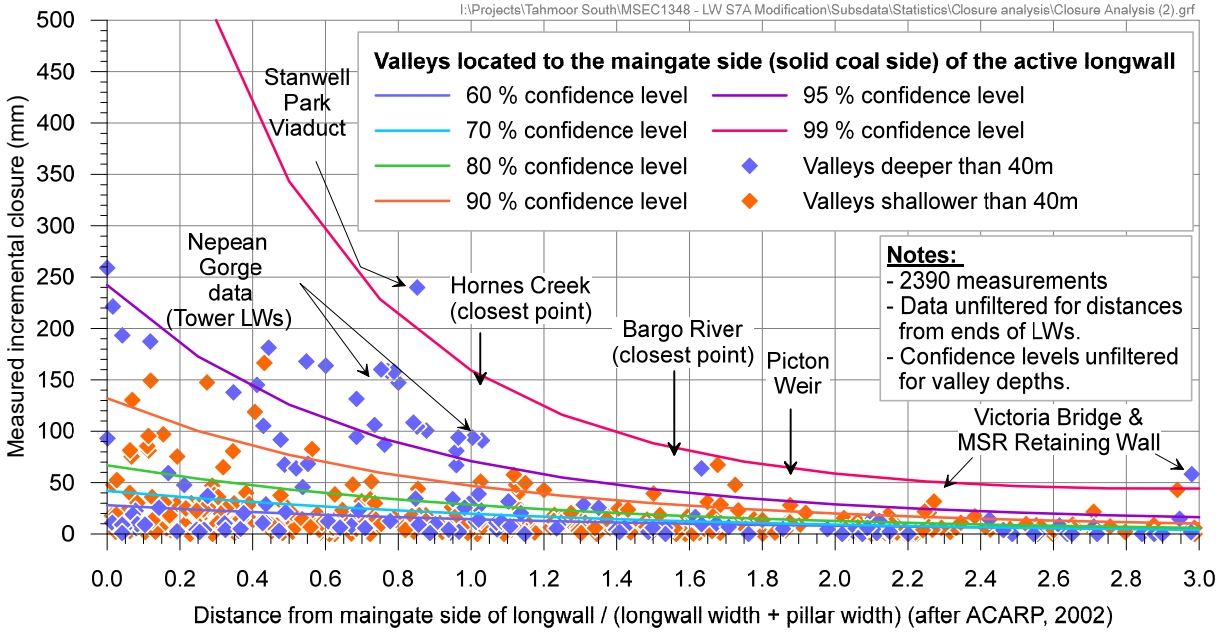



**Fig. 3.15 Observed incremental valley closure against normalised distance from the maingate edge of longwalls / (longwall width + pillar width)**

The closest distance between Hornes Creek and LW S7A is approximately 330 metres at a sharp bend. The statistical analyses indicates that the ACARP prediction of maximum incremental closure of 130 mm at the closest point to Hornes Creek is reasonably conservative:

- When compared against the empirical database based on the offset distance of 330 metres, it can be seen from Fig. 3.13 that the likelihood of exceedance is less than 1 in 100 (i.e. above the 99% confidence level curve).
- When compared against the empirical dataset based on a normalised offset distance of 1.03, it can be seen from Fig. 3.15 that the likelihood of exceedance is between 1 in 20 and 1 in 100 (i.e. between the 95% and 99% confidence level curves).

Upstream of the bend, the distance between Hornes Creek and LW S7A is between 470 metres and 620 metres. The statistical analyses indicates that the ACARP prediction of maximum incremental closure of 60 mm at the closest point to Hornes Creek is reasonably conservative:

- When compared against the empirical database based on the offset distance of 470 to 600 metres, it can be seen from Fig. 3.13 that the likelihood of exceedance is considerably less than 1 in 100 (i.e. above the 99% confidence level curve).
- When compared against the empirical dataset based on a normalised offset distance of 1.5 to 1.9, it can be seen from Fig. 3.15 that the likelihood of exceedance is between 1 in 20 and 1 in 100 (i.e. between the 95% and 99% confidence level curves).

While the statistical analyses show that the valley closure prediction is likely to be conservative, the empirical data presented in Fig. 3.13 and Fig. 3.15 shows there are two outliers at distances greater than 600 metres from previously extracted longwalls. These relate to recently observed closure during the mining of Tahmoor LW W3 and LW W4 across Stonequarry Creek at the Victoria Bridge and a Retaining Wall at 84.687 km on the Main Southern Railway. LW W4 was relatively short in length and incremental valley closure would likely have been greater if LW W4 was longer. LW W4 was also the last longwall to be extracted in this mining domain. Valley closure would likely have continued to develop at a greater magnitude if additional longwalls had been extracted closer to the monitoring sites. The observed closure, however, only developed along one arm of Stonequarry Creek, where less than 10 mm of valley closure was observed where the Picton Viaduct crosses Stonequarry Creek, 300 metres upstream of Victoria Bridge. The observations are discussed in Section 3.10.5.

The case study is relevant to the extraction of LW S7A to the side of Hornes Creek and the Bargo River as both sites involve a regionally significant valley (Stonequarry Creek compared to Bargo River) and both are located near a major geological fault system (Nepean Fault compared to the Central Fault). The case study is a reminder that greater valley closure movements can sometimes occur. The potential for greater than predicted movements has been considered when conducting impact assessments for Hornes Creek and the Bargo River.

### 3.3.4. Potential impacts on Hornes Creek

The impact assessments for Hornes Creek within the 600m Study Area are provided in the following sections. The assessments provided in this report should be read in conjunction with the Water Management Plan (Tahmoor Coal, 2023a) and the Biodiversity Management Plan (Tahmoor Coal, 2023c), which assess the consequences of the impacts on surface water flows and ecology.

***Potential for increased levels of ponding, scouring or desiccation due to mining-induced tilt***

Mining can potentially result in increased levels of ponding in locations where the mining-induced tilts oppose and are greater than the natural stream gradients that exist before mining. Mining can also potentially result in an increased likelihood of scouring of the stream beds in the locations where the mining-induced tilts considerably increase the natural stream gradients that exist before mining.

In this case, the predicted changes in grade along Hornes Creek due to the proposed extraction of LW S7A are negligible. The potential for impacts due to mining-induced changes in stream gradients is also irrelevant for the section downstream of Pool HC-16, given that this section is usually inundated with stored water.

***Potential for fracturing and surface water flow diversion in the stream***

A summary of observed experiences of impacts due to previous longwall mining adjacent but not directly beneath streams was discussed in Section 3.2.3.

The section of Hornes Creek downstream of Pool HC-16 is located approximately 330 metres from the proposed LW S7A at its closest point at the sharp bend in the stream. This section of Hornes Creek is located within the stored waters behind the Picton Weir. Based on the previous experiences at Tahmoor Mine, it is unlikely that the extraction of the proposed longwalls would result in adverse impacts on this section of the stream.

Minor fractures in bedrock have previously been observed in isolated locations at offset distances between 330 metres and 500 metres in the Southern Coalfield. In the event that minor, isolated surface fractures develop within the stored water areas of Hornes Creek due to the extraction of LW S7A, the fractures would likely not be detected as the bedrock is covered by alluvial sediment and frequently by stored water.

Even if the predictions and impact assessments were exceeded, the likelihood of impacts on surface flow is considered extremely low given that water levels are controlled by the Picton Weir. Previously observed experiences have found that mining-induced sub-surface fracturing in this section of the Bargo River have been filled by sediment that is stored behind the Picton Weir reducing the potential for impacts on surface water flows.

The section of Hornes Creek upstream of Pool HC-16 is located between 470 metres and 620 metres from the proposed LW S7A. The likelihood of fracturing occurring in this section of the creek is considered to be low. In the unlikely event that fracturing occurs, the fractures are expected to be minor and isolated.

The likelihood of fracturing resulting in surface flow diversion is considered to be very low given the offset distance of LW S7A to this section of stream.

Further detailed discussions on the impacts and consequences of changes in the surface water flows are provided in the Water Management Plan (Tahmoor Coal, 2023a).

***Potential for Gas Emissions and Changes to Water Quality***

Gas emissions from the sandstone strata have been previously observed above and adjacent to mining areas in the Southern Coalfield, and some gas emissions have also been observed in water bores. Analyses of gas compositions indicate that the Bulli seam is not the direct and major source of the gas and that the most likely source is the Hawkesbury Sandstone (APCRC, 1997).

Gas emissions may occur and become visible in the stored water behind the Picton Weir as a result of the proposed extraction of the longwalls. Where these gas releases occur into the water column there is insufficient time for any substantial amount of gas to dissolve into the water. The majority of the gas is released into the atmosphere and is unlikely to have an adverse impact on water quality.

A description of potential water quality impacts and environmental consequences is presented in the Water Management Plan (Tahmoor Coal, 2023a) and the Biodiversity Management Plan (Tahmoor Coal, 2023c).

### 3.3.5. Management of potential impacts on Hornes Creek

Tahmoor Coal has developed a Water Management Plan for LWs S1A to S6A to manage potential impacts on streams during the mining of longwalls, including Hornes Creek. The management plan includes monitoring and triggered response plans. It includes monitoring of the required pre-mining conditions and data collection during mining. Monitoring typically continues for a period following mining.

The Water Management Plan will be updated to include LW S7A (Tahmoor Coal, 2023a).

Tahmoor Coal is currently monitoring ground movements at Hornes Creek during the mining of LW S2A according to the Subsidence Monitoring Plan.

- Six GNSS units have been installed along the tops of Hornes Creek in pairs across the valley. The GNSS units have continuously monitored changes during mining since the commencement of LW S2A. While the GNSS units have measured minor horizontal movements, changes in horizontal distances between the units are less than 5 mm and within survey tolerance.

Tahmoor Coal will continue to monitor changes along Hornes Creek during the extraction of proposed Tahmoor South longwalls, in accordance with the Subsidence Monitoring Plan and Water Management Plan.

## 3.4. Teatree Hollow and tributaries

The locations of Teatree Hollow and its tributaries are shown in Drawing No. MSEC1348-07. The sections of Teatree Hollow and its tributaries within the Study Area are ephemeral first or second order drainage lines having shallow incisions into the natural surface soils.

The catchment area is located above LW S7A in predominantly grazing land, with stream flow captured by a number of farm dams.

### 3.4.1. Predictions for Teatree Hollow and tributaries

The predicted profiles of subsidence, upsidence and closure, using the IPM subsidence model and the 2002 ACARP valley closure prediction model, along the Teatree Hollow and the Tributary to Teatree Hollow are shown in Fig. A.03 and Fig. A.04, respectively.

A summary of the maximum predicted values of incremental vertical subsidence, upsidence and closure for Teatree Hollow and the Tributary to Teatree Hollow is provided in Table 3.6. A summary of the maximum predicted values of total vertical subsidence, upsidence and closure for Teatree Hollow and the Tributary to Teatree Hollow is provided in Table 3.7.

**Table 3.6 Maximum predicted incremental vertical subsidence, upsidence and closure for Teatree Hollow and the Tributary to Teatree Hollow**

| Modified Layout | Longwall | Maximum predicted incremental vertical subsidence (mm) | Maximum predicted incremental upsidence (mm) | Maximum predicted incremental closure (mm) |
|---|---|---|---|---|
| ***Teatree Hollow*** | LW S7A | 925 | 90 | 50 |
| ***Tributary to Teatree Hollow*** | LW S7A | < 20 | < 20 | < 20 |

**Table 3.7 Maximum predicted total vertical subsidence, upsidence and closure for Teatree Hollow and the Tributary to Teatree Hollow**

| Layout | Longwall | Maximum predicted total vertical subsidence (mm) | Maximum predicted total upsidence (mm) | Maximum predicted total closure (mm) |
|---|---|---|---|---|
| ***Teatree Hollow*** | | | | |
| Approved Layout | After LW S6A | 1400* | 400* | 275* |
| Modified Layout | After LW S7A | 1400* | 400* | 275* |
| ***Tributary to Teatree Hollow*** | | | | |
| Approved Layout | After LW S6A | 1350 | 450 | 375 |
| Modified Layout | After LW S7A | 1350 | 450 | 375 |

* *Note: downstream sections of Teatree Hollow have been previously mined beneath by LW1 and LW2 at Tahmoor Mine. The maximum predicted parameters provided in the above table include those resulting from the extraction of these earlier longwalls.*

The proposed LW S7A is located directly beneath the upstream end of Teatree Hollow and it can be seen from Fig. A.03 that the predictions are increased at the upstream end of Teatree Hollow under the *Modified Layout* when compared to the predictions based on the *Approved Layout*.

The Tributary to Teatree Hollow is located to the east of the proposed LW S7A. It can be seen from Fig. A.04 that there is very little change between the predictions under the *Modified Layout* when compared to the predictions based on the *Approved Layout*.

It can be seen from Drawing No. MSEC1348-07 that another first order tributary to Teatree Hollow will be directly mined beneath by LW S7A. This tributary would experience increased subsidence movements under the *Modified Layout* when compared to the predictions based on the *Approved Layout.*

### 3.4.2. Observed subsidence movements during the mining of LWs S1A and S2A directly beneath Teatree Hollow and tributaries

LWs S1A and S2A have mined directly beneath Teatree Hollow and the Tributary to Teatree Hollow.

***Tributary to Teatree Hollow***

Ten GNSS units have been installed along the tops of the Tributary to Teatree Hollow in pairs across the valley, as shown in Drawing No. MSEC1348-15. The GNSS units have measured the development of subsidence and valley closure during the extraction of LWs S1A and S2A.

Observed subsidence during the extraction of LWs S1A and S2A are discussed in Section 2.3, where it can be seen that observed subsidence has been less than predicted.

Changes in horizontal distances can be calculated between GNSS units that are stationed close together and results are shown in Fig. 3.16.

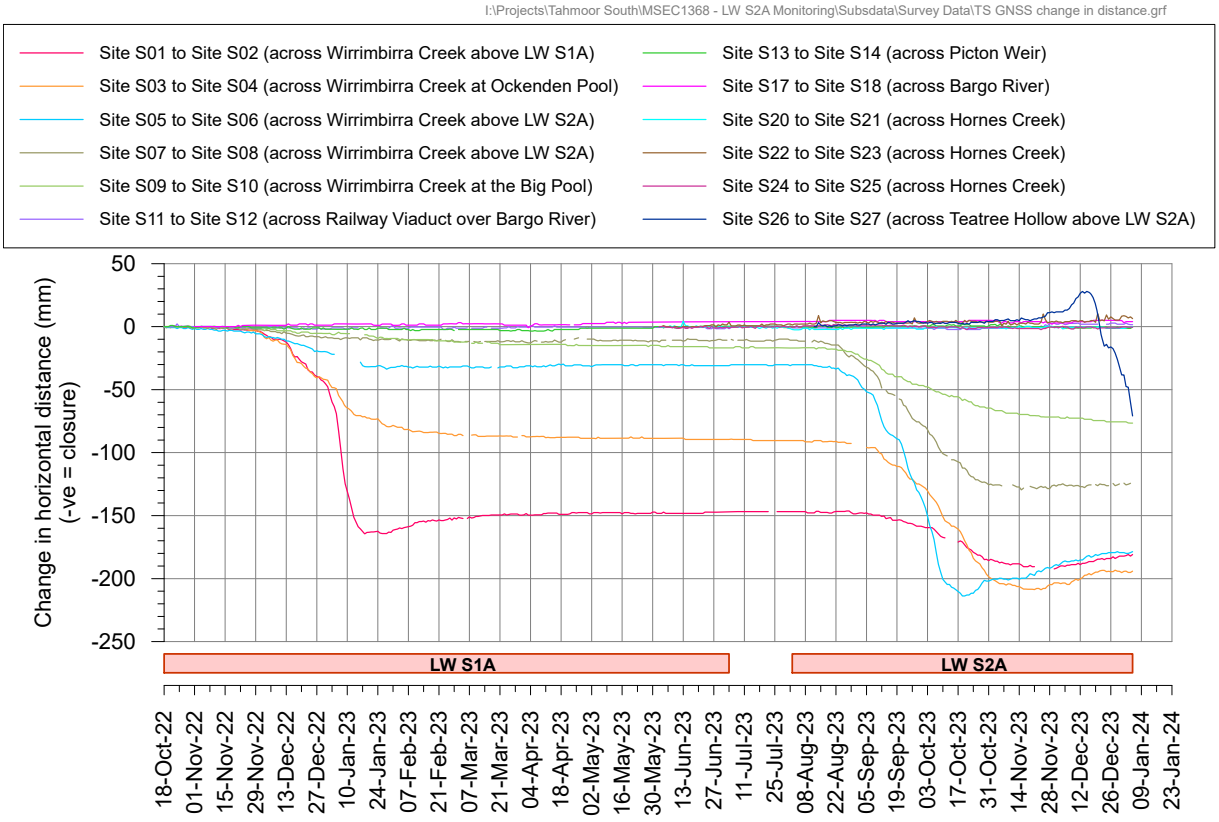



**Fig. 3.16 Observed changes in horizontal distances between GNSS units across the Tributary to Teatree Hollow and Teatree Hollow**

It can be seen from Fig. 3.16 that observed valley closure is less than the predicted maximum closure of 275 mm due to the extraction of LWs S1A and S2A.

In addition to the GNSS units, survey marks have been installed at four locations across valley floor of the Tributary to Teatree Hollow (Wirrimbirra Creek), as shown in Drawing No. MSEC1348-15. The observed development of valley closure at the ground survey lines across the Tributary to Teatree Hollow is shown in Fig. 3.17. The results correlate reasonably well with the observations from GNSS units, taking into account the shorter lengths of the survey lines, which are based within the floor of the creek valley, compared to the distances between the GNSS units, which are mounted at the tops of the valleys.

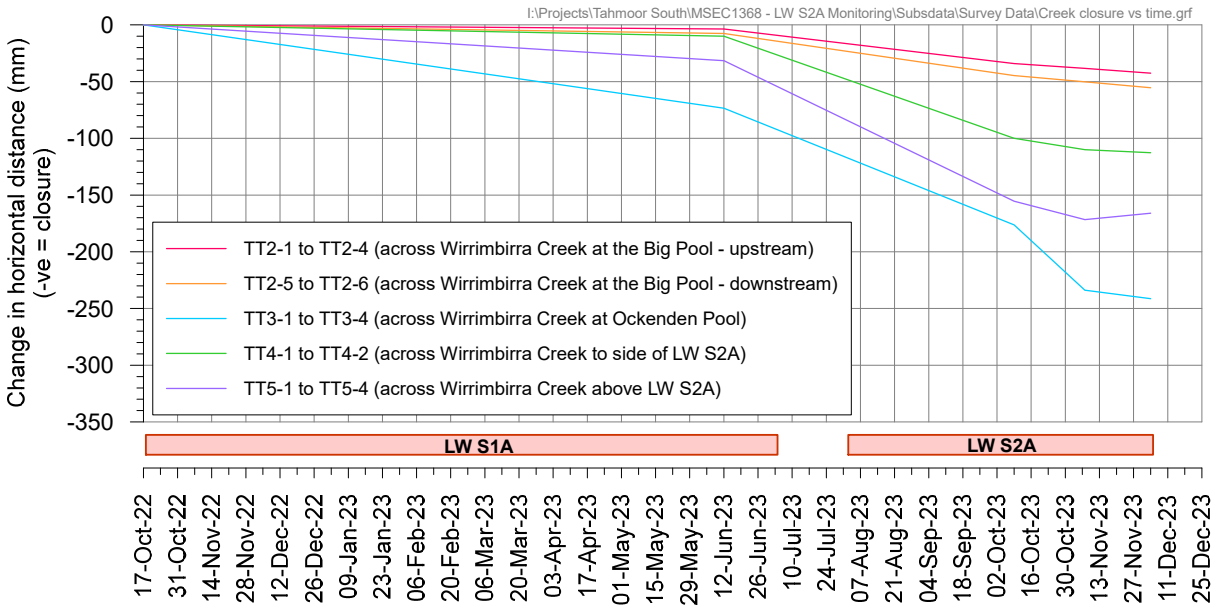



**Fig. 3.17 Observed development of closure across Tributary to Teatree Hollow from ground surveys**

The results from the ground surveys across lines TT2, TT3 and TT5 are shown in Fig. 3.18, Fig. 3.19 and Fig. 3.20, respectively. The survey lines are restricted to the base of the valley floor due to the remoteness of the sites and presence of thick vegetation and do not measure absolute vertical subsidence (this is measured by the GNSS units along the tops of the valley). The ground surveys measure changes in height relative to the first survey peg in the survey lines.

The results show that upsidence and closure has developed within the valley floor, concentrating either in the centre of the valley floor or to one side of the valley floor.

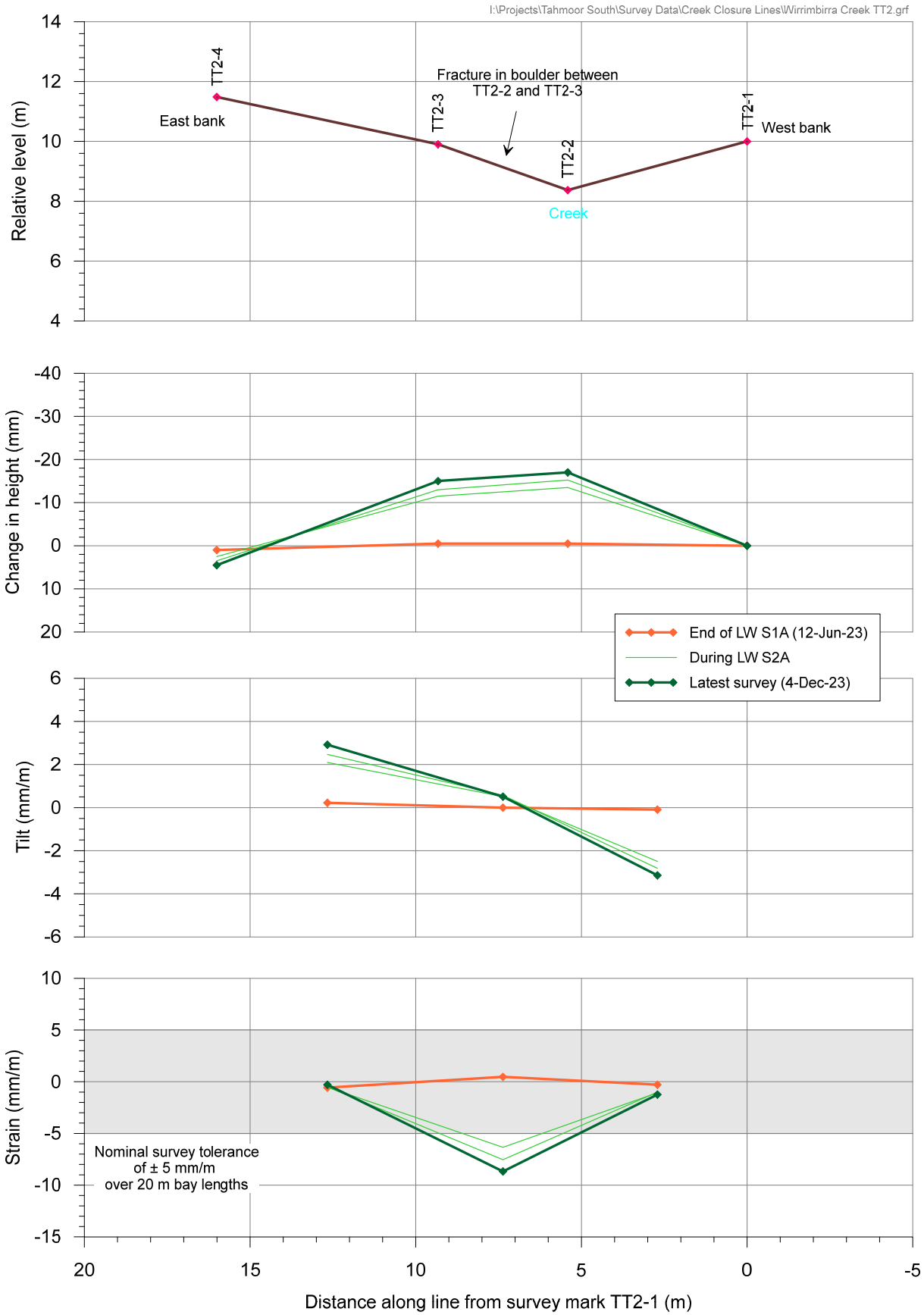



**Fig. 3.18 Observed total changes in height, tilt and strain along survey line TT2 across the Tributary to Teatree Hollow during the mining of LWs S1A and S2A**

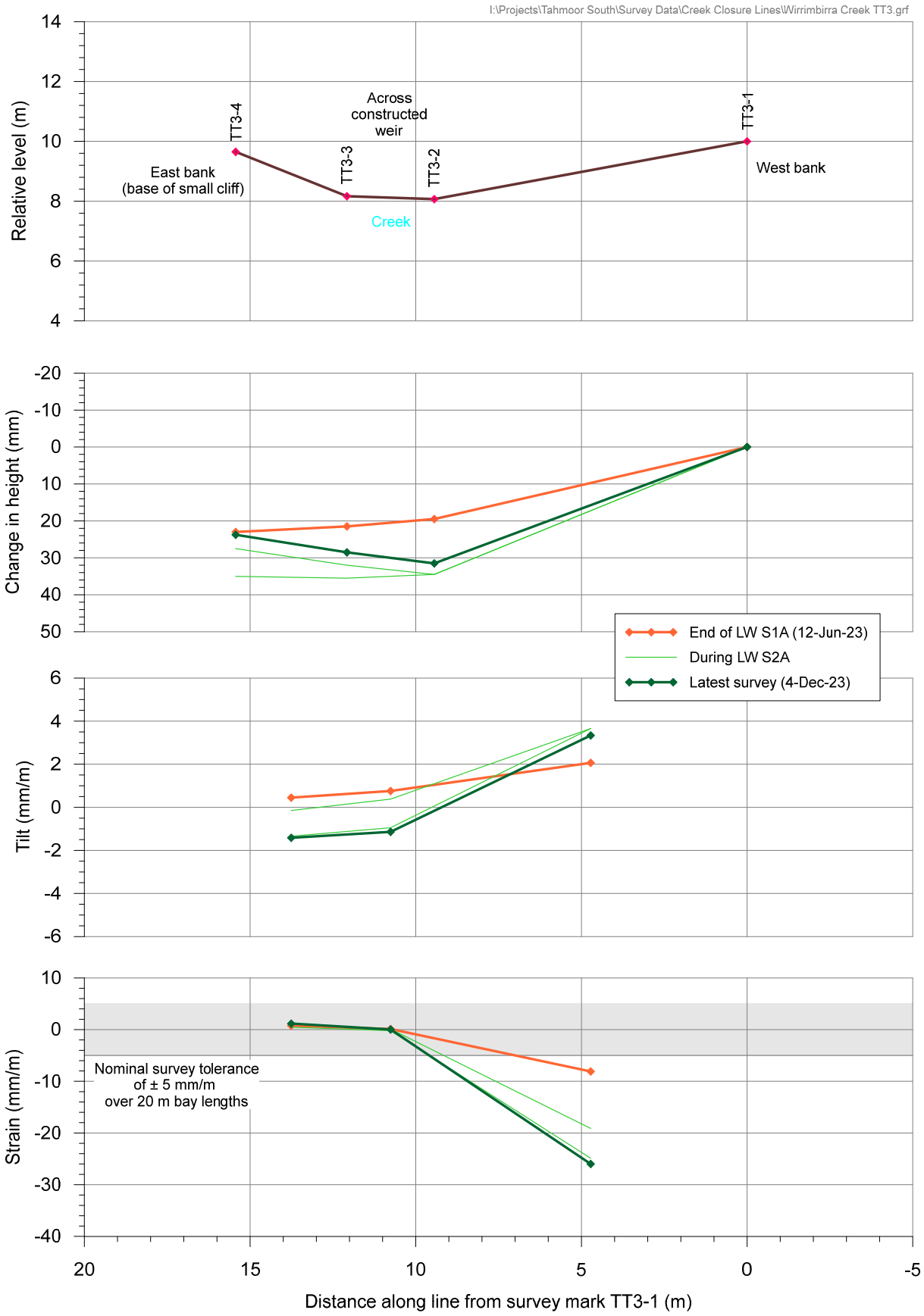



**Fig. 3.19 Observed total changes in height, tilt and strain along survey line TT3 across the Tributary to Teatree Hollow during the mining of LWs S1A and S2A**

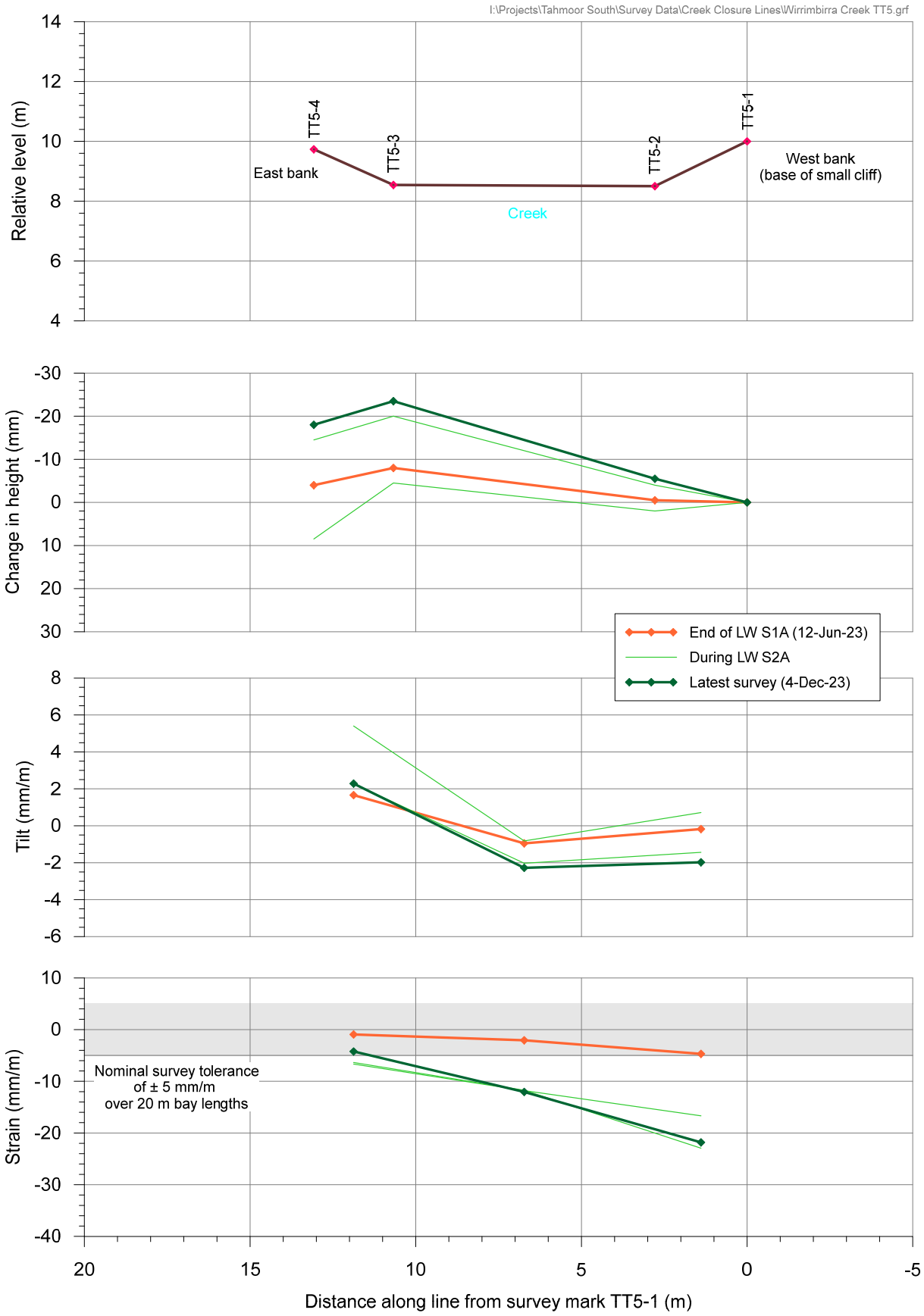



**Fig. 3.20 Observed total changes in height, tilt and strain along survey line TT5 across the Tributary to Teatree Hollow during the mining of LWs S1A and S2A**

### 3.4.3. Potential impacts on Teatree Hollow and tributaries

The impact assessments for Teatree Hollow and its tributaries within the Study Area are provided in the following sections. The assessments provided in this report should be read in conjunction with the Water Management Plan (Tahmoor Coal, 2023a) and the Biodiversity Management Plan (Tahmoor Coal, 2023c), which assess the consequences of the impacts on surface water flows and ecology.

***Potential for increased levels of ponding, scouring or desiccation due to mining-induced tilt***

Mining can potentially result in increased levels of ponding in locations where the mining-induced tilts oppose and are greater than the natural stream gradients that exist before mining. Mining can also potentially result in an increased likelihood of scouring of the stream beds in the locations where the mining-induced tilts considerably increase the natural stream gradients that exist before mining.

A flood study has been completed by ATC Williams on the potential changes to flood levels due to the extraction of LWs S1A to S7A (ATC, 2024). Minor increases to flood levels are predicted in areas subject to flooding under existing conditions above LW S3A at Caloola Road and LW S5A at Yaran Road. The addition of LW S7A does not materially change the results of the flood study and the results are generally consistent with the findings of the EIS.

It is further noted that the predicted 1% AEP flood levels do not extend to surface areas located directly above LW S7A prior to mining or after the extraction of LW S7A.

***Potential for fracturing and surface water flow diversion in the stream***

Teatree Hollow and its tributaries will be directly mined beneath by the *Approved Layout*. It was assessed that fracturing and surface flow diversions will occur in the sandstone bedrock along both streams due to the extraction of the longwalls in the *Approved Layout*. In some of these locations, the fracturing could impact the holding capacity of the standing pools, particularly those located directly above the proposed longwalls. It is unlikely, however, that there would be any net loss of water from the catchment. Mining-induced fractures and impacts on surface water flow and pool water levels have been observed during the extraction of LW S1A and LW S2A.

The addition of LW S7A does not materially change this assessment, though the extent of impacts increases further upstream to the include the headwaters of two first order sections in the catchment.

While the extent of impacts is increased, Tahmoor Coal will continue to develop and implement measures to manage the potential for impacts on Teatree Hollow and its tributaries during the extraction of LWs S1A to S7A.

***Potential for Gas Emissions and Changes to Water Quality***

Gas emissions from the sandstone strata have been previously observed above and adjacent to mining areas in the Southern Coalfield, and some gas emissions have also been observed in water bores. Analyses of gas compositions indicate that the Bulli seam is not the direct and major source of the gas and that the most likely source is the Hawkesbury Sandstone (APCRC, 1997).

As LW S7A is proposed to extract directly beneath the headwaters of first order tributaries, any gas emissions that occur will release into the atmosphere and is unlikely to have an adverse impact on water quality.

A description of potential water quality impacts and environmental consequences is presented in the Water Management Plan (Tahmoor Coal, 2023a) and the Biodiversity Management Plan (Tahmoor Coal, 2023c).

### 3.4.4. Management of potential impacts on Teatree Hollow and tributaries

Tahmoor Coal has developed a Water Management Plan for LWs S1A to S6A to manage potential impacts on streams during the mining of longwalls, including Teatree Hollow and its tributaries. The management plan includes monitoring and triggered response plans. It includes monitoring of the required pre-mining conditions and data collection during mining. Monitoring typically continues for a period following mining.

The Water Management Plan will be updated to include LW S7A (Tahmoor Coal, 2023a).

## 3.5. Cliffs

### 3.5.1. Descriptions of the cliffs

The locations of cliffs within the Study Area are shown in Drawing No. MSEC1348-07. A total of 19 cliffs are located within the 600m Study Area for Natural Features, of which 5 cliffs are located within the Study Area.

The cliffs are located within the Hawkesbury Sandstone along the Bargo River and Hornes Creek, at distances of between 275 metres and 600 metres from LW S7A. Photographs of the cliff lines are shown in Fig. 3.1, Fig. 3.9 and Fig. 3.28. There is no direct vehicle access to the cliffs within the Study Area though some cliffs can be reached on foot via walking trails. The Picton Weir is located beneath Cliff C_0800, which is located approximately 575 metres from LW S7A and setback approximately 50 metres from the dam wall (refer Fig. 3.32). A photograph of the cliff above Picton Weir is provided in Fig. 3.21.

**Fig. 3.21 Cliff C_00800 above the Picton Weir**

For the purposes of this report, a cliff has been defined as a continuous rockface having a maximum height greater than 10 metres, a minimum length of 20 metres and a minimum slope of 2 in 1, i.e. having a minimum angle to the horizontal of 63°. The definition is consistent with the definition provided in the Project Approval of the EIS. The locations and heights of cliffs within the Study Area were determined by Fluvial Systems based on the results of an airborne laser scan, refer to Fluvial Systems (2013).

The closest cliff (MSEC ID C_00130, DP ID BC1) is located approximately 275 metres from LW S7A. The cliff has been surveyed by aerial photogrammetry by MNC Consulting. The result of the survey is shown in Fig. 3.22.

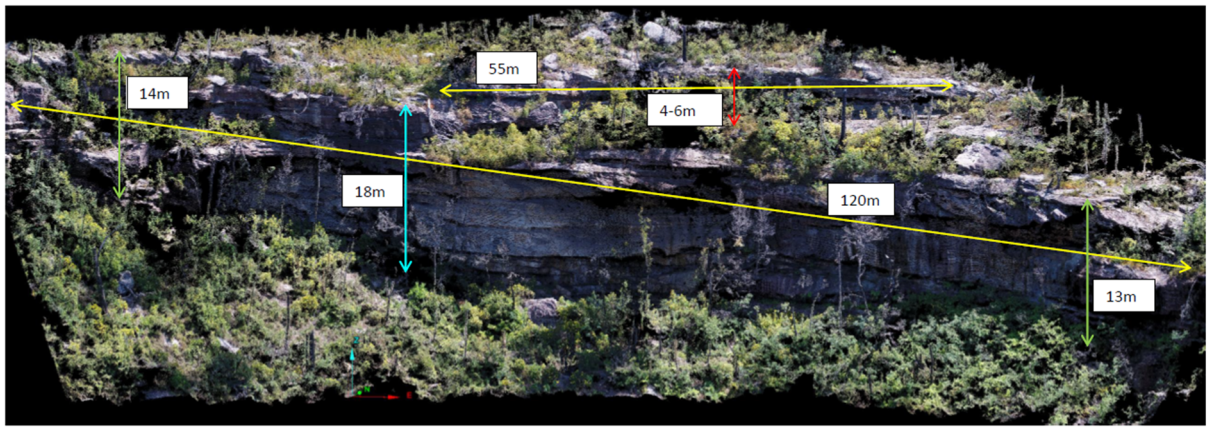



*Image courtesy MNC Consulting*

**Fig. 3.22 Digital reconstruction of aerial photogrammetry survey of Cliff C_00130**

The cliff is measured to be approximately 120 metres long with a maximum height of 18 metres, when the smaller upper section of the cliff is included in the height calculation with the main cliff. The cliff includes an overhang of approximately 4 to 5 metres in depth which is 50 metres long. The total face area has been calculated to be 2,685 $m^2$.

The second closest cliff (MSEC ID C_02060) is located approximately 360 metres from LW S7A. The cliff has been surveyed using aerial photogrammetry by MNC Consulting. The result of the survey is shown in Fig. 3.23.

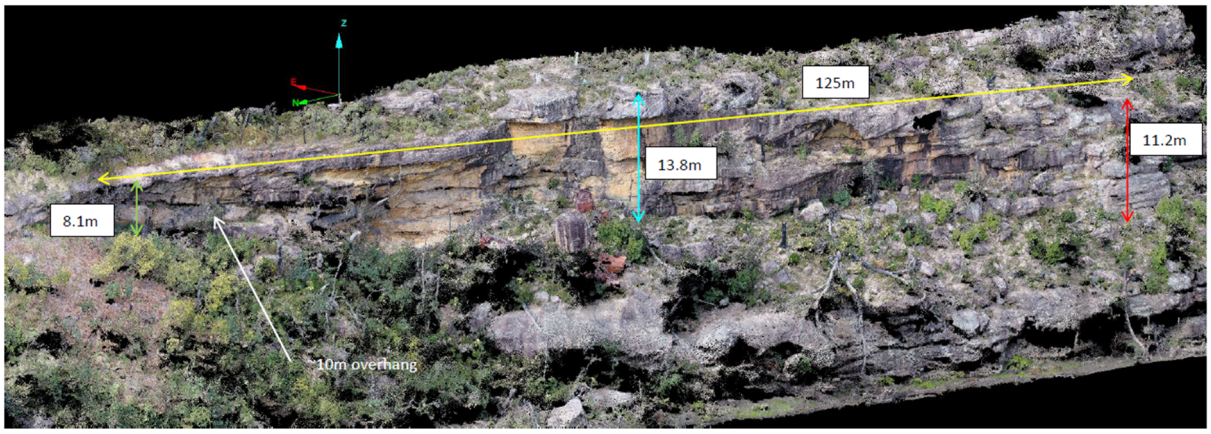



*Image courtesy MNC Consulting*

**Fig. 3.23 Digital reconstruction of aerial photogrammetry survey of Cliff C_02060**

The cliff is measured to be approximately 125 metres long with a maximum height of 14 metres. The cliff includes an overhang of approximately 10 metres at the northern end. The total face area has been calculated to be 1,583 $m^2$.

### 3.5.2. Predictions for the cliffs

A summary of the maximum predicted values of total vertical subsidence, tilt and the maximum predicted total hogging curvature and sagging curvature at the 19 identified cliffs is provided in Table 3.8. Because of the distance between the cliffs and the *Approved Layout* LWs S1A to S6A, the predicted subsidence movements due to the extraction of these longwalls are negligible, and hence the predicted total subsidence movements shown in Table 3.8 are essentially the incremental subsidence movements due to LW S7A.

**Table 3.8 Maximum predicted total vertical subsidence, tilt and curvature for cliffs due to the extraction of LWs S1A to S7A**

| Modified Layout<br>After LW S7A | Maximum Predicted Total Conventional Subsidence (mm) | Maximum Predicted Total Conventional Tilt (mm/m) | Maximum Predicted Total Hogging Curvature ($km^{-1}$) | Maximum Predicted Total Sagging Curvature ($km^{-1}$) |
|---|---|---|---|---|
| C_00130 | 60 | < 0.5 | < 0.01 | < 0.01 |
| C_00710 | 25 | < 0.5 | < 0.01 | < 0.01 |
| C_00800 | < 20 | < 0.5 | < 0.01 | < 0.01 |
| C_00830 | < 20 | < 0.5 | < 0.01 | < 0.01 |
| C_00920 | < 20 | < 0.5 | < 0.01 | < 0.01 |
| C_01160 | < 20 | < 0.5 | < 0.01 | < 0.01 |
| C_01280 | < 20 | < 0.5 | < 0.01 | < 0.01 |
| C_01610 | 30 | < 0.5 | < 0.01 | < 0.01 |
| C_02020 | < 20 | < 0.5 | < 0.01 | < 0.01 |
| C_02060 | 40 | < 0.5 | < 0.01 | < 0.01 |
| C_02170 | < 20 | < 0.5 | < 0.01 | < 0.01 |
| C_02240 | 25 | < 0.5 | < 0.01 | < 0.01 |
| C_02670 | < 20 | < 0.5 | < 0.01 | < 0.01 |
| C_02920 | < 20 | < 0.5 | < 0.01 | < 0.01 |
| C_03370 | < 20 | < 0.5 | < 0.01 | < 0.01 |
| C_05140 | 20 | < 0.5 | < 0.01 | < 0.01 |
| C_07220 | 30 | < 0.5 | < 0.01 | < 0.01 |
| C_11150 | 20 | < 0.5 | < 0.01 | < 0.01 |
| C_11590 | < 20 | < 0.5 | < 0.01 | < 0.01 |

### 3.5.3. Impact assessments for cliffs located above solid coal

The cliffs are located more than 275 metres from the proposed LW S7A and will not be directly mined beneath.

It is extremely difficult to assess the likelihood of cliff instabilities based upon predicted ground movements. The likelihood of a cliff becoming unstable is dependent on a number of factors which are difficult to fully quantify. These factors include jointing, inclusions, weaknesses within the rock mass, groundwater pressure and seepage flow behind the rockface. Even if these factors could be determined, it would still be difficult to quantify the extent to which these factors influence the stability of a cliff naturally or when it is exposed to mine subsidence movements. It is possible, therefore, that cliff instabilities may occur during mining that may be attributable to either natural causes, mine subsidence, or both.

The likelihood of cliff instabilities can be assessed using case studies where previous longwall mining has occurred close to but not directly beneath cliffs. Although very minor rock falls have been observed over solid coal outside the extracted goaf areas of longwall mining in the Southern Coalfield, there have been no recorded large cliff instabilities outside the extracted goaf areas of longwall mining in the Southern Coalfield. This statement is based on the following observations:-

- ***Tahmoor Longwalls 24A to 26***

  Tahmoor Longwalls 24A to 26 were mined near and adjacent to the cliff lines along the Bargo River valley between November 2007 and July 2011. The cliff lines are continuous on both sides of the valley along this section of the river. The cliffs are located at a minimum distance of 300 metres east of Longwall 24A, at their closest point to these longwalls. Whilst the overall valley depths, within one depth of cover of this gorge, were over 100 metres, the heights of the cliffs are around 60 metres and are formed within the Hawkesbury Sandstone.

  Tahmoor Longwalls 24A to 26 have void widths of 285 metres, solid chain pillar widths of 35 metres to 40 metres and were extracted from the Bulli seam at a depth of cover of 350 metres at the base of the gorge and 450 metres around the plateau areas. There were no impacts observed on the cliffs along the Bargo River Valley as a result of the extraction of Tahmoor Longwalls 24A to 26.

- ***Appin Longwalls 301 and 302 near the Cataract River***

  Appin Longwalls 301 and 302 were mined adjacent to a number of cliff lines located along the Cataract River valley between October 2006 and September 2007. A total of 68 cliffs were identified within a 35 degree angle of draw from these longwalls. These cliffs had continuous lengths ranging between 5 metres and 230 metres, overall cliff heights ranging between 10 metres and 37 metres, overall valley depths, within one depth of cover of the river, ranging from 50 to 75 metres, and had been formed within the Hawkesbury Sandstone.

  Appin Longwalls 301 and 302 have void widths of 260 metres, solid chain pillar widths of 40 metres and were extracted from the Bulli seam at a depth of cover of 420 metres at the base of the gorge and 490 metres around the plateau areas. These longwalls mined to within 50 metres of the identified locations of the cliffs along the Cataract River valley.

  There were no large cliff instabilities observed as a result of the extraction of Appin Longwalls 301 and 302. There were, however, five minor rock falls or disturbances which occurred during the mining period, of which, three were considered likely to have occurred due to a substantial rainfall event and one was probably a natural instability of the cliff overhang. Nevertheless, the length of cliff line disturbed as a result of the extraction of Appin Longwalls 301 and 302 was, therefore, estimated to be less than 0.5 % of the total face area of the cliff lines within the mining domain.

- ***Tower Longwalls 18 to 20 and Appin Longwalls 701 to 704 near the Nepean River***

  Tower Longwalls 18 to 20 and Appin Longwalls 701 to 704 mined adjacent to a number of cliff lines located along the Nepean River valley. A total of approximately 50 cliffs were identified within a 35 degree angle of draw from these longwalls. The cliffs had continuous lengths ranging between 5 metres and 225 metres, overall heights ranging between 10 metres and 40 metres, overall valley depths, within one depth of cover of the river, ranging from 60 to 80 metres and had been formed within the Hawkesbury Sandstone.

  Tower Longwalls 18 to 20 have void widths of 235 metres, solid chain pillar widths of 40 metres and were extracted from the Bulli seam at a depth of cover of 460 metres at the base of the gorge and 510 metres around the plateau areas. Appin Longwalls 701 to 704 have void widths of 320 metres, solid chain pillar widths of 40 metres and were extracted from the Bulli seam at a depth of cover of 460 metres at the base of the gorge and 510 metres around the plateau areas.

  Tower Longwall 20 was mined directly beneath some cliffs located at the confluence of Elladale Creek and the Nepean River. Appin Longwalls 701 to 704 mined to within 75 metres of the identified locations of the cliffs along the Nepean River valley.

  There were no cliff instabilities observed as a result of the extraction of Tower Longwalls 18 to 20 and Appin Longwalls 701 to 704.

Based on this previous experience of mining at Tahmoor, Appin and Tower Collieries, it is unlikely that cliffs beyond the extent of the longwall panels will experience large instabilities. It is possible that isolated rock falls could occur during the mining period due to natural weathering processes. Any impacts are expected to represent less than 0.5 % of the total face area of the cliffs.

The cliffs are located in area that is very difficult to access publicly. In the very unlikely event that an isolated rock fall occurs, the likelihood of a rock fall affecting public safety is assessed to be extremely low.

### 3.5.4. Impact assessments for the cliffs based on increased predictions

If the actual mine subsidence movements exceeded those predicted values by a factor of 2 times, the likelihood of impacts for the cliffs that are located well outside the proposed LW S7A would still be expected to be very low.

While the predicted ground movements are important parameters when assessing the potential impacts on the cliffs, it is noted that the impact assessments for cliff instabilities have primarily been based on historical observations from previous longwall mining in the Southern Coalfield.

### 3.5.5. Management of potential impacts on cliffs

Tahmoor Coal has developed a Land Management Plan for managing potential impacts on cliffs during the mining of LWs S1A to S6A. The management plan includes:

- Identification of all structures, dams and roads that are in close proximity to cliffs;
- Site investigation of cliffs by a qualified geotechnical engineer;
- Baseline mapping of cliffs to measure face area;
- Monitoring, including ground survey and visual inspections; and
- Erection of warning signs and consultation with landowners if impacts are observed.

It is recommended that Tahmoor Coal continue to develop management plans to manage potential impacts on cliffs during the mining of the proposed LW S7A. The Land Management Plan will be extended to include management of potential impacts due to the extraction of LW S7A.

## 3.6. Steep Slopes

The locations of the steep slopes are shown in Drawing No. MSEC1348-07.

The purpose of identifying steep slopes for this assessment is to highlight areas in which existing ground slopes may be marginally stable. As a conservative first pass, a steep slope has been defined as an area of land having a gradient greater than 1 in 3 (33 % or 18.3°). The definition is consistent with the definition provided in the Project Approval of the EIS layout. The minimum slope of 1 to 3 represents a slope that would generally be considered stable for slopes consisting of rocky soils or loose rock fragments. Clearly the stability of natural slopes varies depending on their soil or rock types, and in many cases, natural slopes are stable at much higher gradients than 1 to 3 (for example, talus slopes in Hawkesbury Sandstone).

The steep slopes were identified by Fluvial Systems from an airborne laser scan supplied by Tahmoor Coal. The steep slopes within the Study Area can be broadly categorised as:

a) Steep slopes on the sides of valleys;
b) Batters of road and railway embankments and cuttings;
c) Slopes on farm dams.

Types (b) and (c) are addressed later in this report.

The steep slopes on the sides of valleys are predominantly found in Hawkesbury Sandstone and consist of a mixture of cliffs and rock outcrops, which are stable at vertical to overhanging, and screed slopes with rocky soils and loose rock fragments. The majority of slopes are stabilised, to some extent, by natural vegetation.

The ranges of predicted subsidence parameters for the steep slopes are similar to those predicted along the streams, which are provided in Section 3.2.2.

There has been extensive experience of mining beneath steep slopes in the Southern Coalfield. These include steep slopes along the Cataract, Nepean, Bargo and Georges Rivers and streams such as Myrtle Creek and Redbank Creek above Tahmoor Mine Longwalls 22 to 32, slopes on Redback Range above Tahmoor Mine Longwalls 26 and 27 and slopes along ridges and valleys above Tahmoor LWs W1-W4. No large-scale slope failures have been observed along these slopes, even where longwalls have been mined directly beneath them. Surface cracking and minor rock falls along clifflines or rock outcrops have been observed, for example, during the mining of Appin Longwalls 301 and 302 adjacent to the Cataract River, however, no large-scale slope failures have been observed.

Potential impacts on steep slopes would generally result from the movement of soils, causing tension cracks to appear at the tops of the slopes and compression ridges to form at the bottoms of the slopes. These movements are consistent with observations of upsidence and closure of creek valleys where compression is developed at the bottoms of the valleys and tension is developed at the tops of the valleys. If tension cracks were left untreated it is possible that soil erosion could occur.

It is possible, therefore, that some remediation might be required to ensure that mining-induced surface cracking does not result in the formation of soil erosion channels. In some cases, erosion protection measures may be needed, such as the planting of additional vegetation in order to stabilise the slopes in the longer term.

While in most cases impacts to slopes are likely to consist of surface cracking, there remains a low probability of large-scale slope slippage. The probability is assessed to be very low for slopes that will not be directly mined beneath by the longwalls. Experience indicates that the probability of mining induced large-scale slippages is extremely low due to the substantial depths of cover within the Study Area. While the risk is extremely low, some risk remains and attention must therefore be paid to any structures or roads that may be located in the vicinity of steep slopes.

There are no structures or roads located along natural steep slopes within the Study Area.

### 3.6.1. Management of potential impacts on steep slopes

Tahmoor Coal has developed a Land Management Plan for managing potential impacts on steep slopes during the mining of LWs S1A to S6A. The management plan includes:

- Identification of all structures, dams and roads that are in close proximity to steep slopes;
- Site investigation and landslide risk assessment of structures near slopes by a qualified geotechnical engineer;
- Site investigation and structural assessment of structures where recommended by the geotechnical engineer. This may include recommendations to mitigate against potential impacts;
- Monitoring, including ground survey and visual inspections; and
- Remediation if cracking or slippage occurs.

It is recommended that Tahmoor Coal continue to develop management plans to manage potential impacts on slopes during the mining of the proposed LW S7A. The Land Management Plan will be extended to include management of potential impacts due to the extraction of LW S7A.

## 3.7. Main Southern Railway

The location of the Main Southern Railway is shown in Drawing No. MSEC1348-08. It can be seen that a section of the Main Southern Railway and associated infrastructure are located within the Study Area, however the proposed LW S7A is not located directly beneath the Main Southern Railway. The closest distance between the Railway and the proposed LW S7A is approximately 400 metres.

### 3.7.1. Description of the Main Southern Railway

The Main Southern Railway is a key national transport route that carries substantial freight and passenger services between Sydney and Melbourne. The Main Southern Railway is leased by Australian Rail Track Corporation (ARTC), who is responsible for maintaining the track.

Approximately 500 metres of track is located within the Study Area between kilometrages 100.1 km and 100.6 km.

The railway line is a dual track consisting of 60 kg rail on concrete sleepers with a mix of straight and curved track sections within the Study Area. The maximum speed limits on both tracks are 95 km/h for normal services and 105 km/h for XPT services. A photograph of a section of the railway at 99.400 km directly above proposed LW S4A is provided in Fig. 3.24.

*Photograph courtesy Newcastle Geotech*

**Fig. 3.24 Main Southern Railway at 100.121 km**

Two railway culverts are located within the Study Area at 100.121 km and 100.425 km, as shown in Drawing No. MSEC1348-08. A summary is provided in Table 3.9.

**Table 3.9 Rail culverts potentially affected by LW S1A-S6A**

| Kilometrage (km) | Diameter (mm) | Description | Location relative to Proposed Longwalls |
|---|---|---|---|
| 100.121 km | 1500 dia | Skewed brick arch culvert with 1500 mm dia concrete extension on both sides. Separation observed between brick arch culvert and concrete extension on Down side. | Above LW S4A |
| 100.425 km | 1500 dia | Skewed brick arch culvert with brick wingwalls on both sides (no concrete extensions) | Above LW S5A |

Based on boreholes drilled by Newcastle Geotech, the culverts appear to be either founded on natural soils or on the rock surface with no evidence of the culverts being constructed against rock. The culverts are located within rail embankments that are up to 6 metres in height.

A small cutting is located at 100.310 km, which up to 2 metres high in competent sandstone rock. Wellers Road Overbridge is located approximately 540 metres from LW S7A.

*Photograph courtesy Robinson Rail*

**Fig. 3.25 Culvert with concrete extension on Up side at 100.121 km**

*Photograph courtesy Robinson Rail*

**Fig. 3.26 Culvert with concrete extension on Up side at 100.425 km**

### 3.7.2. Predictions for the Main Southern Railway

The predicted profiles of total subsidence, tilt and change in track grade along the alignment of the Main Southern Railway are shown in Fig. A.05, which is included in Appendix A. Predicted profiles of cross tilt, change in track cant and long twist along the railway are shown in Fig. A.06 while predicted profiles of horizontal movement along the track, changes in 100 m long bays and change in Rail SFT are shown in Fig. A.07.

A summary of the maximum predicted incremental subsidence parameters due to the extraction of LW S7A is provided in Table 3.10.

**Table 3.10 Maximum predicted incremental subsidence parameters along the alignment of the Main Southern Railway due to the extraction of LW S7A**

| Modified Layout | Maximum predicted incremental subsidence (mm) | Maximum predicted change in Grade (%) | Maximum predicted incremental hogging curvature along alignment ($km^{-1}$) | Maximum predicted incremental sagging curvature along alignment ($km^{-1}$) |
|---|---|---|---|---|
| LW S7A | 40 | < 0.05 | < 0.01 | < 0.01 |

A summary of the maximum predicted total subsidence parameters after the extraction of LW S7A is provided in Table 3.11.

**Table 3.11 Maximum predicted total conventional subsidence parameters along the alignment of the Main Southern Railway due to the extraction of LWs S1A to S7A**

| Layout | Maximum predicted total subsidence (mm) | Maximum predicted change in Grade (%) | Maximum predicted total hogging curvature along alignment ($km^{-1}$) | Maximum predicted total sagging curvature along alignment ($km^{-1}$) |
|---|---|---|---|---|
| Approved Layout | | | | |
| After LW S6A | 1350 | 0.85 | 0.10 | 0.20 |
| Modified Layout | | | | |
| After LW S7A | 1400 | 0.85 | 0.10 | 0.20 |

It can be seen from Fig. A.05, A.06 and A.07 and the preceding two tables that predicted subsidence movements along the Railway for the *Modified Layout* are similar or only slightly higher than the corresponding predicted conventional subsidence movements for the *Approved Layout*. The locations of the predicted maxima for subsidence, tilt along the Railway and curvature remain the same.

### 3.7.3. Impact assessments for the Main Southern Railway

The Railway will be directly mined beneath by the *Approved Layout*. There is extensive experience of mining directly beneath railways in the Southern Coalfield which demonstrates that impacts can be managed with the implementation of suitable management strategies.

The Railway is located approximately 400 metres from the proposed LW S7A at its closest point. The Railway is predicted to experience minor additional subsidence movements due to the proposed extraction of LW S7A.

The addition of LW S7A under the *Modified Layout* does not materially change the impact assessment, though the potential for impacts increases slightly within the Study Area.

***Track geometry***

The predicted differential subsidence movements are expected to result in negligible changes to track geometry, as they are an order of magnitude less than the maximum allowable deviations specified in Australian Rail Track Corporation's National Code of Practice. Non-conventional subsidence movements could result in impacts on track geometry, however, and potential impacts can be managed with the implementation of an effective subsidence management plan, which is discussed later in this report.

***Track grades***

The predicted changes in track gradient along the Main Southern Railway due to the extraction of LW S7A are an order of magnitude less than the existing gradients, as shown in Fig. A.05.

While non-conventional movements could result in localised changes in track grades, it should be noted, however, that they occur over short lengths, which is of less concern as freight trains are many hundreds of metres long. It is expected, however, that track resurfacing would be required to reduce the magnitude of the mining-induced undulations in the track.

***Rail stress***

The predicted mining-induced ground strains are predicted to result in changes in rail stress less than 10 degrees, which is not expected to be sufficient to warrant immediate preventative action on a track with concrete sleepers.

Non-conventional subsidence movements could result in impacts on rail stress, however, and potential impacts can be managed with the implementation of an effective subsidence management plan, which is discussed later in this report.

***Wellers Road Overbridge***

The Wellers Road Overbridge is located at Bargo at 101.162 km outside the Study Area. The Overbridge is 370 metres from the commencing end of LW S6A and 540 metres from LW S7A.

The bridge is predicted to experience less than 20 mm of conventional subsidence, with negligible tilt, curvature and strain due to the extraction of LWs S1A to S7A.

The bridge is expected to experience far field horizontal movements, as discussed in Report No. MSEC1192 for LWs S1A to S6A. With the implementation of an effective subsidence management plan, the development of ground movements and impacts can be detected early with time to implement intervention measures before the bridge becomes unserviceable.

***Railway Culverts and Embankments***

The culverts at 100.121 km and 100.425 km are predicted to experience less than 40 mm additional subsidence and 20 mm additional valley closure due to the extraction of proposed LW S7A.

Potential impacts from the additional subsidence and valley closure on the culverts and embankments can be managed with the implementation of an effective subsidence management plan, which is discussed later in this report.

***Railway Cuttings***

The cutting at 100.310 km is predicted to experience 40 mm of additional subsidence due to the extraction of proposed LW S7A.

Tahmoor Mine has successfully mined directly beneath railway cuttings during the extraction of Longwalls 25 to 32, with only minor impacts observed on cuttings. It is extremely unlikely that the cutting will experience adverse impacts due to the extraction of LW S7A.

***Signalling and communications systems***

The potential for impacts on cabling and wiring along the track is considered to be very low. Mine subsidence impacts on electrical and telecommunications cabling is historically very low in the Southern Coalfield. It is extremely unlikely that the signalling and communications will experience adverse impacts due to the extraction of LW S7A.

### 3.7.4. Management of potential impacts on the Main Southern Railway

Tahmoor Coal and the Australian Rail Track Corporation (ARTC) have developed a detailed risk management plan for managing potential mine subsidence impacts on the Main Southern Railway due to the extraction of LWs S1A to S6A. The Railway Management Plan will be updated to include LW S7A (Tahmoor Coal, 2023a).

The management measures described in this plan are similar to those that have been developed in consultation with ARTC and successfully implemented at Tahmoor Mine and Appin Colliery, as described in a paper by Pidgeon, et al. (2011).

A Rail Management Group has been coordinated to develop the risk management strategies. The Rail Management Group includes representatives from ARTC, Tahmoor Coal and specialist consultants in the fields of railway track engineering, geotechnical engineering, structural engineering, track signalling, mine subsidence, risk assessment and project management. The Technical Committee consults with the Resources Regulator and the Office of the National Rail Safety Regulator.

Works by the Rail Management Group include:-

- Identification of potential impacts on the railway;
- Undertaking a risk management approach, where identified risks are assessed and risk control measures are implemented; and
- Development of management measures that include mitigation and preventive works, monitoring plans, triggered response plans and communication plans; and
- Supervision and oversight of railway track and infrastructure mitigation, monitoring and maintenance of affected rail track and infrastructure.

With an appropriate management plan in place, it is considered that the Main Southern Railway will remain safe and serviceable at all times during and after the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

## 3.8. Roads

The locations of the local roads are shown in Drawing No. MSEC1348-09 in Appendix B, where there are sections of four roads located within the Study Area. The entire length of Yarran Road and sections of Caloola Road, Remembrance Drive, and Wellers Road at Elvy Street are all located within the Study Area. These local roads are maintained by Wollondilly Shire Council.

There are three road drainage culverts located within the Study Area, one under Caloola Road and two under Remembrance Drive in the vicinity of Yarran Road, although none of these are located directly over LW S7A. The culverts are reinforced concrete pipes (RCP).

Remembrance Drive is supported by two road embankments located within the Study Area, one north of Yarran Road (identified as RE3) and one south of Yarran Road (RE2). Both of these are located directly over LW S5A and will not be mined beneath during extraction of LW S7A.

Remembrance Drive passes through a rock cutting between Caloola Road and Yarran Road, which is located within the Study Area directly above LW S4A and not directly over LW S7A.

### 3.8.1. Predictions for the roads

***Yarran Road***

Yarran Road is a sealed no-through road that connects to Remembrance Drive from the west. It is located directly above LW S7A and also crosses LWs S5A and S6A, and therefore could experience the full range of predicted subsidence movements due to the extraction of LW S7A. The predicted profiles of conventional subsidence, tilt and curvature along the alignment of Yarran Road, resulting from the extraction of the proposed longwalls, is shown in Fig. A.08, which is included in Appendix A.

A summary of the maximum predicted incremental conventional subsidence parameters for Yarran Road, due to the extraction of S7A, is provided in Table 3.12.

**Table 3.12 Maximum predicted incremental conventional subsidence parameters for Yarran Road due to the extraction of LW S7A**

| Longwall | Maximum predicted incremental subsidence (mm) | Maximum predicted incremental tilt along alignment (mm/m) | Maximum predicted incremental tilt across alignment (mm/m) | Maximum predicted incremental hogging curvature in any direction ($km^{-1}$) | Maximum predicted incremental sagging curvature in any direction ($km^{-1}$) |
|---|---|---|---|---|---|
| ***Modified Layout*** | | | | | |
| LW S7A | 950 | 3.5 | 7.0 | 0.04 | 0.05 |

A summary of the maximum predicted total conventional subsidence parameters for Yarran Road, after the extraction of each longwall, is provided in Table 3.13.

The predicted tilts are the maxima along and across the alignment of the road after the completion of each longwall. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each longwall.

**Table 3.13 Maximum predicted total conventional subsidence parameters for Yarran Road due to the extraction of LWs S1A to S7A**

| Longwall | Maximum predicted total subsidence (mm) | Maximum predicted total tilt along alignment (mm/m) | Maximum predicted total tilt across alignment (mm/m) | Maximum predicted total hogging curvature in any direction ($km^{-1}$) | Maximum predicted total sagging curvature in any direction ($km^{-1}$) |
|---|---|---|---|---|---|
| ***Approved Layout*** | | | | | |
| LW S1A | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| LW S2A | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| LW S3A | 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| LW S4A | 100 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| LW S5A | 1050 | 8.0 | 2.0 | 0.09 | 0.20 |
| LW S6A | 1300 | 7.0 | 4.0 | 0.09 | 0.20 |
| ***Modified Layout*** | | | | | |
| After LW S7A | 1350 | 6.5 | 7.5 | 0.10 | 0.20 |

It can be seen from Fig. A.08 and the preceding two tables that predicted subsidence, tilt along Yarran Road and curvatures for the *Modified Layout* are similar or only slightly higher than the corresponding predicted conventional subsidence movements for the *Approved Layout*. The locations of the predicted maxima for subsidence, tilt and curvature along Yarran Road remain the same.

***Caloola Road***

Caloola Road is a sealed no-through road that connects to Remembrance Drive from the west, via entry and exit ramps along the base of an embankment at Remembrance Drive.

Caloola Road is not located directly above LW S7A but crosses LWs S3A to S5A at the northern end of the Study Area. Caloola Road therefore would be expected to experience only small additional subsidence movements due to extraction of LW S7A. The predicted profiles of conventional subsidence, tilt and curvature along the alignment of Caloola Road, resulting from the extraction of the proposed longwalls, is shown in Fig. A.09, which is included in Appendix A.

A summary of the maximum predicted incremental conventional subsidence parameters for Caloola Road, due to the extraction of S7A, is provided in Table 3.14.

**Table 3.14 Maximum predicted incremental conventional subsidence parameters for Caloola Road due to the extraction of LW S7A**

| Longwall | Maximum predicted incremental subsidence (mm) | Maximum predicted incremental tilt along alignment (mm/m) | Maximum predicted incremental tilt across alignment (mm/m) | Maximum predicted incremental hogging curvature in any direction ($km^{-1}$) | Maximum predicted incremental sagging curvature in any direction ($km^{-1}$) |
|---|---|---|---|---|---|
| ***Modified Layout*** | | | | | |
| LW S7A | 60 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |

A summary of the maximum predicted total conventional subsidence parameters for Caloola Road, after the extraction of each longwall, is provided in Table 3.15.

The predicted tilts are the maxima along and across the alignment of the road after the completion of each longwall. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each longwall.

**Table 3.15 Maximum predicted total conventional subsidence parameters for Caloola Road due to the extraction of LWs S1A to S7A**

| Longwall | Maximum predicted total subsidence (mm) | Maximum predicted total tilt along alignment (mm/m) | Maximum predicted total tilt across alignment (mm/m) | Maximum predicted total hogging curvature in any direction ($km^{-1}$) | Maximum predicted total sagging curvature in any direction ($km^{-1}$) |
|---|---|---|---|---|---|
| ***Approved Layout*** | | | | | |
| LW S1A | 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| LW S2A | 80 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| LW S3A | 875 | 5.5 | 6.0 | 0.09 | 0.09 |
| LW S4A | 1150 | 5.0 | 6.5 | 0.11 | 0.20 |
| LW S5A | 1300 | 6.0 | 5.5 | 0.11 | 0.20 |
| LW S6A | 1350 | 6.5 | 6.0 | 0.12 | 0.20 |
| ***Modified Layout*** | | | | | |
| After LW S7A | 1400 | 6.5 | 6.5 | 0.12 | 0.20 |

The predicted conventional subsidence movements along Caloola Road for the *Modified Layout* are similar or only slightly higher than the corresponding predicted conventional subsidence movements for the *Approved Layout*. The locations of the predicted maxima for the conventional subsidence movements, tilt and curvature remain the same.

***Remembrance Drive***

Remembrance Drive is the main road linking the M31 Hume Motorway with the townships of Bargo and Tahmoor and traverses generally flat terrain along the western side of the Main Southern Railway. It crosses LWs S1A to S5A but does not cross directly above LW S7A. Remembrance Drive therefore would be expected to experience only small additional subsidence movements due to LW S7A following extraction of LWs S1A to S6A. The predicted profiles of conventional subsidence and tilt along the alignment of Remembrance Drive, resulting from the extraction of the proposed longwalls, are shown in Fig. A.10, which is included in Appendix A.

A summary of the maximum predicted incremental conventional subsidence parameters for Remembrance Drive, due to the extraction of S7A, is provided in Table 3.16.

**Table 3.16 Maximum predicted incremental conventional subsidence parameters for Remembrance Drive due to the extraction of LW S7A**

| Longwall | Maximum predicted incremental subsidence (mm) | Maximum predicted incremental tilt along alignment (mm/m) | Maximum predicted incremental tilt across alignment (mm/m) | Maximum predicted incremental hogging curvature in any direction ($km^{-1}$) | Maximum predicted incremental sagging curvature in any direction ($km^{-1}$) |
|---|---|---|---|---|---|
| ***Modified Layout*** | | | | | |
| LW S7A | 60 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |

A summary of the maximum predicted total conventional subsidence parameters for Remembrance Drive, after the extraction of each longwall, is provided in Table 3.17.

The predicted tilts are the maxima along the alignment of the road after the completion of each longwall. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each longwall.

**Table 3.17 Maximum predicted total conventional subsidence parameters for Remembrance Drive due to the extraction of LWs S1A to S7A**

| Longwall | Maximum predicted total subsidence (mm) | Maximum predicted total tilt along alignment (mm/m) | Maximum predicted total tilt across alignment (mm/m) | Maximum predicted total hogging curvature in any direction ($km^{-1}$) | Maximum predicted total sagging curvature in any direction ($km^{-1}$) |
|---|---|---|---|---|---|
| ***Approved Layout*** | | | | | |
| LW S1A | 200 | 1.5 | 4.0 | 0.06 | 0.03 |
| LW S2A | 975 | 5.0 | 5.5 | 0.08 | 0.20 |
| LW S3A | 1150 | 7.0 | 4.5 | 0.10 | 0.20 |
| LW S4A | 1300 | 6.0 | 5.5 | 0.12 | 0.20 |
| LW S5A | 1350 | 5.5 | 6.0 | 0.13 | 0.20 |
| LW S6A | 1350 | 6.5 | 5.5 | 0.13 | 0.25 |
| ***Modified Layout*** | | | | | |
| After LW S7A | 1400 | 7.0 | 5.0 | 0.13 | 0.25 |

It can be seen that the predicted conventional subsidence movements for Remembrance Drive for the *Modified Layout* are similar or only slightly higher than the corresponding predicted conventional subsidence movements for the *Approved Layout*. The locations of the predicted maxima for subsidence, tilt and curvature along Remembrance Drive remain the same.

***Wellers Road***

Wellers Road is predicted to experience maximum total vertical subsidence of 20 mm of due to the extraction of LWs S1A to S7A, with tilts less than 0.5 mm/m and hogging and sagging curvature less than 0.01 $km^{-1}$.

### 3.8.2. Impact assessments for the roads

The local roads will be directly mined beneath by the *Approved Layout*. There is extensive experience of mining directly beneath local roads in the Southern Coalfield which demonstrates that impacts can be managed with the implementation of suitable management strategies. In all cases the local roads have remained in safe and serviceable condition and have been remediated using normal road maintenance techniques.

Longwalls 22 to 32 and LW W1-W3 at Tahmoor Mine have mined directly beneath 28 kilometres of local roads and a total of 54 impact sites have been observed. The observed rate of impact on the local roads equates to an average of one impact for every 520 metres of pavement. In most cases, the impacts were relatively minor and were remediated by locally resurfacing the pavements.

The most severe impacts were located where substantial non-conventional movements had developed. These impact sites were identified using visual and ground monitoring and remediation was undertaken during active subsidence to maintain these roads in safe and serviceable conditions.

The addition of LW S7A under the *Modified Layout* does not materially change this assessment, though the extent of impacts increases further west along Yarran Road.

While the extent of impacts is increased, Tahmoor Coal will continue to develop and implement measures to manage the potential for impacts on local roads during the extraction of LWs S1A to S7A.

### 3.8.3. Management of potential impacts on the roads

Tahmoor Coal and Wollondilly Shire Council have implemented extensive measures to manage potential impacts on local roads and the associated structures due to the extraction of LWs S1A to S6A, in accordance with a Subsidence Management Plan. This plan will be updated to include potential impacts due to the extraction of LW S7A under the *Modified Layout*.

With an appropriate management plan in place, it is considered that the local roads will remain safe and serviceable at all times during and after the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

## 3.9. Services Infrastructure

The locations of electrical services and telecommunications infrastructure, gas, potable water and sewer pipelines is shown in Drawing No. MSEC1348-09. It can be seen that there are elements of each of these all located within the Study Area, as described in the following sections.

### 3.9.1. Electrical services infrastructure

Electrical infrastructure located within the Study Area comprises 11 kV and low voltage powerlines which are located across the area, generally following the alignment of Yarran Road, Caloola Road and Remembrance Drive, or the Main Southern Railway. There are no transmission lines or higher voltage powerlines located within the Study Area.

The power lines generally comprise aerial copper cables supported on timber poles, but there are also some sections of direct buried cables. The power lines are owned and operated by Endeavour Energy.

Because there are powerlines located directly above LW S7A, these therefore could experience the full range of predicted subsidence movements due to extraction of the longwalls under the *Modified Layout*.

The predicted profiles of conventional subsidence, tilt and curvature along the powerlines following the alignment of local roads are as predicted for these roads themselves (see Section 3.8). The profiles are shown in Figs. A.08 to A.10 in Appendix A, while maximum predicted incremental subsidence movements due to LW S7A are summarised in Table 3.12 for Yarran Road, Table 3.14 for Caloola Road and Table 3.16 for Remembrance Drive. Maximum predicted total conventional subsidence movements after extraction of LW S7A are summarised in Table 3.13 for Yarran Road, Table 3.15 for Caloola Road and Table 3.17 for Remembrance Drive.

As discussed in relation to the local roads, any additional subsidence movements due to extraction of LW S7A under the *Modified Layout* are slight when compared to the *Approved Layout*, and the locations of the predicted maxima do not change along these powerline alignments.

The electrical infrastructure will be directly mined beneath by the *Approved Layout*. There is extensive experience of mining directly beneath electrical infrastructure in the Southern Coalfield which demonstrates that impacts can be managed with the implementation of suitable management strategies. In all cases the electrical infrastructure have remained in safe and serviceable condition and have been remediated using normal maintenance techniques.

The addition of LW S7A under the *Modified Layout* does not materially change this assessment, though the extent of impacts increases further west along Yarran Road.

Tahmoor Coal and Endeavour Energy have implemented extensive measures to manage potential impacts on electrical infrastructure due to the extraction of LWs S1A to S6A under the *Approved Layout*, in accordance with a Subsidence Management Plan. This plan will be updated to include potential impacts due to the extraction of LW S7A under the *Modified Layout*.

With an appropriate management plan in place, it is considered that the electrical infrastructure will remain safe and serviceable at all times during and after the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

### 3.9.2. Telecommunications infrastructure

Telecommunications infrastructure within the Study Area comprises optical fibre cables and copper cables which are owned by Telstra, the National Broadband Network (NBN) and TPG. The optical fibre cables are direct buried or buried in conduit. There is an NBN telecommunications tower and adjacent shed located at No. 3166 Remembrance Drive, with access from Yarran Road. The tower and shed are located directly above LW S6A, as shown in Drawing No. MSEC1348-09.

- The **Telstra** optical fibre cable follows the alignment of the Main Southern Railway and crosses directly above the proposed LWs S1A to S5A but does not cross directly above LW S7A. Telstra copper cables are generally direct buried and follow the alignments of local roads across the Study Area.
- The **NBN** optical fibre cable follows the alignment of Remembrance Drive but does not cross directly above LW S7A. NBN copper service cables follow the alignments of local roads across the Study Area.
- The **TPG** optical fibre cable follows the alignment of Remembrance Drive from the Wollondilly Anglican College to the Bargo Exchange, following the same route as the NBN optical fibre cable.

The predicted profiles of conventional subsidence, tilt and curvature along the optical fibre cables and copper cables following the alignment of the Main Southern Railway and the local roads are as predicted for the railway and these roads themselves (see Section 3.7 and Section 3.8). The profiles are shown in Fig. A.05 for the Telstra optical fibre cable alongside the Main Southern Railway, and Figs. A.08 to A.10 for the optical fibre and copper cables along the local roads.

The corresponding maximum predicted incremental subsidence movements due to LW S7A are summarised in Table 3.12 for Yarran Road, Table 3.14 for Caloola Road and Table 3.16 for Remembrance Drive. Maximum predicted total conventional subsidence movements after extraction of LW S7A are summarised in Table 3.13 for Yarran Road, Table 3.15 for Caloola Road and Table 3.17 for Remembrance Drive.

As discussed in relation to the local roads, any additional subsidence movements due to extraction of LW S7A under the *Modified Layout* are slight when compared to the *Approved Layout*, and the locations of the predicted maxima do not change along the alignments of these telecommunications cables.

The NBN telecommunications tower and shed located at No. 3166 Remembrance Drive (access from Yarran Road) will not be directly mined beneath during extraction of LW S7A, however they will experience some additional subsidence movements under the *Modified Layout* when compared to the *Approved Layout*. The maximum predicted incremental subsidence movements due to LW S7A are summarised in Table 3.18

**Table 3.18 Maximum predicted incremental conventional subsidence parameters for the NBN telecommunications tower at No. 3166 Remembrance Drive due to the extraction of LW S7A**

| Longwall | Maximum predicted incremental subsidence (mm) | Maximum predicted incremental tilt (mm/m) | Maximum predicted incremental hogging curvature in any direction ($km^{-1}$) | Maximum predicted incremental sagging curvature in any direction ($km^{-1}$) |
|---|---|---|---|---|
| ***Modified Layout*** | | | | |
| LW S7A | | | | |
| Shed | 175 | 1.0 | 0.01 | < 0.01 |
| Tower | 175 | 1.0 | 0.01 | < 0.01 |

A summary of the maximum predicted total conventional subsidence parameters for the NBN tower and shed for the *Approved Layout* and for the *Modified Layout*, is provided in Table 3.19. Predictions of conventional subsidence, tilt and curvature have been made at the centroid and at points located around the perimeter of the tower and the shed, as well as at points located at a distance of 20 metres from the perimeter of each structure. The predicted tilts are the maxima along and across the structures after the completion of the proposed longwalls. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each longwall.

**Table 3.19 Maximum predicted total conventional subsidence parameters for the NBN telecommunications tower at No. 3166 Remembrance Drive**

| Structure | Maximum predicted total subsidence (mm) | Maximum predicted total tilt (mm/m) | Maximum predicted hogging curvature in any direction ($km^{-1}$) | Maximum predicted sagging curvature in any direction ($km^{-1}$) |
|---|---|---|---|---|
| ***Approved Layout*** | | | | |
| (after LW S6A) | | | | |
| Shed | 900 | 3.0 | 0.05 | 0.04 |
| Tower | 850 | 2.5 | 0.04 | 0.04 |
| ***Modified Layout*** | | | | |
| (after LW S7A) | | | | |
| Shed | 1050 | 3.5 | 0.05 | 0.21 |
| Tower | 1050 | 3.5 | 0.05 | 0.22 |

The NBN telecommunications tower is expected to experience some additional subsidence movements during the extraction of proposed LWs S7A. These are not likely to affect the structural integrity of the tower, although predicted tilts of 3.5 mm/m, while small, may affect the operation of the antennae on top of the structure. The tilts can be readily adjusted by either re-levelling the pole or the individual antennae, if required.

Tahmoor Coal has developed Subsidence Management Plans in consultation with Telstra, NBN and TPG to manage potential impacts on the telecommunications infrastructure due to the extraction of LWs S1A to S6A under the *Approved Layout*. This plan will be updated to include potential impacts due to the extraction of LW S7A under the *Modified Layout*.

With appropriate management plans in place, it is considered that the telecommunications infrastructure will remain safe and serviceable at all times during and after the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

### 3.9.3. Gas infrastructure

Gas infrastructure located within the Study Area is owned by Jemena and comprises a 150 mm diameter steel main which generally follows the alignment of Remembrance Drive, and a short section of 50 mm nylon pipeline alongside Wellers Road, on the southern boundary of the Study Area. The gas main along Remembrance Drive crosses LWs S1A to S5A but does not cross directly above LW S7A. The nylon gas pipeline alongside Wellers Road also does not cross directly above LW S7A.

The steel gas main along Remembrance Drive therefore would be expected to experience only small additional subsidence movements due to LW S7A following extraction of LWs S1A to S6A. The predicted profiles of conventional subsidence and tilt along the steel gas main beside Remembrance Drive, resulting from the extraction of the proposed longwalls, are shown in Fig. A.11, which is included in Appendix A.

A summary of the maximum predicted incremental conventional subsidence parameters for the Jemena gas main along Remembrance Drive, due to the extraction of S7A, is provided in Table 3.20.

**Table 3.20 Maximum predicted incremental conventional subsidence parameters for Jemena Gas Main along Remembrance Drive due to the extraction of LW S7A**

| Longwall | Maximum predicted incremental subsidence (mm) | Maximum predicted incremental tilt along alignment (mm/m) | Maximum predicted incremental hogging curvature in any direction ($km^{-1}$) | Maximum predicted incremental sagging curvature in any direction ($km^{-1}$) |
|---|---|---|---|---|
| ***Modified Layout*** | | | | |
| LW S7A | 50 | < 0.5 | < 0.01 | < 0.01 |

A summary of the maximum predicted total conventional subsidence parameters for the Jemena gas main along Remembrance Drive, after the extraction of each longwall, is provided in Table 3.21. The predicted additional subsidence movements due to the extraction of LW S7A are very slight and these are not expected to result in any additional impacts on the gas infrastructure under the *Modified Layout*.

The predicted tilts are the maxima along the alignment of the road after the completion of each longwall. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each longwall.

**Table 3.21 Maximum predicted total conventional subsidence parameters for Jemena Gas Main along Remembrance Drive due to the extraction of LWs S1A to S7A**

| Longwall | Maximum predicted total subsidence (mm) | Maximum predicted total tilt along alignment (mm/m) | Maximum predicted total hogging curvature in any direction ($km^{-1}$) | Maximum predicted total sagging curvature in any direction ($km^{-1}$) |
|---|---|---|---|---|
| ***Approved Layout*** | | | | |
| LW S1A | 325 | 2.5 | 0.06 | 0.06 |
| LW S2A | 1000 | 5.0 | 0.08 | 0.20 |
| LW S3A | 1200 | 6.5 | 0.10 | 0.21 |
| LW S4A | 1300 | 6.0 | 0.12 | 0.21 |
| LW S5A | 1350 | 6.5 | 0.12 | 0.21 |
| LW S6A | 1375 | 7.5 | 0.12 | 0.21 |
| ***Modified Layout*** | | | | |
| After LW S7A | 1400 | 7.5 | 0.12 | 0.21 |

The nylon gas pipeline alongside Wellers Road also does not cross directly above LW S7A and is predicted to experience less than 20 mm of subsidence. There is extensive experience of mining directly beneath nylon gas pipelines above Tahmoor LWs 22 to 32 where no impacts were experienced. Based on the subsidence predictions and past experiences observed, it is extremely unlikely that the nylon gas pipeline along Wellers Road will experience adverse impacts due to the extraction of the proposed LW S7A.

Tahmoor Coal has developed a Subsidence Management Plan in consultation with Jemena to manage potential impacts on local gas infrastructure due to the extraction of LWs S1A to S2A under the *Approved Layout*. Tahmoor Coal and Jemena are currently developing an updated Subsidence Management Plan to manage potential impacts on local gas infrastructure due to the extraction of LWs S3A to S6A under the *Approved Layout*. This plan will be updated to include potential impacts due to the extraction of LW S7A under the *Modified Layout*.

With an appropriate management plan in place, it is considered that the gas infrastructure will remain safe and serviceable at all times during and after the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

### 3.9.4. Potable Water infrastructure

The water pipelines within the Study Area are owned and operated by Sydney Water. The potable water infrastructure includes a Cast Iron Cement Lined (CICL) 450 mm diameter watermain which follows the alignment of Remembrance Drive, before crossing beneath the Main Southern Railway just north of Yarran Road and following Great Southern Road. 100 mm and 200 mm diameter Ductile Iron Cement Lined (DICL) water pipelines are located along Caloola Road, Yarran Road and along a short section Remembrance Drive to the south of the railway crossing. The types of pipeline within the Study Area are mainly DICL and CICL, with short sections of Steel Cement Lined (SCL) beneath road crossings.

The predicted profiles of conventional subsidence, tilt and curvature along the water pipelines following the alignment of local roads are as predicted for these roads themselves (see Section 3.8). The profiles are shown in Figs. A.08 to A.10 in Appendix A, while maximum predicted incremental subsidence movements due to LW S7A are summarised in Table 3.12 for Yarran Road, Table 3.14 for Caloola Road and Table 3.16 for Remembrance Drive. Maximum predicted total conventional subsidence movements after extraction of LW S7A are summarised in Table 3.13 for Yarran Road, Table 3.15 for Caloola Road and Table 3.17 for Remembrance Drive.

As discussed in relation to the local roads, any additional subsidence movements due to extraction of LW S7A under the *Modified Layout* are slight when compared to the *Approved Layout*, and the locations of the predicted maxima do not change along the pipelines.

Tahmoor Coal and Sydney Water have implemented extensive measures to manage potential impacts on potable water infrastructure due to the extraction of LWs S1A to S6A under the *Approved Layout*, in accordance with a Subsidence Management Plan. This plan will be updated to include potential impacts due to the extraction of LW S7A under the *Modified Layout*.

With an appropriate management plan in place, it is considered that the potable water infrastructure will remain safe and serviceable at all times during and after the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

### 3.9.5. Sewer infrastructure

The sewer infrastructure within the Study Area is owned and operated by Sydney Water, and comprises a 180 mm diameter pressure main along Remembrance Drive. The sewer pressure main crosses LWs S1A to S5A but does not cross directly above LW S7A. There is no further sewer reticulation network along the local roads within the Study Area for the *Modified Layout*. The sewerage system was designed to accommodate mine subsidence movements and consists of polyethylene (PE) pipelines.

The predicted profiles of conventional subsidence, tilt and curvature along the sewer pressure main following the alignment of Remembrance Drive are as predicted for Remembrance Drive (see Section 3.8). The profiles are shown in Fig. A.10 in Appendix A. The maximum predicted incremental subsidence movements along Remembrance Drive due to LW S7A are summarised in Table 3.16 and the maximum predicted total conventional subsidence movements after extraction of LW S7A are summarised in Table 3.17.

As discussed in relation to Remembrance Drive, any additional subsidence movements due to extraction of LW S7A under the *Modified Layout* are slight when compared to the *Approved Layout*, and the locations of the predicted maxima do not change along the pipelines.

Tahmoor Coal and Sydney Water have implemented extensive measures to manage potential impacts on the sewer infrastructure due to the extraction of LWs S1A to S6A under the *Approved Layout*, in accordance with a Subsidence Management Plan. This plan will be updated to include potential impacts due to the extraction of LW S7A under the *Modified Layout*.

With an appropriate management plan in place, it is considered that the sewer infrastructure will remain safe and serviceable at all times during and after the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

## 3.10. Picton Weir

### 3.10.1. Description and location

The Picton Weir is located on the Bargo River just downstream of the confluence with Hornes Creek. The weir was constructed in the late 19th century and it was built to provide water to the surrounding townships. It is now heavily silted and is no longer used for water supply. Water retained by the weir is released at its base through a seized open valve and outlet pipe. Photographs of the Weir, taken in September 2023, are shown in Fig. 3.27.

*Photograph courtesy MNC Consulting*

**Fig. 3.27 Close up view of Picton Weir**

*Photograph courtesy MNC Consulting*

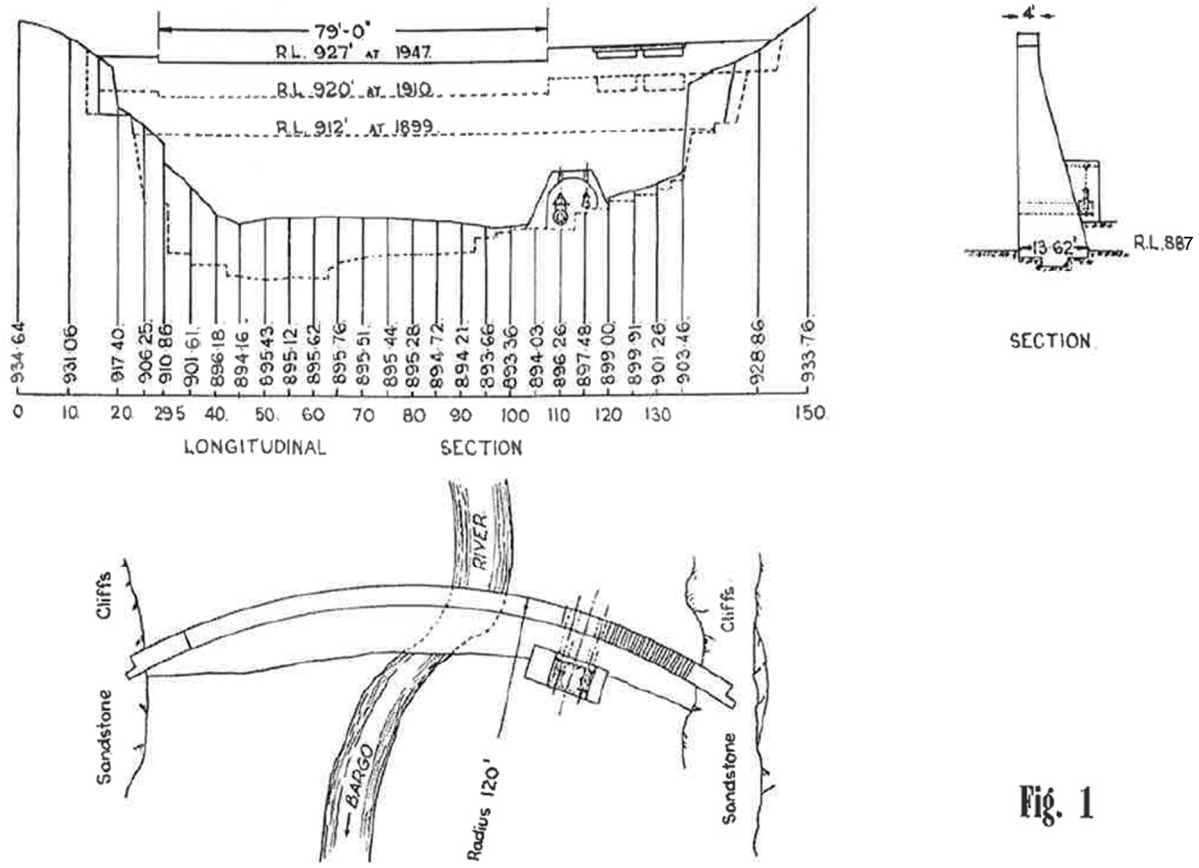
**Fig. 3.28 Wide angle view of Picton Weir**

The Picton Weir is located approximately 605 metres from LW S7A at its closest point. As shown in Fig. 3.29, LW S7A is proposed to approach the Weir from the southeast but stops approximately 75 metres before it is directly square with the Weir. No impacts were reported on the Picton Weir during the mining of previously extracted Longwalls 14 to 19, the closest of which was approximately 1.5 kilometres from the Weir (Longwall 19).

**Fig. 3.29 Location of Picton Weir relative to LW S7A**

The Picton Weir was constructed in 1899 at RL 912 (Imperial units) (Haigh, 1954). The level was raised by 8 ft to RL 920 in 1910 and raised a further 7 ft in 1947 to RL 927. Drawings describing the weir's dimensions were provided by Haigh (1954) and are produced in Fig. 3.30. The lowest foundation level at RL 887 was reported by the Picton Post (1945) to be a few feet below the river bed level.

Worley Consulting have found a reasonable correlation between the elevations shown in Fig. 3.30 and a photogrammetry survey of the Weir by MNC Consulting, allowing for the fact that the foundation level of RL 887 is below the river bed and water that is pooling at the downstream base of the Weir.




*Source: Haigh (1954) from Sydney Water Board Journal*

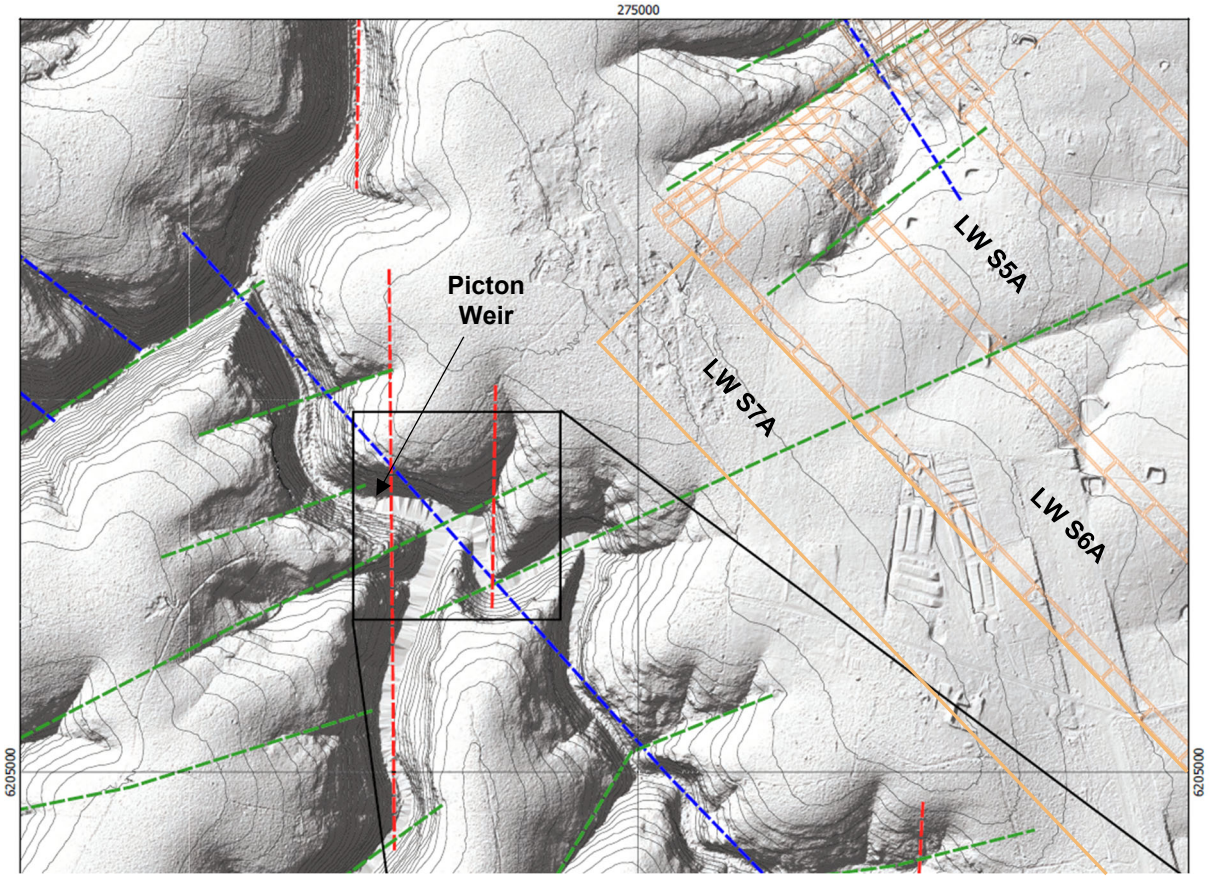
**Fig. 3.30 Construction drawings of Picton Weir**

### 3.10.2. Geotechnical assessment

Tahmoor Coal has engaged geotechnical engineer PSM (2023) to conduct a geotechnical investigation and assessment of the rock mass surrounding the Picton Weir. The investigation includes a review of available geological, geomorphological and mining reports, identification of potential geological structures, site inspections and logging and interpretation of two vertical boreholes that have been drilled by Tahmoor Coal on either side of Picton Weir.

Picton Weir near the Central Fault complex, which lies to the south and west of the proposed LW S7A. The fault was described by MBGS (2013) and PSM (2023) as a normal fault trending northwest with vertical displacement up to 20 metres, east side up (laying over the west side). The fault was identified in the 2D seismic lines and was also intercepted in one drill hole (JB06) where the Wongawilli Seam has been displaced. The fault was not observed by PSM during the geological field mapping and the boreholes did not intercept it.

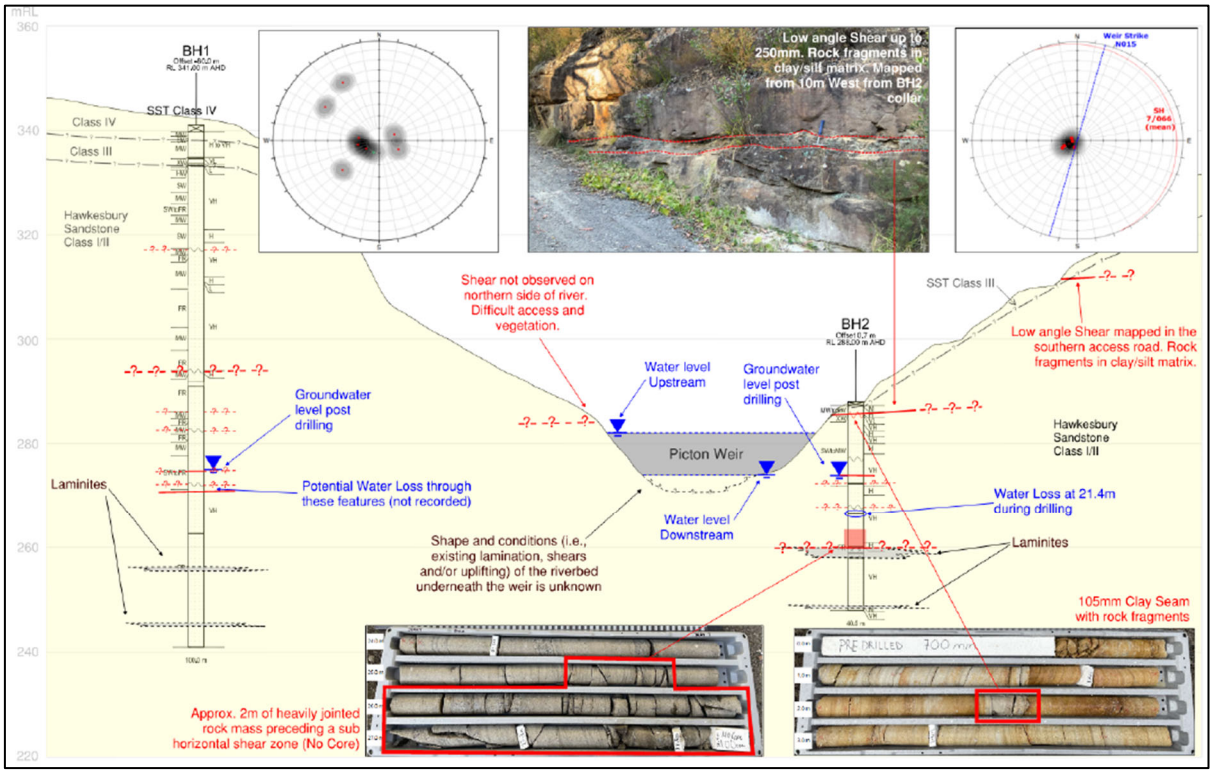
The Gordon Geotechniques (2013) report advised that the Central Fault zone was associated with a number of features including a change in Bulli Seam fluidity and thinning of the Balgownie to Bulli Seam interburden. The downstream part of Hornes Creek follows the surface expression of the Central Fault. PSM (2023) advised that the double kink in Hornes Creek, upstream of the Picton Weir could be attributable to conjugated lineaments sub-perpendicular to the Central Fault complex, as shown in Fig. 3.31.




*Source: Marked up extract from Figure 3 of PSM (2023) to include LW S7A*

**Fig. 3.31 PSM Lineament Assessment (PSM, 2023)**

PSM (2023) has developed a conceptual geological model based on the results of field investigations and borehole mapping. A cross-section through the Weir structure is reproduced in Fig. 3.32.




*Source: Figure 5 of PSM (2023)*

**Fig. 3.32 PSM Conceptual Geological Model – Cross Section through Picton Weir (PSM, 2023)**

The key findings of the assessment by PSM (2023) are summarised below.

- The ground conditions encountered are consistent with those associated with natural valley bulging;
- Low angle shears were observed in both boreholes and mapped from field investigations. There does not appear to be persistence of any single structure that is continuous beneath the entire width of the Weir;
- Initial groundwater readings suggest that current levels are lower than expected in a valley of this depth, which suggests that there is a network of interconnected structures that cause water levels to drain rapidly towards the valley;
- There is, therefore, a potential for movement along sub-horizontal bedding and, in particular, along low angle shears in response to mining-induced valley closure and upsidence. Concentrated movements along a single defect, however, appears unlikely.
- There is also a potential for movement along sub-vertical joints and/or cross begging in response to mining-induced valley closure and upsidence. The movements are likely to be limited due to the low persistence of sub-vertical joints that generally terminate against bedding partings and shears. Movements along cross bedding is possible but likely where defects are already showing some dilation, such as those observed at the base of the abutments.

### 3.10.3. Subsidence predictions

The Picton Weir is located approximately 605 metres from LW S7A at its closest point. The Weir is located outside the predicted limit of subsidence and is, therefore, predicted to experience negligible conventional subsidence movements.

Predictions of non-conventional valley closure and upsidence movements along the Bargo River were provided in Section 3.2. As shown in Fig. A.02, the Bargo River is predicted to experience less than 20 mm of incremental valley closure and upsidence at the Picton Weir due to the proposed extraction of LW S7A.

A summary of the predicted values of incremental vertical subsidence, upsidence and closure at the Picton Weir on the Bargo River is provided in Table 3.22 and the predicted total values of vertical subsidence, upsidence and closure at the Picton Weir is provided in Table 3.23.

**Table 3.22 Predicted incremental vertical subsidence, upsidence and closure at Picton Weir**

| Layout | Longwall | Predicted incremental vertical subsidence (mm) | Predicted incremental upsidence (mm) | Predicted incremental closure (mm) |
|---|---|---|---|---|
| Modified Layout | LW S7A | < 20 | < 20 | < 20 |

**Table 3.23 Predicted total vertical subsidence, upsidence and closure at Picton Weir**

| Layout | Longwall | Predicted total vertical subsidence (mm) | Predicted total upsidence (mm) | Predicted total closure (mm) |
|---|---|---|---|---|
| Approved Layout | After LW S6A | < 20 | < 20 | < 20 |
| Modified Layout | After LW S7A | < 20 | 20 | < 20 |

### 3.10.4. Statistical analyses of valley closure movements at Picton Weir

Statistical analyses of previously measured valley closure in the Southern Coalfield have been conducted based on monitoring data from Tahmoor Colliery and nearby Appin and West Cliff Collieries, where depths of cover and extraction heights are similar to those proposed for LW S7A. The results of the statistical analyses are described in Section 3.3 of this report and can be applied to the Picton Weir.

It is noted, however, that LW S7A is proposed to be extracted up to but stop short of the Weir, while the analyses includes sites where previously extracted longwalls had mined past them. The analyses, therefore, are expected to provide a conservative assessment.

Observed incremental valley closure at sites located above solid, unmined coal, are shown relative to their distances from the maingate edges of previously extracted longwalls in Fig. 3.13. A total of 2390 measurements have been plotted, sorted into groups based on valley depths that are greater than or less than 40 metres. Where surveys were conducted on multiple occasions during the extraction of a longwall, only the maximum measured incremental closure for each longwall has been plotted.

The confidence levels, based on fitted *Generalised Pareto Distributions* (GPDs), have also been shown in Fig. 3.13 to illustrate the spread of the data. The GPD and confidence levels have been calculated without filtering the data based on valley depths, nor the locations of the sites relative to the sides or ends of the longwalls.

A summary of the probabilities of exceedance for valley closure for survey bays at distance that is relevant to the distance between the Picton Weir and LW S7A, based on the fitted General Pareto Distribution function, is provided in Table 3.24.

**Table 3.24 Probabilities of exceedance for valley closure for survey bays located at distance of 600 m from the nearest goaf edge in the Southern Coalfield**

| Statistical parameter | Probability of Exceedance | Incremental valley closure (mm) |
|---|---|---|
| Offset distance from maingate of active LW of 600 m | 1 in 2.5 (0.4) | 5 |
| | 1 in 3.3 (0.3) | 7 |
| | 1 in 5 (0.20) | 9 |
| | 1 in 10 (0.10) | 12 |
| | 1 in 20 (0.05) | 16 |
| | 1 in 100 (0.01) | 26 |

When compared against the ACARP prediction of maximum incremental closure of <20 mm, it can be seen that the prediction of valley closure is reasonably conservative.

An alternative statistical approach was conducted to check the fitted confidence level curves that are shown in Fig. 3.13. A histogram showing the distribution of observed valley closure for a subset of sites that were located between 450 metres and 750 metres from the maingate side of previously extracted longwalls is shown in Fig. 3.33.

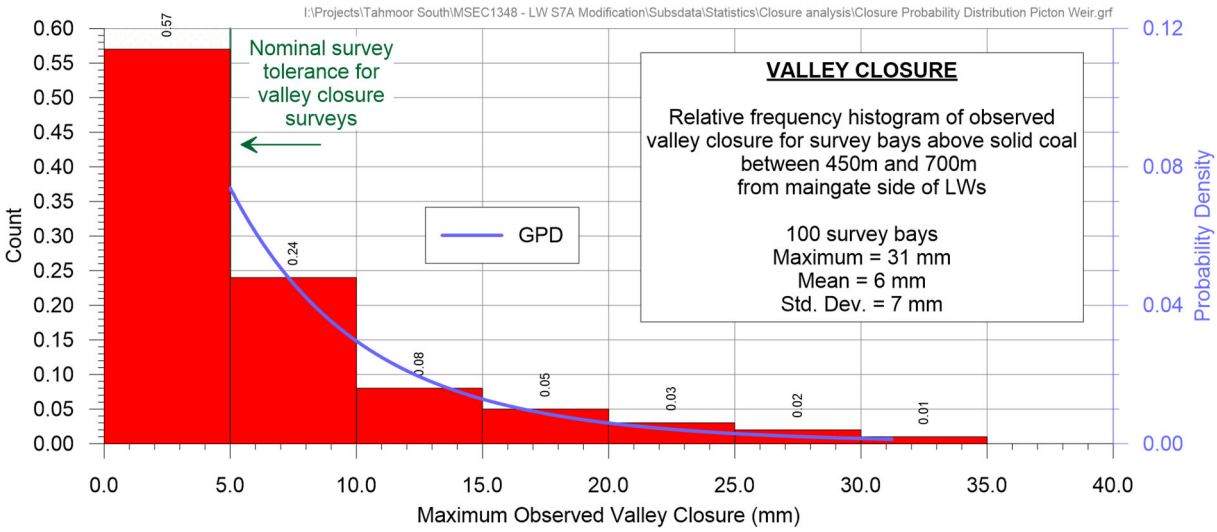



**Fig. 3.33 Frequency distribution of observed valley closure for survey bays between 450m and 750m from maingate side of previously extraction LWs in Southern Coalfield**

The average measured closure within the dataset was 6 mm and maximum observed closure was 31 mm, with 95 % of sites recording less 21 mm of closure and 99 % of sites recording less than 29 mm of closure. The results compare reasonably well with the values in Table 3.24.

As discussed in Section 3.3 of this report, the reason for the more conservative prediction by the ACARP method can be explained by the way in which the ACARP normalises the offset distances by dividing them by the sum of the longwall panel width and chain pillar width.

Observed incremental valley closure at sites located above solid, unmined coal, are shown relative to their normalised distances from the maingate edges of previously extracted longwalls in Fig. 3.15.

A summary of the probabilities of exceedance for valley closure for survey bays at a normalised distance that is relevant to the normalised distance between the Picton Weir and LW S7A, based on the fitted General Pareto Distribution function, is provided in Table 3.25.

**Table 3.25 Probabilities of exceedance for valley closure for survey bays located at normalised distance of 1.875 from the nearest goaf edge in the Southern Coalfield**

| Statistical parameter | Probability of Exceedance | Incremental valley closure (mm) |
|---|---|---|
| Normalised Offset distance from maingate of active LW / (LW width + pillar width) of 600/(283+37) = 1.875 | 1 in 2.5 (0.4) | 2.5 |
| | 1 in 3.3 (0.3) | 10 |
| | 1 in 5 (0.20) | 14 |
| | 1 in 10 (0.10) | 22 |
| | 1 in 20 (0.05) | 32 |
| | 1 in 100 (0.01) | 64 |

When compared against the ACARP prediction of maximum incremental closure of <20 mm, it can be seen that the prediction of valley closure is conservative but less when compared to statistical analyses based on distances that are not normalised.

Closer examination of the statistical analyses found that the calculated confidence levels based on normalised distances were influenced by two outliers, which relate to recently observed closure during the mining of Tahmoor LW W3 and LW W4 across Stonequarry Creek at the Victoria Bridge and a Retaining Wall at 84.687 km on the Main Southern Railway. The observations are discussed in the following section.

### 3.10.5. Case study of observed valley closure movements during the mining of LW W1-W4

While the statistical analyses show that the valley closure prediction at Picton Weir is likely to be conservative, the empirical data presented in Fig. 3.13 and Fig. 3.15 shows that there are two outliers at distances greater than 600 metres from previously extracted longwalls. These relate to recently observed closure during the mining of Tahmoor LW W3 and LW W4 across Stonequarry Creek at the Victoria Bridge and a Retaining Wall at 84.687 km on the Main Southern Railway.

The case study is relevant to the extraction of LW S7A to the side of the Picton Weir as both sites involve a regionally significant valley (Stonequarry Creek compared to Bargo River) and both are located near a major geological fault system (Nepean Fault compared to the Central Fault).

Tahmoor Coal extracted LW W1-W4 in the Western Domain, which is located to the west of the township of Picton. LW W1-W4 were extracted between November 2019 and September 2022.

LW W1-W4 were bounded by Stonequarry Creek to the north, Matthews and Cedar Creek to the west, previously extracted LWs 22 to 32 to the south, and the Main Southern Railway, Stonequarry Creek and the Nepean Fault complex to the east. A map showing the location of LW W1-W4 relative to these features is provided in Fig. 3.34. The longwall panels were extracted from north to south.

Valley closure was observed to gradually develop across Stonequarry Creek between the bridge abutments and piers at Victoria Bridge and across Stonequarry Creek at the Retaining Wall at 84.867 km during the mining of LW W3 and LW W4. The closure commenced when the western abutment, closest to the longwalls, no longer moved in concert with the eastern abutment towards the longwalls and started to move northeast into the valley. The observed valley closure coincided with:

- Observed absolute horizontal movement of Thirlmere Way Underbridge and Connellan Crescent Overbridge in a north-easterly direction away from LWs W1-W4 and LW32 (refer Fig. 3.34 and Fig. 3.35);
- Observed absolute horizontal movement in a north-easterly direction at survey pegs spaced every 20 metres along the Main Southern Railway from 89.5 km (south of Thirlmere Way Underbridge) to the north beyond Connellan Crescent Overbridge, away from LWs W1-W4 and LW32. The magnitude of horizontal movements diminished along the railway corridor to the north, transitioning gradually between approximately 88.6 km and 88.8 km, such that measured ground strains and changes over long bay lengths did not result in measurable changes in rail stress on the track, with minor lateral shearing across the railway corridor at 88.750 km.

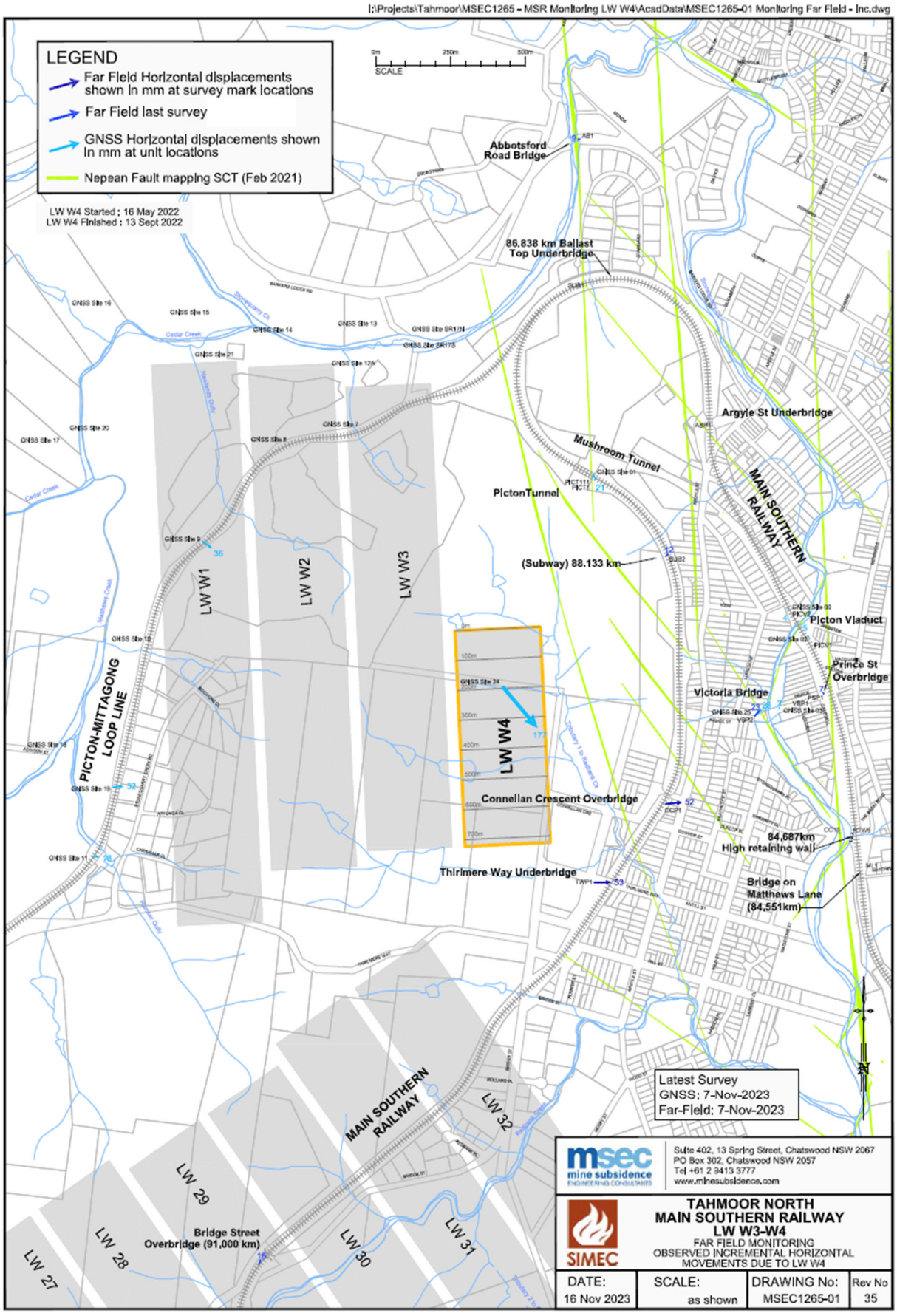



**Fig. 3.34 Observed incremental horizontal movements during the mining of LW W4**

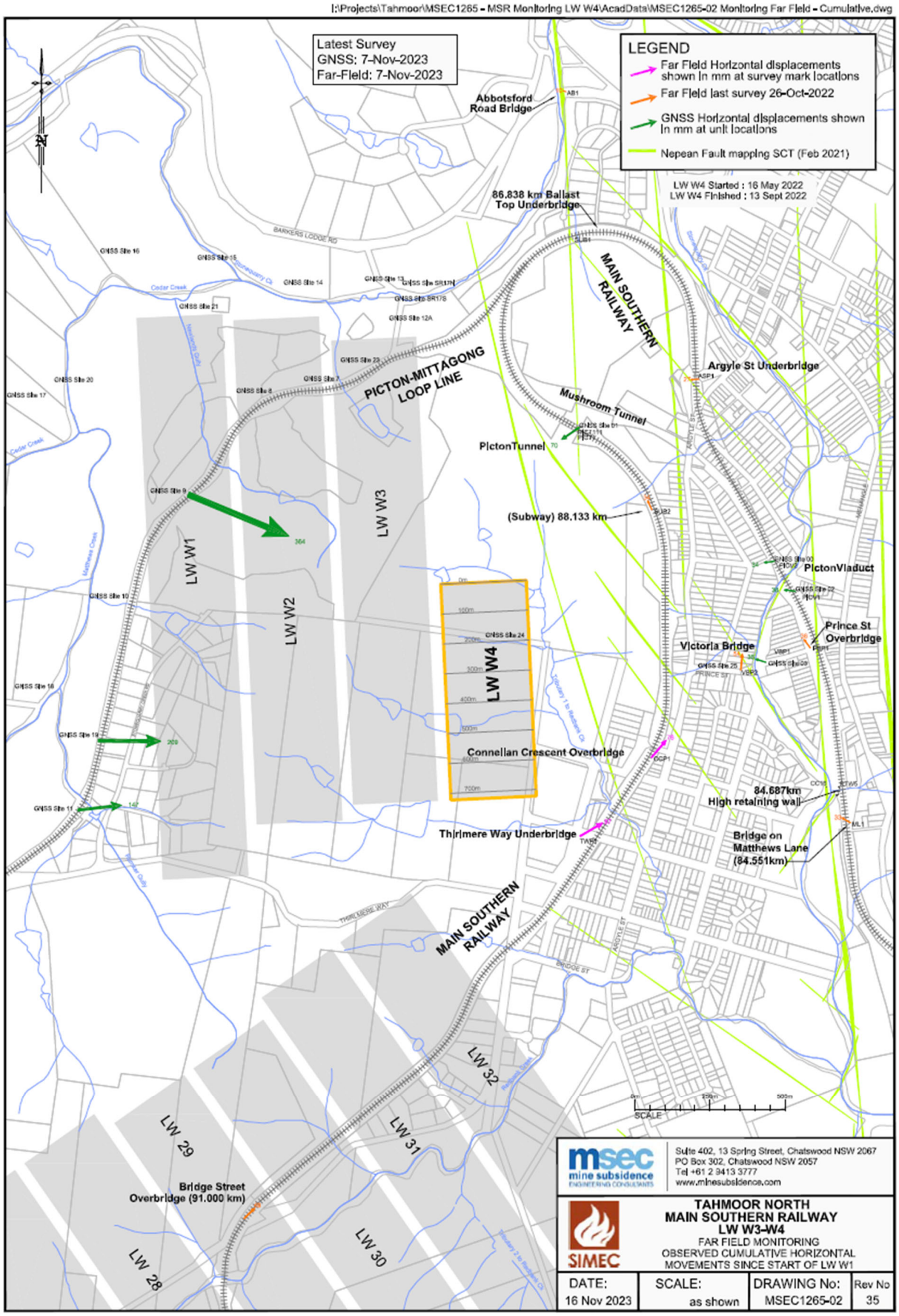



**Fig. 3.35 Observed total horizontal movements during the mining of LW W1-W4**

The observed development of valley closure across Stonequarry Creek at Victoria Bridge is shown in Fig. 3.36. The distances between Victoria Bridge from the maingate edges of each longwall are annotated on the graph.

The Retaining Wall at 84.867 km was monitored by Tahmoor Coal at the request of the Australian Rail Track Corporation during the mining of LW W1-W4. The main purpose of the surveys was to confirm that the wall was not deforming in response to differential far field movements. The survey consisted of a series of survey marks mounted on the wall, which were surveyed from the opposite side of Stonequarry Creek. The survey was measured in relative 3D coordinates and did not measure changes in the absolute 3D position of the survey marks.

While no measurable differential movements were observed between the marks on the wall, the measured distances between the wall and a survey mark on the opposite side of Stonequarry Creek gradually closed.

The observed development of valley closure across Stonequarry Creek at Retaining Wall at 84.867 km is shown in Fig. 3.37. The distances between the Retaining Wall from the maingate edges of each longwall are annotated on the graph.

Approximately 300 metres upstream (northeast) of Victoria Bridge, Tahmoor Coal extensively monitored changes at the Picton Viaduct during the mining of LWs 31, 32 and LW W1-W4. No measurable differential movements were observed across or along the Viaduct. A summary graph showing the observed changes in horizontal distances between two GNSS units on either side end of the Viaduct across Stonequarry Creek is shown in Fig. 3.38. Less than 10 mm of valley closure was observed, which is close to survey tolerance, taking into account that the GNSS units were installed in 2018. While the installed units were the best available at the time, GNSS technology has improved with later models.

The key lessons from the case study are provided below.

- Valley closure developed at the Victoria Bridge and Retaining Wall at a considerable distance away from LW W3 and LW W4. The represent outliers within the Southern Coafield empirical database.
- LW W4 was relatively short in length and incremental valley closure would likely have been greater if LW W4 had been longer, particularly at the Retaining Wall as the longwall panels were not extraction south of them.
- LW W4 was also the last longwall to be extracted in this mining domain. Valley closure would likely have continued to develop at a greater magnitude if additional longwalls had been extracted closer to the monitoring sites.
- The observed closure, however, only developed along one arm of Stonequarry Creek, where less than 10 mm of valley closure was observed where the Picton Viaduct crosses Stonequarry Creek, 300 metres upstream of Victoria Bridge.
- The observed valley closure movements coincided with an observation of horizontal movements towards Stonequarry Creek, away from the longwall mining area.
- The observed horizontal movements and valley closure developed gradually during mining.

The case study is a reminder that while the prediction model for valley closure is generally conservative, actual valley closure movements can sometimes exceed predictions. The movements can, however, be detected early as each successive longwall approaches Picton Weir. The potential for greater than predicted movements is considered when conducting impact assessments for the Picton Weir.

Tahmoor Coal is currently monitoring ground movements at Picton Weir and along Hornes Creek according to the Subsidence Monitoring Plan. The monitoring locations are shown in Drawing No. MSEC1348-15.

- A pair of GNSS units have been installed at the tops of the Bargo River at each end of the Picton Weir. The GNSS units have continuously monitored changes during mining since the commencement of LW S1A. While the GNSS units have measured minor horizontal movements towards the active mining area, changes in horizontal distances between the units are less than 5 mm and within survey tolerance.
- Six GNSS units have been installed along the tops of Hornes Creek in pairs across the valley. The GNSS units have continuously monitored changes during mining since the commencement of LW S2A. While the GNSS units have measured minor horizontal movements towards the active mining area, changes in horizontal distances between the units are less than 5 mm and within survey tolerance.

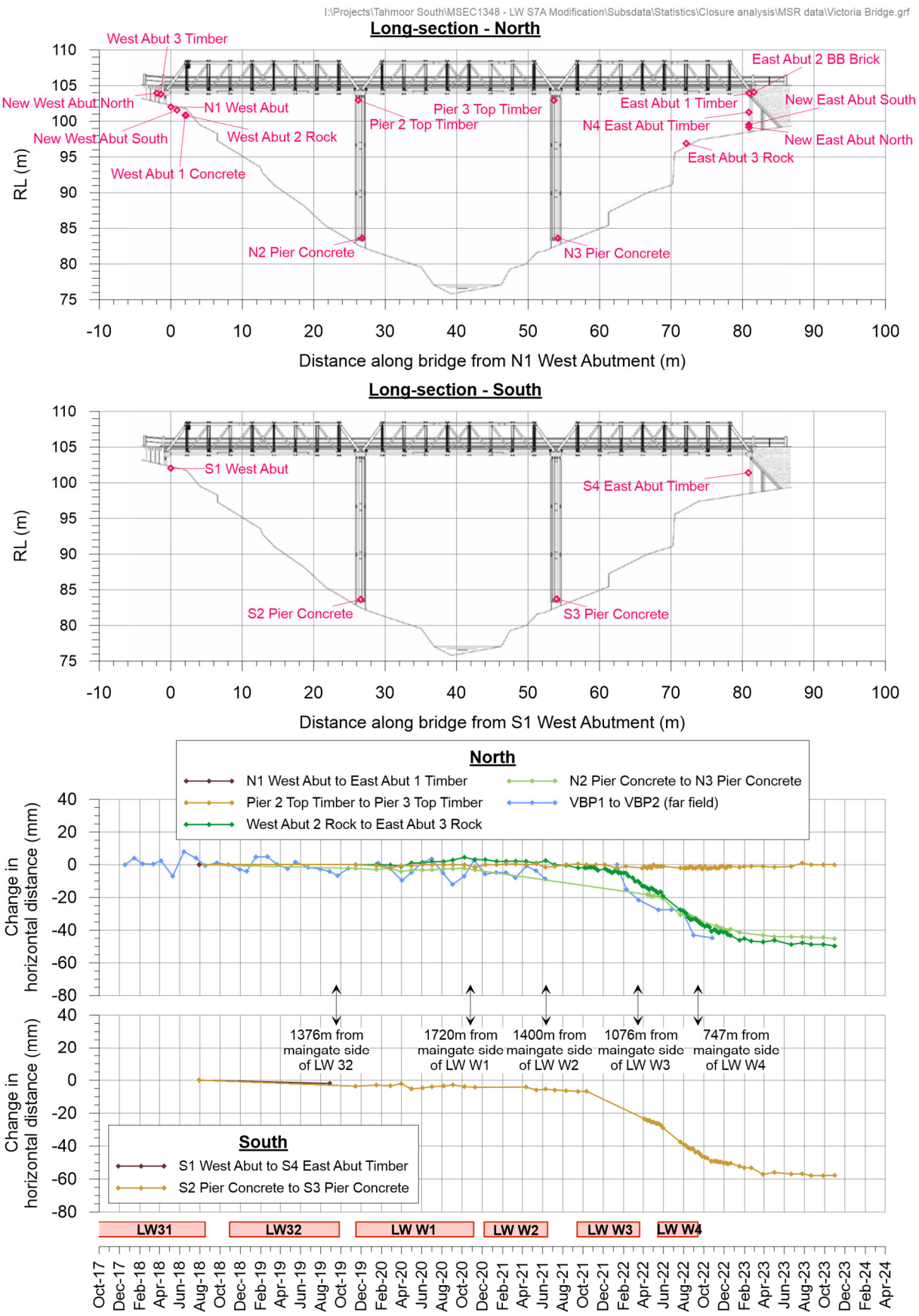



**Fig. 3.36 Observed development of closure across Stonequarry Creek at Victoria Bridge during the mining of LWs 31, 32 and LW W1-W4**

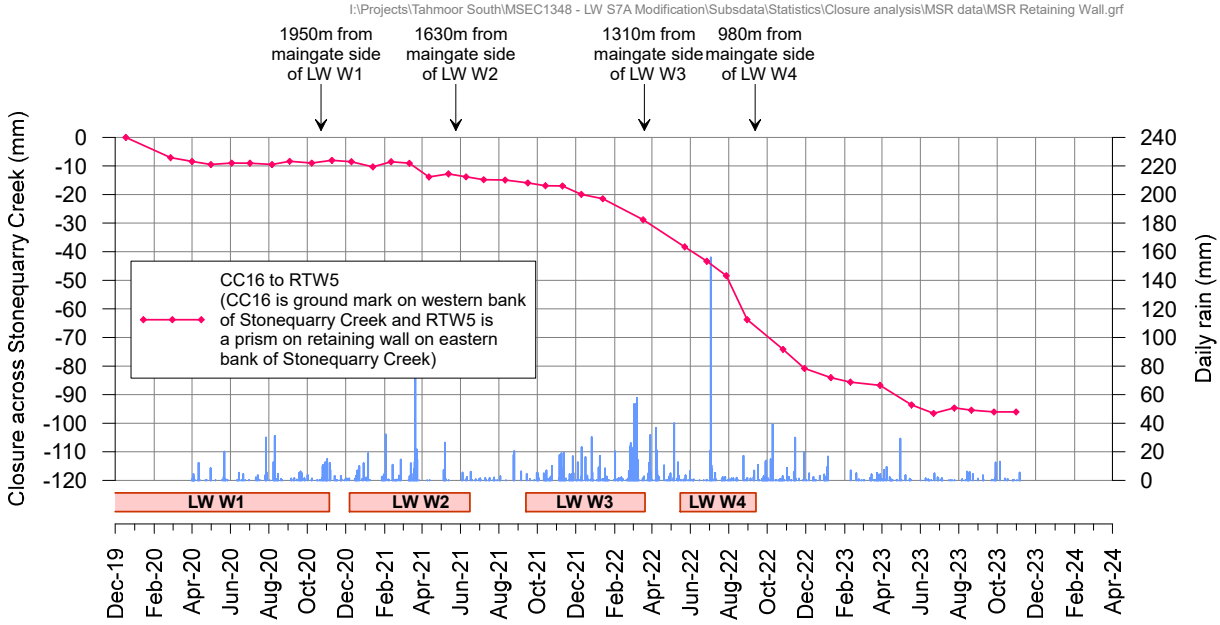



**Fig. 3.37 Observed development of closure across Stonequarry Creek at Retaining Wall at 84.687 km on the Main Southern Railway during the mining of LW W1-W4**

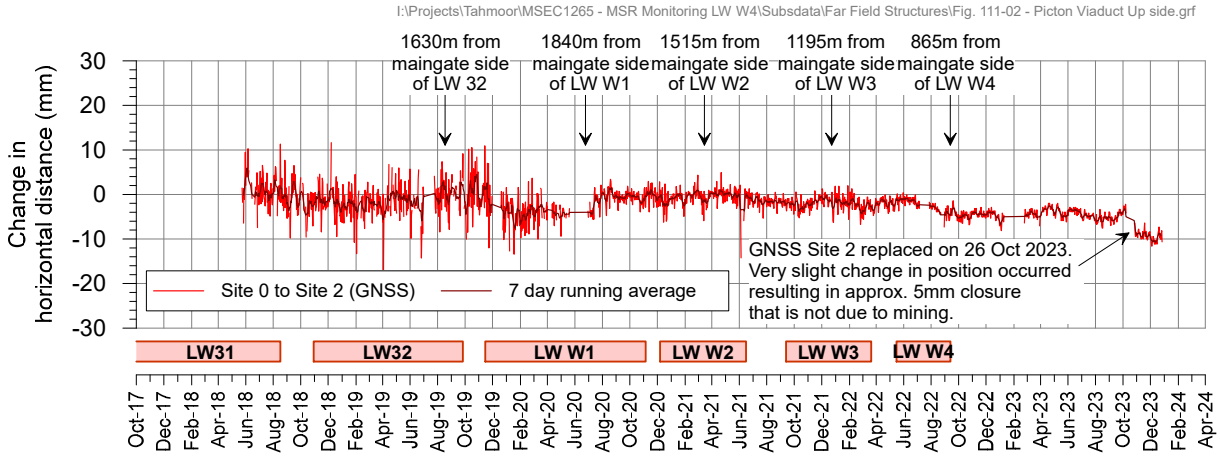



**Fig. 3.38 Observed changes in horizontal distance across Stonequarry Creek at Picton Viaduct on the Main Southern Railway during the mining of LWs 31, 32 and LW W1-W4**

### 3.10.6. Managing potential far field impacts on the Picton Weir

Tahmoor Coal has engaged Worley Consulting to develop a 3D structural model of the Weir, to assess its existing condition and assess potential structural impacts from potential mine subsidence movements. The assessment includes a sensitivity analysis that incrementally assesses the effects of valley closure at values up to and greater than predictions.

Tahmoor Coal is currently consulting with Wollondilly Shire Council to develop a Subsidence Management Plan to manage the potential for impacts to the Picton Weir due to the extraction of LWs S1A to S6A under the *Approved Layout*. This plan will be updated to include potential impacts due to the extraction of LW S7A under the *Modified Layout*.

Tahmoor Coal is currently developing management measures to ensure that it remains safe throughout the mining period and that impacts on the Picton Weir do not result in environmental consequences on the Bargo River due to the extraction of LWs S3A to S7A. The study requires input from structural, geotechnical and subsidence engineers. The management measures may include a combination of:

- Mitigation or strengthening measures prior to mining;
- Installation of a monitoring system, which includes, among other things:
    - GNSS monitoring at both ends of the Picton Weir (Sites S13 and S14, both installed),
    - GNSS monitoring at a location between LWs S1A to S7A and the Picton Weir (Site S19, installed);
    - GNSS monitoring at three pairs across Hornes Creek (Sites S20 to S25, installed);
    - Survey marks on rockfaces on both sides of the Picton Weir (installed);
    - Survey marks on the Picton Weir (to be installed prior to start of LW S3A);
    - Photogrammetric survey of shape of dam wall and surrounding rockfaces on both sides of the Picton Weir (baseline survey completed);
    - Vertical inclinometers in boreholes at mine side of the Picton Weir (boreholes drilled, inclinometer tubing to be installed prior to start of LW S3A);
    - Groundwater level monitoring in vertical inclinometers at mine side of the Picton Weir (to be installed prior to start of LW S3A);
    - Water level monitoring upstream of Picton Weir (to be installed prior to start of LW S3A);
    - Detailed visual inspection of Picton Weir and surrounding rockfaces by UAV (baseline inspection completed); and
    - Visual inspections during mining.
    - Install crack monitoring of existing gauges
- Conduct regular visual inspections of the Picton Weir; and
- Implement planned responses if triggered by monitoring and inspections.

As Tahmoor Mine will progressively approach the Picton Weir, it will be possible to review observations during the mining of each longwall and adjust the mine plan, if necessary to reduce the potential for impacts on Picton Weir. Picton Weir is also located beyond the finishing ends of the longwalls and it will be possible to stop the longwall face early, if necessary based on actual monitoring observations.

With an appropriate management plan in place, it is considered that the Picton Weir will remain safe and serviceable at all times due to the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

## 3.11. Rural structures

### 3.11.1. Descriptions of the rural structures

The locations of the rural structures (Structure Type R) within the Study Area are shown in Drawing No. MSEC 1348-11.

There are 276 rural structures which have been identified on private properties within Study Area, of which 48 structures (17 % of the total number of rural structures) will be mined directly beneath by the proposed LW S7A. There are a further 145 rural structures within the Study Area which will be mined directly beneath by longwalls S1A to S6A under the *Approved Layout*. The rural structures include sheds, garages, carports, gazebos, pergolas, greenhouses, shade structures and other non-residential structures. The locations and sizes of the rural structures were determined from aerial photographs of the area.

### 3.11.2. Predictions for rural structures

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and at the vertices of each rural structure, as well as at eight equally spaced points placed radially around the centroid and vertices at a distance of 20 metres. In the case of a rectangular shaped structure, predictions have been made at a minimum of 45 points within and around the structure.

A summary of the maximum predicted values of incremental conventional subsidence, tilt and curvature for each of the rural structures within the Study Area due to extraction of LW S7A is provided in Table C.04, in Appendix C. A summary of the maximum predicted values of total conventional subsidence, tilt and curvature for each of the rural structures within the Study Area after extraction of LWs S1A to S7A is also provided in Table C.04. The predicted tilts provided in this table are the maxima in any direction after the completion of each longwall. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each longwall.

Distributions of the maximum predicted incremental conventional subsidence and tilt for the rural structures due to extraction of LW S7A are illustrated in Fig. 3.39, while Fig. 3.40 shows the corresponding distributions of maximum predicted total conventional subsidence and final tilt after extraction of LWs S1A to S7A under the *Modified Layout*.

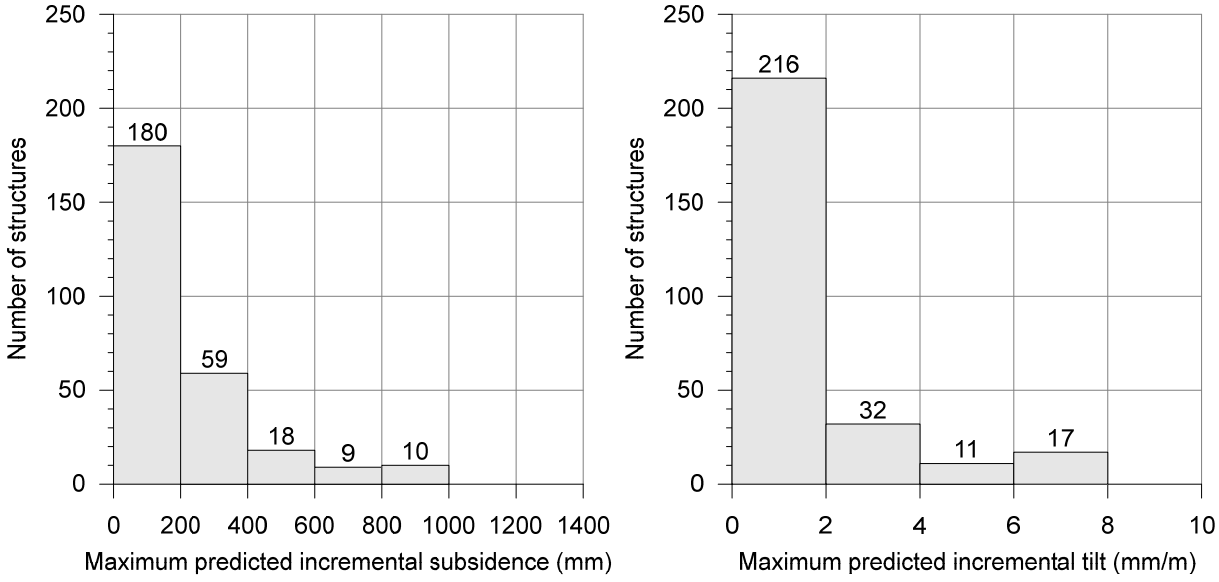



**Fig. 3.39 Maximum predicted incremental conventional subsidence and tilt for the rural structures within the Study Area due to extraction of LW S7A**

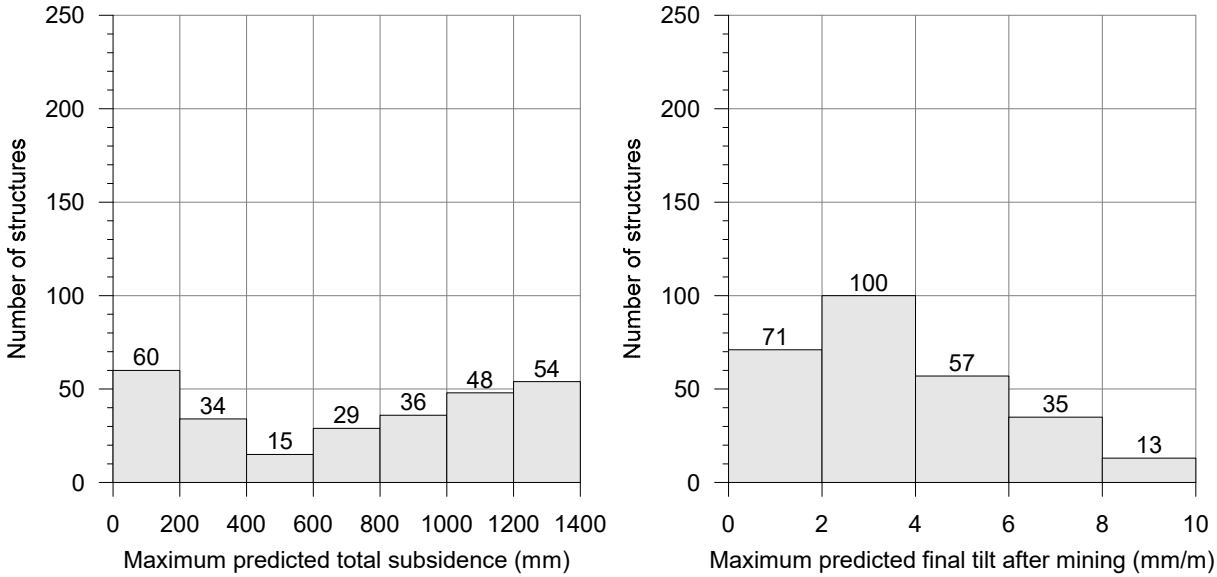



**Fig. 3.40 Maximum predicted total conventional subsidence and tilt for the rural structures within the Study Area after extraction of LWs S1A to S7A**

These distributions indicate that for a large number of the rural structures in the Study Area (180 out of 276 structures, or 65% of the total), the maximum predicted incremental subsidence due to LW S7A is less than 200 mm and thus a relatively small proportion of the maximum predicted total subsidence after extraction of LWs S1A to S7A. Similarly, the maximum predicted incremental tilt due to LW S7A is relatively small (< 2 mm/m) for most structures in the Study Area (216 out of 276 structures, or 78% of the total).

Distributions of the maximum predicted incremental conventional hogging and sagging curvatures for the structures due to extraction of LW S7A are illustrated in Fig. 3.41, while Fig. 3.42 shows the corresponding distributions of maximum predicted total conventional hogging and sagging curvatures after extraction of LWs S1A to S7A under the *Modified Layout*.

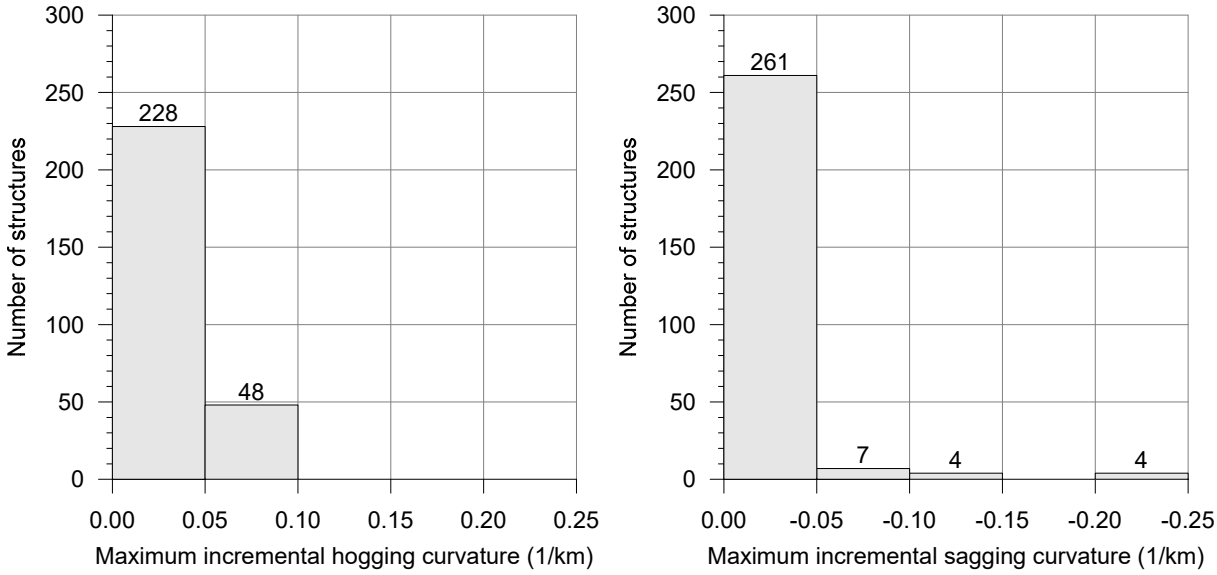



**Fig. 3.41 Maximum predicted incremental conventional hogging curvature (left) and sagging curvature (right) for the farm dams within the Study Area due to extraction of LW S7A**

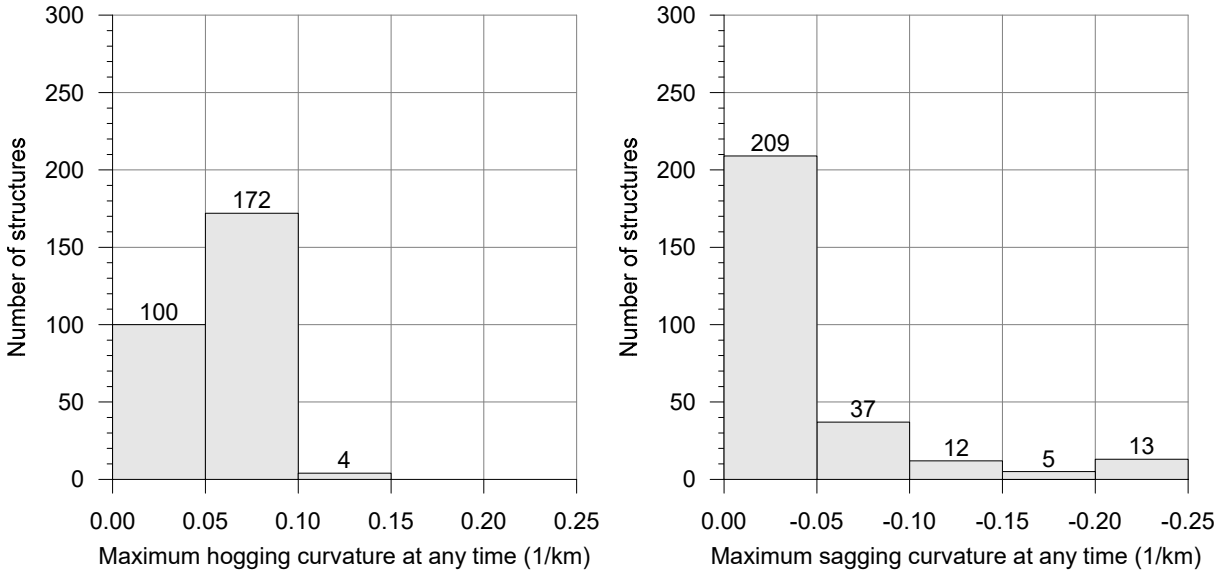



**Fig. 3.42 Maximum predicted conventional hogging curvature (left) and sagging curvature (right) for tanks within the Study Area due to extraction of LW S7A**

These distributions show that the maximum predicted incremental curvatures due to LW S7A are relatively small for most of the rural structures in the Study Area (of the 276 structures there are a total of 228 structures or 83% with hogging curvature < 0.05 $km^{-1}$ and 261 structures or 95% with sagging curvature < 0.05 $km^{-1}$).

The maximum predicted conventional curvatures for the rural structures are 0.12 $km^{-1}$ hogging and 0.23 $km^{-1}$ sagging, which equate to minimum radii of curvature of 8.3 kilometres and 4.3 kilometres, respectively. The maximum predicted conventional strains for the rural structures, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1.8 mm/m tensile and 3.5 mm/m compressive. Non-conventional movements can also occur as a result of, among other things, anomalous movements. The analysis of strains provided in Section 2.5 includes those resulting from both conventional and non-conventional anomalous movements.

The rural structures are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 2.5. The results for survey bays located above goaf are provided in Fig. 2.6 and the results for survey bays located above solid coal are provided in Fig. 2.8.

### 3.11.3. Impact assessments for rural structures

The maximum predicted tilt for the rural structures is 8.5 mm/m (i.e. 0.85 %), which represents a change in grade of 1 in 118. The majority of the rural structures within the Study Area are of lightweight construction and able to tolerate mining-induced tilt. It has been found from past longwall mining experience that tilts of the magnitudes predicted within the Study Area generally do not result in adverse impacts on rural structures. Some minor serviceability impacts could occur at the higher levels of predicted tilt, including door swings and issues with roof and pavement drainage, all of which can be remediated using normal building maintenance techniques.

There is extensive experience of mining directly beneath rural structures in the Southern Coalfield which indicates that the incidence of impacts on these structures is very low and the structures have remained in safe and serviceable conditions. This is not surprising as rural structures are generally small in size and of light-weight construction, which makes them less susceptible to impact than houses which are typically more rigid.

Tahmoor Mine has mined directly beneath more than 2000 rural structures of similar construction during the mining of LWs 22 to 32 and LW W1-W3. It has managed the mining induced impacts with the implementation of suitable management strategies. The structures have remained safe and serviceable during mining.

Whilst the predicted subsidence parameters for the proposed longwalls are greater than those at Tahmoor North, it would still be expected that the rates of impact would be low and could be managed with the implementation of suitable management strategies. Impacts on rural structures have been successfully managed elsewhere in the NSW Coalfields, where the predicted subsidence parameters were similar to or greater than those predicted for the proposed longwalls.

Based on previous experiences, it is expected that the rural structures within the Study Area would remain safe and serviceable during the mining period, provided that they are in sound existing condition. The risk of impact is clearly greater if the structures are in poor existing condition, though the chances of there being a public safety risk remains very low. A number of rural structures which were in poor existing condition have been directly mined beneath and these structures have not experienced impacts during mining.

Impacts on the rural structures that occur as the result of the extraction of the proposed longwalls are expected to be remediated using well established building techniques. With these remediation measures available, it is unlikely that there would be long term impacts on rural structures resulting from the extraction of the proposed longwalls.

### 3.11.4. Impact assessments for rural structures based on increased predictions

If the actual tilts exceeded those predicted by a factor of 2 times, the maximum tilt at the rural structures would be 17 mm/m (i.e. 1.7 %), or a change in grade of 1 in 59. In this case, the incidence of serviceability impacts, such as door swings and issues with gutter and pavement drainage, would increase in the locations of greatest tilt, such as adjacent to the active longwall maingate and adjacent to the ends of the proposed longwalls. It would still be unlikely that stabilities of these rural structures would be affected by tilts of these magnitudes.

If the actual curvatures exceeded those predicted by a factor of 2 times, the incidence of impacts would increase for the rural structures located directly above the proposed longwalls. Since rural structures are generally small in size and of light-weight construction, they would still be expected to remain safe, serviceable and repairable using normal building maintenance techniques. With the implementation of any necessary remediation measures, it is unlikely that there would be any substantial long-term impacts on the rural structures.

While the predicted ground movements are important parameters when assessing the potential impacts on the rural structures, it is noted that the impact assessments were primarily based on historical observations from previous longwall mining in the Southern Coalfield. The overall levels of impact on the rural structures, resulting from the extraction of the proposed longwalls, are expected to be similar to those observed where longwalls have previously mined directly beneath rural structures in the Southern Coalfield.

### 3.11.5. Management of potential impacts on rural structures

Tahmoor Coal has developed a Subsidence Management Plan to manage potential impacts to farm buildings during the mining of LWs S1A to S6A under the *Approved Layout*. The management plan provides for identification of buildings in poor pre-mining condition that are hazardous or may become hazardous due to mining, and monitoring of structures during active subsidence. If impacts occur, the structure will be repaired in accordance with the *Coal Mine Subsidence Compensation Act 2017*.

The Subsidence Management Plan will be updated to include potential impacts due to the extraction of LW S7A under the *Modified Layout*.

With an appropriate management plan in place, it is considered that rural structures can be maintained at all times due to the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

## 3.12. Tanks

### 3.12.1. Descriptions of the tanks

The locations of the tanks (Structure Type T) within the Study Area are shown in Drawing No. MSEC1348-11. These include both septic tanks and potable water storage tanks, and which comprise in-ground and above ground tanks of concrete or steel or polyethylene construction.

There are 67 tanks which have been identified within the Study Area, of which 16 are located directly above LW S7A. A further 27 tanks are located directly above longwalls S1A to S6A under the *Approved Layout* and 24 tanks will not be directly mined beneath by the planned longwalls. The locations and sizes of the tanks were determined from aerial photographs of the area and kerb side inspections. There are also a number of smaller rainwater tanks associated with the houses which are not shown in these drawings.

### 3.12.2. Predictions for the tanks

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and at points located around the perimeter of each tank, as well as at points located at a distance of 20 metres from the perimeter of each tank.

A summary of the maximum predicted values of incremental conventional subsidence, tilt and curvature for each tank within the Study Area due to extraction of LW S7A is provided in Table C.05, in Appendix C. A summary of the maximum predicted values of total conventional subsidence, tilt and curvature for each tank within the Study Area after extraction of LWs S1A to S7A is also provided in Table C.07. The predicted tilts provided in this table are the maxima in any direction after the completion of each longwall. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each longwall.

Distributions of the maximum predicted incremental conventional subsidence and tilt for the tanks due to extraction of LW S7A are illustrated in Fig. 3.43, while Fig. 3.44 shows the corresponding distributions of maximum predicted total conventional subsidence and final tilt after extraction of LWs S1A to S7A under the *Modified Layout*.

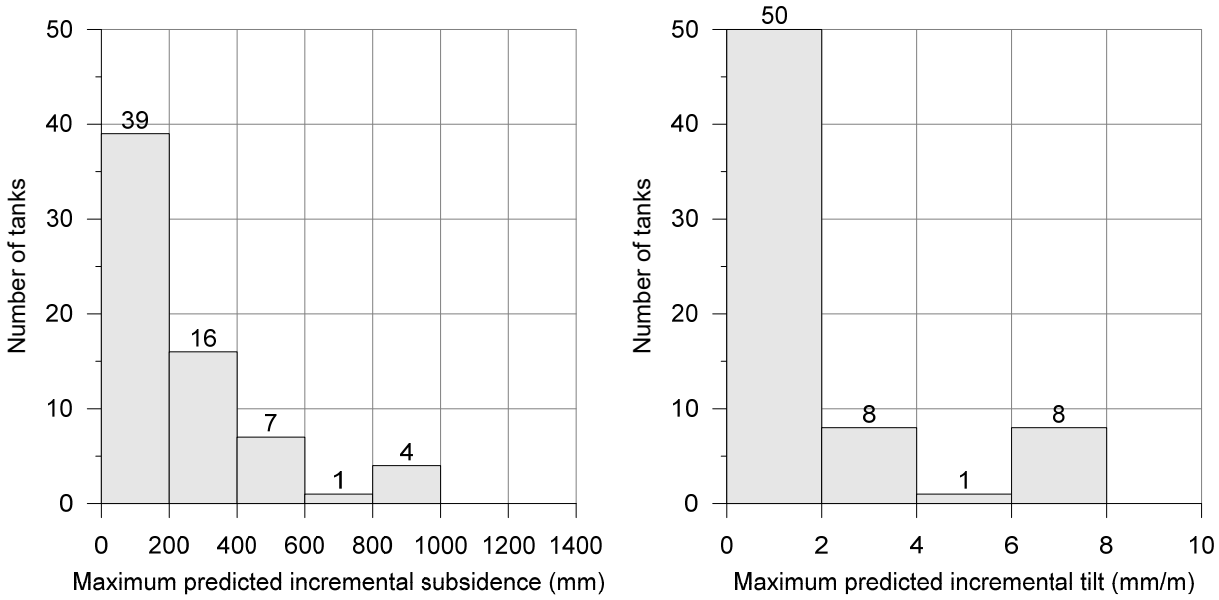



**Fig. 3.43 Maximum predicted incremental conventional subsidence and tilt for the tanks within the Study Area due to extraction of LW S7A**

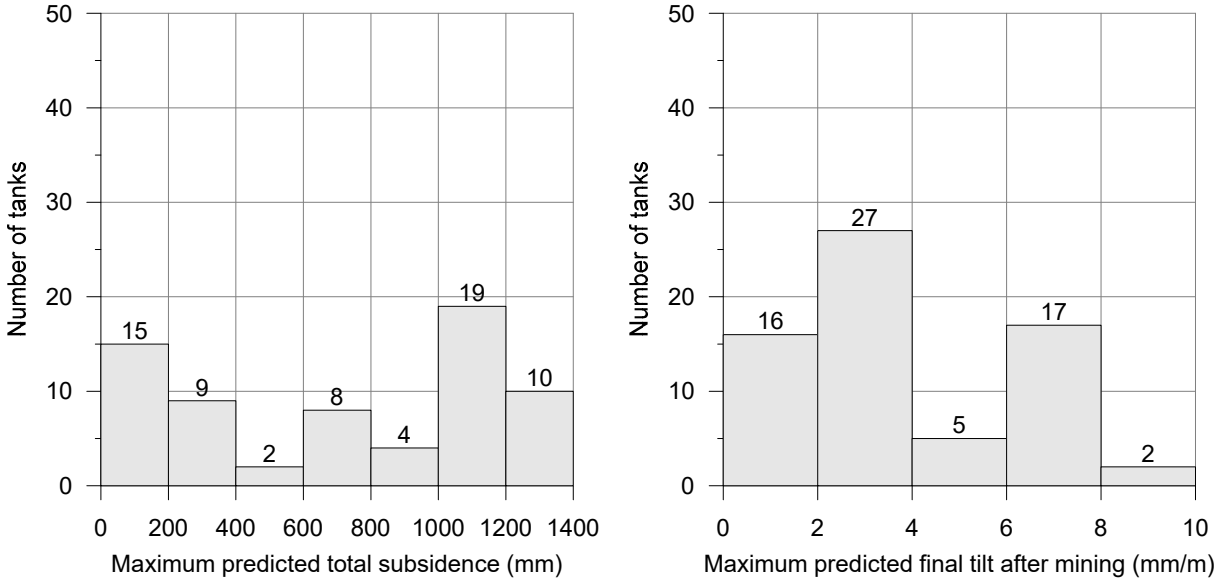



**Fig. 3.44 Maximum predicted total conventional subsidence and tilt for the tanks within the Study Area after extraction of LWs S1A to S7A**

These distributions indicate that for most tanks in the Study Area (55 out of 67 tanks, or 82% of the total), the maximum predicted incremental subsidence due to LW S7A is a relatively small proportion of the maximum predicted total subsidence after extraction of LWs S1A to S7A. Similarly, the maximum predicted incremental tilt due to LW S7A is relatively small (< 2 mm/m) for most tanks in the Study Area (50 out of 67 tanks, or 75% of the total).

Distributions of the maximum predicted incremental conventional hogging and sagging curvatures for the tanks due to extraction of LW S7A are illustrated in Fig. 3.45, while Fig. 3.46 shows the corresponding distributions of maximum predicted total conventional hogging and sagging curvatures after extraction of LWs S1A to S7A under the *Modified Layout*.

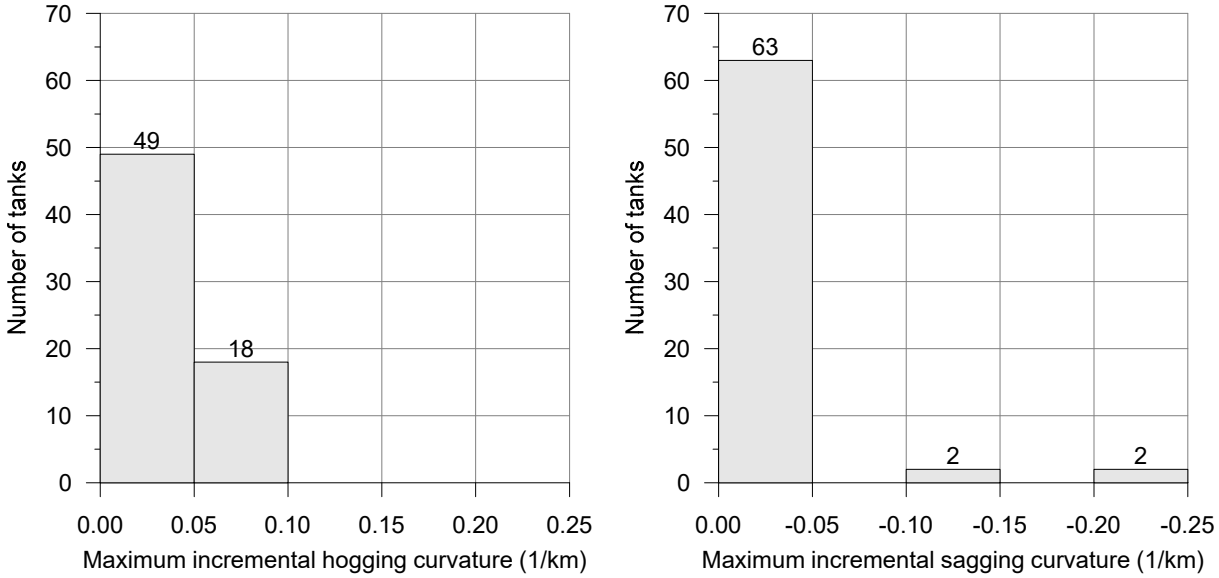



**Fig. 3.45 Maximum predicted incremental conventional hogging curvature (left) and sagging curvature (right) for the farm dams within the Study Area due to extraction of LW S7A**

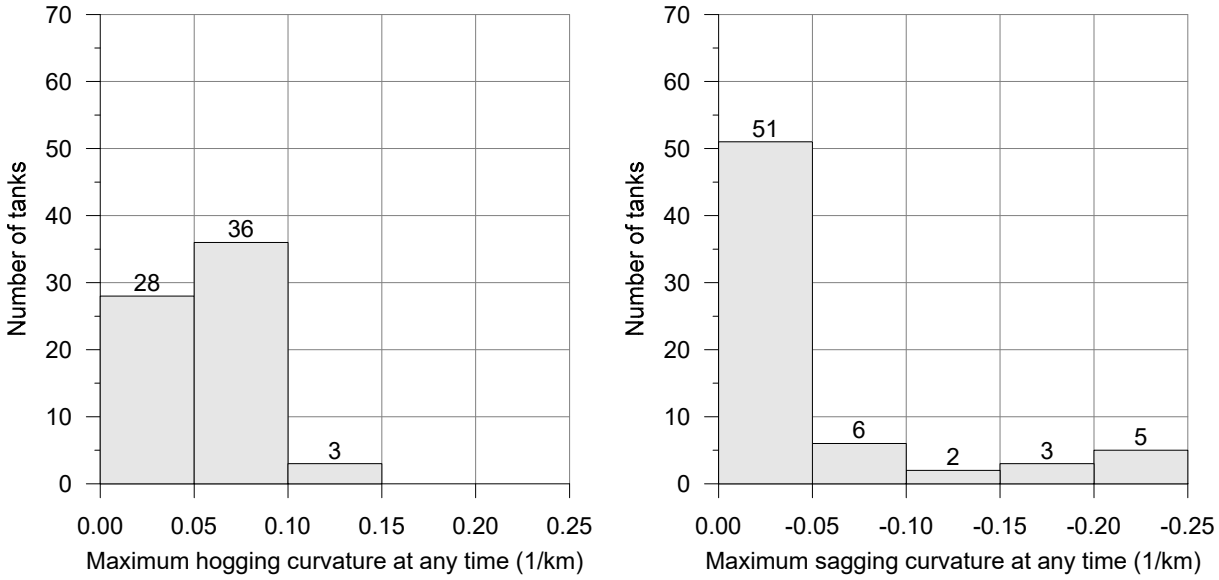



**Fig. 3.46 Maximum predicted conventional hogging curvature (left) and sagging curvature (right) for tanks within the Study Area due to extraction of LW S7A**

These distributions show that the maximum predicted incremental hogging curvature due to LW S7A is < 0.10 $km^{-1}$ for almost all of the tanks in the Study Area (64 out of 67 pools, or 96% of the total), and the maximum predicted incremental sagging curvature due to LW S7A is < 0.05 $km^{-1}$ for 51 out of 67 tanks (or 76 %).

The maximum predicted conventional strains for the tanks, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1.8 mm/m tensile and 3.5 mm/m compressive. Non-conventional movements can also occur as a result of, among other things, anomalous movements. The analysis of strains provided in Section 2.5 includes those resulting from both conventional and non-conventional anomalous movements.

The tanks are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 2.5. The results for survey bays located above goaf are provided in Fig. 2.6 and the results for survey bays located above solid coal are provided in Fig. 2.8.

### 3.12.3. Impact assessments for the tanks

Tilt can potentially affect the serviceability of tanks by altering the water levels in the tanks, which can in turn affect the minimum level of water which can be released from the outlets. The maximum predicted conventional tilt for the tanks within the Study Area is 8.5 mm/m (i.e. 0.85 %), which represents a change in grade of 1 in 118. The predicted changes in grade are small and unlikely, therefore, to result in any adverse impacts on the serviceability of the tanks.

The tanks are typically constructed above ground level and, therefore, are unlikely to experience the curvatures and ground strains resulting from the extraction of the proposed longwalls. It is possible that any buried water pipelines associated with the tanks within the Study Area could be impacted by the ground strains, if they are anchored by the tanks, or by other structures in the ground.

Any impacts are expected to be of a minor nature, including leaking pipe joints, and could be easily repaired. With these remedial measures in place, it would be unlikely that there would be any adverse impacts on the pipelines associated with the tanks.

### 3.12.4. Impact assessments for the tanks based on increased predictions

If the actual tilts exceeded those predicted by a factor of 2 times, the maximum tilt at the tanks would be 17 mm/m (i.e. 1.7 %), or a change in grade of 1 in 59. In this case, the incidence of serviceability impacts, such as changes in the minimum water levels which can be released from the outlets, could increase in the locations of greatest tilt, such as adjacent to the active longwall maingate and adjacent to the ends of the proposed longwalls. Impacts would be expected to be remediated by relevelling the tanks.

If the actual curvatures exceeded those predicted by a factor of 2 times, the incidence of impacts on the tank structures would not be expected to change substantially, as they are not expected to experience these ground movements. The incidence of impacts on the buried pipelines would, however, be expected to increase in the locations directly above the proposed longwalls. Impacts would still be expected to be of a minor nature which could be easily repaired. With these remediation measures in place, it would be unlikely that there would be long term impacts on the pipelines associated with the tanks.

### 3.12.5. Management of potential impacts on the tanks

Tahmoor Coal has developed a Subsidence Management Plan to manage potential impacts to tanks during the mining of LWs S1A to S6A under the *Approved Layout*. The management plan provides for identification of tanks in poor pre-mining condition that are hazardous or may become hazardous due to mining, and monitoring of structures during active subsidence. If impacts occur, the structure will be repaired in accordance with the *Coal Mine Subsidence Compensation Act 2017*.

The Subsidence Management Plan will be updated to include potential impacts due to the extraction of LW S7A under the *Modified Layout*.

With an appropriate management plan in place, it is considered that tanks can be maintained at all times due to the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

## 3.13. Farm dams

There are 20 farm dams (Structure Type D) which have been identified within the Study Area and their locations are shown in Drawing No. MSEC1348-11. The maximum plan dimensions and plan areas for these dams are provided in Table C.07, in Appendix C.

The locations and sizes of the farm dams were determined from aerial photographs of the area. The distributions of the longest lengths and surface areas of the farm dams within the Study Area are shown in Fig. 3.47.

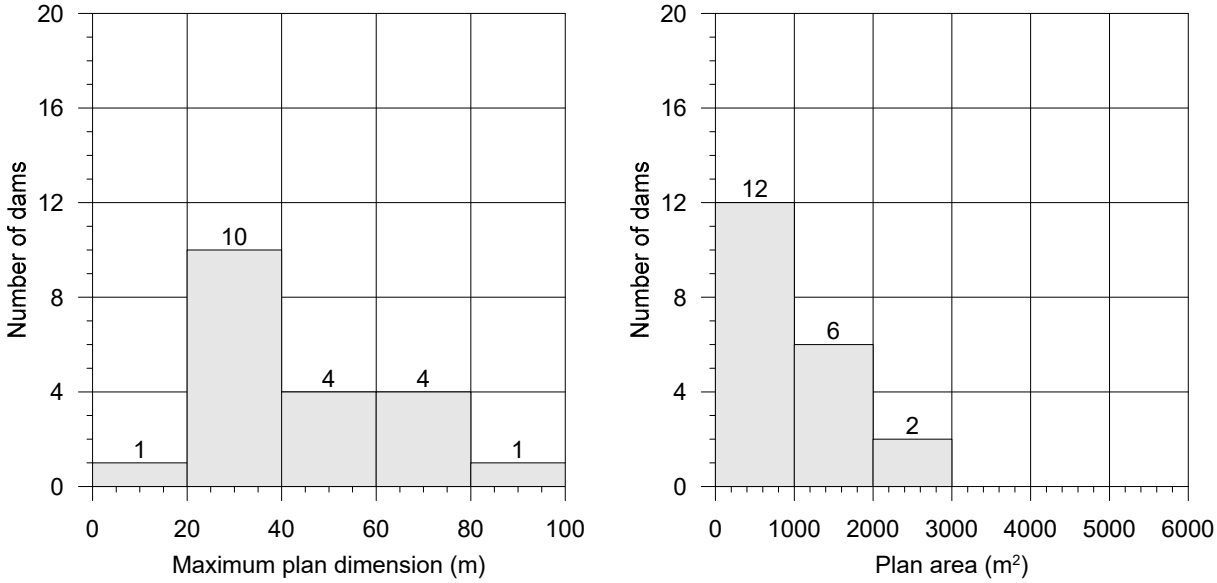



**Fig. 3.47 Distributions of longest lengths and surface areas of the farm dams**

The longest lengths of the farm dams within the Study Area vary between 16 metres and 99 metres and the plan areas vary between 170 $m^2$ and 2,925 $m^2$.

The dams are typically of earthen construction and have been established by localised cut and fill operations within the natural streams. The farm dams are generally shallow, with the dam wall heights generally being less than 3 metres.

Only one of these dams is located directly above the proposed LW S7A under the *Modified Layout*. This dam is identified as BYR_095_d01, with a maximum plan dimension of 43 m and a plan area 1,003 $m^2$. All of the remaining 19 dams located within the current Study Area were predicted to experience some subsidence movements due to extraction of LWs S1A to S6A under the *Approved Layout.*

### 3.13.1. Predictions for the farm dams

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and around the perimeters of each farm dam, as well as at points located at a distance of 20 metres from the perimeter of each dam.

A summary of the maximum predicted values of incremental conventional subsidence, tilt and curvature for each farm dam within the Study Area due to extraction of LW S7A is provided in Table C.07, in Appendix C. A summary of the maximum predicted values of total conventional subsidence, tilt and curvature for each farm dam within the Study Area after extraction of LWs S1A to S7A is also provided in Table C.07. The predicted tilts provided in this table are the maxima in any direction after the completion of each longwall. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each longwall.

Distributions of the maximum predicted incremental conventional subsidence and tilt for the farm dams due to extraction of LW S7A are illustrated in and Fig. 3.51, while Fig. 3.49 shows the corresponding distributions of maximum predicted total conventional subsidence and final tilt after extraction of LWs S1A to S7A under the *Modified Layout*.

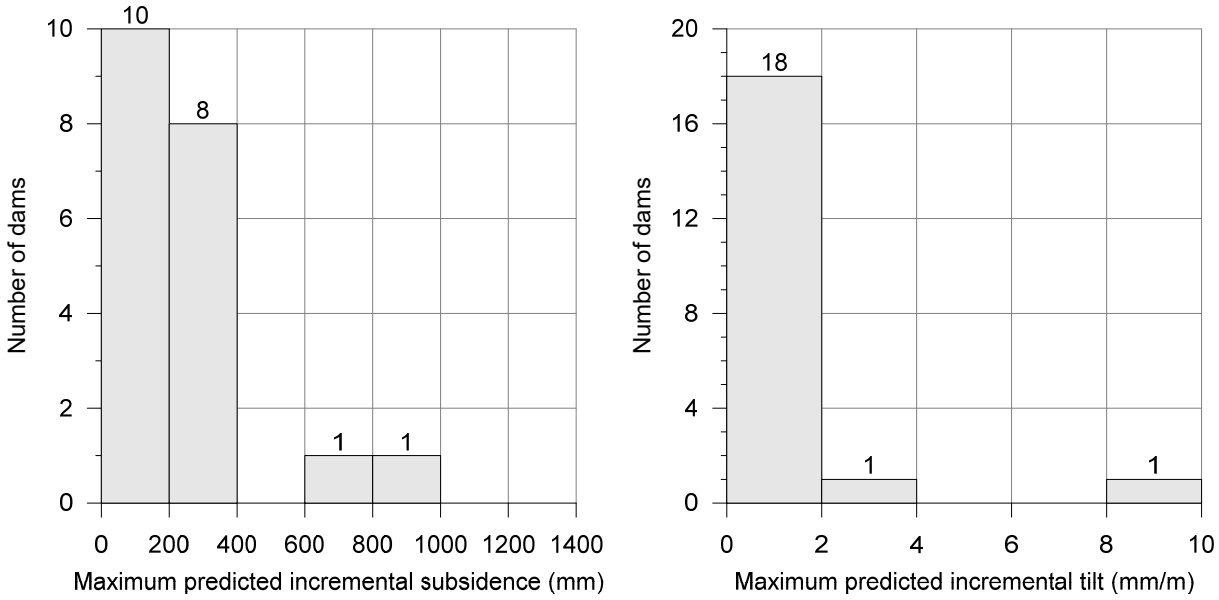



**Fig. 3.48 Maximum predicted incremental conventional subsidence and tilt for the farm dams within the Study Area due to extraction of LW S7A**

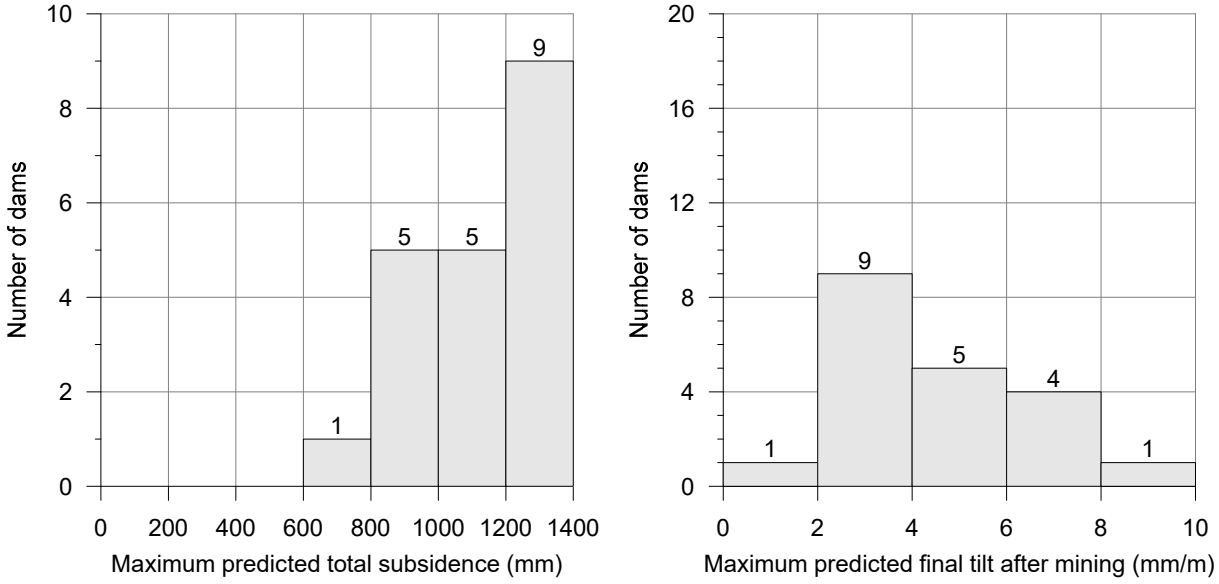



**Fig. 3.49 Maximum predicted total conventional subsidence and tilt for the farm dams within the Study Area after extraction of LWs S1A to S7A**

These distributions indicate that for most dams in the Study Area (18 out of 20 dams, or 90% of the total), the maximum predicted incremental subsidence due to LW S7A is a relatively small proportion of the maximum predicted total subsidence after extraction of LWs S1A to S7A. Similarly, the maximum predicted incremental tilt due to LW S7A is relatively small (< 2 mm/m) for most dams in the Study Area (18 out of 20 dams, or 90% of the total).

Distributions of the maximum predicted incremental conventional hogging and sagging curvatures for the farm dams due to extraction of LW S7A are illustrated in Fig. 3.50, while Fig. 3.51 shows the corresponding distributions of maximum predicted total conventional hogging and sagging curvatures after the extraction of LWs S1A to S7A under the *Modified Layout*.

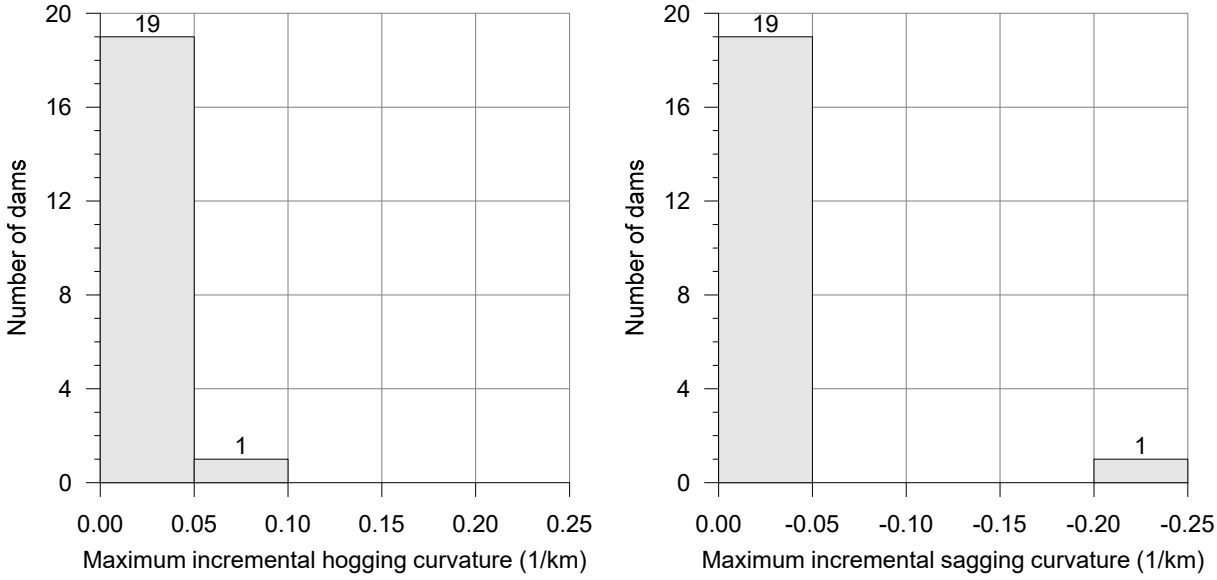



**Fig. 3.50 Maximum predicted incremental conventional hogging curvature (left) and sagging curvature (right) for the farm dams within the Study Area due to extraction of LW S7A**

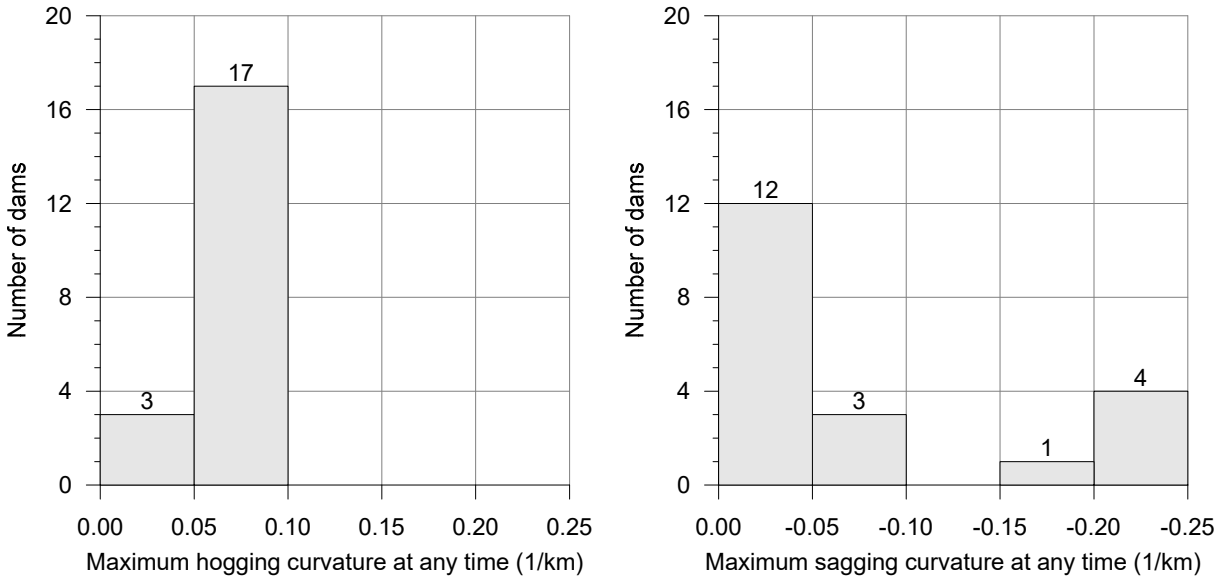



**Fig. 3.51 Maximum predicted total conventional hogging curvature (left) and sagging curvature (right) for the farm dams after extraction of LWs S1A to S7A**

These distributions show that for most dams in the Study Area (19 out of 20 dams, or 95% of the total), the maximum predicted incremental curvatures due to LW S7A are relatively small (< 0.05 $km^{-1}$) for both hogging and sagging curvatures. It is only the dam located directly above LW S7A where predicted incremental curvature exceeds 0.05 $km^{-1}$.

The maximum predicted conventional strains for the farm dams, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1.5 mm/m tensile and 3.3 mm/m compressive. Non-conventional movements can also occur as a result of, among other things, anomalous movements. The analysis of strains provided in Section 2.5 includes those resulting from both conventional and non-conventional anomalous movements.

The farm dams are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 2.5. The results for survey bays located above goaf are provided in Fig. 2.6 and the results for survey bays located above solid coal are provided in Fig. 2.8.

The farm dams have typically been constructed within the streams and, therefore, may be subjected to valley related movements resulting from the extraction of the proposed longwalls. The equivalent valley heights at the dams are very small and it is expected, therefore, that the predicted valley related upsidence and closure movements at the dam walls would be much less than the predicted conventional subsidence movements and would not be substantial.

### 3.13.2. Impact Assessments for the farm dams

The maximum predicted final tilt for the farm dams is 8.5 mm/m (i.e. 0.85 %), which represents a change in grade of 1 in 118. Mining induced tilts can affect the water levels around the perimeters of farm dams, with the freeboard increasing on one side, and decreasing on the other. Tilt can potentially reduce the storage capacity of farm dams, by causing them to overflow, or can affect the stability of the dam walls.

The predicted changes in freeboard at the farm dams within the Study Area were determined by taking the difference between the maximum predicted subsidence and the minimum predicted subsidence anywhere around the perimeter of each farm dam. The predicted maximum changes in freeboard at the farm dams within the Study Area after the completion of longwalls S1A to S7A under the *Modified Layout*, are provided in Table C.07, in Appendix C, and are illustrated in Fig. 3.52.

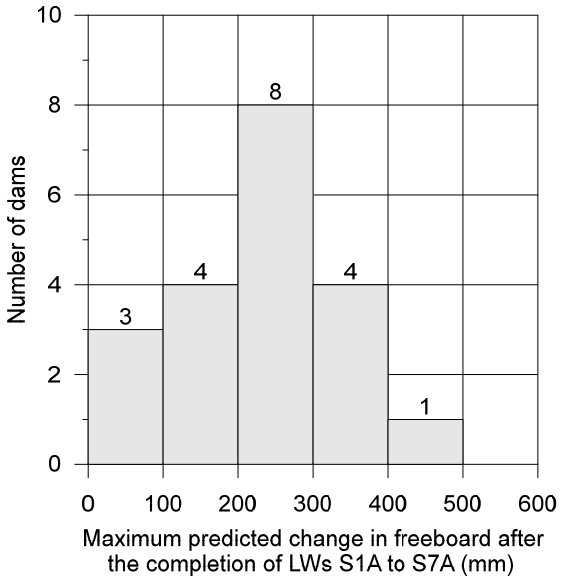



**Fig. 3.52 Predicted changes in freeboards for the farm dams within the Study Area**

It can be seen from the above figure, that the predicted changes in freeboard are less than 300 mm at 15 of 20 dams (i.e. 75 % of the total), and less than 500 mm at all 20 dams located within the Study Area, including the dam located directly above LW S7A. It is unlikely that the majority of the farm dams within the Study Area would experience adverse impacts on the storage capacities due to these small changes in freeboard. However, any reduced storage levels could be remediated by increasing the height of the affected dam wall.

The maximum predicted conventional curvatures for farm dams under the *Modified Layout* are 0.10 $km^{-1}$ hogging and 0.23 $km^{-1}$ sagging, which represent minimum radii of curvature of 10.0 kilometres and 4.3 kilometres, respectively. These are similar to the maximum predicted curvatures (0.14 $km^{-1}$ hogging and 0.22 $km^{-1}$) and minimum radii of curvature (7.1 kilometres and 4.5 kilometres, respectively) under the *Approved Layout*. The predicted curvatures and strains could be sufficient to result in cracking in the bases and walls of some farm dams within the Study Area.

There is extensive experience of mining directly beneath farm dams in the Southern Coalfield, which indicates that the incidence of impacts on these features is very low. Farm dams are commonly constructed with cohesive materials in the bases and walls which can absorb the conventional subsidence movements typically experienced in the Southern Coalfield without the development of substantial cracking. Non-conventional movements can result in localised cracking and deformations at the surface and, where coincident with farm dams, could result in adverse impacts.

Tahmoor Coal has mined LW22 to LW32 and LW W1-W3 beneath approximately 110 dams. While a small number of landowners have advised of impacts, there has been one claim to SA NSW for impacts on farm dams at the time of the report.

Similarly, South32 Illawarra Coal has mined directly beneath more than 200 farm dams in Appin Area 3, Appin Area 4, Appin Area 7, Appin Area 9 and West Cliff Area 5. Loss of water was reported for one dam in Appin Area 7, however, it was noted that this dam was of poor, shallow construction and seepage was observed at the base of the dam wall prior to mining.

Whilst the predicted subsidence parameters for the proposed longwalls are greater than those at Tahmoor North and at Appin and West Cliff Collieries, it would still be expected that the rates of impact on the farm dams would be very low and could be managed with the implementation of suitable management strategies.

Any substantial cracking in the dam bases or walls could be repaired by reinstating with cohesive materials. If any farm dams were to lose water as a result of mining, the mine would provide an alternative water source until the completion of repairs in accordance with the *Coal Mine Subsidence Compensation Act 2017*.

### 3.13.3. Impact assessments for the farm dams based on increased predictions

If the actual tilts exceeded those predicted by a factor of 2 times, the maximum tilt at the farm dams, at the completion of mining, would be 17 mm/m (i.e. 1.7 %), or a change in grade of 1 in 59. In this case, there would be 9 dams within the *Study Area* (i.e. 45 % of the total) where the predicted change in freeboard was greater than 500 mm. In some cases, the tilts could be sufficient to reduce the capacities of the farm dams below acceptable levels, however, these could be remediated by increasing the heights of the affected dam walls.

If the actual curvatures or strains exceeded those predicted by a factor of 2 times, the likelihood and extent of cracking would increase for the farm dams located directly above the proposed longwalls. Any surface cracking would still be expected to be of a minor nature and could be readily repaired by reinstating with cohesive materials. If any farm dams were to lose water as a result of mining, the mine would provide an alternative water source until the completion of repairs in accordance with the *Coal Mine Subsidence Compensation Act 2017*.

### 3.13.4. Management of potential impacts on the farm dams

Tahmoor Coal has developed a Subsidence Management Plan to manage potential impacts to farm dams during the mining of LWs S1A to S6A under the *Approved Layout*. The management plan includes an assessment of potential environmental or safety consequences as a result of dam breach. The management plan provides for visual monitoring of dams immediately prior to and after active subsidence at each dam.

If impacts occur to the dams, Tahmoor Coal will supply water to the landowner on a temporary basis until the dam is repaired in accordance with the *Coal Mine Subsidence Compensation Act 2017*.

The Subsidence Management Plan will be updated to include potential impacts due to the extraction of LW S7A under the *Modified Layout*.

With an appropriate management plan in place, it is considered that dams can be maintained at all times due to the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

## 3.14. Commercial and business establishments

A total of 29 structures are located within the Study Area that are used for commercial or business purposes by three different establishments. These are Bargo Valley Produce, Ingham Turkey Farm and the Canine Country Club and Cattery. These establishments were included within the Study Area for LWs S1A to S6A under the *Approved Layout*.

As shown in Drawing No. MSEC1348-11, the structures are all located on properties along Yarran Road and 26 of the 29 structures (90 %) will be directly mined beneath by LW S7A under the *Modified Layout*.

### 3.14.1. Predictions for the commercial and business establishments

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and at points located around the perimeter of each structure, as well as at points located at a distance of 20 metres from the perimeter of each structure.

A summary of the maximum predicted values of incremental conventional subsidence, tilt and curvature for each of the commercial structures within the Study Area due to extraction of LW S7A is provided in Table C.09, in Appendix C. A summary of the maximum predicted values of total conventional subsidence, tilt and curvature for each of the commercial structures within the Study Area after extraction of LWs S1A to S7A is also provided in Table C.09. The predicted tilts provided in this table are the maxima in any direction after the completion of each longwall. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each longwall.

Distributions of the maximum predicted incremental conventional subsidence and tilt for the commercial structures due to extraction of LW S7A are illustrated in Fig. 3.53, while Fig. 3.54 shows the corresponding distributions of maximum predicted total conventional subsidence and final tilt after extraction of LWs S1A to S7A under the *Modified Layout*.

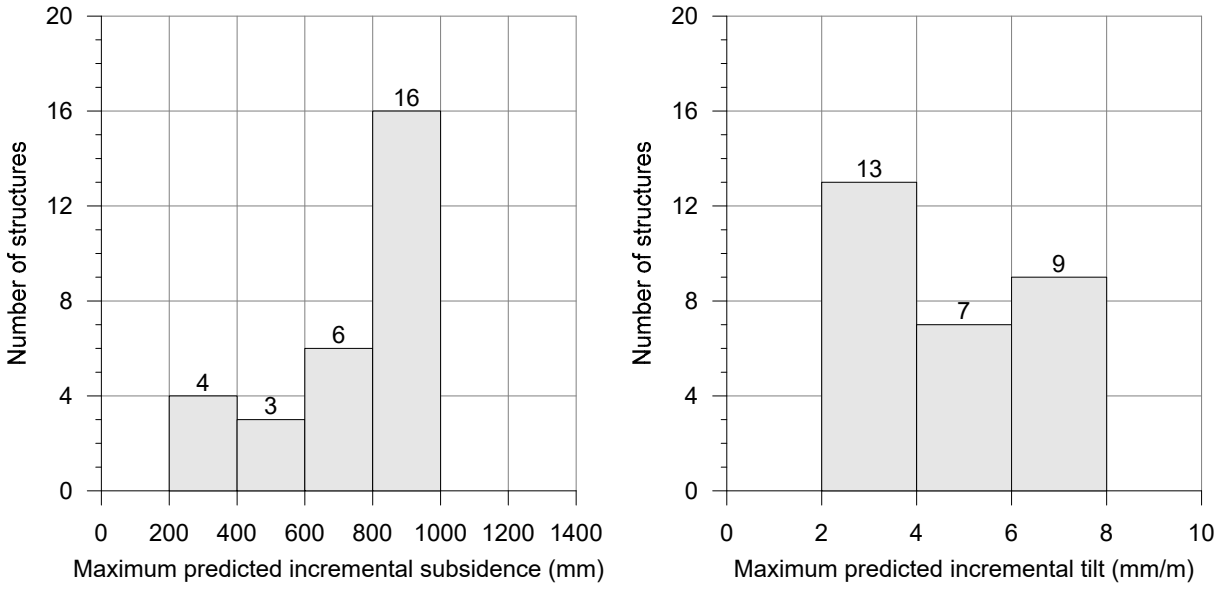



**Fig. 3.53 Maximum predicted incremental conventional subsidence and tilt for the commercial structures within the Study Area due to extraction of LW S7A**

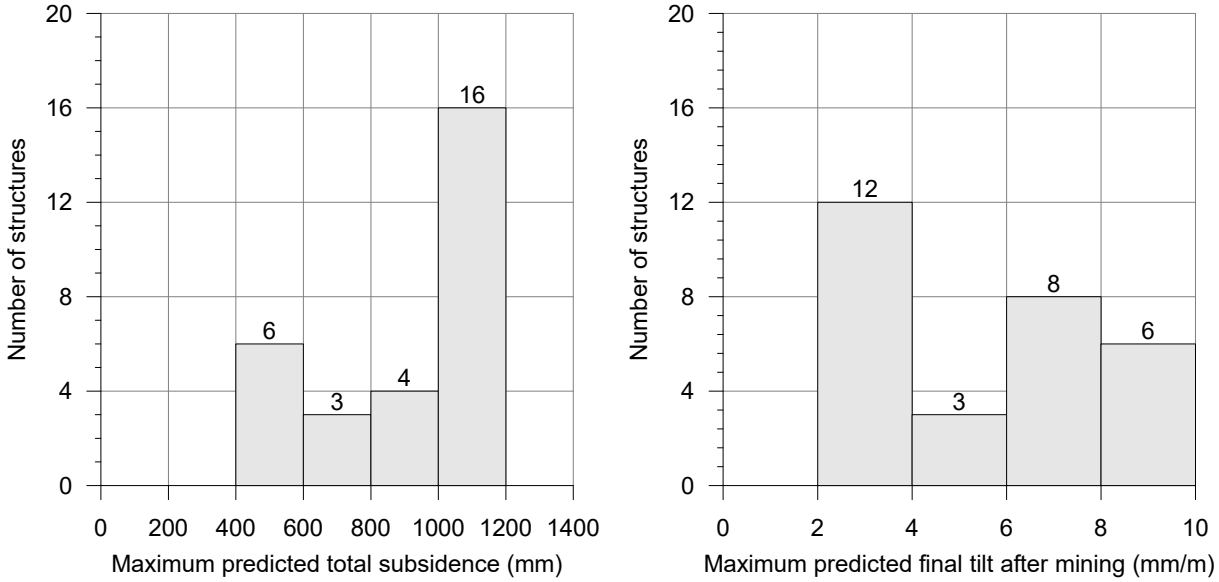



**Fig. 3.54 Maximum predicted total conventional subsidence and tilt for the commercial structures within the Study Area after extraction of LWs S1A to S7A**

These distributions indicate that, for the commercial structures in the Study Area the maximum predicted incremental subsidence due to LW S7A is a relatively large proportion of the maximum predicted total subsidence after extraction of LWs S1A to S7A. This is to be expected, as the commercial establishments are located along Yarran Road and most will be directly mined beneath by the proposed LW S7A. Similarly, the distribution of the maximum predicted incremental tilt due to LW S7A is similar to the distribution of the maximum predicted final tilt after extraction of all LWs S1A to S7A under the *Modified Layout.*

Distributions of the maximum predicted incremental conventional hogging and sagging curvatures for the commercial structures due to extraction of LW S7A are illustrated in Fig. 3.55, while Fig. 3.56 shows the corresponding distributions of maximum predicted total conventional hogging and sagging curvatures after extraction of LWs S1A to S7A under the *Modified Layout*.

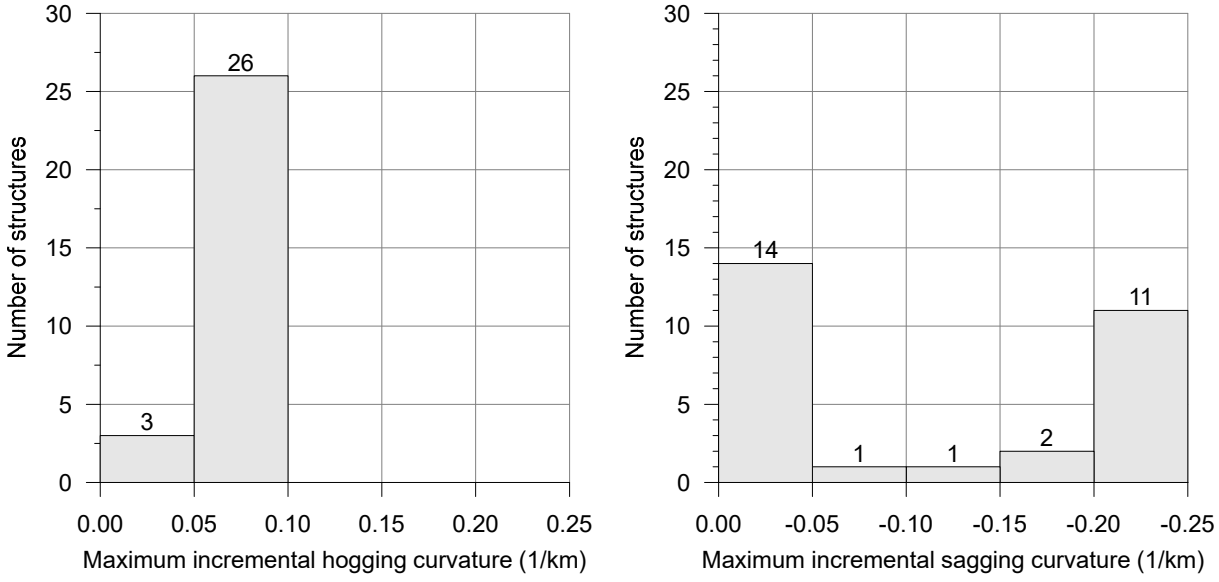



**Fig. 3.55 Maximum predicted incremental conventional hogging (left) and sagging (right) curvatures for commercial structures within the Study Area due to extraction of LW S7A**

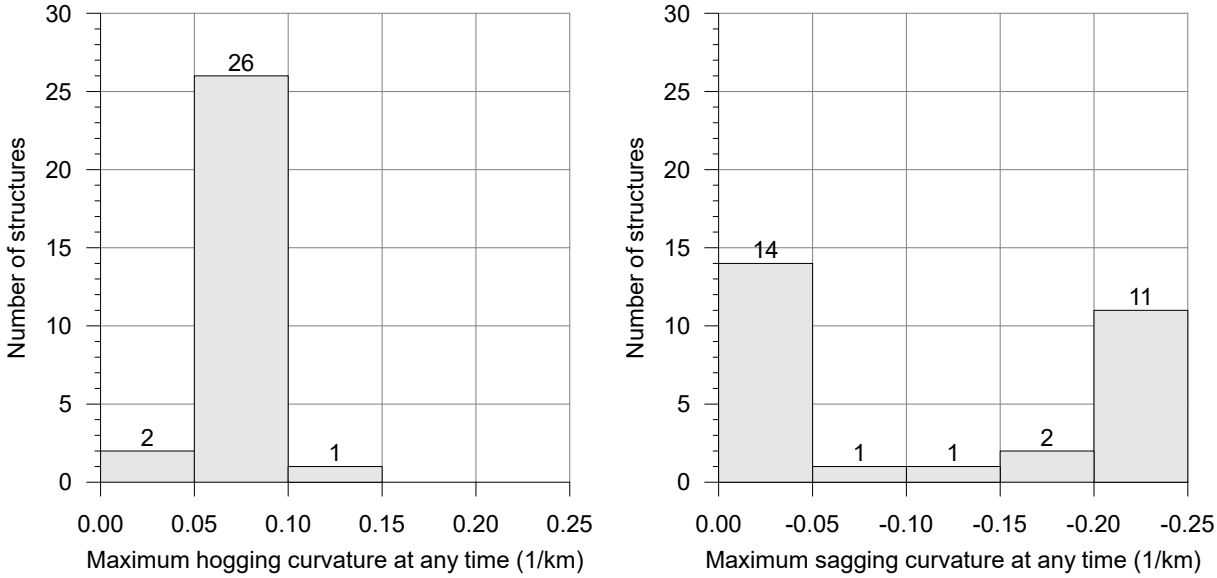



**Fig. 3.56 Maximum predicted total conventional hogging curvature (left) and sagging curvature (right) for the commercial structures after extraction of LWs S1A to S7A**

As expected, these distributions are almost identical for the maximum predicted incremental and total conventional hogging curvatures. The distributions are in fact identical for the maximum predicted incremental and total conventional sagging curvatures.

The maximum predicted conventional strains for the commercial and business establishments, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1.8 mm/m tensile and 3.3 mm/m compressive. Non-conventional movements can also occur as a result of, among other things, anomalous movements. The analysis of strains provided in Section 2.5 includes those resulting from both conventional and non-conventional anomalous movements.

The structures are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 2.5. The results for survey bays located above goaf are provided in Fig. 2.6 and the results for survey bays located above solid coal are provided in Fig. 2.8.

Tahmoor Coal has previously developed and acted in accordance with risk management plans to successfully manage potential impacts to industrial, commercial and business establishments during the mining of LWs 22 to 32, including a turkey processing plant, a large shopping centre, horticultural businesses, industrial and commercial establishments and a variety of shops.

Each business is unique in terms of the structures on the property and the activities that are conducted on each property. For this reason, Tahmoor Coal has committed to developing individual subsidence management plans in consultation with the owners of each business that are predicted to experience more than 20 mm of subsidence due to the extraction of LWs S5A and S6A under the *Approved Layout*. The subsidence management plans will be extended to include the extraction of the proposed LW S7A.

The management strategy for each business would include:

- Consultation with the owner of each business
- Pre-mining hazard identification inspection of each structure by structural engineer
- Identification and assessment of potential impacts to the operation of each business and safety of workers and the general public
- Consideration of mitigation measures to reduce risk prior to the commencement of subsidence movements
- Consideration of appropriate monitoring measures
- Consideration of appropriate triggered responses during mining
- Development of an agreed detailed subsidence management plan between Tahmoor Coal and the owners of each business

Each management plan would be reviewed periodically by Tahmoor Coal and the owners of each business. With an appropriate management plan in place, it is considered that commercial and business establishments can be maintained at all times due to the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

## 3.15. Swimming pools

The locations of the swimming pools (Structure Type P) within the Study Area are shown in Drawing No. MSEC1348-11. There are 13 swimming pools have been identified within the Study Area, of which 3 are located directly above LW S7A. A further 8 pools are located directly above longwalls S1A to S6A under the *Approved Layout*. Two pools will not be directly mined beneath by the planned longwalls. The locations and sizes of the pools were determined from orthophotographs of the area.

All of the swimming pools located within the current Study Area were predicted to experience some subsidence movements due to extraction of LWs S1A to S6A under the *Approved Layout*.

One above-ground pool previously identified above the proposed LW S7A has been removed since the structures were previously identified in Report No. MSEC1192 (BYR_055-p01).

### 3.15.1. Predictions for the swimming pools

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and at points located around the perimeter of each pool, as well as at points located at a distance of 20 metres from the perimeter of each pool.

A summary of the maximum predicted values of incremental conventional subsidence, tilt and curvature for each swimming pool within the Study Area due to extraction of LW S7A is provided in Table C.06, in Appendix C. A summary of the maximum predicted values of total conventional subsidence, tilt and curvature for each swimming pool within the Study Area after extraction of LWs S1A to S7A is also provided in Table C.06. The predicted tilts provided in this table are the maxima in any direction after the completion of each longwall. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each longwall.

Distributions of the maximum predicted incremental conventional subsidence and tilt for the swimming pools due to extraction of LW S7A are illustrated in Fig. 3.57, while Fig. 3.58 shows the corresponding distributions of maximum predicted total conventional subsidence and final tilt after extraction of LWs S1A to S7A under the *Modified Layout*.

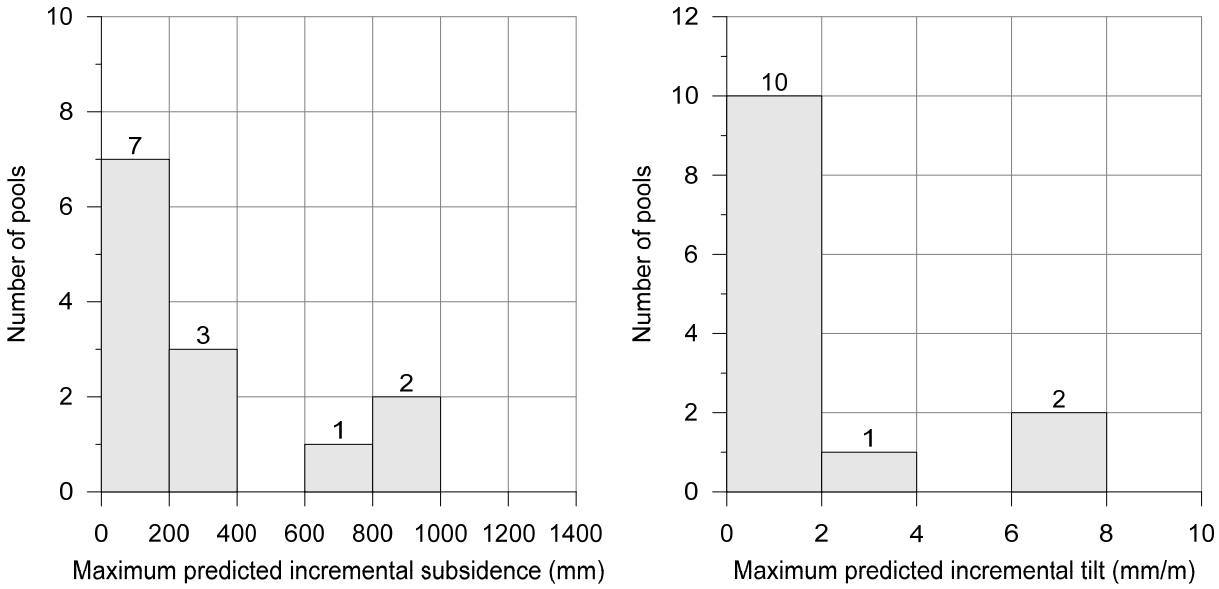



**Fig. 3.57 Maximum predicted incremental conventional subsidence and tilt for the swimming pools within the Study Area due to extraction of LW S7A**

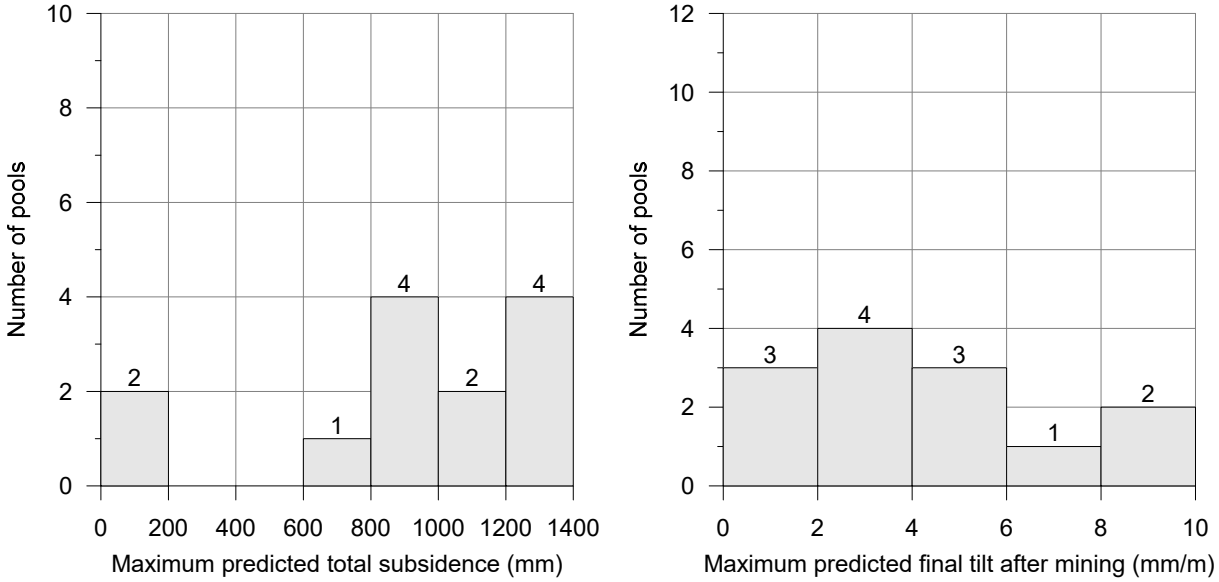



**Fig. 3.58 Maximum predicted total conventional subsidence and tilt for the swimming pools within the Study Area after extraction of LWs S1A to S7A**

These distributions indicate that for most swimming pools in the Study Area (10 out of 13 pools, or 77% of the total), the maximum predicted incremental subsidence due to LW S7A is a relatively small proportion of the maximum predicted total subsidence after extraction of LWs S1A to S7A. Similarly, the maximum predicted incremental tilt due to LW S7A is relatively small (< 2 mm/m) for most swimming pools in the Study Area (10 out of 13 pools, or 77% of the total).

Distributions of the maximum predicted incremental conventional hogging and sagging curvatures for the swimming pools due to extraction of LW S7A are illustrated in Fig. 3.59, while Fig. 3.60 shows the corresponding distributions of maximum predicted total conventional hogging and sagging curvatures after extraction of LWs S1A to S7A under the *Modified Layout*.

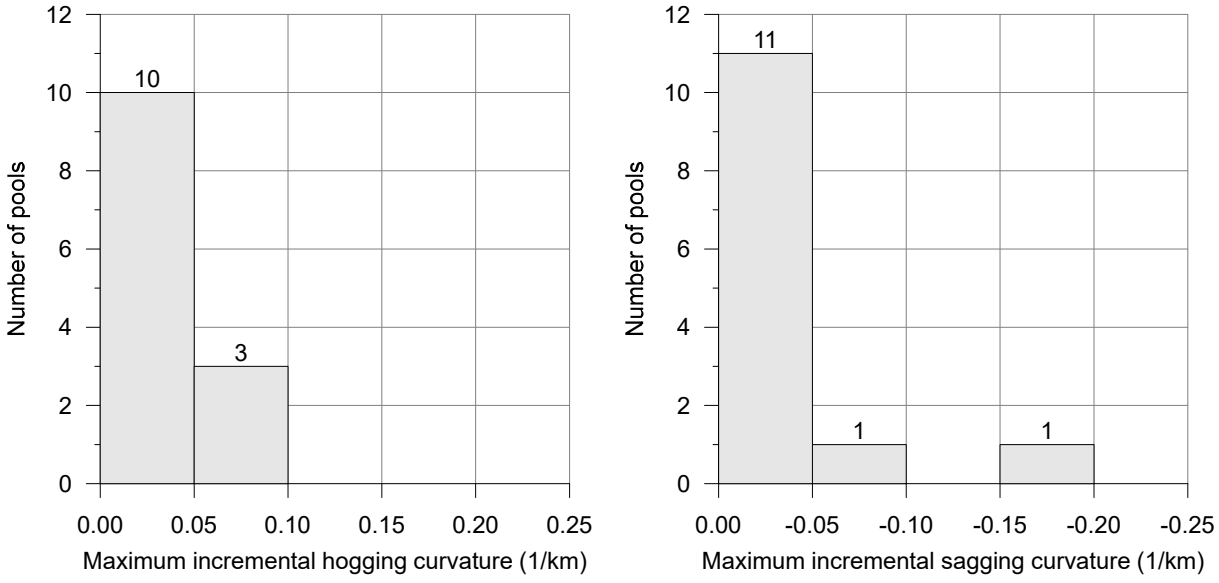



**Fig. 3.59 Maximum predicted incremental conventional hogging curvature (left) and sagging curvature (right) for the swimming pools within the Study Area due to extraction of LW S7A**

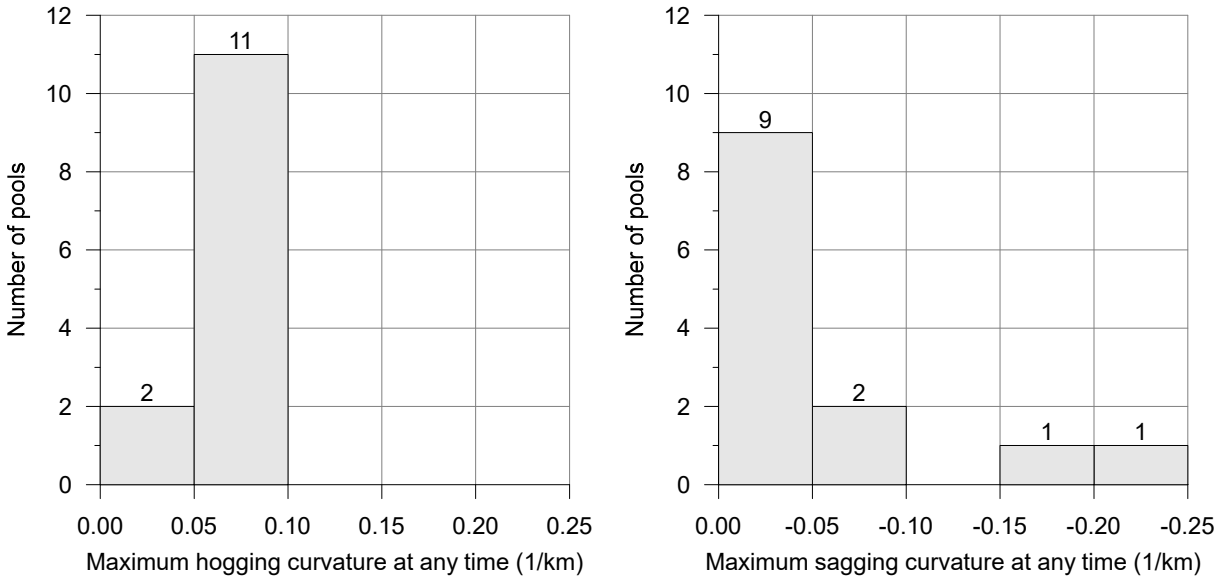



**Fig. 3.60 Maximum predicted total conventional hogging curvature (left) and sagging curvature (right) for the swimming pools after extraction of LWs S1A to S7A**

These distributions show that for most swimming pools in the Study Area, the maximum predicted incremental hogging curvature due to LW S7A is relatively small (< 0.05 $km^{-1}$ for 10 out of 13 pools, or 77% of the total), and the maximum predicted incremental sagging curvature due to LW S7A is also relatively small (< 0.05 $km^{-1}$ for 11 out of 13 pools, or 85 %).

The maximum predicted conventional strains for the pools, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1.4 mm/m tensile and 3.5 mm/m compressive. Non-conventional movements can also occur as a result of, among other things, anomalous movements. The analysis of strains provided in Section 2.5 includes those resulting from both conventional and non-conventional anomalous movements.

The pools are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 2.5. The results for survey bays located above goaf are provided in Fig. 2.6 and the results for survey bays located above solid coal are provided in Fig. 2.8.

### 3.15.2. Impact assessments for the swimming pools

Mining-induced tilts are more noticeable in pools than other structures due to the presence of the water line and the small gap to the edge coping, particularly when the pool lining has been tiled. Skimmer boxes are also susceptible of being lifted above the water line due to mining tilt.

The Australian Standard AS2783-1992 (Use of reinforced concrete for small swimming pools) requires that pools be constructed level ± 15 mm from one end to the other. This represents a tilt of approximately 3 mm/m for pools that are 10 metres in length. Australian Standard AS/NZS 1839:1994 (Swimming pools – Pre-moulded fibre-reinforced plastics – Installation) also requires that pools be constructed with a tilt of 3 mm/m or less.

There are 3 pools within the *Study Area* (i.e. 23 % of the total) which are predicted to experience final tilts of 3 mm/m or less, at the completion of the proposed longwalls, which is similar to or less than the Australian Standard.

There are 7 pools (i.e. 54 % of the total) predicted to experience final tilts between 3 mm/m and 7 mm/m and 3 pools (i.e. 23 % of the total) predicted to experience final tilts greater than 7 mm/m. The maximum predicted final tilt for the pools is 8.5 mm/m (i.e. 0.85 %), which represents a change in grade of 1 in 118. It is likely that a number of these pools would require some remediation of the pool copings.

The maximum predicted conventional curvatures for the pools are 0.09 $km^{-1}$ hogging and 0.23 $km^{-1}$ sagging, which equate to minimum radii of curvature of 10.8 kilometres and 4.3 kilometres, respectively. Whilst the predicted subsidence parameters for the proposed longwalls are greater than those at Tahmoor North, it would still be expected that the rates of impact on pools at Tahmoor North would provide a reasonable guide to the likely levels of impact.

Observations during the mining of Tahmoor Mine LWs 22 to 32 have shown that pools, particularly in-ground pools, are more susceptible to severe impacts than houses and other structures. Pools cannot be easily repaired and most of the impacted pools need to be replaced.

As of June 2017, a total of 157 pools have experienced mine subsidence movements during the mining of Tahmoor Mine Longwalls 22 to 30, of which 141 were located directly above the extracted longwalls. A total of 36 pools have reported impacts, all of which were located directly above the extracted longwalls. This represents an impact rate of approximately 23 %. A higher proportion of impacts have been observed for in-ground pools, particularly fibreglass pools. The majority of the impacts related to tilt or cracking, though in a small number of cases the impacts were limited to damage to skimmer boxes or the edge coping.

It is expected that the rate of impact on the pools within the Study Area would be similar, but, slightly greater than those previously experienced at Tahmoor North. Impacts to the pools would be repaired or, if required the pool would be replaced in accordance with the *Coal Mine Subsidence Compensation Act 2017*.

### 3.15.3. Impact assessments for the swimming pools based on increased predictions

If the actual tilts exceeded those predicted by a factor of 2 times, the final tilts would be 3 mm/m or less at 2 pools within the Study Area (i.e. 15 % of the total) at the completion of mining. In this case, there would be 3 pools (i.e. 23 % of the total) predicted to experience final tilts between 3 mm/m and 7 mm/m and 8 pools (i.e. 62 % of the total) predicted to experience final tilts greater than 7 mm/m. It is possible that most of the pools within the Study Area would require some remediation of the coping due to the mining induced tilt, if the actual tilts exceeded those predicted by a factor of 2 times.

If the actual curvatures exceeded those predicted by a factor of 2 times, the incidence of impacts would increase for the pools located directly above the proposed longwalls. While the predicted ground movements are important parameters when assessing the potential impacts on the pools, it is noted that the impact assessments were primarily based on observed rate of impact from Tahmoor North. The overall levels of impact on the pools, resulting from the extraction of the proposed longwalls, are expected to be similar to, but, slightly greater than those observed at Tahmoor North.

### 3.15.4. Management of potential impacts on the swimming pools

Tahmoor Coal has developed a Subsidence Management Plan to manage potential impacts to swimming pools during the mining of LWs S1A to S6A under the *Approved Layout*. This includes a pre-mining inspection of pools, pool fences and gates and measurement of levels around the pools.

While not strictly related to the pool structure, a number of pool gates have been impacted as the result of the previous extraction of longwalls beneath pools. While the gates can be easily repaired, the worst-case consequence of breaching pool fence integrity could be severe. As a result, Tahmoor Coal inspects the integrity of pool fences once a week for pools that are experiencing active subsidence during mining.

The Subsidence Management Plan will be updated to include potential impacts due to the extraction of LW S7A under the *Modified Layout*.

With an appropriate management plan in place, it is considered that pools and pool fences can be maintained at all times due to the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non- conventional movements occurred.

## 3.16. Houses

### 3.16.1. Descriptions of the houses

There are 62 houses that have been identified within the Study Area under the *Modified Layout.* Of these, 49 houses are located directly above the proposed longwalls. The locations of the houses are shown in Drawing No. MSEC1348-11 and details are provided in Tables C.02 and C.03, in Appendix C.

The locations, sizes, and construction details of the houses were determined from orthophotographs of the area in 2017, 2021 and 2023, kerbside inspections in 2013 and *Google Street View*® in February 2021. In some cases, the houses were inspected at the request or consent of the landowners.

Given the medium-term nature of the proposed mining activity, it is likely that there will be a growth and renewal of houses over time. It is likely the total number of houses affected by the extraction of the proposed longwalls will be greater than currently identified. Two houses within the Study Area had been extended since the structures were previously identified in Report No. MSEC1192.

The following provides further discussions on the details of the houses within the Study Area.

*Locations*

Under the *Approved Layout* there were 65 houses located directly above the proposed LWs S1A to S6A, as shown in Table 3.26. An additional 11 houses are located directly above the proposed S7A under the *Modified Layout*. All of the houses located directly above the proposed LW S7A were already predicted to experience some subsidence movements due to extraction of LWs S1A to S6A under the *Approved Layout.*

**Table 3.26 Number of houses located directly above each longwall**

| Layout | Longwall | Number of houses directly above each proposed longwall |
|---|---|---|
| *Approved Layout* LWs S1A to S6A | LW S1A | 0 |
| | LW S2A | 1 |
| | LW S3A | 13 |
| | LW S4A | 20 |
| | LW S5A | 20 |
| | LW S6A | 11 |
| | **Total (LWs S1A to S6A)** | **65** |
| *Modified Layout* LWs S1A to S7A | LW S7A | 11 |
| | **Total (LWs S1A to S7A)** | **76** |

*Maximum plan dimension, plan area and height*

Distributions of the maximum plan dimensions and plan areas of the houses within the Study Area are provided in Fig. 3.61. The majority of the houses are between 10 metres and 30 metres in length, with an average of 21 metres. The majority of the houses have plan areas between 100 $m^2$ and 300 $m^2$, with an average of 240 $m^2$. These distributions of houses by maximum plan dimension and plan area are similar to the distributions of houses by plan dimension and plan area under the *Approved Layout*.

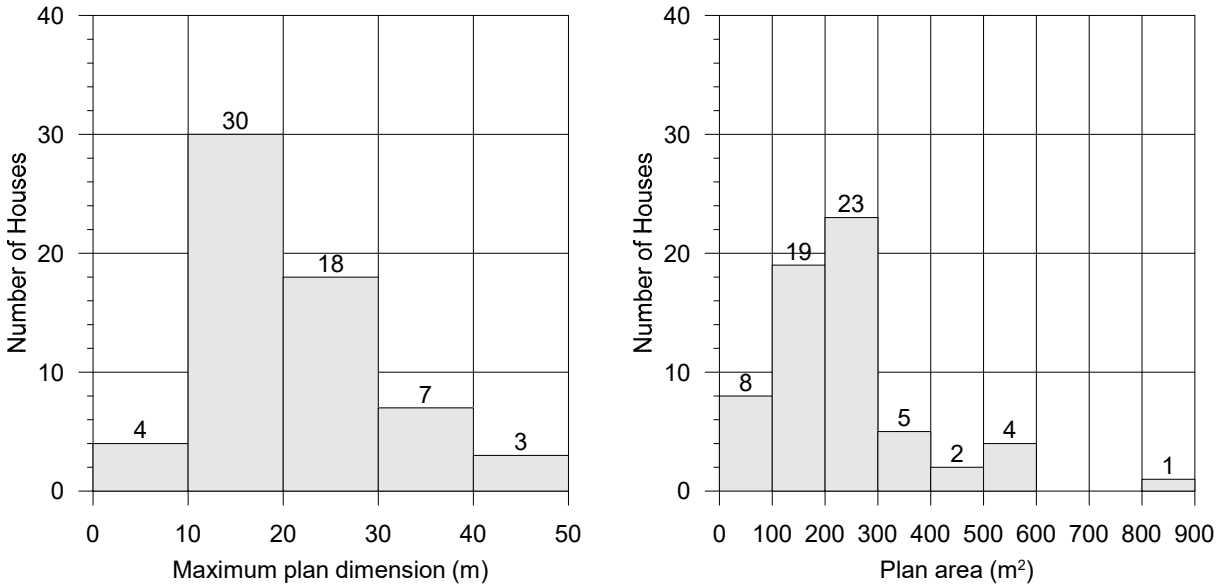



**Fig. 3.61 Distribution of houses by maximum plan dimension and plan area**

The houses have been categorised into four groups, on the basis of their maximum plan dimension and the number of stories. A summary of these house type categories is provided in Table 3.27 below. It is noted that two-storey houses include split-level houses.

**Table 3.27 House type categories**

| House type | Description | Number | Percentage |
|---|---|---|---|
| H1 | Single-storey with maximum plan dimension less than 30 metres | 49 | 79 % |
| H2 | Single-storey with maximum plan dimension of 30 metres or greater | 9 | 15 % |
| H3 | Two-storey with maximum plan dimension less than 30 metres | 3 | 4.5 % |
| H4 | Two-storey with maximum plan dimension of 30 metres or greater | 1 | 1.5 % |

It can be seen from the above table that the majority of houses within the Study Area are single-storey with a maximum plan dimension less than 30 metres (i.e. Type H1). There is one two-storey house with a maximum plan dimension greater than 30 metres (i.e. Type H4), which is located on Wellers Road and not directly above the proposed LWs S1A to S7A.

*Type of construction*

Distributions of the wall and footing construction of the houses within the Study Area are provided in Fig. 3.62. The most common construction method among the houses within the Study Area is brick or brick-veneer (38 houses, or approximately 60 %), followed by weatherboard (20 houses or approximately 32 %). Half of the houses within the Study Area are supported by slab on ground, while 17 of the remaining houses (27 %) have either brick piers or strip footings. The footing type for the remaining houses could not be determined at this point in time from street survey.

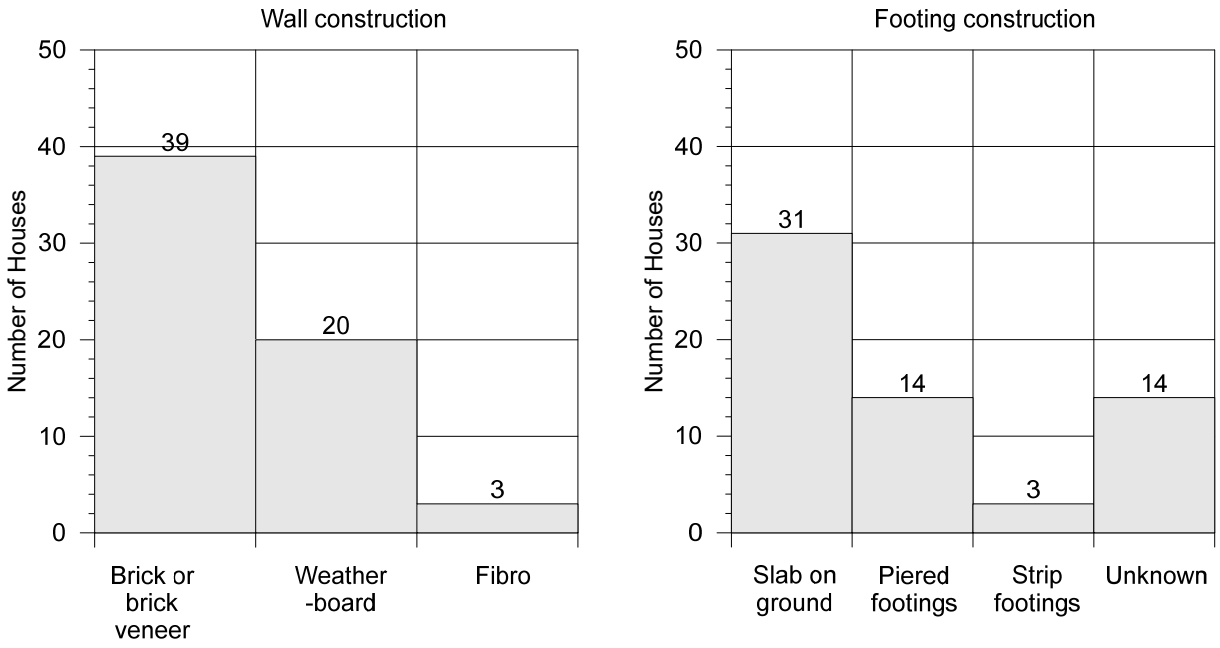



**Fig. 3.62 Distributions of wall and footing construction for houses within the Study Area**

Following a review of impacts to houses during the mining of Tahmoor Mine Longwalls 22 to 25, it was found that there was a noticeable difference in structural performance in response to mine subsidence movements between the following construction types:-

- Brick or brick-veneer houses constructed on a ground slab;
- Brick or brick-veneer houses constructed on strip footings or piers; and
- Weatherboard or fibro houses constructed on either ground slabs, strip footings or piers.

The distribution of houses construction type within the Study Area is provided in Table 3.28.

**Table 3.28 Distribution of houses by construction type**

| Description | Number of houses | Percentage of houses |
|---|---|---|
| Brick or brick-veneer houses constructed on a ground slab | 28 | 45% |
| Brick or brick-veneer houses constructed on strip footings or piers or foundation type is currently unknown | 11 | 18 % |
| Weatherboard or fibro houses constructed on ground slabs, strip footings, piers | 23 | 37 % |

A map showing the spatial distribution of structures by construction type is provided in Fig. 3.63.

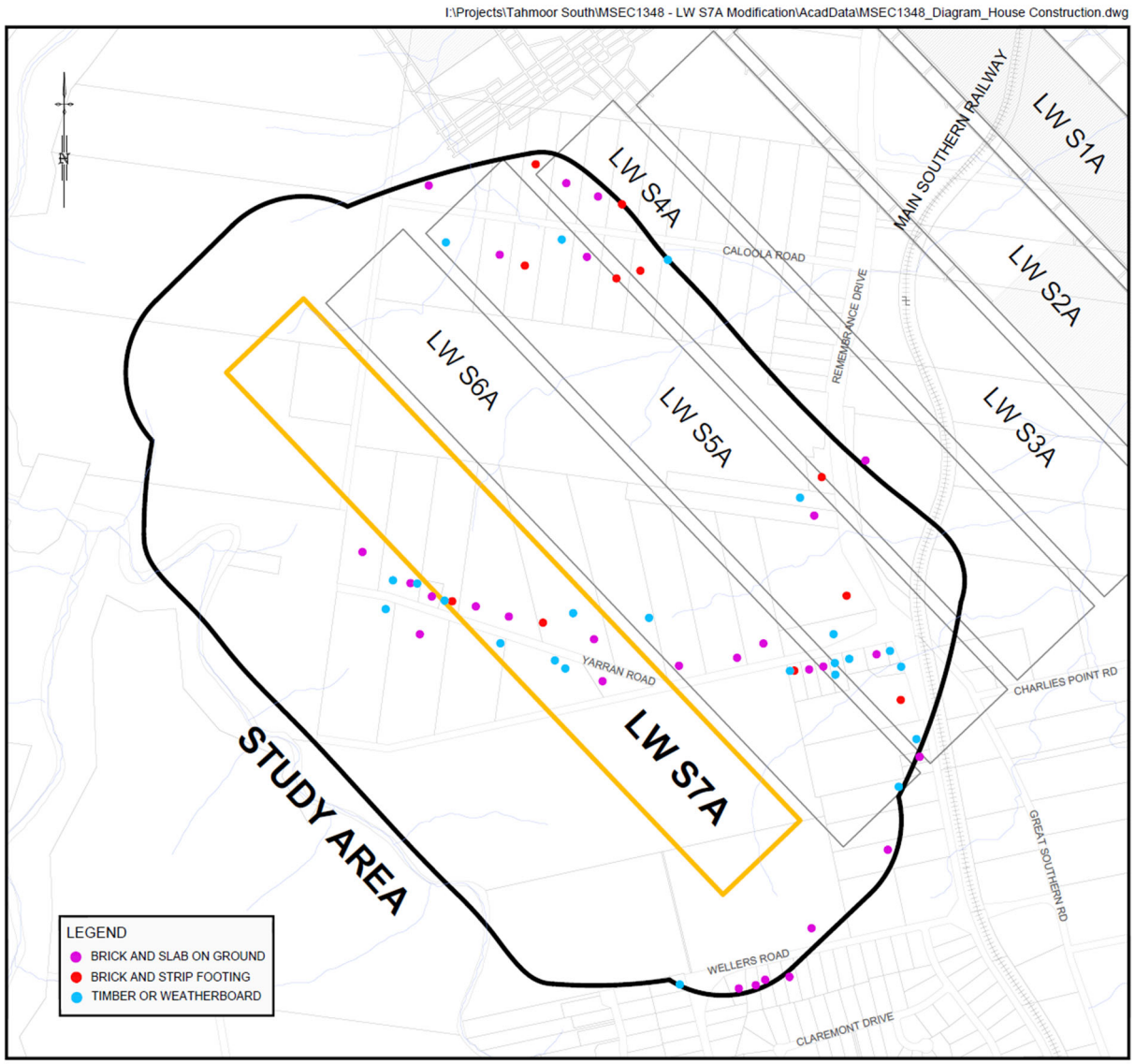



**Fig. 3.63 Location of houses by construction type**

The information on construction types has been undertaken using *Google Street View*® images and front of house inspections. It is possible that some houses will be renovated or rebuilt before the proposed longwalls are extracted.

As discussed in Section 3.16.3, construction type is an input parameter to the probabilistic method of assessment of impacts.

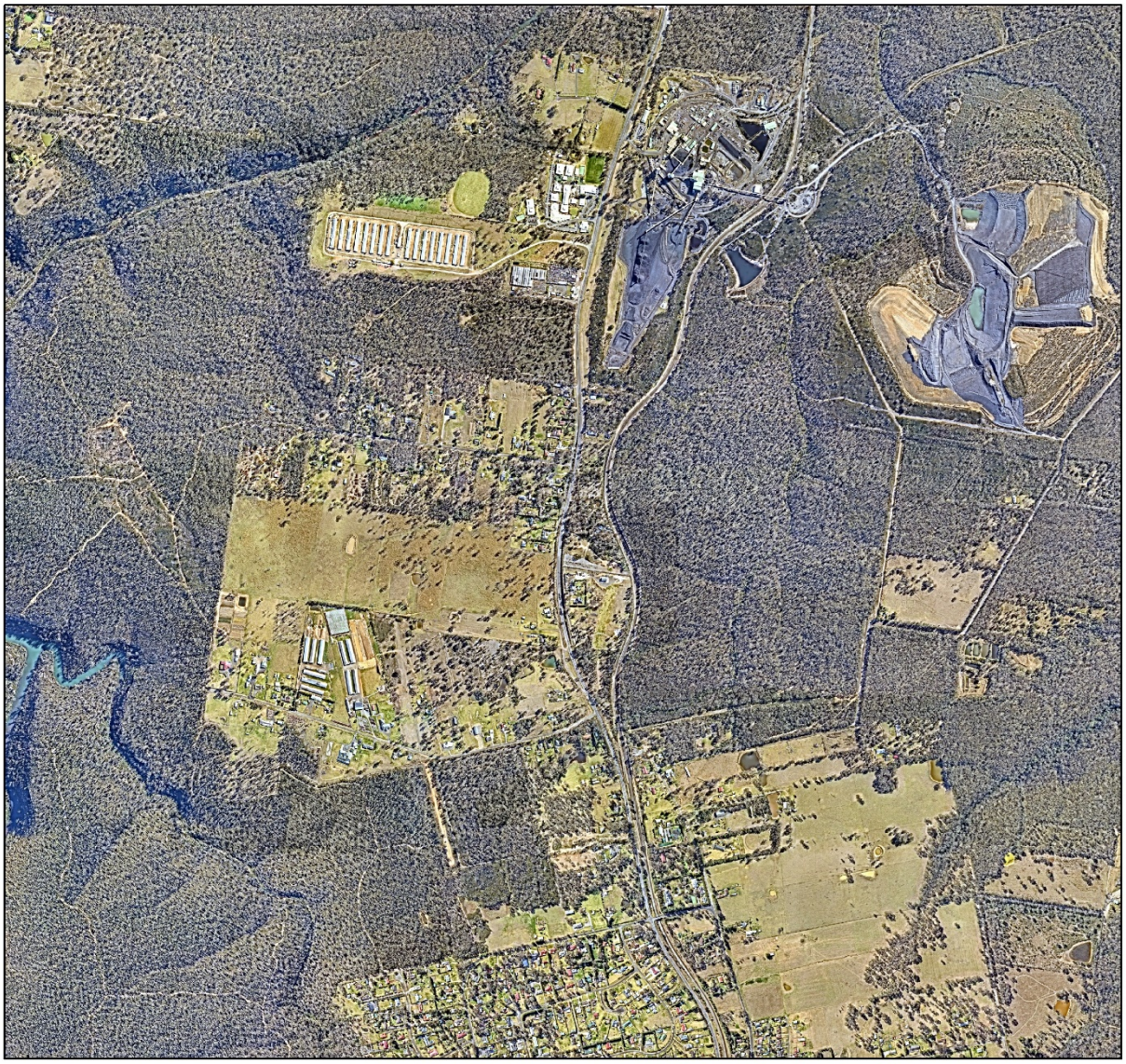
*Age of houses*

The Bargo area has expanded from a rural township to an urban village, as demonstrated by the following two images. An aerial photograph taken in 1975 is shown in Fig. 3.64. The most recent available aerial photograph in 2021 is shown in Fig. 3.65 for comparison. A large proportion of the houses in the Study Area (65 %) have been built since the Bargo Mine Subsidence District was declared in 1975.

House age has been determined by examination of a series of historical aerial photographs provided by Land and Property Information. The photographs that were available over the Study Area were taken in 1963, 1975, 1984, 1994, 2002 and Tahmoor Mine commissioned orthophotographs over the Study Area in 2013. A Nearmap image taken in 2017 was used to identify houses with the Study Area at the time MSEC's report in support of the original EIS was submitted. A Nearmap image taken in 2021 was used to identify new houses with the Study Area at the time of preparing the Extraction Plan. A Nearmap images taken in 2023 was used to identify new houses with the Study Area at the time of preparing this report.

*Photograph courtesy Department of Lands (now Spatial Services NSW)*

**Fig. 3.64 Aerial photograph of Study Area in 1975 when Mine Subsidence District was declared**



*Photograph courtesy Nearmap*

**Fig. 3.65 Aerial photograph of Study Area in 2023**

A map showing the spatial distribution of houses by age is provided in Fig. 3.67 and it can be seen that the older houses (tan and magenta coloured marks) are located throughout the Study Area. A histogram showing the distribution of houses by age is shown in Fig. 3.66.

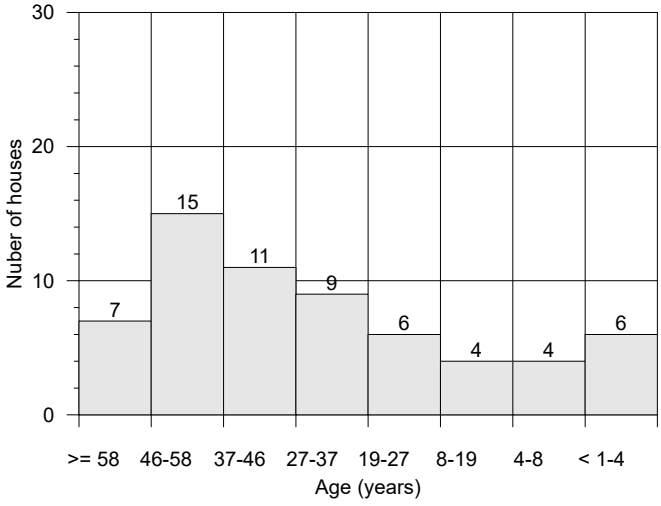



**Fig. 3.66 Distribution of Houses by Age as at 2023**

It can be seen from Fig. 3.66 that, as at 2021, a large proportion of houses were constructed between 27 and 58 years ago, that is between 1975 and 1994.

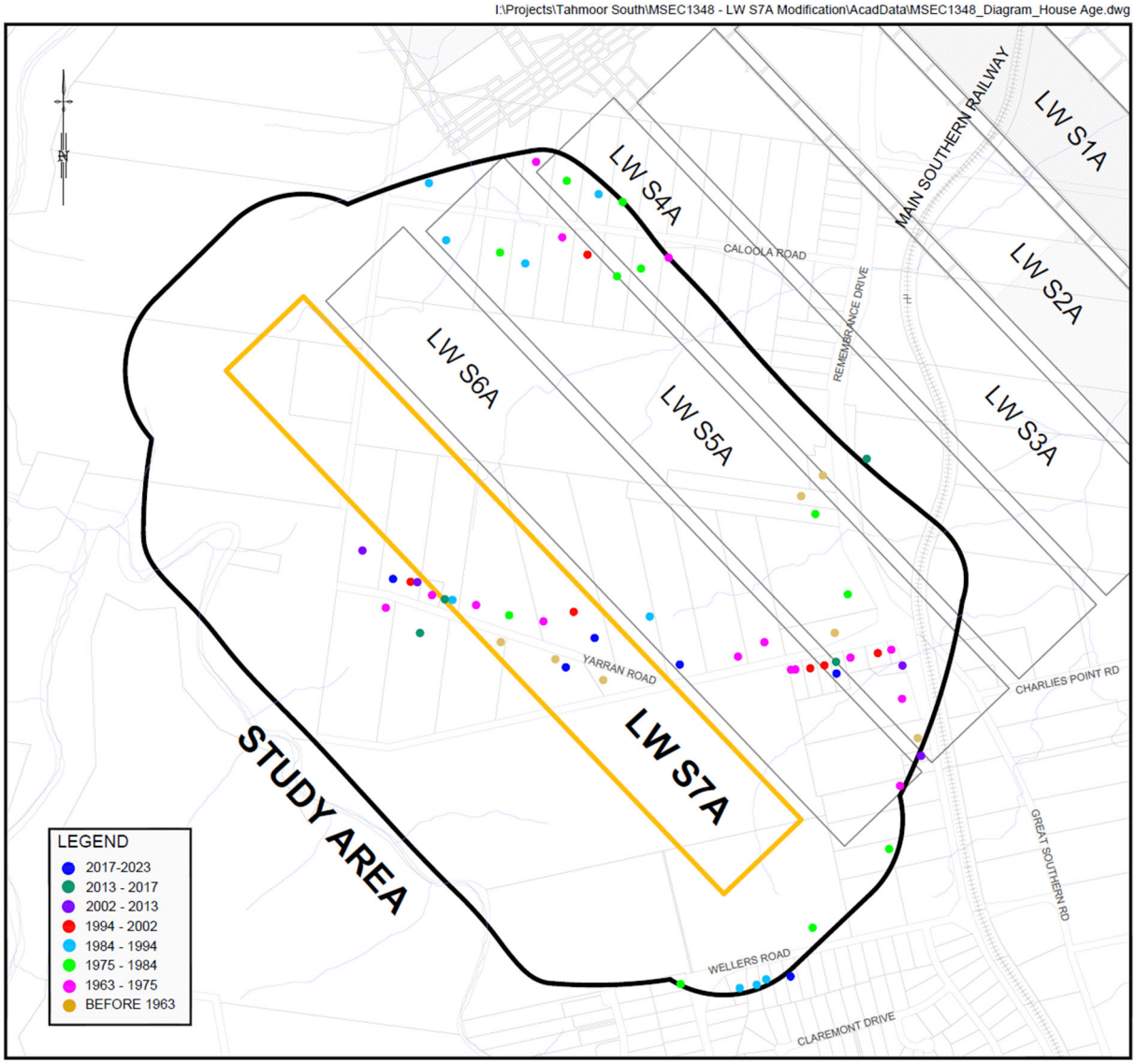



**Fig. 3.67 Location of houses by age**

### 3.16.2. Predictions for the houses

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and at the vertices of each house, as well as eight equally spaced points placed radially around the centroid and vertices at a distance of 20 metres. In the case of a rectangular shaped structure, predictions have been made at a minimum of 45 points within and around the structure.

A summary of the maximum predicted values of conventional subsidence, tilt and curvature for each house within the Study Area, resulting from the extraction of the proposed longwalls, is provided in Table C.03, in Appendix C. The predicted tilts provided in this table are the maxima in any direction after the completion of each longwall. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each longwall.

Distributions of the maximum predicted incremental conventional subsidence for the houses due to extraction of LW S7A are illustrated in Fig. 3.68, while Fig. 3.69 shows the corresponding distributions of maximum predicted total conventional subsidence after extraction of LWs S1A to S7A under the *Modified Layout*.

Distributions of the maximum predicted incremental conventional tilt for the houses due to extraction of LW S7A are illustrated in Fig. 3.70, while Fig. 3.71 shows the corresponding distributions of maximum predicted total conventional tilt during and after extraction of LWs S1A to S7A under the *Modified Layout*.

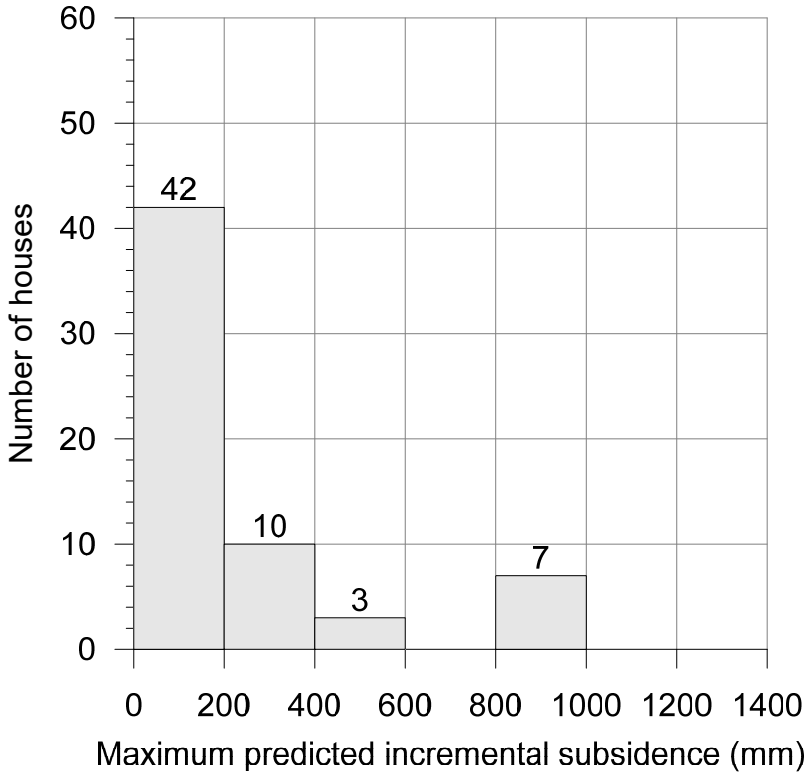



**Fig. 3.68 Maximum predicted incremental conventional subsidence for the houses within the Study Area due to extraction of LW S7A**

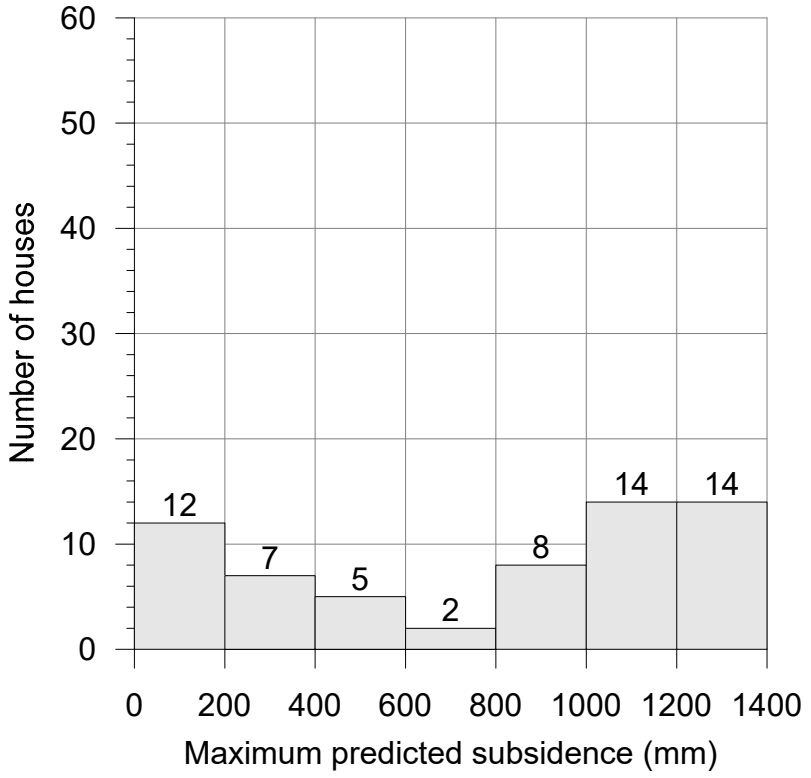



**Fig. 3.69 Maximum predicted total conventional subsidence for the houses within the Study Area after extraction of LWs S1A to S7A**

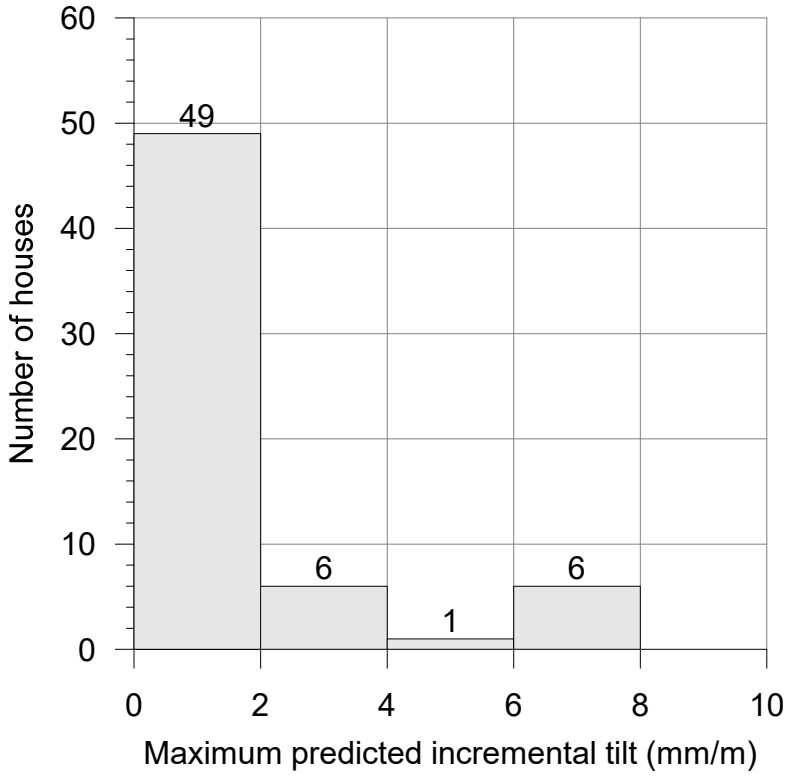



**Fig. 3.70 Maximum predicted incremental conventional tilts for the houses within the Study Area due to extraction of LW S7A**

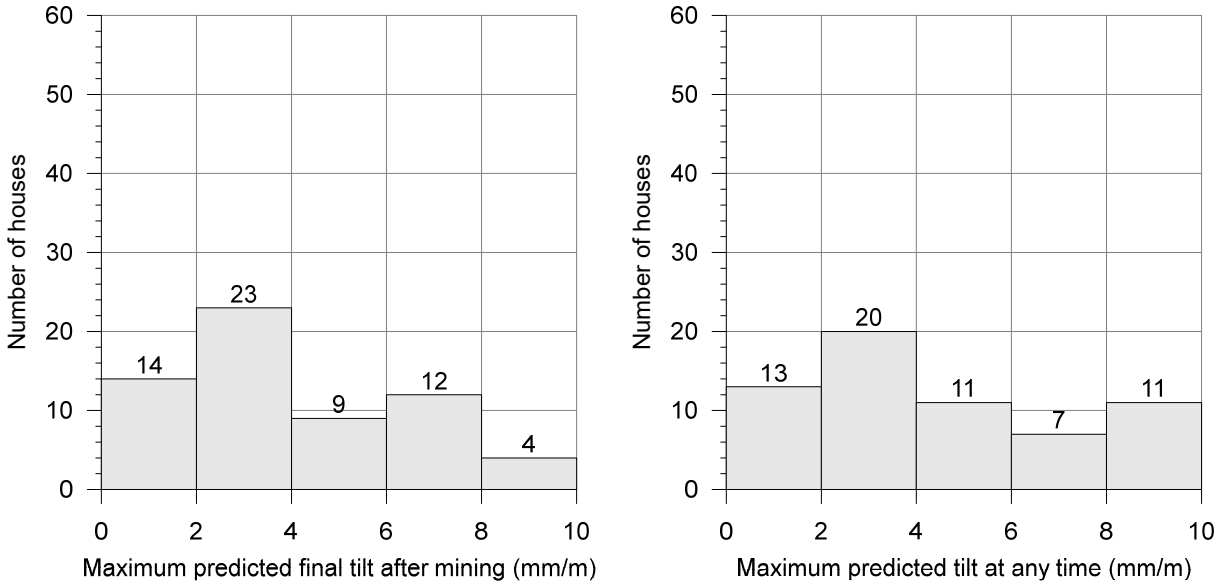



**Fig. 3.71 Maximum predicted conventional tilts after the extraction of longwalls S1A to S7A (left) and maximum predicted conventional tilts after extraction of any longwall (right)**

These distributions indicate that for most houses in the Study Area (52 out of 62 houses, or 84% of the total), the maximum predicted incremental subsidence due to LW S7A is a relatively small proportion of the maximum predicted total subsidence after extraction of LWs S1A to S7A. Similarly, the maximum predicted incremental tilt due to LW S7A is relatively small (< 2 mm/m) for most houses in the Study Area (49 out of 62 houses, or 79% of the total).

Distributions of the maximum predicted incremental conventional hogging and sagging curvatures for the houses due to extraction of LW S7A are illustrated in Fig. 3.72, while Fig. 3.73 shows the corresponding distributions of maximum predicted total conventional hogging and sagging curvatures after extraction of LWs S1A to S7A under the *Modified Layout*.

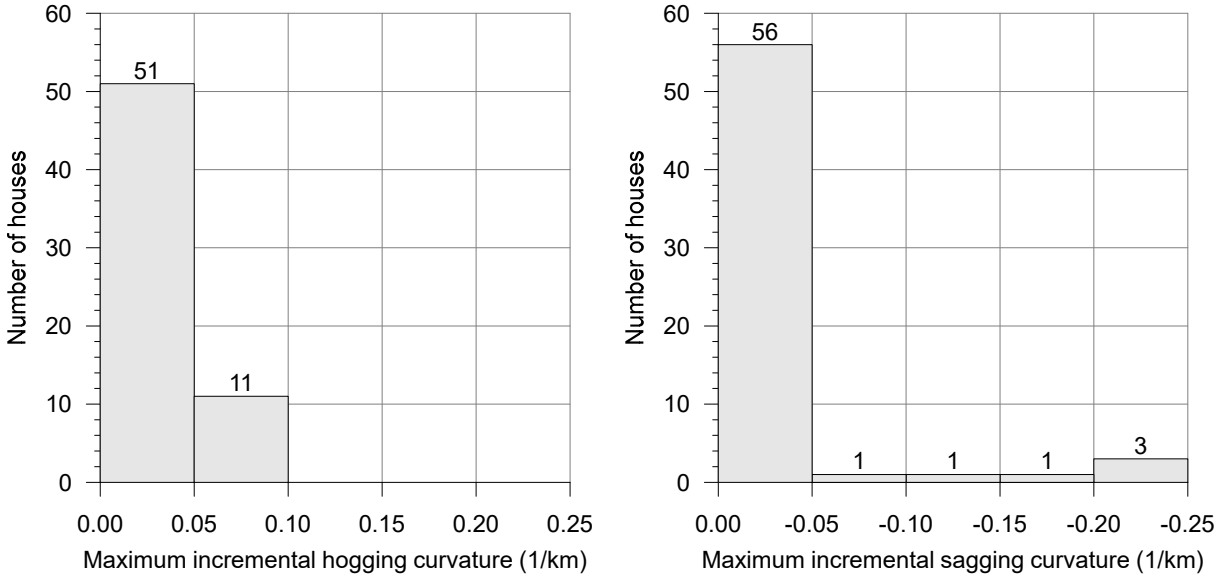



**Fig. 3.72 Maximum predicted incremental conventional hogging curvature (left) and sagging curvature (right) for the houses within the Study Area due to extraction of LW S7A**

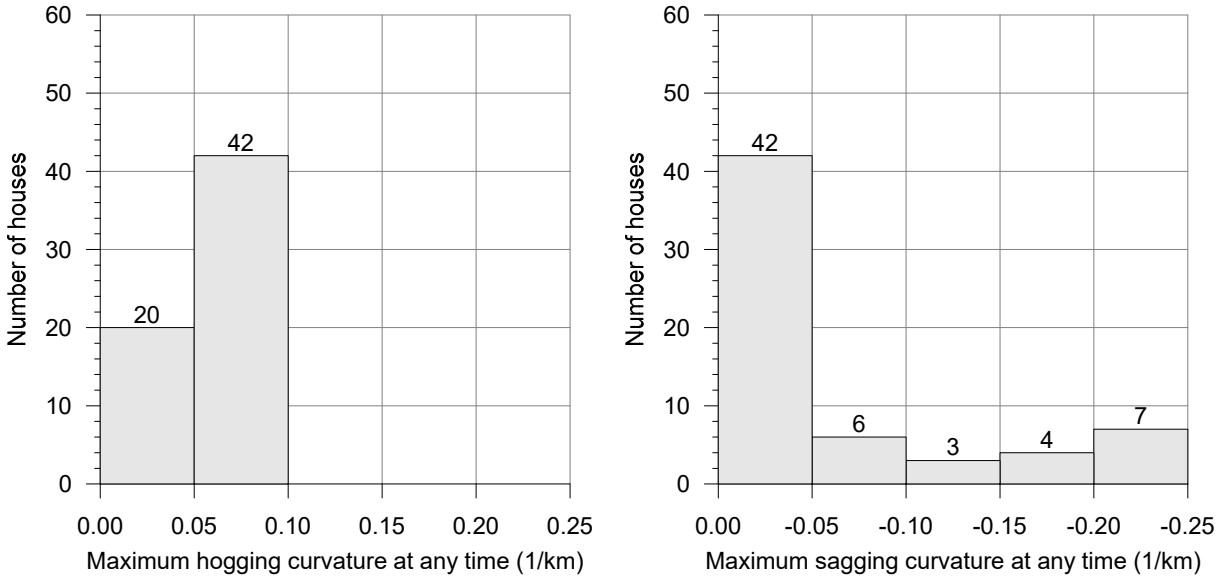



**Fig. 3.73 Maximum predicted conventional hogging curvature (left) and sagging curvature (right) for the houses within the Study Area after extraction of LWs S1A to S7A**

These distributions show that the maximum predicted incremental hogging curvature due to LW S7A is < 0.10 $km^{-1}$ for all of the houses in the Study Area, and the maximum predicted incremental sagging curvature due to LW S7A is < 0.05 $km^{-1}$ for 56 out of 62 tanks (or 84 %).

The maximum predicted conventional strains for the houses, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1.4 mm/m tensile and 3.5 mm/m compressive. Non-conventional movements can also occur as a result of, among other things, anomalous movements. The analysis of strains provided in Section 2.5 includes those resulting from both conventional and non-conventional anomalous movements.

The houses are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 2.5. The results for survey bays located above goaf are provided in Fig. 2.6 and the results for survey bays located above solid coal are provided in Fig. 2.8.

### 3.16.3. Impact assessments for the houses

The following sections provide the impact assessments for the houses within the Study Area.

*Potential impacts resulting from vertical subsidence*

Vertical subsidence does not directly affect the stability or serviceability of houses. The potential for impacts on houses is affected by differential subsidence, which includes tilt, curvature and strain, and the impact assessments based on these parameters are described in the following sections.

Vertical subsidence may affect the heights of some the houses above the flood level. The potential impacts on the houses resulting from the changes in flood level from the proposed mining has been assessed as part of the flood model, which is described in the Water Management Plan (Tahmoor Coal, 2023a).

*Potential impacts resulting from tilt*

It has been found from past longwall mining experience that tilts of less than 7 mm/m generally do not result in any substantial impacts on houses. Some minor serviceability impacts can occur at these levels of tilt, including door swings and issues with roof gutter and wet area drainage, all of which can be remediated using normal building maintenance techniques. Tilts greater than 7 mm/m can result in greater serviceability impacts which may require more substantial remediation measures, including the relevelling of wet areas or, in some cases, the relevelling of the building structure.

The predicted maximum tilts are less than 7 mm/m at 53 of the houses within the Study Area (i.e. 85 % of the total) at the completion of mining. It is expected that only minor serviceability impacts would occur at these houses, as the result of tilt, which could be remediated using normal building techniques.

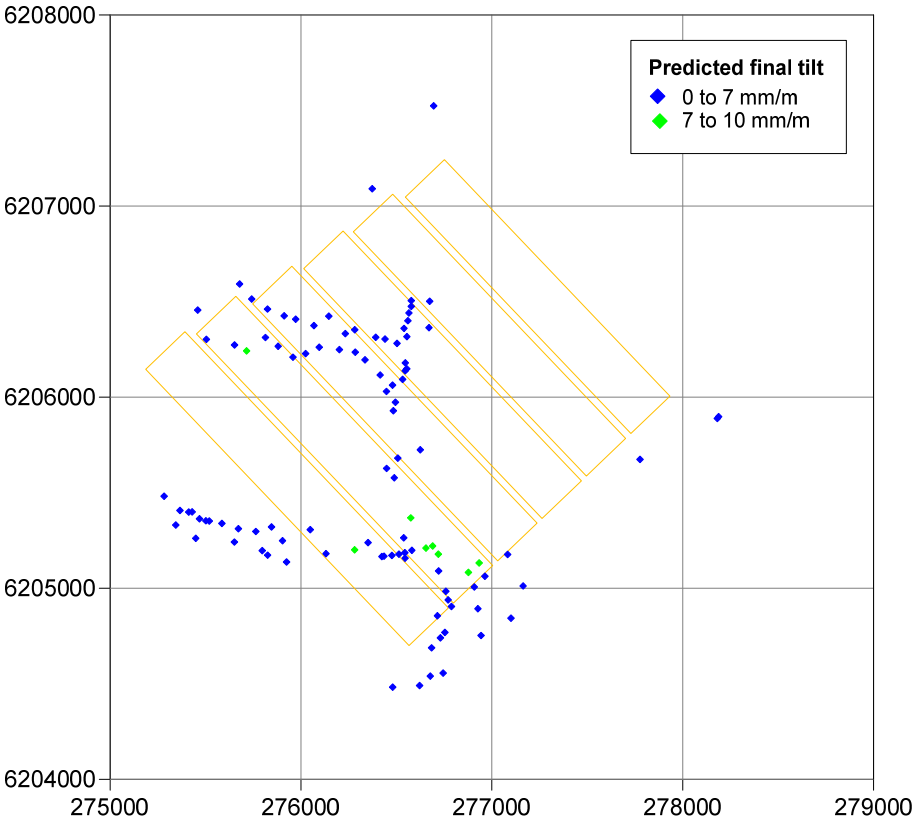
The maximum predicted tilt for the houses is 8.5 mm/m (i.e. 0.85 %, or 1 in 118). A total of 9 houses (i.e. 15 % of the total) are predicted to experience tilts greater than 7 mm/m. The potential for serviceability impacts is greater for these houses. In some cases, more substantial remediation measures may be required, such as relevelling of the building structure.

It should be noted that the effect of extracting LW S7A under the *Modified Layout* is predicted to result in a reduction of tilt for some houses when compared to be *Approved Layout*. This is because mining-induced tilts due to the extraction of LWs S1A to S6A is predicted to be reversed due to the extraction of LW S7A.

The distribution of predicted final tilts for the houses within the Study Area after the extraction of LW S6A is provided in Fig. 3.74 and LW S7A is provided in Fig. 3.75.

It can be seen that some houses that were predicted to experience more than 7 mm/m tilt after the extraction of LW S6A are predicted to experience a reduction in tilt after the extraction of LW S7A.

Houses located above previously extracted longwalls at Tahmoor have experienced mining-induced tilts within the predicted range for the *Amended Layout*. This includes tilts at magnitudes of 10 mm/m and greater, which were observed above Tahmoor Mine LW 24A and above the south-eastern ends of LWs 25 and 26, in the areas of increased subsidence. To date, there have been very few claims to SA NSW for impacts on houses as a result of mining induced tilt. Claims in these areas have mainly been based on impacts resulting from mining induced curvatures or strains.




*Note: the image is reproduced from Report No. MSEC1192*

**Fig. 3.74 Distribution of predicted final tilts for the houses at the completion of LW S6A**

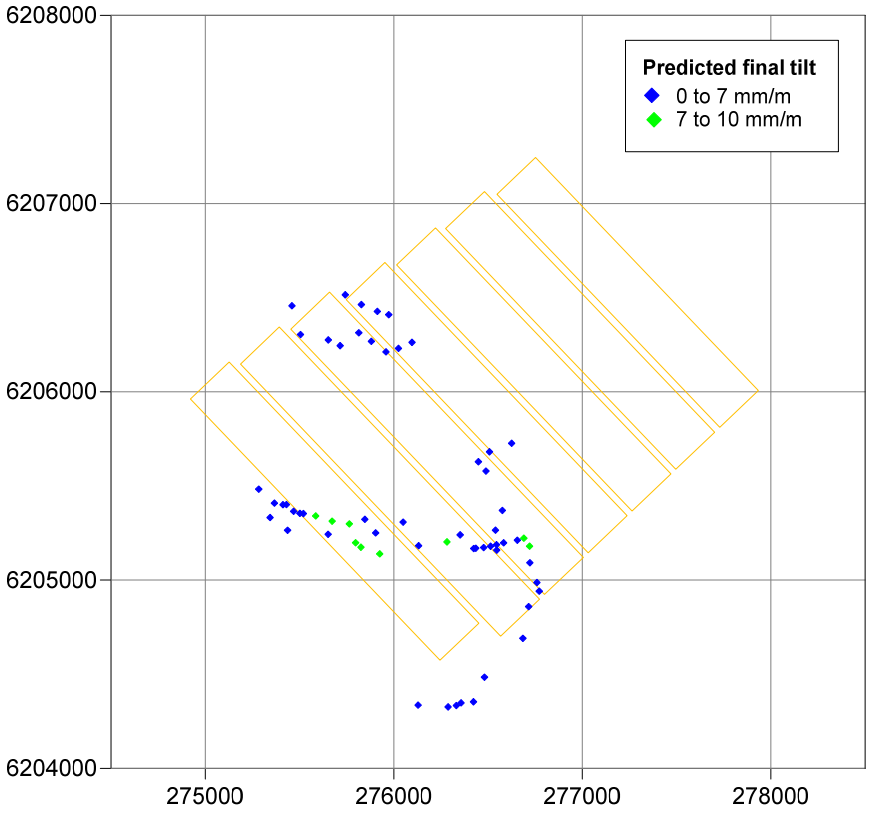



**Fig. 3.75 Distribution of predicted final tilts for the houses at the completion of LW S7A**

The distribution of measured tilts for the survey bays located in the area of increased subsidence above LWs 24B, 25 and 26, is provided in Fig. 3.76. A gamma function has also been fitted to the observed data which is shown by the blue curve.

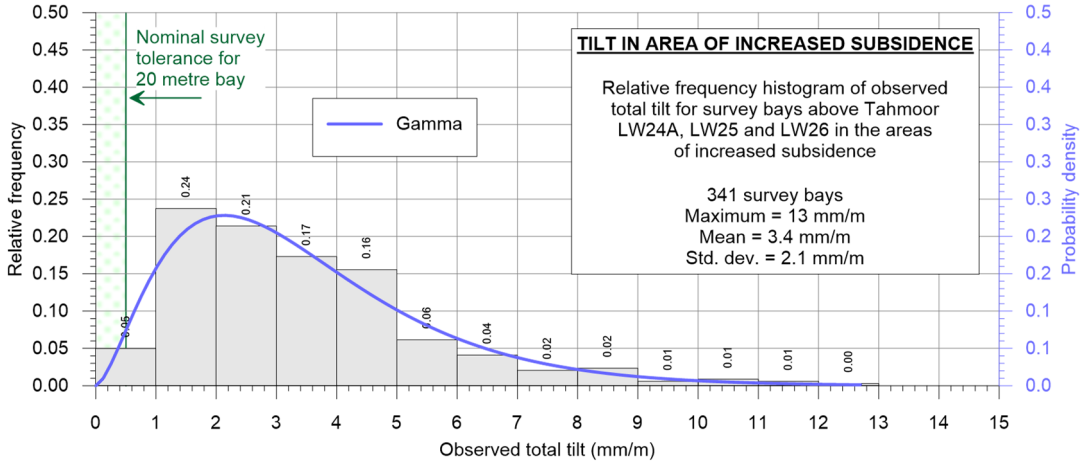



**Fig. 3.76 Distribution of measured tilts for survey bays located in the areas of increased subsidence above Tahmoor Mine longwalls 24A, 25 and 26**

It can be seen from the above figure, that the maximum observed total tilt for the survey bays in the areas of increased subsidence was 13 mm/m, which is greater than the maximum predicted tilt at the houses directly above the proposed longwalls, which is 9 mm/m.

The range of predicted tilts for the houses within the Study Area, therefore, is less than that observed above previously extracted longwalls at Tahmoor Mine, including LW 24A and above the south-eastern ends of LWs 25 and 26, in the areas of increased subsidence. It is expected that the incidence of claims for impacts resulting from the mining induced tilt would be low, due to the extraction of the proposed longwalls, as was previously experienced in the areas of increased subsidence.

It is expected that, in all cases, the houses within the Study Area will remain in safe and serviceable conditions as the result of the mining induced tilts as tilts by themselves rarely impact on the stability of building structures at the levels that are predicted to occur.

*Potential impacts resulting from curvature and strain*

It has been found from past longwall mining experience that the majority of mining-induced impacts on houses are a result of curvature and strain.

All 62 houses within the *Study Area* are predicted to experience hogging curvatures less than 0.10 $km^{-1}$ and 48 houses (i.e. 77 % of the total) are predicted to experience sagging curvatures less than 0.10 $km^{-1}$, which represent minimum radii of curvature of 10 kilometres.

The maximum predicted curvatures for the houses within the *Study Area* are 0.10 $km^{-1}$ hogging and 0.23 $km^{-1}$ sagging, which represent minimum radii of curvature of 10.5 kilometres and 4.3 kilometres, respectively.

The distribution of predicted curvatures for the houses within the Study Area is provided in Fig. 3.77.

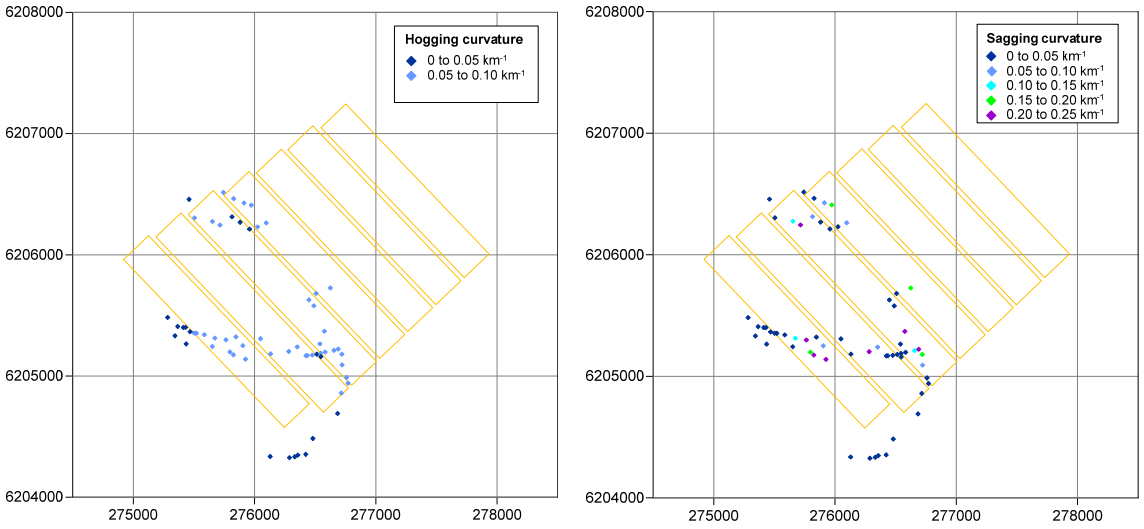



**Fig. 3.77 Distribution of predicted hogging curvatures (left) and sagging curvatures (right) for houses at the completion of mining**

The above figure shows that the greatest predicted curvatures occur directly above the proposed longwalls.

Houses located above previously extracted longwalls at Tahmoor have experienced mining-induced curvatures within the predicted range for the *Amended Layout*. This includes curvatures greater than 0.10 km$^{-1}$, which were observed above Tahmoor Mine LW 24A and above the south-eastern ends of LWs 25 and 26, in the areas of increased subsidence. The distributions of measured hogging and sagging curvatures for the survey bays located in the area of increased subsidence above LW 24A, LWs 25 and 26, is provided in Fig. 3.78. Generalised Pareto Distributions (GDPs) have also been fitted to the observed data which are shown by the blue curves.

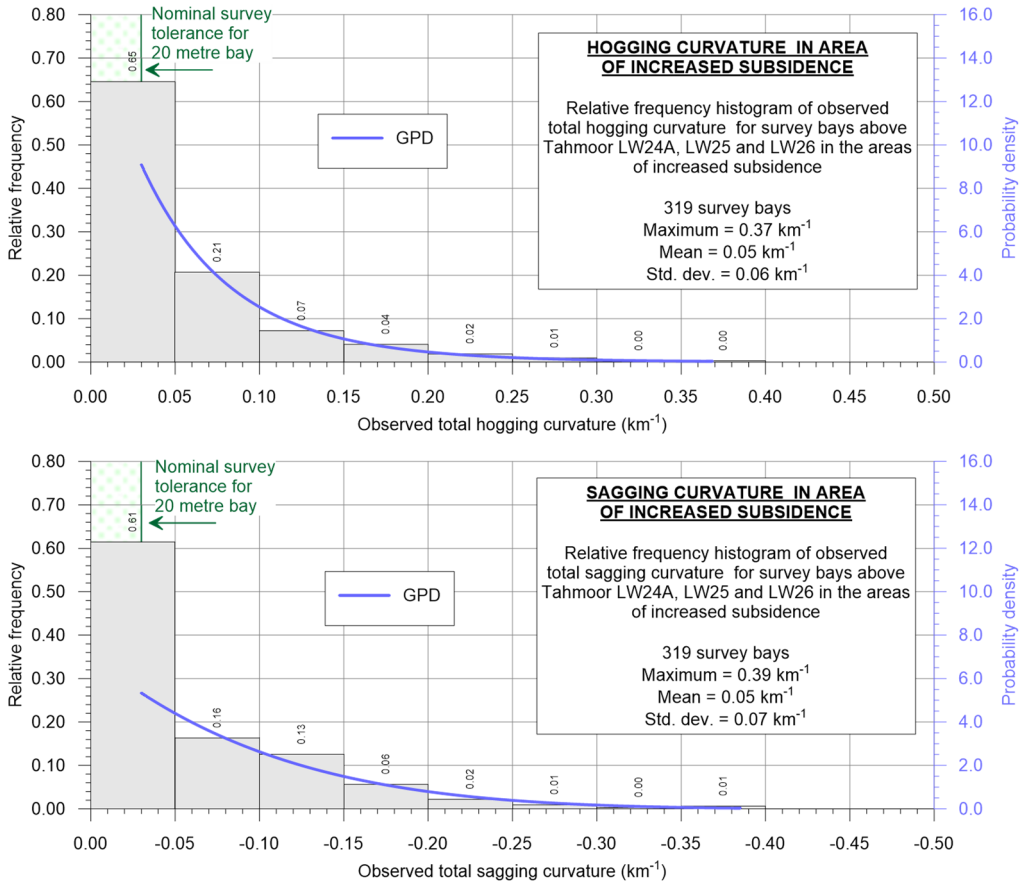



**Fig. 3.78 Distributions of measured curvatures for survey bays located in the areas of increased subsidence above Tahmoor Mine LWs 24A, 25 and 26**

It can be seen from the above figure, that the maximum observed total curvatures for the survey marks in the areas of increased subsidence were 0.37 $km^{-1}$ hogging and 0.39 $km^{-1}$ sagging, which are greater than the maximum predicted curvatures at the houses within the Study Area of 0.10 $km^{-1}$ hogging and 0.23 $km^{-1}$ sagging.

The range of predicted curvatures for the houses within the Study Area are, therefore, less than those observed above previously extracted longwalls at Tahmoor Mine, including LW 24A and above the eastern ends of LWs 25 and 26 in the areas of increased subsidence. It is expected, therefore, that the incidence of claims for impacts resulting from the mining induced curvature and strain for the proposed longwalls would be similar to but slightly less than those previously experienced in the areas of increased subsidence. The methods for predicting and assessing impacts on building structures have developed over time as knowledge and experience has grown. MSEC has provided predictions and impact assessments for the houses within the Study Area using the latest methods available at the time of writing.

Building structures have been directly mined beneath at a number of collieries throughout the NSW Coalfields. The experience gained has provided substantial information that has been used to continually develop the methods of impact assessment for houses. The assessments provided in this report are based on the latest research, which is summarised in Appendix C of Report No. MSEC1192.

Trend analyses were conducted following the mining of Tahmoor Mine LWs 22 to 29. The analyses indicated that the chance of impact is higher for the following houses:-

- Houses predicted to experience higher strains and curvatures,
- Houses with masonry walls,
- Masonry walled houses that are constructed on strip footings,
- Larger houses, and
- Houses with variable foundations, such as those with extensions added.

The probabilities of impacts for each house within the Study Area have been assessed using the method developed as part of ACARP Research Project C12015 (Waddington, 2009) and it has been updated based on observations of impacts at Tahmoor up to 2016 when the extraction of Longwall 29 was completed. This method uses the primary parameters of ground curvature and type of construction and is described in Appendix C of Report No. MSEC1192. The parameter of strain is indirectly used in this method due to its relationship with curvature. A summary of the predicted movements and the assessed impacts for each house within the Study Area is provided in Table C.03, in Appendix C.

The overall distribution of the assessed impacts for the houses within the Study Area is provided in Table 3.29. The assessed impacts have been determined based on the existing construction type of each house, as described in Section 3.16.1.

**Table 3.29 Assessed impacts for houses within the Study Area**

| Group | Repair category | | | |
|---|---|---|---|---|
| | No Claim or R0 | R1 or R2 | R3 or R4 | R5 |
| All houses (total of 62) | 41 (66 %) | 14 (23 %) | 6 (9 %) | 1 (1 %) |
| Directly above proposed longwalls (total of 49) | 30 (59 %) | 13 (26 %) | 5 (10 %) | 1 (2 %) |
| Directly above solid coal (total of 13) | 11 (83 %) | 2 (13 %) | 0 (4 %) | < 1 (< 0.5 %) |

In comparison, extensive data has come from the extraction of Tahmoor Mine Longwalls 22 to 29, where approximately 1,900 houses have experienced mine subsidence movements. A summary of the observed distribution of impacts for all houses within a 35° angle of draw of previously extracted Longwalls 22 to 29 as at 2016 is provided in Table 3.30.

**Table 3.30 Observed frequency of impacts for building structures resulting from the extraction of Tahmoor Mine longwalls 22 to 29**

| Group | Repair category | | | |
|---|---|---|---|---|
| | No Claim or R0 | R1 or R2 | R3 or R4 | R5 |
| All houses within 35 degree angle of draw of LWs 22 to 29 (total of 1890) | 1430 (76 %) | 329 (17 %) | 111 (6 %) | 20 (1 %) |
| All houses, located directly above LWs 24A to 27 in Zone of Increased Subsidence (total of 432) | 235 (54 %) | 128 (30 %) | 55 (13 %) | 14 (3 %) |

As discussed previously, the range of predicted curvatures for the houses within the Study Area are less than but similar to those observed above Tahmoor Mine Longwalls 24A to 27 within the observed zone of increased subsidence.

When the assessed distribution of impacts for the houses located directly above the proposed longwalls (second row of Table 3.29) are compared with the observed distribution of impacts of houses and major civil structures located directly above Longwalls 24A to 27 within the zone of increased subsidence (bottom row of Table 3.30), it can be seen that these are reasonably similar.

As mentioned earlier, the assessed impacts have been undertaken based on the existing construction type of each house. It is recognised that houses may be rebuilt in the future before the proposed mining occurs. The proportion of houses impacted by mining would, for example, increase if a greater proportion of houses are constructed directly above the proposed longwalls, or if a greater proportion of houses are constructed with brick walls rather than timber-framed weatherboard style structures. The most vulnerable style of house affected by mine subsidence movements above Tahmoor Mine Longwalls 22 to 29 were constructed as brick or brick-veneer houses on strip footings.

Severe impacts have previously occurred as a result of substantial non-conventional movements and in plateau areas away from incised valleys, such as where the houses are located within the Study Area. The precise location of non-conventional movements cannot be predicted prior to mining. The impacts, however, develop gradually such that they can be detected early and repairs can be undertaken incrementally to ensure that the houses remain safe and serviceable during mining.

As noted in Appendix C of Report No. MSEC1192, at the time of writing ACARP Research Project C12015 (Waddington, 2009), the observed proportion of houses where the Mine Subsidence Board (MSB, now SA NSW) and affected landowners had agreed to rebuild rather than repair, i.e. Category R5 impacts was less than 0.5 %. Since the publication of the research report, the proportion of houses where a decision has been made to rebuild has increased to approximately 1.1 % overall and 3.2 % above Longwalls 24A to 27 within the observed zone of increased subsidence.

The observed proportion of houses with Category R1 to R4 impacts have also increased since the original ACARP study. This is partly due to the time lag effect between the mining impact, when damage is claimed by residents and when the nature and level of the damage requiring repairs is assessed in detail by SA NSW. The latest review includes observations up to the end of Longwall 29 in 2016, which was approximately two years after the completion of Longwall 27 and one year after the completion of Longwall 28, which was the last panel to directly mine beneath the urban areas of Tahmoor.

The primary risk associated with mining beneath houses is public safety. Residents have not been exposed to immediate and sudden safety hazards as a result of impacts that occur due to mine subsidence movements in the NSW Coalfields, where the depths of cover were greater than 350 metres, such as the case above the proposed longwalls. This includes the recent experience at Tahmoor Mine, which has affected more than 1,950 houses, and the experiences at Appin, Teralba, West Cliff and West Wallsend Collieries, which have affected around 500 houses.

Emphasis is placed on the words “immediate and sudden” as in rare cases, some structures have experienced severe impacts, but the impacts did not present an immediate risk to public safety as they developed gradually with ample time to temporarily relocate residents.

All houses within the Study Area are expected to remain safe and repairable throughout the mining period, provided that effective management measures are adopted during mining and these are described in Section 3.16.4.

### 3.16.4. Management of potential impacts on the houses

Tahmoor Mine has extensive experience of mining beneath urban areas. It has developed and acted in accordance with a risk management process to manage potential impacts to residential structures during the mining of LWs 22 to 32, LWs W1-W4 and LWs S1A and S2A.

The Subsidence Management Process has been developed in consideration of the following facts and observations:

1. Australian standards have been available for use in the design of structures since 1948. The great majority of structures at Tahmoor and Thirlmere (approximately 80 %) have been constructed after the declaration of the Bargo Mine Subsidence District in November 1975.
2. There is sufficient redundancy in structural design such that ductile deformation will develop and be noticeable to residents before structural failure occurs.
3. Subsidence movements develop gradually over time at Tahmoor Mine as they have above other previously extracted longwalls at similar depths of cover.
4. Experiences during the mining of LWs 22 to 32 and LWs W1-W3 have found that the most effective method of managing potential impacts on the safety and serviceability of structures are by way of community consultation. Residents living within the active subsidence zone have often provided early feedback to Tahmoor Mine and/or SA NSW about impacts developing at their houses or along their local roads. Contact is made well before impacts develop to a level of severity sufficient to become a safety hazard.
5. On the basis of the above, there is sufficient time for residents to notify Tahmoor Mine or SA NSW of significant displacement or deflection well before structural failure will occur.
6. The conclusions are supported by the observation that residents have not been exposed to immediate and sudden safety hazards as a result of impacts that occur due to mine subsidence movements at Tahmoor Mine and above other previously extracted longwalls at similar depths of cover. This includes the recent experience at Tahmoor Mine during the mining of LWs 22 to 32 and LWs W1-W4, which have affected more than 2000 houses and civil structures.

While severe impacts have developed during the mining of LWs 22 to 32, there is sufficient redundancy in structural design such that when structures have experienced severe impacts, they have developed gradually with ample time for residents to notify Tahmoor Mine or SA NSW to repair the structure and/or relocate residents before structural failure occurs.

While the three most important factors in managing risks to public safety are redundancy in structural design, gradual development of subsidence movements and an effective community consultation program, a number of additional management measures have been undertaken, including site specific investigations, regular surveys and inspections during mining and triggered response measures.

Tahmoor Coal has developed a Subsidence Management Plan to manage potential impacts to houses during the mining of LWs S1A to S6A under the *Approved Layout*. It is recommended that Tahmoor Coal continues its current practice of ensuring that built structures remain safe and serviceable at all times during mining. It is recommended that Tahmoor Coal, in consultation with landowners, study the potential for impacts on the structures and other infrastructure and develop management measures. The study would require input from structural and subsidence engineers. The risk management process includes the following processes:-

1. Regular consultation, cooperation and coordination with the community before, during and after mining. This includes letters and door knocking to all residents of structures that will soon be affected by subsidence. The letters offer a free pre-mining inspection and hazard identification inspection by a structural engineer;
2. Site-specific investigations, where they are necessary and appropriate, into the conditions of buildings and associated structures and their surrounding environment (where access is allowed). The site-specific investigations have been and will continue to be undertaken early so that there is adequate time, if required, to arrange additional inspections and/or surveys and implement any mitigation measures before mining-induced impacts are experienced;

   For properties located directly above the first 300 metres of the commencing end of a longwall, the investigations are targeted to be undertaken prior to extraction or at the latest, they will be undertaken prior to the first 200 metres of extraction of the longwall.

   The site-specific investigations include the following:

   a) Identification of structures from aerial photographs and kerbside inspections;
   b) Front of house risk and visual screening inspections by Tahmoor Coal in company with a structural engineer for all properties that are predicted to experience more than 20 mm of incremental vertical subsidence due to the extraction of each upcoming longwall. The purpose of the inspections is to identify hazards where access has not been granted by the landowner.

In some cases, particularly in semi-rural and rural areas, it is difficult to inspect a structure that is remote from the street front. Where these cases involve properties that are located directly above a longwall, Tahmoor Coal will request access to conduct a pre-mining inspection and hazard identification inspection by a structural engineer;

c) Tahmoor Coal will request access to conduct pre-mining geotechnical inspections of structures located on or immediately adjacent to steep slopes that are predicted to experience more than 20 mm of incremental vertical subsidence due to the extraction of each longwall;

d) Tahmoor Coal will request access to conduct pre-mining hazard identification inspections by a structural engineer (where access is allowed by the landowner) to properties with structures that have been specifically targeted on the basis that may be more sensitive to mine subsidence movements. These include:

   i) Commercial and business establishments, public amenities and public utilities;

   ii) Structures of heritage significance;

   iii) Structures that are located above hidden creeks (none identified within the *Study Area*);

   iv) Structures that are located above mapped geological structures (none identified within the *Study Area*);

   v) Structures that are located on or adjacent to steep slopes or that have been recommended for structural inspection by the geotechnical engineer;

   vi) Structures that have been identified as being potentially unstable or unsafe by landowners (Item 1), or from the front of house inspections (Item 2b);

   vii) Houses and units located outside the declared Mine Subsidence Districts; and

   viii) Houses and units estimated to have been constructed prior to the declaration of the Bargo Mine Subsidence District (in November 1975).

3. Implementation of pre-mining mitigation measures following inspections by the geotechnical engineer and the structural engineer, in consultation and agreement with the landowner.

4. Surveys and inspections during mining within the active subsidence area:

   a) detailed visual inspections and vehicle-based inspections along the streets;

   b) ground surveys along the streets;

   c) specific ground surveys for selected properties, where recommended by the geotechnical engineer or structural engineer due to their proximity to steep slopes or pre-existing condition;

   d) visual inspections of residential structures that are either: located on or adjacent to steep slopes, are in poor existing condition (based on the hazard identification inspections), have previously reported impacts, or where recommended by the Structures Response Group;

   e) visual inspections of pool fences and gates; and

   f) visual inspections of commercial, industrial and business establishments, public amenities and public utilities.

With appropriate management plans in place, it is considered that the houses will remain safe and serviceable at all times due to the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non- conventional movements occurred.

The Subsidence Management Plan will be updated to include potential impacts due to the extraction of LW S7A under the *Modified Layout*.

## 3.17. Archaeological Sites

There are no lands within the Study Area declared as an Aboriginal Place under the *National Parks and Wildlife Act 1974*.

There are 9 archaeological sites which have been recently identified along Hornes Creek by heritage consultant EMM (2024) within the 600m Study Area for Natural Features. Their locations are shown in Drawing No. MSEC1348-10. The proposed LW S7A will not extract directly beneath the sites.

- 7 rockshelter sites were recorded, of which 6 sites contained potential archaeological deposits. No art was identified, although indeterminate charcoal markings were observed on the walls of two shelters.
- One grinding groove site was identified on a rockbar within Hornes Creek.
- One isolated find was identified on a fire track.

Detailed descriptions of the archaeological sites within the Study Area are provided in the Aboriginal Cultrual Heritage Assessment.

### 3.17.1. Predictions for the archaeological sites

The predicted conventional subsidence, tilts and curvatures for the archaeological sites within the Study Area are provided in Table C.10, in Appendix D. A summary of the maximum predicted conventional subsidence parameters for the archaeological sites is provided in Table 3.31. The predicted tilts are the maxima after the completion of any or all of the proposed longwalls. The predicted curvatures are the maxima at any time during or after the extraction of the proposed longwalls.

**Table 3.31 Maximum Predicted Total Conventional Subsidence Parameters for the Archaeological Sites**

| Site Type | Maximum predicted total conventional subsidence (mm) | Maximum predicted total conventional tilt (mm/m) | Maximum predicted total conventional hogging curvature ($km^{-1}$) | Maximum predicted total conventional sagging curvature ($km^{-1}$) |
|---|---|---|---|---|
| Rock Shelter Site (WP1258RS) | 50 | < 0.5 | < 0.01 | < 0.01 |
| Grinding Grooves (WP1263GG) | 20 | < 0.5 | < 0.01 | < 0.01 |
| Isolated Find (48-2-0275) | 20 | < 0.5 | < 0.01 | < 0.01 |

The maximum predicted conventional strains for the archaeological sites, based on applying a factor of 15 to the maximum predicted conventional curvatures, are less than 0.2 mm/m tensile and compressive. Non-conventional movements can also occur as a result of, among other things, anomalous movements. The analysis of strains provided in Chapter 2.0 includes those resulting from both conventional and non-conventional anomalous movements.

The archaeological sites are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 2.5.1. The results for survey bays above solid coal are provided in Fig. 2.8.

The grinding groove site is located on a rockbar within the valley and, therefore, could experience valley-related movements. A summary of the maximum predicted upsidence and closure movements for the stream at the location of this site is provided in Table 3.32.

**Table 3.32 Maximum predicted total upsidence and closure for the archaeological sites**

| Site Type | Stream | Maximum predicted total upsidence (mm) | Maximum predicted total closure (mm) |
|---|---|---|---|
| Grinding Grooves (WP1263GG) | Hornes Creek | 45 | 65 |

### 3.17.2. Impact assessments for the rock shelter

There are 9 rock shelters identified within the 600m Study Area for Natural Features to the west of LW S7A on Hornes Creek. The closest site is located approximately 330 metres to the side of LW S7A.

The maximum predicted conventional tilts and curvatures for the rock shelters are negligible and unlikely to result in adverse impacts on the rock shelter sites.

It is extremely difficult to assess the likelihood of instabilities for the rock shelters based upon predicted ground movements. The likelihood of the shelters becoming unstable is dependent on a number of factors which are difficult to fully quantify. These factors include jointing, inclusions, weaknesses within the rockmass, groundwater pressure and seepage flow behind the rockface. Even if these factors could be determined, it would still be difficult to quantify the extent to which these factors may influence the stability of the shelter naturally or when it is exposed to mine subsidence movements.

In this case, the shelters are located away from the proposed LW S7A, with the closest distance of 330 metres. As discussed in the assessment for cliffs in Section 3.5, no cliff instabilities have previously been observed above solid, unmined coal, during previous longwall mining in the Southern Coalfield at similar depths of cover. It is, therefore, unlikely that cliffs beyond the extent of the longwall panels will experience large instabilities. It is possible that isolated rock falls could occur during the mining period due to natural weathering processes. Any impacts are expected to represent less than 0.5 % of the total face area of the cliffs. The identified aboriginal rock shelter sites are a small proportion of the overall total face area of the cliffs, and any impacts are, therefore, expected to be even less 0.5 %.

Based on the experience from the Southern Coalfield, the likelihood of substantial physical impacts on rock shelters within the Study Area is very low.

### 3.17.3. Impact assessments for the Grinding Groove site

The grinding groove site is located approximately 520 metres to the side of LW S7A.

The maximum predicted conventional tilts and curvatures for the grinding groove site are negligible and unlikely to result in adverse impacts on the grinding groove site.

Hornes Creek is predicted to experience valley closure, including at the rockbar that hosts the grinding grooves. As discussed in Section 3.3, given the offset distance of the grinding site relative to LW S7A, the likelihood of fracturing occurring is considered to be low and in the unlikely event that it occurs, the fractures are expected to be minor and isolated. The identified grooves are a small proportion of the rockbar and, therefore, the likelihood of a fracture intersecting the griding grooves is considered to be extremely low.

### 3.17.4. Impact assessments for the Isolated Find site

The isolated find site is located approximately 520 metres to the side of LW S7A.

The maximum predicted conventional tilts and curvatures for the isolated find site are negligible and unlikely to result in adverse impacts on the isolated find site.

Given the offset distance of the site relative to LW S7A, the potential for cracking of the surface soils as a result of mine subsidence movements is extremely low. It is unlikely, however, that the isolated finds themselves would be impacted by surface cracking.

### 3.17.5. Impact assessments for the archaeological sites based on increased predictions

If the actual mine subsidence movements exceeded those predicted values by a factor of 2 times, the likelihood of impacts would still be expected to be very low.

While the predicted ground movements are important parameters when assessing the potential impacts on the rock shelters on cliffs, it is noted that the impact assessments for cliff instabilities have primarily been based on historical observations from previous longwall mining in the Southern Coalfield.

Similarly, while the predicted conventional and non-conventional ground movements at the grinding groove site are very small, it is noted that the impact assessments for rockbars have primarily been based on historical observations from previous longwall mining in the Southern Coalfield.

### 3.17.6. Management of potential impacts on the archaeological sites

Tahmoor Coal has developed a Heritage Management Plan to manage potential impacts to Aboriginal heritage sites for LWs S1A to S6A. The management plan included consultation with the community, monitoring and reporting. Tahmoor Coal will develop a Heritage Management Plan as part of the Mod 3 application for LW S7A, in consultation with the community, to manage the potential impacts on Aboriginal heritage sites during the extraction of the proposed longwalls.

## 3.18. Heritage Sites

There are no heritage sites located within the Study Area, as shown in Drawing No. MSEC1348-10.

The Wellers Road Overbridge and Picton Weir are items of heritage significance and their locations relative to the Study Area are shown in Drawing No. MSEC1348-10.

As discussed in Section 3.7, Tahmoor Coal and ARTC have implemented extensive measures to manage potential impacts on the Main Southern Railway and the associated railway structures due to the extraction of LW S1A to S6A, in accordance with a Railway Management Plan. The Railway Management Plan includes measures to manage potential impacts on Wellers Road Overbridge.

As discussed in Section 3.7, while the Wellers Road Overbridge is predicted to experience additional absolute horizontal movements as a result of the extraction of LW S7A, the potential for impacts on Wellers Road Overbridge due to differential horizontal movements does not materially change.

While the potential for impacts due to the extraction of LW S7A under the *Modified Layout* does not materially change from the potential for impacts under the *Approved Layout*, Tahmoor Coal will continue to implement the planned measures to manage the potential for impacts on the Main Southern Railway, as is currently planned during the extraction of LW S1A to S6A. The Railway Management Plan will be extended to include management of potential impacts due to the extraction of LW S7A.

As discussed in Section 3.10, Tahmoor Coal and Wollondilly Shire Council are developing measures to manage potential impacts on the Picton Weir due to the extraction of LW S1A to S6A, in accordance with a Picton Weir Management Plan, which is required prior to the commencement of LW S3A.

While the potential for impacts on the Picton Weir due to the extraction of LW S7A is higher than the potential for impacts under the *Approved Layout*, the methods of managing potential impacts on the Weir does not materially change. The Picton Weir Management Plan will be extended to include management of potential impacts due to the extraction of LW S7A.

## 3.19. Summary

The maximum predicted subsidence parameters within the Study Area, based on the *Modified Layout*, are similar to those based on the *Approved Layout*.

The potential for impacts has been assessed based on the predicted subsidence movements, consultation with infrastructure owners and experiences gained during the extraction of previous longwalls at Tahmoor Mine and more broadly from experiences during the extraction of previous longwalls at similar depths of cover at nearby mines in the Southern Coalfield.

The overall findings of the assessments undertaken by MSEC are that the levels of impact and damage to all identified natural features and built infrastructure are manageable and can be controlled by the preparation and implementation of Subsidence Management Plans (or Extraction Plans), many of which have been successfully implemented during previous mining at Tahmoor Mine. These management plans are developed in consultation with the owners of infrastructure and are approved by relevant government agencies. The findings in this report should be read in conjunction with all other associated consultant reports.

Recommended management measures generally include monitoring of ground movements and the condition of surface features. Some mitigation measures are recommended to mitigate or avoid the risk of serious consequences should impacts occur to some critical surface features.

It is recommended that Tahmoor Coal continues to develop management plans to manage the potential impacts for the surface features due to the extraction of the proposed LW S7A.

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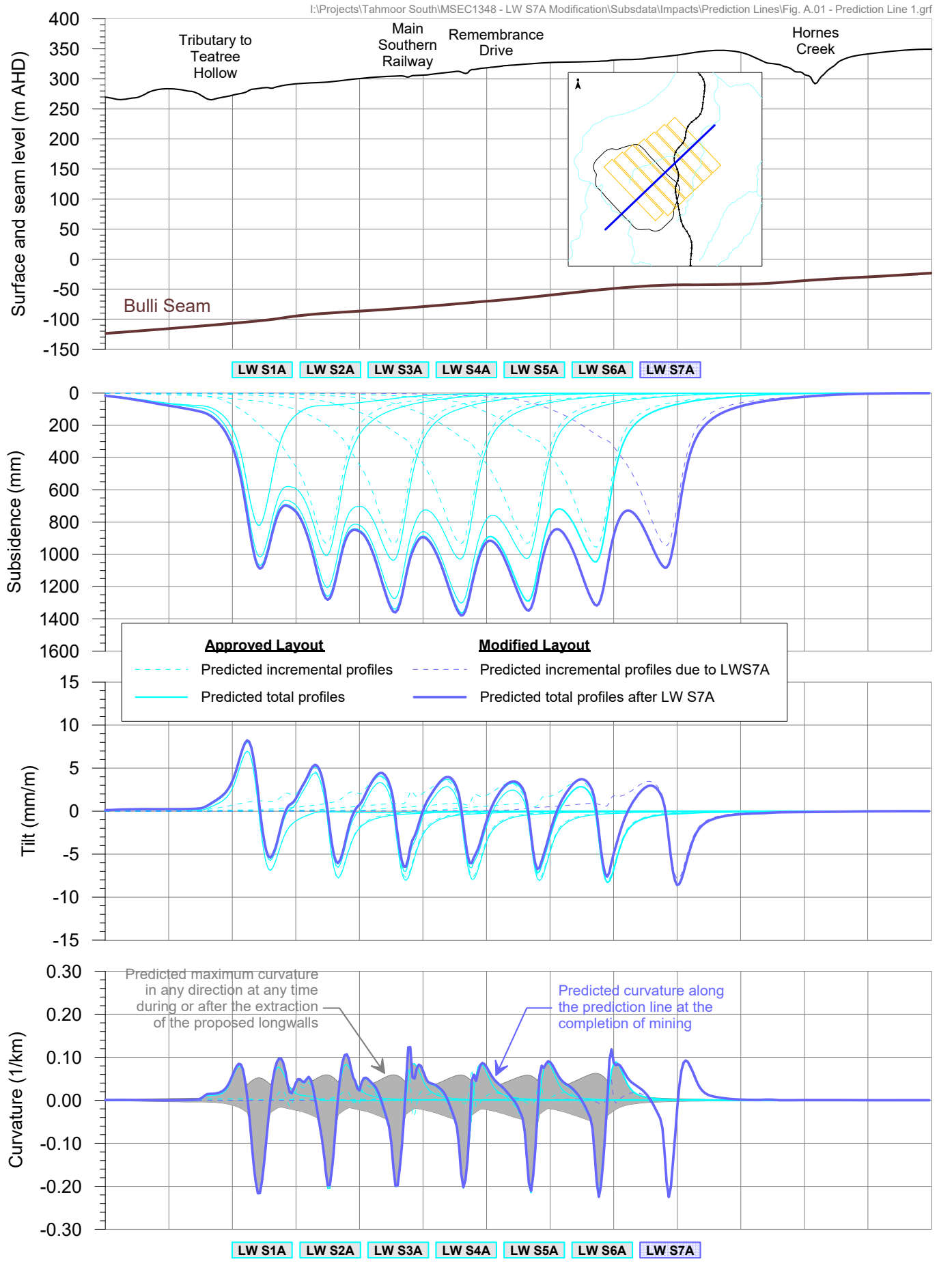
# APPENDIX A. FIGURES

# Predicted profiles of conventional subsidence, tilt and curvature along Prediction Line 1 resulting from the extraction of Longwalls S1A to S7A




msec

**Fig. A.01**

# Predicted profiles of subsidence, upsidence and closure along Bargo River and Hornes Creek resulting from the extraction of Longwalls S1A to S7A

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\Subsdata\Impacts\Streams\Fig. A.02 - Bargo River & Hornes Creek.grf

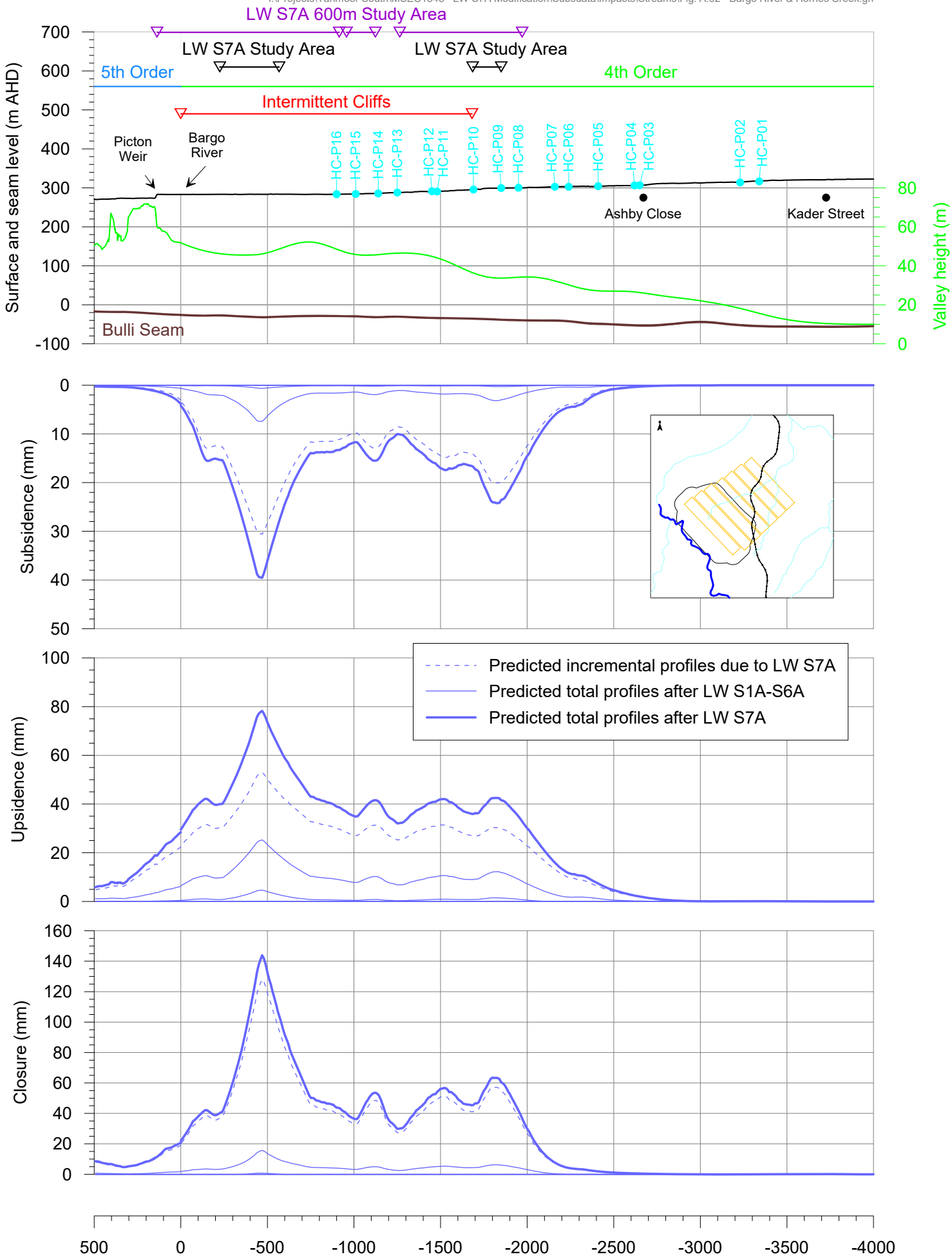



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**Fig. A.02**

# Predicted profiles of subsidence, upsidence and closure along Teatree Hollow resulting from the extraction of Longwalls S1A to S7A

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\Subsdata\Impacts\Streams\Fig. A.03 - Teatree Hollow.grf

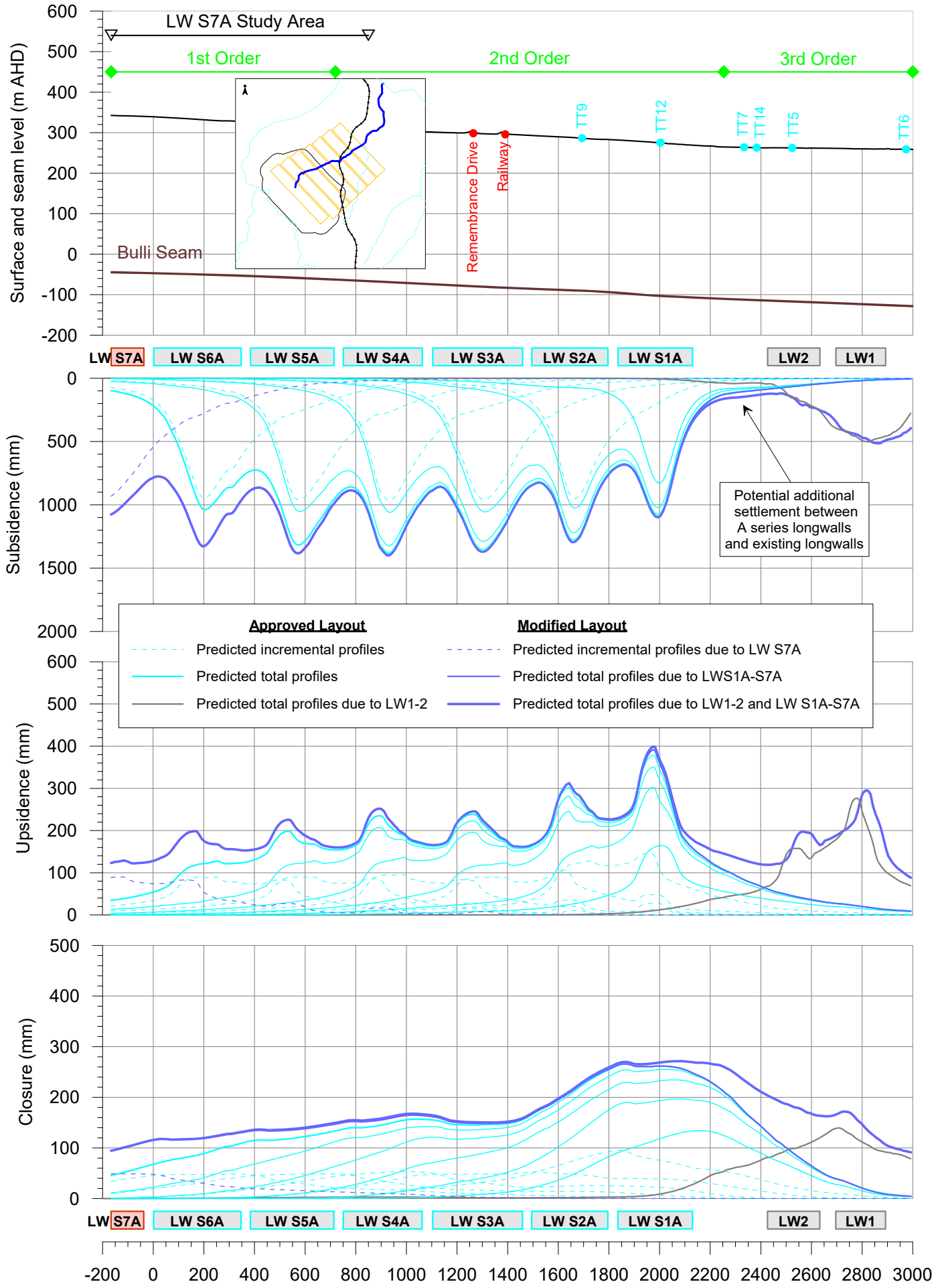


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Fig. A.03

# Predicted profiles of subsidence, upsidence and closure along Tributary of Teatree Hollow resulting from the extraction of Longwalls S1A to S7A

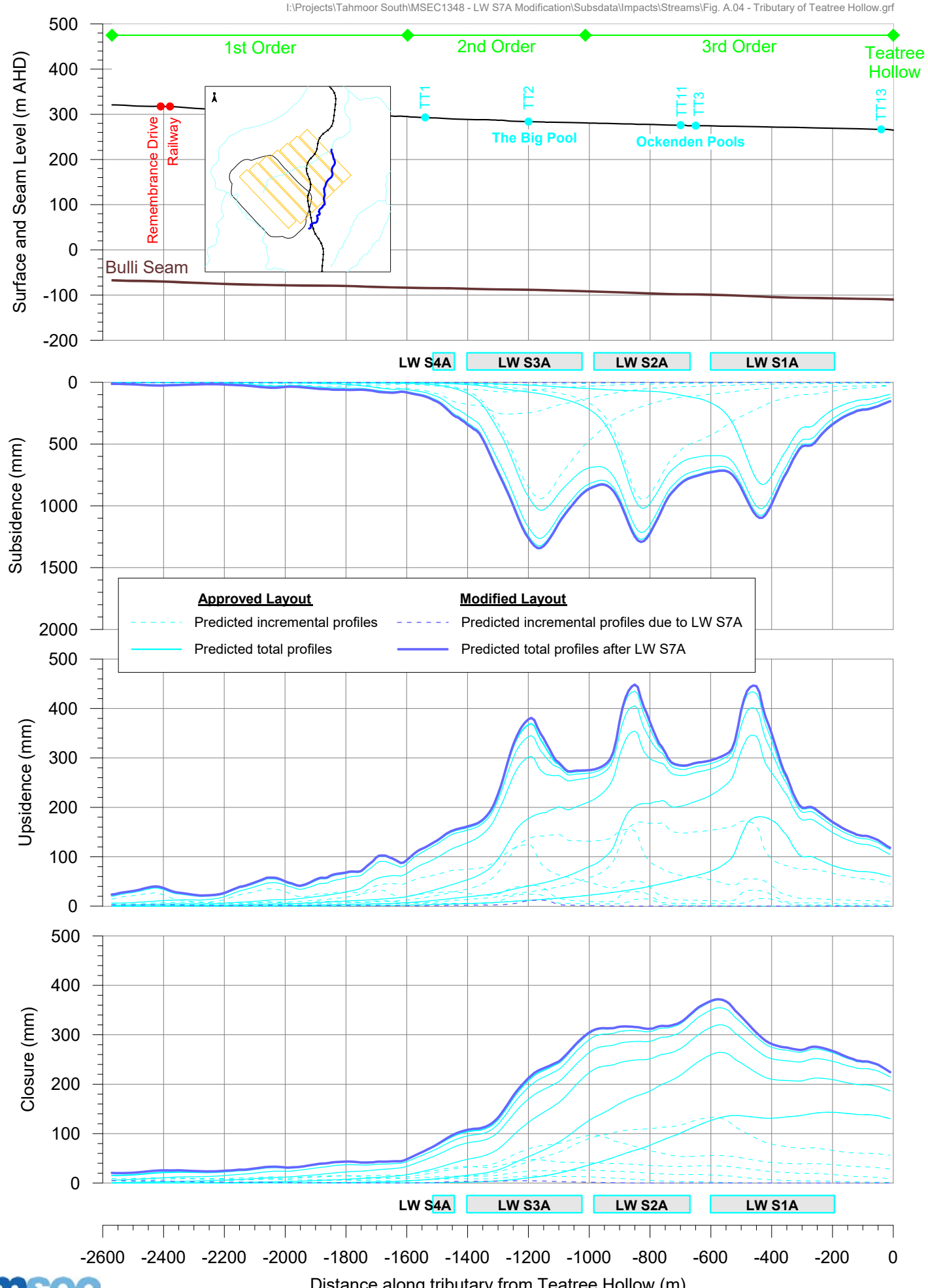



Fig. A.04

# Predicted profiles of conventional subsidence, tilt and change in grade along the Main Southern Railway due to the extraction of Longwalls S1A to S7A

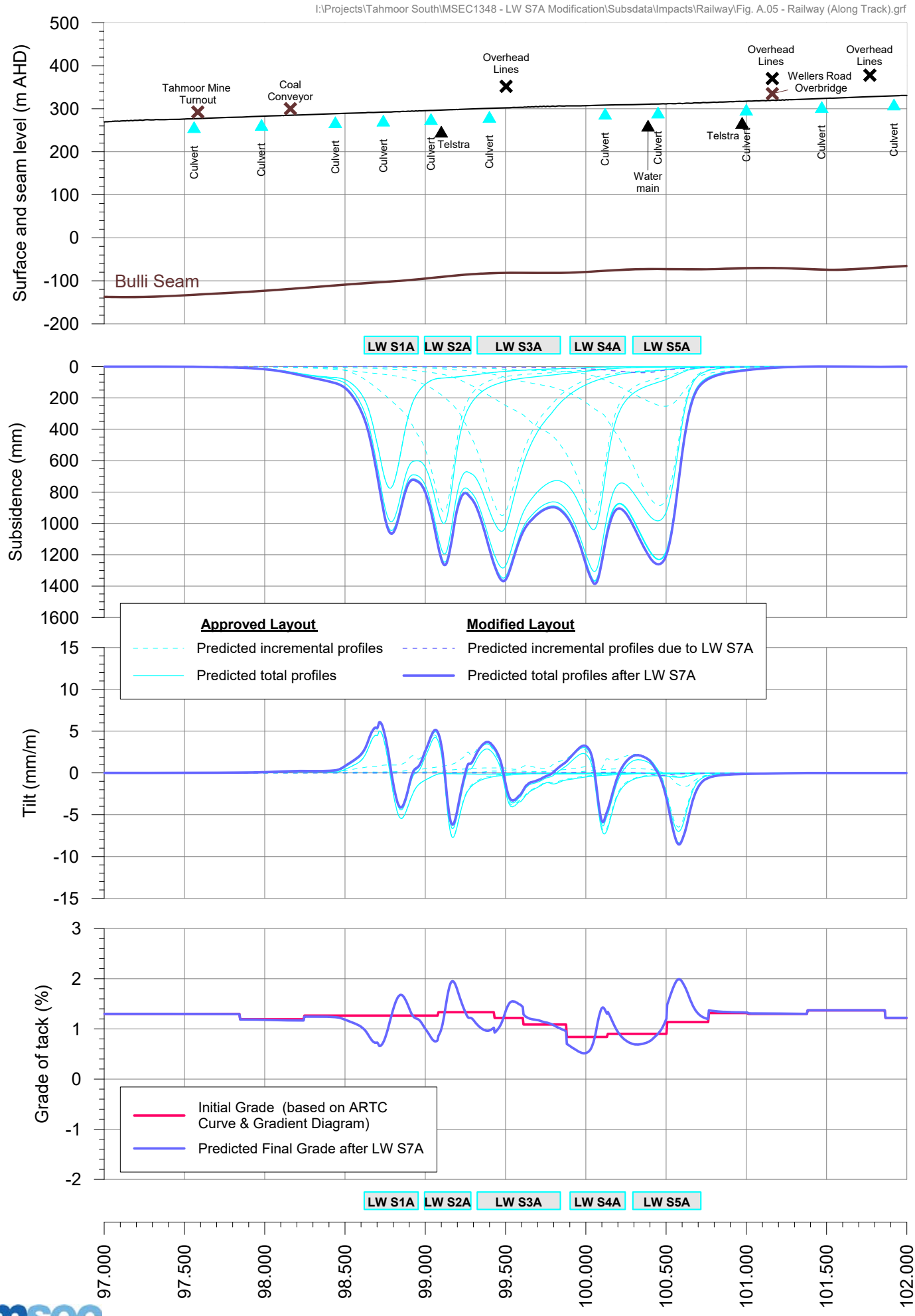



Fig. A.05

# Predicted profiles of conventional cross tilt, change in track cant and long twist along the Main Southern Railway due to the extraction of Longwalls S1A to S7A

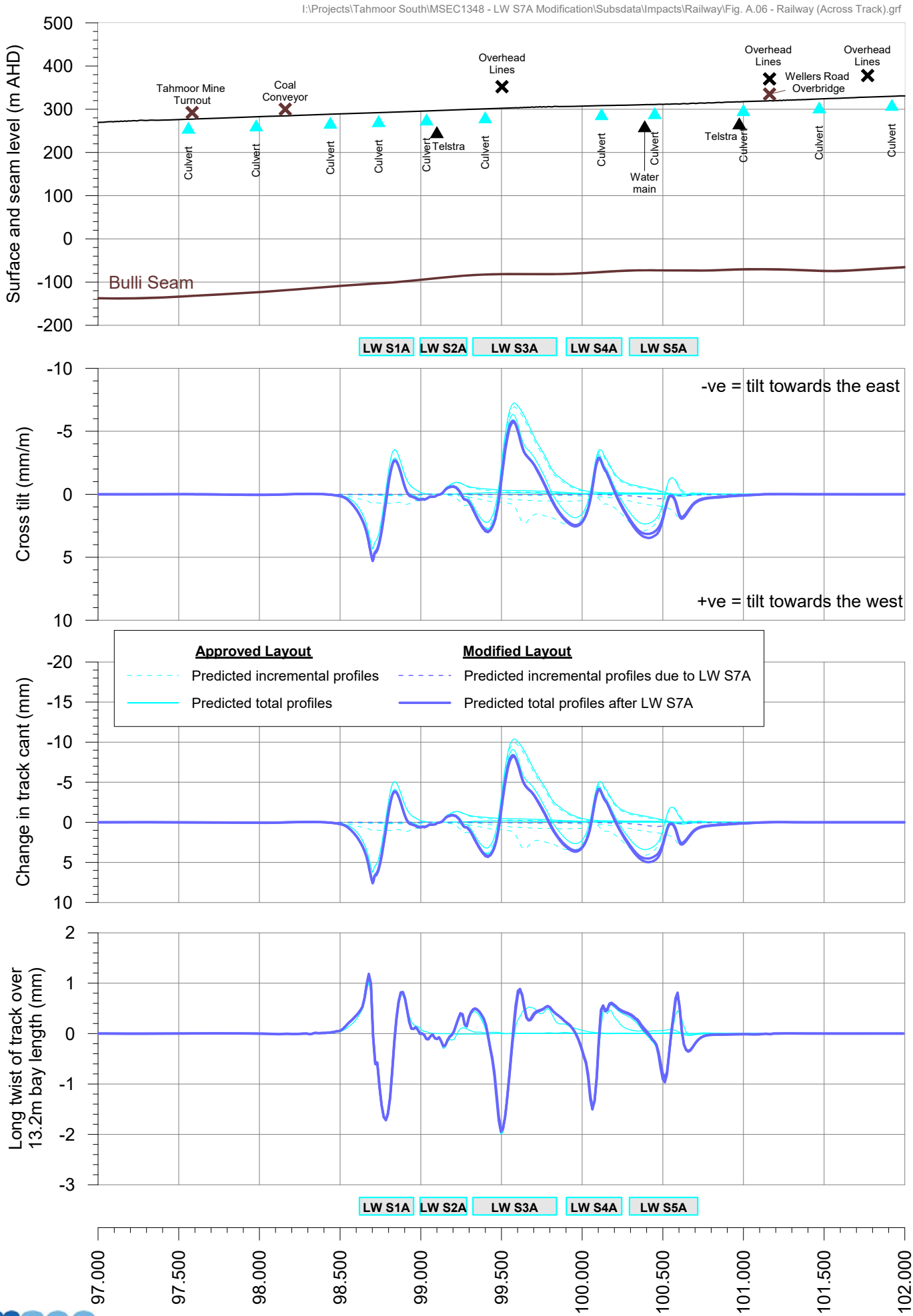



Fig. A.06

# Predicted profiles of conventional horizontal movement along track, change in 100 metre long bay length and change in SFT for the Main Southern Railway due to the extraction of Longwalls S1A to S7A

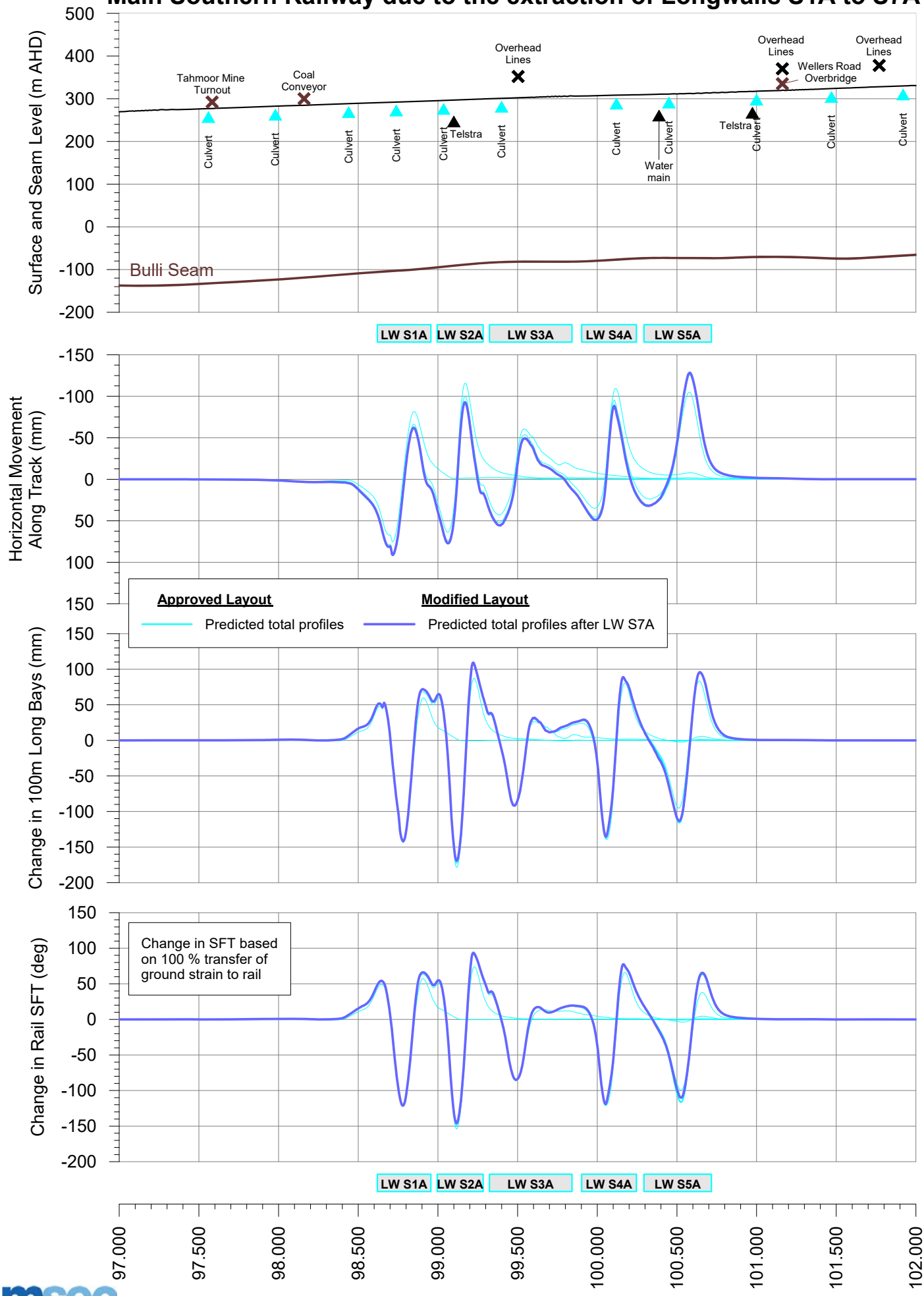
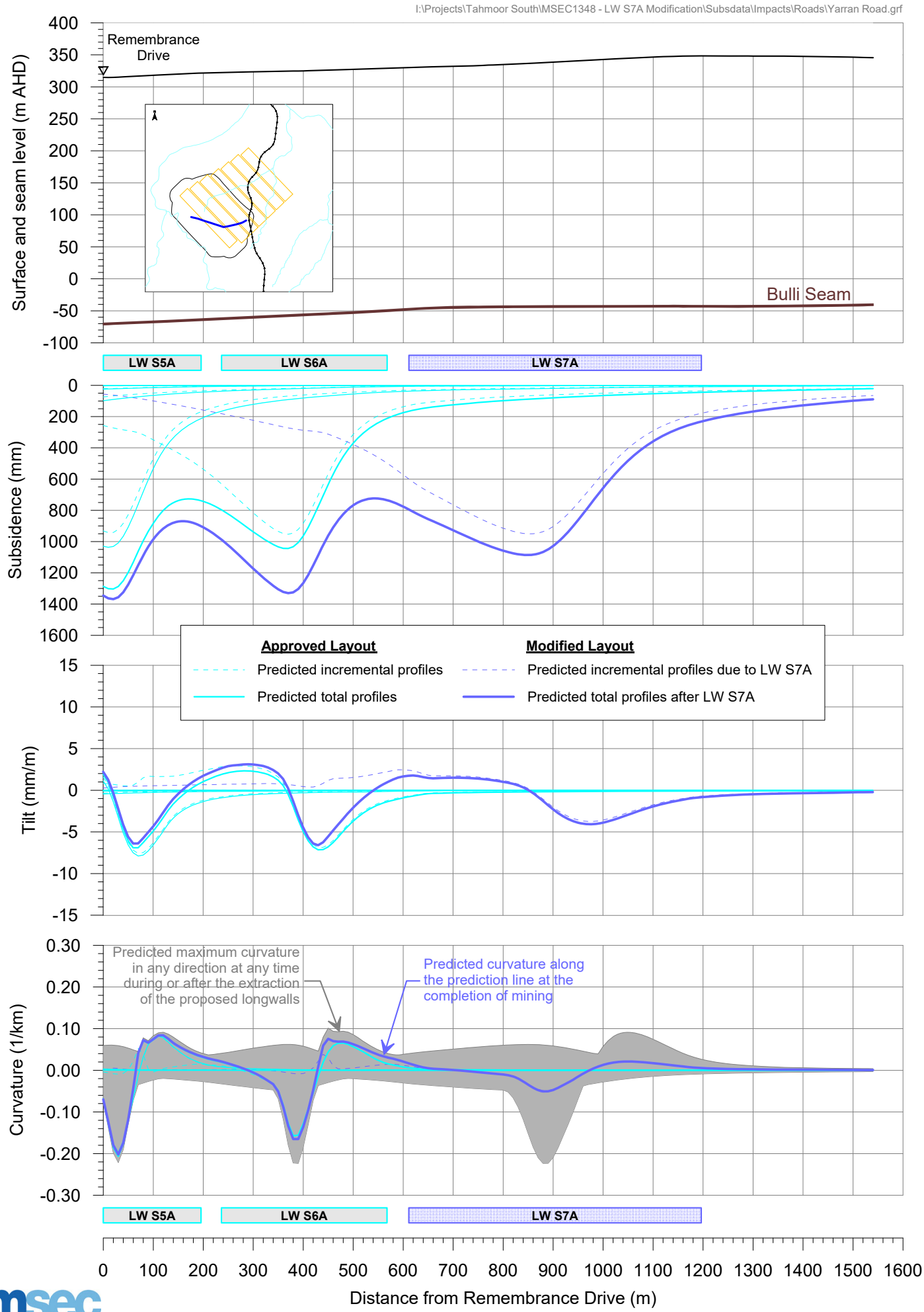



Fig. A.07

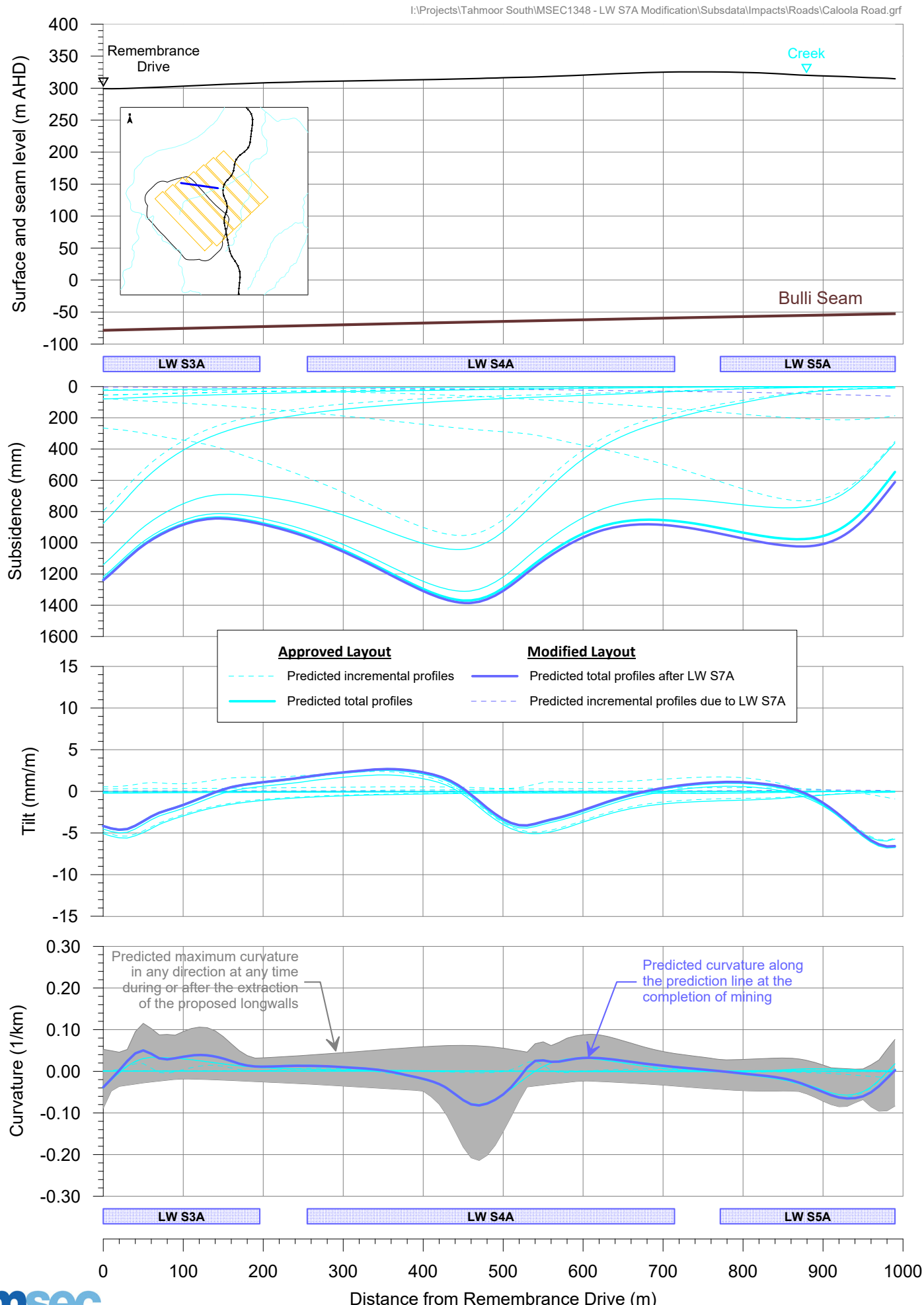
# Predicted profiles of conventional subsidence, tilt and curvature along Yarran Road resulting from the extraction of Longwalls S1A to S7A




msec

Fig. A.08

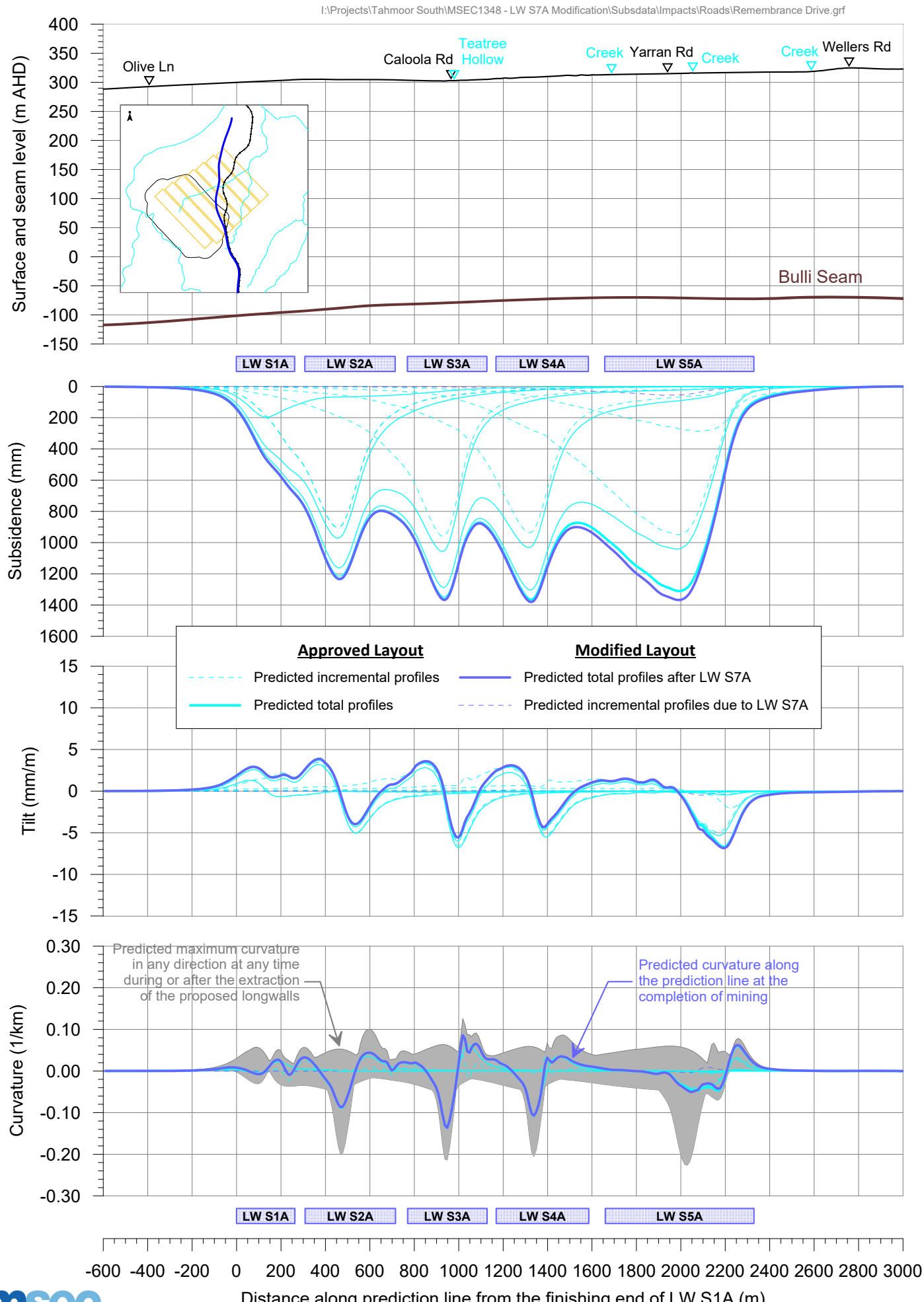
# Predicted profiles of conventional subsidence, tilt and curvature along Caloola Road resulting from the extraction of Longwalls S1A to S7A




msec

Fig. A.09

# Predicted profiles of conventional subsidence, tilt and curvature along Remembrance Drive resulting from the extraction of Longwalls S1A to S7A




msec

Fig. A.10

# Predicted profiles of conventional subsidence, tilt and curvature along Remembrance Drive and the 150mm steel gas main resulting from the extraction of Longwalls S1A to S7A

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\Subsdata\Impacts\Gas\Fig. A.11 - Gas Main.grf

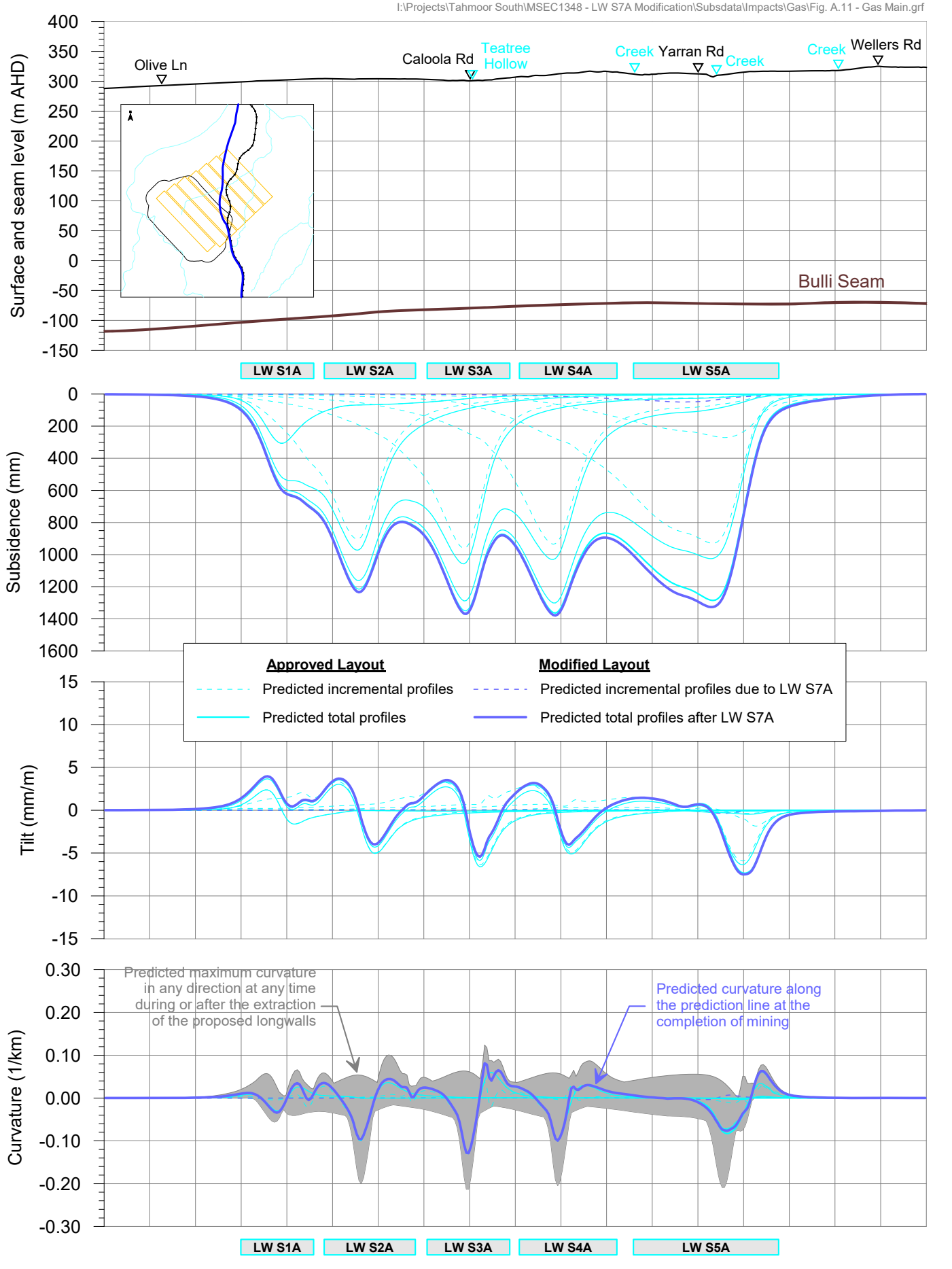



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Fig. A.11

# APPENDIX B. DRAWINGS

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-01 General Layout.dwg

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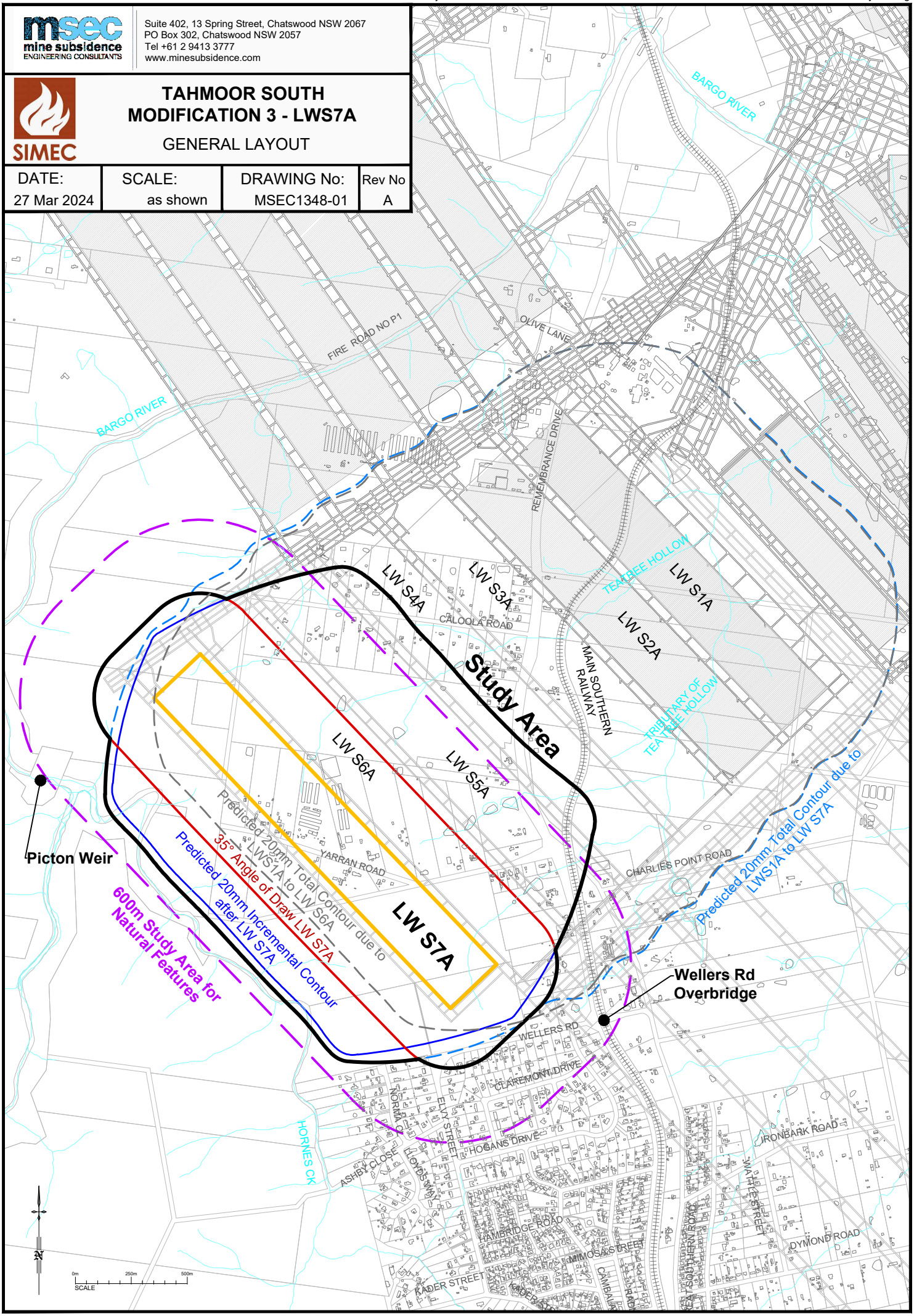
# TAHMOOR SOUTH MODIFICATION 3 - LWS7A

## GENERAL LAYOUT

| DATE: | SCALE: | DRAWING No: | Rev No |
|---|---|---|---|
| 27 Mar 2024 | as shown | MSEC1348-01 | A |



I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-02 Surface Level Contours.dwg

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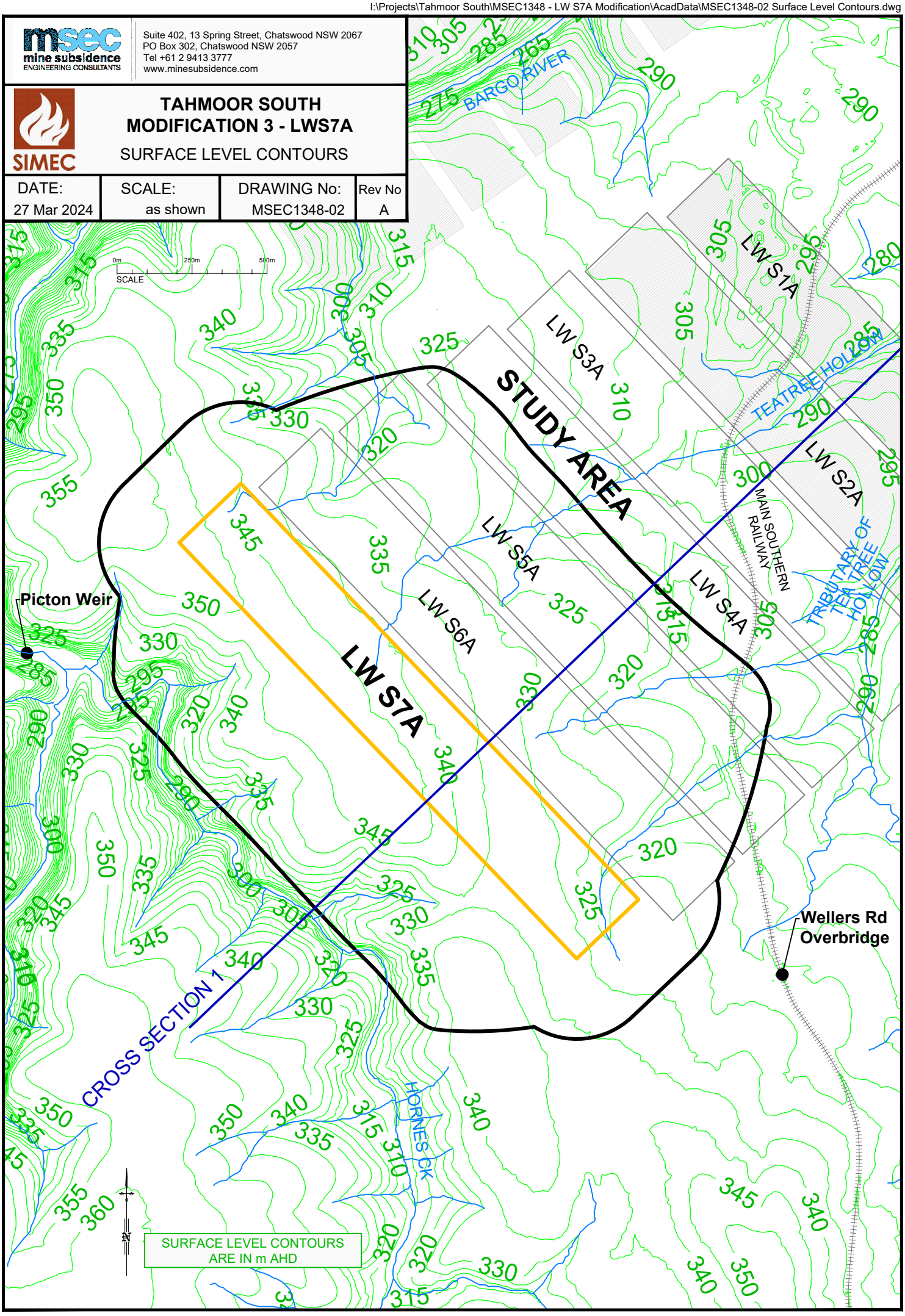
# TAHMOOR SOUTH MODIFICATION 3 - LWS7A

## SURFACE LEVEL CONTOURS

| DATE: | SCALE: | DRAWING No: | Rev No |
|---|---|---|---|
| 27 Mar 2024 | as shown | MSEC1348-02 | A |



I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-03 Seam Roof Contours.dwg

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# TAHMOOR SOUTH MODIFICATION 3 - LWS7A

## BULLI SEAM ROOF CONTOURS

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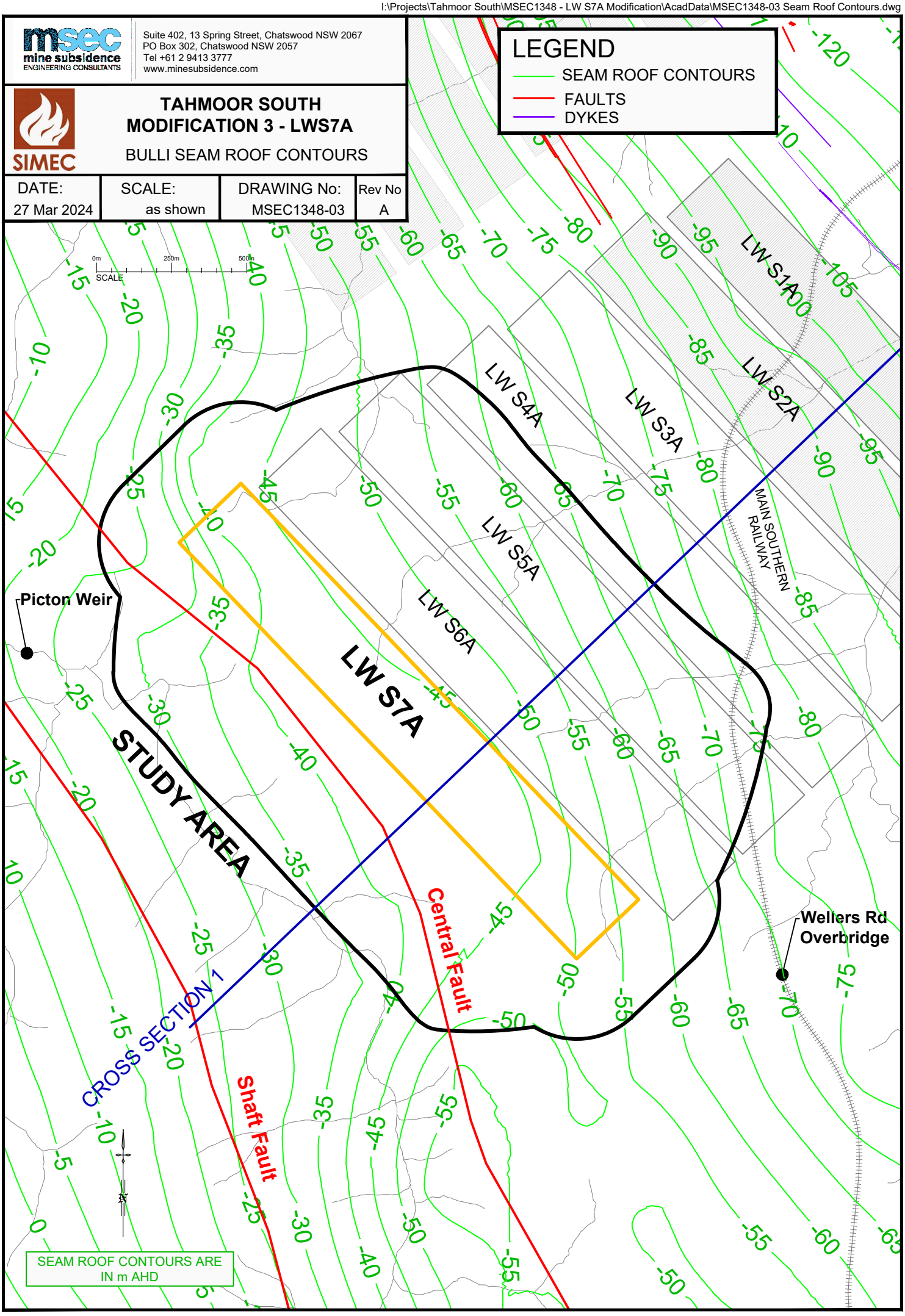
|---|---|---|---|
| 27 Mar 2024 | as shown | MSEC1348-03 | A |



I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-04 Depth of Cover Contours.dwg

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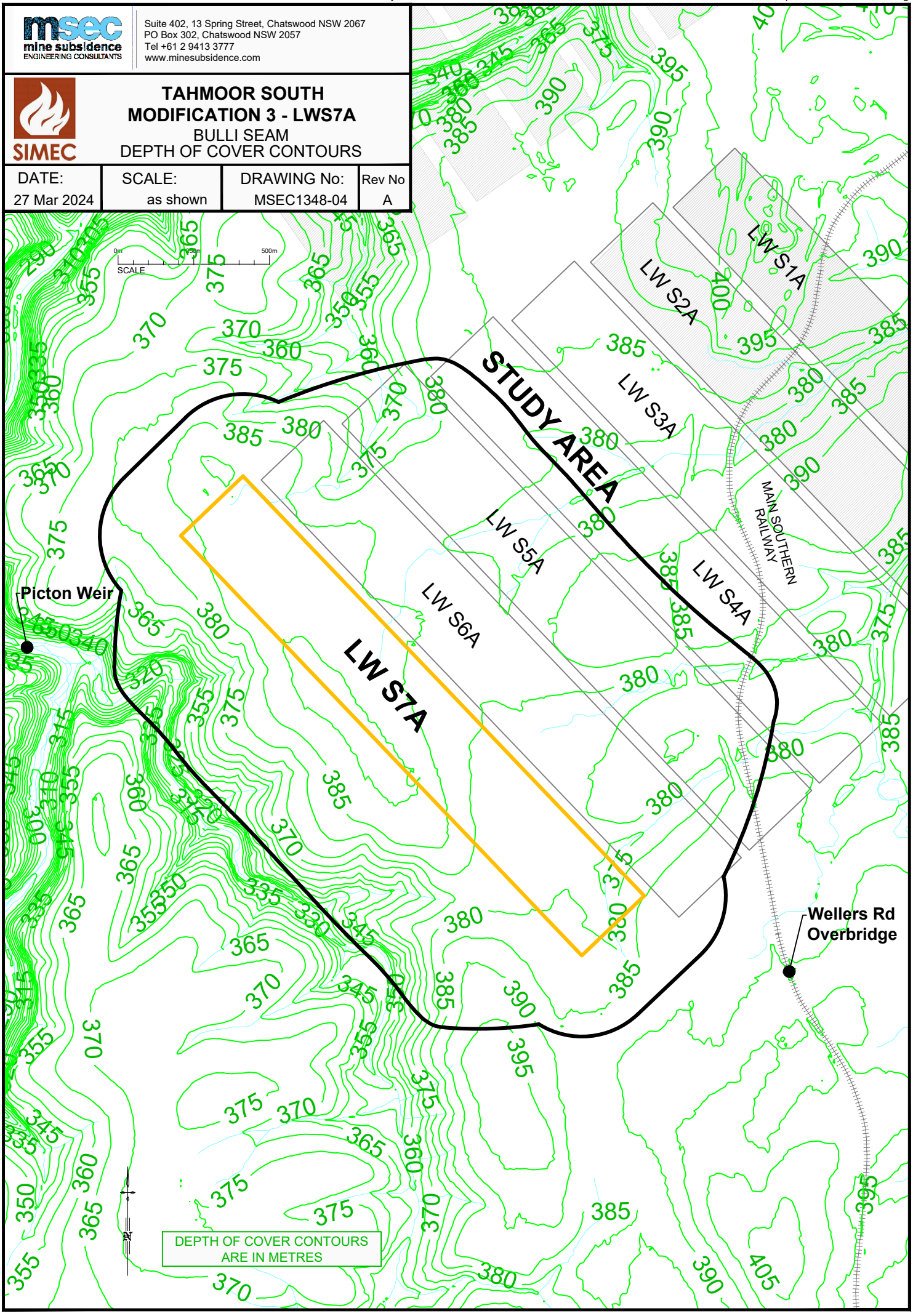
# TAHMOOR SOUTH MODIFICATION 3 - LWS7A

BULLI SEAM
DEPTH OF COVER CONTOURS

| DATE: | SCALE: | DRAWING No: | Rev No |
|---|---|---|---|
| 27 Mar 2024 | as shown | MSEC1348-04 | A |



I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-05 Extraction Height.dwg

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# TAHMOOR SOUTH MODIFICATION 3 - LWS7A

## EXTRACTION HEIGHT

| DATE: | SCALE: | DRAWING No: | Rev No |
|---|---|---|---|
| 27 Mar 2024 | as shown | MSEC1348-05 | A |

0m 250m 500m
SCALE

LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
LW S7A
STUDY AREA
MAIN SOUTHERN RAILWAY
Picton Weir
Wellers Rd Overbridge

## LEGEND

- 2.15m - 2.2m
- 2.2m - 2.25m
- 2.25m - 2.3m
- 2.3m - 2.35m
- 2.35m - 2.4m
- 2.45m - 2.5m
- 2.5m - 2.55m
- 2.55m - 2.6m

N

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-06 Geology.dwg

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# TAHMOOR SOUTH MODIFICATION 3 - LWS7A

GEOLOGICAL STRUCTURES AT BULLI SEAM LEVEL

| DATE: | SCALE: | DRAWING No: | Rev No |
|---|---|---|---|
| 27 Mar 2024 | as shown | MSEC1348-06 | A |

0m 250m 500m
SCALE

LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
LW S7A
STUDY AREA

Picton Weir
Wellers Rd Overbridge

Central Fault
Shaft Fault

OLIVE LANE
REMEMBRANCE DRIVE
FIRE ROAD NO P1
CALOOLA ROAD
MAIN SOUTHERN RAILWAY
YARRAN ROAD
CHARLIES POINT RD
GREAT SOUTHERN RD
WELLERS ROAD
CLAREMONT DRIVE
NORMA CLOSE
ELVY STREET
ASHBY CLOSE
LLOYDSWAY
HOGANS DRIVE
HAMBRIDGE ROAD
MIMOSA STREET

LEGEND
FAULT
DYKE

N

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-07 Natural Features.dwg

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# TAHMOOR SOUTH MODIFICATION 3 - LWS7A

## NATURAL FEATURES

| DATE: | SCALE: | DRAWING No: | Rev No |
|---|---|---|---|
| 27 Mar 2024 | as shown | MSEC1348-07 | A |

LEGEND
- POOLS
- CLIFFS
- STEEP SLOPES
- WATERCOURSE

Pool locations, cliffs and steep slopes were identified courtesy Fluvial Systems

BARGO RIVER
TEATREE HOLLOW
TRIBUTARY OF TEA TREE HOLLOW
HORNES CK
MAIN SOUTHERN RAILWAY
STUDY AREA
LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
LW S7A
600m Study Area for Natural Features
Picton Weir
Wellers Rd Overbridge
C_02680
C_01570
C_01060
C_01210
C_04580
C_07630
C_03210
C_00590
C_00910
C_00580
C_01280
C_07410
C_00800
C_03370
C_00720
C_04750
C_01360
C_02070
C_11150
C_00130
C_02060
C_01610
C_07220
C_02020
C_02920
C_00710
C_00830
C_00920
C_05140
C_01640
C_00630
C_08660
C_07810
C_05210
C_01150
C_04290
C_00430
C_00470
C_00660
C_01160
C_02670
C_11590
C_02240
HC-P16
HC-P15
HC-P14
HC-P13
HC-P12
HC-P11
HC-P10
HC-P09
HC-P08
HC-P07
HC-P06
HC-P05
HC-P04
HC-P03
HC-P02
HC-P01
TH-P01
TTH-P02
TTH-P01
0m
250m
500m
SCALE

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-08 Railways.dwg

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# TAHMOOR SOUTH MODIFICATION 3 - LWS7A

## MAIN SOUTHERN RAILWAY

| DATE: | SCALE: | DRAWING No: | Rev No |
|---|---|---|---|
| 27 Mar 2024 | as shown | MSEC1348-08 | A |

0m 250m 500m
SCALE

LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
LW S7A
STUDY AREA
MAIN SOUTHERN RAILWAY
Picton Weir
Wellers Rd Overbridge (101.162km)
OLIVE LANE
REMEMBRANCE DRIVE
FIRE ROAD NO P1
CALOOLA ROAD
YARRAN ROAD
CHARLIES POINT RD
GREAT SOUTHERN RD
WELLERS ROAD
CLAREMONT DRIVE
NORMA CLOSE
ELVY STREET
ASHBY CLOSE
LLOYDS WAY
HOGANS DRIVE
HAMBRIDGE ROAD
MIMOSA STREET

98.445 98.4 km 98.5 km 98.6 km 98.739 98.7 km 98.8 km 98.9 km 99.035 99 km 99.1 km 99.2 km 99.3 km 99.338 99.4 km 99.5 km 99.6 km 99.7 km 99.8 km 99.9 km 100 km 100.121 100.1 km 100.2 km 100.3 km 100.4 km 100.425 100.5 km 100.6 km 100.7 km 100.8 km 100.9 km 101 km 101.000 101.1 km 101.2 km 101.3 km 101.4 km 101.470 101.5 km 101.6 km 101.7 101 101 101.920 102 102.1 102.2 102.244 102.279 102.3

LEGEND
EMBANKMENT
CUTTING

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-09 Surface Infrastructure.dwg

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# TAHMOOR SOUTH MODIFICATION 3 - LWS7A

## SURFACE INFRASTRUCTURE

| DATE: | SCALE: | DRAWING No: | Rev No |
|---|---|---|---|
| 27 Mar 2024 | as shown | MSEC1348-09 | A |

LEGEND
- POWERLINES
- GAS PIPELINES
- POTABLE WATER PIPELINES
- SEWER PIPELINES
- TELECOMMUNICATIONS
- GROUND WATER BORES
- BOREHOLES

0m 250m 500m
SCALE

LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
LW S7A
STUDY AREA
MAIN SOUTHERN RAILWAY
Picton Weir
NBN Tower
BARGO SHAFT
No3 SHAFT
Wellers Rd Overbridge (101.162km)
98.445
98.739
99.035
99.338
100.121
100.425
101.000
101.470
101.920
102.244
102.279
OLIVE LANE
FIRE ROAD NO P1
CALOOLA ROAD
YARRAN ROAD
CHARLIES POINT RD
GREAT SOUTHERN RD
WELLERS ROAD
CLAREMONT DRIVE
HOGANS DRIVE
ELVY STREET
NORMA CLOSE
ASHBY CLOSE
LLOYDSWAY
HAMBRIDGE ROAD
MIMOSA STREET

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-10 Arch & Heritage Sites.dwg

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# TAHMOOR SOUTH MODIFICATION 3 - LWS7A

## ARCHAEOLOGICAL & HERITAGE SITES

| DATE: | SCALE: | DRAWING No: | Rev No |
|---|---|---|---|
| 27 Mar 2024 | as shown | MSEC1348-10 | A |

0m 250m 500m
SCALE

N

No3 SHAFT
OLIVE LANE
REMEMBRANCE DRIVE
Tahmoor Mine
LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
LW S7A
52-2-3968
CALOOLA ROAD
MAIN SOUTHERN RAILWAY
Wirrimbirra Sanctuary
Picton Weir
WP1253 RS
WP1255 RS
WP1261 RS
WP1258 RS
WP1260 RS
WB1257 RS
WP1256 RS
YARRAN ROAD
STUDY AREA
Cemetery
CHARLIES POINT RD
GREAT SOUTHERN RD
Kalinya Gardens
WP1263 GG
WP1264 IF
Wellers Road bridge
WELLERS ROAD
Wellers Rd Overbridge (101.162km)
CLAREMONT DRIVE
NORMA CLOSE
ELVY STREET
HOGANS DRIVE
ASHBY CLOSE
LLOYDS WAY
HAMBRIDGE ROAD
MIMOSA ST
Homestead
FIRE ROAD NO P1
BARGO SHAFT

LEGEND
- ARCHAEOLOGICAL SITES
- HERITAGE SITES

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-11 Built Features.dwg

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# TAHMOOR SOUTH MODIFICATION 3 - LWS7A

## BUILT FEATURES

| DATE: | SCALE: | DRAWING No: | Rev No |
|---|---|---|---|
| 27 Mar 2024 | as shown | MSEC1348-11 | A |

0m 250m 500m
SCALE

N

No3 SHAFT
OLIVE LANE
Tahmoor Mine
REMEMBRANCE DRIVE
Wollondilly Anglican College
Inghams Bargo Chicken Breeder Production Complex
Auto Wreckers
Bargo Petroleum and Hill Top Pit Stop
FIRE ROAD NO P1
Tahmoor Garden Centre
MAIN SOUTHERN RAILWAY
LW S1A
LW S4A
CALOOLA ROAD
LW S2A
LW S6A
Australian Wildlife Sanctuary
LW S5A
LW S3A
Picton Weir
Bargo Valley Produce
MKD Machinery
Inghams Turkey Farm
NBN Tower
Bargo Cemetery
YARRAN ROAD
Canine Country Club and Cattery
CHARLIES POINT RD
LW S7A
STUDY AREA
GREAT SOUTHERN RD
WELLERS ROAD
Wellers Rd Overbridge (101.162km)
CLAREMONT DRIVE
NORMA CLOSE
ELVY STREET
HOGANS DRIVE
ASHBY CLOSE
LLOYDS WAY
Sydney Water Reservoir
HAMBRIDGE ROAD
MIMOSA ST
BARGO SHAFT
Existing Mine shaft of Historical workings

LEGEND
- COMMERCIAL
- PUBLIC AMENITIES
- PUBLIC UTILITIES
- HOUSES
- RURAL STRUCTURES
- POOLS
- DAMS

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-12 Pred Inc Subs due to LW S7A.dwg

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# TAHMOOR SOUTH MODIFICATION 3 - LWS7A

## PREDICTED INCREMENTAL SUBSIDENCE DUE TO LWS7A

| DATE: | SCALE: | DRAWING No: | Rev No |
|---|---|---|---|
| 27 Mar 2024 | as shown | MSEC1348-12 | A |

0m 250m 500m
SCALE

BARGO RIVER

LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
LW S7A

Picton Weir

Prediction Line 1

MAIN SOUTHERN RAILWAY

Wellers Rd Overbridge (101.162km)

1050mm

HORNES CK

LEGEND
SUBSIDENCE CONTOUR COLOUR SCALE (mm)

900
800
700
600
500
400
300
200
100
50
20

NOTE:
The value of the Subsidence Contours, from the outside to the inside of the panels, are 20mm, 50mm, 100mm, 200mm, and so forth, in 100mm increments.

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-13 Pred Total Subs due to LW S7A.dwg

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# TAHMOOR SOUTH MODIFICATION 3 - LWS7A

## PREDICTED TOTAL SUBSIDENCE DUE TO LW S1A TO LW S7A

| DATE: | SCALE: | DRAWING No: | Rev No |
|---|---|---|---|
| 27 Mar 2024 | as shown | MSEC1348-13 | A |

0m 250m 500m
SCALE

BARGO RIVER

LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
LW S7A

MAIN SOUTHERN RAILWAY

Picton Weir

Prediction Line 1

1350mm

1200mm

Wellers Rd Overbridge (101.162km)

HORNES CK

LEGEND
SUBSIDENCE CONTOUR COLOUR SCALE (mm)
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
50
20

NOTE:
The value of the Subsidence Contours, from the outside to the inside of the panels, are 20mm, 50mm, 100mm, 200mm, and so forth, in 100mm increments.

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-14 Pred Total Subs due to LW S6B.dwg

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# TAHMOOR SOUTH MODIFICATION 3 - LWS7A

## PREDICTED TOTAL SUBSIDENCE DUE TO LW S1A TO LW S6B

| DATE: | SCALE: | DRAWING No: | Rev No |
|---|---|---|---|
| 27 Mar 2024 | as shown | MSEC1348-14 | A |

0m 500m 1000m
SCALE

N

BARGO RIVER

LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
LW S7A
MAIN SOUTHERN RAILWAY

Picton Weir

1350mm

1200mm

Prediction Line 1

Wellers Rd Overbridge (101.162km)

LW S1B
LW S2B
LW S3B
LW S4B
LW S5B
LW S6B

HORNESCK

LEGEND

SUBSIDENCE CONTOUR COLOUR SCALE (mm)

1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
50
20

NOTE:
The value of the Subsidence Contours, from the outside to the inside of the panels, are 20mm, 50mm, 100mm, 200mm, and so forth, in 100mm increments.

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-15 Subsidence Monitoring.dwg

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# TAHMOOR SOUTH PROJECT EXTRACTION PLAN LW S1A TO LW S7A

## SUBSIDENCE MONITORING

| DATE: | SCALE: | DRAWING No: | Rev No |
|---|---|---|---|
| 27 Mar 2024 | 1:25000 | MSEC1348-15 | A |

Series of survey marks (one on each side of bank) above previously extracted longwalls, subject to access by land owners & available lines of sight.

STUDY AREA

LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
LW S7A

Railway Viaduct
MAIN SOUTHERN RAILWAY
BARGO RIVER ROAD
REMEMBRANCE DR
STRATFORD RD
ROCKFORD ROAD
OLIVE GROVE
FIRE ROAD NO P1
BARGO RIVER GORGE
Tahmoor Colliery
Wollondilly Anglican College
Poultry Sheds
Wrecker
Igloos
Service Station
Gantry
Hidden creek
TEATREE HOLLOW
Tahmoor Garden Centre
CALOOLA ROAD
Along Tahmoor Mine property boundary
Teatree 3
Teatree 2
Australian Wildlife Sanctuary
Concrete materials plant
Picton Weir
NBN Tower
YARRAN ROAD
CHARLIES POINT RD
Wellers Rd Bridge
WELLERS RD
HOGANS DRIVE
GLAREMONT DRIVE
ASHBY CL
ELVY STREET
LLOYDS WAY
HAMBRIDGE ROAD
KADER STREET
MIMOSA STREET
CAMBALAN STREET
RADNOR ROAD
GWYNN HUGHES STREET
NOONGAH ST
BINGARRA PLACE
NOORAL STREET
GREAT SOUTHERN RD
ANTHONY ROAD
IRONBARK ROAD
WATTLE STREET
DYMOND ROAD
GOVERNMENT ROAD
BARGO ROAD
JOHNSTON RD
HORNES CK
BARGO RIVER
DOG TRAP

S01 S02 S03 S04 S05 S06 S07 S08 S09 S10 S11 S12 S13 S14 S15 S16 S17 S18 S19 S20 S21 S22 S23 S24 S25 S26 S27

TT9 TT12

278 000
6 208 000
6 206 000
6 204 000

## LEGEND

- WATER MONITORING SITE
- INSTALLED MONITORING LINES
- INSTALLED MONITORING PEGS
- PROPOSED MONITORING LINES
- PROPOSED CREEK MONITORING PEGS
- PROPOSED CREEK CROSSLINES
- INSTALLED GNSS
- CRITICAL POLES MONITORING
- WATERCOURSE

# APPENDIX C. TABLES

# Table C.01 - Predictions for Stream Pools

| Stream | Pool | Predicted Total Subsidence after all Longwalls (mm) | Predicted Total Upsidence after all Longwalls (mm) | Predicted Total Closure after all Longwalls (mm) |
|---|---|---|---|---|
| | | | | |
| Hornes Creek | HC-P01 | < 20 | < 20 | < 20 |
| | HC-P02 | < 20 | < 20 | < 20 |
| | HC-P03 | < 20 | < 20 | < 20 |
| | HC-P04 | < 20 | < 20 | < 20 |
| | HC-P05 | < 20 | < 20 | < 20 |
| | HC-P06 | < 20 | < 20 | < 20 |
| | HC-P07 | < 20 | < 20 | < 20 |
| | HC-P08 | < 20 | 40 | 50 |
| | HC-P09 | 20 | 40 | 60 |
| | HC-P10 | < 20 | 40 | 50 |
| | HC-P11 | < 20 | 40 | 60 |
| | HC-P12 | < 20 | 40 | 50 |
| | HC-P13 | < 20 | 30 | 30 |
| | HC-P14 | < 20 | 40 | 50 |
| | HC-P15 | < 20 | 40 | 40 |
| | HC-P16 | < 20 | 40 | 50 |
| Teatree Hollow | TT9 | 1300 | 275 | 225 |
| | TT12 | 1100 | 400 | 250 |
| | TT7 | 100 | 90 | 175 |
| | TT14 | 100 | 80 | 150 |
| | TT5 | 70 | 50 | 100 |
| | TT6 | < 20 | < 20 | < 20 |
| | TT4 | < 20 | < 20 | < 20 |
| | TT8 | < 20 | < 20 | < 20 |
| Tributary of Teatree Hollow | TT1 | 125 | 125 | 70 |
| | TT2 | 1300 | 375 | 225 |
| | TT11 | 850 | 300 | 325 |
| | TT3 | 800 | 300 | 350 |
| | TT13 | 200 | 125 | 250 |
| | | | | |

# Table C.02 - Details of Houses

| House Ref. | Maximum Plan Dimension (m) | Plan Area (m2) | Number of Stories | Wall Construction | Footing Construction | Wall and Footing Construction | Roof Constructtion | House Located Above Goaf | House Located Above Solid Coal |
|---|---|---|---|---|---|---|---|---|---|
| BCA_001_h01 | 21 | 234 | 1 | Fibro | Slab on Ground | Timber Framed | Metal | 1 | |
| BCA_010_h01 | 24 | 252 | 1 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Metal | 1 | |
| BCA_015_h01 | 18 | 227 | 1 | Brick or Brick-Veneer | N/A | Brick with Unknown Footings | Metal | 1 | |
| BCA_020_h01 | 17 | 217 | 1 | Weatherboard | N/A | Timber Framed | Metal | 1 | |
| BCA_025_h01 | 30 | 298 | 1 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Metal | 1 | |
| BCA_030_h01 | 32 | 291 | 1 | Brick or Brick-Veneer | N/A | Brick with Unknown Footings | Tiled | 1 | |
| BCA_035_h01 | 17 | 181 | 1 | Brick or Brick-Veneer | N/A | Brick with Unknown Footings | Tiled | 1 | |
| BCA_040_h01 | 14 | 159 | 1 | Weatherboard | Suspended on Piers | Timber Framed | Metal | 1 | |
| BCA_095_h01 | 22 | 279 | 1 | Brick or Brick-Veneer | N/A | Brick with Unknown Footings | Tiled | 1 | |
| BCA_100_h01 | 31 | 370 | 1 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Metal | 1 | |
| BCA_105_h01 | 22 | 259 | 1 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Tiled | 1 | |
| BCA_110_h01 | 23 | 189 | 1 | Brick or Brick-Veneer | Strip Footing | Brick with Strip Footings | Metal | | 1 |
| BCA_120_h01 | 19 | 230 | 1 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Metal | | 1 |
| BEL_001_h01 | 19 | 293 | 1 | Fibro | Suspended on Piers | Timber Framed | Metal | | 1 |
| BRE_140_h01 | 28 | 361 | 1 | Brick or Brick-Veneer | Strip Footing | Brick with Strip Footings | Metal | 1 | |
| BRE_143_h01 | 17 | 176 | 1 | Weatherboard | Suspended on Piers | Timber Framed | Metal | 1 | |
| BRE_148_h01 | 20 | 303 | 1 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Tiled | 1 | |
| BRE_154_h01 | 19 | 174 | 1 | Brick or Brick-Veneer | Strip Footing | Brick with Strip Footings | Tiled | 1 | |
| BRE_165_h01 | 9 | 63 | 1 | Weatherboard | N/A | Timber Framed | Metal | 1 | |
| BRE_167_h01 | 19 | 160 | 2 | Brick or Brick-Veneer | N/A | Brick with Unknown Footings | Tiled | 1 | |
| BRE_177_h01 | 14 | 158 | 1 | Weatherboard | Suspended on Piers | Timber Framed | Metal | 1 | |
| BRE_187_h01 | 29 | 396 | 2 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Tiled | 1 | |
| BRE_191_h01 | 15 | 134 | 1 | Weatherboard | N/A | Timber Framed | Metal | 1 | |
| BRE_201_h01 | 22 | 272 | 1 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Metal | | 1 |
| BRE_515_h02 | 26 | 401 | 2 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Tiled | 1 | |
| BWE_019_h02 | 35 | 519 | 2 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Metal | 1 | |
| BWE_023_h01 | 26 | 296 | 1 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Tiled | 1 | |
| BWE_025_h01 | 18 | 225 | 1 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Tiled | 1 | |
| BWE_027_h01 | 18 | 208 | 1 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Tiled | | 1 |
| BWE_051_h01 | 22 | 201 | 1 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Tiled | | 1 |
| BYR_001_h01 | 10 | 95 | 1 | Weatherboard | Suspended on Piers | Timber Framed | Tiled | 1 | |
| BYR_005_h01 | 22 | 165 | 1 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Tiled | 1 | |
| BYR_015_h01 | 17 | 232 | 1 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Tiled | 1 | |
| BYR_025_h01 | 35 | 538 | 1 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Metal | 1 | |
| BYR_035_h01 | 17 | 119 | 1 | Weatherboard | N/A | Timber Framed | Metal | 1 | |
| BYR_045_h01 | 18 | 152 | 1 | Weatherboard | Suspended on Piers | Timber Framed | Metal | 1 | |
| BYR_045_h02 | 50 | 819 | 1 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Metal | 1 | |
| BYR_055_h01 | 19 | 275 | 1 | Brick or Brick-Veneer | N/A | Brick with Unknown Footings | Tiled | 1 | |
| BYR_065_h01 | 18 | 245 | 1 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Tiled | 1 | |
| BYR_065_h02 | 15 | 131 | 1 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Metal | 1 | |
| BYR_075_h01 | 21 | 264 | 1 | Brick or Brick-Veneer | N/A | Brick with Unknown Footings | Tiled | 1 | |

# Table C.02 - Details of Houses

| House Ref. | Maximum Plan Dimension (m) | Plan Area (m2) | Number of Stories | Wall Construction | Footing Construction | Wall and Footing Construction | Roof Constructtion | House Located Above Goaf | House Located Above Solid Coal |
|---|---|---|---|---|---|---|---|---|---|
| BYR_075_h02 | 10 | 80 | 1 | Weatherboard | Suspended on Piers | Timber Framed | Metal | 1 | |
| BYR_084_h01 | 17 | 171 | 1 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Tiled | | 1 |
| BYR_085_h01 | 19 | 200 | 1 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Tiled | | 1 |
| BYR_085_h02 | 8 | 45 | 1 | Weatherboard | Suspended on Piers | Timber Framed | Metal | | 1 |
| BYR_085_h03 | 18 | 147 | 1 | Weatherboard | Slab on Ground | Timber Framed | Metal | | 1 |
| BYR_095_h01 | 37 | 591 | 1 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Metal | | 1 |
| BYR_105_h01 | 11 | 87 | 1 | Fibro | Suspended on Piers | Timber Framed | Metal | | 1 |
| BYR_115_h02 | 48 | 592 | 1 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Metal | | 1 |
| BYR_125_h01 | 18 | 156 | 1 | Weatherboard | Suspended on Piers | Timber Framed | Metal | 1 | |
| BYR_135_h01 | 16 | 141 | 1 | Weatherboard | Suspended on Piers | Timber Framed | Tiled | 1 | |
| BYR_135_h02 | 41 | 484 | 1 | Weatherboard | Slab on Ground | Timber Framed | Metal | 1 | |
| BYR_145_h01 | 21 | 215 | 1 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Tiled | 1 | |
| BYR_150_h01 | 12 | 102 | 1 | Brick or Brick-Veneer | N/A | Brick with Unknown Footings | Tiled | 1 | |
| BYR_150_h02 | 7 | 39 | 1 | Weatherboard | N/A | Timber Framed | Tiled | 1 | |
| BYR_152_h01 | 20 | 257 | 1 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Tiled | 1 | |
| BYR_154_h01 | 27 | 327 | 1 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Tiled | 1 | |
| BYR_156_h01 | 22 | 268 | 1 | Weatherboard | Suspended on Piers | Timber Framed | Metal | 1 | |
| BYR_156_h02 | 12 | 95 | 1 | Weatherboard | Suspended on Piers | Timber Framed | Metal | 1 | |
| BYR_158_h01 | 14 | 77 | 1 | Weatherboard | Suspended on Piers | Timber Framed | Metal | 1 | |
| BYR_160_h01 | 30 | 285 | 1 | Brick or Brick-Veneer | Slab on Ground | Brick with Slab on Ground | Tiled | 1 | |
| BYR_162_h01 | 18 | 156 | 1 | Weatherboard | N/A | Timber Framed | Metal | 1 | |

# Table C.03 - Predictions for Houses

| House Ref. | Predicted Incremental Subsidence due to LW S7A (mm) | Predicted Incremental Tilt due to LW S7A (mm/m) | Predicted Incremental Hogging Curvature due to LW S7A (1/km) | Predicted Incremental Sagging Curvature due to LW S7A (1/km) | Predicted Total Subsidence after LW S1A to S7A (mm) | Predicted Final Tilt after all Longwalls (mm/m) | Predicted Maximum Tilt after any Longwall (mm/m) | Predicted Total Hogging Curvature after LW S1A to S7A (1/km) | Predicted Total Sagging Curvature after LW S1A to S7A (1/km) | Predicted Probability of Nil or Category R0 Impact (%) | Predicted Probability of Category R1 or R2 Impact (%) | Predicted Probability of Category R3 or R4 Impact (%) | Predicted Probability of Category R5 Impact (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCA_001_h01 | 125 | 1.0 | < 0.01 | 0.01 | 550 | 5.5 | 5.5 | 0.05 | 0.03 | 71.6 | 19.4 | 8.6 | 0.4 |
| BCA_010_h01 | 100 | 0.5 | < 0.01 | < 0.01 | 1200 | 6.5 | 8.0 | 0.09 | 0.14 | 49.5 | 35.8 | 13.6 | 1.0 |
| BCA_015_h01 | 90 | < 0.5 | < 0.01 | < 0.01 | 1350 | 7.0 | 8.0 | 0.09 | 0.22 | 42.2 | 35.2 | 15.7 | 6.9 |
| BCA_020_h01 | 50 | < 0.5 | < 0.01 | < 0.01 | 1200 | 4.0 | 4.0 | 0.05 | 0.05 | 71.3 | 19.6 | 8.7 | 0.4 |
| BCA_025_h01 | 40 | < 0.5 | < 0.01 | < 0.01 | 1150 | 4.0 | 4.0 | 0.05 | 0.04 | 66.3 | 26.3 | 7.0 | 0.5 |
| BCA_030_h01 | 40 | < 0.5 | < 0.01 | < 0.01 | 1100 | 3.5 | 3.5 | 0.05 | 0.04 | 54.7 | 28.2 | 13.5 | 3.7 |
| BCA_035_h01 | 30 | < 0.5 | < 0.01 | < 0.01 | 950 | 2.0 | 4.5 | 0.09 | 0.03 | 46.4 | 32.7 | 15.2 | 5.7 |
| BCA_040_h01 | 20 | < 0.5 | < 0.01 | < 0.01 | 1250 | 6.5 | 8.0 | 0.09 | 0.10 | 69.0 | 21.4 | 9.1 | 0.5 |
| BCA_095_h01 | 20 | < 0.5 | < 0.01 | < 0.01 | 1300 | 6.5 | 8.0 | 0.08 | 0.18 | 43.0 | 34.7 | 15.6 | 6.7 |
| BCA_100_h01 | 30 | < 0.5 | < 0.01 | < 0.01 | 1050 | 6.0 | 7.5 | 0.08 | 0.06 | 58.3 | 31.3 | 9.8 | 0.6 |
| BCA_105_h01 | 30 | < 0.5 | < 0.01 | < 0.01 | 700 | 4.0 | 4.0 | 0.05 | 0.03 | 65.4 | 26.9 | 7.2 | 0.5 |
| BCA_110_h01 | 30 | < 0.5 | < 0.01 | < 0.01 | 425 | 5.0 | 5.0 | 0.06 | 0.01 | 51.8 | 29.5 | 14.5 | 4.2 |
| BCA_120_h01 | 30 | < 0.5 | 0.01 | < 0.01 | 100 | 1.5 | 1.5 | 0.02 | < 0.01 | 77.2 | 18.3 | 4.2 | 0.3 |
| BEL_001_h01 | < 20 | < 0.5 | < 0.01 | < 0.01 | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 | 95.7 | 3.3 | 0.8 | 0.1 |
| BRE_140_h01 | 30 | < 0.5 | < 0.01 | < 0.01 | 1000 | 3.0 | 3.0 | 0.06 | 0.03 | 50.6 | 30.1 | 15.0 | 4.4 |
| BRE_143_h01 | 50 | < 0.5 | < 0.01 | < 0.01 | 1300 | 3.5 | 3.5 | 0.06 | 0.04 | 70.9 | 19.8 | 8.8 | 0.5 |
| BRE_148_h01 | 50 | < 0.5 | < 0.01 | < 0.01 | 1300 | 4.0 | 4.0 | 0.06 | 0.05 | 63.5 | 28.5 | 7.9 | 0.1 |
| BRE_154_h01 | 80 | < 0.5 | < 0.01 | < 0.01 | 1350 | 7.0 | 8.0 | 0.06 | 0.22 | 42.1 | 35.2 | 15.7 | 6.9 |
| BRE_165_h01 | 70 | 1.0 | < 0.01 | < 0.01 | 1300 | 7.0 | 8.0 | 0.08 | 0.19 | 66.3 | 23.0 | 10.2 | 0.5 |
| BRE_167_h01 | 50 | 1.0 | 0.02 | < 0.01 | 850 | 5.0 | 6.0 | 0.09 | 0.05 | 46.5 | 32.6 | 15.2 | 5.7 |
| BRE_177_h01 | < 20 | < 0.5 | < 0.01 | < 0.01 | 425 | 6.0 | 6.0 | 0.08 | < 0.01 | 69.1 | 21.1 | 9.3 | 0.5 |
| BRE_187_h01 | < 20 | < 0.5 | < 0.01 | < 0.01 | 275 | 5.0 | 5.0 | 0.08 | < 0.01 | 58.6 | 31.2 | 9.7 | 0.6 |
| BRE_191_h01 | < 20 | < 0.5 | < 0.01 | < 0.01 | 225 | 4.0 | 4.0 | 0.08 | < 0.01 | 69.1 | 21.2 | 9.2 | 0.5 |
| BRE_201_h01 | < 20 | < 0.5 | < 0.01 | < 0.01 | 60 | 0.5 | 0.5 | < 0.01 | < 0.01 | 91.5 | 7.4 | 1.0 | 0.2 |
| BRE_515_h02 | 20 | < 0.5 | < 0.01 | < 0.01 | 1300 | 6.5 | 8.0 | 0.09 | 0.17 | 47.2 | 36.4 | 15.2 | 1.2 |
| BWE_019_h02 | < 20 | < 0.5 | < 0.01 | < 0.01 | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 | 95.3 | 4.4 | 0.2 | 0.1 |
| BWE_023_h01 | < 20 | < 0.5 | < 0.01 | < 0.01 | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 | 95.4 | 4.3 | 0.2 | 0.1 |
| BWE_025_h01 | < 20 | < 0.5 | < 0.01 | < 0.01 | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 | 95.4 | 4.3 | 0.2 | 0.1 |
| BWE_027_h01 | < 20 | < 0.5 | < 0.01 | < 0.01 | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 | 95.4 | 4.3 | 0.2 | 0.1 |
| BWE_051_h01 | < 20 | < 0.5 | < 0.01 | < 0.01 | 30 | < 0.5 | < 0.5 | < 0.01 | < 0.01 | 94.0 | 5.4 | 0.5 | 0.1 |
| BYR_001_h01 | 150 | 0.5 | < 0.01 | < 0.01 | 950 | 3.5 | 6.0 | 0.09 | 0.02 | 69.0 | 21.3 | 9.2 | 0.5 |
| BYR_005_h01 | 250 | 1.0 | 0.02 | 0.01 | 1300 | 4.0 | 4.0 | 0.06 | 0.08 | 59.4 | 30.8 | 9.3 | 0.5 |
| BYR_015_h01 | 300 | 1.0 | 0.05 | 0.02 | 1350 | 7.5 | 8.5 | 0.08 | 0.23 | 43.6 | 37.1 | 17.3 | 2.0 |
| BYR_025_h01 | 550 | 3.0 | 0.04 | 0.03 | 750 | 2.0 | 3.5 | 0.08 | 0.03 | 58.9 | 31.0 | 9.5 | 0.5 |
| BYR_035_h01 | 450 | 2.0 | 0.03 | 0.02 | 800 | 3.5 | 5.5 | 0.09 | 0.02 | 69.0 | 21.3 | 9.2 | 0.5 |
| BYR_045_h01 | 900 | 3.5 | 0.06 | 0.04 | 1050 | 3.0 | 3.0 | 0.06 | 0.04 | 70.9 | 19.8 | 8.8 | 0.5 |
| BYR_045_h02 | 950 | 3.5 | 0.06 | 0.09 | 1100 | 3.0 | 3.0 | 0.06 | 0.09 | 57.1 | 32.0 | 10.3 | 0.6 |
| BYR_055_h01 | 950 | 7.5 | 0.06 | 0.21 | 1100 | 8.0 | 8.0 | 0.06 | 0.22 | 42.2 | 35.2 | 15.7 | 6.9 |
| BYR_065_h01 | 800 | 8.0 | 0.09 | 0.13 | 950 | 8.5 | 8.5 | 0.09 | 0.13 | 50.3 | 35.6 | 13.1 | 1.0 |
| BYR_065_h02 | 450 | 6.5 | 0.09 | 0.02 | 550 | 7.0 | 7.0 | 0.09 | 0.02 | 56.6 | 32.3 | 10.5 | 0.7 |
| BYR_075_h01 | 300 | 4.0 | 0.07 | 0.02 | 375 | 4.5 | 4.5 | 0.08 | 0.02 | 47.4 | 32.1 | 15.1 | 5.4 |
| BYR_075_h02 | 225 | 2.5 | 0.05 | 0.01 | 300 | 3.0 | 3.0 | 0.05 | 0.01 | 71.2 | 19.7 | 8.7 | 0.4 |
| BYR_084_h01 | 200 | 2.0 | 0.03 | < 0.01 | 250 | 2.5 | 2.5 | 0.04 | < 0.01 | 70.4 | 23.4 | 6.0 | 0.3 |
| BYR_085_h01 | 175 | 1.5 | 0.02 | < 0.01 | 225 | 2.0 | 2.0 | 0.03 | < 0.01 | 75.6 | 19.5 | 4.6 | 0.3 |
| BYR_085_h02 | 200 | 1.5 | 0.03 | < 0.01 | 250 | 2.0 | 2.0 | 0.03 | < 0.01 | 77.7 | 15.5 | 6.5 | 0.3 |
| BYR_085_h03 | 150 | 1.0 | 0.01 | < 0.01 | 200 | 1.5 | 1.5 | 0.01 | < 0.01 | 87.4 | 8.9 | 3.6 | 0.1 |
| BYR_095_h01 | 150 | 1.0 | 0.01 | < 0.01 | 175 | 1.0 | 1.0 | 0.01 | < 0.01 | 84.3 | 12.9 | 2.5 | 0.3 |
| BYR_105_h01 | 90 | < 0.5 | < 0.01 | < 0.01 | 125 | 0.5 | 0.5 | < 0.01 | < 0.01 | 93.2 | 5.0 | 1.7 | 0.1 |
| BYR_115_h02 | 100 | 0.5 | < 0.01 | < 0.01 | 150 | 1.0 | 1.0 | < 0.01 | < 0.01 | 88.7 | 9.5 | 1.5 | 0.3 |
| BYR_125_h01 | 350 | 5.0 | 0.08 | 0.02 | 425 | 5.5 | 5.5 | 0.09 | 0.02 | 69.0 | 21.3 | 9.2 | 0.5 |

# Table C.03 - Predictions for Houses

| House Ref. | Predicted Incremental Subsidence due to LW S7A (mm) | Predicted Incremental Tilt due to LW S7A (mm/m) | Predicted Incremental Hogging Curvature due to LW S7A (1/km) | Predicted Incremental Sagging Curvature due to LW S7A (1/km) | Predicted Total Subsidence after LW S1A to S7A (mm) | Predicted Final Tilt after all Longwalls (mm/m) | Predicted Maximum Tilt after any Longwall (mm/m) | Predicted Total Hogging Curvature after LW S1A to S7A (1/km) | Predicted Total Sagging Curvature after LW S1A to S7A (1/km) | Predicted Probability of Nil or Category R0 Impact (%) | Predicted Probability of Category R1 or R2 Impact (%) | Predicted Probability of Category R3 or R4 Impact (%) | Predicted Probability of Category R5 Impact (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BYR_135_h01 | 850 | 8.0 | 0.08 | 0.16 | 1000 | 8.5 | 8.5 | 0.09 | 0.17 | 66.8 | 22.7 | 10.0 | 0.5 |
| BYR_135_h02 | 900 | 8.0 | 0.09 | 0.21 | 1050 | 8.5 | 8.5 | 0.09 | 0.22 | 65.6 | 23.4 | 10.5 | 0.5 |
| BYR_145_h01 | 950 | 6.5 | 0.06 | 0.22 | 1100 | 7.5 | 7.5 | 0.06 | 0.23 | 43.6 | 37.1 | 17.3 | 2.0 |
| BYR_150_h01 | 250 | 1.0 | 0.02 | 0.01 | 1300 | 3.5 | 3.5 | 0.06 | 0.05 | 50.9 | 30.0 | 14.8 | 4.3 |
| BYR_150_h02 | 275 | 1.0 | 0.02 | 0.01 | 1300 | 3.5 | 3.5 | 0.06 | 0.05 | 70.6 | 20.1 | 8.8 | 0.5 |
| BYR_152_h01 | 225 | 1.0 | 0.02 | 0.01 | 1200 | 4.0 | 4.0 | 0.05 | 0.04 | 64.6 | 27.6 | 7.5 | 0.3 |
| BYR_154_h01 | 200 | 1.0 | 0.01 | 0.01 | 1100 | 3.5 | 3.5 | 0.05 | 0.04 | 66.5 | 26.1 | 6.9 | 0.4 |
| BYR_156_h01 | 175 | 1.0 | 0.01 | < 0.01 | 1000 | 3.0 | 3.0 | 0.06 | 0.03 | 70.4 | 20.2 | 8.9 | 0.5 |
| BYR_156_h02 | 200 | 1.0 | 0.01 | < 0.01 | 1000 | 3.5 | 3.5 | 0.04 | 0.04 | 73.3 | 18.4 | 8.0 | 0.3 |
| BYR_158_h01 | 150 | 0.5 | < 0.01 | < 0.01 | 900 | 2.0 | 4.5 | 0.09 | 0.03 | 69.0 | 21.3 | 9.2 | 0.5 |
| BYR_160_h01 | 100 | 0.5 | < 0.01 | < 0.01 | 1250 | 7.0 | 8.5 | 0.10 | 0.10 | 54.4 | 33.4 | 11.4 | 0.8 |
| BYR_162_h01 | 80 | 0.5 | < 0.01 | < 0.01 | 1350 | 7.0 | 8.5 | 0.08 | 0.23 | 65.5 | 23.5 | 10.5 | 0.5 |
| **Maxima:** | **950** | **8.0** | **0.09** | **0.22** | **1350** | **8.5** | **8.5** | **0.10** | **0.23** | | | | |

# Table C.04 - Predictions for Rural Structures

| Structure Ref. | Maximum Plan Dimension (m) | Predicted Incremental Subsidence due to LW S7A (mm) | Predicted Incremental Tilt due to LW S7A (mm/m) | Predicted Incremental Hogging Curvature due to LW S7A (1/km) | Predicted Incremental Sagging Curvature due to LW S7A (1/km) | Predicted Total Subsidence after LW S1A to S7A (mm) | Predicted Final Tilt after all Longwalls (mm/m) | Predicted Maximum Tilt after any Longwall (mm/m) | Predicted Total Hogging Curvature after LW S1A to S7A (1/km) | Predicted Total Sagging Curvature after LW S1A to S7A (1/km) |
|---|---|---|---|---|---|---|---|---|---|---|
| BCA_001_r01 | 8 | 125 | 1.0 | < 0.01 | 0.01 | 500 | 5.0 | 5.0 | 0.05 | 0.01 |
| BCA_001_r02 | 17 | 225 | 1.0 | 0.01 | 0.01 | 1000 | 6.0 | 6.0 | 0.02 | 0.07 |
| BCA_001_r03 | 7 | 225 | 1.0 | 0.01 | 0.01 | 1050 | 4.5 | 4.5 | 0.03 | 0.06 |
| BCA_001_r04 | 6 | 250 | 1.0 | 0.01 | 0.01 | 1150 | 5.0 | 5.0 | 0.04 | 0.06 |
| BCA_001_r05 | 15 | 250 | 1.5 | 0.01 | 0.02 | 1000 | 8.0 | 8.0 | 0.03 | 0.12 |
| BCA_001_r07 | 4 | 150 | 1.0 | < 0.01 | 0.01 | 600 | 6.0 | 6.0 | 0.04 | 0.04 |
| BCA_001_r09 | 3 | 250 | 1.0 | 0.01 | 0.01 | 1150 | 5.0 | 5.0 | 0.04 | 0.06 |
| BCA_001_r10 | 4 | 250 | 1.0 | 0.02 | 0.01 | 1200 | 5.0 | 5.0 | 0.04 | 0.06 |
| BCA_010_r01 | 10 | 100 | 0.5 | < 0.01 | < 0.01 | 1100 | 6.5 | 8.0 | 0.09 | 0.05 |
| BCA_010_r02 | 12 | 125 | 0.5 | < 0.01 | < 0.01 | 900 | 4.5 | 6.5 | 0.09 | 0.05 |
| BCA_010_r03 | 7 | 125 | 0.5 | < 0.01 | < 0.01 | 950 | 5.0 | 7.0 | 0.09 | 0.04 |
| BCA_010_r04 | 6 | 100 | 0.5 | < 0.01 | < 0.01 | 1100 | 6.5 | 8.0 | 0.09 | 0.04 |
| BCA_010_r05 | 4 | 100 | 0.5 | < 0.01 | < 0.01 | 1150 | 6.5 | 8.0 | 0.09 | 0.05 |
| BCA_010_r06 | 11 | 100 | 0.5 | < 0.01 | < 0.01 | 1150 | 6.5 | 8.0 | 0.09 | 0.05 |
| BCA_010_r07 | 6 | 100 | 0.5 | < 0.01 | < 0.01 | 1100 | 6.5 | 8.0 | 0.09 | 0.05 |
| BCA_010_r08 | 10 | 175 | 0.5 | 0.01 | < 0.01 | 950 | 3.0 | 3.0 | 0.05 | 0.04 |
| BCA_010_r09 | 6 | 125 | 0.5 | < 0.01 | < 0.01 | 900 | 4.5 | 6.5 | 0.09 | 0.04 |
| BCA_015_r01 | 16 | 100 | 0.5 | < 0.01 | < 0.01 | 1250 | 7.0 | 8.0 | 0.09 | 0.13 |
| BCA_015_r02 | 18 | 100 | 0.5 | < 0.01 | < 0.01 | 1300 | 7.0 | 8.0 | 0.09 | 0.13 |
| BCA_015_r03 | 4 | 100 | 0.5 | < 0.01 | < 0.01 | 1150 | 6.5 | 8.0 | 0.09 | 0.05 |
| BCA_020_r02 | 4 | 50 | < 0.5 | < 0.01 | < 0.01 | 1200 | 4.0 | 4.0 | 0.05 | 0.05 |
| BCA_020_r03 | 6 | 50 | < 0.5 | < 0.01 | < 0.01 | 1250 | 4.0 | 4.0 | 0.05 | 0.05 |
| BCA_020_r07 | 6 | 40 | < 0.5 | < 0.01 | < 0.01 | 1150 | 4.0 | 4.0 | 0.04 | 0.05 |
| BCA_020_r08 | 20 | 50 | < 0.5 | < 0.01 | < 0.01 | 1250 | 4.0 | 4.0 | 0.05 | 0.05 |
| BCA_020_r09 | 4 | 50 | < 0.5 | < 0.01 | < 0.01 | 1250 | 4.0 | 4.0 | 0.05 | 0.05 |
| BCA_020_r10 | 5 | 50 | < 0.5 | < 0.01 | < 0.01 | 1300 | 4.0 | 4.0 | 0.05 | 0.05 |
| BCA_020_r11 | 2 | 60 | < 0.5 | < 0.01 | < 0.01 | 1300 | 4.5 | 4.5 | 0.05 | 0.06 |
| BCA_020_r12 | 2 | 60 | < 0.5 | < 0.01 | < 0.01 | 1300 | 4.0 | 4.0 | 0.05 | 0.06 |
| BCA_020_r13 | 2 | 60 | < 0.5 | < 0.01 | < 0.01 | 1300 | 4.0 | 4.0 | 0.05 | 0.08 |
| BCA_020_r14 | 2 | 60 | < 0.5 | < 0.01 | < 0.01 | 1350 | 4.0 | 4.0 | 0.05 | 0.11 |
| BCA_020_r15 | 2 | 60 | < 0.5 | < 0.01 | < 0.01 | 1350 | 4.0 | 4.0 | 0.05 | 0.14 |
| BCA_020_r16 | 2 | 60 | < 0.5 | < 0.01 | < 0.01 | 1350 | 4.0 | 4.0 | 0.05 | 0.18 |
| BCA_020_r17 | 2 | 70 | < 0.5 | < 0.01 | < 0.01 | 1350 | 3.5 | 3.5 | 0.05 | 0.20 |
| BCA_020_r18 | 2 | 70 | < 0.5 | < 0.01 | < 0.01 | 1350 | 3.5 | 3.5 | 0.06 | 0.22 |
| BCA_025_r01 | 12 | 40 | < 0.5 | < 0.01 | < 0.01 | 1150 | 4.0 | 4.0 | 0.05 | 0.04 |
| BCA_025_r03 | 4 | 50 | < 0.5 | < 0.01 | < 0.01 | 1250 | 4.0 | 4.0 | 0.05 | 0.04 |
| BCA_025_r04 | 4 | 50 | < 0.5 | < 0.01 | < 0.01 | 1250 | 4.0 | 4.0 | 0.05 | 0.05 |
| BCA_025_r05 | 9 | 50 | < 0.5 | < 0.01 | < 0.01 | 1300 | 4.0 | 4.0 | 0.06 | 0.05 |
| BCA_025_r07 | 3 | 60 | < 0.5 | < 0.01 | < 0.01 | 1300 | 4.0 | 4.0 | 0.06 | 0.05 |
| BCA_025_r08 | 4 | 60 | < 0.5 | < 0.01 | < 0.01 | 1350 | 4.0 | 4.0 | 0.06 | 0.05 |
| BCA_025_r09 | 3 | 40 | < 0.5 | < 0.01 | < 0.01 | 1200 | 4.0 | 4.0 | 0.05 | 0.04 |
| BCA_030_r01 | 7 | 40 | < 0.5 | < 0.01 | < 0.01 | 1050 | 3.5 | 3.5 | 0.04 | 0.03 |
| BCA_030_r02 | 10 | 50 | < 0.5 | < 0.01 | < 0.01 | 1300 | 4.0 | 4.0 | 0.06 | 0.05 |

# Table C.04 - Predictions for Rural Structures

| Structure Ref. | Maximum Plan Dimension (m) | Predicted Incremental Subsidence due to LW S7A (mm) | Predicted Incremental Tilt due to LW S7A (mm/m) | Predicted Incremental Hogging Curvature due to LW S7A (1/km) | Predicted Incremental Sagging Curvature due to LW S7A (1/km) | Predicted Total Subsidence after LW S1A to S7A (mm) | Predicted Final Tilt after all Longwalls (mm/m) | Predicted Maximum Tilt after any Longwall (mm/m) | Predicted Total Hogging Curvature after LW S1A to S7A (1/km) | Predicted Total Sagging Curvature after LW S1A to S7A (1/km) |
|---|---|---|---|---|---|---|---|---|---|---|
| BCA_030_r03 | 13 | 40 | < 0.5 | < 0.01 | < 0.01 | 1150 | 3.5 | 3.5 | 0.05 | 0.04 |
| BCA_030_r04 | 6 | 40 | < 0.5 | < 0.01 | < 0.01 | 1150 | 4.0 | 4.0 | 0.05 | 0.04 |
| BCA_035_r01 | 11 | 30 | < 0.5 | < 0.01 | < 0.01 | 900 | 1.5 | 4.0 | 0.08 | 0.03 |
| BCA_035_r02 | 13 | 40 | < 0.5 | < 0.01 | < 0.01 | 1100 | 3.5 | 3.5 | 0.05 | 0.04 |
| BCA_035_r03 | 3 | 40 | < 0.5 | < 0.01 | < 0.01 | 1150 | 4.0 | 4.0 | 0.05 | 0.04 |
| BCA_035_r04 | 3 | 30 | < 0.5 | < 0.01 | < 0.01 | 950 | 2.0 | 3.0 | 0.07 | 0.03 |
| BCA_040_r02 | 10 | 20 | < 0.5 | < 0.01 | < 0.01 | 1150 | 6.0 | 8.0 | 0.09 | 0.03 |
| BCA_040_r03 | 5 | 20 | < 0.5 | < 0.01 | < 0.01 | 1100 | 5.5 | 8.0 | 0.09 | 0.03 |
| BCA_040_r04 | 5 | 20 | < 0.5 | < 0.01 | < 0.01 | 1050 | 5.0 | 7.5 | 0.09 | 0.03 |
| BCA_040_r05 | 7 | 30 | < 0.5 | < 0.01 | < 0.01 | 1050 | 5.0 | 7.5 | 0.09 | 0.03 |
| BCA_040_r06 | 6 | 30 | < 0.5 | < 0.01 | < 0.01 | 1000 | 4.0 | 6.0 | 0.09 | 0.02 |
| BCA_095_r02 | 9 | 20 | < 0.5 | < 0.01 | < 0.01 | 1200 | 6.0 | 7.5 | 0.07 | 0.14 |
| BCA_095_r03 | 11 | 20 | < 0.5 | < 0.01 | < 0.01 | 1250 | 6.5 | 8.0 | 0.07 | 0.16 |
| BCA_100_r01 | 9 | 20 | < 0.5 | < 0.01 | < 0.01 | 800 | 5.5 | 6.5 | 0.07 | 0.05 |
| BCA_100_r02 | 7 | 20 | < 0.5 | < 0.01 | < 0.01 | 800 | 6.0 | 6.5 | 0.06 | 0.05 |
| BCA_100_r03 | 6 | 20 | < 0.5 | < 0.01 | < 0.01 | 800 | 6.0 | 6.5 | 0.06 | 0.05 |
| BCA_100_r04 | 3 | 30 | < 0.5 | < 0.01 | < 0.01 | 800 | 4.5 | 5.5 | 0.07 | 0.05 |
| BCA_100_r05 | 5 | 30 | < 0.5 | < 0.01 | < 0.01 | 800 | 4.5 | 5.5 | 0.07 | 0.05 |
| BCA_105_r01 | 11 | 30 | < 0.5 | < 0.01 | < 0.01 | 850 | 4.5 | 4.5 | 0.03 | 0.04 |
| BCA_105_r02 | 14 | 30 | < 0.5 | < 0.01 | < 0.01 | 500 | 4.5 | 4.5 | 0.04 | 0.02 |
| BCA_105_r03 | 16 | 30 | < 0.5 | < 0.01 | < 0.01 | 750 | 4.5 | 4.5 | 0.03 | 0.04 |
| BCA_105_r04 | 8 | 30 | < 0.5 | < 0.01 | < 0.01 | 750 | 4.0 | 4.0 | 0.06 | 0.04 |
| BCA_105_r05 | 3 | 30 | < 0.5 | < 0.01 | < 0.01 | 700 | 4.5 | 4.5 | 0.06 | 0.03 |
| BCA_110_r01 | 12 | 30 | < 0.5 | < 0.01 | < 0.01 | 425 | 5.0 | 5.0 | 0.06 | < 0.01 |
| BCA_110_r02 | 7 | 20 | < 0.5 | < 0.01 | < 0.01 | 400 | 4.5 | 4.5 | 0.04 | 0.01 |
| BCA_110_r04 | 9 | 20 | < 0.5 | < 0.01 | < 0.01 | 375 | 4.0 | 4.0 | 0.04 | < 0.01 |
| BCA_110_r07 | 11 | 40 | < 0.5 | < 0.01 | < 0.01 | 850 | 5.0 | 5.0 | 0.03 | 0.04 |
| BCA_120_r01 | 7 | 30 | < 0.5 | 0.01 | < 0.01 | 125 | 1.5 | 1.5 | 0.03 | < 0.01 |
| BCA_120_r02 | 5 | 30 | 0.5 | 0.01 | < 0.01 | 125 | 1.5 | 1.5 | 0.03 | < 0.01 |
| BCA_120_r03 | 3 | 30 | 0.5 | 0.01 | < 0.01 | 125 | 1.5 | 1.5 | 0.03 | < 0.01 |
| BCA_120_r04 | 5 | < 20 | < 0.5 | < 0.01 | < 0.01 | 70 | 0.5 | 0.5 | < 0.01 | < 0.01 |
| BCA_120_r05 | 11 | 20 | < 0.5 | < 0.01 | < 0.01 | 100 | 1.0 | 1.0 | 0.02 | < 0.01 |
| BCA_120_r06 | 7 | 20 | < 0.5 | < 0.01 | < 0.01 | 90 | 1.0 | 1.0 | 0.02 | < 0.01 |
| BCA_120_r07 | 4 | < 20 | < 0.5 | < 0.01 | < 0.01 | 70 | 0.5 | 0.5 | < 0.01 | < 0.01 |
| BCA_120_r09 | 3 | < 20 | < 0.5 | < 0.01 | < 0.01 | 90 | 1.0 | 1.0 | 0.01 | < 0.01 |
| BCA_120_r10 | 3 | 20 | < 0.5 | < 0.01 | < 0.01 | 100 | 1.5 | 1.5 | 0.02 | < 0.01 |
| BEL_001_r01 | 17 | < 20 | < 0.5 | < 0.01 | < 0.01 | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| BEL_001_r02 | 11 | < 20 | < 0.5 | < 0.01 | < 0.01 | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| BEL_001_r04 | 4 | < 20 | < 0.5 | < 0.01 | < 0.01 | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| BEL_001_r05 | 8 | < 20 | < 0.5 | < 0.01 | < 0.01 | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| BEL_001_r06 | 3 | < 20 | < 0.5 | < 0.01 | < 0.01 | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| BNO_043_r04 | 9 | < 20 | < 0.5 | < 0.01 | < 0.01 | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| BRE_090_r01 | 10 | 40 | < 0.5 | < 0.01 | < 0.01 | 1250 | 3.5 | 3.5 | 0.06 | 0.04 |

# Table C.04 - Predictions for Rural Structures

| Structure Ref. | Maximum Plan Dimension (m) | Predicted Incremental Subsidence due to LW S7A (mm) | Predicted Incremental Tilt due to LW S7A (mm/m) | Predicted Incremental Hogging Curvature due to LW S7A (1/km) | Predicted Incremental Sagging Curvature due to LW S7A (1/km) | Predicted Total Subsidence after LW S1A to S7A (mm) | Predicted Final Tilt after all Longwalls (mm/m) | Predicted Maximum Tilt after any Longwall (mm/m) | Predicted Total Hogging Curvature after LW S1A to S7A (1/km) | Predicted Total Sagging Curvature after LW S1A to S7A (1/km) |
|---|---|---|---|---|---|---|---|---|---|---|
| BRE_140_r01 | 11 | 30 | < 0.5 | < 0.01 | < 0.01 | 1000 | 3.0 | 3.0 | 0.05 | 0.03 |
| BRE_140_r02 | 6 | 30 | < 0.5 | < 0.01 | < 0.01 | 1050 | 3.0 | 3.0 | 0.04 | 0.03 |
| BRE_143_r01 | 3 | 50 | < 0.5 | < 0.01 | < 0.01 | 1300 | 3.5 | 3.5 | 0.06 | 0.04 |
| BRE_143_r02 | 6 | 50 | < 0.5 | < 0.01 | < 0.01 | 1300 | 3.5 | 3.5 | 0.06 | 0.05 |
| BRE_143_r03 | 7 | 50 | < 0.5 | < 0.01 | < 0.01 | 1300 | 3.5 | 3.5 | 0.06 | 0.05 |
| BRE_148_r01 | 7 | 50 | < 0.5 | < 0.01 | < 0.01 | 1300 | 3.5 | 3.5 | 0.06 | 0.06 |
| BRE_148_r02 | 8 | 50 | < 0.5 | < 0.01 | < 0.01 | 1350 | 3.5 | 3.5 | 0.06 | 0.08 |
| BRE_148_r03 | 7 | 60 | < 0.5 | < 0.01 | < 0.01 | 1350 | 3.0 | 3.0 | 0.06 | 0.22 |
| BRE_148_r04 | 2 | 50 | < 0.5 | < 0.01 | < 0.01 | 1350 | 3.5 | 3.5 | 0.06 | 0.06 |
| BRE_148_r05 | 6 | 50 | < 0.5 | < 0.01 | < 0.01 | 1350 | 3.5 | 3.5 | 0.06 | 0.12 |
| BRE_154_r01 | 6 | 80 | < 0.5 | < 0.01 | < 0.01 | 1350 | 7.0 | 8.0 | 0.07 | 0.22 |
| BRE_154_r02 | 9 | 90 | 0.5 | < 0.01 | < 0.01 | 1350 | 7.0 | 8.0 | 0.08 | 0.20 |
| BRE_154_r03 | 10 | 90 | < 0.5 | < 0.01 | < 0.01 | 1350 | 7.0 | 8.0 | 0.08 | 0.22 |
| BRE_154_r04 | 11 | 100 | 0.5 | < 0.01 | < 0.01 | 1300 | 7.0 | 8.0 | 0.09 | 0.15 |
| BRE_154_r05 | 5 | 100 | 0.5 | < 0.01 | < 0.01 | 1200 | 7.0 | 8.0 | 0.09 | 0.05 |
| BRE_154_r06 | 4 | 100 | 0.5 | < 0.01 | < 0.01 | 1150 | 7.0 | 8.0 | 0.09 | 0.04 |
| BRE_154_r07 | 10 | 100 | 0.5 | < 0.01 | < 0.01 | 1200 | 7.0 | 8.0 | 0.09 | 0.06 |
| BRE_167_r01 | 11 | 60 | 1.0 | 0.02 | < 0.01 | 900 | 5.0 | 6.5 | 0.09 | 0.05 |
| BRE_167_r02 | 9 | 70 | 1.0 | 0.02 | < 0.01 | 850 | 4.0 | 5.5 | 0.09 | 0.04 |
| BRE_167_r03 | 12 | 70 | 1.0 | 0.02 | < 0.01 | 800 | 3.5 | 4.5 | 0.08 | 0.04 |
| BRE_167_r04 | 12 | 80 | 1.0 | 0.02 | < 0.01 | 800 | 3.0 | 4.0 | 0.08 | 0.04 |
| BRE_167_r06 | 9 | 70 | 1.0 | 0.02 | < 0.01 | 800 | 3.0 | 3.5 | 0.07 | 0.04 |
| BRE_167_r07 | 7 | 70 | 1.0 | 0.02 | < 0.01 | 800 | 3.0 | 3.0 | 0.07 | 0.05 |
| BRE_167_r08 | 6 | 60 | 1.0 | 0.02 | < 0.01 | 800 | 3.5 | 4.5 | 0.08 | 0.05 |
| BRE_167_r09 | 6 | 50 | 1.0 | 0.02 | < 0.01 | 750 | 3.5 | 3.5 | 0.07 | 0.05 |
| BRE_167_r10 | 3 | 50 | 1.0 | 0.02 | < 0.01 | 750 | 3.5 | 4.5 | 0.08 | 0.05 |
| BRE_167_r12 | 3 | 50 | 1.0 | 0.02 | < 0.01 | 750 | 3.5 | 3.5 | 0.06 | 0.05 |
| BRE_167_r13 | 4 | 50 | 1.0 | 0.02 | < 0.01 | 750 | 3.5 | 3.5 | 0.06 | 0.05 |
| BRE_167_r14 | 3 | 60 | 1.0 | 0.02 | < 0.01 | 750 | 3.5 | 3.5 | 0.06 | 0.05 |
| BRE_167_r15 | 29 | 50 | 1.0 | 0.02 | < 0.01 | 800 | 4.5 | 4.5 | 0.05 | 0.06 |
| BRE_167_r16 | 19 | 60 | 1.0 | 0.02 | < 0.01 | 800 | 4.0 | 4.0 | 0.05 | 0.05 |
| BRE_167_r17 | 14 | 90 | 1.5 | 0.02 | < 0.01 | 900 | 4.0 | 4.0 | 0.04 | 0.05 |
| BRE_167_r18 | 3 | 60 | 1.0 | 0.02 | < 0.01 | 800 | 3.5 | 4.5 | 0.08 | 0.05 |
| BRE_167_r19 | 6 | 80 | 1.5 | 0.02 | < 0.01 | 900 | 4.5 | 4.5 | 0.03 | 0.05 |
| BRE_177_r01 | 6 | < 20 | < 0.5 | < 0.01 | < 0.01 | 450 | 6.0 | 6.0 | 0.08 | 0.01 |
| BRE_187_r01 | 9 | < 20 | < 0.5 | < 0.01 | < 0.01 | 350 | 6.0 | 6.0 | 0.09 | < 0.01 |
| BRE_189_r01 | 12 | < 20 | < 0.5 | < 0.01 | < 0.01 | 200 | 3.5 | 3.5 | 0.08 | < 0.01 |
| BRE_191_r01 | 13 | < 20 | < 0.5 | < 0.01 | < 0.01 | 225 | 3.5 | 3.5 | 0.08 | 0.01 |
| BRE_191_r02 | 4 | < 20 | < 0.5 | < 0.01 | < 0.01 | 275 | 4.5 | 4.5 | 0.10 | 0.02 |
| BRE_195_r02 | 12 | < 20 | < 0.5 | < 0.01 | < 0.01 | 125 | 1.0 | 1.0 | 0.02 | 0.01 |
| BRE_195_r03 | 8 | < 20 | < 0.5 | < 0.01 | < 0.01 | 125 | 1.5 | 1.5 | 0.03 | 0.02 |
| BRE_195_r04 | 4 | < 20 | < 0.5 | < 0.01 | < 0.01 | 80 | 1.0 | 1.0 | < 0.01 | < 0.01 |
| BRE_195_r06 | 8 | < 20 | < 0.5 | < 0.01 | < 0.01 | 150 | 2.0 | 2.0 | 0.03 | 0.02 |

# Table C.04 - Predictions for Rural Structures

| Structure Ref. | Maximum Plan Dimension (m) | Predicted Incremental Subsidence due to LW S7A (mm) | Predicted Incremental Tilt due to LW S7A (mm/m) | Predicted Incremental Hogging Curvature due to LW S7A (1/km) | Predicted Incremental Sagging Curvature due to LW S7A (1/km) | Predicted Total Subsidence after LW S1A to S7A (mm) | Predicted Final Tilt after all Longwalls (mm/m) | Predicted Maximum Tilt after any Longwall (mm/m) | Predicted Total Hogging Curvature after LW S1A to S7A (1/km) | Predicted Total Sagging Curvature after LW S1A to S7A (1/km) |
|---|---|---|---|---|---|---|---|---|---|---|
| BRE_195_r07 | 7 | < 20 | < 0.5 | < 0.01 | < 0.01 | 80 | 0.5 | 0.5 | < 0.01 | < 0.01 |
| BRE_195_r08 | 6 | < 20 | < 0.5 | < 0.01 | < 0.01 | 70 | 0.5 | 0.5 | < 0.01 | < 0.01 |
| BRE_195_r12 | 4 | < 20 | < 0.5 | < 0.01 | < 0.01 | 125 | 1.5 | 1.5 | 0.03 | 0.02 |
| BRE_195_r13 | 2 | < 20 | < 0.5 | < 0.01 | < 0.01 | 100 | 1.0 | 1.0 | 0.01 | 0.01 |
| BRE_195_r14 | 7 | < 20 | < 0.5 | < 0.01 | < 0.01 | 100 | 1.0 | 1.0 | 0.02 | 0.01 |
| BRE_195_r15 | 4 | < 20 | < 0.5 | < 0.01 | < 0.01 | 100 | 1.0 | 1.0 | 0.01 | 0.01 |
| BRE_201_r01 | 17 | < 20 | < 0.5 | < 0.01 | < 0.01 | 50 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| BRE_201_r02 | 5 | < 20 | < 0.5 | < 0.01 | < 0.01 | 50 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| BRE_201_r03 | 4 | < 20 | < 0.5 | < 0.01 | < 0.01 | 60 | 0.5 | 0.5 | < 0.01 | < 0.01 |
| BRE_201_r04 | 2 | < 20 | < 0.5 | < 0.01 | < 0.01 | 60 | 0.5 | 0.5 | < 0.01 | < 0.01 |
| BRE_201_r05 | 12 | < 20 | < 0.5 | < 0.01 | < 0.01 | 50 | 0.5 | 0.5 | < 0.01 | < 0.01 |
| BWE_023_r01 | 10 | < 20 | < 0.5 | < 0.01 | < 0.01 | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| BWE_025_r01 | 8 | < 20 | < 0.5 | < 0.01 | < 0.01 | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| BWE_025_r02 | 10 | < 20 | < 0.5 | < 0.01 | < 0.01 | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| BWE_027_r01 | 12 | < 20 | < 0.5 | < 0.01 | < 0.01 | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| BWE_027_r08 | 9 | < 20 | < 0.5 | < 0.01 | < 0.01 | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| BWE_027_r09 | 6 | < 20 | < 0.5 | < 0.01 | < 0.01 | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| BWE_029_r03 | 4 | < 20 | < 0.5 | < 0.01 | < 0.01 | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| BWE_029_r04 | 7 | < 20 | < 0.5 | < 0.01 | < 0.01 | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| BWE_041_r04 | 30 | < 20 | < 0.5 | < 0.01 | < 0.01 | 30 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| BWE_051_r01 | 18 | < 20 | < 0.5 | < 0.01 | < 0.01 | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| BWE_051_r02 | 5 | < 20 | < 0.5 | < 0.01 | < 0.01 | 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| BWE_051_r03 | 10 | < 20 | < 0.5 | < 0.01 | < 0.01 | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| BWE_051_r04 | 10 | < 20 | < 0.5 | < 0.01 | < 0.01 | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| BWE_051_r05 | 2 | < 20 | < 0.5 | < 0.01 | < 0.01 | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| BWE_051_r07 | 7 | < 20 | < 0.5 | < 0.01 | < 0.01 | 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| BYR_001_r02 | 19 | 150 | 0.5 | < 0.01 | < 0.01 | 950 | 4.0 | 6.0 | 0.09 | 0.02 |
| BYR_001_r03 | 8 | 125 | 0.5 | < 0.01 | < 0.01 | 1000 | 5.0 | 7.0 | 0.09 | 0.03 |
| BYR_001_r05 | 5 | 125 | 0.5 | < 0.01 | < 0.01 | 1050 | 5.0 | 7.5 | 0.09 | 0.03 |
| BYR_005_r01 | 7 | 250 | 1.0 | 0.02 | 0.01 | 1300 | 3.5 | 3.5 | 0.06 | 0.09 |
| BYR_005_r02 | 13 | 250 | 1.0 | 0.02 | 0.01 | 1300 | 4.0 | 4.0 | 0.06 | 0.07 |
| BYR_005_r03 | 17 | 250 | 1.0 | 0.02 | 0.01 | 1300 | 4.0 | 4.0 | 0.06 | 0.06 |
| BYR_005_r04 | 6 | 250 | 1.0 | 0.02 | 0.01 | 1300 | 3.5 | 3.5 | 0.06 | 0.10 |
| BYR_005_r05 | 9 | 225 | 1.0 | 0.02 | 0.01 | 1200 | 4.0 | 4.0 | 0.06 | 0.04 |
| BYR_005_r06 | 4 | 200 | 1.0 | 0.01 | 0.01 | 1150 | 4.0 | 4.0 | 0.05 | 0.04 |
| BYR_015_r01 | 12 | 275 | 1.0 | 0.02 | 0.01 | 1350 | 6.0 | 6.5 | 0.06 | 0.23 |
| BYR_015_r02 | 12 | 300 | 1.0 | 0.02 | 0.02 | 1350 | 7.5 | 8.0 | 0.06 | 0.23 |
| BYR_015_r06 | 4 | 250 | 1.0 | 0.02 | 0.01 | 1300 | 3.5 | 3.5 | 0.06 | 0.15 |
| BYR_015_r07 | 29 | 300 | 1.5 | 0.05 | 0.02 | 1350 | 8.0 | 8.5 | 0.11 | 0.23 |
| BYR_025_r05 | 4 | 475 | 2.5 | 0.03 | 0.03 | 750 | 1.5 | 3.5 | 0.08 | 0.03 |
| BYR_025_r08 | 6 | 550 | 3.0 | 0.04 | 0.03 | 750 | 2.0 | 2.5 | 0.05 | 0.03 |
| BYR_025_r09 | 24 | 350 | 1.5 | 0.06 | 0.02 | 1150 | 8.0 | 8.5 | 0.12 | 0.05 |
| BYR_035_r02 | 7 | 475 | 2.0 | 0.03 | 0.02 | 800 | 3.0 | 5.0 | 0.08 | 0.02 |

# Table C.04 - Predictions for Rural Structures

| Structure Ref. | Maximum Plan Dimension (m) | Predicted Incremental Subsidence due to LW S7A (mm) | Predicted Incremental Tilt due to LW S7A (mm/m) | Predicted Incremental Hogging Curvature due to LW S7A (1/km) | Predicted Incremental Sagging Curvature due to LW S7A (1/km) | Predicted Total Subsidence after LW S1A to S7A (mm) | Predicted Final Tilt after all Longwalls (mm/m) | Predicted Maximum Tilt after any Longwall (mm/m) | Predicted Total Hogging Curvature after LW S1A to S7A (1/km) | Predicted Total Sagging Curvature after LW S1A to S7A (1/km) |
|---|---|---|---|---|---|---|---|---|---|---|
| BYR_035_r03 | 7 | 450 | 2.0 | 0.03 | 0.02 | 800 | 3.0 | 5.0 | 0.08 | 0.02 |
| BYR_035_r04 | 12 | 450 | 2.0 | 0.03 | 0.02 | 850 | 4.0 | 5.5 | 0.09 | 0.02 |
| BYR_035_r05 | 7 | 400 | 2.0 | 0.03 | 0.02 | 900 | 5.0 | 7.0 | 0.09 | 0.03 |
| BYR_035_r06 | 9 | 400 | 2.0 | 0.04 | 0.02 | 900 | 5.5 | 7.5 | 0.11 | 0.03 |
| BYR_035_r07 | 7 | 375 | 2.0 | 0.06 | 0.02 | 1050 | 7.5 | 8.5 | 0.12 | 0.03 |
| BYR_035_r08 | 12 | 425 | 2.0 | 0.03 | 0.02 | 900 | 5.0 | 7.0 | 0.09 | 0.02 |
| BYR_035_r09 | 5 | 400 | 2.0 | 0.03 | 0.02 | 900 | 5.0 | 7.0 | 0.09 | 0.02 |
| BYR_035_r10 | 2 | 400 | 2.0 | 0.03 | 0.02 | 900 | 5.0 | 7.0 | 0.09 | 0.03 |
| BYR_035_r12 | 4 | 425 | 2.0 | 0.03 | 0.02 | 800 | 4.0 | 5.5 | 0.09 | 0.02 |
| BYR_035_r13 | 11 | 500 | 2.5 | 0.03 | 0.03 | 750 | 1.5 | 3.5 | 0.07 | 0.03 |
| BYR_045_r10 | 7 | 950 | 3.5 | 0.06 | 0.06 | 1050 | 3.0 | 3.0 | 0.06 | 0.06 |
| BYR_045_r11 | 21 | 900 | 3.5 | 0.06 | 0.05 | 1050 | 3.0 | 3.0 | 0.06 | 0.05 |
| BYR_065_r01 | 12 | 750 | 8.0 | 0.09 | 0.07 | 850 | 8.5 | 8.5 | 0.09 | 0.07 |
| BYR_065_r02 | 9 | 800 | 8.0 | 0.08 | 0.11 | 900 | 8.5 | 8.5 | 0.09 | 0.11 |
| BYR_065_r03 | 4 | 350 | 4.5 | 0.08 | 0.02 | 425 | 5.0 | 5.0 | 0.09 | 0.02 |
| BYR_065_r04 | 3 | 425 | 6.0 | 0.09 | 0.02 | 500 | 6.5 | 6.5 | 0.09 | 0.02 |
| BYR_065_r05 | 21 | 850 | 8.0 | 0.09 | 0.14 | 950 | 8.5 | 8.5 | 0.09 | 0.14 |
| BYR_065_r06 | 18 | 750 | 8.0 | 0.09 | 0.08 | 900 | 8.5 | 8.5 | 0.09 | 0.08 |
| BYR_065_r07 | 7 | 550 | 7.5 | 0.09 | 0.03 | 650 | 8.0 | 8.0 | 0.09 | 0.03 |
| BYR_065_r08 | 4 | 350 | 5.0 | 0.08 | 0.02 | 425 | 5.5 | 5.5 | 0.09 | 0.02 |
| BYR_065_r09 | 2 | 350 | 5.0 | 0.08 | 0.02 | 425 | 5.5 | 5.5 | 0.09 | 0.02 |
| BYR_065_r10 | 4 | 750 | 8.0 | 0.09 | 0.07 | 850 | 8.5 | 8.5 | 0.09 | 0.07 |
| BYR_065_r11 | 3 | 650 | 8.0 | 0.09 | 0.03 | 800 | 8.5 | 8.5 | 0.09 | 0.03 |
| BYR_065_r12 | 6 | 600 | 7.5 | 0.09 | 0.03 | 700 | 8.5 | 8.5 | 0.09 | 0.03 |
| BYR_075_r01 | 15 | 325 | 4.5 | 0.08 | 0.02 | 400 | 5.0 | 5.0 | 0.08 | 0.02 |
| BYR_075_r02 | 11 | 350 | 5.0 | 0.08 | 0.02 | 425 | 5.5 | 5.5 | 0.09 | 0.02 |
| BYR_075_r03 | 11 | 400 | 5.5 | 0.09 | 0.02 | 475 | 6.0 | 6.0 | 0.09 | 0.02 |
| BYR_075_r04 | 11 | 650 | 8.0 | 0.09 | 0.03 | 750 | 8.5 | 8.5 | 0.09 | 0.03 |
| BYR_075_r05 | 10 | 275 | 3.5 | 0.07 | 0.01 | 350 | 4.0 | 4.0 | 0.07 | 0.01 |
| BYR_075_r06 | 3 | 250 | 3.0 | 0.06 | 0.01 | 325 | 3.5 | 3.5 | 0.06 | 0.01 |
| BYR_075_r07 | 3 | 300 | 4.0 | 0.08 | 0.02 | 375 | 4.5 | 4.5 | 0.08 | 0.02 |
| BYR_075_r08 | 14 | 250 | 3.0 | 0.06 | 0.01 | 325 | 3.0 | 3.0 | 0.06 | 0.01 |
| BYR_075_r09 | 6 | 225 | 2.0 | 0.04 | 0.01 | 275 | 2.5 | 2.5 | 0.05 | 0.01 |
| BYR_075_r10 | 2 | 250 | 3.0 | 0.06 | 0.01 | 325 | 3.0 | 3.0 | 0.06 | 0.01 |
| BYR_075_r11 | 4 | 225 | 2.5 | 0.05 | 0.01 | 300 | 3.0 | 3.0 | 0.05 | 0.01 |
| BYR_075_r12 | 3 | 300 | 4.0 | 0.07 | 0.01 | 375 | 4.5 | 4.5 | 0.08 | 0.01 |
| BYR_075_r13 | 14 | 450 | 6.0 | 0.09 | 0.02 | 500 | 6.5 | 6.5 | 0.09 | 0.02 |
| BYR_084_r01 | 8 | 200 | 2.0 | 0.04 | 0.01 | 275 | 2.5 | 2.5 | 0.04 | 0.01 |
| BYR_084_r02 | 8 | 275 | 3.5 | 0.06 | 0.01 | 350 | 3.5 | 3.5 | 0.07 | 0.01 |
| BYR_084_r03 | 8 | 250 | 3.0 | 0.06 | 0.01 | 325 | 3.5 | 3.5 | 0.06 | 0.01 |
| BYR_084_r04 | 14 | 225 | 2.0 | 0.04 | 0.01 | 275 | 2.5 | 2.5 | 0.04 | 0.01 |
| BYR_084_r05 | 9 | 250 | 3.0 | 0.06 | 0.01 | 325 | 3.5 | 3.5 | 0.06 | 0.01 |
| BYR_084_r06 | 7 | 300 | 3.5 | 0.07 | 0.01 | 350 | 4.0 | 4.0 | 0.07 | 0.01 |

# Table C.04 - Predictions for Rural Structures

| Structure Ref. | Maximum Plan Dimension (m) | Predicted Incremental Subsidence due to LW S7A (mm) | Predicted Incremental Tilt due to LW S7A (mm/m) | Predicted Incremental Hogging Curvature due to LW S7A (1/km) | Predicted Incremental Sagging Curvature due to LW S7A (1/km) | Predicted Total Subsidence after LW S1A to S7A (mm) | Predicted Final Tilt after all Longwalls (mm/m) | Predicted Maximum Tilt after any Longwall (mm/m) | Predicted Total Hogging Curvature after LW S1A to S7A (1/km) | Predicted Total Sagging Curvature after LW S1A to S7A (1/km) |
|---|---|---|---|---|---|---|---|---|---|---|
| BYR_085_r01 | 16 | 175 | 1.5 | 0.02 | < 0.01 | 225 | 1.5 | 1.5 | 0.02 | < 0.01 |
| BYR_085_r03 | 19 | 175 | 1.5 | 0.02 | < 0.01 | 225 | 2.0 | 2.0 | 0.03 | < 0.01 |
| BYR_085_r04 | 4 | 250 | 3.0 | 0.06 | 0.01 | 325 | 3.5 | 3.5 | 0.06 | 0.01 |
| BYR_085_r05 | 4 | 200 | 2.0 | 0.03 | 0.01 | 250 | 2.5 | 2.5 | 0.04 | 0.01 |
| BYR_085_r06 | 17 | 400 | 5.5 | 0.09 | 0.02 | 500 | 6.0 | 6.0 | 0.09 | 0.02 |
| BYR_085_r08 | 4 | 275 | 3.0 | 0.06 | 0.01 | 325 | 3.5 | 3.5 | 0.07 | 0.01 |
| BYR_085_r09 | 6 | 150 | 1.0 | 0.01 | < 0.01 | 200 | 1.5 | 1.5 | 0.02 | < 0.01 |
| BYR_085_r10 | 9 | 150 | 1.0 | 0.02 | < 0.01 | 200 | 1.5 | 1.5 | 0.02 | < 0.01 |
| BYR_085_r11 | 5 | 200 | 2.0 | 0.03 | < 0.01 | 250 | 2.0 | 2.0 | 0.03 | < 0.01 |
| BYR_085_r12 | 10 | 300 | 3.5 | 0.07 | 0.01 | 375 | 4.0 | 4.0 | 0.08 | 0.01 |
| BYR_085_r13 | 5 | 350 | 5.0 | 0.08 | 0.02 | 425 | 5.5 | 5.5 | 0.09 | 0.02 |
| BYR_085_r14 | 5 | 600 | 7.5 | 0.09 | 0.03 | 700 | 8.5 | 8.5 | 0.09 | 0.03 |
| BYR_085_r15 | 6 | 225 | 2.0 | 0.04 | 0.01 | 275 | 2.5 | 2.5 | 0.04 | 0.01 |
| BYR_085_r16 | 3 | 200 | 1.5 | 0.03 | < 0.01 | 250 | 2.0 | 2.0 | 0.03 | < 0.01 |
| BYR_095_r02 | 12 | 200 | 1.5 | 0.03 | < 0.01 | 250 | 2.0 | 2.0 | 0.03 | < 0.01 |
| BYR_095_r03 | 12 | 200 | 2.0 | 0.03 | < 0.01 | 250 | 2.0 | 2.0 | 0.03 | < 0.01 |
| BYR_095_r04 | 19 | 225 | 2.5 | 0.05 | 0.01 | 300 | 3.0 | 3.0 | 0.05 | 0.01 |
| BYR_095_r05 | 16 | 250 | 2.5 | 0.05 | 0.01 | 300 | 3.0 | 3.0 | 0.05 | 0.01 |
| BYR_095_r06 | 4 | 125 | 0.5 | < 0.01 | < 0.01 | 150 | 1.0 | 1.0 | < 0.01 | < 0.01 |
| BYR_105_r01 | 11 | 90 | < 0.5 | < 0.01 | < 0.01 | 125 | 0.5 | 0.5 | < 0.01 | < 0.01 |
| BYR_105_r02 | 10 | 80 | < 0.5 | < 0.01 | < 0.01 | 100 | 0.5 | 0.5 | < 0.01 | < 0.01 |
| BYR_105_r03 | 15 | 70 | < 0.5 | < 0.01 | < 0.01 | 100 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| BYR_105_r07 | 5 | 80 | < 0.5 | < 0.01 | < 0.01 | 100 | 0.5 | 0.5 | < 0.01 | < 0.01 |
| BYR_105_r09 | 3 | 80 | < 0.5 | < 0.01 | < 0.01 | 125 | 0.5 | 0.5 | < 0.01 | < 0.01 |
| BYR_105_r10 | 2 | 80 | < 0.5 | < 0.01 | < 0.01 | 125 | 0.5 | 0.5 | < 0.01 | < 0.01 |
| BYR_115_r01 | 18 | 125 | 1.0 | 0.01 | < 0.01 | 175 | 1.0 | 1.0 | 0.01 | < 0.01 |
| BYR_115_r02 | 6 | 100 | 0.5 | < 0.01 | < 0.01 | 150 | 1.0 | 1.0 | < 0.01 | < 0.01 |
| BYR_115_r04 | 5 | 100 | 0.5 | < 0.01 | < 0.01 | 125 | 0.5 | 0.5 | < 0.01 | < 0.01 |
| BYR_115_r08 | 14 | 100 | 0.5 | < 0.01 | < 0.01 | 150 | 1.0 | 1.0 | < 0.01 | < 0.01 |
| BYR_115_r09 | 9 | 90 | < 0.5 | < 0.01 | < 0.01 | 125 | 0.5 | 0.5 | < 0.01 | < 0.01 |
| BYR_115_r10 | 6 | 100 | 0.5 | < 0.01 | < 0.01 | 125 | 0.5 | 0.5 | < 0.01 | < 0.01 |
| BYR_115_r11 | 2 | 125 | 1.0 | 0.01 | < 0.01 | 175 | 1.0 | 1.0 | 0.01 | < 0.01 |
| BYR_125_r04 | 9 | 275 | 3.5 | 0.06 | 0.01 | 350 | 3.5 | 3.5 | 0.07 | 0.01 |
| BYR_135_r01 | 9 | 800 | 8.0 | 0.09 | 0.09 | 900 | 8.5 | 8.5 | 0.09 | 0.09 |
| BYR_135_r02 | 9 | 800 | 8.0 | 0.09 | 0.11 | 900 | 8.5 | 8.5 | 0.09 | 0.11 |
| BYR_135_r03 | 3 | 700 | 8.0 | 0.09 | 0.04 | 850 | 8.5 | 8.5 | 0.09 | 0.04 |
| BYR_135_r04 | 7 | 500 | 7.0 | 0.09 | 0.03 | 600 | 8.0 | 8.0 | 0.09 | 0.03 |
| BYR_145_r01 | 11 | 950 | 3.0 | 0.06 | 0.22 | 1100 | 3.0 | 3.0 | 0.06 | 0.23 |
| BYR_145_r02 | 11 | 950 | 5.5 | 0.06 | 0.22 | 1100 | 6.5 | 6.5 | 0.06 | 0.23 |
| BYR_145_r03 | 12 | 950 | 3.5 | 0.06 | 0.12 | 1100 | 3.0 | 3.0 | 0.06 | 0.13 |
| BYR_145_r05 | 3 | 950 | 5.0 | 0.06 | 0.22 | 1100 | 5.5 | 5.5 | 0.06 | 0.23 |
| BYR_145_r06 | 4 | 950 | 6.0 | 0.06 | 0.22 | 1100 | 7.0 | 7.0 | 0.06 | 0.23 |
| BYR_145_r07 | 2 | 950 | 3.5 | 0.06 | 0.09 | 1100 | 3.0 | 3.0 | 0.06 | 0.09 |

# Table C.04 - Predictions for Rural Structures

| Structure Ref. | Maximum Plan Dimension (m) | Predicted Incremental Subsidence due to LW S7A (mm) | Predicted Incremental Tilt due to LW S7A (mm/m) | Predicted Incremental Hogging Curvature due to LW S7A (1/km) | Predicted Incremental Sagging Curvature due to LW S7A (1/km) | Predicted Total Subsidence after LW S1A to S7A (mm) | Predicted Final Tilt after all Longwalls (mm/m) | Predicted Maximum Tilt after any Longwall (mm/m) | Predicted Total Hogging Curvature after LW S1A to S7A (1/km) | Predicted Total Sagging Curvature after LW S1A to S7A (1/km) |
|---|---|---|---|---|---|---|---|---|---|---|
| BYR_150_r01 | 7 | 275 | 1.0 | 0.02 | 0.01 | 1300 | 3.5 | 3.5 | 0.06 | 0.05 |
| BYR_150_r02 | 8 | 250 | 1.0 | 0.02 | 0.01 | 1300 | 3.5 | 3.5 | 0.06 | 0.05 |
| BYR_150_r03 | 12 | 250 | 1.0 | 0.02 | 0.01 | 1300 | 3.5 | 3.5 | 0.06 | 0.05 |
| BYR_150_r04 | 10 | 275 | 1.0 | 0.02 | 0.01 | 1350 | 3.5 | 3.5 | 0.06 | 0.09 |
| BYR_152_r01 | 8 | 200 | 1.0 | 0.01 | 0.01 | 1100 | 3.5 | 3.5 | 0.05 | 0.04 |
| BYR_152_r02 | 7 | 225 | 1.0 | 0.01 | 0.01 | 1150 | 4.0 | 4.0 | 0.05 | 0.04 |
| BYR_152_r03 | 15 | 225 | 1.0 | 0.02 | 0.01 | 1200 | 4.0 | 4.0 | 0.05 | 0.04 |
| BYR_152_r04 | 3 | 250 | 1.0 | 0.02 | 0.01 | 1250 | 4.0 | 4.0 | 0.06 | 0.05 |
| BYR_152_r05 | 5 | 250 | 1.0 | 0.02 | 0.01 | 1300 | 4.0 | 4.0 | 0.06 | 0.05 |
| BYR_152_r06 | 12 | 275 | 1.0 | 0.02 | 0.01 | 1300 | 4.0 | 4.0 | 0.06 | 0.05 |
| BYR_152_r07 | 3 | 250 | 1.0 | 0.02 | 0.01 | 1250 | 4.0 | 4.0 | 0.06 | 0.04 |
| BYR_154_r01 | 9 | 225 | 1.0 | 0.01 | 0.01 | 1150 | 4.0 | 4.0 | 0.05 | 0.04 |
| BYR_156_r01 | 10 | 175 | 1.0 | 0.01 | < 0.01 | 1000 | 3.0 | 3.0 | 0.05 | 0.03 |
| BYR_158_r01 | 3 | 150 | 0.5 | < 0.01 | < 0.01 | 900 | 1.5 | 3.5 | 0.08 | 0.03 |
| BYR_158_r02 | 14 | 150 | 0.5 | < 0.01 | < 0.01 | 900 | 1.5 | 4.0 | 0.09 | 0.03 |
| BYR_160_r01 | 9 | 90 | 1.0 | < 0.01 | < 0.01 | 1200 | 7.0 | 8.5 | 0.10 | 0.07 |
| BYR_160_r02 | 11 | 100 | 0.5 | < 0.01 | < 0.01 | 1150 | 7.0 | 8.5 | 0.10 | 0.04 |
| BYR_162_r01 | 9 | 70 | 0.5 | < 0.01 | < 0.01 | 1350 | 7.0 | 8.0 | 0.06 | 0.23 |
| **Maxima:** | | **950** | **8.0** | **0.09** | **0.22** | **1350** | **8.5** | **8.5** | **0.12** | **0.23** |

# Table C.05 - Predictions for Tanks

| Structure Ref. | Maximum Plan Dimension (m) | Predicted Incremental Subsidence due to LW S7A (mm) | Predicted Incremental Tilt due to LW S7A (mm/m) | Predicted Incremental Hogging Curvature due to LW S7A (1/km) | Predicted Incremental Sagging Curvature due to LW S7A (1/km) | Predicted Total Subsidence after LW S1A to S7A (mm) | Predicted Final Tilt after all Longwalls (mm/m) | Predicted Maximum Tilt after any Longwall (mm/m) | Predicted Total Hogging Curvature after LW S1A to S7A (1/km) | Predicted Total Sagging Curvature after LW S1A to S7A (1/km) |
|---|---|---|---|---|---|---|---|---|---|---|
| BCA_001_t01 | 7 | 100 | 1.5 | 0.015 | < 0.01 | 325 | 5.0 | 5.0 | 0.06 | < 0.01 |
| BCA_001_t02 | 2 | 125 | 1.0 | < 0.01 | < 0.01 | 550 | 5.0 | 5.0 | 0.04 | 0.03 |
| BCA_010_t01 | 3 | 90 | < 0.5 | < 0.01 | < 0.01 | 1250 | 6.5 | 8.0 | 0.09 | 0.18 |
| BCA_010_t02 | 2 | 100 | 0.5 | < 0.01 | < 0.01 | 1150 | 6.5 | 8.0 | 0.09 | 0.06 |
| BCA_010_t03 | 2 | 100 | 0.5 | < 0.01 | < 0.01 | 1100 | 6.5 | 8.0 | 0.09 | 0.04 |
| BCA_010_t04 | 2 | 175 | 0.5 | 0.011 | < 0.01 | 950 | 3.0 | 3.0 | 0.05 | 0.04 |
| BCA_015_t01 | 4 | 80 | < 0.5 | < 0.01 | < 0.01 | 1350 | 6.5 | 8.0 | 0.05 | 0.22 |
| BCA_015_t02 | 3 | 100 | 0.5 | < 0.01 | < 0.01 | 1150 | 7.0 | 8.0 | 0.09 | 0.04 |
| BCA_015_t03 | 3 | 100 | 0.5 | < 0.01 | < 0.01 | 1150 | 7.0 | 8.0 | 0.09 | 0.05 |
| BCA_025_t01 | 1 | 40 | < 0.5 | < 0.01 | < 0.01 | 1100 | 3.5 | 3.5 | 0.04 | 0.04 |
| BCA_100_t01 | 4 | 20 | < 0.5 | < 0.01 | < 0.01 | 1000 | 6.5 | 7.0 | 0.07 | 0.07 |
| BCA_105_t01 | 2 | 30 | < 0.5 | < 0.01 | < 0.01 | 650 | 4.0 | 4.0 | 0.04 | 0.02 |
| BCA_105_t02 | 2 | 20 | < 0.5 | < 0.01 | < 0.01 | 700 | 5.0 | 5.0 | 0.06 | 0.02 |
| BCA_120_t01 | 3 | 20 | < 0.5 | < 0.01 | < 0.01 | 90 | 1.0 | 1.0 | 0.02 | < 0.01 |
| BCA_120_t02 | 2 | 30 | 0.5 | 0.011 | < 0.01 | 125 | 1.5 | 1.5 | 0.03 | < 0.01 |
| BRE_148_t01 | 2 | 60 | < 0.5 | < 0.01 | < 0.01 | 1350 | 3.0 | 3.0 | 0.06 | 0.22 |
| BRE_154_t01 | 4 | 80 | < 0.5 | < 0.01 | < 0.01 | 1350 | 6.5 | 7.5 | 0.06 | 0.22 |
| BWE_027_t01 | 2 | < 20 | < 0.5 | < 0.01 | < 0.01 | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| BWE_027_t02 | 2 | < 20 | < 0.5 | < 0.01 | < 0.01 | < 20 | < 0.5 | < 0.5 | < 0.01 | < 0.01 |
| BYR_001_t01 | 1 | 125 | 0.5 | < 0.01 | < 0.01 | 900 | 3.0 | 5.5 | 0.09 | 0.02 |
| BYR_001_t02 | 3 | 125 | 0.5 | < 0.01 | < 0.01 | 950 | 3.5 | 5.5 | 0.09 | 0.02 |
| BYR_005_t01 | 3 | 250 | 1.0 | 0.017 | 0.013 | 1300 | 3.5 | 3.5 | 0.06 | 0.08 |
| BYR_015_t01 | 8 | 325 | 1.5 | 0.052 | 0.017 | 1250 | 8.0 | 8.5 | 0.11 | 0.16 |
| BYR_015_t02 | 3 | 250 | 1.0 | 0.017 | 0.014 | 1350 | 3.5 | 3.5 | 0.06 | 0.17 |
| BYR_025_t01 | 3 | 325 | 1.5 | 0.054 | 0.018 | 1100 | 8.0 | 8.5 | 0.12 | 0.04 |
| BYR_055_t03 | 6 | 400 | 2.0 | 0.076 | 0.022 | 1000 | 6.5 | 8.0 | 0.12 | 0.03 |
| BYR_065_t01 | 9 | 500 | 7.0 | 0.086 | 0.025 | 600 | 7.5 | 7.5 | 0.09 | 0.03 |
| BYR_065_t02 | 3 | 550 | 7.0 | 0.086 | 0.026 | 600 | 8.0 | 8.0 | 0.09 | 0.03 |
| BYR_065_t03 | 2 | 450 | 6.5 | 0.086 | 0.022 | 550 | 7.0 | 7.0 | 0.09 | 0.02 |
| BYR_075_t01 | 3 | 250 | 3.0 | 0.060 | 0.013 | 325 | 3.5 | 3.5 | 0.06 | 0.01 |
| BYR_075_t02 | 2 | 225 | 2.5 | 0.049 | 0.012 | 300 | 3.0 | 3.0 | 0.05 | 0.01 |
| BYR_075_t03 | 2 | 600 | 7.5 | 0.087 | 0.029 | 700 | 8.5 | 8.5 | 0.09 | 0.03 |
| BYR_075_t04 | 2 | 650 | 8.0 | 0.087 | 0.031 | 750 | 8.5 | 8.5 | 0.09 | 0.03 |
| BYR_075_t05 | 2 | 300 | 4.0 | 0.075 | 0.015 | 375 | 4.5 | 4.5 | 0.08 | 0.02 |
| BYR_075_t06 | 2 | 300 | 4.0 | 0.075 | 0.015 | 375 | 4.5 | 4.5 | 0.08 | 0.02 |
| BYR_084_t01 | 3 | 275 | 3.0 | 0.063 | 0.013 | 325 | 3.5 | 3.5 | 0.07 | 0.01 |
| BYR_085_t01 | 3 | 500 | 7.0 | 0.088 | 0.025 | 600 | 8.0 | 8.0 | 0.09 | 0.03 |
| BYR_085_t02 | 3 | 550 | 7.5 | 0.088 | 0.027 | 650 | 8.0 | 8.0 | 0.09 | 0.03 |
| BYR_085_t03 | 3 | 150 | 1.0 | 0.013 | < 0.01 | 200 | 1.5 | 1.5 | 0.02 | < 0.01 |
| BYR_085_t04 | 3 | 150 | 1.0 | 0.014 | < 0.01 | 200 | 1.5 | 1.5 | 0.02 | < 0.01 |
| BYR_085_t05 | 2 | 125 | 1.0 | < 0.01 | < 0.01 | 175 | 1.0 | 1.0 | < 0.01 | < 0.01 |
| BYR_085_t06 | 2 | 150 | 1.0 | 0.016 | < 0.01 | 200 | 1.5 | 1.5 | 0.02 | < 0.01 |
| BYR_095_t01 | 3 | 200 | 2.0 | 0.028 | < 0.01 | 250 | 2.0 | 2.0 | 0.03 | < 0.01 |

# Table C.05 - Predictions for Tanks

| Structure Ref. | Maximum Plan Dimension (m) | Predicted Incremental Subsidence due to LW S7A (mm) | Predicted Incremental Tilt due to LW S7A (mm/m) | Predicted Incremental Hogging Curvature due to LW S7A (1/km) | Predicted Incremental Sagging Curvature due to LW S7A (1/km) | Predicted Total Subsidence after LW S1A to S7A (mm) | Predicted Final Tilt after all Longwalls (mm/m) | Predicted Maximum Tilt after any Longwall (mm/m) | Predicted Total Hogging Curvature after LW S1A to S7A (1/km) | Predicted Total Sagging Curvature after LW S1A to S7A (1/km) |
|---|---|---|---|---|---|---|---|---|---|---|
| BYR_095_t02 | 3 | 200 | 2.0 | 0.031 | < 0.01 | 250 | 2.0 | 2.0 | 0.03 | < 0.01 |
| BYR_095_t03 | 2 | 100 | 0.5 | < 0.01 | < 0.01 | 150 | 1.0 | 1.0 | < 0.01 | < 0.01 |
| BYR_105_t01 | 2 | 90 | < 0.5 | < 0.01 | < 0.01 | 125 | 0.5 | 0.5 | < 0.01 | < 0.01 |
| BYR_115_t01 | 4 | 125 | 1.0 | 0.011 | < 0.01 | 175 | 1.0 | 1.0 | 0.01 | < 0.01 |
| BYR_115_t02 | 4 | 125 | 1.0 | 0.011 | < 0.01 | 175 | 1.0 | 1.0 | 0.01 | < 0.01 |
| BYR_115_t03 | 2 | 80 | < 0.5 | < 0.01 | < 0.01 | 100 | 0.5 | 0.5 | < 0.01 | < 0.01 |
| BYR_115_t04 | 2 | 80 | < 0.5 | < 0.01 | < 0.01 | 100 | 0.5 | 0.5 | < 0.01 | < 0.01 |
| BYR_115_t05 | 2 | 100 | 0.5 | < 0.01 | < 0.01 | 125 | 0.5 | 0.5 | < 0.01 | < 0.01 |
| BYR_115_t06 | 3 | 80 | < 0.5 | < 0.01 | < 0.01 | 125 | 0.5 | 0.5 | < 0.01 | < 0.01 |
| BYR_145_t01 | 2 | 950 | 6.5 | 0.063 | 0.222 | 1100 | 7.5 | 7.5 | 0.06 | 0.23 |
| BYR_145_t02 | 2 | 950 | 2.5 | 0.064 | 0.220 | 1100 | 2.5 | 2.5 | 0.06 | 0.23 |
| BYR_145_t03 | 2 | 950 | 3.5 | 0.064 | 0.132 | 1100 | 3.0 | 3.0 | 0.06 | 0.14 |
| BYR_145_t04 | 2 | 950 | 3.5 | 0.064 | 0.119 | 1100 | 3.0 | 3.0 | 0.06 | 0.12 |
| BYR_150_t01 | 2 | 275 | 1.0 | 0.018 | 0.014 | 1350 | 3.5 | 3.5 | 0.06 | 0.09 |
| BYR_152_t01 | 2 | 275 | 1.0 | 0.017 | 0.014 | 1300 | 4.0 | 4.0 | 0.06 | 0.05 |
| BYR_152_t02 | 2 | 275 | 1.0 | 0.017 | 0.014 | 1300 | 4.0 | 4.0 | 0.06 | 0.05 |
| BYR_152_t03 | 2 | 225 | 1.0 | 0.015 | 0.012 | 1150 | 4.0 | 4.0 | 0.05 | 0.04 |
| BYR_152_t04 | 2 | 225 | 1.0 | 0.015 | 0.012 | 1150 | 4.0 | 4.0 | 0.05 | 0.04 |
| BYR_154_t01 | 2 | 200 | 1.0 | 0.014 | 0.011 | 1100 | 3.5 | 3.5 | 0.05 | 0.04 |
| BYR_154_t02 | 2 | 200 | 1.0 | 0.013 | 0.010 | 1100 | 3.5 | 3.5 | 0.05 | 0.04 |
| BYR_156_t01 | 2 | 175 | 1.0 | 0.012 | < 0.01 | 1000 | 3.0 | 3.0 | 0.04 | 0.03 |
| BYR_156_t02 | 2 | 175 | 1.0 | 0.012 | < 0.01 | 1000 | 3.0 | 3.0 | 0.04 | 0.03 |
| BYR_156_t03 | 2 | 175 | 1.0 | 0.012 | < 0.01 | 1000 | 3.5 | 3.5 | 0.04 | 0.03 |
| BYR_156_t04 | 2 | 175 | 1.0 | 0.012 | < 0.01 | 1000 | 3.5 | 3.5 | 0.04 | 0.04 |
| | **Maxima:** | **950** | **8.0** | **0.09** | **0.22** | **1350** | **8.5** | **8.5** | **0.12** | **0.23** |

# Table C.06 - Predictions for Pools

| Structure Ref. | Maximum Plan Dimension (m) | Predicted Incremental Subsidence due to LW S7A (mm) | Predicted Incremental Tilt due to LW S7A (mm/m) | Predicted Incremental Hogging Curvature due to LW S7A (1/km) | Predicted Incremental Sagging Curvature due to LW S7A (1/km) | Predicted Total Subsidence after LW S1A to S7A (mm) | Predicted Final Tilt after all Longwalls (mm/m) | Predicted Maximum Tilt after any Longwall (mm/m) | Predicted Total Hogging Curvature after LW S1A to S7A (1/km) | Predicted Total Sagging Curvature after LW S1A to S7A (1/km) |
|---|---|---|---|---|---|---|---|---|---|---|
| BCA_035_p01 | 7 | 30 | < 0.5 | < 0.01 | < 0.01 | 950 | 2.0 | 3.0 | 0.07 | 0.03 |
| BCA_100_p01 | 10 | 20 | < 0.5 | < 0.01 | < 0.01 | 1000 | 6.0 | 7.0 | 0.08 | 0.06 |
| BCA_105_p01 | 9 | 30 | < 0.5 | < 0.01 | < 0.01 | 700 | 4.0 | 4.5 | 0.05 | 0.03 |
| BCA_120_p01 | 9 | 20 | < 0.5 | < 0.01 | < 0.01 | 100 | 1.0 | 1.0 | 0.02 | < 0.01 |
| BRE_148_p01 | 9 | 50 | < 0.5 | < 0.01 | < 0.01 | 1300 | 3.5 | 3.5 | 0.06 | 0.05 |
| BRE_167_p01 | 8 | 60 | 1.0 | 0.02 | < 0.01 | 850 | 4.0 | 5.5 | 0.09 | 0.04 |
| BYR_005_p01 | 10 | 250 | 1.0 | 0.02 | 0.01 | 1300 | 4.0 | 4.0 | 0.06 | 0.05 |
| BYR_015_p01 | 9 | 300 | 1.0 | 0.04 | 0.02 | 1300 | 8.0 | 8.5 | 0.06 | 0.23 |
| BYR_045_p01 | 11 | 900 | 3.5 | 0.06 | 0.05 | 1050 | 3.0 | 3.0 | 0.06 | 0.05 |
| BYR_065_p01 | 6 | 900 | 8.0 | 0.06 | 0.19 | 1000 | 8.5 | 8.5 | 0.06 | 0.20 |
| BYR_095_p01 | 9 | 150 | 1.0 | 0.01 | < 0.01 | 200 | 1.5 | 1.5 | 0.02 | < 0.01 |
| BYR_135_p01 | 10 | 750 | 8.0 | 0.09 | 0.06 | 850 | 8.5 | 8.5 | 0.09 | 0.06 |
| BYR_152_p01 | 12 | 250 | 1.0 | 0.02 | 0.01 | 1250 | 4.0 | 4.0 | 0.06 | 0.04 |
| **Maxima:** | | **900** | **8.0** | **0.09** | **0.19** | **1300** | **8.5** | **8.5** | **0.09** | **0.23** |

# Table C.07 - Predictions for Farm Dams

| Dam Ref. | Maximum Length (m) | Plan Area (m2) | Predicted Incremental Subsidence due to LW S7A (mm) | Predicted Incremental Tilt due to LW S7A (mm/m) | Predicted Incremental Hogging Curvature due to LW S7A (1/km) | Predicted Incremental Sagging Curvature due to LW S7A (1/km) | Predicted Total Subsidence after LW S1A to S7A (mm) | Predicted Final Tilt after all Longwalls (mm/m) | Predicted Maximum Tilt after any Longwall (mm/m) | Predicted Total Hogging Curvature after LW S1A to S7A (1/km) | Predicted Total Sagging Curvature after LW S1A to S7A (1/km) | Predicted Change in Freeboard (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCA_001_d01 | 25 | 345 | 250 | 1.0 | 0.02 | 0.01 | 1175 | 5.5 | 5.5 | 0.03 | 0.07 | 300 |
| BCA_010_d01 | 21 | 251 | 150 | 0.5 | < 0.01 | < 0.01 | 875 | 3.5 | 5.5 | 0.09 | 0.04 | 100 |
| BCA_015_d01 | 26 | 342 | 60 | < 0.5 | < 0.01 | < 0.01 | 1250 | 5.0 | 5.0 | 0.04 | 0.08 | 250 |
| BCA_110_d01 | 24 | 414 | 30 | < 0.5 | < 0.01 | < 0.01 | 625 | 6.5 | 6.5 | 0.06 | 0.05 | 350 |
| BRE_090_d01 | 52 | 1889 | 150 | 0.5 | < 0.01 | < 0.01 | 975 | 4.5 | 6.5 | 0.09 | 0.03 | 100 |
| BRE_090_d02 | 24 | 310 | 30 | < 0.5 | < 0.01 | < 0.01 | 975 | 2.5 | 3.0 | 0.07 | 0.03 | 100 |
| BRE_090_d03 | 69 | 1849 | 225 | 1.0 | 0.01 | 0.01 | 1200 | 3.5 | 3.5 | 0.05 | 0.04 | 300 |
| BRE_090_d04 | 36 | 508 | 300 | 1.0 | 0.04 | 0.01 | 1275 | 6.5 | 7.0 | 0.04 | 0.22 | 250 |
| BRE_143_d01 | 29 | 534 | 125 | 0.5 | < 0.01 | < 0.01 | 925 | 3.5 | 5.5 | 0.09 | 0.03 | 50 |
| BRE_148_d01 | 35 | 693 | 225 | 1.0 | 0.01 | 0.01 | 1200 | 3.5 | 3.5 | 0.06 | 0.04 | 250 |
| BRE_148_d02 | 22 | 170 | 225 | 1.0 | 0.01 | 0.01 | 1225 | 3.5 | 3.5 | 0.06 | 0.04 | 200 |
| BRE_154_d01 | 76 | 2658 | 70 | < 0.5 | < 0.01 | < 0.01 | 1375 | 6.5 | 7.5 | 0.06 | 0.23 | 200 |
| BRE_154_d02 | 64 | 1554 | 100 | 0.5 | < 0.01 | < 0.01 | 1325 | 7.0 | 8.5 | 0.10 | 0.20 | 500 |
| BRE_167_d01 | 99 | 2924 | 175 | 1.5 | 0.01 | 0.02 | 1075 | 4.0 | 5.0 | 0.09 | 0.05 | 300 |
| BRE_167_d02 | 16 | 180 | 225 | 2.0 | 0.01 | 0.02 | 1300 | 4.0 | 4.0 | 0.06 | 0.08 | 200 |
| BYR_005_d01 | 28 | 404 | 250 | 1.0 | 0.02 | 0.01 | 1275 | 4.0 | 4.0 | 0.06 | 0.05 | 250 |
| BYR_005_d02 | 73 | 1662 | 175 | 1.0 | 0.01 | < 0.01 | 1050 | 3.5 | 3.5 | 0.08 | 0.04 | 200 |
| BYR_015_d01 | 50 | 1415 | 250 | 1.0 | 0.02 | 0.01 | 1325 | 4.0 | 4.0 | 0.06 | 0.16 | 300 |
| BYR_065_d01 | 44 | 790 | 650 | 3.0 | 0.04 | 0.03 | 825 | 2.0 | 3.5 | 0.07 | 0.03 | 50 |
| BYR_095_d01 | 43 | 1003 | 950 | 8.0 | 0.06 | 0.21 | 1100 | 8.5 | 8.5 | 0.06 | 0.22 | 350 |
| | | **Maxima:** | **950** | **8.0** | **0.06** | **0.21** | **1375** | **8.5** | **8.5** | **0.10** | **0.23** | **500** |

# Table C.08 - Predictions for Public Utilities

| Structure Ref. | Description | Structure Type | Predicted Incremental Subsidence due to LW S7A (mm) | Predicted Incremental Tilt due to LW S7A (mm/m) | Predicted Incremental Hogging Curvature due to LW S7A (1/km) | Predicted Incremental Sagging Curvature due to LW S7A (1/km) | Predicted Total Subsidence after LW S1A to S7A (mm) | Predicted Final Tilt after all Longwalls (mm/m) | Predicted Maximum Tilt after any Longwall (mm/m) | Predicted Total Hogging Curvature after LW S1A to S7A (1/km) | Predicted Total Sagging Curvature after LW S1A to S7A (1/km) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BYR_200_pu01 | Comms shed - NBN - 2574006 | Shed | 175 | 1.0 | 0.01 | < 0.01 | 1050 | 3.5 | 3.5 | 0.05 | 0.21 |
| BYR_200_pu02 | Comms tower - NBN - 2574006 | Tower | 175 | 1.0 | 0.01 | < 0.01 | 1050 | 3.5 | 3.5 | 0.05 | 0.22 |
| | | **Maxima:** | **175** | **1.0** | **0.01** | **0.00** | **1050** | **3.5** | **3.5** | **0.05** | **0.22** |

# Table C.09 - Predictions for Commercial and Business Establishments

| Structure Ref. | Maximum Plan Dimension (m) | Description | Structure Type | Predicted Incremental Subsidence due to LW S7A (mm) | Predicted Incremental Tilt due to LW S7A (mm/m) | Predicted Incremental Hogging Curvature due to LW S7A (1/km) | Predicted Incremental Sagging Curvature due to LW S7A (1/km) | Predicted Total Subsidence after LW S1A to S7A (mm) | Predicted Final Tilt after all Longwalls (mm/m) | Predicted Maximum Tilt after any Longwall (mm/m) | Predicted Total Hogging Curvature after LW S1A to S7A (1/km) | Predicted Total Sagging Curvature after LW S1A to S7A (1/km) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BYR_055_c01 | 29 | Bargo Valley Produce | Shed | 950 | 3.5 | 0.06 | 0.21 | 1050 | 3.0 | 3.0 | 0.06 | 0.21 |
| BYR_055_c02 | 41 | Bargo Valley Produce | Shed | 950 | 6.0 | 0.06 | 0.21 | 1050 | 6.5 | 6.5 | 0.06 | 0.22 |
| BYR_055_c03 | 89 | Bargo Valley Produce | Poultry Shed | 900 | 3.5 | 0.06 | 0.08 | 1050 | 3.0 | 3.0 | 0.06 | 0.08 |
| BYR_055_c04 | 89 | Bargo Valley Produce | Poultry Shed | 900 | 3.5 | 0.06 | 0.04 | 1050 | 3.0 | 3.0 | 0.06 | 0.04 |
| BYR_055_c05 | 89 | Bargo Valley Produce | Poultry Shed | 750 | 3.5 | 0.05 | 0.04 | 900 | 2.5 | 2.5 | 0.05 | 0.04 |
| BYR_055_c06 | 89 | Bargo Valley Produce | Poultry Shed | 650 | 3.0 | 0.04 | 0.03 | 850 | 2.5 | 3.0 | 0.07 | 0.03 |
| BYR_055_c07 | 91 | Bargo Valley Produce | Greenhouse | 650 | 3.0 | 0.07 | 0.03 | 1000 | 6.0 | 8.0 | 0.12 | 0.03 |
| BYR_055_t01 | 8 | Bargo Valley Produce | Tank | 950 | 2.5 | 0.06 | 0.20 | 1050 | 2.5 | 2.5 | 0.06 | 0.21 |
| BYR_055_t02 | 3 | Bargo Valley Produce | Tank | 750 | 3.5 | 0.05 | 0.04 | 950 | 2.5 | 2.5 | 0.05 | 0.04 |
| BYR_065_c06 | 91 | Ingham Turkey Farm | Poultry Shed | 950 | 8.0 | 0.09 | 0.21 | 1050 | 8.5 | 8.5 | 0.09 | 0.22 |
| BYR_065_c07 | 96 | Ingham Turkey Farm | Poultry Shed | 950 | 8.0 | 0.08 | 0.21 | 1050 | 8.5 | 8.5 | 0.09 | 0.22 |
| BYR_065_c08 | 83 | Ingham Turkey Farm | Poultry Shed | 950 | 8.0 | 0.06 | 0.21 | 1050 | 8.5 | 8.5 | 0.06 | 0.22 |
| BYR_065_c09 | 11 | Ingham Turkey Farm | Poultry Shed | 950 | 2.5 | 0.06 | 0.21 | 1050 | 2.5 | 2.5 | 0.06 | 0.21 |
| BYR_065_c10 | 15 | Ingham Turkey Farm | Poultry Shed | 950 | 3.0 | 0.06 | 0.19 | 1050 | 2.5 | 2.5 | 0.06 | 0.19 |
| BYR_065_c11 | 26 | Ingham Turkey Farm | Poultry Shed | 950 | 7.0 | 0.06 | 0.21 | 1100 | 7.5 | 7.5 | 0.06 | 0.22 |
| BYR_065_c12 | 91 | Ingham Turkey Farm | Poultry Shed | 950 | 5.5 | 0.06 | 0.21 | 1100 | 6.0 | 6.0 | 0.06 | 0.22 |
| BYR_065_c13 | 90 | Ingham Turkey Farm | Poultry Shed | 950 | 3.5 | 0.06 | 0.21 | 1100 | 3.0 | 3.0 | 0.06 | 0.22 |
| BYR_065_c14 | 91 | Ingham Turkey Farm | Poultry Shed | 950 | 3.5 | 0.06 | 0.11 | 1050 | 2.5 | 2.5 | 0.06 | 0.12 |
| BYR_065_t02 | 5 | Ingham Turkey Farm | Tank | 950 | 2.5 | 0.06 | 0.21 | 1100 | 3.0 | 3.0 | 0.06 | 0.22 |
| BYR_065_t03 | 4 | Ingham Turkey Farm | Tank | 850 | 8.0 | 0.06 | 0.16 | 1000 | 8.5 | 8.5 | 0.07 | 0.17 |
| BYR_135_c01 | 14 | Canine Country Club and Cattery | Shed | 700 | 8.0 | 0.09 | 0.03 | 800 | 8.5 | 8.5 | 0.09 | 0.03 |
| BYR_135_c02 | 20 | Canine Country Club and Cattery | Shed | 350 | 4.5 | 0.08 | 0.02 | 425 | 5.0 | 5.0 | 0.09 | 0.02 |
| BYR_135_c03 | 9 | Canine Country Club and Cattery | Shed | 650 | 8.0 | 0.09 | 0.03 | 750 | 8.5 | 8.5 | 0.09 | 0.03 |
| BYR_135_c04 | 17 | Canine Country Club and Cattery | Shed | 400 | 5.5 | 0.09 | 0.02 | 475 | 6.0 | 6.0 | 0.09 | 0.02 |
| BYR_135_c05 | 26 | Canine Country Club and Cattery | Shed | 400 | 5.5 | 0.09 | 0.02 | 475 | 6.0 | 6.0 | 0.09 | 0.02 |
| BYR_135_c06 | 3 | Canine Country Club and Cattery | Shed | 400 | 5.5 | 0.09 | 0.02 | 475 | 6.0 | 6.0 | 0.09 | 0.02 |
| BYR_135_c07 | 14 | Canine Country Club and Cattery | Shed | 500 | 7.0 | 0.09 | 0.03 | 600 | 7.5 | 7.5 | 0.09 | 0.03 |
| BYR_135_c08 | 25 | Canine Country Club and Cattery | Awning | 400 | 5.5 | 0.09 | 0.02 | 500 | 6.5 | 6.5 | 0.09 | 0.02 |
| BYR_135_c09 | 6 | Canine Country Club and Cattery | Shed | 350 | 4.5 | 0.08 | 0.02 | 425 | 5.0 | 5.0 | 0.09 | 0.02 |
| | | | **Maxima:** | **950** | **8.0** | **0.09** | **0.21** | **1100** | **8.5** | **8.5** | **0.12** | **0.22** |

# Table C.10 - Tahmoor South - Predictions for Archaeological Sites

| Site ID | Type | Predicted Total Subsidence after all Longwalls (mm) | Predicted Total Tilt after all Longwalls (mm/m) | Predicted Total Hogging Curvature after all Longwalls (1/km) | Predicted Total Sagging Curvature after all Longwalls (1/km) | Predicted Total Upsidence after all Longwalls (mm) | Predicted Total Closure after all Longwalls (mm) |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| WP1253 RS | Rock shelter | 20 | < 0.5 | < 0.01 | < 0.01 | - | - |
| WP1255 RS | Rock shelter | 40 | < 0.5 | < 0.01 | < 0.01 | - | - |
| WP1256 RS | Rock shelter | 40 | < 0.5 | < 0.01 | < 0.01 | - | - |
| WB1257 RS | Rock shelter | 40 | < 0.5 | < 0.01 | < 0.01 | - | - |
| WP1258 RS | Rock shelter | 50 | < 0.5 | < 0.01 | < 0.01 | - | - |
| WP1260 RS | Rock shelter | 20 | < 0.5 | < 0.01 | < 0.01 | - | - |
| WP1261 RS | Rock shelter | 30 | < 0.5 | < 0.01 | < 0.01 | - | - |
| WP1263 GG | Grinding grooves | 20 | < 0.5 | < 0.01 | < 0.01 | 45 | 65 |
| WP1264 IF | Isolated find | 20 | < 0.5 | < 0.01 | < 0.01 | - | - |
| | | | | | | | |
| | | **50** | **< 0.5** | **< 0.01** | **< 0.01** | **45** | **65** |

# Appendix C

## Biodiversity development assessment report

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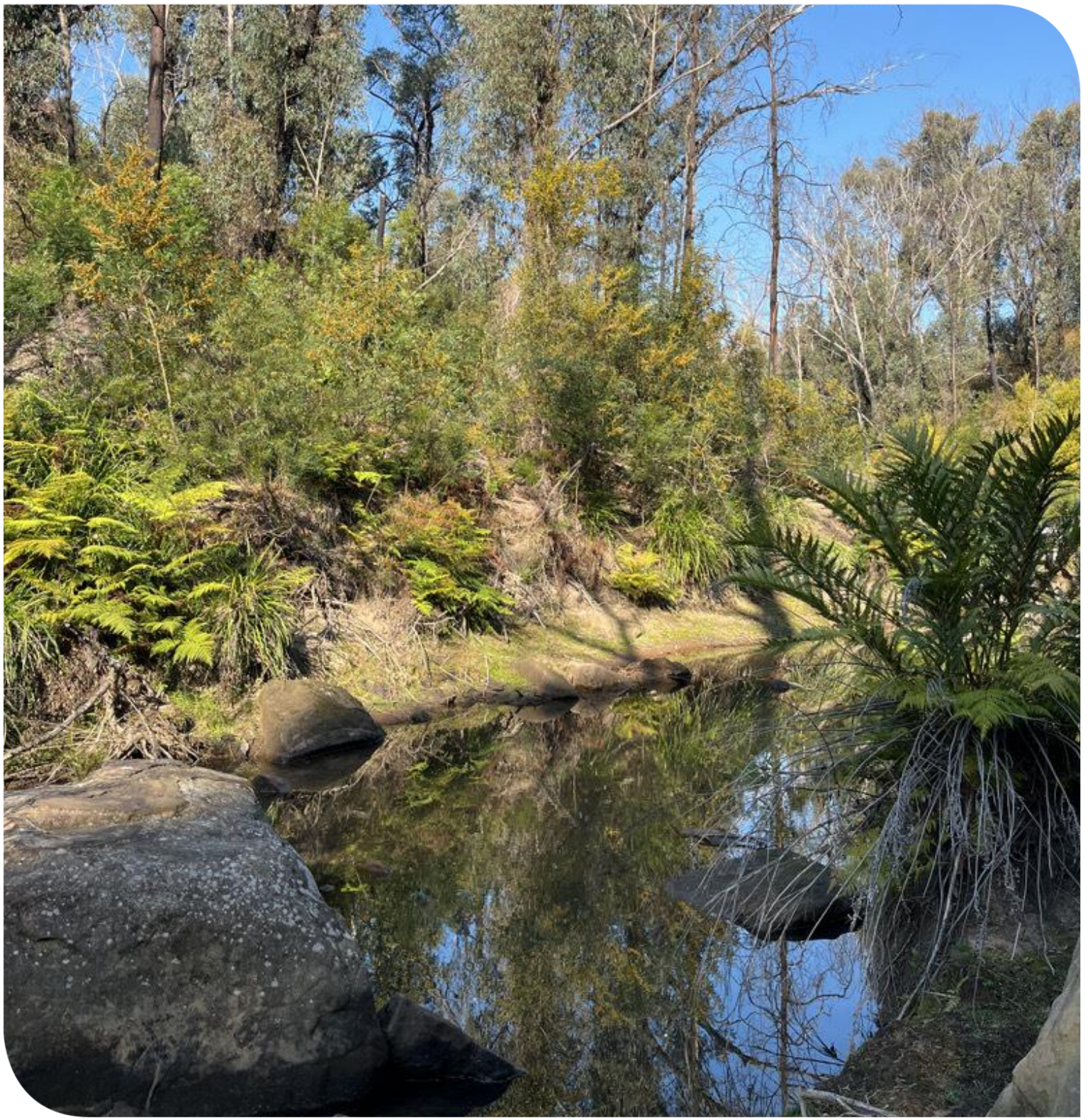
# Tahmoor South Coal Project – SSD 8445

## Biodiversity Development Assessment Report (Modification 3)

Prepared for SIMEC | 17 May 2024



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| Project number | Client | Project manager | LGA |
|---|---|---|---|
| 8184 | SIMEC | Stephen Bloomfield | Wollondilly Shire Council |
| This Biodiversity Development Assessment Report has been prepared based on the requirements of (and information provided under) the Biodiversity Assessment Method as certified by BAM Accredited Assessor: Stephen Bloomfield (BAAS18054) | | | |

| Version | Author | Review | Status | Date |
|---|---|---|---|---|
| D1 | Stephen Bloomfield, Amy Legge, Jesse Cass | David Fleming (Niche) | Draft | 11 March 2024 |
| D2 | Stephen Bloomfield | Ryan Sébire (Niche) | Final draft | 12 March 2024 |
| R0 | Stephen Bloomfield | James Wearne (EMM) | Interim Final Report | 22 March 2024 |
| R1 | Stephen Bloomfield | | Final Report | 17 May 2024 |

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# Executive summary

***Context***

Niche Environment and Heritage Pty Ltd (Niche) was engaged by SIMEC Mining, to prepare a Biodiversity Development Assessment Report (BDAR) for the proposed addition of Longwall S7A (LW S7A) to the South Domain area at Tahmoor Mine (the Project), Bargo, NSW. The Subject Land is located adjacent to, and to the south of, the existing Tahmoor South, situated generally between Caloola Road in the north, Remembrance Driveway and the Main Southern Railway line in the east, Wellers Road in the south, and Hornes Creek in the west.

This report describes the ecological values within the development footprint as per the Biodiversity Assessment Methodology (BAM) (DPIE 2020a), and determines whether the Project is likely to have an impact on threatened biodiversity listed under the NSW *Biodiversity Conservation Act 2016* (BC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The ecological assessment, generally undertaken in accordance with the BAM and in consultation with the Biodiversity Conservation Division (BCD), focussed primarily on the validation of vegetation mapping within publicly accessible areas. Given the nature of the Project (i.e. subsidence related impacts only) a variation of the BAM was proposed and adopted following BCD approval. Surveys did not include collection of floristic and habitat data from BAM plots, or targeted surveys for flora or fauna species; instead, presence of all candidate species was assumed based on the validation of the Plant Community Types (PCTs) present.

***Results***

Six plant community types (PCTs) were mapped within the Subject Land:

- PCT 3598 Woronora Plateau Scribbly Gum Woodland
- PCT 3611 Nattai Plateau Bloodwood-Peppermint Forest
- PCT 3614 Southern Highlands Sandstone Peppermint Forest
- PCT 3616 Sydney Hinterland Grey Gum Transition Forest
- PCT 3618 Sydney Hinterland Sandflat Peppermint Forest
- PCT 3619 Sydney Hinterland Enriched Sandstone Bloodwood Forest

None of the PCTs present align to a Threatened Ecological Community (TEC) listed under the BC Act or EPBC Act. Therefore, the Project would not impact on any TECs listed on the BC or EPBC Acts.

Two threatened flora species were recorded opportunistically within the Subject Land, Bargo Geebung (*Persoonia bargoensis*) and Mittagong Geebung (*Persoonia glaucescens*). Neither of these species are considered to be at risk of subsidence impacts caused by the Project.

No threatened fauna were recorded.

Due to the nature of the Project (i.e. prescribed impacts only; no vegetation clearing or surface disturbance), of all the threatened species assumed present only eight species are considered to potentially be impacted by subsidence, given their association with waterways, drainage lines and/or cliff line areas:

- Woronora Beard-heath (*Leucopogon exolasius*)
- Brown Pomaderris (*Pomaderris brunnea*)
- Large-eared Pied Bat (*Chalinolobus dwyeri*)
- Giant Burrowing Frog (*Heleioporus australiacus*)

- Broad-headed Snake (*Hoplocephalus bungaroides*)
- Little Bent-winged Bat (*Miniopterus australis*)
- Large Bent-winged Bat (*Miniopterus orianae oceanensis*)
- Red-crowned Toadlet (*Pseudophryne australis*).

The following MNES entities were assumed present and considered under the EPBC Act Significant Impact Criteria Assessment:

- Woronora Beard-heath
- Brown Pomaderris
- Broad-headed Snake
- Large-pied eared bat
- Giant Burrowing Frog.

The assessments concluded that the Project is not likely to result in a significant impact on any of these species.

***Impact assessment***

The Project has the potential to result in prescribed impacts to waterways, drainage lines and cliff line areas due to subsidence associated with longwall mining. However, the impact is considered to be negligible or would not adversely impact any TEC, or threatened flora, fauna, their populations or habitats.

The Project will *not* result in:

- Direct removal of native vegetation or areas of TEC
- Removal of threatened flora habitat
- Removal of threatened fauna habitat
- Direct disturbance to waterways and their associated banks and riparian vegetation.

***Avoid/mitigate impacts***

Measures to reduce the impact of the Project on local flora and fauna are detailed in the report and include:

- The current mine location permits the use of existing pit top facilities to access the proposed LWS7A via Tahmoor South Domain
- This mine design consideration minimises surface impacts from mining through the avoidance of establishing new surface facilities
- The Project design maximises the protection of the cliff lines and natural features within the drainage lines, including Hornes Creek, and reduces the potential for the Project to impact the biodiversity values associated with these habitats. This avoids significant impacts to those species assumed to be present and potentially using these habitats, such as the Red-crowned, Giant Burrowing Frog and threatened microbats.

***Credit calculations and offsetting***

Due to the nature of the Project (i.e. prescribed impacts only; no vegetation clearing or surface disturbance):

- 0 ecosystem credits are required to offset impacts to native vegetation resulting from the Project
- 0 species credit species require offsetting as a result of the Project.

# Glossary and list of abbreviations

| Term or abbreviation | Definition |
|---|---|
| ASS | Acid Sulfate Soils |
| BAM | Biodiversity Assessment Method |
| BAM-C | Biodiversity Assessment Method Credit Calculator |
| BC Act | NSW *Biodiversity Conservation Act 2016* |
| BCD | Biodiversity Conservation and Sciences Directorate within the NSW Department of Climate Change, Energy, the Environment and Water |
| BC Reg | NSW *Biodiversity Conservation Regulation 2017* |
| BDAR | Biodiversity Development Assessment Report |
| BMP | Biodiversity Management Plan |
| BOS | NSW Biodiversity Offsets Scheme |
| CEMP | Construction Environmental Management Plans |
| DCCEEW | Commonwealth Department of Climate Change, Energy, the Environment and Water |
| DPIE | NSW Department of Planning, Industry and Environment (formerly DECCW, DECC, DEC, OEH) |
| EMPs | Environmental Management Plans |
| EMS | Environmental Management System |
| EP&A Act | NSW *Environmental Planning and Assessment Act 1979* |
| EPBC Act | Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* |
| GIS | Geographic Information System |
| ha | Hectare/s |
| IBRA | Interim Biogeographic Regionalisation for Australia |
| IPC | Independent Planning Commission |
| km | Kilometre/s |
| LEP | Local Environment Plan |
| LGA | Local Government Area |
| Locality | The Subject Land and surrounds, nominally a 10 km radius from the Subject Land |
| m | Metre/s |
| MNES | Matters of National Environmental Significance (from the Commonwealth Environment Protection and Biodiversity Conservation Act 1999). |
| MSEC | Mine Subsidence Engineering Consultants |
| Mtpa | Million tonnes per annum |
| NSW DCCEEW | NSW Department of Climate Change, Energy, the Environment and Water |
| PCT | Plant Community Type |
| RDP | Rapid Data Point |
| REA | Reject Emplacement Area |

| Term or abbreviation | Definition |
|---|---|
| ROM | Run-of-mine |
| SAII | Serious and Irreversible Impacts |
| SEARs | Secretary's Environmental Assessment Requirements |
| SVTM | State Vegetation Type Map |
| Subject Land | The area contained within the 20 mm predicted subsidence zone, and the 35° angle of draw line around LW S7A. It encompasses the area of prescribed impact.<br>Note, for the context of this BDAR, Subject Land is sometimes interchangeable used with Development Footprint. |
| TEC | Threatened Ecological Community |
| tpa | Tonnes per annum |
| VI | Vegetation Integrity as calculated by the BAM Calculator |

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# Declarations

## Certification under clause 6.15 Biodiversity Conservation Act 2016

I certify that this report has been prepared based on the requirements of, and information provided under, the Biodiversity Assessment Method and clause 6.15 of the *Biodiversity Conservation Act 2016* (BC Act).

Signature:

Date: 17 May 2024

BAM Assessor Accreditation no: BAAS18054

This BDAR has been prepared to meet the requirements of BAM 2020.

## Details and experience of author/s and contributors

This BDAR has been prepared by the Niche accredited personnel and support staff identified in Table 1.

**Table 1. Assessor and support staff qualifications and resources.**

| Name | BAM Assessor Accreditation number | Position/Role | Tasks performed | Relevant qualifications |
|---|---|---|---|---|
| Luke Baker | BAAS17033 | General Manager Operations – Niche<br>Project director/manager | Project direction and support | BAppSc<br>Accredited Biodiversity Assessor |
| Stephen Bloomfield | BAAS18054 | Principal Ecology – Niche<br>Project Manager | Project management, field survey (including vegetation validation and targeted flora survey), report preparation, impact assessment, data management and review/audit, BAM Calculations | BAppSc (Coastal Mgmt)<br>Accredited Biodiversity Assessor |
| David Fleming | - | Natural Capital Senior Principal – Niche<br>Report review | Review of report | CEnvP |
| Ryan Sébire | - | Ecology Senior Consultant | Report edits | BEnvSc&Mgnt |
| Amy Legge | Pending approval | Senior Ecology Consultant – Niche<br>Project support | Field survey (including vegetation validation and targeted flora survey), report preparation, impact assessment, data management and review/audit, BAM Calculations | BSc (Cons Bio) |

| Name | BAM Assessor Accreditation number | Position/Role | Tasks performed | Relevant qualifications |
|---|---|---|---|---|
| Lily Cains | - | Ecology Consultant – Niche Project support | Field survey (including vegetation validation and targeted flora survey), data management | BSc |
| Justin Meredith | - | Environmental Approvals Consultant – Niche Project support | Report preparation | BSc (EnvSc) |
| Tamika Flanigan | - | Natural Capital Consultant – Niche Project Support | Report preparation | BEnvSc |
| Harrison Binks | - | Spatial Services Consultant – Niche Project support | Spatial management, analysis and figure preparation | BEnv (GIS) |

## Conflict of interest

I declare that I have considered the circumstances and there is no actual, perceived or potential conflict of interest:

This declaration has been made in the interests of full disclosure to the decision-maker. Full disclosure has also been provided to the client.

Signature:

Date: 17 May 2024

BAM Assessor Accreditation no: BAAS19016

# Stage 1: Biodiversity Assessment

## 1. Introduction

### 1.1 Proposed development

#### 1.1.1 Background

Tahmoor Coal Pty Ltd (Tahmoor Coal) owns and operates the Tahmoor Mine, an underground coal mine between the townships of Tahmoor and Bargo, approximately 80 kilometres (km) south-west of Sydney in the Southern Coalfields of NSW (Figure 1 and Figure 2). Tahmoor Coal is a wholly owned entity within the SIMEC Mining Division of the GFG Alliance group.

Niche Environment and Heritage (Niche) was previously commissioned by Tahmoor Coal to assess the ecological values and impacts associated with the Tahmoor South Project (South Domain area at Tahmoor Mine). The Biodiversity Assessment Report and the relevant updates (Niche 2022) supported the NSW Independent Planning Commission (IPC) in granting development consent (SSD 8445) for the Tahmoor South Project on 23 April 2021. Development consent SSD 8445 permits extraction and processing of up to 4 Mtpa of run-of-mine (ROM) coal from the Bulli Seam until 2032 using longwall mining methods. The approved longwalls authorised by the SSD 8445 include an 'A' series of longwall panels (LW S1A-S6A) and a 'B' series of longwall panels (LW S1B-S6B). Tahmoor Coal are currently extracting coal from Longwall LW S2A.

Development consent SSD 8445 has been modified on two instances:

- Modification 1 (Mod 1) was granted on 19 July 2022 and authorised an extension of time, until 31 December 2023, for the new water treatment plant to be commissioned
- Modification 2 (Mod 2) was granted on 13 June 2023 and authorised the transfer and storage of water treatment plant brine in underground workings.

Tahmoor Coal is proposing to extract an additional longwall panel, LW S7A. LW S7A will be added to the A series and represents the third modification to the development consent (Modification 3).

The LW S7A Subject Land largely overlaps with the existing Tahmoor South approved mining area. A small portion of the Subject Land that occurs adjacent to, and to the south of, the existing Tahmoor South approved mining area, was not part of that approved mining area.

Niche was commissioned by SIMEC to prepare a Biodiversity Development Assessment Report (BDAR) to support the proposed Modification application for the addition of LW S7A (the Project).

Mine Subsidence Engineering Consultants (MSEC) was commissioned by SIMEC to prepare the subsidence report for the Project that undertakes subsidence predictions and impact assessments for the proposed LW S7A (MSEC 2024).

#### 1.1.2 Location

The Subject Land is located adjacent to, and to the south of, the existing Tahmoor South approved mining area, at Bargo. It is situated generally between Caloola Road in the north, Remembrance Driveway and the Main Southern Railway line in the east, Wellers Road in the south, and Hornes Creek in the west.

### 1.1.3 The Proposed development and Subject Land

Tahmoor Coal is seeking to modify SSD 8445 (Mod 3) under Section 4.55(2) of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) to authorise:

- An additional longwall panel (LW S7A) to the approved 'A' series longwall panel layout
- Removal of restrictions imposed by Condition A6 on the requirement for mining to be completed within 10 years following the commencement of second workings in the Tahmoor South mining area
- An increase in the maximum volume of ROM coal authorised by Condition A11(b) of SSD 8445 that can be extracted and processed on site from 33 million tonnes per annum (Mtpa) to 35 Mtpa.

Refer to Figure 3 for the proposed layout of LW 7SA in relation to the approved longwalls associated with the Tahmoor South Project.

LW S7A will extract coal between a minimum extraction height of 2.1 metres (m) and a maximum extraction height of 2.5 m.

The existing approved Reject Emplacement Area (REA) will continue to be used for the storage of reject material to a maximum height of RL 320 m. The existing REA does not need to be expanded as part of the Project.

All proposed works are to be confined to the underground or existing disturbed areas (e.g. REA) that were assessed as part of the approved Tahmoor South Project. No vegetation clearing or other direct impacts are expected to occur on the surface within the Subject Land.

This BDAR has been prepared in accordance with the Biodiversity Assessment Methodology (BAM) (NSW Department of Planning Industry and Environment [DPIE] 2020). The objective of the BDAR is to describe and assess the ecological values within the Subject Land and surrounds within NSW, determine whether the Project is likely to have an impact on threatened biodiversity listed under the NSW *Biodiversity Conservation Act 2016* (BC Act) and identify and quantify any associated biodiversity offsetting requirements. The offset requirements are calculated using the BAM Calculator (BAM-C).

This BDAR cross references MSEC's subsidence report to determine the indirect and/or prescribed impacts on biodiversity.

***Subject Land***

The Subject Land is approximately 343.7 ha in size, the limits of which have been determined through reference to the subsidence report (MSEC 2024). MSEC define the Subject Land as the zone where the predicted subsidence effects, based on the Modified Layout, are different to those predicted based on the Approved Layout. The Subject Land has been based on the following:

- 35° angle of draw line around LW S7A, based on the Modified Layout;
- The limit where the predicted incremental vertical subsidence due to the extraction of LW S7A on the tailgate (eastern side) of the panel is greater than 20 mm
- The limit where the predicted incremental total subsidence due to the extraction of LWs S1A to S7A on the maingate (western side) of the panel is greater than 20 mm.

The Subject Land is zoned as RU1 Primary Production and RU2 Rural Landscape in the Wollondilly Local Environmental Plan 2011 (LEP).

The elevation of the Subject Land ranges in height between 280 m and 330 m. The topography is generally flat with slight undulations, apart from the western portion of the Subject Land where the land falls steeply away to Hornes Creek.

The Subject Land is comprised of land that is largely cleared or partially cleared, however there are large stands of intact native vegetation. The cleared land is made up of areas of predominately exotic pasture grassland and areas of scattered native trees. The native vegetation contains woodland and riparian communities occurring in various conditions, that are best described as Dry Sclerophyll Forest.

The Subject Land is traversed by eight first order tributaries leading to (and inclusive of) Hornes Creek, in addition to two first order tributaries connecting to Tea Tree Hollow. Both creek lines lead into Bargo River and further to Nepean River.

Cliff lines, rock outcropping, ledges, crevices and some exfoliated rock occur within the woodland area in the west of the Subject Land.

The Subject Land does not adjoin any National Parks, State Parks or nature reserves.

The Subject Land currently contains residential dwellings and farms that are occupied and numerous dams.

## 1.2 Biodiversity Offsets Scheme entry

Development Consent for the Project is sought under the State Significant Development provisions (i.e. Division 4.7) under Part 4 of the EP&A Act. As such, a BDAR prepared in accordance with the BAM (DPIE 2020a) is required to assess impacts to biodiversity as per the NSW *Biodiversity Conservation Act 2016* (BC Act).

## 1.3 Excluded impacts

The impacts directly associated with the mining below the land surface are not considered as part of the BDAR.

Category 1-exempt land has not been considered as part of this BDAR.

## 1.4 Matters of National Environmental Significance

This BDAR considers impacts to Matters of National Environmental Significance (MNES) listed under the EPBC Act. The Project is not considered to have a significant impact on any MNES and is unlikely to be considered a “Controlled Action”. As such, the Project has not been referred to the Commonwealth Minister for the Environment and Water. Further, the Project does not require assessment under the Bilateral Agreement between NSW and the Commonwealth.

## 1.5 Information sources

Resources and survey guidelines reviewed in the preparation of this BDAR are detailed in

Table 2.

**Table 2. Assessment resources/guidelines**

| Assessment resources/guidelines | |
|---|---|
| **Resources** | • Biodiversity Assessment Method (BAM) (DPIE 2020a)<br>• BAM Operational Manual 2020 – Stage 1 (DPIE 2022)<br>• BAM Operational Manual 2020 – Stage 2 (DPE 2023)<br>• BAM Calculator User Guide (OEH 2018a)<br>• BAM – Important Areas Mapping (NSW DCCEEW 2024e)<br>• NSW State Vegetation Type Map (DPE 2022)<br>• Bionet Atlas (NSW DCCEEW 2024a)<br>• NSW Bionet Vegetation Classification database (NSW DCCEEW 2024b)<br>• Protected Matters Search Tool (DCCEEW 2023a)<br>• SPRAT Database (DCCEEW 2023b) |
| **Survey guidelines** | NSW<br>• Surveying threatened plants and their habitats NSW survey guide for the Biodiversity Assessment Method (DPIE 2020b).<br>• 'Species credit' threatened bats and their habitats, NSW survey guide for the Biodiversity Assessment Method (DPIE 2021).<br>• NSW survey guide for threatened frogs, a guide for the survey of threatened frogs and their habitats for the Biodiversity Assessment Method (DPIE 2020c).<br>• 2004 Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft) (DEC 2004).<br>Commonwealth<br>• Survey Guidelines for Australia's Threatened Bats (DEWHA 2010a)<br>• Survey Guidelines for Australia's Threatened Birds (DEWHA 2010b)<br>• Survey Guidelines for Australia's Threatened Frogs (DEWHA 2010c)<br>• Survey Guidelines for Australia's Threatened Reptiles (DSEWPaC 2011a)<br>• Survey Guidelines for Australia's Threatened Mammals (DSEWPaC 2011b)<br>• Draft Survey Guidelines for Australia's Threatened Orchids (DEWHA 2013a) |

# 2. Methods

## 2.1 Site context methods

### 2.1.1 Landscape features

Landscape features within the Subject Land and within a 1500 m buffer of the Subject Land (the assessment area) must be assessed as detailed in Section 3 of the BAM. Landscape features within the assessment area were identified through a combination of field surveys, database searches and literature review.

The database searches and literature review involved analysis of the following sources:

- NSW State Vegetation Type Map (SVTM) (DPE 2022)
- Interim Biogeographic Regionalisation for Australia (IBRA) version 7.0 (DCCEEW 2024)
- NSW (Mitchell) Landscapes version 3.1 (NSW DCCEEW 2024f).

Furthermore, field surveys conducted across the Subject Land involved the identification of landscape features including rivers, streams and wetlands as well as geological features of significance.

The landscape features identified are described in Section 3.2.2.

### 2.1.2 Native vegetation cover

The percentage of native vegetation cover in the assessment area was estimated according to Section 3.2 of the BAM (DPIE 2020a). The assessment area includes the Subject Land and a 1500 m buffer zone around it. The NSW SVTM (DPE 2022) was initially used to map native vegetation within the assessment area and was then cross referenced with aerial imagery to further refine areas of native and exotic cover.

All native vegetation within the assessment area was digitised using Geographic Information System (GIS) editing tools and the area calculated as a percentage of the assessment area.

## 2.2 Deviation from the BAM

Given the nature of the Project (i.e. prescribed impacts only), no direct and indirect impacts are expected. As such, a deviation to the BAM has been adopted as part of the BDAR. The field assessment did not include:

- Collection of floristic and habitat data from BAM plots, or
- Targeted, or seasonal, surveys for any flora and /or fauna candidate species.

As an alternative the following was proposed and discussed with Russel Moule (Senior Conservation Planning Officer) of the Biodiversity Conservation and Sciences Directorate (BCD) in early consultation undertaken by Niche:

- Vegetation mapping of the Subject Land (SVTM) was reviewed and publicly available areas of the Subject Land ground-truthed and validated by rapid data points (RPD)
- Validated Plant Community Types (PCTs) entered in the BAM-C at benchmark condition i.e. 100 for each attribute
- All predicted and candidate species generated by the BAM-C to be assumed present.
- Concentrate any threatened flora and fauna survey (not in accordance with BAM survey guidelines) to those areas that may be potentially impacted by subsidence (e.g. riparian zones and cliff lines)
- Candidate species known to utilise those areas that may be potentially impacted by subsidence (e.g. riparian zones and cliff lines) were the focus of the impact assessment.

Russel Moule (BCD) accepted the proposed approach on 25 July 2023 (Annex 1).

## 2.3 Native vegetation, threatened ecological communities and vegetation integrity

### 2.3.1 Existing information

PCTs in the Subject Land were determined according to Section 4.2 of the BAM (DPIE 2020a). Desktop review of the SVTM (DPE 2022) and BioNet Vegetation Classification (NSW DCCEEW 2024b) were used to identify potentially occurring PCTs.

### 2.3.2 Mapping native vegetation extent

Given the purpose of the native vegetation survey was to validate the SVTM (DPE 2022), areas within the Subject Land that would be potentially impacted by subsidence (e.g. riparian zones) were a key focus.

Native vegetation extent within the Subject Land was mapped using the SVTM (DPE 2022) and data collected from 33 RDPs across the site during vegetation surveys, as well as incidental observations. Information collected from RDPs can include the dominant species and percentage cover of each stratum, and habitat features (i.e. hollow-bearing trees, geology, ground debris). Draft vegetation mapping developed from the SVTM (DPE 2022) was refined following field surveys.

Filters were applied to the BioNet Vegetation Classification (NSW DCCEEW 2024) using a combination of Interim Biogeographic Regionalisation for Australia (IBRA) region, IBRA sub-region, vegetation formation and species composition. Analysis of floristic data from the RDPs, abiotic factors, such as landscape position, soil type, geology influence, and other relevant information was used to determine the most appropriate PCTs for the Subject Land.

### 2.3.3 Plot-based vegetation survey

No survey plots were conducted as part of the assessment given the nature of the Project (i.e. prescribed impacts only) (refer to Section 2.2).

### 2.3.4 Vegetation integrity survey

Typically, values collected from the plot-based survey (i.e. quantitative measures of composition, structure and function for each vegetation zone) carried out at a site are entered into the BAM-C, which compares these values with the benchmark data for the vegetation class, providing a vegetation integrity score for each vegetation zone. This score represents the overall condition of the vegetation compared to the benchmark value (out of 100). The BAM-C then uses this data to calculate the number of biodiversity credits that are required for a development.

As no plot-based survey was conducted as part of the assessment no plot data existed to input into the BAM-C to determine a vegetation integrity score. As such, the vegetation integrity assessment was carried out by using benchmark values for each PCT present within the subject land and entering these into the BAM-C.

## 2.4 Threatened flora survey methods

### 2.4.1 Review of existing information

A preliminary run of the BAM-C tool (using benchmark condition for mapped PCTs) was conducted to identify candidate species credit species and predicted ecosystem credit species known or predicted to occur within the Subject Land.

A review of relevant literature, databases and existing vegetation mapping was undertaken to identify other threatened biodiversity with the potential to occur in the Subject Land. The following resources were used for this purpose:

- Database searches (August 2023):
  - *NSW BioNet Atlas Database* (NSW DCCEEW 2024a) for spatial records of threatened flora listed under the BC Act within a 10 km radius of the Subject Land.
  - *EPBC Act Protected Matters Search Tool* (PMST) (DCCEEW 2023) for flora and ecological communities identified as MNES known from or with potential habitat within a 10 km radius of the Subject Land
  - Previous records and species information for predicted threatened species available in the TBDC (NSW DCCEEW 2024a) and Threatened Species Profile Database (NSW DCCEEW 2024d) were also reviewed.
- Previous reports:
    - MSEC (2024). Subsidence predictions and impact assessments: Tahmoor Coal - Modification 3 - Longwall S7A. Prepared for Tahmoor Coal. Dated November 2023.
    - Niche (2024). Tahmoor Mine Western Domain Terrestrial Ecology Monitoring Report Riparian vegetation and amphibian monitoring Spring 2023. Prepared for Tahmoor Coal. Dated February 2024.
    - Niche (2023). Tahmoor Mine Western Domain Terrestrial Ecology Monitoring Report Riparian vegetation and amphibian monitoring Autumn 2023. Prepared for Tahmoor Coal. Dated April 2023.
    - Niche (2022b). Tahmoor Mine Western Domain Terrestrial Ecology Monitoring Report Riparian vegetation and amphibian monitoring Spring 2022. Prepared for Tahmoor Coal. Dated December 2022.
    - Niche (2022c).Tahmoor Mine Western Domain Terrestrial Ecology Monitoring Report Riparian vegetation and amphibian monitoring Autumn 2022. Prepared for Tahmoor Coal. Dated April 2022.
    - Niche (2021a). Tahmoor Mine Western Domain Terrestrial Ecology Monitoring Report Riparian vegetation and amphibian monitoring Spring 2021. Prepared for Tahmoor Coal. Dated November 2021.
    - Niche (2021b). Tahmoor Mine Western Domain Terrestrial Ecology Monitoring Report Riparian vegetation and amphibian monitoring Autumn 2021. Prepared for Tahmoor Coal. Dated February 2021.
    - Niche (2020a). Tahmoor South Project –Amended Biodiversity Assessment Report, February 2020.
    - Niche (2020b). Tahmoor South Project Amendment August 2020: Biodiversity Assessment Update dated August 2020.
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    - Niche (2020d). Tahmoor Mine Western Domain Terrestrial Ecology Monitoring Report Riparian vegetation and amphibian monitoring Autumn 2018-2020. Prepared for Tahmoor Coal. Dated May 2020.
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- Niche (2018b). Tahmoor Colliery Longwalls 31 to 37 - Baseline riparian vegetation and frog monitoring report 2018. Prepared for Tahmoor Coal. Dated July 2018.
- Niche (2014a). Tahmoor South Aquatic Ecology Impact Assessment, Prepared for Tahmoor Coal 2014.
- Niche (2014b). Tahmoor South Project Terrestrial Monitoring Project Year 2013-2014.
- Niche (2013). Tahmoor South Project Terrestrial Monitoring Project Year 2012-2013.
- Niche (2012). Tahmoor South Project Pilot Study, Prepared for Tahmoor Coal.

With reference to Niche (2024), it is noted that one of the threatened flora monitoring locations occurs within the Subject Land. Threatened flora Site 4 (TF4), monitors a local population of Bargo Geebung (*Persoonia bargoensis*), directly above the proposed LW S7A, in the eastern portion of the Subject Land south of Yarran Road (Figure 6) (Niche 2024).

### 2.4.2 Habitat constraints assessment

Suitable threatened flora habitat was identified by database and literature searches as the extent of the species' associated PCTs within the Subject Land. The Subject Land is known to support ample habitat for numerous threatened flora species, with many individuals recorded over the previous years of surveys completed by Niche. These species include:

- Bargo Geebung
- Bynoes Wattle (*Acacia bynoeana*)
- Brown Pomaderris (*Pomaderris brunnea*)
- Small-flower Grevillea (*Grevillea parviflora* subsp. *parviflora*)
- *Epacris purpurascens* var. *purpurascens.*

### 2.4.3 Field surveys

No targeted flora surveys were conducted as part of the assessment given the nature of the Project (i.e. prescribed impacts only) (refer to Section 2.2).

## 2.5 Threatened fauna survey methods

### 2.5.1 Review of existing information

Refer to Section 2.4.1.

### 2.5.2 Habitat constraints assessment

A brief habitat assessment was completed during September 2023 and involved opportunistically recording the following fauna habitat features within the Subject Land:

- Vegetation structure and age
- Site condition
- Dominant flora species in each stratum
- Evidence of feral animals
- Large stick nests suitable for raptors
- Hollow-bearing trees
- Rocky areas, including escarpments, outcrops and pagodas

- The abundance of potential roosting habitat, including rocky areas containing caves, tunnels, mines, culverts, overhangs, escarpments, outcrops, crevices or boulder piles
- Logs, fallen timber and leaf litter
- Ephemeral and permanent waterbodies
- Evidence of disturbance (e.g. grazing, fire, tracks, logged stumps, erosion)
- Important feed trees and shrubs (e.g. primary feed trees for Koala *Phascolarctos cinereus*)
- Abundance of ground or arboreal termite mounds
- Mistletoe.

Where possible, bat habitat features (e.g. caves, overhangs, escarpments, outcrops, crevices, boulder piles) were inspected to determine potential suitability for roosting bats. The GPS location of notable habitat features with potential to support roosting bats was recorded when observed.

Areas within the Subject Land that would be potentially impacted by subsidence and a likely habitat requirement for threatened species (e.g. riparian zones and cliff lines/rock outcrops) were a key focus.

MSEC (2024) undertook mapping of features (cliffs and rock face features) using photogrammetry. The subsidence report is used to assess potential impacts to bats in Section 8.3.1 of the BDAR.

### 2.5.3 Field surveys

No targeted fauna surveys were conducted as part of the assessment given the nature of the Project (i.e. prescribed impacts only) (refer to Section 2.2).

## 2.6 Weather conditions

Field surveys were undertaken over several days in September 2023 as summarised in Table 3. This data is intended to provide a general overview of weather conditions at the time of field survey.

**Table 3. Climatic conditions during surveys**

| Survey undertaken | Date | Time | Temperature (min. & max.) | Wind | Rainfall (mm) |
|---|---|---|---|---|---|
| RDPs, habitat assessment, opportunistic threatened plant survey | 07/09/2023 | 0930-1600 | Min. 2.5°C<br>Max. 28.7°C | NNW 50 km/h | 0 |
| RDPs, habitat assessment, opportunistic threatened plant survey | 12/09/2023 | 0900-1500 | Min. 3.0°C<br>Max. 21.6°C | SSW 17 km/h | 0 |
| RDPs, habitat assessment, opportunistic threatened plant survey | 22/09/2023 | 0930-1430 | Min. 7.8°C<br>Max. 20.7°C | SSW 26 km/h | 0.6 |
| RDPs, habitat assessment, opportunistic threatened plant survey | 28/09/2023 | 1000-1430 | Min. 13.9°C<br>Max. 23.4°C | N 28 km/h | 12.8 |

## 2.7 Limitations

- Given the nature of the Project (i.e. prescribed impacts only) no targeted, or seasonal, surveys for any flora and /or fauna candidate species were conducted. To overcome this:
  - the SVTM was reviewed and publicly available areas of the Subject Land validated. Based on the presence of the PCTs identified the BAM-C was used to generate the predicted and candidate species. All predicted and candidate species generated by the BAM-C have been assumed present for the purpose of the BDAR.

- Threatened flora and fauna surveys (not in accordance with BAM survey guidelines) were restricted to those areas that may be potentially impacted by subsidence (e.g. riparian zones and cliff lines).

- Some plant species are cryptic and may remain undetected during the survey. This is the case with orchid species, annuals (completing their life cycle within a single season) and some perennials being inconspicuous unless flowering or in fruit. Therefore, not all plants found could be accurately identified. Additionally, some fauna species can only be detected during certain seasons (e.g., migration patterns or intra-torpor periods). These limitations were addressed by assuming presence of all threatened species based on the validated PCTs within the Subject Land.
- During the 2019/2020 Summer bushfires (Black Summer Bushfires), the area within the Subject Land was severely burnt (the canopy and understorey completed burnt, according to field observations and the Fire Extent and Severity Mapping [FESM]). The unprecedented severity of the fire may have potentially influenced the viability of areas to support threatened flora, and habitat for Giant Burrowing Frog and Red-crowned Toadlet.

# 3. Site Context

## 3.1 Assessment area

The BDAR assessment area for the Project (encompassing a 1,500 m buffer surrounding the Subject Land) is 2,112.43 ha, and includes:

- 579.63 ha of non-native vegetation and/or cleared areas/infrastructure
- 1,532.8 ha of woody vegetation.

The assessment area, showing the extent of woody and non-woody native vegetation is shown on Figure 3.

## 3.2 Landscape features

Landscape features within the Subject Land and assessment area are described below in accordance with Section 3.1 of the BAM (DPIE 2020a).

### 3.2.1 IBRA bioregions and IBRA subregions

The Subject Land is located wholly within the Sydney Basin IBRA region of NSW and the Cumberland IBRA subregion (Figure 2).

### 3.2.2 Rivers, streams, estuaries and wetlands

The Subject Land is located in the Hawkesbury-Nepean catchment with the natural waterway features comprising of tributaries of the Bargo River, and Hornes Creek (Figure 2). Hornes Creek, which is located within the 600 m offset boundary for LW S7A, will primarily be impacted by the Project (extraction of coal from LW S7A). Bargo River is outside of the potential 600 m offset boundary for LW S7A; however, it does receive waters from some first order tributaries in the north of the Subject Land. There are no estuaries or wetlands within, in close proximity to, or downstream of, the Subject Land.

### 3.2.3 Habitat connectivity

The broader Bargo River, and Hornes Creek catchment areas (to the west and north of the Subject Land), have moderate to high connectivity to crownland reserves, with extensive areas of intact native vegetation and moderate to high-quality habitats to support threatened flora and fauna species (Figure 2).

### 3.2.4 Karst, caves, crevices, cliffs, rocks or other geological features of significance

Two cliffs are located within the 600 m offset boundary of LW S7A. One is located within a tributary to the Bargo River, and another cliff is located along Hornes Creek (Figure 8).

### 3.2.5 Areas of outstanding biodiversity value

There are no areas of outstanding biodiversity value, as declared by the NSW Minister for the Environment, within the Subject Land.

### 3.2.6 NSW (Mitchell) landscape

The Subject Land is located within the following NSW (Mitchell) Landscapes (NSW DCCEEW 2024f):

- Picton – Razorback Hills (61% cleared) (90.7% of the Subject Land)
- Nattai Plateau Wollemi Ranges (11% cleared) (9.3% of the Subject Land).

The Subject Land occurs almost entirely within the Picton – Razorback Hills landscape with only a small area occurring within the Nattai Plateau Wollemi Ranges landscape in the western portion of the Subject Land (Figure 2). As such, the Picton – Razorback Hills landscape was used in the BAM-C for Project.

### 3.2.7 Additional landscape features

No additional landscape features have been identified in any Secretary's Environmental Assessment Requirements (SEARs) for the Project.

### 3.2.8 Soil hazard features

The majority of the Subject Land is underlain by a mixture of shale and sandstone geology, with sandstone being dominant along, and in association with, Hornes Creek. Limitations to the soil landscapes present include extreme soil erosion hazard (on the steep slopes) and low soil fertility (Bannerman and Hazelton 2011). According to NSW DCCEEW mapping (2024h) there is no Acid Sulfate Soils (ASS) in the vicinity of the Subject Land.

## 3.3 Native vegetation cover

Table 4 summarises the extent of native vegetation cover within the 1,500 m assessment area. Figure 8 shows native vegetation cover within the assessment area.

Native vegetation cover was assessed within a 1,500 m buffer around the Subject Land. The total area within the 1,500 m buffer is 2,112.43 ha, and the area of native vegetation within this is 1,532.8 ha. Native vegetation therefore represents a percent cover of 73%. This falls into the >70% category within the BAM Calculator (Figure 2).

**Table 4. Native vegetation cover in the assessment area**

| | |
|---|---|
| **Assessment area (ha)** | 2,112.43 ha |
| **Total area of native vegetation cover (ha)** | 1,532.8 ha |
| **Percentage of native vegetation cover (%)** | 73% |
| **Class (0-10, >10-30, >30-70 or >70%)** | >70% |

# 4. Native vegetation, threatened ecological communities and vegetation integrity

## 4.1 Native vegetation extent

The Subject Land contains 1,532.8 ha of native woody vegetation in various condition states from dense woodland to scattered trees. Figure 2 shows all areas within the Subject Land identified as containing native vegetation.

### 4.1.1 Changes to the mapped native vegetation extent

The extent of native vegetation within the Subject Land is similar to that shown on the aerial imagery used in the figures, and the SVTM (DPE 2022); One main difference was the lack of PCT 3615 Sydney Hinterland Apple-Blackbutt Gully Forest. This PCT was not located within the Subject Land.

### 4.1.2 Areas that are not native vegetation

Areas within the Subject Land that are not native vegetation include roads, access roads, buildings and dams, and those grassland areas that occur in association with the semi-rural properties present and are dominated by exotic groundcover species.

## 4.2 Plant community types

Vegetation within the Subject Land has been assessed as aligning with the PCTs identified within Table 5 and their extent is shown in Figure 5. Detailed descriptions of each PCT including species used to aid in determining PCTs and justification for alignment to each of the nominated PCTs are provided in Annex 2.

**Table 5. PCTs identified within the Subject Land**

| PCT ID | PCT name | Subject Land (ha) |
|---|---|---|
| 0 | Non-Native | 106.31 |
| 3598 | Woronora Plateau Scribbly Gum Woodland | 20.49 |
| 3611 | Nattai Plateau Bloodwood-Peppermint Forest | 1.62 |
| 3614 | Southern Highlands Sandstone Peppermint Forest | 2.72 |
| 3616 | Sydney Hinterland Grey Gum Transition Forest | 24.14 |
| 3618 | Sydney Hinterland Sandflat Peppermint Forest | 1.27 |
| 3619 | Sydney Hinterland Enriched Sandstone Bloodwood Forest | 185.72 |
| **Total area** | | **342.27** |

## 4.3 Threatened ecological communities

None of the PCTs present in the Subject Land align to any Threatened Ecological Communities (TECs) listed under the BC Act or EPBC Act.

## 4.4 Vegetation zones

Vegetation within the Subject Land was validated and assigned a PCT. Given the objective of the BDAR and nature of the Project (i.e. prescribed impact only), PCTs were not refined to multiple condition classes (i.e. vegetation zones); instead each PCT was considered to be present at benchmark condition (i.e. high) (Table 6).

**Table 6. Vegetation zones and plot requirements**

| Vegetation zone | PCT | Condition[1] | Area (ha) Subject Land | Area (ha) impacted | Patch size class | No. vegetation integrity plots required | No. vegetation integrity plots completed | No. vegetation integrity plots used in assessment | Plot IDs of vegetation integrity plots used in assessment |
|---|---|---|---|---|---|---|---|---|---|
| 3598_high | 3598 | High | 20.49 | 0 | ☐ <5 ha<br>☐ 5–24 ha<br>☐ 25–100 ha<br>☒ >100 ha | 0 | 0 | 0 | n/a |
| 3611_high | 3611 | High | 1.62 | 0 | ☐ <5 ha<br>☐ 5–24 ha<br>☐ 25–100 ha<br>☒ >100 ha | 0 | 0 | 0 | n/a |
| 3614_high | 3614 | High | 2.72 | 0 | ☐ <5 ha<br>☐ 5–24 ha<br>☐ 25–100 ha<br>☒ >100 ha | 0 | 0 | 0 | n/a |
| 3616_high | 3616 | High | 24.14 | 0 | ☐ <5 ha<br>☐ 5–24 ha<br>☐ 25–100 ha<br>☒ >100 ha | 0 | 0 | 0 | n/a |
| 3618_high | 3618 | High | 1.27 | 0 | ☐ <5 ha<br>☐ 5–24 ha<br>☐ 25–100 ha | 0 | 0 | 0 | n/a |

[1] Condition states were not recorded, given the purpose of the assessment being to validate the PCTs present to generate the potentially occurring species credit species. As benchmark data for each PCT is used within the BAM Calculator a condition state of high has been attributed to each PCT.

| Vegetation zone | PCT | Condition[1] | Area (ha) Subject Land | Area (ha) impacted | Patch size class | No. vegetation integrity plots required | No. vegetation integrity plots completed | No. vegetation integrity plots used in assessment | Plot IDs of vegetation integrity plots used in assessment |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | ☒ >100 ha | | | | |
| 3619_high | 3619 | High | 185.72 | 0 | ☐ <5 ha<br>☐ 5–24 ha<br>☐ 25–100 ha<br>☒ >100 ha | 0 | 0 | 0 | n/a |

Patch size for all vegetation zones was given the highest score in the BAM (>100 hectares) (Table 6), as the native vegetation in the Subject Land is directly connected other large areas of native vegetation (refer to Figure 1 and Figure 2).

## 4.5 Vegetation integrity (vegetation condition)

### 4.5.1 Vegetation integrity survey plots

As previously stated, no survey plots were undertaken as part of the assessment. Instead the vegetation was validated using RDPs (plant species recorded via RDPs are provided in Annex 3), and benchmark data for those PCTs was used for the purpose of the BAM Calculator.

### 4.5.2 Use of benchmark data

Benchmark data was sourced from the NSW BioNet Vegetation Classification (NSW DCCEEW 2023b) for each PCT in the relevant IBRA Bioregion (DCCEEW 2024) (Table 7).

**Table 7. Vegetation integrity scores**

| Vegetation zone | Composition condition score | Structure condition score | Function condition score | Vegetation integrity score | Hollow bearing trees present? |
|---|---|---|---|---|---|
| 3598_high | 100 | 100 | 100 | 100 | Yes |
| 3611_high | 100 | 100 | 100 | 100 | Yes |
| 3614_high | 100 | 100 | 100 | 100 | Yes |
| 3616_high | 100 | 100 | 100 | 100 | Yes |
| 3618_high | 100 | 100 | 100 | 100 | Yes |
| 3619_high | 100 | 100 | 100 | 100 | Yes |

# 5. Habitat suitability for threatened species

## 5.1 Identification of threatened species for assessment

### 5.1.1 Ecosystem credit species

All ecosystem credit species generated by the BAM Calculator were assumed present within the Subject Land. Ecosystem credit species are listed in Table 8. No further assessment is required for these species unless they are dual credit species which are assessed further in Section 5.2.

**Table 8. Predicted ecosystem credit species**

| Common name | Scientific name | Listing status | | Dual credit species | Sources | Species retained for further assessment? | Reason for exclusion from further assessment | Vegetation zone ID species retained within, including PCT ID | Sensitivity to gain class |
|---|---|---|---|---|---|---|---|---|---|
| | | BC Act | EPBC Act | | | | | | |
| Regent Honeyeater | *Anthochaera phrygia* | CE | CE | Yes | BAM-C | Yes | n/a | 3616, 3619 | High |
| Dusky Woodswallow | *Artamus cyanopterus cyanopterus* | V | - | No | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | Moderate |
| Gang-gang Cockatoo | *Callocephalon fimbriatum* | V | - | Yes | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | Moderate |
| Glossy Black-Cockatoo | *Calyptorhynchus lathami lathami* | V | V | Yes | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | High |
| Speckled Warbler | *Chthonicola sagittata* | V | - | No | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | High |
| Brown Treecreeper (eastern subspecies) | *Climacteris picumnus victoriae* | V | - | No | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | High |

| Common name | Scientific name | Listing status | | Dual credit species | Sources | Species retained for further assessment? | Reason for exclusion from further assessment | Vegetation zone ID species retained within, including PCT ID | Sensitivity to gain class |
|---|---|---|---|---|---|---|---|---|---|
| | | BC Act | EPBC Act | | | | | | |
| Varied Sittella | *Daphoenositta chrysoptera* | V | - | No | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | Moderate |
| Spotted-tailed Quoll | *Dasyurus maculatus* | V | E | No | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | High |
| Black-necked Stork | *Ephippiorhynchus asiaticus* | E | - | No | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | Moderate |
| Eastern False Pipistrelle | *Falsistrellus tasmaniensis* | V | - | No | BAM-C | Yes | n/a | 3598, 3614, 3616, 3618, 3619 | High |
| Little Lorikeet | *Glossopsitta pusilla* | V | - | No | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | High |
| Painted Honeyeater | *Grantiella picta* | V | V | No | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | Moderate |
| White-bellied Sea-Eagle | *Haliaeetus leucogaster* | V | - | Yes | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | High |

| Common name | Scientific name | Listing status | | Dual credit species | Sources | Species retained for further assessment? | Reason for exclusion from further assessment | Vegetation zone ID species retained within, including PCT ID | Sensitivity to gain class |
|---|---|---|---|---|---|---|---|---|---|
| | | BC Act | EPBC Act | | | | | | |
| Little Eagle | *Hieraaetus morphnoides* | V | - | Yes | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | Moderate |
| White-throated Needletail | *Hirundapus caudacutus* | - | V | No | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | High |
| Broad-headed Snake | *Hoplocephalus bungaroides* | E | V | No | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3619 | High |
| Swift Parrot | *Lathamus discolor* | E | CE | Yes | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | Moderate |
| Broad-billed Sandpiper | *Limicola falcinellus* | V | - | Yes | BAM-C | Yes | n/a | 3611, 3614, 3616, 3618, 3619 | High |
| Square-tailed Kite | *Lophoictinia isura* | V | - | Yes | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | Moderate |
| Hooded Robin (south-eastern form) | *Melanodryas cucullata cucullata* | V | - | No | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | Moderate |

| Common name | Scientific name | Listing status | | Dual credit species | Sources | Species retained for further assessment? | Reason for exclusion from further assessment | Vegetation zone ID species retained within, including PCT ID | Sensitivity to gain class |
|---|---|---|---|---|---|---|---|---|---|
| | | BC Act | EPBC Act | | | | | | |
| Black-chinned Honeyeater (eastern subspecies) | *Melithreptus gularis gularis* | V | - | No | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | Moderate |
| Eastern Coastal Free-tailed Bat | *Micronomus norfolkensis* | V | - | No | BAM-C | Yes | n/a | 3598, 3616, 3618, 3619 | High |
| Little Bent-winged Bat | *Miniopterus australis* | V | - | Yes | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | High |
| Large Bent-winged Bat | *Miniopterus orianae oceanensis* | V | - | Yes | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | High |
| Turquoise Parrot | *Neophema pulchella* | V | - | No | BAM-C | Yes | n/a | 3598, 3616, 3619 | High |
| Barking Owl | *Ninox connivens* | V | - | Yes | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | High |

| Common name | Scientific name | Listing status | | Dual credit species | Sources | Species retained for further assessment? | Reason for exclusion from further assessment | Vegetation zone ID species retained within, including PCT ID | Sensitivity to gain class |
|---|---|---|---|---|---|---|---|---|---|
| | | BC Act | EPBC Act | | | | | | |
| Powerful Owl | *Ninox strenua* | V | - | Yes | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | High |
| Eastern Osprey | *Pandion cristatus* | V | - | Yes | BAM-C | Yes | n/a | 3616, 3618, 3619 | Moderate |
| Yellow-bellied Glider | *Petaurus australis* | V | - | No | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | High |
| Scarlet Robin | *Petroica boodang* | V | - | No | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | Moderate |
| Flame Robin | *Petroica phoenicea* | V | - | No | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | Moderate |
| Grey-headed Flying-fox | *Pteropus poliocephalus* | V | V | Yes | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | High |
| Yellow-bellied Sheathtail-bat | *Saccolaimus flaviventris* | V | - | No | BAM-C | Yes | n/a | 3598, 3616, 3619 | High |

| Common name | Scientific name | Listing status | | Dual credit species | Sources | Species retained for further assessment? | Reason for exclusion from further assessment | Vegetation zone ID species retained within, including PCT ID | Sensitivity to gain class |
|---|---|---|---|---|---|---|---|---|---|
| | | BC Act | EPBC Act | | | | | | |
| Greater Broad-nosed Bat | *Scoteanax rueppellii* | V | - | No | BAM-C | Yes | n/a | 3598, 3616, 3619 | High |
| Diamond Firetail | *Stagonopleura guttata* | V | - | No | BAM-C | Yes | n/a | 3611, 3614, 3616, 3619 | Moderate |
| Masked Owl | *Tyto novaehollandiae* | V | - | Yes | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | High |
| Sooty Owl | *Tyto tenebricosa* | V | - | Yes | BAM-C | Yes | n/a | 3598, 3611, 3616, 3619 | High |
| Rosenberg's Goanna | *Varanus rosenbergi* | V | - | No | BAM-C | Yes | n/a | 3598, 3611, 3614, 3616, 3618, 3619 | High |

NSW and Commonwealth Status: CE = Critically Endangered, E = Endangered, V = Vulnerable, - = not listed.

### 5.1.2 Species credit species

Species credit species identified by the BAM-C and desktop review are detailed below.

#### 5.1.2.1 Flora

A total of 35 threatened flora species and four threatened flora populations were identified from the BAM-C as potential candidate threatened flora species (Table 9). No additional species were added to Table 9.

Table 9 details the listing status, associated PCTs and statement regarding the requirement for further assessment. The list of threatened flora species was reviewed to identify threatened flora species that have, or may have, suitable habitat within the Development Footprint.

Six flora candidate species or populations listed in Table 9 were excluded from further assessment*:*

- *Acacia gordonii*
- Gosford Wattle (*Acacia prominens*) - endangered population in the Hurstville and Kogarah LGAs
- *Grevillea parviflora subsp. supplicans*
- *Marsdenia viridiflora subsp. viridiflora* - endangered population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith LGAs
- *Pomaderris prunifolia* - endangered population in the Parramatta, Auburn, Strathfield and Bankstown LGAs
- *Wahlenbergia multicaulis* (Tadgell's Bluebell) - endangered population Auburn, Bankstown, Baulkham Hills, Canterbury, Hornsby, Parramatta and Strathfield LGAs.

#### 5.1.2.2 Fauna

A total of 28 threatened fauna species and one threatened fauna population were identified from the BAM-C as potential candidate threatened flora species (Table 10). No additional species were added to Table 10.

Table 10 details the listing status, associated PCTs and statement regarding the requirement for further assessment. The list of threatened flora species was reviewed to identify threatened flora species that have, or may have, suitable habitat within the Development Footprint.

Five fauna candidate species listed in Table 10 were excluded from further assessment*:*

- Regent Honeyeater (*Anthochaera phrygia*)
- Gang-gang Cockatoo (*Callocephalon fimbriatum*) - endangered population in the Hornsby and Ku-ring-gai Local Government Areas
- Swift Parrot (*Lathamus discolor*)
- Broad-billed Sandpiper (*Limicola falcinellus*)
- Grey-headed Flying-fox (*Pteropus poliocephalus*)

**Table 9. Predicted flora species credit species**

| Common name | Scientific name | Listing status | | Sources | Species retained for further assessment? | Reason for exclusion from further assessment | Vegetation zone ID species retained within, including PCT ID |
|---|---|---|---|---|---|---|---|
| | | BC Act | EPBC Act | | | | |
| Bynoe's Wattle | *Acacia bynoeana* | E | V | BAM-C | Yes | - | 3598, 3614, 3616, 3619 |
| Flockton Wattle | *Acacia flocktoniae* | V | V | BAM-C | Yes | - | 3611, 3619 |
| | *Acacia gordonii* | E | E | BAM-C | No | Geographic limitations. Subject Land does not occur north of the Great Western Highway. | n/a |
| Gosford Wattle, Hurstville and Kogarah Local Government Areas (LGAs) | *Acacia prominens* | EP | - | BAM-C | No | Geographic limitations. Subject Land not within the Hurstville and Kogarah LGAs. | n/a |
| Downy Wattle | *Acacia pubescens* | V | V | BAM-C | Yes | - | 3611, 3616, 3619 |
| Netted Bottle Brush | *Callistemon linearifolius* | V | - | BAM-C | Yes | - | 3619 |
| Dwarf Kerrawang | *Commersonia prostrata* | E | - | BAM-C | Yes | - | 3618 |
| | *Darwinia biflora* | V | - | BAM-C | Yes | - | 3616, 3619 |
| | *Darwinia peduncularis* | V | - | BAM-C | Yes | - | 3616, 3619 |
| | *Deyeuxia appressa* | E | E | BAM-C | Yes | - | 3616 |
| | *Dillwynia tenuifolia* | V | - | BAM-C | Yes | - | 3616, 3618, 3619 |
| | *Epacris purpurascens var. purpurascens* | V | - | BAM-C | Yes | - | 3598, 3616, 3619 |
| Camfield's Stringybark | *Eucalyptus camfieldii* | V | V | BAM-C | Yes | - | 3598, 3616, 3619 |
| Bauer's Midge Orchid | *Genoplesium baueri* | E | E | BAM-C | Yes | - | 3598, 3616, 3619 |

| Common name | Scientific name | Listing status | | Sources | Species retained for further assessment? | Reason for exclusion from further assessment | Vegetation zone ID species retained within, including PCT ID |
|---|---|---|---|---|---|---|---|
| | | BC Act | EPBC Act | | | | |
| Juniper-leaved Grevillea | *Grevillea juniperina subsp. juniperina* | V | - | BAM-C | Yes | - | 3616 |
| Small-flower Grevillea | *Grevillea parviflora subsp. parviflora* | V | V | BAM-C | Yes | - | 3598, 3616, 3618, 3619 |
| | *Grevillea parviflora subsp. supplicans* | E | - | BAM-C | No | Geographic limitations. Subject Land does not occur north of the Great Western Highway. | n/a |
| | *Gyrostemon thesioides* | E | - | BAM-C | Yes | - | 3618 |
| | *Hibbertia fumana* | CE | - | BAM-C | Yes | - | 3616, 3619 |
| | *Hibbertia puberula* | E | - | BAM-C | Yes | - | 3598, 3611, 3616, 3619 |
| | *Hibbertia superans* | E | - | BAM-C | Yes | - | 3616, 3619 |
| | *Lasiopetalum joyceae* | V | V | BAM-C | Yes | - | 3616 |
| Woronora Beard-heath | *Leucopogon exolasius* | V | V | BAM-C | Yes | - | 3598, 3611, 3616, 3619 |
| | *Leucopogon fletcheri subsp. fletcheri* | E | - | BAM-C | Yes | - | 3616, 3618, 3619 |
| *Marsdenia viridiflora R. Br. subsp. viridiflora* population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith LGAs. | *Marsdenia viridiflora subsp. viridiflora* | EP | - | BAM-C | No | Geographic limitations. Subject Land not within the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith LGAs. | n/a |

| Common name | Scientific name | Listing status | | Sources | Species retained for further assessment? | Reason for exclusion from further assessment | Vegetation zone ID species retained within, including PCT ID |
|---|---|---|---|---|---|---|---|
| | | BC Act | EPBC Act | | | | |
| Deane's Paperbark | *Melaleuca deanei* | V | V | BAM-C | Yes | - | 3598, 3614, 3616, 3619 |
| Bargo Geebung | *Persoonia bargoensis* | E | V | BAM-C | Yes | - | 3598, 3614, 3616, 3618, 3619 |
| Mittagong Geebung | *Persoonia glaucescens* | E | V | BAM-C | Yes | - | 3598, 3611, 3614, 3616, 3619 |
| Hairy Geebung | *Persoonia hirsuta* | E | E | BAM-C | Yes | - | 3598, 3611, 3614, 3616, 3619 |
| Nodding Geebung | *Persoonia nutans* | E | E | BAM-C | Yes | - | 3616, 3619 |
| | *Pimelea curviflora var. curviflora* | V | V | BAM-C | Yes | - | 3616, 3619 |
| Brown Pomaderris | *Pomaderris brunnea* | E | V | BAM-C | Yes | - | 3614, 3616, 3619 |
| *P. prunifolia* in the Parramatta, Auburn, Strathfield and Bankstown LGAs | *Pomaderris prunifolia* | EP | - | BAM-C | No | Geographic limitations. Subject Land not within the Parramatta, Auburn, Strathfield and Bankstown LGAs. | n/a |
| Sydney Plains Greenhood | *Pterostylis saxicola* | E | E | BAM-C | Yes | - | 3616, 3619 |
| | *Pultenaea parviflora* | E | V | BAM-C | Yes | - | 3619 |
| Eastern Australian Underground Orchid | *Rhizanthella slateri* | V | E | BAM-C | Yes | - | 3611, 3614, 3616, 3618, 3619 |
| | *Tetratheca glandulosa* | V | - | BAM-C | Yes | - | 3611, 3616, 3619 |
| Tadgell's Bluebell in the Auburn, Bankstown, Baulkham Hills, Canterbury, Hornsby, | *Wahlenbergia multicauli* | EP | - | BAM-C | No | Geographic limitations. Subject Land not within the Auburn, Bankstown, Baulkham Hills, Canterbury, Hornsby, | n/a |

| Common name | Scientific name | Listing status | | Sources | Species retained for further assessment? | Reason for exclusion from further assessment | Vegetation zone ID species retained within, including PCT ID |
|---|---|---|---|---|---|---|---|
| | | BC Act | EPBC Act | | | | |
| Parramatta and Strathfield LGAs | | | | | | Parramatta and Strathfield LGAs. | |
| | *Zieria involucrata* | E | V | BAM-C | Yes | - | 3616, 3619 |

NSW and Commonwealth Status: CE = Critically Endangered, E = Endangered, EP = Endangered Population, V = Vulnerable, - = not listed.

**Table 10. Predicted fauna species credit species**

| Common name | Scientific name | Listing status | | Sources | Species retained for further assessment? | Reason for exclusion from further assessment | Vegetation zone ID species retained within, including PCT ID |
|---|---|---|---|---|---|---|---|
| | | BC Act | EPBC Act | | | | |
| Regent Honeyeater | *Anthochaera phrygia* | E | CE | BAM-C | No | Habitat constraints. Subject Land not within the Important Habitat Map for the species. | 3616, 3619 |
| Bush Stone-curlew | *Burhinus grallarius* | E | - | BAM-C | Yes | - | 3598, 3614, 3616, 3618, 3619 |
| Gang-gang Cockatoo | *Callocephalon fimbriatum* | V | E | BAM-C | Yes | - | 3598, 3611, 3614, 3616, 3618, 3619 |
| Gang-gang Cockatoo population in the Hornsby and Ku-ring-gai LGAs | | EP | - | BAM-C | No | Geographic limitations. Subject Land not within the Hornsby and Ku-ring-gai LGAs. | n/a |
| Glossy Black-Cockatoo | *Calyptorhynchus lathami lathami* | V | V | BAM-C | Yes | - | 3598, 3611, 3614, 3616, 3618, 3619 |
| Eastern Pygmy-possum | *Cercartetus nanus* | V | - | BAM-C | Yes | - | 3598, 3611, 3614, 3616, 3618, 3619 |
| Large-eared Pied Bat | *Chalinolobus dwyeri* | V | V | BAM-C | Yes | - | 3598, 3611, 3614, 3616, 3618, 3619 |

| Common name | Scientific name | Listing status | | Sources | Species retained for further assessment? | Reason for exclusion from further assessment | Vegetation zone ID species retained within, including PCT ID |
|---|---|---|---|---|---|---|---|
| | | BC Act | EPBC Act | | | | |
| White-bellied Sea-Eagle | *Haliaeetus leucogaster* | V | - | BAM-C | Yes | - | 3598, 3611, 3614, 3616, 3618, 3619 |
| Giant Burrowing Frog | *Heleioporus australiacus* | V | V | BAM-C | Yes | - | 3598, 3611, 3614, 3616, 3618, 3619 |
| Little Eagle | *Hieraaetus morphnoides* | V | - | BAM-C | Yes | - | 3598, 3611, 3614, 3616, 3618, 3619 |
| Broad-headed Snake | *Hoplocephalus bungaroides* | E | E | BAM-C | Yes | - | 3598, 3611, 3614, 3616, 3619 |
| Swift Parrot | *Lathamus discolor* | E | CE | BAM-C | No | Habitat constraints. Subject Land not within the Important Habitat Map for the species. | n/a |
| Broad-billed Sandpiper | *Limicola falcinellus* | - | V | BAM-C | No | Habitat constraints. Subject Land not within the Important Habitat Map for the species, and lacks suitable habitat. | 3611, 3614, 3616, 3618, 3619 |
| Square-tailed Kite | *Lophoictinia isura* | V | - | BAM-C | Yes | - | 3598, 3611, 3614, 3616, 3618, 3619 |
| Cumberland Plain Land Snail | *Meridolum corneovirens* | E | - | BAM-C | Yes | - | 3616 |
| Little Bent-winged Bat | *Miniopterus australis* | V | - | BAM-C | Yes | - | 3598, 3611, 3614, 3616, 3618, 3619 |
| Large Bent-winged Bat | *Miniopterus orianae oceanensis* | V | - | BAM-C | Yes | - | 3598, 3611, 3614, 3616, 3618, 3619 |
| Southern Myotis | *Myotis macropus* | V | - | BAM-C | Yes | - | 3598, 3611, 3616, 3618, 3619 |
| Barking Owl | *Ninox connivens* | V | - | BAM-C | Yes | - | 3598, 3611, 3614, 3616, 3618, 3619 |

| Common name | Scientific name | Listing status | | Sources | Species retained for further assessment? | Reason for exclusion from further assessment | Vegetation zone ID species retained within, including PCT ID |
|---|---|---|---|---|---|---|---|
| | | BC Act | EPBC Act | | | | |
| Powerful Owl | *Ninox strenua* | V | - | BAM-C | Yes | - | 3598, 3611, 3614, 3616, 3618, 3619 |
| Eastern Osprey | *Pandion cristatus* | V | - | BAM-C | Yes | - | 3616, 3618, 3619 |
| Southern Greater Glider | *Petauroides volans* | - | V | BAM-C | Yes | - | 3598, 3611, 3614, 3616, 3618, 3619 |
| Squirrel Glider | *Petaurus norfolcensis* | V | - | BAM-C | Yes | - | 3598, 3611, 3614, 3616, 3618, 3619 |
| Koala | *Phascolarctos cinereus* | V | E | BAM-C | Yes | - | 3598, 3611, 3614, 3616, 3618, 3619 |
| Dural Land Snail | *Pommerhelix duralensis* | E | E | BAM-C | Yes | - | 3616, 3619 |
| Red-crowned Toadlet | *Pseudophryne australis* | V | - | BAM-C | Yes | - | 3598, 3611, 3614, 3616, 3619 |
| Grey-headed Flying-fox | *Pteropus poliocephalus* | V | V | BAM-C | No | Habitat constraints. No breeding camps were observed, nor are any known to occur, within the Subject Land. | 3598, 3611,3614, 3616, 3618, 3619 |
| Masked Owl | *Tyto novaehollandiae* | V | - | BAM-C | Yes | - | 3598, 3611, 3614, 3616, 3618, 3619 |
| Sooty Owl | *Tyto tenebricosa* | V | - | BAM-C | Yes | - | 3598, 3611, 3616, 3619 |

NSW and Commonwealth Status: CE = Critically Endangered, E = Endangered, EP = Endangered Population, V = Vulnerable, - = not listed.

## 5.2 Presence of candidate species credit species

### 5.2.1 Flora candidate species

A total of 33 flora candidate species were retained for further assessment (Table 9).

The requirement for further assessment under the BAM for each of these species to determine requirement for targeted survey and presence/absence from the Subject Land (and the subsequent requirement for credits to be generated) was determined by consideration of the following:

- Presence of habitat and geographic constraints (as identified in the TBDC) within the impact area
- Presence or absence of species microhabitats as determined during the field survey
- Condition of habitat present, including whether the habitat is degraded to the point that the species is unlikely to use the habitat.

Table 11 details the list of candidate threatened flora species generated from the BAM Calculator and whether they were identified as requiring further assessment under the BAM. In accordance with Section 5.2.4 of the BAM, flora candidate species identified in Table 9 as requiring further assessment were assumed to be present. Two of these were opportunistically detected within the Subject Land during the survey: Bargo Geebung (*Persoonia bargoensis*) and Mittagong Geebung (*Persoonia glaucescens*).

Due to the nature of the Project (i.e. prescribed impacts only; no vegetation clearing or surface disturbance) only two flora candidate species are considered to potentially be impacted by subsidence:

- Woronora Beard-heath (*Leucopogon exolasius*)
- Brown Pomaderris (*Pomaderris brunnea*).

**Table 11. Determining the presence of candidate flora species credit species on the Subject Land**

| Common name | Scientific name | Listing status | | Method used to determine presence | Present? | Further assessment required? (BAM Subsections 5.2.5 and 5.2.6) |
|---|---|---|---|---|---|---|
| | | BC Act | EPBC Act | | | |
| Bynoe's Wattle | *Acacia bynoeana* | E | V | Assumed present | Assumed present | No |
| Flockton Wattle | *Acacia flocktoniae* | V | V | Assumed present | Assumed present | No |
| Downy Wattle | *Acacia pubescens* | V | V | Assumed present | Assumed present | No |
| Netted Bottle Brush | *Callistemon linearifolius* | V | - | Assumed present | Assumed present | No |
| Dwarf Kerrawang | *Commersonia prostrata* | E | - | Assumed present | Assumed present | No |
| | *Darwinia biflora* | V | - | Assumed present | Assumed present | No |
| | *Darwinia peduncularis* | V | - | Assumed present | Assumed present | No |

| Common name | Scientific name | Listing status | | Method used to determine presence | Present? | Further assessment required? (BAM Subsections 5.2.5 and 5.2.6) |
|---|---|---|---|---|---|---|
| | | BC Act | EPBC Act | | | |
| | *Deyeuxia appressa* | E | E | Assumed present | Assumed present | No |
| | *Dillwynia tenuifolia* | V | - | Assumed present | Assumed present | No |
| | *Epacris purpurascens var. purpurascens* | V | - | Assumed present | Assumed present | No |
| Camfield's Stringybark | *Eucalyptus camfieldii* | V | V | Assumed present | Assumed present | No |
| Bauer's Midge Orchid | *Genoplesium baueri* | E | E | Assumed present | Assumed present | No |
| Juniper-leaved Grevillea | *Grevillea juniperina subsp. juniperina* | V | - | Assumed present | Assumed present | No |
| Small-flower Grevillea | *Grevillea parviflora subsp. parviflora* | V | V | Assumed present | Assumed present | No |
| | *Gyrostemon thesioides* | E | - | Assumed present | Assumed present | No |
| | *Hibbertia fumana* | CE | - | Assumed present | Assumed present | No |
| | *Hibbertia puberula* | E | - | Assumed present | Assumed present | No |
| | *Hibbertia superans* | E | - | Assumed present | Assumed present | No |
| | *Lasiopetalum joyceae* | V | V | Assumed present | Assumed present | No |
| Woronora Beard-heath | *Leucopogon exolasius* | V | V | Assumed present | Assumed present | Yes |
| | *Leucopogon fletcheri subsp. fletcheri* | E | - | Assumed present | Assumed present | No |
| Deane's Paperbark | *Melaleuca deanei* | V | V | Assumed present | Assumed present | No |
| Bargo Geebung | *Persoonia bargoensis* | E | V | Assumed present | Yes | No |
| Mittagong Geebung | *Persoonia glaucescens* | E | V | Assumed present | Yes | No |
| Hairy Geebung | *Persoonia hirsuta* | E | E | Assumed present | Assumed present | No |
| Nodding Geebung | *Persoonia nutans* | E | E | Assumed present | Assumed present | No |

| Common name | Scientific name | Listing status | | Method used to determine presence | Present? | Further assessment required? (BAM Subsections 5.2.5 and 5.2.6) |
|---|---|---|---|---|---|---|
| | | BC Act | EPBC Act | | | |
| | *Pimelea curviflora var. curviflora* | V | V | Assumed present | Assumed present | No |
| Brown Pomaderris | *Pomaderris brunnea* | E | V | Assumed present | Assumed present | Yes |
| Sydney Plains Greenhood | *Pterostylis saxicola* | E | E | Assumed present | Assumed present | No |
| | *Pultenaea parviflora* | E | V | Assumed present | Assumed present | No |
| Eastern Australian Underground Orchid | *Rhizanthella slateri* | V | E | Assumed present | Assumed present | No |
| | *Tetratheca glandulosa* | V | - | Assumed present | Assumed present | No |
| | *Zieria involucrata* | E | V | Assumed present | Assumed present | No |

### 5.2.2 Fauna candidate species

A total of 24 candidate species were retained for further assessment (Table 10).

The requirement for further assessment under the BAM for each of these species to determine requirement for targeted survey and presence/absence from the Subject Land (and the subsequent requirement for credits to be generated) was determined by consideration of the following:

- Presence of habitat and geographic constraints (as identified in the TBDC) within the impact area
- Presence or absence of species microhabitats as determined during the field survey
- Condition of habitat present including whether the habitat is degraded to the point that the species is unlikely to use the habitat
- Vagrant species.

Table 12 details the list of candidate threatened flora species generated from the BAM Calculator and whether they were identified as requiring further assessment under the BAM. In accordance with section 5.2.4 of the BAM, fauna candidate species identified in Table 10 as requiring further assessment were assumed to be present.

Due to the nature of the Project (i.e. prescribed impacts only; no vegetation clearing or surface disturbance) only six species are considered to potentially be impacted by subsidence:

- Large-eared Pied Bat (*Chalinolobus dwyeri*)
- Giant Burrowing Frog (*Heleioporus australiacus*)
- Broad-headed Snake (*Hoplocephalus bungaroides*)
- Little Bent-winged Bat (*Miniopterus australis*)
- Large Bent-winged Bat (*Miniopterus orianae oceanensis*)

- Red-crowned Toadlet (*Pseudophryne australis*).

**Table 12. Determining the presence of candidate fauna species credit species on the subject land**

| Common name | Scientific name | Listing status | | Method used to determine presence | Present? | Further assessment required? (BAM Subsections 5.2.5 and 5.2.6) |
|---|---|---|---|---|---|---|
| | | BC Act | EPBC Act | | | |
| Bush Stone-curlew | *Burhinus grallarius* | E | - | Assumed present | Assumed present | No |
| Gang-gang Cockatoo | *Callocephalon fimbriatum* | V | E | Assumed present | Assumed present | No |
| Glossy Black-Cockatoo | *Calyptorhynchus lathami* | V | V | Assumed present | Assumed present | No |
| Eastern Pygmy-possum | *Cercartetus nanus* | V | - | Assumed present | Assumed present | No |
| Large-eared Pied Bat | *Chalinolobus dwyeri* | V | V | Assumed present | Assumed present | Yes |
| White-bellied Sea-Eagle | *Haliaeetus leucogaster* | V | - | Assumed present | Assumed present | No |
| Giant Burrowing Frog | *Heleioporus australiacus* | V | V | Assumed present | Assumed present | Yes |
| Little Eagle | *Hieraaetus morphnoides* | V | - | Assumed present | Assumed present | No |
| Broad-headed Snake | *Hoplocephalus bungaroides* | E | E | Assumed present | Assumed present | Yes |
| Square-tailed Kite | *Lophoictinia isura* | V | - | Assumed present | Assumed present | No |
| Cumberland Plain Land Snail | *Meridolum corneovirens* | E | - | Assumed present | Assumed present | No |
| Little Bent-winged Bat | *Miniopterus australis* | V | - | Assumed present | Assumed present | Yes |
| Large Bent-winged Bat | *Miniopterus orianae oceanensis* | V | - | Assumed present | Assumed present | Yes |
| Southern Myotis | *Myotis macropus* | V | - | Assumed present | Assumed present | No |
| Barking Owl | *Ninox connivens* | V | - | Assumed present | Assumed present | No |
| Powerful Owl | *Ninox strenua* | V | - | Assumed present | Assumed present | No |
| Eastern Osprey | *Pandion cristatus* | V | - | Assumed present | Assumed present | No |
| Southern Greater Glider | *Petauroides volans* | - | V | Assumed present | Assumed present | No |

| Common name | Scientific name | Listing status | | Method used to determine presence | Present? | Further assessment required? (BAM Subsections 5.2.5 and 5.2.6) |
|---|---|---|---|---|---|---|
| | | BC Act | EPBC Act | | | |
| Squirrel Glider | *Petaurus norfolcensis* | V | - | Assumed present | Assumed present | No |
| Koala | *Phascolarctos cinereus* | V | E | Assumed present | Assumed present | No |
| Dural Land Snail | *Pommerhelix duralensis* | E | E | Assumed present | Assumed present | No |
| Red-crowned Toadlet | *Pseudophryne australis* | V | - | Assumed present | Assumed present | Yes |
| Masked Owl | *Tyto novaehollandiae* | V | - | Assumed present | Assumed present | No |
| Sooty Owl | *Tyto tenebricosa* | V | - | Assumed present | Assumed present | No |

***NB: BAM-C***

While the method used to determine presence of species in Table 11 and Table 12 is 'Yes (assumed present)', 'No (expert report)' has actually been used in the Habitat survey tab in the BAM-C, as prescribed impacts are the only potential impact to species credit species and there is no clearing proposed. Should 'Yes (assumed present)' be selected an area of impact must be entered. As the BAM-C does not allow for '0 ha' to be entered, a credit obligation is generated.

While expert reports were not used, this work around was deemed most appropriate.

## 5.3 Threatened species surveys

### 5.3.1 Threatened fauna

No threatened fauna surveys were undertaken for the purpose of the BDAR. However, various targeted fauna surveys have been completed for the original Tahmoor South Project (Niche 2018), as well as for various other studies within the broader Tahmoor South project area. None of these surveys intersect the Subject Land.

Hornes Creek is located within the Subject Land and supports ample habitat for amphibian species such as Red-crowned Toadlet (*Pseudophryne australis*) and Giant Burrowing Frog (*Heleioporus australiacus*). In 2013, Niche recorded Red-crowned Toadlet on Hornes Creek near amphibian monitoring site 4 (located within the Subject Land). From 2013, biannual (Spring and Autumn) amphibian monitoring has occurred on Hornes Creek; no individuals have been identified since the commencement of that monitoring (11 years ago).

### 5.3.2 Threatened flora

No threatened flora surveys were undertaken for the purpose of the BDAR. However, various targeted flora surveys have been completed for the original Tahmoor South Project (Niche 2018), as well as for various other studies within the broader Tahmoor South project area. The majority of these surveys do not

intersect the Subject Land, however, monitoring site 4 (TF4) of the South Spring terrestrial monitoring program (2024) occurs within the eastern portion with the Subject Land, south of Yarran Road.

The Subject Land is known to supports ample habitat for numerous threatened flora species, with many individuals recorded over the previous years of surveys completed by Niche. These species include (Figure 7):

- Bargo Geebung (*Persoonia bargoensis*)
- Bynoe's Wattle (*Acacia bynoeana*)
- Brown Pomaderris (*Pomaderris brunnea*)
- Small-flower Grevillea (*Grevillea parviflora* subsp. *parviflora*)
- *Epacris purpurascens* var. *purpurascens.*

Monitoring site TF4 supports 34 Bargo Geebung individuals, within a 10 x 10 m fixed monitoring plot (Niche 2024).

Incidental sightings of threatened flora have occurred during the current field surveys.

## 5.4 Expert reports

No expert reports were used in place of threatened species surveys.

## 5.5 More appropriate local data (where relevant)

No additional local data was used in place of threatened species surveys.

## 5.6 Area or count, and location of suitable habitat for a species credit species (a species polygon)

Species credits are required for those species identified as present within the impact area. To determine the offset requirement, species polygons (areas of occupied/potential habitat for the species) are to be prepared in accordance with the steps described in Section 6.4 of the BAM. Species polygons for those candidate species identified in Tables 11 and 12 as requiring further assessment are presented in Figure 8. All species have an 'area' unit of measure (NSW DCCEEW 2023a). The total area of habitat for each species within the Subject Land is provided in Table 13.

**Table 13. Results for species identified/assumed as present**

| Common name | Scientific name | Biodiversity risk weighting (BAM-C & TBDC*) | SAII entity** (BAM-C & TBDC) | Habitat constraints / microhabitats present on the Subject Land / vegetation zone | Abundance – No. individual plants present on Subject Land (flora with unit of measure of count) | Extent (ha) of suitable habitat present within development footprint (flora or fauna with unit of measure of area) | TBDC species specific recommendations e.g. buffers, general comments (where relevant)[2] | Habitat condition (vegetation integrity score for each vegetation zone in the polygon – area species only) |
|---|---|---|---|---|---|---|---|---|
| Woronora Beard-heath | *Leucopogon exolasius* | High (2) | No | PCTs 3598, 3611, 3616, 3619 | n/a | 3598_high – 20.49<br>3611_high- 1.62<br>3616_high- 24.14<br>3619_high- 185.72 | n/a | 3598_high - 100<br>3611_high - 100<br>3616_high - 100<br>3619_high - 100 |
| Brown Pomaderris | *Pomaderris brunnea* | High (2) | No | PCTs 3614, 3616, 3619 | n/a | 3614_high- 2.72<br>3616_high- 24.14<br>3619_high- 185.72 | n/a | 3614_high - 100<br>3616_high - 100<br>3619_high - 100 |
| Large-eared Pied Bat | *Chalinolobus dwyeri* | Very High (3) | Yes | PCTs 3598, 3611, 3614, 3616, 3618, 3619 within a 2 km radius of identified roosting habitat (such as rocky areas containing caves, overhangs, escarpments, outcrops, or crevices). | n/a | 3598_high – 20.49<br>3611_high- 1.62<br>3614_high- 2.72<br>3616_high- 24.14<br>3618_high- 1.27<br>3619_high- 185.72 | The species polygon boundary should align with PCTs on the subject land to which the species is associated that are within 2km of identified potential roost habitat features (OEH, 2018). | 3598_high - 100<br>3611_high - 100<br>3614_high - 100<br>3616_high - 100<br>3618_high - 100<br>3619_high - 100 |
| Giant Burrowing Frog | *Heleioporus australiacus* | Moderate (1.5) | No | PCTs 3598, 3611, 3614, 3616, 3618, 3619 within 300 m radius of the top of the bank of suitable aquatic habitat (such as ephemeral | n/a | 3598_high – 20.49<br>3611_high- 1.62<br>3614_high- 2.72<br>3616_high- 24.14 | The species polygon boundary should align with PCTs on the subject land to which the species is associated within 300 m | 3598_high - 100<br>3611_high - 100<br>3614_high - 100<br>3616_high - 100 |

[2] Survey guidelines were also consulted.

| Common name | Scientific name | Biodiversity risk weighting (BAM-C & TBDC*) | SAII entity** (BAM-C & TBDC) | Habitat constraints / microhabitats present on the Subject Land / vegetation zone | Abundance – No. individual plants present on Subject Land (flora with unit of measure of count) | Extent (ha) of suitable habitat present within development footprint (flora or fauna with unit of measure of area) | TBDC species specific recommendations e.g. buffers, general comments (where relevant)[2] | Habitat condition (vegetation integrity score for each vegetation zone in the polygon – area species only) |
|---|---|---|---|---|---|---|---|---|
| | | | | flowing streams that have permanent pools or upland swamps). | | 3618_high- 1.27<br>3619_high- 181.95 | radius of the bank of suitable aquatic habitat (DPIE, 2020). | 3618_high - 100<br>3619_high - 100 |
| Broad-headed Snake | *Hoplocephalus bungaroides* | Very High (3) | Yes | PCTs 3598, 3611, 3614, 3616, 3619 with identified habitat in the Subject Land such as rocky areas, including escarpments and outcrops within the Sydney Sandstone geologies. Include a 100 m buffer from the edge of suitable habitat. | n/a | 3598_high – 4.92<br>3611_high- 0.19<br>3614_high- 2.71<br>3619_high- 3.21 | The species polygon boundary should align with PCTs on the subject land to which the species is associated including a 100 m buffer the edge of the suitable habitat (DPE, 2022a). | 3598_high - 100<br>3611_high - 100<br>3614_high - 100<br>3619_high - 100 |
| Little Bent-winged Bat | *Miniopterus australis* | Very High (3) | Yes | PCTs 3598, 3611, 3614, 3616, 3618, 3619 within a 100 m radius of identified breeding habitat including caves or other features, used for breeding. | n/a | 3598_high – 4.92<br>3611_high- 0.19<br>3614_high- 2.71<br>3618_high- 0.97<br>3619_high- 3.21 | The species polygon boundary should align with PCTs on the subject land to which the species is associated that are within 100 m of identified potential roost habitat features (OEH, 2018). | 3598_high - 100<br>3611_high - 100<br>3614_high - 100<br>3618_high - 100<br>3619_high - 100 |
| Large Bent-winged Bat | *Miniopterus orianae oceanensis* | Very High (3) | Yes | PCTs 3598, 3611, 3614, 3616, 3618, 3619 within a 100 m radius of identified breeding habitat including | n/a | 3598_high – 20.49<br>3611_high- 1.62<br>3614_high- 2.72 | The species polygon boundary should align with PCTs on the subject land to which the species | 3598_high - 100<br>3611_high - 100<br>3614_high - 100 |

| Common name | Scientific name | Biodiversity risk weighting (BAM-C & TBDC*) | SAII entity** (BAM-C & TBDC) | Habitat constraints / microhabitats present on the Subject Land / vegetation zone | Abundance – No. individual plants present on Subject Land (flora with unit of measure of count) | Extent (ha) of suitable habitat present within development footprint (flora or fauna with unit of measure of area) | TBDC species specific recommendations e.g. buffers, general comments (where relevant)[2] | Habitat condition (vegetation integrity score for each vegetation zone in the polygon – area species only) |
|---|---|---|---|---|---|---|---|---|
| | | | | caves or other features, used for breeding. | | 3616_high- 24.14<br>3618_high- 1.27<br>3619_high- 185.72 | is associated that are within 100 m of identified potential roost habitat features (OEH, 2018). | 3616_high - 100<br>3618_high - 100<br>3619_high - 100 |
| Red-crowned Toadlet | *Pseudophryne australis* | Moderate (1.5) | No | PCTs 3598, 3611, 3614, 3616, 3619 within 100 m radius of the top of the bank of suitable aquatic habitat (such as ephemeral streams or pools within areas of native vegetation on Triassic sandstones). | n/a | 3598_high – 8.42<br>3611_high- 1.62<br>3614_high- 2.61<br>3616_high- 14.26<br>3619_high- 68.1 | The species polygon boundary should align with PCTs on the subject land to which the species is associated within 100 m radius of the bank of suitable aquatic habitat (DPIE, 2020). | 3598_high - 100<br>3611_high - 100<br>3614_high - 100<br>3616_high - 100<br>3619_high - 100 |

MNES assumed present in the Subject Land and their area of suitable habitat that has the potential to be impacted by subsidence (i.e. water courses and cliff lines, and associated habitat) are presented in Table 14.

**Table 14. Results for EPBC Act listed species present (recorded within the subject land)**

| Common name | Scientific name | Abundance – No. individual plants present on subject land (flora with unit of measure as count) | Extent (ha) of suitable habitat present on site (flora or fauna with unit of measure as area) |
|---|---|---|---|
| **Flora** | | | |
| Woronora Beard-heath | *Leucopogon exolasius* | n/a | 231.97 |
| Brown Pomaderris | *Pomaderris brunnea* | n/a | 212.58 |
| **Fauna** | | | |
| Large-eared Pied Bat | *Chalinolobus dwyeri* | n/a | 235.96 |
| Giant Burrowing Frog | *Heleioporus australiacus* | n/a | 232.19 |
| Broad-headed Snake | *Hoplocephalus bungaroides* | n/a | 11.03 |

# 6. Identifying prescribed impacts

Prescribed impacts comprise additional biodiversity impacts which may result from the Project and must be assessed as part of the NSW BOS, as per clause 6.1 of the BC Regulation. Prescribed impacts and their potential presence within the Subject Land are identified in Table 15. Details of the impacts, as well as avoidance and minimisation measures for prescribed impacts are detailed in Section 7.2.

**Table 15. Prescribed impacts identified**

| Feature | Present | Description of feature characteristics and location | Threatened entities that use, are likely to use, or are part of the habitat feature |
|---|---|---|---|
| Karst, caves, crevices, cliffs, rocks or other geological features of significance | ☒Yes / ☐No | Five cliffs have been identified within the Subject Land, located within the Hawkesbury Sandstone along the Bargo River and Hornes Creek (MSEC 2024). While overhangs and crevices have been identified within the cliff areas, large cave areas have not been. MSEC (2024) predicts subsidence impacts on cliffs to be negligible. | Broad-headed Snake<br>Large-eared Pied Bat<br>Little Bent-winged Bat<br>Large Bent-winged Bat |
| Human-made structures | ☒Yes / ☐No | There are multiple dwellings, farming structures, sheds and other human structures within the Subject Land. | Multiple species of threatened microbats have been recorded within the locality and are known to roost within human-made structures. However, any threatened entity that occurs within the Subject Land is unlikely to be impacted by the Project. The Project is limited to underground mining; demolition of human-made structures is not required. |
| Non-native vegetation | ☒Yes / ☐No | Non-native vegetation within the Subject Land includes those grassland areas that occur in association with the semi-rural properties present and are dominated by exotic groundcover species. | Threatened birds may forage over exotic grassland areas, sourcing seed and nesting material, or hunting for lizards and small mammals in areas adjacent to remnant woodland.<br>The Project is limited to underground mining and vegetation (native and non-native) removal is not required. Further, subsidence is not considered to impact areas of non-native vegetation. |
| Habitat connectivity | ☒Yes / ☐No | The landscape within the Subject Land and adjoining areas consists of a mosaic of cleared land used for agricultural and rural purposes, large lifestyle residential lots, as well as large areas of remnant native vegetation. The native vegetation within the Subject Land is directly connected to remnant vegetation to | It is likely that multiple threatened entities utilise the native vegetation. The Project is limited to underground mining and native vegetation removal is not required. Further, subsidence is not considered to impact areas of non-native vegetation. As such, habitat connectivity, and any threatened entity that utilises the |

| Feature | Present | Description of feature characteristics and location | Threatened entities that use, are likely to use, or are part of the habitat feature |
|---|---|---|---|
| | | the west, north and south of the Subject Land, and only tenuously connected to patchy areas of native vegetation to the east of the Subject Land. | Subject Land, will not be impacted by the Project. |
| Waterbodies, water quality and hydrological processes | ☒Yes / ☐No | Multiple drainages lines have been identified within the Subject Land, draining into either Hornes Creek (in the west) or Tea Tree Hollow Creek (in the east), both of which ultimately flow into Bargo River.<br>Numerous farm dams are also present within the Subject Land.<br>The Project has the capacity to affect water quality and interrupt normal hydrological processes. | Giant Burrowing Frog<br>Red-crowned Toadlet |
| Wind turbine strikes (wind farm development only) | ☐Yes / ☒No | n/a | n/a |
| Vehicle strikes | ☐Yes / ☒No | n/a | n/a |

# Stage 2: Impact assessment

## 7. Avoid and minimise impacts

In accordance with the BAM, proponents must demonstrate the measures employed to avoid, mitigate and offset impacts of a project on biodiversity values. This section outlines the avoidance, management and mitigation measures that have been incorporated into the Project design or will be employed during construction, operation or completion of the Project to reduce impacts on biodiversity values.

### 7.1 Avoid and minimise direct and indirect impacts

As previously mentioned in Section 1.1.3, the Project does not require any surface disturbance. The Project is limited to underground mining and vegetation (native and non-native) removal is not required. Therefore, the Project will not result in any direct impact to biodiversity.

#### 7.1.1 Project location

The current mine location permits the use of existing pit top facilities to access the proposed LWS7A via Tahmoor South Domain.

#### 7.1.2 Project design

The current mine plan proposes to complete underground mining with access to the Tahmoor South Domain provided from the existing pit top facilities. This mine design consideration minimises surface impacts from mining through the avoidance of establishing new surface facilities.

### 7.2 Avoid and minimise prescribed impacts

In accordance with the BAM, proponents must demonstrate the measures employed to avoid, mitigate and offset impacts of a project on biodiversity values. This section outlines the avoidance, management and mitigation measures that have been incorporated into the Project design or will be employed during construction, operation or completion of the Project to reduce impacts on biodiversity values.

#### 7.2.1 Project location

Site selection for the Project has been largely dictated by the existing approved Tahmoor South Project. The longwall is a sufficient distance from sensitive receiving environments, such as waterbodies, drainage lines and cliff areas, such the impacts are considered negligible.

#### 7.2.2 Project design

The design and measurements of the longwall mean that predicted subsidence impacts fall largely within the 20 mm predicted subsidence zone assessed as part of the approved mining area. This has therefore resulted in a minor area to the west that has not been previously assessed. The design maximises the protection of the cliff lines and natural features within the drainage lines, including Hornes Creek, and reduces any potential for the Project to impact the biodiversity values associated with these habitats. This avoids impacts to those species assumed to be present and potentially using these habitats, such as the Red-crowned, Giant Burrowing Frog and threatened microbats.

### 7.3 Other measures considered

No other measures have been considered.

## 7.4 Summary of measures to avoid and minimise impacts

Management and mitigation measures to be implemented prior to the extraction of LW S7A are detailed in Table 16.

**Table 16. Avoidance and minimisation measures for direct, indirect and prescribed impacts**

| Item # | Action | Outcome | Timing | Responsibility |
|---|---|---|---|---|
| **Pre-construction/construction/post-construction** | | | | |
| 1 | Revise the existing Biodiversity Management Plan (BMP) prepared for the current development consent (SSD 8445). The BMP will include:<br>• Establishment permanent floristic monitoring plots to collect baseline data in accordance with the BAM<br>• Amphibian monitoring and photo-point monitoring at suitable monitoring sites<br>• Further investigations to determine ongoing presence of threatened fauna habitat in the locality. | To protect biodiversity within the Subject Land as determined in the BMP | Bi-annually (Spring and Autumn) | Project manager/Project ecologist |

# 8. Impact assessment

An assessment of the potential impact of the Project on biodiversity is provided below. As previously mentioned no direct or indirect impacts are likely as a result of the Project as the action is limited to underground mining and vegetation (native and non-native) removal is not required. As such, there are no areas of indirect impact that would require offset for the Project

The Project has the potential to affect biodiversity where entities occur in association with those areas susceptible to subsidence impact, such as drainage lines, waterbodies and cliffs/caves. These impacts are identified as prescribed impacts. The prescribed impact of subsidence, while negligible, would be appropriately managed and monitored throughout the life of the mine, as discussed in Table 16.

## 8.1 Direct impacts

### 8.1.1 Residual direct impacts

As discussed in Section 1.1.3, the Project does not require any surface disturbance. The Project is limited to underground mining and vegetation (native and non-native) removal is not required. Therefore, the Project will not result in any direct impact to biodiversity.

### 8.1.2 Change in vegetation integrity score

This section is not applicable.

## 8.2 Indirect impacts

As discussed in Section 1.1.3, the Project does not require any surface disturbance. The Project is limited to underground mining and vegetation (native and non-native) removal is not required. Existing management measures will continue to be implemented to manage the ongoing indirect impacts associated with the current approved operations.

## 8.3 Prescribed impacts

Prescribed impacts will be managed and mitigated via the measures detailed in Table 16.

Prescribed biodiversity impacts are impacts on biodiversity values in addition to, or instead of, impacts from clearing vegetation and/or loss of habitat. Prescribed additional biodiversity impacts (prescribed impacts) must be assessed as part of the NSW Biodiversity Offsets Scheme, as per clause 6.1 of the NSW *Biodiversity Conservation Regulation 2017* (BC Regulation). The BC Regulation states:

1) The impacts on biodiversity values of the following actions are prescribed (subject to subclause (2)) as biodiversity impacts to be assessed under the biodiversity offsets scheme:
   a) the impacts of development on the following habitat of threatened species or ecological communities—
      i) karst, caves, crevices, cliffs and other geological features of significance,
      ii) rocks,
      iii) human made structures,
      iv) non-native vegetation,
   b) the impacts of development on the connectivity of different areas of habitat of threatened species that facilitates the movement of those species across their range,

c) the impacts of development on movement of threatened species that maintains their lifecycle[3],

d) the impacts of development on water quality, water bodies and hydrological processes that sustain threatened species and threatened ecological communities (including from subsidence or upsidence resulting from underground mining or other development),

e) the impacts of wind turbine strikes on protected animals,

f) the impacts of vehicle strikes on threatened species of animals or on animals that are part of a threatened ecological community.

An analysis of prescribed impacts has been provided in Table 15 for the threatened species credit species that have been confirmed/assumed to have presence within the development footprint.

### 8.3.1 Subsidence and its potential to impact terrestrial ecology values

Predictions regarding the likelihood and potential impact of subsidence for the Tahmoor South Project were investigated, and reported by MSEC (2024). Natural surface features sensitive to subsidence movements identified by MSEC (2024) include the following:

- Streams within the predicted limits of 20 mm total upsidence and 20 mm total closure
- Cliffs
- Bargo River.

These features provide habitat for a range of biodiversity, and therefore consideration of the potential effects of subsidence on these features and threatened biodiversity has been addressed in this report.

The potential effects of subsidence include:

- Fracturing of river and creek beds, which may result in:
  - Increased levels of ponding, scouring or desiccation due to mining tilt
  - Fracturing and surface water flow diversion in the streams
  - Potential water quality changes/contamination
  - Contamination of surface waters by gas drainage
  - Potential for gas emissions and changes to water quality.
- Instability and rock falls along cliff-faces
- Slippages, erosion and rock falls on steep slopes and rock ledges.

A summary of the predicted impacts that the Project may have on natural surface features sensitive to subsidence (as described by MSEC 2024), and the associated potential impacts to ecology, are described in Table 17. An assessment of the potential subsidence related impacts on native vegetation and species credits are discussed in the sections following.

[3] The BAM (DPIE 2020) does not provide assessment requirements for this prescribed matter.

**Table 17. Predicted effects of subsidence on natural features within the Tahmoor South Subject Land (MSE 2024)**

| Type | Description of natural feature | Subsidence impact | Potential biodiversity impact |
|---|---|---|---|
| Bargo River | The Bargo River commences north of Colo Vale and near the townships of Hill Top and Yerrinbool and flows generally towards the north and to the west of the Bargo township. The Bargo River then flows to the west and north of the proposed Tahmoor South longwalls. The Bargo River then drains into the Nepean River approximately 4.9 km north-east of Longwall S1A.<br>While the Bargo River is located outside the Subject Land, a short 200 m long section of the Bargo River at the confluence with Hornes Creek is located within the 600m Subject Land for Natural Features. The 200 m long section commences from the Picton Weir and continues up to the confluence of Hornes Creek and slightly around the bend in the Bargo River. This length of the river that | The surface water flows in this section of the river are controlled by the Picton Weir, (also called the Bargo Weir) with discharge regulated by a fixed discharge valve.<br>The 200 m long length of the Bargo River that is immediately upstream from the Picton Weir and located inside the Subject Land is approximately 4.9km north-east from the proposed Longwall S1A. The closest distance between the Bargo River and the closest longwall (LW S7A) is approximately 520 m.<br>At this distance from the basecase longwall panels and with these low predicted ground movements, the river is not expected to experience any noticeable subsidence or upsidence movements. MESC (2024) states that the maximum total upsidence for the modified layout is 30mm with maximum predicted total subsidence to be <20mm.<br>There has been a long history of mining directly beneath or near the Bargo River at Tahmoor Mine. While impacts have occurred when various previously extracted longwalls were mined directly beneath the river, impacts have been not observed when mining has been undertaken more than 500 m away from the river.<br>Based on the previous experience at Tahmoor Mine, it is unlikely, that the extraction of the proposed longwall would result in any adverse impacts on the river. Even if the predictions and impact assessments were exceeded, the likelihood of pool drainage is considered extremely low given the water flows in the river. | Subsidence within the Bargo River has the potential to impact on the range of aquatic, riparian and terrestrial flora and fauna dependant on the riverine habitat and its water. However, given it has been concluded that it is extremely unlikely that the extraction of the proposed longwalls would result in any adverse impacts on the river, it is considered unlikely that ecological values dependant on the river would be significantly or adversely impacted by the Project. Any impacts are likely to be highly localised and relatively minor in nature.<br>An aquatic ecology assessment for the Project undertaken by Niche (Niche 2018) similarly concluded that, given the above, the quality and quantity of available aquatic habitat in the Bargo River is unlikely to be impacted by the Project. |

| Type | Description of natural feature | Subsidence impact | Potential biodiversity impact |
|---|---|---|---|
| | is within the Subject Land is a 5th order perennial stream as defined by the Strahler Stream Order Method. | | |
| Hornes Creek | Hornes Creek commences west of the township of Bargo and flows generally towards the north-west before<br>draining into the Bargo River. Hornes Creek catchment is located to the south-southwest of LW S1A-S6A. Water levels in the downstream section of Hornes Creek are controlled by the Picton Weir. The downstream section of Hornes Creek meanders inside and outside the Subject Land and the majority of<br>the downstream section is located inside the 600m Subject Land for Natural Features. | Potential for increased levels of ponding, scouring or desiccation due to mining-induced tilt.<br>Change in the grade of a stream has the potential to lead to increased ponding, scouring, desiccation. MSEC (2024) states: "Mining can also potentially result in an increased likelihood of scouring of the stream beds in the locations where the mining induced tilts considerably increase the natural stream gradients that exist before mining."<br>It is also stated by MSEC (2024) that "predicted changes in grade along Hornes Creek due to proposed extraction of LW S7A are negligible. The potential for impacts due to mining-induced changes in stream gradients is also irrelevant for the section downstream of Pool HC-16, given that this section is usually inundated with stored water."<br>The streams flow predominantly over Hawkesbury Sandstone, which has a high resilience to scouring. As discussed in the report by Fluvial Systems (2013), mud was commonly found in the channel bed with soft knickpoints in small streams on the plateau. The predicted maximum increases in grade are up to 1.2 %, which are relatively small compared to the natural gradients and, therefore, the potential for increased scouring is not expected to be substantial.<br>Further discussions on the potential changes in ponding and flooding along the streams and the impacts, consequences and implications of the changes are provided by the specialist surface water consultant in the report by Hydro Engineering and Consulting (2018). | Increased ponding may result in a change to microhabitats (debris, riffles, etc.) that may impact upon existing amphibian habitat along the creeks within the Subject Land, in particular along Dog Trap creek. This may decrease habitat for amphibians that are sensitive to changes to microhabitats. However, it is noted that MSEC predicts that such changes to be relatively negligible. |
| | | Potential for fracturing and surface water flow diversion in the streams.<br>MSEC (2024) states that "The section of Hornes Creek upstream of Pool HC-16 is located between 470 m and 620 m from the proposed LW S7A. The likelihood of | The fracturing and changes to surface water flow may result in a decrease in the number of existing pools along the creeks in the Subject Land. This may |

| Type | Description of natural feature | Subsidence impact | Potential biodiversity impact |
|---|---|---|---|
| | | fracturing occurring in this section of the creek is considered to be low. In the unlikely event that fracturing occurs, the fractures are expected to be minor and isolated. The likelihood of fracturing resulting in surface flow diversion is considered to be very low given the offset distance of LW S7A to this section of stream."<br>Furthermore, the water levels are controlled by Picton Weir, resulting in negligible impacts on surface flow in the instance that impact predictions were exceeded.<br>MSEC (2024) observed that previous longwall mining produced surface fracturing of exposed bedrock and in flute holes downstream of LW12 and LW13. However, no impacts to water flow were detected. Given that the proposed additional longwall are significantly further than LW12 and LW13, it is unlikely that surface water flow will be diverted away from the natural watercourse. | impact upon pools which amphibians rely on for breeding and lifecycle development. However, MESC (2024) states that the proposed longwalls are unlikely to have an adverse impact on the impacted areas of the stream. MESC (2024) also states that "In the event that minor, isolated surface fractures develop within the stored water areas of Hornes Creek due to the extraction of LW S7A, the fractures would likely not be detected as the bedrock is covered by alluvial sediment and frequently by stored water". |
| | | Potential water quality changes due to subsidence<br>The following has been extracted from Hydro Engineering and Consulting (2018):<br>Liberation of contaminants can occur from subsidence induced fracturing in watercourses, causing localised and transient increases in iron concentrations and other constituents due to flushing of freshly exposed fractures in the sandstone rocks which contain iron and other mineralisation. This sort of impact has the potential to affect Tea Tree Hollow, Dog Trap Creek, and Eliza Creek, Cow Creek and Carters Creek and downstream watercourses. Fracturing of bed rock is predicted to occur and upsidence related buckling of stream beds is predicted along some sections of these creeks.<br>Based on past experience in the Southern Coalfields, including experience at Tahmoor North, it is expected that upsidence induced fracturing may lead to releases of aluminium, iron, manganese and zinc. It is likely these will be seen as transient spikes in the concentration of these and possibly other metals which would be relatively localised. The extent of these impacts is expected to be similar to impacts observed in | The potential changes to water quality through subsidence are predicted to be localised (Hydro Engineering and Consulting 2018 in MSEC 2024). This may have an impact to local amphibians if they were to occupy a pool that has had a change in water quality. |

| Type | Description of natural feature | Subsidence impact | Potential biodiversity impact |
|---|---|---|---|
| | | similar streams in the Southern Coalfield i.e. iron staining and flocs in pools and localised and transient spikes in iron, manganese and aluminium in waterways previously undermined.<br>Changes to chemical characteristics of surface flows can also occur as a result of changes in baseflow. One of the effects of longwall subsidence on watercourses commonly reported is the emergence of ferruginous springs. These concentrated (point) inflows have a distinctive orange to red/brown colouration caused by enhanced groundwater inflows and oxidation of iron commonly present in shallow groundwater in the area. This is often accompanied by iron flocs, staining of the bed, increased turbidity and the build-up of iron rich slimes. Changes can also occur to the chemical composition of surface flows due to either increased or decreased groundwater fed baseflow. | |
| | | Potential contamination of surface waters by gas drainage.<br>MESC (2024) states: "Gas emissions from the sandstone strata have been previously observed above and adjacent to mining areas in the Southern Coalfield, and some gas emissions have also been observed in water bores. Analyses of gas compositions indicate that the Bulli seam is not the direct and major source of the gas and that the most likely source is the Hawkesbury Sandstone (APCRC, 1997)."<br>While not affecting water quality per se, the gas expression associated with release of strata gas has the potential to cause vegetation dieback in the vicinity of the gas release point. | Gas emission has the potential to result in decreased water quality. However, as noted in MSEC (2024), the majority of the gas is released into the atmosphere and unlikely to impact water quality. Gas emissions also have the potential to cause vegetation dieback around the gas release points. The reduction in vegetation cover could |

| Type | Description of natural feature | Subsidence impact | Potential biodiversity impact |
|---|---|---|---|
| | | Potential for gas emissions and changes to water quality.<br>MSEC (2024) states gas emissions from the sandstone strata have been previously observed above and adjacent to mining areas in the Southern Coalfield, and some gas emissions have also been observed in water bores. Analyses of gas compositions indicate that the Bulli Seam is not the direct and major source of the gas and that the most likely source is the Hawkesbury Sandstone (APCRC, 1997).<br>It is likely that gas emissions will occur as a result of the mining of the longwalls. Gas is often released into rivers and streams as these areas form topographical low points in the landscape. Where these gas releases occur into the water column there is insufficient time for any significant amount of gas to dissolve into the water. The majority of the gas is released into the atmosphere and is unlikely to have an adverse impact on water quality.<br>As mentioned above, however, it is possible for substantial gas emissions at the surface to cause localised vegetation die-back. This is a rare event and has only occurred previously on one occasion at Tower Mine, over small areas in the base of the Cataract Gorge that had been directly mined beneath by Longwalls 10 and 14. These impacts were limited to small areas of vegetation, local to the points of emission, and when the gas emissions declined, the affected areas were successfully restored. | As discussed above, the potential for localised vegetation die-back is possible, and unlikely to result in substantial impacts. |
| Teatree Hollow and Tributaries | The sections<br>of Teatree Hollow and its tributaries within the Subject Land are ephemeral first or second order drainage<br>lines having shallow incisions into the natural surface soils.<br>The catchment area is located above LW S7A in | Potential for increases levels of ponding, scouring or desiccation due to mining-induced tilt.<br>Change in the grade of a stream has the potential to lead to increased ponding, scouring, desiccation. MESC (2024) states that “Mining can potentially result in increased levels of ponding in locations where the mining-induced tilts oppose and are greater than the natural stream gradients that exist before mining. Mining can also potentially result in an increased likelihood of scouring of the stream beds in the locations where the mining-induced tilts considerably increase the natural stream gradients that exist before mining.”<br>The streams flow predominantly over Hawkesbury Sandstone, which has a high resilience to scouring. As discussed in the report by Fluvial Systems (2013), mud was commonly found in the channel bed with soft knickpoints in small streams on the | Increased ponding may result in a change to microhabitats (debris, riffles, etc.) that may impact upon existing amphibian habitat along the creeks within the Subject Land. This may decrease habitat for amphibians that are sensitive to changes to microhabitats. However, it is noted that MSEC predicts that such changes to be relatively negligible. |

| Type | Description of natural feature | Subsidence impact | Potential biodiversity impact |
|---|---|---|---|
| | predominantly grazing land, with stream flow captured by a number of farm dams. | plateau. The predicted maximum increases in grade are up to 1.2 %, which are relatively small compared to the natural gradients and, therefore, the potential for increased scouring is not expected to be substantial.<br>Further discussions on the potential changes in ponding and flooding along the streams and the impacts, consequences and implications of the changes are provided by the specialist surface water consultant in the report by Hydro Engineering and Consulting (2018).<br>MSEC (2024) also notes that minor increases to flood levels are predicted in areas subject to flooding under existing conditions above LW S3A and LW S5A, but the addition of LW S7A will not change the flood study. | |
| | | Potential for fracturing and surface water flow diversion in the stream.<br>MESC (2024) states that "Teatree Hollow and its tributaries will be directly mined beneath by the Approved Layout. It was assessed that fracturing and surface flow diversions will occur in the sandstone bedrock along both streams due to the extraction of the longwalls in the Approved Layout. In some of these locations, the fracturing could impact the holding capacity of the standing pools, particularly those located directly above the proposed longwalls. It is unlikely, however, that there would be any net loss of water from the catchment. Mining-induced fractures and impacts on surface water flow and pool water levels have been observed during the extraction of LW S1A and LW S2A. The addition of LW S7A does not materially change this assessment, though the extent of impacts increases further upstream to the include the headwaters of two first order sections in the catchment. While the extent of impacts is increased, Tahmoor Coal will continue to develop and implement measures to manage the potential for impacts on Teatree Hollow and its tributaries during the extraction of LWs S1A to S7A."<br>Furthermore, the water levels are controlled by Picton Weir, resulting in reduced impacts on surface flow in the instance that impact predictions were exceeded. | The fracturing and changes to surface water flow may result in a decrease in the number of existing pools along the creeks in the Subject Land. This may impact upon pools which amphibians rely on for breeding and lifecycle development. However, MESC (2024) states that the proposed longwalls are unlikely to have an adverse impact on the impacted areas of the stream. MESC (2024) also states that "In the event that minor, isolated surface fractures develop within the stored water areas of Hornes Creek due to the extraction of LW S7A, the fractures would likely not be detected as the bedrock is covered by alluvial sediment and frequently by stored water". |
| | | Potential for gas emissions and changes to water quality.<br>MSEC (2024) states that "Gas emissions from the sandstone strata have been previously observed above and adjacent to mining areas in the Southern Coalfield, and | As discussed above, the potential for localised vegetation die-back is possible, |

| Type | Description of natural feature | Subsidence impact | Potential biodiversity impact |
|---|---|---|---|
| | | some gas emissions have also been observed in water bores. Analyses of gas compositions indicate that the Bulli seam is not the direct and major source of the gas and that the most likely source is the Hawkesbury Sandstone (APCRC, 1997)."<br>It is predicted that due to the position of LW S7A being directly underneath the headwaters of first order tributaries, gas emissions will be released into the atmosphere. Water quality is therefore unlikely to be adversely impacted.<br>As mentioned above, however, it is possible for substantial gas emissions at the surface to cause localised vegetation die-back. This is a rare event and has only occurred previously on one occasion at Tower Mine, over small areas in the base of the Cataract Gorge that had been directly mined beneath by Longwalls 10 and 14. These impacts were limited to small areas of vegetation, local to the points of emission, and when the gas emissions declined, the affected areas were successfully restored. | and unlikely to result in substantial impacts. |
| Cliffs | A total of 19 cliffs are located within the 600m Subject Land for Natural Features, of which 5 cliffs are located within the Subject Land. The cliffs are located within the Hawkesbury Sandstone along the Bargo River and Hornes Creek, at distances of between 275 m and 600 m from LW S7A. | According to MSEC (2024), a total of 19 cliffs are located within the Subject Land. The cliffs are located more than 275 m from the proposed LW S7A and will not be directly mined beneath.<br>It is noted by MSEC (2024) that it is extremely difficult to assess the likelihood of cliff instabilities based upon predicted ground movements. The likelihood of a cliff becoming unstable is dependent on a number of factors which are difficult to fully quantify. These factors include jointing, inclusions, weaknesses within the rock mass, groundwater pressure and seepage flow behind the rockface. Even if these factors could be determined, it would still be difficult to quantify the extent to which these factors influence the stability of a cliff naturally or when it is exposed to mine subsidence movements. It is possible, therefore, that cliff instabilities may occur during mining that may be attributable to either natural causes, mine subsidence, or both.<br>The likelihood of cliff instabilities along the Nepean River, Bargo River and Hornes Creek has been assessed by MSEC (2024) using case studies where previous longwall mining has occurred close to but not directly beneath cliffs. The case studies have indicated that very minor rock falls have been observed outside the extracted goaf | Some fauna species are dependent on the specialised habitat of the cliff faces/ rock ledges and overhangs for survival. This habitat has the potential to support habitat for reptile species, and microbat species for roosting. Potential impacts to threatened fauna as a result of impacts to cliffs within the Subject Land are addressed in Section 8.3.2. |

| Type | Description of natural feature | Subsidence impact | Potential biodiversity impact |
|---|---|---|---|
| | | areas of longwall mining in the Southern Coalfield, however there have been no recorded large cliff instabilities.<br>Based on this previous experience of mining at Tahmoor, Appin and Tower Collieries, it is unlikely that cliffs beyond the extent of the longwall mining area will experience large instabilities. It is possible that isolated rock falls could occur, particularly at those that have weathered to be marginally stable naturally and at those located closest to previously extracted longwall panels and the proposed longwall mining area. Any impacts are expected to represent less than 0.5 % of the total face area of the cliffs.<br>The cliffs along Hornes Creek and Bargo River will not be directly mined beneath by the proposed LW S7A. | |
| Steep slopes | MSEC (2024) states that a steep slope has been defined as an area of land having a gradient greater than 1 in 3 (33% or 18.3°).<br>The locations of the steep slopes within the Subject Land are detailed in MSEC (2024) however encompass:<br>a) Steep slopes on the sides of valleys<br>b) Batters of road and railway embankments and cuttings<br>c) slopes on farm dams | Potential impacts on steep slopes would generally result from the down slope movement of soils, causing tension cracks to appear at the tops of the slopes and compression ridges to form at the bottoms of the slopes. If tension cracks were left untreated it is possible that erosion could occur.<br>The steep slopes on the sides of valleys are predominantly found in Hawkesbury Sandstone and consist of a mixture of cliffs and rock outcrops, which are stable at vertical to overhanging, and screed slopes with rocky soils and loose rock fragments. The majority of slopes are stabilised, to some extent, by natural vegetation.<br>There is extensive experience of mining beneath steep slopes in the Southern Coalfield. These include steep slopes along the Cataract, Nepean, Bargo and Georges Rivers and streams such as Myrtle Creek and Redbank Creek above Tahmoor Colliery Longwalls 22 to 27. No large-scale slope failures have been observed along these slopes, even where longwalls have been mined directly beneath them. Minor rock falls along cliff lines or rock outcrops have been observed, for example, during the mining of Appin Longwalls 301 and 302 adjacent to the Cataract River.<br>It is possible, therefore, that some remediation might be required to ensure that mining-induced surface cracking does not result in the formation of soil erosion channels. In some cases, erosion protection measures may be needed, such as the planting of additional vegetation in order to stabilise the slopes in the longer term.<br>While in most cases impacts to slopes are likely to consist of surface cracking, there remains a low probability of large-scale slope slippage. The probability is assessed to | Slippage of earth and rocks down steep slopes and rock falls have the potential to directly impact (destroy/smother) vegetation, flora and fauna habitat as well as directly injure or kill native fauna. Biodiversity more likely to be impacted are those species dependant on rocky outcrops and ledges, and include microbats, reptiles and some mammals. As the probability of rock falls and large-scale slippages is considered to be very low, the potential impact on threatened biodiversity is negligible. |

| Type | Description of natural feature | Subsidence impact | Potential biodiversity impact |
|---|---|---|---|
| | | be very low for slopes that will not be directly mined beneath by the longwalls. Experience indicates that the probability of mining-induced large-scale slippages is extremely low due to significant depth of cover. | |

### 8.3.2 Karst, caves, crevices, cliffs, rocks or other geological features of significance

#### 8.3.2.1 Nature

Cliffs and rock features are present within the western portion of the Subject Land. These features are located adjacent to Hornes Creek which intersects the western limit of the Subject Land. A total of 5 cliffs were identified within the Subject Land. These cliffs and rocky features are typical habitat for many threatened reptiles, either as nesting or foraging habitat, and may also provide roosting habitat for threatened bats.

#### 8.3.2.2 Extent

The Project will not result in direct physical impacts to rocky habitat.

#### 8.3.2.3 Duration

The duration of this prescribed impact would be during extraction of LW S7A.

#### 8.3.2.4 Consequences

This proposal will involve longwall mining. Mining beneath cliff lines is known to result in instabilities, slippages and creature surface fissures (see Table 17 for further details). However, previous knowledge of longwall mining in the Southern Coalfield (e.g. Tahmoor LW 24A-26, Appin LW 301-302) has determined that longwall mining that does not occur directly underneath a cliff face is highly unlikely to result in slippages and rock falls (MSEC 2024). Any threatened fauna that may be inhabiting the cliffs and rock faces are unlikely to be adversely affected by the Project.

### 8.3.3 Human-made structures

#### 8.3.3.1 Nature

Human-made structures have been identified within the central and eastern portion of the Subject Land. These structures have the potential to provide nesting and roosting habitat for species of threatened microbats.

#### 8.3.3.2 Extent

The Project will not result in direct physical impacts to human-made structures.

#### 8.3.3.3 Duration

The duration of this prescribed impact would be during extraction of LW S7A.

#### 8.3.3.4 Consequences

Human-made structures will not be demolished or impacted for this proposal. Threatened species which may be inhabiting human-made structures within the Subject Land are therefore unlikely to be impacted.

### 8.3.4 Non-native vegetation

#### 8.3.4.1 Nature

Areas of non-native vegetation exist within the Subject Land in the form of modified pastures and introduced weeds. These areas may be utilised by threatened species as foraging or roosting habitat. Threatened owl species, such as Masked Owl, are known to utilise open fields as foraging habitat.

#### 8.3.4.2 Extent

The Project will not result in the direct removal of non-native vegetation. Indirect impacts to non-native are also unlikely.

#### 8.3.4.3 Duration

The duration of this prescribed impact would be during extraction of LW S7A.

#### 8.3.4.4 Consequences

Non-native vegetation will not be removed or modified for this proposal. Threatened species which are inhabiting areas of non-native vegetation within the Subject Land are unlikely to be impacted.

### 8.3.5 Habitat connectivity

#### 8.3.5.1 Nature

The Subject Land incorporates large areas of intact native vegetation, providing connectivity with habitat within the Subject Land to areas of high-quality habitat north and west of the Subject Land. This proposal does not require the removal of vegetation; however, the proposed mining may indirectly result in a reduction in native vegetation cover and subsequently habitat connectivity. The potential reduction in vegetation cover would be the result of gas emissions. This has the potential to impact the ability of threatened to travel throughout the landscape. However, the frequency of gas emissions has been noted as very low and is unlikely to reduce vegetation cover to an extent in which habitat connectivity is compromised or modified.

#### 8.3.5.2 Extent

The Project will not result in the direct removal of native vegetation. Indirect impacts to native are also unlikely.

#### 8.3.5.3 Duration

The duration of this prescribed impact would be during extraction of LW S7A.

#### 8.3.5.4 Consequences

Connectivity is unlikely to be impacted by this proposal. MSEC (2024) acknowledged that gas emissions may occur as a result of this proposal. Gas emissions may result in localised vegetation dieback which could reduce the extent of the canopy and vegetation cover. However, the frequency of gas emissions has been noted as very low and is unlikely to reduce vegetation cover to an extent in which habitat connectivity is compromised or modified. Connectivity, in its current extent, is expected to be maintained throughout the Subject Land and surrounding areas.

### 8.3.6 Waterbodies, water quality and hydrological processes

#### 8.3.6.1 Nature

There are several waterways within the Subject Land, including:

- Bargo River
- Hornes Creek
- Teatree Hollow and tributaries
- Numerous farm dams.

These waterbodies are likely utilised as drinking water and foraging habitat by threatened species, such as Koalas, microbats, and woodland birds.

#### 8.3.6.2 Extent

The Project will not result in the direct disturbance of any waterbodies. Impacts from subsidence are considered to be minimal to negligible.

#### 8.3.6.3 Duration

The duration of this prescribed impact would be during extraction of LW S7A.

#### 8.3.6.4 Consequences

The proposal will involve longwall mining which may disrupt watery quality and hydrogeological processes. This includes reducing water quality, flow of surface water, scouring and desiccation due to mining-induced tilting. Subsequently, this could have negative impacts for threatened fauna inhabiting the impacted waterbodies, or utilising the waterway as a water source. However, it has been identified that any impacts to waterbodies and geological processes will be minimal to negligible (see Table 17 for details). Therefore, any threatened fauna associated the waterbodies or hydrological processes which may experience minor impacts are unlikely to be adversely affected.

#### 8.3.6.5 Maximum predicted offset liability

Given the negligible impact to species dependent on waterbodies it is not considered necessary to calculate an offset liability.

### 8.3.1 Wind turbine strikes

The Project is not a wind farm development. This prescribed impact is not applicable to the Project.

### 8.3.2 Vehicle strikes

The Project will not increase the volume of traffic above the land surface. As such, no threatened or protected fauna will be impacted. This prescribed impact is not applicable to the Project.

## 8.4 Mitigating residual impacts – management measures and implementation

Section 8.4 of the BAM (DPIE 2020a) requires a BDAR to describe measures to mitigate and manage residual impacts following impact avoidance and minimisation measures. Given the Project is restricted to underground mining, and that there are no direct or indirect residual impacts, measures to mitigate and manage such impacts have not been provided.

Section 8.5 provides further detail on management measures as the impacts of the Project are prescribed only and are difficult to measure.

It is noted that:

- Tahmoor Coal currently has a Tahmoor Environmental Management System (EMS), which includes a series of Environmental Management Plans (EMPs) that outline the mitigation and management programs for key environmental aspects at the mine.
  Operations at Tahmoor will continue to be managed in accordance with the EMS and associated EMPs, which will be revised and updated to incorporate the outcomes of this assessment.
- To ensure compliance with development consent SDD 8445 (Condition C8) for LW S1A-S6A, Niche prepared the BMP for the Extraction Plan (which also included a Subsidence Monitoring Plan and Trigger Action Response Plan/s [TARPs]) (Niche 2022a). The BMP will be updated prior to the extraction of LW S7A.

## 8.5 Adaptive management strategy for uncertain impacts (where relevant)

An adaptive management plan can be used to address impacts that are infrequent, uncertain or difficult to measure, such as prescribed impacts, and should be developed where mitigation measures have not been proposed as part of a BDAR. Given the proposed action is restricted to underground mining, and that the impacts of the Project are prescribed only and are difficult to measure, adaptive management is considered appropriate.

The aim of the adaptive management plan is to assess and manage development-related risks to ensure that there are no exceedances of criteria and performance measures provided. Any exceedance of such criteria or performance measures may be subject to offset or other provisions as may be specified in a development consent and/or penalty or offence provisions under the EP&A Act or EP&A Regulation.

A Before-After-Control-Impact (BACI) framework is proposed to be implemented, where feasible, for monitoring and has been incorporated in the design of the TARP triggers. The monitoring program aims to develop a baseline (before) dataset for a range of biodiversity features and to assess operational and post-mining (after) impacts through the monitoring of reference (control) and performance measure (impact) sites.

The revised BMP will identify the monitoring locations for amphibians, riparian vegetation condition and threatened flora. Should threatened species or TECs be recorded during the baseline study, the monitoring program and associated TARPs will be updated, where required.

Measures to manage impacts to the aquatic environment and consider relevant triggers (i.e. macroinvertebrate, aquatic habitat and water quality) have not been discussed here as the BDAR determines the impacts of a proposal on terrestrial biodiversity values only (Section 1.2.b. of the BAM [DPIE 2020]). The revised BMP will include aquatic environment triggers.

# 9. Serious and irreversible impacts (SAII)

## 9.1 Assessment for serious and irreversible impacts on biodiversity values

The following entities identified at risk of SAII have been assumed present within the Subject Land:

- Large-eared Pied Bat (*Chalinolobus dwyeri*)
- Broad-headed Snake (*Hoplocephalus bungaroides*)
- Little Bent-winged Bat (*Miniopterus australis*)
- Large Bent-winged Bat (*Miniopterus orianae oceanensis*).

These species have been assumed present and identified as those SAII that may be potentially impacted by the Project as their habitat associations (i.e. cliffs/caves) are sensitive to subsidence impacts. However, with reference to MSEC (2024) the impacts to these sensitive habitat features as a result of the Project are considered negligible.

The Project is considered unlikely to cause a SAII to any TEC or threatened species.

None of the SAII entities listed above are considered further.

### 9.1.1 Additional impact assessment provisions for TECs at risk of an SAII

No TECs at risk of SAII were identified in the Subject Land.

### 9.1.2 Additional impact assessment provisions for threatened species at risk of an SAII

Refer to Section 9.1.

# 10. Impact summary

## 10.1 Determine an offset requirement for impacts

### 10.1.1 Impacts on native vegetation and TECs or ECs (ecosystem credits)

No areas of native vegetation will be directly impacted as the proposed action is restricted to underground mining. As such, no ecosystem credits will be required to be offset as part of the Project.

**Table 18. Impacts that do not require offset – ecosystem credits**

| Vegetation zone | PCT name | TEC | Impact area (ha) | TEC association | Entity at risk of an SAII? | Current VI score |
|---|---|---|---|---|---|---|
| 3598_high | Woronora Plateau Scribbly Gum Woodland | No | 20.49 | n/a | No | 100 |
| 3611_high | Nattai Plateau Bloodwood-Peppermint Forest | No | 1.62 | n/a | No | 100 |
| 3614_high | Southern Highlands Sandstone Peppermint Forest | No | 2.72 | n/a | No | 100 |
| 3616_high | Sydney Hinterland Grey Gum Transition Forest | No | 24.14 | n/a | No | 100 |
| 3618_high | Sydney Hinterland Sandflat Peppermint Forest | No | 1.27 | n/a | No | 100 |
| 3619_high | Sydney Hinterland Enriched Sandstone Bloodwood Forest | No | 185.72 | n/a | No | 100 |

While subsidence is a likely impact associated with the Project, it is identified as a prescribed impact and is addressed in Section 10.1.3.

### 10.1.2 Impacts on threatened species and their habitat (species credits)

No threatened species or their habitat will be directly impacted as the proposed action is restricted to underground mining. As such, no species credits will be required to be offset as part of the Project.

While subsidence is a likely impact associated with the Project, it is identified as a prescribed impact and is addressed in Section 10.1.3.

### 10.1.3 Indirect and prescribed impacts

Indirect and prescribed impacts that remain after measures to avoid, minimise and mitigate have been applied, may be offset using additional biodiversity credits (above the credit requirement generated by the BAM C for direct impacts) and/or other conservation measures.

Indirect impacts as a result of the Project are not considered to occur.

Prescribed impacts described in Section 6, are likely to be restricted to sensitive environmental features such as waterways and cliff lines. A consideration of the candidate species that are likely to rely on such

environments, and reference to the subsidence impact report (MSEC 2024), has concluded that the likelihood of impact is low. In addition, mitigation measures and adaptive management are recommended to be implemented. As such, prescribed impacts are not considered to require offsets.

## 10.2 Impacts that do not need further assessment

Impacts not requiring offset in accordance with BAM subsection 9.2.1(3.) are as detailed in Table 19.

**Table 19. Impacts that do not need further assessment for ecosystem credits**

| Impact | Location within Development Footprint | Justification why no further assessment is required |
|---|---|---|
| Clearing of non-native vegetation | Grassland areas that occur in association with the semi-rural properties present and are dominated by exotic groundcover species | Does not contain suitable habitat for threatened biodiversity assessed. |
| Removal of farm dams, access tracks and infrastructure | Present throughout the Subject Land, concentrated | Unlikely to contain suitable habitat for threatened biodiversity. While human-made structures in the Subject Land may provide suitable roosting habitat for threatened microbats, none are likely to be impacted by the Project. The Project is limited to underground mining; demolition of human-made structures is not required. Further, subsidence impacts on these structures is not considered to be significant or result in any long-term impacts. |

# 11. Biodiversity credit report

The BAM identifies the BAM-C as the appropriate tool for quantifying the offsets required in both ecosystem credit and species credit terms. A calculation of the nature and extent of biodiversity credits required due to ecological impacts associated with the Project has been undertaken using the BAM-C.

The case has been finalised and submitted via the online BAM Calculator.

No threatened entities listed under the EPBC Act are required to be offset for the project, as the project does not result in a significant impact on any threatened biodiversity listed under the EPBC Act.

## 11.1 Ecosystem credits

Given the nature of the Project (i.e. no surface disturbance), no vegetation clearing is required. The potential for vegetation to be impacted as a result of subsidence is considered negligible. As such, the Project will not incur an ecosystem credit liability. For reference, the matching offset trading group for each PCT has been provided in Table 20.

***Erroneous BAM-C calculations***

While no areas of vegetation will be directly impacted by the Project, the BAM-C does not allow for '0 ha' to be entered. As such, the smallest area permitted to be entered in the BAM-C, 0.01 ha, was used. This in turn has calculated a total of six ecosystem credits to be offset, one for each PCT as follows:

- 3598 – 1 credit
- 3611 – 1 credit
- 3614 – 1 credit
- 3616 – 1 credit
- 3618 – 1 credit
- 3619 – 1 credit.

This is an error, and the total ecosystem credits to be offset should be 0.

The full BAM-C biodiversity credit report is provided in Annex 4. Ecosystem and species credits required (BAM-C Credit report)

**Table 20. Ecosystem credit class and matching credit profile**

| Ecosystem credit | Attributes shared with matching credits | | | | | | |
|---|---|---|---|---|---|---|---|
| | PCT name | PCT vegetation class | PCT vegetation formation | Associated TEC or EC | Offset trading group (BAM Section 10.2, Tables 4 & 5) | Hollow bearing trees present? | IBRA subregion (in which proposal is located) |
| 3598 | Woronora Plateau Scribbly | Sydney Coastal Dry | Dry Sclerophyll Forests (Shrubby | n/a | Sydney Coastal Dry Sclerophyll | Yes | Cumberland |

| Ecosystem credit | Attributes shared with matching credits | | | | | | |
|---|---|---|---|---|---|---|---|
| | PCT name | PCT vegetation class | PCT vegetation formation | Associated TEC or EC | Offset trading group (BAM Section 10.2, Tables 4 & 5) | Hollow bearing trees present? | IBRA subregion (in which proposal is located) |
| | Gum Woodland | Sclerophyll Forests | sub-formation) | | Forests < 50% cleared | | |
| 3611 | Nattai Plateau Bloodwood-Peppermint Forest | Sydney Hinterland Dry Sclerophyll Forests | Dry Sclerophyll Forests (Shrubby sub-formation) | n/a | Sydney Hinterland Dry Sclerophyll Forests < 50% cleared | Yes | Cumberland |
| 3614 | Southern Highlands Sandstone Peppermint Forest | Sydney Hinterland Dry Sclerophyll Forests | Dry Sclerophyll Forests (Shrubby sub-formation) | n/a | Sydney Hinterland Dry Sclerophyll Forests < 50% cleared | Yes | Cumberland |
| 3616 | Sydney Hinterland Grey Gum Transition Forest | Sydney Hinterland Dry Sclerophyll Forests | Dry Sclerophyll Forests (Shrubby sub-formation) | n/a | Sydney Hinterland Dry Sclerophyll Forests ≥ 50% and less than 70% cleared | Yes | Cumberland |
| 3618 | Sydney Hinterland Sandflat Peppermint Forest | Sydney Hinterland Dry Sclerophyll Forests | Dry Sclerophyll Forests (Shrubby sub-formation) | n/a | Sydney Hinterland Dry Sclerophyll Forests < 50% cleared | Yes | Cumberland |
| 3619 | Sydney Hinterland Enriched Sandstone Bloodwood Forest | Sydney Hinterland Dry Sclerophyll Forests | Dry Sclerophyll Forests (Shrubby sub-formation) | n/a | Sydney Hinterland Dry Sclerophyll Forests < 50% cleared | Yes | Cumberland |

## 11.2 Species credits

Given that the Project will result in prescribed impacts only, of which an assessment of such impacts on candidate species has been assessed as low, no species credits species will be required to be offset as part of the Project.

The full BAM-C Biodiversity Credit Report is provided in Annex 4. Ecosystem and species credits required (BAM-C Credit report)

***NB: BAM-C***

While the method used to determine presence of species in Table 11 and Table 12 is 'Yes (assumed present)', 'No (expert report)' has actually been used in the Habitat survey tab in the BAM-C, as prescribed impacts are the only potential impact to species credit species and there is no clearing proposed. Should 'Yes (assumed present)' be selected an area of impact must be entered. As the BAM-C does not allow for '0 ha' to be entered, a credit obligation is generated.

While expert reports were not used, this work around was deemed most appropriate.

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# Figures

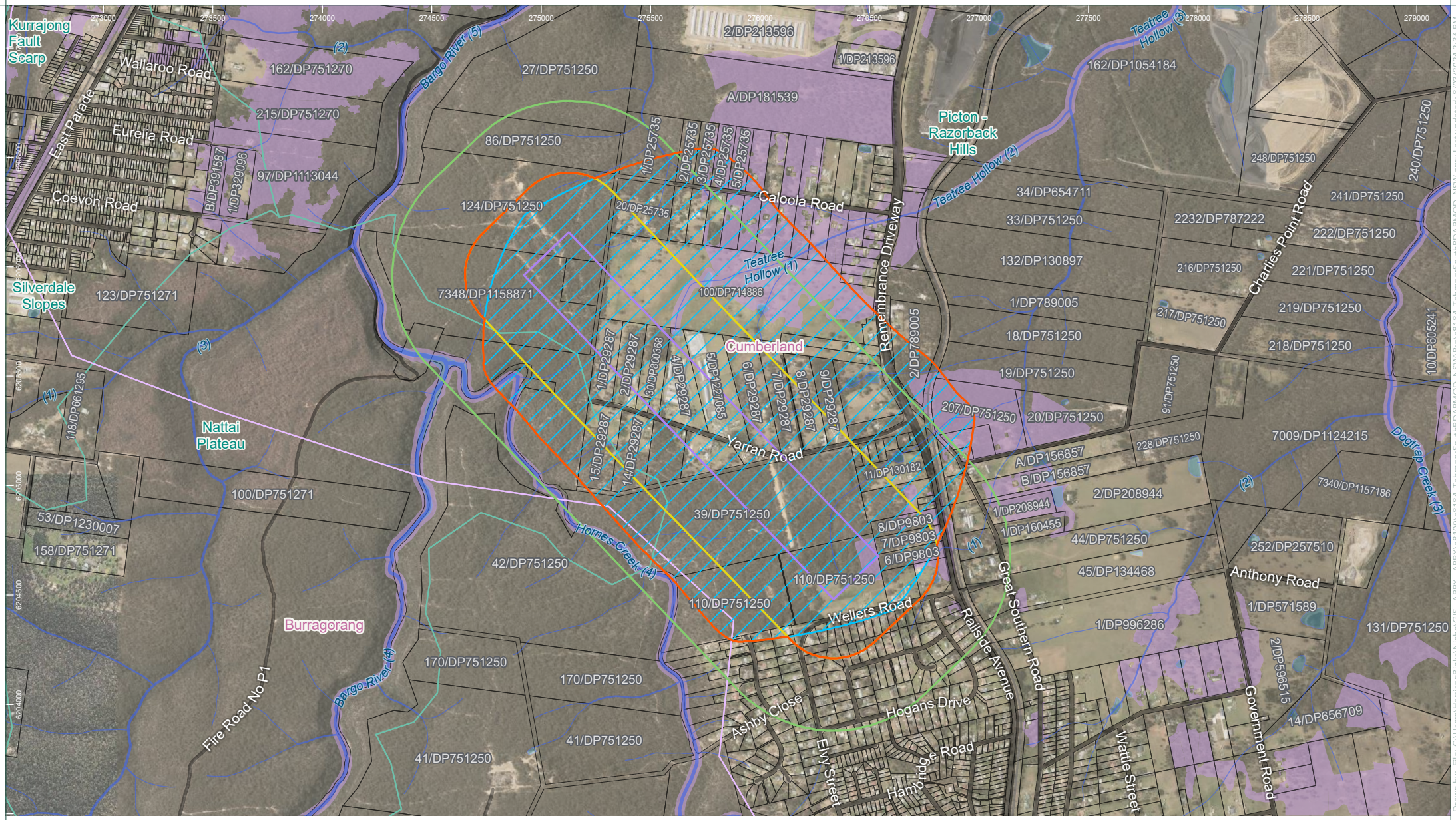


Figure 1

Site Map

Tahmoor South - Biodiversity Development Assessment Report (Modification 3)

Niche PM: Stephen Bloomfield
Niche Proj. #: 8184
Client: SIMEC Mining

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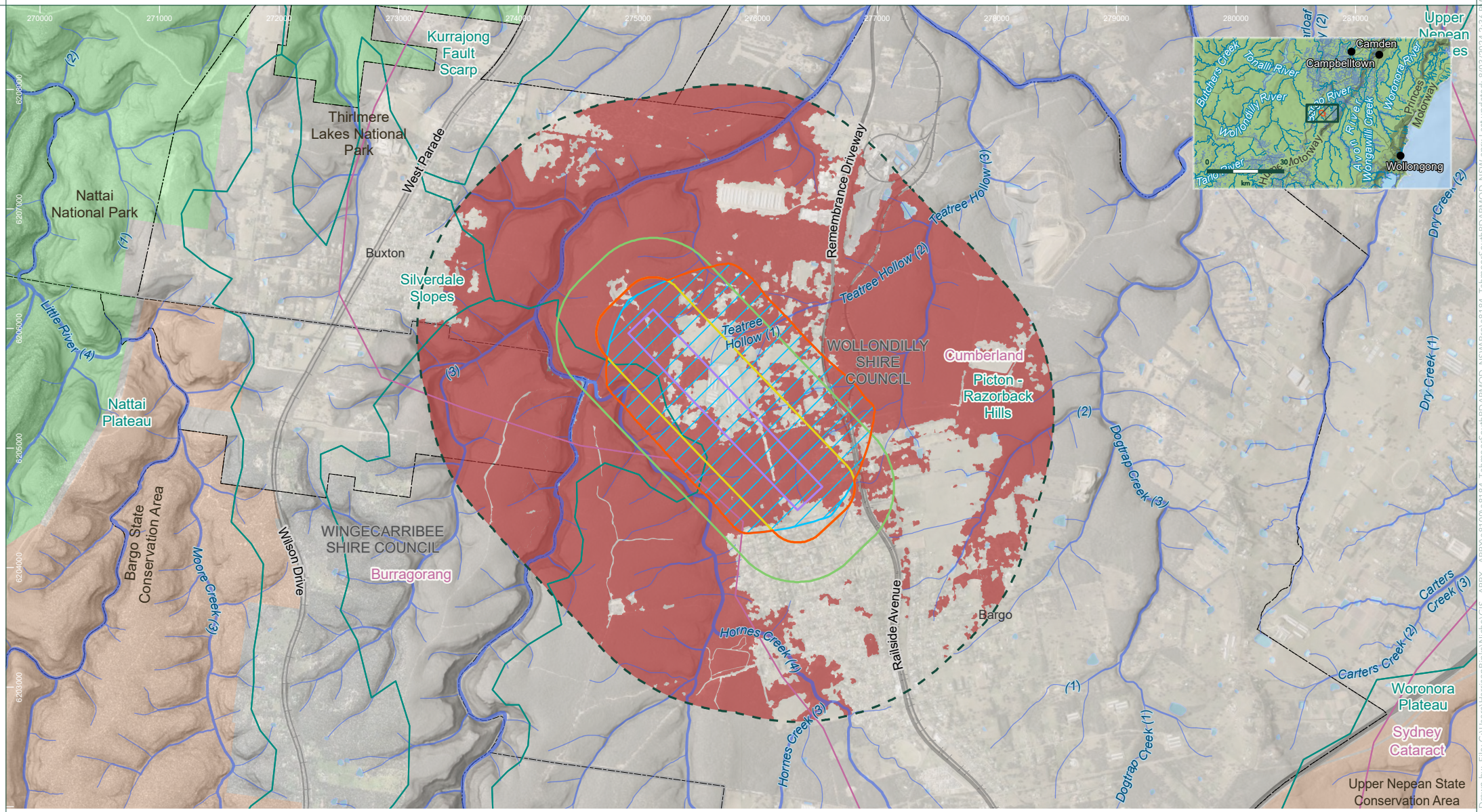


- Subject Land
- Assessment Area
- Mitchell Landscapes v3.1
- IBRA region / subregion
- Native Vegetation
- LW S7A
- LW S7A 35° angle of draw
- LW S7A 600m offset boundary
- LW S7A predicted 20mm subsidence

**Hydrography**

Strahler Stream Order

- 1
- 2
- 3
- 4
- 5
- Waterbody

**Transport**

- Major road
- Minor road
- Rail

**Protected Areas of NSW**

NPWS Reserve

- National Park
- State Conservation Area

**Administrative and Property Boundaries**

- Local Government Area
- Suburb

0 1 km

GDA2020 MGA Zone 56

Figure 2

## Location Map

Tahmoor South - Biodiversity Development Assessment Report (Modification 3)

Niche PM: Stephen Bloomfield
Niche Proj. #: 8184
Client: SIMEC Mining

World Hillshade: Esri, CGIAR/ World_Ocean_Base: NIWA, GeosciencesAustralia, Esri, GEBCO, Garmin, NaturalVue/ public/NSW_Imagery: © Department of Customer Service 2020/ Terrain: Multi-Directional Hillshade: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community | Watercourses, Waterbodies, Road and Rail alignments, Protected areas of NSW © Spatial Services 2021. | Niche uses GDA2020 as standard for all project-related data. In order to ensure that data from numerous sources and coordinate systems is aligned, on-the-fly transformation to GDA2020 MGA Zone 56 is used in the map above. For ease of reference, the grid tick marks and labels shown around the border of the map are presented in GDA2020 MGA Zone 56.

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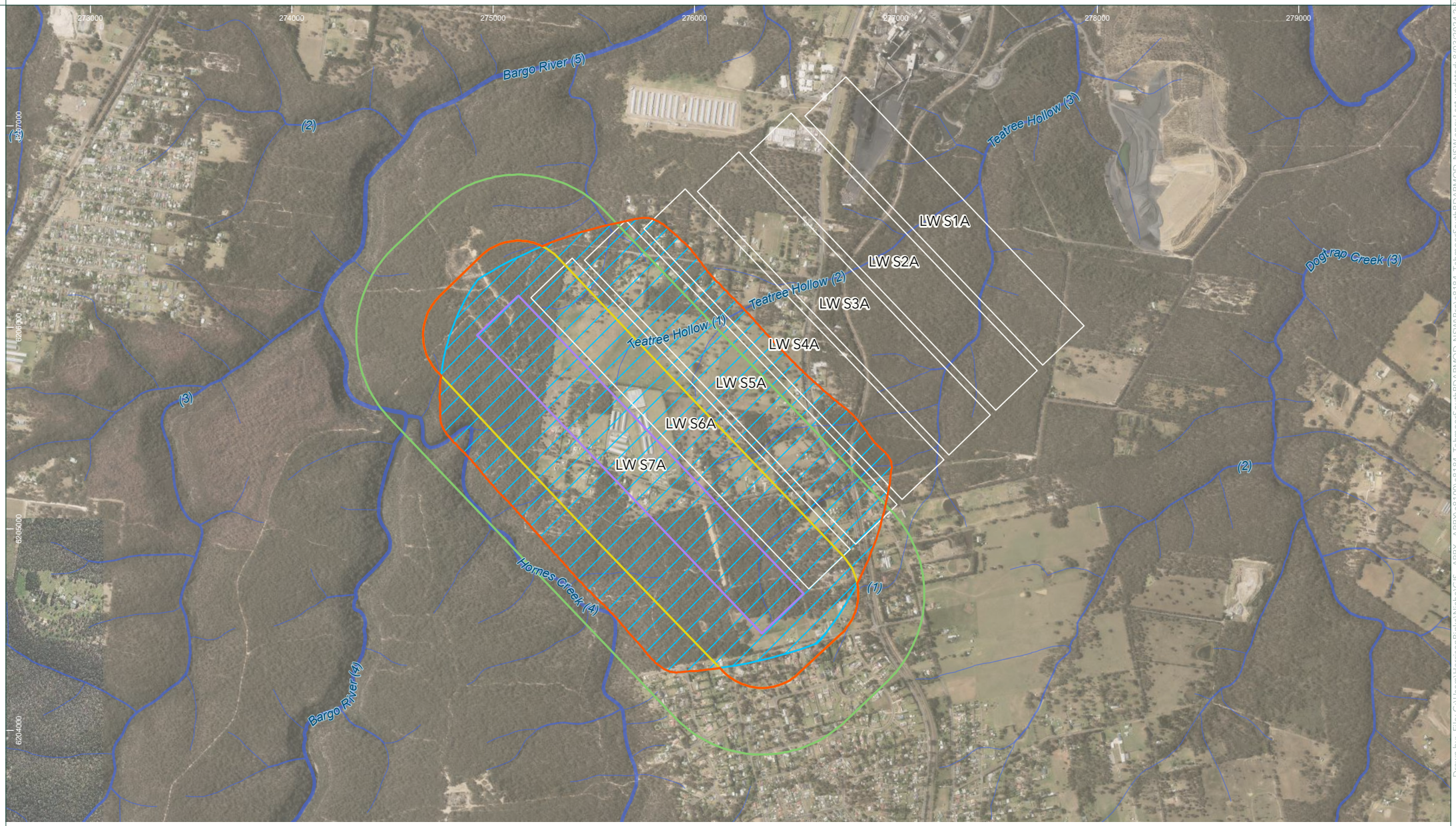


Subject Land

Other approved longwalls (LW S1-6A)

LW S7A

LW S7A 35° angle of draw

LW S7A 600m offset boundary

LW S7A predicted 20mm subsidence

Hydrography

Strahler Stream Order

1

2

3

4

5

0 600

m

GDA2020 MGA Zone 56

Figure 3

## Development layout

Tahmoor South - Biodiversity Development Assessment Report (Modification 3)

Niche PM: Stephen Bloomfield
Niche Proj. #: 8184
Client: SIMEC Mining

public/NSW_Imagery: © Department of Customer Service 2020/ Terrain: Multi-Directional Hillshade: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community | Watercourses, Waterbodies, Road and Rail alignments, Protected areas of NSW © Spatial Services 2021. | Niche uses GDA2020 as standard for all project-related data. In order to ensure that data from numerous sources and coordinate systems is aligned, on-the-fly transformation to GDA2020 MGA Zone 56 is used in the map above. For ease of reference, the grid tick marks and labels shown around the border of the map are presented in GDA2020 MGA Zone 56.

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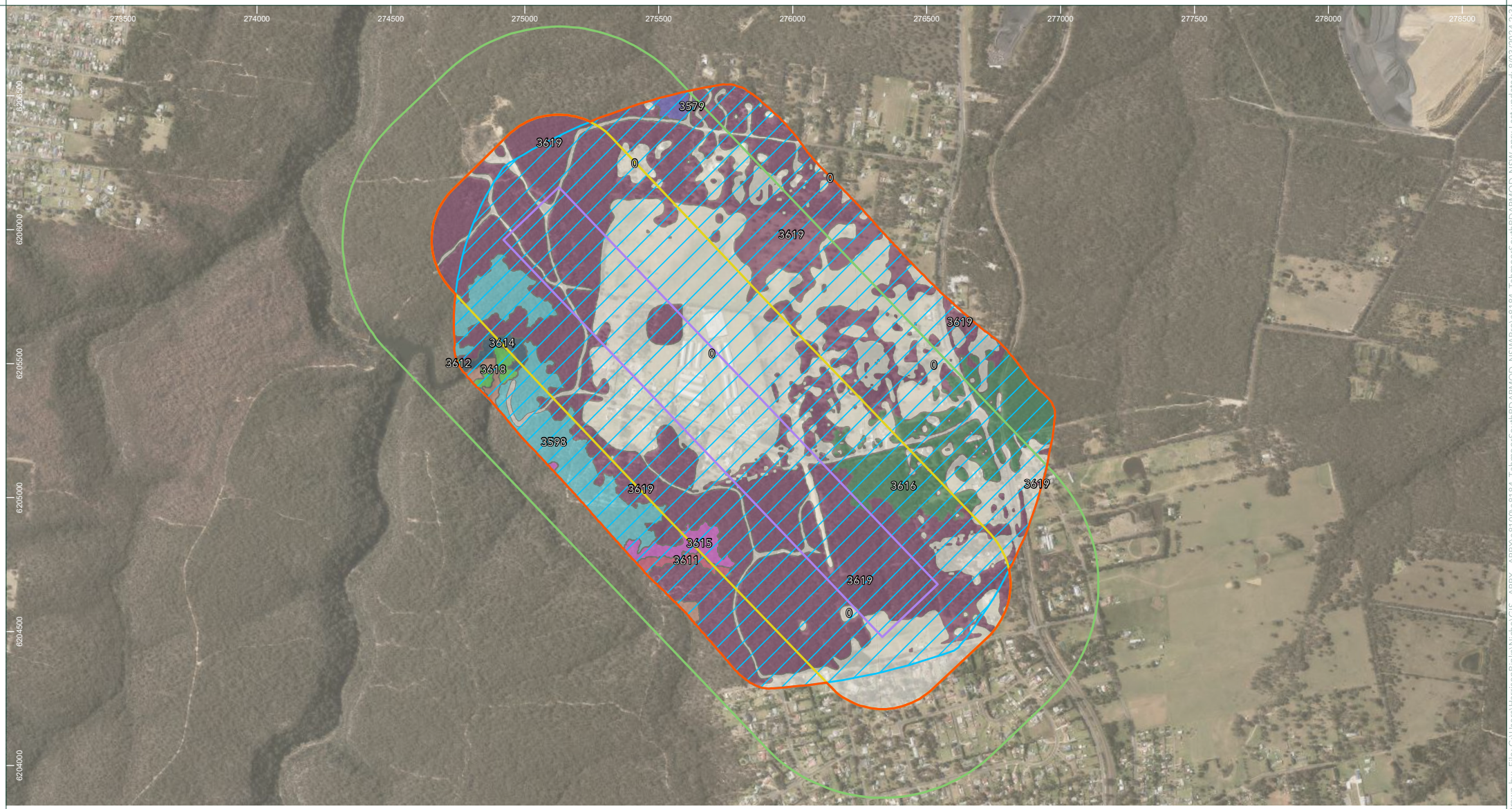


Subject Land
LW S7A
LW S7A 35° angle of draw
LW S7A 600m offset boundary

LW S7A predicted 20mm subsidence

NSW State Vegetation Type Mapping (SVTM 2.0)

0: Not classified

3579: Blue Mountains Scribbly Gum Swamp Woodland

3598: Woronora Plateau Scribbly Gum Woodland

3611: Nattai Plateau Bloodwood-Peppermint Forest

3612: Nattai Plateau Peppermint Gully Forest

3614: Southern Highlands Sandstone Peppermint Forest

3615: Sydney Hinterland Apple-Blackbutt Gully Forest

3616: Sydney Hinterland Grey Gum Transition Forest

3618: Sydney Hinterland Sandflat Peppermint Forest

3619: Sydney Hinterland Enriched Sandstone Bloodwood Forest

0 400
m
GDA2020 MGA Zone 56

Figure 4

## Native vegetation extent

Tahmoor South - Biodiversity Development Assessment Report (Modification 3)

Niche PM: Stephen Bloomfield
Niche Proj. #: 8184
Client: SIMEC Mining

public/NSW_Imagery: © Department of Customer Service 2020/ Terrain: Multi-Directional Hillshade: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community | Watercourses, Waterbodies, Road and Rail alignments, Protected areas of NSW © Spatial Services 2021. | Niche uses GDA2020 as standard for all project-related data. In order to ensure that data from numerous sources and coordinate systems is aligned, on-the-fly transformation to GDA2020 MGA Zone 56 is used in the map above. For ease of reference, the grid tick marks and labels shown around the border of the map are presented in GDA2020 MGA Zone 56.

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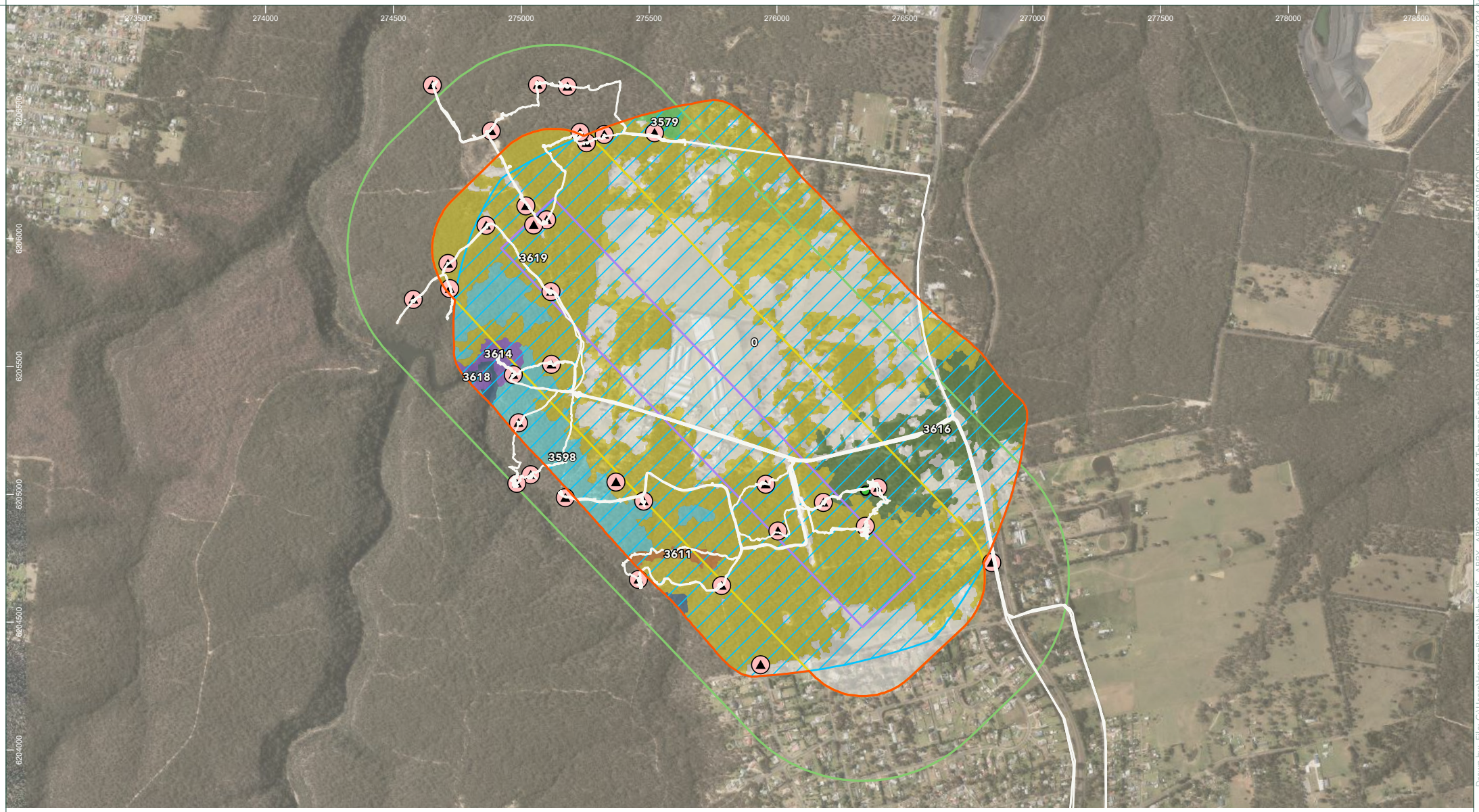


Subject Land
LW S7A
LW S7A 35° angle of draw
LW S7A 600m offset boundary

LW S7A predicted 20mm subsidence

Survey effort
Survey tracks
Threatened flora site 4 (TF4) (Niche 2024)

Florstics RDP

PCTs
0: Not Native
3579: Blue Mountains Scribbly Gum Swamp Woodland
3598: Woronora Plateau Scribbly Gum Woodland
3611: Nattai Plateau Bloodwood-Peppermint Forest
3614: Southern Highlands Sandstone Peppermint Forest
3616: Sydney Hinterland Grey Gum Transition Forest
3618: Sydney Hinterland Sandflat Peppermint Forest
3619: Sydney Hinterland Enriched Sandstone Bloodwood Forest

0 400
m
GDA2020 MGA Zone 56

Figure 5

PCTs & survey effort

Tahmoor South - Biodiversity Development Assessment Report (Modification 3)

Niche PM: Stephen Bloomfield
Niche Proj. #: 8184
Client: SIMEC Mining

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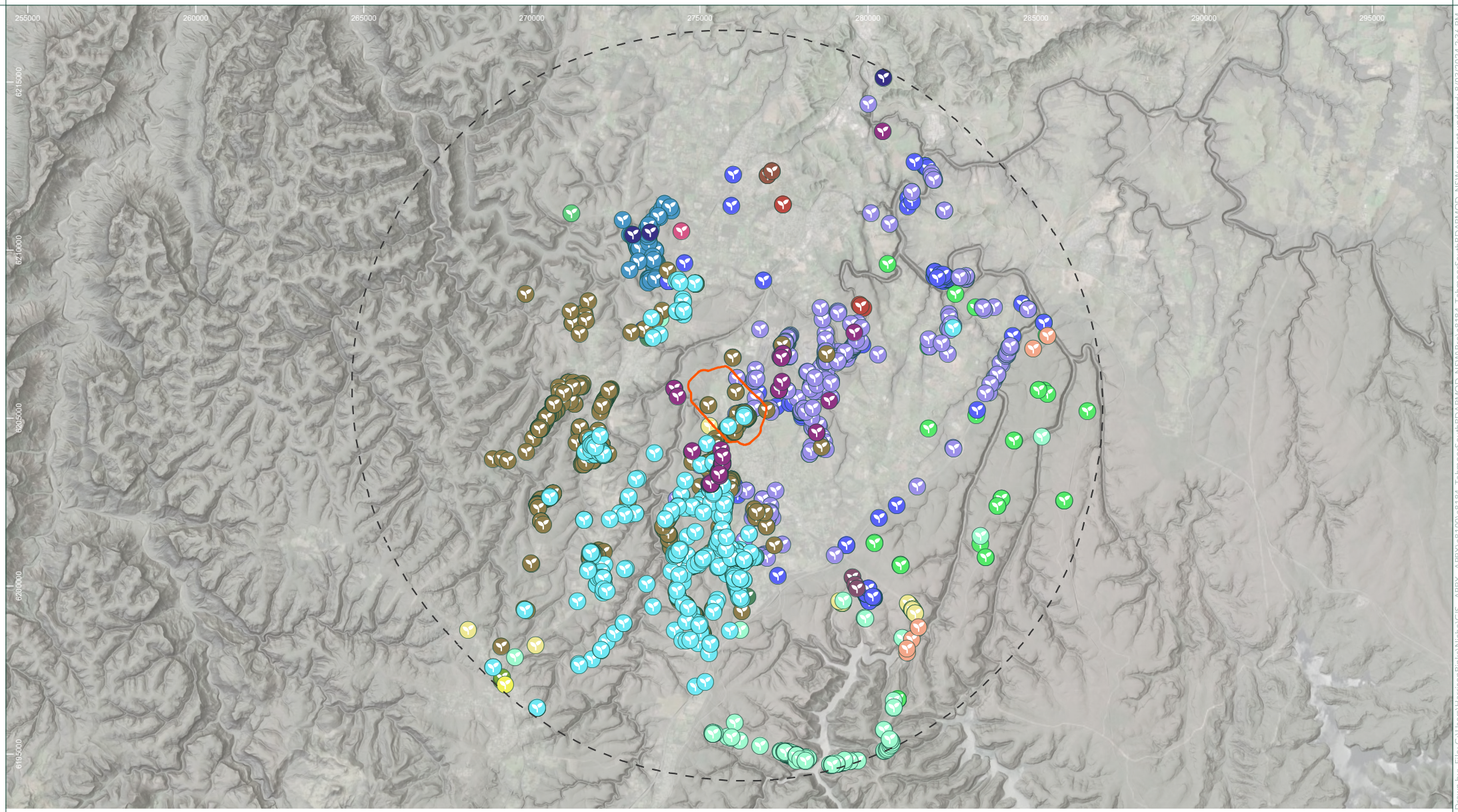


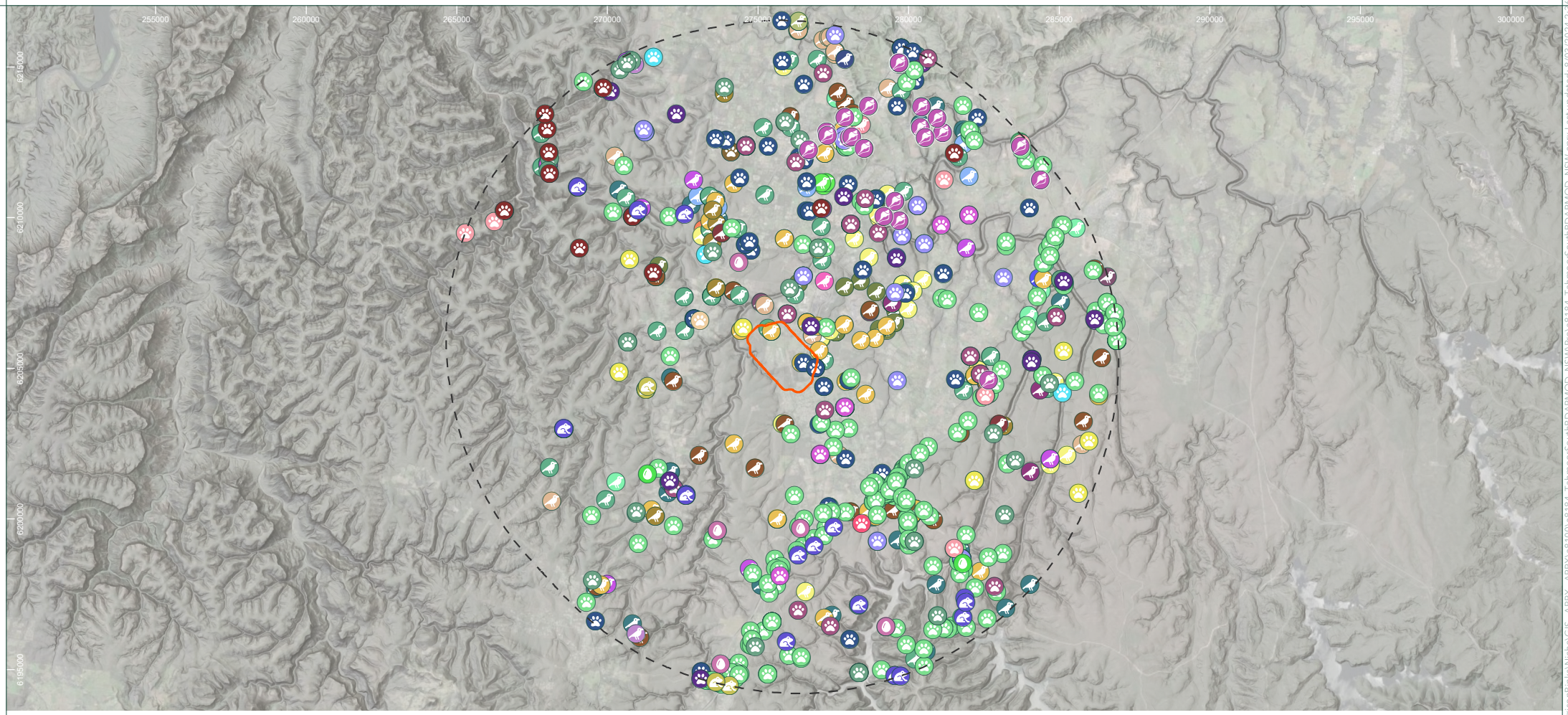

Figure 6

NSW Bionet Atlas threatened species 10km search - Flora

Tahmoor South - Biodiversity Development Assessment Report (Modification 3)

Niche PM: Stephen Bloomfield
Niche Proj. #: 8184
Client: SIMEC Mining

NSW Office of Environment and Heritage's BioNet Atlas, which holds the data from a number of custodians. Data Obtained 13/12/2023. | World Imagery: Earthstar Geographics/ Terrain: Multi-Directional Hillshade: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community | Watercourses, Waterbodies, Road and Rail alignments, Protected areas of NSW © Spatial Services 2021. | Niche uses GDA2020 as standard for all project-related data. In order to ensure that data from numerous sources and coordinate systems is aligned, on-the-fly transformation to GDA2020 MGA Zone 56 is used in the map above. For ease of reference, the grid tick marks and labels shown around the border of the map are presented in GDA2020 MGA Zone 56.




Subject Land

10km buffer

**Threatened Fauna Species (Bionet, 2024)**

Aves

- Australasian Bittern
- Black Falcon
- Black-chinned Honeyeater (eastern subspecies)
- Blue-billed Duck
- Brown Treecreeper (eastern subspecies)
- Bush Stone-curlew
- Diamond Firetail
- Dusky Woodswallow
- Gang-gang Cockatoo
- Little Eagle
- Little Lorikeet
- Masked Owl
- Pilotbird
- Powerful Owl
- Regent Honeyeater
- Scarlet Robin
- Sooty Owl
- Sooty Tern
- South-eastern Glossy Black-Cockatoo
- South-eastern Hooded Robin
- Speckled Warbler
- Square-tailed Kite
- Swift Parrot
- Turquoise Parrot
- Varied Sittella
- White-bellied Sea-Eagle
- White-throated Needletail

Mammalia

- Brush-tailed Rock-wallaby
- Eastern Coastal Free-tailed Bat
- Eastern False Pipistrelle
- Eastern Pygmy-possum
- Greater Broad-nosed Bat
- Grey-headed Flying-fox
- Koala
- Large Bent-winged Bat
- Large-eared Pied Bat
- Little Bent-winged Bat
- Southern Greater Glider
- Southern Myotis
- Spotted-tailed Quoll
- Squirrel Glider
- Yellow-bellied Glider
- Yellow-bellied Sheathtail-bat

Reptilia

- Broad-headed Snake
- Rosenberg's Goanna

Amphibia

- Giant Burrowing Frog
- Red-crowned Toadlet

Gastropoda

- Cumberland Plain Land Snail

Sensitive species not displayed

- Broad-headed Snake
- Gang-gang Cockatoo
- Masked Owl
- Powerful Owl
- Regent Honeyeater
- Sooty Owl
- South-eastern Glossy Black-Cockatoo
- Square-tailed Kite
- Turquoise Parrot

0 3
km

GDA2020 MGA Zone 56

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Niche

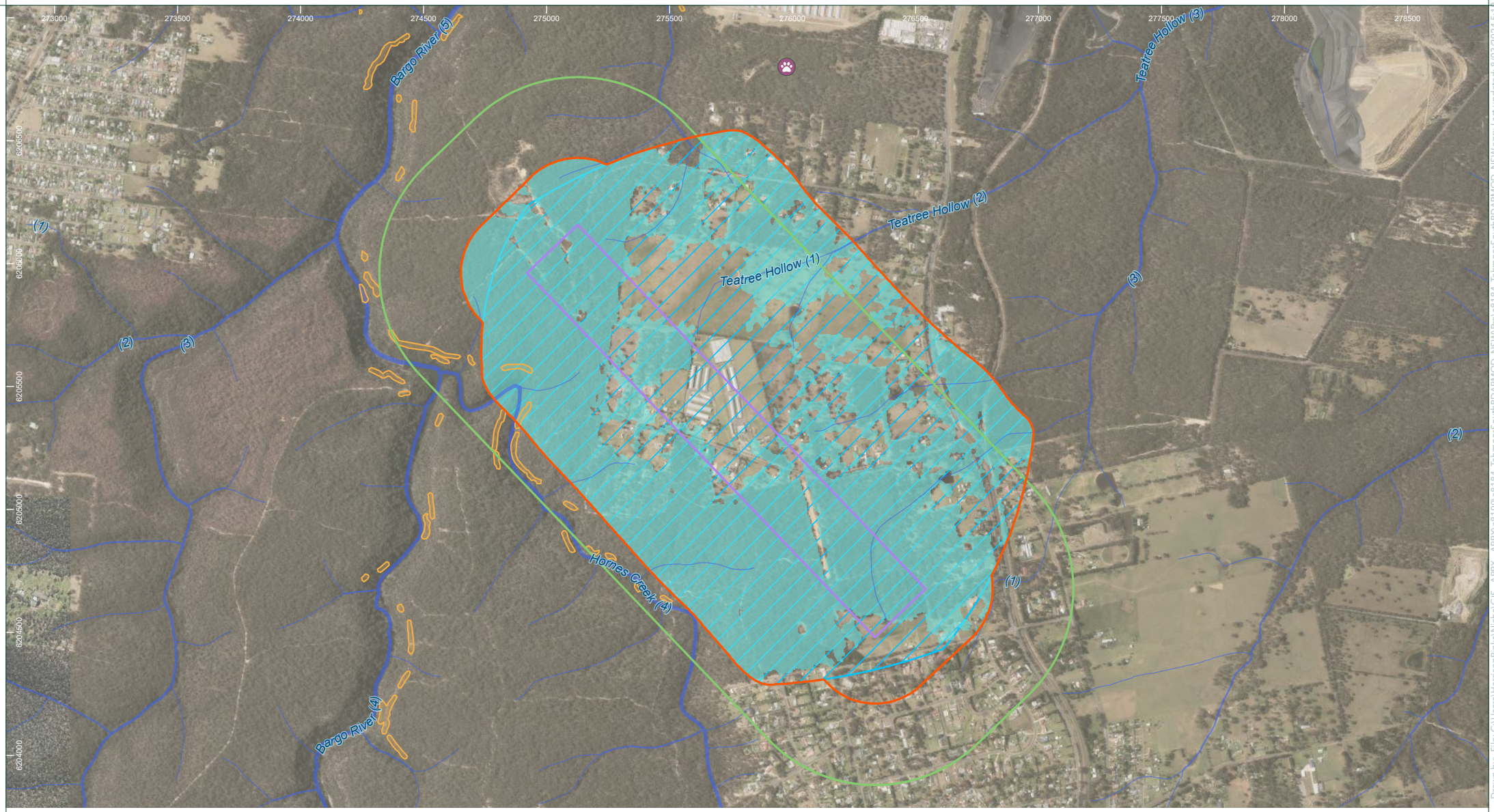
Figure 7

NSW Bionet Atlas threatened species 10km search - Fauna

Tahmoor South - Biodiversity Development Assessment Report (Modification 3)

Niche PM: Stephen Bloomfield
Niche Proj. #: 8184
Client: SIMEC Mining

NSW Office of Environment and Heritage's BioNet Atlas, which holds the data from a number of custodians. Data Obtained 13/12/2023. | World Imagery: Earthstar Geographics/ Terrain: Multi-Directional Hillshade: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community | Watercourses, Waterbodies, Road and Rail alignments, Protected areas of NSW © Spatial Services 2021. | Niche uses GDA2020 as standard for all project-related data. In order to ensure that data from numerous sources and coordinate systems is aligned, on-the-fly transformation to GDA2020 MGA Zone 56 is used in the map above. For ease of reference, the grid tick marks and labels shown around the border of the map are presented in GDA2020 MGA Zone 56.




Subject Land
LW S7A
LW S7A 600m offset boundary
LW S7A predicted 20mm subsidence
Clifflines/overhang areas

Fauna species polygons
Large-eared Pied Bat

Threatened Fauna Records
Bionet
Large-eared Pied Bat

Hydrography
Strahler Stream Order
1
2
3
4
5

0 400
m
GDA2020 MGA Zone 56

Figure 8.1

## Candidate species credit species records & species polygons - Large-eared Pied Bat

Tahmoor South - Biodiversity Development Assessment Report (Modification 3)

Niche PM: Stephen Bloomfield
Niche Proj. #: 8184
Client: SIMEC Mining

public/NSW_Imagery: © Department of Customer Service 2020/ Terrain: Multi-Directional Hillshade: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community | Watercourses, Waterbodies, Road and Rail alignments, Protected areas of NSW © Spatial Services 2021. | Niche uses GDA2020 as standard for all project-related data. In order to ensure that data from numerous sources and coordinate systems is aligned, on-the-fly transformation to GDA2020 MGA Zone 56 is used in the map above. For ease of reference, the grid tick marks and labels shown around the border of the map are presented in GDA2020 MGA Zone 56.

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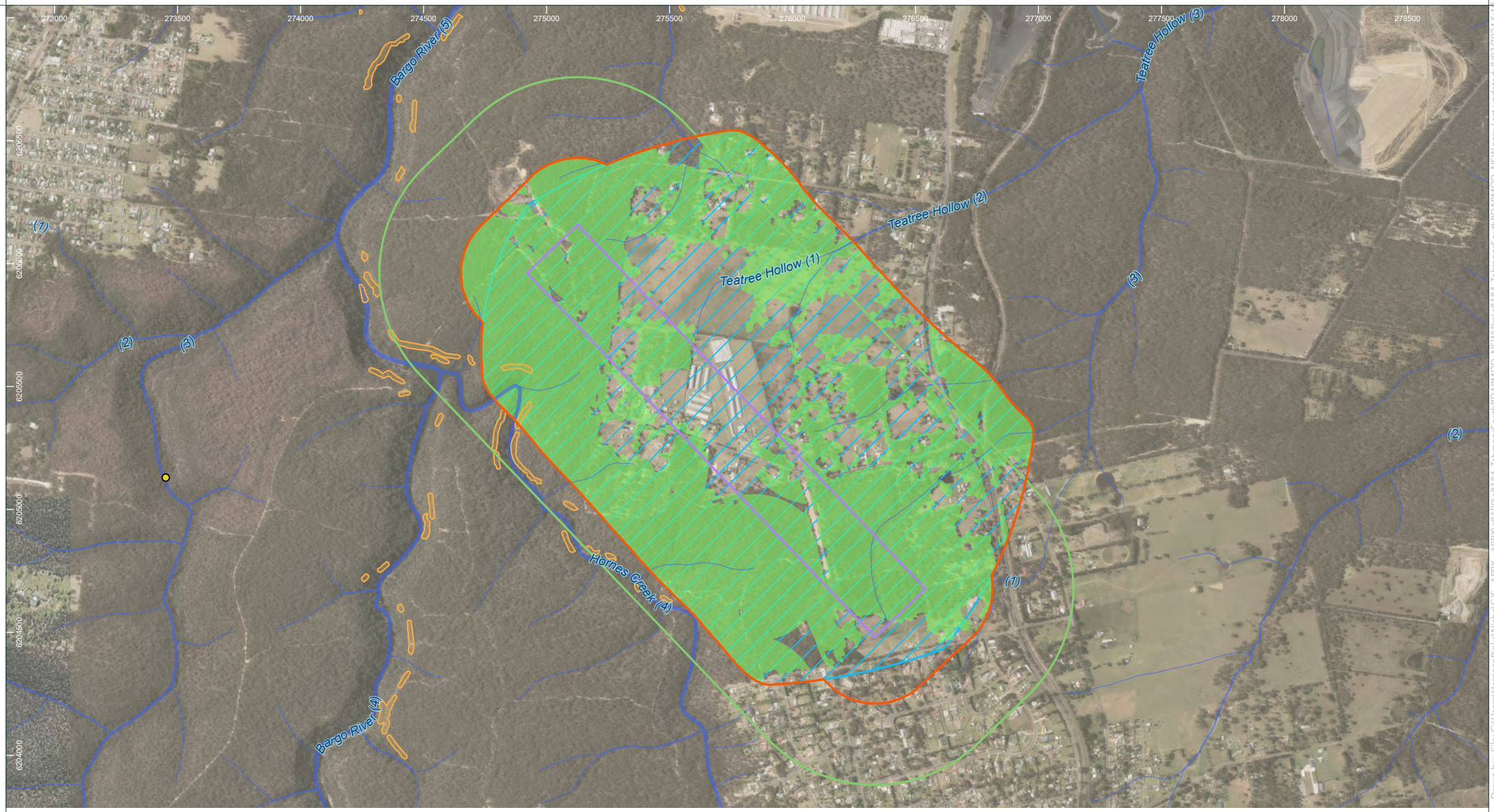


Subject Land
LW S7A
LW S7A 600m offset boundary
LW S7A predicted 20mm subsidence

Clifflines/overhang areas

Fauna species polygons
Giant Burrowing Frog

Threatened Fauna Records
Niche survey records
Giant Burrowing Frog

Hydrography
Strahler Stream Order
1
2
3
4
5

0 400
m
GDA2020 MGA Zone 56

Figure 8.2

Candidate species credit species records & species polygons - Giant Burrowing Frog

Tahmoor South - Biodiversity Development Assessment Report (Modification 3)

Niche PM: Stephen Bloomfield
Niche Proj. #: 8184
Client: SIMEC Mining

public/NSW_Imagery: © Department of Customer Service 2020/ Terrain: Multi-Directional Hillshade: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community | Watercourses, Waterbodies, Road and Rail alignments, Protected areas of NSW © Spatial Services 2021. | Niche uses GDA2020 as standard for all project-related data. In order to ensure that data from numerous sources and coordinate systems is aligned, on-the-fly transformation to GDA2020 MGA Zone 56 is used in the map above. For ease of reference, the grid tick marks and labels shown around the border of the map are presented in GDA2020 MGA Zone 56.

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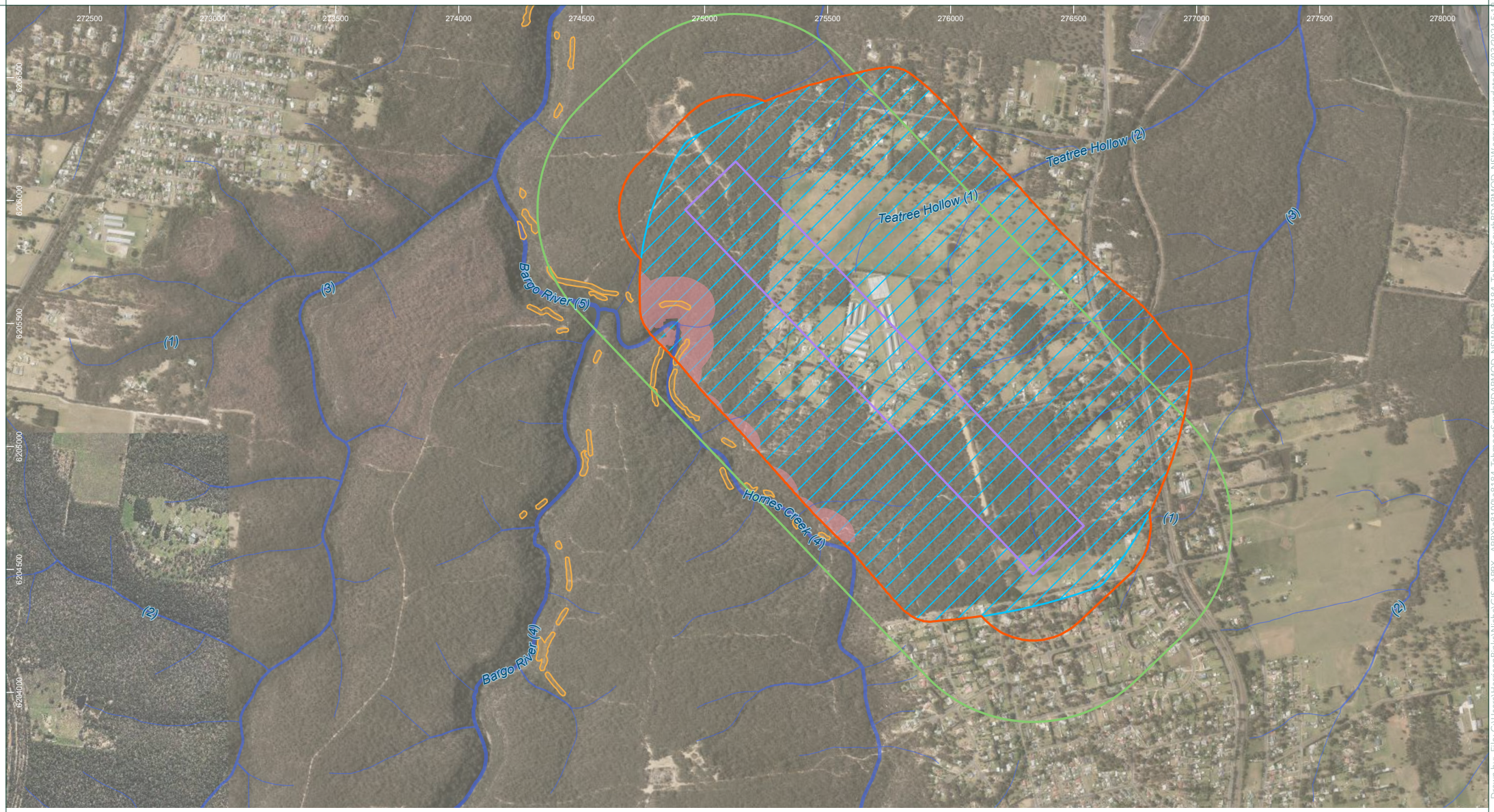


Subject Land
LW S7A
LW S7A 600m offset boundary

LW S7A predicted 20mm subsidence
Clifflines/overhang areas

Fauna species polygons
Broad-headed Snake

Hydrography
Strahler Stream Order
1
2
3
4
5

0 400
m
GDA2020 MGA Zone 56

Figure 8.3

## Candidate species credit species records & species polygons - Broad-headed Snake

Tahmoor South - Biodiversity Development Assessment Report (Modification 3)

Niche PM: Stephen Bloomfield
Niche Proj. #: 8184
Client: SIMEC Mining

public/NSW_Imagery: © Department of Customer Service 2020/ Terrain: Multi-Directional Hillshade: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community | Watercourses, Waterbodies, Road and Rail alignments, Protected areas of NSW © Spatial Services 2021. | Niche uses GDA2020 as standard for all project-related data. In order to ensure that data from numerous sources and coordinate systems is aligned, on-the-fly transformation to GDA2020 MGA Zone 56 is used in the map above. For ease of reference, the grid tick marks and labels shown around the border of the map are presented in GDA2020 MGA Zone 56.

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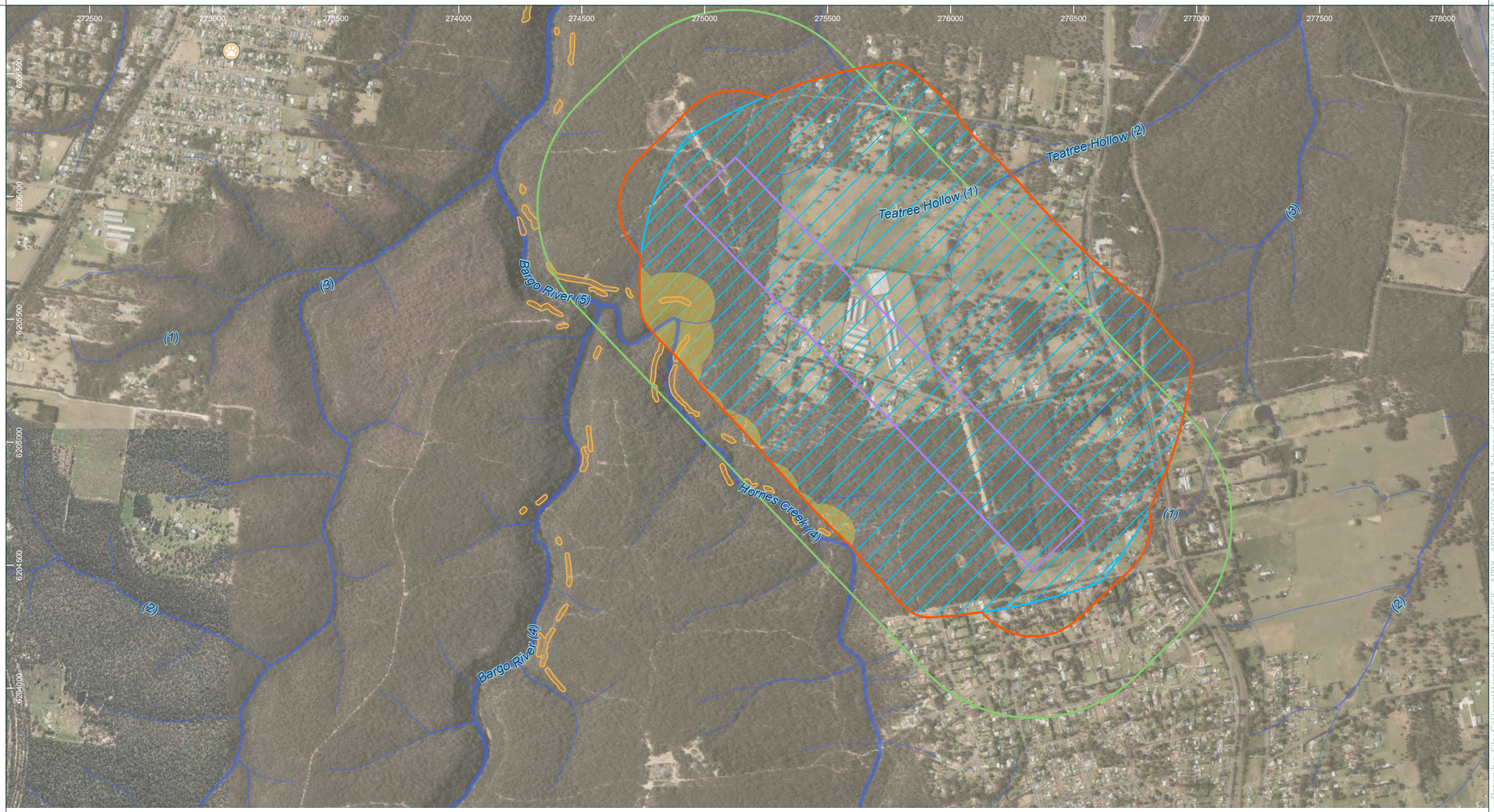


Subject Land
LW S7A
LW S7A 600m offset boundary
LW S7A predicted 20mm subsidence
Clifflines/overhang areas

Fauna species polygons
Little Bent-winged Bat

Threatened Fauna Records
Bionet
Little Bent-winged Bat

Hydrography
Strahler Stream Order
1
2
3
4
5

0 400
m
GDA2020 MGA Zone 56

Figure 8.4

Candidate species credit species records & species polygons - Little Bent-winged Bat

Tahmoor South - Biodiversity Development Assessment Report (Modification 3)

Niche PM: Stephen Bloomfield
Niche Proj. #: 8184
Client: SIMEC Mining

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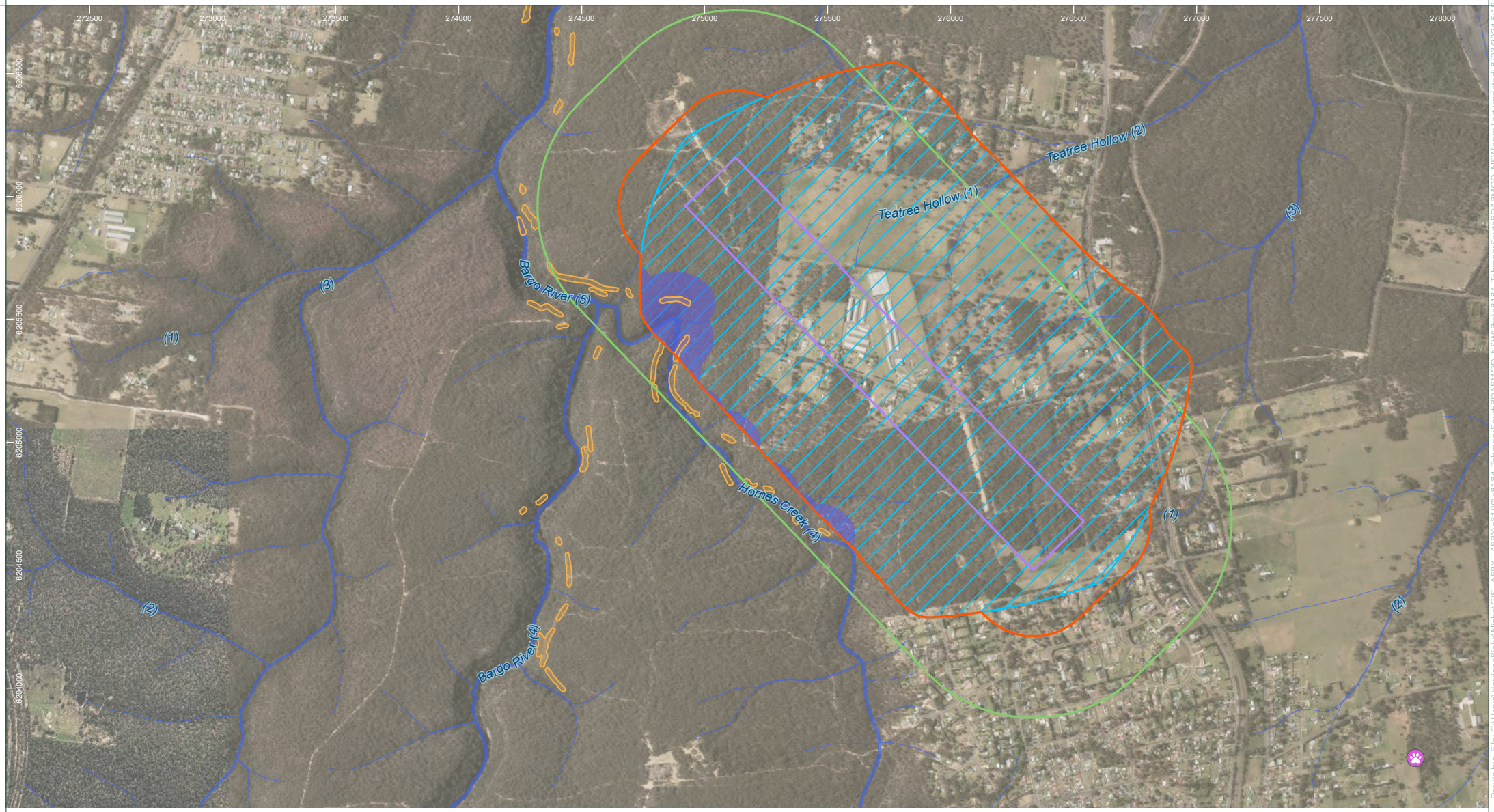


Subject Land
LW S7A
LW S7A 600m offset boundary
LW S7A predicted 20mm subsidence
Clifflines/overhang areas
Fauna species polygons
Large Bent-winged Bat
Threatened Fauna Records
Bionet
Large Bent-winged Bat
Hydrography
Strahler Stream Order
1
2
3
4
5

0 400
m
GDA2020 MGA Zone 56

Figure 8.5

Candidate species credit species records & species polygons - Large Bent-winged Bat

Tahmoor South - Biodiversity Development Assessment Report (Modification 3)

Niche PM: Stephen Bloomfield
Niche Proj. #: 8184
Client: SIMEC Mining

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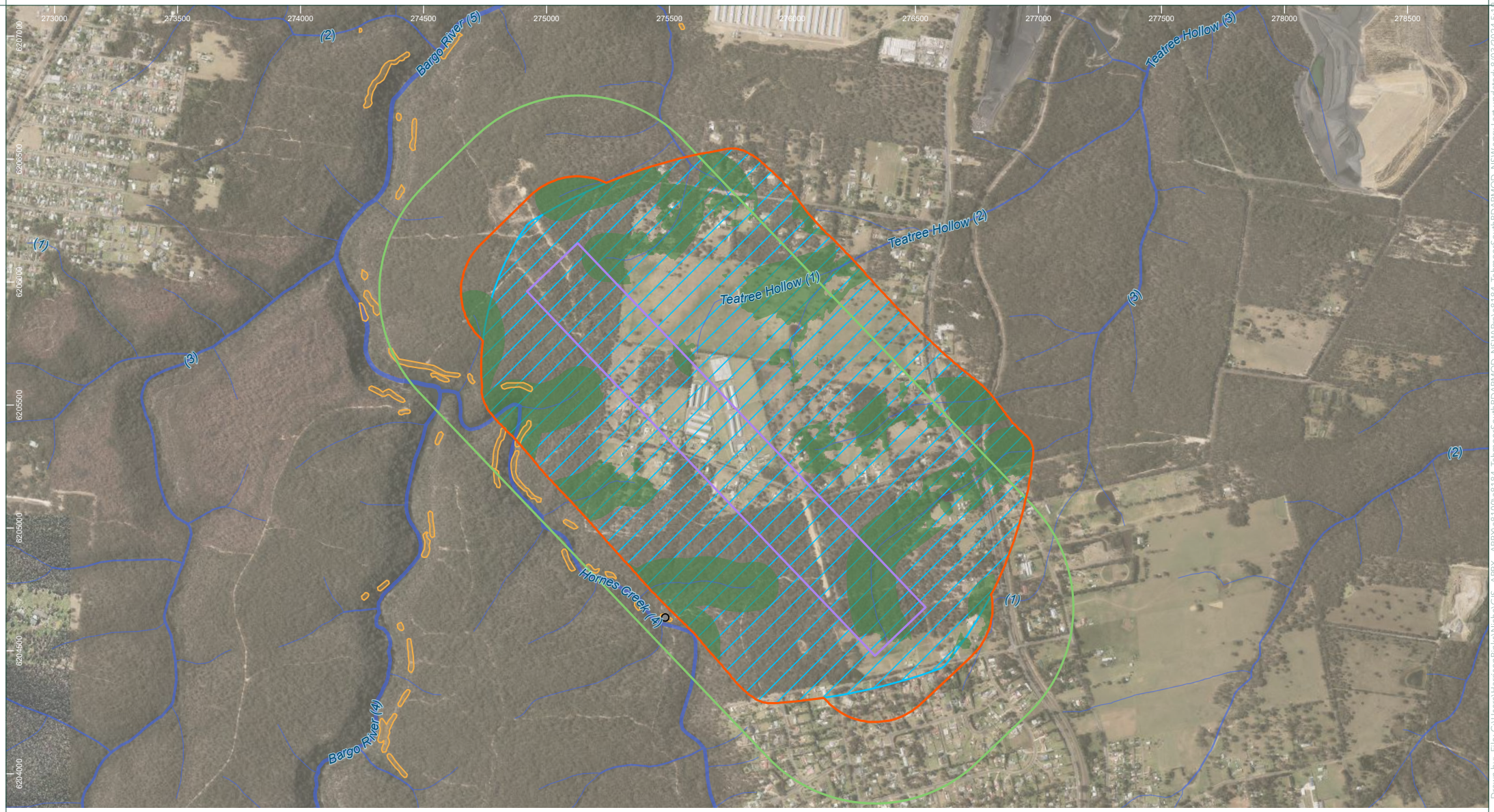


Figure 8.6

## Candidate species credit species records & species polygons - Red-crowned Toadlet

Tahmoor South - Biodiversity Development Assessment Report (Modification 3)

Niche PM: Stephen Bloomfield
Niche Proj. #: 8184
Client: SIMEC Mining

public/NSW_Imagery: © Department of Customer Service 2020/ Terrain: Multi-Directional Hillshade: Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community | Watercourses, Waterbodies, Road and Rail alignments, Protected areas of NSW © Spatial Services 2021. | Niche uses GDA2020 as standard for all project-related data. In order to ensure that data from numerous sources and coordinate systems is aligned, on-the-fly transformation to GDA2020 MGA Zone 56 is used in the map above. For ease of reference, the grid tick marks and labels shown around the border of the map are presented in GDA2020 MGA Zone 56.

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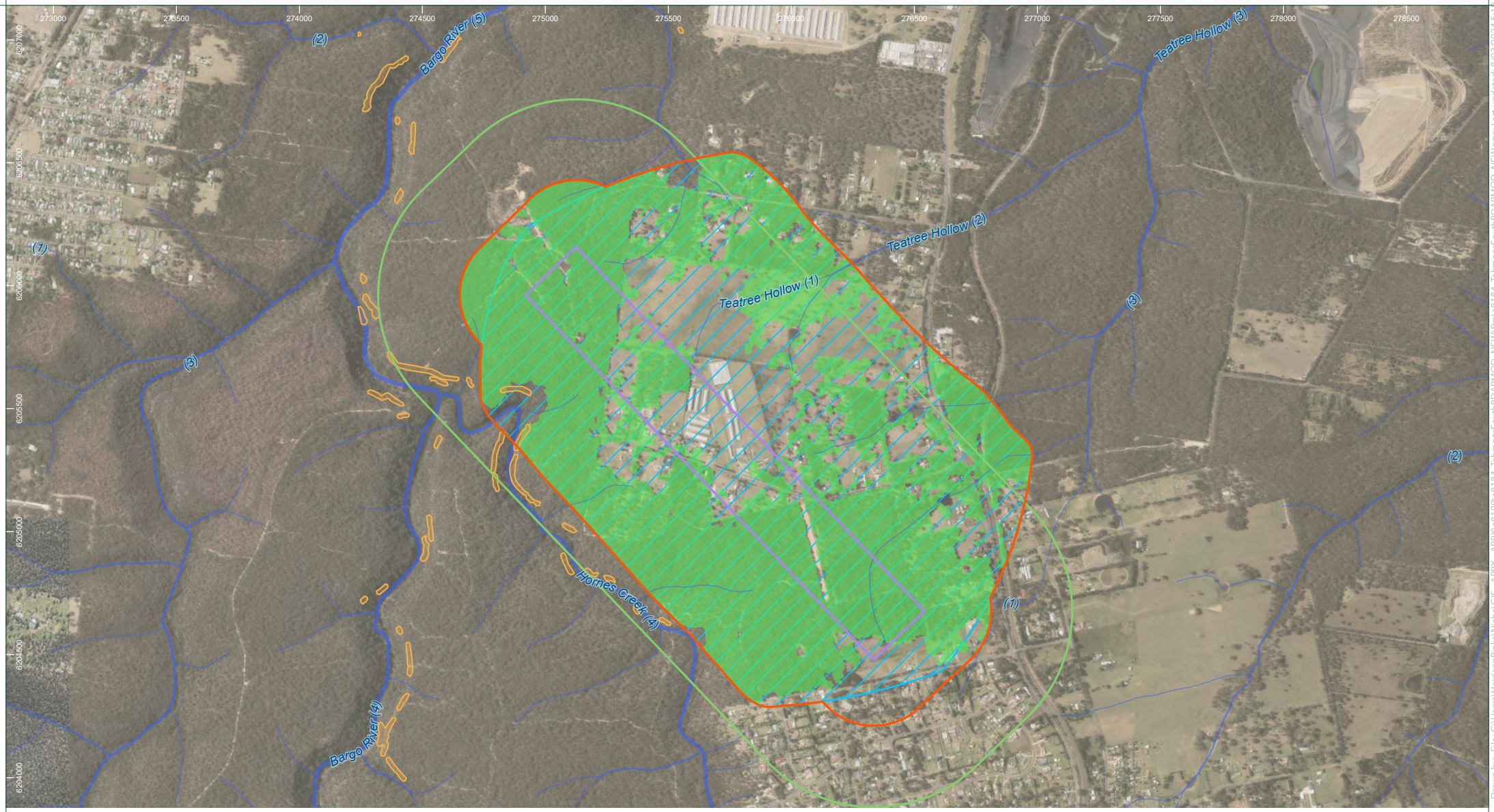


Subject Land
LW S7A
LW S7A 600m offset boundary

LW S7A predicted 20mm subsidence
Clifflines/overhang areas

Flora species polygons
Woronora Beard-heath

Hydrography
Strahler Stream Order
1
2
3
4
5

0 400
m
GDA2020 MGA Zone 56

Figure 8.7

Candidate species credit species records & species polygons - Woronora Beard-heath

Tahmoor South - Biodiversity Development Assessment Report (Modification 3)

Niche PM: Stephen Bloomfield
Niche Proj. #: 8184
Client: SIMEC Mining

Drawn by: File: C:\Users\HarrisonBinks\Niche\GIS - APRX - APRX\a8100\a8184_TahmoorSouthBDARMOD_NSW\Prova8184_TahmoorSouthBDARMOD_NSWaprx Last updated: 8/03/2024 5:19 PM

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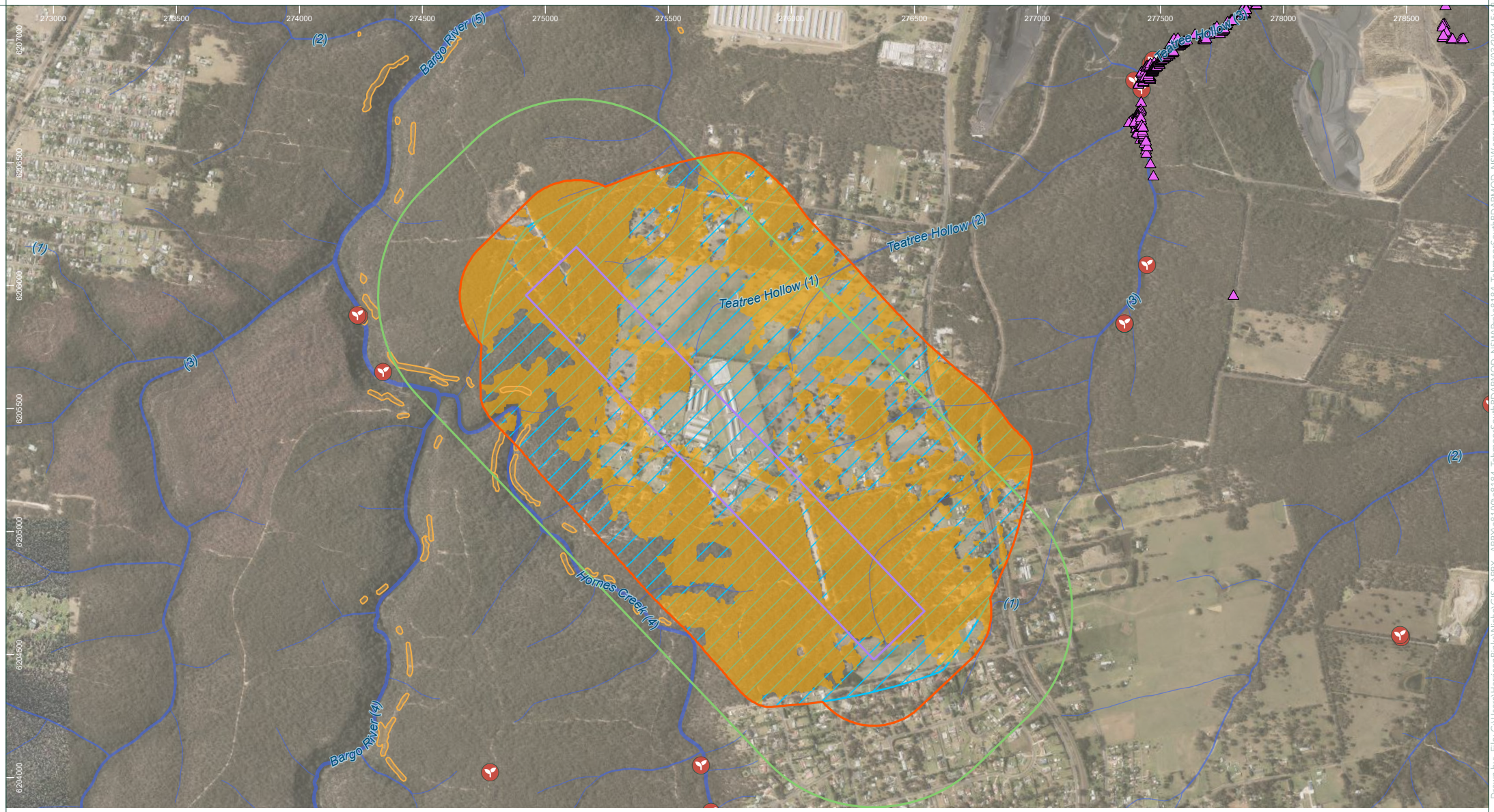


Subject Land
LW S7A
LW S7A 600m offset boundary
LW S7A predicted 20mm subsidence

Clifflines/overhang areas

Flora species polygons
Brown Pomaderris

Threatened Flora Records
Niche survey records
Brown Pomaderris

Bionet
Brown Pomaderris

Hydrography
Strahler Stream Order
1
2
3
4
5

0 400
m
GDA2020 MGA Zone 56

Drawn by: File: C:\Users\HarrisonBinks\Niche\GIS - APRX - APRX\a8100\a8184_TahmoorSouthBDARMOD_NSWProva8184_TahmoorSouthBDARMOD_NSW.aprx Last updated: 8/03/2024 5:19 PM

Figure 8.8

Candidate species credit species records & species polygons - Brown Pomaderris

Tahmoor South - Biodiversity Development Assessment Report (Modification 3)

Niche PM: Stephen Bloomfield
Niche Proj. #: 8184
Client: SIMEC Mining

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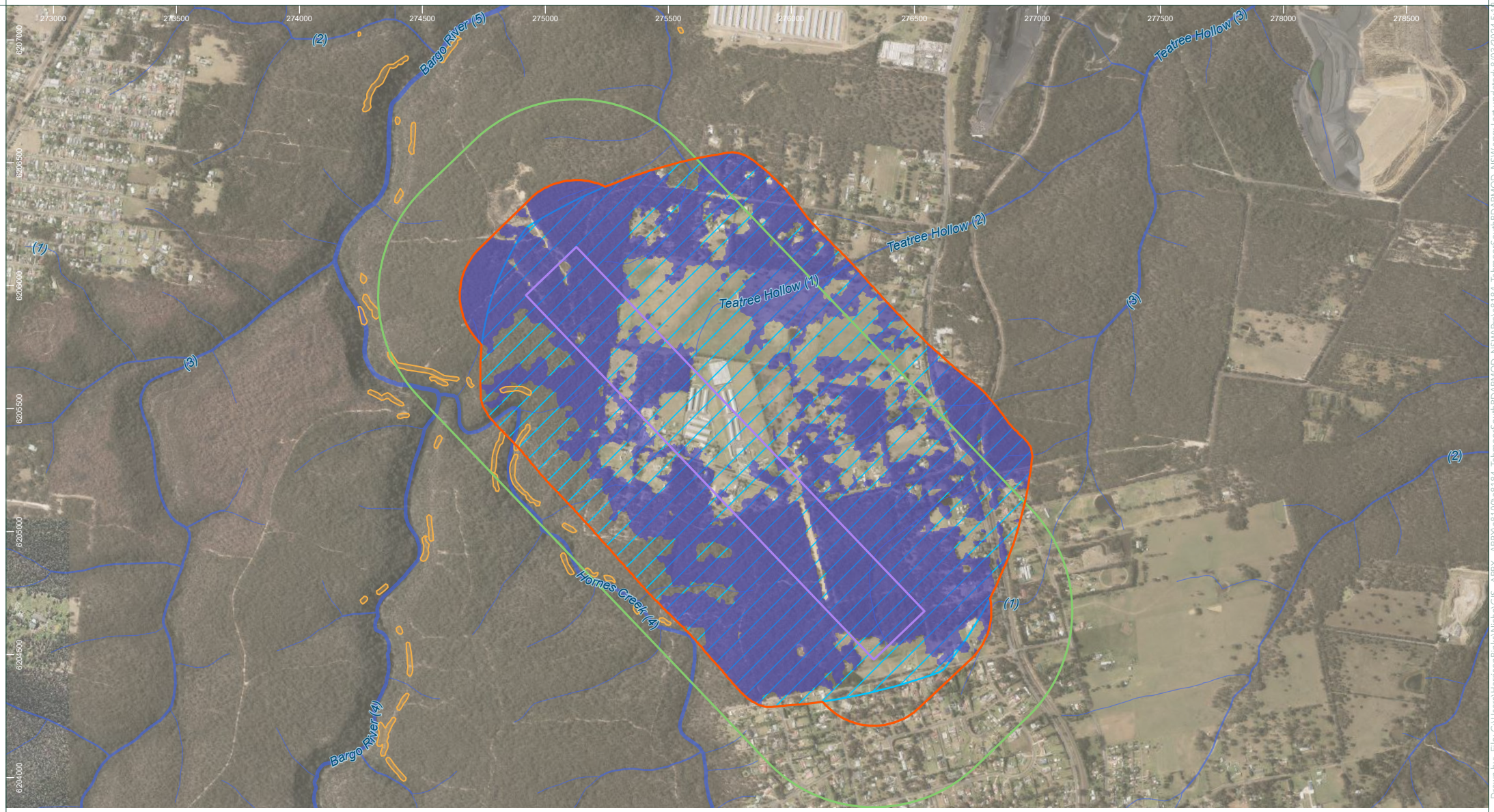


Subject Land
LW S7A
LW S7A 600m offset boundary
LW S7A predicted 20mm subsidence
Clifflines/overhang areas
Flora species polygons
Sydney Plains Greenhood
Hydrography
Strahler Stream Order
1
2
3
4
5

0 400
m
GDA2020 MGA Zone 56

Figure 8.9

Candidate species credit species records & species polygons - Sydney Plains Greenhood

Tahmoor South - Biodiversity Development Assessment Report (Modification 3)

Niche PM: Stephen Bloomfield
Niche Proj. #: 8184
Client: SIMEC Mining

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# Annex 1. Confirmed survey approach - BCD correspondence

| | |
|---|---|
| **From:** | Russell Moule |
| **To:** | Luke Baker; Stephen Bloomfield |
| **Cc:** | James Wearne; Charlie Wheatley; Chris Page |
| **Subject:** | RE: Tahmoor South proposed modification (LWS 7A) - biodiversity assessment pathway |
| **Date:** | Tuesday, 25 July 2023 2:42:56 PM |
| **Attachments:** | image001.png |

Hi Luke,

Thanks for making contact.

For this modification and based on the info provided to date, your below approach for points 1 to 5 seems fine. A few comments to your other below points:
Points 6 & 7 may be accurate – yet we don't yet have the level detail you may have, so can't comment yet.
Point 8 (prescribed impacts) – a reminder to see my 4th bullet point below (you left of the list some e.g. caves, crevices, cliffs, rocks and other geological features of significance).
Point 9 is fine.
Point 10 – please ensure that we also have access to all reports etc (MSEC predication and specialist assessment predictions) that you use for prescribed impact assessment.

Let me know if you feel there is still need to meet to discuss.
Kind regards,

**Russell Moule**
**Senior Conservation Planning Officer**
**Planning (Illawarra)**
**South East Branch**

Biodiversity and Conservation Division | Department of Planning and Environment
**E** russell.moule@environment.nsw.gov.au
Level 3, 84 Crown Street, Wollongong NSW 2500
www.dpie.nsw.gov.au

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**From:** Luke Baker <lbaker@niche-eh.com>
**Sent:** Monday, 24 July 2023 5:48 PM
**To:** Russell Moule <russell.moule@environment.nsw.gov.au>; Stephen Bloomfield <sbloomfield@niche-eh.com>
**Cc:** James Wearne <jwearne@emmconsulting.com.au>; Charlie Wheatley <charlie.wheatley@simecgfg.com>; Chris Page <Chris.Page@environment.nsw.gov.au>
**Subject:** RE: Tahmoor South proposed modification (LWS 7A) - biodiversity assessment pathway

Hi Russell

Thank you for sending through.

Given the history of this particular project, and the nature of the biodiversity assessment, can we

please have a follow up discussion to confirm the approach to the BDAR.

I would specifically like to discuss the approach below, and confirm it would be sufficient in this particular case.

1. Vegetation of the subject site to be based off regional mapping, with some validation within publicly accessible areas. Based on our experience, there would be conservatively estimated to include 5 x PCTs (including Shale Sandstone Transition Forest) that may occur within the subject site. Note: No upland swamps are present.
2. All PCTs within the subject site are assumed to be at benchmark condition. Thus no need for BAM plot collection as assuming best condition.
3. PCTs and benchmark entered into BAM-C to generate species list.
4. All threatened flora species are assumed to be present within the Subject Site – as it will not be possible to survey to the guidelines, nor are experts available.
5. All threatened fauna species are assumed to be present within the Subject Site– as it will not be possible to survey to the guidelines, nor are experts available.
6. Direct impact = nil
7. Indirect impact = nil
8. Prescribed impacts: Of the species assumed present, these to be filtered based on habitat reliance on watercourses, ridgelines, GDEs.
9. Grouped species polygon figures provided for these subject species where prescribed impacts could occur.
10. Prescribed impact assessment: Based off MSEC predication and specialist assessment predictions, these species are assessed accordingly – as per the previous Tahmoor South Project BAR.

If there are any direct or indirect impacts (eg. Rehabilitation impact associated with the REA), than we understand that this would need to confirm specifically with the BAM (ie. plot collection, and threatened species survey).

Are we able to meet this week to discuss? If so, can you please nominate a time for Stephen and I to follow up.

Thanks again Russell

**Luke Baker**
General Manager - Operations
0488 224 008
NSW Head Office – Sydney
Dharug Country
PO Box 2443 North Parramatta NSW 1750

**From:** Russell Moule <russell.moule@environment.nsw.gov.au>
**Sent:** Wednesday, July 19, 2023 4:08 PM
**To:** Stephen Bloomfield <sbloomfield@niche-eh.com>
**Cc:** James Wearne <jwearne@emmconsulting.com.au>; Charlie Wheatley <charlie.wheatley@simecgfg.com>; Luke Baker <lbaker@niche-eh.com>; Chris Page <Chris.Page@environment.nsw.gov.au>
**Subject:** Tahmoor South proposed modification (LWS 7A) - biodiversity assessment pathway

Hi Stephen,

Following on from our meeting yesterday, while there was merit in your suggested approach, we note the *Biodiversity Conservation Act 2016* and the *Biodiversity Conservation (Savings and Transitional) Regulation 2017* requires a Biodiversity Development Assessment Report (BDAR) to be submitted with a modification. See:

- Section 7.17 of the *Biodiversity Conservation Act 2016*
- Section 30 of the *Biodiversity Conservation (Savings and Transitional) Regulation 2017*
- Section 30A of the *Biodiversity Conservation (Savings and Transitional) Regulation 2017*

Where a BDAR is pursued for this proposed modification we note that:

- A BDAR will need to align with the Biodiversity Assessment Method (BAM 2020);
- The BDAR will need to use the revised Plant Community Type (PCT) classification for the NSW coastal and tablelands bioregions as in Bionet Vegetation Classification (note: relevant existing plot data might be used in Plot to PCT Assignment Tool);
- The BDAR will need to include the threatened species associations with the PCT as in Bionet Threatened Biodiversity Data Collection (TBDC);
- As mentioned during the meeting yesterday, a dominant focus of our review will be on prescribed impacts, especially: water bodies, water quality and hydrological processes; and caves, crevices, cliffs, rocks and other geological features of significance (and these impacts to frogs, bats and snake threatened species etc.);
- Our focus for review would also include adaptive management for any uncertain biodiversity impacts;
- Consider if any newly listed threatened species or ecological communities need to be assessed;
- We would also expect to see assessment in the BDAR of any direct/indirect impacts to native vegetation (albeit restored native vegetation) associated with proposed works at the REA (note: a streamlined assessment as per BAM 2020 Appendix D could be an option for planted native vegetation).

Please let me know if you have any questions.
Regards,

**Russell Moule**
**Senior Conservation Planning Officer**
**Planning (Illawarra)**
**South East Branch**

Biodiversity and Conservation Division | Department of Planning and Environment

**E** russell.moule@environment.nsw.gov.au
Level 3, 84 Crown Street, Wollongong NSW 2500
www.dpie.nsw.gov.au

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# Annex 2. Plant community descriptions

| PCT 3598 – Woronora Plateau Scribbly Gum Woodland | |
|---|---|
| **PCT ID** | 3598 |
| **PCT name** | Woronora Plateau Scribbly Gum Woodland |
| **Vegetation formation** | Dry Sclerophyll Forests (Shrubby sub-formation) |
| **Vegetation class** | Sydney Coastal Dry Sclerophyll Forests |
| **Per cent cleared value (%)** | 4.28 |
| **Extent within development footprint (ha)** | 20.49 |
| **Conservation status** | This PCT is not associated with any TEC listed under the BC or EPBC Acts. |
| **Justification of PCT selection** | PCT 3598 is described as a mid-high to tall heathy sclerophyll open forest or woodland (DPE 2023b). Within the Subject Land, PCT 3598 was dominated by *Eucalyptus piperita* with *Eucalyptus racemosa* also commonly present. This is consistent with the description and the species listed as frequently occurring in PCT 3598.<br>Within PCT 3598 in the Subject Land, there is a mid-dense shrub layer which is dominated by *Banksia serrata*, *Lambertia formosa*, *Persoonia levis* and *Petrophile sessilis*. All these species are consistent with the description of PCT 3598, with many listed as frequently occurring.<br>The lower stratum of PCT 3598 within the Subject Land is also consistent with the description of the PCT. The ground cover is characterised by an open cover of graminoids and grasses including *Lomandra obliqua* and *Cyathochaeta diandra*.<br>Furthermore, PCT 3598 is mapped within the Subject Land by the SVTM and its position within the Subject Land also matches the landscape position of the PCT description which is described as being found on broad Hawkesbury Sandstone ridges across the Woronora and eastern Nattai plateaus in southern Sydney (DPE 2023b).<br>It was therefore determined that PCT 3598 is the best fit PCT due to the presence of characteristic species including canopy species, vegetation structure and landscape position. |
| **RDP Photo** | |

| PCT 3611 – Nattai Plateau Bloodwood-Peppermint Forest | |
|---|---|
| **PCT ID** | 3611 |
| **PCT name** | Nattai Plateau Bloodwood-Peppermint Forest |
| **Vegetation formation** | Dry Sclerophyll Forest (Shrubby sub-formation) |
| **Vegetation class** | Sydney Hinterland Dry Sclerophyll Forests |
| **Per cent cleared value (%)** | 2.47 |
| **Extent within development footprint (ha)** | 1.62 |
| **Conservation status** | This PCT is not associated with any TEC listed under the BC or EPBC Acts. |
| **Justification of PCT selection** | PCT 3611 is described as a tall to very tall dry sclerophyll open forest.<br>PCT 3611 is also mapped within the Subject Land by the SVTM and its position within the Subject Land also matches the landscape position of the PCT description which is described as being found on the broad Hawkesbury Sandstone ridges and exposed upper slopes of the Nattai, Wanganderry and Burragorang tablelands in the southern Blue Mountains (DPE 2023b).<br>It was therefore determined that PCT 3611 is the best fit PCT due to the presence of characteristic species including canopy species, vegetation structure and landscape position. |
| **RDP Photo** | n/a |

| PCT 3614 – Southern Highlands Sandstone Peppermint Forest | |
|---|---|
| **PCT ID** | 3614 |
| **PCT name** | Southern Highlands Sandstone Peppermint Forest |
| **Vegetation formation** | Dry Sclerophyll Forest (Shrubby sub-formation) |
| **Vegetation class** | Sydney Hinterland Dry Sclerophyll Forests |
| **Per cent cleared value (%)** | 7.62 |
| **Extent within development footprint (ha)** | 2.72 |
| **Conservation status** | This PCT is not associated with any TEC listed under the BC or EPBC Acts. |
| **Justification of PCT selection** | Within the Subject Land, PCT 3614 was present as a tall dry shrubby sclerophyll open forest (DPE 2023b). The canopy was dominated by *Eucalyptus piperita* which is consistent with the description of PCT 3614.<br><br>The understorey consisted of species such as *Hardenbergia violacea* and *Cassytha glabella* both consist with frequently occurring species in PCT 3614.<br><br>PCT 3614 is also mapped within the Subject Land by the SVTM and its position within the Subject Land also matches the landscape position of the PCT description which is described as being found on semi-sheltered slopes on Hawkesbury Sandstone at the elevated southern ends of the Woronora and Nattai tablelands (DPE 2023b).<br><br>It was therefore determined that PCT 3614 is the best fit PCT due to the presence of characteristic species including canopy species, vegetation structure and landscape position. |
| **RDP Photo** | n/a |

| PCT 3616 – Sydney Hinterland Grey Gum Transition Forest | |
|---|---|
| **PCT ID** | 3616 |
| **PCT name** | Sydney Hinterland Grey Gum Transition Forest |
| **Vegetation formation** | Dry Sclerophyll Forest (Shrubby sub-formation) |
| **Vegetation class** | Sydney Hinterland Dry Sclerophyll Forests |
| **Per cent cleared value (%)** | 61.88 |
| **Extent within development footprint (ha)** | 24.14 |
| **Conservation status** | This PCT is not associated with any TEC listed under the BC or EPBC Acts. |
| **Justification of PCT selection** | Within the Subject Land, PCT 3616 was present as a tall shrubby sclerophyll woodland with a with a sparse low shrub layer. The canopy was dominated by *Eucalyptus punctata, Corymbia gummifera , Eucalyptus eugenioides* and *Allocasuarina littorallis.* This is consistent with the description and the species listed as frequently occurring in PCT 3616 (DPE 2023b).<br><br>The shrub layer consisted of *Pimelea linifolia, Kunzea ambigua, Acacia terminalis* and *Hakea sericea*. The species present in the shrub layer are all associated with PCT 3616.<br><br>The ground layer of PCT 3616 within the Subject Land was dominated by *Aristida vagans* and *Austrostipa pubescens.* Both of these species are consistent with the PCT 3616 description and are described as commonly occurring.<br><br>Furthermore, PCT 3616 is mapped within the Subject Land by the SVTM and its position within the Subject Land also matches the landscape position of the PCT description which is described as being found on enriched Hawkesbury sandstone ridges around the Sydney area (DPE 2023b).<br><br>It was therefore determined that PCT 3616 is the best fit PCT due to the presence of characteristic species including canopy species, vegetation structure and landscape position. |
| **RDP Photo** | |

| PCT 3618 – Sydney Hinterland Sandflat Peppermint Forest | |
|---|---|
| **PCT ID** | 3618 |
| **PCT name** | Sydney Hinterland Grey Gum Transition Forest |
| **Vegetation formation** | Dry Sclerophyll Forest (Shrubby sub-formation) |
| **Vegetation class** | Sydney Hinterland Dry Sclerophyll Forests |
| **Per cent cleared value (%)** | 14.22 |
| **Extent within development footprint (ha)** | 1.27 |
| **Conservation status** | This PCT is not associated with any TEC listed under the BC or EPBC Acts. |
| **Justification of PCT selection** | Within the Subject Land, PCT 3618 was present as a tall sclerophyll open forest (DPE 2023b). The canopy was dominated by *Eucalyptus piperita,* which aligns with the PCT 3618 description.<br><br>The midstorey in the Subject Land occurred as a lower sparse dry shrub layer and contained species characteristic of PCT 3618. The midstorey species included, *Acacia longifolia, Acacia parramattensis, Acacia floribunda* and *Callicoma serratifolia*.<br><br>The ground cover is strongly characterised by a high frequency of grasses, graminoids, ferns and forbs. The ground cover present within the Subject Land included *Pteridium esculentum* and *Lomandra longifolia* which are both species that are strongly characteristic of PCT 3618. The ground cover also included species that occur in high frequency in PCT 3618, *Adiantum aethiopicum* and *Schoenus melanostachys*.<br><br>PCT 3618 is also mapped within the Subject Land by the SVTM and its position within the Subject Land also matches the landscape position of the PCT description which is described as being found along creeks near Thirlmere along the edge of the sandstone plateau in the south-west of Sydney(DPE 2023b).<br><br>It was therefore determined that PCT 3618 is the best fit PCT due to the presence of characteristic species including canopy species, vegetation structure and landscape position. |
| **RDP Photo** | |

| PCT 3619 – Sydney Hinterland Enriched Sandstone Bloodwood Forest | |
|---|---|
| **PCT ID** | 3619 |
| **PCT name** | Sydney Hinterland Enriched Sandstone Bloodwood Forest |
| **Vegetation formation** | Dry Sclerophyll Forest (Shrubby sub-formation) |
| **Vegetation class** | Sydney Hinterland Dry Sclerophyll Forests |
| **Per cent cleared value (%)** | 25.41 |
| **Extent within development footprint (ha)** | 185.72 |
| **Conservation status** | This PCT is not associated with any TEC listed under the BC or EPBC Acts. |
| **Justification of PCT selection** | PCT 3619 was found within the Subject Land in the form of a tall shrubby sclerophyll open forest. The canopy was made up of *Corymbia gummifera, Eucalyptus globoidea* and *Eucalyptus racemosa.* This is consistent with canopy and structure of PCT 3616 which is described as a tall, rarely very tall, shrubby sclerophyll open forest or woodland. The tree canopy is described as frequently includes a higher cover of *Corymbia gummifera* together with one or more stringybark eucalyptus such as *Eucalyptus globoidea*. These species may also be occasionally accompanied by species of scribbly gum such as *Eucalyptus racemosa* (DPE 2023b).<br><br>The midstratum was reflective of the PCT 3619 description and included species such as *Acacia linifolia, Persoonia levis, Lambertia formosa, Lomatia silaifolia* and *Isopogon anemonifolius*.<br><br>The dominant species in the ground layer consisted of *Cyathochaeta diandra*, *Cassytha glabella* and *Patersonia sericea*. C*yarhochaeta diandra* is a ground species characteristic of PCT 3619 and all three of these species are found to frequently occur in PCT 3619.<br><br>PCT 3619 is also mapped within the Subject Land by the SVTM and its position within the Subject Land also matches the landscape position of the PCT description which is described as being found on exposed, slightly enriched Hawkesbury sandstone ridges on the margins of the Cumberland plain, western and south-western Sydney (DPE 2023b).<br><br>PCT 3619 is the best fit PCT due to the presence of characteristic species including canopy species, vegetation structure and landscape position. |
| **RDP Photo** | |

## Annex 3. Flora species recorded (RDPs)

| Scientific name | Common Name |
|---|---|
| *Acacia brownii* | Heath wattle |
| *Acacia decurrens* | Black wattle |
| *Acacia elata* | Cedar wattle |
| *Acacia floribunda* | White sally wattle |
| *Acacia linearifolia* | Narrow-leaved wattle |
| *Acacia linifolia* | White wattle |
| *Acacia longifolia* | Long-leaved wattle |
| *Acacia myrtifolia* | Mrytle wattle |
| *Acacia parramattensis* | Parramatta wattle |
| *Acacia spp.* | |
| *Acacia terminalis* | Sunshine wattle |
| *Acacia terminalis subsp. angustifolia* | Sunshine wattle |
| *Acacia ulicifolia* | Prickly moses |
| *Allocasuarina littoralis* | Black she-oak |
| *Aristida vagans* | Threeawn speargrass |
| *Banksia ericifolia* | Lantern banksia |
| *Banksia serrata* | Old man banksia |
| *Banksia spinulosa* | Hairpin banksia |
| *Baumea spp.* | |
| *Bossiaea obcordata* | Spiny bossiaea |
| *Callicoma serratifolia* | Silver-leaf butterwood |
| *Callistemon salignus* | Willow bottlebrush |
| *Callistemon spp.* | |
| *Calochlaena dubia* | Soft bracken |
| *Cassytha glabella* | Slender devil's twine |
| *Caustis flexuosa* | Curly wig |
| *Ceratopetalum gummiferum* | Christmas bush |
| *Comesperma ericinum* | Heath milkwort |
| *Conospermum taxifolium* | Variable smoke-bush |
| *Corymbia gummifera* | Red bloodwood |
| *Daviesia corymbosa* | Narrow leaf bitter pea |
| *Dillwynia parvifolia* | Small parrot-pea |
| *Epacris microphylla* | Coral heath |
| *Epacris pulchella* | Wallum heath |
| *Eriostemon australasius* | Pink wax flower |

| Scientific name | Common Name |
|---|---|
| *Eucalyptus eugenioides* | Thin-leaved stringybark |
| *Eucalyptus globoidea* | White stringybark |
| *Eucalyptus piperita* | Sydney peppermint |
| *Eucalyptus punctata* | Grey gum |
| *Eucalyptus racemosa* | Narrow-leaved scribbly gum |
| *Eucalyptus sieberi* | Silvertop ash |
| *Eucalyptus spp.* | |
| *Gompholobium grandiflorum* | Golden glory peas |
| *Grevillea sericea* | Silky grevillea |
| *Grevillea sphacelata* | Grey spider flower |
| *Grevillea spp.* | |
| *Hakea dactyloides* | Finger hakea |
| *Hakea sericea* | Silky hakea |
| *Hardenbergia violacea* | False sarsaparilla |
| *Isopogon anemonifolius* | Broad-leaved drumsticks |
| *Kunzea ambigua* | Tick bush |
| *Kunzea ericoides* | Kanuka |
| *Lambertia formosa* | Mountain devil |
| *Lambertia spp.* | |
| *Lasiopetalum ferrugineum* | Rusty velvet-bush |
| *Lepidosperma laterale* | Variable swordsedge |
| *Leptospermum arachnoides* | Spidery tea-tree |
| *Leptospermum polygalifolium* | Tantoon |
| *Lepyrodia scariosa* | Chaffy scale-rush |
| *Lomandra longifolia* | Spiny-head mat-rush |
| *Lomandra obliqua* | Twisted mat-rush |
| *Lomatia myricoides* | River lomatia |
| *Lomatia silaifolia* | Crinkle bush |
| *Mirbelia rubiifolia* | Heathy mirbelia |
| *Persoonia bargoensis* | Bargo geebung |
| *Persoonia levis* | Broad-leaved geebung |
| *Persoonia linearis* | Narrow-leaved geebung |
| *Petrophile sessilis* | Conesticks |
| *Pimelea linifolia* | Slender rice flower |
| *Platysace lanceolata* | Shrubby platysace |
| *Platysace linearifolia* | Carrot tops |
| *Pomaderris spp.* | |

| Scientific name | Common Name |
|---|---|
| *Pteridium esculentum* | Bracken fern |
| *Pteridium spp.* | |
| *Pultenaea blakelyi* | Blakely's pea bush |
| *Pultenaea villosa* | Hairy bush-pea |
| *Schoenus melanostachys* | Black bog-rush |
| *Styphelia triflora* | Pink five-corners |
| *Todea barbara* | King fern |
| *Xanthorrhoea spp.* | |
| *Xanthosia pilosa* | Woolly xanthosia |
| *Xylomelum pyriforme* | Woody pear |

# Annex 4. Ecosystem and species credits required (BAM-C Credit report)

# BAM Biodiversity Credit Report (Like for like)

## Proposal Details

Assessment Id
00045900/BAAS18054/24/00045901

Proposal Name
Tahmoor South BDAR Modification - with candidate species obligation

BAM data last updated *
14/03/2024

Assessor Name
Stephen M Bloomfield

Assessor Number
BAAS18054

BAM Data version *
67

Proponent Names

Report Created
17/05/2024

BAM Case Status
Finalised

Assessment Revision
3

Assessment Type
Major Projects

Date Finalised
17/05/2024

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

## Potential Serious and Irreversible Impacts

| Name of threatened ecological community | Listing status | Name of Plant Community Type/ID |
|---|---|---|
| **Nil** | | |

| Species |
|---|
| **Nil** |

## Additional Information for Approval

PCT Outside Ibra Added

None added

PCTs With Customized Benchmarks

| PCT |
| --- |
| No Changes |

Predicted Threatened Species Not On Site

| Name |
| --- |
| No Changes |

## Ecosystem Credit Summary (Number and class of biodiversity credits to be retired)

| Name of Plant Community Type/ID | Name of threatened ecological community | Area of impact | HBT Cr | No HBT Cr | Total credits to be retired |
| --- | --- | --- | --- | --- | --- |
| 3598-Woronora Plateau Scribbly Gum Woodland | Not a TEC | 0.0 | 1 | 0 | 1 |
| 3619-Sydney Hinterland Enriched Sandstone Bloodwood Forest | Not a TEC | 0.0 | 1 | 0 | 1 |
| 3616-Sydney Hinterland Grey Gum Transition Forest | Not a TEC | 0.0 | 1 | 0 | 1 |
| 3618-Sydney Hinterland Sandflat Peppermint Forest | Not a TEC | 0.0 | 1 | 0 | 1 |
| 3611-Nattai Plateau Bloodwood-Peppermint Forest | Not a TEC | 0.0 | 1 | 0 | 1 |
| 3614-Southern Highlands Sandstone Peppermint Forest | Not a TEC | 0.0 | 1 | 0 | 1 |

**3598-Woronora Plateau Scribbly Gum Woodland**

**Like-for-like credit retirement options**

| Class | Trading group | Zone | HBT | Credits | IBRA region |
|---|---|---|---|---|---|
| Sydney Coastal Dry Sclerophyll Forests This includes PCT's: 1681, 3578, 3579, 3580, 3581, 3582, 3583, 3584, 3585, 3586, 3587, 3588, 3589, 3590, 3591, 3592, 3593, 3594, 3595, 3596, 3597, 3598 | Sydney Coastal Dry Sclerophyll Forests <50% | 3598_High | Yes | 1 | Cumberland, Burragorang, Pittwater, Sydney Cataract, Wollemi and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site. |

**3611-Nattai Plateau Bloodwood-Peppermint Forest**

**Like-for-like credit retirement options**

| Class | Trading group | Zone | HBT | Credits | IBRA region |
|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| | Sydney Hinterland Dry Sclerophyll Forests This includes PCT's: 612, 621, 624, 1614, 1631, 1666, 1667, 3599, 3600, 3601, 3602, 3603, 3604, 3605, 3606, 3607, 3608, 3609, 3610, 3611, 3612, 3613, 3614, 3615, 3616, 3617, 3618, 3619, 3620, 3621, 3622, 3623, 3625, 3626, 3627 | Sydney Hinterland Dry Sclerophyll Forests <50% | 3611_High | Yes | 1 | Cumberland, Burragorang, Pittwater, Sydney Cataract, Wollemi and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site. |

| **3614-Southern Highlands Sandstone Peppermint Forest** | **Like-for-like credit retirement options** | | | | | |
|---|---|---|---|---|---|---|
| | Class | Trading group | Zone | HBT | Credits | IBRA region |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Sydney Hinterland Dry Sclerophyll Forests This includes PCT's: 612, 621, 624, 1614, 1631, 1666, 1667, 3599, 3600, 3601, 3602, 3603, 3604, 3605, 3606, 3607, 3608, 3609, 3610, 3611, 3612, 3613, 3614, 3615, 3616, 3617, 3618, 3619, 3620, 3621, 3622, 3623, 3625, 3626, 3627 | Sydney Hinterland Dry Sclerophyll Forests <50% | 3614_high | Yes | 1 | Cumberland, Burragorang, Pittwater, Sydney Cataract, Wollemi and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site. |

| **3616-Sydney Hinterland Grey Gum Transition Forest** | **Like-for-like credit retirement options** | | | | | |
|---|---|---|---|---|---|---|
| | Class | Trading group | Zone | HBT | Credits | IBRA region |
| | Sydney Hinterland Dry Sclerophyll Forests This includes PCT's: 621, 3609, 3616 | Sydney Hinterland Dry Sclerophyll Forests >=50% and <70% | 3616_High | Yes | 1 | Cumberland, Burragorang, Pittwater, Sydney Cataract, Wollemi and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site. |

**3616-Sydney Hinterland Grey Gum Transition Forest**

**3618-Sydney Hinterland Sandflat Peppermint Forest**

**Like-for-like credit retirement options**

| Class | Trading group | Zone | HBT | Credits | IBRA region |
|---|---|---|---|---|---|
| Sydney Hinterland Dry Sclerophyll Forests This includes PCT's: 612, 621, 624, 1614, 1631, 1666, 1667, 3599, 3600, 3601, 3602, 3603, 3604, 3605, 3606, 3607, 3608, 3609, 3610, 3611, 3612, 3613, 3614, 3615, 3616, 3617, 3618, 3619, 3620, 3621, 3622, 3623, 3625, 3626, 3627 | Sydney Hinterland Dry Sclerophyll Forests <50% | 3618_High | Yes | 1 | Cumberland, Burragorang, Pittwater, Sydney Cataract, Wollemi and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site. |

**3619-Sydney Hinterland Enriched Sandstone Bloodwood Forest**

**Like-for-like credit retirement options**

| Class | Trading group | Zone | HBT | Credits | IBRA region |
|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| | Sydney Hinterland Dry Sclerophyll Forests This includes PCT's: 612, 621, 624, 1614, 1631, 1666, 1667, 3599, 3600, 3601, 3602, 3603, 3604, 3605, 3606, 3607, 3608, 3609, 3610, 3611, 3612, 3613, 3614, 3615, 3616, 3617, 3618, 3619, 3620, 3621, 3622, 3623, 3625, 3626, 3627 | Sydney Hinterland Dry Sclerophyll Forests <50% | 3619_High | Yes | 1 | Cumberland, Burragorang, Pittwater, Sydney Cataract, Wollemi and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site. |

## Species Credit Summary

No Species Credit Data

## Credit Retirement Options

Like-for-like credit retirement options

# Annex 5. EPBC Act Significant Impact Criteria Assessment

Assessments of Significance and supplementary information (where relevant) are presented for the following MNES in relation to the Project:

- Threatened fauna species
  - Broad-headed Snake
  - Large-pied eared bat
  - Giant Burrowing Frog
- Threatened flora species
  - *Pomaderris brunnea*
  - *Leucopogon exolasius*.

## Threatened fauna species

| **Broad-headed Snake (*Hoplocephalus bungaroides*)** |
|---|
| **Distribution**<br>The Broad-headed Snake is largely confined to Triassic and Permian sandstones, including the Hawkesbury, Narrabeen and Shoalhaven groups, within the coast ranges in an area approximately 250 km from Sydney. Broad-headed Snake shelter in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring. The species is found to move from the sandstone rocks to shelter in crevices or hollows in large trees within 500 m of escarpments in summer (OEH 2024)<br>**Life cycle, habitat requirements and site**<br>Broad-headed Snakes are live-bearing. They mate during the cool season from autumn to spring and their live offspring are observed to be born in the warm months of summer to early autumn. Juveniles and gravid (i.e. 'pregnant') females remain the exposed rocky ridges, escarpments, outcrops and bluffs during the cooler months.<br>**Survey/records within the Site and surrounds**<br>There is one record of the Broad-headed Snake within 10 km of the Subject Land (DCCEEW 2024a). Targeted survey for the species was not conducted as part of the assessment.<br>**Impact Summary**<br>No areas of suitable habitat for the Broad-headed Snake will be directly or indirectly impacted as a result of the Project. Impacts from subsidence are not considered likely to impact the sandstone outcropping areas or steep slopes present, such that the habitat for this species would be impacted. |
| **An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:** |
| **lead to a long-term decrease in the size of an important population of a species** |
| The Broad-headed Snake has not been recorded in the Subject Land during current or previous surveys, noting that the current assessment did not include targeted survey. Nor has it previously been recorded within the Subject Land. No known local population of the Broad-headed Snake is therefore known to occur within the Subject Land. The closest record obtained from BioNet is a record approximately 8 km to the north-west of the Subject Land in Nattai National Park (DCCEEW 2024a). The area of Nattai National Park where the record is from contains extensive deep incised gullies and cliff lines.<br>Potential habitat for the species is also quite limited within the Subject Land. The Broad-headed Snake is known to be selective in its selection of rock outcrops for habitat. The Broad-headed Snake is known to occupy ridgelines facing north or west, as the species relies upon specific thermal conditions that are only attained in such ridgelines. These outcrops must have limited to no shading from the woodland canopy, again to allow penetration of high levels of sunlight. Finally, the outcrop must also include suitable rock exfoliations, which take the form of thin layers of rock resting directly on larger rock and without sand or debris between the layers (Pringle et al. (2003), Webb and Shine (1994) and Webb and Shine (1998a, 1998b & 1998c). Within the Subject Land, suitable potential habitat is limited to a number of cliff line habitats along the valley of Hornes Creek. According to MSEC (2024) a total of five cliffs are located within the Subject Land. The closest cliff is located approximately 275 m from the proposed LW s7A and will not be directly mined beneath. The likelihood of cliff instabilities along the Nepean River, Bargo River and Hornes Creek have been assessed by MSEC (2024) using case studies where previous longwall mining has occurred close to but not directly beneath cliffs. The case studies have indicated very minor rock falls have been observed previously. Based on previous mining experience in the locality, it is unlikely that the cliffs beyond the extent of the longwall mining area will experience large instabilities. Any impacts are expected to represent less than 0.5% of the total face of area of the cliff. Furthermore, the likelihood of subsidence impacting the precise exfoliating rock habitat for which a Broad-headed Snake resides is considered to be low. As |

| Broad-headed Snake (*Hoplocephalus bungaroides*) |
|---|
| such, it is considered unlikely that the Broad-headed Snake would be subject to impacts that would lead to a long-term decrease in the size of an important population. |
| **reduce the area of occupancy of the species** |
| Subsidence impacts as a result of the Project are likely to cause some minor and isolated rock falls and cracking as detailed above, impacting a very small area of potential habitat for the species within the Subject Land. It is highly unlikely isolated/minor subsidence impacts would reduce the area of occupancy of an important population, should it occur. |
| **fragment an existing population into two or more populations** |
| Based on previous mine subsidence predictions, subsidence impacts associated within the Project could potentially result in rock falls and surface cracking. Given there is only one previous record for the species in the locality an important population of Broad-headed Snake is unlikely to occur. The Project therefore is unlikely to fragment an existing important population of the species into two or more populations. |
| **adversely affect habitat critical to the survival of a species** |
| No critical habitat has been listed for the species on the EPBC Act Register of Critical Habitat. Given that the species has not been recorded in the Subject Land and the lack of previous records in the locality, the Subject Land is not likely to support habitat critical to the survival of the Broad-headed Snake. |
| **disrupt the breeding cycle of an important population** |
| The following is known about the breeding cycle of the Broad-headed Snake (DEC 2005):<br>• Preferred habitat is centred on the communities occurring on the Triassic sandstone of the Sydney Basin.<br>• The sites where they occur are typified by exposed sandstone outcrops and benching and in these locations the vegetation is mainly woodland, open woodland and/or heath.<br>• Seasonally occupies distinctive microhabitats within these broader habitat types. They utilise rock crevices and exfoliating sheets of weathered sandstone during the cooler months and tree hollows during summer.<br>• Nocturnal to crepuscular (active at dusk) and is an 'ambush predator', preying predominantly on lizards, particularly Lesueurs Velvet Geckos, at least during the cooler months.<br>• During this time the species can be found frequenting exposed sandstone ridgetops where it refuges under exfoliating sheets of sandstone resting on naked rock or within crevices. These refuges often have a predominantly west to north westerly aspect. This aspect effect is thought to provide thermoregulatory advantage and maximises temperature levels for the peak feeding periods of early evening.<br>• During the warmer months of the year they become arboreal frequenting tree hollows and undergo a presumed dietary shift to small mammals, although crepuscular arboreal skinks (*Eulamprus tenuis*) have also been reported in the diet of summer captured individuals (G. Turner 1998 unpublished).<br>• They give birth to live young (ovoviviparous)<br>• The Project is unlikely to disrupt the breeding cycle of an important population due to the following:<br>• Subsidence impacts are likely to be minimal and isolated. Only small-scale impacts to surface rock and potential habitat are considered likely to occur.<br>• The species has not been previously recorded in the Subject Land.<br>• The species was not recorded during surveys undertaken to date.<br>• The majority of potential habitat for the species is unlikely to be impacted by the Project<br>• Hollow-bearing trees would not be impacted by subsidence.<br>• Food sources are unlikely to be impacted by the Project. |
| **modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline** |
| It is unlikely that the Project would result in the loss of habitat to the extent that the species is likely to decline. Based on previous subsidence predictions localised and isolated rock falls and surface cracking may occur (MSEC 2024). However, the area to be impacted is unlikely to significantly reduce the extent and quality of potential Broad-headed Snake habitat present, such that the species is likely to decline. |
| **result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat** |
| It is unlikely the Project would introduce invasive species that are harmful to the species habitat. |
| **introduce disease that may cause the species to decline** |
| It is unlikely the Project would introduce disease that is harmful to the species. |
| **interfere substantially with the recovery of the species.** |
| The Project is unlikely to substantially interfere with the recovery of the Broad-headed Snake. Degradation of breeding habitat through subsidence impacts is considered highly unlikely. Further, the area to be potentially affected is likely to be isolated and insignificant when compared to the availability of potential habitat in the Subject Land and surrounding locality. |

**Broad-headed Snake (*Hoplocephalus bungaroides*)**

**Conclusion:**

The proposed action is unlikely to have a significant impact on the Broad-headed Snake due to the following:

- An important population is unlikely to be present within the Subject Land given the lack of records.
- Subsidence related impacts to habitat are likely to be minor and isolated.

| Large-eared Pied Bat (*Chalinolobus dwyeri*) |
|---|
| **Distribution**<br>Found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW.<br>**Life cycle, habitat requirements and site**<br>Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Petrochelidon ariel*), frequenting low to mid-elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves and overhangs. They remain loyal to the same cave over many years. Forages for small, flying insects below the forest canopy. Likely to hibernate through the coolest months.<br>**Survey/records within the Site and surrounds**<br>The BioNet Atlas has seven records within the locality (10 km radius) (DCCEEW 2024a). Targeted survey for the species was not conducted as part of the assessment.<br>**Impact Summary**<br>No areas of suitable habitat for the Large-eared Pied Bat will be directly or indirectly impacted as a result of the Project. Impacts from subsidence are not considered likely to impact the sandstone cliffs present in association with Hornes Creek, such that the habitat for this species would be impacted. |
| **An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:** |
| **lead to a long-term decrease in the size of a population;** |
| Although targeted survey for Large-eared Pied Bat was not conducted during the survey, there is one record of the species along the Bargo River to the north of the Subject Land.<br>The Large-eared Pied Bat may utilise caves and rocky crevices for roosting and breeding habitat but forages nearby in woodland or forested habitat (DERM 2011).The National Recovery Plan for the species (DERM2011) notes that all records of the species are within several kilometres of cliff lines or rocky terrain and that sandstone cliffs and fertile wooded valley habitat within close proximity of each other should be considered habitat critical to the survival of the Large-eared Pied Bat. According to MSEC (2024), a total of five cliffs are located within the Subject Land. The cliffs may provide roosting habitat for the species. The cliffs are generally located within the valley of Hornes Creek.<br>As detailed in MSEC (2024), the closest cliff is located approximately 275 m from the proposed LW S7A and will not be directly mined beneath. Therefore, as the cliffs do not occur directly above the longwalls, the cliffs are predicted to experience very low levels of vertical subsidence and are not expected to experience any substantial conventional tilts, curvatures or strains (MSEC 2024). The likelihood of cliff instabilities along Hornes Creek has been assessed by MSEC (2024) using case studies where previous longwall mining has occurred close to but not directly beneath cliffs. The case studies have indicated that very minor rock falls have been observed outside the extracted goaf areas of longwall mining in the Southern Coalfield, although there have been no recorded large cliff instabilities. These case studies are supported by previous impacts from mining at Tahmoor, Appin and Tower Collieries, which have not experienced any large instabilities beyond the extent of the longwall mining area (MSEC 2024).<br>Given that the cliffs will not be directly mined beneath and any expected impacts represent less than 0.5% of the total face of area of the cliff, it is considered unlikely that the Project would lead to a long term decrease in the size of a Large-eared Pied Bat population. |
| **reduce the area of occupancy of the species;** |
| It is unlikely that the Project would reduce the area of occupancy of the Large-eared Pied Bat as the impacts as a result of subsidence within the Subject Land are anticipated to be localised and minor, and only a very small area of potential habitat for the species within the Subject Land would be affected. |
| **fragment an existing important population into two or more populations;** |
| It is unlikely that the Project would fragment an existing population of the Large-eared Pied Bat as the impacts as a result of subsidence within the Subject Land are anticipated to be localised and minor, and only a very small area of potential habitat for the species within the Subject Land would be affected. |
| **adversely affect habitat critical to the survival of a species;** |
| No critical habitat has been listed for the species on the EPBC Act Register of Critical Habitat. The Subject Land is not likely to support habitat critical to the survival of the Large-eared Pied Bat given the species is more likely to utilise the extensive deeper gullies of the Bargo River. |
| **disrupt the breeding cycle of an important population;** |
| The following is known about the breeding cycle of the Large-eared Pied Bat (DEC 2005):<br>• Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Petrochelidon ariel*), frequenting low to mid-elevation dry open forest and woodland close to these |

| Large-eared Pied Bat (*Chalinolobus dwyeri*) |
|---|
| features. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves and overhangs. They remain loyal to the same cave over many years.<br>• Found in well-timbered areas containing gullies.<br>• The relatively short, broad wing combined with the low weight per unit area of wing indicates manoeuvrable flight. This species probably forages for small, flying insects below the forest canopy.<br>• Likely to hibernate through the coolest months.<br>• It is uncertain whether mating occurs early in winter or in spring. The Project is unlikely to have an adverse effect on the species ability to breed successfully due to the following:<br>• Subsidence impacts to potential habitat would be localised and minor.<br>• Habitat features within the Subject Land are likely to be extensive and not all areas of potential habitat would be impacted by the Project.<br>• Not all habitat features are likely to be impacted by subsidence e.g. logs, tree hollows. |
| **modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;** |
| The species has not been previously recorded in the Subject Land. Subsidence impacts to potential habitat are likely to be minor and isolated. It is unlikely that the Project would result in the loss of habitat to the extent that the species is likely to decline. Further, extensive areas of foraging and breeding habitat occur immediately adjacent to the Subject Land and within the wider locality. |
| **result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;** |
| It is unlikely that the Project would result in an increase in feral pest activity that may impact potential Large-eared Pied Bat habitat. |
| **introduce disease that may cause the species to decline; or** |
| It is unlikely that the Project would result in the introduction of a disease that may cause the species to decline. |
| **interfere substantially with the recovery of the species.** |
| The Project is unlikely to interfere substantially with the recovery of the species as impacts on potential Large-eared Pied Bat habitat as a result of subsidence is likely to consist of isolated rock falls, and surface rock cracking. As such, this species habitat is unlikely to be impacted by the Project. |
| **Conclusion:**<br>The proposed action is unlikely to have a significant impact on the Large-eared Pied Bat due to the following:<br>• The species is not known from the Subject Land.<br>• No important populations are known to occur within the Subject Land.<br>• Subsidence related impacts are likely to be isolated and minor in nature. |

**Giant Burrowing Frog (Heleioporus australiacus)**

**Distribution**

The Giant Burrowing Frog occurs in NSW and Victoria along the coast and adjacent ranges. It occurs in two disjunct populations: a northern population largely confined to the sandstone geology of the Sydney Basin and extending as far south as Ulladulla, and a southern population occurring from north of Narooma through to Walhalla, Victoria (OEH 2012). This species occurs within the Sydney Basin, South East Coastal Plain, South East Corner, South Eastern Highlands and Australian Alps IBRA Bioregions and the East Gippsland, West Gippsland, Southern Rivers, Hawkesbury/Nepean and Sydney Metro Natural Resource Management Regions.

**Life cycle, habitat requirements and site**

The Giant Burrowing Frog occurs in areas of native vegetation (Penman et al. 2004) and can be found in heath, woodland and open dry sclerophyll forest on a variety of soils, except for clay-based soils (OEH 2012). The species has not been recorded from cleared land. The Giant Burrowing Frog spends more than 95% of the time in non-breeding habitats, which are areas up to 300 m from breeding sites. While in these areas, individuals burrow below the soil surface or in the leaf litter. Individual frogs occupy a series of burrow sites, some of which are used repeatedly (OEH 2012). Breeding habitat is generally soaks or pools within first or second order streams. It is also found in ephemeral or permanent artificial drainage ditches and culverts on roadsides (with a rock or sand/clay base) (Rescei 1997). They are also commonly recorded from 'hanging swamp' seepage lines. Individuals move into the breeding site immediately before, or following, heavy rain and occupy these sites for up to 10 days (Penman 2005). This species breeds mainly in autumn but has been recorded calling throughout the year. Egg masses are foamy with an average of approximately 500-800 eggs and are laid in burrows or under vegetation in small pools. After rain, tadpoles are washed into larger pools where they complete their development in ponds. Tadpole development takes between 3-12 months with late developing tadpoles overwintering and completing development when warmer temperatures return (OEH 2012).

**Survey/records within the Site and surrounds**

The BioNet Atlas has four records within the locality (10 km radius) (DCCEEW 2024a). Targeted survey for the species was not conducted as part of the assessment.

**Impact Summary**

No areas of suitable habitat for the Giant Burrowing Frog will be directly or indirectly impacted as a result of the Project. Impacts from subsidence are not considered likely to impact the drainage lines present, such that the habitat for this species would be impacted.

**An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:**

**lead to a long-term decrease in the size of a population;**

Targeted survey for the Giant Burrowing Frog was not conducted as part of the assessment; the closest record is approximately 4 km west of the Subject Land.

Breeding habitat is generally soaks or pools within first or second order streams. It is also found in ephemeral or permanent artificial drainage ditches and culverts on roadsides (with a rock or sand/clay base) (Rescei 1997). Horne's creek and other drainage lines located within the Subject Land would provide suitable habitat for Giant Burrowing frogs.

Change in the grade of a stream due to mining induced tilt has potential to lead to increased ponding, scouring, desiccation. MSEC (2024) states that "predicted changes in grade along Hornes Creek due to proposed extraction of LW S7A are negligible. The potential for impacts due to mining-induced changes in stream gradients is also irrelevant for the section downstream of Pool HC-16, given that this section is usually inundated with stored water." The predicted maximum increases in grade are up to 1.2 %, which are relatively small compared to the natural gradients and, therefore, the potential for increased scouring is not expected to be substantial. Similarly, to Hornes creek, Tea Tree hollow drainage lines and Bargo River are also considered to experience little to no impact from mining induced tilt.

The section of Hornes Creek upstream of Pool HC-16 is located between 470 m and 620 m from the proposed LW S7A. The likelihood of fracturing occurring in this section of the creek is considered to be low. In the unlikely event that fracturing occurs, the fractures are expected to be minor and isolated. The likelihood of fracturing resulting in surface flow diversion is considered to be very low given the offset distance of LW S7A to this section of stream.

Liberation of contaminants can occur from subsidence induced fracturing in watercourses, causing localised and transient increases in iron concentrations and other constituents due to flushing of freshly exposed fractures in the sandstone rocks which contain iron and other mineralisation. This sort of impact has the potential to affect Tea Tree Hollow, Dog Trap Creek, and Eliza Creek, Cow Creek and Carters Creek and downstream watercourses. Fracturing of bed rock is predicted to occur and upsidence related buckling of stream beds is predicted along some sections of these creeks (Hydro Engineering and Consulting 2018). The potential changes in water quality through subsidence are predicted to be localised. This may have an impact on Giant Burrowing Frog if they occupy a pool that has a change in water quality.

Gas emissions have been previously observed in creek lines adjacent to mining area in the Southern Coalfield. Gas emission has the potential to result in decreased water quality. The majority of gas is released into the atmosphere and is unlikely to impact on the water quality but has the potential to impact the surrounding vegetation and cause dieback (MSEC 2024).

| Giant Burrowing Frog (Heleioporus australiacus) |
|---|
| Given the extent of potential foraging habitat available within the surrounding landscape and the low likelihood of impacts as a result of subsidence, it is considered unlikely that the Project would lead to a long term decrease in the size of a Giant Burrowing Frog population. |
| **reduce the area of occupancy of the species;** |
| Subsidence impacts as a result of the Project are likely to cause minor impacts on the water systems found within the Subject Land as detailed above. It is highly unlikely isolated/minor subsidence impacts would reduce the area of occupancy of the Giant Burrowing Frog, should it be present. |
| **fragment an existing important population into two or more populations;** |
| It is unlikely that the Project would fragment an existing important population of the Giant Burrowing Frog into two or more populations considering subsidence impacts within the Subject Land are anticipated to be localised and minor. |
| **adversely affect habitat critical to the survival of a species;** |
| No critical habitat has been listed for the species on the EPBC Act Register of Critical Habitat. The Subject Land is not likely to support habitat critical to the survival of the Giant Burrowing Frog given the species has not been found within the Subject Land and there are areas of more suitable habitat surrounding the Subject Land. |
| **disrupt the breeding cycle of an important population;** |
| Giant Burrowing Frog requires soaks or pools within first or second order streams. They lay their eggs in burrows or under vegetation in small pools. After rain, tadpoles are washed into larger pools where they complete their development in ponds. Giant Burrowing Frog require still, shallow and unshaded aquatic sites with emergent aquatic plants and free of predatory fish. The Project would not disrupt the breeding cycle of an important Giant Burrowing Frog population. |
| **modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;** |
| The impact from subsidence is considered to be low. Mining induced tilting is expected to have only minor impacts on the gradient and potential scouring of the creek lines. Considering the proposed LW S7A is located between 470 m and 620 m from Hornes Creek the likelihood of fracturing resulting in surface flow diversion is considered to be very low (MSEC 2024). Therefore, it is considered unlikely that the subsidence impacts would decrease the availability of the habitat for Giant Burrowing Frog and would result in the decline of the species. |
| **result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;** |
| The Giant Burrowing Frog is threatened by the predation of eggs and tadpoles by plague minnow (*Gambusia holbrooki*) (Morgan & Buttemer 2006) and, to a lesser extent, European carp (*Cyprinus carpio*), goldfish (*Carassius auratus*), brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) (DEC 2005). The Project will not result in the introduction of any of these species.<br>The Project is not likely to result in the introduction of any other invasive species that may establish in potential habitat for the Giant Burrowing Frog. |
| **introduce disease that may cause the species to decline; or** |
| Giant Burrowing Frog is threatened by Chytridiomycosis caused by infection with chytrid fungus (*Batrachochytrium dendrobatidis*). This project will not result in the introduction of this or any other diseases. |
| **interfere substantially with the recovery of the species.** |
| The Project will not interfere with the recovery of the Giant Burrowing Frog. |
| **Conclusion:**<br>The proposed action is unlikely to have a significant impact on the Giant Burrowing Frog due to the following:<br>• The species is not known from the Subject Land.<br>• No important populations are known to occur within the Subject Land.<br>• Subsidence related impacts are likely to be isolated and minor in nature. |

## Threatened flora species

***Pomaderris brunnea***

**Distribution**

A population of *Pomaderris brunnea* was recorded along Teatree Hollow Creek during the survey. Over 300 individuals were recorded within the gully environment of Teatree Hollow Creek.

The species has also been previously recorded in creeklines at Wirrimbirra Sanctuary (Bargo) (SEWPAC 2013). The Wirrimbirra population contained 900 plants in the late 1980s (SEWPAC 2013).

Together, these local records are likely to form a local population of the species totalling at least 1,235 individuals.

**Life cycle, habitat requirements and site**

In the Sydney region this species is found typically near the coast, on Sydney sandstones. In this area it grows in woodland on semi-cleared scrub, on clay and alluvial soils of floodplains and creek lines. This species flowering times are September-October (DCCEEW 2024b).

**Survey/records within the Site and surrounds**

There are 70 *Pomaderris brunnea* records within 10 km of the Subject Land, 56 of these being from the last five years (DCCEEW 2024a). Two records are within 1 km north-west of the Subject Land, along Bargo River. Although no *Pomaderris brunnea* was recorded during the surveys there is suitable habitat within the Subject Land and in the surrounding areas.

**Impact Summary**

No areas of suitable habitat for *Pomaderris brunnea* will be directly or indirectly impacted as a result of the Project. Impacts from subsidence are not considered likely to impact the riparian vegetation present, such that the habitat for this species would be impacted.

**An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:**

**lead to a long-term decrease in the size of a population;**

The Project will not result in the removal of any of the important population and subsidence is unlikely to result in a decrease in the population of the species as:

- *Pomaderris brunnea* is not a strictly water dependent species. It does not occur in the watercourse. It occurs in moist forest communities and gullies often near water.
- Hornes Creek experiences periods of dryness. Whilst it is a possibility that subsidence can result in loss of water from watercourses, the population of *Pomaderris brunnea* in the Subject Land is already exposed to such conditions.
- Teatree Hollow Creek has been previously mined beneath. No declines in the population have been previously observed.
- Any vegetation die back from gas emissions is likely to be isolated and localised. Based on previous experience in the Southern Coalfields, it is unlikely that any gas emissions would cause significant impact to the vegetation.

The Project is therefore unlikely to result in a long-term decrease in the size of a *Pomaderris brunnea* population.

**reduce the area of occupancy of the species;**

The Project will not result in the removal any *Pomaderris brunena* and will not reduce the total area of occupancy of the population. Adaptive management measures would prevent prescribed impacts affecting the species area of occupancy.

**fragment an existing important population into two or more populations;**

The Project will not result in a direct impact to the species or its habitat. The Project will not fragment a known population of the species.

**adversely affect habitat critical to the survival of a species;**

The Project is unlikely to adversely affect habitat critical to the survival of the species as:

- No individuals will be directly impacted.
- Potential habitat for the species is unlikely to be significantly impacted by the Project.
- The species is found within the Wirrimbirra Sanctuary which occurs within the locality (SEWPaC 2013). This population is unlikely to be impacted by the Project.

**disrupt the breeding cycle of an important population;**

The following is known about the breeding cycle of *Pomaderris brunnea*:

- The species is expected to live for 10-20 years, while the minimum time to produce seed is estimated to be 4-6 years
- Grows in moist woodland or forest on clay and alluvial soils of flood plains and creek lines.
- Flowers appear in September and October.

The Project is unlikely to disrupt the breeding cycle of an important population as:

- No individuals will be cleared.
- Adaptive management measures would prevent prescribed impacts from occurring.
- The Project is unlikely to impact known dispersal or reproduction mechanisms.

| ***Pomaderris brunnea*** |
|---|
| • The Project is unlikely to result in changes to the fire regime for the species as appropriate fire regimes will be implemented in accordance with the Tahmoor Coal Bushfire Management Plan. |
| **modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;** |
| Subsidence impacts to potential *Pomaderris brunnea* habitat are likely to be minor and isolated. It is unlikely that the Project would result in the loss of habitat to the extent that the species is likely to decline. Further, extensive areas of suitable habitat occur within, and beyond the limits of, the Subject Land. The Project will not result in the likely decline of the species. |
| **result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;** |
| It is unlikely that the Project would result in the introduction of any invasive species that may cause the species to decline. |
| **introduce disease that may cause the species to decline; or** |
| It is unlikely that the Project would result in the introduction of a disease that may cause the species to decline. |
| **interfere substantially with the recovery of the species.** |
| A National Recovery Plan for *Pomaderris brunnea* was developed in 2011. The overall objective of recovery is to minimise the probability of extinction of Pomaderris brunnea in the wild and to increase the probability of populations becoming self-sustaining in the long term. No individuals of the species would be impacted by the Project. Adaptive management measures are proposed to minimise and prevent prescribed impacts to the species. It is unlikely that the Project would interfere substantially with the recovery of the species. |
| **Conclusion**<br>The Project would not result in a significant impact to *Pomaderris brunnea* due to the following:<br>• No individuals of *Pomaderris brunnea* will be directly impacted.<br>• *Pomaderris brunnea* was not observed within habitat that may be impacted by subsidence.<br>• The habitat for *Pomaderris brunnea* is relatively extensive within the locality. |

| *Leucopogon exolasius* (Woronora beard-heath) |
|---|
| **Distribution**<br>*Leucopogon exolasius* is endemic to the Sydney region and central coast occurring within the Sydney Metro and Hawkesbury-Nepean Natural Resource Management Regions. The species occurs along the upper Georges River and Heathecote National Park (NP) and Royal NP and is also known from the Blue Mountains along the Grose River. This species inhabits woodland on sandstone and prefers rocky hillsides along creek banks up to 100 m altitude (DCCEEW 2024b).<br>**Life cycle, habitat requirements and site**<br>*Leucopogon exolasius* inhabits woodland on sandstone (and sandy alluvium) and prefers rocky hillsides along creek banks. The species occupies areas with low nutrient soils, up to an altitude of 100 m above sea level and between 1000-1400 mm rainfall. The species flowers in August (and has been known to extend to September) and its fruit matures in October. Germination of dormant seeds occurs via seasonal changes rather than fire, but fire may enhance the process once begun (DCCEEW 2024b).<br>**Survey/records within the Site and surrounds**<br>There are no records of *Leucopogon exolasius* within 10 km of the Subject Land (DCCEEW 2024a).<br>**Impact Summary**<br>No areas of suitable habitat for *Leucopogon exolasius* will be directly or indirectly impacted as a result of the Project. Impacts from subsidence are not considered likely to impact the riparian vegetation present, such that the habitat for this species would be impacted. |
| **An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:** |
| **lead to a long-term decrease in the size of a population;** |
| *Leucopogon exolasius* is not a strictly water dependent species. It does not occur in the watercourse. It occurs in moist forest communities and gullies often near water. As such, the Project would not impact upon an important population. |
| **reduce the area of occupancy of the species;** |
| The Project would not impact upon an important population. |
| **fragment an existing important population into two or more populations;** |
| The Project would not impact any known individuals of *Leucopogon exolasius*. As such, the Project would not fragment an existing important population into two or more populations. |
| **adversely affect habitat critical to the survival of a species;** |
| The Project is unlikely to adversely affect habitat critical to the survival of the species as subsidence impacts on potential habitat for the species is considered to be minor and localised. |
| **disrupt the breeding cycle of an important population;** |
| No important population occurs within the Subject Land, as such, the breeding cycle would not be impacted. |
| **modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;** |
| Based on previous mapping (Tozer 2006), the area of potential habitat in the locality is over 20,000 ha, comprising of Cumberland Shale Sandstone Transition Forest, Western Sandstone Gully Forest, Upper Georges River Sandstone Woodland and Sydney Hinterland Transition Woodland.<br>Subsidence impacts to potential *Pomaderris brunnea* habitat are likely to be minor and isolated.<br>Given the extensive area of potential habitat in the locality, and the minor impact as a result of subsidence, it is unlikely the Project would modify, destroy, remove or isolate the availability of quality of habitat to the extent that the species is likely to decline. |
| **result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;** |
| It is unlikely that the Project would result in the introduction of any invasive species that may cause the species to decline. |
| **introduce disease that may cause the species to decline; or** |
| It is unlikely that the Project would result in the introduction of a disease that may cause the species to decline. |
| **interfere substantially with the recovery of the species.** |
| No known individuals of this species would be removed by the Project. Therefore, it is unlikely that the Project will interfere substantially with the recovery of the species. |
| **Conclusion:**<br>The Project would not result in a significant impact to *Leucopogon exolasius* due to the following:<br>• No individuals of *Leucopogon exolasius* will be directly impacted.<br>• *Leucopogon exolasius* was not observed within habitat that may be impacted by subsidence. |

| ***Leucopogon exolasius* (Woronora beard-heath)** |
| --- |
| • The habitat for *Leucopogon exolasius* is extensive within the locality. |

## Annex 6. Digital files created for the BDAR

The spatial data created for the figures presented in the BDAR has been packaged and will be submitted along with the BDAR. The data package includes the following spatial files:

- 10km buffer
- 1500m Native vegetation extent
- Assessment Area
- Bionet Fauna
- Bionet Flora
- Clifflines/overhang areas
- Fauna species polygons
- Flora species polygons
- Floristics RDP
- LW S7A 35degree angle of draw
- LW S7A 600m offset boundary
- LW S7A
- LW S7A predicted 20mm subsidence
- Niche survey records (Brown Pomaderris)
- Niche survey records (Giant Burrowing Frog & Red-crowned Toadlet)
- NSW State Vegetation Mapping 2.0
- Other approved longwalls (LW S1-6A)
- Subject Land
- Survey tracks
- Threatened flora site 4 TF (Niche 2024).

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Historical heritage
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**Environmental management and approvals**
Impact assessments
Development and activity approvals
Rehabilitation
Stakeholder consultation and facilitation
Project management

**Environmental offsetting**
Offset strategy and assessment (NSW, QLD, Commonwealth)
Accredited BAM assessors (NSW)
Biodiversity Stewardship Site Agreements (NSW)
Offset site establishment and management
Offset brokerage
Advanced Offset establishment (QLD)

# Appendix D
## Aboriginal cultural heritage assessment

EMM
creating opportunities

# Tahmoor Mine Modification 3

## Aboriginal Cultural Heritage Assessment

Prepared for Tahmoor Mine Pty Ltd

April 2024

# Tahmoor Mine Modification 3

## Aboriginal Cultural Heritage Assessment

Tahmoor Mine Pty Ltd

E230438 RP6

April 2024

| Version | Date | Prepared by | Approved by | Comments |
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| 1 | 19 March 2024 | Nicolas Reilly | Alan Williams | Draft |
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# Executive Summary

Tahmoor Coal is seeking to modify development consent SSD 8445 to include an additional longwall panel (longwall panel S7A) to the existing approved Tahmoor South mine plan. EMM Consulting Pty Limited (EMM) has been engaged by Tahmoor Coal Pty Ltd (the proponent) to undertake an Aboriginal cultural heritage assessment report (ACHA) in support of an application to modify the Tahmoor South development consent SSD 8445 (Modification 3).

The assessment adopted the process and methods outline in Heritage NSW's *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* guidelines. The consultation process initially identified 53 Aboriginal stakeholder organisations who may have had an interest in the project. Following notification of these organisations, 19 responded requesting to be consulted upon the project. Aboriginal participation with on-Country field assessments were limited to organisations and/or individuals who had participated in earlier heritage assessments within the study area and/or reflected locally based Tharawal traditional owners. Field assessment was completed over two days (19 and 21 February 2024) and included representatives from Cubbitch Barta Native Title Claimant Aboriginal Corporation.

The study area was situated within an area previous subject to assessment as part of earlier approvals for the Tahmoor South coal mine. These previous investigations have demonstrated that rockshelters and/or grinding grooves within deeply incised sandstone gorges is the prevalent cultural assemblage within the study area. Only one portion within the modification aligned with these types of environment – a small section of Hornes Creek in the northwest. Subsequently, the assessment undertook archaeological field survey that was targeted in these areas where outcropping sandstone is predicted to occur and where sites such as rockshelters as may be present.

The assessment resulted in nine sites being identified. This included a single rockshelter (Hornes Creek RS5 [#52-2-4978]), three rockshelters with potential artefact deposit (PAD) (Hornes Creek RS 1 [#52-2-4974], Hornes Creek RS3 [#52-2-4976] and Hornes Creek RS7 [#52-2-4981]), three rockshelters with artefacts and PAD (Hornes Creek RS2 [#52-2-4975], Hornes Creek RS4 [#52-2-4977] and Hornes Creek RS6 [#52-2-4982]), a single grinding groove site (Hornes Creek GG1 [#52-2-4980]) and a single isolated stone artefact (Hornes Creek IF1 [#52-2-4979]). Three of these sites were outside the study area.

All of the six sites within the study area, as well as Hornes Creek GG1 (#52-2-4980) which is within 10m of the study area would have potential to be partially impacted by the Project, being situated on the edge of the predicted subsidence zone. However, detailed subsidence modelling suggests the risk of changes to the cultural assemblage, which is several hundred metres from the Project, would be low, and very unlikely to occur. It is considered that cumulative impacts from the Project would be limited, with rockshelters well represented in the regional cultural assemblage, and the unlikely nature of any substantive impacts occurring. Impacts to the grinding groove site would have greater cumulative impact, having limited representation in the region, but similarly Project impacts are considered unlikely.

Recommendations are proposed for inclusion in the modification to guide post-approval requirements for Aboriginal heritage. These include:

- The existing Tahmoor South coal project Heritage Management Plan (HMP) for LW S1A-S6A should be updated to include to newly recorded Aboriginal sites with specific management measures for pre-construction recording, additional investigation (if required), a monitoring program, and integration into the Trigger Action Response Plan in the event of observed impacts (see Section 10.2 for further discussion and guidance). Following this update, the title of the HMP should be updated to include LW S7A.

- Consultation should be maintained with the registered Aboriginal parties (RAPs) throughout the life of the project and subsequent ground disturbance stages of the project.

- A copy of the Aboriginal cultural heritage assessment (ACHA) should be lodged with AHIMS and provided to the RAPs.

- AHIMS Site Recording Forms for the newly identified Aboriginal site within the study area should be submitted to the AHIMS database once their validation has been completed.
- If any part of the construction footprint is located outside the areas identified in this ACHA, or if any alteration is proposed further assessment of these area(s) should be undertaken to identify and appropriately manage Aboriginal objects and/or sites that may be present.
- Where the heritage consultant changes through the project, suitable hand over should be undertaken to ensure no loss or mistranslation of the intent of the information, findings and future steps in heritage management occur.

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# 1 Introduction

## 1.1 Background

EMM Consulting Pty Limited (EMM) has been engaged by Tahmoor Coal Pty Ltd (the proponent) to undertake an Aboriginal cultural heritage assessment report (ACHA) in support of an application to modify the Tahmoor South State significant development consent SSD 8445 (Modification 3).

Tahmoor Coal is seeking to modify development consent SSD 8445 to include an additional longwall panel (LW S7A) to the existing approved mine plan.

The inclusion of LW S7A will extend mining operations at Tahmoor Mine by approximately nine months. Condition A6 of SSD 8445 authorises mining operations to be carried out on site until 31 December 2033, or until 10 years from the commencement of second workings, whichever is sooner. EMM understands that second workings under SSD 8445 commenced in October 2022. As a result, mining operations must be completed by October 2032. The inclusion of LW S7A will extend mining beyond October 2032; however, all mining will still be completed by 31 December 2033. To accommodate the additional time required to extract LW S7A, an amendment to condition A6 of SSD 8445 will also be required as part of the modification application to remove the restriction of mining operations required to be completed within ten years following the commencement of second workings.

The proposed modification will not require any additional surface infrastructure, increase the maximum annual run-of-mine (ROM) coal approved to be extracted, or increase the maximum annual volume of coal approved to be transported from site.

### 1.1.1 Approval pathway

The recommended approval pathway will be to modify development consent SSD 8445 pursuant to section 4.55(2) of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). Development consents can be modified under section 4.55(2) of the EP&A Act provided they are substantially the same development as the development for which the consent was originally granted. Development consent SSD 8445 was granted to Tahmoor Coal on 23 April 2021 for the extraction of up to 4 million tonnes per annum (Mtpa) of ROM coal from the Bulli Seam over a 10-year period. Development consent SSD 8445 permits longwall mining of six panels within an 'A-series' and six panels within a 'B-series' of longwalls. The proposed LW S7A is an additional longwall panel in the A series of longwalls and within the existing Tahmoor South study area. It is also within the Study Area identified for Tahmoor South and assessed by technical studies (including subsidence, ecology and heritage) as part of the Tahmoor South Environmental Impact Statement (EIS) and subsequent amendment reports.

Based on the information available, it is understood that the proposed modification can be considered to be substantially the same development as originally approved and can therefore be assessed and approved pursuant to section 4.55(2) of the EP&A Act. The suitability of section 4.55(2) approval pathway will require confirmation from the NSW Department of Planning, Housing and Infrastructure (DPHI).

The consent authority for the modification will be the Minister for Planning or delegate.

## 1.2 Study area

The Tahmoor South coal project is situated in 80 kilometres (km) south-west of the Sydney Central Business District and 50 kilometres (km) northwest of Wollongong and Port Kembla, in the Southern Coalfields of NSW (Figure 1.1). It is approximately 30 km south-west of the suburb of Campbelltown and to the west of the M31 Hume Motorway. Tahmoor Mine's existing surface facilities are located some 2.5 km south of the village of Tahmoor and ~4 km north of the village of Bargo.

The proposed activity falls within the 'subsidence study area' that has been previously assessed as part of the Tahmoor South Project (Niche 2020) and is shown in Figure 1.1.

The study area referred to in this report is defined as the surface area that could be affected by the mining of proposed LW S7A. The extent of the study area has been calculated by combining the areas bound by the following limits:

1. a 35-degree angle of draw from the extents of proposed longwall panel S7A

2. the predicted limit of vertical subsidence, taken as the 20 millimetres (mm) subsidence contour resulting from the extraction of the proposed longwall.

## 1.3 Purpose and scope of this report

This ACHA is an appendix to the broader environmental assessment and should be read in conjunction with it. It documents the results of archaeological investigations undertaken to identify the extent and significance of any physical remains and intangible values of past Aboriginal visitation, use and occupation within the study area. The objectives of the investigation were to:

- consult with and involve key Aboriginal community members and knowledge holders to identify areas and places of cultural value within or in the vicinity of the study area

- compile a review of existing environmental, historical and archaeological information for the study area, by identifying and summarising known and previously recorded Aboriginal heritage places, cultural values areas and landforms of archaeological interest in its immediate surrounds

- determine if any Aboriginal objects, places, cultural values areas, or areas of archaeological potential are present (or are likely to be present) within the EIS study area and final Study area (with a focus on the additional disturbance area), as well as areas of existing disturbance, through ground-truthing, including field survey and test excavations

- identify the type, nature, and extent of any Aboriginal sites, objects, archaeological deposits, potential archaeological deposits, and cultural values areas within or near the study area

- map the locations of known and potential Aboriginal sites, objects and deposits and cultural values areas identified

- assess the archaeological and cultural significance of the study area

- assess and identify heritage constraints and opportunities and the potential impacts of the modification

- identify and recommend measures to mitigate any heritage impacts and risks to the modification.

The assessment adopted methods in accordance with the requirements of the following NSW government guidelines:

- *Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW* (OEH, 2011)

- *Aboriginal Cultural Heritage Consultation Requirements for Proponents* (DECCW 2010)

- *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (DECCW 2010).

## 1.4 Legislative context

There are several Commonwealth and State Acts (and associated regulations) that manage and protect Aboriginal cultural heritage (Appendix A provides further details). These are summarised in Table 1.1.

**Table 1.1 Commonwealth and State legislation with potential relevance to the modification**

| Legislation | Description | Relevant to the Project? | Details |
|---|---|---|---|
| **Commonwealth** | | | |
| *Environment Protection and Biodiversity Conservation Act 1999* | Recognises sites with universal value on the World Heritage List (WHL). Protects Indigenous heritage places with outstanding heritage value to the nation on the National Heritage List (NHL), and significant heritage value on the Commonwealth Heritage List (CHL). | No | There are no Indigenous heritage places within the study area that are listed on the WHL, NHL, or the CHL. |
| *Native Title Act 1993* | Established a system for recognising Aboriginal and Torres Strait Islander peoples' rights and interests over lands and waters by Aboriginal people. Provides for negotiation and registration of Indigenous Land Use Agreements (ILUAs).<br>Often used in NSW to identify relevant stakeholders for consultation. | No | A request to search the National Native Title Tribunal was made on 1 November 2023. There are no active Native Title claims which interact with the study area. |
| *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* | Preserves and protects declared areas and objects of particular significance to Aboriginal and Torres Strait Islander people that are under threat from injury or desecration. | No | There are no areas or objects within the study area subject to a Declaration under the Act. |
| **State** | | | |
| *Environmental Planning and Assessment Act 1979* | Requires environmental impacts, including to Aboriginal heritage, to be considered in land use planning.<br>Provides for the development of environmental planning instruments, including State Environmental Planning Policies and Local Environmental Plans. | Yes | The modification is being assessed as a modification to an SSD project under Part 4, Division 4.1, of this Act, and is subject to specific environmental assessment and reporting requirements. These requirements stipulate that Aboriginal heritage impact assessment is required (in accordance with standard Heritage NSW procedures and guidelines) to assess whether the Project has the potential to impact on Aboriginal objects, sites, or places of Aboriginal heritage significance. |
| *National Parks and Wildlife Act 1974* | Provides blanket protection for all Aboriginal objects and declared Aboriginal places. Includes processes and mechanisms for development where Aboriginal objects are present, or where Aboriginal Places are proposed for harm. | Yes | While an Aboriginal heritage impact permit to harm tangible Aboriginal cultural heritage under this Act is not required for SSD projects, the process require guidelines prepared under this Act to be adopted. |

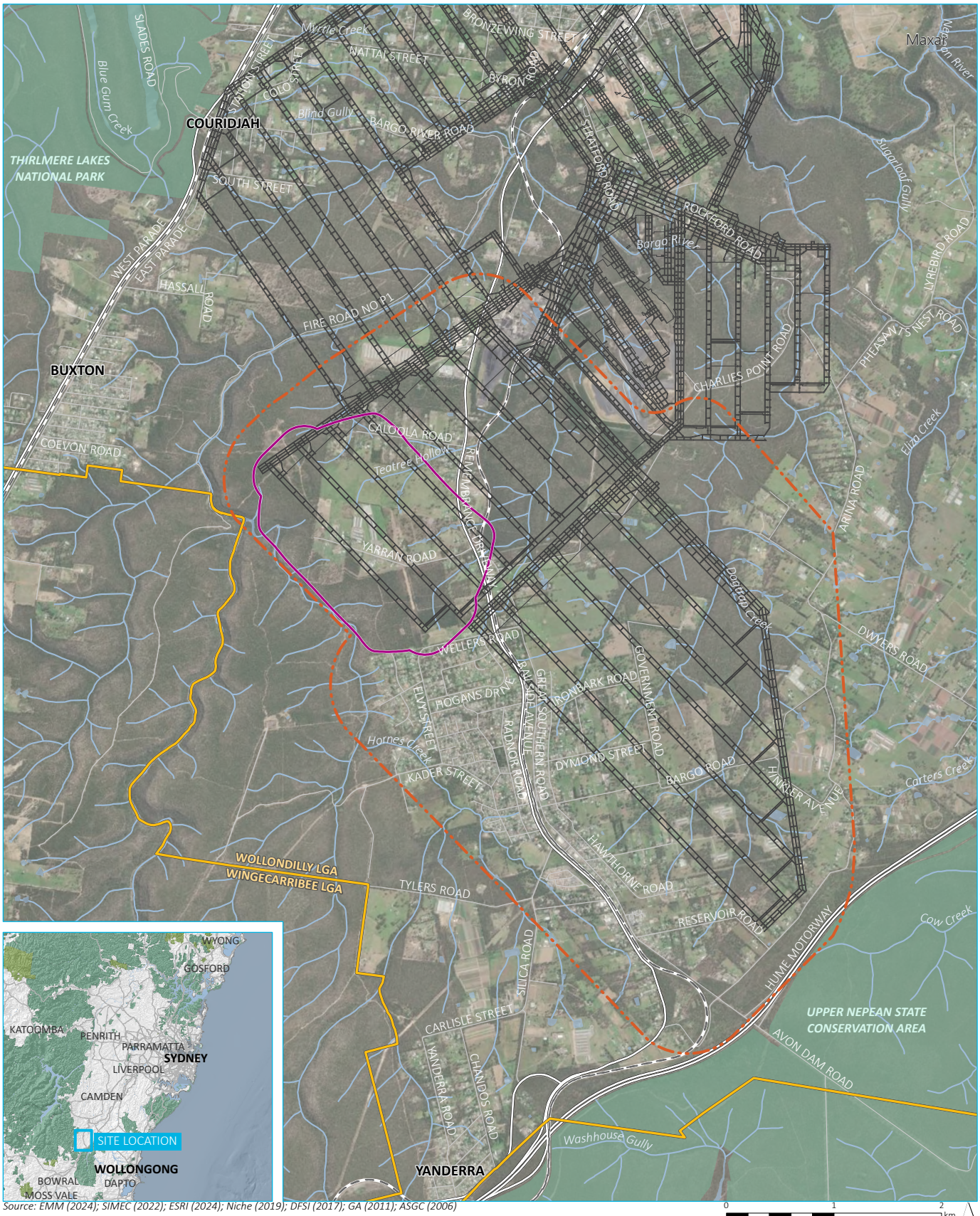
**Table 1.1 Commonwealth and State legislation with potential relevance to the modification**

| Legislation | Description | Relevant to the Project? | Details |
|---|---|---|---|
| *Aboriginal Land Rights Act 1983* | Establishes Local Aboriginal Land Councils (LALCs). Allows transfer of ownership of vacant crown land to a LALC.<br>The Office of the Registrar, *Aboriginal Land Rights Act 1983 (ORALRA)*, registers Aboriginal land claims and maintains the Register of Aboriginal Owners. Often used in NSW to identify relevant stakeholders for consultation. | No | The study area is within the boundaries of the Tharawal Local Aboriginal Land Council, which is a registered Aboriginal party for this modification and has been consulted.<br>A request to search the Register of Aboriginal Owners was made to the ORALRA on 1 November 2023. The study area does not appear to have Registered Aboriginal Owners pursuant to Division 3 of the Act. |

## 1.5 Limitations

This report is based on existing and publicly available environmental and archaeological information (including the AHIMS data) and reports about the study area. The background research did not include any independent verification of the results and interpretations of externally sourced existing reports (except where the ground-truthing was undertaken). The report further makes archaeological predictions based on these existing data and targeted ground-truthing, and that may contain errors depending on the accuracy of these third-party studies and the extent of ground-truthing investigations.

This report does not consider historical and/or built heritage unless specifically related to Aboriginal heritage values. Such heritage items are addressed in other parts of the modification documentation.




Source: EMM (2024); SIMEC (2022); ESRI (2024); Niche (2019); DFSI (2017); GA (2011); ASGC (2006)

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KEY

- Study area
- ACHA study area (indicative) (Niche 2019)
- Mine plan

Existing environment

- Rail line
- Major road
- Minor road
- Watercourse/drainage line
- Waterbody
- NPWS reserve
- State forest
- Local government area

# Study area

Tahmoor South Coal Project
SSD 8445 Modification 3
Figure 1.1

EMM creating opportunities

# 2 Aboriginal consultation

## 2.1 Key findings

- The assessment adopted the processes and methods outlined in DECCW's *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW, 2010).
- The consultation process initially identified 53 Aboriginal stakeholder organisations who may have had an interest in the project. Following notification of these organisations, 19 responded as wishing to be registered for subsequent consultation through the project. Tharawal Local Aboriginal Lands Council did not register however were included as the study area falls within their administrative boundary
- Due to the level of previous investigation, the level of on-Country activities was limited. Ultimately, targeted field survey was undertaken over two days, 19 and 21 February 2024. This included representatives of Cubbitch Barta Native Title Aboriginal Claimants Aboriginal Corporation.
- Discussions with registered Aboriginal parties to date has been generally positive for the modification, with many having worked with Tahmoor Coal over several years on cultural heritage management across the region.

A summary of the consultation process is provided below, and full documentation of the consultation process is provided in Appendix B.

## 2.2 The process

Two parallel and overlapping consultation processes were undertaken as part of the ACHA. As a requirement of the legislative process, consultation was undertaken in accordance with Heritage NSW guidelines (Section 2.3.1). In addition, numerous other communication strategies were employed to improve and maintain dialogue with the local Aboriginal community (Section 2.2.2).

### 2.2.1 Heritage NSW guidelines

Aboriginal consultation for this modification has been undertaken in accordance with procedures set out in the Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010 (DECCW, 2010). These guidelines identify a five-stage process:

1. Pre-notification – identification of the Aboriginal individuals and/or communities relevant to the study area by contacting several state government agencies.
2. Notification – contacting all Aboriginal individuals and/or communities identified in Stage 1 to determine their interest in being consulted during the modification. This includes direct communication and the placement of advertisements in local media seeking further expressions of interest from Aboriginal individuals and/or communities that may have been missed through Stage 1. Those Aboriginal individuals and/or communities that wish to be consulted become a 'registered' Aboriginal party (RAP).
3. Presentation of Project information/assessment methodology – briefing RAPs about the Project and scope of any Aboriginal heritage assessment and investigations. This is usually undertaken through written correspondence, but can include meetings, and may undergo several iterations throughout the modification as the nature of the assessment changes (e.g. surface ground-truthing may lead to a requirement for test excavations).

4. Impacts and mitigation strategies – discussion of potential impacts to cultural materials and mitigation options with the RAPs prior to developing the ACHA. This is often undertaken either onsite at the end of any field program and/or as part of Stage 5.

5. Report review – the RAPs are provided an opportunity to review and comment upon the draft ACHA, to contribute input into the overall findings, significance and management of cultural heritage.

The consultation process for the modification had two aims:

- to comply with the Heritage NSW consultation procedures to obtain input on the ACHA process
- to identify cultural places and intangible values that may be affected by the modification.

### 2.2.2 Other communication strategies

In addition to the required steps outlined in Section 2.2.1, EMM implemented a range of other strategies to promote transparent and frequent two-way dialogue between the Aboriginal community and the modification.

Specifically, the strategy included the following additional activities:

- Field investigation participation –RAPs were offered the opportunity to attend a range of field survey and test excavations activities carried out across the study area.

## 2.3 This modification

### 2.3.1 Liaising with Heritage NSW

As part of the ACHA, various interactions with Heritage NSW have been undertaken:

- Provision of information of the registered Aboriginal stakeholders involved in the Project following the notification process (Appendix B) –14 April 2022 (Appendix B.1 and Appendix B.3).

### 2.3.2 Liaising with RAPs

Initial stages of the consultation process identified 53 Aboriginal stakeholders in the region (Appendix B.2). Following notification, 19 organisations and/or individuals registered an interest in the early stages of the modification (July 2022; Table 2.2) (Appendix B.3). The RAPs include several local Aboriginal organisations and/or individuals based in Tahmoor and/or immediate surrounds, as well as a smaller proportion that are based in Sydney but have traditional and/or contemporary connections to the region. One RAP requested that their name be kept confidential. Tharawal LALC did not register an interest for this modification, however have been included as the study area is within their administrative boundaries. As this modification is a modification of an existing ACHA, on-Country opportunities were limited, and only RAPs that had already worked on previous iterations of the Tahmooor South project were invited to participate. However, all RAPs were provided with the opportunity to comment on the methodology and review drafts of the ACHA (Appendix B).

Guntawang Aboriginal Resources Incorporated provided email correspondence on the 6 December 2023 that they agree with the methodology and also made general comments that young and non-local people were being increasingly engaged to participate in field assessments generally. They also advocated that Elders and older Aboriginal People with local knowledge and experience should be at the forefront of consultation and engagement. Cubbitch Barta Native Title Aboriginal Claimants Aboriginal Corporation provided phone correspondence on 7 December 2023, which advocated for decreased mining under Dogtrap Creek. They were reassured that no new plans were made to modify the mining under Dogtrap Creek from this modification.

Table 2.1 provides a summary of the main steps undertaken to conform with Heritage NSW guidelines.

### Table 2.1 Summary of Aboriginal consultation undertaken for the modification

| Consultation stage | Description | Date initiated | Date completed | Notes |
|---|---|---|---|---|
| 1 | Government Agency Pre-Notification | 1 November 2023 | 20 November 2023 | Additional details provided in Appendix B.3. |
| | Advertisement in *The District Reporter* | 17 November 2023 | 17 November 2023 | A tearsheet is provided in Appendix B.3. |
| | Notification and registration of potential Aboriginal stakeholders | 17 November 2023 | 1 December 2023 | Additional details are provided in Appendix B.3. |
| | Advising Heritage NSW and Tharawal LALC of RAPs | 11 December 2023 | 11 December 2023 | Additional details are provided in Appendix B.3. |
| 2/3 | Presentation of information about the proposed project; and gathering information about cultural significance | 5 December 2023 | 2 January 2024 | Additional details are provided in Appendix B.4. |
| | Field survey | 19 February 2024 | 21 February 2024 | Additional details are provided in Section 6. |
| 4 | Review of draft ACHA report | 19 March 2024 | 16 April 2024 | Additional details are provided in Appendix B.5. |

### Table 2.2 List of registered Aboriginal parties for the Project

| Organisation | Contact | Date of registration |
|---|---|---|
| Tharawal Local Aboriginal Lands Council | Julie Dannevig | 17 November 2023 |
| Didge Ngunawal Clan | Lillie Carroll | 17 November 2023 |
| Konanggo ACHS | Robert Young | 17 November 2023 |
| Pamela Young | Pamela Young | 17 November 2023 |
| RAW Cultural Healing | Raymond Weatherill | 18 November 2023 |
| Thomas Dahlstrom | Thomas Dahlstrom | 19 November 2023 |
| Mundawari Heritage Consultants | Dean Delponte | 20 November 2023 |
| A1 Indigenous Services | Carolyn Hickey | 20 November 2023 |
| Cubbitch Barta Native Title Aboriginal Claimants | Glenda Chalker | 20 November 2023 |
| Clive Freeman | Clive Freeman | 20 November 2023 |
| Butucarbin Aboriginal Corportation | Jennifer Beale | 20 November 2023 |
| Kamilaroi Yanktjatjara Working Group | Phil Khan | 21 November 2023 |
| Barraby Cultrual Services | Lee Field | 21 November 2023 |
| Yurrandali | Bo Field | 21 November 2023 |

**Table 2.2 List of registered Aboriginal parties for the Project**

| Organisation | Contact | Date of registration |
|---|---|---|
| *Name Withheld* | - | 22 November 2023 |
| Mura Culture Service | Phillip Carroll | 27 November 2023 |
| Guntawang Aboriginal Resources Incorporated | Wendy Morgan | 28 November 2023 |
| D'harawal Traditional Descendants and Knowledge Holders Circle | Gawaian Bodkin-Andrews | 30 November 2023 |
| Wori Wooilywa | Daniel Chalker | 1 December 2023 |
| Murra Bidgee Mullangari Aboriginal Corporation | Ryan Johnson | 7 December 2023 |

## 2.4 Aboriginal stakeholders feedback

This ACHA was provided to the RAPs for a 28-day period between 19 March and 16 April 2024 for their inputs and comments. Where received, these are provided in Appendix C and summarised below:

- On the 20 March 2024, Wendy Morgan of Guntawang Aboriginal Resources Incorporated stated that the undergrowth in the study area is extremely thick and the land needs to have a cultural burn.
- No changes to the ACHA were requested by the RAPs during the 28-day period.

# 3 Existing environment

## 3.1 Key findings

- The study area is in a semi-rural setting, characterised by rolling hills within valleys that have been cleared for pastoral grazing and borders to the west onto deeply incised sandstone Country.
- The study area has a diverse geological and geomorphological landscape providing a range of environments and ecotones which would have resulted in attractive resources being available to past Aboriginal populations. The study area contains only one significant water resource, Hornes Creek, running along the west edge of the project, and which was likely utilised by Aboriginal people in the past.
- The majority of the soil landscapes across the Study area are characterised by shallow duplex soils, which consist of an upper soil A1-Horizon and underlying B2-Horizon. Cultural materials are typically found in the A1 horizon, although this unit is commonly affected by recent natural and development activities (e.g. vegetation clearance, cropping, mining).
- Based on regional data, site types are likely to be constrained to surface and/or shallowly buried stone artefactual material to the east, with increasing potential for rockshelters and/or grinding grooves in the incised sandstone outcropping near Hornes Creek. Uncleared vegetation within the riparian corridor in the east of the study area may contain culturally modified trees.

## 3.2 Rationale

Understanding environmental context assists with predictions of archaeological potential, such as the likelihood of archaeological material being present in the landscape, its spatial distribution and its preservation. Landscape features were an important factor for the choice of camping and transitory and ceremonial areas used by Aboriginal people. Similarly, these landscape features and historical land-use plays a role in the level of preservation and the integrity of archaeological sites.

A landscape consisting of suitable topography, hydrology, geology and soils has strong links with natural resources that would have been available to, and sought after, by Aboriginal people. Flora and fauna would have provided food, tools and ceremony (culturally modified trees); proximity to fresh water was necessary for life and growing crops, as well as gathering fish and eels. Landscape features, such as sandstone overhangs, were useful for shelter; stone artefacts were manufactured from raw stone material that was collected from quarry sites; and stone arrangements relied on the landscape.

## 3.3 Landscape overview

The study area is situated on the south-western edge of the Sydney Basin. It is located within a semi-rural setting, characterised by rolling hills within valleys that have been cleared for pastoral grazing and that borders onto sandstone scarp features and incised stream channels to the west.

The majority of the study area comprises gently undulating hills and plateaus, sloping gently to the east and becoming more steeply incised and rugged to the west of the study area beside Hornes Creek.

The topography of the study area is shown on Figure 3.1.

## 3.4 Hydrology

The study area is part of the Nepean River catchment. The main drainage feature that influences the study area comprises Hornes Creek (Strahler 4th order) that flows south to north within and outside the eastern boundary of the study area before meeting the Bargo River just outside the study area to the north-west. The water levels in Hornes Creek are controlled by Picton Weir. Several 1st order tributaries to Hornes Creek, Teatree Hollow Creek and the Bargo River flow from the centre of the study area bisecting the rolling hills as shallow drainage lines to the east and steeper gullies to the west.

The hydrology of the study area is shown in Figure 3.1.

## 3.5 Geology and geomorphology

The study area is located within the Sydney Basin, formed by crustal rifting in the Early Permian and the laying down of marine sediment that changed to non-marine coal measures toward the end of the early Permian. During the mid Triassic Period, the basin uplifted to become dry land and erosion continues from that time until the present.

Within the region, Hawkesbury Sandstone is the main landform influence. It is a flat lying massive quartzose sandstone with an extent of some 20,000 $km^2$ and is often exposed within erosional landscapes, primarily along larger rivers and creeks and is the main cliff forming sequence of the region. Hawkesbury Sandstone geology is mapped along the western edge of the study area following the main drainage features of the study area (Figure 3.2).

The majority of the study area is situated on the Mittagong Formation, a sedimentary rock that was laid down in the Triassic Period. It comprises interbedded fine-grained sandstone and shale between Ashfield Shale (above) and Hawkesbury Sandstone (below).

Overall, outcropping sandstone with potential to feature Aboriginal sites is most likely to occur on the Hawkesbury soil landscape, particularly the scarps above Hornes Creek and the rockbars within it. There is limited potential for outcropping sandstone in incised stream channels of the Lucas Heights soil landscape (refer Figure 3.2).

## 3.6 Soil landscapes

The study area contains three soil landscapes which are defined in the *Soil Landscapes of Wollongong/Port Hacking* (Hazelton and Tille 1990): Hawkesbury, Lucas Heights and Blacktown. The soil landscapes within the study area are presented in Table 3.1 and shown in Figure 3.3.

Soil landscape classifications and their boundaries provide pre-defined areas that are classified by several geographic features, and which are informative for the archaeological investigation. They provide localised information including landform patterns, soils, geology, rock outcrop percentage, land use and vegetation. This information provides another layer to categorise the landscape for the predictive model, additional to what a topographic description can provide. Soil landscape information builds on underlying geology and describes the depths of residual soils and colluvial soils and identifies areas that are characterised by erosion or skeletal soils and exposed bedrock versus those that may contain a deeper profile where cultural material may be buried.

## Table 3.1 Soil landscapes of the study area

| Soil landscape and type | Landform pattern and hydrology | Landform elements | Location in study area | Slope and relief | Geology | Soil summary | Implications for archaeology |
|---|---|---|---|---|---|---|---|
| Lucas Heights (residual) | Gently undulating crests, ridges and plateau surfaces.<br>Teatree Hollow Creek (3rd order) and low order tributaries. | Gently undulating plateau surfaces and ridges (200–1,000 m wide). | Majority of the study area. | Level to gently inclined slope gradients of <10%.<br>Local relief is <30 m. | Mittagong Formation – inter-bedded shale, laminate and fine to medium grained quartz sandstone.<br>Rock outcrop is absent. | Crests and slopes: loose greyish brown fine sandy loam over sandy clay loam.<br>Crests and plateaus: hard setting loam (1020 cm) over yellow pedal clay up to 1 m deep. Frequent ironstones.<br>Valley flats and depressions: apedal sands and sandy loams of 1–2 m depth. | Low-moderate potential for grinding groove sites in the stream channels and for low density artefact scatters to occur in proximity to these streams.<br>Potential for culturally modified trees in the east of the study area where areas of uncleared vegetation remain. |
| Hawkesbury (colluvial) | Rugged, rolling to very steep hills.<br>Hawkesbury soil landscape surrounds Hornes Creek at the western edge of the study area. | Valleys are narrow and incised.<br>Crests and ridge are convex and narrow (<100 m wide). | Eastern boundary | Slopes are moderately inclined to precipitous.<br>Local relief 100-200m with slope gradients of 20-70%. | Hawkesbury Sandstone – medium to coarse-grained quartz sandstone with minor shale and laminate lenses.<br>Rock outcrop is common and occurs as horizontal benches and broken scarps up to 10 m high. Rock outcrops and cobbles cover up to 50% of ground surface. | Shallow (<50 cm) discontinuous Lithosols/Silicious Sands associated with rock outcrop.<br>Crests and ridges: up to 20 cm loose sand over yellow clayey subsoil or solid bedrock.<br>Sideslopes: discontinuous soils with frequent rock fragments. 10–30 cm of loose sand over light to medium clay above bedrock.<br>Total soil depths, although variable is usually <70 cm.<br>Vally flats: depositional sands (usually deeper than 100 cm) swampy with high organic matter content. | Outcropping Hawkesbury Sandstone is suitable for the occurrence of Aboriginal grinding grooves, rock shelters (including those with art), rock engravings and modified rock pools.<br>Uncleared vegetation within the riparian corridors in the east of the study area may contain culturally modified trees. |

**Table 3.1 Soil landscapes of the study area**

| Soil landscape and type | Landform pattern and hydrology | Landform elements | Location in study area | Slope and relief | Geology | Soil summary | Implications for archaeology |
|---|---|---|---|---|---|---|---|
| Blacktown (residual)) | Undulating landscape with broad drainage depressions and valley flats. | Broad crests and ridges. | Small area in the south-east of the study area | Local relief 10–20 m<br>Predominantly gentle slopes 5–10%. | Wianamatta Group Shales: sandstone outcrop not expected. | Shallow to moderately deep red, brown and yellow podzolic soils. | Low potential for low density artefact scatters and modified trees where vegetation remains. |

## 3.7 Flora and fauna

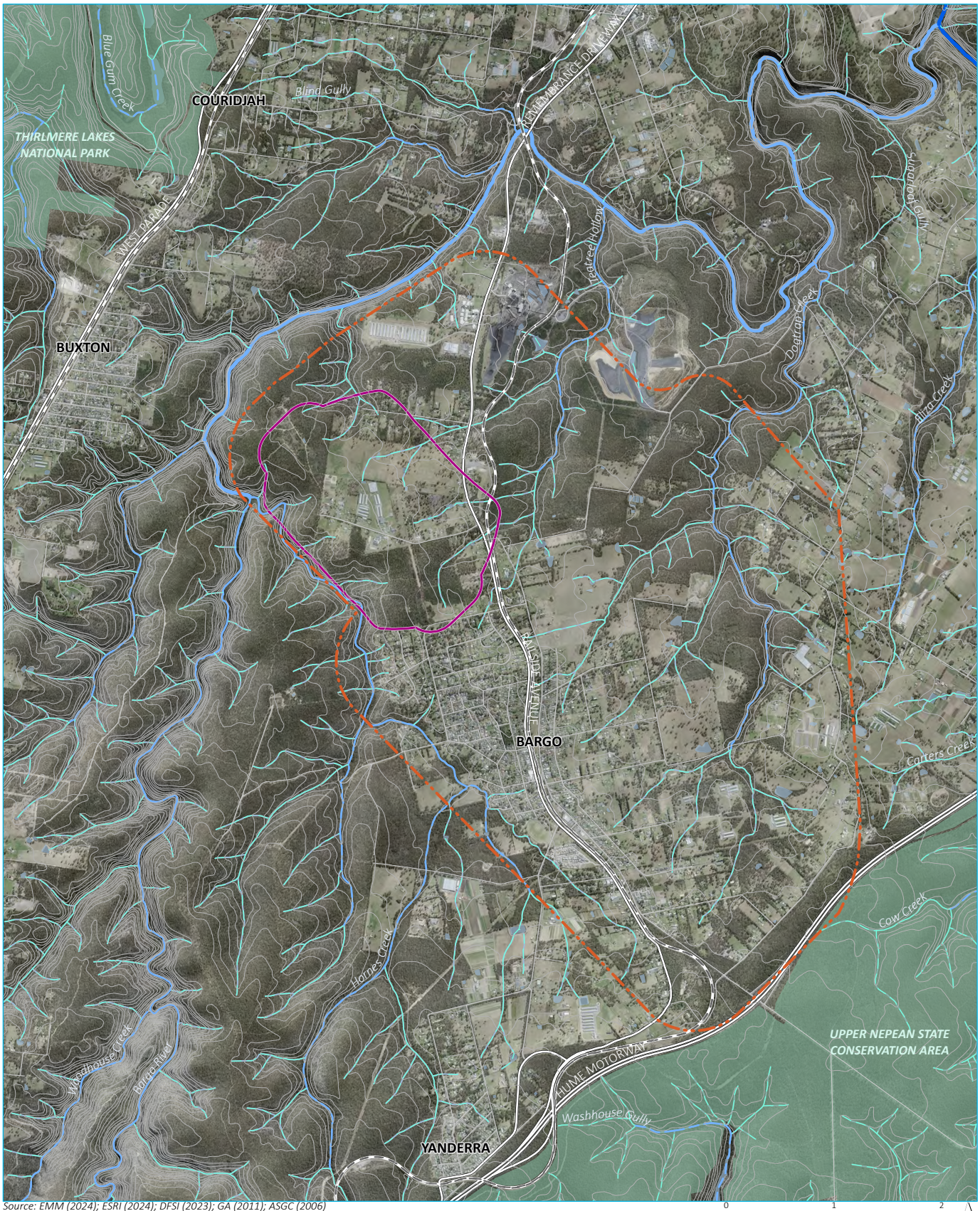
Along Hornes Creek in the west of the study area the vegetation is uncleared eucalypt woodland, open-forest (dry sclerophyll forest) and open tall forest (wet sclerophyll forest).

Majority of the study area is extensively cleared eucalypt low open-forest and eucalypt low woodland with sclerophyllous scrub understory. Dominant tree species include turpentine smooth-barked apple red bloodwood, silvertop ash, snappy gum and Sydney peppermint. Understory species include black she-oak, blue mountains mallee ash and heath banksia.

## 3.8 Land use and disturbance

The dominant character of the study area is small rural holdings with cleared pastures for animal grazing on kikuyu dominated pastures and agriculture. Historical land use and disturbance is likely to have affected open sites such as stone artefacts and culturally modified trees, which are unlikely to be impacted by subsidence from the project. Areas likely to feature Aboriginal objects and sites on outcropping sandstone are expected to be minimally disturbed by human activities because they are in rugged landscapes generally not suitable for development. Localised disturbance of stream channels has occurred through construction of culverts, bridges and water diversion management.

Other potential sources of disturbance to Aboriginal sites include natural process of flooding and erosion and animal activity such as burrowing in rockshelters.




Source: EMM (2024); ESRI (2024); DFSI (2023); GA (2011); ASGC (2006)

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GDA 1994 MGA Zone 56

N

KEY

- Study area
- ACHA study area (indicative) (Niche 2019)
- Mine plan

Existing environment

- Rail line
- Major road
- Minor road
- Contour interval (10 m)
- Waterbody
- NPWS reserve

Strahler order

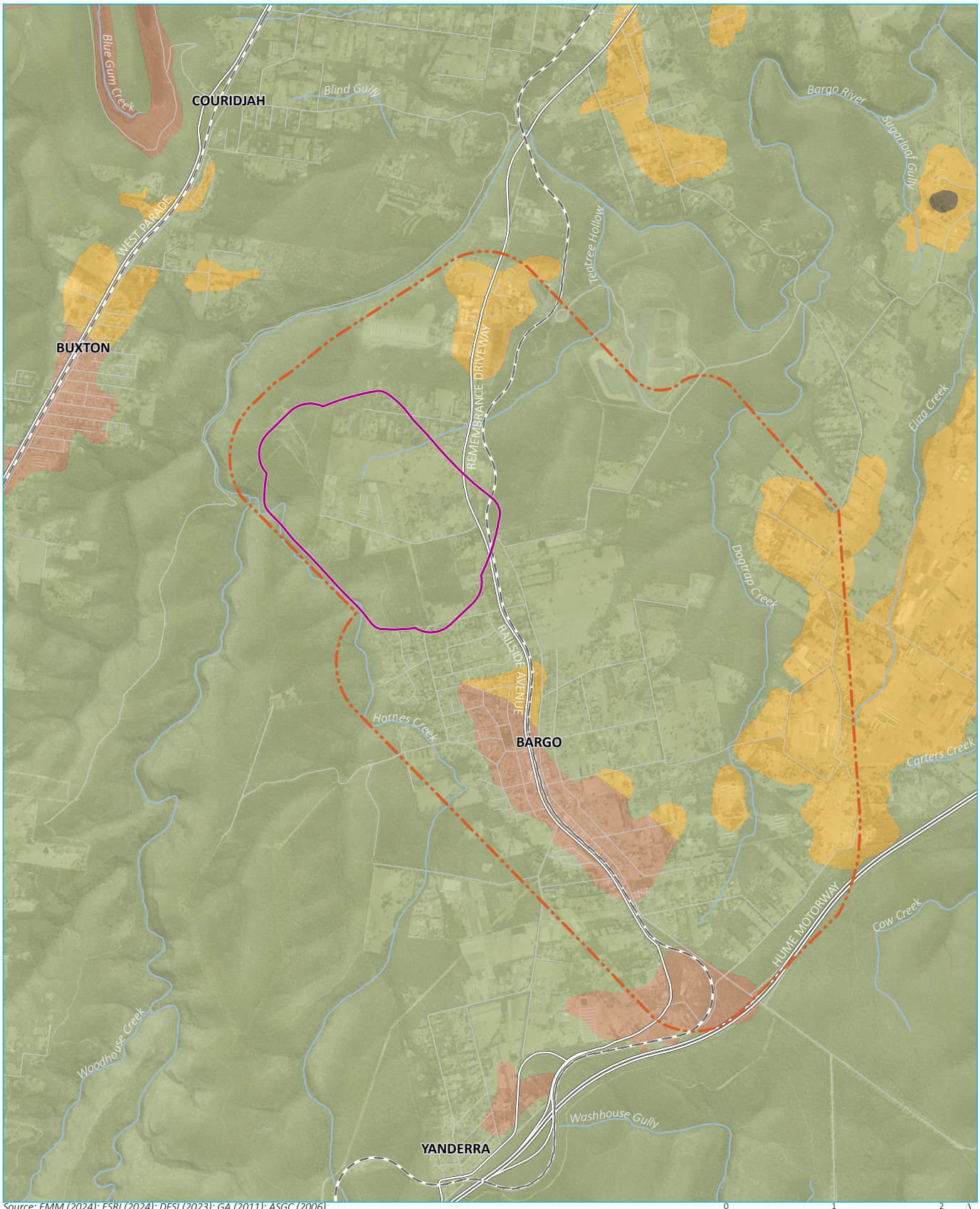
- 1st order
- 2nd order
- 3rd order
- 4th order
- 5th order
- 7th order

# Topography and hydrology

Tahmoor South Coal Project
SSD 8445 Modification 3
Figure 3.1

EMM creating opportunities

X:\2023\E230438- Tahmoor MOD 3\GIS\02_Maps\ACHA002_TopographyandHydrology_20240110_01\ACHA002_TopographyandHydrology_20240110_01.aprx




Source: EMM (2024); ESRI (2024); DFSI (2023); GA (2011); ASGC (2006)

0 1 2 km

GDA 1994 MGA Zone 56

N

X:\2023\E230438- Tahmoor MOD 3\GIS\02_Maps\ACHA003_Geology_20240110_01\ACHA003_Geology_20240110_01.aprx

KEY

- Study area
- ACHA study area (indicative) (Niche 2019)
- Mine plan

Existing environment

- Rail line
- Major road
- Minor road
- Named watercourse

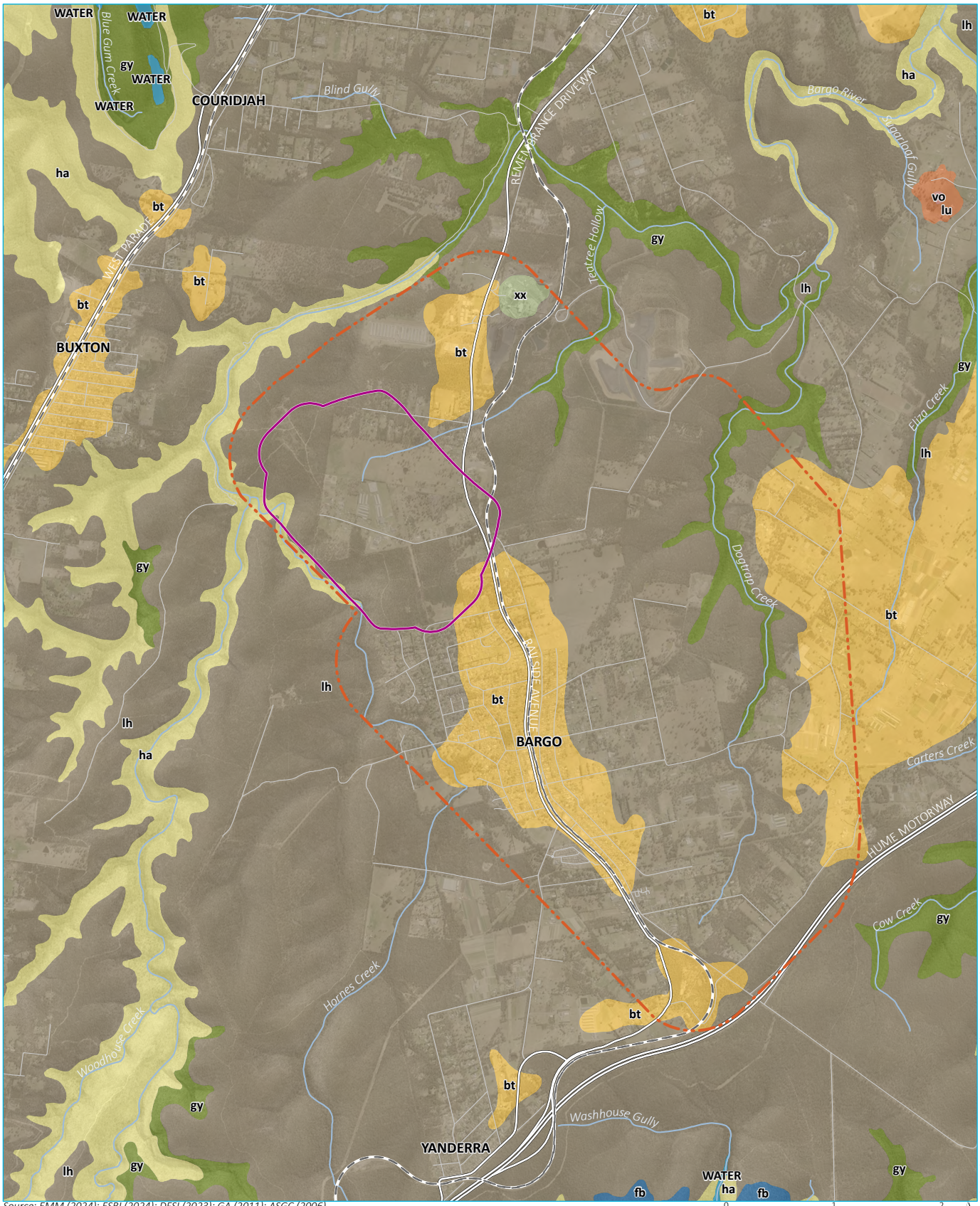
Geology

- Ashfield Shale
- Hawkesbury Sandstone
- undifferentiated
- unnamed

## Geology

Tahmoor South Coal Project
SSD 8445 Modification 3
Figure 3.2

EMM
creating opportunities




*Source: EMM (2024); ESRI (2024); DFSI (2023); GA (2011); ASGC (2006)*

0 1 2 km

GDA 1994 MGA Zone 56

N

X:\2023\E230438- Tahmoor MOD 3\GIS\02_Maps\ACHA004_Soil_20240110_01\ACHA004_Soil_20240110_01.aprx

KEY

- Study area
- ACHA study area (indicative) (Niche 2019)
- Mine plan

Existing environment

- Rail line
- Major road
- Minor road
- Named watercourse

Soil

- COha | Hawkesbury
- DTxx | Disturbed terrain
- ERgy | Gymea
- ERlu | Luddenham
- REbt | Blacktown
- REfb | Faulconbridge
- RElh | Lucas heights
- REvo | Volcanic
- Water

# Soils

Tahmoor South Coal Project
SSD 8445 Modification 3
Figure 3.3

EMM
creating opportunities

# 4 Ethno-historical context

## 4.1 Key findings

- Aboriginal people of the study area spoke the Dharawal language, whose territory extended across a vast area from Botany Bay to Jervis Bay. Dharawal groups were distinguished as fresh, salt or bitter water depending on whether they inhabited the coast, swamps or inland river valleys.
- The study area was potentially occupied by the Nattai clan, a sub group of the Dharawal, whose traditional land appear situated in the vicinity of nearby Mowbray Park.
- Historical information provides several observations in relation to the early nineteenth century Aboriginal society, but no site specific areas of activity within the study area.

## 4.2 Regional context

Information about the socio-cultural structure of Aboriginal society prior to European contact largely comes from ethno-historical accounts made by colonial settlers. These accounts and observations were often made after significant social disruption due to disease and displacement. As a result, this information is often contentious, particularly in relation to language group boundaries. Therefore, it is likely that language group boundaries were far more diffuse than the arbitrary demarcations drawn by colonial observers.

Over thirty separate Aboriginal groups populated the wider Sydney Basin in 1788CE, each with their own country, practices, diets, dress, and dialects. We now know of these groups as 'clans' and each identified with broader cultural-linguistic groups known as 'tribes' - Darug, Darkinjung, Gundungarra, Dharawal (Tharawal), Guringai (Coastal Darug), Eora (Coastal Darug) and Awabakal. At the time of European settlement in the region, the Dharawal tribes had established a regional network linking the highlands west of the Illawarra escarpment and the coastal plain (Stokes 2015). Dharawal clans were distinguished as 'fresh water', 'bitter water' or 'salt water' people depending on whether they inhabited the coastal regions, swamps or plateaus and inland river valleys. Their territory extended across a vast area, from the south side of Botany Bay along the coast as far as the Shoalhaven River and Jervis Bay, from the coast to the Georges River and inland as possibly far west as Appin, Moss Vale and Camden. Evidently, a shared language enabled the transmission of knowledge, customs, and lore as well as items and resources. This is perhaps best demonstrated by Backhouse's 1836 account of coastal people travelling to the 'Cow-Pastures' (Camden) to learn a new song (Backhouse 1849 in Organ 1993).

Environmental conditions in this region throughout the Holocene were fertile and relatively stable and ethno-historical evidence suggests that population densities at contact were high (McDonald 2008, p.3). Resources for Aboriginal people in the local area would have included fish and eels from the creeks, and land mammals such as kangaroos, wallabies and possums.

Aboriginal rock art in the Sydney Basin is found on Hawkesbury sandstone formations. McDonald (2008) argues that the rock art has a distinctive regional style and coincides with the archaeologically most visible period of late Holocene occupation. Most rock art in the region is less than 5,000 years old and was produced up until European contact but ceased soon after. While it is not known how rock art functioned across this region, stylistic behaviours demonstrating social group affiliation and identity was an important cultural marker. Some of these social practices have not survived in the archaeological record such as body making and items of organic material such as bark, but they can be seen in the surviving rock art. Most of the regions large engraving sites are on ridgelines away from economic resource areas (McDonald 2008, p.5).

Six months after the arrival of the First Fleet in 1788, cattle escaped from Sydney Cove and travelled to the Menangle-Camden area about 90 km south-west of Sydney, an area that became known as the Cowpastures. Dharawal people recorded these animals in a rockshelter now known as Bull Cave (Liston 1888) near Campbelltown.

The first land grants in the local area were issued in 1815. The Great Southern Road between Sydney and the Southern Highlands opened the area to settlers. These changes impacted the traditional lives of Aboriginal people in the local area, resulting in social and cultural dislocation. Nevertheless, many Dharawal people continue to live in the local area and surrounding regions and continue to care for Country. Recent research suggests that the pathways linking Dharawal groups socially and economically continued to be used throughout the first fifty years of European colonisation. Dharawal people came together for ceremonies and exchanged objects such as ground edged hatchets and raw materials (Stokes 2015).

While bark huts have not survived in the archaeological record, they are frequently mentioned in ethnographic accounts, as is the use of rockshelters,

> (t)hey appear to live chiefly in the caves and hollows of the rocks which nature has supplied them with, the rocks about the shore being mostly shelving and overhanging so as to afford a tolerable retreat (Barrington 1802 in McDonald 2008 p.24).

Ethnographic records contain occasional references to local Indigenous people. Barallier (1802, in Mitchell 1938) records passing through the area of Picton and having a hut built for him by Bungin, probably near Matthews Creek,

> The place where I decided to spend the night was on the territory of the mountaineer Bungin. He gave a proof of his friendship and gratefulness for my good treatment by building* a hut for me, and I was very thankful for his kind attention.
> [*The natives do not allow any stranger to inhabit the territories they have appropriated to themselves. They themselves build huts for the strangers they wish to receive as friends.]

At 'Runkard's Island', about 2 miles from Picton, three carved trees were recorded by W.A. Cuneo in 1894 as marking the grave of 'King' Mullingully,

> a leader of great influence in the Burragorang Valley…. [and] a strong opponent of the whites' advent thereto in the early days" (Gullick 1918, p.13).

The glyph on the west tree was carved with diamonds, 4 feet high and situated about two feet from the ground (Gullick 1918, p.52). A local Aboriginal man known as Bundle guided Meehan, Throsby and Hume on their expedition to find an overland route to Jervis Bay in 1818. He appears in the blanket returns for the Stonequarry Police District (Picton) in 1833, 1834 and 1837. Bundle was known as the last Chief of the Cowpastures (Liston 1988, p.59).

Disease and warfare, most notably the massacre at Appin in (1816) depleted Dharawal numbers. In 1845, Matthew McAlister of Picton reported that there were 67 Aboriginal people in his district and numbers were falling (Liston 1988, p.55).

## 4.3 Information provided by RAPs

Traditionally, Aboriginal cultural knowledge, customs and history was transmitted orally, being passed down from generation to generation. The has been no cultural knowledge provided by the RAPs during the assessment.

# 5 Archaeological context

## 5.1 Key findings

- Regional studies indicate that Aboriginal people first visited and occupied the Sydney Basin between ~45,000-35,000 years ago. Populations remained low in the late Pleistocene and were focussed along the banks of major river systems, such as the Hawkesbury-Nepean River. After ~18,000 years ago, there is an increasing archaeologically-observed presence across the basin, including the initiation of a number of sites, such as Burrill Lake and Bass Point. Increasing numbers and diversity of sites in the last 10,000 years, and especially the last 5,000 years, suggests a significant population established across most environments of the basin; and it is during this time that the socio-economic and religious systems observed at European contact likely developed.

- Regionally, there have been a range of investigations and assessments for over 40 years. These studies indicate that archaeological sites are dominated by rockshelters (and associated features) and grinding grooves in this region. In the case of rockshelters, these are generally found in association with steep sandstone escarpments, often in elevated position above the high energy creeks common to the region; while grinding grooves are commonly found in, or on the banks of, creeks where geological outcrops are present. Studies suggest that the majority of these sites date to the last 5,000 years, although there is some evidence of deposits extending back to ~15,000 years regionally.

- Numerous investigations have been undertaken of the study area, including as part of the broader Tahmoor South coal project. These investigations identified a range of cultural materials, with a focus on Dogtrap Creek, situated several hundred metres east of the study area. While these previous studies encompassed the study area, none undertook any on-site investigations of the locale.

- A review of Heritage NSW's database identified 85 previously documented sites within the region. These were dominated by rockshelters (n=49) and artefact sites (21), with rarer site types such as: open art sites, culturally modified tree, grinding grooves, open camp sites, PAD sites and rock engravings making up the remainder of the cultural assemblage. No sites were identified within the study area however there are five Aboriginal sites in close proximity to the study area (<1 km).

## 5.2 Regional context

Many contemporary Aboriginal cultures note their custodianship of the landscape since time immemorial, from an archaeological perspective the first peopling of Australia by large groups of hunter-gatherers occurred ~50 ka (Bradshaw et al. 2019; O'Connell et al. 2018). The peopling of the continent was rapid, with sites such as Devil's Lair (WA), Warratyi (SA), and Lake Mungo (NSW) all occupied within a few thousand years of arrival (Bowler et al. 2003; Hamm et al. 2016; Turney et al. 2001). Genomic research has shown that following these initial explorations of the continent, regional populations or nomadic sedentism, was established by ~40 ka (Tobler et al. 2017). These small populations were highly mobile, but remained within a broad spatial geographic area, dictated in general by the nature of resources and water availability. In the case of some of the arid parts of the continent, mobility encompassed thousands of square kilometres (Gould 1977), while major riverine corridors such as the Murray River had near permanent settlements (Pardoe 1995).

In NSW, the earliest evidence of Aboriginal people are human remains recovered from the lunette in Lake Mungo and dating to ~42 ka (Bowler et al. 2003; O'Connell et al. 2018). The presence of red ochre covering the remains represents a society with significant cultural and symbolic complexity (Langley et al. 2011). Near the coastal edge, the earliest populations were found at Cranebrook Terrace, near Penrith. Here a handful of rudimentary stone tools were found in an alluvial unit, some 8 m below the current surface, which were dated to ~40–45 ka (Williams et al. 2017).

However, it is not until ~35 ka, that regional populations appear to have become established in the Sydney Basin, and which appeared to consist of small bands of people focussed mainly along major river systems, including the Hawkesbury-Nepean, Parramatta, Georges and Hunter Rivers (Hughes et al. 2014; Williams et al. 2012; 2014). These rivers formed key ecological refuges that hunter-gatherer groups used to survive major climatic events such as the Last Glacial Maximum (21±3 ka) – a cool and arid climatic period. Well-established archaeological models suggest populations experienced a major reduction in size (by as much as 60%), and settlement contraction and abandonment across much of the continent during this time (Veth 1993; Williams et al. 2013). Although, recent research suggests that the story may be more complex than this (e.g. Tobler et al. 2017).

The terminal Pleistocene and early Holocene (~18–8 ka) was characterized by significant environmental change, notably the rapid inundation of much of the coastal shelf, resulting in the reduction of the continent by ~21% (~2 million km$^2$) (Williams et al. 2018), in tandem with improving climatic conditions – the Holocene climatic optimum (Williams et al. 2015a; 2015b). More broadly, these conditions resulted in increasing population growth, expansion of ranging territories, increasing sedentism (longer patch residence time) and the beginnings of low-level food production (e.g. aquaculture), and ultimately the initiation of social and cultural groupings observed in the late Holocene (Williams et al. 2015b). Within the Sydney Basin, a large number of sites are first initiated during this time, including Burrill Lake (~20 ka), Bass Point (~17 ka), and Loggers Shelter in Mangrove Creek (~11 ka) (Bowdler 1970; Lampert 1971; Attenbrow 2004; AMBS 2006, p.87). This is also the case in the greater Blue Mountains area, where dated rockshelter sites in the area suggest that Aboriginal occupation extended as far back as 14,000 years ago, and potentially as early as 22,000 years ago (Stockton 1973; Stockton & Holland 1974).

More broadly, at this time we see a much broader range of archaeological site types occurring, such as the Roonka Flat burial ground on the banks of the Murray River, within which some 147 individuals were interred through the Holocene (Pate et al. 1998), and the increasing use of marine resources. Many of the previous refuges were subject to abandonment or a re-structuring of land use (Dortch 1979; Fitzsimmons et al., 2019). These activities suggest the ability to undertake large-scale movements to mitigate environmental distress was becoming increasingly difficult and was addressed through diversification of hunter-gathering behaviours and, at least in part, technological advances and investment (Williams et al. 2015b).

The late Holocene saw significant population increase, with hunter-gatherers reaching their zenith of ~1.2 million at 0.5 ka, a tenfold increase on Pleistocene levels (Williams, 2013). Data suggests that the highest populations during this time were in the southeast of Australia. Williams et al. (2015b) suggest that this increase was likely a result of intensification of earlier technological advancements, including hafting-technology, plant and seed processing, and localised landscape management (using fire), allowing climatic downturns to be successfully weathered. These included strong arid El Nino Southern Oscillation (ENSO) conditions between 4–2 ka, and increasingly turbulent climatic conditions during the Medieval Climatic Anomaly (1.3–1 ka) (generally wetter) and Little Ice Age (0.3–0.5 ka) (generally drier) (Williams et al. 2010; 2015a). A result of these denser populations was decreasing freedom of movement and the formation of strong classificatory kinship systems, complex cultural and symbolic landscapes based on geographic totemism (the 'Dreaming'), distinctive graphic art systems, land rights in the form of ritual property, and formalized exchange networks (Williams et al. 2015a).

Apart from archaeological assessments associated with the Study area (Section 5.4), very few other archaeological investigations have been conducted in the region, indicative of the long established agricultural and farming practises of the region. One notable study undertaken by Dan Witter (2004) conducted a broad, large-scale study of Aboriginal archaeology in western NSW, including the Lake Cowal area. Witter (2004) classified the Lake Cowal area as lying within the Southwestern Slopes bioregion which extends south from Dunedoo, through central NSW to northeast Victoria, and terminates on the western fringes of the Great Dividing Range. The bioregion is primarily situated on Wiradjuri Country, encompassing the lower slopes of the Great Dividing Range, which Witter (2004) describes physiographically as 'a transitional zone between the high plateaus of the Dividing Range and the vast plains to the west… [and includes] a pocket of riverine plains around Condobolin' (Niche 2018: 25; Witter 2004: 137).

Witter's (2004) study confirmed that open campsites characterised by surface stone artefact scatters are the most common site type in the region and though they occur on all landforms, they are most prevalent in stream valleys and crests. Other site types such as heat retainer ovens (hearths) and ground implements such as axes, are present in the region though relatively uncommon, as are suitable outcrops of raw materials used for stone toolmaking (Niche 2018: 35). Quartz was identified as a very common raw material used for making stone tools. Historically, the region has been subjected to extensive agricultural development with farming practices impacting both surface and potential subsurface artefactual sites. Witter (2004) notes that this, in conjunction with unfavourable landscape preservation conditions reduces the potential for identifying Pleistocene-age sites (>10,000 years old) in the region.

Witter's regional model is valuable for understanding the general archaeological landscape of Central West NSW; however, he notes that unique, localised variations in landscape features and environmental conditions can result in a diversity of site types and frequencies, while remaining consistent with the broader archaeological landscape of the region (Niche 2018: 25; Witter 2004: 134). Such is the case with Lake Cowal, noting it is a significant landscape feature. Numerous archaeological investigations been conducted as part of the environmental assessment process for the development of the CGO, and the resulting accumulation of information has demonstrated that while the local archaeological context is broadly consistent with the regional model, Lake Cowal has distinctly identifiable locales where specific activities were being undertaken west of the lake, such as routine domestic activities (cooking, tool preparation and maintenance), hunting and woodworking activities, and potential warfare and ritualistic activities.

## 5.3 Local context

This region was subject to a regional study by the Department of Planning and Environment for the Greater Macarthur Investigation Area (AHMS, 2015). Their synthesis of the region was as follows:

> Archaeological studies have been undertaken in this subregion since the early 1980s, but on a much lesser scale than the Cumberland subregion. The earliest investigations were focussed on Lucas Heights during the development of a waste disposal facility. Studies by Silcox, Brayshaw, Attenbrow & Negerevich, Koettig and McDonald recorded extensive numbers of sites in the vicinity of Bardens and Mill Creeks (Silcox, 1980; Brayshaw, 1982; Attenbrow & Negerevich, 1981; Koettig & McDonald, 1984). These sites were predominantly rockshelters containing art and/or deposits.
>
> Investigations carried out at a number of the sites indicate that initial occupation of this area commenced relatively late in the Holocene period, that is, less than 3,000 years ago and continued until close to the time of European arrival. Cultural material present in excavated deposits reflects a predominantly 'inland' economy with minimal exploitation of estuarine resources (Navin Officer Heritage Consultants 1997: 4-45).
>
> Similar findings occurred on surveys undertaken in Wedderburn by Smith & Crew and Sefton - an investigation of Yeoman's Estate located eight sites, including five rockshelters, two grinding grooves and a culturally modified tree (Smith & Crew, 1988; Smith, 1991; Sefton, 1981, 1982, 1986, 1987, 1990).
>
> Of note was an extensive study of the Holsworthy Military Area as a possible location for the second Sydney airport in the late 1990's. Navin Officer built on extensive studies already undertaken of the military area by the Sydney Prehistory Group and Australian Museum Business Services. Before the field investigations, some 295 sites were documented (Navin Officer Heritage Consultants 1997: 4-57).
>
> At the completion of the field inspections, Navin Officer documented over 800 archaeological sites in the Holsworthy Military Area.

These sites were almost exclusively constrained to the deeply incised creek valleys and ravines running through the military area, and were comprised of isolated finds (n=37), artefact scatters (n=19), culturally modified trees (n=48), grinding grooves (n=185), open engraving sites (n=15), open sites and grinding grooves and engravings (n=10), rock shelters (n=659) (Navin Officer Heritage Consultants 1997: 5-14).

In 2002, Jim Kelton carried out an archaeological assessment of a proposed sewerage transfer from the Hoxton Park Release Area to the Liverpool Sewerage Treatment Plant (STP) (Central West Archaeology and Heritage Services, 2002). The development involved laying 7 kilometres of pipeline between the two locations using trenching and tunnelling methods. No Aboriginal sites or objects were located during the field survey. Two PADs, however, were identified adjacent to the corridor: on the northern and southern banks of Cabramatta Creek, Hoxton Park (adjacent to the Hinchinbrook Creek junction) and the northern bank and adjacent alluvial terrace of the second crossing of Cabramatta Creek (approximately 400 metres east of the Hinchinbrook Creek junction). More recently, Cultural Heritage Connections undertook a preliminary assessment of the proposed Southern Sydney Freight Line situated just west of the Georges River. This assessment, running from Macarthur to Ingleburn identified 17 archaeological sites in close proximity to the subject area. These sites were predominantly artefact scatters (n=10), culturally modified trees (n=5) and a potential archaeological deposit (Cultural Heritage Connections, 2006). No sites were recorded within the study area.

Similar findings were made by EMM as part of an unpublished study of proposed water infrastructure at nearby Lake Avon:

To the west [of Lake Avon], in the uplands and above the escarpment, the archaeological signature sees increasing diversity, with the steep sandstone country more conducive to rockshelter (and associated deposits), grinding grooves and engraving site types. While open sites – stone artefact scatters – continue to be documented, and can be characterised as of low density surface or shallow (<30cm) deposits composed of primarily quartz and chert raw materials (eg AMBS 2007; Didben 2005; Silcox 1987), several of these other site types become more dominate. Excavations of a number of these rockshelter sites have occurred, and suggest occupation may have begun as early as ~15ka (Kelton and Mills 2003), but more commonly appear to date to the last few thousand years. For the most part, these shelters continue to show a fairly ephemeral, albeit repeated, use of the region. The location of these sites were generally limited to the presence of steep, near vertical, sandstone geology, but often occurred on elevations, rather than valley floors, where flooding can scour such features. Conversely, grinding grooves are more commonly found adjacent, and within creekbeds where geological outcropping is exposed. In a study of grinding grooves at Picton, north of the study area, Niche (2019) analysed some 89 previously documented sites, and identified that the majority of sites contained a single groove, but examples of up to 91 were recorded; and that inter-site groove counts can vary greatly but are most likely to occur either within a stream bed or within rockshelter features. They further found that the groove sites were commonly found in smaller drainage lines. A regional study by Dibden (2019) identified 182 sites containing grinding grooves (2,015 grooves overall). The number of grinding grooves ranged from one to 92 with 70% having 10 grinding grooves or less ($\bar{x}$=11.1). Although she found the vast majority of groove sites were constrained to the Cataract river catchment, north of the study area.

…Of note, Dibden's (2019) study, entitled *Drawing in the Land: Rock Art in the Upper Nepean, Sydney Basin, New South Wales …* provides a critical picture of the past history of the region. She analysed the features, composition and content of some 810 previously documented archaeological sites across the Upper Nepean catchment, of which 627 (~77%) were rockshelters. 171 of these were within the Avon catchment in the general vicinity of the study area, with some 140 containing 1,562 individual art motifs and 72 exhibiting an archaeological deposit or stone artefacts. These values reflect approximately 1.17 sites per square kilometre. The study broke activity in these shelters down into three main time periods: i) >4,000 years ago ii) 4000-1600 years ago; and iii) <1600 years ago.

The earliest phase is characterised by intaglio[1] art and is constrained to two sites; one of which (Cad 5; #52-5-0334) is situated within a few hundred metres of the proposed Bank of Avon reservoir works. Phases 2 and 3 were more widespread, with 45 sites in the Avon catchment containing phase 2 art, comprised of mainly red graphics and stencils and 217 exhibiting phase 3 art dominated by charcoal graphics and stencils. None of the sites containing large or significant assemblages are identified in the vicinity of the study area; the divide between Avon and Cordeaux catchments being the focus activity during these phases. Phase 2 and 3 sites are generally found on ridgelines, crests, upper valley slopes, and watershed divides. Phase 2 art sites generally contained large living areas in substantive rockshelters, the later phase 3 sites have a more diverse distribution in a range of previously unused and often difficult to access rockshelters, indicative of changing social behaviour potentially as a result of the arrival of Europeans.

A further study is of relevance was undertaken by Jo McDonald Cultural Heritage Management (JMCHM) in 2003, consisting of archaeological excavations on the banks of Wingecarribee Swamp (JMCHM, 2006). These works were initiated by Sydney Catchment Authority following a structural collapse of several of the swamp's banks, and which resulted in the loss of substantive parts of a peat unit, which exposing a number of Aboriginal sites. JMCHM investigated two of the seven areas containing cultural material – both in the general vicinity of the Intermediate Shaft 1– and undertook the excavations of ~27m$^2$. These excavations indicated the formation of the peat unit, ~50cm in thickness, began forming ~2, 700 years ago, and contained evidence of past visitation. Specifically, 521 artefact (7-74/m$^2$) were recovered within 20m of the swamps' edge, primarily in the upper 40cm of the soil profile. The assemblage was dominated by silcrete and quartz raw materials with lesser occurrences of fine grained siliceous and fossilised wood; and reflected multiple phases of occupation of the area, which in some instances preceded the formation of the peat unit forming the focus of the study.

## 5.4 Local previous studies

A number of previous local studies have been undertaken, many of them associated with the Tahmoor Coal mine. These are summarised below.

### 5.4.1 Tahmoor South coal project (Niche 2019, 2020)

Niche Environment and Heritage Pty Ltd (Niche) prepared an Aboriginal cultural heritage assessment (Niche 2019) to accompany the project EIS. The ACHA assessed the study area for both the A series and B series of longwalls in Tahmoor South (see Figure 1.1). This assessment included the proposed study area of Mod 3. As part of the assessment, an Aboriginal cultural heritage survey was conducted over 16 days in 2013, a reassessment of the condition of sites was conducted over three days in October 2017 and an additional day in October 2018. Further assessment required for the project was undertaken by EMM in 2019 which included archaeological test excavation at TSC2 ventilation shaft site location (in proximity to AHIMS site # 52-2-4487) as recommended by Niche and additional archaeological survey of proposed electrical transmission line (ETL) corridors. Fieldwork for the ACHA was completed by archaeologists and Registered Aboriginal Parties (RAPs). It is noted that ventilation shaft sites TSC1 and TSC2 have not been constructed to-date.

The ACHA included the outcomes of an Aboriginal consultation process, an archaeological investigation (survey and test excavation), and consideration of potential impacts. No Aboriginal sites were recorded within the current study area of this project or within the general vicinity (<200 m).

The ACHA completed by Niche in 2018 for the Tahmoor South Project was amended following changes to the mine plan in 2020.

[1] Intaglio relates to an image that is engraved into a surface, and paint applied to the incised lines created.

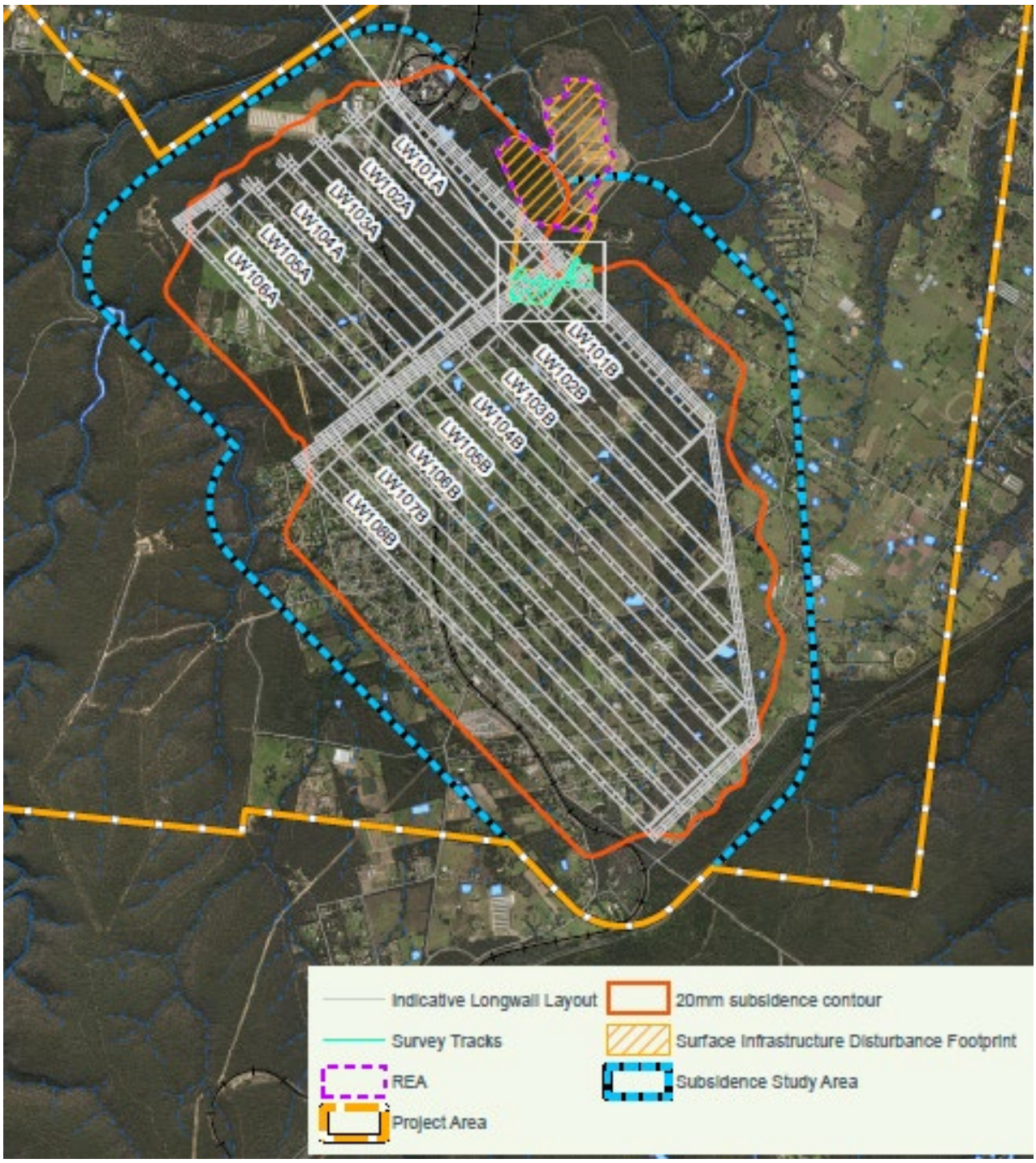
The assessment, which encompasses the current study area, focused on drainage lines as they are the most archaeologically sensitive landforms and are also the most likely to be affected by subsidence impacts from underground mining. The assessment identified 24 sites of low significance, two sites of moderate significance and four sites of high significance.

The most common site types recorded in the study area were rockshelter sites with art and/or deposit as well as axe grinding groove sites. The rarest site types recorded were culturally modified trees (n=1). On the plateau and rolling hills away from major drainage lines the archaeological record consists primarily of stone artefacts scatters and occasional culturally modified trees. A limitation to this characterisation is that sites containing stone artefacts are dependent on there being exposure and erosion to enable them being detected, and extensive clearing of the timber on the plains will have removed the majority of culturally modified trees.

The report concluded:

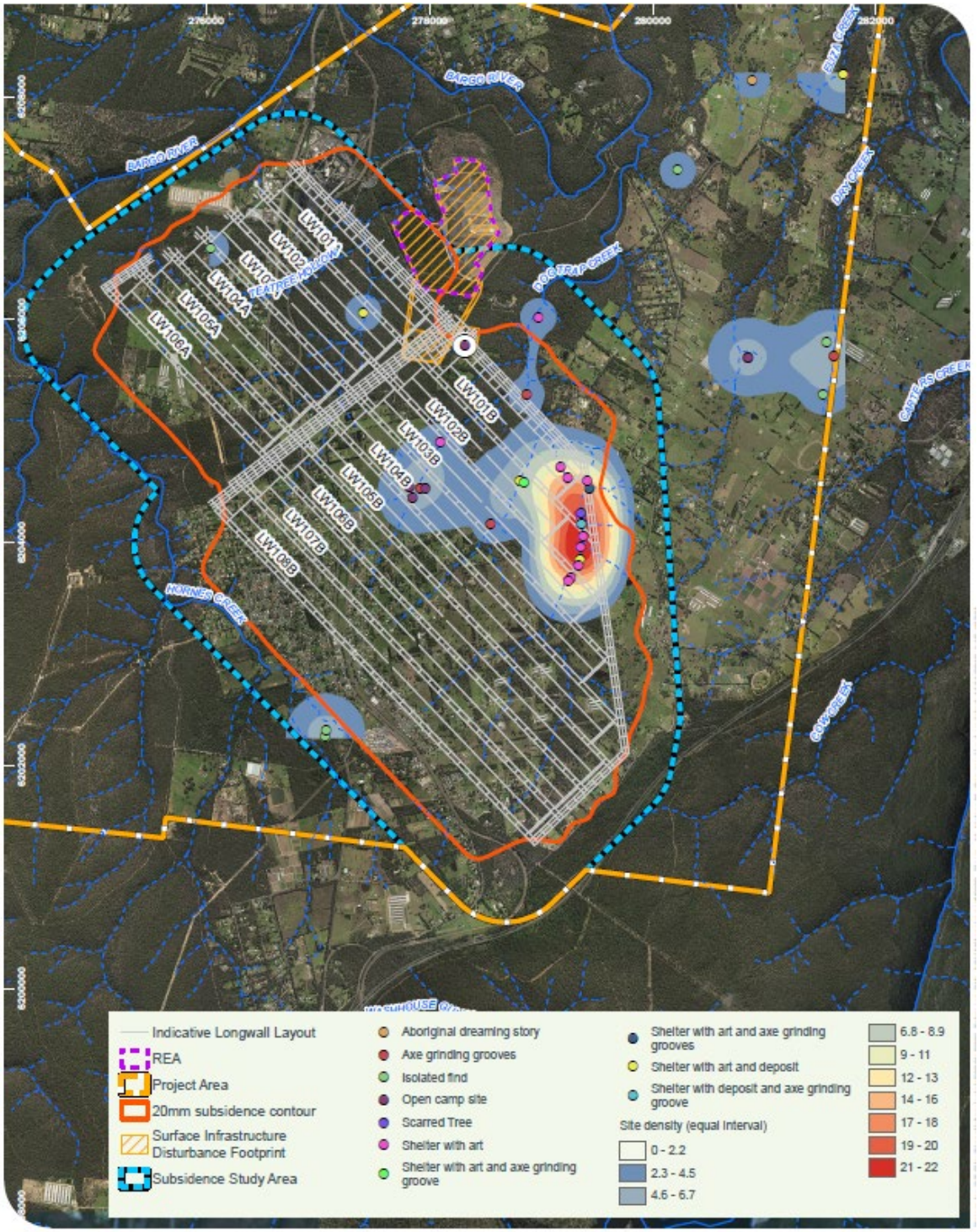
> Nevertheless, the general observation that larger sites containing stone artefacts (these are interpreted to be representative of more intensive or more repeated use of particular areas by Aboriginal people in the past) are only found in close proximity to drainage lines is relevant and confirmed by the results of this assessment (White and McDonald 2010). Where there are exposed sandstone platforms within the subject area grinding grooves sites are present, and this is typical for the region, representing a utilitarian use of these areas by Aboriginal people in the past. Notably, however, many of the rock shelters also contain axe grinding grooves.
>
> The most notable cultural heritage within the Subject Area is the cluster of rock art and occupation sites within Dogtrap Creek. This type of site clustering is not evidenced elsewhere within the local area, and is rare in the region. The clustering of sites can be explained partly by the fact that Dogtrap Creek presents a unique feature in the region, being larger than most drainage lines, but smaller than the massive gorges and cliffs of the Bargo and Nepean Rivers. As such, Dogtrap Creek would have been readily accessible to Aboriginal people in the past, and contains rock shelters that were still large enough for occupation and artistic expression. However, the fact that suitable rock shelters were present is only part of the story of past Aboriginal land use for the Subject Area and Dogtrap Creek. The density and diversity of sites and motifs within Dogtrap Creek suggests the area was a significant cultural precinct for Aboriginal people in the past, including the recent past during the first contacts with European people based on interpretation of some of the motifs present" (Niche 2020, p.56).

However, while this study included the current study area, field investigation focussed only on surface infrastructure, and which is some distance from the proposed modification (Plate 5.1).




Source: Niche 2020 (Figure 7)

**Plate 5.1** **Survey coverage for the Tahmoor South ACHA shown in green. The MOD 3 study area is situated to the west of LW106A within the subsidence study area marked with a dashed blue line.**




Source: Niche 2020

**Plate 5.2** **The archaeological findings of Niche (2020). A key focus was towards Dogtrap Creek, which is some distance from the study area.**

### 5.4.2 TSC2 ventilation shaft (EMM 2020)

In 2020, EMM undertook test excavation on the Lucas Heights soil landscape adjacent to the current study area, near AHIMS site #52-2-4487 (Charlies Point Road OCS-1) in response to an amendment to the Tahmoor South coal project, specifically the addition of a proposed powerline route to the proposed ventilation shaft site TSC 1 (EMM 2020b). Soils across the excavation program consistently comprised of a shallow (<10–15 cm) moderate to highly compacted silty clay loam A1 soil horizon with frequent gravel inclusions and ironstone nodules, with an underlying dull yellow orange mottled basal clay (Plate 5.3).

Overall, no cultural materials were encountered, and the report concluded that archaeological resources of the area are more likely to be concentrated in closer proximity to water sources (i.e. within 200 m) and in association with rock outcrops (i.e. shelter sites). The location of the disturbance footprint of TSC 2 and Aboriginal site Charlies Point Road OCS-1 is 500 m from the nearest water source (Dogtrap Creek) and was situated on a featureless, plain landform within which focal points for past activity cannot be readily defined.

The archaeological potential of the test excavation area was assessed as low to moderate. Surface artefacts identified as Charlies Point Road OCS-1 demonstrate that artefacts have the potential to occur, however the results of the test excavation in identifying no archaeological material support the assessment that Aboriginal objects are likely to be in very low density.

Source: EMM 2020b p.15

**Plate 5.3 Typical Lucas Heights soil profile**

### 5.4.3 Tahmoor Western Domain LW W1 – W2 ACHA (EMM 2019)

EMM conducted an archaeological field survey assisted by RAP representatives from Cubbitch Barta Native Title Claimants Aboriginal Corporation and the Tharawal LALC. The fieldwork involved survey and baseline recording of all rockshelters and grinding groove sites within the study area for LW W1–W2 and further survey of the wider LW W3–W4 to account for all sandstone Aboriginal site types within the locale.

A total of 30 Aboriginal sites were identified in the study area, comprising 25 previously documented sites and five newly identified during the survey. Rockshelters were the most frequently occurring site types in the study area (n=22, 73%), occurring predominantly in the sandstone escarpment adjacent to Matthews and Cedar Creeks. Artefact sites were also prevalent (n=6, 20%) comprising five isolated finds and one artefact scatter. The remaining sites were a grinding groove site (#52-2-2068) and a culturally modified tree (#52-2-2100).

### 5.4.4 Tahmoor Western Domain LW W3 – W4 ACHA (EMM 2021)

An update to the 2019 report was undertaken in 2021 to support the variation of existing approvals, and expand the long wall mining. This report utilised information from EMM (2019), and found that of the 30 previously identified sites, eight would be within the potential subsidence zone of the proposed activities.

The focus of the ACHA was on the potential subsidence to a significant grinding groove site, #52-2-2068, from the works. The site consisted of some 120 discrete grooves in two main locales on exposed sandstone within the base of the creek (Plate 5.4 and Plate 5.5). The site was considered highly significant, and as a result was proposed for ongoing monitoring during the activities to ensure impacts did not occur. As of the date of this report, regular monitoring was continuing at the site.

Source: EMM 2019, 2021

**Plate 5.4** **Stonequarry Creek #1 (#52-3-2068), a significant grinding groove site at Stonequarry Creek, north of the study area**

Source: EMM 2019, 2021

**Plate 5.5 Detail of grinding grooves at Stonequarry Creek #1 (#52-3-2068), a significant grinding groove site at Stonequarry Creek, north of the study area**

### 5.4.5 Redbank Creek 4 – grinding groove site (Niche 2019)

In 2019, Niche completed a comparative analysis of local Aboriginal site features to inform rarity and representativeness, with a focus on grinding groove sites and sites associated with watercourses in the Picton area (Niche 2019). The study area was centred on the grinding groove site Redbank Creek 4 (#52-2-2082) which is on a sandstone platform within the bed of Redbank Creek, a second order stream approximately 3 km south-east of the current study area.

The Niche 2019 study area used AHIMS site information (n=89) and grouped sites according to their associated watercourse comprising Redbank Creek, Dogtrap Creek, Eliza Creek, Matthews Creek, Myrtle Creek and Stonequarry Creek.

Niche found that the creeks of the Picton area contain a diverse site feature assemblage with sandstone rockshelter sites and open artefact sites being the most prevalent site type, as is typical for the area and once again representing the "transitional" nature of the interface between the plain and plateau landscapes. A total of 39 rockshelter type sites were used in the comparative study. Notably Dogtrap Creek, which although not a particularly large drainage line, contained an extraordinary cluster of art sites (n=17), many of which are of high archaeological and cultural significance. Niche (2018 p.35) described this as a "significant archaeological complex, with no similar site concentrations currently known in the surrounding area".

Grinding groove sites were less common and have only been recorded along Redbank Creek (n=1), Dogtrap Creek (n=4) and Stonequarry Creek (n=4). Niche provided a breakdown of groove counts for the nine sites in the Picton area. The results show that inter-site groove counts can vary greatly but are most likely to occur either within a stream bed or within rockshelter features.

### 5.4.6 Teatree Hollow Rockshelter test excavation (EMM 2023)

As part of the Tahmoor South Extraction Plan for longwalls LWS1A – S6A, a heritage management plan (HMP) was developed that provided direction on the management of cultural materials that may interact with the proposed development activities. One of the requirements was the proactive investigation of a documented rockshelter, Teatree Hollow 2013.1 (AHIMS #52-2-4471), situated on the eastern bank of Teatree Hollow Creek (refer Figure 5.2).

While the site was considered of very low risk of being adversely affected by the under-mining of the locale, discussions with Heritage NSW and the registered Aboriginal parties sought to obtain some archaeological information from the site prior to the development activities should harm and/or destruction ultimately result.

In 2022, targeted excavation of three 0.25 $m^2$ test pits within the rockshelter was undertaken with RAP participation (Plate 5.6 and Plate 5.7). The findings of the investigations are summarised in the report as follows:

> General overview
>
> Overall, the excavations found a relatively shallow archaeological deposit, on average ~28cm thick. This consisted primarily of two units: i) an upper compact brown (10YR 5/3) fine sand with frequent charcoal flecks, some 5 cm thick and reflecting the modern, trampled, land surface; over-laying ii) a yellowish brown (10YR 5/4) loose medium to coarse sand, and believed to reflect degrading sandstone either from the under-lying geology and/or from collapsing rockfall. Of note was a thin very dark grey (10YR 3/1) coarse sand with abundant charcoal found below (ii) in the north-eastern corner of test pit #3, and which has been hypothesised as a possible hearth feature. Charcoal samples were recovered from this feature and will provide a maximum age for the deposits within the site (see below). Artefacts were recovered from this feature, which is located in the deepest and highest part of the rockshelter. It is the only part of the site with a substantive flat surface where a person may sit or lay.

The deposits were situated immediately over undulating sandstone outcropping in all test pits. Test pits #1, #2 and #4 all contained numerous roots of various sizes from established nearby vegetation running along the soil-bedrock interface; and it is probable that these have resulted in some post-taphonomic modifications of the cultural deposits and associated stone artefacts.

Chronology

Of the collected chronological samples, 10 charcoal samples from test pits #3 and #4 were processed by the Chronos laboratory at University of New South Wales.

These samples were selected, either being within or associated with the possible hearth feature in test pit #3 and/or where the highest stone artefact densities were recovered.

The samples range in age from 1,700 calibrated years BP (before present) and 301 calibrated years BP. The substantive bioturbation and root intrusions throughout the soil profiles have resulted in numerous reversals and mixing of these ages. For example, the deepest sample recovered (UNSW-2004) provided one of the youngest ages. Conversely, several of the oldest samples were collected from unit (ii) that forms one of the upper units sitting across the cultural deposit.

However, a suite of ages recovered from the possible hearth feature found at the base of test pit 3, all return ages between ~800-1,000 calibrated years BP (including UNSW-1995, -1996, -1997 and -2000). Several of the ages from unit (ii) that overlies the possible hearth feature also return ages between ~800-1,100 calibrated years BP. The only sample collected from unit (i) returned an age of 439-144 calibrated years BP (UNSW-2000), and this aligns with some of the youngest samples recovered from the underlying unit (ii).

While a comprehensive age-depth model is not feasible given the variability within the samples, a general indication of the age of the site can be determined. Specifically, the majority of the deposits appear to date to between ~450- 1,200 calibrated years BP, with some suggestion of a possible earlier formation as early as ~1,700 years BP. The uppermost units, effectively the current surface of the site, began forming over the last 400 years, and the limited data suggests continually formation up to, and into the post-Contact period.

The majority of the cultural assemblage was recovered from spits 5 and 6 within test pit #4. This is unfortunately one of the most variable cluster of samples collected. However, it appears likely this reflects an occupation focus around 1,000 calibrated years BP.

Stone artefact analysis

A detailed lithic analysis has been undertaken by Dr Trudy Doelman at the University of Sydney, and is presented in Appendices B and C. In summary, a total of 116 artefacts were recovered. These were primarily found in test pits #3 and #4 situated in the centre and largest part of the rockshelter. To the north, the site is a steep sandstone slope to a rocky edge on the creek and can be used to access the site, but would be entirely unsuitable for sitting or sleeping; while to the south the roof slopes down dramatically and a person would be unable to stand in this of the site. Despite a narrow piece of deposit being present in the south, no substantive cultural materials were encountered in test pits #1 and #2, and suggest this was not a well used part of the site in the past.

The artefacts recovered from test pits #3 and #4 are found in close proximity to surface artefact scatters previously recorded (Plate 1), and unit (ii) may be the source of these cultural materials eroding down the face of the rockshelter in the vicinity of the dripline. In contrast to the surface scatter, the recovered assemblage is dominated by very small (<2 cm) artefacts, or micro-debitage, and may reflect the smaller fragments from artefact production occurring within the rockshelter and that have been trampled or

bioturbated into the deposits. These were primarily found to depths of ~8-14 cm below surface (spits 4-7), and which would be within a trampling zone, especially during wetter conditions. It is probable that these artefacts may reflect a single occupation event given the potential for movement through the shallow soil profile.

The artefacts recovered were dominated by milky quartz raw materials, with a small number of banded IMTC (indurated mudstone/tuff/chert) and silcrete. Two fragments of basalt were encountered, and which may reflect flaking of a ground implement, such as a hand axe.

The assemblage lacked substantive diagnostic information, but suggests a late Holocene (<5,000 years ago) deposition. The fragments from an edge ground axe also constrain the assemblage to <3,500 years ago when this tool type reached the region. The assemblage therefore aligns well with the radiocarbon data recovered from the site and suggesting visitation in the last <1,500 or so years. The assemblage included the remains of at least 11 cores, and strongly suggests habitation and/or repeated occupation, rather than a brief hunting or re-tooling camp. The use of water-rolled milky quartz pebbles suggest a local source of raw materials, as well as longer transport of some of the other lesser used materials recovered.

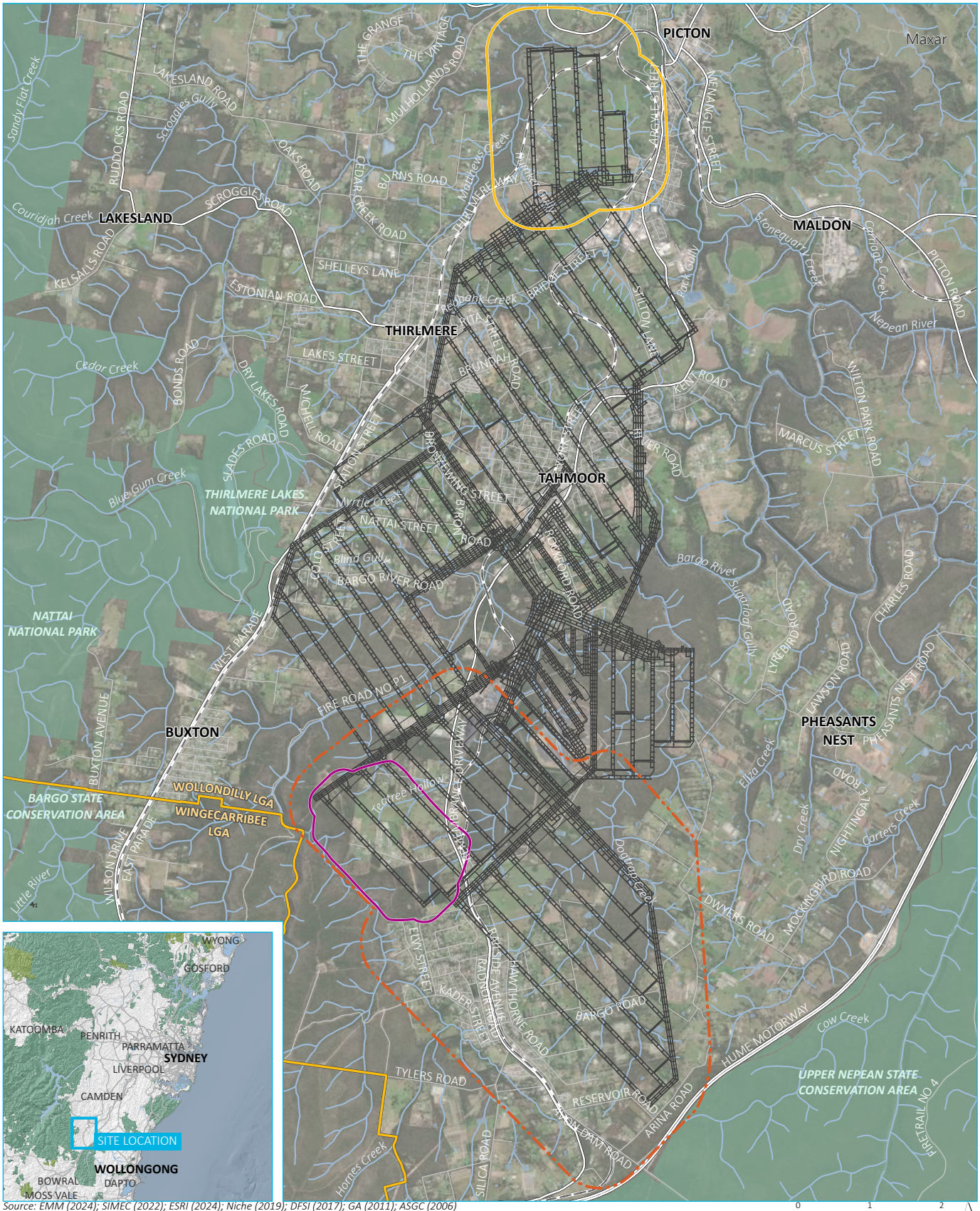
The site continues to be monitored as part of the ongoing operations at the site. At the time of this report, no impacts from subsidence had been observed since the initiation of the development activities in late 2022.

Source: EMM 2023

**Plate 5.6 Excavations undertaken at Teatree Hollow rockshelter, #52-2-4471, as a protective measure in the event of unexpected subsidence, looking south**

Source: EMM 2023

**Plate 5.7** **Excavations undertaken at Teatree Hollow rockshelter, #52-2-4471, as a protective measure in the event of unexpected subsidence, looking north**




Source: EMM (2024); SIMEC (2022); ESRI (2024); Niche (2019); DFSI (2017); GA (2011); ASGC (2006)

KEY

- Study area
- EMM (2019,2021)
- Niche (2019,2020)
- Mine plan

Existing environment

- Rail line
- Major road
- Minor road
- Watercourse/drainage line
- Waterbody
- NPWS reserve
- State forest
- Local government area

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# Local previous studies

Tahmoor South Coal Project
SSD 8445 Modification 3
Figure 5.1

EMM
creating opportunities

## 5.5 AHIMS data

The Aboriginal Heritage Information Management System (AHIMS) database is managed by Heritage NSW and includes a location and description of Aboriginal objects and sites recorded through academic research and cultural heritage management (see Appendix C.1 for further explanation of Aboriginal site features). The search identified any Aboriginal sites or places registered within the Study area and aids predictions for the frequency and distribution of Aboriginal site types in the broader landscape. A copy of all AHIMS searches is provided in Appendix C.2.

EMM conducted a search of the AHIMS database to cover the Study area on 18 January 2024 (between longitudes 150.5131 and 150.6367 and latitudes -34.3021 and -34.2311).

A total of 85 previously documented sites were identified (Table 5.1, Figure 5.2). The most common site types within the search area are rockshelters (n=49), followed by various stone artefactual sites including isolated finds and artefact scatters (n=21). In addition there were four grinding grooves sites, three areas of potential archaeological deposit (PAD), two culturally modified trees, a rock engraving, an open art site and an open camp site. There are also three restricted sites in the search area, which Heritage NSW (DCCEEW) has confirmed are outside the study area (David Gordon, pers. Comm. 7 February 2024).

Spatially, rockshelters and grinding groove sites are confined to watercourses typically within steeply incised sandstone Country. Most open artefact sites are identified on gentle slopes in proximity to watercourses.

No Aboriginal objects or sites are documented within the study area. The nearest sites to the study area:

- AHIMS #52-2-1380: Fire Road No. P1 – Rock engraving site located on sandstone outcrop ~100 m away from an unnamed first order stream that branches off the Bargo River and 500 m to the west of the study area. The rock engraving consists of a single straight line, 1 cm wide and 0.5 cm deep.

- AHIMS #52-2-2042: Couridjah 4 Tahmoor – Rockshelter with art, 500 m to the north of the study area. Shelter is a sandstone overhang, formed by cavernous weathering, located on Hawkesbury soil profile. No level area was located in front of the shelter. Art consists of a single adult left hand stencil, created with red ochre.

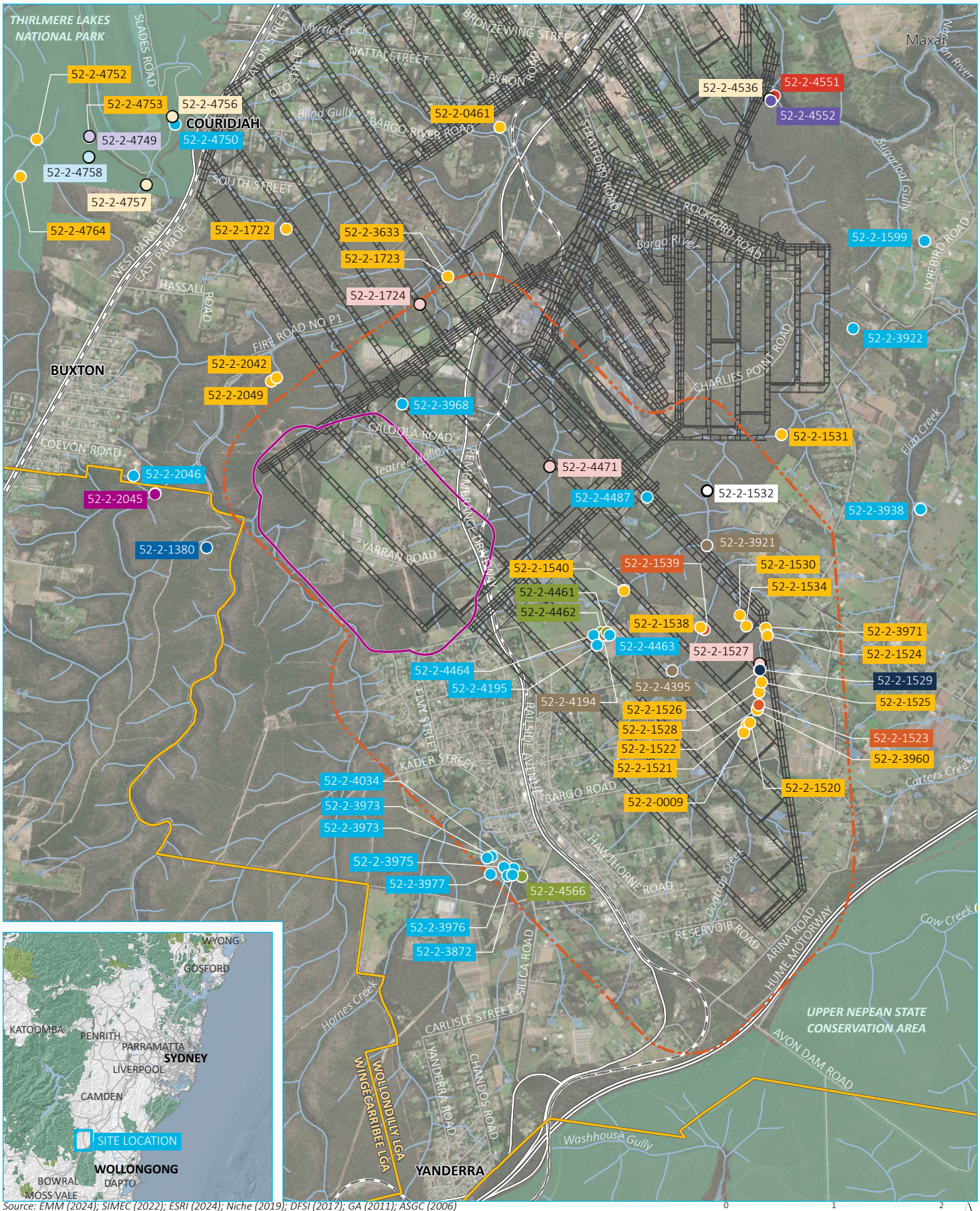
- AHIMS #52-2-2045 East Buxton One; Lot 62 DP 751270 – Rockshelter with deposit, 950 m to the west of the study area – Large sandstone rockshelter located on the Hawkesbury soil profile. The shelter is one of three located on the scarp. Half of the shelter is sloping rock, with rockfall covering a further 20% of the shelter floor. One quartz flake was recorded in the dripline. No art was detected during the recording of the site.

- AHIMS #52-2-2049 Coridjah 5 (Tahmoor) – Rockshelter with art, 500 m to the north of the study area. Site is a sandstone overhang rockshelter located on the Hawkesbury soil profile. Shelter is cavernous and likely formed by weathering and rockfalls. Sprayed red pigment was recorded on the lower ceiling, considered the equivalent to amount used for three hand stencils. A further section of sprayed red pigment was recorded on the rear wall of the shelter. At the time of recording, the shelter floor had been disturbed by wombats and the red pigment was degraded.

- AHIMS #52-2-3968: Remembrance Drive 2013.1 – Open site artefact scatter, 200 m to the east of the study area. Comprises two silcrete artefacts recorded on an established track. The artefacts were recorded on a knoll within an undulating plain in an area of limited visibility. The site is located ~200 m from the nearest water course.

**Table 5.1 Previously documented Aboriginal objects and sites within the AHIMS database**

| Site Type | Number of recordings (n) |
|---|---|
| Open Art Site | 1 |
| Artefact | 21 |
| Culturally Modified Tree | 2 |
| Grinding Groove | 4 |
| Open Camp Site | 1 |
| PAD | 3 |
| Restricted | 3 |
| Rock Engraving | 1 |
| Rockshelter | 49 |
| **Total** | **85** |




Source: EMM (2024); SIMEC (2022); ESRI (2024); Niche (2019); DFSI (2017); GA (2011); ASGC (2006)

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KEY

- Study area
- ACHA study area (indicative) (Niche 2019)
- Mine plan

Existing environment

- Rail line
- Major road
- Minor road
- Watercourse/drainage line
- Waterbody
- NPWS reserve
- State forest
- Local government area

AHIMS (by site type)

- Art Site
- Artefact
- Culturally Modified Tree
- Grinding Groove
- Open Camp Site
- PAD
- Restricted
- Rock Engraving
- Selter with PAD
- Shelter with Art
- Shelter with Art and Deposit
- Shelter with Art and Grinding Grooves
- Shelter with Art and PAD
- Shelter with Art and Stone Arrangement
- Shelter with Deposit
- Shelter with PAD
- Shleter with Art

# Previous documented Aboriginal objects and sites in, or near, the study area

Tahmoor South Coal Project
SSD 8445 Modification 3
Figure 5.2

EMM creating opportunities

## 5.6 Predictive model

Landscape analysis teamed with a review of previous archaeological investigations and mapped AHIMS results demonstrates that the study area was utilised by Aboriginal people in the past and that archaeological traces remain throughout the landscape.

Outcropping Hawkesbury Sandstone is suitable for the occurrence of Aboriginal grinding grooves, rockshelters (including those with art), rock engravings and modified rock pools. Landscape analysis indicates that outcropping sandstone is confined to deeply incised streams, scarps and cliff lines. Therefore, areas of high risk within the study area where there is potential for impacts to occur from subsidence are areas that that have high potential to feature sandstone type sites. This includes:

- all Hawkesbury soil landscape boundaries
- anywhere that >40% slope extends beyond these soil landscape polygons.

Extensive sandstone expanses within the stream bed of Hornes Creek, where the stream channel is wider and more easily accessible, may contain the right conditions for more grinding grooves to be present. Grinding grooves that are the result of shaping stone hatchets are likely to be present near water as this is an essential element for the manufacture process.

Overall, the study area has very limited potential to feature sandstone-type Aboriginal archaeological sites outside of incised stream channels and adjacent scarps in areas mapped with Hawkesbury sandstone geology.

The predictions for the distribution of scatters of stone artefacts or isolated artefacts in the study area are generally consistent with established models in eastern NSW that are based on proximity to water and the reliability of the water source. Larger sites with higher artefact densities are likely to occur near reliable streams, whereas smaller, low-density sites may occur near ephemeral streams. Elevated landforms with good outlook near streams are areas most likely to have been chosen for camp sites. The AHIMS search results provide a cursory image of the distribution of stone artefact sites and supports that they are commonly found in association with both ephemeral and reliable streams in open rolling hill landform patterns.

Historical land use and disturbance levels in the study area are unlikely to have affected sandstone-type Aboriginal sites. Historical vegetation clearance and agricultural land use are likely to have removed most traces of modified trees and displaced Aboriginal stone artefacts. More intensive disturbance such as infrastructure and housing developments are likely to have removed entire archaeological deposits if present.

Based on above, a predictive model has been developed, and is outlined in Table 5.2.

**Table 5.2 Predictive model of site locations**

| Site type | Prediction for study area |
|---|---|
| **Sandstone site types** | |
| Rockshelters with pigment art and/or archaeological deposit | Rockshelters featuring stone artefacts, PAD and art have been recorded beside a tributary to Bargo River to the north of the study area and beside Teatree Hollow and tributaries to Dogtrap Creek. This demonstrates that scarp adjacent to incised stream channels (typically 3rd order and above) on Hawkesbury Sandstone geology are suitable to feature such site types.<br>Topographic and geological data indicates that rockshelters are highly unlikely to occur outside Hornes Creek within the study area. Teatree Hollow (3rd order) and other 1st and 2nd order streams in the study area are not incised to the level that could feature rockshelter sites. Rockshelters have negligible potential to occur on Mittagong Formation geology that covers the central and eastern portions of the study area. |

## Table 5.2 Predictive model of site locations

| Site type | Prediction for study area |
|---|---|
| | The potential to identify new rockshelters is unclear considering that although Niche surveyed the Tahmoor South project study area, it is unclear whether they walked the western section of the current study area near Hornes Creek. |
| Grinding grooves, engraved rock art and engraved groove channels | Grinding groove sites are relatively common in landscapes with outcropping sandstone.<br>Grinding grooves have potential to occur within other stream beds or adjacent areas of outcropping Hawkesbury Sandstone, but such areas would be limited by pooled and flowing water, sediment and narrower stream beds. Within the study area, sections of the sandstone stream bed of Hornes Creek that are more open and accessible represent the most ideal landscape feature to contain grinding grooves. There is potential for grooves to occur in rockshelters.<br>The potential to identify new rockshelters in the study area is unclear because of gaps in background information, including mapped survey tracks from previous investigations.<br>Grinding grooves have low to negligible potential to occur within streams mapped on Mittagong Formation geology unless very close to transition zones with Hawkesbury sandstone geology.<br>Engraved rock art and engraved groove channels are much rarer than grinding groove sites but could also occur on suitable outcropping sandstone expanses. |
| **Non-sandstone site types** | |
| Open artefact sites and isolated finds | Open stone artefact scatters and isolated finds are the site types most likely to occur in the study area. These may occur anywhere as background scatter but are most likely to occur close to reliable sources of water (generally within 200 m). Although stone artefact sites may be present in these areas, their detection is dependent on favourable ground surface visibility conditions. Further, more recent ground disturbance, for instance through farming or flooding, will have an effect on the accuracy of the predictive model.<br>High sensitivity for open stone artefact sites includes level to gently inclined, elevated landforms near high order streams including crests, spurs, terraces and lower slopes/foot slopes that were above regular inundation and provided good outlook.<br>Smaller and lower density artefact scatters and isolated artefacts may occur near the ephemeral tributaries (3rd order and below).<br>Isolated artefacts or small artefact scatters may occur anywhere away from watercourses. These are most likely to be identified on level to gently inclined terrain but not moderately inclined areas that would have been too steep for occupation or on low-lying floodplains where regular inundation would have prevented focussed activities. |
| Culturally modified trees | Culturally modified trees (scarred or carved) may occur where native vegetation has been preserved. This is more likely in the western half of the western half of the study area beside Hornes Creek. |
| Quarries (stone or ochre) | Aboriginal stone quarries are unlikely to occur within the study area. No potential sources of material such as silcrete, tuff, quartzite and basalt has been identified. Quartz is known to occur within sandstone geology, but the suitability of local quartz is unknown. |
| Middens | Middens of bone, charcoal, stone and freshwater shells may occur along extensive and reliable river systems. However, they are rare in the local landscape and are likely to have been disturbed or removed by historical land use. If present, they are most likely to occur in association with open camp sites. |
| Stone arrangements | Stone arrangements are most likely to occur on elevated and relatively flat landforms (e.g. crests, terraces, ridges) nearby sources of outcropping cobbles or small boulders capable of being moved manually. However, it is very likely that they have been disturbed and/or destroyed by historical land use practices. |
| Burials | Burials can occur anywhere in the landscape, but their identification is rare. |

# 6 Field Investigations

## 6.1 Key findings

- An archaeological field survey was undertaken by EMM and Aboriginal representatives. The field survey was targeted and focussed on the Hornes Creek corridor, within which rockshelters and/or grinding grooves were considered probable.
- The field survey encompassed some 6.83 km of pedestrian transects, and encompassed a wide range of landforms, including stream channels, scarps, hillslopes and terraces.
- Overall, the field investigation documented nine newly identified Aboriginal sites. These sites included a rockshelter (n=1), rockshelters with PAD (n=3), rockshelters with artefacts and PAD (n=3), a single grinding groove site, and a single isolated stone artefact. Of these, six would be within the study area, while three would fall outside its curtilage.

## 6.2 Approach and methods

EMM conducted the archaeological field survey over two days with the assistance of Cubbitch Barta Native Title Claimants Aboriginal Corporation on 19 and 21 February 2024.

The sampling strategy targeted landforms where outcropping sandstone is predicted to occur with the aim of identifying sandstone-type Aboriginal sites. These areas are detailed in the predictive model (Table 5.2) and in summary comprises stream channels and adjacent scarp (where applicable) above mapped Hawkesbury Sandstone geology. The only areas not surveyed within these criteria were those that formed into inaccessible cliff lines and minor portions of 1$^{st}$ order streams which were clearly deeply silted and overgrown with no potential for outcropping stone.

The primary aims of the survey were to:

- identify Aboriginal archaeological sites and/or places with the assistance of Aboriginal participants
- characterise the landscape to aid predictions of archaeological potential and sensitivity
- identify sites or areas that would require further investigation if planned for development as part of the modification
- identify sites or areas to be avoided by development, where possible
- identify areas with minor or negligible Aboriginal cultural heritage values that hold no constraint for development.

The archaeological survey and data collection methods followed Section 2.2 of the *Code of Practice for the Archaeological Investigation of Aboriginal Objects in NSW* (DECCW 2010). The study area was divided into discrete transects and aligned with discrete landforms where feasible.

The survey involved pedestrian field transects within defined landform units. The survey team comprised three people per day. Transect width was generally one person wide (2 m) due to the nature of the terrain. Notwithstanding, this calculation does not account for more obtrusive site types such as grinding grooves and scar trees which are observable from a much greater distance.

The survey team targeted ground exposures along transects, where cultural material was possible to be identified throughout the flat landscape. It must, however, be noted that archaeological surveys are inherently limited by ground surface visibility conditions and therefore any survey, despite the intensity of survey effort and spacing of survey transects, is considered to only *sample* the archaeological landscape. The archaeological survey did not aim to cover the entire ground surface within the study area, but rather to characterise the archaeological landscape.

The effectiveness of the survey is determined through recording and analysing survey coverage data. It is evaluated for its effectiveness in identifying the distribution of Aboriginal objects across the landscape, taking into account the potential for archaeological deposits. The percentage of the ground surface exposed in each landform and the visible ground surface within exposures (as ground exposures are often obscured by vegetation, gravels, etc) influences the survey results. For example, an archaeologically sensitive landform surface that is highly exposed by erosion is likely to reveal Aboriginal objects, whereas a similar landform that is thickly grassed will obscure surface artefacts if they are present. Overall, calculation of effective survey coverage is used to estimate not only how much area was physically surveyed, but also how favourable the survey conditions were for the identification of Aboriginal sites.

Site recording was completed in accordance with the *Code of Practice for the Archaeological Investigation of Aboriginal Objects in NSW* (DECCW 2010). Site locations and their details were recorded with digital tablets using site recording forms created by EMM on the Survey123 application for ArcGIS (Esri© software). The digital tablets had a location accuracy of up to ±3 m which is similar to hand-held non-differential GPS units (~5 m). The Survey123 forms allowed for a site's location, details and representative photographs to be linked together, which avoided potential post-fieldwork issues around data integrity.

### 6.2.1 Survey limitations

As noted in Section 6.2, the focus of the survey sampling strategy was to characterise the archaeological landscape of the study area for sandstone-type sites. It has not aimed to address the complete distribution of archaeological sites throughout the study area (e.g. open artefact sites and/or modified trees). Overall, surface visibility was very low due to dense vegetation (Plate 6.8) which limited the opportunity to identify artefact sites apart from areas of exposure such as beneath rockshelter driplines or on vehicle tracks.

The survey team was limited to publicly accessible land only. Fortunately, landforms with potential to feature sandstone site types were accessible as they are associated with stream channels and adjacent corridors of Crown Land. The areas available to verify landforms of low potential for sandstone-type sites was accessed via publicly accessible roads and fire trails.

### 6.2.2 Criteria for recording rockshelter sites

Aboriginal people made extensive use of the landscape and features such as rockshelters. In providing an archaeological assessment of the sites EMM has used specific criteria while acknowledging that in all likelihood, most of the sandstone overhangs in the study area were used by Aboriginal people in the past, whether or not there is surviving evidence. We rely on RAPs to provide information regarding the cultural significance of sites, particularly in the absence of archaeological evidence.

The criteria used by archaeologists for recording rockshelters often varies. As such, EMM used their standard criteria to ensure a consistent approach. Specifically:

- rockshelters with one or more Aboriginal objects visible on the rockshelter floor (stone artefacts in the case of this assessment) were recorded as the site type 'rockshelter with deposit'
- rockshelters without evidence of occupation but with floor soil deposit and sufficient room and shelter for at least one adult, were recorded as 'rockshelter with PAD'
- rockshelters with pigment or charcoal were recorded as 'rockshelter with art'.

The minimum rockshelter dimensions for this category were generally a roof height, length and depth of one metre in each direction (1 $m^3$). Theoretically, excavation of any of these shelter deposits may recover stone artefacts and other cultural deposits.

Rockshelters with only bare rock floors and no floor soil deposit or evidence for art or artefacts were not recorded. There is no empirical way to validate occupation without the presence of a soil deposit, pigment or engravings.

## 6.3 Results

The field investigation encompassed 13 transects extending 6.83 km. Overall, exposure was poor with an average exposure of ~22%, and effective coverage of ~7% (Table 6.1). However, it should be noted that statistics for effective coverage when targeting more obtrusive site types such as rockshelters are less useful because their identification is not dependent on ground surface visibility.

Hornes Creek is distinctly incised in Hawkesbury Sandstone, and has a steep scarped valley with prominent, although discontinuous vertical sandstone ledges in the lower elevations of the scarped valley. Overhangs of undercut sandstone are prevalent along the upper scarp. River levels are likely higher today than in the past due to Picton Weir (Plate 6.1).

The field investigation ultimately identified nine newly identified Aboriginal sites (Section 6.3.1). These were all found in the rugged sandstone terrain (Hawkesbury soil landscape) beside Hornes Creek, and especially on upper scarp landforms where six of the seven rockshelter sites were located. No sites were identified on the Lucus Heights soil landscape (Table 6.2). These findings align with regional models (Section 5).

Overall, the vegetation was characterised by dense undergrowth and a sparse canopy of young eucalypts. No trees of sufficient age to contain cultural scars were observed. In general, surface visibility was poor across the survey area.

Rockshelters, or overhangs with potential for habitation, were frequently found in the scarp above Hornes Creek. These were primarily found on upper slopes or crests where steep escarpments were most prevalent, and result in the formation of such features. Arguably, the most significant of these sites was Hornes Creek RS6 (AHIMS #52-2-4982), which had the greatest amenity and PAD, and Hornes Creek RS2 (AHIMS #52-2-4975) which is a long, high but shallow overhang, where a small cluster of artefacts and PAD was identified. One grinding groove site was found on a rock platform within the stream channel of Hornes Creek.

The most valuable aspect of the survey was completing a comprehensive investigation of sandstone features around Hornes Creek to account for visible rockshelters and grinding groove sites within the study area. The survey was also effective in establishing areas that are very unlikely to feature outcropping sandstone suitable for grinding groove sites. This comprises all land outside the scarps and stream channels on mapped Hawkesbury sandstone geology within the study area.

**Table 6.1 Survey coverage**

| Transect number | Length (m) | Area ($m^2$) | Landform | Exposure (%) | Visibility (%) | Effective coverage ($m^2$) | Effective coverage (%) | Aboriginal sites identified |
|---|---|---|---|---|---|---|---|---|
| 1 | 1478.56 | 6 | terrace | 80 | 50 | 3548.5 | 40 | |
| 2 | 285.60 | 2 | watercourse (1st order) | 10 | 10 | 5.7 | 1 | |
| 3 | 289.05 | 2 | upper scarp | 10 | 10 | 5.8 | 1 | Hornes Creek RS1 (AHIMS #52-2-4974) |

## Table 6.1 Survey coverage

| Transect number | Length (m) | Area ($m^2$) | Landform | Exposure (%) | Visibility (%) | Effective coverage ($m^2$) | Effective coverage (%) | Aboriginal sites identified |
|---|---|---|---|---|---|---|---|---|
| 4 | 235.45 | 2 | footslope | 10 | 10 | 4.7 | 1 | |
| 5 | 264.95 | 2 | upper scarp | 50 | 40 | 106.0 | 20 | Hornes Creek RS2 (AHIMS #52-2-4975) |
| 6 | 357.29 | 2 | footslope | 20 | 20 | 28.6 | 4 | |
| 7 | 301.16 | 2 | upper scarp | 10 | 10 | 6.0 | 1 | Hornes Creek RS3 (AHIMS #52-2-4976)<br>Hornes Creek RS4 (AHIMS #52-2-4977)<br>Hornes Creek RS5 (AHIMS #52-2-4978) |
| 8 | 1085.47 | 4 | hillslope | 20 | 30 | 260.5 | 6 | |
| 9 | 578.83 | 2 | upper scarp | 10 | 10 | 11.6 | 1 | Hornes Creek RS6 (AHIMS #52-2-4982) |
| 10 | 532.29 | 2 | footslope | 10 | 10 | 10.6 | 1 | Hornes Creek RS7 (AHIMS #52-2-4981) |
| 11 | 486.78 | 2 | watercourse (4th order) | 40 | 40 | 155.8 | 16 | Hornes Creek GG1 (AHIMS #52-2-4980) |
| 12 | 590.33 | 2 | footslope | 10 | 30 | 35.4 | 3 | |
| 13 | 345.68 | 2 | hillslope | 10 | 10 | 6.9 | 1 | Hornes Creek IF1 (AHIMS #52-2-4979) |
| *Average* | *525.5* | | | *22* | *21.5* | | 7 | |
| **Total** | **6831.43** | | | | | | | |

## Table 6.2 Landform summary

| Landform | Soil Landscape | Landform area ($m^2$) | Percentage of survey effort | Sites |
|---|---|---|---|---|
| Footslope | Hawkesbury | 3430.71 | 15.77 | Hornes Creek RS7 (AHIMS #52-2-4981) |
| Hillslope | Lucus Heights | 5033.23 | 23.14 | Hornes Creek IF1 (AHIMS #52-2-4979) |

**Table 6.2 Landform summary**

| Landform | Soil Landscape | Landform area ($m^2$) | Percentage of survey effort | Sites |
|---|---|---|---|---|
| Terrace | Lucus Heights | 8871.37 | 40.79 | |
| Upper Scarp | Hawkesbury | 2867.97 | 13.19 | Hornes Creek RS1 (AHIMS #52-2-4974)<br>Hornes Creek RS2 (AHIMS #52-2-4975)<br>Hornes Creek RS3 (AHIMS #52-2-4976)<br>Hornes Creek RS4 (AHIMS #52-2-4977)<br>Hornes Creek RS5 (AHIMS #52-2-4978)<br>Hornes Creek RS6 (AHIMS #52-2-4982) |
| Watercourse (1st order) | Lucus Heights | 571.21 | 2.63 | |
| Watercourse (4th order) | Hawkesbury | 973.55 | 4.48 | Hornes Creek GG1 (AHIMS #52-2-4980) |

**Plate 6.1 Confluence of Hornes Creek and Bargo River showing the dense vegetation and steep scarps. View from the top of the scarp, looking west. Location of Picton Weir is indicated by the arrow**

**Plate 6.2** **Survey transect 1: Fire trail on the terrace above the escarpment**

**Plate 6.3** **Survey transect 2: Stream channel (1st order)**

**Plate 6.4** **Survey transect 3: Upper scarp**

**Plate 6.5** **Survey transect 4: Lower scarp beside Hornes Creek**

**Plate 6.6** **Survey transect 5: Upper scarp**

**Plate 6.7** **Survey transect 6: Footslope**

**Plate 6.8** **Survey transect 7: Upper scarp above Hornes Creek, view north**

**Plate 6.9** **Survey transect 8: hillslope**

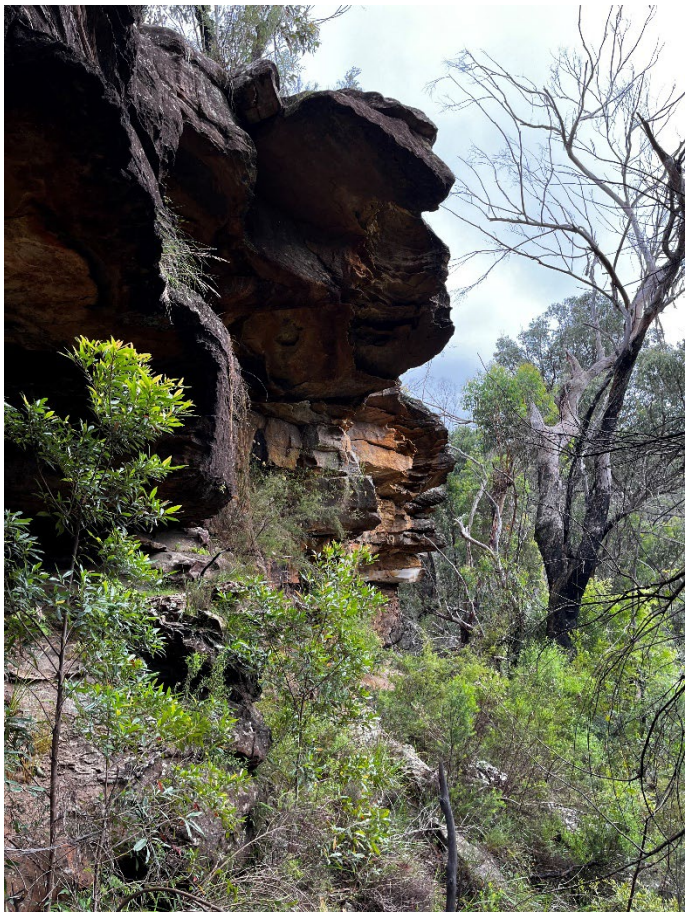


**Plate 6.10** **Transect 9: Upper scarp**

Plate 6.11 Transect 10: footslope

Plate 6.12 Transect 11: Stream channel (4th order)

**Plate 6.13 Transect 12: Footslope**

### 6.3.1 Sites identified

A total of nine sites were identified during the archaeological field survey, comprising six within the study area and three just outside the curtilage.

Table 6.3 provides a description of each of these sites and their location is shown on Figure 6.1. Photographs of all sites are included as Plate 6.14 to Plate 6.27.

In summary:

- seven newly identified rockshelters were recorded (six within the study area), six contained PAD, and three contained artefacts and PAD
- no rockshelters with art were identified although indeterminate charcoal markings were observed on the walls of two shelters
- one grinding groove site was identified on a rockbar within Hornes Creek
- one isolated stone artefact was identified on a fire track outside the study area.

No trees of sufficient age to retain culturally modified scars were observed within the study area.

## Table 6.3 Aboriginal sites identified during survey

| AHIMS number | Site name | Site type | Description | Landform | Survey unit | Easting | Northing | Images |
|---|---|---|---|---|---|---|---|---|
| **Sites within the study area** | | | | | | | | |
| 52-2-4975 | Hornes Creek RS2 | Rockshelter with deposit and artefacts | High, shallow rockshelter with deposit and artefacts. Overhang extends for approximately 80 m along the upper scarp. Artefacts were identified under the dripline within a 1 $m^2$ area. Artefacts included a mudstone flake, a quartz flake piece and a silcrete flake. | Upper scarp | 5 | 274838.4 | 6205539 | Plate 6.15 |
| 52-2-4976 | Hornes Creek RS3 | Rockshelter with deposit | Cavernous, open shelter facing west on the upper scarp. Rockshelter has a rock platform base overlaid with 10-20 cm depth of sandy PAD and a large area of PAD below the drip line. | Upper scarp | 7 | 274901.6 | 6205402 | Plate 6.16 |
| 52-2-4977 | Hornes Creek RS4 | Rockshelter with deposit and artefact | Large, west facing rockshelter with good amenity and area of PAD (6 x 4 m). Charcoal graffiti and disturbance from recent campfires in the shelter. Indeterminate charcoal markings, partly covered in lichen may represent earlier artworks. One silcrete debitage flake. | Upper scarp | 7 | 274922.7 | 6205413 | Plate 6.17<br>Plate 6.18<br>Plate 6.19 |
| 52-2-4978 | Hornes Creek RS5 | Rockshelter | Low shelter (1.7 m high) with charcoal graffiti and some indeterminate charcoal markings. No PAD. | Upper scarp | 7 | 274931.9 | 6205472 | Plate 6.20<br>Plate 6.21 |
| 52-2-4982 | Hornes Creek RS6 | Rockshelter with deposit and artefact | Large rockshelter formed by cavernous weathering, facing north above Hornes Creek. A small micro-debitage mudstone flake was found within the dripline. The shelter contains an area of PAD approximately 6 x 3 m. | Upper scarp | 9 | 274755 | 6205411 | Plate 6.22<br>Plate 6.23 |
| 52-2-4981 | Hornes Creek RS7 | Rockshelter with deposit | Small rockshelter with PAD (approximately 1 x 3 m) beside Hornes Creek. | Footslope | 10 | 274800.1 | 6205450 | Plate 6.24 |
| **Sites outside the study area** | | | | | | | | |
| 52-2-4980 | Hornes Creek GG1 | Grinding grooves | Narrow grinding grooves, possibly from spear sharpening, located on a sandstone platform in Hornes Creek. The grooves (n=7) are oriented north – south. The deepest groove is approximately 5 mm deep, 130 mm long and 15 mm wide. | Creek ($4^{th}$ order) | 11 | 275507.5 | 6204594 | Plate 6.25<br>Plate 6.26 |

## Table 6.3 Aboriginal sites identified during survey

| AHIMS number | Site name | Site type | Description | Landform | Survey unit | Easting | Northing | Images |
|---|---|---|---|---|---|---|---|---|
| 52-2-4974 | Hornes Creek RS1 | Rockshelter with deposit | West facing rockshelter near the confluence of Hornes Creek and the Bargo River. Shelter is quite shallow with a rock base and a limited area of PAD. | Upper scarp | 3 | 274694.3 | 6205567 | Plate 6.14 |
| 52-2-4979 | Hornes Creek IF1 | Isolated find | Grey silcrete horseshoe core (33 mm). Multidirectional flaking has removed all cortex. Located on a fire trail, amongst gravel, leading down to Hornes Creek. | Hillslope | 13 | 275522.9 | 6204580 | Plate 6.27 |

**Plate 6.14** Hornes Creek RS1 (#52-2-4974). West facing shelter with deposit on the upper scarp near the confluence of Hornes Creek and the Bargo River

**Plate 6.15** Hornes Creek RS2 (#52-2-4975). Long, high, shallow rockshelter with deposit. Three artefacts identified below the dripline

**Plate 6.16** **Hornes Creek RS3 (#52-2-4976). Cavernous rockshelter with rock platform base and shallow PAD on the upper scarp**

**Plate 6.17** **Hornes Creek RS4 (#52-2-4977). Large, west facing rockshelter on the upper scarp. One silcrete flake and indeterminate charcoal markings beneath lichen**

Plate 6.18 Hornes Creek RS4 (#52-2-4977). Indeterminate charcoal markings beneath lichen

Plate 6.19 Hornes Creek RS4 (#52-2-4977). Small silcrete flake

Plate 6.20 Hornes Creek RS5 (#52-2-4978). Low shelter on the upper scarp

Plate 6.21 Indeterminate charcoal markings (Hornes Creek RS5 (#52-2-4978))

Plate 6.22 Hornes Creek RS6 (#52-2-4982): Rockshelter with deposit on the upper scarp above Hornes Creek

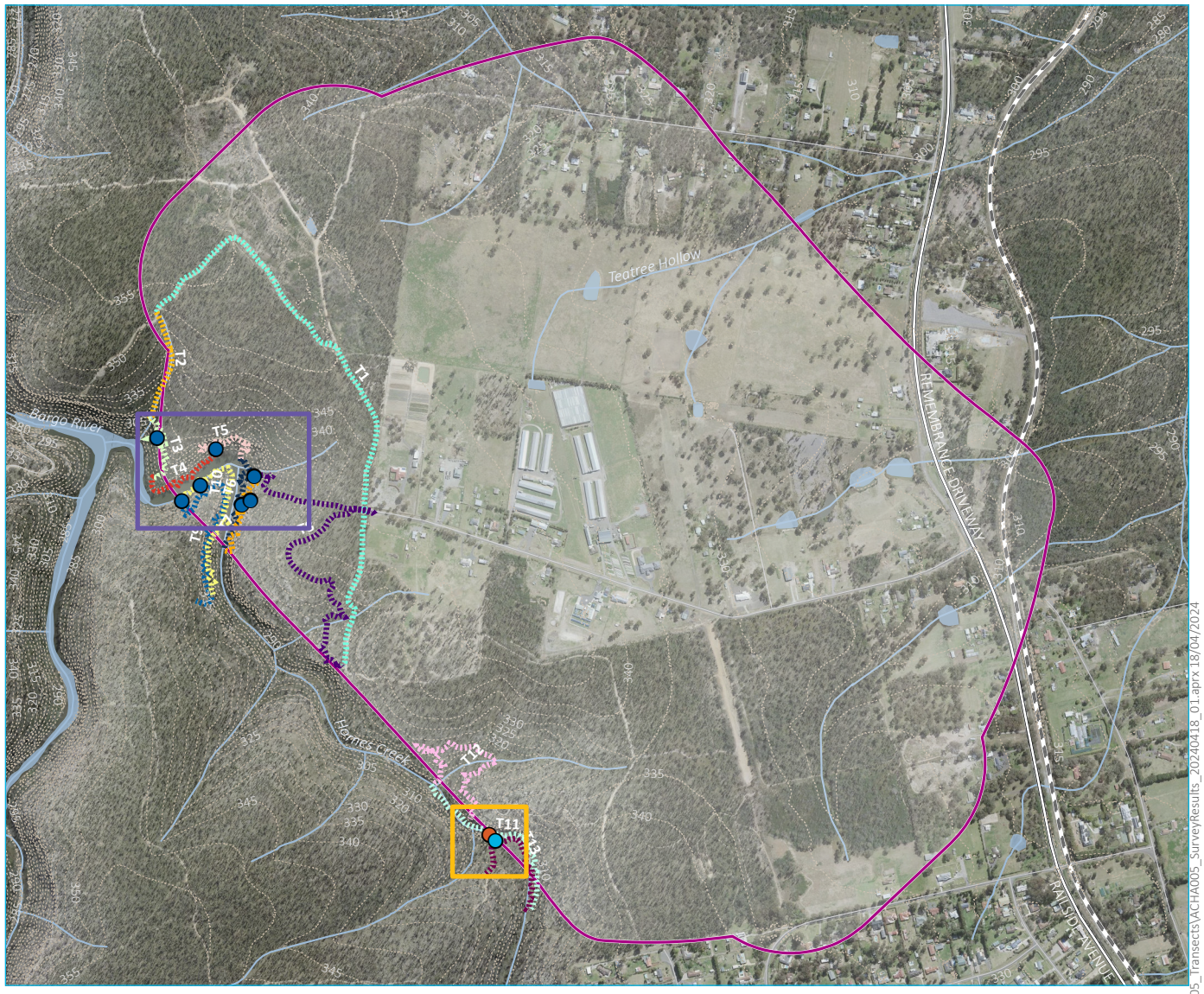
Plate 6.23 Small mudstone flake found beneath the dripline (Hornes Creek RS6 [#52-2-4982])

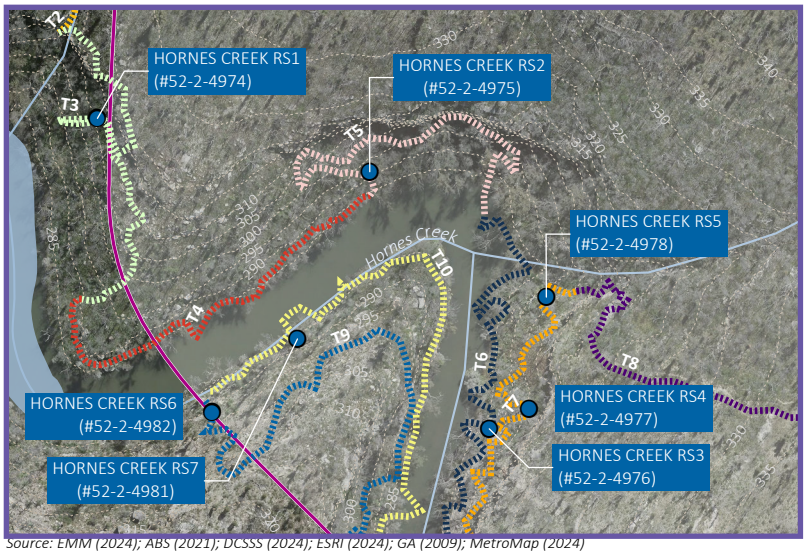
**Plate 6.24** **Hornes Creek RS7 (#52-2-4981): small rockshelter beside Hornes Creek**

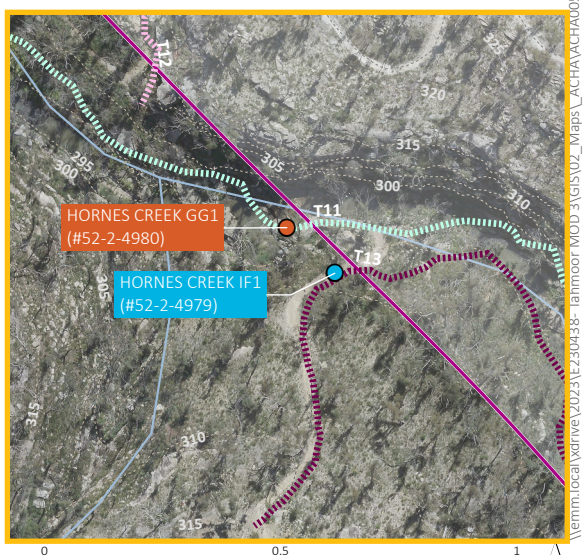
**Plate 6.25** **Hornes Creek GG1 (#52-2-4980): Narrow grinding grooves on rock platform in Hornes Creek. View west**

Plate 6.26 Hornes Creek GG1 (#52-2-4980): Narrow grinding grooves in sandstone platform

Plate 6.27 Hornes Creek IF1 (#52-2-4979): Silcrete core on fire trail. View north east




*Source: EMM (2024); ABS (2021); DCSSS (2024); ESRI (2024); GA (2009); MetroMap (2024)*

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## KEY

Study area

Site location
- Grinding groove
- Isolated find
- Rock shelter

Transect
- T1- terrace
- T2- watercourse (1st order)
- T3- upper scarp
- T4- footslope
- T5- upper scarp
- T6- footslope
- T7- upper scarp
- T8- hillslope
- T9- upper scarp
- T10- footslope
- T11- watercourse (4th order)
- T12- footslope
- T13- hillslope

Existing environment
- Rail line
- Major road
- Minor road
- 5 m contour
- Watercourse/drainage line
- Waterbody

Survey results

Tahmoor South Coal Project
SSD 8445 Modification 3
Figure 6.1

EMM
creating opportunities

# 7 The archaeological resource

## 7.1 Key findings

- The Tahmoor Coal mine has been subject to numerous archaeological investigations over the last decade, which has included the study area. This has provided substantive foundational information on the nature and distribution of cultural materials across the study area. These have demonstrated that the focus of past activity was likely within rockshelters, caves and overhangs within the incised sandstone Country common for across this locale. Dogtrap Creek, Stonequarry Creek and Teatree Hollow Creek, all to the north or east, have substantive evidence of past visitation of at least the last two millennia and extending into the post-Contact period.

- The assessment undertook targeted archaeological field survey and test excavations to explore and document the Aboriginal objects, sites and places within the study area, and to align them within the regional context. Overall, the findings largely conformed with the regional model, and reveal that visitation and occupation was prevalent within the incised sandstone valleys and river corridors.

- The investigations identified six discrete Aboriginal objects and sites within the study area. These consisted of a rockshelter (n=1), rockshelters with PAD (n=2), rockshelters with artefacts and PAD (n=3). These were primarily located within the Hornes Creek river corridor. A further three sites, a grinding groove, a rockshelter with PAD and isolated stone artefact, were found outside the study area, also within the Hornes Creek river corridor.

## 7.2 Results and synthesis

The study area is an example of a transitional landscape that borders many of the currently populated areas of the Woronora Plateau Southern Highlands to the south-west. These areas are generally at the interface of Hawkesbury Sandstone and Wianamatta Shale geology and represent favourable conditions for rockshelter habitation, stone hatchet manufacture and open camp site occupation. Essentially, rugged sandstone landscapes transition into open rolling hills within just a few kilometres. This would have provided Aboriginal people with a diverse landscape for occupation ranging from habitable shelters protected from the elements to open landscapes near various stream networks suitable for short- and long-term camping.

Another implication of these transitional zones is that the scarp landscapes and rockshelters within them are relatively easily accessible. Although still considered rugged, the deeply incised streams on Hawkesbury Sandstone in the study area only have a local relief of up to 30 m and are approachable from both the stream bed and the plateaus above. This contrasts with areas of Hawkesbury Sandstone further away from its interface with Wianamatta Shale geology such as in the Nattai National Park (approximately 3 km west of the study area) and the Upper Nepean State Conservation area where local relief on scarps are up to 200 m; these would be much more daunting areas to traverse and occupy rockshelters.

Considering the above, the study area would have provided a variety of resource zones including riparian and woodland areas. Hornes Creek and its primary tributaries would have been the source of reliable water for Aboriginal people and the fauna that they hunted. The rockshelters along the scarps adjacent to the Bargo River, immediately to the west of the study area and now identified on Hornes Creek would have provided safe and sheltered places with a view of the surrounding area. Those that are located near water are a favoured place for people to live (Burke and Smith 2004). The presence of art and grinding grooves within some shelters are a testament to the occupation of certain rockshelters, and the accumulated soil at the base of many shelters provide potential for further evidence.

Field investigations validated this regional model. Some seven rockshelters were encountered within the Hornes Creek corridor (Figure 7.1). Most of the rockshelters occur in the upper sandstone escarpment above Hornes Creeks (n=6) and one was found on the footslope immediately beside the creek. One of the rockshelters comprised a long (80 m), but shallow continuous overhang along the upper scarp that would have provided limited shelter. However, the presence of artefacts indicates occupational use. Rock platforms with pools were present In Hornes Creek, upstream of Picton Weir, particularly in the southern half of the study area. However, grinding groove sites such as those at Stonequarry Creek were not evident, but a group of seven grooves were encountered in the bed of Hornes Creek (Figure 7.1).

While there is potential for artefact sites to occur anywhere in the landscape and there are some recorded artefact sites in the vicinity of the study area, if present, artefact sites are likely to be low density scatters or isolated finds. Indeed, a single isolated stone artefact was found along one of the many fire-trails in the locale. The main environmental features that indicate archaeological sensitivity for the presence of open stone artefact sites are the study area's level-to-gently inclined landforms such as lower slopes, elevated terraces or plains, hill crests and to a lesser extent, ridge lines. The most sensitive landscapes are mainly areas on these landform types near the major perennial streams such as Hornes Creek and Teatree Hollow Creek.

Mature trees of suitable age for exhibiting carving or scarring (culturally modified trees) are most likely to occur in riparian corridors and areas of uncleared forest in the west of the study area. The eastern half of the study area has been mostly cleared of the woodland and forest areas, while the open woodland beside Hornes Creek was characterised by regrowth eucalypts and a dense understory.

No project-specific intangible or cultural sites or places were identified as part of the consultation or field investigations.

*Source: EMM (2024); ABS (2021); DCSSS (2024); ESRI (2024); GA (2009); MetroMap (2024)*

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KEY

- Study area
- Site location
  - Grinding groove
  - Isolated find
  - Rock shelter
- Existing environment
  - Rail line
  - Major road
  - Minor road
  - 5 m contour
  - Watercourse/drainage line
  - Waterbody

# Archaeological Resource

Tahmoor South Coal Project
SSD 8445 Modification 3
Figure 7.1

EMM
creating opportunities

# 8 Significance assessment

## 8.1 General

All Aboriginal objects in NSW are protected under the *National Parks and Wildlife Act 1974. It is* recognised that the destruction of sites may be necessary to allow other activities or developments to occur. In order for the consent authority to make informed decisions on such matters, an important element of cultural resource management is determining the significance of cultural heritage places and objects to understand what may be lost; and how best it can be mitigated. However, it is highlighted that something can be of little or no significance and still be protected under the Act.

Cultural significance is outlined in Article 1.2 of the *Burra Charter* - the best practise document for managing cultural heritage – as 'aesthetic, historic, scientific, social or spiritual value for past, present or future generations' (Australia ICOMOS 2013). These values are reiterated in the NSW guidelines, which determines cultural significance of a place can be assessed by identifying the values that are present across the subject area and assessing what is important and why (OEH 2011). In assessing the scientific significance of sites, aspects such as rarity and representativeness and the integrity must be considered. Generally speaking a site or object that is rare will have a heightened significance, although a site that is suitable of conservation as 'representative' of its type will also be significant. Conversely an extremely rare site may no longer be significant if its integrity has been sufficiently compromised.

The criteria adopted for this report are defined in Table 8.1. The management implications of these sites' significance are discussed in subsequent sections.

**Table 8.1 A summary of criteria used to assess the cultural significance (OEH 2011, 8–10)**

| Criterion | Definition |
|---|---|
| **Social value**—Does the place have a strong or special association with a particular community or cultural group for social, cultural or spiritual reasons? | Social (or cultural) value refers to the spiritual, traditional, historical or contemporary associations and attachments the place or area has for Aboriginal people. Social or cultural value is how people express their connection with a place and the meaning that place has for them.<br>Social or cultural value can only be identified through consultation with Aboriginal people. |
| **Historic value**—Is the place important to the cultural or natural history of the local area and/or region and/or state? | Historic value refers to the association of a place with a historically important person, event, phase or activity. Historic places do not always have physical evidence of their historical importance (such as structures, planted vegetation or landscape modifications). They may have 'shared' historic values with other (non-Aboriginal) communities. |
| **Scientific (archaeological) value**—Does the place have potential to yield information that will contribute to an understanding of the cultural or natural history of the local area and/or region and/or state? | Scientific (archaeological) value refers to the importance of a landscape, area, place or object because of its rarity, representativeness and the extent to which it may contribute to further understanding and information.<br>Information about scientific values is gathered through archaeological investigation undertaken in this report. |
| **Aesthetic value**—Is the place important in demonstrating aesthetic characteristics in the local, regional, and/or State environment? | Aesthetic value refers to the sensory, scenic, architectural and creative aspects of the place. It is often linked with social value, and can consider form, scale, colour, texture and material of the fabric or landscape, and the smell and sounds associated with the place and its use. This value is only relevant to archaeological sites on only rare occasions, such as rockshelters that contain art, or culturally modified trees in prominent positions, etc. |

## 8.2 Statement of significance

The assessment identified nine sites in or near the study area, six of which are within the study area. These findings demonstrate an extensive and continued use of the region extending back several millennia and potentially longer. The results align well with the broader regional archaeological picture, specifically geologically dependent sites including rockshelters and grinding grooves being prevalent. These sites highlight the importance of vertical escarpments and major water courses to Aboriginal visitation and occupation in the past.

When considering the scientific significance, many of the sites can be considered to have moderate (local) value with the ability to provide information on the past activities of the area (research potential) (Table 8.2). These primarily include the rockshelters with artefacts and/or PAD. All of these can be subject to further investigations, such as archaeological excavation, and which can provide data on the timing, behaviour and environments within which people visited and used the locale. Larger rockshelters, particularly those that contain observed cultural material, are assessed as having higher scientific significance compared with those that are smaller and/or contain no observed cultural material. Of these, Hornes Creek RS2 (#52-2-4975) and Hornes Creek RS6 (#52-2-4982) are considered to have the highest research potential containing artefacts and extensive PAD that could be further investigated.

Grinding grooves that indicate the re-sharpening of tools and equipment was undertaken in the past. These sites are generally significant both in the information they can provide on past dietary habits through residue techniques that can extract plant and animal materials from the groove – embedded by the tool being sharpened. While grinding grooves have a good representation in the wider region, these narrow grooves are unusual, as wider, axe grinding groove sites are more common in the local area. Hornes Creek GG1 (#52-2-4980); therefore, has been classified as of moderate scientific significance, as a result of its local rarity.

Hornes Creek IF1 (#52-2-4979) is considered to have limited, if any research potential. While important in demonstrating the longevity and continued use of the region by Aboriginal people in the past, it is considered that little further information can be obtained from additional investigation of this site.

All the sites have some level of aesthetic significance, but only few can consider it an intrinsic part of their significance. These include the grinding groove site that require some form of running water usually (although various isolated pools following rain can also be used), and several of the rockshelters adjacent creeks that were likely selected by people in the past, at least in part, due to their aesthetic appeal.

Site specific cultural values have not been provided by the Aboriginal participants to date, and the values presented in Table 8.2 are based on discussions in the field during recording,

Table 8.2 provides a summary of the significance values for each Aboriginal object and/or site identified.

**Table 8.2 Significance of Aboriginal site identified during survey**

| AHIMS number | Site name | Site type | Significance | | | | |
|---|---|---|---|---|---|---|---|
| | | | Scientific | Aesthetic | Historical | Cultural | Overall |
| **Sites within the study area** | | | | | | | |
| 52-2-4975 | Hornes Creek RS2 | Rockshelter with deposit and artefacts | High | Moderate | | Moderate | High |
| 52-2-4976 | Hornes Creek RS3 | Rockshelter with deposit | Low | Low | | Low | Low |
| 52-2-4977 | Hornes Creek RS4 | Rockshelter with deposit and artefact | Moderate | Moderate | | Moderate | Moderate |

## Table 8.2 Significance of Aboriginal site identified during survey

| AHIMS number | Site name | Site type | Significance | | | | |
|---|---|---|---|---|---|---|---|
| | | | Scientific | Aesthetic | Historical | Cultural | Overall |
| 52-2-4978 | Hornes Creek RS5 | Rockshelter | Low | Low | | Low | Low |
| 52-2-4982 | Hornes Creek RS6 | Rockshelter with deposit and artefact | High | Moderate | | Moderate | High |
| 52-2-4981 | Hornes Creek RS7 | Rockshelter with deposit | Low | Low | | Low | Low |
| **Sites outside the study area** | | | | | | | |
| 52-2-4980 | Hornes Creek GG1 | Grinding grooves | Moderate | Moderate | | Moderate | Moderate |
| 52-2-4974 | Hornes Creek RS1 | Rockshelter with deposit | Low | Low | | Low | Low |
| 52-2-4979 | Hornes Creek IF1 | Isolated find | Low | Low | | Low | Low |

Notes: 1. Values are only assigned where the site fulfils that specific criterion.

2. In the case of the cultural criterion, it is ranked in relation to whether the site is important to one individual (low), a mixed view from the Aboriginal participants (moderate) or broad-scale support from all stakeholders (high). Further details are presented in Section 2.4.

3. The overall significance is comparable with the highest ranking achieved in any of the four main criteria.

# 9 Impact assessment

## 9.1 Key findings

- The Project would consist of the expansion and continuation of underground coal mining of the Tahmoor South Coal project. In relation to Aboriginal heritage, impacts would be primarily associated with uneven subsidence to the ground surface from these activities; and which is variable depending on proximity to the proposed longwall activities.

- There are six recorded sites within the study area: six rockshelters with PAD and/or artefacts, as well as a grinding groove site within 10m from the study area boundary. These would all have potential to be partially impacted by the Project, being situated on the edge of the predicted subsidence zone. However, detailed subsidence modelling suggests the risk of changes to the cultural assemblage, which is several hundred metres from the proposed LW S7A, would be low, and very unlikely to occur. (Two further sites were identified outside of the study area, and would not be impacted).

- It is considered that cumulative impacts from the modification would be limited, with rockshelters well represented in the regional cultural assemblage, and the unlikely nature of any substantive impacts occurring. Impacts to the grinding groove site would have greater cumulative impact, having limited representation in the region, but similarly modification impacts are considered unlikely.

## 9.2 Measures to minimise harm and alternatives

The sites most at risk of impacts from subsidence due to the extraction of LW S7A are rockshelters and grinding grooves, sites which are assessed as having cultural and scientific value. While the risk of impact to these sites has been assessed by Mine Subsidence Engineering Consultants (MSEC) as unlikely, they are only predictions and inherently have some have residual risk of error, which is why they are presented with probability ratings. Accordingly, despite practicable measures to avoid harm being undertaken by Tahmoor Coal, if subsidence impacts did occur, they could constitute harm through cracking and movement of sandstone-type sites.

Any artefact scatters, isolated finds are very unlikely to experience subsidence related impacts as they are open sites where impacts are limited to cracking in the surface soils which could lead to erosion channels if left untreated but it is very unlikely that an Aboriginal objects would be impacted by surface cracking.

However low the probability of subsidence, it is important to account for certain Aboriginal sites within an underground mine area, particularly rockshelters and grinding groove sites by gathering baseline data and considering their significance. Secondly, it is important to monitor any changes that may occur during and after mining operations (Section 9.2.1). Such management activities are proposed in Section 10.

The proposed extraction of LWS7A will not involve surface infrastructure or surface disturbance works.

### 9.2.1 Monitoring as management

Monitoring programs in the Southern Coalfields have commonly demonstrated that subsidence effects on sandstone-type Aboriginal sites is relatively simple and unobtrusive – although there have been exceptions (Regal and Reeves 2017). Regal and Reeves (2017) propose that cracking or lateral movement or block fall is so unobtrusive that if not for detailed monitoring programs it would be potentially indistinguishable from natural weathering processes (which include block fall, exfoliation, cracking and movement). The resulting argument is that precautionary management approach rather than interventionist approach is advised as engineering responses such as drilling relief slots, propping shelters or installing driplines are likely to have a greater detrimental effect to a site's value than the effects of subsidence (Reeves and Regal 2017).

Regal (2022) reviewed each of rockshelters and found that impacts have been observed at less than 10% of sites monitored in the region, and that direct impacts to archaeological features have occurred at 0.82% of sites monitored (Regal 2022).

Ongoing monitoring during subsidence will allow Tahmoor Coal to act accordingly. For example in EMM (2021), MSEC reassessed the impact of underground mining on Stonequarry Creek after approximately 1,000 m of extraction from LW W1. The findings of this resulted in minor changes to the project to further conserve identified cultural materials based on the results.

## 9.3 Modification impacts

The impact assessment presented in this chapter addresses the potential subsidence impacts from the secondary extraction of coal for LW S7A. Longwall mining involves the extraction of large panels of coal approximately 375–385 m underground. This will result in subsidence and subsidence induced movements at the ground surface, as well as far valley movements and non-conventional subsidence movements that are more difficult to predict, which have potential to harm the sandstone-type site within the study area.

### 9.3.1 Longwall mining

Longwall mining is a method of underground coal mining that involves the extraction of large panels of coal by progressively shaving slices of coal from the longwall face under the protection of hydraulic roof supports. As coal is excavated the weight of the overlying ground, originally supported by the coal, becomes supported only by the remaining pillars or walls. This causes the mine void walls to compress and the overlying rock to crack and tilt into the void.

Subsidence at the ground surface occurs as underlying strata collapse into the void, which is called the goaf. The ground at the surface subsides vertically and at the edges of the subsidence zone it tilts and moves horizontally towards the centre of the goaf (IESC 2014). These horizontal movements result in:

a) tensile strains, leading to cracking of the ground surface; and

b) compressive strains, when the distance between two points decreases, potentially pushing the ground upwards.

### 9.3.2 Definition of impact type

Direct impacts can occur on a varying scale. Disturbance, where artefacts are moved locally from their current setting, is distinguished from loss where artefacts are removed entirely from their current context or destroyed.

Disturbance means Aboriginal sites and objects will be disrupted and moved a short distance through the displacement of ground. Partial disturbance occurs where a portion of a site will be disturbed. Total disturbance is when the entirety of the Aboriginal site will be disturbed.

Loss entails complete removal of a site's elements, such as through large-scale earthworks. The total modification of a landscape also can constitute loss, even if artefacts are collected and later returned to the modified surface in their original position because the context (an integral part of archaeological site value) is irretrievably lost. Total loss is when the entirety of a site will be lost as a result of the project. Partial loss describes the loss of part of a site.

## 9.4 Aboriginal heritage impact

The potential impacts on seven recorded sites have been considered. These include the six recorded rockshelters with PAD and/or artefacts within the study area, as well as the grinding groove site located <10 m outside the study area. Hornes Creek GG1 (AHIMS #52-2-4980) was included in the consideration due to the significance of the site (Section 8.2). Longwall mining causes subsidence at the ground surface resulting in tensile and compressive strains. Streams and valleys are the natural surface features most sensitive to subsidence movements. As such grinding groove sites and rockshelters located along the valleys of streams could therefore experience valley related movements of upsidence and valley closure movements.

Archaeological sites which are most susceptible to subsidence-induced damage are rockshelters generally associated with cliff lines (NSW DoP, 2008 p.84). Fracturing has historically been observed in the Southern Coalfield, with more significant fracturing tending to occur near the bases of rivers, creeks and valleys, as the result of valley related movements (MSEC 2019). MSEC has prepared a subsidence impact assessment for the cultural materials within, and outside of, the Study Area (MSEC, 2024). The likelihood of damage occurring at these sites was assessed on criteria which considers theoretical cracking limits caused by strains and tilts. The predicted impact of the extraction of the longwalls S1A to S7A along the Bargo River and Hornes Creek is presented in Plate 9.1. Overall there is a higher level of subsidence, upsidence and closure that is predicted to occur from the addition of Longwall S7A. A summary of the predicted probability of impact of the longwall extraction on the newly recorded Aboriginal sites is presented in Table 9.1. While there is some movement that is predicted to occur, the overall likelihood of this movement causing an impact on the newly recorded Aboriginal sites is considered low (MSEC 2024).

The report further indicates:

- the cliffs that contain the newly recorded rockshelters is considered unlikely to experience any major instabilities due to the proposed extraction of LW S7A
- Hornes Creek GG1 (AHIMS #52-2-4980) is located on a flat sandstone slab and the grooves are not located across natural joints of the rock. The likelihood of fracturing occurring at Hornes Creek GG1 (AHIMS #52-2-4980) is also considered low and in the unlikely event that it occurs, the fractures are expected to be minor and isolated.

To align with the Heritage NSW guidelines, all sites are considered to be subject to partial impacts from the modification, since there is potential movement of up to 5 cm, and this may result in changes to conditions that would impact cultural materials (e.g. erosion of deposits from changed hydrology, etc). It is considered improbable however that such change, if it eventuates, would result in the complete loss of identified cultural materials, since it would be unlikely to result in complete collapse of a rockshelter for example. Further, all identified cultural material is several hundred metres from the longwall, and located on the edge of the predicted 40 mm total subsidence contour, and as such the risk of subsidence is considered low.

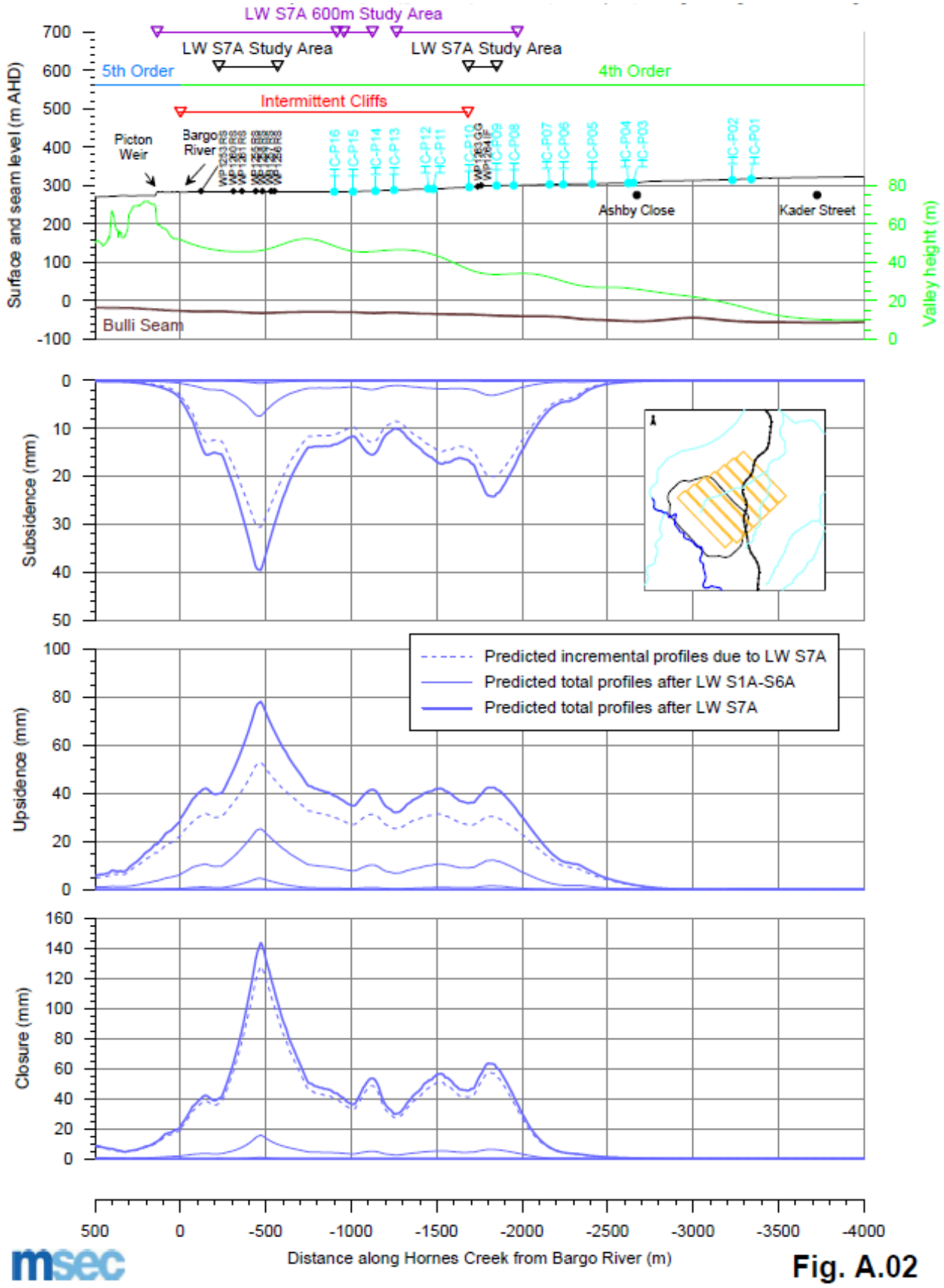
Table 9.1 summarises the potential impacts to Aboriginal sites within the study area.

**Table 9.1 Predicted likelihood of impact to Aboriginal heritage sites (MSEC 2024)**

| AHIMS | Site name | Site type | Significance assessment | Location in relation to LW S7A | Total Subsidence (mm) | Maximum tilt (mm/m) | Total hogging curvature (1/km) | Total sagging curvature (1/km) | Total upsidence (mm) | Total closure |
|---|---|---|---|---|---|---|---|---|---|---|
| 52-2-4975 | Hornes Creek RS2 | Rockshelter with deposit and artefacts | High | ~300 m south west | 40 | < 0.5 | < 0.01 | < 0.01 | - | - |
| 52-2-4976 | Hornes Creek RS3 | Rockshelter with deposit | Low | ~350 m south west | 40 | < 0.5 | < 0.01 | < 0.01 | - | - |
| 52-2-4977 | Hornes Creek RS4 | Rockshelter with deposit and artefact | Moderate | ~350 m south west | 40 | < 0.5 | < 0.01 | < 0.01 | - | - |
| 52-2-4978 | Hornes Creek RS5 | Rockshelter | Low | ~300 m south west | 50 | < 0.5 | < 0.01 | < 0.01 | - | - |
| 42-2-4982 | Hornes Creek RS 6 | Rockshelter with deposit and artefact | High | ~400 m south west | 20 | < 0.5 | < 0.01 | < 0.01 | - | - |
| 52-2-4981 | Hornes Creek RS7 | Rockshelter with deposit | Low | ~350 m south west | 30 | < 0.5 | < 0.01 | < 0.01 | - | - |
| 52-2-4980 | Hornes Creek GG1 | Grinding grooves | Moderate | ~400 m south west | 20 | < 0.5 | < 0.01 | < 0.01 | 45 | 65 |

## Table 9.2 Impact assessment of Aboriginal heritage sites in or within 10 m of the study area

| AHIMS | Site name | Type of potential harm | Degree of potential harm | Consequence of potential harm | Notes |
|---|---|---|---|---|---|
| 52-2-4975 | Hornes Creek RS2 | Indirect | Partial | Partial loss of value | This site in several hundred metres from LW S7A, and within a zone considered of low likelihood to experience minor subsidence. |
| 52-2-4976 | Hornes Creek RS3 | Indirect | Partial | Partial loss of value | This site in several hundred metres from LW S7A, and within a zone considered of low likelihood to experience minor subsidence. |
| 52-2-4977 | Hornes Creek RS4 | Indirect | Partial | Partial loss of value | This site in several hundred metres from LW S7A, and within a zone considered of low likelihood to experience minor subsidence. |
| 52-2-4978 | Hornes Creek RS5 | Indirect | Partial | Partial loss of value | This site in several hundred metres from LW S7A, and within a zone considered of low likelihood to experience minor subsidence. |
| 42-2-4982 | Hornes Creek RS6 | Indirect | Partial | Partial loss of value | This site in several hundred metres from LW S7A, and within a zone considered of low likelihood to experience minor subsidence. |
| 52-2-4981 | Hornes Creek RS7 | Indirect | Partial | Partial loss of value | This site in several hundred metres from LW S7A, and within a zone considered of low likelihood to experience minor subsidence. |
| 52-2-4980 | Hornes Creek GG1 | Indirect | Partial | Partial loss of value | This site in several hundred metres from LW S7A, and within a zone considered of low likelihood to experience minor subsidence. |




Source: MSEC 2024

**Plate 9.1** **Predicted profiles of subsidence, upsidence and closure along Bargo River and Hornes Creek resulting from extraction of Longwalls S1A to S7A**

## 9.5 Cumulative impacts and intergenerational loss/equity

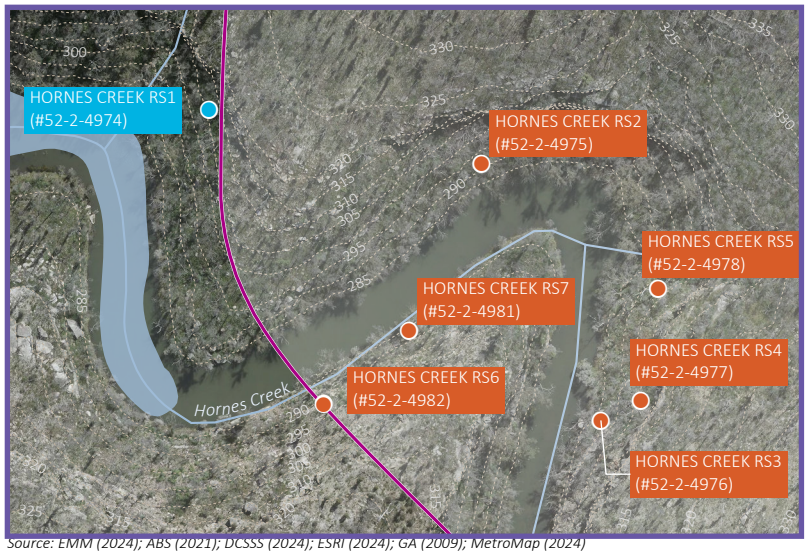
Cumulative impacts are the successive, incremental and combined impacts of activities on the cultural heritage values of a site or sites. The predicted impacts to Aboriginal sites are considered to be unlikely. Therefore, If the impacts from the modification remain within predicted limits, they are likely to have a negligible cumulative impact.

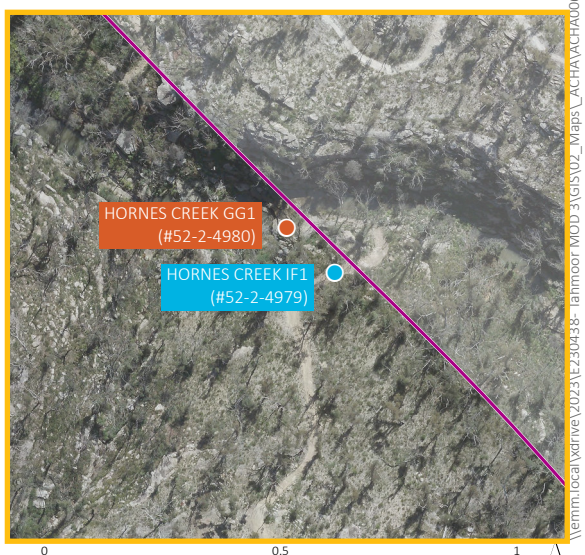
This is consistent with previous coal extraction within the Southern Coalfields where impacts to rockshelters and other Aboriginal cultural heritage sites due to subsidence related impacts from underground mining have traditionally been very low. For example, subsidence monitoring programmes since 1990 (Sefton 2000; Regal and Reeves 2017) of 185 sandstone rockshelter sites and 21 open sandstone platform sites, found changes attributable to subsidence at 18 sites and archaeological features (art panels) were affected at two sites. Rockshelter collapse is rare and has not been documented in the Southern Coalfields since the collapse of Whale Cave thirty years ago (Regal and Reeves 2017).

There is a small residual risk that extraction of LW S7A may result in the partial harm of one or more of the rockshelters. However, as no art was identified within the rockshelters, if cracking was to occur – the most common form of impact from such mining - the impact would harm the overall context of the site (i.e. the natural sandstone shelter or platform) rather than any specific archaeological features. Given the changes caused by total subsidence are predicted to be less than 5 cm, they could be considered to reflect natural weathering and landscape evolution. Currently, AHIMS data has identified 49 rockshelters within the immediate locale (Section 5.5), and as such the cultural assemblage identified here would account for 12.5% of this site type. Each site accounting for ~1.7% of the cultural assemblage. Impacts to a large number of the sites, which would be in contrast to the last decade of cultural heritage management in the region, would be required to result in significant cumulative impacts.

At the grinding groove site, the risk of partial harm is slightly higher as it is on a platform in a creek bed that is more susceptible to valley related movement. If cracking were to occur, it is possible that the crack would result in harm to one or more of the grinding grooves. While the risk is of partial harm to the grinding groove site is slightly higher relative to the rockshelter sites, the overall likelihood of harm occurring still remains low. The recent work focussing on Redbank Creek 4 (Section 5.4.5), which was in a higher risk zone and contained a more extensive series of grooves, suggests loss of this site would be unlikely. However, if large-scale impacts were to occur to the site, this would result in some cumulative impact to the grinding groove site type within the locale, with few examples documented in the region to date (Section 0).

Based on above, it is considered that there is a low likelihood of large-scale loss of cultural materials from the Project. Any potential impacts are low, and management activities are proposed to closely monitor for any change where such impacts need to be considered and changes and/or intervention undertaken. As such, it is considered that the modification would have limited, if any, cumulative impact.




Source: EMM (2024); ABS (2021); DCSSS (2024); ESRI (2024); GA (2009); MetroMap (2024)

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KEY

- Study area
- Outside of study area
- Partial loss of value

Existing environment

- Rail line
- Major road
- Minor road
- 5 m contour
- Watercourse/drainage line
- Waterbody

Potential impacts of the project

Tahmoor South Coal Project
SSD 8445 Modification 3
Figure 9.1

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# 10 Management strategy and recommendations

## 10.1 Key findings

- The ACHA concludes that seven Aboriginal objects and/or sites are within 10m of the study area. These are all within predicted subsidence areas, and as such are considered to be partially impacted by the Project. However, the risk of subsidence is considered to be low, and would be <5 cm in landscape change (Section 9.4). The sites include six rockshelter sites and one grinding grooves site. (Two further sites were identified outside of the study area, and would not be impacted)

- Recommendations are proposed to guide post-approval requirements (Section 10.3). These include updating the existing Heritage Management Plan (HMP) for LW S1A-S6A of the Tahmoor South coal project to incorporate the findings and requirements of this report.

## 10.2 Management strategy

### 10.2.1 Summary of findings

The ACHA process, which included consultation with the Aboriginal community and field investigations, identified six Aboriginal site within the study area: Hornes Creek RS2 (#52-2-4975), Hornes Creek RS3 (#52-2-4976), Hornes Creek RS4 (#52-2-4977), Hornes Creek RS5 (#52-2-4978), Hornes Creek RS6 (#52-2-4982), Hornes Creek RS 7 (#52-2-4981). A grinding groove site, Hornes Creek GG1 (AHIMS #52-2-4980), was recorded within 10m of the study area. A further rockshelter and isolated stone artefact were documented >10m outside of the study area.

Previous assessments of the study area as part of the earlier Tahmoor South Coal project found limited potential for cultural materials. The focus of these earlier works where at Dogtrap Creek, while Stonequarry, Matthews and Cedar Creeks further afield are also documented as containing substantive cultural materials in the form of rockshelters, grinding grooves and various densities of stone artefacts. However, while the study area was in earlier assessments, no field investigations of the locale had occurred.

A field survey of the study area was subsequently undertaken, and which focussed on steep and incised Sandstone valleys encompassing Hornes Creek. Based on previous findings, these environments were considered the most probable to encompass cultural materials. Overall, some seven Aboriginal sites identified dominated by rockshelters. These were all relatively small, and in various instances included both stone artefacts and/or shallow deposit within which they may occur. In addition, a grinding groove site was found on a large sandstone slab in the base of Hornes Creek and consisting of seven narrow grooves.

Of these sites, all are situated within the predicted subsidence zone. As such, all would be potentially impacted by the project. However, modelling by MSEC (2024) suggests that any subsidence would be of low likelihood to occur, and would be limited to a few centimetres of landscape change. While this may result in cracking and/or other minor damage to sites, such as rockshelters, major collapse or destruction would not be expected.

### 10.2.2 Post-approval requirements

It is difficult to assess the likelihood of instabilities for rockshelters based upon predicted ground movements as the likelihood of the shelters becoming unstable is dependent on several factors which are difficult to fully quantify. These factors include jointing, inclusions, weaknesses within the rock mass, groundwater pressure and seepage flow behind the rockface. Even if these factors could be determined, it would still be difficult to quantify the extent to which these factors may influence the stability of the shelter naturally or when it is exposed to mine subsidence movements (MSEC, 2022, p.140).

The most common management strategy to mitigate the effects of subsidence on rockshelters and grinding grooves within the general region has been prescribed monitoring program of the sites to assess potential impacts from the under-mining. An exception to this is the excavation program Teatree Hollow 2013.1 (#52-2-4471). While the site was considered of very low risk of being adversely affected by the under-mining of the locale, discussions with Heritage NSW and the registered Aboriginal parties sought to obtain some archaeological information from the site prior to the development activities should harm and/or destruction ultimately result. The project was implemented, and ultimately co-designed with the local Aboriginal community, with strong success, both providing the necessary information in the event of impact, and for providing information about the past. The predicted impacts of the newly recorded rockshelters and grinding groove are all lower than those predicted for Teatree Hollow 2013.1. Given this, it is considered that a monitoring program is sufficient to appropriately manage these sites, but should be further discussed as part of the development of the proposed Heritage Management Plan (HMP) update outlined below. This monitoring program should be preceded by a detailed recording of the sites in order to assess their current condition, which is also a requirement of the HMP and subsequent actions.

A HMP has previously been developed for LW S1A-S6A of the Tahmoor South Coal project that outlines the management of Aboriginal sites within the study area (EMM 2023). Rather than developing new management documents, it is recommended that the newly identified Aboriginal sites should be included in an updated version of the HMP, with specific management measures aligned with the discussion above. Specifically, the update should include any pre-construction documentation and archival recording, additional investigations if proposed, and inclusion in the relevant trigger action response plan (TARP). The latter dictating intervention and mitigation measures in the event that harm is observed.

## 10.3 Recommendations

The following recommendations should be integrated into the management of this project:

- The existing Tahmoor South coal project HMP for LW S1A-S6A should be updated to include to newly recorded Aboriginal sites with specific management measures for pre-mining recording, additional investigation (if required), a monitoring program, and integration into the TARP in the event of observed impacts (see Section 10.2 for further discussion and guidance). Following this update, the title of the HMP should be updated to include LW S7A.
- Consultation should be maintained with the RAPs throughout the life of the modification.
- A copy of the ACHA should be lodged with AHIMS and provided to the RAPs.
- AHIMS Site Recording Forms for the newly identified Aboriginal site within the study area should be submitted to the AHIMS database once their validation has been completed.
- If any part of the construction footprint is located outside the areas identified in this ACHA, or if any alteration is proposed further assessment of these area(s) should be undertaken to identify and appropriately manage Aboriginal objects and/or sites that may be present.
- Where the heritage consultant changes through the project, suitable hand over should be undertaken to ensure no loss or mistranslation of the intent of the information, findings and future steps in heritage management occur.

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# Appendix A
## Legislative context

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## A.1 Commonwealth

### *Aboriginal and Torres Strait Islander Heritage Protection Act 1984*

The *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* preserves and protect areas (especially sacred or intangible sites) and places of particular significance to Aboriginal people from damage or destruction. Steps necessary for the protection of a threatened place are outlined in a gazetted Ministerial Declaration (Sections 9 and 10); and which can result in a cessation of any development activity.

In addition, the Act also protects objects by Declaration, notably Aboriginal skeletal remains (Section 12). This can be applied at a State level where a State is unwilling or unable to provide such protection.

### *Environment Protection and Biodiversity Conservation Act 1999*

The *Environment Protection and Biodiversity Conservation Act 1999* provides for protection of natural and cultural heritage places. The Act establishes a National Heritage List (NHL) and a Commonwealth Heritage List (CHL) upon which places of natural or cultural significance can be listed. Sites at a national level and can be in public or private ownership. The CHL is limited to places owned by the Commonwealth, and most frequently encompass Department of Defence sites. Sites and places listed on the NHL are considered to be of State and local heritage value, even if they are not listed or documented as such at a State level.

The values of sites and places on the NHL/ CHL are protected under the EPBC Act. The Act requires that the Minister administering the Act assess any action which has, will have, or is likely to have, a significant impact on the heritage values. Where relevant, a referral is made to the relevant Commonwealth Department, and either approval, approval with controls, or rejection of the proposed action is determined.

### *Native Title Act 1993*

The *Native Title Act 1993* provides recognition and protection for native title. The Act establishes the managing body, National Native Title Tribunal, who administers native title claims to rights and interests over lands and waters by Aboriginal people. It also administers the future act processes that allow proponents to identify and manage potential native title issues for a given activity on a site where a claim has yet to be made or finalised.

In addition, the Act provides for Indigenous Land Use Agreements (ILUA), which is an agreement between a native title group and others about the use and management of land and waters. ILUAs were introduced as a result of amendments to the Act in 1998. They allow people to negotiate flexible and bipartisan agreements to suit their particular circumstances often circumventing lengthy timeframes associated with the native title process. An ILUA can be negotiated over areas where native title has, or has not yet, been determined. They can be part of a broader determination or settled separately.

## A.2 State

### *Environmental Planning and Assessment Act 1979*

The *Environmental Planning and Assessment Act 1979* (EP&A Act) is the over-arching Act that dictates the nature of assessment and management of the environment during a development project, and within which heritage forms a component. requires that environmental and heritage impacts are considered by consent authorities prior to granting development approvals.

The Act has two main approval pathways within which heritage needs to be considered. Generally for smaller scale (either financially or spatially), Parts 4 (Division 4.1) and 5 (Division 5.1) of the Act are implemented. Part 4 requires that a proponent submits a Development Application (DA) to local council for a given development, and within this document a consideration of Aboriginal and historical heritage is required. The specific nature of the assessment is usually determined at a pre-DA meeting with the council, and in relation to the relevant heritage Acts. Where Aboriginal heritage is identified as an issue, the DA may become Integrated Development, whereby the State government is also required to review and provide comments on the DA prior to its issue. Part 5 of the Act is a similar process, but only relates to approvals developed and issued by State government departments. Each State government department has their own internal approach to considering environmental issues, but ultimately must develop a Review of Environmental Factors (REF), which is comparable to a DA, and which requires consideration and management of heritage. Similarly where heritage is identified as an issue, liaison with relevant State consent authorities and approvals under other Acts may still be required.

The other approval pathway relates to State Significant Development and/or Infrastructure (Parts 4.7 and 5.2, respectively). These processes require an Environmental Impact Statement (EIS) to be developed for a project and assessed currently by the Department of Planning, Industry and Environment. Importantly, the SSD and SSI processes turns off a number of pieces of other legislation, including parts of the *National Parks and Wildlife Act 1974*. In the case of Aboriginal heritage, both the assessment and approval for harm are dictated by the Secretary's Environmental Assessment Requirements (SEARs) outlining the contents and scope of the EIS, and the Project Approval that dictates controls on how a development should proceed.

### *National Parks and Wildlife Act 1974*

The National Parks and Wildlife Act 1974 (NPW Act) provides protection for Aboriginal objects and places across NSW:

- An Aboriginal object is defined as *"Any deposit, object or material evidence (not being a handicraft made for sale) relating to the Aboriginal habitation of the area that comprises New South Wales, being habitation before or concurrent with (or both) the occupation of that area by persons of non-Aboriginal extraction and includes Aboriginal remains."*

- An Aboriginal place is "any place declared to be an Aboriginal place under section 84". This is a very specific piece of legislation that provides process and management of Aboriginal sites of cultural, but not necessarily scientific, values. They are commonly, but not always associated with intangible values.

- Any place declared to be an Aboriginal place by the Minister for the Environment, under Section 84 of the Act, is also protected.

It is an offence to disturb Aboriginal objects or places without an Aboriginal Heritage Impact Permit (AHIP), which is outlined in Section 90 of the Act. Currently, such permits can be sought from the Chief Executive of the NSW Department of Premier and Cabinet (DPC), with the recent relocation of the Office of Environment and Heritage.

To obtain an AHIP, certain assessment and documentation (outlined in this report) must be provided to DPC for their consideration. Once satisfied, they may endorse an AHIP to harm cultural heritage either conditionally or unconditionally. They can also refuse an application as outlined in Section 90C of the Act, and which can be appealed in accordance with Section 90L.

### *Aboriginal Land Rights Act 1983*

The *Aboriginal Land Rights Act 1983* provides process and protocols for the transfer of vacant Crown land ownership to a Local Aboriginal Land Council, where the land is not for an essential purpose or for residential land. These lands are then managed and maintained by the Local Aboriginal Land Council.

For the purposes of this report, the Act is primarily important to inform relevant Aboriginal communities for consultation; and where Crown land forms part of the development area may require additional liaison with the LALC as a potential, or existing, landowner.

# Appendix B
## Aboriginal community consultation

EMM
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## B.1 Consultation log and communications record

***Aboriginal Consultation Requirements for Proponents* (DECCW 2010)***

**ABORIGINAL COMMUNICATIONS LOG**

**Project Name:** Tahmoor Coal Project MOD 3 **Project #:** XXX

| DATE | OUTGOING / INCOMING | ORGANISATION | CONTACT MADE BY | CONTACT TO | CONTACT TYPE | COMMENTS |
|---|---|---|---|---|---|---|
| 1-Nov-23 | Outgoing | Heritage NSW | Laressa Barry | ACH team | Email | Requested information on Aboriginal stakeholders for the project. |
| 1-Nov-23 | Outgoing | Tharawal Local Aboriginal Land Council | Laressa Barry | CEO | Email | Requested information on Aboriginal stakeholders for the project. |
| 1-Nov-23 | Outgoing | The Office of the Registrar, Aboriginal Land Rights Act 1983 | Laressa Barry | Aboriginal Owners team | Email | Requested information on Aboriginal stakeholders for the project. |
| 1-Nov-23 | Outgoing | National Native Title Tribunal | Laressa Barry | Geospatial Services | Email | Requested information on Aboriginal stakeholders for the project. |
| 1-Nov-23 | Outgoing | Native Title Services NTSCORP | Laressa Barry | The Manager | Email | Requested information on Aboriginal stakeholders for the project. |
| 1-Nov-23 | Outgoing | Wollondilly Shire Council | Laressa Barry | The Manager | Email | Requested information on Aboriginal stakeholders for the project. |
| 1-Nov-23 | Outgoing | Greater Sydney Local Land Service (former CMA) | Laressa Barry | The Manager | Email | Requested information on Aboriginal stakeholders for the project. |
| 2-Nov-23 | incoming | Wollondilly Shire Council | Rob Moran | Laressa Barry | Email | Provided with list of potential Aboriginal stakeholders. |
| 14-Nov-23 | incoming | Heritage NSW | Barry Gunther | Laressa Barry | Email | Provided with list of potential Aboriginal stakeholders. |
| | | | | | | |
| 17-Nov-23 | incoming | Didge Ngunawal Clan | Lily Carroll | Laressa Barry | Email | Registered an interest in the project |
| 17-Nov-23 | incoming | Konanggo ACHS | Robert Young | Laressa Barry | Email | Registered an interest in the project |
| 18-Nov-23 | incoming | RAW Cultural Healing | Raymond Weatherill | Laressa Barry | Email | Registered an interest in the project |
| 19-Nov-23 | incoming | Thomas Dahlstrom | Thomas Dahlstrom | Laressa Barry | Email | Registered an interest in the project |
| 20-Nov-23 | incoming | National Native Title Tribunal | Geospatial services | Laressa Barry | Email | Confirmed there are no overlapping Determinations, ILUAs, Applications or claims over the proposed modification area. |
| 20-Nov-23 | incoming | Mundawari HC | Dean Delponte | Laressa Barry | Email | Registered an interest in the project |
| 20-Nov-23 | incoming | A1 Indigenous Services | Carolyn Hickey | Laressa Barry | Email | Registered an interest in the project |
| 20-Nov-23 | incoming | Cubbitch Barta Native Title Aboriginal Claimants | Glenda Chalker | Laressa Barry | Email | Registered an interest in the project |
| 20-Nov-23 | incoming | Clive Freeman | Clive Freeman | Laressa Barry | Email | Registered an interest in the project |
| 20-Nov-23 | incoming | Butucarbin Aboriginal Corporation | Jennifer Beale | Laressa Barry | Email | Registered an interest in the project |
| 21-Nov-23 | incoming | Kamilaroi Yankuntjatjara Working Group | Phil Khan | Laressa Barry | Email | Registered an interest in the project |
| 21-Nov-23 | incoming | The Office of the Registrar, Aboriginal Land Rights Act 1983 | Karen Carter | Laressa Barry | Email | Provided with list of potential Aboriginal stakeholders. |
| 21-Nov-23 | incoming | Barraby Cultural Services | Lee Field | Laressa Barry | Email | Registered an interest in the project |
| 21-Nov-23 | incoming | yurrandali | Bo Field | Laressa Barry | Email | Registered an interest in the project |
| 22-Nov-23 | incoming | [redacted] | [redacted] | Laressa Barry | Email | Registered an interest in the project |
| 27-Nov-23 | incoming | Mura Culture Services | Phillip Carroll | Laressa Barry | Email | Registered an interest in the project |
| 28-Nov-23 | incoming | Guntawang Aboriginal Resources Incorporated | Wendy Morgan | Laressa Barry | Email | Registered an interest in the project |
| 30-Nov-23 | incoming | D'harawal Traditional Descendants and Knowledge Holders Circle | Gawaian Bodkin-Andrews | Laressa Barry | Email | Registered an interest in the project (on behalf of several Dharawal Elders) |
| 1-Dec-23 | incoming | Wori Wooilywa | Daniel Chalker | Laressa Barry | Email | Registered an interest in the project |
| 5-Dec-23 | incoming | All RAPs | Laressa Barry | All RAPs | Email | Emailed proposed assessment methodology letter. |
| 6-Dec-23 | incoming | Guntawang Aboriginal Resources Incorporated | Wendy Morgan | Laressa Barry | Email | Wendy confirmed that she reviewed the methodology letter and was satisfied that all protocols were being adhered to for the ACHA process for this Mod 3. Made a general comment that young/not local people were increasingly being engaged to participate in excavations more generally, and advocated that elders, and older Aboriginal people with local knowledge and experience, should be at the forefront of consultation and engagement. Laressa acknowledged and pledge to pass feedback along to the client, for future stages of work. |
| 7-Dec-23 | incoming | Cubbitch Barta Native Title Aboriginal Claimants | Glenda Chalker | Laressa Barry | Phone | Called with concerns over the Modification designs, as CB had advocated to reduce mining from occuring under Dog Trap Creek. Left message with LB, and called Amanda Bateman from Tahmoor Coal, to voice concerns. Amanda assured Glenda there had been a misunderstanding of the reading of the designs, and that no plans were made to modify the approval to allow mining underneath Dog Trap Creek. Glenda was satisfied that her concerns were allayed. I called Glenda back to confirm what Amanda had explained, again Glenda was satisfied with the response. |
| 11-Dec-23 | outgoing | Heritage Mailbox; Tharawal LALC | Laressa Barry | ACH team; CEO | Email | Provided with list of registered Aboriginal stakeholders, as well as copies of the project notification and advertisement tearsheet. |
| 29/Jan/24 | Outgoing | Cubbitch Barta Native Title Aboriginal Claimants | Nicolas Reilly | Glenda Chalker | Phone | Call to discuss that a site inspection was now required for the ACHA. NR checked CB's preliminary availability for site inspection of study area. Glenda advised that CB are only available on Monday, Wednesday and Friday of the week of the 19th |
| 29/Jan/24 | Outgoing | Tharawal Local Aboriginal Land Council | Nicolas Reilly | Julie Dannevig | Phone | No answer NR left a message with name and number and requested a call back |
| 31/Jan/24 | Outgoing | Cubbitch Barta Native Title Aboriginal Claimants | Nicolas Reilly | Glenda Chalker | Email | Email inviting RAP to site indpection on Monday, Wednesday and Friday of the week of the 19th. Requested insurances and sub-consultant contract |
| 31/Jan/24 | Outgoing | Tharawal Local Aboriginal Land Council | Nicolas Reilly | Julie Dannevig | Email | Email inviting RAP to site indpection on Monday, Wednesday and Friday of the week of the 19th. Requested insurances and sub-consultant contract |
| 7/Feb/24 | Outgoing | Cubbitch Barta Native Title Aboriginal Claimants | Nicolas Reilly | Glenda Chalker | Phone | Call to follow up on insurances and to check the email had been received. Glenda stated that she had received the email and confirmed CB would take part. Stated that internet had been down and that she would send through documentation when internet was back up |
| 13/Feb/24 | Outgoing | Tharawal Local Aboriginal Land Council | Nicolas Reilly | Julie Dannevig | Phone | Call to follow up on invitation - no response, message left |
| 13/Feb/24 | Outgoing | Cubbitch Barta Native Title Aboriginal Claimants | Nicolas Reilly | Glenda Chalker | Phone | Call to follow up on insurances and sub consultant form. GC mentiuoned that she had just renewed insurances and was tracking down certificate of currency. Would send through once they were found |
| 13/Feb/24 | Outgoing | Cubbitch Barta Native Title Aboriginal Claimants | Nicolas Reilly | Glenda Chalker | Email | Email to confirm that the meeting point for the survey were the Tahmoor coal head office |

| | | | | | | |
|---|---|---|---|---|---|---|
| 13/Feb/24 | Outgoing | Tharawal Local Aboriginal Land Council | Nicolas Reilly | Julie Dannevig | Email | Email to confirm that the meeting point for the survey were the Tahmoor coal head office - No repsonse from Tharawal |
| Fieldwork | | | | | | |
| 19, 21/Feb/24 | | Cubbtich Barta Native Titile Aboriginal Claimants | | | | Field survey was undertaken with the assistance of Cubbitch Barta Native Title Aboriginal Claimants over 2 days on 19 and 21 February 2024. |
| ACHA Review | | | | | | |
| 19-Mar-24 | Outgoing | All RAPs | Nicolas Reilly | All RAPs | Email | NR emailed a copy of the ACHA and invited RAPs to provide input and feedback by 16 April 2024. |
| 20-Mar-24 | Incoming | Cubbitch Barta Native Title Aboriginal Claimants | Glenda Chalker | Nicolas Reilly | Email | GC requested a hard copy of the ACHA |
| 20-Mar-24 | Incoming | Guntawang Aboriginal Resources Incorporated | Wendy Morgan | Nicolas Reilly | Email | Wendy stated that the undergrowth in the area is extremely thick and that the land needs to have a cultural burn. Stated Guntawang had nothing more to add to the report |
| 26-Mar-24 | Incoming | Clive Freeman | Clive Freeman | Nicolas Reilly | Email | Thanked EMM for the document, stated that it looked good from their end. |
| 28-Mar-24 | Outgoing | Cubbitch Barta Native Title Aboriginal Claimants | Nicolas Reilly | Glenda Chalker | Email | NR checked to see if GC received the hard copy of the ACHA that was sent in the mail |
| 2/Apr/24 | Incoming | Cubbitch Barta Native Title Aboriginal Claimants | Glenda Chalker | Nicolas Reilly | Email | GC said that she had received the hard copy of the ACHA |
| 16/Apr/24 | Incoming | Kamilaroi Yankuntjatjara Working Group | Phil Kahn | Nicolas Reilly | Email | PK said he was having trouble opening the document and requested that it be resent. NR resent the document. PK was still having trouble opening the document. NR tried to resend the link. PK still couldn't open the document. NR sent the document via wetransfer. PK was able to access the document and stated that they agree with and support the recommendations of the ACHA |

## B.2 List of identified Aboriginal stakeholders in the region

| |
|---|
| Tharawal Local Aboriginal Lands Council |
| Didge Ngunawal Clan |
| Konanggo ACHS |
| Pamela Young |
| RAW Cultural Healing |
| Thomas Dahlstrom |
| Mundawari Heritage Consultants |
| A1 Indigenous Services |
| Cubbitch Barta Native Title Aboriginal Claimants |
| Clive Freeman |
| Butucarbin Aboriginal Corporation |
| Kamilaroi Yankuntjatjara Working Group |
| Barraby Cultural Services |
| Yurrandali |
| *Name Withheld* |
| Mura Culture Services |
| Guntawang Aboriginal Resources Incorporated |
| D'harawal Traditional Descendants and Knowledge Holders Circle |
| Wori Wooilywa |
| Murra Bidgee Mullangari Aboriginal Corporation |

## B.3 Stage 1 Notification and registration

## Laressa Barry

**From:** [redacted]
**Sent:** Friday, 17 November 2023 4:24 PM
**To:** Laressa Barry
**Cc:** Laressa Barry
**Subject:** Re: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to register

CAUTION: This email originated outside of the Organisation.

Hi Laressa

Can you please register us on this project a Tahmoor

Kind regards
Paul Boyd & Lilly Carroll
Directors DNC
[redacted]

Sent from Yahoo Mail for iPhone

On Friday, November 17, 2023, 3:27 pm, Laressa Barry [redacted] wrote:

> Good afternoon,
>
> EMM has been commissioned by Tahmoor Coal Pty Ltd to undertake an Aboriginal cultural heritage assessment (ACHA) for a proposed modification (MOD 3) to the Tahmoor South Coal Project. Please find attached a letter outlining the project, and an invitation to register your interest for the project.
>
> I invite you to register your interest by 1 December 2023.
>
> We look forward to working with you for this project.
>
> Thank you and kind regards


**Laressa Barry**
Senior Archaeologist | Aboriginal Heritage Team Leader (A)
T 02 9493 9500
M [redacted]
LI Connect on LinkedIn

EMM creating opportunities

**emmconsulting.com.au**
SYDNEY | Gamaraigal Country, Ground floor, 20 Chandos Street, St Leonards NSW 2065
*Note: My work days are Monday, Tuesday, and Thursday*

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## Laressa Barry

**From:** [redacted]
**Sent:** Friday, 17 November 2023 4:27 PM
**To:** Laressa Barry; [redacted]
**Cc:** Pamela Young
**Subject:** Re: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to register
**Attachments:** E230438_Notification_v1.0.pdf; Biz Cover 2024.pdf; COC 2024.pdf; icare 2024.pdf

CAUTION: This email originated outside of the Organisation.

Dear Laressa,

Thank you for the email and invitation to register Laressa

Konanggo Aboriginal Cultural Heritage Services (KACHS) would like to register an expression of interest in the Tahmoor South SSD 8445 - Proposed Modification (Mod 3) ACHA

KACHS will provide Aboriginal RAPS with cultural knowledge and knowledge of the land with years of experience working in mainstream services/agencies.

I have cc'd Pamela within this email and has strong cultural knowledge learning from Elder's all around NSW and N.T
Pamela has worked in NPWS, OEH and Heritage NSW as a Senior Conservation Repatriation Heritage Officer for over 23 years and has connected in communities and countries with respect.

I (Robert) have learnt cultural knowledge from my Men's Elders/Seniors and have worked over 12 years in NPWS and OEH as a National Park Ranger/Tour Guide/Visitor Services Guide at Royal NP and Kamay NP, Ku-ring- gai NP, plus working over two decades in culturally supporting Aboriginal communities/countries throughout NSW

KACHS provides cultural heritage knowledge/experience from a female/male cultural lenses supporting, connecting and healing country, this is beneficial for the archaeologists and proponents.

Culturally we both have over 20 years of cultural and heritage knowledge working on country with experience in all capacities for field surveys, experience in artefacts, experienced in scarred/ring tree's, wet/dry sieving, test excavations/salvage excavations, burial repatriations (Pamela) and working well in team environment.
KACHS has had the privilege and honour working on many projects with archaeologists throughout NSW/ACT.

KACHS has strong affiliation and connection to the lands of Sydney Basin, living, working in and around Sydney suburbs, West, South, East and North protected significant sites, cultural learning and culturally supporting these sites

KACHS will be honoured working on country and have attached my insurance documents within this email

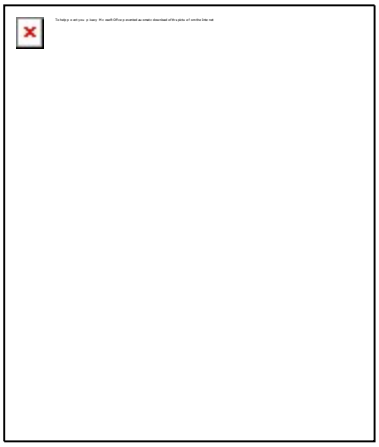
Looking forward working with EMM Consulting and Tahmoor Coal Pty Ltd

Please keep the registration (EOI), feedback or comments provided from KACHS in a confidential manner and happy to share with EMM Consulting, Tahmoor Coal Pty Ltd and Heritage NSW.

KACHS preferred communication is either email or phone and my details are below

Yours In Culture,

Robert Young
Konanggo Aboriginal Cultural Heritage Services
2/42 Crawford Road, Brighton Le Sands 2216 NSW
Email: [redacted]
Phone: [redacted]



---

**From:** Laressa Barry [redacted]
**Sent:** Friday, 17 November 2023 3:27 PM
**Cc:** Laressa Barry [redacted]
**Subject:** SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to register

Good afternoon,
EMM has been commissioned by Tahmoor Coal Pty Ltd to undertake an Aboriginal cultural heritage assessment (ACHA) for a proposed modification (MOD 3) to the Tahmoor South Coal Project. Please find attached a letter outlining the project, and an invitation to register your interest for the project.
I invite you to register your interest by 1 December 2023.

We look forward to working with you for this project.
Thank you and kind regards

**Laressa Barry**
Senior Archaeologist | Aboriginal Heritage Team Leader (A)
EMM creating opportunities
T 02 9493 9500
M [redacted]
LI Connect on LinkedIn
**emmconsulting.com.au**
**SYDNEY | Gamaraigal Country, Ground floor, 20 Chandos Street, St Leonards NSW 2065**
*Note: My work days are Monday, Tuesday, and Thursday*

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## Laressa Barry

**From:** RAW Cultural Healing [redacted]
**Sent:** Saturday, 18 November 2023 10:18 PM
**To:** Laressa Barry
**Subject:** Re: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to register

CAUTION: This email originated outside of the Organisation.

Can You Register Raw Cultural Healing for All Aspects of this Project.
Thankyou
Raymond Weatherall
[redacted]

Sent from Outlook for Android

**From:** Laressa Barry [redacted]
**Sent:** Friday, November 17, 2023 3:27:27 PM
**Cc:** Laressa Barry [redacted]
**Subject:** SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to register

Good afternoon,
EMM has been commissioned by Tahmoor Coal Pty Ltd to undertake an Aboriginal cultural heritage assessment (ACHA) for a proposed modification (MOD 3) to the Tahmoor South Coal Project. Please find attached a letter outlining the project, and an invitation to register your interest for the project.
I invite you to register your interest by 1 December 2023.

We look forward to working with you for this project.
Thank you and kind regards

**Laressa Barry**
Senior Archaeologist | Aboriginal Heritage Team Leader (A)
EMM creating opportunities
T 02 9493 9500
M [redacted]
LI Connect on LinkedIn
emmconsulting.com.au
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## Laressa Barry

**From:** Thomas Dahlstrom [redacted]
**Sent:** Sunday, 19 November 2023 4:59 PM
**To:** Laressa Barry
**Subject:** Re: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to register

CAUTION: This email originated outside of the Organisation.

Hi Laressa

I hope you are well.
Can you please register myself on the list of RAPs involved with this project please.

Kind regards

Thomas Dahlstrom
Cultural Heritage Consultant

On 17 Nov 2023, at 3:27 pm, Laressa Barry [redacted] wrote:

Good afternoon,
EMM has been commissioned by Tahmoor Coal Pty Ltd to undertake an Aboriginal cultural heritage assessment (ACHA) for a proposed modification (MOD 3) to the Tahmoor South Coal Project. Please find attached a letter outlining the project, and an invitation to register your interest for the project. I invite you to register your interest by 1 December 2023.

We look forward to working with you for this project.
Thank you and kind regards

**Laressa Barry**
Senior Archaeologist | Aboriginal Heritage Team Leader (A)

<image001.png> <image002.png>

T 02 9493 9500
M [redacted]
LI Connect on LinkedIn
**emmconsulting.com.au**

**SYDNEY | Gamaraigal Country, Ground floor, 20 Chandos Street, St Leonards NSW 2065**

*Note: My work days are Monday, Tuesday, and Thursday*

**<image003.png>**

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**Laressa Barry**

**From:** Carolyn .H [redacted]
**Sent:** Monday, 20 November 2023 8:46 AM
**To:** Laressa Barry
**Subject:** Re: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to register
**Attachments:** A1.WC2024.pdf; A1.PL2024.pdf

CAUTION: This email originated outside of the Organisation.


**Contact: Carolyn Hickey**
**Mobile:** [redacted]
**Email:** [redacted]
**Address:** [redacted]
**ABN: : 20 616 970 327**


Hi,
Thank you for your email, I would like to register in being involved in all levels of consultation for this project.
Including, Meetings, Reports, Sharing Cultural Information, and available Field Work.

About the founder Carolyn Hickey
I am a traditional owner with over 25 years experience in helping preserve Aboriginal cultural heritage on projects.
I hold cultural knowledge relevant to determining the cultural significance of Aboriginal objects and values that exist in the project area.
**I have attached A1 Indigenous Services Insurances**

***A1 INDIGENOUS SERVICES PTY LTD Represents over 100 Indigenous Locals***

**When Selecting Groups for Engagement;**
Please consider that **A1 INDIGENOUS SERVICES** is a member of the **NSW INDIGENOUS CHAMBER OF COMMERCE.**
We carry the NSWICC Assured logo showing that **A1 Indigenous Services** has met National Policy requirements as upheld by the First Australians Chamber of Commerce and Industry (FACCI) for being identified as a **100% First Nations Owned Indigenous Business** That has demonstrate compliance with Government and Industry Regulators.

Please feel free to contact me on details supplied

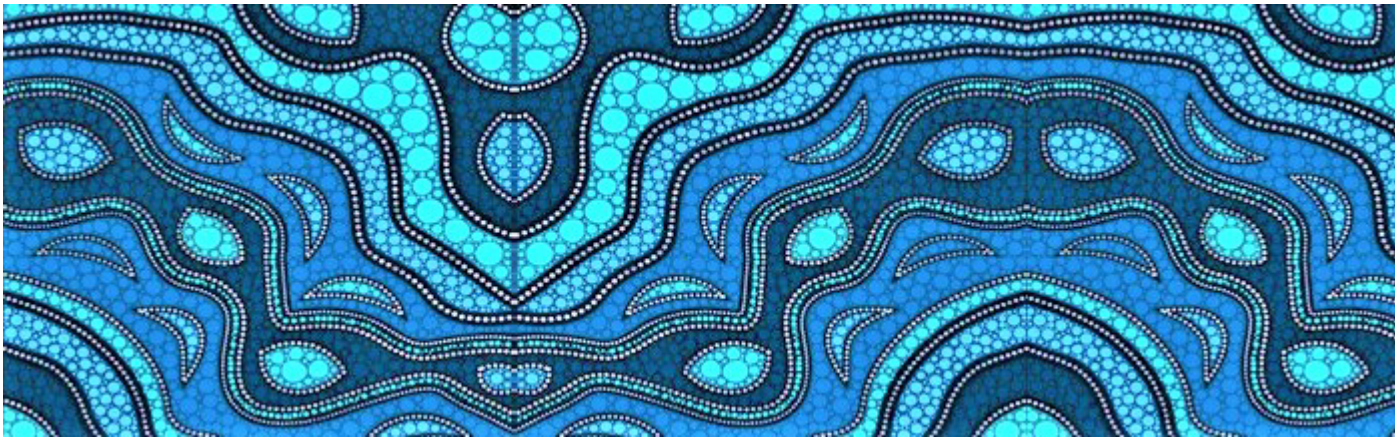
Kind Regards,
Carolyn Hickey

**A1 INDIGENOUS SERVICES is now a member of the NSW INDIGENOUS CHAMBER OF COMMERCE**

A business or enterprise carrying the NSWICC Assured logo has met National Policy requirements as upheld by the First Australians Chamber of Commerce and Industry (FACCI) for being identified as a First Nations Business Owner or Entrepreneur and the business must demonstrate compliance with Government and Industry Regulators.

**(Certificate attached)** A certificate confirms that the Enterprise listed above has met all requirements of the NSWICC's Assured Program , operating as a100% Aboriginal Owned, Operated and Controlled Business. The NSW Indigenous Chamber of Commerce (NSWICC) is the Peak body for Aboriginal Business in New South Wales and a member of the First Australians Chamber of Commerce and Industry (FACCI)

**A1 Indigenous Services is 100%, Indigenous Owned Australian Company**
**which offers a range of services to the construction industry.**
**It is our mission to commit to an innovative approach to a better future for Indigenous employment and community.**
**While improving ways to close the gap in Aboriginal participation in the construction Industry.**
**Building strength in aboriginal communities and our Indigenous labour force.**



**From:** Laressa Barry [redacted]
**Sent:** Friday, 17 November 2023 3:27 PM
**Cc:** Laressa Barry [redacted]
**Subject:** SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to register

Good afternoon,
EMM has been commissioned by Tahmoor Coal Pty Ltd to undertake an Aboriginal cultural heritage assessment (ACHA) for a proposed modification (MOD 3) to the Tahmoor South Coal Project. Please find attached a letter outlining the project, and an invitation to register your interest for the project.
I invite you to register your interest by 1 December 2023.

We look forward to working with you for this project.
Thank you and kind regards

**Laressa Barry**
Senior Archaeologist | Aboriginal Heritage Team Leader (A)
EMM creating opportunities
T 02 9493 9500
M [redacted]
LI Connect on LinkedIn
**emmconsulting.com.au**
**SYDNEY | Gamaraigal Country, Ground floor, 20 Chandos Street, St Leonards NSW 2065**
*Note: My work days are Monday, Tuesday, and Thursday*

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## Laressa Barry

**From:** Butucarbin Heritage [redacted] >
**Sent:** Monday, 20 November 2023 9:44 PM
**To:** Laressa Barry
**Subject:** Re: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to register

CAUTION: This email originated outside of the Organisation.

Dear Laressa,

On behalf of Butucarbin, I would like to register for this project.

Kind regards,
Jenny

On Fri, Nov 17, 2023 at 3:27 PM Laressa Barry [redacted] wrote:

> Good afternoon,
>
> EMM has been commissioned by Tahmoor Coal Pty Ltd to undertake an Aboriginal cultural heritage assessment (ACHA) for a proposed modification (MOD 3) to the Tahmoor South Coal Project. Please find attached a letter outlining the project, and an invitation to register your interest for the project.
>
> I invite you to register your interest by 1 December 2023.
>
> We look forward to working with you for this project.
>
> Thank you and kind regards

**Laressa Barry**
Senior Archaeologist | Aboriginal Heritage Team Leader (A)
T 02 9493 9500
M [redacted]
LI Connect on LinkedIn

emmconsulting.com.au
SYDNEY | Gamaraigal Country, Ground floor, 20 Chandos Street, St Leonards NSW 2065
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## Laressa Barry

**From:** Clive Freeman [redacted]
**Sent:** Monday, 20 November 2023 4:05 PM
**To:** Laressa Barry
**Subject:** Re: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to register

CAUTION: This email originated outside of the Organisation.

Hi team,

Pleas register my interest in the project. Please advise if you require any additional information.

Kind Regards

Clive Freeman
Ba Sci Human Geography, Ba Arts Archaeology Honours, pathway PhD Archaeology.
Managing Director Freeman & Marx Pty Ltd environmental and archaeological consultancy.

On 17 Nov 2023, at 3:27 pm, Laressa Barry [redacted] wrote:

Good afternoon,
EMM has been commissioned by Tahmoor Coal Pty Ltd to undertake an Aboriginal cultural heritage assessment (ACHA) for a proposed modification (MOD 3) to the Tahmoor South Coal Project. Please find attached a letter outlining the project, and an invitation to register your interest for the project. I invite you to register your interest by 1 December 2023.

We look forward to working with you for this project.
Thank you and kind regards

**Laressa Barry**
Senior Archaeologist | Aboriginal Heritage Team Leader (A)

<image001.png> <image002.png>

T 02 9493 9500
M [redacted]
LI Connect on LinkedIn
**emmconsulting.com.au**

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**<E230438_Notification_v1.0.pdf>**

## Laressa Barry

**From:** Glenda Chalker [redacted]
**Sent:** Monday, 20 November 2023 9:24 AM
**To:** Laressa Barry
**Subject:** RE: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to register

CAUTION: This email originated outside of the Organisation.

Laressa
Please register Cubbitch Barta for this project.
I would have liked to see a map of where this modification is to take place
Glenda

**From:** Laressa Barry [redacted]
**Sent:** Friday, 17 November 2023 3:27 PM
**Cc:** Laressa Barry
**Subject:** SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to register

Good afternoon,
EMM has been commissioned by Tahmoor Coal Pty Ltd to undertake an Aboriginal cultural heritage assessment (ACHA) for a proposed modification (MOD 3) to the Tahmoor South Coal Project. Please find attached a letter outlining the project, and an invitation to register your interest for the project.
I invite you to register your interest by 1 December 2023.

We look forward to working with you for this project.
Thank you and kind regards

**Laressa Barry**
Senior Archaeologist | Aboriginal Heritage Team Leader (A)
EMM creating opportunities
T 02 9493 9500
M [redacted]
LI Connect on LinkedIn
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SYDNEY | Gamaraigal Country, Ground floor, 20 Chandos Street, St Leonards NSW 2065

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## Laressa Barry

**From:** Dean Delponte [redacted]
**Sent:** Monday, 20 November 2023 8:20 AM
**To:** Laressa Barry
**Subject:** Re: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to register
**Attachments:** CONFIDENTIAL - SCHEDULE OF FEES.pdf

CAUTION: This email originated outside of the Organisation.

Hi Laressa,

Please register MHC for the proposed modification to the Tahmoor South Coal Project.

Thank you!!

Kind Regards

Dean Delponte
[redacted]

On Fri, 17 Nov 2023 at 15:27, Laressa Barry [redacted] wrote:

> Good afternoon,
>
> EMM has been commissioned by Tahmoor Coal Pty Ltd to undertake an Aboriginal cultural heritage assessment (ACHA) for a proposed modification (MOD 3) to the Tahmoor South Coal Project. Please find attached a letter outlining the project, and an invitation to register your interest for the project.
>
> I invite you to register your interest by 1 December 2023.
>
> We look forward to working with you for this project.
>
> Thank you and kind regards
>
> **Laressa Barry**
> Senior Archaeologist | Aboriginal Heritage Team Leader (A)
> T 02 9493 9500
> M [redacted]
> LI Connect on LinkedIn
>
> EMM creating opportunities
> emmconsulting.com.au
> SYDNEY | Gamaraigal Country, Ground floor, 20 Chandos Street, St Leonards NSW 2065

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## Laressa Barry

**From:** Phil Khan [redacted]
**Sent:** Tuesday, 21 November 2023 1:14 PM
**To:** Laressa Barry
**Subject:** RE: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to register
**Attachments:** Public liability 2023 to 2024.pdf; Icare 2023.pdf

CAUTION: This email originated outside of the Organisation.

Hi Laressa,

Thank you for informing us that **EMM Consulting** will be involved in an Aboriginal Cultural Heritage Assessment for **Tahmoor South Proposed Modification (MOD 3)** &,that you are inviting Aboriginal organisations to register, if they wish too be involved in the community consultation process.

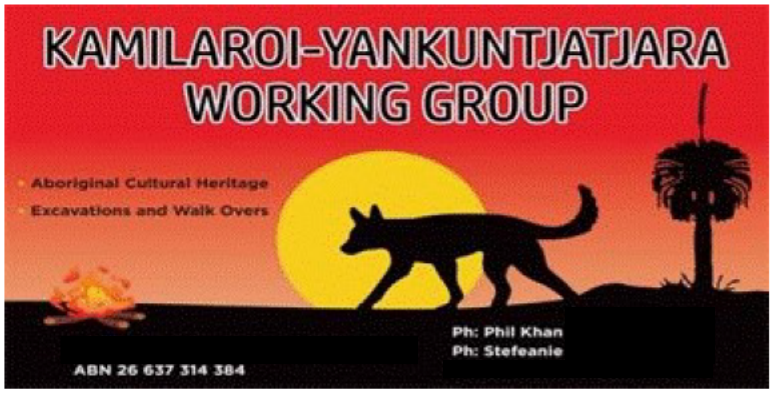
As a senior Aboriginal person for the past 50yrs, I actively participate in the protection of the Aboriginal Cultural Heritage throughout the Sydney Basin, & particularly throughout Western Sydney, on behalf of Kamilaroi Yankuntjatjara Working Group I wish to provide to you my organisation's registration of interest.

I wish to be involved & participate in all levels of consultation/project involvement. I wish to attend all meetings, participate in available field work & receive a copy of the report.

I have attached a copy of Kamilaroi Yankuntjatjara Working group's Public Liability Insurance & Workers Compensation certificate.
Our RAPS have up to 15yrs Cultural Heritage experience in – field work which involves manual excavation (digging), sieving , identifying artefacts, setting up transits, setting up equipment, packing equipment, site surveys & attending meetings (Focus groups, CwC, interpretation).

Should you wish me to provide further information, please do not hesitate to contact me on [redacted] or Stefeanie on [redacted]

Kind Regards
Phil Khan – Director
[redacted]
ABN 26 637 314 384




Sent from Mail for Windows

**From:** Laressa Barry
**Sent:** Friday, 17 November 2023 3:27 PM
**Cc:** Laressa Barry
**Subject:** SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to register

Good afternoon,
EMM has been commissioned by Tahmoor Coal Pty Ltd to undertake an Aboriginal cultural heritage assessment (ACHA) for a proposed modification (MOD 3) to the Tahmoor South Coal Project. Please find attached a letter outlining the project, and an invitation to register your interest for the project.
I invite you to register your interest by 1 December 2023.

We look forward to working with you for this project.
Thank you and kind regards

**Laressa Barry**
Senior Archaeologist | Aboriginal Heritage Team Leader (A)
creating opportunities
T 02 9493 9500
M [redacted]
LI Connect on LinkedIn
**emmconsulting.com.au**
**SYDNEY | Gamaraigal Country, Ground floor, 20 Chandos Street, St Leonards NSW 2065**
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## Laressa Barry

**From:** BCS GROUP [redacted]
**Sent:** Tuesday, 21 November 2023 5:36 PM
**To:** Laressa Barry
**Cc:** Bo Field
**Subject:** Re: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to register

CAUTION: This email originated outside of the Organisation.

Good afternoon Laressa

Thank you for your email. On behalf of Yurrandaali & BCS Group we wish to register our interest in this project.

Kind regards
Lee Field
Bo Field

On Friday, November 17, 2023, Laressa Barry [redacted] wrote:

> Good afternoon,
>
> EMM has been commissioned by Tahmoor Coal Pty Ltd to undertake an Aboriginal cultural heritage assessment (ACHA) for a proposed modification (MOD 3) to the Tahmoor South Coal Project. Please find attached a letter outlining the project, and an invitation to register your interest for the project.
>
> I invite you to register your interest by 1 December 2023.
>
> We look forward to working with you for this project.
>
> Thank you and kind regards

**Laressa Barry**
Senior Archaeologist | Aboriginal Heritage Team Leader (A)

T 02 9493 9500

M [redacted]

LI Connect on LinkedIn

emmconsulting.com.au

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--
Regards,
Lee

**Lee Field (she/her)**
Aboriginal Cultural Heritage Officer - Sydney region

Manager and Director

[redacted]

**BCS Group**

[redacted]

[redacted]

I acknowledge the Aboriginal people of the country on which I work, their traditions, culture and a shared history and identity. I also pay my respects to Elders past and present and recognise the continued connection to country. Sovereignty has never been ceded. It always was and always will be, Aboriginal land.

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## Laressa Barry

**From:** [redacted]
**Sent:** Wednesday, 22 November 2023 2:20 PM
**To:** Laressa Barry
**Subject:** Re: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Register

CAUTION: This email originated outside of the Organisation.

We are registering our organisation as we at [redacted] are identified First Nations people who hold cultural knowledge relevant to this project area and we wish to register an interest in the process of community consultation. As part of our registering we look forward to the opportunity to provide culturally appropriate information and to comment on the cultural heritage significance of Aboriginal Culture and heritage We are registering [redacted] in a full capacity. We have worked on a vast number of projects as Cultural Heritage Officers in the project area. We are currently involved on many projects in the subject area. My family and other family members have lived in the area and family currently reside in the surrounding areas. We are registering in a full capacity. We are Aboriginal people who are culturally & heritage aware. We have the necessary ability, experience, skills, insight and the knowledge to identify artefacts on field work. And as Aboriginal People we connect thru the land, thru our Ancestors and our Heritage. Therefore we are able participate on all levels. We have worked with many archaeologists across a broad landscape. We have consulted with most archeological companies over many years on projects. We have all the relevant insurances and safety gear. We are all fit, capable and adapt to a vast landscape.
Contact is preferred via email: [redacted] The contact number, email and contact person is also listed in the signature.
Please do not disclose any of our details to LALC. We have responded for inclusion, to participate on all levels.
Thanks.

Kind regards
[redacted]
Director
[redacted]

On 17 Nov 2023, at 3:27 pm, Laressa Barry [redacted] wrote:

Good afternoon,
EMM has been commissioned by Tahmoor Coal Pty Ltd to undertake an Aboriginal cultural heritage assessment (ACHA) for a proposed modification (MOD 3) to the Tahmoor South Coal Project. Please find attached a letter outlining the project, and an invitation to register your interest for the project.
I invite you to register your interest by 1 December 2023.

We look forward to working with you for this project.
Thank you and kind regards

**Laressa Barry**
Senior Archaeologist | Aboriginal Heritage Team Leader (A)

<image001.png> <image002.png> T 02 9493 9500
M [redacted]

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**emmconsulting.com.au**

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## Laressa Barry

**From:** Phillip Carroll [redacted]
**Sent:** Monday, 27 November 2023 12:07 PM
**To:** Laressa Barry
**Subject:** Re: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to register

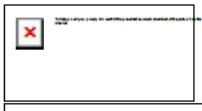
CAUTION: This email originated outside of the Organisation.

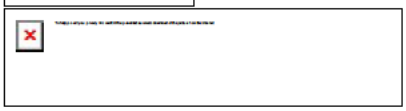
Good Afternoon

Please register Mura Culture Services for this project

Regards
Phil.C

Mobile number - [redacted]
Email- [redacted]
ABN 93 731 390 245





On Fri, Nov 17, 2023 at 3:27 PM Laressa Barry [redacted] wrote:

> Good afternoon,
>
> EMM has been commissioned by Tahmoor Coal Pty Ltd to undertake an Aboriginal cultural heritage assessment (ACHA) for a proposed modification (MOD 3) to the Tahmoor South Coal Project. Please find attached a letter outlining the project, and an invitation to register your interest for the project.
>
> I invite you to register your interest by 1 December 2023.
>
> We look forward to working with you for this project.
>
> Thank you and kind regards
>
> **Laressa Barry**
> Senior Archaeologist | Aboriginal Heritage Team Leader (A)
> T 02 9493 9500
> M [redacted]

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## Laressa Barry

**From:** Wendy Morgan [redacted]
**Sent:** Tuesday, 28 November 2023 3:44 PM
**To:** Laressa Barry
**Subject:** Re: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to register

CAUTION: This email originated outside of the Organisation.

Hi Laressa,

Guntawang Aboriginal Resources Inc would like to register an interest in the Tahmoor Coal Pty Ltd ACHA for the proposed modifications (MOD #) to the Tahmoor South Coal Project. Our cultural and heritage sites officer has years of experience to offer your project.

We look forward to working with you.

kind regards,
Wendy Morgan
CEO GARI
[redacted]

---

**From:** Laressa Barry [redacted]
**Sent:** Friday, November 17, 2023 3:27 PM
**Cc:** Laressa Barry [redacted]
**Subject:** SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to register

Good afternoon,
EMM has been commissioned by Tahmoor Coal Pty Ltd to undertake an Aboriginal cultural heritage assessment (ACHA) for a proposed modification (MOD 3) to the Tahmoor South Coal Project. Please find attached a letter outlining the project, and an invitation to register your interest for the project.
I invite you to register your interest by 1 December 2023.

We look forward to working with you for this project.
Thank you and kind regards

**Laressa Barry**
Senior Archaeologist | Aboriginal Heritage Team Leader (A)
EMM creating opportunities
T 02 9493 9500
M [redacted]
LI Connect on LinkedIn
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## Laressa Barry

**From:** Gawaian Bodkin-Andrews [redacted]
**Sent:** Thursday, 30 November 2023 11:15 PM
**To:** Laressa Barry
**Subject:** RE: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to register

CAUTION: This email originated outside of the Organisation.

Dear Laressa,

The D'harawal Traditional Descendants and Knowledge Holders Circle met on Thursday the 23rd of November, 2023, and through full consensus, agreed to be registered as an 'interested' party to this Aboriginal cultural heritage assessment. Attendees of that meeting were Aunty Frances Bodkin, Uncle John Foster, Uncle Gavin Andrews, Aunty Karen Adams, Shannon Foster, Nicole Pearce (invited Wiradjuri guest), and myself.

I will relay all communications back to the Circle members (which are not limited to the above mentioned names).

Yours Faithfully, Gawaian.

Professor Gawaian Bodkin-Andrews | Director of Indigenous Research
Office of the Deputy Vice-Chancellor Indigenous Leadership
Working from D'harawal Country (my home Country)
***Aylo warrawarra ngamuru baruda*** – To see tomorrow, you must first know yesterday.
***Ngeeyinee bulima nandiritah*** – May you always see the beauty of the earth.

*Western Sydney University acknowledges the Darug, Eora, Dharawal, and Wiradjuri peoples and thanks them for their support of its work on their lands (Greater Western Sydney and beyond).*

**From:** Laressa Barry [redacted]
**Sent:** Friday, 17 November 2023 3:27 PM
**Cc:** Laressa Barry [redacted]
**Subject:** [External] SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to register

Good afternoon,
EMM has been commissioned by Tahmoor Coal Pty Ltd to undertake an Aboriginal cultural heritage assessment (ACHA) for a proposed modification (MOD 3) to the Tahmoor South Coal Project. Please find attached a letter outlining the project, and an invitation to register your interest for the project.
I invite you to register your interest by 1 December 2023.

We look forward to working with you for this project.
Thank you and kind regards

**Laressa Barry**
Senior Archaeologist | Aboriginal Heritage Team Leader (A)

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T 02 9493 9500
M [redacted]
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## Laressa Barry

**From:** Daniel Chalker [redacted]
**Sent:** Friday, 1 December 2023 4:52 PM
**To:** Laressa Barry
**Subject:** Re: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to register

CAUTION: This email originated outside of the Organisation.

Yarma Laressa

We would like to acknowledge the land owners as the first nation's families of the country. We would like to acknowledge and pay thanks to mother earth for providing for us, Father for looking over us and the sprites for helping guide us. Also we pay our respects to the old the young and the new.

We thank you for your invitation to register for the Aboriginal Cultural Heritage Assessment at Tahmoor South Proposed Modification (MOD 3), New South Wales. We would like to be involved in the consultation process and are also able to provide field workers if required.

Thank you again and please feel free to contact me if you require anything further.

Thankyou

Daniel Chalker
[redacted]
wpri wooilywa

Sent from Outlook for Android

**From:** Laressa Barry [redacted]
**Sent:** Friday, November 17, 2023 3:27:27 PM
**Cc:** Laressa Barry [redacted]
**Subject:** SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to register

Good afternoon,
EMM has been commissioned by Tahmoor Coal Pty Ltd to undertake an Aboriginal cultural heritage assessment (ACHA) for a proposed modification (MOD 3) to the Tahmoor South Coal Project. Please find attached a letter outlining the project, and an invitation to register your interest for the project.
I invite you to register your interest by 1 December 2023.

We look forward to working with you for this project.
Thank you and kind regards

**Laressa Barry**
Senior Archaeologist | Aboriginal Heritage Team Leader (A)
EMM creating opportunities
T 02 9493 9500
M [redacted]
LI Connect on LinkedIn
emmconsulting.com.au

## Laressa Barry

**From:** Ryan Johnson [redacted]
**Sent:** Thursday, 7 December 2023 8:27 AM
**To:** Laressa Barry
**Subject:** Re: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to register

CAUTION: This email originated outside of the Organisation.

Hi Laressa
Please register our company for the above project
Thanks
Ryan johnson

On 17 Nov 2023, at 3:27 pm, Laressa Barry [redacted] wrote:

Good afternoon,
EMM has been commissioned by Tahmoor Coal Pty Ltd to undertake an Aboriginal cultural heritage assessment (ACHA) for a proposed modification (MOD 3) to the Tahmoor South Coal Project. Please find attached a letter outlining the project, and an invitation to register your interest for the project. I invite you to register your interest by 1 December 2023.

We look forward to working with you for this project.
Thank you and kind regards

**Laressa Barry**
Senior Archaeologist | Aboriginal Heritage Team Leader (A)

<image001.png> <image002.png>

T 02 9493 9500
M [redacted]
LI Connect on LinkedIn
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**SYDNEY | Gamaraigal Country, Ground floor, 20 Chandos Street, St Leonards NSW 2065**

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## B.4 Stage 2 and 3 – presentation of information and gathering cultural information

Ground floor 20 Chandos Street
St Leonards NSW 2065
PO Box 21
St Leonards NSW 1590
02 9493 9500
www.emmconsulting.com.au

5 December 2023

**Re: Tahmoor South SSD 8445 - Proposed Modification (Mod 3) - Aboriginal cultural heritage assessment - Proposed assessment methodology**

Dear Sir/Madam ,

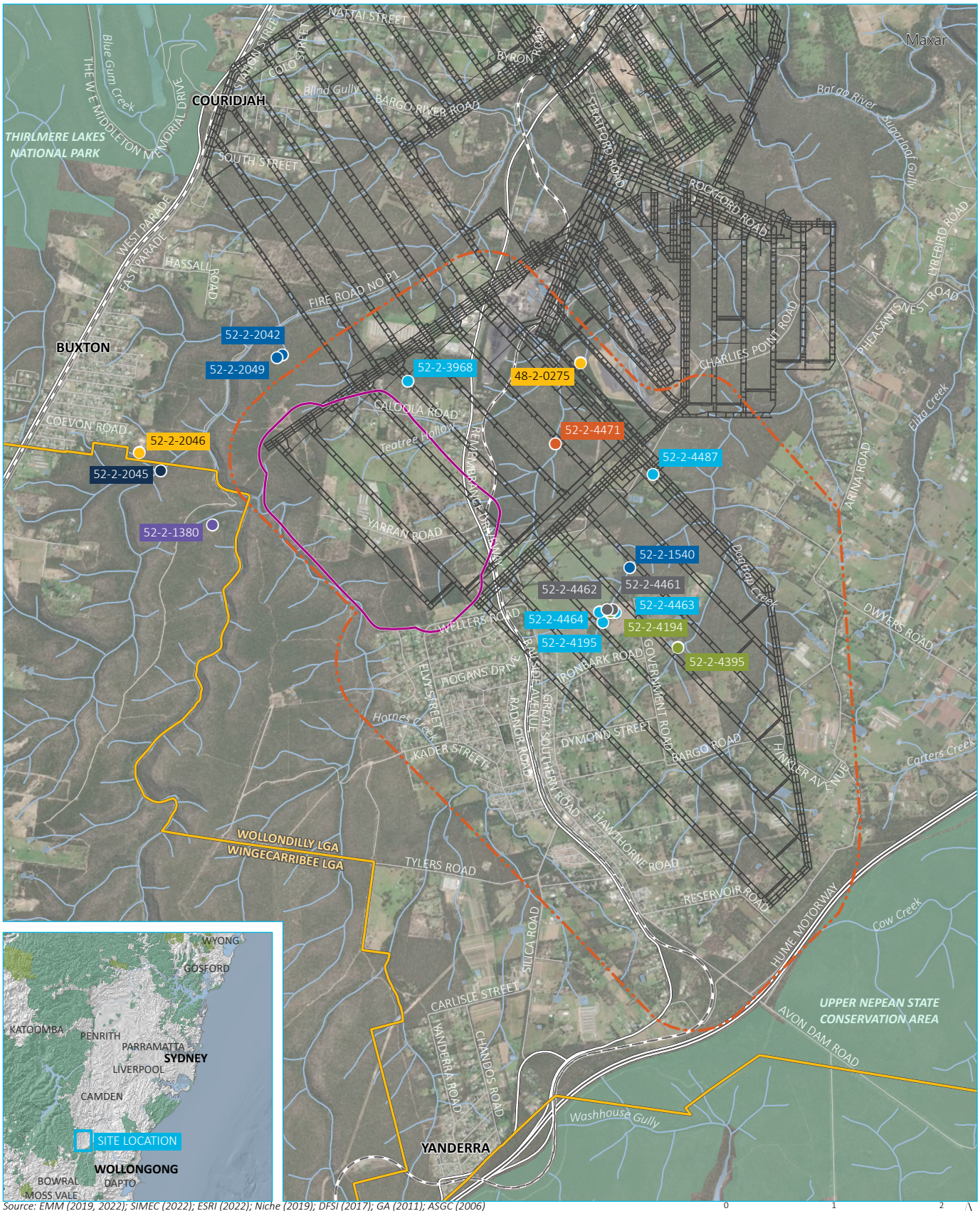
# 1 Introduction

Thank you for your continued interest in the Tahmoor South Coal Project Development (SSD 8445) proposed modification (Mod 3) (hereafter 'the project'). Tahmoor Coal owns and operates the Tahmoor Mine, an existing underground coal mine in the Southern Coalfields of NSW which 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. The Tahmoor South Domain is located south of the Bargo River and east of Remembrance Driveway and the township of Bargo. Longwall mining is used to extract coal within the bounds of Consolidated Coal Lease (CCL) 716 and CCL 747. Twelve longwalls are approved for extraction in this domain which are divided into six northern (A series) and six southern (B series) longwalls. Tahmoor Coal is seeking to include an additional long wall panel (LW S7A) to the existing approved mine plan. The Tahmoor South Coal Project area (corresponding to the area assessed by Niche Environment and Heritage in 2019), and the Mod 3 area, are illustrated overleaf in Figure 1.1.

The modification also seeks to remove the restriction on the requirement for mining to be completed within 10 years following the commencement of second workings in the Tahmoor South mining area, and to increase the maximum volume of ROM coal authorised by Condition A11(b) of SSD 8445 that can be extracted and processed on site from 33 million tonnes per annum (Mtpa) to 35 Mtpa. The proposed modification will not require any additional surface infrastructure, increase the maximum annual run-of-mine (ROM) coal approved to be extracted, or increase the maximum annual volume of coal approved to be transported from site.

Tahmoor Coal has engaged EMM Consulting Pty Ltd (EMM) to prepare an Aboriginal cultural heritage assessment (ACHA) for the study area of the project. This document is provided in accordance with sections 4.2 and 4.3 of the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW 2010), which sets out the Aboriginal consultation requirements for the project. The aims of this letter are to:

- Provide an overview of the project and how it will be assessed;
- Establish the purpose and aims of the Aboriginal consultation process;
- Seek information about any Aboriginal cultural heritage values associated with the project and how they may affect, inform or refine the project and/or assessment methods;
- Identify any culturally appropriate protocols that registered parties wish to be adopted during the information gathering process (eg protocols during site inspection, or handling of culturally sensitive information); and
- Present a draft of the intended assessment methods for your review and comment.




Source: EMM (2019, 2022); SIMEC (2022); ESRI (2022); Niche (2019); DFSI (2017); GA (2011); ASGC (2006)

0 1 2 km

GDA 1994 MGA Zone 56

N

\\emmsvr1\EMM2\2023\E230438- Tahmoor MOD 3\GIS\02_Maps\ACHA001_StudyArea_20231201_01\ACHA001_StudyArea_20231201_01.aprx

KEY

- Study area
- ACHA study area (indicative) (Niche 2019)
- Mine plan

Existing environment

- Rail line
- Major road
- Minor road
- Watercourse/drainage line
- Waterbody
- NPWS reserve
- State forest
- Local government area

AHIMS (by site type)

- Artefact scatter
- Grinding groove site
- Isolated find
- PAD
- Rock Engraving
- Rockshelter with art, deposit
- Shelter with art
- Shelter with deposit

DRAFT

# Study area

Tahmoor South Coal Project
SSD 8445 Modification 3
Figure 1.1

EMM
creating opportunities

# 2 Project Information

## 2.1 Previous investigations

An Environmental Impact Statement (EIS) was exhibited in early 2019 to gain approval for the Tahmoor South Coal Project, which involves use of the existing surface infrastructure and the expansion of underground longwall mining to the south of the existing workings (referred to as the Tahmoor South Domain). Tahmoor Coal subsequently revised the proposed mine design and submitted amended development applications on two occasions (in February and August 2020). In April 2021, Tahmoor Coal received State Significant Development Application Approval (SSD 8445) for the project.

Niche Environment and Heritage Pty Ltd (Niche) prepared an Aboriginal cultural heritage assessment (Niche 2019) to accompany the project EIS. The ACHA assessed the project area for both the A series and B series of longwalls in Tahmoor South. This assessment included the proposed project area of Mod 3 (see Figure 1.1). As part of the assessment, an Aboriginal cultural heritage survey was conducted over 16 days in 2013, a reassessment of the condition of sites was conducted over three days in October 2017 and an additional day of survey in October 2018. Further assessment required for the project was undertaken by EMM in 2019 which included archaeological test excavation at TSC2 ventilation shaft site location (in proximity to AHIMS site # 52-2-4487) as was recommended by Niche; and additional archaeological survey of proposed electrical transmission line (ETL) corridors. This additional fieldwork was completed by archaeologists and Registered Aboriginal Parties (RAPs).

The ACHA included the outcomes of an Aboriginal consultation process, an archaeological investigation (survey and test excavation), and consideration of potential impacts. No Aboriginal sites were recorded within the current Mod 3 study area, or within the general vicinity (<200m).

As part of the Tahmoor South Extraction Plan for longwalls LWS1A – S6A, a heritage management plan (HMP) was developed that provided direction on the management of Aboriginal cultural materials that may interact with the proposed development activities. One of the requirements was the proactive investigation of a documented rockshelter, Teatree Hollow 2013.1 (AHIMS #52-2-4471), situated on the eastern bank of Teatree Hollow Creek (refer Figure 1.1). While the site was considered of very low risk of being adversely affected by the under-mining of the locale, discussions with Heritage NSW and the registered Aboriginal parties sought to obtain some archaeological information from the site prior to the development activities in the event of harm and/or destruction to the rockshelter. In 2022, targeted excavation of three 0.25 $m^2$ test pits within the shelter was undertaken with RAP participation, and 116 artefacts were recovered. Radiocarbon dating suggests that Aboriginal visitation of the site primarily occurred between ~800-1,200 years ago.

# 3 Aboriginal stakeholder engagement

In accordance with the consultation process, EMM contacted a number of State and Commonwealth government organisations to provide information on Aboriginal individuals and organisations known to participate in cultural heritage management in the relevant LGAs. This was undertaken on 1 November 2023, and responses were received from Heritage NSW, the National Native Title Tribunal, the Office of the Registrar Aboriginal Land Rights Act and the Greater Sydney Local Land Service. Once this information was obtained, a process of notifying these individuals and organisations was undertaken. This included distribution of letters advising them of the project, and publication of a public notice in *The District Reporter* newspaper on 17 November 2023.

Following this notification process, 19 Aboriginal stakeholders have expressed an interest in being involved in the project:

- Didge Ngunawal Clan
- Konanggo ACHS
- Pamela Young
- RAW Cultural Healing
- Thomas Dahlstorm
- Mundawarri Heritage Consultants
- A1 Indigenous Services
- Cubbitch Barta Native Title Aboriginal Claimants
- Clive Freeman
- Butucarbin Aboriginal Corporation
- Kamilaroi Yankunjatjara Working Group
- Barraby Cultural Services
- Yurrandali
- Name withheld
- Mura Cultural Services
- Guntawang Aboriginal Resources Incorporated
- D'harawal Traditional Descendants and Knowledge Holders Circle
- Wori Wooilywa
- Tharawal LALC

From here on, these stakeholders are referred to as Registered Aboriginal Parties (RAPs). The roles, functions and responsibilities of all stakeholders involved in the consultation process are outlined in Table 3.1.

The information and feedback relevant to this project assessment that we are currently requesting from RAPs is detailed in Section 5 of this letter.

**Table 3.1 Roles and responsibilities**

| Stakeholder | Responsibility |
|---|---|
| RAPs | Provide cultural perspective, views, knowledge and advice to EMM.<br>Indicate areas of cultural significance.<br>Provide Aboriginal sites representatives for archaeological fieldwork (if desired), and ensure representatives are suitably qualified and insured).<br>Have an awareness and understanding of the commercial environment and constraints in which the applicant operates.<br>Demonstrate awareness and understanding of the opportunities to provide input in the ACHA and management recommendations for the continued design, construction and operation of the project.<br>Identify, raise, and discuss cultural concerns, perspectives and assessment requirements (if any). |
| Tahmoor Coal/EMM | Undertake the ACHA in accordance with the relevant policies, legislation and guidelines, including coordinating and directing the fieldwork.<br>Facilitate the Aboriginal consultation process.<br>Consider the cultural perspectives, views, knowledge and advice of the RAPs in assessing cultural significance and developing management measures.<br>Provide clear management measures that comply with relevant legislation, guidelines and significance. |
| All stakeholders | Mutual respect (each person has the right to have a say and be heard).<br>Communicate in a professional manner. |

# 4 Assessment and methodology

## 4.1 Overview

The purpose of the assessment is to identify and manage the Aboriginal cultural heritage sites and values of all areas that will be affected by the proposed Mod 3 development. In summary, this will involve:

- consultation with the Aboriginal stakeholders to identify socio-cultural values of the study area and places of special significance that should be considered
- a search of the AHIMS register for records of previously registered Aboriginal sites
- a review of past Aboriginal heritage reports covering the study area
- environmental landscape analysis to identify past Aboriginal resources and suitable occupation areas
- synthesis of background research to develop a predictive model of Aboriginal site location
- Aboriginal focus group meeting (AFG) meeting on Country (where possible), to inform an assessment of significance for Aboriginal cultural heritage values in the Mod 3 area (with input from the registered Aboriginal stakeholders)
- where required, an impact assessment of how the project will affect Aboriginal cultural heritage values in the Mod 3 area and

- development of management recommendations based on the results of the assessment and input from registered Aboriginal stakeholders during the consultation process and particularly from the draft ACHA review period.

## 4.2 Aboriginal focus group meetings

Following the review of this methodology, selected RAPs will be invited to an AFG meeting on Country. A significant focus of the AFG will be to discuss intangible values associated with the project's study area, such as connections to other cultural places, stories, view-lines, contemporary values, etc. Selection of the RAP participants at the AFG will ultimately be at the discretion of Tahmoor Coal.

RAPs who do not attend will continue to be included in all other aspects of the assessment including the review process.

**Note: The study area has already been subject to archaeological investigations within the previous ACHA (Niche 2019). as per the Code of Practice, and at this stage we do not propose additional on-site field investigation works.** As such, a site inspection of the study area to reassess the findings of the original ACHA (Niche 2019) and provide further ground truthing to inform the updated management recommendations would only be undertaken if deemed necessary. Any fieldwork, survey or test excavation, would be undertaken in accordance with Code of Practice requirements.

## 4.3 Timeframes

The following indicative timeframes would apply:

- Distribution of this document to registered Aboriginal stakeholders: 5 December 2023
- RAP comments on the methodology: throughout January 2024
- AFG meeting: January 2024
- Distribution of the draft ACHA report for RAP review and comment: February 2024
- Report finalisation: March 2024

# 5 What we need from you

In addition to the archaeological evidence described above, Aboriginal heritage incorporates a wide range of values such as stories, traditions and cultural practices. EMM welcomes advice from the Aboriginal community about cultural values (which might include archaeological sites or other types of values) relevant to the study area and its surrounds. EMM is relying on the Aboriginal community for advice on nonarchaeological and intangible Aboriginal values for the study area. We are happy to discuss any information which you are willing to share and will respect confidentiality where requested.

EMM would appreciate your feedback on the above methodology proposed for the investigation and assessment of the study area. In responding, please also consider the following questions:

- Are there any other knowledge-holders or traditional owner groups we should be contacting to obtain cultural information on this area?

- Are there any protocols in relation to community interaction and/or cultural heritage that you would like adopted during the project?
- Are you aware of any Aboriginal objects, places, sites or stories of cultural significance and/or importance that you are aware of within the study area? If so, please advise us how you wish them to be dealt with during the project.
- Are you aware of any past or current fishing and hunting activities within the project study area? Do you have any views on how these should be managed into the future?
- Is the information you are providing sensitive, gender specific, etc? If so, how would you like the information you provide to EMM to be managed? Noting that some documentation for the ACHA process will be required.
- Do you require any further information prior to EMM proceeding with the ACHA investigations?
- In your response, can you please also clearly identify who you would like EMM to talk to within your organisation, and provide contact details for these individuals. Please also ensure your preferred method of communication (eg telephone call, e-mail, letter etc) is highlighted for subsequent stages of the project.

# 6 Closing

We look forward to receiving any response your organisation wishes to make about the proposed method by **8 January 2024**. Your response will be documented and considered in the assessment. Most importantly, your cultural information is also welcome within this timeframe; but it can also be submitted up until the completion of the draft ACHA.

Please feel free to contact me with any questions.

Yours sincerely

**Nicolas Reilly**
Archaeologist
[redacted]

## Laressa Barry

**From:** Laressa Barry
**Sent:** Monday, 11 December 2023 11:39 AM
**To:** Wendy Morgan
**Subject:** RE: Tahmoor South Coal Project Modification 3 - Assessment methodology

Hi Wendy,
Thank you for your time reviewing the document and for your feedback below.
I have taken your feedback on board and will pass along to Tahmoor Coal, and I do agree that people with local knowledge and experience should be at the forefront of any community discussions and fieldwork. This should include local elders and knowledge holders.

As you know Niche prepared the original ACHA and chose the fieldwork representatives on that occasion, but I'll be sure to pass your feedback on for future works, as it comes up.
Thanks again for sharing your knowledge and wisdom with us.

Kind regards,

**Laressa Barry**
Senior Archaeologist | Aboriginal Heritage Team Leader (A)

T 02 9493 9500
M [redacted]
www.emmconsulting.com.au

*Note: My work days are Monday, Tuesday, and Thursday*

---

**From:** Wendy Morgan [redacted]
**Sent:** Wednesday, December 6, 2023 1:16 PM
**To:** Laressa Barry [redacted]
**Subject:** Re: Tahmoor South Coal Project Modification 3 - Assessment methodology

CAUTION: This email originated outside of the Organisation.

---

Hi Laressa and Nicolas,

From my reading of the Tahmoor South Coal Project Modifications 3 I understand that all protocols are been adhered to for the ACHA process.

My main concern is that young people aboriginal and non-aboriginal are been included in the excavation process they have not idea of artefacts shavings they just want to dig/sieve to get paid. Have any questions or concerns been put to the participants about their surroundings. This land as sacred significant to our people.

I would like to see that any older aboriginal people be included in the works who understands the importance of the artefacts to our community.

Kind regards

Wendy Morgan
CEO GARI
[redacted]

**From:** Laressa Barry [redacted]
**Sent:** Tuesday, December 5, 2023 4:52 PM
**Cc:** Nicolas Reilly [redacted]
**Subject:** Tahmoor South Coal Project Modification 3 - Assessment methodology

Good Afternoon stakeholders,

As discussed, please find attached now a methodology letter that provides some background and our proposed assessment methodology for assessing the Mod 3 study area.
You'll see from the letter that we are not proposing to do any additional fieldwork at this stage, but are proposing to undertake a focus group meeting in January 2024 to discuss the project, cultural values, and management recommendations.

On behalf of my colleague Nicolas Reilly, please find attached the methodology letter for your review and thoughts. I'd appreciate any feedback or comments you may have. I appreciate this is a busy time of year, so was hoping to get your feedback by 8 January.
Please reach out if you have any questions or require any additional information.

Thank you and kind regards,

**Laressa Barry**
Senior Archaeologist | Aboriginal Heritage Team Leader (A)
EMM creating opportunities
T 02 9493 9500
M [redacted]
LI Connect on LinkedIn
**emmconsulting.com.au**
**SYDNEY | Gamaraigal Country, Ground floor, 20 Chandos Street, St Leonards NSW 2065**
*Note: My work days are Monday, Tuesday, and Thursday*

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## Laressa Barry

**From:** Amanda Bateman [redacted]
**Sent:** Thursday, 7 December 2023 9:20 AM
**To:** Laressa Barry
**Cc:** Charlie Wheatley
**Subject:** FW: Tahmoor South Coal Project Modification 3 - Assessment methodology
**Attachments:** 20231101 - LW S7A Community Letter.pdf; MSEC1348_Diagram_General Layout_LWS7A-A-Series Longwalls_231030.pdf

CAUTION: This email originated outside of the Organisation.

Hi Laressa

Thank you for returning my call. I provided the below response to Glenda yesterday and provided her with the attached Mod 3 mine plan sent to all the affected residents that will now be in the subsidence zone.

As advised, if you need a copy of the whole Tahmoor South A & B series longwalls with the Dogtrap Creek shortened area let us know and we can seek this from MSEC.

Kind regards

**Amanda Bateman**
Community Liaison Specialist
[redacted]

**SIMEC Mining**
2975 Remembrance Driveway
Bargo NSW 2574
simec.com

*We acknowledge and pay respect to First Nations people as the Traditional Owners and ongoing custodians of the lands on whi*

**From:** Amanda Bateman
**Sent:** Wednesday, 6 December 2023 3:27 PM
**To:** Glenda Chalker [redacted]
**Subject:** RE: Tahmoor South Coal Project Modification 3 - Assessment methodology

Hi Glenda

Thank you for providing this email and notification to assist us with your complaint. I confirm the notification is in relation to a Tahmoor South Modification (Mod 3) being requested to DPE for approval to mine one new longwall South 7A as a continuation of the A series longwalls which are currently being mined.

I have attached the letter and mine plan provided to the residents who will be impacted by the additional longwall S7A being proposed to the A series.

As discussed, there has been no planning for the B series longwalls as yet and no submissions have been made to mine beneath Dogtrap Creek. We have contacted EMM to inform them of the use of the incorrect mine plan which was used for the 2020 Tahmoor South EIS submission but was not the final approved mine plan.

Thank you for bringing this matter to our attention. If you have any further questions or concerns about the longwall South 7A modification proposal, please let me know.

Kind regards

**Amanda Bateman**
Community Liaison Specialist
[redacted]

**SIMEC Mining**
2975 Remembrance Driveway
Bargo NSW 2574
simec.com

*We acknowledge and pay respect to First Nations people as the Traditional Owners and ongoing custodians of the lands on whi*

**From:** Glenda Chalker [redacted]
**Sent:** Wednesday, 6 December 2023 2:44 PM
**To:** Amanda Bateman [redacted]
**Subject:** FW: Tahmoor South Coal Project Modification 3 - Assessment methodology

You don't often get email from [redacted] Learn why this is important

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**From:** Laressa Barry [redacted]
**Sent:** Tuesday, 5 December 2023 4:52 PM

**Cc:** Nicolas Reilly
**Subject:** Tahmoor South Coal Project Modification 3 - Assessment methodology

Good Afternoon stakeholders,

As discussed, please find attached now a methodology letter that provides some background and our proposed assessment methodology for assessing the Mod 3 study area.
You'll see from the letter that we are not proposing to do any additional fieldwork at this stage, but are proposing to undertake a focus group meeting in January 2024 to discuss the project, cultural values, and management recommendations.

On behalf of my colleague Nicolas Reilly, please find attached the methodology letter for your review and thoughts. I'd appreciate any feedback or comments you may have. I appreciate this is a busy time of year, so was hoping to get your feedback by 8 January.
Please reach out if you have any questions or require any additional information.

Thank you and kind regards,

**Laressa Barry**
Senior Archaeologist | Aboriginal Heritage Team Leader (A)

EMM creating opportunities

T 02 9493 9500
M [redacted]
LI Connect on LinkedIn
**emmconsulting.com.au**

**SYDNEY | Gamaraigal Country, Ground floor, 20 Chandos Street, St Leonards NSW 2065**

*Note: My work days are Monday, Tuesday, and Thursday*

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## B.5 Aboriginal feedback of the draft ACHA

**From:** Nicolas Reilly
**To:** Nicolas Reilly
**Cc:** Alan Williams
**Bcc:** [redacted]
**Subject:** SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to review ACHA
**Date:** Tuesday, 19 March 2024 4:54:00 PM
**Attachments:** image001.png
image002.png
image003.png
image004.png

---

Good afternoon,

Thank you for you continued interest in the Tahmoor Coal Project. The purpose of this email is to invite you to provide comment on the draft Aboriginal Cultural Heritage Assessment (ACHA) for the modification as required under Heritage NSW's Aboriginal cultural heritage consultation requirements for proponents 2010.

I invite you to please have a look through the document and if you would like to provide any feedback, thoughts or input. I would greatly appreciate any feedback at any time that suits, via phone, email or letter form, but please aim to get that back to me within 28 days before **Tues 16 April 2024.**

If you have any problems accessing the report, or want to chat further, please feel free to give me a call.

Tahmoor_South

Kind regards,

**Nic Reilly** (he/him)
Archaeologist
Heritage and Ecology

M [redacted]

Connect with us

MELBOURNE | Suite 8.03, Level 8,
454 Collins Street, Melbourne 3000

**This email was sent from Wurundjeri Country (https://aiatsis.gov.au/explore/map-indigenous-australia)**

**From:** Wendy Morgan
**To:** Nicolas Reilly
**Subject:** RE: Nicolas Reilly shared the folder "Tahmoor_South" with you
**Date:** Wednesday, 20 March 2024 1:03:40 PM
**Attachments:** image001.png
image002.png
image003.png
image005.png
image006.png

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Hi Nicolas,

Guntawang Aboriginal Resources Inc would just like to mention that the undergrowth in this area is extremely think, and the land needs to have a cultural burn. We have nothing more to offer to this report.

Kind regards

Wendy Morgan
CEO GARI
[redacted]

**From:** Nicolas Reilly [redacted]
**Sent:** Tuesday, March 19, 2024 4:53 PM
**To:** [redacted]
**Subject:** Nicolas Reilly shared the folder "Tahmoor_South" with you

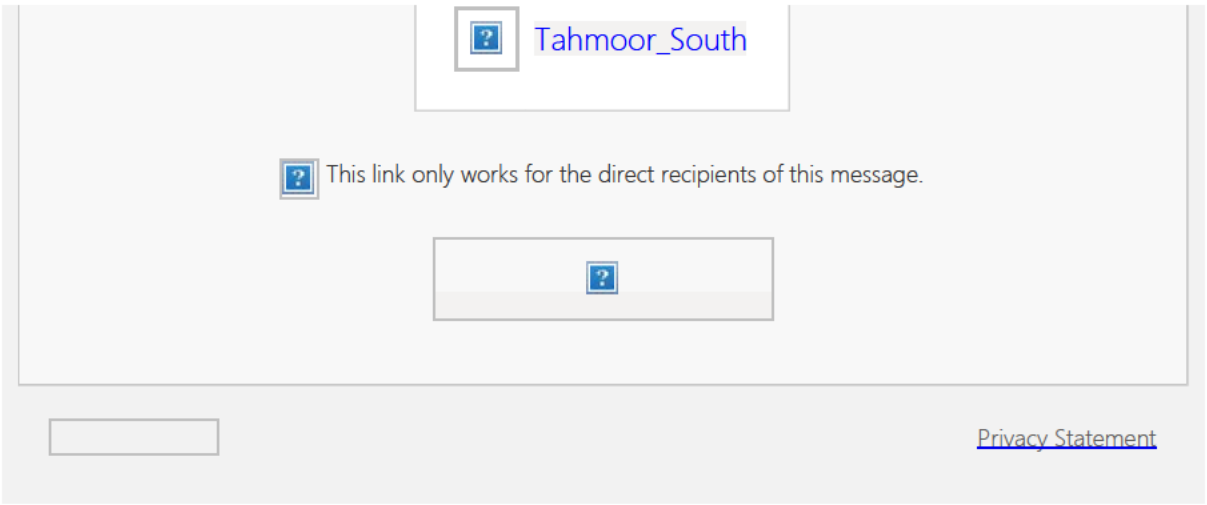
## Nicolas Reilly shared a folder with you

Good afternoon,

Attached is a copy of the draft ACHA for you to view and provide comments.

If you have any trouble please let me know.

Cheers,
Nic Reilly

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**From:** Clive Freeman
**To:** Nicolas Reilly
**Cc:** James Wearne; Alan Williams
**Subject:** Re: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to review ACHA
**Date:** Tuesday, 26 March 2024 5:30:45 PM
**Attachments:** image001.png
image002.png
image003.png

CAUTION: This email originated outside of the Organisation.

Hi team,

Thank you for the document it looks good from our end.

Please let me know if you require anything further from us, if not we look forward to working with you as the project progresses.

Kind Regards

Clive Freeman
Ba Sci Human Geography, Ba Arts Archaeology Honours, pathway PhD Archaeology.
Managing Director Freeman & Marx Pty Ltd environmental and archaeological consultancy.

On Tuesday, March 19, 2024, 4:31 pm, Nicolas Reilly [redacted] wrote:

> Good afternoon,
>
> Thank you for you continued interest in the Tahmoor Coal Project. The purpose of this email is to invite you to provide comment on the draft Aboriginal Cultural Heritage Assessment (ACHA) for the modification as required under Heritage NSW's Aboriginal cultural heritage consultation requirements for proponents 2010.
>
> I invite you to please have a look through the document and if you would like to provide any feedback, thoughts or input. I would greatly appreciate any feedback at any time that suits, via phone, email or letter form, but please aim to get that back to me within 28 days before **Tues 16 April 2024.**
>
> If you have any problems accessing the report, or want to chat further, please feel free to give me a call.
>
> Kind regards,
>
> **Nic Reilly** (he/him)
> Archaeologist
> Heritage and Ecology
>
> M [redacted]
>
> Connect with us
>
> **MELBOURNE | Suite 8.03, Level 8, 454 Collins Street, Melbourne 3000**
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**From:** Glenda Chalker
**To:** Nicolas Reilly
**Subject:** RE: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to review ACHA
**Date:** Tuesday, 2 April 2024 4:13:06 PM
**Attachments:** image001.png
image002.png
image003.png
image004.png

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Yes thank you Nic

**From:** Nicolas Reilly [redacted]
**Sent:** Thursday, 28 March 2024 10:33 AM
**To:** Glenda Chalker
**Subject:** RE: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to review ACHA

Hi Glenda,

We sent out a hardcopy on Monday. Can you confirm whether that has arrived?

Cheers,
Nic

**From:** Glenda Chalker [redacted]
**Sent:** Wednesday, March 20, 2024 2:45 PM
**To:** Nicolas Reilly [redacted]
**Subject:** RE: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to review ACHA

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Nicolas,
I would like a hard copy please
Glenda Chalker

**From:** Nicolas Reilly [redacted]
**Sent:** Tuesday, 19 March 2024 4:55 PM
**To:** Nicolas Reilly
**Cc:** Alan Williams
**Subject:** SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to review ACHA

Good afternoon,

Thank you for you continued interest in the Tahmoor Coal Project. The purpose of this email is to invite you to provide comment on the draft Aboriginal Cultural Heritage Assessment (ACHA) for the modification as required under Heritage NSW's Aboriginal cultural heritage consultation requirements for proponents 2010.

I invite you to please have a look through the document and if you would like to provide any feedback, thoughts or input. I would greatly appreciate any feedback at any time that suits, via phone, email or letter form, but please aim to get that back to me within 28 days before **Tues 16 April 2024.**

If you have any problems accessing the report, or want to chat further, please feel free to give me a call.

Tahmoor_South

Kind regards,

**Nic Reilly** (he/him)
Archaeologist
Heritage and Ecology

M [redacted]

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454 Collins Street, Melbourne 3000

**This email was sent from Wurundjeri Country (https://aiatsis.gov.au/explore/map-indigenous-australia)**

**From:** Phil Khan
**To:** Nicolas Reilly
**Subject:** RE: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to review ACHA
**Date:** Tuesday, 16 April 2024 1:47:20 PM
**Attachments:** image002.gif
image007.png
image008.png
image009.png
image010.png
image011.png

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HI Nicolas,

Thank you for your ACHA re Tahmoor South Proposed  Modification (MOD 3), we agree and support your recommendations.

Kind Regards
Phil Khan – Director
P [redacted]
E [redacted]
ABN 26 637 314 384

Sent from Mail for Windows

**From:** Nicolas Reilly [redacted]
**Sent:** Tuesday, April 16, 2024 11:39:20 AM
**To:** Phil Khan [redacted]
**Subject:** RE: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to review ACHA

Hey Phil,

Seems very strange. I have tried to send through a wetransfer of the document that should hopefully come through soon.

Cheers,
Nic

**From:** Phil Khan [redacted]
**Sent:** Tuesday, April 16, 2024 11:17 AM

**To:** Nicolas Reilly [redacted]
**Subject:** RE: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to review ACHA

CAUTION: This email originated outside of the Organisation.

---

Hi Nicholas,

It keeps coming up with this error, but we should be on your system?

# That didn't work

We're sorry, but [redacted] can't be found in the emmconsult-my.sharepoint.com directory. Please try again later, while we try to automatically fix this for you.

Kind Regards
Phil Khan – Director
P [redacted]
E [redacted]
ABN 26 637 314 384

Sent from Mail for Windows

---

**From:** Nicolas Reilly [redacted]
**Sent:** Tuesday, April 16, 2024 11:02:19 AM
**To:** Phil Khan <[redacted]
**Subject:** RE: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to review ACHA

Hi Phil,

E230438_TahmoorMOD3_ACHA_V1.1.pdf

Try this link here.

Nic

---

**From:** Phil Khan [redacted]>
**Sent:** Tuesday, April 16, 2024 10:57 AM
**To:** Nicolas Reilly [redacted]
**Subject:** RE: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to review ACHA

CAUTION: This email originated outside of the Organisation.

---

Hi Nicolas,

Unfortunately I still cannot access not sure why not.

Kind Regards
Phil Khan – Director
P [redacted]
E [redacted]
ABN 26 637 314 384

Sent from Mail for Windows

---

**From:** Nicolas Reilly [redacted]
**Sent:** Tuesday, April 16, 2024 10:36:59 AM
**To:** Phil Khan [redacted]
**Subject:** RE: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to review ACHA

Hi Phil,

I just re-shared the file with you. Let me know if it doesn't work and we can try sort something out.

Cheers,
Nic

---

**From:** Phil Khan <[redacted]
**Sent:** Tuesday, April 16, 2024 10:26 AM
**To:** Nicolas Reilly[redacted]
**Subject:** RE: SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to review ACHA

CAUTION: This email originated outside of the Organisation.

Hi Nicolas,

I cant access the report, would you mind resending it to me?

Kind Regards
Phil Khan – Director
P [redacted]
E [redacted]
ABN 26 637 314 384

Sent from Mail for Windows

---

**From:** Nicolas Reilly[redacted]
**Sent:** Tuesday, March 19, 2024 4:54:57 PM
**To:** Nicolas Reilly[redacted]
**Cc:** Alan Williams[redacted]
**Subject:** SSD 8445 - Tahmoor South Proposed Modification (MOD 3) ACHA - Invitation to review ACHA

Good afternoon,

Thank you for you continued interest in the Tahmoor Coal Project. The purpose of this email is to invite you to provide comment on the draft Aboriginal Cultural Heritage Assessment (ACHA) for the modification as required under Heritage NSW's Aboriginal cultural heritage consultation requirements for proponents 2010.

I invite you to please have a look through the document and if you would like to provide any feedback, thoughts or input. I would greatly appreciate any feedback at any time that suits, via phone, email or letter form, but please aim to get that back to me within 28 days before **Tues 16 April 2024.**

If you have any problems accessing the report, or want to chat further, please feel free to give me

a call.

Tahmoor_South

Kind regards,

**Nic Reilly** (he/him)
Archaeologist
Heritage and Ecology

M [redacted]

Connect with us

**MELBOURNE | Suite 8.03, Level 8,**
**454 Collins Street, Melbourne 3000**

**This email was sent from Wurundjeri Country (https://aiatsis.gov.au/explore/map-indigenous-australia)**

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# Appendix C
## Archaeological background

EMM
creating opportunities

## C.1 Site definitions and recording methods used for this assessment

In the AHIMS database, Aboriginal sites are defined in several ways. At the simplest level, sites are recorded as 'closed' or 'open'. Closed sites are associated with rockshelters and include other evidence of Aboriginal occupation that may be present, such as areas where subsurface Aboriginal objects may occur within the shelter ('potential archaeological deposit' (PAD)), faunal remains, and art on the shelter walls (paintings/engravings). Open sites are broadly defined and encompass all other types of Aboriginal site features that are located in areas where there is no rockshelter. The most common open site features found generally include artefacts, grinding grooves, art, culturally modified trees, and shell deposits (middens) (OEH 2012). The presence or absence of stone artefacts is often a defining factor in site identification, with almost every site likely to have at least some associated artefacts, as discard or loss of this most ubiquitous and practically indestructible marker of past Aboriginal visitation.

Any one site (or group of linked sites described as a 'complex') can contain several different site features. For example, a shelter may have art on the walls, artefacts on the floor surface or outside the shelter, and be predicted to contain faunal remains and further artefacts in the accumulated deposit inside.

A description of terms used to describe different site features known to occur in the vicinity of the study area is provided in Table C.1 and use definitions provided by OEH and those adopted by EMM in their field investigations to produce consistency in recording. Similarly, there may be places of contemporary significance to Aboriginal people in the region and that will require consultation with this community to identify.

**Table C.1 Site definitions and recording**

| Site feature | Definition and recording methods |
|---|---|
| Aboriginal ceremony and Dreaming | Previously referred to as mythological sites these are spiritual/story places where no physical evidence of previous use of the place may occur, e.g. natural unmodified landscape features, ceremonial or spiritual areas, men's/women's sites, dreaming (creation) tracks, marriage places, etc. |
| Artefact site (open stone artefact site) | Objects such as stone tools, and associated flaked material, spears, manuports, grindstones, discarded stone flakes, modified glass or shell demonstrating evidence of use of the area by Aboriginal people.<br>Open stone artefact sites were defined by the presence of one (isolated find) or more (artefact scatter) stone artefacts visible on the ground surface. The boundaries of a site are limited to the spatial extent of the visible stone artefacts. The mapped site points and/or 'site areas' do not represent the areas of potential archaeological deposit (PAD) that also apply to some sites (refer to the term 'PAD' below).<br>Open stone artefact sites were recorded by marking each artefact location or each cluster of artefacts within a 5 m radius as a separate waypoint in the GPS. Site boundaries were allocated by drawing a line around the cluster waypoints for each site using ArcGIS software. Stone artefacts more than 50 m apart were recorded as separate sites. EMM acknowledges that the 50 m rule applied here is an arbitrary distinction for site boundaries and is used mainly for efficiencies in site management and to establish consistency in site recording methods |
| Burials | A traditional or contemporary (post-contact) burial of an Aboriginal person, which may occur outside designated cemeteries and may not be marked, e.g. in caves, marked by stone cairns, in sand areas, along creek banks etc. |
| Fish trap | A modified area on watercourses where fish were trapped for short-term storage and gathering. |
| Grinding grooves | Grinding grooves were defined as an area of outcropping bedrock containing evidence of one or more grinding grooves where ground-stone hatchets or other grinding practices (i.e. seed grinding) were implemented. |
| Habitation structure | Structures constructed by Aboriginal people for short- or long-term shelter. More temporary structures are commonly preserved away from the NSW coastline, may include historic camps of contemporary significance. Smaller structures may make use of natural materials such as branches, logs and bark sheets or manufactured materials such as corrugated iron to form shelters. Archaeological remains of a former structure such as chimney/fireplace, raised earth building platform, excavated pits, rubble mounds, etc. |

## Table C.1 Site definitions and recording

| Site feature | Definition and recording methods |
|---|---|
| Modified tree (carved or scarred) | Trees which show the marks of modification as a result of cutting of bark from the trunk for use in the production of shields, canoes, boomerangs, burials shrouds, for medicinal purposes, foot holds etc., or alternately intentional carving of the heartwood of the tree to form a permanent marker to indicate ceremonial use/significance of a nearby area, again these carvings may also act as territorial or burial markers.<br>Modified trees (either carved or scarred) can be difficult to identify. Scars commonly occur on trees through natural processes such a branch tears, insect damage, storm and fire damage and faunal damage. Scars can also occur from mechanical damage from vehicles or farming equipment.<br>The attributes of potential scarred trees were discussed during the survey amongst archaeologists and RAPs before it was decided if a scar would be recorded or not. A precautionary approach was adopted, whereby some of the more ambiguous examples were recorded anyway. The assessment of scar trees was made from the experience of the survey team and the guideline *Aboriginal scarred trees in New South Wales: a field manual* (DEC 2005). In some of the more ambiguous examples, it cannot be verified whether some scars recorded during the survey are of natural or Aboriginal origin. In such instances, an expert evaluation by a scar tree expert (arborist or other) would be required to determine the status of certain trees. |
| Potential archaeological deposit (PAD) | An area where Aboriginal objects may occur below the ground surface.<br>The term 'potential archaeological deposit' was first applied in Sydney regional archaeology in the 1980s, and referred to rockshelters that were large enough and contained enough accumulated deposit to allow archaeologists to predict that subsurface cultural material was likely to be present. Since then the term has come to include open sites where the same prediction can be made.<br>EMM has defined PADs as the predicted extent of concentrated subsurface Aboriginal objects in a particular area. PADs are not technically Aboriginal sites until, and if, subsurface Aboriginal objects are identified, which is typically established through archaeological test excavation. PAD areas have been assigned to landforms that are distinguishable from the surrounding landscape (e.g. elevated areas with good outlook overlooking watercourses) as being likely to retain higher artefact densities than the assumed 'background scatter' of archaeological material in the broader landscape.<br>The identification of PADs associated with Aboriginal open camp sites was partly based on observations in the field and discussions with RAPs, but also related to the predictive model. Although PAD was attributed to areas for a variety of reasons, the main qualifiers were:<br>• The presence of surface artefacts or other Aboriginal objects. Ground surface visibility as part of the archaeological survey effort was typically considered high enough in each PAD area to identify at least one or more surface artefacts thereby indicating likelihood of subsurface potential. Notwithstanding, finding no visible surface artefacts in an area would not disqualify an area from being attributed with PAD.<br>• Level to gently inclined ground (<10%) indicating suitable camping or activity areas.<br>• Contours that distinguish the landforms with PAD from the surrounding landscape (e.g. spur crest, hill crest or knoll). Landform boundaries were also interpreted through observations in the field. Notably, rocky crest landforms that were protected from intensive cultivation were often attributed with PAD.<br>• Proximity to water: typically up to 100 m from 1st and 2nd order streams and up to 200 m from 3rd order streams and above. Elevated landforms at the confluence of higher order streams were also more likely to be attributed with PAD.<br>EMM acknowledges that all PAD areas have been historically cleared of native vegetation and some have been subject to pasture improvements such as ploughing. As such, the term PAD does not assume high subsurface integrity; instead it is a prediction of potential subsurface artefact concentrations.<br>All stone quarry sites are predicted to have PAD. The assumption is that in most cases the visible surface material at quarries is represented by larger artefacts (such as cores) and that smaller material (e.g. flakes) is likely to be buried. |
| Restricted | Site information contained in the Aboriginal Heritage Information Management System is available only to certain authorised groups of people, as requested by the Aboriginal community. Detailed information may not be available in search reports. |

## Table C.1 Site definitions and recording

| Site feature | Definition and recording methods |
|---|---|
| Shell | An accumulation or deposit of shellfish from beach, estuarine, lacustrine or riverine species resulting from Aboriginal gathering or consumption. Usually found in deposits previously referred to as shell middens. Must be found in association with other objects like stone tools, fish bones, charcoal, fireplaces/hearths, and burials. Will vary greatly in size and composition. |
| Stone quarry | Usually a source of good quality stone which is quarried and used for the production of stone tools.<br>Stone quarries represent where Aboriginal people gathered raw stone materials for stone tools and/or manufactured stone tools from the adjacent source material. Quarry sites are found at rock outcrops where the material was of suitable quality to have been used to manufacture stone tools. Stone quarries were defined by the presence of outcropping stone material with nearby evidence of the same material type used in the stone tool manufacture process. This was most commonly indicated by large stone cores or stone flakes distributed amongst the same naturally outcropping material.<br>EMM acknowledges that the 'open stone artefact' site type shares some of the same characteristics as 'stone quarries', such as the presence of stone artefacts. However, they have been distinguished from each other because quarries can not only represent open camping activities, but also a fixed location where Aboriginal people needed to visit to extract a resource. In contrast, the locations of typical open camp sites were not fixed, but chosen by Aboriginal people for their favourable conditions. |

## C.2 AHIMS search data

# AHIMS Web Services (AWS)

Note: This Excel report shows the sites found in AHIMS on the 18/01/2024. If this date is not the same as the original date of the Search Results letter.

| Site ID | Site name | Datum | Zone | Easting | Northing | Context | Site status | Primary contact |
|---|---|---|---|---|---|---|---|---|
| 52-2-3372 | Nicola No 28 | GDA | 56 | 282346 | 6202187 | Closed sit | Valid | Searle |
| 52-2-4750 | Couridjah OCS-2 | GDA | 56 | 273926 | 6209232 | Open site | Valid | |
| 52-2-2049 | Couridjah 5 (Tahmoor) | AGD | 56 | 274820 | 6206850 | Closed sit | Valid | |
| 52-2-1521 | Dogtrap Creek 1 | GDA | 56 | 279239 | 6203655 | Closed sit | Valid | |
| 52-2-1539 | Bargo; | GDA | 56 | 278844 | 6204539 | Closed sit | Valid | |
| 52-2-1599 | Bandibong; | AGD | 56 | 280890 | 6208150 | Open site | Valid | |
| 52-2-4462 | BDTC PAD01 | GDA | 56 | 277887 | 6204512 | Open site | Valid | |
| 52-2-1522 | Dogtrap Creek;;; | GDA | 56 | 279336 | 6203805 | Closed sit | Valid | |
| 52-2-1546 | Dry Creek | AGD | 56 | 281890 | 6207230 | Closed sit | Valid | |
| 52-2-3943 | Dry Creek IA 1 | GDA | 56 | 281523 | 6205328 | Open site | Valid | |
| 52-2-3371 | Nicola No 27 | GDA | 56 | 281657 | 6202294 | Closed sit | Valid | Searle |
| 52-2-4464 | BDTC AS02 | GDA | 56 | 277815 | 6204489 | Open site | Valid | |
| 52-2-0461 | Courijah; | AGD | 56 | 276943 | 6209208 | Closed sit | Valid | |
| 52-2-3363 | Nicola No 19 | GDA | 56 | 282465 | 6202851 | Closed sit | Valid | Searle |
| 52-2-1540 | Bargo | GDA | 56 | 278097 | 6204900 | Closed sit | Valid | |
| 52-2-4752 | Blue Gum Creek Shelte | GDA | 56 | 272642 | 6209094 | Closed sit | Valid | |
| 52-2-4753 | Baraba Shelter 3 | GDA | 56 | 273127 | 6209112 | Closed sit | Valid | |
| 52-2-4756 | Lake Couridjah PAD 1 | GDA | 56 | 273901 | 6209305 | Closed sit | Valid | |
| 52-2-3938 | ELIZA CREEK OAS 1 | GDA | 56 | 280851 | 6205658 | Open site | Valid | |
| 52-2-1527 | Dogtrap Creek 6 | GDA | 56 | 279358 | 6204224 | Closed sit | Valid | |
| 52-2-1531 | Dog Trap Creek; | AGD | 56 | 279560 | 6206350 | Closed sit | Valid | |
| 52-2-1724 | Couridjah 3 | AGD | 56 | 276200 | 6207560 | Closed sit | Valid | |
| 52-2-4765 | Blue Gum Creek 5 | GDA | 56 | 272221 | 6208250 | Closed sit | Valid | |
| 52-2-4758 | Baraba Scar Tree 1 | GDA | 56 | 273125 | 6208930 | Open site | Valid | |
| 52-2-4757 | Baraba 2 | GDA | 56 | 273660 | 6208674 | Closed sit | Valid | |
| 52-2-3922 | Dogtrap Creek IA-1 | GDA | 56 | 280225 | 6207339 | Open site | Valid | |
| 52-2-4195 | BDTC-AS01 | GDA | 56 | 277847 | 6204392 | Open site | Valid | |
| 52-2-4194 | BDTC-GGO1 | GDA | 56 | 277918 | 6204487 | Open site | Valid | |
| 52-2-3960 | Dog Trap Creek 2013.1 | GDA | 56 | 279334 | 6203792 | Closed sit | Valid | |
| 52-2-1526 | Dogtrap Creek 5 | GDA | 56 | 279355 | 6204163 | Closed sit | Valid | |
| 52-2-2355 | Restriction applied. Please contact | ahims@environment.nsw.gov.au. | | | | Open site | Valid | Mr.Gavin Andrews |
| 52-2-3968 | Rememberance Drive 2 | GDA | 56 | 276036 | 6206636 | Open site | Valid | |
| 52-2-3633 | Couridjah 2 | GDA | 56 | 276460 | 6207820 | Open site | Valid | |
| 52-2-3944 | Dry Creek GG 1 | GDA | 56 | 281626 | 6205669 | Open site | Valid | |
| 52-2-4867 | Little River AFT | GDA | 56 | 271113 | 6205511 | Open site | Valid | |
| 52-2-4749 | Baraba 4 | GDA | 56 | 273131 | 6209122 | Closed sit | Valid | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 52-2-2035 | P 2;Crown Land; | AGD | 56 | 273550 | 6201630 | Closed sit | Valid | |
| 52-2-3973 | Bargo Artefact Scatter | GDA | 56 | 276866 | 6202433 | Open site | Valid | |
| 52-2-1530 | Dogtrap Creek | GDA | 56 | 279173 | 6204671 | Open site | Valid | |
| 52-2-0009 | Bargo;Dog Trap Creek; | AGD | 56 | 279210 | 6203580 | Closed sit | Valid | |
| 52-2-3942 | DRY CREEK OAS 1 | GDA | 56 | 280851 | 6205658 | Open site | Valid | |
| 52-2-4461 | BDTC PAD02 | GDA | 56 | 277939 | 6204512 | Open site | Valid | |
| 52-2-1523 | Dogtrap Creek 2 | GDA | 56 | 279349 | 6203840 | Closed sit | Valid | |
| 52-2-1528 | Dogtrap Creek 7 | GDA | 56 | 279353 | 6203957 | Closed sit | Valid | |
| 52-2-3971 | Dogtrap Creek 2013.2 | GDA | 56 | 279412 | 6204552 | Closed sit | Valid | |
| 52-2-4551 | Urbis RS/PAD 3 | GDA | 56 | 279496 | 6209500 | Closed sit | Valid | |
| 52-2-1545 | Dry Creek | AGD | 56 | 281870 | 6207220 | Closed sit | Valid | |
| 52-2-4034 | SW CORNER BARGO | GDA | 56 | 277072 | 6202320 | Open site | Valid | |
| 52-2-3360 | Nicola No 16 | GDA | 56 | 281414 | 6201957 | Closed sit | Valid | Searle |
| 52-2-4473 | Eliza Creek 2013.1 | GDA | 56 | 281508 | 6208088 | Closed sit | Valid | |
| 52-2-2046 | East Buxton Isolated Fi | AGD | 56 | 273540 | 6205970 | Open site | Valid | |
| 52-2-1723 | Couridjah 1 | AGD | 56 | 276460 | 6207820 | Closed sit | Valid | |
| 52-2-3977 | Bargo Isolated Find 2 | GDA | 56 | 276856 | 6202265 | Open site | Valid | |
| 52-2-1529 | Dogtrap Creek;. | GDA | 56 | 279359 | 6204167 | Closed sit | Valid | |
| 52-2-1525 | Dogtrap Creek 4 | GDA | 56 | 279375 | 6204052 | Closed sit | Valid | |
| 52-2-3362 | Nicola No 18 | GDA | 56 | 282121 | 6202926 | Closed sit | Valid | Searle |
| 52-2-4471 | Teatree Hollow 2013.1 | GDA | 56 | 277406 | 6206055 | Closed sit | Valid | |
| 52-2-3972 | Dry Creek 2013.1 | GDA | 56 | 281560 | 6205800 | Open site | Valid | |
| 52-2-0575 | Restriction applied. Please contact ahims@environment.nsw.gov.au. | | | | | Closed sit | Valid | Mrs.glenda chalker |
| 52-2-1380 | Fire road No P1; | AGD | 56 | 274220 | 6205300 | Open site | Valid | |
| 52-2-3975 | Bargo Artefact Scatter | GDA | 56 | 276981 | 6202332 | Open site | Valid | |
| 52-2-3976 | Bargo Isolated Find 1 | GDA | 56 | 277015 | 6202250 | Open site | Valid | |
| 52-2-1533 | Dog Trap Creek ART;; | GDA | 56 | 279173 | 6204671 | Closed sit | Valid | |
| 52-2-1534 | Dog Trap Creek ART; | GDA | 56 | 279235 | 6204573 | Closed sit | Valid | |
| 52-2-1520 | Dogtrap Creek | GDA | 56 | 279264 | 6203676 | Closed sit | Valid | |
| 52-2-1538 | Bargo | GDA | 56 | 278809 | 6204558 | Closed sit | Valid | |
| 52-2-1524 | Dogtrap Creek 3 | GDA | 56 | 279429 | 6204484 | Closed sit | Valid | |
| 52-2-4536 | Urbis RS/PAD 1 | GDA | 56 | 279450 | 6209475 | Closed sit | Valid | |
| 52-2-4552 | Urbis RS/PAD 2 | GDA | 56 | 279462 | 6209450 | Closed sit | Valid | |
| 52-2-3970 | Eliza Creek 2013.2 | GDA | 56 | 281704 | 6208204 | Closed sit | Valid | |
| 52-2-4566 | TR-PAD-001 | GDA | 56 | 277147 | 6202248 | Open site | Valid | |
| 52-2-4487 | Charlies Point Road OC | GDA | 56 | 278313 | 6205768 | Open site | Valid | |
| 52-2-4764 | Blue Gum Shelter 4 | GDA | 56 | 272488 | 6208749 | Closed sit | Valid | |
| 52-2-2045 | East Buxton One;Lot 6; | AGD | 56 | 273740 | 6205800 | Closed sit | Valid | |
| 52-2-4597 | Restriction applied. Please contact ahims@environment.nsw.gov.au. | | | | | Open site | Valid | Mrs.glenda chalker |
| 52-2-3974 | Bargo Artefact Scatter | GDA | 56 | 276824 | 6202416 | Open site | Valid | |
| 52-2-1532 | Dog Trap Creek; | AGD | 56 | 278870 | 6205830 | Closed sit | Valid | |
| 52-2-4395 | Government Road AGC | GDA | 56 | 278544 | 6204158 | Open site | Valid | |
| 52-2-3921 | Dogtrap Creek AGG-1 | GDA | 56 | 278867 | 6205321 | Open site | Valid | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 52-2-4463 | BDTC AS03 | GDA | 56 | 277963 | 6204488 | Open site | Valid | |
| 52-2-2042 | Couridjah 4 Tahmoor | AGD | 56 | 274870 | 6206880 | Closed sit | Valid | |
| 52-2-1722 | Couridjah 1 | AGD | 56 | 274960 | 6208260 | Closed sit | Valid | |
| 52-2-3969 | Eliza Creek 2013.3 | GDA | 56 | 281714 | 6208196 | Closed sit | Valid | |
| 52-2-3361 | Nicola No 17 | GDA | 56 | 281899 | 6202876 | Closed sit | Valid | Searle |
| 52-2-3872 | Bargo Sports Ground - | GDA | 56 | 277060 | 6202257 | Open site | Valid | |

Report generated by AHIMS Web Service on 18/01/2024 for Nicolas Reilly (Emm Consulting) for the following area at Lat, Long From : -34.3021, 150.5131 - Lat, Long To : -34.2311, 150.6367. Number of Aboriginal sites and Aboriginal ol
This information is not guaranteed to be free from error omission. Office of Environment and Heritage (NSW) and its employees disclaim liability for any act done or omission made on the information and consequences of such acts or om

letter obtained during the Basic Search, then the search results might be different. The PDF version of this report will always coincide with the Basic Sear

| Site features | Site types | Recorders | Reports | Permits | Longitude GDA94 | Latitude GDA94 |
|---|---|---|---|---|---|---|
| Art (Pigment or Engraved) : 1, Artefact : 1 | | Mrs.Caryll Sefton | | | 150.64 | -34.30 |
| Artefact : - | | Niche Environment and | Heritage,Ms.Rebecca Chalker | | 150.55 | -34.23 |
| Art (Pigment or Engrave | Shelter with Art | Mrs.Caryll Sefton | 97959 | | 150.56 | -34.25 |
| Art (Pigment or Engrave | Shelter with Art | Warren Bluff,Niche Envi | 1333 | | 150.60 | -34.28 |
| Art (Pigment or Engrave | Shelter with Art | Warren Bluff,Niche Envi | 1333 | | 150.60 | -34.28 |
| Artefact : - | Open Camp Site | Warren Bluff | 1333 | | 150.62 | -34.24 |
| Potential Archaeological Deposit (PAD) : - | | Artefact Heritage and | Environment - Pyrmont,Mr.Ryan Taddeucci | | 150.59 | -34.28 |
| Art (Pigment or Engrave | Shelter with Art | Warren Bluff,Niche Envi | 1333 | | 150.60 | -34.28 |
| Art (Pigment or Engrave | Shelter with Art | Warren Bluff | | | 150.63 | -34.25 |
| Artefact : 1 | | Niche Environment and | Heritage | | 150.63 | -34.27 |
| Art (Pigment or Engraved) : 13, Artefact : 1 | | Mrs.Caryll Sefton | | | 150.63 | -34.30 |
| Artefact : - | | Artefact Heritage and | Environment - Pyrmont,Mr.Ryan Taddeucci | | 150.59 | -34.28 |
| Art (Pigment or Engrave | Shelter with Art | Doctor.Johan Kamming | 103104 | | 150.58 | -34.23 |
| Artefact : 5, Potential Archaeological Deposit (P/ | | Mrs.Caryll Sefton | | | 150.64 | -34.29 |
| Art (Pigment or Engrave | Shelter with Art | Warren Bluff,Niche Envi | 1333 | | 150.59 | -34.27 |
| Art (Pigment or Engraved) : - | | Niche Environment and | Heritage,Ms.Rebecca Chalker | | 150.53 | -34.23 |
| Art (Pigment or Engraved) : - | | Niche Environment and | Heritage,Ms.Rebecca Chalker | | 150.54 | -34.23 |
| Potential Archaeological Deposit (PAD) : - | | Niche Environment and | Heritage,Ms.Rebecca C | 5208 | 150.55 | -34.23 |
| Artefact : 1 | | Niche Environment and | Heritage | | 150.62 | -34.27 |
| Art (Pigment or Engrave | Shelter with Art | Warren Bluff,Niche Envi | 1333 | | 150.60 | -34.28 |
| Art (Pigment or Engrave | Shelter with Art | Warren Bluff | 1333 | | 150.61 | -34.26 |
| Art (Pigment or Engrave | Shelter with Art,Shelter | Mrs.Caryll Sefton | 3017 | | 150.57 | -34.25 |
| Art (Pigment or Engraved) : - | | Niche Environment and | Heritage,Ms.Rebecca Chalker | | 150.53 | -34.24 |
| Modified Tree (Carved or Scarred) : - | | Niche Environment and | Heritage,Ms.Rebecca Chalker | | 150.54 | -34.24 |
| Potential Archaeological Deposit (PAD) : - | | Niche Environment and | Heritage,Ms.Rebecca Chalker | | 150.54 | -34.24 |
| Artefact : 1 | | Niche Environment and | Heritage,Ms.Renee Regal | | 150.61 | -34.25 |
| Artefact : - | | Artefact Heritage and | Environment - Pyrmont,Ms.Alyce Howard | | 150.59 | -34.28 |
| Grinding Groove : - | | Artefact Heritage and | Environment - Pyrmont,Ms.Alyce Howard | | 150.59 | -34.28 |
| Art (Pigment or Engraved) : - | | Niche Environment and | Heritage,Ms.Renee Regal | | 150.60 | -34.28 |
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| | | Mr.Mark Simon | | | | |
| Artefact : - | | Niche Environment and | Heritage,Mr.Jamie Reeves | | 150.57 | -34.26 |
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| Grinding Groove : 1 | | Niche Environment and | Heritage | | 150.63 | -34.27 |
| Artefact : - | | Heritage Now - Belmont,Ms.Crystal Phillips | | | 150.51 | -34.27 |
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| Artefact : 1 | | Niche Environment and Heritage | | | 150.62 | -34.27 |
| Potential Archaeological Deposit (PAD) : - | | Artefact Heritage and Environment - Pyrmont,Mr.Ryan Taddeucci | | | 150.59 | -34.28 |
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| Art (Pigment or Engrave | Shelter with Art | Warren Bluff,Niche Envi | 1333 | | 150.60 | -34.28 |
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| Artefact : 1 | | Doctor.Peter Kabaila | | | 150.58 | -34.30 |
| Art (Pigment or Engraved) : 2 | | Mrs.Caryll Sefton | | | 150.62 | -34.30 |
| Artefact : - | | Niche Environment and Heritage,Ms.Renee Regal | | | 150.63 | -34.25 |
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| Art (Pigment or Engrave | Shelter with Art | Mrs.Caryll Sefton | | | 150.57 | -34.25 |
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| Art (Pigment or Engraved) : - | | Niche Environment and Heritage,Ms.Rebecca Chalker | | | 150.53 | -34.24 |
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| Artefact : - | | Mr.Josh Symons | | | 150.58 | -34.30 |
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| Artefact : - | | Artefact Heritage and Environment - Pyrmont,Mr.Ryan Taddeucci | | 150.59 | -34.28 |
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| Art (Pigment or Engrave | Shelter with Art | Mrs.Caryll Sefton | 3017 | 150.56 | -34.24 |
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| Potential Archaeological Deposit (PAD) : -, Artef | | Mrs.Caryll Sefton | | 150.63 | -34.29 |
| Artefact : 6 | | Mr.Mark Simon,Kelleher Nightingale Consulting Pty Ltd | | 150.58 | -34.30 |

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# Appendix E
## Geomorphology assessment

EMM
creating opportunities

# Tahmoor Mod 3 - LW S7A

Technical Specialist Report

## Geomorphology

Dr Christopher J Gippel

January 2024

FLUVIAL SYSTEMS

# Tahmoor Mod 3 - LW S7A

Geomorphology

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| Prepared by | Christopher Gippel |
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# GLOSSARY OF TERMS

| Term | Definition |
|---|---|
| Alluvium (alluvial) | Sediment deposited distant from its source after transport by flowing water, as in a riverbed, floodplain, delta, or alluvial fan. |
| Catchment | The area from which a surface watercourse or a groundwater system derives its water. |
| Cliff | A continuous rock face, including overhangs, having a minimum length of 20 m, a minimum height of 10 m and a minimum slope of 2 to 1 (≥63.4º). |
| Composition (of riparian vegetation) | Represented by 3 structural classes - tree (woody and >3 m high) shrub (woody) and ground vegetation. |
| Cover (of riparian vegetation) | Foliar projective cover of the ground. |
| Discharge | A release of water from a particular source. |
| Ferruginous colloids | Iron oxyhydroxides present in colloidal (fine particulate) form suspended in river water; an orange-red colour; water appears turbid. |
| Ferruginous seep | Dissolution (precipitation) of iron oxyhydroxides from iron-bearing groundwater where it emerges to the surface; also, bacteria can oxidize iron dissolved in groundwater to produce ferric oxide; an orange-red colour. |
| Fracture | A minor break in the continuity of solid rock; could be ancient (joint), or recent (in this context, subsidence induced). |
| Fragility (geomorphic) | Relative ease of adjustment of bed material, channel geometry, and channel planform when subjected to degradation or certain threatening activities (Cook and Schneider, 2006) (see also Resilience). |
| Geology | Science of the origin, history, and structure of the earth. |
| Geomorphic condition (of a stream) | Relative state of stream geomorphic characteristics relative to the state that is unimpacted by human disturbance (Fryirs, 2003). |
| Geomorphology | The science of the structure, origin, and development of the topographical features of the earth's surface. |
| Gorge | A stream type, found in a rectangular or slot valley with cliffs, and located in sediment transport zones where there is very little sediment storage. |
| Grid (in GIS) | An array of rectangular or square cells, with a numerical attribute value for the cell stored in its centroid; often refers to elevation but can describe any attribute (see also Raster). |
| Headwater | A stream type found in V-shaped valleys, and located within source zones for sediment. |
| Hydraulic | Refers to the physical properties of flow: velocity, depth and bed shear stress. |
| Hydrology | The study of rainfall and surface water runoff processes. |
| Impact | Influence or effect exerted by a project or other activity on the natural, built and community environment. |
| Incision | Deepening of a channel by scour (erosion) (see also Scour) |

| Term | Definition |
|---|---|
| Joint | A fracture in solid rock where the displacement associated with the opening of the fracture is greater than the displacement due to lateral movement in the plane of the fracture (up, down or sideways) of one side relative to the other. |
| Knickpoint | A local steep fall in channel bed elevation. |
| Landscape character | The aggregate of built, natural and cultural aspects that make up an area and provide a sense of place. Includes all aspects of a tract of land – built, planted and natural topographical and ecological features. |
| Large wood | Wood fallen into streams, larger than 0.1 m diameter and more than 1 m long. |
| LiDAR | Light Detection and Ranging (see ACRONYMS), also known as airborne laser scanning; a remote sensing tool that is used to map ground elevation. |
| Long profile | A plot of elevation against distance, in this case along a stream bed. |
| Longwall | A system of coal mining, where the coal seam is extracted from on a broad front or long face. |
| Minor cliff | A continuous rock face, including overhangs, having a minimum length of 20 m, heights of 5 – 10 m and a minimum slope of 2 to 1 (≥63.4º), or; a rock face having a maximum length of 20 m, a minimum height of 10 m and a minimum slope of 2 to 1 (≥63.4º). |
| Pollutant | Any matter that is not naturally present in the environment. |
| Polygon (in GIS) | A closed shape defined by a connected sequence of x,y coordinate pairs, where the first and last coordinate pair are the same and all other pairs are unique. |
| Pool | A deeper section of a stream that retains water. |
| Raster (in GIS) | A spatial data model that defines space as an array of equally sized cells arranged in rows and columns, and composed of single or multiple bands (see also Grid). |
| Regolith | The material that is found between unweathered bedrock and the ground surface, including weathered bedrock, deposits and soil. |
| Resilience (geomorphic) | Low fragility, with only minor changes likely, regardless of the level of damaging impact (Brierley and Fryirs, 2000, 2005, 2006; Brierley et al., 2011; Fryirs and Brierley, 2006). |
| Riparian | Relating to the banks of a natural waterway. |
| River Styles® | A geomorphic classification based on valley setting, level of floodplain development, bed materials and reach-scale physical features within the stream (see also Stream type) |
| Rock bar | A relatively narrow bar of exposed bedrock elevated above the bed level and crossing all or most of the channel. |
| Rock face | A rock face having a minimum length of 20 m, heights 3 – 5 m and a minimum slope of 2 to 1 (≥63.4º). |
| Rockfall | A relatively small landslide confined to the removal of individual and superficial rocks from a cliff face (Selby, 1982). |
| Rock slab | A long and wide exposure of solid bedrock on the bed for a distance at least three times the width of the channel. |

| Term | Definition |
|---|---|
| Scour | Persistent removal of sediment from the bed of a stream channel by fluvial erosion. Opposite to Aggrade. |
| Steep slope | An area of land having a gradient between 1 in 3 (33% or 18.4º) and 2 in 1 (200% or 63.4º). |
| Stream | A general term that covers all morphological features, from small rivulets to large rivers, that perennially, intermittently or ephemerally convey concentrated water flow (see also Waterway). |
| Stream order | According to the Strahler system, whereby a headwater stream is order 1, and the order increases by 1 when a stream of a given order meets one of the same order. |
| Stream type | A geomorphic classification based on valley setting, level of floodplain development, bed materials and reach-scale physical features within the stream, consistent with River Styles® (see also River Styles®) |
| Subsidence | The vertical lowering, sinking or collapse of the ground surface. |
| Talus | An accumulation of rock debris at the base of a cliff, likely to have a slope between 26.6° (1 to 2) and 36.9° (4 to 3). |
| Terrain analysis | The automated analysis of landforms using digital elevation data sets. |
| Tributary | A river or stream flowing into a larger river or lake. |
| Vector (in GIS) | A coordinate-based data model that represents geographic features as points, lines, and polygons. |

# ACRONYMS

| Acronym | Expansion |
|---|---|
| AHD | Australian Height Datum |
| DEM | Digital Elevation Model |
| GIS | Geographic Information System |
| GPS | Global Positioning System |
| LiDAR | Light Detection and Ranging |
| ML | Mining Lease |
| SAGA | System for Automated Geoscientific Analyses |

# UNITS

| Symbol | Unit |
|---|---|
| ha | Hectare |
| km | Kilometre |
| m | Metre |
| $m^2$ | Metres squared |
| $m^3$ | Metres cubed |
| mm | Millimetre |
| ML/d | Megalitres per day |

# Executive Summary

This report documented the geomorphological character of the LW S7A Study Area using repeatable field and desktop methods. The risks to geomorphic stream form and process associated with changes due to subsidence were qualitatively assessed.

Characterisation of the geomorphology of the Study Area was approached at the landscape and stream reach/point scales. Streams were classified according to Strahler stream order and geomorphological type, and geomorphic features of the streams were measured in the field at the reach/point-scale. The field survey was a repeat of a survey undertaken in 2013.

The field data were collected by a team of 2 people in 2 days over the period 20 and 21 July 2023. In general, the measurements were made using standard techniques from the literature. The intention was to capture morphological variability at the habitat scale. The field survey involved walking the streams and regularly following a sampling protocol. The lengths of Hornes Creek and Bargo River within the Study Area were walked in their entirety. A comprehensive set of variables was measured at sites in the field. At some sites only a sub-set of the variables was measured. Most of the observations involved recording presence/absence or measuring a quantity. For practical reasons, the survey focused on pools, knickpoints and bedrock featured that were large relative to the channel size. Some variables were quantified using a subjective visual estimation method. These variables included the relative strength of the variability in the channel shape; bed material calibre, and vegetation cover and continuity.

Terrain analysis, the automated analysis of landforms using digital elevation data sets, was undertaken using four LiDAR (Light Detection and Ranging) derived DEMs (Digital Elevation Model) flown on different dates since 2012. Field and desktop data were used to classify streams according to geomorphic type, geomorphic condition, as well as to quantify geomorphic features, in particular, pools.

The Study Area is located in a region characterised by generally weakly developed soils on sandstone and shale. Some of the soils are highly susceptible to erosion by concentrated water flow, but this would be expected of weakly developed soils in steep environments. The susceptibility of the soils to water erosion is part of the natural process of delivery of sediment to streams. The streams of the Study Area comprise Hornes Creek and Bargo River, which are both eroded into rocky gorges, plus six small headwater streams that are tributaries of these watercourses. The gorges are rimmed by cliffs of various lengths and heights, with densely vegetated talus slopes below the cliffs. These cliffs, and the talus slopes below them, appeared to be relatively stable.

Being bedrock controlled, the streams of the Study Area are naturally resistant to geomorphic change. The majority of streams were in a stable, close to natural geomorphic condition. The streams were affected by loss of trees in the riparian zone due to the effects of a severe bushfire in 2019/20 followed by a sequence of large floods in 2021 and 2022. The streams were also characterised by presence of ferruginous suspended colloids. These factors do not have strong implications for geomorphic condition, but they could have relevance for ecological condition.

The proposed mining is not expected to present a significant risk to change in geomorphic character of the streams. Any changes that do occur would be expected to recover quickly because the streams are resilient and in generally good geomorphic condition (i.e. essentially natural with intact form and process). A qualitative assessment found that the overall risk of geomorphic change due to subsidence was negligible. Geomorphological changes can have implications for other aspects of the environment – other relevant technical specialists should be consulted for detailed assessments of associated risks.

# 1 Introduction

## 1.1 Project description

### 1.1.1 Background

Tahmoor Coal Pty Ltd (Tahmoor Coal) owns and operates the Tahmoor Mine, an underground coal mine located approximately 80 kilometres (km) south-west of Sydney in the Southern Coalfields of New South Wales (NSW). Tahmoor Mine is located within the Wollondilly and Wingecarribee local government areas (LGAs) (refer to Figure 1).

Tahmoor Mine operates in accordance with State significant development consent (SSD 8445) granted on 23 April 2021 by the NSW Independent Planning Commission (IPC). Development consent SSD 8445 permits extraction and processing of up to 4 million tonnes per annum (tpa) of run-of-mine (ROM) coal from the Bulli Seam until 2032 using longwall mining methods. The approved longwalls authorised by SSD 8445 are shown in Figure 2 and includes an A series of longwall panels (Longwalls South 1A-6A (LW S1A-S6A)) and a B series of longwall panels (Longwalls South 1B-6B (LW S1B-S6B)). Longwall extraction under the Tahmoor South development consent commenced on 18 October 2022. Tahmoor Coal are currently extracting coal from Longwall LW S2A.

Development consent SSD 8445 has been modified on two occasions:

- Modification 1 (Mod 1) was granted on 19 July 2022 and authorised an extension of time, until 31 December 2023, for the new water treatment plant to be commissioned.
- Modification 2 (Mod 2) was granted on 13 June 2023 and authorised the transfer and storage of water treatment plant brine in underground workings.

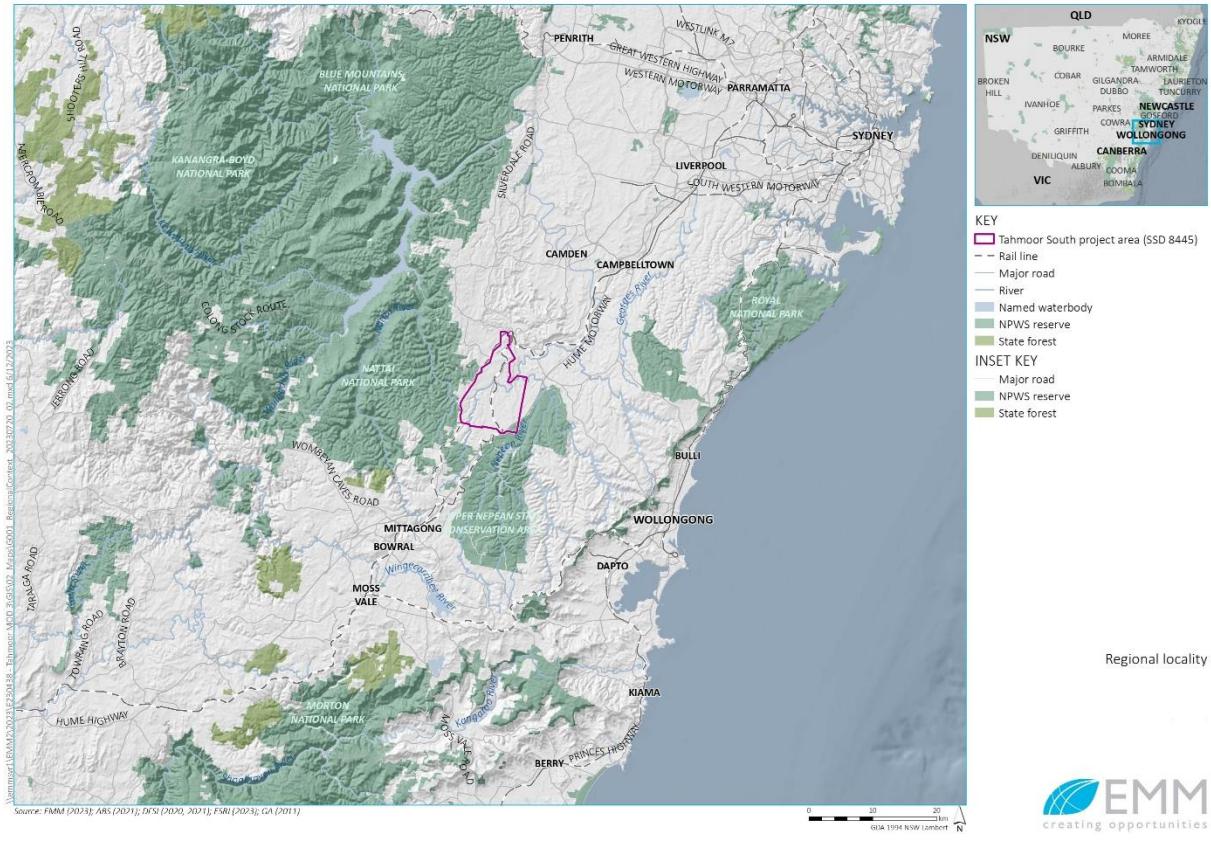



**Figure 1. Regional locality. Source: EMM.**

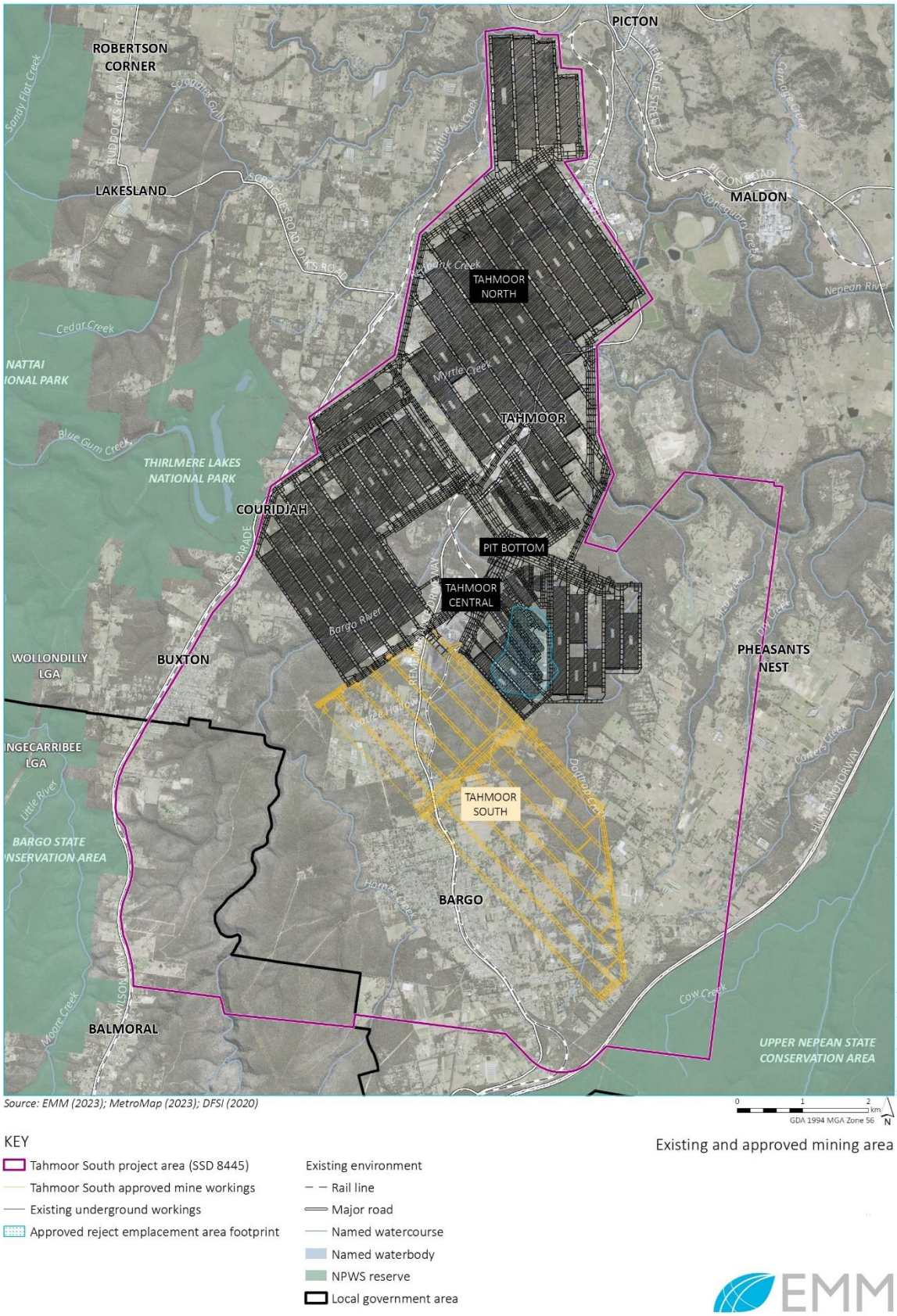



**Figure 2. Existing and approved mining. Source: EMM.**

### 1.1.2 Proposed modification

Tahmoor Coal is seeking to modify SSD 8445 (Mod 3) under Section 4.55(2) of the Environmental Planning and Assessment Act 1979 (EP&A Act) to authorise:

- an additional longwall panel (LW S7A) to the approved A series longwall panel layout
- removal of restrictions imposed by Condition A6 on the requirement for mining to be completed within 10 years following the commencement of second workings in the Tahmoor South mining area
- an increase in the maximum volume of ROM coal authorised by Condition A11(b) of SSD 8445 that can be extracted and processed on site from 33 million tonnes per annum (Mtpa) to 35 Mtpa.

A summary of the approved Project and modifications proposed is provided in Table 1 and illustrated in Figure 3.

**Table 1. Proposed modification summary table**

| Element | Approved Project | Project with proposed Mod 3 |
|---|---|---|
| Project area | The Tahmoor South project area is illustrated in Figure 1. | No change. |
| Mining areas | As shown in Figure 2. | Include mining of LW S7A as shown in Figure 3. |
| Extraction and processing rate | Up to 4 Mtpa of ROM coal per annum.<br>33 Mt of ROM coal over the life of the project. | No change to annual extraction limit.<br>Increase in life of mine ROM coal extraction limit from 33 Mt to 35 Mt. |
| Mine life | Until 31 December 2033, or until 10 years from the commencement of second workings, whichever is the sooner. | Mining operations carried out until 31 December 2033.<br>Remove restriction 'or until 10 years from the commencement of second workings, whichever is the sooner' from condition A6. |
| Mining method | Longwall mining method. | No change. |
| Coal reject management | Continued use of existing REA, where reject material may be emplaced up to a maximum height of RL 320 m. | No change. |
| Transportation by rail | A maximum of 4 laden trains may leave the site in any 24-hour period. | No change. |
| Transportation by road | A maximum of 200,000 t per annum of material (including ROM coal, product coal, and coal reject material) may be transported to and from the site by road, at a rate of:<br>• 3,000 t per day<br>• 16 truck movements per hour<br>• 158 truck movements in total per day. | No change. |
| Mine water management | Mine water is collected in underground sumps and pumped from the mine to the existing water management system at the surface facilities area.<br>Treated mine water is reused underground or for other non-potable uses or discharged via the existing LDP1 to Tea Tree Hollow. | No change. |
| Disposal of brine | Transfer of brine from the WTP underground for storage in the Western Domain mining area. | Continued transfer of brine from WTP operations for duration of additional mining. |

| Element | Approved Project | Project with proposed Mod 3 |
|---|---|---|
| Operating hours | Underground mining operations:<br>• 24 hours a day, 7 days a week.<br>Road transportation:<br>• between 7.00 am to 6.00 pm Monday to Saturday.<br>Construction activities at the surface facilities site and ventilation shaft site:<br>• between 7.00 am to 6.00 pm Monday to Friday;<br>• 8.00 am to 1.00 pm Saturday; and<br>• no construction activities on Sundays or public holidays unless the Planning Secretary agrees otherwise.<br>Drilling activities at the ventilation shaft sites may be undertaken 24 hours a day, 7 days a week. | No change. |
| Rehabilitation | • Progressive rehabilitation.<br>• Final rehabilitation and closure in accordance with a Rehabilitation Strategy and Rehabilitation Management Plan. | No change. |
| Workforce | Ongoing employment for approximately 400 full time equivalent (FTE) employees. | No change. |

### 1.1.3 Longwall S7A

Development consent SSD 8445 permits longwall mining of six panels within an ‘A-series’ and six panels within a ‘B-series’ of longwalls. The proposed longwall panel LW S7A is an additional longwall panel in the A series of longwalls and within the existing Tahmoor South Project Area.

LW S7A will extract coal between a minimum extraction height of 2.1 metres (m) and a maximum extraction height of 2.5 m. Further details of the proposed LW S7A dimensions are summarised in Table 2.

**Table 2. Longwall S7A dimensions.**

| Longwall ID | Overall void length including installation heading (m) | Overall void width including first workings (m) | Overall tailgate chain pillar width (m) |
|---|---|---|---|
| LW S7A | 1918 | 285 | 36 |

LW S7A has been included in the mine plan following a revision of the geological interpretation of the location of the Central Fault, which is located to the south west of the Tahmoor South Project area.

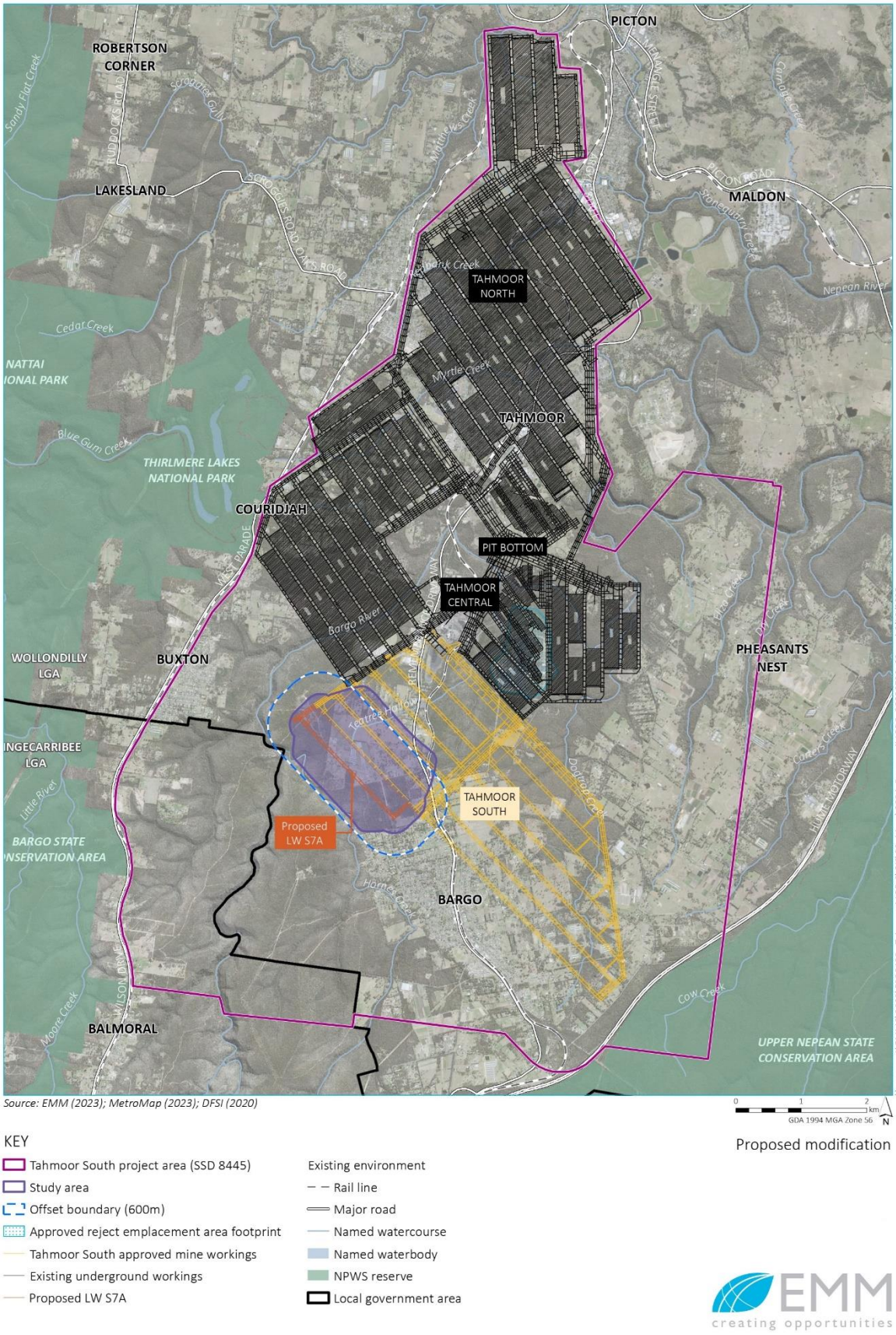



**Figure 3. Proposed modification. Source: EMM.**

### 1.1.4 Mining timeframes

Condition A6 of SSD 8445 states:

> *Mining operations may only be carried out on the site until 31 December 2033, or until 10 years from the commencement of second workings, whichever is the sooner.*

The Tahmoor South second workings under SSD 8445 commenced in October 2022. As a result, in accordance with condition A6 of SSD 8445, mining operations must be completed by October 2032.

The inclusion of LW S7A will extend mining beyond October 2032 by approximately nine months, with all approved and proposed mining operations to still be completed by 31 December 2033.

Tahmoor Coal seeks to remove the restriction imposed by Condition A6 of SSD 8445 for mining operations to be completed within 10 years from the commencement of second workings undertaken under SSD 8445 to enable sufficient time for LW S7A to be extracted.

Extraction of LW S7A will be completed prior to mining moving to the B-series panels. It is anticipated extraction of LW S7A will commence in January 2027 and be completed in September 2027.

### 1.1.5 ROM extraction

Condition A11(b) of SSD 8445 authorises a maximum of 33 Mt of ROM coal to be extracted and processed on site over the life of the development. The extraction of LW S7A will add approximately 2 Mt of coal to the total volume of coal extracted over the life of the development.

Tahmoor Coal seeks to increase the maximum volume of coal authorised to be extracted over the life of the development from 33 Mt to 35 Mt.

### 1.1.6 Reject management

The additional 2 Mt of ROM coal extracted from LW S7A, will produce an associated 0.6 MT of reject material. This reject material is proposed to be stored within the existing footprint and approved heights of Tahmoor Coal's existing REA.

## 1.2 Background and scope of this report

### 1.2.1 Background to this report

Tahmoor South consists of 12 longwalls, split into two panels of 6 longwalls labelled the A series and B series. Tahmoor Coal is mining the A series longwalls from 2022 to around 2026. The proposed LW S7A is an additional longwall panel in the A series of longwalls. In 2013 Fluvial Systems Pty Ltd prepared a geomorphology technical report for Tahmoor Coal Pty Ltd (Gippel, 2013) as a contribution to the Tahmoor South Environmental Impact Statement (EIS) and subsequent amendment reports.

The proposed LW S7A lies within the Study Area identified by Gippel (2013) for the Tahmoor South geomorphology assessment. LW S7A is located in proximity to Hornes Creek and a short reach of the Bargo River. Hornes Creek was previously mapped as a 4th Order stream in the vicinity of mining area and the reach of the Bargo River was mapped as a 5th Order stream. These reaches of Hornes Creek and the Bargo River were previously assessed in the 2013 technical report for Tahmoor South (Gippel, 2013).

This report re-visits the previously assessed reaches of Hornes Creek and Bargo River for the purpose of assessing the impact of LW S7A, which extends closer to the watercourses than the Tahmoor South longwall plan assessed by Gippel (2013) (Figure 3). The geomorphic character of the watercourses was re-assessed, as natural changes could have occurred over the 10-year period since the 2013 assessment. The 2023 assessment described in this report was carried out using the same methodology and site locations used in 2013. Landscape-scale characteristics geology, soils, topography, valley depth and landform classes were considered stable over the 10-year timeframe and were not re-assessed in this report. Information concerning those characteristics can be found in Gippel (2013). Stream Order was considered stable over the 10-year timeframe and was not re-assessed. River Styles was also considered stable over the 10-year timeframe, but was re-mapped here as a more comprehensive dataset became available after the 2013 assessment.

The focus of this report was stream reach-scale and point-scale characteristics, which potentially could have changed over the 10-year period since 2013. A new methodological approach was developed to characterise pool

distribution and morphological characteristics using spatial data sets. Also, this report assessed new vegetation variables using spatial data not available at the time of the 2013 assessment.

The purpose of this report is to characterise the physical environment in the area potentially impacted by LW S7A from a geomorphologic perspective, to assess the risk of impact of the predicted subsidence on geomorphological features, to identify appropriate measures to mitigate the risk of any identified impacts, and to specify appropriate ongoing monitoring of sensitive geomorphological features that should be implemented by Tahmoor Coal Pty Ltd.

### 1.2.2 Report scope

The scope of work for this report includes, but is not limited to:

1. Identify relevant geomorphological features that would be sensitive to mine subsidence changes in the subsidence impact area of LW S7A, including mapping of major and minor cliff lines and Stream Orders. Particular focus should be placed on updating the existing mapped rock bars, shallow alluvium (i.e. less than 2 m deep) and permanent or semi-permanent pools within the subsidence impact area.
2. Characterise the geomorphology of watercourses and cliffs within the area of potential subsidence associated with LW S7A and undertake an updated baseline assessment of conditions (including channel and bank stability) of watercourses and/or water bodies that could be affected by subsidence. Baseline assessments should consider updating and reviewing previous observation made covering the elements:
    - observations of flow / pool holding capacity, ferruginous seeps, iron staining and flocculation, gas emissions, evidence of surface flow diversion / underflow / subsurface flow
    - observations of knickpoints and recommendations of measures for preventing/managing further knickpoint formation
    - indicative pool volumes and potential water holding capacity.
3. Review and update photographs at the existing nominated photo locations for each existing or new geomorphological feature. This should include GPS co-ordinates of each location.
4. Prepare an impact assessment of predicted subsidence associated with LW S7A on geomorphological features including consideration of approved impacts verses changes in impacts as a result of the proposed additional longwall panel.
5. Identify appropriate mitigation and management measures to mitigate the risk of any identified impacts on geomorphological features as a result of LW S7A.
6. Identify any appropriate ongoing monitoring of sensitive geomorphological features to be implemented by Tahmoor Coal Pty Ltd, including survey locations and monitoring methods.

# 2 Methodology

## 2.1 Study Area

The Study Area (Figure 3) is defined as the surface area that is likely to be affected by the extraction of LW S7A, calculated by combining the predicted limit of vertical subsidence, taken as the 20 mm subsidence contour resulting from extraction, and a 35° angle of draw line from the limit of proposed extraction LW S7A.

An expansion of the Study Area to 600 m from extraction (Figure 3) was established as a buffer for natural features. In deep valleys and gorges in the Southern Coalfield, closure and upsidence movements have been detected more than 500 m from the edges of longwalls (Kay et al., 2006), which is why a 600 m buffer for natural features was recommended in the independent inquiry report *Impacts of Underground Coal Mining on Natural Features in the Southern Coalfields – Strategic Review* (Department of Planning NSW, 2008). In this report the buffer is referred to as the 600 m offset.

The natural features assessed in this report included Hornes Creek from Bargo to Picton Weir pond, a distance of 2000 m, and Bargo River from Picton Weir wall to the boundary of existing underground workings (Figure 3), a distance of 2330 m. Parts of Hornes Creek run very close to the 20 mm subsidence contour, and up to around 80 m inside the 600 offset. Bargo River is entirely outside the 600 m offset. This report also assessed cliffs on both sides of Hornes Creek and Bargo River. Some of these cliffs were inside the 600 m offset.

In this report, some maps show data extending outside the formal boundary of the Study Area and 600 m offset established for assessment of LW S7A. In such cases, the information located outside the Study Area and 600 m offset was included to show the continuity of the attribute. The areas encompassing those data, as well as the areas within the formal boundaries of the Study area and 600 m offset are collectively referred to in this report as the Study Area (of this report). Field data were collected by walking the watercourses, the courses of which ran variable distances from the Study Area 600 m offset boundary (Figure 3).

## 2.2 Geomorphologically-relevant stream reach- and point-scale variables

Stream-reach and point-scale variables were used to characterise geomorphological processes and forms that could be at risk of direct subsidence impacts. The variables were selected mainly on the basis of their relevance to well documented potential impacts of mining on streams and their valleys (Holla and Barclay, 2000; Blodgett and Kuipers, 2002; Kay et al., 2006; Parsons Brinkerhoff, 2007; Department of Planning NSW, 2008; Hebblewhite, 2009), which can be summarised as:

- Fracturing in the riverbed and rock bars
- Surface water flow diversion from the surface to the shallow sub-strata
- Increased ponding, flooding or desiccation
- Increased stream bed and bank erosion
- Changes to stream alignment
- Changes to water quality
- Impacts on terrestrial and aquatic flora and fauna
- damage to vertical or near-vertical cliff faces and overhangs, resulting in collapse and potential landslides

The sensitivity of stream geomorphic character to physical disturbance, such as mining-related subsidence, can be described in terms of stream channel fragility/resilience. Fragility is the ease of adjustment of bed material, channel geometry, and channel planform when subjected to degradation or certain threatening activities, and resilience is the property of having low fragility (Cook and Schneider, 2006; Brierley et al., 2011). Different stream types have characteristic levels of fragility. In NSW, the commonly used standard for classifying stream geomorphic type is River Styles® classification, which is based on valley setting, level of floodplain development, bed materials and reach-scale physical features within the stream (Brierley et al., 2011). The potential for physical recovery after disturbance depends on stream geomorphic condition, whereby streams in good condition (undisturbed and close to natural state) are more likely to be resilient and recover faster than those that are already degraded (Outhet and Cook, 2004; Brierley et al., 2011).

The change in physical form of streams over time (morphological dynamism) can manifest in a number of ways. Alluvial streams naturally migrate laterally across their floodplain without necessarily changing in cross-sectional shape, but streams confined within bedrock valleys, like those within the Study Area of this report, maintain a relatively stable position over the management time scale (here defined as < 100 years). In cross-section, streams can widen, narrow, deepen (scour), or shallow (aggrade). Such changes occur naturally, but could be of concern if human-related disturbance causes the rate of change, or the extent of change, to exceed the natural ranges. Mining-related subsidence is more likely to impact stream bed elevation than stream bank lateral position, with creation of, or accelerated headward migration of, knickpoints being a potential threat to channel stability. Knickpoints are a local steep fall in channel bed elevation and are a common, natural feature of streams. All of the knickpoints on Hornes Creek and Bargo River in the Study Area of this report were stable (or fixed), taking the form of a local control, such as a resistant lithological unit, fault, or large coarse sediment supply. Under disturbance from mining-induced subsidence, or a significant increase in stream flow, existing hard knickpoints were assumed to be resilient to change.

Streams of the Southern Coalfield area that flow through sandstone/shale geology typically have a significant proportion of their beds formed in exposed bedrock. The bedrock manifests as flat to gently sloping slabs of rock exposed along a bedding plane, and elevated bars of rock crossing the channel. Exposed rock is often associated with pools, either by forming a low permeability bed surface, or by acting as the hydraulic control that backs up water in the pool. In the Study Area, the Hawkesbury Sandstone is typically present as massive beds with widely spaced and roughly orthogonal (i.e. sub-vertical to vertical) joint sets. The spacings between major parallel joints were reported by Herbert (1983) as 3 – 10 m, while the review of Pells (1993) indicated that the Hawkesbury Sandstone in Southern Catchment Area of Sydney had joint spacing of 3 – 4 to 30 – 40 m with an average of 7 – 15 m. Thus, it would be expected to find natural fractures in the bedrock of the stream beds. These fractures are mostly very old in geological terms, and relate to previous episodes of deformation and relief of stress. Underground mining can cause compressive horizontal strain in the vicinity of streams, particularly those within deep valleys. This can manifest as a rise in the level of the base of the valley, which in the mining context is usually referred to as upsidence (Waddington and Kay, 2003; Kay et al, 2006). Similar movements can occur naturally, but it is generally understood that the process is accelerated by mining (Kay et al., 2006). Fracturing of rock in river beds and subsequent surface water flow diversion are well recognised impacts associated with mining beneath rivers (Kay et al., 2006; Total Environment Centre, 2007; NSW Department of Planning, 2008). The fractures in stream beds associated with mining have a different appearance to the geologically-old fractures (joints) in the rock. Photographs of this phenomenon in Department of Planning NSW (2008) and Total Environment Centre (2013) illustrate open fractures with fresh, sharp edges, whereas the ancient fractures associated with joints would generally be expected to appear tight, with edges weathered to the same extent as the rock itself. Geoterra (2007) and Geoterra (2011) observed cracks in the bed of Myrtle Creek up to 10 mm wide that were associated with Tahmoor Mine longwall mining. This report included observations of the type of rock feature present in stream beds (i.e. massive slab, or bar), the density of fractures present on bedrock features, and noted any instances of loss of flow to the sub-surface.

The description of broad habitat zones of a stream by Department of Primary Industries NSW (2013) included pools, gravel beds (or "riffles"), snags, wetlands and riparian (riverbank) vegetation, as well as microhabitats within these zones. Pools and riffles are the two habitat elements of streams that have received the most attention from a geomorphological and ecological perspective (Frissell et al., 1986; Maddock, 1999). Pools are commonly a focus of habitat assessments because of their ecological importance, especially as a refuge when streams stop flowing (Bond et al, 2008). Riffles act as hydraulic controls on pools in alluvial streams, but they would not be expected to be common in Hornes Creek and Bargo River in the Study Area, which are bedrock controlled. Pools would likely be found in association with large wood, coarse deposits of sediment and in particular, rock bars. As rock bars are potentially at risk of mining-induced fracturing, so too are the pools that the rock bars impound. Thus, this report included observations of pool presence, dimensions, and the type of hydraulic control.

Based on the above considerations, reach- and point-scale variable groups considered relevant to this report were:

- Stream geomorphic type and condition
- Riparian and in-channel vegetation
- In-channel bedrock features
- In-channel pools
- Channel slope

- Channel dimensions
- Channel bed materials
- Knickpoints
- Characteristics of fractures in channel bedrock
- Other observations, e.g. suspended ferruginous colloids in the stream water

## 2.3 Field survey

### 2.3.1 Sampling approach

The field survey undertaken for this report repeated the survey done on Hornes Creek and Bargo River for the 2013 study of Gippel (2013). Every effort was made to visit the same sites to enable a direct comparison of existing stream character with that observed in 2013. Unfortunately, due to tall dense forest and gorge topography, the accuracy of GPS positioning was often worse than 10 metres. This meant that it was not always possible to confidently locate the exact position of sites observed in the 2013 survey.

The field data were collected by a team of 2 people over 2 days. Hornes Creek was surveyed on 20 July 2023 and Bargo River was surveyed on 21 July 2023. The field survey involved walking the streams and following the sampling protocol at the points of interest (Figure 4). Data were recorded on a GPS-equipped tablet computer. At each observation point, two photographs were taken with the tablet device, one looking downstream and one looking upstream. Each photograph was linked to the data from the site within the digital data form.

Six small First Order headwater streams within the Study Area were inaccessible due to steepness of the terrain, dense vegetation, or in the case of Bargo River, they were on the opposite side of the river to the access track (Figure 4).

### 2.3.2 Field sampled variables

A comprehensive set of variables was measured at sites in the field (Table 3). At some sites only a sub-set of the variables was measured. In general, the measurements were done using standard techniques from the literature. Most of the observations involved recording presence/absence or measuring a quantity.

The survey focused on pools, knickpoints and bedrock featured that were large relative to the channel size. The intention was to capture morphological variability at the habitat scale. There is no standard threshold for the minimum size of useful habitat, so project-specific thresholds were set.

Significant pools were at least 0.2 metres deep and longer than 4 times the average channel width in the area. This minimum size was intended to make the field survey feasible and does not relate to a minimum size required to support a particular ecological community or perform some other physical, chemical or ecological function. The streams of the Study Area contained many pools smaller than those that were recorded here, but it was not feasible to include them in the survey. Pool dimensions were relative to the level of the hydraulic control (i.e. as if the pool was full of water). The depth of a pool when it is just filled to the level of the hydraulic control is known as the residual pool depth (Lisle, 1987).

Significant knickpoints were deemed to be higher than 0.2 m. Significant knickpoints were defined as having a height at least double that of the average amplitude of local roughness elements. For practical reasons it was necessary to judge this visually. The type of knickpoint was judged as hard or soft, depending on the material forming the face of the knickpoint.

Significant bedrock features were identified as either rock bars, defined as a relatively narrow bar of exposed bedrock elevated above the bed level and crossing all or most of the channel, or rock slab, defined as a long and wide exposure of solid bedrock on the bed for a distance at least three times the width of the channel. The presence of less significant bedrock features was also noted when recording bed material size. Fractures in bed material were identified and counted along a transect extending for the maximum practical length of exposed rock.

Some variables were quantified using a subjective visual estimation method. These variables included the relative strength of the variability in the channel shape; bed material calibre (visual estimation was regularly calibrated against measurement), and vegetation cover and continuity. While error can be expected in such estimates, it was minimised by using the same experienced observer for every estimate and conducting the fieldwork over one unbroken period of time.

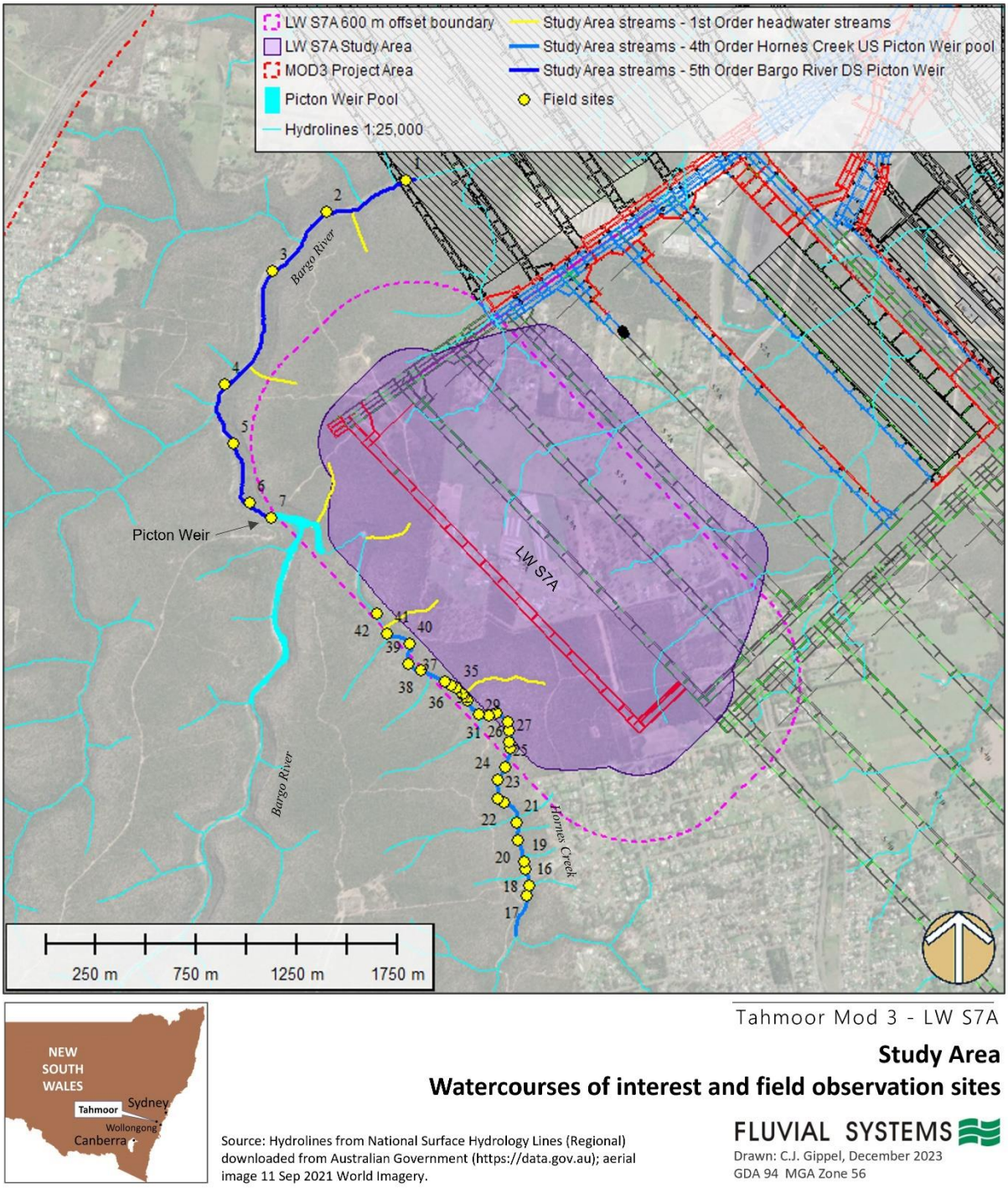



**Figure 4. Geomorphologic field survey sites and watercourses of interest to this report. Picton Weir pool area and 1st Order tributaries were inaccessible.**

**Table 3. Field measured geomorphologically-relevant variables.**

| Variable | Description of variable measurement |
|---|---|
| Flow conditions | Dry or flowing at the time of survey |
| Channel setting | Longitudinal continuity, number of channels, and degree of valley confinement |
| Valley shape | Perceived relative relief, shape of valley walls, presence of cliffs (gorge or not gorge) |
| Chanel shape variability | Strength of variability in form in cross-section and profile, and regularity of form in the downstream bed profile (3 classes each) |
| Bed material calibre | Presence of, and dominant, material for 7 classes (adapted from Brakensiek et al., 1979):<br>• Mud (silt and clay)<br>• Sand (0.06 - 2 mm)<br>• Gravel (2 - 64 mm)<br>• Cobble (64 - 256 mm)<br>• Boulder (exceed 256 mm)<br>• Exposed bedrock slab<br>• Artificial (hard lined) |
| Large wood and log jams | Count of items over 20 m length of channel; large wood is ≥0.1 m diameter and ≥1 m long (Gippel, 1995; Gippel et al., 1996); log jam is 3 or more locked pieces of large wood |
| Pool dimensions | Length, maximum width and maximum depth (as if full to the level of the hydraulic control), measured using a laser rangefinder (±0.1 m accuracy) |
| Pool hydraulic control | Type for 5 classes - rock bar, boulders, cobble/gravel/sand, cohesive material, or artificial |
| Exposed bedrock feature | Type for 3 classes - rock bar in the bed (elevated and crossing all or most of the channel), rock slab in bed (exposed bedrock on the bed for at least 3 x the channel width), or other (presence noted in bed material calibre) |
| Count of fractures visible in bedrock | Count of fractures along a transect of variable length (depending on the observable length of exposed rock), with length measured using a rangefinder or tape |
| Channel dimensions | Bed width, bankfull width, bankfull depth, measured using a rangefinder or tape |
| Knickpoint type and dimensions | Material type for 2 classes - hard rock, or soft, erodible material - and height from top edge to elevation of downstream hydraulic control, measured using a retractable tape |
| Ferruginous material | Presence/absence of seeps on rock, or colloidal material suspended in stream water |
| In-channel vegetation | Type for 6 classes - 4 macrophyte types, grass and filamentous algae - and cover (6 Braun-Blanquet classes) |
| Width of riparian vegetation | Left and right, up to a maximum of 50 m, measured using rangefinder |
| Continuity of riparian vegetation | Left and right, downstream continuity along the riparian zone (6 Braun-Blanquet classes) |
| Composition and cover of riparian vegetation | Left and right, type for 3 classes - tree (woody and >3 m high) shrub (woody) and ground vegetation – and cover within 5 x 5 m plots (6 Braun-Blanquet classes) |
| Other observations | Any feature not otherwise covered and considered potentially relevant to geomorphologic characterisation or geomorphologic condition |

Vegetation cover and continuity were estimated using the Braun-Blanquet rank scale, which provides a rapid, robust and repeatable estimate of cover abundance (Wikum and Shanholtzer, 1978). Cover refers to foliar projective cover of the ground. The Braun-Blanquet scale was the same as the original, except that the lowest class was sub-divided to provide a class (<1% cover) to describe the situation where cover was essentially absent, as used by Causton (1988) (Table 4):

**Table 4. Braun-Blanquet rank scale of vegetation foliage cover.**

| Cover | Score |
|---|---|
| <1% | 0 |
| 1 – 5% | 1 |
| >5 – 25% | 2 |
| >25 – 50% | 3 |
| >50 – 75% | 4 |
| >75% | 5 |

### 2.3.3 Derived field variables

Three variables were derived from the raw field-collected data:

- Bedrock fracture density
- Pool volume
- Riparian vegetation cover index

Bedrock fracture density ($F$) was calculated as the count of fractures ($N$) divided by the length of rock over which they were counted ($L_R$), multiplied by 10 to convert the value to frequency per 10 m:

$$F = 10\left(\frac{N}{L_R}\right)$$

Pools were measured for their length ($L_P$), maximum width ($W_P$) and maximum depth ($D_P$) (as if the pool was full of water to the level of the hydraulic control). It was observed that most pools had a trapezoidal shape in cross-section and profile. The width and depth measurements were both factored by 0.7 to achieve an estimate of pool volume ($V_P$), reported in the unit of $m^3$:

$$V_P = 0.7W_P \cdot 0.7D_P \cdot L_P$$

At each sampling site, the cover abundances of riparian trees, $T$, shrubs, $S$, and ground cover, $G$, were rapidly estimated at plots approximately 5 x 5 m in size, with cover scored as an integer from 0 to 5. Vegetation cover of the left and right sides of the channel were measured separately. A cover index was devised to rate both the degree of coverage of the ground by plants, and the vegetation structure. A high degree of cover was rated higher than a low degree of cover, and trees were rated more valuable than shrubs, and shrubs rated more valuable than ground cover. The coverage rating was based on the higher geomorphic stability, habitat availability, and energy and nutrients provided by greater plant abundance. The plant structure rating was based on the different capacity of trees, shrubs and ground cover to provide these same services, as well as the additional ability of trees to provide shade. For each plot, the raw cover abundance scores for trees were averaged to give a riparian tree cover score ($C_T$) between 0 and 5 that was then classified using the Braun-Blanquet rank scale (Table 4):

$$C_T = \left(T_{left} + T_{right}\right)/2$$

For each plot, the raw cover abundance scores for trees, shrubs and ground cover were weighted and summed, and then converted to a riparian tree cover score ($C_V$) between 0 and 1:

$$C_V = \left(\frac{3T_{left} + 2S_{left} + G_{left}}{24} + \frac{3T_{right} + 2S_{right} + G_{right}}{24}\right)/2$$

An index score of at least 1.0 would be achieved if tree, shrub and ground cover were all in the 50 – 75% or >75% cover classes. A very well vegetated site might achieve a combined factored score exceeding 1.0, in which case

the score would be rounded down to 1.0. The index score of 0 – 1 was multiplied by 100 to get combined cover in percent, which was then classified using the 0 – 5 Braun-Blanquet rank scale (Table 4).

## 2.4 Spatial data analysis and mapping

Geomorphology is concerned with both physical form and process. Process involves the dimension of time, so tends to be more difficult to measure and model than form. For this reason, geomorphologic assessments often interpret process on the basis of an analysis of physical form. Terrain analysis is concerned with the automated analysis of landforms and landform attributes using digital elevation data sets. The analysis involves application of algorithms within a GIS (Geographic Information System) at detailed scales over wide areas to map physical characteristics of interest. Similarly, vegetation analysis and mapping can be undertaken within a GIS using publicly available spatial data sets.

Spatial data analysis was undertaken using two different GIS applications: Global Mapper™ V25.0 19 Nov 2023 Build (Blue Marble Geographics), and SAGA (System for Automated Geoscientific Analyses) GIS (http://www.saga-gis.org; Institute of Geography, Section for Physical Geography, Klimacampus and University of Hamburg, Germany) (Cimmery, 2007-2010; Böhner et al., 2006; Böhner et al., 2008).

### 2.4.1 River Styles

NSW Department of Planning, Industry and Environment and Macquarie University together developed the River Styles Spatial Layer for New South Wales (NSW Office of Water, 2012). The database provides River Style, fragility, sensitivity to disturbance, condition, rarity and recovery potential for all third and higher order rivers in NSW. The data set is based on River Styles reports completed by various analysts in various agencies over the past two decades. The River Styles assessment for the Hawkesbury-Nepean basin was undertaken by Department of Land & Water Conservation, NSW (2001). For most basins, the mapped stream network includes named and Third Order streams, including one Second Order and one First Order tributary of each. The database can be accessed at https://datasets.seed.nsw.gov.au/dataset/new-south-wales-river-styles-spatial-dataset.

### 2.4.2 LiDAR elevation data availability

The topography of the Study Area was defined by four sets of LiDAR (Light Detection and Ranging) ground surface elevation data, listed below from oldest to most recent:

1. 2013 point cloud and 2 m DEM (Digital Elevation Model) data - supplied by Tahmoor Coal in 2013, compiled from LiDAR data surveyed in two flights, one conducted in 2012 and one in 2013. The later flight covered the Study Area for LW S7A. A metadata statement from Fugro Spatial Solutions which supplied part of the total Tahmoor data set indicated that target point density was 1 – 6 points per square metre, vertical accuracy was 0.13 m @ 67% CI, horizontal accuracy was 0.26 m @ 67% CI. The point cloud data were gridded to a 1 m DEM within the Project Area, referred to in this report as 7 – 8 February 2013 data.
2. 2016 1 m DEM data – compiled from Wollongong 2016-07-02 2 km x 2 km 1 m Resolution DEM and Wollongong 2016-05-16 2 km x 2 km 1 m Resolution DEM downloaded from NSW Spatial Services, Department of Finance, Services and Innovation, ELVIS - Elevation and Depth - Foundation Spatial Data (http://elevation.fsdf.org.au/). Data were processed to ICSM standards level C3. The data has an accuracy of 0.3 m (95% Confidence Interval) vertical and 0.8 m (95% Confidence Interval) horizontal with unknown minimum point density of laser returns. The data are referred to in this report as 16 May / 2 July 2016 data.
3. 2019 1 m DEM data – compiled from Wollongong 2 km x 2 km 1 m Resolution downloaded from NSW Spatial Services, Department of Finance, Services and Innovation, ELVIS - Elevation and Depth - Foundation Spatial Data (http://elevation.fsdf.org.au/). The flights were conducted over the period 29-30 June 2019. The data set contains a ground surface model derived from Spatial Services Category 1 (Classification Level 3) LiDAR from an RIEGL VQ-780i (Aerometrex Pty Ltd). The data has an accuracy of 0.3 m (95% Confidence Interval) vertical and 0.8 m (95% Confidence Interval) horizontal with unknown minimum point density of laser returns. The data are referred to in this report as 29-30 June 2019 data.
4. 2022 point cloud and 1 m DEM data – supplied by MSEC. Metadata were not supplied with this dataset. The flight was conducted on 15 July 2022. The coverage included Hornes Creek down to Picton Weir pool but it did not cover Bargo River area of interest. The data are referred to in this report as 15 July 2022 data.

LiDAR cannot penetrate water, so the above datasets do not necessarily represent 'ground' within the bed of stream channels, depending on stream flow on the day of the flight. The significance for this study of water being present in the stream channels at the time of the LiDAR flight is that pool depth would be underestimated from the resulting elevation data.

There are no flow gauges on Hornes Creek or Bargo River. The closest gauges are 212203 – Nepean River at Pheasants Nest Weir (upstream of Bargo River) and 212208 - Nepean River at Maldon Weir (downstream of Bargo River) (Table 5). Water released from Cataract Dam flows down the Cataract River to Broughtons Pass Weir. Water released from Nepean Dam and Cordeaux Dam flows downstream to Pheasants Nest Weir on the Nepean River, where it is diverted via a 7-kilometre-long tunnel to Broughtons Pass Weir. Thus, baseflows at Pheasants Nest Weir and Maldon Weir do not necessarily reflect natural hydrological conditions. Although flow at Pheasants Nest Weir was low on 15 July 2022, it was high at Maldon Weir (Table 5). The watercourses are likely to have had high baseflows in mid-July, as for Greater Sydney overall, July 2022 was the wettest July on record since 1900, with most of that rain falling in the first week of the month. These wet conditions possibly explain why in the 15 July 2022 dataset, most of the channel of Hornes Creek had no laser return data available. The Nepean River flow data (Table 5) suggest that the 7 – 8 February 2013 and 16 May / 2 July 2016datasets would likely have been affected by water in the channels, while it appears that the 29 – 30 June 2019 data were collected during dry conditions.

**Table 5. Nepean River discharge on dates of LiDAR flights.**

| LiDAR data set | Flow at 212203 Nepean River at Pheasants Nest Weir (ML/d) | Flow at 212208 Nepean River at Maldon Weir (ML/d) |
|---|---|---|
| 7 – 8 February 2013 | 1853 – 1763 | 358 – 300 |
| 16 May / 2 July 2016 | 922 / 1411 | 29 / 110 |
| 29 – 30 June 2019 | 16 – 16 | 15 – 16 |
| 15 July 2022 | 15 | 2191 |

### 2.4.3 Pool distribution, dimensions and volumes from LiDAR data

The field inspection attempted to characterise significant pools, but a combination of access difficulty, measurement difficulty, GPS positional inaccuracy, and the very high number of pools present, meant that the result was not comprehensive. An alternative methodology using terrain analysis was developed to characterise the distribution of all pools within the watercourses, and to also characterise the perimeter, surface area, maximum depth and volume of each identified pool.

The downstream distribution of pool depth was measured by first filling sinks in the DEM along the channel to create a new DEM that simulated the condition of baseflow, with all pools full to the level set by the downstream hydraulic control. Sinks were filled using the method of Planchon and Darboux (2001) within SAGA GIS. This method retained a downstream slope of 0.01 on the water surface. Subtraction of the original DEM from the sink-filled DEM produced a DEM of pool morphology. Pool depth would be underestimated in areas of water presence, but the areal extent would be correct. The downstream distribution of cross-sectional maximum pool depth was mapped at 1 metre intervals by extracting the maximum value of the pool depth pixels intersected by 1 metre-spaced transects perpendicular to the thalweg and passing through the width of the channel. To test the consistency of the method of characterising the downstream profile of pool depth, it was applied to the 2013, 2016 and 2019 LiDAR data. The limited extent of the 2022 LiDAR data did not include all of the stream lengths of interest to this report.

The raster representation of the sinks (i.e. pool bathymetry) was converted to vector format in GIS to produce a distribution of pool surface polygons. This provided a map of all pools identified within the channel reaches. For each polygon, calculations were performed within GIS to measure the attributes pool volume, perimeter, surface area and maximum depth. This sequence of operations was performed only with the 2013 LiDAR data, which had good resolution of features within the stream channels.

### 2.4.4 Cliff distribution

Cliffs within the Study Area were identified by Gippel (2013) on the basis of a standard definition that has been used in previous similar assessments. As well as cliffs, Gippel (2013) identified steep slopes and 'potential talus slopes', a sub-class of steep slopes. Only the cliff data are referred to in this report. Cliffs were identified from steep slopes on the basis of having a minimum slope of 2:1 (V:H) (200% or 63.4$^{o}$). Sub-classes of cliffs were defined on the basis of height and length:

- Cliffs: >=10 m high, any length:
  - Long and high cliffs (following the strict definition of 'cliff'): >=10 m high and >=20 m long
  - Short and high cliffs: >=10 m high and <20 m long
- Minor cliffs: 5 to <10m high, any length
- Rock faces: 3 to 5 m high, any length

Gippel (2013) used the 7 – 8 February 2013 LiDAR to identify cliffs. In this report, the 7 – 8 February 2013 LiDAR was compared with the 29 – 30 June 2019 LiDAR within the cliff polygons identified by Gippel (2013) to investigate any major changes to cliff morphology. Upon subtraction of the 2019 data from the 2013 data, a negative difference would suggest cliff collapse within those polygons. A positive difference must represent error.

### 2.4.5 Riparian tree canopy cover year 2000 and loss in cover year 2000 to year 2021

The Global Forest Change (GFC) project of Hansen et al. (2013) provides a relative indicator of spatiotemporal trends in forest loss dynamics globally. It provides data on tree cover (tree height >5 m) in the reference year 2000, as well as data on the removal of trees in subsequent years to 2021, if the canopy cover of one LANDSAT pixel-size land unit (in the range 25 – 30 m pixels) falls below 30%. Annually updated GFC data are provided by the Global Land Analysis and Discovery (GLAD) laboratory at the University of Maryland, in partnership with Global Forest Watch (GFW) (https://storage.googleapis.com/earthenginepartners-hansen/GFC-2022-v1.10/download.html).

The GFC products include the following layers, all at approximately 27 - 28 m pixels in the Study Area:

- Tree canopy cover for year 2000 (treecover2000)

  Tree cover in the year 2000, defined as canopy closure for all vegetation taller than 5 m in height. Encoded as a percentage per output grid cell, in the range 0 – 100.

- Global forest cover gain 2000 – 2012 (gain)

  Forest gain during the period 2000 – 2012, defined as the inverse of loss, or a non-forest to forest change entirely within the study period. Encoded as either 1 (gain) or 0 (no gain).

- Year of gross forest cover loss event (lossyear)

  Forest loss during the period 2000 – 2020, defined as a stand-replacement disturbance, or a change from a forest to non-forest state. Encoded as either 0 (no loss) or else a value in the range 1 – 20, representing loss detected primarily in the year 2001 – 2021, respectively.

- Data mask (datamask)

  Three values representing areas of no data (0), mapped land surface (1), and permanent water bodies (2).

The GFC data were used to map riparian tree canopy cover in the year 2000 and annual loss (cause unattributed) for each year from 2001 to 2021.

The pixel size of Landsat-derived data (approximately 27 - 28 m pixels in the Study Area) is close to the functional width of a stream forested riparian zone. In this study, the riparian zone was defined by a 40 m wide buffer around Bargo River and Hornes Creek centrelines, which resulted in the riparian zone being represented by 2 to 4 pixels of data (i.e. approximately 60 - 120 m wide zone).

### 2.4.6 Riparian forest canopy height

The GLAD dataset Global Land Cover and Land Use Change 2000 – 2020 (GLCLUC 2000-2020) (Potapov et al., 2022) quantifies changes in forest canopy extent and height, cropland, built-up lands, surface water, and

perennial snow and ice extent from the year 2000 to 2020 at approximately 27 - 28 m pixels in the Study Area (https://glad.geog.umd.edu/dataset/GLCLUC2020). The forest canopy height was mapped globally for woody vegetation of ≥5 m (https://glad.earthengine.app/view/forest-height-2000-2020). The global Landsat-based forest height model calibrated for the year 2019 using GEDI observations was employed. The same model was applied to estimate forest height for the years 2000 and 2020. To reduce errors and noise in the model outputs extensive filtering of the output products was implemented. A set of global products were derived from the year 2000 and 2020 forest height maps.

Forest canopy height in year 2000 and 2020 and net change in height between year 2000 and 2020 was mapped for the riparian zone defined by a 40 m wide buffer around Bargo River and Hornes Creek centrelines.

### 2.4.7 Bushfire history, extent, and severity

The impact of fire on geomorphological forms and processes has long been recognised. Fire alters vegetation and soil properties which can change the way soil and sediment is transferred through catchments. The geomorphic consequences of fire are determined by (a) characteristics of the fire regime, mainly frequency and intensity; and (b) geomorphic sensitivity or erodibility of the landscape (Swanson, 1981; Nyman and Sheridan, 2014).

Fire usually reduces soil aggregate stability and can induce, enhance or destroy soil water repellency; changes which have implications for infiltration, overland flow and rainsplash detachment (Shakesby and Doerr, 2006). Research has shown elevated, sometimes extremely large post-fire soil losses before geomorphological stability is re-established (Shakesby and Doerr, 2006; Lourenço et al., 2012). Biswas et al. (2021) found that, in the headwaters of the River Murray, sediment loads increased as a consequence of storm activity and rainfall following the 2019–2020 Australian bushfire season. Peak turbidity in the Murray River reached values of up to 4200 nephelometric turbidity units (NTU). Model simulations suggested that, compared to the pre-fire condition, the sediment load could increase by five times in the first year following a bushfire. It was estimated that Lake Hume would receive up to 600,000 metric tonnes of sediment per month in the period immediately following the bushfire. A review by Nyman and Sheridan (2014) reported that the magnitude of the increase in sediment load relative to the unburned state is highly variable, ranging from 10 – 1000 times the background levels. Bixby et al. (2015) identified a number of research gaps in the understanding of the impacts of fire effects on aquatic ecosystems.

GLAD produced the Global Forest Loss due to Fire 2001 – 2021 (GFLDF 2001 – 2021) at approximately 27 - 28 m pixels in the Study Area, with data disaggregated into forest loss due to fire versus other disturbance drivers (Tyukavina et al., 2022) (https://glad.umd.edu/dataset/Fire_GFL). Each value of forest loss has an associated estimate of the certainty of the forest loss being due to fire, expressed as either high, medium or low certainty. In the Study Area, forest loss due to fire was high certainty in almost all pixels.

The Fire Extent and Severity Mapping (FESM) products (https://datasets.seed.nsw.gov.au/dataset/fire-extent-and-severity-mapping-fesm) were developed by NSW Department of Planning and Environment Remote Sensing and Regulatory Mapping in collaboration with the NSW Rural Fire Service. The FESM used a semi-automated approach to mapping fire extent and severity, a metric of the loss of biomass caused by fire, through a machine learning framework to map fire extent and intensity for the years 2016 to 2022. The 2016/17 modelling was based on Landsat 8 satellite imagery, which is available at a resolution of 30 m pixels, while datasets for later years was based on Sentinel 2 satellite imagery, which is available at a resolution of 10 m pixels. The FESM dataset includes all wildfires with a fire start date between July and June that covered an area >100 ha for 2016/17, 2017/18, and >10 ha for 2018/19, 2019/20, 2020/21 and 2021/22. Fire severity was assigned to one of 5 classes: unburnt, low severity (burnt understory, unburnt canopy), moderate severity (partial canopy scorch), high severity (complete canopy scorch, partial canopy consumption), extreme (full canopy consumption).

The FESM utilises both Landsat (2016/17) and Sentinel 2 (2017/18 onwards) imagery, while the GFLDF 2001 – 2021 dataset utiises Landsat imagery for all years 2000 to 2021. White and Gibson (2022) compared FESM outputs from Sentinel 2 and Landsat 8 sensors across 27 case study fires. They compared the mapped areas of fire severity classes between outputs and assessed the classification agreement at random sampling points. They found very similar levels of accuracy for both sensor algorithms and substantial agreement between the outputs from the two sensors. They attributed differences partly to differences in sensor resolution (10 m and 30 m pixel sizes for Sentinel 2 and Landsat 8, respectively) and suggested that the differences may be influenced by landscape complexity, such as terrain roughness and foliage cover. While the study of White and Gibson (2022) found that applying the same algorithm to Landsat and Sentinel 2 imagery produced comparable results, no comparison has been made of FESM and GFLDF 2001 – 2021 fire extent distributions for the common years 2016/17 to 2020/21. These products are ostensibly mapping the same phenomenon, but while FESM measures severity of the burn on all vegetation and ground, the GFLDF 2001 – 2021 only measures tree canopy loss.

## 2.5 Flood distribution

One of the strongest influences on stream channel morphology is hydrology. Due to lack of hydrology data specific to Bargo River and Hornes Creek, this report could only infer hydrological impact. Hydrology was investigated qualitatively by examining the distribution of flood events measured at the nearby gauges on the Nepean River: 212203 – Nepean River at Pheasants Nest Weir (upstream of Bargo River) and 212208 - Nepean River at Maldon Weir (downstream of Bargo River).

Water released from Cataract Dam flows down the Cataract River to Broughtons Pass Weir. Water released from Nepean Dam and Cordeaux Dam flows downstream to Pheasants Nest Weir on the Nepean River, where it is diverted via a 7-kilometre-long tunnel to Broughtons Pass Weir. Thus, while baseflows at Pheasants Nest Weir and Maldon Weir would not necessarily reflect natural hydrological conditions, when flood flows overtop the weirs, the flow record from the gauges would likely reflect similar conditions occurring in nearby Hornes Creek and Bargo River.

To investigate the hydrological conditions experienced since the previous assessment in 2013, mean daily discharge data for stations 212203 and 212208 were downloaded from WaterNSW Continuous Water Monitoring Network (https://realtimedata.waternsw.com.au/water.stm) for the period 2013 to 2023. In these data, small and moderate flood peaks at Maldon Weir were usually similar in magnitude to those at Pheasants Nest Weir, but the peaks of large floods were usually higher at Maldon Weir. During the peaks of the two largest floods that occurred since 2013 (peaking on 8/03/2022 and 4/07/2022), the Maldon gauge failed for several days, or was incapable of measuring the discharge. It can be reasonably assumed that these two floods were also the two largest events to occur at Maldon Weir gauge, as well as in Hornes Creek and Bargo River, over the period 2013 to 2023.

## 2.6 Impact assessment

The main mining-related agent of change that could cause an impact on geomorphological processes and forms in the Study Area is subsidence. Subsidence could bring about a number of geomorphic responses (Table 6) that would constitute an environmental impact with possible implications for environmental values. This report evaluated these risks qualitatively.

**Table 6. Potential geomorphic responses to mining-related causes.**

| Potential geomorphic response (event type) | | Causes |
|---|---|---|
| 1. | Change in stream type, irreversible over management time scales (< 100 years) | 1, 2, 3, 4, 5, 6 |
| 2. | Change of alignment of channel | 3, 4 |
| 3. | Reduction of existing in-channel pool volume | 1, 2, 3, 6 |
| 4. | Formation of new in-channel pool, or deepening of existing pools | 4 |
| 5. | Migration of soft knickpoint upstream at faster than natural rate | 3 |
| 6. | Increase of sediment supply to channel | 3, 5 |
| 7. | Increase of sediment accumulation in channel | 4, 6 |
| 8. | Increase of sediment scouring in channel | 3 |
| 9. | Increase in cover (density) of vegetation on channel bed and riparian zone (baseflow shift from high depth of water to shallow depth) | 6 |
| 10. | Decrease in cover (density) of vegetation on channel bed and riparian zone (baseflow shift from shallow depth of water to dry, or from shallow to deep) | 6 |
| 11. | Increase in rockfall frequency above natural rate | 5 |

| | **Mining related cause** |
|---|---|
| 1 | Local fracturing of rock bars that act as hydraulic controls on pools. |
| 2 | Local fracturing of bedrock in the bed of pools. |
| 3 | Local increase in slope of channel bed. |
| 4 | Local decrease in slope of channel bed. |
| 5 | Partial or total face collapse of cliff, minor cliff and rock face. |
| 6 | Reduction in stream flow (due to extensive fracturing). |

# 3 Existing environment

## 3.1 Landscape-scale characteristics summary

Landscape-scale characteristics geology, soils, topography, valley depth, and landform classes were considered stable over the 10-year timeframe and were not re-assessed in this report. Information concerning those characteristics can be found in Gippel (2013).

The Study Area is located in a region characterised by generally weakly developed soils on sandstone and shale. Some of the soils are highly susceptible to erosion by concentrated water flow, but in this would be expected of weakly developed soils in steep environments. The susceptibility of the soils to water erosion is part of the natural process of delivery of sediment to streams. The streams comprise small headwater streams on relatively low gradient plateau landscapes and streams eroded into rocky gorges. The gorges are rimmed by cliffs of various lengths and heights, with densely vegetated talus slopes below the cliffs. On the basis of field observation, Gippel (2013) considered that these cliffs, and the talus slopes below them, were relatively stable.

## 3.2 Cliffs

Gippel (2013) characterised and mapped the cliffs of the Hornes Creek and Bargo River gorges along the stream reaches assessed for this report using 7 – 8 February 2013 LiDAR data on a 1.5 m grid. In this report, the 1 m grid 7 – 8 February 2013 LiDAR elevation data was compared with the 1 m grid 29 – 30 June 2019 LiDAR elevation data within the cliff polygons identified by Gippel (2013) along the Hornes Creek and Bargo River gorges to investigate any major changes to cliff morphology. Upon subtraction of the 2019 data from the 2013 data, a negative difference would suggest cliff collapse within those polygons. A positive difference must represent error as cliffs would not be expected to increase in height unless impacted by mining (which was not a factor in this case).

Overall, the differences in cliff elevation between 2013 and 2019 were relatively small (Table 7), considering that LiDAR error tends to be higher in areas of very steep slope. Also, the differences in elevation were evenly distributed between positive and negative differences, suggesting that most differences were within the error of the LiDAR and the methodology employed to define cliff polygons (Table 7). There was one cliff location where the difference in cliff elevation was outside the expected range of error. just downstream of Picton Weir, on the left side of the gorge, the data suggest that between 2013 and 2019 an approximately 160-metre-long section of cliff retreated laterally up to 5 metres over the full height of the cliff face (Figure 5). Profiles taken from 2013, 2016 and 2019 LiDAR suggest a progressive cliff face retreat along the middle section of the cliff, but towards the ends of the cliff the cliff face position is inconsistent with time (Figure 6, Figure 7 and Figure 8). Also, the profiles do not indicate the presence of newly fallen rock at the base of the cliff. Examination of high resolution NearMap imagery supplied by MSEC, dated 10/02/2010, 01/10/2014, 13/11/2019 and 05/04/2020 did not reveal any evidence of collapse and retreat of the cliff top. This apparent contradiction in LiDAR and imagery data could not be resolved here, but an error in the LiDAR data along this cliff line is the most likely explanation. LiDAR error on this specific cliff could be due to a combination of its height, steepness, and aspect relative to the flight direction.

**Table 7. Statistical summary of the distribution of changes in average elevations within cliff polygons identified by Gippel (2013) along Hornes Creek and Bargo River gorges between 2013 and 2019.**

| Cliff class (as classified in 2013 study) | N (cliff polygons) | Change in average elevation between 2013 and 2019*† (m) | | | | |
|---|---|---|---|---|---|---|
| | | Maximum | 10th percentile | 50th percentile | 90th percentile | Minimum |
| 1. Cliffs >=10 m high, all lengths | 42 | 3.8 | 1.8 | 0.0 | -2.9 | -9.7 |
| 1a. Cliffs >=10 m high and >=20 m long | 16 | 3.8 | 2.4 | 0.3 | -3.5 | -9.7 |
| 1b. Cliffs >=10 m high and <20 m long | 26 | 2.9 | 1.4 | -0.1 | -2.8 | -5.3 |
| 2. Minor cliffs 5 to <10m high, all lengths | 208 | 4.9 | 2.8 | 0.3 | -2.5 | -35.0 |
| 3. Rock faces 3 to 5 m high, all lengths | 695 | 6.8 | 2.1 | 0.1 | -2.0 | -9.9 |

* a negative difference would suggest cliff collapse within cliff polygons. A positive difference must represent error.

† Elevation differences between 2013 and 2019 data at individual pixels within polygons were greater than statistics based on average differences between all pixels within polygons, as provided in this table.

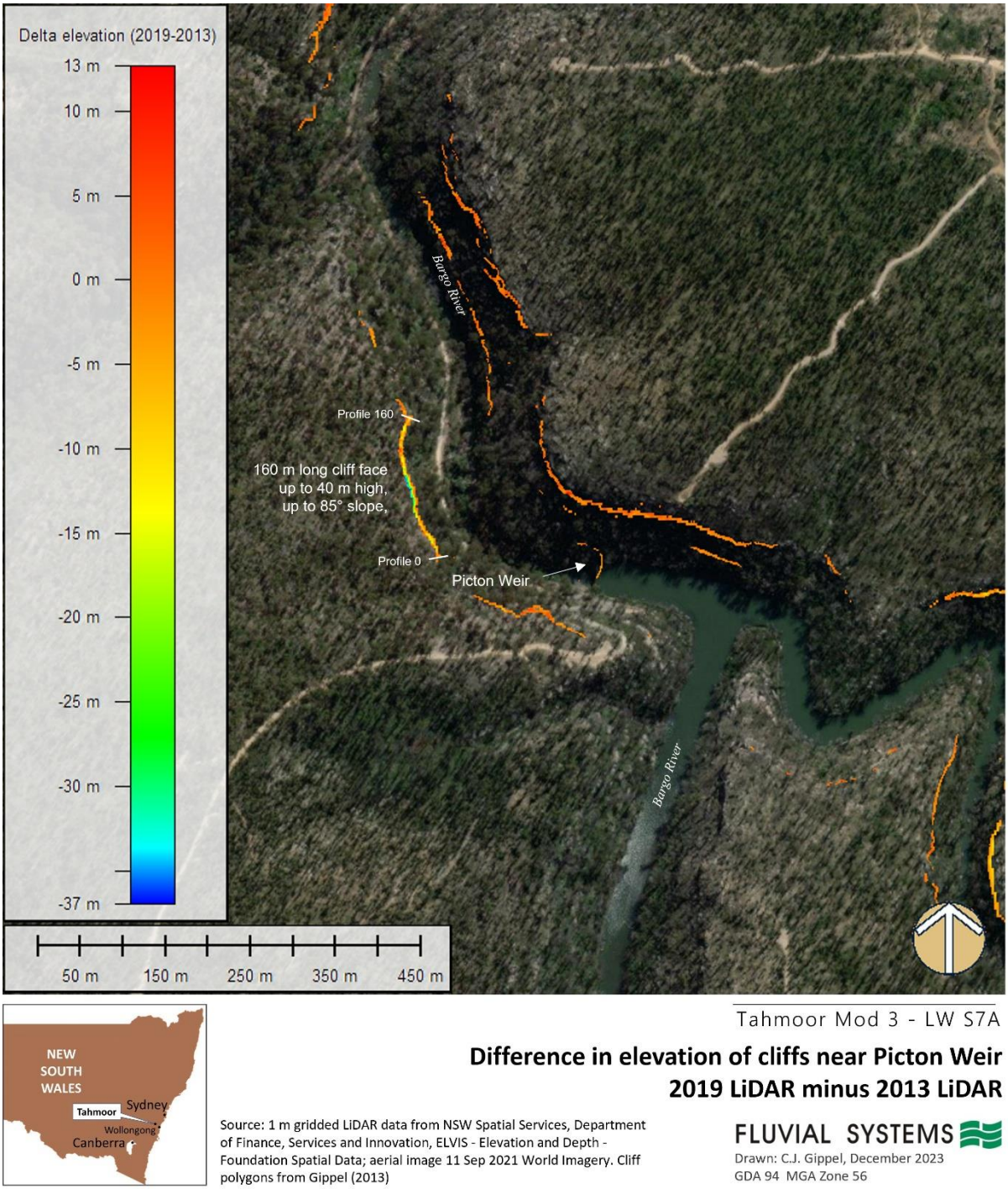



**Figure 5. Detail of difference in elevation of cliffs in the gorge in the vicinity of Picton Weir between 2019 and 2013. The LiDAR comparison suggested an extreme change had occurred at only one cliff line in the study area.**

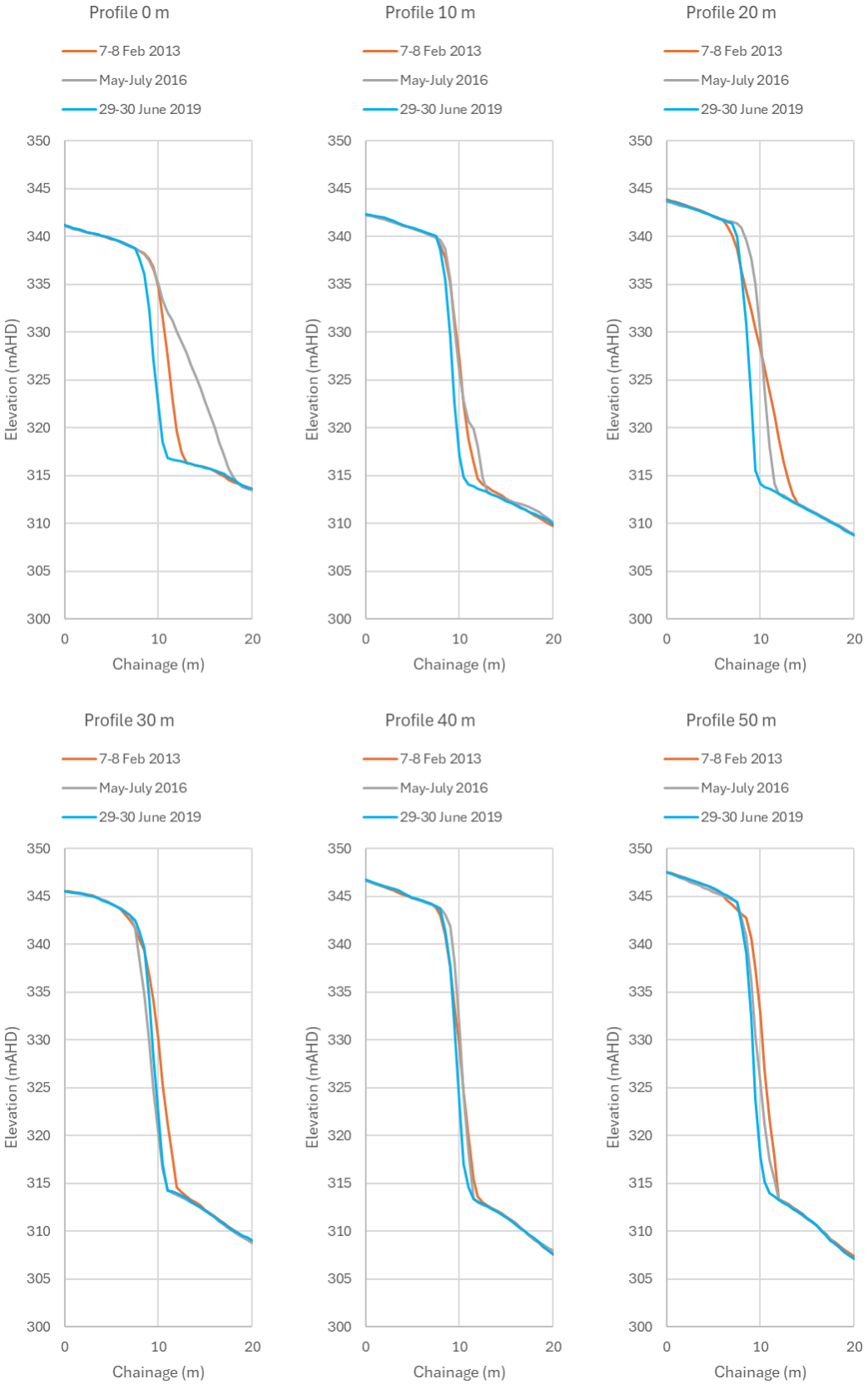



**Figure 6. Profiles 0 – 50 m (south to north) at 10 m spacing along cliff on the left side of the gorge in the vicinity of Picton Weir, measured from 2019, 2016 and 2013 LiDAR. No vertical exaggeration.**

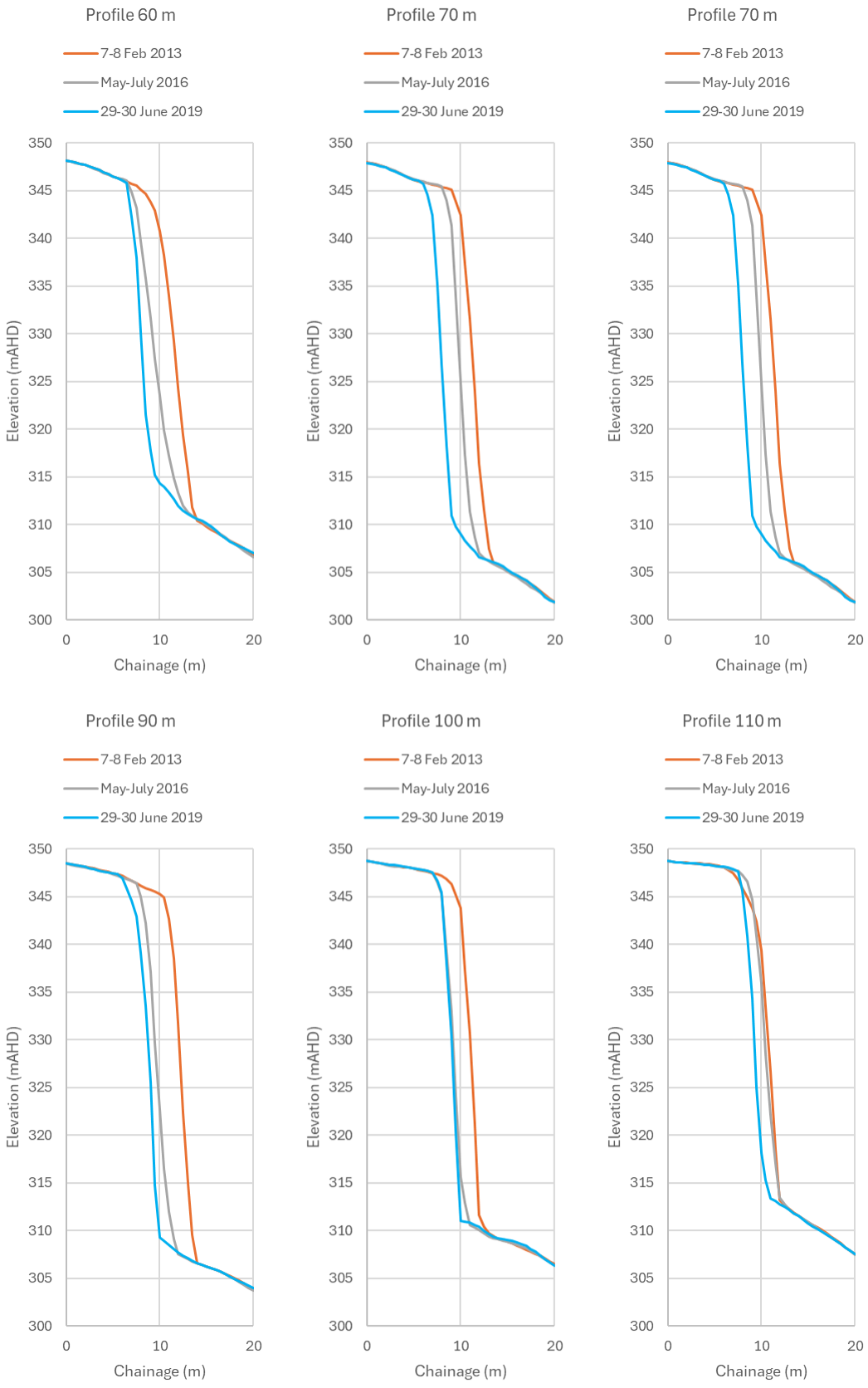



**Figure 7. Profiles 60 – 110 m (south to north) at 10 m spacing along cliff on the left side of the gorge in the vicinity of Picton Weir, measured from 2019, 2016 and 2013 LiDAR. No vertical exaggeration.**

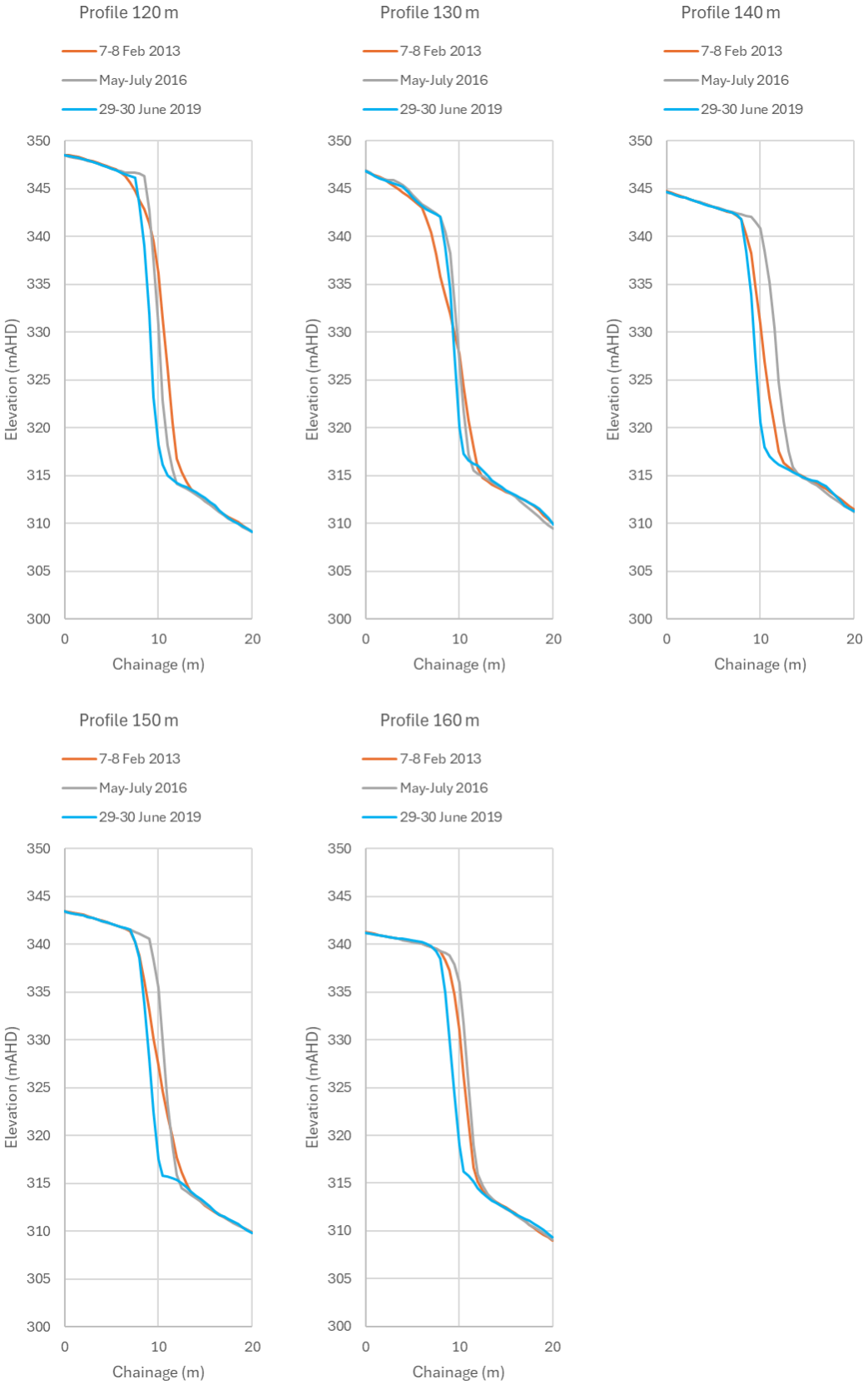



**Figure 8. Profiles 120 – 160 m (south to north) at 10 m spacing along cliff on the left side of the gorge in the vicinity of Picton Weir, measured from 2019, 2016 and 2013 LiDAR. No vertical exaggeration.**

## 3.3 River Styles

The River Styles – Style and Condition independently assessed and mapped at detailed scale by Gippel (2013) was consistent with the River Styles information provided by the River Styles Spatial Layer for New South Wales. There was only one Style within the Study Area, Gorge (Figure 9), and it was in 'Good' condition (Figure 10). This is a geomorphic stream type that has 'Low' fragility (i.e. resistant to degradation) (Figure 11), and combined with its 'Good' condition, was classified as worthy of being managed for conservation (Figure 12).

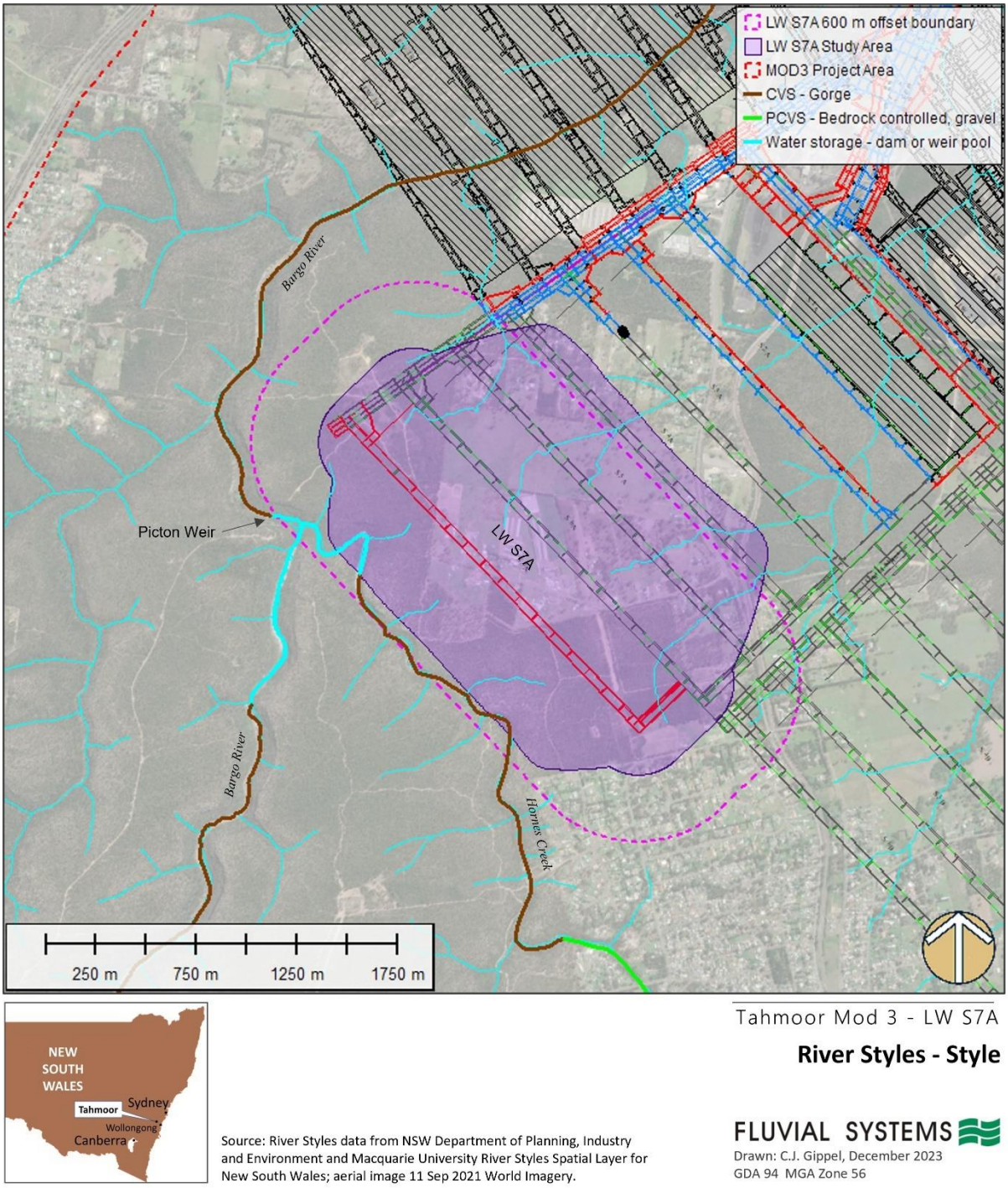



**Figure 9. River Styles - Style.**

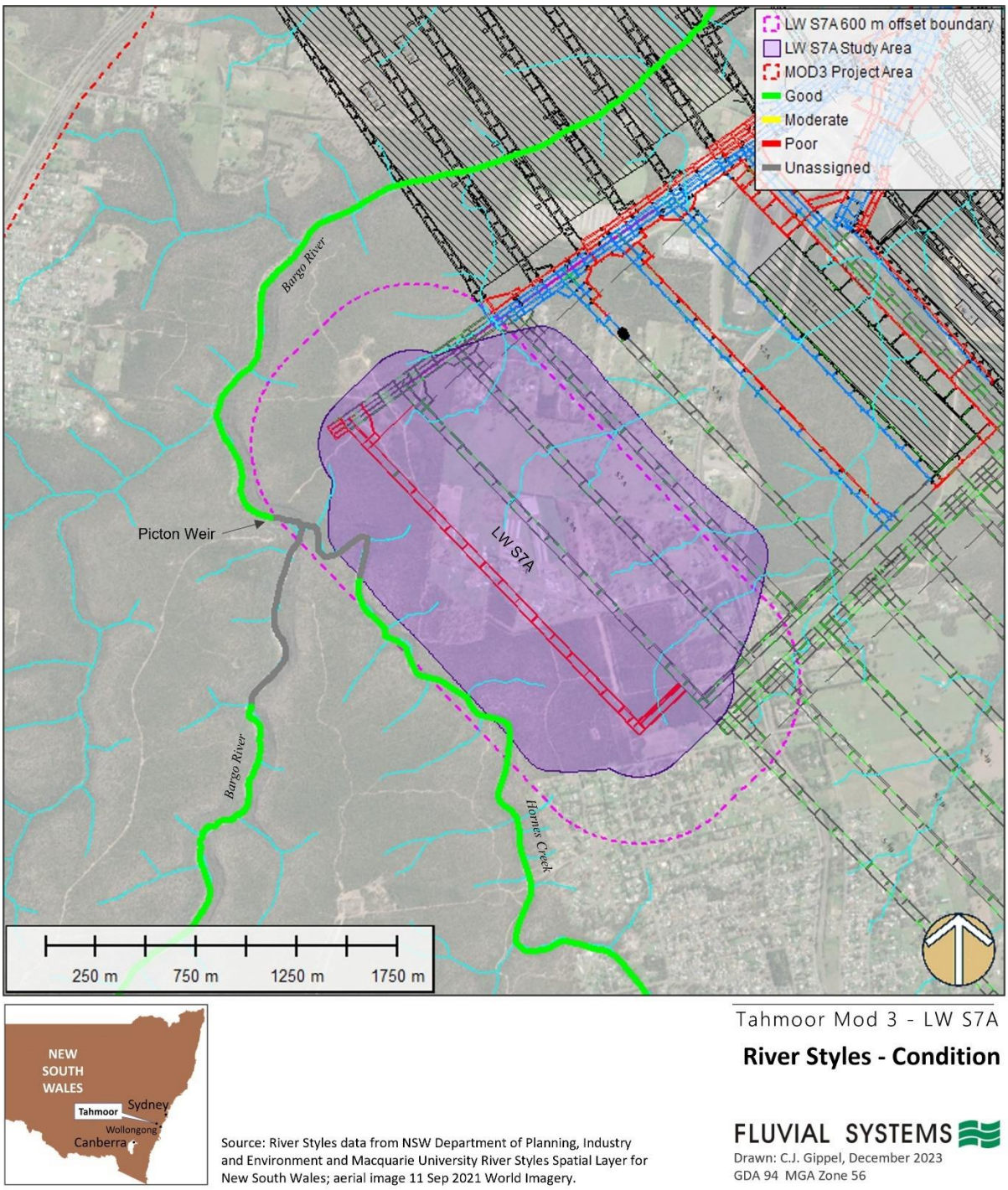



**Figure 10. River Styles - Condition.**

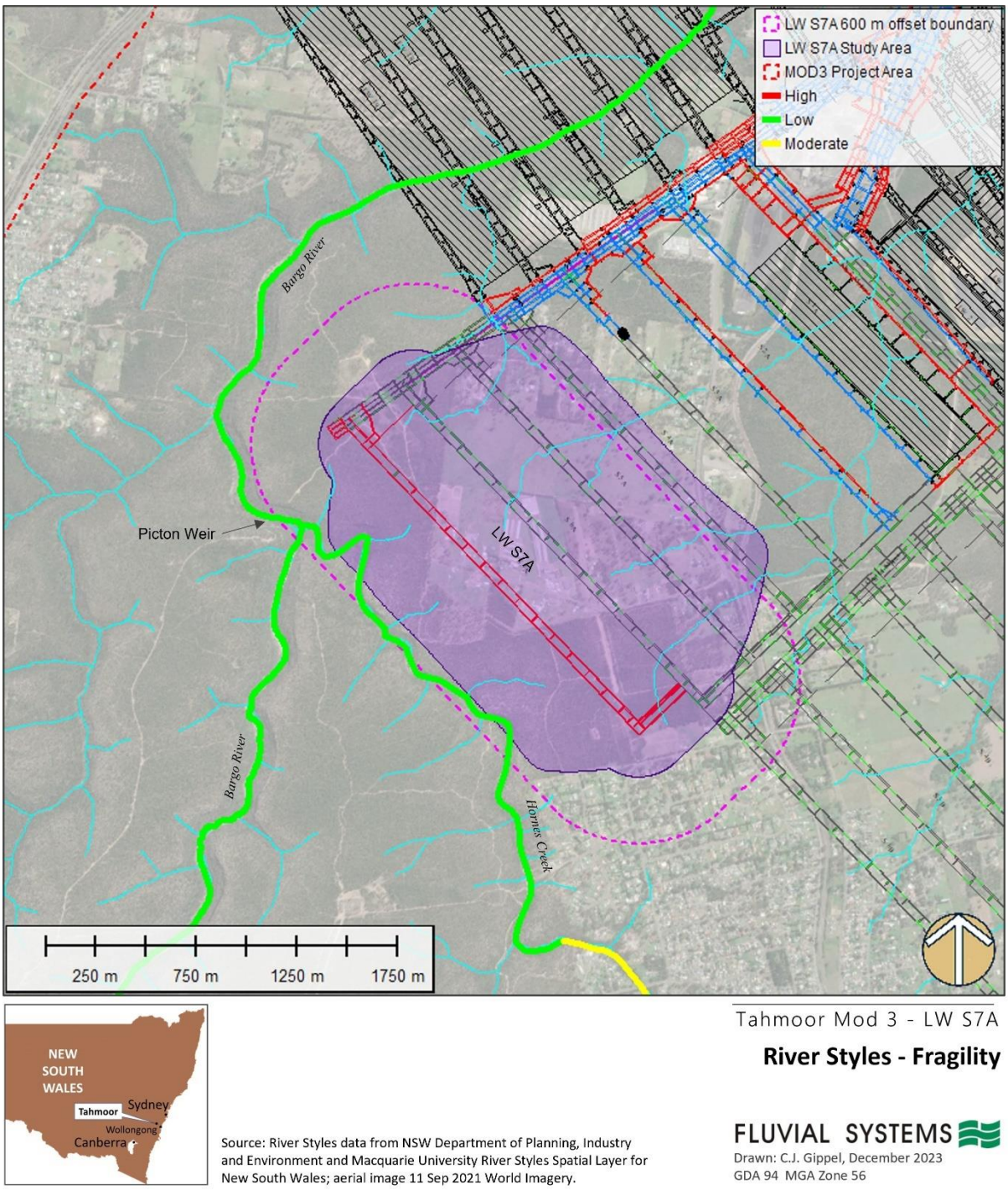



**Figure 11. River Styles - Fragility.**

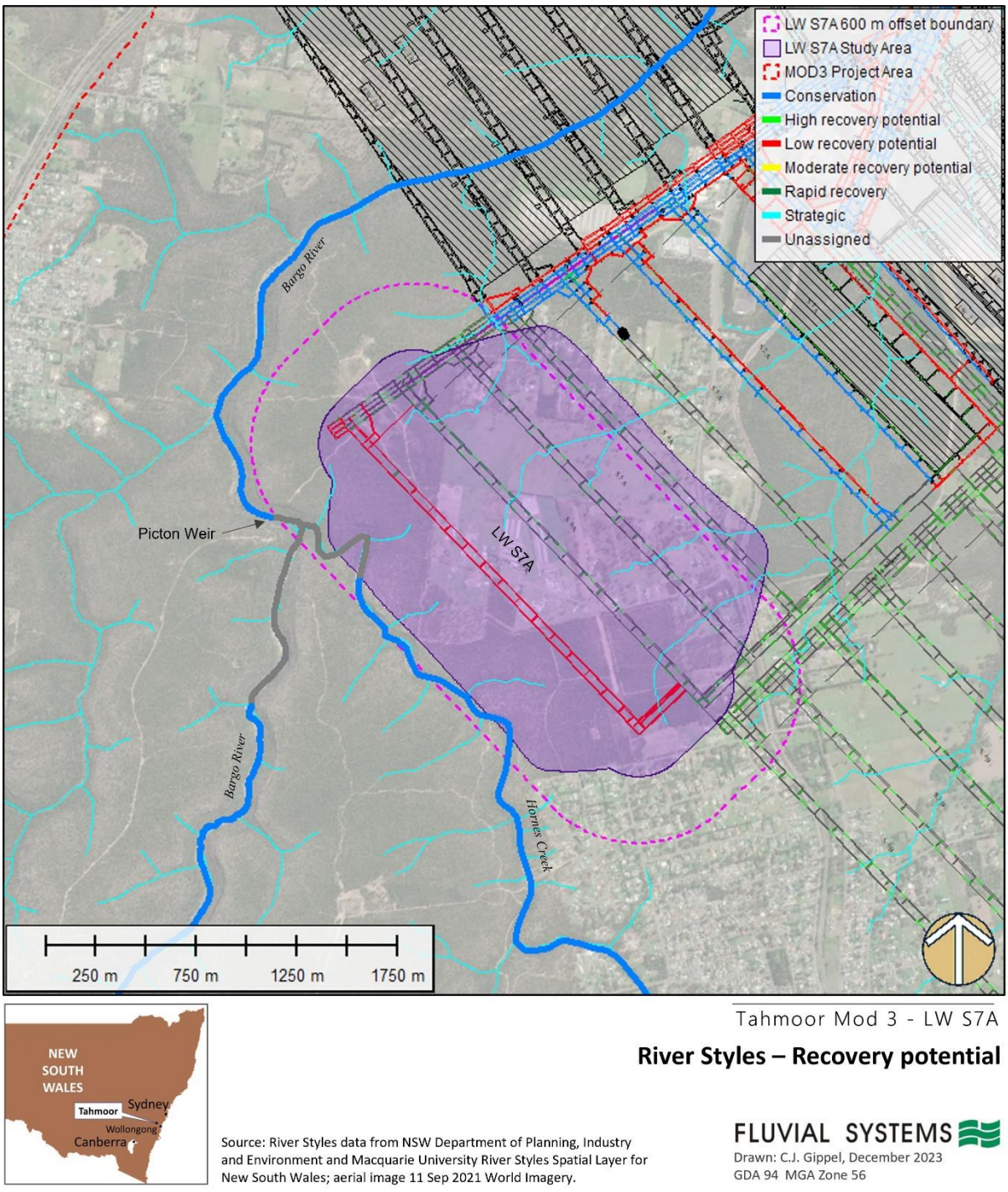



**Figure 12. River Styles – Recovery potential.**

## 3.4 Field observations

Overall, most of the differences in geomorphic characteristics recoded at field sites in 2023 were minor. The main differences related to riparian vegetation structure and ferruginous material in the water and on the bed.

Dominant bed material was the same, except at sites 40 and 41 (Hornes Creek) which were cobble in 2013 and boulder in 2023, and site 3 (Bargo River) which was bedrock in 2013 and boulder in 2023. These are minor differences that are likely within measurement error.

The large wood count varied non-systematically between the 2013 and 2023 surveys but the range covered by the data was the same (Figure 13).

Differences in knickpoint height between the 2013 and 2023 surveys were within measurement error (Figure 14), which is not surprising as all knickpoints were set in hard stable material.

Pool dimensions varied somewhat between the 2013 and 2023 surveys (Figure 15). Most of the differences would be within measurement error. Some of the differences could have been related to the lower flow rate that occurred during the 2023 survey, possibly affecting the perception of pool boundaries.

The greatest difference between the 2013 and 2023 field observations related to riparian vegetation structure. The cover of riparian trees was systematically lower in 2023, although the combined cover index scores were similar between surveys (Figure 16). This can be explained by shrubs and ground cover having colonised the spaces previously shaded by tree cover.

Apart from the stark differences in riparian vegetation structure between 2013 and 2023, another dramatic difference was the widespread presence of ferruginous colloids in the water and precipitated on or staining the bed material in 2023. Ferruginous colloids were observed along Hornes Creek upstream of site 31 located at chainage 1260 m (in particular at sites 16, 18, 19, 22, 24, 26, and 30). The downstream 740 m of the creek was clear of ferruginous colloids, iron precipitates and iron staining. Bargo River had pervasive high concentrations of ferruginous colloids in the water and iron precipitates and iron staining on the bed material. Water in the large, deep, shaded pool immediately downstream of Picton Weir, and water within the weir pool itself, was clear of ferruginous colloids. Investigation of the source of the high concentrations of iron oxides in the stream water in 2023 would require hydrogeological and water chemistry expertise, and was not done as part of this study.

A major difference between 2013 and 2023 geomorphological conditions on Bargo River related to the condition of No P1 Fire Trail. In 2013 the trail was in good condition, with Picton Weir accessible by vehicle. In 2023 the trail became impassable a short distance from Tahmoor due to fallen trees. Closer to Picton Weir, where field sites 1 to 5 were located, the trail was affected by occasional slumping and scouring by local runoff from small tributaries. More extensive damage in the form of surface stripping was also apparent. This damage appeared to have been caused by inundation and scour of the trail by large flood flows.

Photographs of each site taken in 2013 and 2023 are compared in Appendix 1. A photograph of damage to No P1 Fire Trail was included with Bargo River site 3.

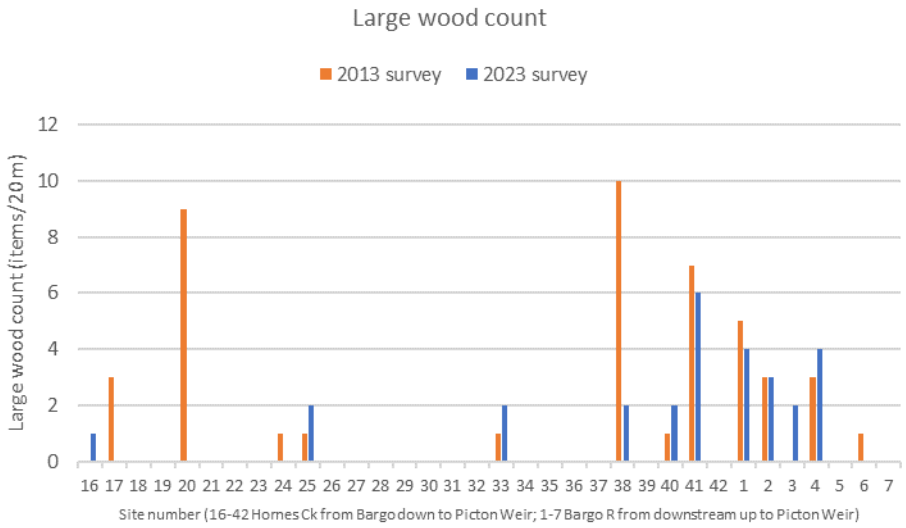



**Figure 13. Large wood count observed in 2013 and 2023 surveys. Note: this variable was not measured at every site.**

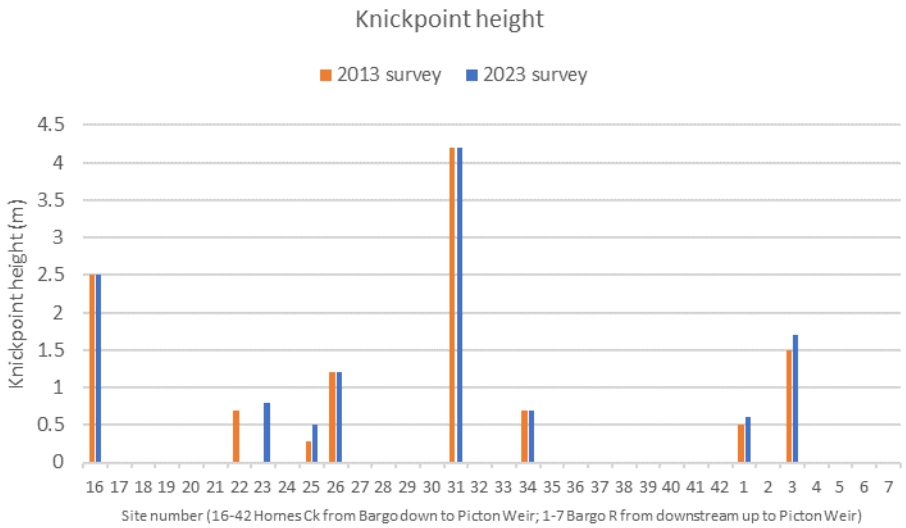



**Figure 14. Knickpoint height observed in 2013 and 2023 surveys. Note: this variable was not measured at every site.**

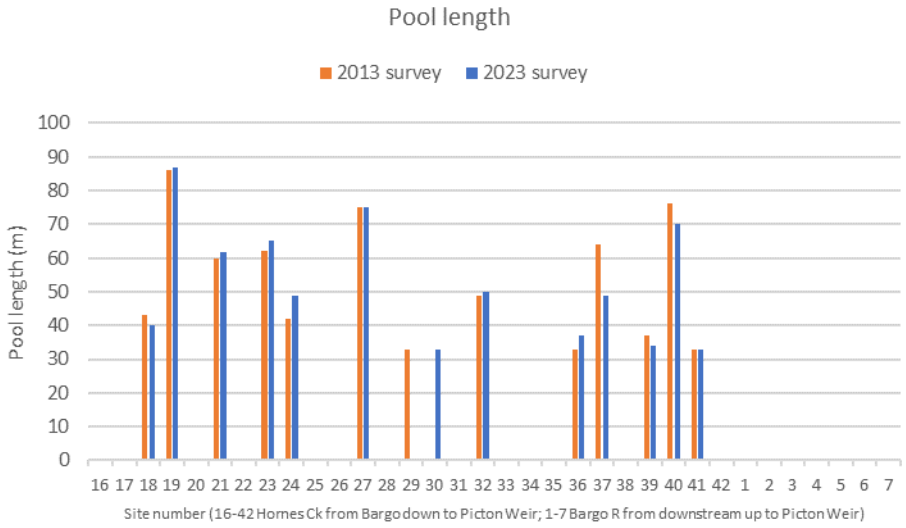



**Figure 15. Pool length observed in 2013 and 2023 surveys. Note: this variable was not measured at every site.**

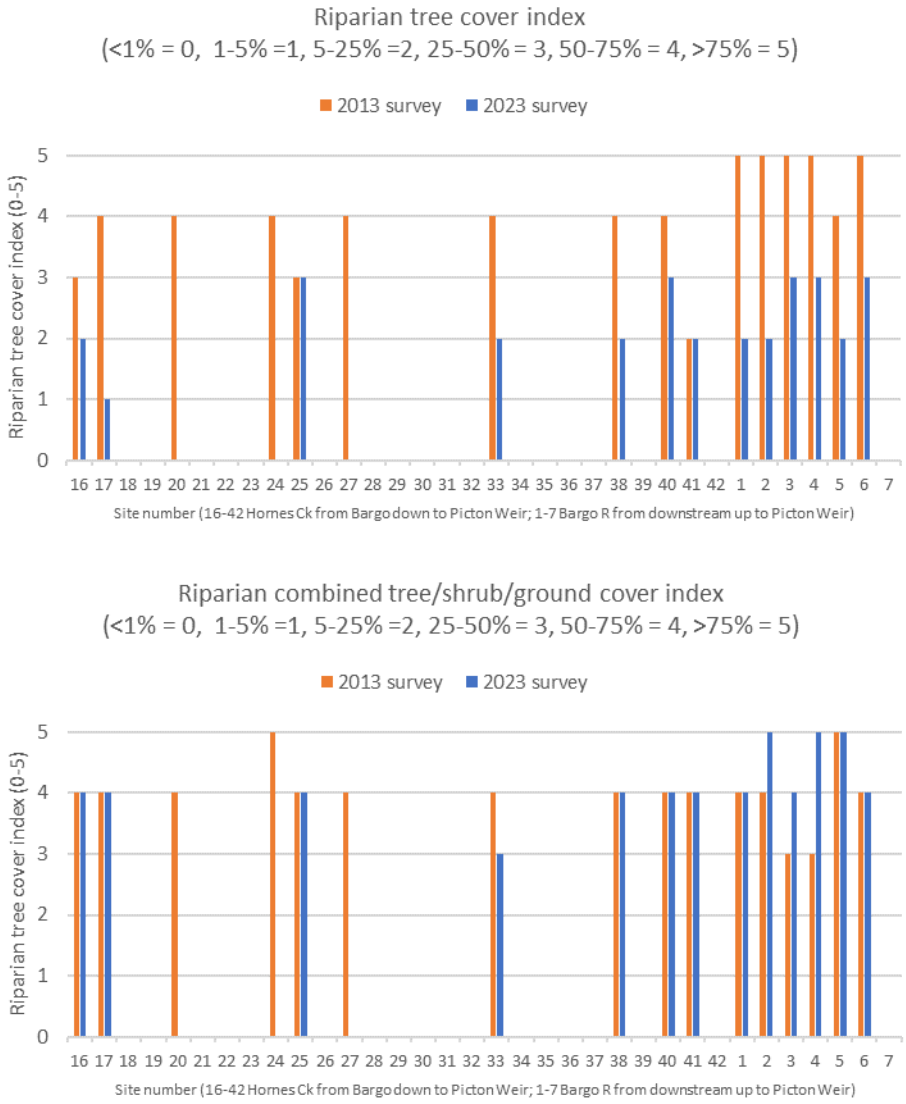



**Figure 16. Riparian tree cover index (top) and Riparian combined cover index (bottom) measured in 2013 and 2023 surveys. Note: this variable was not measured at every site.**

## 3.5 Riparian forest canopy cover

Forest canopy percentage cover and height were assessed over a 40 m wide riparian buffer over the period 2000 to 2020. Forest canopy cover in the riparian zones of Hornes Creek and Bargo River was dense in year 2000 (Figure 17), but significant loss of cover occurred in year 2020 (Figure 18). Similarly, the riparian zone of both watercourses was densely vegetated by tall trees in year 2000 (Figure 19), but by year 2020 tall trees were virtually eliminated over lengths of the riparian zones (Figure 20 and Figure 21). This result is consistent with the field observations.

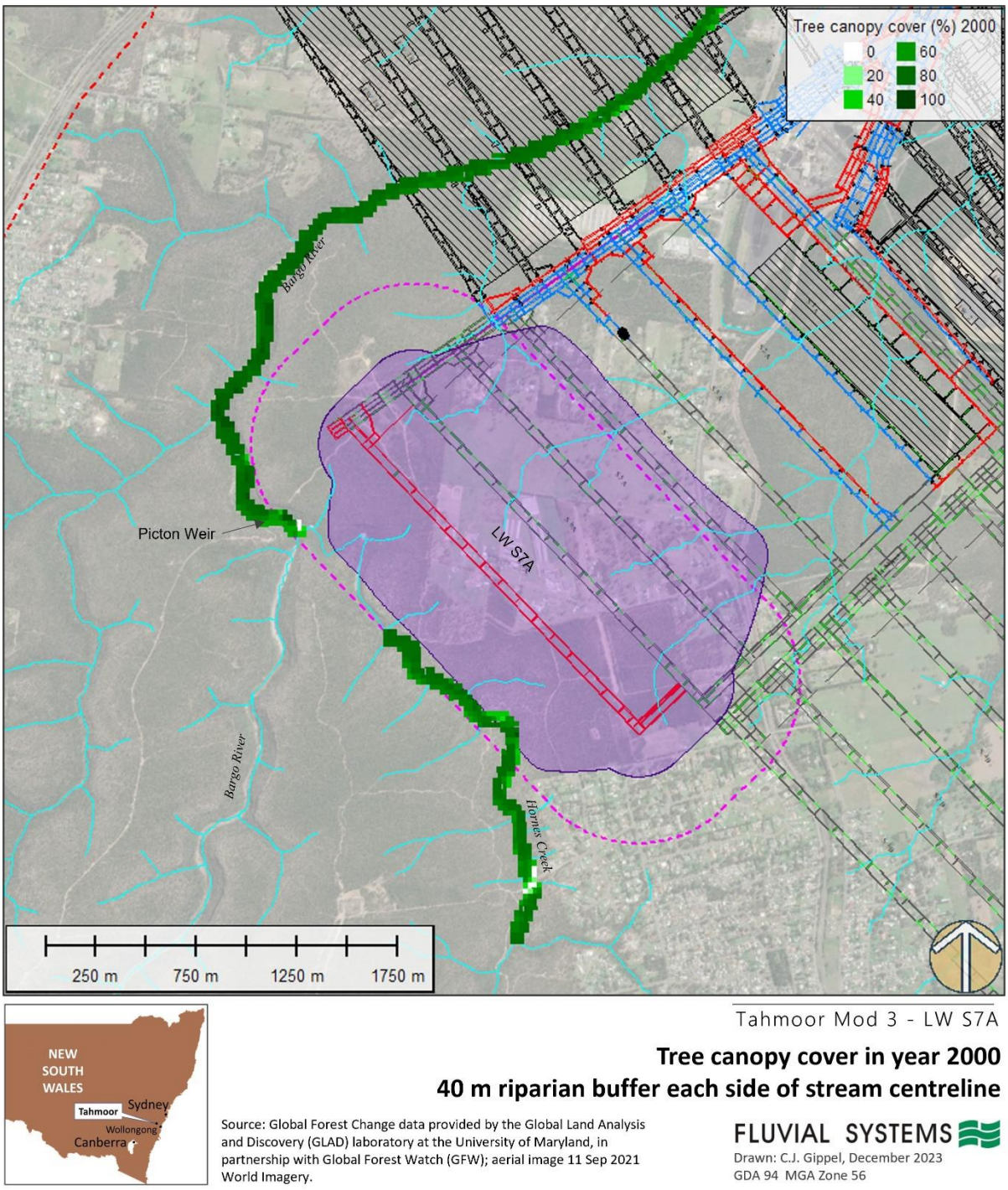



**Figure 17. Tree canopy cover (percent cover) in the year 2000.**

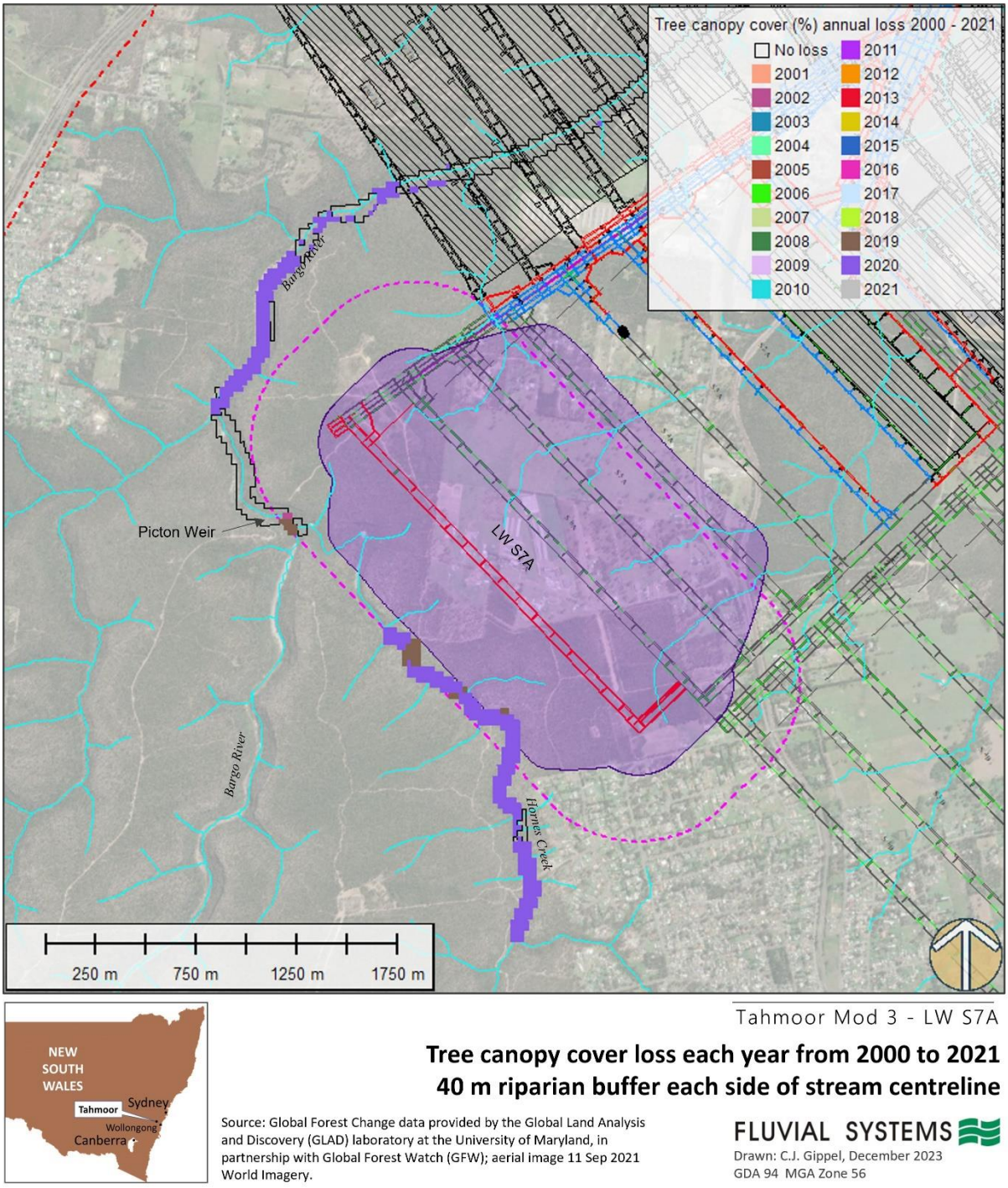



**Figure 18. Tree canopy cover (percent cover) loss each year from 2000 to 2021. Majority of loss occurred in year 2020.**

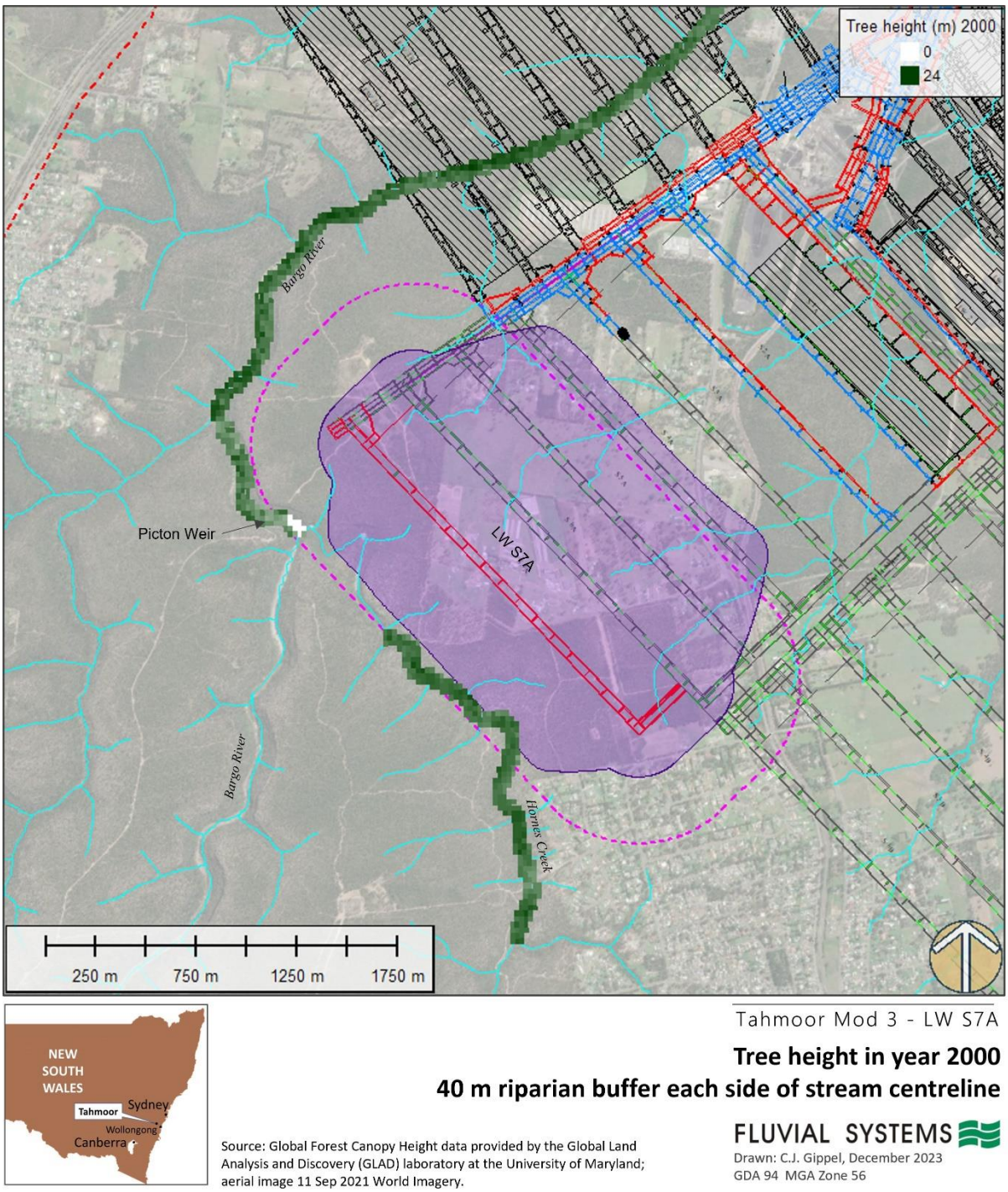



**Figure 19. Tree canopy height in year 2000.**

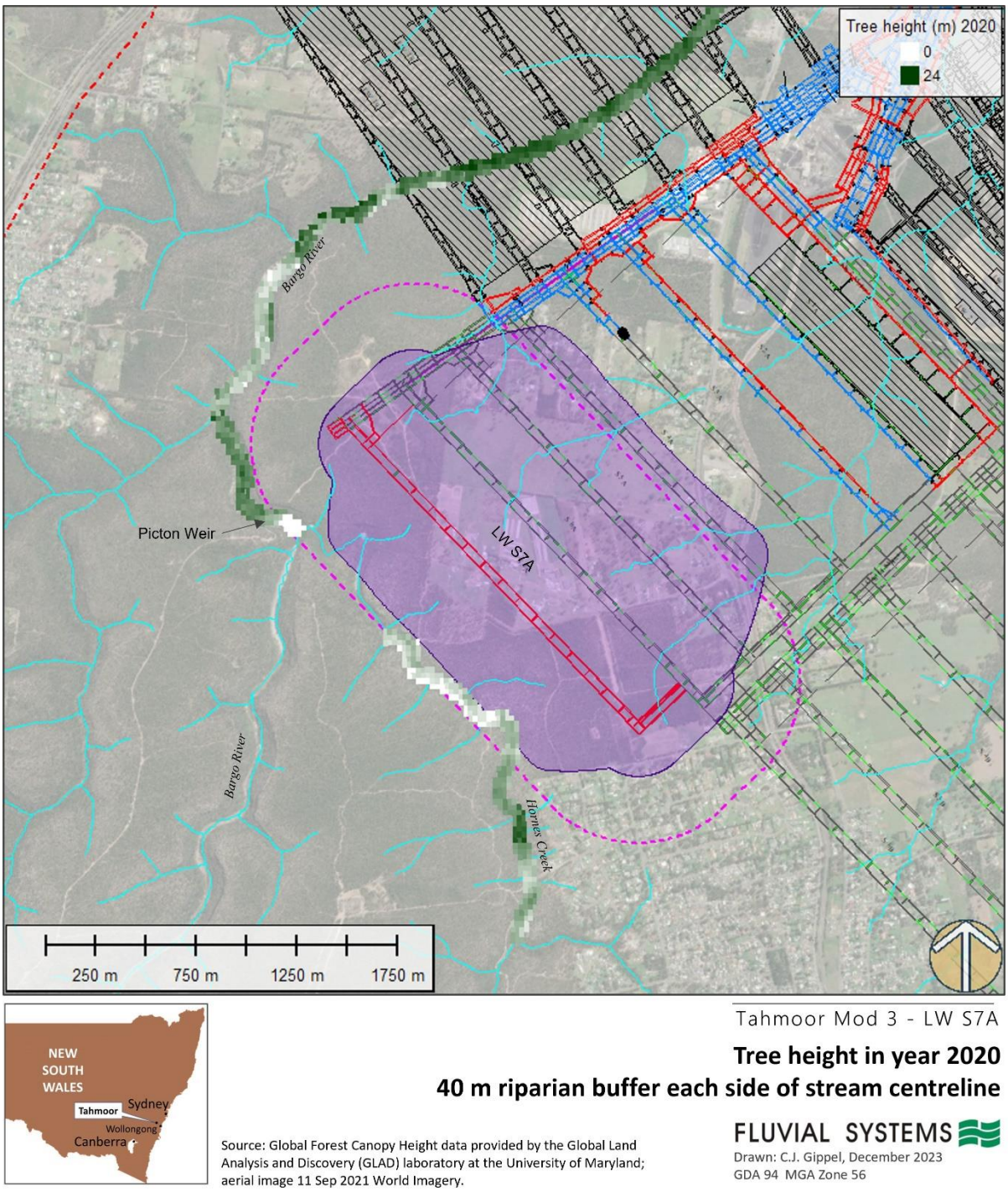



**Figure 20. Tree canopy height in year 2020.**

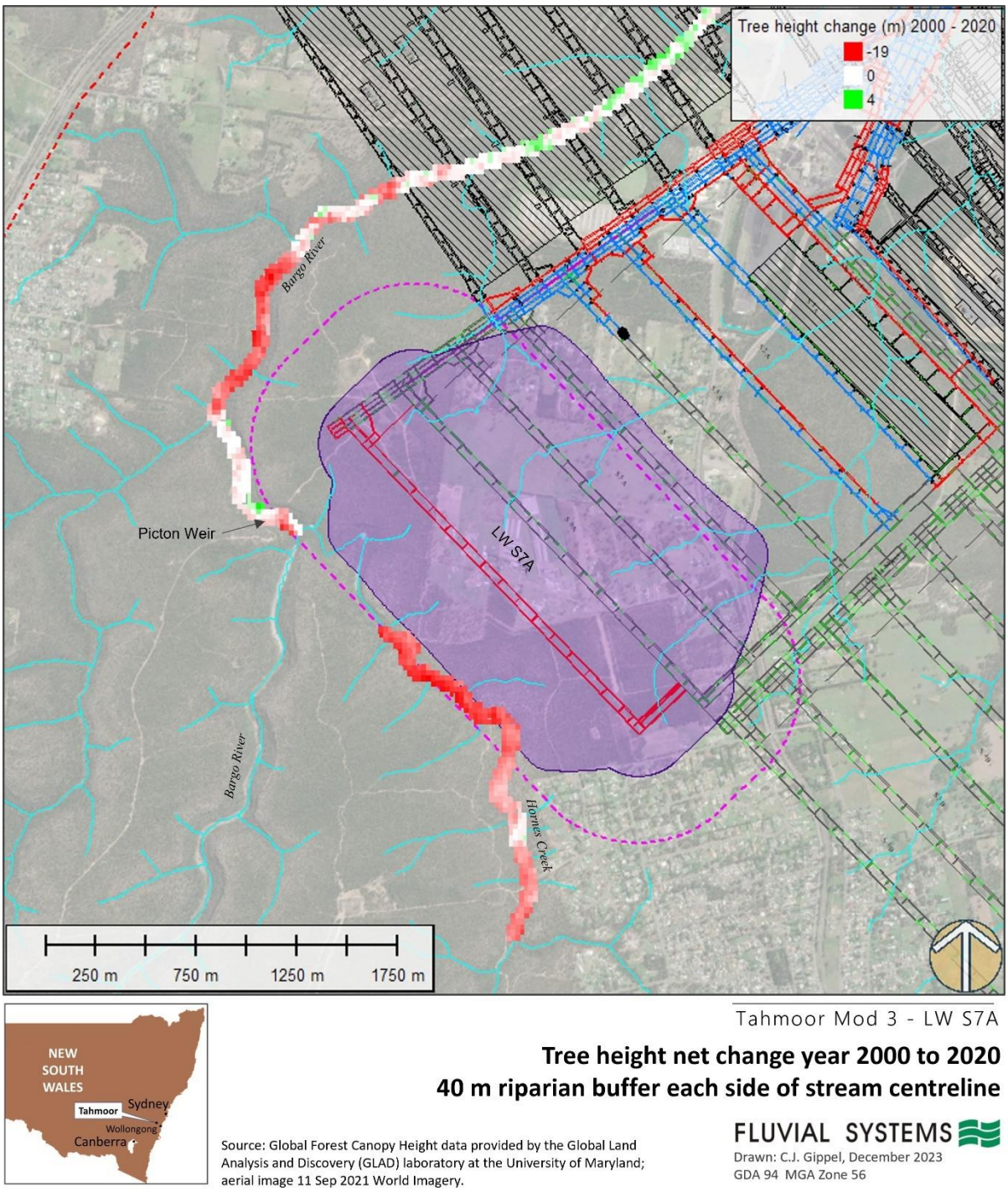



**Figure 21. Tree canopy height net change from 2000 to 2020.**

## 3.6 Bushfire occurrence

Two sources of spatial data were used to map the areas of the Study Area burned by fires in recent years. The spatial pattern of burned and unburned areas within the Study Area produced by the GLAD Global Forest Loss Due to Fire (GFLDF) 2001 – 2021 dataset matched closely with the tree canopy cover and tree height data produced by GLAD. Much of Hornes Creek and Bargo River were burned in early 2020, with a short reach immediately downstream of Picton Weir escaping the blaze (Figure 22). The pattern of fire burn severity for the 2019/20 season provided by the Fire Extent and Severity Mapping (FESM) dataset was similar to the area burned

mapped by the GFLDF dataset. The areas mapped low burn intensity by FESM were mostly not registered as burned by GFLDF mapping.

The bushfire data explain the temporal and spatial patterns of forest canopy and tree height loss mapped by the GLAD datasets. All of the forest and bushfire datasets are consistent with the field observations made for this study.

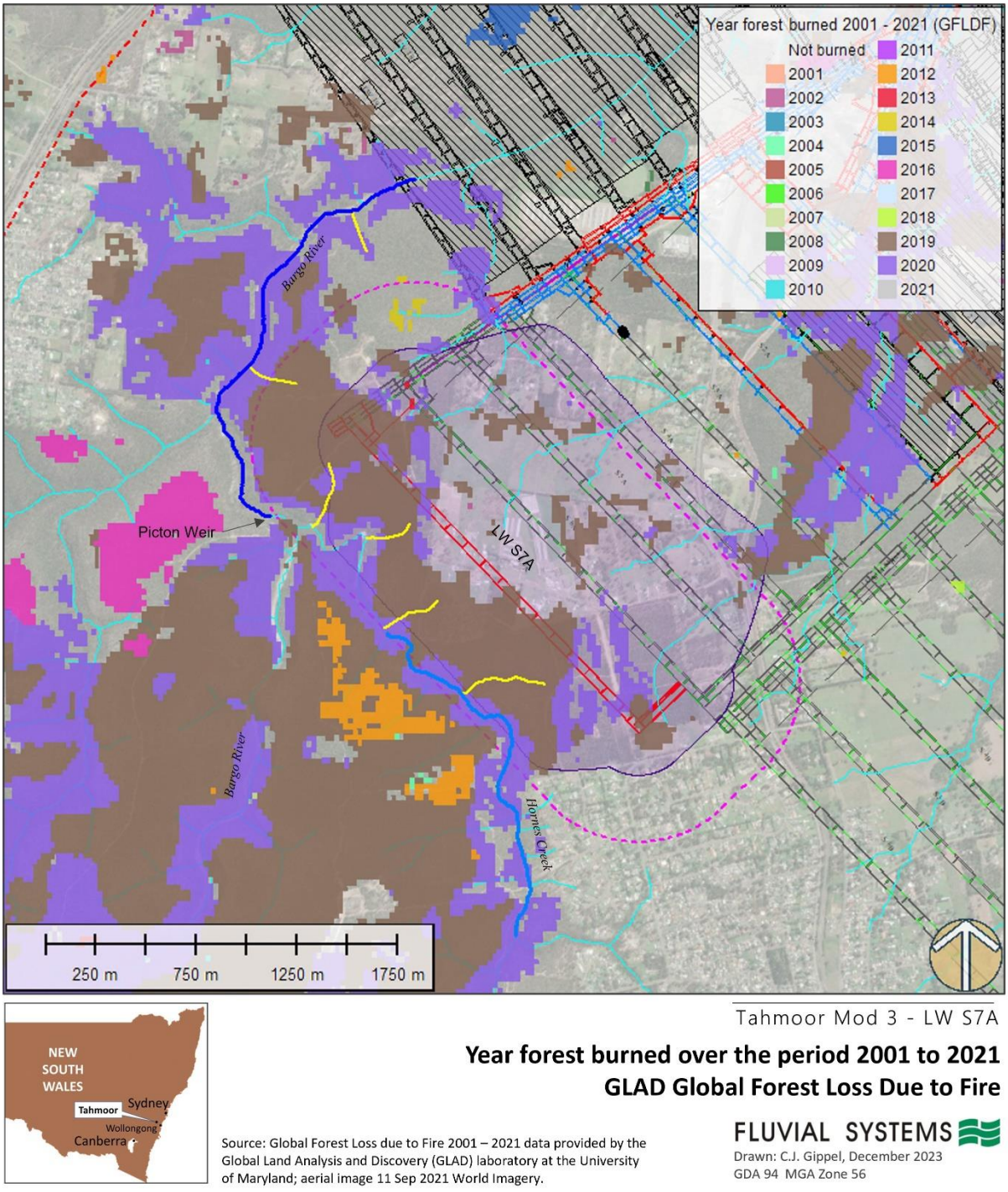



**Figure 22. Year forest burned over the period 2001 to 2021 (calendar years). Most of the area burned in 2019 and 2020.**

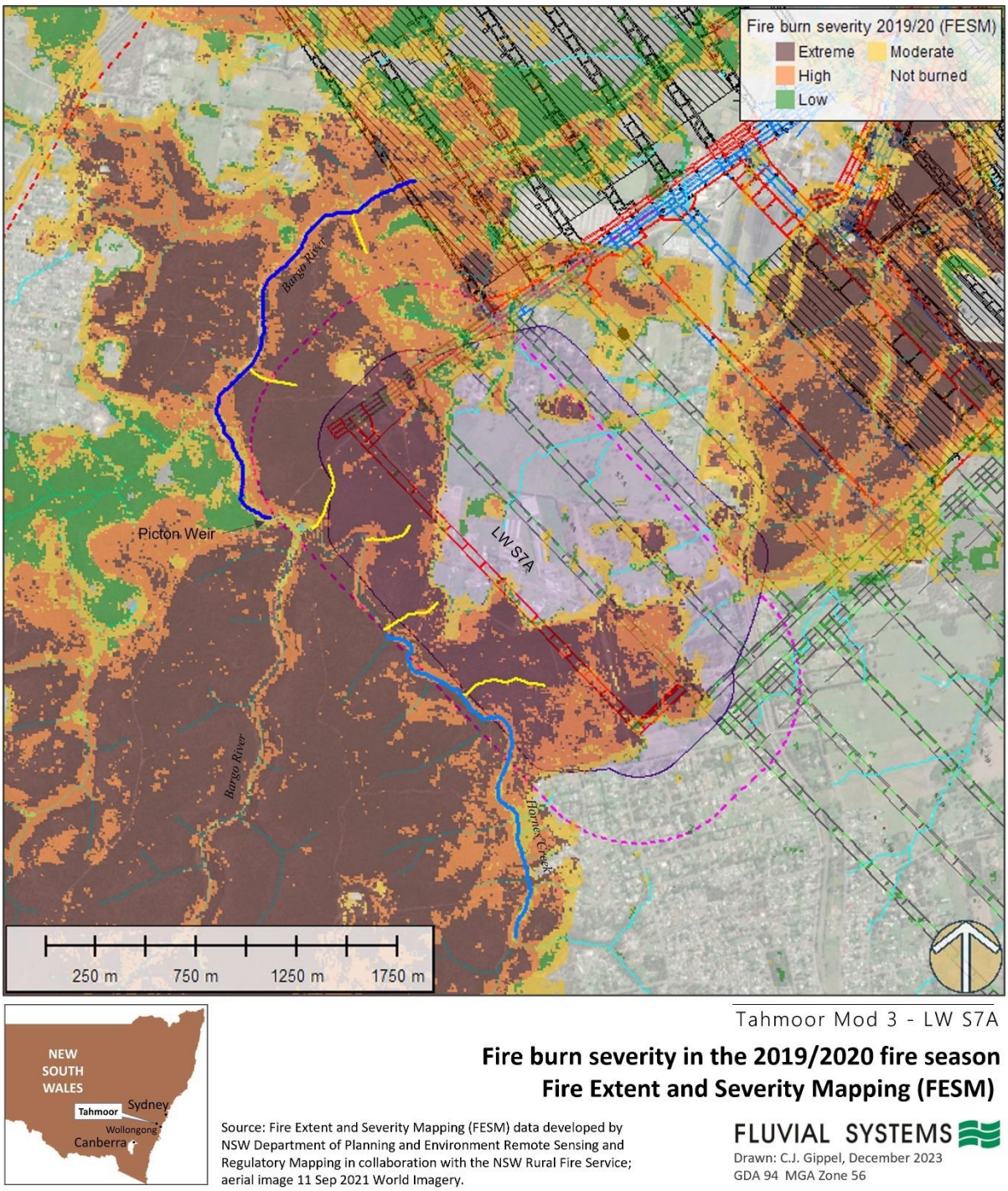



**Figure 23. Fire burn severity in the 2019/2020 fire season.**

## 3.7 Hydrology

The hydrology of the Nepean River over the period 2013 to 2020 was characterised by relatively infrequent and small magnitude flood events (Figure 24). In contrast, the period 2021 and 2022 was characterised by a sequence of moderate and major floods. This flood period immediately followed the extensive and severe bushfires of 2019 and 2020. It would be expected that this combination of events would produce extreme conditions for sediment erosion and transport, and channel adjustment. Certainly, the observed damage to No P1 Fire Trail is understandable. Whilst the fires and floods dramatically scoured riparian trees from the stream channels, being

bedrock controlled, their morphology appeared to be largely unaltered. This is consistent with the 'Low' fragility and 'Good' condition of the channels. Also, within a year of the floods much of the riparian zone has been colonised by regrowth.

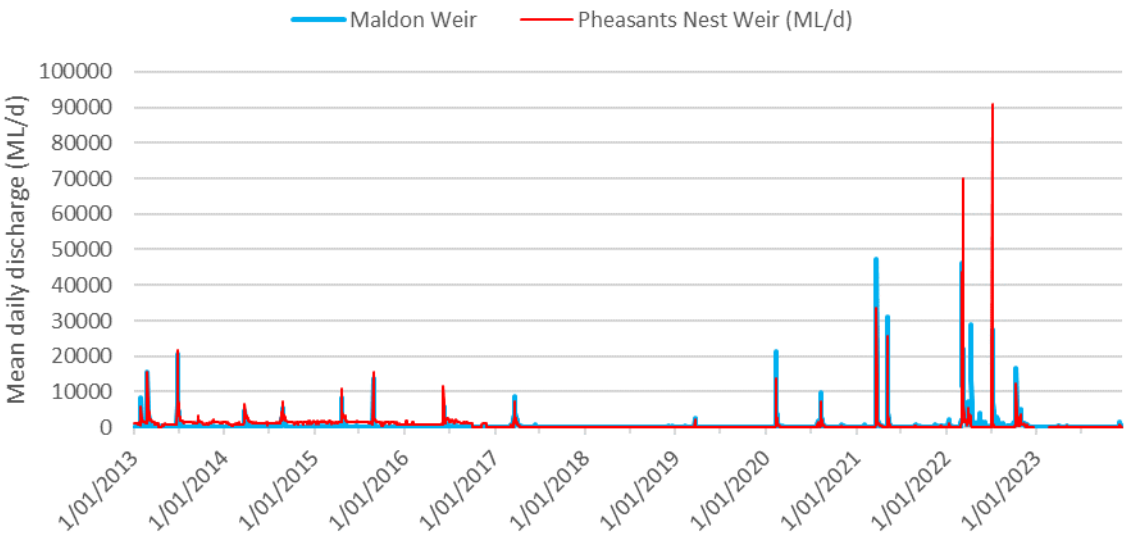



**Figure 24. Hydrographs for the Nepean River at two gauges for the period 2013 to 2023.**

## 3.8 Pools

### 3.8.1 Downstream profiles of pool depth

The downstream pattern of pool depth derived from LiDAR data along Hornes Creek illustrated the high frequency of occurrence of pools, and the high variability of pool depth (Figure 25). As expected, the pools along Bargo River were deeper and longer than those along Hornes Creek (Figure 26). The positions and relative depths of the pools derived from the LiDAR datasets were also illustrated using long profiles of elevation (Figure 27 and Figure 28).

The downstream patterns of pool depth produced by the 2013, 2016 and 2019 LiDAR datasets differed in detail, but the overall patterns and scales of the pools were comparable between these LiDAR datasets. The 2022 LiDAR produced much lower pool depths for Hornes Creek (and was unavailable for Bargo River), largely because of the paucity of laser returns from the channel.

The positions of pools recorded on Hornes Creek by handheld GPS in the field did not consistently align with the longest or deepest pools derived from the LiDAR datasets. It should be noted however, that there was no field protocol that required consistent recording of the position of pools at the head, tail or middle of the pool. The number of pools identified on Hornes Creek by the LiDAR was much greater than the number of pools measured in the field. However, the impracticality of measuring every pool in the creek meant that measured pools were subjectively judged in the field as being more significant than unmeasured pools, and some pools were inaccessible due to difficult terrain or vegetation.

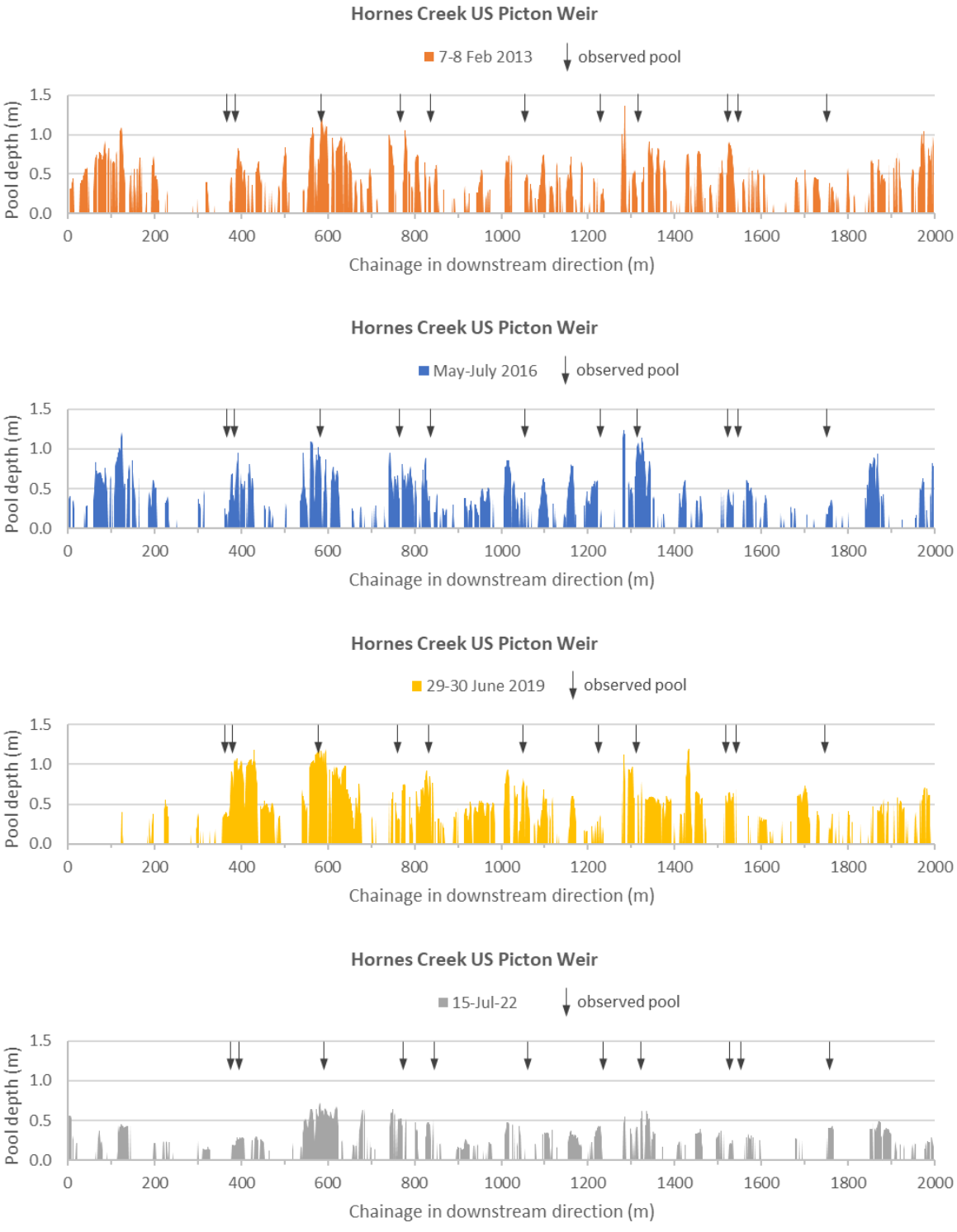



**Figure 25. Downstream pattern of pool cross-sectional maximum depth for Hornes Creek, using LiDAR-derived 1 m grids from four different dates.**

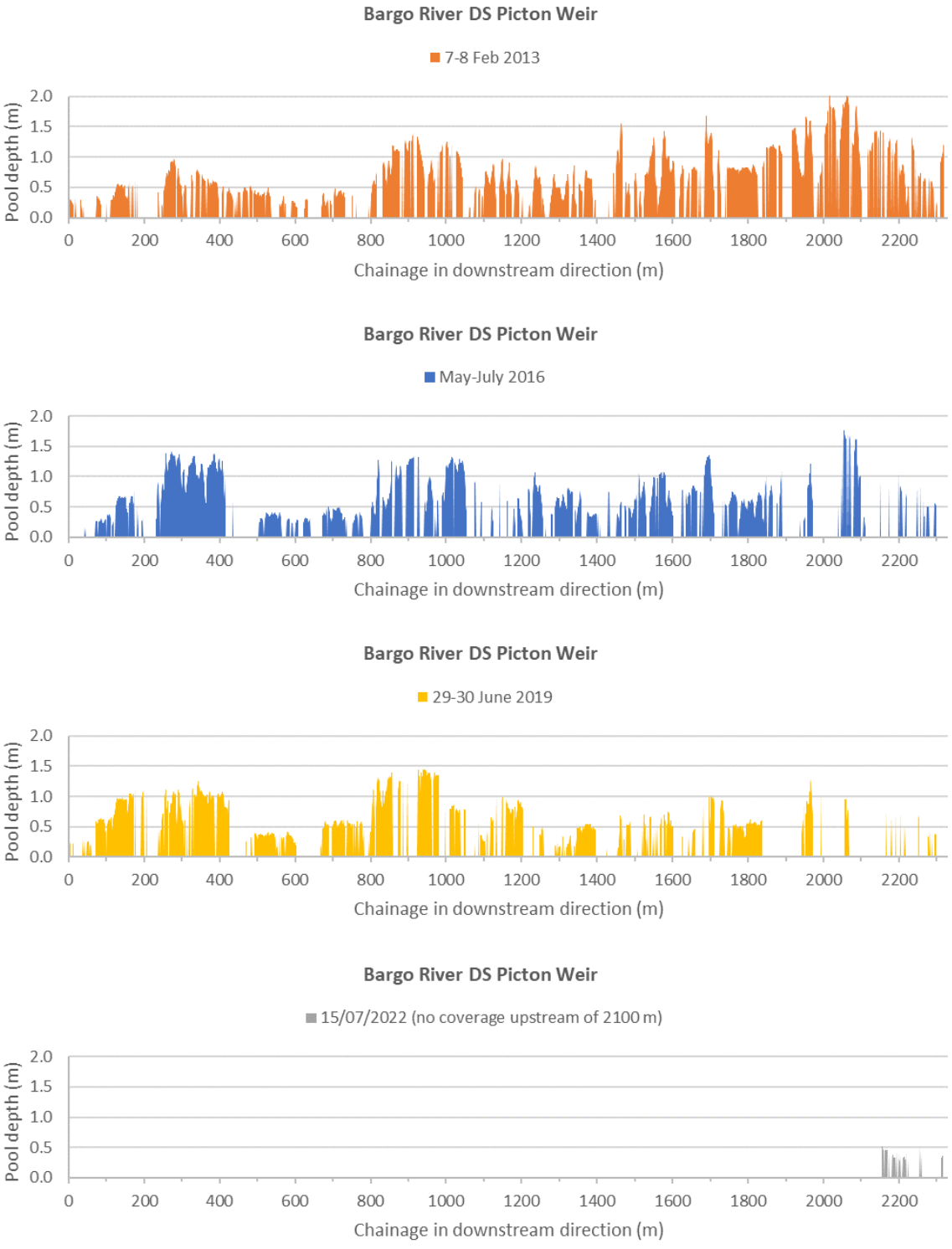



**Figure 26. Downstream pattern of pool cross-sectional maximum depth for Bargo River, using LiDAR-derived 1 m grids from four different dates.**

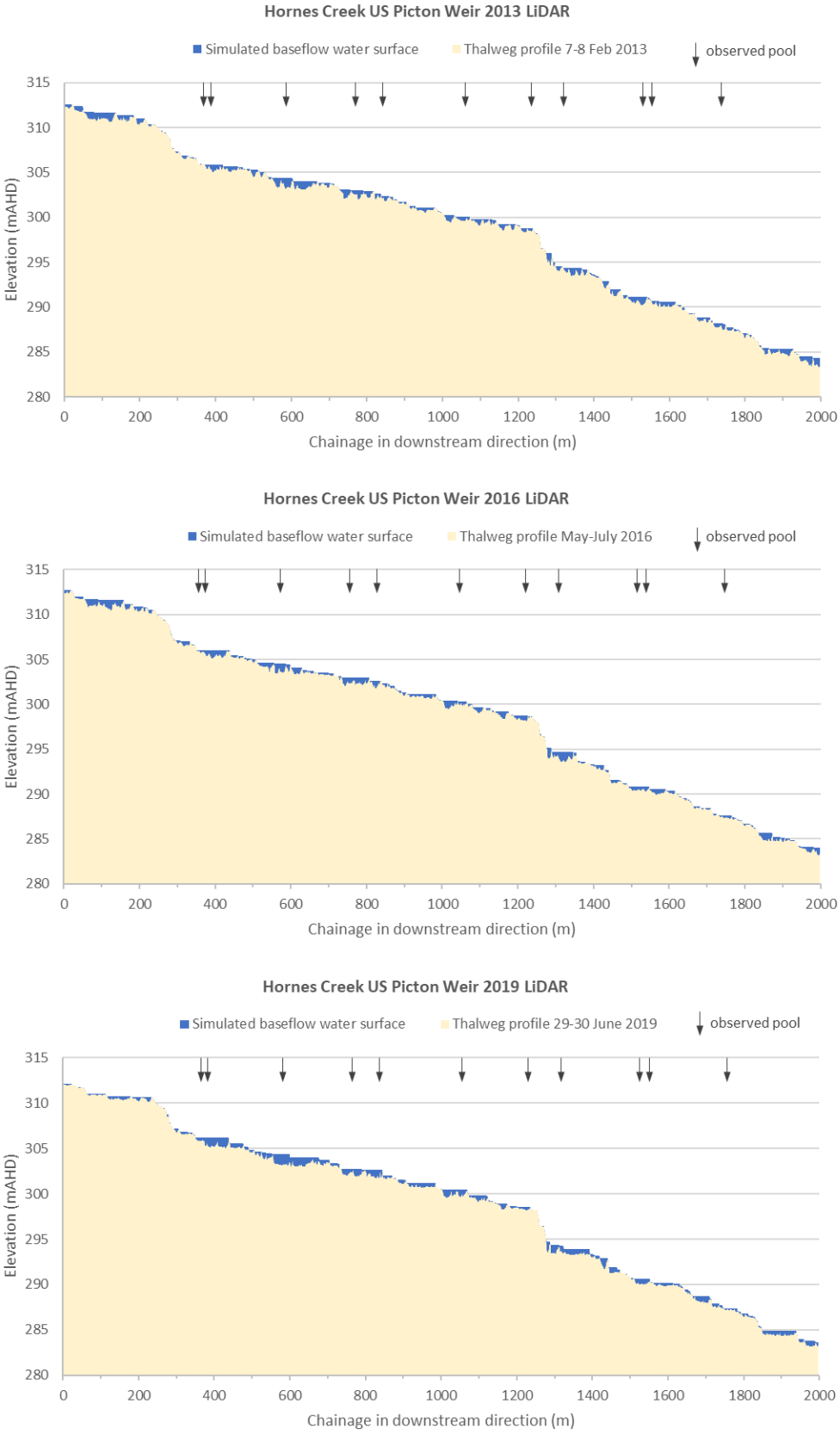
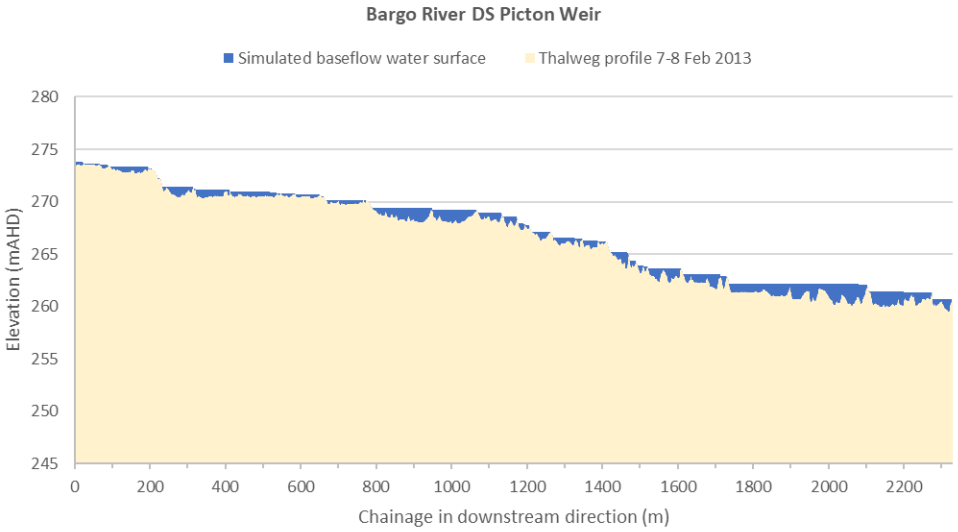
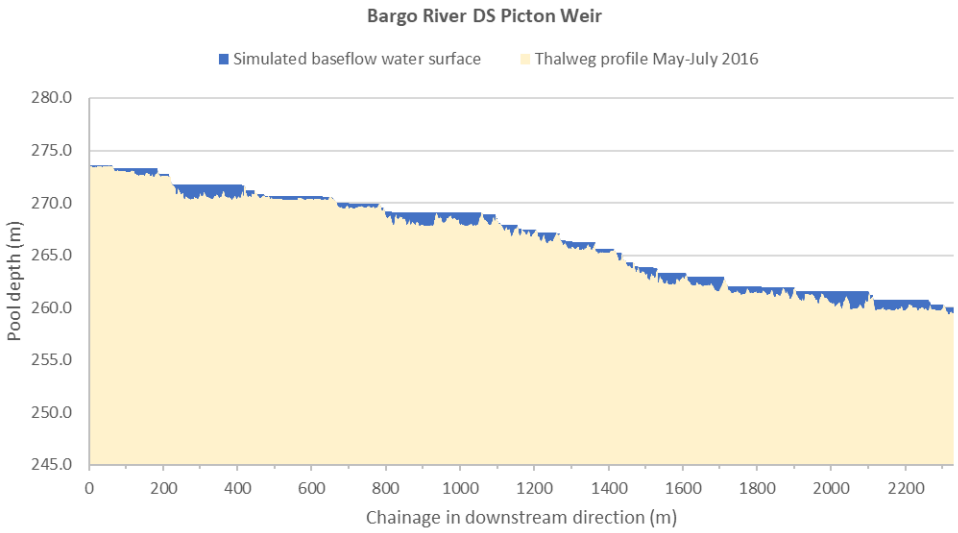



**Figure 27. Longitudinal profile of Hornes Creek, using LiDAR-derived 1 m grids from three different dates.**



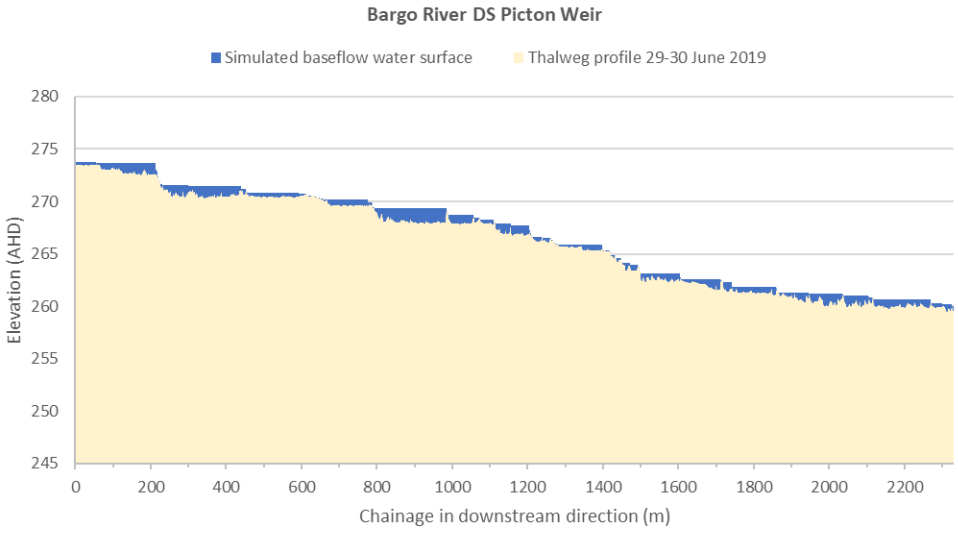




**Figure 28. Longitudinal profile of Bargo River, using LiDAR-derived 1 m grids from three different dates.**

### 3.8.2 Spatial distribution of pool polygons with attributes

A terrain analysis procedure was applied to the 7-8 Feb 2013 LiDAR dataset to automatically derive polygons of every discrete pool on Hornes Creek (Figure 29) and Bargo River (Figure 30). The procedure was not constrained by a minimum pool size criterion, so some pools were formed from a single pixel, 1 square metre in area. If these data are later applied to a situation where a minimum pool size criterion has been established, then the small pools can be discarded from the dataset.

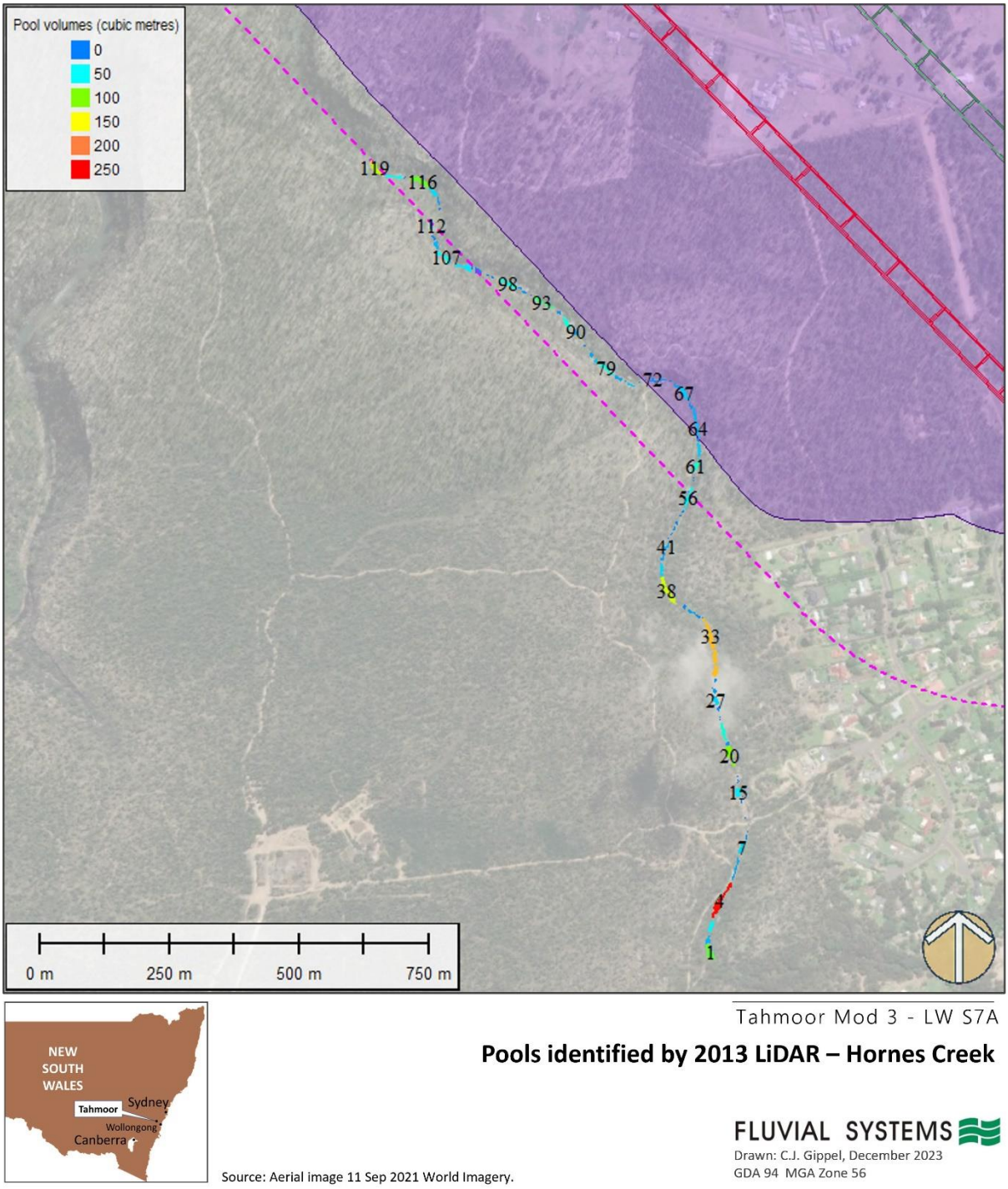



**Figure 29. Distribution of automatically derived pool polygons on Hornes Creek.**

In total, Hornes Creek down to Picton Weir pool, a distance of 2000 m, had 119 discrete pool polygons, and Bargo River from Picton weir to the existing underground workings, a distance of 2330 m, had 37 discrete polygons. Each pool polygon was sequentially numbered for identification, and the attributes surface area, perimeter, maximum depth, and volume were calculated for every polygon.

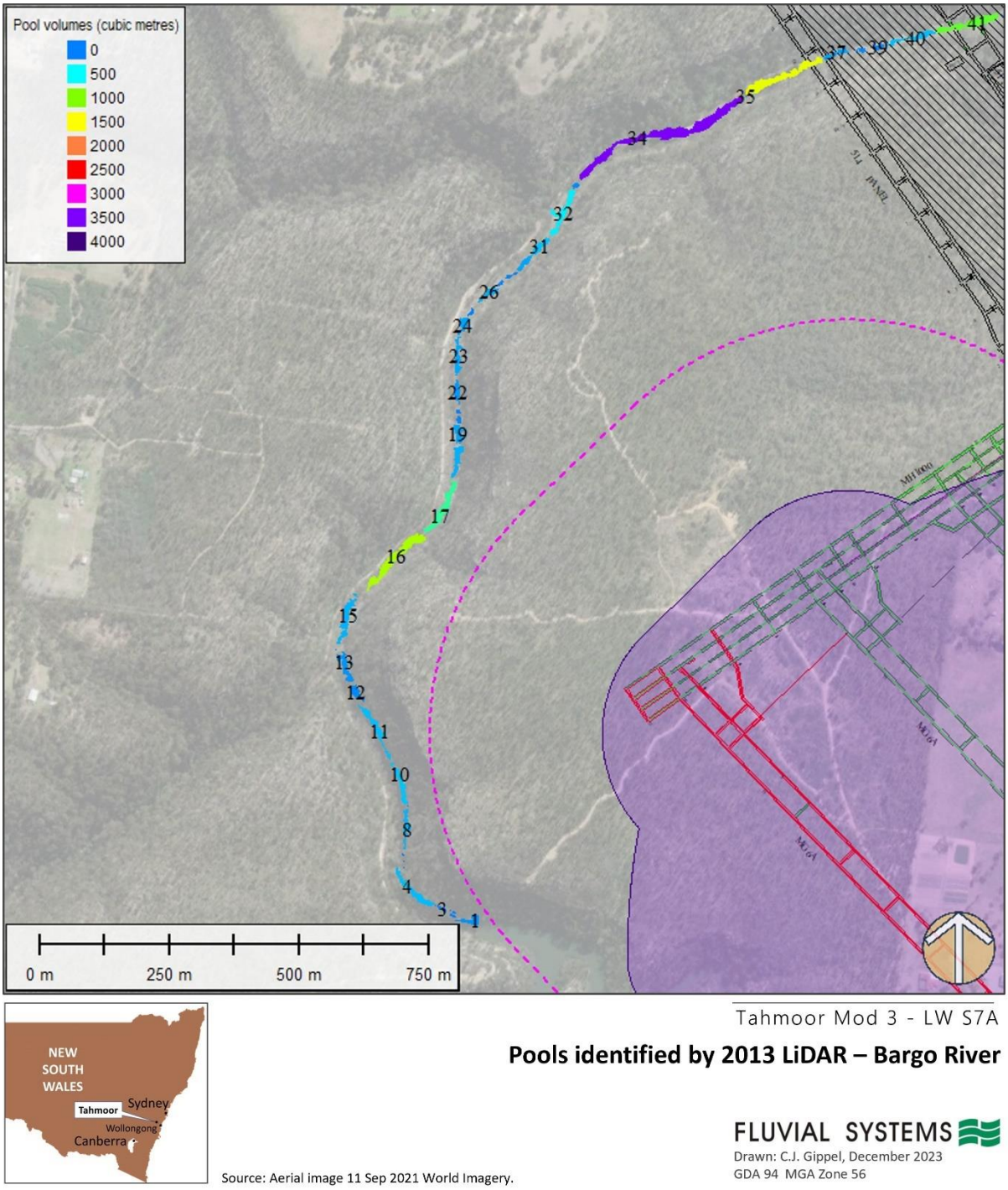



**Figure 30. Distribution of automatically derived pool polygons on Bargo River.**

Histograms were used to statistically describe the distributions of pool attributes (**Error! Reference source not found.** and **Error! Reference source not found.**). The pool maximum depths and volumes should be considered

minimum estimates, as the effect of water in the channel at the time of the LiDAR flight would effectively reduce measured pool depth.

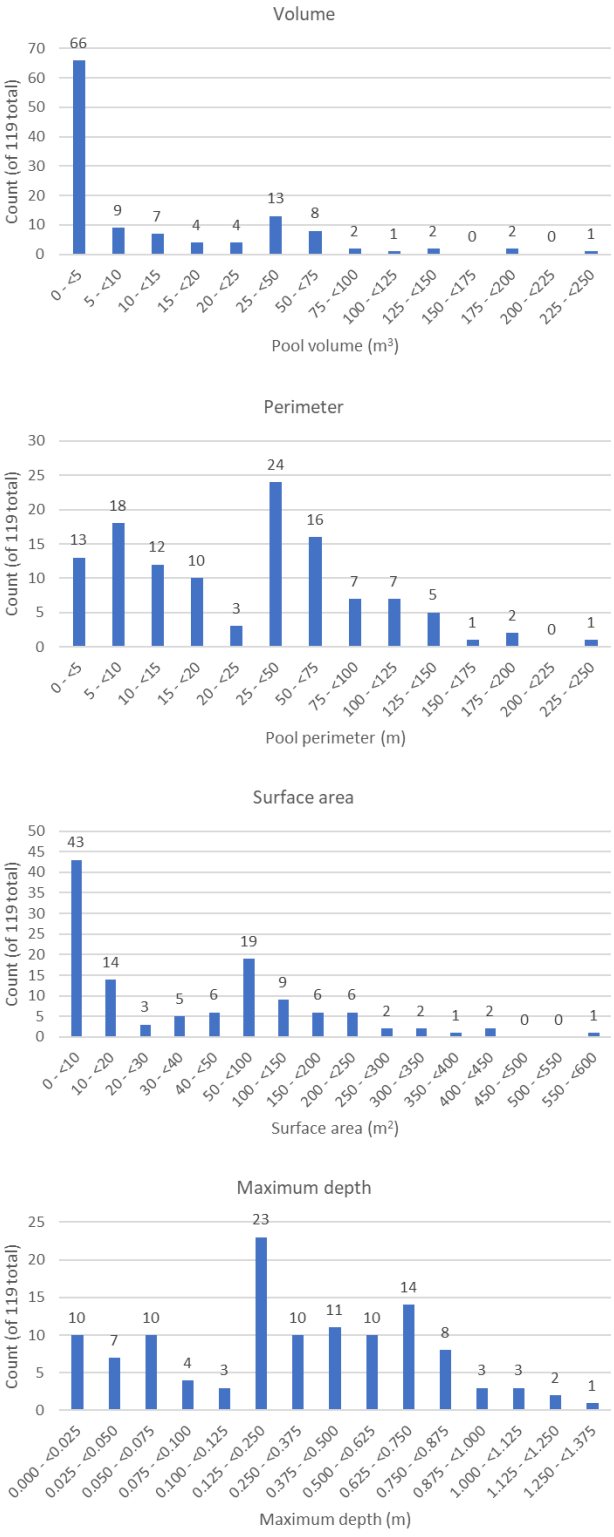



**Figure 31. Statistical descriptions of attributes of pool polygons on Hornes Creek, defined using 2013 LiDAR-derived 1 m grid. N = 119.**

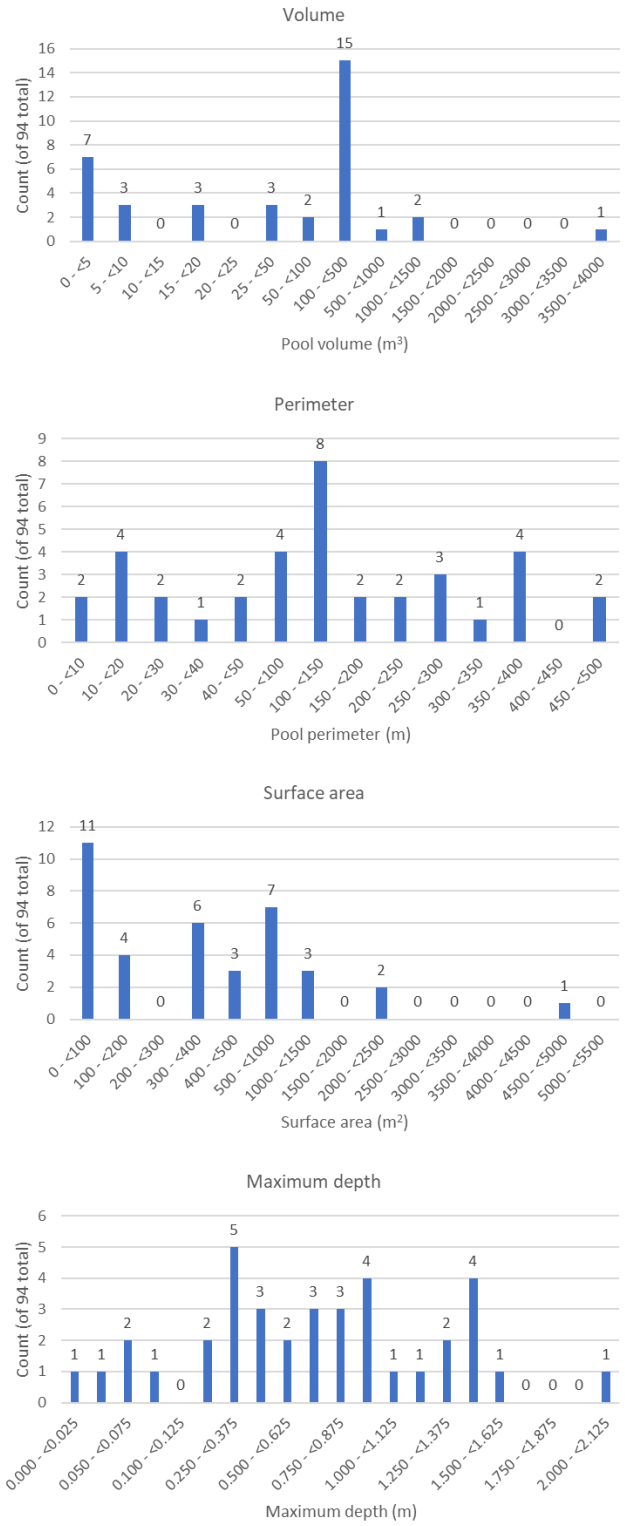



**Figure 32. Statistical descriptions of attributes of pool polygons on Bargo River defined using 2013 LiDAR-derived 1 m grid. N = 37.**

# 4 Impact assessment

The following geomorphic risks were evaluated qualitatively. For additional information on assessment of these and associated risks, refer to reports by other relevant technical specialists.

## 4.1 Events where the risk is constant over the entire Study Area

**1. Change in stream type over management time scales (< 100 years)**

The only stream types occurring in the Study Area were 'Headwater' and 'Gorge'. Cook and Schneider (2006) defined these two types as having 'Low' fragility, which they defined as:

> "*Resilient ('unbreakable'). Minimal or no adjustment potential. Only minor changes occur such as bedform alteration and the Style or sub-Style never changes to another one regardless of the level of damaging impact*"

Furthermore, Nanson and Young (1983) noted that streams in the Sydney Basin "…*are stable on resistant bedrock*". Thus, the likelihood of a change in stream type, either irreversible or reversible, is rare.

If such an event were to occur, it would be localised and affect 'Headwater' rather than 'Gorge' stream type, with 'Headwater' changing to 'Cut and Fill' (Cook and Schneider, 2006). Such a change would be reversible with management action, so the consequence would be minor.

**2. Change of alignment of channel**

The streams in the Study Area are all confined by valleys, with beds and banks controlled by bedrock or hard regolith. The likelihood of a change of alignment is rare. If such an event were to occur it would only be in small Headwater streams, so the consequence would be minor.

## 4.2 Events where the risk varies over the Study Area

**1. Reduction of existing in-channel pool volume**

The likelihood of a reduction of in-channel pools depends on the extent of mining-induced fracturing of rock bars and rock slabs that form the beds of pools. There is a high probability of at least part of the bed of most pools in the Study Area would have had been formed in bedrock. Fracturing of rock bars that form the hydraulic controls of significant pools would be likely to result in pools holding water for a shorter period of the year, assuming hydrology was unaltered. The potential for fracturing to occur is assessed within the separate subsidence impact assessment.

**2. Formation of new in-channel pool**

The formation of new pools, or deepening of existing pools, would be the result of uneven or differential subsidence. The likelihood of this event occurring depends on the spatial distribution and depth of subsidence. The potential for uneven or differential subsidence is assessed within the separate subsidence impact assessment.

**3. Migration of uncohesive knickpoint upstream at faster than natural rate**

Knickpoints in uncohesive material were not found in Hornes Creek and Bargo River within the Study Area.

**4. Increase of sediment supply to channel**

Sediment supply to the streams in the Study Area seems to be low, evidenced by the generally low accumulation of sediment in the channels. In addition, the streams would be high energy during flood conditions and would have sufficient power to transfer sediment downstream. Most of the stream reaches were either free of loose sediment, or contain boulders, with lesser quantities of cobble gravel, sand and mud present. In reference to cliffs of the Sydney Basin, Nanson and Young (1983) noted that "*The escarpment naturally erodes extremely slowly*" and that "*Non-cliffed sandstone valley walls are stable*". This suggests that rockfall is rare and the talus slopes are stable, which is evidenced (and in turn, assisted) by the dense vegetation cover on the talus. An increase in sediment supply to the channels would require destabilisation of talus slopes through an increase in their slope beyond the angle of repose.

**5. Increase of sediment accumulation in channel**

In reference to streams of the Sydney Basin, Nanson and Young (1983) noted that "*There is very little sediment in storage in channels*", and this was confirmed by the field survey. This observation is explained by the high energy conditions that would occur under storm event (high flow) conditions. The likelihood of increased sediment accumulation in channels would be related to a reduction in stream power below the sediment transport threshold. The likelihood of this would be rare.

**6. Increase of sediment scouring in channel**

The likelihood of an increase in the rate of sediment scouring would normally be linked to a steepening of channel slopes, and increased stream power. However, under existing conditions, sediment transport is very efficient (i.e. most of the readily transportable material is transported), and the majority of stream beds cannot scour because they are bedrock controlled, so there is limited scope for increasing sediment scour. Thus, the likelihood of increased sediment scouring of channels would be rare.

**7. Increase in cover (density) of vegetation on channel bed (baseflow shift from high depth of water to shallow depth)**

Macrophytes were uncommon in streams of the Study Area, explained by the rocky beds and banks, and relatively steep banks on pools, where macrophytes would normally be expected. Also, the streams are high energy, and macrophytes would be frequently disrupted, preventing establishment of large areas of plant cover. The likelihood of significantly increased cover of vegetation on channel beds due to reduced baseflow would be minor.

**8. Decrease in cover (density) of vegetation on channel bed (baseflow shift from shallow depth of water to dry, or from shallow to deep)**

As for a decrease in baseflow, the likelihood of significantly decreased cover of vegetation on channel beds due to increased baseflow would be minor.

**9. Increase in rockfall frequency above natural rate**

The likelihood of a significant increase in the rate of rockfall from cliffs and talus slopes depends on the spatial distribution and depth of subsidence.

# 5 Safeguards and management

## 5.1 Monitoring

The foundation of geomorphological monitoring is periodically repeated high resolution LiDAR survey, undertaken during dry conditions when there is increased chance of ground strike. Visual inspections and photographic surveys supplement LiDAR survey, but they are limited in their coverage and detail, and involve subjectivity.

Permanent reference points for regular photographic recording were established in the 2013 survey, and the present survey attempted to repeat the 2013 survey. This proved difficult in some locations due to high relief terrain and tall trees impairing GPS signal, and access difficulties. Nevertheless, this approach is worth pursuing. It is not feasible to monument or tag the photopoint locations due to restricted visibility within dense vegetation and likelihood of tags being moved under high flow conditions. Photographs must be assessed, and then reported on, by a professional geomorphologist. It is difficult to assess photographs in isolation, so to put the photographs in context, the geomorphologist will need to undertake supplementary investigations.

This report provides a second set of data for the baseline geomorphic condition of streams in the Study Area, the first set being collected in 2013. The methodology used in this report to survey geomorphic characteristics is in most respects repeatable, and as such, the geomorphological survey undertaken for this report should be repeated after mining to identify potential impacts associated with subsidence. Visual field investigation is the most subjective component of monitoring, and it should be supplemented by analysis of spatial datasets and other relevant data.

The geomorphic response to subsidence is likely to be slow, so a frequency of five years for a Study Area-wide re-survey and reporting of stream geomorphological condition is suggested, or alternatively, following mining of LWS7A.

## 5.2 Safeguards and management measures

Mitigation is to eliminate or reduce the frequency, magnitude, or severity of exposure to risks, or to minimise the potential impact of a threat. Given the resilient and resistant steam type found in the Study Area, and the distance of the streams from significant mine subsidence related processes, subsidence was considered to pose a negligible risk to stream geomorphology. Given that no particular impacts are expected, specific management approaches to mitigating possible future impacts are not suggested here.

# 6 Conclusion

This report documented the geomorphological character of Bargo River and Hornes Creek in the Study Area. The report used repeatable methods which were fully described. The data described the benchmark condition from which the future geomorphic condition of the streams in the Study Area can be compared.

The streams assessed in this report comprised one geomorphic type, ‘Gorge’. The streams were geomorphologically resistant and resilient because of the common presence of bedrock in the stream beds, and the confined setting of the valleys (i.e. no alluvial floodplains were present). Thus, mining is not expected to present a significant risk to change in geomorphic character of the streams. Any changes that do occur would be expected to recover quickly because the streams have ‘Low’ fragility (i.e. resilient) and in are in ‘Good’ geomorphic condition (i.e. essentially natural with intact form and process). Evidence was found that the streams underwent little if any structural change in response to the 2019/2020 bushfires followed by a sequence of large floods in 2021 and 2022.

The risks to geomorphic stream form and process associated with subsidence were qualitatively assessed. Overall, the risk of change to geomorphic character due to subsidence was judged to be negligible.

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# 8 Appendix 1. Photographs of field sites in 2013 and 2023

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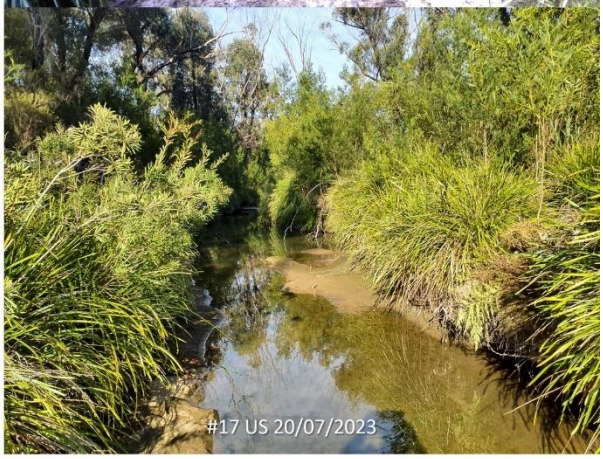
#17 US 14/02/2013

#17 DS 20/07/2023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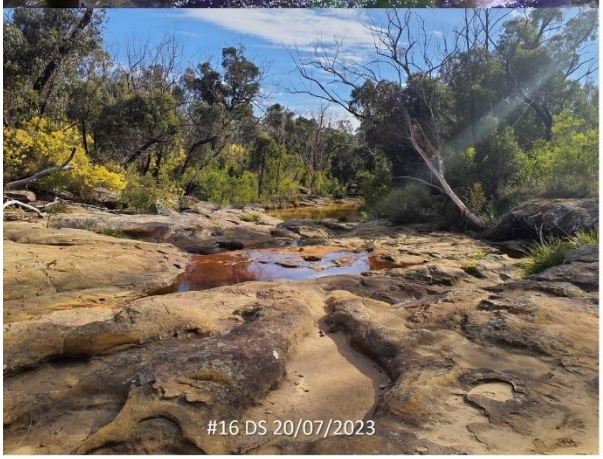
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#18 US 14/02/2013

#18 DS 20/07/2023

#18 US 20/07/2023

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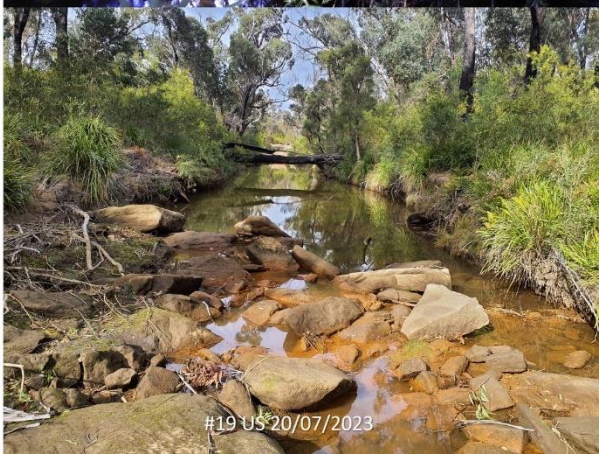
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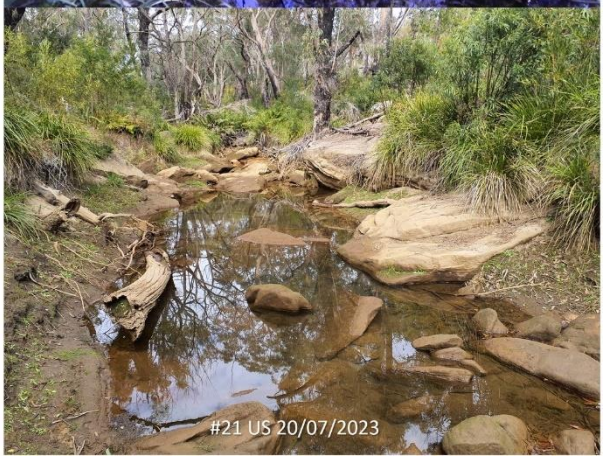

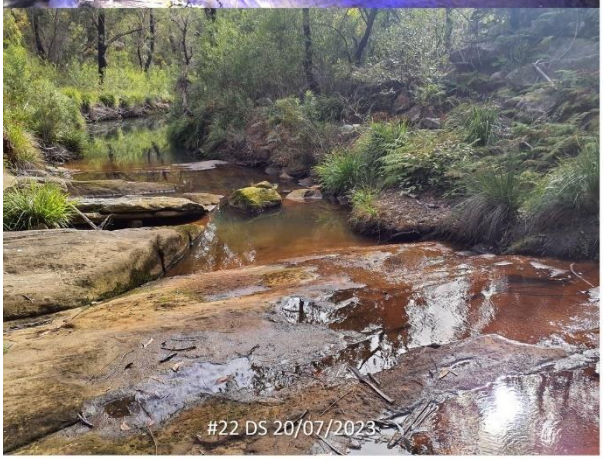


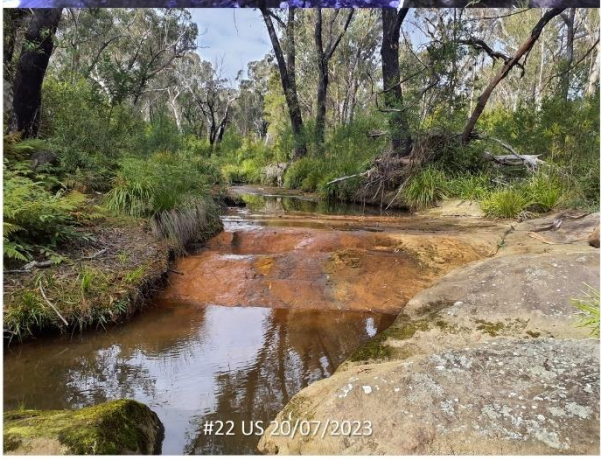

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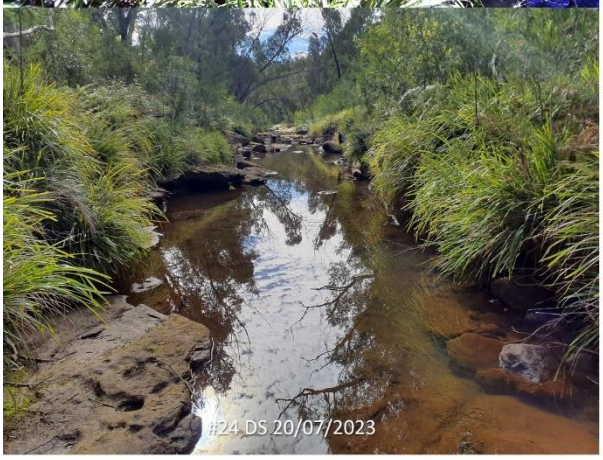
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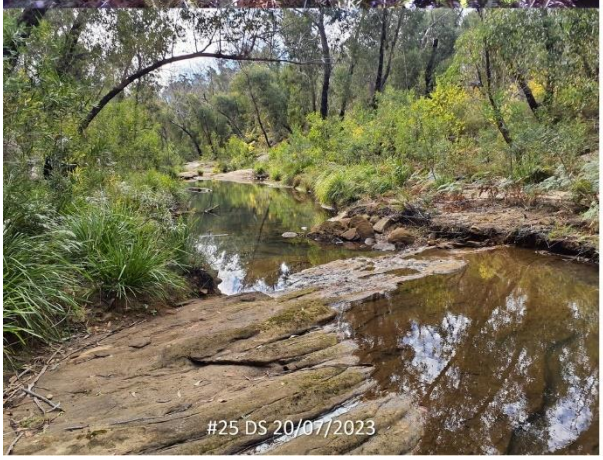
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#26 US 14/02/2013

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#26 US 20/07/2023

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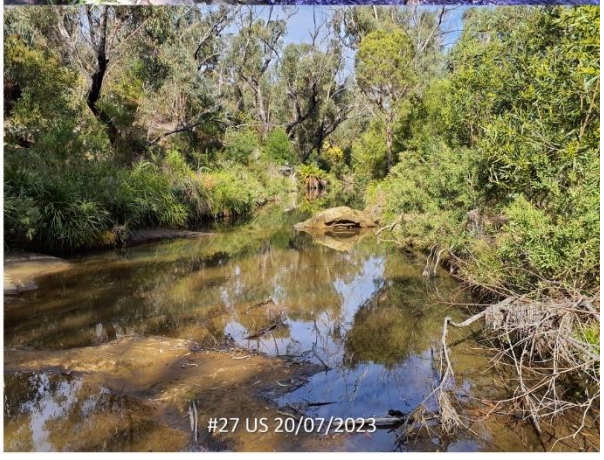
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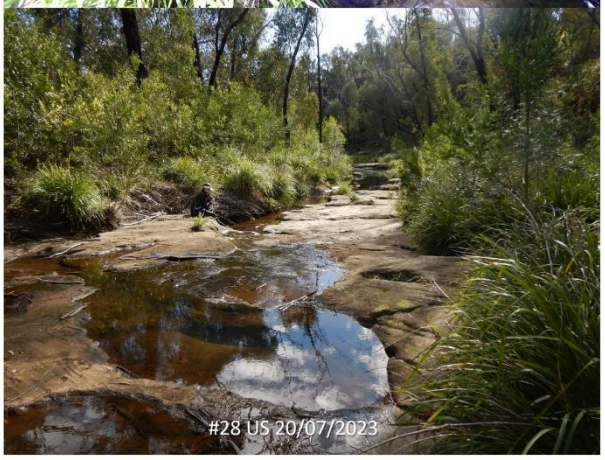
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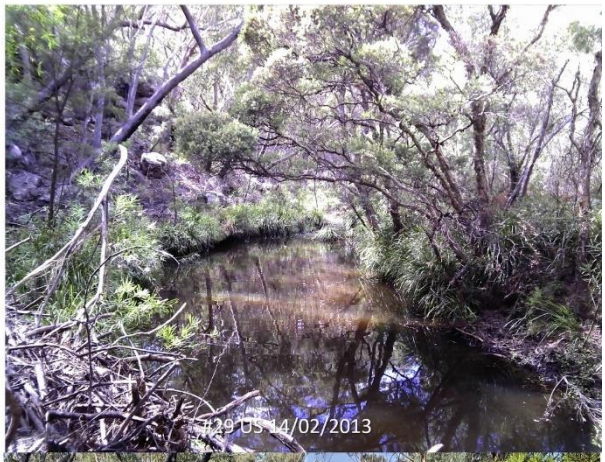
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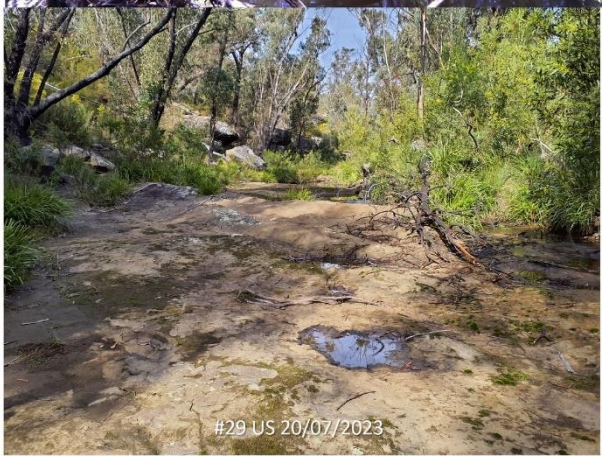
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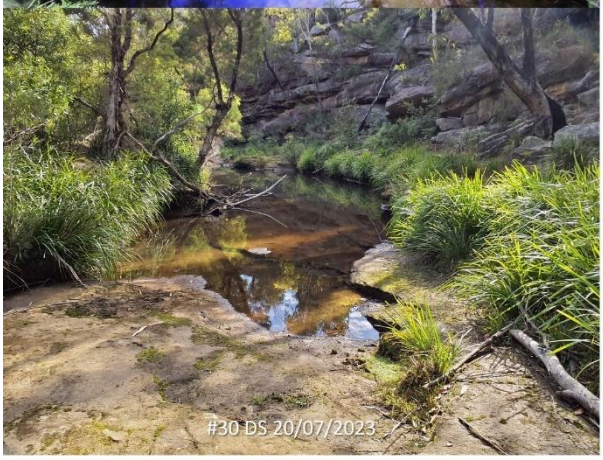
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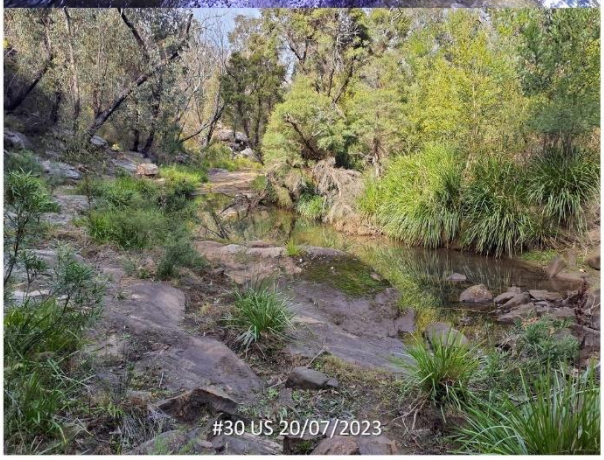
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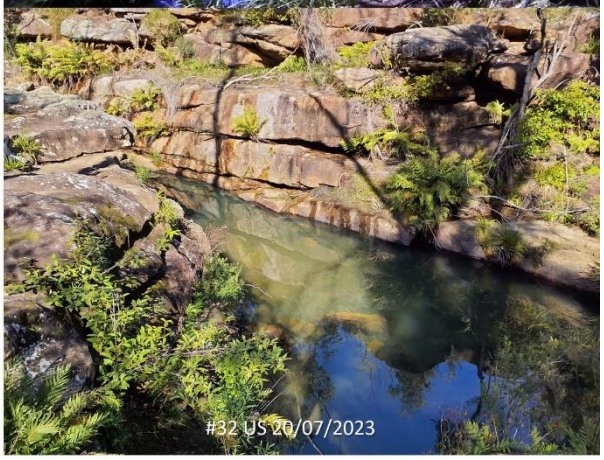
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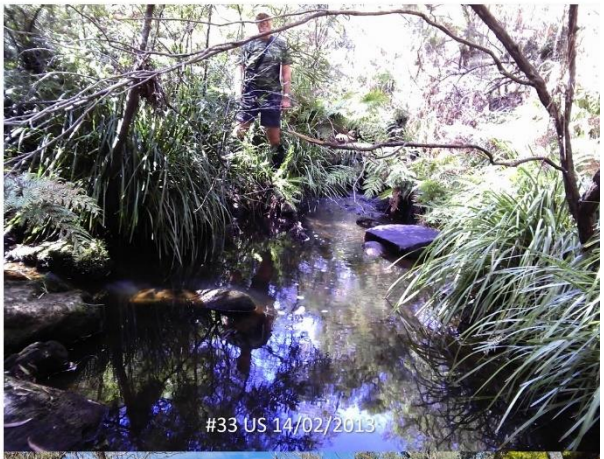
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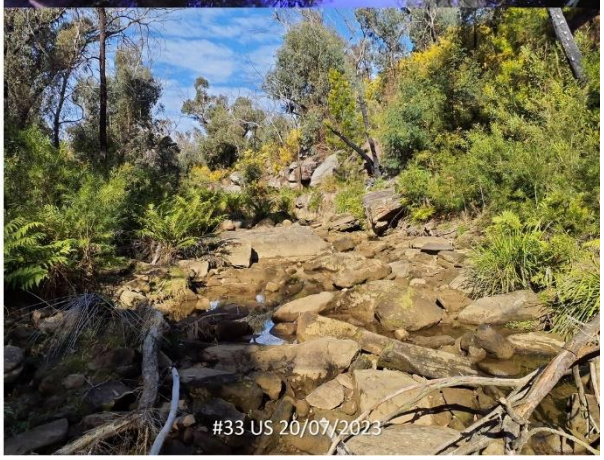
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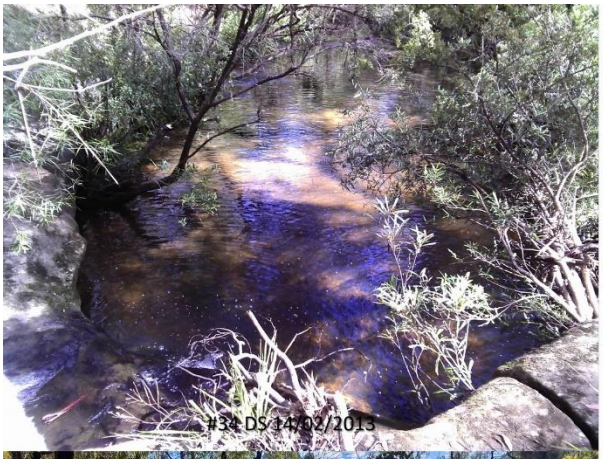
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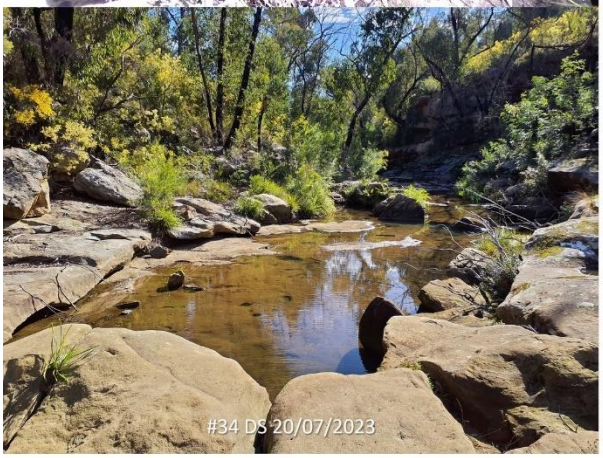
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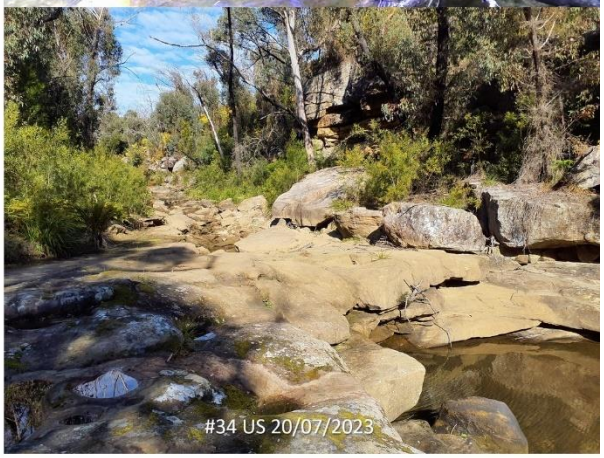
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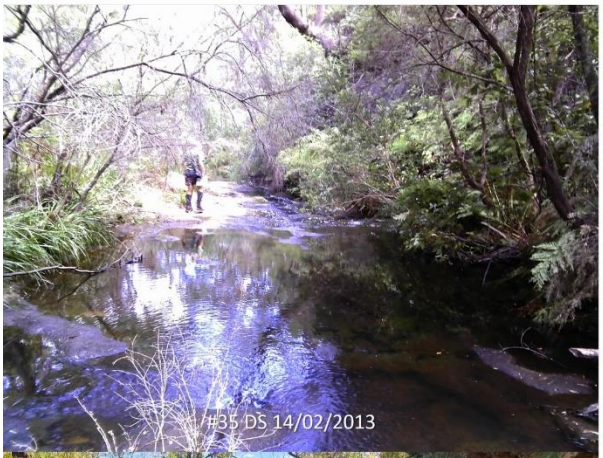
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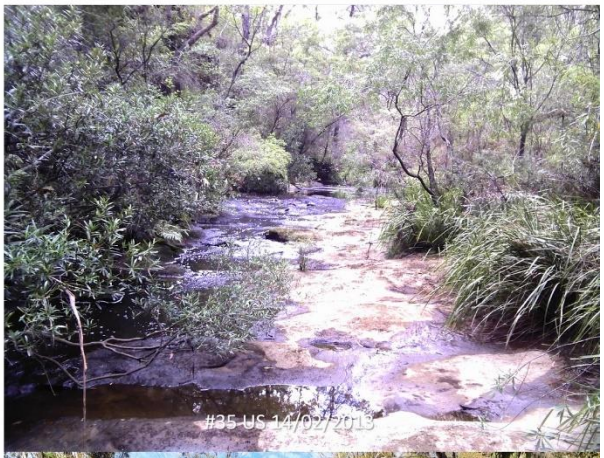
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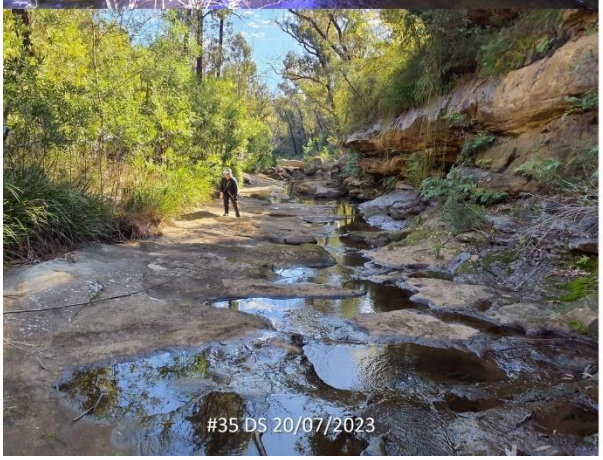
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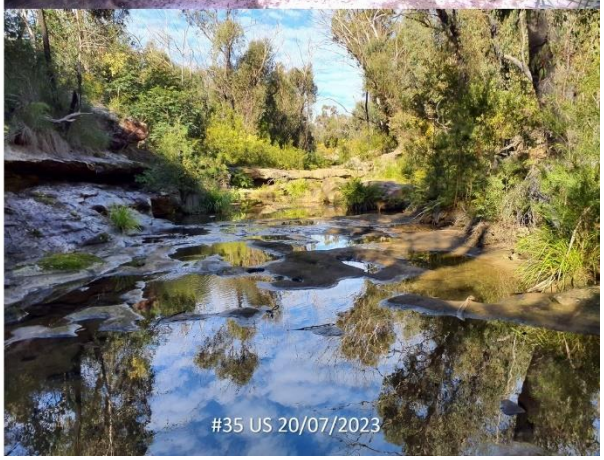
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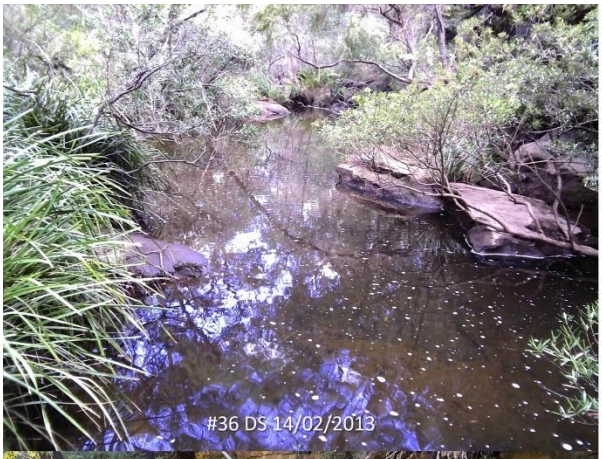
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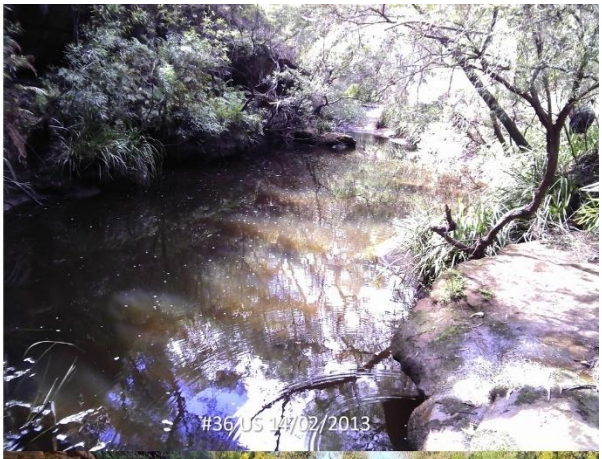
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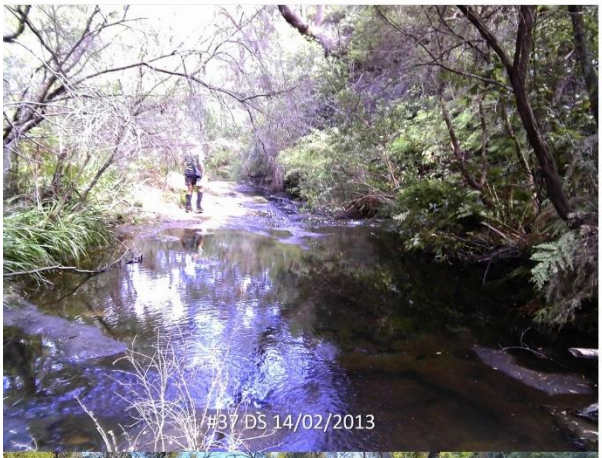
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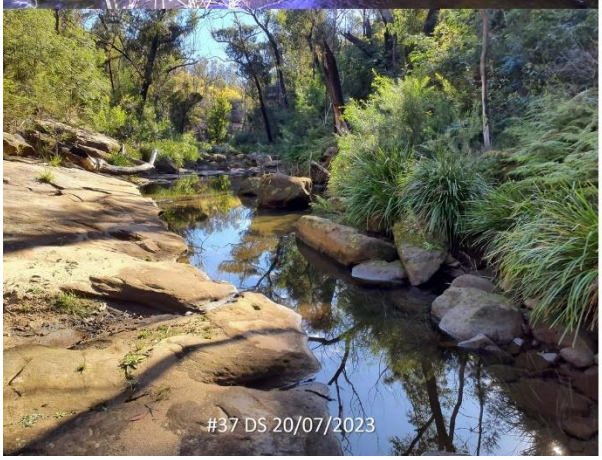
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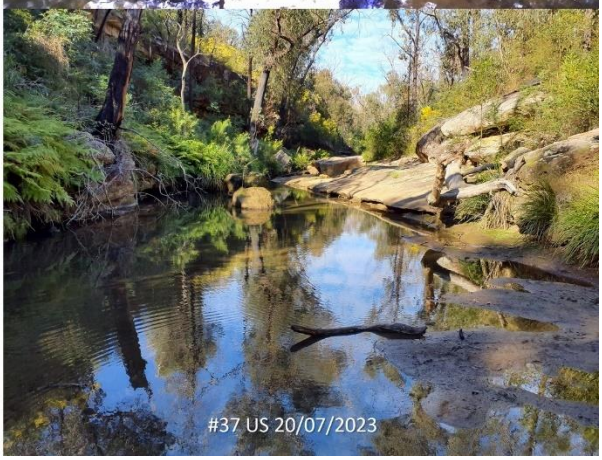
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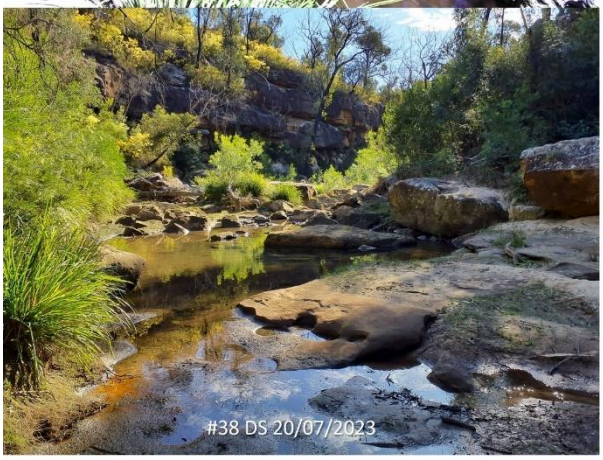
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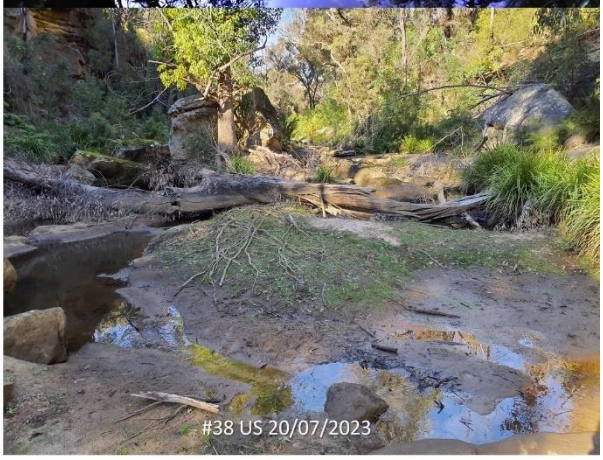
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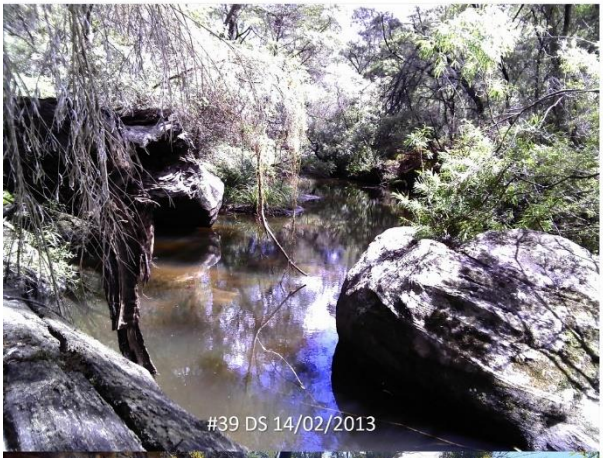
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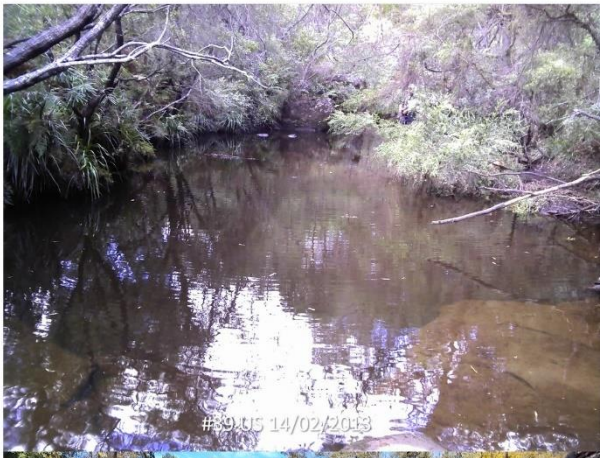
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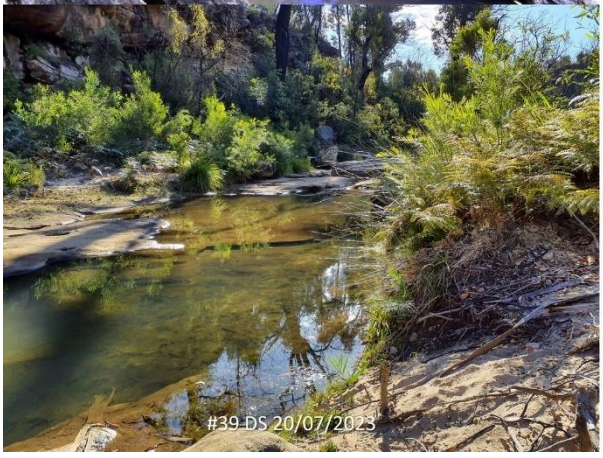
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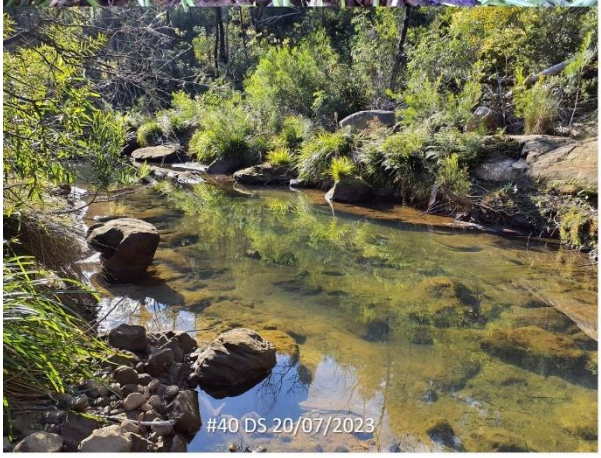
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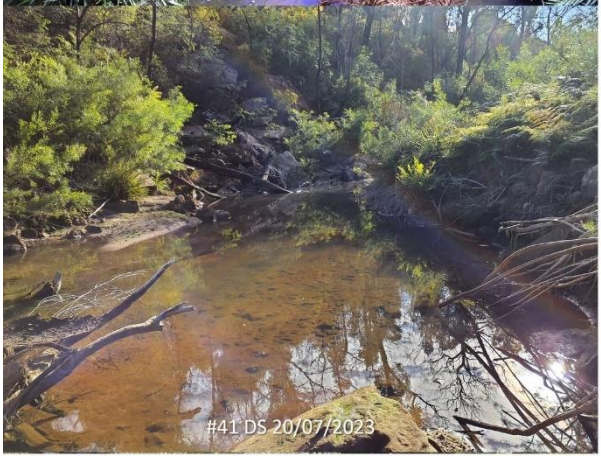
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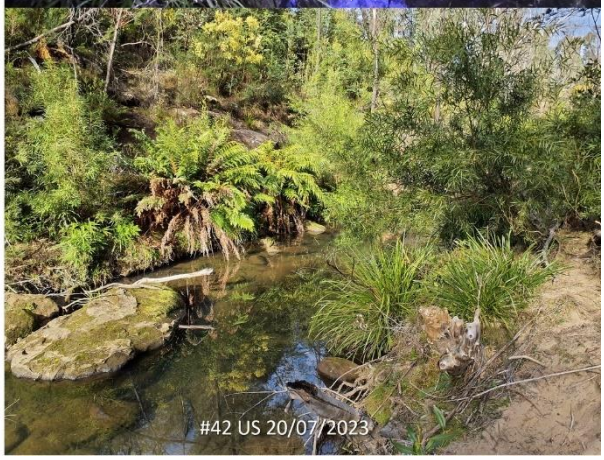
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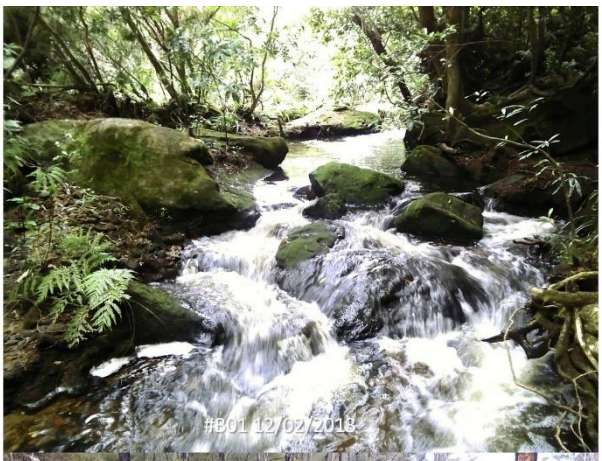
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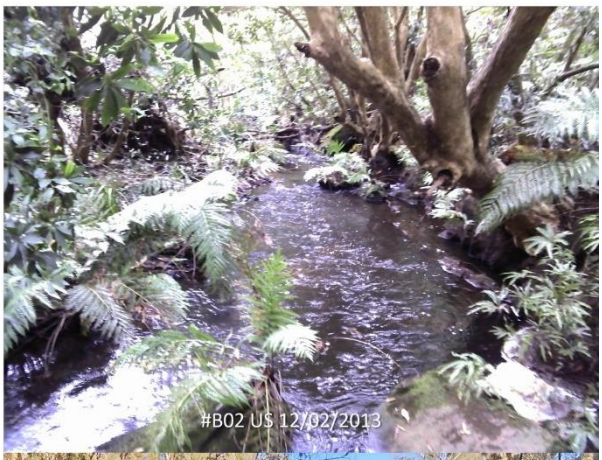
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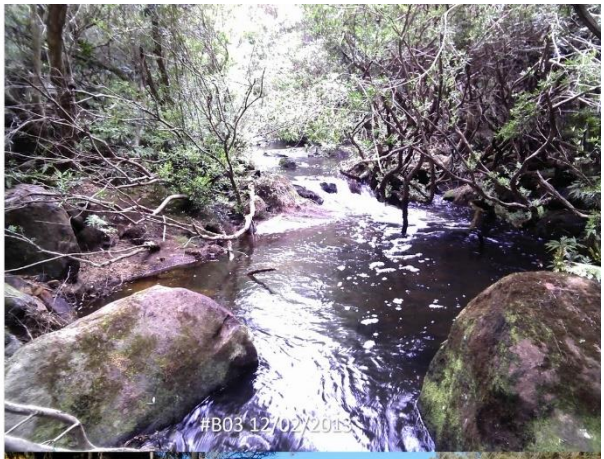
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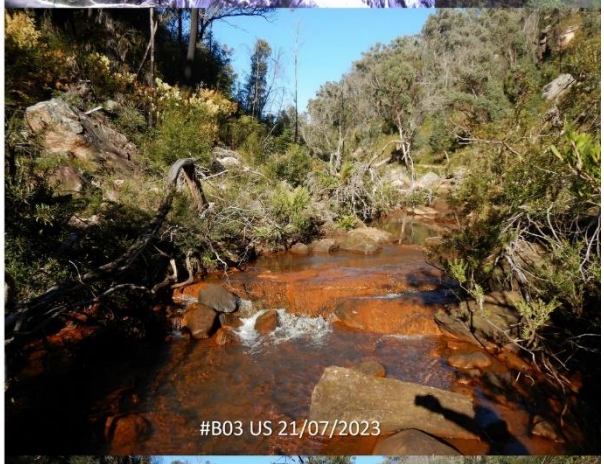
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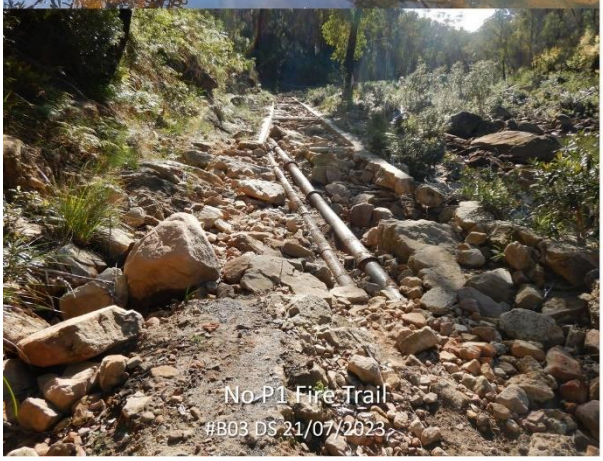
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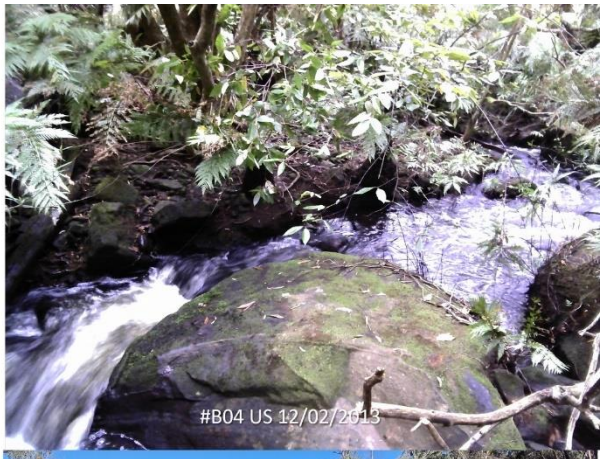
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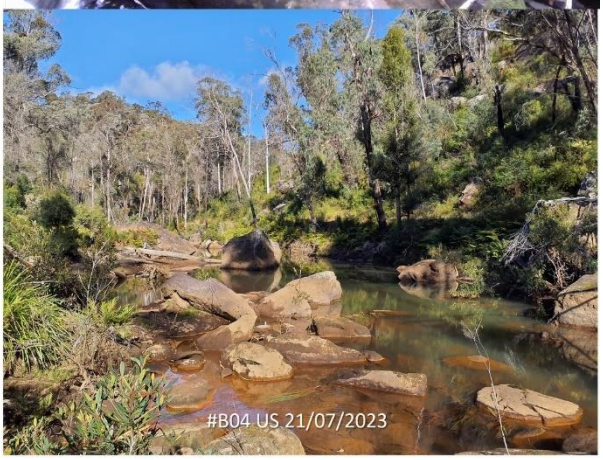
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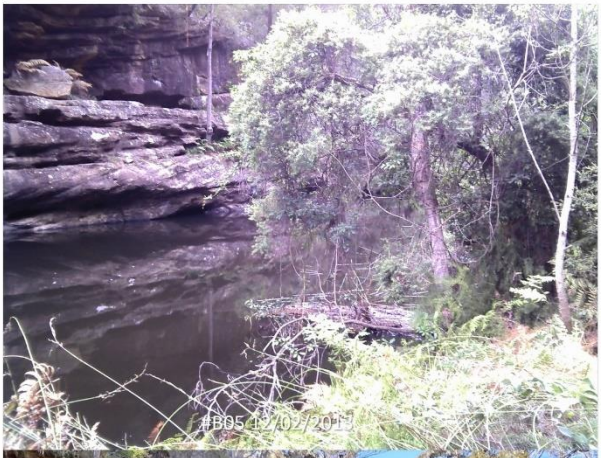
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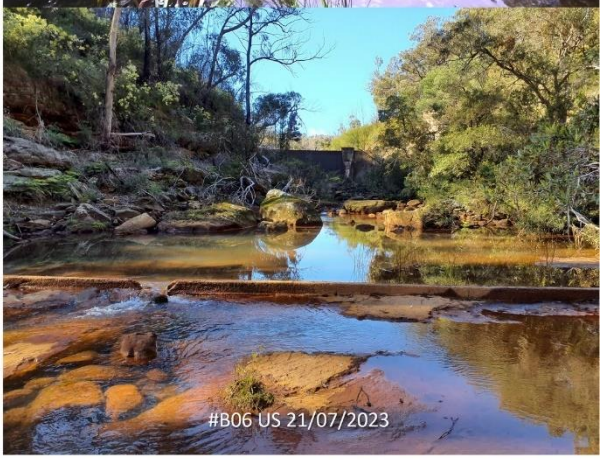
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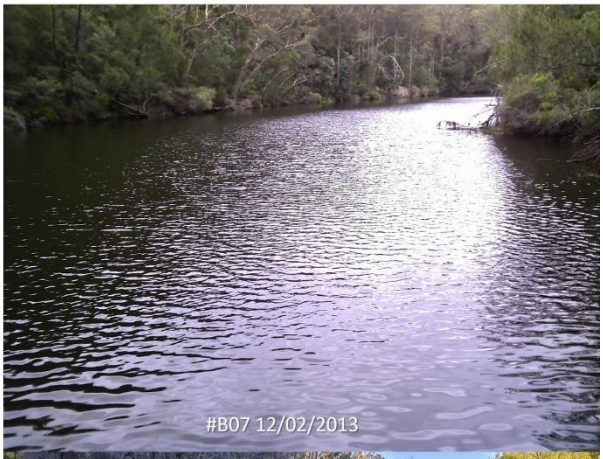
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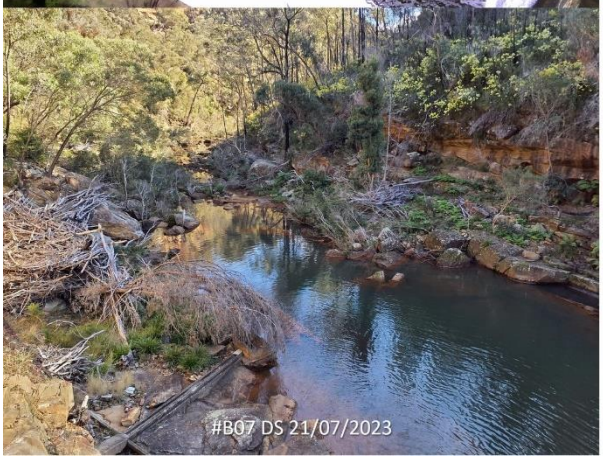
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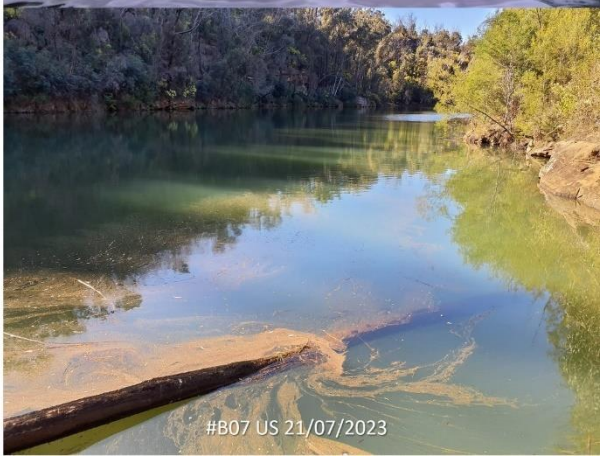
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# Appendix F
## Surface water impact assessment

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# REPORT

**TAHMOOR COAL PTY LTD**
ABN: 97 076 663 968

**Tahmoor South SSD 8445**
**Modification 3**

**Surface Water Assessment**

121171-23R001-rev0
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# 1 INTRODUCTION

## 1.1 Background

Tahmoor Coal Pty Ltd (Tahmoor Coal) owns and operates the Tahmoor Mine, an existing underground coal mine located approximately 80 kilometres (km) south-west of Sydney. The Tahmoor Mine is located within the Wollondilly Shire Council (WSC) Local Government Area (LGA). Underground workings extend north under the towns of Tahmoor and Picton with two ventilation shafts located on the outskirts of Tahmoor. The location of the Tahmoor Mine in the regional context is shown in **Map 1.**

The Tahmoor South Project (the Project) was approved on 23 April 2021 by the Independent Planning Commission (IPC), enabling an extension of mining operations at the Tahmoor Mine until 31 December 2033 or until 10 years from the commencement of second workings, whichever is the sooner. Development Consent SSD 8445 permits extraction and processing of up to 4 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal from the Bulli Seam.

Two modifications to Development Consent SSD 8445 have been approved as follows:

- Modification 1: authorising an extension of time to 31 December 2023 for commissioning of a Water Treatment Plant.
- Modification 2: authorising the transfer of brine from the Water Treatment Plant and storage of the brine in underground historical workings (Tahmoor North Western Domain Longwalls W1-W4 – refer **Map 2**).

The approved longwalls authorised by SSD 8445 are shown on **Map 3** and include the A series, Longwalls South 1A-6A (LW S1A-S6A) and the B series, Longwalls South 1B-6B (LW S1B-S6B). **Map 3** shows the predicted 20 millimetre (mm) subsidence contour associated with the approved Tahmoor South A series longwalls (A Series Subsidence Area). Extraction of LW S1A commenced on 18 October 2022, with mining of LW S3A progressing as at the time of writing.

## 1.2 Proposed Modification

Tahmoor Coal is seeking to modify SSD 8445 (Modification 3) under Section 4.55(2) of the Environmental Planning and Assessment 1979 (EP&A Act) to authorise:

- An additional longwall panel (LW S7A) to the approved A series longwall panel layout.
- Removal of restrictions imposed by Condition A6 on the requirement for mining to be completed within 10 years following commencement of second workings in the Tahmoor South mining area.
- An increase in the maximum tonnage of ROM coal that can be extracted and processed on site from 33 million tonnes (Mt), as currently authorised by Condition A11(b) of SSD 8445, to 35 Mt.

The location of proposed LW S7A and the Study Area associated with Modification 3 (the Modification) are shown on **Map 3**. The Study Area has been defined as the zone of predicted subsidence effects associated with mining of LW S7A in excess of that currently approved for LW S1A-S6A. **Map 3** also shows the 600 metre (m) Study Area for natural features (600 m buffer from LW S7A).

The Modification would comprise no change to:

- The annual ROM coal extraction limit of 4 Mtpa.
- The mining method, coal reject management method or the mine water management methods.
- The method of material transportation via road or rail.
- The brine storage method.

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## 1.3 Assessment Scope

As a component of the Modification application, ATC Williams Pty Ltd (ATCW) was commissioned by Tahmoor Coal to prepare a Surface Water Assessment (SWA). The scope of the SWA comprised:

1. Review of the environmental management performance of the Project in relation to surface water and water resources.
2. Operational water and salt balance modelling of the Tahmoor Mine water management system to reflect the proposed Modification.
3. A flood study to assess the potential cumulative effect of mining of LW S1A-S7A on localised flooding.
4. Assessment of the potential impacts of the proposed Modification on the quantity and quality of surface water resources.
5. Review of the existing surface water monitoring, management and mitigation strategies and provision of relevant recommendations.

The outcomes of the assessment are detailed herein.



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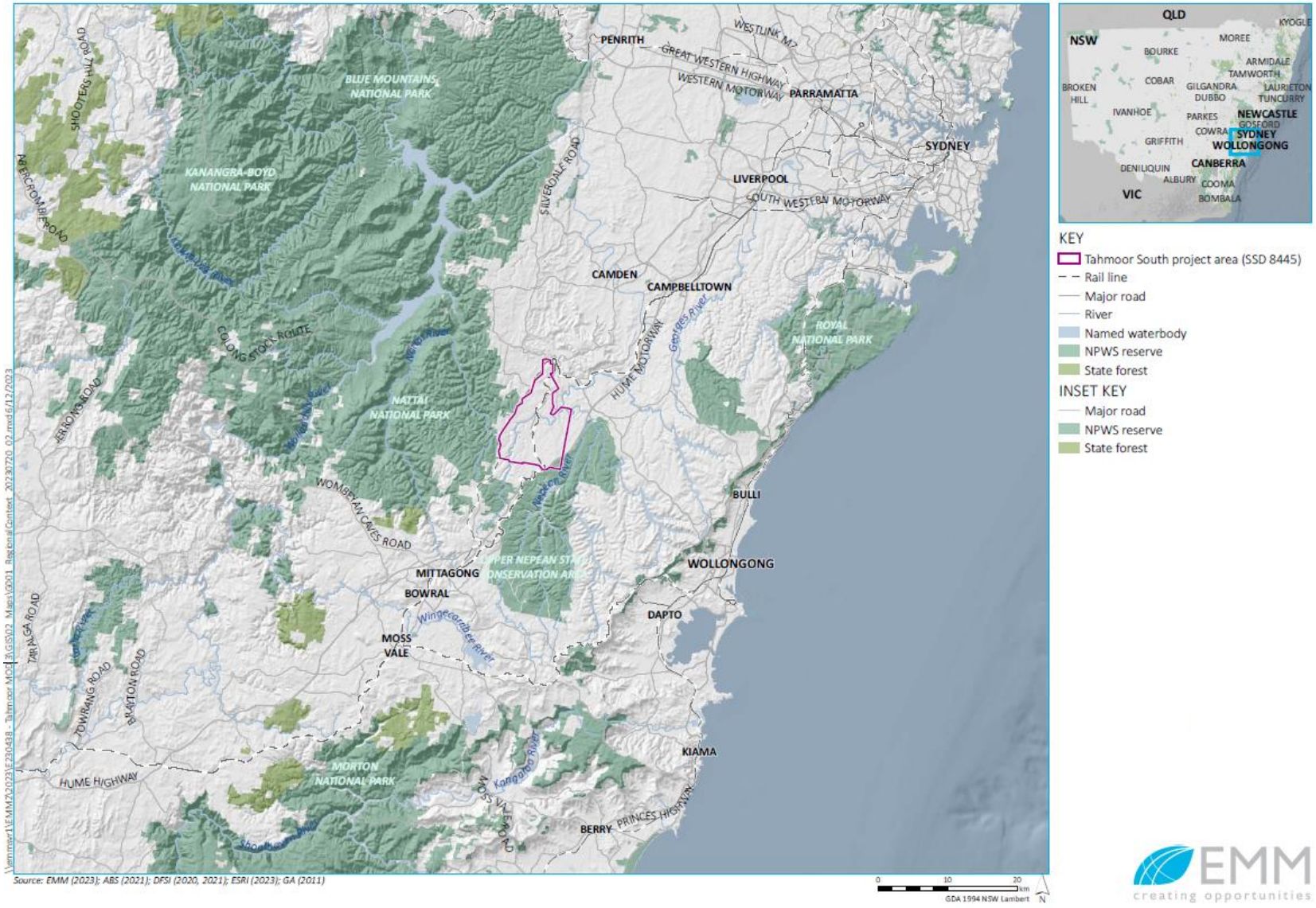
## MAP 1: REGIONAL CONTEXT

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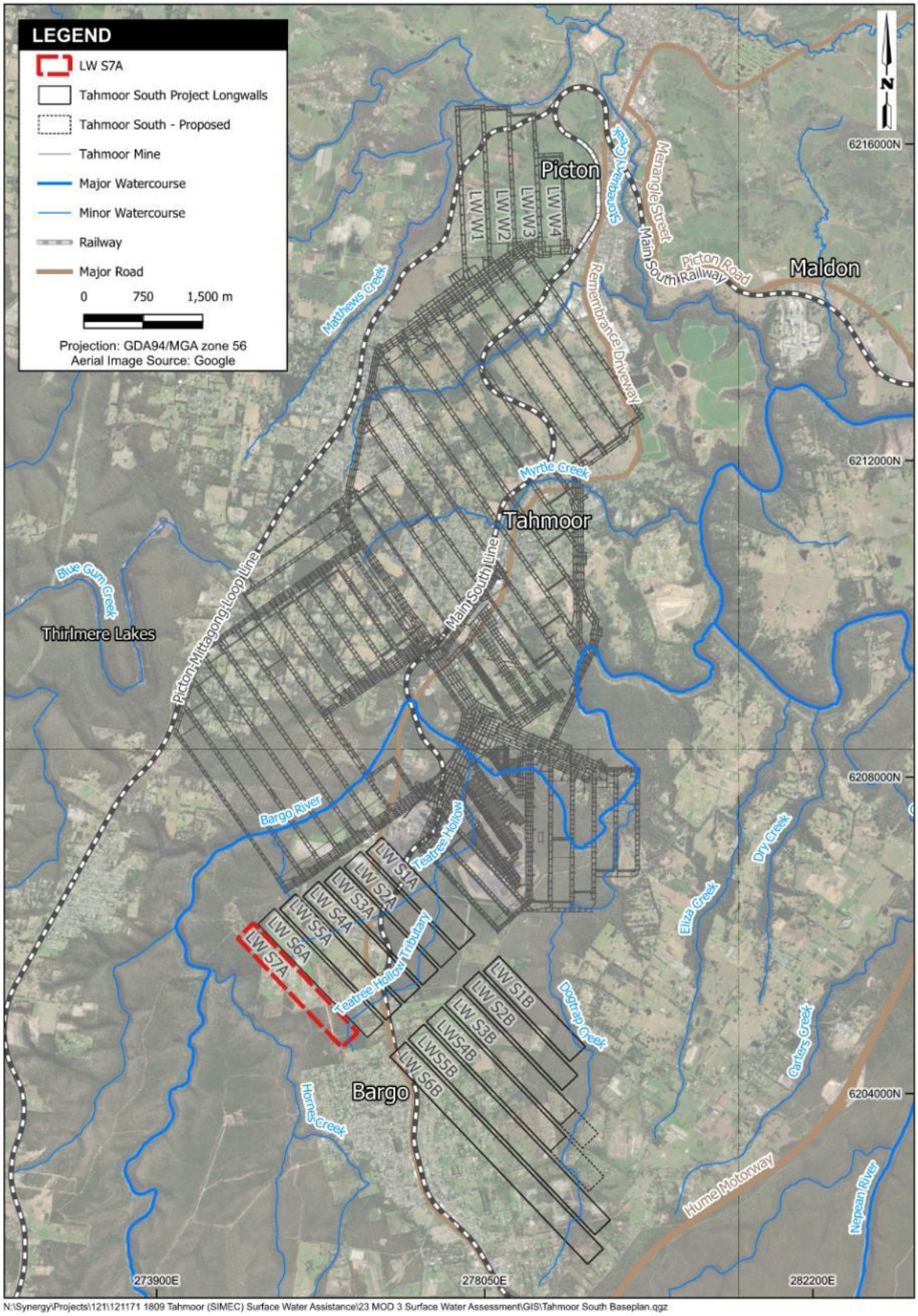
## MAP 2: TAHMOOR SOUTH PROJECT AND MODIFICATION LAYOUT

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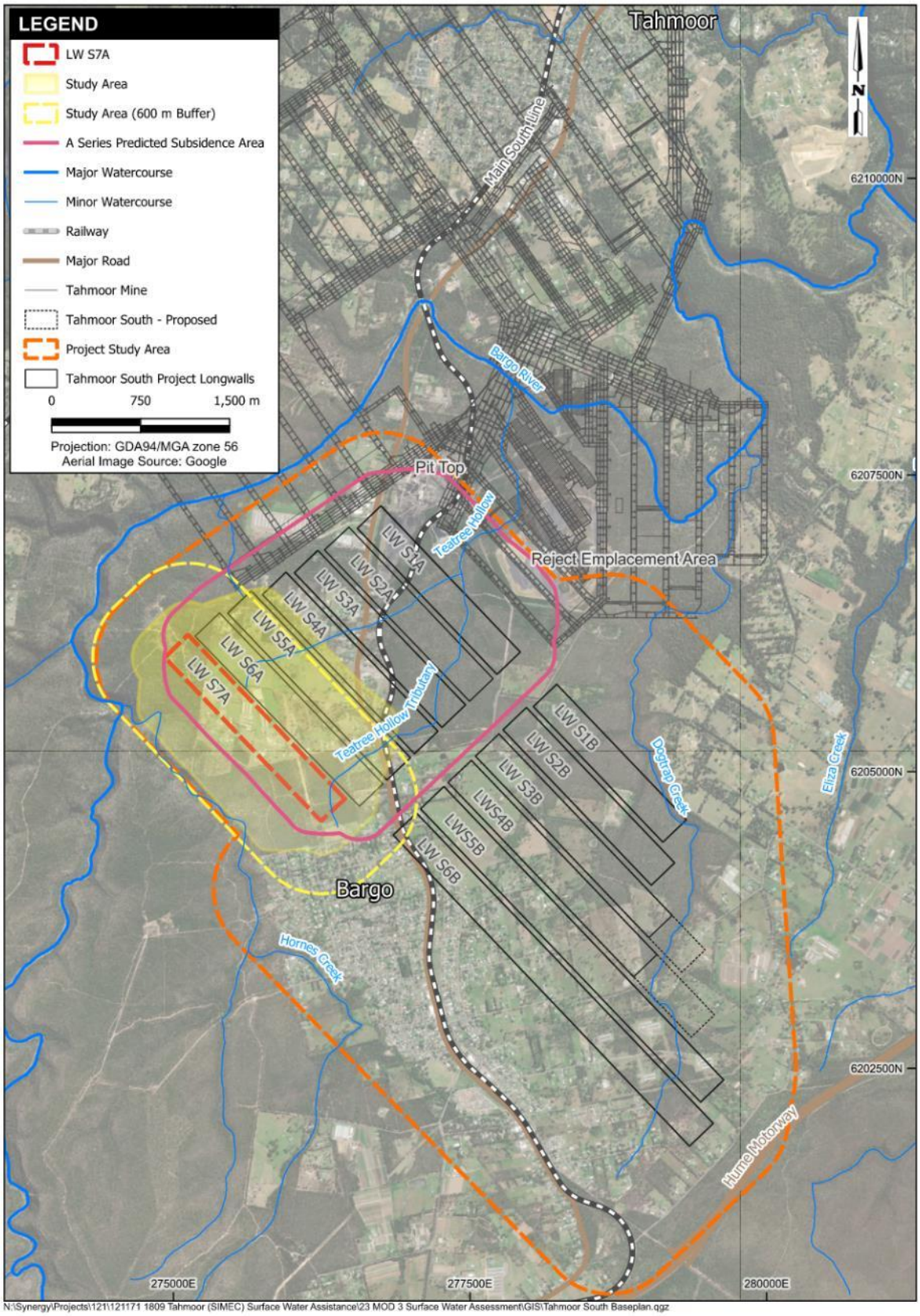
## MAP 3: MODIFICATION STUDY AREA



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# 2 SURFACE WATER RESOURCES AND REVIEW OF ENVIRONMENTAL PERFORMANCE

## 2.1 Regional Overview

The Study Area is situated within the Bargo River catchment (refer **Map 4**). The headwaters of the Bargo River rise approximately 18 km to the south of the Tahmoor Mine. The confluence of the Bargo River and the Nepean River is located approximately 9 km downstream of the Tahmoor Mine.

The Nepean River flows to the east of the Tahmoor Mine, with its headwaters rising in the coastal ranges to the south of the Tahmoor Mine. Streamflow in the Nepean River near the Tahmoor Mine is highly regulated by the Upper Nepean Water Supply Scheme, operated by WaterNSW, which incorporates four major water supply dams on the Cataract, Cordeaux, Avon and Nepean Rivers. Releases from the Cordeaux, Avon and Nepean Dams are made to enable withdrawal for water supply purposes from the Pheasants Nest Weir located further downstream on the Nepean River. The Nepean Dam is situated some 18 km upstream of the Bargo River confluence, while the Pheasants Nest Weir is located approximately 7 km upstream of the confluence. The Nepean River flows into the Warragamba River near Wallacia at which point it is referred to as the Hawkesbury-Nepean River. The Hawkesbury-Nepean catchment is one of the largest coastal catchments in NSW with an area of some 21,400 km$^2$ from its mouth in Broken Bay on the northern side of the Sydney Metropolitan area.

## 2.2 Surface Water Catchments

The Study Area is located predominantly within the Teatree Hollow catchment which is a sub-catchment of the Bargo River (refer **Map 4**). Small portions of the Study Area are also located within the Hornes Creek and Bargo River catchments. The Dogtrap Creek catchment, which overlies the approved B series longwalls, is located to the east of the Study Area. Teatree Hollow, Dogtrap Creek and the Bargo River catchment have, to varying degrees, experienced subsidence-related effects due to historical mining operations at the Tahmoor Mine.

The stream order[1] of Teatree Hollow, Teatree Hollow tributary, Hornes Creek, the Bargo River and the Bargo River tributary within and adjacent to the Study Area is shown in **Map 5**. The locations of pools in Teatree Hollow, Teatree Hollow tributary, Hornes Creek and the Bargo River tributary within and adjacent to the Study Area are also shown in **Map 5**.

### 2.2.1 Teatree Hollow Catchment

Teatree Hollow traverses the Tahmoor Mine area, with the confluence of Teatree Hollow and the Bargo River located approximately 600 metres (m) downstream of the Tahmoor Mine Pit Top. The mid to upper reaches of Teatree Hollow overlie the approved LW S1A-S6A while the headwater of Teatree Hollow tributary overlies the southern end of the proposed LW S7A. The Teatree Hollow catchment is approximately 8 km$^2$ as shown in **Map 4**.

The upper reaches of Teatree Hollow traverse farmland and rural-residential properties while the mid to lower reaches predominantly traverse bushland. The upper reaches of Teatree Hollow tributary traverse bushland, farmland and rural-residential properties while the mid to lower reaches predominantly traverse bushland. Teatree Hollow is a third order stream downstream of LW S1A and the confluence with Teatree Hollow tributary (refer **Map 5**). Teatree Hollow tributary is a third order stream above LW S1A to LW S3A.

The upper reaches of Teatree Hollow and Teatree Hollow tributary are characterised by a low relief landscape, with a dominant bed material of mud (cohesive clay/silt/sand) and notable grass coverage (Gippel, 2013). Teatree Hollow and Teatree Hollow tributary are ill-defined in the upper reaches, with surface water travelling predominantly as overland flow or in shallow, eroded gullies.

[1] Strahler stream order classification scheme (Strahler, 1952).



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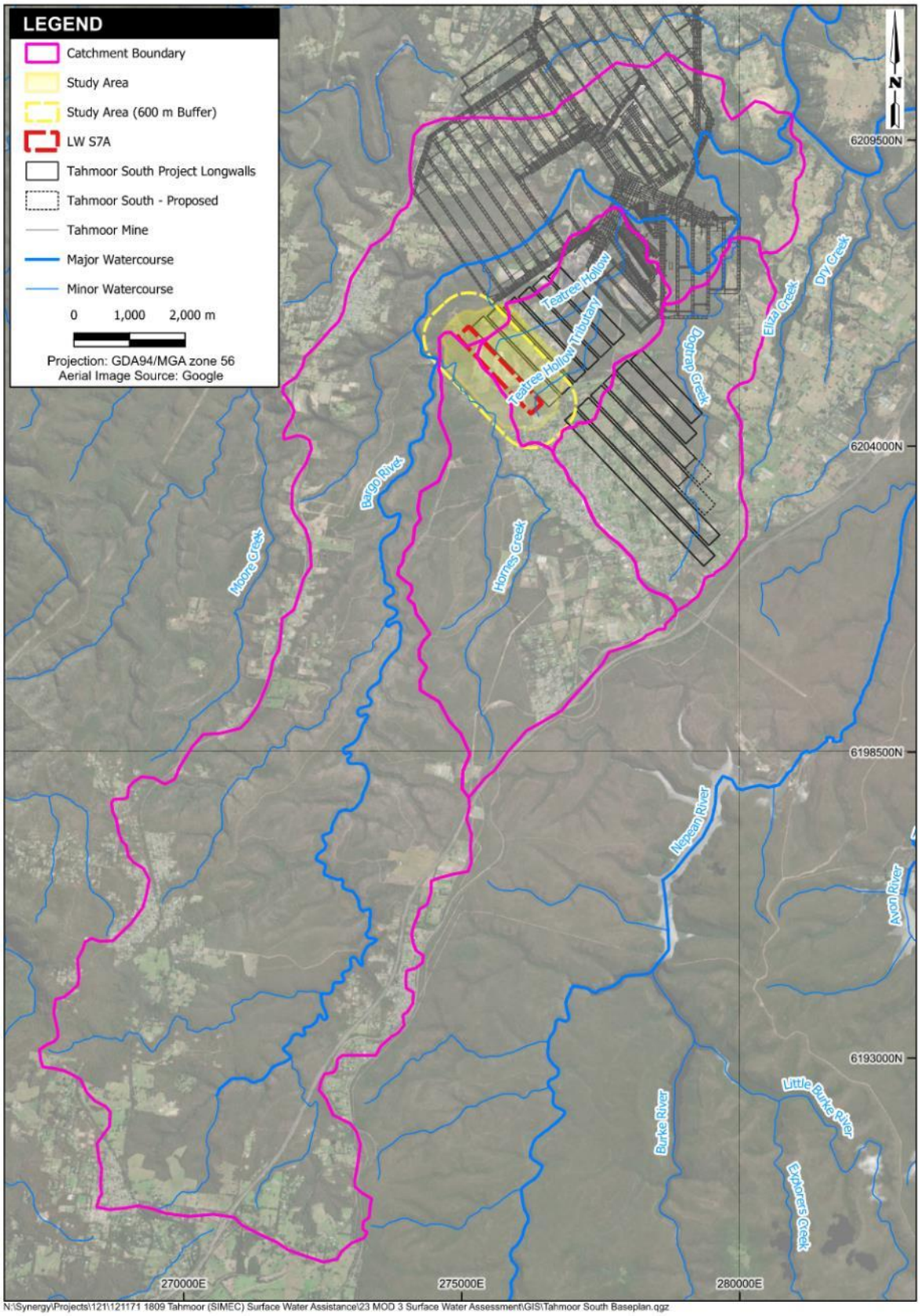
## MAP 4: SURFACE WATER CATCHMENTS



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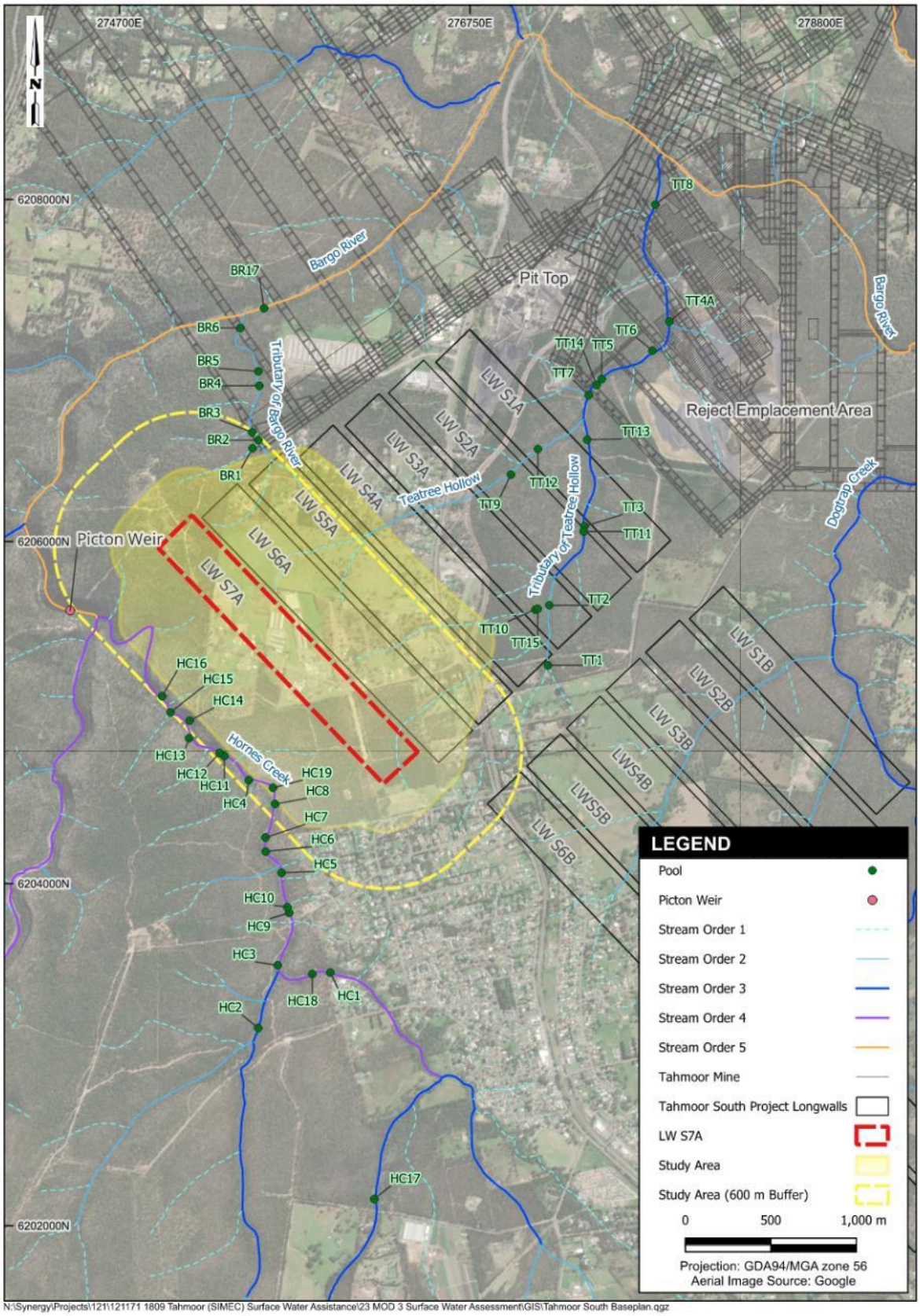
## MAP 5: POOLS AND STREAM ORDER



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In the mid to lower reaches, the landscape is characterised as high relief, with dominant bed material of mud, sand, boulders and/or exposed bedrock and little low flow channel grass coverage (Gippel, 2013). The main channels of Teatree Hollow and Teatree Hollow tributary become progressively more defined with distance downstream.

A total of 15 pools were mapped in Teatree Hollow and Teatree Hollow tributary, as shown in **Map 5**. The pool hydraulic controls comprise rockbars, boulders and cohesive clay/silt/sand (Gippel, 2013). It is noted that pools in Teatree Hollow and Teatree Hollow tributary are not present within the Study Area.

Ferruginous seeps and suspended colloids were observed at locations in Teatree Hollow and Teatree Hollow tributary during the baseline surveys conducted in 2022 (BES, 2022a; b). In addition, gas bubbling was observed in shallow ponded water at channel morphology site CM6 (refer **Map 8** for location) (BES, 2022c).

### 2.2.2 Hornes Creek Catchment

The lower reaches of Hornes Creek traverse the edge of the Study Area as shown in **Map 4**. The catchment area of Hornes Creek is approximately 19.3 km$^2$ and largely comprises bushland with some rural-residential and residential areas. Hornes Creek is a fourth order stream within and adjacent to the Study Area (refer **Map 5**).

The Picton Weir is located just downstream of the confluence of Hornes Creek and the Bargo River. Stored water in the Picton Weir is understood to extend to pool HC16 in Hornes Creek (refer **Map 5**). The Picton Weir was constructed in the late 19$^{th}$ century to supply the township of Bargo. Currently, the weir is heavily silted and no longer used for town water supply.

Hornes Creek is located in a confined valley with the bed material predominantly comprised of exposed bedrock. The baseline geomorphology surveys conducted in 2013 and 2023 identified that Hornes Creek was generally in good geomorphic condition, classified as essentially natural with intact form and processes (Gippel, 2013; 2023). A total of 12 pools were mapped in Hornes Creek within or adjacent to the Study Area boundary, with a further five pools mapped upstream. The pool hydraulic controls were found to comprise boulders and/or rockbars.

Gippel (2023) noted that the cover of riparian trees was systematically lower in 2023 as compared to that identified in 2013. This was attributed to shrubs and ground cover vegetation colonising the spaces previously shaded by tree cover. In addition, Gippel (2023) noted widespread ferruginous colloids in the water and precipitated on or staining the bed material of the mid to upper reaches of Hornes Creek. The downstream 740 m of the creek was clear of ferruginous colloids, iron precipitates and iron staining.

### 2.2.3 Bargo River Catchment

The Bargo River catchment area is approximately 130 km$^2$ at its confluence with the Nepean River. The Bargo River flows into the Nepean River approximately 9 km downstream of the Teatree Hollow confluence (refer **Map 4**). The lower 4 km of the river pass through the Bargo River Gorge, which is characterised by steep rock faces up to 110 m high.

The river flows in a generally north-easterly direction through incised valleys and gorges to its confluence with the Nepean River. Flow in the mid to upper reaches of the Bargo River is intermittent while flow in the downstream reach of the Bargo River (downstream of the confluence with Teatree Hollow) is perennial due to persistent licensed discharges from the Tahmoor Mine. The reach of the Bargo River adjacent to the Tahmoor Mine downstream of the Picton Weir has previously been affected by mining-induced subsidence.

The headwaters of a second order tributary of the Bargo River overlie the western edge of LW S5A and LW S6A (refer **Map 5**). Rock slabs and bedrock outcrop were mapped in the mid to lower reach of the tributary and a total of 6 pools were identified with the dominant pool control comprising boulders (Gippel, 2013).

The baseline geomorphology surveys conducted in 2013 and 2023 identified that the Bargo River adjacent to the Tahmoor Mine was generally in good geomorphic condition[2]. Sites in the Bargo River tributary where the redirection of surface flow to the subsurface was observed, presumed to be

[2] Essentially natural with intact form and processes.



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associated with historical mining-induced bed fracturing, were classified as having moderate geomorphic condition (Gippel, 2013). During the 2023 survey, high concentrations of ferruginous colloids were observed in the Bargo River, with iron precipitates and iron staining on the bed material. Ferruginous colloids were not observed at or immediately downstream of the Picton Weir (Gippel, 2023).

## 2.3 Surface Water Compliance

Water management at the Tahmoor Mine is undertaken in accordance with SSD 8445 and Environment Protection Licence (EPL) 1389 as detailed in the LW S1A – S6A Extraction Plan Water Management Plan (Tahmoor Coal, 2023) and the Tahmoor South Water Management Plan (Tahmoor Coal, 2022). The LW S1A – S6A Water Management Plan (EP WMP) details the surface water monitoring program, site specific guideline values (SSGVs), impact assessment criteria and response plan to be implemented in the event of a trigger exceedance related to the Project.

### 2.3.1 Performance Measures and Trigger Action Response Plans

The subsidence impact performance measures, as specified in SSD 8445, and the performance indicators for natural features, as defined in the EP WMP, are summarised in **Table 1**.

**TABLE 1: PERFORMANCE MEASURES AND PERFORMANCE INDICATORS**

| Feature | Subsidence Performance Measures | Subsidence Performance Indicators |
|---|---|---|
| All watercourses within the Subsidence Area | No greater subsidence impact or environmental consequences to water quality, water flows (including baseflow) or stream health (including riparian vegetation), than predicted in the EIS. | Exceedance of the impact assessment criteria, as defined in the relevant Level 1 to Level 3 trigger, where a Level 3 trigger denotes progression towards a potential exceedance of the performance measure. |
| Other watercourses | Negligible environmental consequences including beyond those predicted in the EIS, including:<br>• negligible diversion of flows or changes in the natural drainage behaviour of pools;<br>• negligible decline in baseline channel stability;<br>• negligible gas releases and iron staining; and<br>• negligible increase in water turbidity. | The performance measure will be considered to be exceeded if a Level 3 TARP is triggered in relation to water level decline and/or water quality changes and the investigation outcomes indicate a mining related impact based on monitoring data for sites in Hornes Creek and the Bargo River. |

The trigger action response plans (TARPs) in the EP WMP are implemented to enable assessment of the potential impacts of mining on watercourses within and adjacent to the Project Study Area (refer **Map 3**) and to assess compliance against the subsidence impact performance measures, as defined in SSD 8445.

The surface water related TARPs, as defined in the EP WMP, pertain to:

- water quality;
- pool water level;
- physical features and natural behaviour of watercourses within the Subsidence Area; and
- channel stability, sedimentation and erosion.



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Specific actions and responses are required to be implemented in the event of a trigger level exceedance. Each TARP typically comprises four trigger levels as follows:

- 'Normal Condition' – conditions are considered consistent with natural variability / baseline conditions.
- Level 1 – indicates an initial deviation from baseline conditions and implementation of relevant actions and responses.
- Level 2 – indicates further progression of a deviation from baseline conditions and implementation of additional relevant actions and response.
- Level 3 – indicates potential persistent deviation from baseline conditions, initiation of detailed investigation and consideration of Watercourse Corrective Action Management Plan.

### 2.3.2 EPL 1389

In accordance with EPL 1389, Tahmoor Coal is licensed to discharge from one licensed discharge point (LDP1) and three licensed overflow points (LOPs) as summarised in **Table 2**. The locations of LDP1 and the LOPs are shown in **Map 6**.

**TABLE 2: EPL 1389 LICENSED DISCHARGE AND OVERFLOW POINTS**

| Discharge / Overflow Point | Type of Discharge Point | Location Description | Discharge Limit |
|---|---|---|---|
| LDP1 | Discharge to waters<br>Discharge quality monitoring<br>Volume monitoring | Main water discharge - discharge drain located downstream of the final mine water treatment dam (dam M4) | 15,500 kilolitres per day during low rainfall conditions<br>Unlimited during wet weather conditions*† |
| LOP3 | Discharge to waters | Overflow from sediment dam S9 | Not specified |
| LOP4 | | Overflow from sediment dam S4 | |
| LOP5 | | Overflow from sediment dam S8 | |

* Defined as more than 10 millimetres (mm) rainfall within a 24 hour period.

† Provided that all practical measures are taken to reduce potential water quality impacts.

The current interim water quality limits for discharge to LDP1 are listed in **Table 3**. New limits for the constituents listed in **Table 3** will be defined, in collaboration with the NSW Environment Protection Agency (EPA), once sufficient monitoring data is available from the recently commissioned Water Treatment Plant.



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**TABLE 3: EPL 1389 LICENSED DISCHARGE POINT 1 WATER QUALITY LIMITS**

| Constituent | Discharge Limit |
|---|---|
| Aluminium (µg/L) | 110 |
| Arsenic (µg/L) | 200 |
| Barium (µg/L) | 6,440 |
| Copper (µg/L) | 5 |
| Electrical Conductivity (µS/cm) | 2,600 |
| Enterococci (colony forming units per 100 mL) | 1,700 |
| Nickel (µg/L) | 200 |
| Total Nitrogen (mg/L) | 8 |
| pH | 6.5-9 |
| Total Suspended Solids (mg/L) | 30 |
| Turbidity (NTU) | 150 |
| Zinc (µg/L) | 300 |

Notes: µg/L = micrograms per litres; µS/cm = microsiemens per centimetre; NTU = nephelometric turbidity unit.



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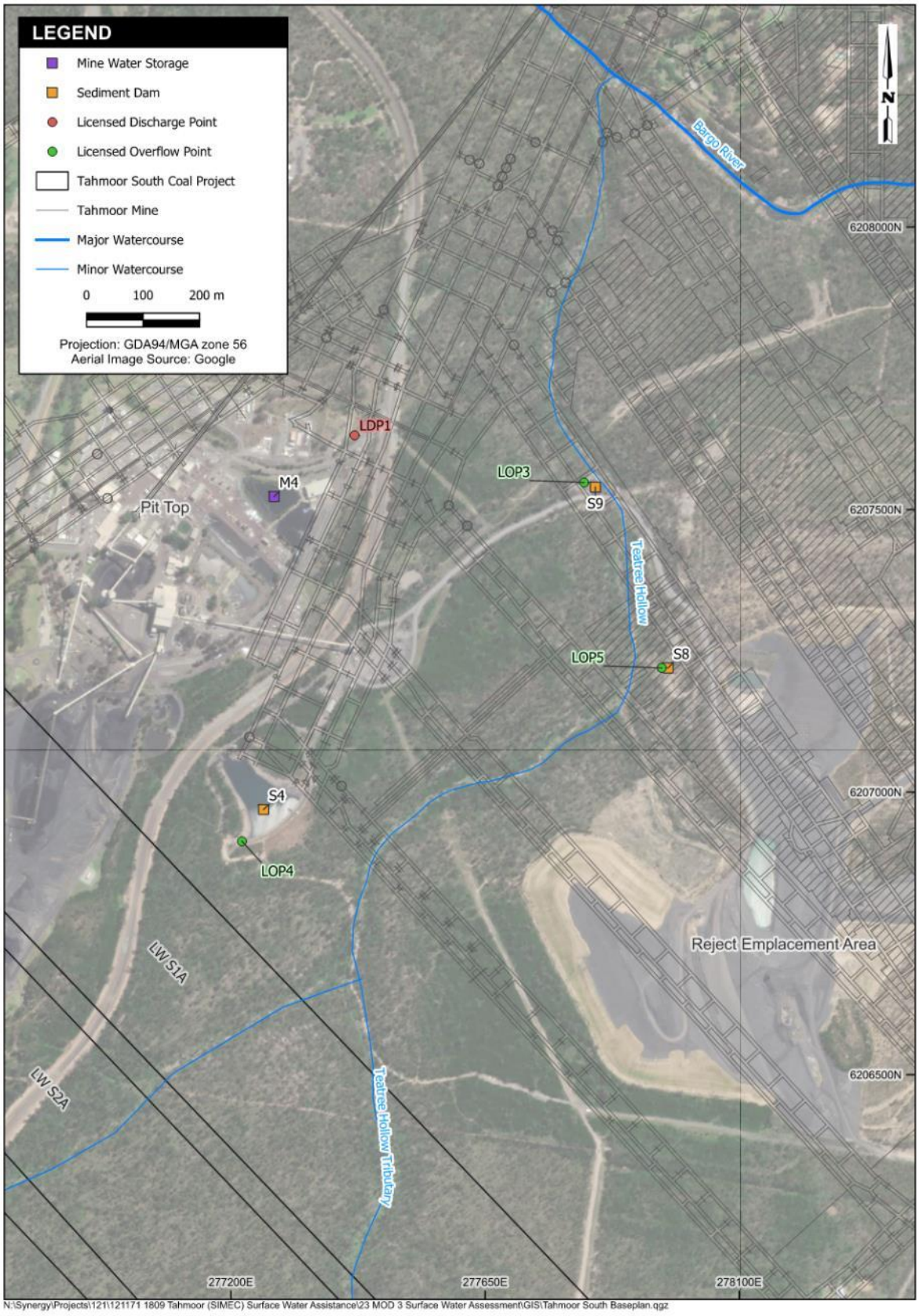
## MAP 6: LICENSED DISCHARGE AND OVERFLOW POINTS



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### 2.3.3 Water Access Licences

Tahmoor Coal holds Water Access Licences (WALs) for the Stonequarry Creek Water Source and Maldon Weir Water Source in accordance with the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2023. A list of the WALs currently held by Tahmoor Coal is provided in **Table 4**.

**TABLE 4: WATER ACCESS LICENCES – SURFACE WATER**

| WAL | Water Sharing Plan | Water Source | Entitlement | Category |
|---|---|---|---|---|
| 25777 | Greater Metropolitan Region Unregulated River Water Sources 2023 | Maldon Weir | 5 ML | Unregulated river |
| 43572 | | Stonequarry Creek | 16 ML | |
| 43656 | | Maldon Weir | 25 ML | |
| 44608 | | Stonequarry Creek | 9 ML | |
| 839757* | | Maldon Weir | 11 ML | |

* lease arrangement

## 2.4 Surface Water Monitoring

A comprehensive surface water monitoring program has been implemented for the Project. The monitoring program relevant to the Study Area is detailed in **Table 5**. The surface water monitoring locations are shown in **Map 7** and **Map 8**. The locations of visually observed pools are shown in **Map 5**.



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**TABLE 5: SURFACE WATER MONITORING PROGRAM RELEVANT TO THE MODIFICATION**

| Feature | Monitoring Component / Location | Pre-mining Monitoring | During Mining Monitoring | Post-mining Monitoring |
|---|---|---|---|---|
| Streamflow | TT-F1<br>DT-F1<br>HC4-QRLa<br>BR13-QRLa | Continuous record. Data downloaded routinely prior to the commencement of secondary extraction in relevant catchment. | Continuous record. Data downloaded and reviewed monthly. | Continuous record, data downloaded and reviewed quarterly for 12 months following the completion of mining or as required in accordance with a Watercourse Corrective Action Management Plan. |
| Surface water quality | Teatree Hollow Catchment:<br>TT1-QLa, TT2-QLa, TT3-QLa, TT7-QLa, TT9-QLa, TT12-QLa, TT13-QLa, TT14-QLa<br>Hornes Creek Catchment:<br>HC1-QLa, HC9-QLa, HC4-QRLa, HC3-QLa, HC13-QLa, HC15-QLa, HC17-QLa<br>Bargo River Catchment:<br>BR3-QLa, BR6-QLa, BR13-QRLa, BR12-QLa, BR16-QLa, BR17-QLa, BR18-QLa<br>Dogtrap Creek Catchment:<br>DT3-QLa, DT4-QLa, DT15-QLa | Monthly sampling prior to secondary extraction of the relevant longwall. | Monthly sampling and analysis or as required by a specified action relevant to a trigger level. | Monthly sampling, analysis and data review for a minimum of 12 months following the completion of mining or as required in accordance with a Watercourse Corrective Action Management Plan. |
| | | *Parameters*:<br>Field analysis: pH, electrical conductivity (EC) and dissolved oxygen (DO), temperature and oxidation reduction potential (ORP).<br>Laboratory analysis for: pH, EC, total dissolved solids, total suspended solids, turbidity, major cations(1), sulphate, alkalinity, chloride, dissolved and total metals(2), total kjeldahl nitrogen, total nitrogen, total phosphorus, total cations and total anions. | | |

Notes:

1. Calcium, magnesium, sodium and potassium.
2. Aluminium, arsenic, barium, copper, iron, lead, lithium, manganese, nickel, selenium, strontium and zinc.



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**TABLE 5 (CONT.): SURFACE WATER MONITORING PROGRAM RELEVANT TO THE MODIFICATION**

| Feature | Monitoring Component / Location | Pre-mining Monitoring | During Mining Monitoring | Post-mining Monitoring |
|---|---|---|---|---|
| Pool water level | Teatree Hollow Catchment:<br>TT1-QLa, TT2-QLa, TT3-QLa, TT7-QLa, TT9-QLa, TT12-QLa, TT13-QLa, TT14-QLa<br>Hornes Creek Catchment:<br>HC1-QLa, HC9-QLa, HC4-QRLa, HC3-QLa, HC13-QLa, HC15-QLa, HC17-QLa<br>Bargo River Catchment:<br>BR3-QLa, BR6-QLa, BR12-QLa, BR13-QRLa, BR16-QLa, BR17-QLa, BR18-QLa<br>Dogtrap Creek Catchment:<br>DT3-QLa, DT4-QLa, DT15-QLa | Continuous record and monthly manual measurements. Continuous data downloaded routinely prior to the commencement of secondary extraction of the relevant longwall. | Continuous record and monthly manual measurements. Continuous data downloaded and reviewed monthly. | Continuous record, monthly manual measurements and data review for a minimum of 12 months following the completion of mining or as required in accordance with a Watercourse Corrective Action Management Plan. |
| Physical features and natural behaviour of pools and reaches | Teatree Hollow, Teatree Hollow tributary, Hornes Creek and the Bargo River tributary | One observation prior to mining using fixed location photo points. | Observations every month during the active subsidence period (after 200 m of secondary extraction of relevant longwall) for sites within the active subsidence zone(1) using fixed location photo points. | Quarterly observations over 12 months for pools that are no longer within the active subsidence zone or as required in accordance with a Watercourse Corrective Action Management Plan. |
| Morphology and channel stability | Headwater and knickpoint sites in Teatree Hollow, Teatree Hollow tributary and the Bargo River tributary | One observation prior to mining using fixed location photo points.<br>One catchment survey of 10 headwater sites. | Observations of knickpoint formation every month during the active subsidence period for sites within the active subsidence zone using fixed location photo points.<br>Annual catchment survey of 10 headwater sites. | One observation of knickpoint formation at sites that are no longer within the active subsidence zone using fixed location photo points.<br>One catchment survey of 10 headwater sites.<br>Post-mining geomorphology survey. |

Notes:

1. Survey area to include upstream, downstream and adjacent pools (to the extent of the potential impact) where a trigger exceedance has occurred at a potential impact site(s) in accordance with the EP WMP TARPs.



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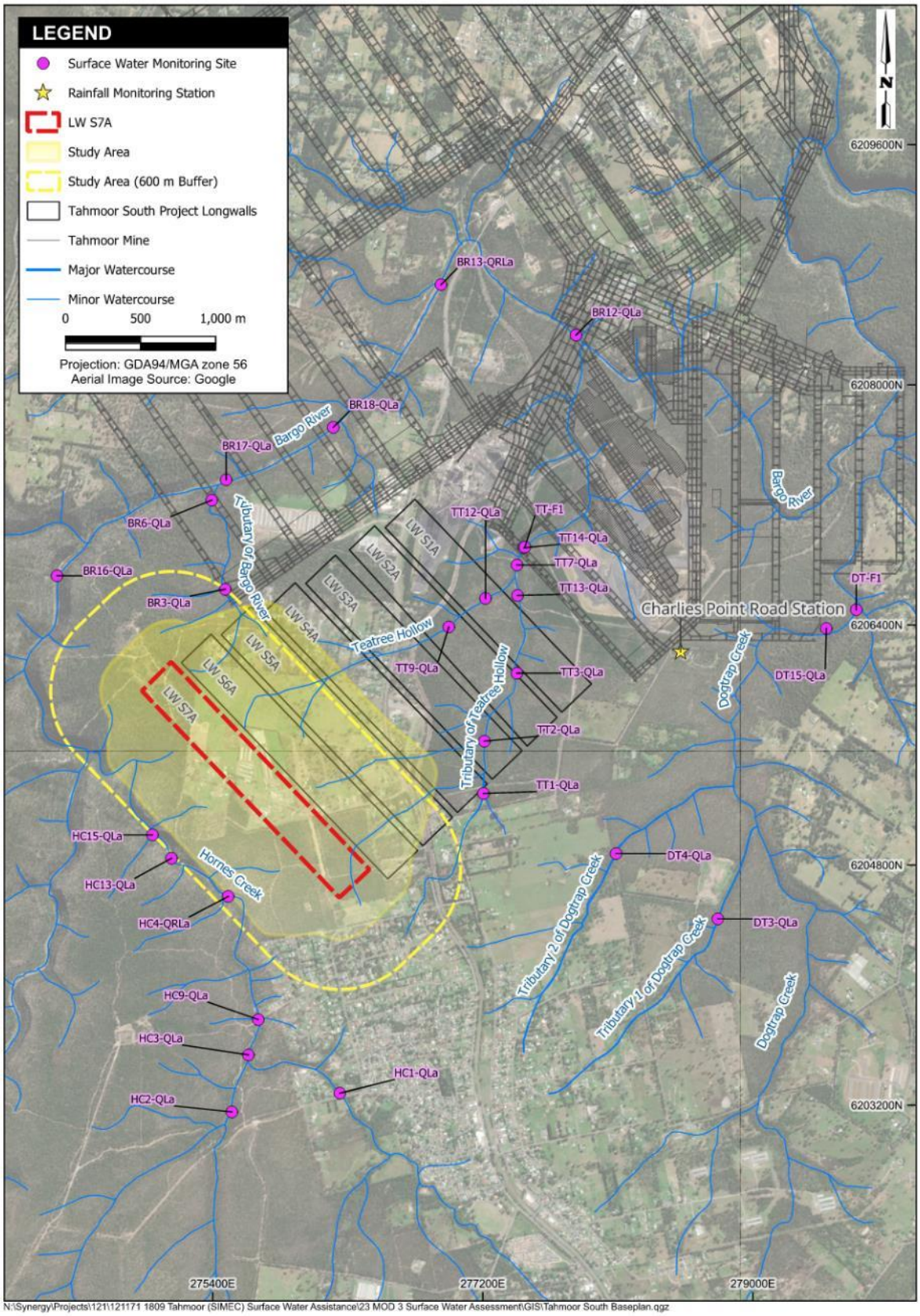
## MAP 7: SURFACE WATER MONITORING SITES RELEVANT TO MODIFICATION

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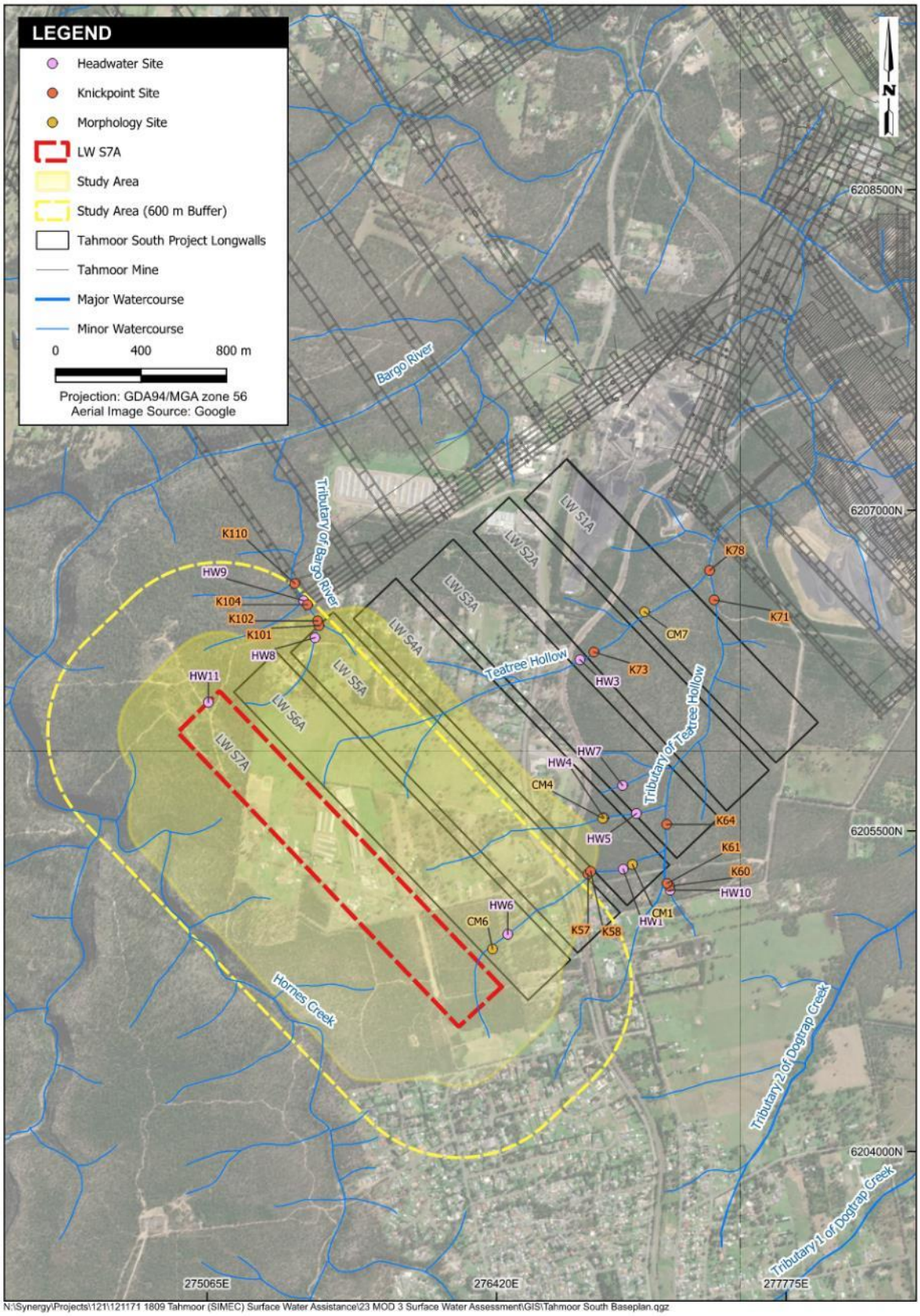
## MAP 8: CHANNEL MORPHOLOGY MONITORING SITES RELEVANT TO MODIFICATION



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## 2.5 Surface Water Characterisation

The following sections summarise the water quality and streamflow trends of watercourses within and adjacent to the Study Area.

It is noted that Hornes Creek, the Bargo River and the Bargo River tributary are currently located outside of the potential influence of mining of LW S1A-S2A. Therefore, impacts to these watercourses have not occurred as a result of mining of LW S1A-S2A.

Effects to Teatree Hollow and Teatree Hollow tributary have occurred as a result of mining of LW S1A-S2A, as detailed in **Section 2.6**.

As detailed in the EP WMP, monitoring sites in the Dogtrap Creek catchment are proposed to be utilised as reference sites to enable assessment of Teatree Hollow water quality, water level and streamflow trends as mining of the A series longwalls progresses. The locations of the Dogtrap Creek reference sites are shown in **Map 7**. Detail pertaining to the water quality and water level characteristics of the Dogtrap Creek reference sites is provided in the EP WMP.

### 2.5.1 Water Quality

The water quality monitoring data is presented as a series of graphs in **Appendix A** for the period of monitoring to March 2024 (herein referred to as the review period). Where the monitored constituent was less than the limit of reporting, the limit of reporting has been presented in the graphs.

The graphs provided in **Appendix A** also present the daily rainfall data recorded at the Tahmoor Coal rainfall station, referred to as "Charlies Point Road", for the period from 8 September 2022 (refer **Map 7** for station location). Daily rainfall data obtained from SILO Point Data[3] for a location in close proximity to Tahmoor South is also presented for the period to 7 September 2022.

#### *2.5.1.1 Teatree Hollow Catchment*

The water quality of Teatree Hollow and Teatree Hollow tributary ranged from slightly acidic to slightly alkaline over the review period. A minimum value of pH 5.6 was recorded at downstream monitoring site TT7-QLa while a maximum value of pH 8.3 was recorded at upstream reference site TT1-QLa.

The field EC values were predominantly recorded below 600 µS/cm at the majority of sites. The EC values tended to be higher at upstream reference site TT1-QLa on Teatree Hollow tributary (median 453 µS/cm) in comparison to downstream monitoring site TT13-QLa (median 188 µS/cm). Slightly elevated EC values (greater than 600 µS/cm) were recorded at times during the baseline period at upstream reference site TT1-QLa and monitoring site TT7-QLa. A maximum EC of 687 µS/cm was recorded at TT7-QLa in October 2020 during the baseline period. A maximum EC of 663 µS/cm was recorded at reference site TT1-QLa in January 2020 during an extended period of below average rainfall.

Slightly elevated EC values were recorded at monitoring sites TT7-QLa and TT14-QLa in early to mid-2023 in comparison to other monitoring sites in Teatree Hollow and Teatree Hollow tributary. A maximum EC of 1,044 µS/cm was recorded at monitoring site TT7-QLa in July 2023. The slightly elevated EC values recorded at TT7-QLa from March to August 2023 resulted in trigger exceedances as detailed in **Section 2.6.4**.

Concentrations of dissolved aluminium tended to be more variable at all sites from 2022 in comparison to concentrations recorded prior to 2022. In general, dissolved aluminium concentrations were recorded below 0.5 mg/L at all sites with the exception of TT2-QLa where a maximum concentration of 0.64 mg/L was recorded in September 2023. Slightly elevated concentrations of dissolved aluminium recorded at TT2-QLa from September to November 2023 resulted in a trigger exceedance as detailed in **Section 2.6.4**.

Dissolved iron concentrations were generally recorded below 2 mg/L at all sites with the exception of TT7-QLa where maximum concentrations of 9.75 mg/L and 6.92 mg/L were recorded in May and June

[3] SILO Point Data is a system which provides synthetic data sets for a specified point by interpolation between surrounding point records held by the Bureau of Meteorology. Refer https://www.longpaddock.qld.gov.au/silo/point-data/.



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2023 respectively. The elevated dissolved iron concentrations recorded at TT7-QLa resulted in trigger exceedances as detailed in **Section 2.6.4**.

Dissolved manganese concentrations of less than 0.6 mg/L were recorded for the majority of the review period, with slightly elevated dissolved manganese concentrations recorded at some sites during below average rainfall periods. A maximum concentration of 3 mg/L dissolved manganese was recorded at reference site TT1-QLa in January 2020.

Dissolved nickel concentrations equal to or less than the limit of reporting (0.001 mg/L) were recorded at the majority of sites and for the majority of the review period. Slightly higher dissolved nickel concentrations were recorded at monitoring site TT7-QLa, ranging up to 0.028 mg/L. From June to August 2023, trigger exceedances in relation to dissolved nickel were reported for TT7-QLa (refer **Section 2.6.4**).

Dissolved zinc concentrations were generally less than 0.06 mg/L at all sites with the exception of TT7-QLa where slightly higher dissolved zinc concentrations were recorded at times. A maximum dissolved zinc concentration of 0.15 mg/L was recorded at monitoring site TT7-QLa in June 2023. From April to August 2023, trigger exceedances in relation to dissolved zinc were reported for TT7-QLa (refer **Section 2.6.4**).

Dissolved copper concentrations equal to or less than the limit of reporting (0.001 mg/L) were recorded for the majority of the review period. A maximum dissolved copper concentration of 0.004 mg/L was recorded at reference site TT1-QLa and monitoring sites TT2-QLa and TT7-QLa in January 2020.

#### *2.5.1.2 Hornes Creek*

The water quality of Hornes Creek ranged from slightly acidic to slightly alkaline over the review record, with a higher median field pH of 7.4 recorded at monitoring site HC4-QRLa in comparison to a median pH 6.8 recorded at HC1-QLa. Lower pH values have been recorded at times at HC9-QLa, with a minimum pH 3.1 recorded in June 2019 during an extended period of below average rainfall[4].

The field EC values recorded at monitoring sites in Hornes Creek were typically less than 400 µS/cm although varied climatically, with higher EC values recorded during periods of below average rainfall, particularly at HC9-QLa. A maximum EC of 694 µS/cm was recorded at HC9-QLa in May 2019, during an extended period of below average rainfall.

Concentrations of dissolved aluminium were variable over the review period, ranging from below the limit of detection (0.01 mg/L) to 0.88 mg/L recorded at HC17-QLa in March 2019. For the majority of the review period, concentrations of dissolved aluminium below 0.2 mg/L were recorded.

Dissolved iron concentrations were recorded below 3 mg/L at all monitoring sites with the exception of HC9-QLa. Dissolved iron concentrations tended to be higher at HC9-QLa during periods of below average rainfall, with a maximum of 13.4 mg/L recorded in February 2019. A median concentration of 0.95 mg/L dissolved iron was calculated based on all records for HC9-QLa.

Dissolved manganese concentrations were typically recorded below 0.4 mg/L at all sites, although slightly elevated dissolved manganese concentrations were recorded at some sites during below average rainfall periods. A maximum concentration of 2.6 mg/L dissolved manganese was recorded at HC4-QRLa in January 2020.

Dissolved nickel concentrations were generally equal to or less than the limit of reporting (0.001 mg/L) at all sites. Slightly elevated dissolved nickel concentrations (equal to or less than 0.02 mg/L) were recorded at HC9-QLa in 2019 during an extended period of below average rainfall.

Dissolved zinc concentrations were generally less than 0.04 mg/L at all sites over the review period. Slightly elevated dissolved nickel concentrations (less than 0.26 mg/L) were recorded at HC17-QLa in 2019 during an extended period of below average rainfall.

Dissolved copper concentrations were generally equal to or less than the limit of reporting (0.001 mg/L) at all sites. A maximum dissolved copper concentration of 0.006 mg/L was recorded at HC17-QLa in February 2019 during a period of below average rainfall.

[4] From 2017 to 2019, an extended and significant period of below average rainfall occurred; classified by BoM as a major drought (BoM, 2024).



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#### *2.5.1.3 Bargo River Catchment*

The water quality of the Bargo River ranged from slightly acidic to alkaline over the review record. Generally lower pH values were recorded at the monitoring sites on the Bargo River tributary (BR3-QLa and BR6-QLa) in comparison to the Bargo River monitoring sites. The pH values tended to be higher at downstream monitoring sites BR12-QLa and BR13-QLa on the Bargo River in comparison to upstream monitoring site BR16-QLa.

The field EC values recorded at all sites varied climatically, with higher EC values recorded during periods of below average rainfall. Typically, the field EC values recorded at monitoring sites in the Bargo River and the Bargo River tributary were less than 350 µS/cm.

Concentrations of dissolved aluminium were generally recorded below 0.2 mg/L at all sites with the exception of BR18-QLa where a maximum concentration of 0.43 mg/L was recorded in July 2023.

Dissolved iron concentrations ranged from less than the limit of reporting (0.05 mg/L) to 1.6 mg/L at monitoring sites on the Bargo River and the Bargo River tributary. Lower dissolved iron concentrations (less than 0.18 mg/L) were recorded at monitoring site BR6-QLa on the Bargo River tributary in comparison to other monitoring sites.

Dissolved manganese concentrations were typically recorded below 0.4 mg/L at all sites, although slightly elevated dissolved manganese concentrations were recorded at some sites during below average rainfall periods. A maximum concentration of 1.1 mg/L dissolved manganese was recorded at BR12-QLa in January 2020.

Dissolved nickel concentrations were generally equal to or less than the limit of reporting (0.001 mg/L) at the majority of sites. Slightly higher dissolved nickel concentrations were recorded at monitoring site BR6-QLa on the Bargo River tributary (less than 0.009 mg/L). A maximum dissolved nickel concentration of 0.03 mg/L was recorded at monitoring site BR12-QLa on the Bargo River in February 2023.

Dissolved zinc concentrations were generally less than 0.01 mg/L at the majority of sites with the exception of BR6-QLa on the Bargo River tributary where slightly higher dissolved zinc concentrations were recorded (median of 0.03 mg/L). A maximum dissolved zinc concentration of 0.064 mg/L was recorded at monitoring site BR12-QLa on the Bargo River in February 2023 immediately following a rainfall event.

Dissolved copper concentrations were generally equal to or less than the limit of reporting (0.001 mg/L) at all sites.

### 2.5.2 Streamflow and Recorded Pool Water Levels

**Appendix B** presents graphs of the automated water level records for pools in Teatree Hollow, Teatree Hollow tributary, Hornes Creek, the Bargo River and the Bargo River tributary for the period of monitoring. Where surveyed, the cease to flow (CTF) level is also presented on the water level graphs. It is noted that the cease to flow (CTF) level refers to the point at which surface water ceases to flow over the pool control (i.e., the lowest point on a rockbar, boulder field or other feature that contains water within the pool and controls surface flow from the pool). In the event that surface flow over the pool control ceases, there may still be leakage from the pool occurring around, through or under the pool control and reporting downstream. The graphs provided in **Appendix B** also present the daily rainfall data recorded at the Tahmoor Coal rainfall station obtained from SILO Point Data.

Streamflow records for monitored sites in Teatree Hollow, Hornes Creek and the Bargo River are presented in the following sections.

#### *2.5.2.1 Teatree Hollow*

A streamflow gauging station was constructed on Teatree Hollow at TT-F1 in June 2022 (refer **Map 7** for location). The gauging station comprises a concrete and steel v-notch weir and upstream water level sensor to enable accurate and continuous low flow monitoring.

The TT-F1 streamflow data is presented in **Graph 1** together with SILO Point Data and Charlies Point Road rainfall data for the period of record. Streamflow data is plotted on a logarithmic scale in order to emphasise lower flows. **Graph 2** presents the streamflow duration curve calculated from TT-F1 baseline monitoring records prior to the commencement of mining of LW S1A (October 2022).



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**Graph 3** presents the cumulative rainfall and streamflow residual for the period of record. The cumulative rainfall residual is calculated as the cumulative deviation from the mean daily rainfall where positive (upward) residual slopes indicate periods of above average rainfall and negative (downward) slopes indicate periods of below average rainfall or streamflow. The cumulative streamflow residual is calculated as the cumulative deviation from the mean daily streamflow.

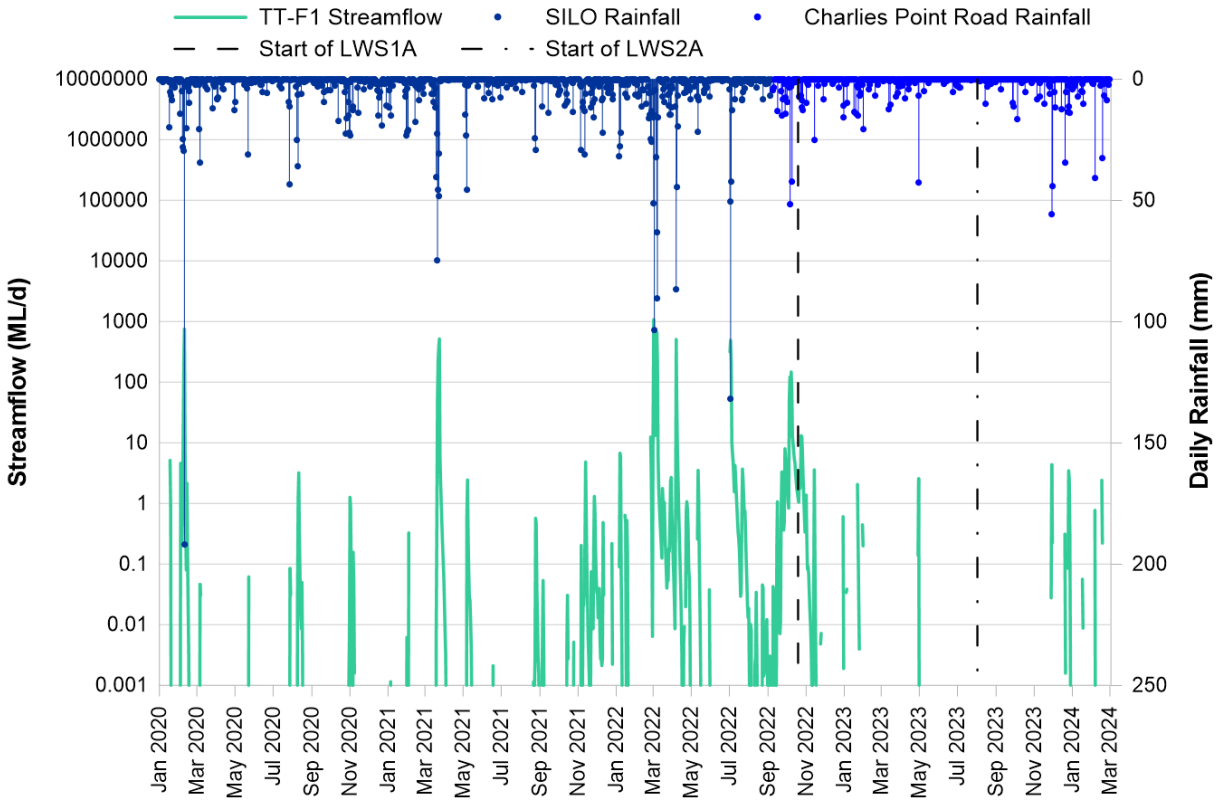
It is noted that streamflow rates in excess of the weir capacity (10 ML/d) are estimated and as such may not be accurate.

The streamflow records presented in **Graph 1** indicate that, for the period of record, streamflow at TT-F1 in Teatree Hollow was intermittent, with extended periods of no flow recorded prior to the commencement of mining of LW S1A. Prior to the commencement of mining of LW S1A, streamflow rates recorded at TT-F1 were less than 0.001 ML/d approximately 72% of the time. Approximately 15% of the time, streamflow rates above 0.1 ML/d were recorded (refer **Graph 2**).

Despite mining related impacts recorded at locations in Teatree Hollow and Teatree Hollow tributary (refer **Section 2.6**), the streamflow data presented in **Graph 1** and **Graph 3** indicates that streamflow trends recorded at monitoring site TT-F1 in Teatree Hollow have been generally consistent with rainfall trends for the period of record. The average rate of streamflow decline recorded during the period November 2022 to December 2023, following commencement of mining of LW S1A and LW S2A, is considered to be generally consistent with that recorded from April to November 2021 prior to the commencement of mining of LW S1A and consistent with the rate of rainfall decline recorded during these periods.

Notwithstanding, a streamflow reduction assessment was conducted for the period January to December 2023 to estimate the volume of surface water reduction attributable to mining effects (refer **Section 2.6.3**).

**GRAPH 1: TEATREE HOLLOW (TT-F1) STREAMFLOW AND RAINFALL**



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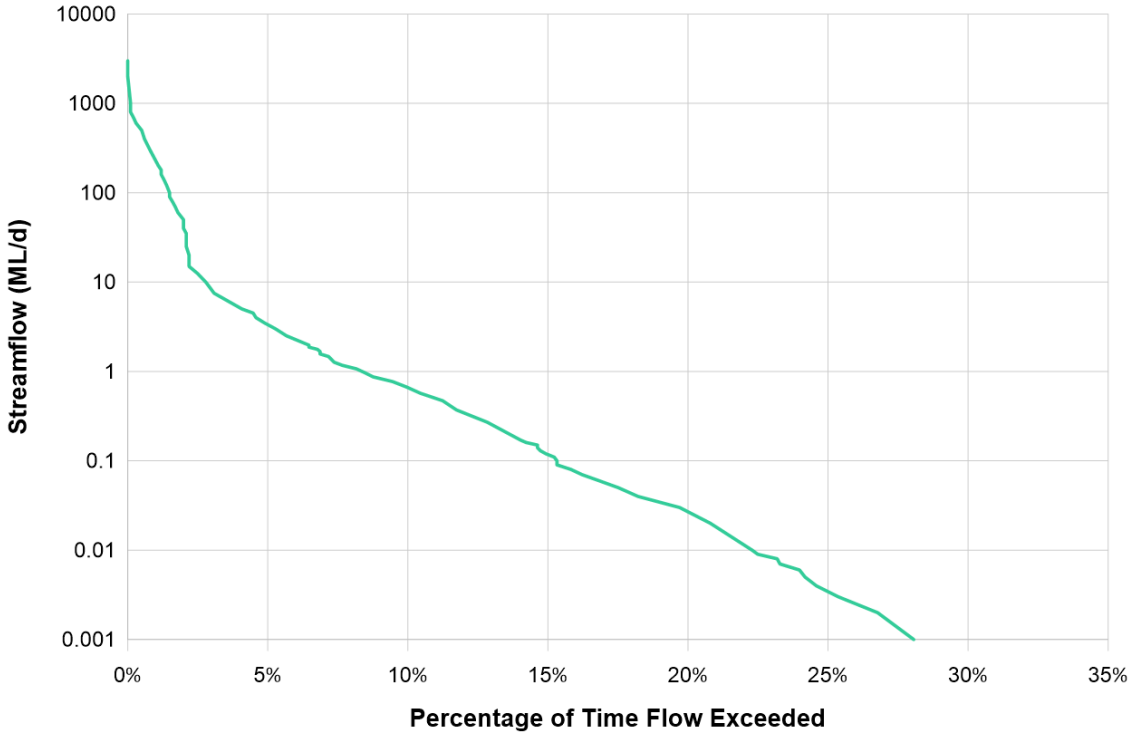
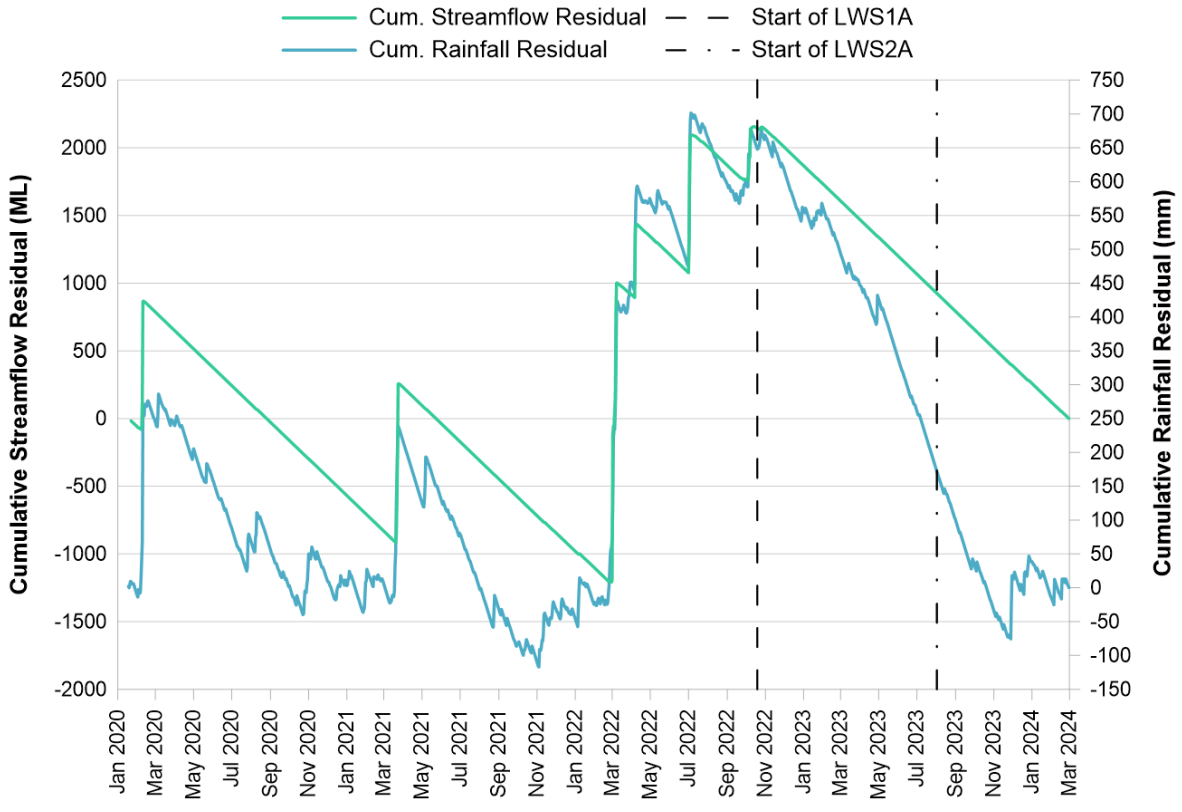
**GRAPH 2: TEATREE HOLLOW (TT-F1) – BASELINE STREAMFLOW DURATION CURVE**




**GRAPH 3: TEATREE HOLLOW (TT-F1) - CUMULATIVE STREAMFLOW AND RAINFALL RESIDUAL**



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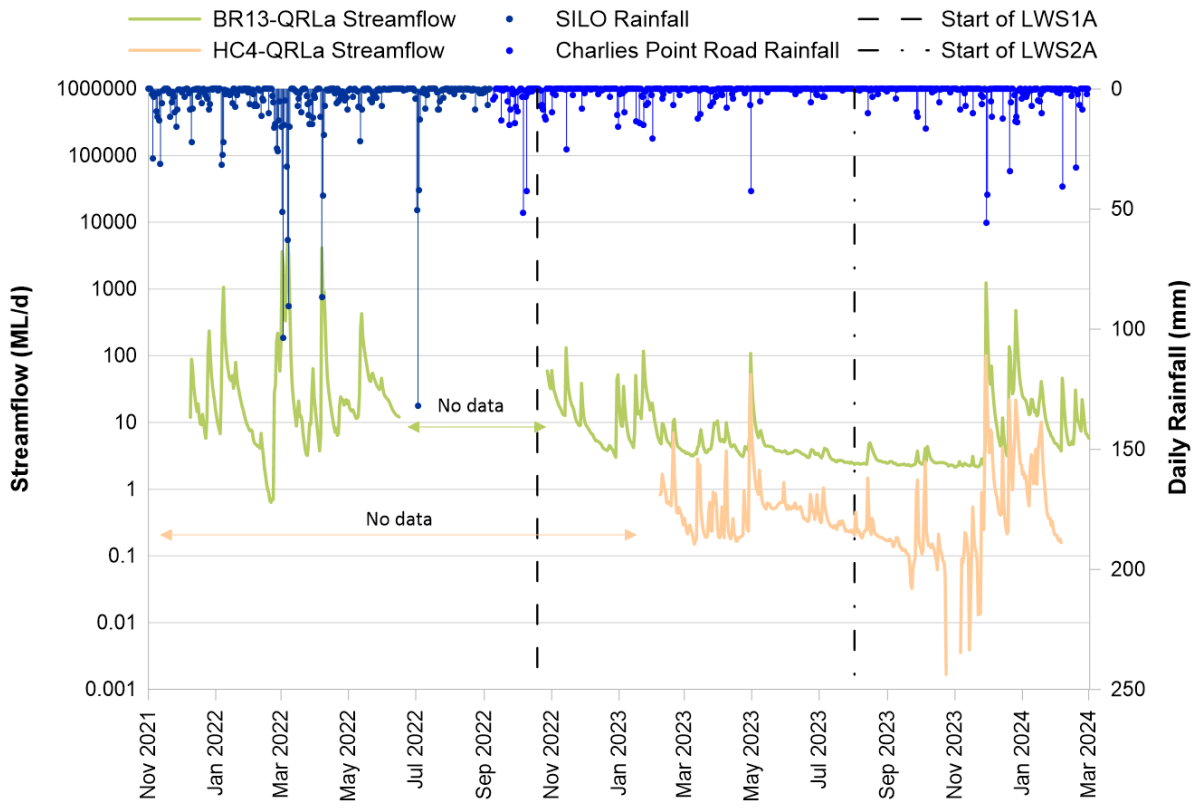
### *2.5.2.2 Hornes Creek and Bargo River*

Approximate streamflow rating relationships have been derived for pool water level monitoring sites HC4-QRLa on Hornes Creek and BR13-QRLa on the Bargo River (refer **Map 7**). It is noted that engineered gauging stations have not been constructed at HC4-QRLa and BR13-QRLa, but rather the rating relationships have been derived based on survey of the natural flow control at each site (rockbar controls). For each site, the ratings were extended to high flows by theoretical means using surveyed stream cross-sections. It is noted that the derived streamflow data is indicative only.

The HC4-QRLa and BR13-QRLa streamflow data is presented in **Graph 4** in comparison to SILO Point Data and Charlies Point Road rainfall data for the period of record. **Graph 5** presents the streamflow duration curve calculated from the HC4-QRLa and BR13-QRLa streamflow data for the period of record.

The estimated streamflow data presented in **Graph 4** and **Graph 5** indicate that, for the period of record, streamflow at BR13-QRLa on the Bargo River was perennial while streamflow at HC4-QRLa on Hornes Creek was near perennial. It is estimated that a streamflow rate of 0.1 ML/d was exceeded at HC4-QRLa on Hornes Creek approximately 90% of the time while an estimated streamflow rate of 2.4 ML/d was exceeded at BR13-QRLa on the Bargo River approximately 90% of the time. A median streamflow rate of 0.3 ML/d was estimated at HC4-QRLa on Hornes Creek while a median streamflow rate of 5.8 ML/d was estimated at BR13-QRLa on the Bargo River during the period of pool water level monitoring.

**GRAPH 4: HORNES CREEK (HC4-QRLa) AND BARGO RIVER (BR13-QRLa) - STREAMFLOW AND RAINFALL**



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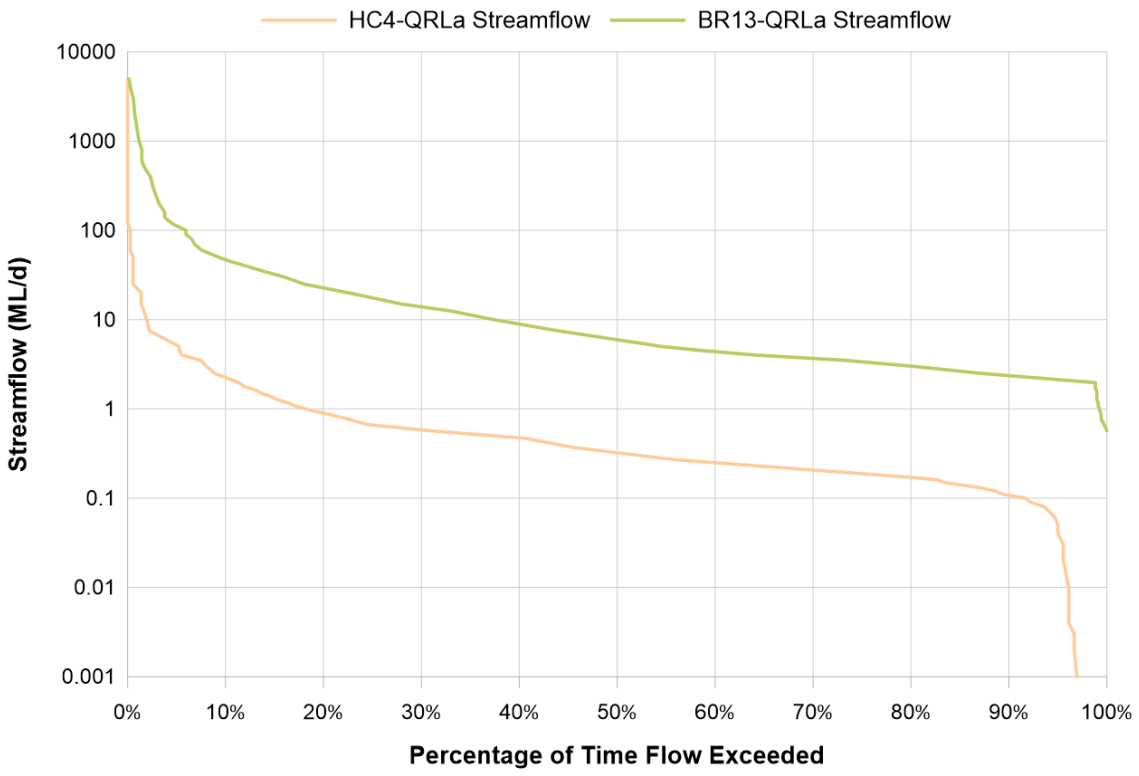
**GRAPH 5: HORNES CREEK (HC4-QRLa) AND BARGO RIVER (BR13-QRLa) – STREAMFLOW DURATION CURVE**




## 2.6 Review of Environmental Performance

The following sections summarise the effects to surface water features within and adjacent to the Study Area associated with mining of LW S1A-S2A.

As noted above, Hornes Creek, the Bargo River and the Bargo River tributary are currently located outside of the potential influence of mining of LW S1A-S2A. To date, impacts to these watercourses have not occurred as a result of mining of LW S1A-S2A.

### 2.6.1 Effects to Physical Features

**Table 6** summarises the impacts to physical features that have been visually observed at pools on Teatree Hollow and Teatree Hollow tributary following commencement of mining of LW S1A-S2A.



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**TABLE 6: SUMMARY OF PHYSICAL EFFECTS AT POOLS**

| Pool | Summary of Visual Inspection Records | Reference |
|---|---|---|
| TT2 | Mining related fractures observed directly upstream of pool TT2 in July 2023. | ENRS (2023a) |
| TT3 | No mining related impacts visually observed. | ENRS (2024a) |
| TT7 | Iron staining in excess of baseline conditions observed from March 2023 to March 2024 (latest survey). | BES (2023a-d)<br>ENRS (2023a-f)<br>ENRS (2024a-c) |
| TT9 | No mining related impacts visually observed. | ENRS (2024c) |
| TT10 | No mining related impacts visually observed. | ENRS (2024a) |
| TT11 | Mining-related fractures observed upstream of pool TT11 in February 2023. | ENRS (2023a) |
| | Minor gas bubbling observed. | ENRS (2023f) |
| TT12 | Mining-related fractures observed upstream, downstream and in the centre of pool TT12 from March 2023. | BES (2023a) |
| TT13 | Fractures visually observed in the centre of pool TT13 in July 2023. | ENRS (2023a) |
| TT15 | No mining related impacts visually observed. | ENRS (2024a) |

### 2.6.2 Water Level Effects

Mining induced-surface fracturing has resulted in atypical declines in water level[5] recorded at pools TT2, TT3, TT12 and TT13 (refer **Appendix B**).

A change in water level behaviour has also been recorded at pool TT7, located downstream of LW S1A. The change in water level behaviour is considered partly related to backwater effects associated with the TT-F1 gauging station weir and partly related to the re-emergence of diverted surface flow from upstream fracturing. Diverted surface flow has been visually observed as re-emerging near the confluence of Teatree Hollow and Teatree Hollow tributary, immediately upstream of pool TT7.

**Table 7** lists the monitoring sites (pools) and period in which a Level 3 trigger in relation to water level has occurred.

**TABLE 7: LEVEL 3 TRIGGER PERIOD - WATER LEVEL**

| Monitoring Site | Pool | Level 3 Trigger Period |
|---|---|---|
| TT2-QLa | TT2 | 13 August to 28 November 2023 |
| TT3-QLa | TT3 | 7 March to 28 November 2023 |
| TT7-QLa | TT7 | 10 November to 28 November 2023 |
| TT12-QLa | TT12 | 7 March to 28 November 2023 |
| TT13-QLa | TT13 | 21 March to 30 April 2023; 14 May to 28 November 2023 |

### 2.6.3 Streamflow Effects

A hydrological model was developed for Teatree Hollow utilising the Australian Water Balance Model (AWBM) (Boughton, 2004). The hydrological model was calibrated to the baseline streamflow dataset recorded at TT-F1 for the period January 2020 to November 2022, prior to mining-related effects to

[5] 'Atypical' surface water characteristics relate to a notable and/or rapid water level decline or change in the water level recessionary behaviour below the cease to flow level which is inconsistent with baseline conditions and cannot be attributed to climatic conditions.



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Teatree Hollow or Teatree Hollow tributary. To assess the potential reduction in streamflow reporting to TT-F1 following commencement of mining of LW S1A-S2A, the modelled streamflow (modelled using recorded daily rainfall data and SILO evaporation data) has been compared to the recorded streamflow at TT-F1. The estimated volumetric reduction in streamflow is given in **Table 8** for the period January to December 2023 in comparison to the Tahmoor Coal annual entitlement for the Maldon Weir water source.

**TABLE 8: ESTIMATED REDUCTION IN TEATREE HOLLOW STREAMFLOW - 2023**

| WAL | Water Sharing Plan | Water Source | Annual Entitlement | Estimated Streamflow Reduction - 2023 |
|---|---|---|---|---|
| 25777 | Greater Metropolitan Region Unregulated River Water Sources 2023 | Maldon Weir | 5 ML | 19.2 ML |
| 43656 | | | 25 ML | |
| 839757 | | | 11 ML | |

As illustrated in **Table 8**, a total reduction in Teatree Hollow streamflow of 19.2 ML was estimated for the period of January to December 2023 due to effects associated with mining of LW S1A-S2A. This compares with a total annual entitlement of 41 ML held by Tahmoor Coal for the Maldon Weir water source.

### 2.6.4 Water Quality Effects

**Table 9** lists the monitoring sites (pools) and period in which a water quality trigger has occurred.

**TABLE 9: TRIGGER LEVELS - WATER QUALITY**

| Monitoring Site | Pool | Trigger Level | Constituent | Trigger Period |
|---|---|---|---|---|
| TT7-QLa | TT7 | Level 3 | Electrical conductivity | March to August 2023 |
| | | Level 1 | Dissolved nickel | June to August 2023 |
| | | Level 2 | Dissolved iron | April to August 2023 |
| | | Level 2 | Dissolved zinc | April to August 2023 |
| TT2-QLa | TT2 | Level 1 | Dissolved aluminium | September to November 2023 |

As noted in **Section 2.6.2**, diverted surface flow has been visually observed as re-emerging near the confluence of Teatree Hollow and Teatree Hollow tributary, immediately upstream of pool TT7.

The interaction of the diverted surface flow with the subsurface geology, in combination with below average rainfall conditions, is considered to have resulted in periodic exceedances of water quality triggers at pool TT7. As stated in **Section 2.5.1.1**, slightly elevated dissolved nickel, dissolved aluminium, dissolved zinc, dissolved iron and electrical conductivity values were recorded at monitoring site TT7-QLa in 2023 after the commencement of mining of LW S1A-S2A. These slightly elevated concentrations reduced after August 2023.

It is noted that the trigger exceedances occurred during periods of below average rainfall when negligible surface flow was reporting to the downstream reach of Teatree Hollow. As such, the load of constituents passing downstream of pool TT7 was likely to have been low.

A Level 1 trigger in relation to dissolved aluminium was recorded at monitoring site TT2-QLa for the period September to November 2023. The pool TT2 water level was very low at the time of sampling and was visually observed as stagnant. As such, it is considered that the dissolved aluminium concentrations recorded from September to November 2023 were reflective of a drying phase rather than typical flow conditions at pool TT2. Following above average rainfall from November 2023, water quality trigger exceedances have not been recorded at monitoring site TT2-QLa.



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### 2.6.5 Summary

As detailed in the Tahmoor South Project Environmental Impact Statement (EIS) (SIMEC, 2019), the Tahmoor South Project Amendment Report (AECOM, 2020) and the Second Project Amendment Report (EMM, 2020), where Teatree Hollow and Teatree Hollow tributary are directly mined beneath, subsidence effects were expected to be of sufficient magnitude to result in the buckling of underlying strata and associated surface fracturing at some locations. At these locations, it was considered likely that water would be diverted from the watercourse into the underlying dilated strata. The diverted flow would be conveyed via the dilated strata and remerge further downstream in the watercourse as surface flow. As such, although Teatree Hollow and Teatree Hollow tributary were likely to incur localised reductions in pool water level and streamflow associated with fracturing in the vicinity of LW S1-S6A, the net reduction in streamflow conveyed from the Teatree Hollow catchment to the Bargo River was expected to be small.

Isolated, episodic pulses in salinity and dissolved metals were expected to occur in Teatree Hollow and the Teatree Hollow tributary due to subsidence induced changes in surface water runoff, underflow and baseflow discharging to these watercourses.

Based on the impacts to surface water features as a result of mining of LW S1A-S2A summarised in the proceeding sections, the following is considered:

- No greater impact than that predicted in the EIS and associated Project Amendment reports has occurred to watercourses within the Subsidence Area.
- No impacts have occurred to other watercourses.
- No exceedance of the performance measures has occurred.
- No material environmental harm has occurred.



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# 3 SURFACE FACILITIES WATER MANAGEMENT

## 3.1 Water Management System

The Tahmoor Mine water management system has been designed to:

- appropriately manage runoff from disturbed areas associated with the Tahmoor Mine;
- increase to a practical maximum the capture and reuse of mine water and disturbed area runoff to meet operational demands;
- increase to a practical maximum on-site water recycling and reuse;
- reduce the capture and use of undisturbed area runoff;
- reduce the use of make-up water from external sources; and
- manage risks to the receiving environment and downstream water users.

A schematic representation of the Tahmoor Mine water management system is shown in **Diagram 1.**

### 3.1.1 Mine Water Storages

The locations of the existing Tahmoor Mine water management storages are shown in **Map 9**. Proposed water management storages, as authorised by SSD 8445, are shown in **Map 10**.



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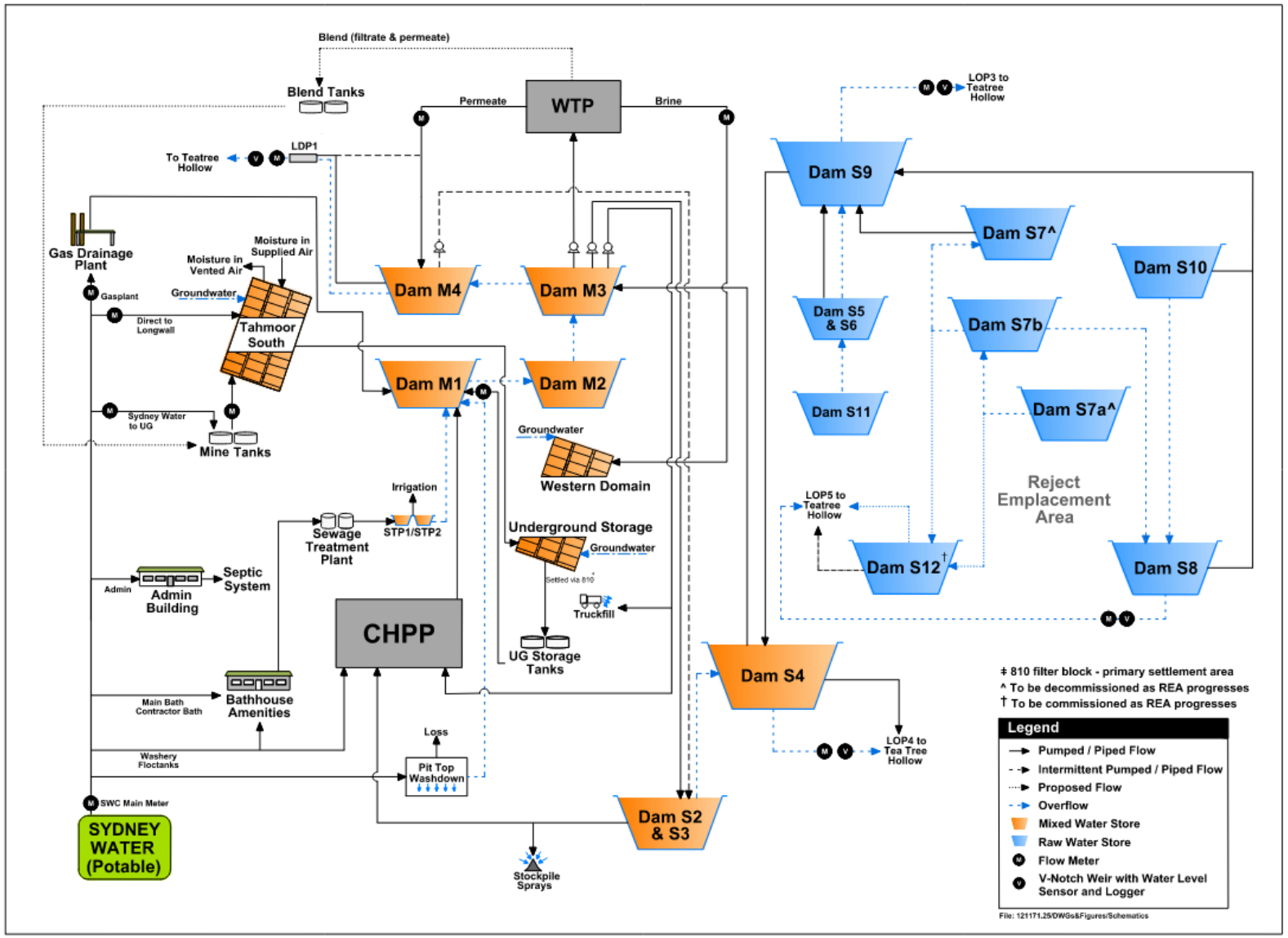
## DIAGRAM 1: WATER MANAGEMENT SYSTEM SCHEMATIC







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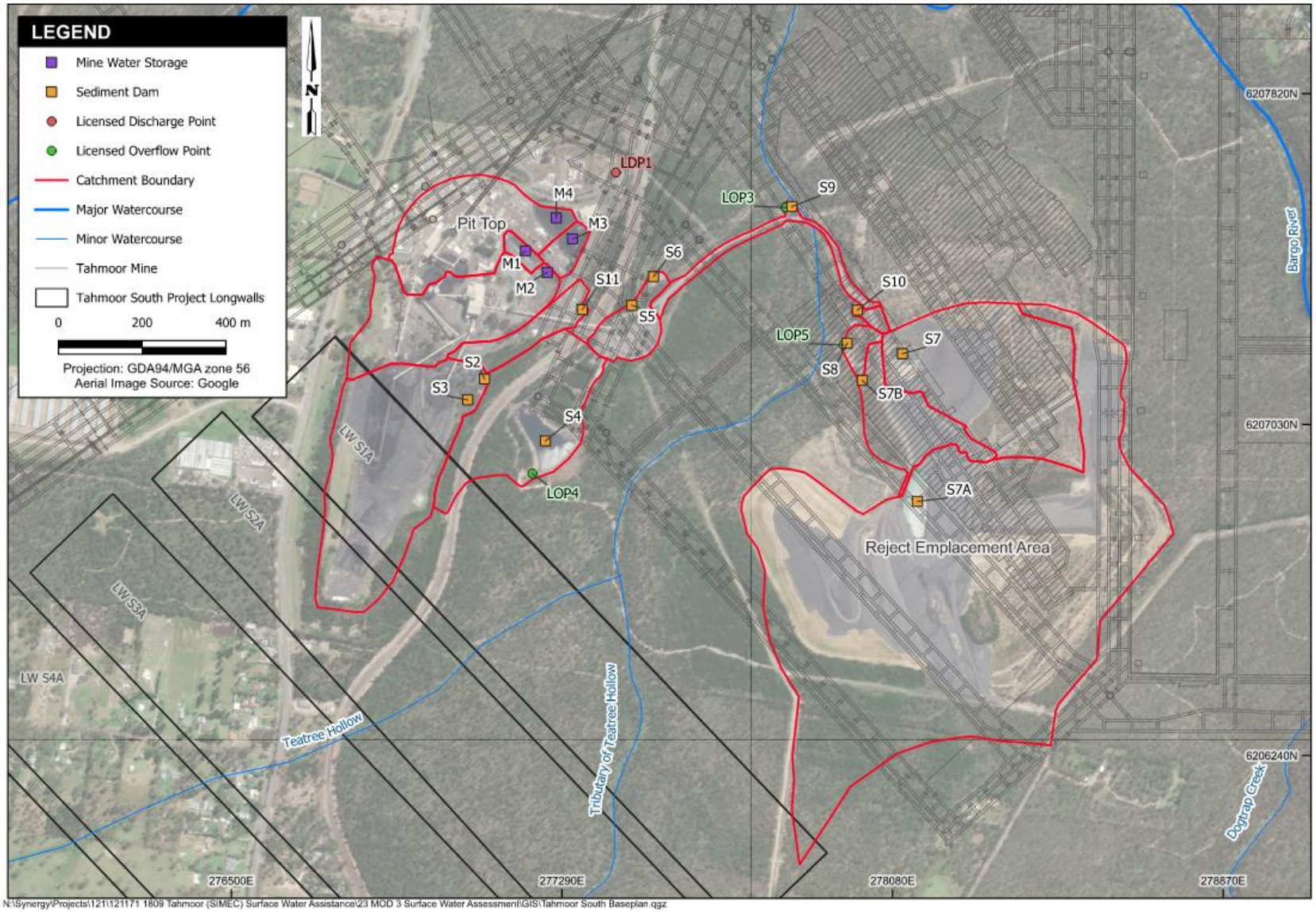
## MAP 9: CURRENT SEDIMENT DAM AND MINE WATER DAM CATCHMENT AREAS



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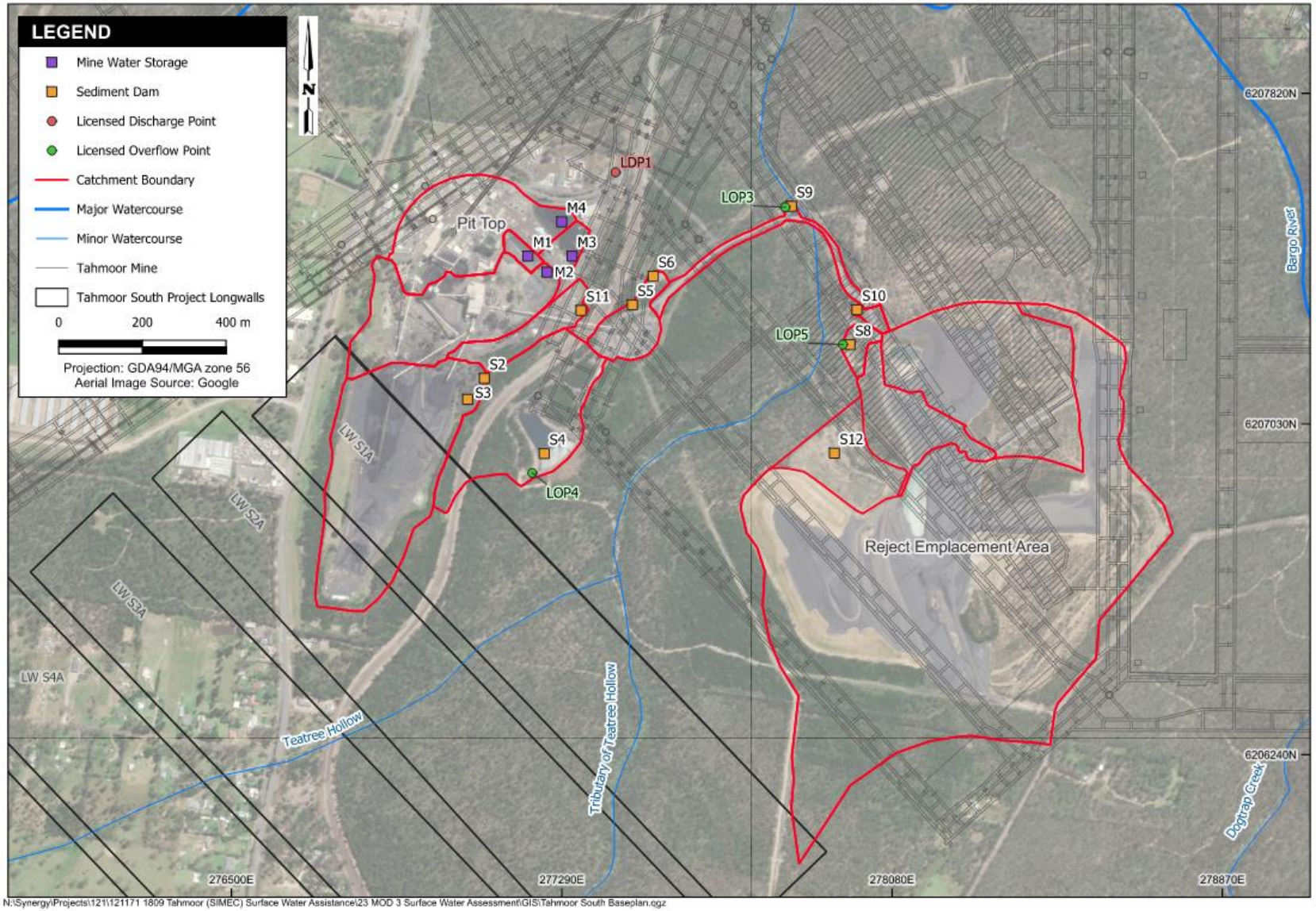
## MAP 10: FUTURE SEDIMENT DAM AND MINE WATER DAM CATCHMENT AREAS



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### 3.1.2 Pit Top Area

The pit top area is predominantly located within the rail loop and encompasses the main surface operations including the Coal Handling and Preparation Plant (CHPP), workshop, warehouse, storage yard areas, Water Treatment Plant (WTP) and mine water dams M1, M2, M3 and M4 (refer **Map 9**). Dam M1 is dosed with flocculant and dam M2 with coagulant, as required, to enhance sediment settling prior to treatment via the WTP.

The CHPP incorporates screening and cyclone circuits to remove inter-burden rock fragments and to separate the coal into coking and thermal products. Coal wash reject material is produced as a waste stream from the CHPP with the fine rejects dewatered in the CHPP using a belt filter press prior to being combined with coarse rejects. This material is conveyed to a transit area on the eastern side of the rail loop prior to being trucked onsite and placed in the Reject Emplacement Area (REA).

Runoff from the workshop area and waste oil tank/storage area reports to an oil water separator. Treated water from the separator reports to dam M1, while the recovered waste oil is transferred to a waste oil tank at the pit top prior to disposal off site. Runoff from the remaining pit top area, including the ROM coal stockpile area and the CHPP, drains to dams M2, M3 and M4. A non-toxic binding agent is used regularly to control dust emissions from the pit top area.

A Gas Drainage Plant and third party Power Generation Station are located adjacent to the mine pit top area. Drainage from this area reports to a surface drain on the outside of the rail loop which discharges to Teatree Hollow via LDP1. The product coal stockpile area drains to dams S2 and S3. Water overflows from these storages into the larger dam S4 where water is automatically dosed with a flocculant. Water from dam S4 is transferred to dam M3 while overflow reports to Teatree Hollow via LOP4 in accordance with EPL 1389.

Effluent from the main bathhouses, production offices and CHPP is treated onsite via the existing sewage treatment plant (STP). Treated water from the STP discharges into two maturation ponds (STP1 and STP2) which currently overflow to dam M1. Tahmoor Coal is investigating alternative options for management of STP discharges including application of treated water for irrigation purposes within the Tahmoor Mine pit top area. Separate septic treatment systems are used to treat sewage from the demountable offices located on site and the main administration building.

Water required in the CHPP is supplied (recycled) from dam M3. A small volume of potable water is supplied by Sydney Water for pump glands, flocculation and reagent dosing. Water in dam M3 is also pumped to a truckfill point near the REA for use in dust suppression on the haul road to the REA and on the REA itself. Water for dust suppression on the product coal stockpile area is drawn from dams S2 and S3.

In future, Tahmoor Coal intend to utilise WTP permeate supply in lieu of Sydney Water Supply for underground mine purposes. At present, permeate from the WTP discharges to Teatree Hollow via LDP1. When the WTP is operating at full capacity, WTP permeate would be transferred either directly to LDP1 or to LDP1 via dam M4.

Dam M4 is operated to maintain sufficient capacity to capture sediment laden runoff during a 95$^{th}$ percentile, 5-day duration rainfall event in accordance with Landcom (2004). As such, during a rainfall event, permeate would discharge directly from the WTP to Teatree Hollow via LDP1. At other times, permeate discharge would occur via dam M4.

### 3.1.3 Reject Emplacement Area

Rejects from the CHPP comprise dewatered fines and coarse reject. These reject streams are mixed and transported via conveyor to a bin and loading area prior to placement in the REA which is located some 1.5 km east of the pit top area – refer **Map 9**.

The REA stormwater management system comprises a network of collection drains and sediment dams (S7, S7a, S7b, S8, S9 and S10) – refer **Diagram 1**. Runoff which collects in these storages is currently pumped to dam S4 for automatic flocculant dosing. Water from dam S4 is pumped to mine water dam M3 or, during wet weather, discharges to Teatree Hollow via LOP4 in accordance with EPL 1389. The REA also includes LOP3 for overflow from dam S9 and LOP5 for overflow from dam S8.

An additional sediment dam (S12), with a total storage capacity of 44.7 ML, is proposed to be commissioned in mid to late 2024 – refer **Map 10**. Dam S12 has been designed to provide sufficient



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capacity to manage sediment laden runoff during a 95th percentile, 5-day duration rainfall event, in accordance with Landcom (2004) and DECC (2008). The design capacity of Dam S12 is sufficient to manage runoff from the catchment area of the existing dam S7, dam S7a and dam S7b which are proposed to be decommissioned as the REA development progresses.

Controlled release from dam S4 to LOP4 and from dam S12 to LOP5 would be undertaken to reinstate the settling zone capacity of the sediment dams within 5 days following capture and settling of the design rainfall event. It is noted that controlled release from dam S4 and dam S12 may be required to be undertaken at intermittent periods following lower intensity rainfall, as well as during rainfall events which equal or exceed the design rainfall, to reinstate the settling zone capacity. Tahmoor Coal would aim to conduct controlled release during rainfall events to promote dilution and reduce the potential for water quality impacts to the downstream receiving environment.

### 3.1.4 Water Treatment Plant

In accordance with Condition B30 of SSD 8445, a WTP was commissioned in late 2023. Under normal operations, the WTP treats up to 3 ML/d of water from dam M3. Dependent on the stored water volume of dam M3, the operating capacity of the WTP may be increased to 6 ML/d with a maximum of 7.2 ML/d able to be treated.

The WTP has been designed to operate with a recovery rate of up to 95% i.e. 95% permeate, 5% brine (Ixom, 2021). The contract water quality requirements of the WTP are listed in **Table 10**.

**TABLE 10: WTP PERMEATE WATER QUALITY CONTRACT REQUIREMENTS**

| Parameter | Units | Water Quality Requirements |
|---|---|---|
| pH | - | 6.5-8.0 |
| Oil and grease | mg/L | <5 |
| Electrical Conductivity | µS/cm | <300 |
| Bicarbonate Alkalinity as $CaCO_3$ | mg/L | <150 |
| Dissolved Aluminium | mg/L | <0.03 |
| Dissolved Arsenic | mg/L | <0.024 |
| Dissolved Barium | mg/L | <0.2 |
| Dissolved Copper | mg/L | <0.0011 |
| Total Manganese | mg/L | <0.2 |
| Dissolved Nickel | mg/L | <0.011 |
| Dissolved Zinc | mg/L | <0.008 |
| Total Iron | mg/L | <0.2 |
| Total Nitrogen | mg/L | <0.25 |

Source: Tahmoor Coal (2021).

### 3.1.5 Brine Disposal

The WTP will produce a brine by-product. Modification 2 of SSD 8445 authorises the storage of the brine from the WTP in the historical workings of the Tahmoor North Western Domain. As a contingency for when brine is unable to be pumped underground for storage, for example during maintenance periods of pumping infrastructure, the WTP will have four brine storage tanks that can store up to 46 kL of brine each, equating to a maximum storage capacity of 184 kL of brine at any given time.



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### 3.1.6 Sydney Water Supply

Tahmoor Coal currently sources additional water supply from Sydney Water for the following purposes (refer **Diagram 1**):

- pit top washdown;
- make-up water supply for the CHPP;
- CHPP flocculation and washery;
- underground mine purposes;
- administration building and bathhouse amenities; and
- Gas Drainage Plant.

In future, Tahmoor Coal intend to utilise permeate supply in lieu of Sydney Water Supply for underground mine purposes. As indicated in **Diagram 1**, permeate may be blended with feed water for underground mine usage. This would be undertaken to reduce the volume of feed water required to be treated via the WTP and subsequently reduce the volume of brine produced.



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# 4 SITE WATER AND SALT BALANCE

## 4.1 Model Description

### 4.1.1 General

A water and salt balance model has been developed for Tahmoor Coal to simulate the storages and linkages shown in schematic form in **Diagram 1**. The water and salt balance model simulates all inflows, outflows, transfers and changes in storage of water on-site at each model time step (i.e. 8-hourly basis).

For each storage, the model simulates:

Change in Storage = Inflow – Outflow

Where:

Inflow includes rainfall runoff, groundwater inflow to the active underground mine and potable water supply.

Outflow includes evaporation, licensed discharge, overflow and water use.

### 4.1.2 Climatic Data and Model Simulation Period

A total of 135 years of daily rainfall and pan evaporation data (from 1889 to 2023) was sourced from the SILO Point Data and input to the site water balance model. The SILO Point Data was obtained for a location near the REA and pit top area.

The model was used to simulate the water balance for the period 1 March 2024 to 1 July 2033 (9 years and 4 months) – to the end of the proposed Project life. The model simulates 135 different daily climatic (rainfall and evaporation) 'realizations' compiled from SILO Point Data for the period from 1889. Modelled realizations were formed by 'moving' along the historical record one year at a time with the first realization comprising the first 9 years and 4 months in the record, the second advancing by one year in the record, the third advancing by two years and so on. The start and end of the historical data was 'linked' so that additional realizations which included years from both the beginning and end of the historical data were combined to generate additional climatic realizations. Using this methodology, 135 realizations of daily rainfall and evaporation for 9 years and 4 months were formulated for use in the model simulations. The results from all realizations were used to generate water storage volume estimates and other relevant water and salt balance statistics. This method effectively includes all recorded historical climatic events in the water balance model, including high, low and median rainfall periods. By ranking simulated outcomes, the model can be used to estimate the probability and consequences of different water management outcomes occurring.

### 4.1.3 Tahmoor Mine Catchments and Sub-Catchments

The pit top area catchments reporting to each storage are shown in **Map 9** and **Map 10**. These catchments are not expected to change over the Project life. Minor changes to the REA catchments are proposed to occur as the REA development progresses, as illustrated in **Map 10**.

The total modelled water management system storage catchment area over the Project life is shown in **Graph 6**. The total catchment area reporting to site storages is currently estimated at 125.8 hectares (ha), increasing to an estimated 129.6 ha following commissioning of dam S12.

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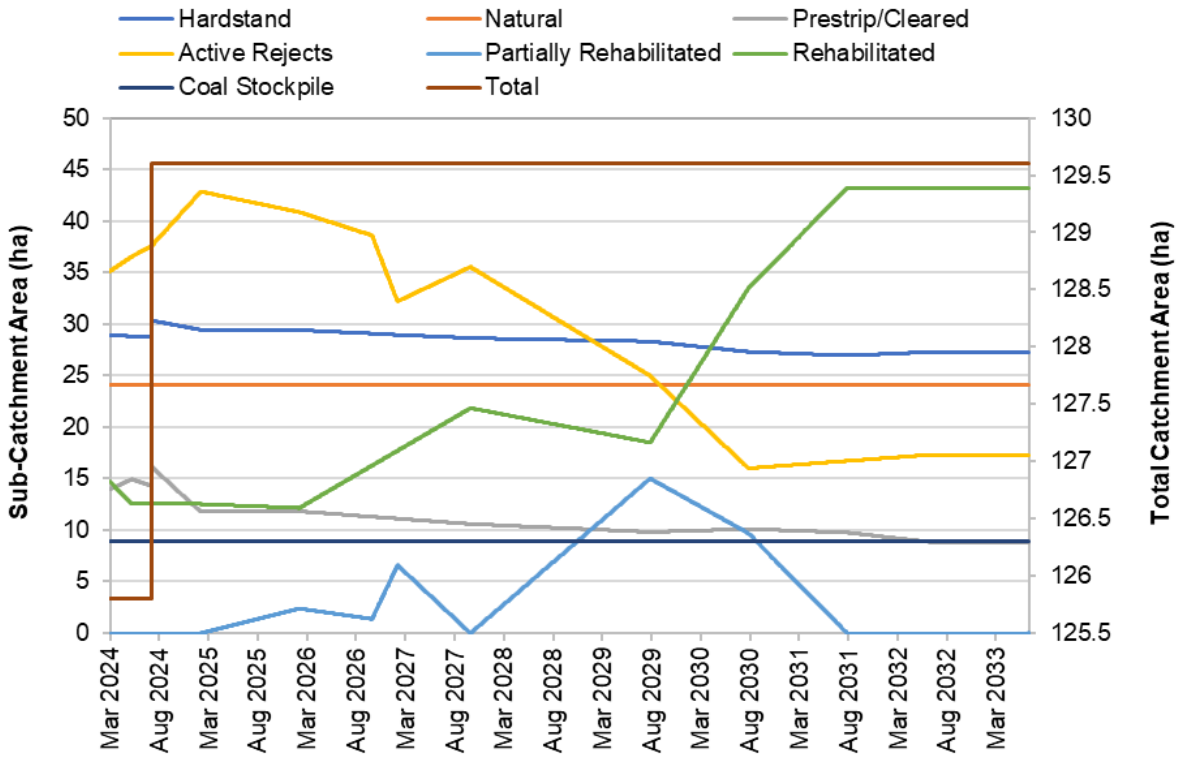
**GRAPH 6: WATER MANAGEMENT SYSTEM SUB-CATCHMENT AND TOTAL CATCHMENT AREA**




### 4.1.4 Rainfall Runoff Modelling

Rainfall runoff in the water balance model is simulated using the Australian Water Balance Model or AWBM (Boughton, 2004). The AWBM is a nationally-recognised, catchment-scale water balance model that estimates streamflow from rainfall and evaporation.

For the purposes of hydrological modelling, catchment areas were split into the following seven different sub-catchment types:

1. Hardstand areas - including roads, paved areas, buildings and storage areas;
2. Natural areas (undisturbed by mining or reject placement activities);
3. Cleared and stripped areas in the REA (i.e. natural areas that have been cleared of vegetation and topsoil stripped in preparation for reject disposal);
4. Active reject disposal areas;
5. Partially rehabilitated reject disposal areas – rehabilitated areas for which vegetation has become partially established;
6. Fully rehabilitated reject disposal areas; and
7. Coal stockpile areas.

The identification of sub-catchment areas was based on the most recent aerial photograph (2023), the current and future water management system (refer **Map 9** and **Map 10**) and planned future progression of the REA. Calculated sub-catchment areas for the entire water management system (all storages) over the Project life are shown in **Graph 6**.

For the natural sub-catchment type, model parameters were derived from an AWBM (rainfall runoff model) calibrated to recorded daily flows at a nearby gauged watercourse[6]. Parameters for other sub-

[6] Redbank Creek flow measured at the gauging station at monitoring site RC11 (GS300048) from December 2009 to March 2013.



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catchment types were initially set based on experience with similar projects and adjusted as part of model calibration (refer **Section 4.1.13**).

### 4.1.5 Water Demand

The CHPP is a major water user at the Tahmoor Coal Mine, however, a significant proportion of the water used is internally recycled via the use of a tailings belt filter press. Make-up water is required to replace residual water exported with the combined process tailings and coarse reject material, moisture in product coal plus minor incidental losses such as wash down, water used in pipe flushing during shut downs and other ancillary uses. The first priority for CHPP make-up water is recycled water from dam M3. Supply from Sydney Water is used as the second priority source of water to satisfy any un-met make-up water demand[7].

The CHPP make-up water demand has been calculated based on forecast tonnages and the following moisture contents:

- ROM (CHPP feed) coal: 7.5% (w/w)
- Coking product coal: 8.5% (w/w)
- Secondary product coal: 6% (w/w)
- Combined (coarse rejects and tailings) rejects (on conveyor): 9% (w/w)

The proposed annual ROM coal production, product and calculated CHPP make-up water demands over the proposed Project life are summarised in **Table 11**.

**TABLE 11: ANNUAL CHPP PROCESSING AND WATER DEMAND RATES**

| Financial Year | Bulk ROM (Mt)* | Product (Mt)† | CHPP Make-Up Demand (ML) |
|---|---|---|---|
| 2024 | 2.5 | 1.5 | 53.4 |
| 2025 | 3.9 | 2.5 | 62.7 |
| 2026 | 3.6 | 2.3 | 97.5 |
| 2027 | 3.8 | 2.6 | 87.5 |
| 2028 | 3.2 | 2.3 | 96.2 |
| 2029 | 3.1 | 2.4 | 79.5 |
| 2030 | 2.7 | 2.1 | 75.7 |
| 2031 | 3.6 | 2.9 | 63.4 |
| 2032 | 3.4 | 2.7 | 84.6 |
| 2033 | 3.5 | 2.8 | 77.5 |

* At ROM moisture; † At Product moisture

Water is also used for dust suppression on the REA, internal haul roads and for suppression of dust emissions from coal stockpiles. Whilst the overall area of the REA will increase slightly, with progressive rehabilitation, it is expected that there will not be a significant increase in dust suppression water demand over the life of the Modification. The advised demand for dust suppression water is 11 ML/annum for the REA and haul roads and 73 ML/annum for coal stockpile areas.

The water demand for the underground mining operations over the life of the Modification has been estimated at an average of 1.7 ML/d and a maximum of 2 ML/d based on long-term monitoring records.

[7] There are also some processes in the CHPP which require potable grade water which cannot be satisfied using water from dam M3 due to water quality constraints – e.g. supply to flocculant tanks and washery potable supply. These demand rates have been based on recent average monitored use data with future variations proportioned according to forecast ROM coal tonnages.



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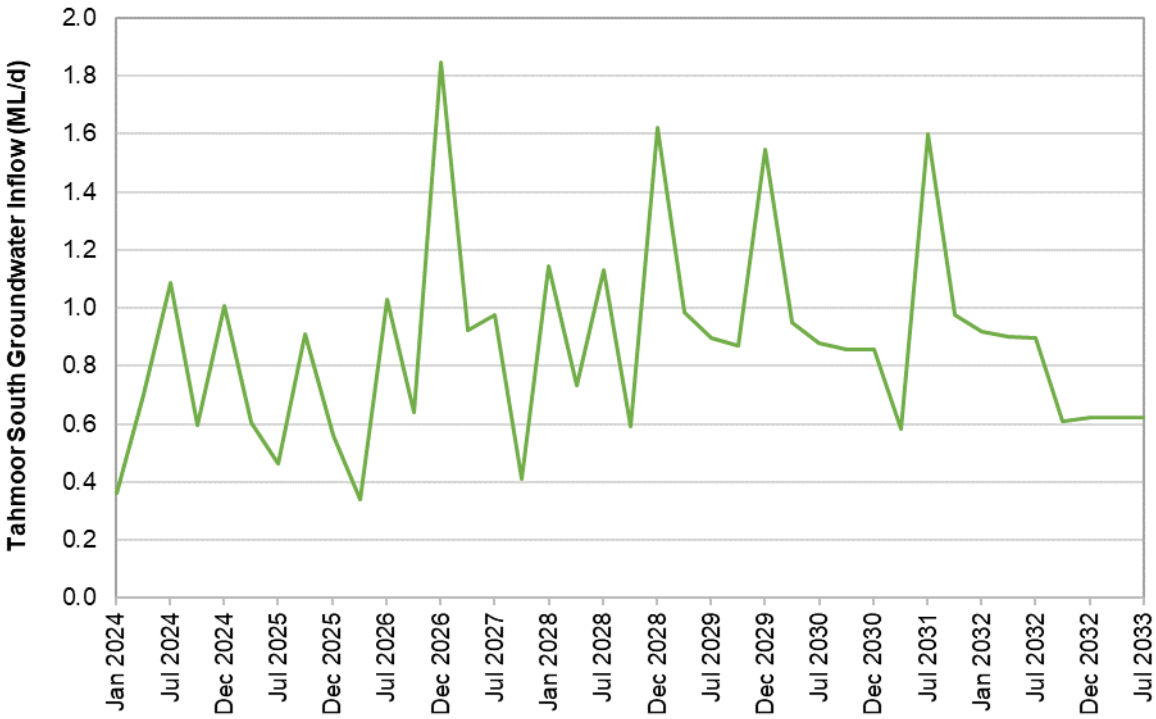
Where the underground mine demand exceeds the supply rate from dam M3, additional supply is sourced from Sydney Water.

As stated in **Section 3.1.6**, Tahmoor Coal intend to blend permeate with feed water in future for underground mine usage. As the required infrastructure is not currently in place, blending has not been considered in the water and salt balance modelling for the Modification. It is considered that the model results therefore reflect a conservative estimate of the Sydney Water demand and the volume of brine predicted to be produced over the life of the Modification.

### 4.1.6 Mine Dewatering

Predictions of groundwater inflow to the Tahmoor South underground mining operations over the life of the proposed Project were provided by SLR (2024). The predicted groundwater inflow rates are plotted in **Graph 7**.

**GRAPH 7: PREDICTED GROUNDWATER INFLOW RATES**




The data presented in **Graph 7** indicates a peak rate of groundwater inflow of 1.85 ML/d in early 2027. On average, a groundwater inflow rate to Tahmoor South of 0.88 ML/d is predicted.

It is noted that, on average, the groundwater inflow predictions for the Modification are less than that previously predicted for LW S1A-S6A (EMM, 2022). This is related to changes to the numerical groundwater flow modelling conducted for the Modification (SLR, 2024).

Moisture in ventilation air entering and leaving the underground mining operations is simulated based on long-term average monthly values calculated from air flow and temperature data supplied by Tahmoor Coal. Values of 0.36 ML/d and 0.67 ML/d were calculated for ventilation inflow and outflow respectively.

### 4.1.7 Protocols for Water Transfers

Tahmoor Coal propose to implement changes to the water transfer protocols such that overflow from sediment dams only occurs during the 95$^{th}$ percentile, 5-day rainfall event in accordance with Landcom (2004).

Current protocols for water transfers are summarised in **Table 12** while the proposed water transfer protocols are summarised in **Table 13**. The current water transfer protocols were simulated in the water



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and salt balance model up to the time of commencement of dam S12 (assumed August 2024) with the proposed water transfer protocols simulated from August 2024.

**TABLE 12: CURRENT SEDIMENT DAM OPERATING TRIGGER VOLUMES**

| Source | Destination | Pump Start Trigger | Pump Stop Trigger | Flow Rate |
|---|---|---|---|---|
| S7 | S9 | S9 < 70% total capacity | S9 >= 70% total capacity | 20 L/s maximum |
| S8 | S9 | S9 < 35% total capacity | S9 >= 35% total capacity | 11.4 L/s |
| S9 | S4 | S9 >= 10% total capacity | S9 < 5% capacity or S4 >= 95% total capacity | 60 L/s |
| S4 | M3 | S4 >= 90% total capacity and M3 < 80% total capacity | S4 < 90% total capacity or M3 >= 80% total capacity | 50 L/s |

**TABLE 13: PROPOSED SEDIMENT DAM OPERATING TRIGGER VOLUMES**

| Source | Destination | Transfer Start Trigger | Transfer Stop Trigger | Flow Rate |
|---|---|---|---|---|
| S7 | S9 | S9 < 70% total capacity and S7 => MOV(1) | S9 > 70% total capacity or S7 <= SSV(2) | 20 L/s |
| S8 | S9 | S9 < 60% total capacity and S8 => 80% total capacity | S9 > 60% total capacity or S8 <= 30% total capacity | 11.4 L/s |
| S9 | S4 | S4 < MOV and S9 > 20% capacity | S4 >= MOV or S9 <= 10% capacity | 60 L/s |
| S12 | Controlled release | S12 >= 75% total capacity | S12 <= SSV | 80 L/s |
| S4 | M3 | M3 <= 57%(3) total capacity and S4 > SSV | M3 > 67%(4) capacity or S4 <= SSV | 50 L/s |
| | Controlled release | S4 > MOV | S4 <= MOV | 50 L/s |

Notes:

1. MOV = maximum operating volume - the volume retained above the maximum operating volume (i.e. total capacity minus maximum operating volume) is equal to the recommended settling zone capacity.
2. SSV = sediment storage zone volume.
3. Estimated percentage of total capacity at 2.65 m depth – trigger level to commence pumping from dam S4.
4. Estimated percentage of total capacity at 3.4 m depth – trigger level to stop pumping from dam S4.

### 4.1.8 Water Management System Inflows and Outflows

The water management system inflows comprise (refer **Diagram 1**):

1. Rainfall runoff
2. Moisture in ROM coal - refer **Section 4.1.5**
3. Sydney Water supply (based on historical records):
    a. CHPP flocculation and washery – 23 litres (L) per ROM tonne
    b. Pit top washdown – average 111 ML/annum
    c. Surface amenities (such as bathhouse and administration area use) – 18 ML/annum
    d. Gas Drainage Plant – 5.3 ML/annum
    e. Underground mine demand - refer **Section 4.1.5**



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f. CHPP make-up water - refer **Section 4.1.5**

4. Groundwater inflow – refer **Section 4.1.6**
5. Moisture entering the underground mine via the ventilation system - refer **Section 4.1.6**

The overall system outflows from the water balance comprise:

1. Evaporation from water storages
2. Moisture in product coal and reject - refer **Section 4.1.5**
3. Moisture exiting the mine via the ventilation system - refer **Section 4.1.6**
4. Haul road and stockpile dust suppression - 84 ML/annum (refer **Section 4.1.6**)
5. Water discharged to the environment (via LDP1 and LOPs)
6. Water losses during truck washdown and other facilities water use - 11 ML/annum based on an estimated 10% loss of wash down use

### 4.1.9 Water Treatment Plant

The WTP was simulated with a normal operating capacity of 3 ML/d and a maximum treatment capacity of 6 ML/d (refer **Section 3.1.4**). A 95% recovery rate was simulated, i.e. 95% permeate, 5% brine, as per the WTP design parameters (Tahmoor Coal, 2021).

### 4.1.10 Brine and Permeate Rates and Salinity

The brine and permeate rates and salinity concentrations were predicted using the following equations from Saltonstall (1982):

Eq. 1 $$Q_f = Q_b + Q_p$$

where: $Q_f$ = simulated feed rate

$Q_b$ = simulated brine rate

$Q_p$ = simulated permeate rate

Eq. 2 $$Q_p = YQ_f$$

where: $Y$ = recovery rate = 95% (Ixom, 2021)

Eq. 3 $$r = \frac{Cf - Cp}{Cf}$$

where: $r$ = salt rejection

$Cf$ = median feed EC of historical data for dam M3 = 2,150 µS/cm

$Cp$ = average permeate calculated from daily records of permeate EC = 25 µS/cm (Ixom, 2021)

Eq. 4 $$\overline{Cp} = (1 - r)\overline{Cf}$$

where: $\overline{Cp}$ = simulated permeate EC

$\overline{Cf}$ = simulated feed water EC

Eq. 5 $$\overline{Cb} = \frac{\overline{Cf} - Y\overline{Cp}}{1 - Y}$$

where: $\overline{Cb}$ = simulated brine EC

It is understood that permeate would be dosed prior to discharge to LDP1 to increase the pH and subsequently the EC to approximately 100 µS/cm.



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### 4.1.11 Salinity Estimates

Salinity (EC) values were estimated from contemporary water quality monitoring data of local surface water monitoring sites, existing site water storages and underground dewatering. Following initial model simulation, the predicted salinity values of the site water storages were reviewed against monitored water quality records and, where relevant, modified to improve the match of recorded to simulated EC values. **Table 14** presents the adopted modelled salinity for each flow component.

**TABLE 14: MODELLED SALINITY**

| Component | | EC (µS/cm) | Basis |
|---|---|---|---|
| Groundwater | | 4,500 | Estimated based on median recorded EC of underground dewatering since the commencement of mining of LW S1A-S2A |
| Sydney Water | | 157 | Average TDS of 80.5 mg/L in 2023 (Sydney Water, 2023a; 2023b; 2023c; 2024) |
| Sub-catchment | Natural | 453 | Long-term median EC recorded at monitoring site TT1-QLa in Teatree Hollow |
| | Hardstand | 732 | Estimated from water quality records for REA dams accounting for the area of hardstand sub-catchment |
| | Cleared and stripped areas | 1,000 | Estimated from water quality records for REA dams accounting for the area of cleared and stripped sub-catchment |
| | Active rejects disposal | 2,900 | Estimated from water quality records for REA dams accounting for the area of active rejects disposal |
| | Partially rehabilitated areas | 1,800 | Estimated from water quality records for REA dams accounting for the area of partial rehabilitation |
| | Rehabilitated areas | 600 | Estimated from water quality records for REA dams accounting for the area of rehabilitated sub-catchment |
| | Coal stockpile areas | 3,929 | Estimated from water quality records for dam S4 accounting for the area of coal stockpile associated with dam S2/S3 |
| WTP | Permeate | 100 | Estimated permeate EC following dosing and prior to release to LDP1 |
| | Brine | Variable – predicted based on equations presented in **Section 4.1.10** | |

To enable mass balance calculations to be simulated in the site water and salt balance, factors were adopted for conversion of EC to total dissolved solids (TDS) based on Rusdyi (2018). The adopted factors are listed in **Table 15** and were linearly interpolated dependent on the simulated EC value.



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**TABLE 15: EC TO TDS CONVERSION FACTOR**

| EC (µS/cm) | Conversion Factor |
|---|---|
| 10 | 0.5 |
| 500 | 0.55 |
| 4,500 | 0.64 |
| 45,000 | 0.7 |
| 65,000 | 0.75 |

#### 4.1.12 Initial Electrical Conductivity Estimates

Initial storage salinities were adopted based on the latest EC records for mine dewatering, LDP1 and the LOPs, just prior to the commencement of the model simulation period. **Table 16** lists the adopted initial stored water EC for each storage.

**TABLE 16: MODELLED INITIAL STORAGE SALINITIES**

| Storage | Adopted Initial Stored Water EC (µS/cm) |
|---|---|
| Dam S7, S7a, S7b, S8 | 1,720 |
| Dam S2/S3, S4 | 1,840 |
| Dam S9 | 1,680 |
| Dam M3 | 1,820 |
| Dam M4 | 1,880 |
| Dam M1, M2 | 2,490 |
| Active Underground Mine | 2,490 |

#### 4.1.13 Model Calibration

As described in HEC (2020), model calibration was undertaken using a two-year period of recorded data for 2014 and 2015 with the aiming of reconciling recorded and simulated release from LDP1 and the LOPs (i.e. dam M4, S4, S8 and S9). As part of calibration, AWBM parameters for sub-catchments were adjusted iteratively to improve the match between modelled and recorded release volumes. Few changes to the site water management system have been implemented since 2014 and therefore it is considered that the model calibration remains valid.

### 4.2 Water and Salt Balance Predictions

The predicted performance of the water management system to meet the design objectives over the proposed Project life has been assessed based on the model results for 135 simulated realizations (refer **Section 4.1.2**). The following model results are presented:

- The average water balance which provides an overall (i.e. high level) understanding of the magnitude of different components of the site water balance.
- Predicted rates of brine and permeate to be produced via the WTP.
- Predicted annual discharge volume (release and overflow) to LDP1.
- Predicted discharge EC to LDP1.
- Predicted frequency of overflow and controlled release events to LOPs.
- Predicted brine volume to be disposed of in the historical Tahmoor North Western Domain.
- Predicted EC of WTP brine to be disposed of in the historical Tahmoor North Western Domain.



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### 4.2.1 Average System Inflows and Outflows

The simulated average annual total system inflows and outflows over the proposed Project life are summarised in **Table 17**. The results have been averaged over the full model simulation period of 9 years and 4 months.

The results presented in **Table 17** indicate that Sydney Water supply is predicted to comprise the largest proportion of total site water inflows while discharge to LDP1 is predicted to comprise the largest proportion of total site water outflows.

It is noted that Tahmoor Coal intend, in future, to blend permeate with feed water for underground mine usage. This would reduce both the Sydney Water demand and the rate of permeate discharge to LDP1.

**TABLE 17: SIMULATED AVERAGE ANNUAL WATER BALANCE RESULTS**

| Description | Volume (ML/annum) | Percentage of Total Inflows / Outflows |
|---|---|---|
| ***Inflows*** | | |
| Rainfall Runoff | 392 | 24% |
| Sydney Water Supply | 783 | 20% |
| Groundwater Inflow to Underground Mine | 323 | 48% |
| Ventilation Moisture (In) | 131 | 8% |
| **Total Inflows** | 1,629 | |
| ***Outflows*** | | |
| Evaporation | 39 | 2% |
| Discharge via LDP1 | 953 | 59% |
| Release via LOPs | 188 | 12% |
| CHPP Make-Up Water Supply | 32 | 2% |
| Haul Road Dust Suppression | 10 | 1% |
| Stockpile Sprays (Dust Suppression) | 73 | 4% |
| Pit Top Washdown Water, Sealing Washdown, Office Supply | 39 | 2% |
| Ventilation Moisture (Out) | 245 | 15% |
| Brine | 48 | 3% |
| **Total Outflows** | 1,627 | |

### 4.2.2 Predicted Permeate and Brine Rates

**Graph 8** presents the simulated feed water rates to the WTP and associated produced brine and permeate rates.



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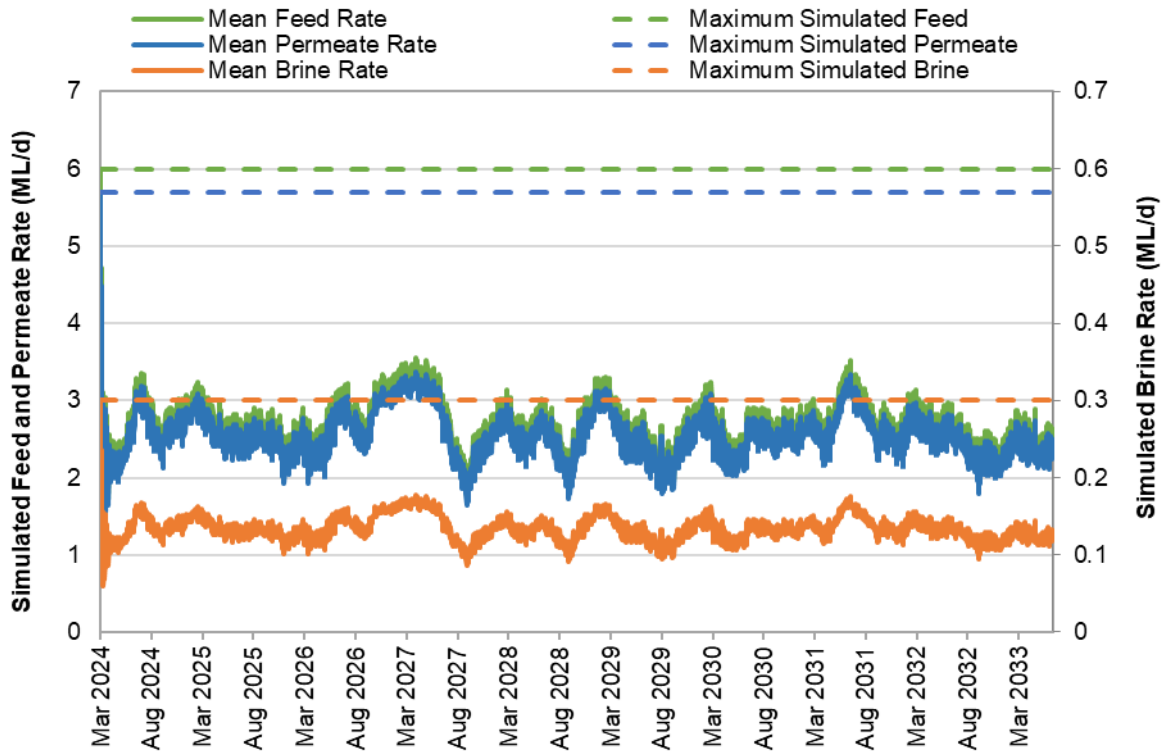
**GRAPH 8: PREDICTED WTP RATES**




Based on the mean model results, the WTP is predicted to treat an average of 2.7 ML/d with an average of 2.56 ML/d permeate and 0.14 ML/d brine produced.

### 4.2.3 Predicted Discharge to LDP1

Simulated annual volumes of water discharged via LDP1 over the Project life - comprising overflow from dam M4, controlled release from dam M4 and permeate release direct from the WTP - are shown in **Graph 9**. The 5$^{th}$ percentile, median and 95$^{th}$ percentile predicted volumes, calculated from all 135 simulated realizations, are presented. It is noted that the volumes for 2024 are for a 10 month period (from March 2024) and the results for 2033 are for a 6 month period (to July 2033).

The results presented in **Graph 9** illustrate that discharge via LDP1 to Teatree Hollow is predicted to peak in 2031 at 1,175 ML based on the 95$^{th}$ percentile results and 1,003 ML based on the median results. The 95$^{th}$ percentile predicted peak annual discharge volume equates to an average of 3.2 ML/d discharged via LDP1 in that year, while the median predicted peak annual discharge volume equates to 2.7 ML/d.

On average, based on the results for the full simulation period (9 years and 4 months) and all 135 realizations, discharge to LDP1 is predicted at 953 ML/annum or 2.6 ML/d (refer **Table 17**). Based on site records, the average daily discharge rate to LDP1 in 2023 was 2.4 ML/d. As such, the predicted average daily discharge rate of 2.6 ML/d is only slightly greater than the average daily discharge recorded in 2023, noting that 2023 was a generally below average rainfall year.

**Graph 10** presents the predicted salinity (EC) duration curves for the model realizations equating to the median and 95$^{th}$ percentile total rainfall for the 9 year, 4 month simulation period.



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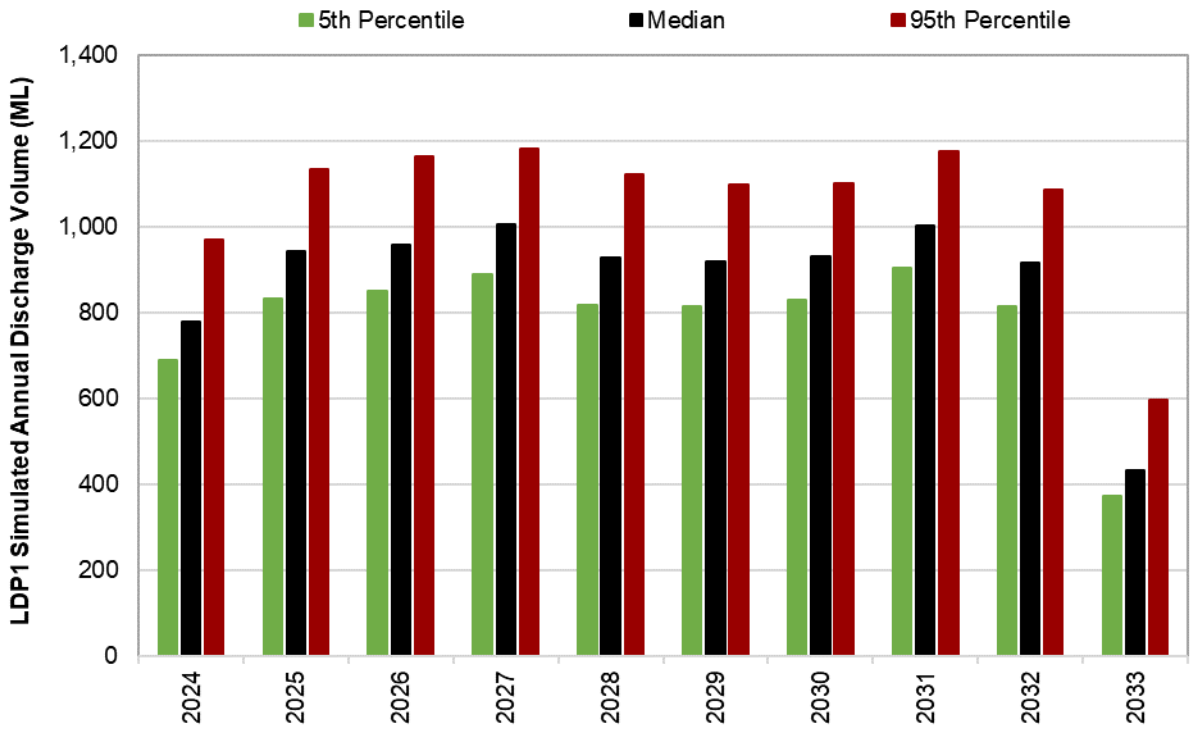
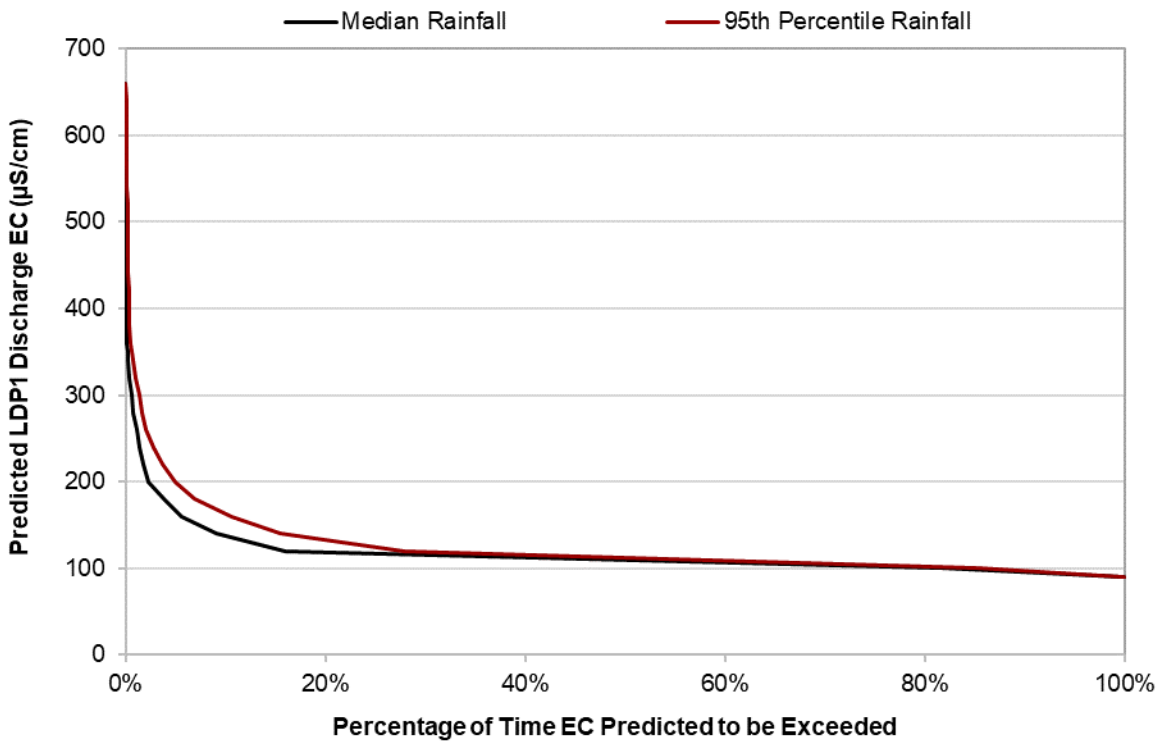
**GRAPH 9: SIMULATED ANNUAL RELEASE AND OVERFLOW VIA LDP1 TO TEATREE HOLLOW**




**GRAPH 10: DISCHARGE VIA LDP1 TO TEATREE HOLLOW - SIMULATED EC DURATION CURVES**



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The results presented in **Graph 10** show that, for the majority of time, the EC of discharge to LDP1 is predicted at less than 350 µS/cm based on the model realizations equating to the median and 95$^{th}$ percentile total rainfall. Few exceedances of 350 µS/cm were predicted to occur during simulated periods of overflow from dam M4.

### 4.2.4 Predicted Frequency of Overflow and Controlled Release to LOPs

Based on the model realizations that equate to the median and 95$^{th}$ percentile total rainfall for the model simulation period (9 years, 4 months), **Table 18** presents the predicted frequency of:

- average number of days per year in which the simulated preceding 5-day cumulative rainfall depth was greater than the 95$^{th}$ percentile, 5-day rainfall depth of 50.7 mm[8] (design rainfall event);
- average number of rainfall events that exceeded this[9];
- average number of days per year in which overflow or release was predicted to occur; and
- average number of predicted overflow or release events per year - where an overflow event is defined as a single period of consecutive days of overflow or release from a dam.

**TABLE 18: PREDICTED FREQUENCY OF RAINFALL, OVERFLOW AND CONTROLLED RELEASE EVENTS**

| Rainfall / Overflow Point | | Median | | 95$^{th}$ Percentile | |
|---|---|---|---|---|---|
| | | Average No. of Days Per Year | Average No. of Events Per Year | Average No. of Days Per Year | Average No. of Events Per Year |
| 95$^{th}$ percentile, 5-day rainfall | | 15 | 4 | 22 | 5 |
| **Overflow Dam** | **Overflow Point** | | | | |
| S9 | LOP3 | 0 | 0 | 1 | 1 |
| S4 | LOP4 | 0 | 0 | 0 | 0 |
| S8 | LOP5 | 3 | 1 | 4 | 1 |
| S12 | LOP5 | 1 | 1 | 3 | 2 |
| **Controlled Release Dam** | **Controlled Release Point** | | | | |
| S4 | LOP4 | 1 | 1 | 5 | 1 |
| S12 | LOP5 | 14 | 2 | 22 | 3 |

The model predictions presented in **Table 18** indicate that, on average, 1-2 overflow events per year are predicted to occur. An average of three controlled release events per year from dam S12 to LOP5 are predicted based on the model realization equating to the 95$^{th}$ percentile total rainfall. This is less than the average number of design rainfall events per year predicted based on the model realization equating to the 95$^{th}$ percentile total rainfall.

### 4.2.5 Predicted Produced Brine Volume

**Graph 11** presents the predicted cumulative volume of brine produced from the WTP over the proposed Project life based on the 5$^{th}$ percentile, median and 95$^{th}$ percentile model results.

[8] Assessment of 134 years of rainfall data obtained from SILO Point Data identified that the 95$^{th}$ percentile 5-day duration rainfall depth for the Tahmoor Mine was 50.7 mm.

[9] An event is defined as a single period of consecutive days in which the preceding 5-day total rainfall depth exceeded the design rainfall depth.



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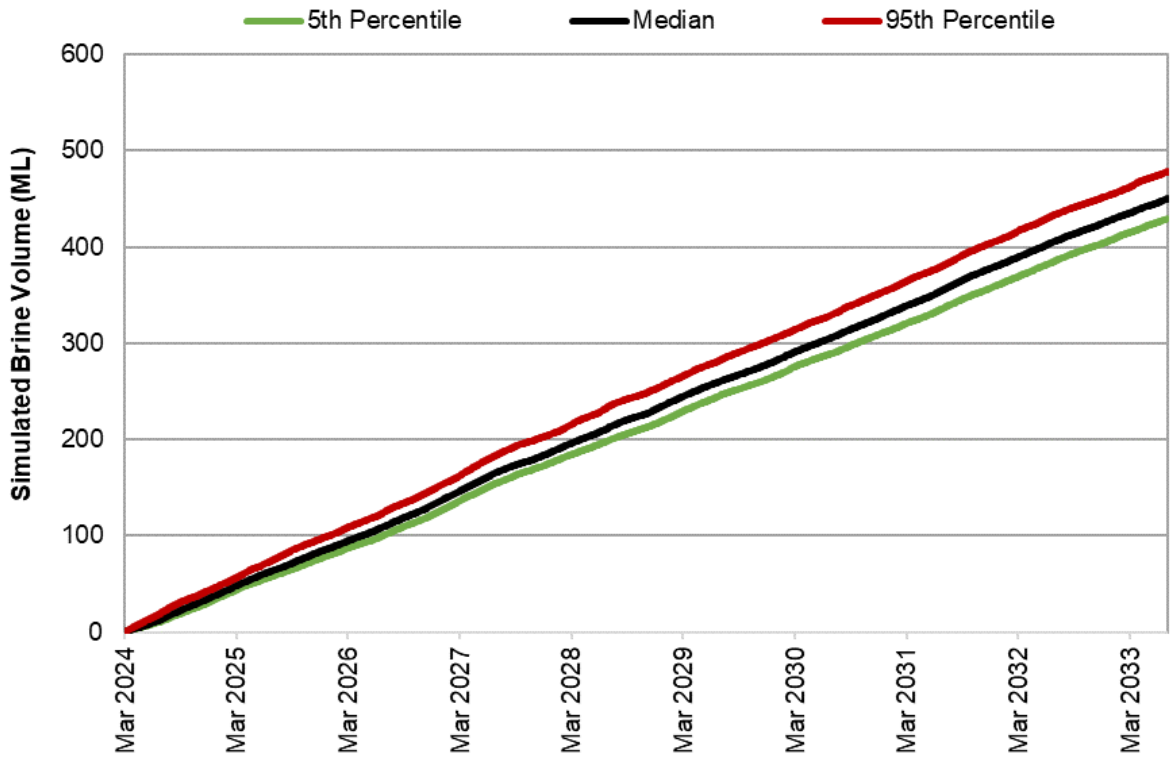
**GRAPH 11: SIMULATED PRODUCED BRINE VOLUME**




The results presented in **Graph 11** indicate that approximately 478 ML of brine is predicted to be produced over the Project life based on the 95$^{th}$ percentile model results. This is less than the corresponding Modification 2 predicted stored brine volume of 690 ML (ATCW, 2022). The difference in predicted brine volume is related to lower groundwater inflow rates simulated based on the revised numerical groundwater model (refer **Section 4.1.6**) as compared to that predicted for Modification 2.

### 4.2.6 Predicted Stored Salt Mass and Salinity Concentration

**Graph 12** presents the predicted brine EC based on the 5$^{th}$ percentile, median and 95$^{th}$ percentile model results. As noted in **Section 4.1.11**, the predicted brine EC is dependent on the predicted feed water EC.

The results presented in **Graph 12** indicate that the brine EC is predicted to range between 17,000 µS/cm and 45,000 µS/cm based on the median and 95$^{th}$ percentile model results.



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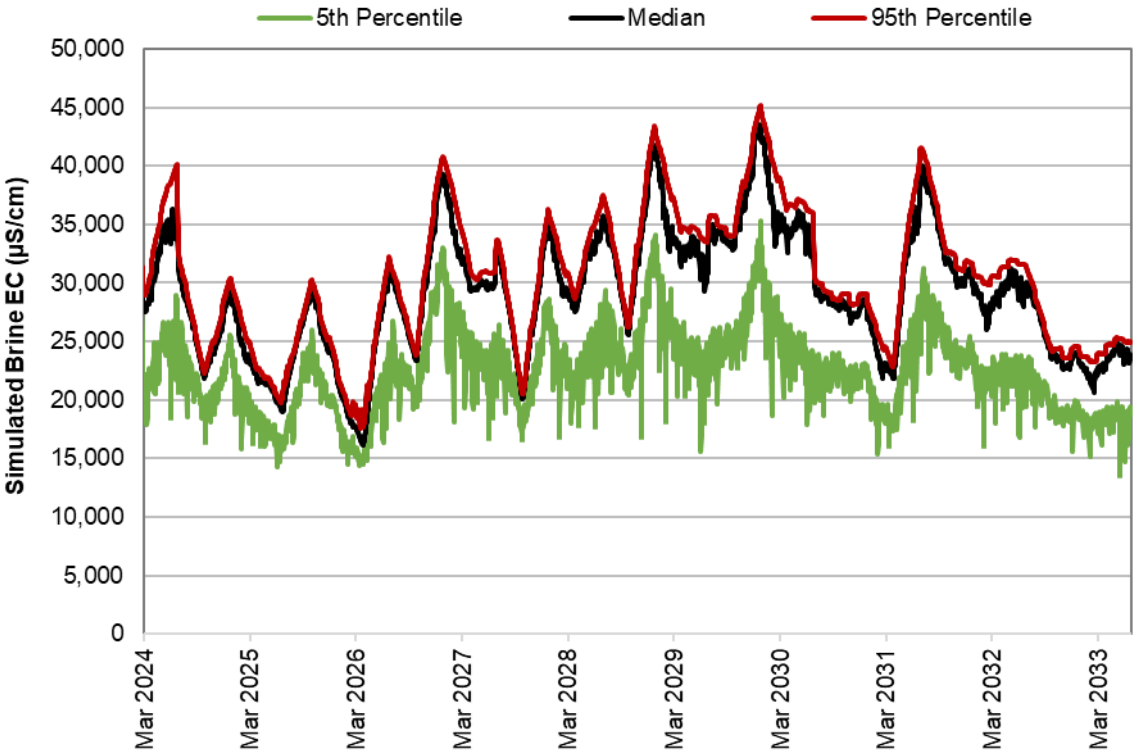
**GRAPH 12: SIMULATED BRINE SALINITY**



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# 5 PREDICTED SUBSIDENCE AND SURFACE WATER IMPACTS

## 5.1 Predicted Subsidence Effects

The predicted subsidence effects associated with the proposed Modification are detailed in MSEC (2024).

The maximum predicted values of total vertical subsidence, upsidence and closure for the Bargo River, Hornes Creek, Teatree Hollow and Teatree Hollow tributary are presented **Table 19**. The predictions after LW S6A are based on the approved Project while the predictions after LW S7A reflect the proposed Modification.

**TABLE 19: MAXIMUM PREDICTED TOTAL VERTICAL SUBSIDENCE, UPSIDENCE AND CLOSURE**

| Watercourse | Longwall | Maximum predicted total vertical subsidence (mm) | Maximum predicted total upsidence (mm) | Maximum predicted total closure (mm) |
|---|---|---|---|---|
| Bargo River | After LW S6A | <20 | <20 | <20 |
| | After LW S7A | <20 | 30 | 20 |
| Hornes Creek | After LW S6A | <20 | <20 | <20 |
| | After LW S7A (downstream of pool HC16) | 40 | 80 | 150 |
| | After LW S7A (upstream of pool HC16) | 25 | 45 | 70 |
| Teatree Hollow | After LW S6A | 1,400* | 400* | 275* |
| | After LW S7A | 1,400* | 400* | 275* |
| Teatree Hollow Tributary | After LW S6A | 1,350 | 450 | 375 |
| | After LW S7A | 1,350 | 450 | 375 |
| *Note: *downstream sections of Teatree Hollow have been previously mined beneath by LW1 and LW2 at the Tahmoor Mine. The maximum predicted parameters provided in the above table include those resulting from the extraction of these earlier longwalls.* | | | | |

Source: MSEC (2024).

As shown in **Table 19**, the maximum total vertical subsidence, upsidence and closure at Teatree Hollow and Teatree Hollow tributary is not predicted to increase as a result of mining of LW S7A.

A slight increase in the Bargo River maximum total upsidence and closure is predicted after LW S7A in comparison to that predicted after LW S6A. A maximum total closure of 150 mm is predicted at Hornes Creek downstream of pool HC16 (refer **Map 5**) after mining of LW S7A. Upstream of pool HC16, a maximum total closure of 70 mm is predicted after mining of LW S7A.

**Map 11** shows the surface topography prior to commencement of mining of LW S1A in comparison to the predicted cumulative post-subsidence topography following mining of LW S1A-S7A.



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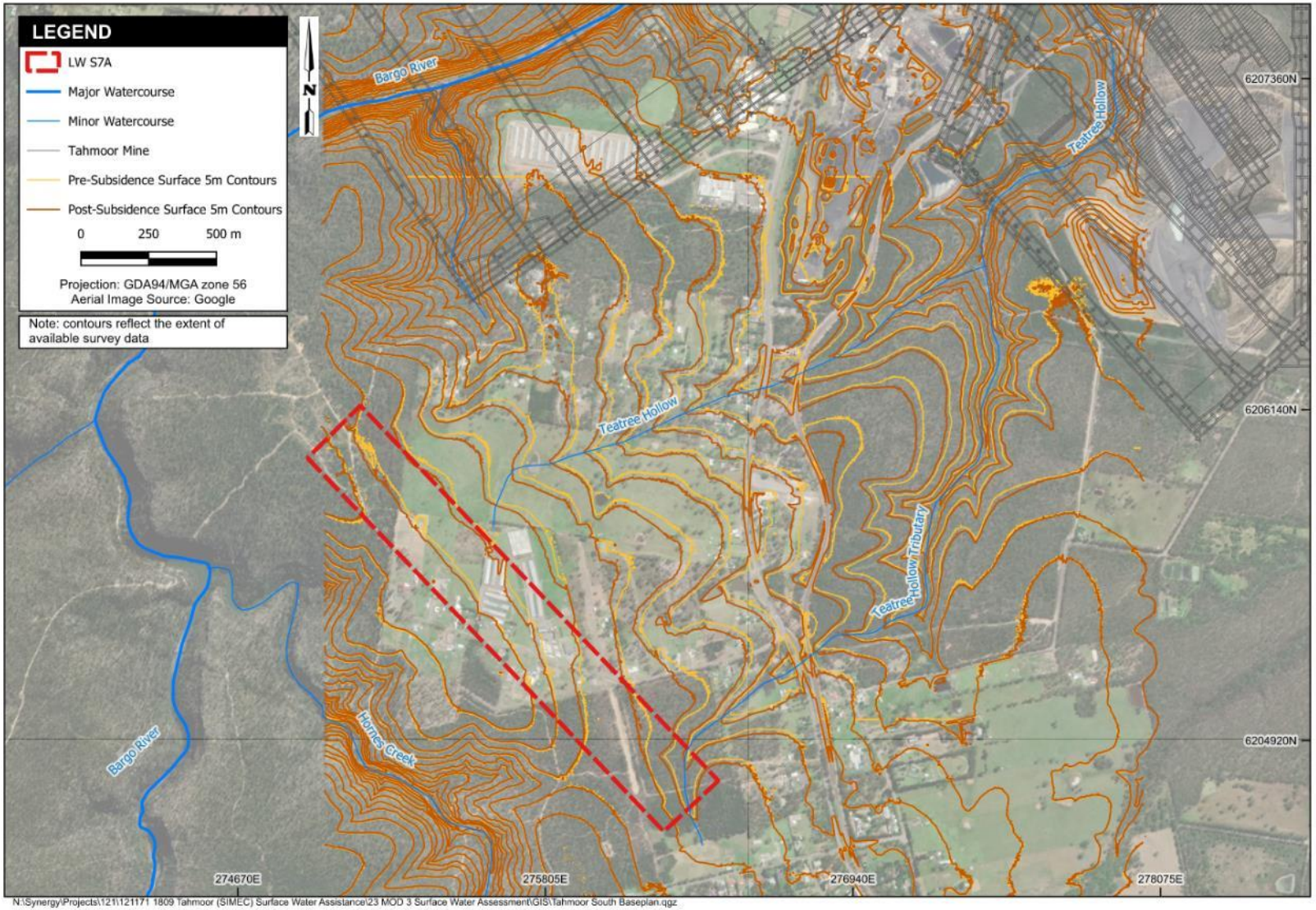
## MAP 11: PRE-SUBSIDENCE AND PREDICTED POST-SUBSIDENCE SURFACE TOPOGRAPHY



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## 5.2 Potential Impacts to Water Quantity

Potential impacts to water quantity associated with the Modification, as detailed in the following sections, include:

- changes in pool water level and streamflow characteristics due to subsidence induced fracturing and tilt;
- reduction in baseflow rates and change in low flow regime;
- change in flood regime of watercourses and local tributary gullies;
- change in overland flow behaviour; and
- increased flows due to controlled release and storage overflow.

### 5.2.1 Potential Impact to Pool Water Level and Streamflow Due to Subsidence Induced Fracturing

#### *5.2.1.1 Bargo River*

The minimum distance from the centreline of the Bargo River to LW S7A is 520 m. The maximum total upsidence and closure associated with mining of LW S7A are predicted to be low, 30 mm and 20 mm respectively. Given the distance of the Bargo River from LW S7A and the low predictions of total upsidence and closure, it is considered very unlikely that surface fractures would develop in the Bargo River (MSEC, 2024).

In the unlikely event that subsidence movements result in opening of existing fractures in the Bargo River downstream of Picton Weir, the high sediment load discharged at times from the Picton Weir may be sufficient to fill widened fractures in the base of the Bargo River (MSEC, 2024).

#### *5.2.1.2 Hornes Creek*

The minimum distance from the centreline of Hornes Creek to LW S7A, downstream of pool HC16 (refer **Map 5**), is 330 m. It is noted that this section of Hornes Creek is influenced by backwater effects from Picton Weir. The minimum distance from the centreline of Hornes Creek to LW S7A, upstream of pool HC16, is 360 m.

As Hornes Creek is not proposed to be directly undermined, the risk of surface fracturing is considered to be low. In the unlikely event that fracturing occurs, the fractures are expected to be minor and isolated (MSEC, 2024). Transport of sediment from upstream Hornes Creek may be sufficient to fill the isolated fractures, thereby reducing the volume of diverted surface flow. Additionally, backwater effects from Picton Weir may be sufficient to maintain water levels in the vicinity of pool HC16.

#### *5.2.1.3 Teatree Hollow and Teatree Hollow Tributary*

As stated in **Section 2.2.1**, the upper reaches of Teatree Hollow tributary overlie LW S7A. Consistent with that detailed in the EIS, where Teatree Hollow and Teatree Hollow tributary are directly undermined, fracturing of sandstone bedrock and subsequent diversion of surface flow may occur.

However, it is noted that the channel of Teatree Hollow tributary is ill-defined in the upper reaches; characterised by a low relief landscape, with a dominant bed material of mud (cohesive clay/silt/sand) and notable grass coverage (Gippel, 2013). Accordingly, while surface fracturing may occur above LW S7A, there is potential for the transported cohesive clay/silt/sand to infill surface fractures and reduce the potential for surface flow diversion.

Should diversion of surface flow occur in the upper reaches of Teatree Hollow tributary, it is expected that the volume of diverted surface flow would be low given the limited catchment area of Teatree Hollow tributary overlying LW S7A. Additionally, as per observations to date following mining of LW S1A to S2A, it is expected that diverted surface flow would re-emerge further downstream in Teatree Hollow tributary or Teatree Hollow (refer **Section 2.6**).

As the maximum total subsidence, upsidence and closure at Teatree Hollow and Teatree Hollow tributary are not expected to increase following mining of LW S7A in comparison to mining of LW S1A

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to LW S6A, it is envisaged that impacts to pool water level and streamflow would be consistent with that detailed in the EIS and associated Project Amendment reports.

### 5.2.2 Potential Impact to Baseflow and Low Flow Regime

Hydrosimulations and SLR (2020) describe baseflow reduction as '…the process of inducing leakage from a creek or river into the aquifer via a downward gradient or weakening of an upward gradient from the aquifer into the watercourse and thereby reducing the rate at which baseflow occurs'.

Predictions of baseflow reduction from watercourses within and adjacent to the Study Area are detailed in SLR (2024). The baseflow reduction predictions have been provided for the following:

- Incremental effects – incremental increase in baseflow reduction associated with mining of LW S7A as compared to the approved Tahmoor South operations.
- Cumulative mining effects – cumulative baseflow reduction associated with the approved Project, the proposed Modification and regional mining activities as compared to the 'no mining' scenario.

The maximum incremental and cumulative baseflow reduction predictions during the proposedProject life are presented in **Table 20.** For comparative purposes, **Table 20** also presents the maximum cumulative baseflow reduction predictions presented in the Tahmoor South Amended Project Report: Groundwater Assessment (Hydrosimulations and SLR, 2020). It is noted that potential cumulative baseflow effects were not quantitatively assessed as a component of the Tahmoor South Project – Second Amendment Report: Groundwater Assessment (Hydrosimulations, 2020).

**TABLE 20: BASEFLOW REDUCTION PREDICTIONS**

| Watercourse | Monitoring Site | Baseflow Reduction Predictions (ML/d) | | |
|---|---|---|---|---|
| | | Incremental Maximum (LW S7A) - Modification[1] | Cumulative Maximum Mining Effects – Modification[1] | Cumulative Maximum Mining Effects – EIS[2] |
| Teatree Hollow | TT8-QLa | 0.0019 | 0.0167 | 0.088 |
| Bargo River | BR13-QRLa | 0.0017 | 0.033 | 0.175 |
| Hornes Creek | HC9-QLa | 0 | 0.0018 | 0.001 |
| Dogtrap Creek | DT-F1 | 0.003 | 0.018 | 0.133 |

Notes:
1. Source: SLR (2024).
2. Source: Hydrosimulations and SLR (2020).

The data presented in **Table 20** show that, with the exception of Hornes Creek, the predicted baseflow reduction associated with cumulative mining effects is not expected to be greater than that presented in Hydrosimulations and SLR (2020). A slight increase in baseflow reduction associated with cumulative mining effects is predicted for Hornes Creek based on the revised numerical groundwater modelling conducted for the Modification. However, it is noted that mining of LW S7A is not predicted to result in baseflow reduction in Hornes Creek.

As stated in **Section 2.5.2.2**, a median streamflow rate of 0.3 ML/d was estimated at HC4-QRLa on Hornes Creek while a median streamflow rate of 5.8 ML/d was estimated at BR13-QRLa on the Bargo River. A cumulative baseflow reduction of 0.0018 ML/d predicted for Hornes Creek equates to 0.55% of the estimated median streamflow rate at HC4-QRLa on Hornes Creek. A cumulative baseflow reduction of 0.033 ML/d predicted for the Bargo River at BR13-QRLa equates to 0.58% of the estimated median streamflow rate at this location.

**Graph 13** and **Graph 14** present the flow duration curves for Hornes Creek (HC4-QRLa) and the Bargo River (BR13-QRLa) with and without the predicted cumulative baseflow reduction.



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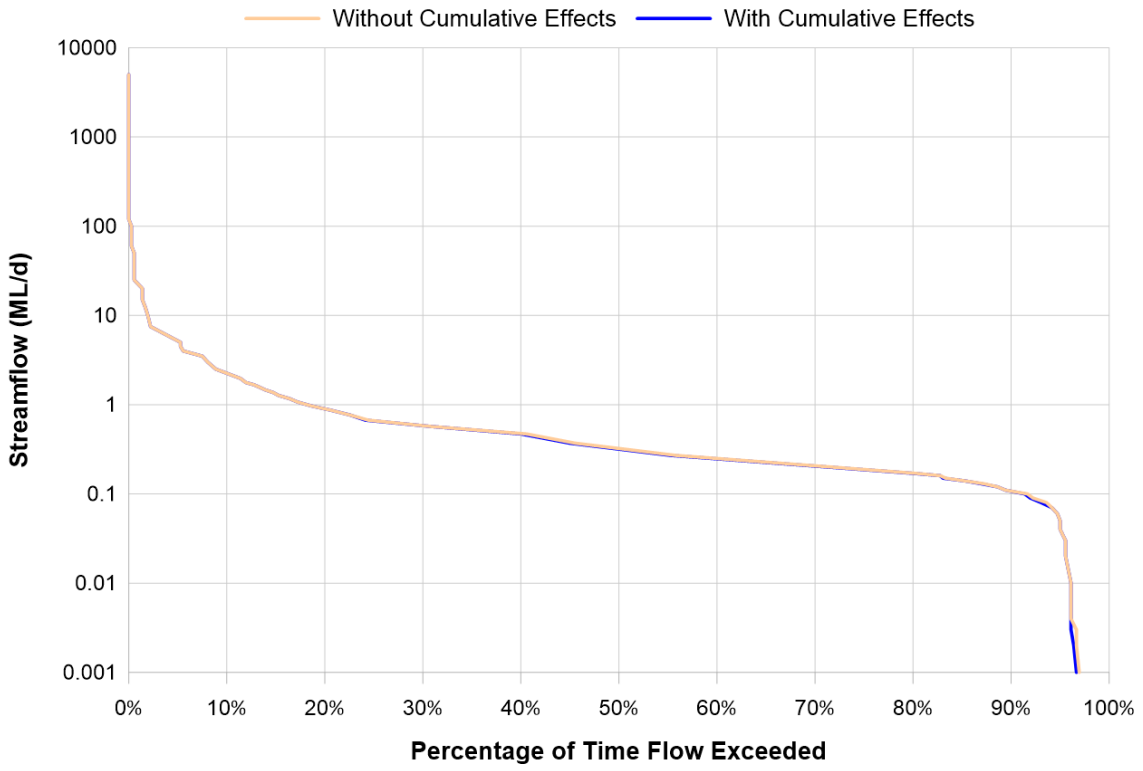
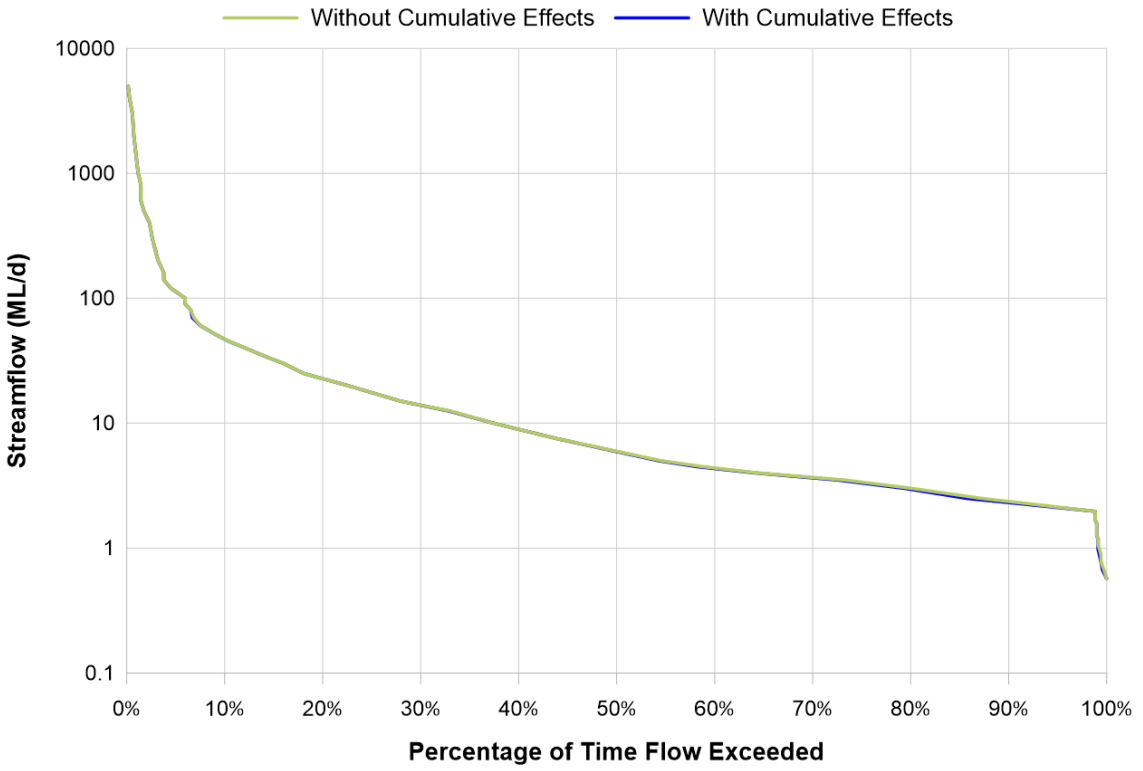
**GRAPH 13: HORNES CREEK (HC4-QRLa) FLOW DURATION CURVE – WITH AND WITHOUT CUMULATIVE BASEFLOW REDUCTION**




**GRAPH 14: BARGO RIVER (BR13-QRLa) FLOW DURATION CURVE – WITH AND WITHOUT CUMULATIVE BASEFLOW REDUCTION**



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As shown in **Graph 13** and **Graph 14**, the predicted reduction in baseflow contribution to Hornes Creek and the Bargo River is considered negligible and would likely be indiscernible from natural fluctuations in streamflow at these locations.

### 5.2.3 Predicted Impact to Flood Regime – Teatree Hollow

Vertical subsidence and tilt associated with mining of LW S7A is predicted to affect a small portion only of the catchment of the Bargo River and Hornes Creek, with subsidence effects expected to be low (refer **Table 19**). As such, increases in the flood extent of the Bargo River and Hornes Creek are unlikely to occur as a result of mining of LW S7A.

As subsidence effects are predicted to be more extensive in the Teatree Hollow catchment, a flood study has been conducted to assess the cumulative effects of mining-induced subsidence associated with LW S1A-S7A on the flood extent of Teatree Hollow and Teatree Hollow tributary. It is noted that the predicted cumulative post-subsidence topography adopted in the flood study was based on a longer LW S7A panel than that proposed for the Modification. As such, it is considered that the predictions of potential flood effects are conservative.

The flood study, included as **Appendix C**, was conducted to assess the potential cumulative effects of the longwall layout and associated subsidence predictions on flooding of land within and adjacent to LW S1A-S7A. Specifically, areas at risk of a potential increase in flood levels due to subsidence induced changes in surface topography have been identified.

**Map 12** and **Map 13** depict the simulated maximum areas inundated during passage of the 1% annual exceedance probability (AEP) peak flow event in the southern (upstream) and northern (downstream) portion of the Teatree Hollow catchment respectively.

The hydraulic model results for the 1% AEP flood event indicate that overbank flooding is predicted to occur under existing conditions at:

- areas upstream of the culverts beneath Remembrance Driveway and Caloola Road (location 1 shown in **Map 12**);
- the corridor between Remembrance Driveway and the railway embankment to the east of Caloola Road (location 2 shown in **Map 12**);
- a portion of the Main South Railway Line adjacent to Teatree Hollow (to the north of location 2 shown in **Map 12**); and,
- to the west of Remembrance Driveway overlying LW S5A (location 3 shown in **Map 12**).

Further downstream, inundation is limited to the main channel areas.

The hydraulic model predictions indicate that the effects of subsidence may result in a minor increase in areas subject to flood inundation on the western side of Remembrance Driveway in the vicinity of Caloola Road (location 1 shown in **Map 12**), the western side of Remembrance Driveway in the vicinity of and Yarran Road (location 3 shown in **Map 12**) and to the east of Caloola Road (location 2 shown in **Map 12**). Based on the hydraulic model predictions for LW S1A-S7A, a maximum increase in the 1% AEP flood level of 0.49 m is predicted to occur at a property bounding Caloola Road and Remembrance Driveway.

It is noted that the predicted increase in flood extent is predominantly related to subsidence effects associated with mining of LW S1A-S6A.

These findings are generally consistent with that presented in the EIS (HEC, 2020). As detailed in HEC (2020):

- the effects of subsidence were predicted to result in an increase in areas subject to flood inundation on the western side of Remembrance Driveway adjacent to Caloola Road during a 1% AEP event; and
- the largest increase in flood inundation was predicted to occur on the western side of Remembrance Driveway overlying LW S3A (referred to as LW 103A in HEC, 2020) - area upstream of the culverts beneath Remembrance Driveway and Caloola Road.



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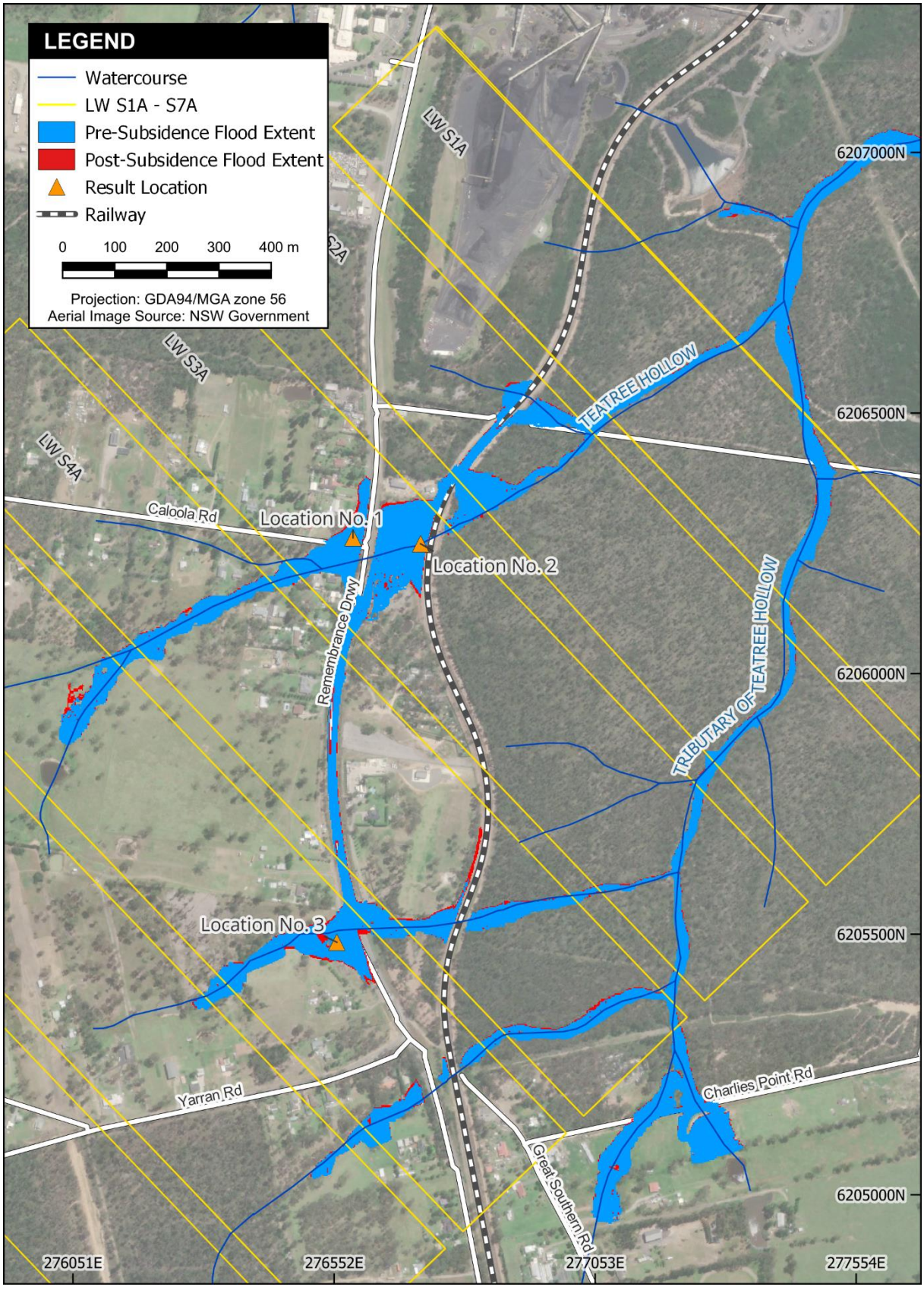
## MAP 12: EXTENT OF PREDICTED 1% AEP FLOODING – SOUTHERN (UPSTREAM) TEATREE HOLLOW CATCHMENT



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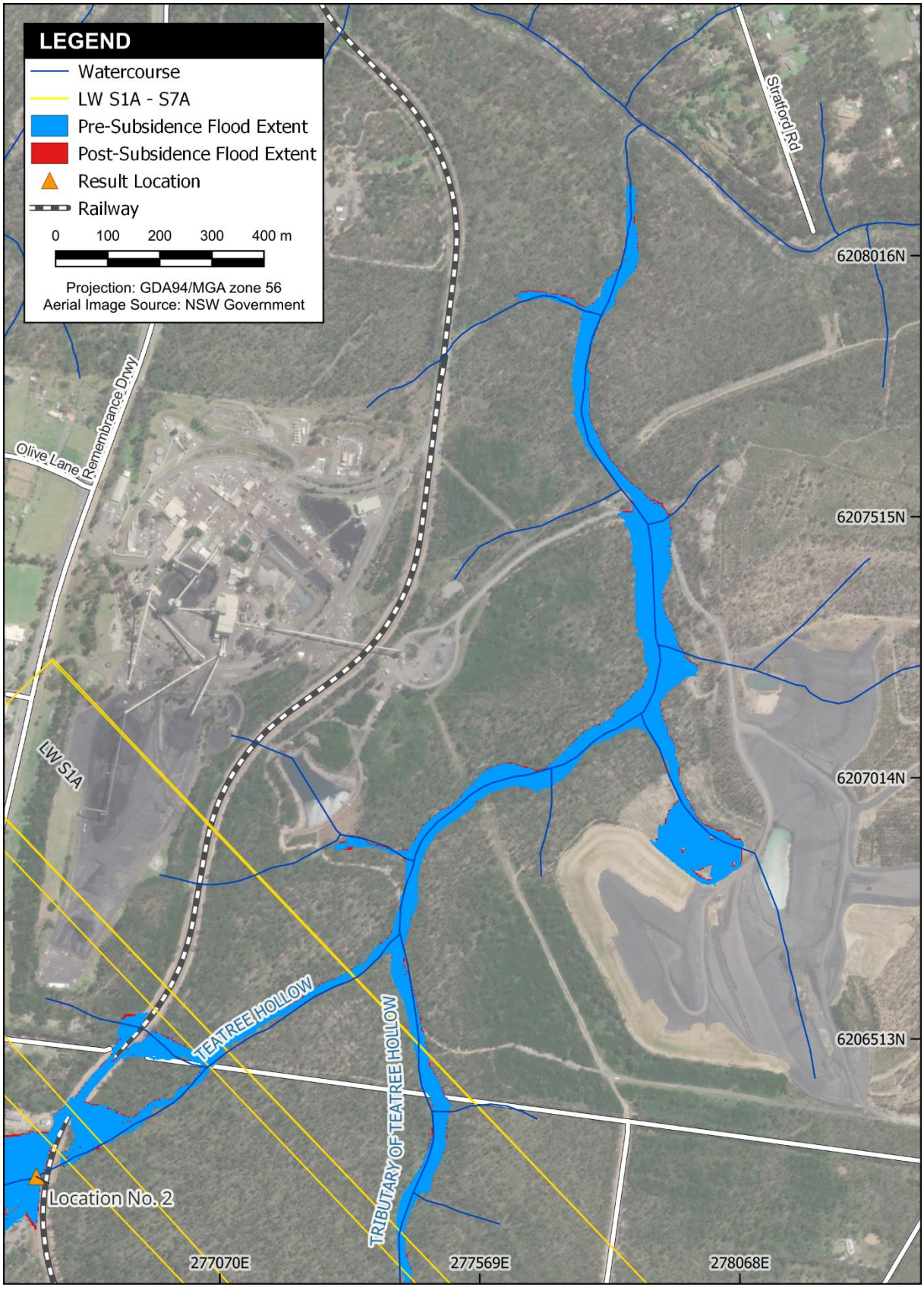
## MAP 13: EXTENT OF PREDICTED 1% AEP FLOODING – NORTHERN (DOWNSTREAM) TEATREE HOLLOW CATCHMENT



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### 5.2.4 Potential Impact to Overland Flow

Negligible change in gradient is predicted to occur to the Bargo River tributary or in the catchment of Hornes Creek (refer **Map 11**).

The maximum predicted incremental tilt associated with mining of LW S7A is 8.9 mm/m and the maximum predicted total tilt after mining of LW S1A-S7A is 10 mm/m (MSEC, 2024). Based on the natural gradient of the surface overlying LW S7A and the predicted post-subsidence topography associated with mining of LW S1A-S7A, subsidence effects are estimated to result in a 0.3% increase in surface gradient overlying LW S7A. While minor changes to the natural drainage behaviour may occur in some locations, the predicted increase in gradient is considered negligible and unlikely to result in significant impacts to overland flow or channel morphology.

### 5.2.5 Potential Impact to Teatree Hollow – Discharge to LDP1

As stated in **Section 4.2.3**, discharge to LDP1 is predicted at 953 ML/annum or 2.6 ML/d on average. The predicted average daily discharge rate of 2.6 ML/d is only slightly greater than the average daily discharge recorded in 2023 (2.4 ML/d). As such, impacts to streamflow in Teatree Hollow downstream of LDP1 are unlikely to occur as a result of the proposed Modification.

### 5.2.6 Potential Impacts to Water Supply

As stated in **Section 2.6.3**, a total reduction in Teatree Hollow streamflow of 19.2 ML was estimated for the period of January to December 2023 due to effects associated with mining of LW S1A-S2A. It is considered that the estimated streamflow reduction is largely reflective of effects associated with upstream fracturing, however, may also comprise baseflow reduction. The estimated total reduction in streamflow is less than the total annual entitlement of 41 ML held by Tahmoor Coal for the Maldon Weir water source.

While streamflow reduction may increase as mining of Tahmoor South progresses, it is expected that majority of streamflow diverted via the subsurface fracture network would re-emerge upstream of pool TT7. It is also considered that mining of LW S7A is unlikely to result in impacts to Teatree Hollow streamflow downstream of pool TT7 in excess of that expected to occur as a result of mining of LW S1A-S6A.

Tahmoor Coal would continue to assess streamflow reduction monitored at TT-F1 in Teatree Hollow on a quarterly basis. Where the streamflow reduction assessment indicated that there was potential for the WAL volume held by Tahmoor Coal to be exceeded in the future, Tahmoor Coal would seek to acquire additional WAL volume from the water market.

Given that permeate discharge would continue to report to Teatree Hollow downstream of LDP1, it is expected that there would be negligible overall reduction in streamflow reporting to the Bargo River via Teatree Hollow for the Project life.

## 5.3 Potential Impacts to Water Quality

### 5.3.1 Subsidence Induced Fracturing and Flow Diversion

Flushing of freshly exposed fractures in sandstone bedrock has the potential to liberate contaminants resulting in localised and transient increases in water quality constituents. Additionally, significant reductions in pool water level and associated transformation processes occurring in stored sediments has the potential to result in intermittent changes in pool water quality characteristics. Subsidence induced fracturing may also increase the extent and prevalence of ferruginous deposition (iron staining).

As stated in **Section 2.6.4**, episodic elevated dissolved nickel, dissolved aluminium, dissolved zinc, dissolved iron and electrical conductivity values have been recorded at monitoring site TT7-QLa (pool TT7) since the commencement of mining of LW S1A-S2A. It is considered that the episodic increases in specific constituents recorded at TT7-QLa were related to the re-emergence of upstream diverted surface flow in combination with below average rainfall conditions. Additionally, an increase in dissolved aluminium was recorded at monitoring site TT2-QLa during a period in which the pool water level was very low and visually observed as stagnant.



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Ferruginous colloids in the water and precipitated on or staining the bed material of Teatree Hollow and Teatree Hollow tributary were observed prior to commencement of mining of LW S1A-S2A. An increase in iron staining has subsequently been observed upstream of pool TT7 following mining of LW S1A and LW S2A.

While it is anticipated that intermittent, episodic increases in specific constituents will continue to occur in Teatree Hollow and Teatree Hollow tributary during mining of LW S1A-S7A, it is not expected that mining of LW S7A would substantially increase this effect. As noted above, the reach of Teatree Hollow tributary overlying LW S7A is characterised by a low relief landscape, with a dominant bed material of mud (cohesive clay/silt/sand) and notable grass coverage. Additionally, pools have not been mapped in the reach of Teatree Hollow tributary overlying LW S7A. As such, it is considered that the potential for flushing of freshly exposed sandstone bedrock fractures and associated liberation of contaminants or increased iron staining is low in the upper reaches of Teatree Hollow tributary overlying LW S7A.

### 5.3.2 Contamination of Surface Waters Associated with Gas Emissions

Methane is naturally present in many natural shallow surface water and groundwater systems as a result of organic decomposition and redox-methanogenesis reactions (NSW Department of Planning, 2008). When sediments are disturbed by mining related subsidence effects, methane derived naturally may be released more rapidly in surface water systems (NSW Department of Planning, 2008). The generative fluxes and concentrations are generally low and inconsequential (NSW Department of Planning, 2008).

As stated in **Section 2.2.1**, gas emissions were observed in shallow ponded water at channel morphology site CM6 (refer **Map 8**) during the baseline period prior to the commencement of mining of LW S1A-S2A. Evidence of vegetation dieback associated with gas emissions at monitoring site CM6 was not observed (BES, 2022c). Gas emissions were also previously observed intermittently at a monitoring site in Matthews Creek during mining of LW W1-W2 in the Western Domain. Evidence of vegetation dieback due to observed gas emissions at this location was not observed (Niche, 2021).

As such, should mining of LW S7A result in gas emissions occurring in local watercourses, it is considered unlikely that impacts to vegetation would occur.

### 5.3.3 Water Quality Effects Associated with Discharge to LDP1

As stated in **Section 4.2.3**, for the majority of time, the EC of discharge to LDP1 is predicted at less than 350 µS/cm based on the model realizations equating to the median and 95$^{th}$ percentile total rainfall. Few exceedances of 350 µS/cm were predicted to occur during simulated periods of overflow from dam M4.

The predicted EC of discharge to LDP1 is generally within the range of EC values recorded at upstream monitoring sites in Teatree Hollow (refer **Section 2.5.1.1**) and, for the majority of time, expected to be less than the ANZECC & ARMCANZ (2000) default guideline value for the protection of slightly disturbed aquatic ecosystems in upland rivers in NSW.

As such, it is considered that the Modification would result in a negligible impact to the water quality of Teatree Hollow downstream of Teatree Hollow.

### 5.3.4 Water Quality Effects Associated with Underground Brine Storage

As stated in SLR (2024), storage of brine in underground historical workings is not predicted to result in an impact to environmental receptors. The contaminant transport model predictions presented in SLR (2024) indicate that solutes associated with the stored brine may migrate upwards following recovery of groundwater levels in the vicinity of the historical Tahmoor North Western Domain. However, the predicted concentrations of constituents migrating to the middle and upper Hawkesbury Sandstone are considered unlikely to represent a risk to environmental receptors including overlying surface water systems (SLR, 2024).



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# 6 MONITORING, MITIGATION AND MANAGEMENT

Water management at the Tahmoor Mine is undertaken in accordance with SSD 8445 and Environment Protection Licence (EPL) 1389 as detailed in the LW S1A – S6A Extraction Plan Water Management Plan (Tahmoor Coal, 2023) and the Tahmoor Mine Water Management Plan (Tahmoor Coal, 2022). The EP WMP details the surface water monitoring program, impact assessment criteria and TARPs pertaining to Teatree Hollow, Teatree Hollow tributary, Hornes Creek, the Bargo River and the Bargo River tributary.

The current surface water monitoring program for the Project, as detailed in **Section 2.4**, is considered comprehensive and sufficient to enable potential surface water impacts associated with the proposed Modification to be appropriately identified. In addition, the TARPs detailed in the EP WMP define appropriate actions and responses necessary to be implemented in the event of a potential impact to surface water systems relevant to the Modification. Post approval of the Modification, the LW S1A – S6A Extraction Plan Water Management Plan (Tahmoor Coal, 2023) would be updated to include water management, monitoring and mitigation measures associated with mining of LW S7A.

In accordance with the Tahmoor South Water Management Plan (Tahmoor Coal, 2022), the site water balance model would continue to be updated and verified on a regular basis to maintain the model as a reliable tool for assessing the effectiveness of the site water management system.



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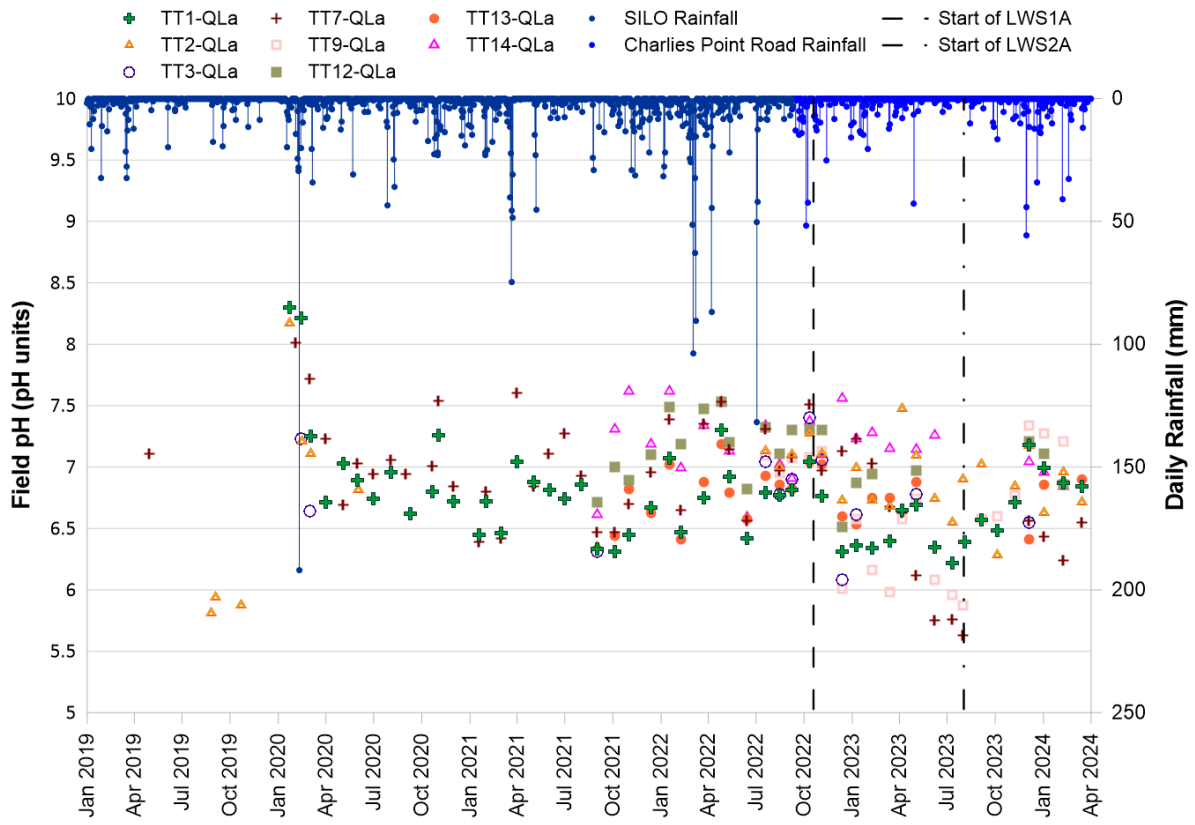
# APPENDICES

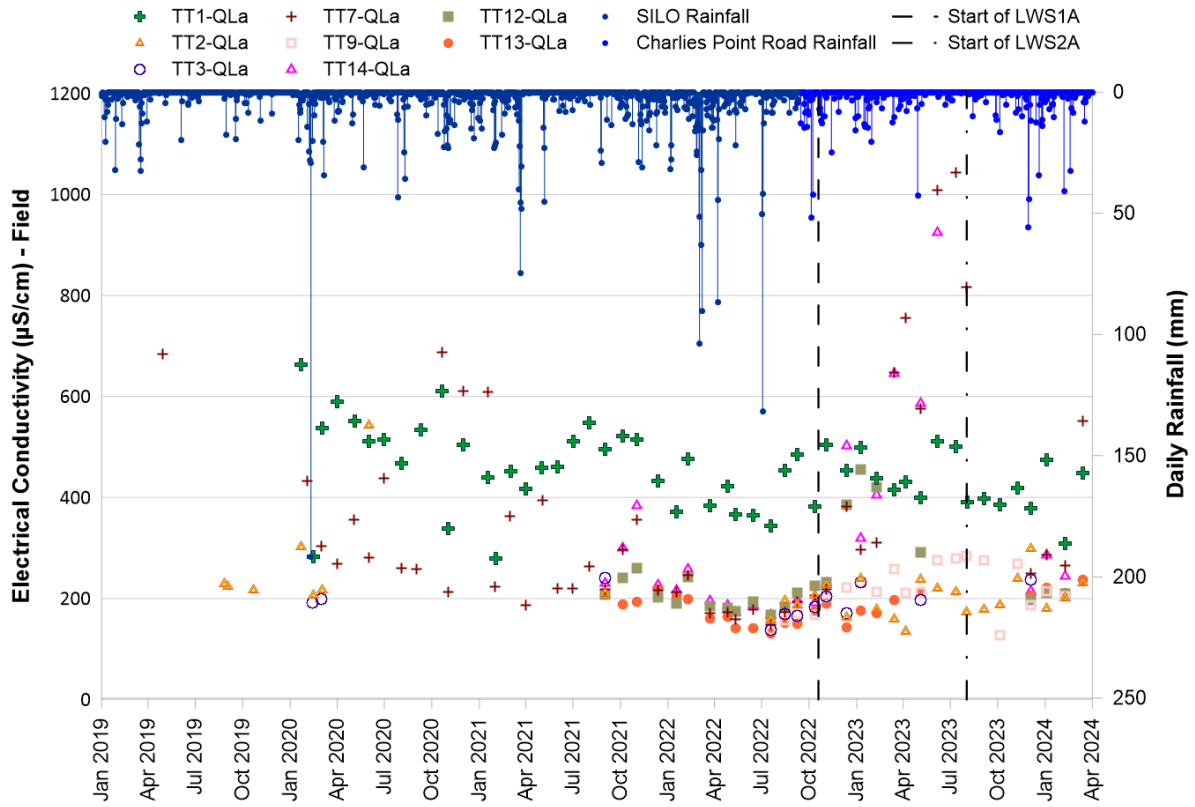
# APPENDIX A – WATER QUALITY PLOTS

## GRAPH A1: TEATREE HOLLOW CATCHMENT - FIELD pH

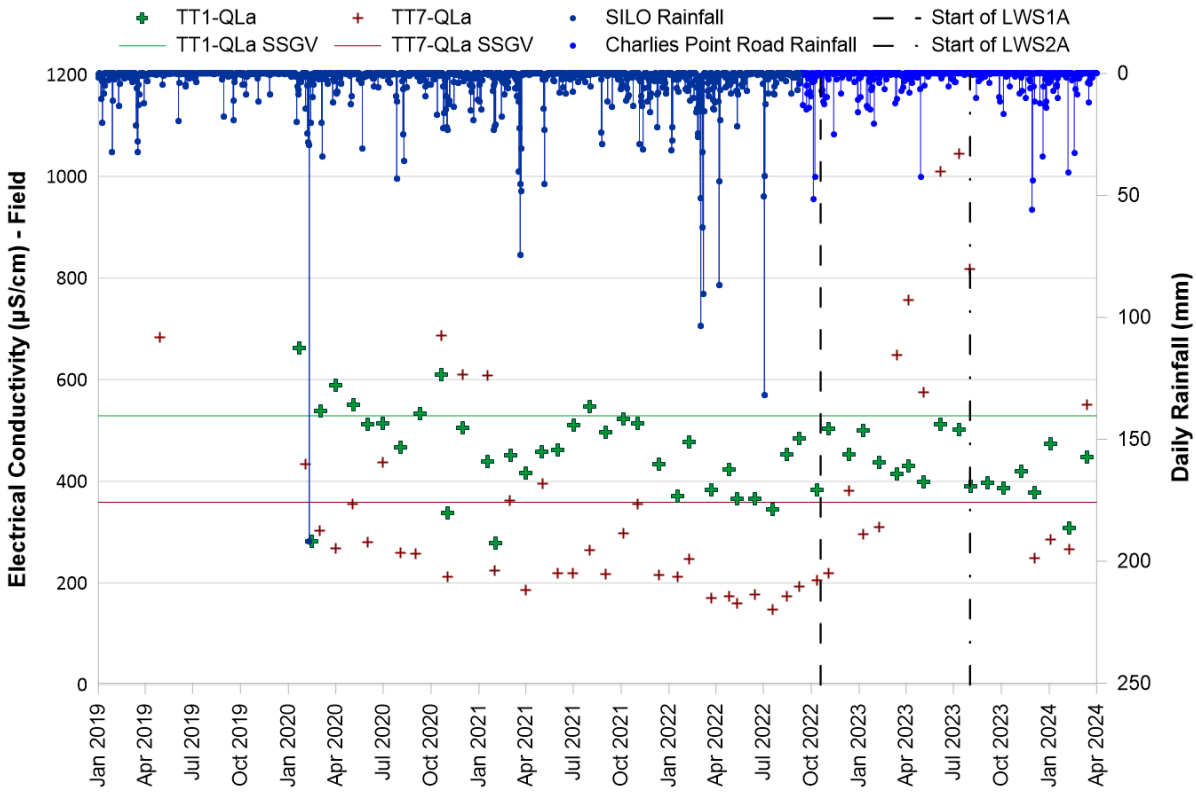



TAILINGS.WATER.WASTE.

## GRAPH A2: TEATREE HOLLOW CATCHMENT - FIELD EC

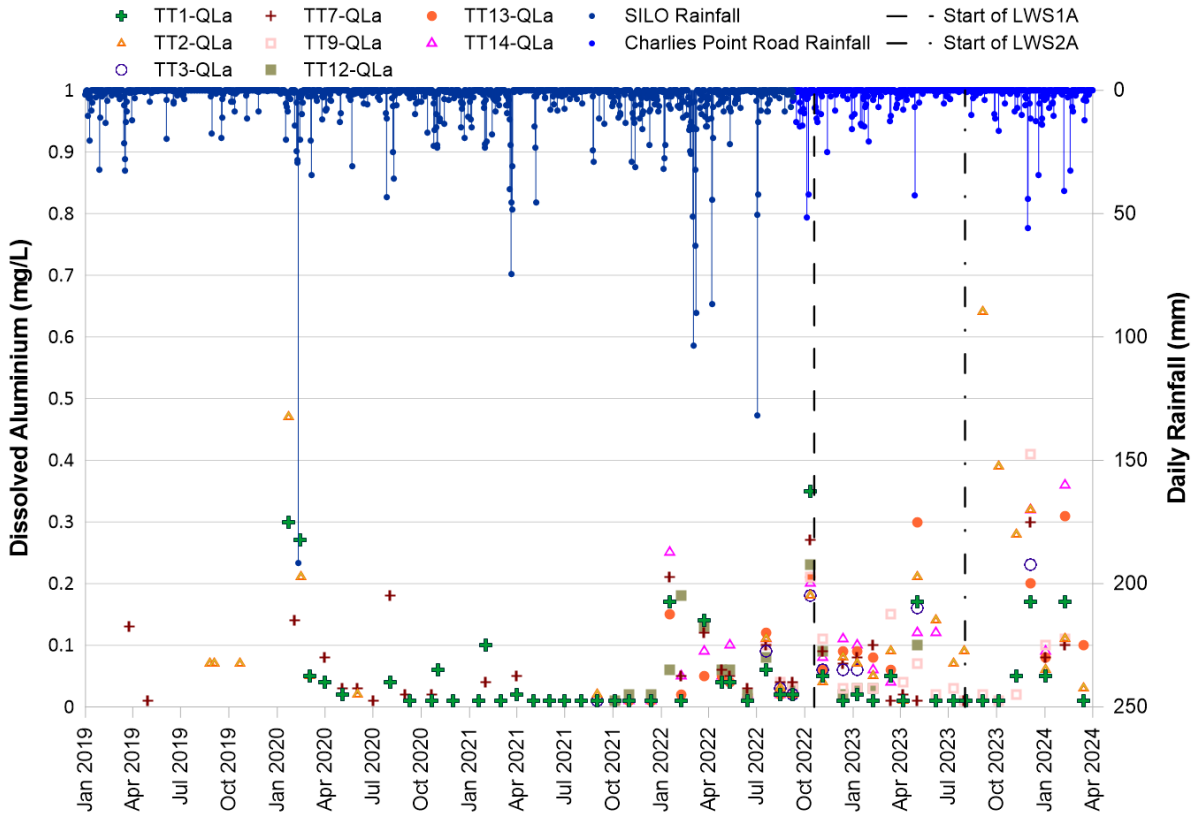



## GRAPH A3: TT1-QLa AND TT7-QLa - FIELD EC

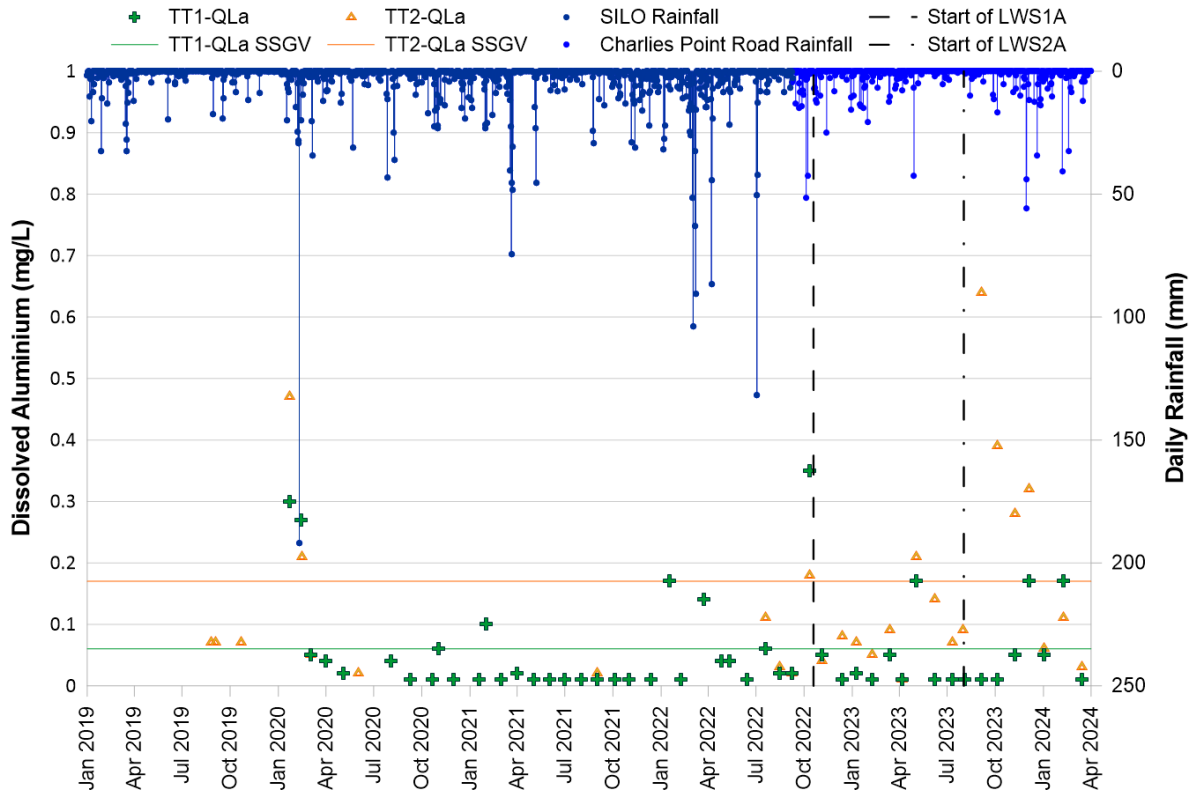



TAILINGS.WATER.WASTE.

## GRAPH A4: TEATREE HOLLOW CATCHMENT - DISSOLVED ALUMINIUM

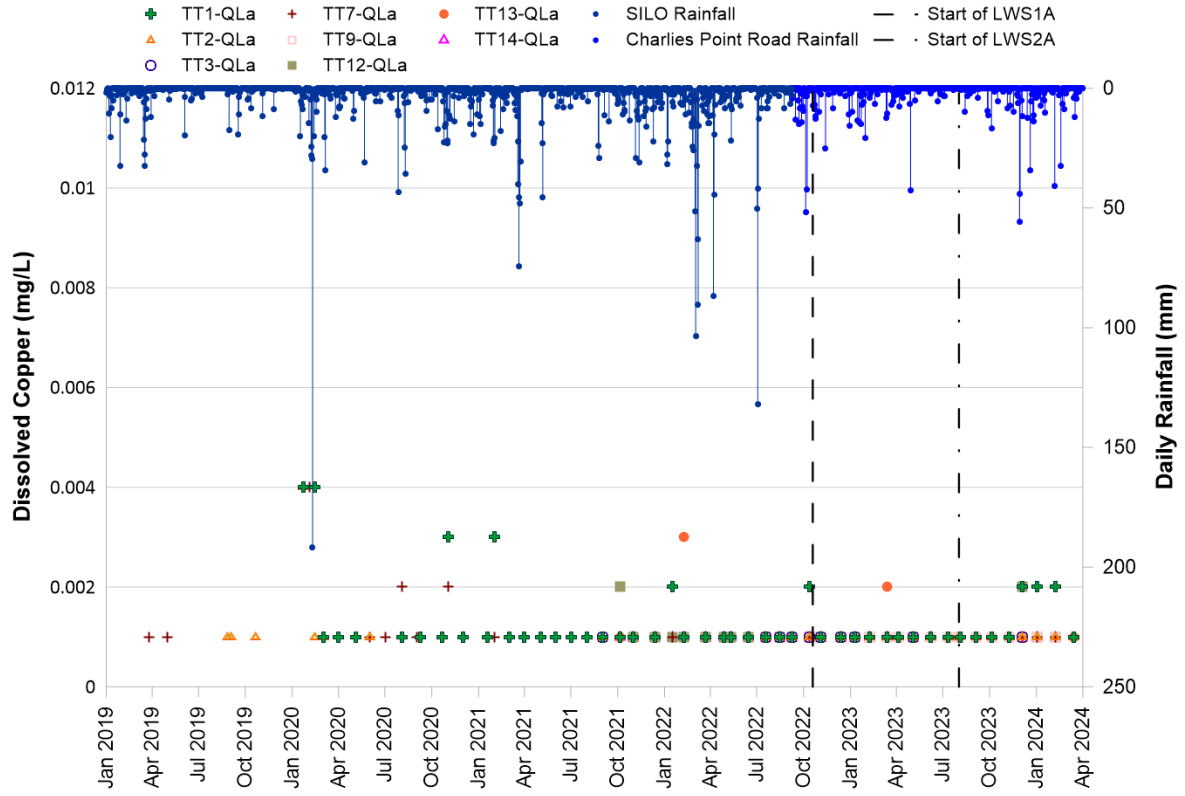



## GRAPH A5: TT1-QLa AND TT2-QLa - DISSOLVED ALUMINIUM

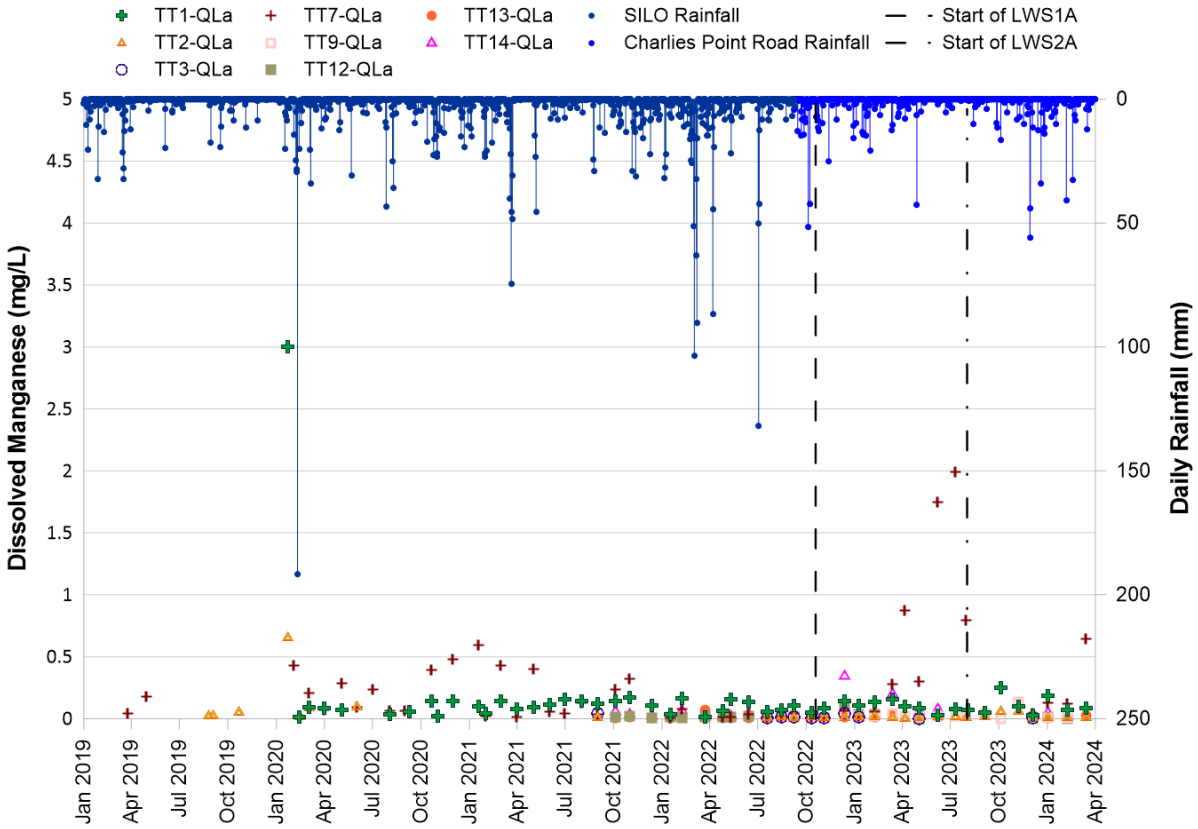



TAILINGS.WATER.WASTE.

## GRAPH A6: TEATREE HOLLOW CATCHMENT - DISSOLVED COPPER

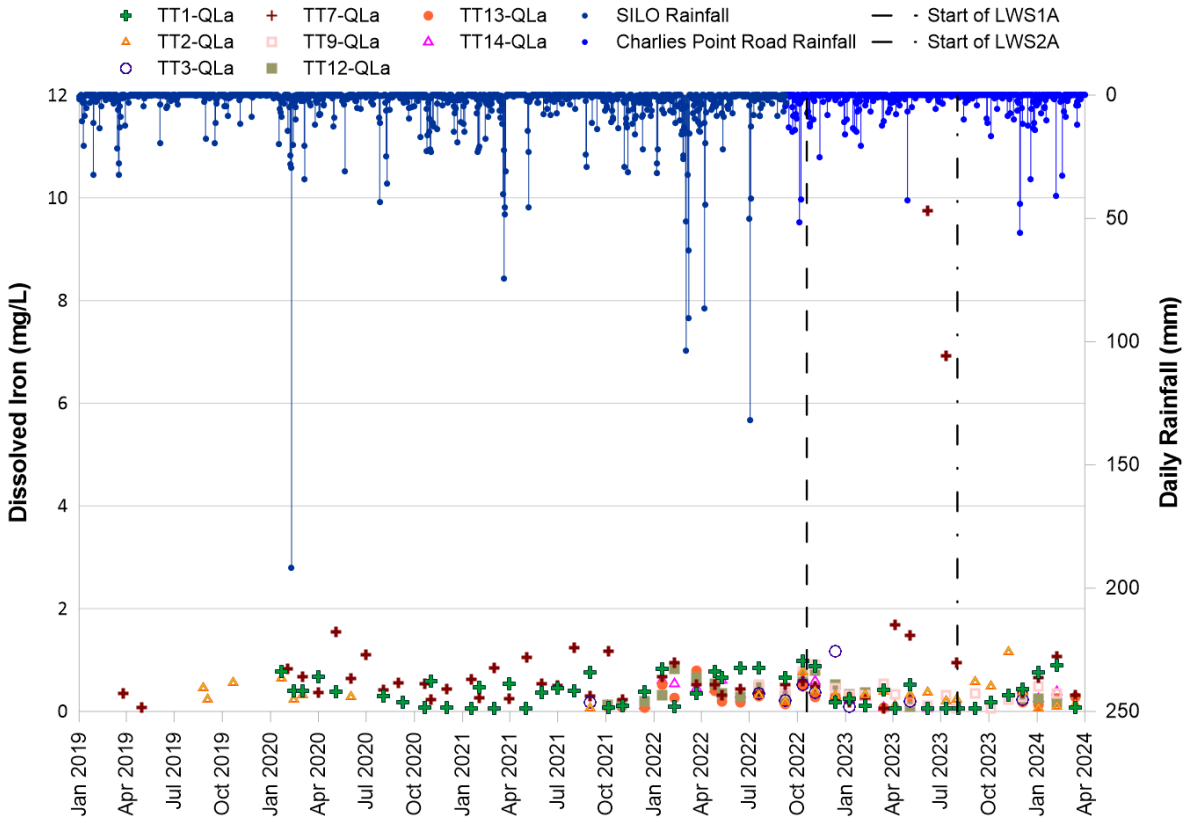



## GRAPH A7: TEATREE HOLLOW CATCHMENT - DISSOLVED MANGANESE

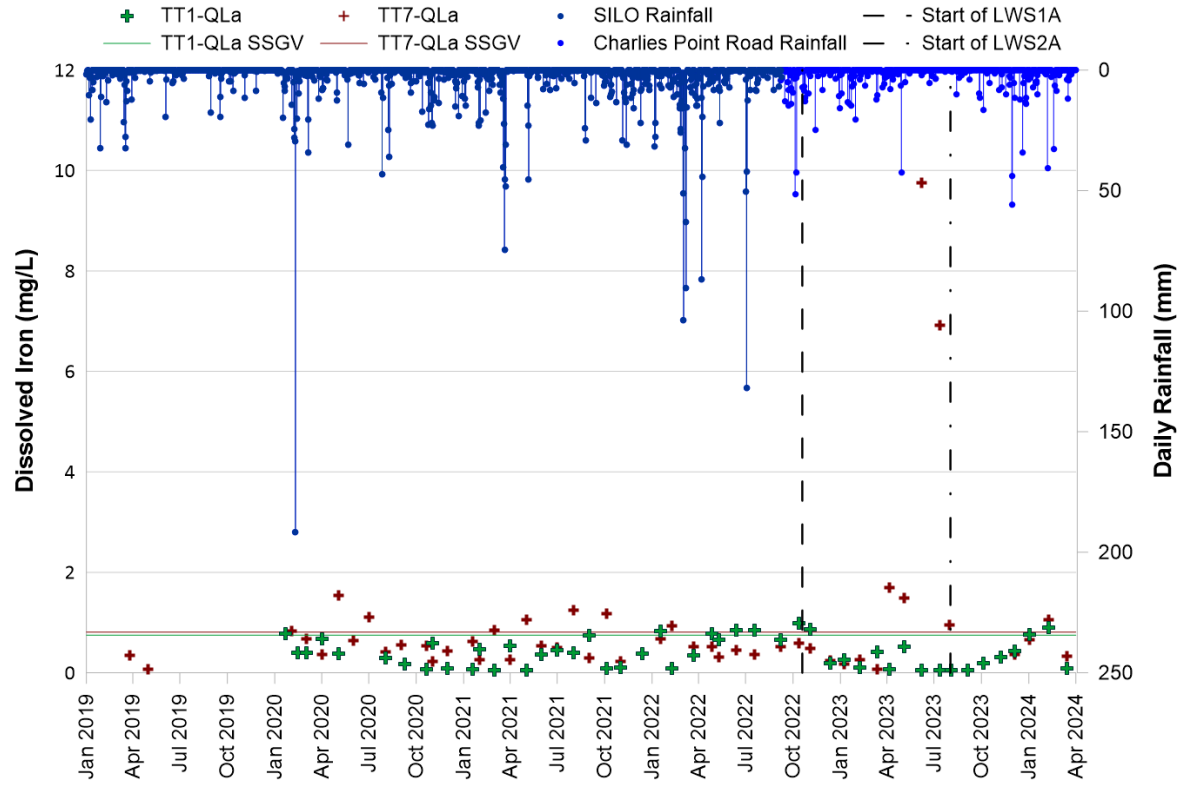



TAILINGS.WATER.WASTE.

## GRAPH A8: TEATREE HOLLOW CATCHMENT - DISSOLVED IRON

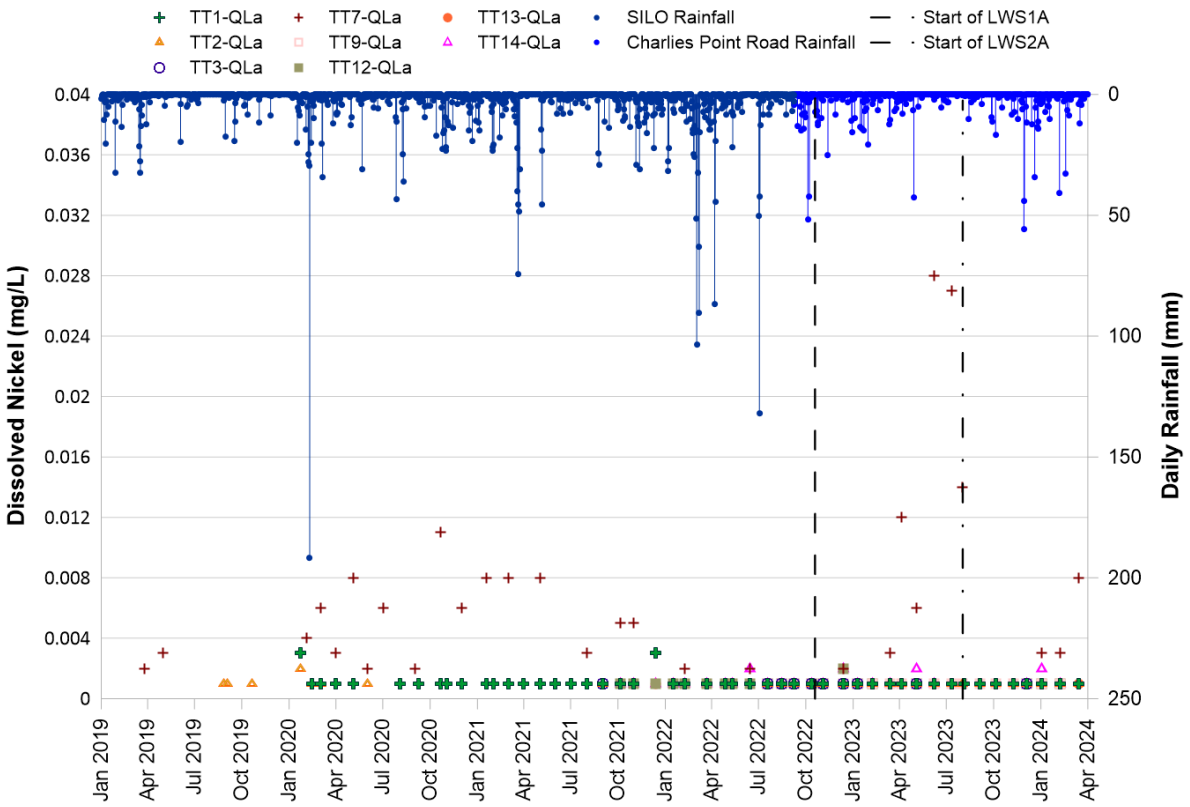



## GRAPH A9: TT1-QLa AND TT2-QLa - DISSOLVED IRON

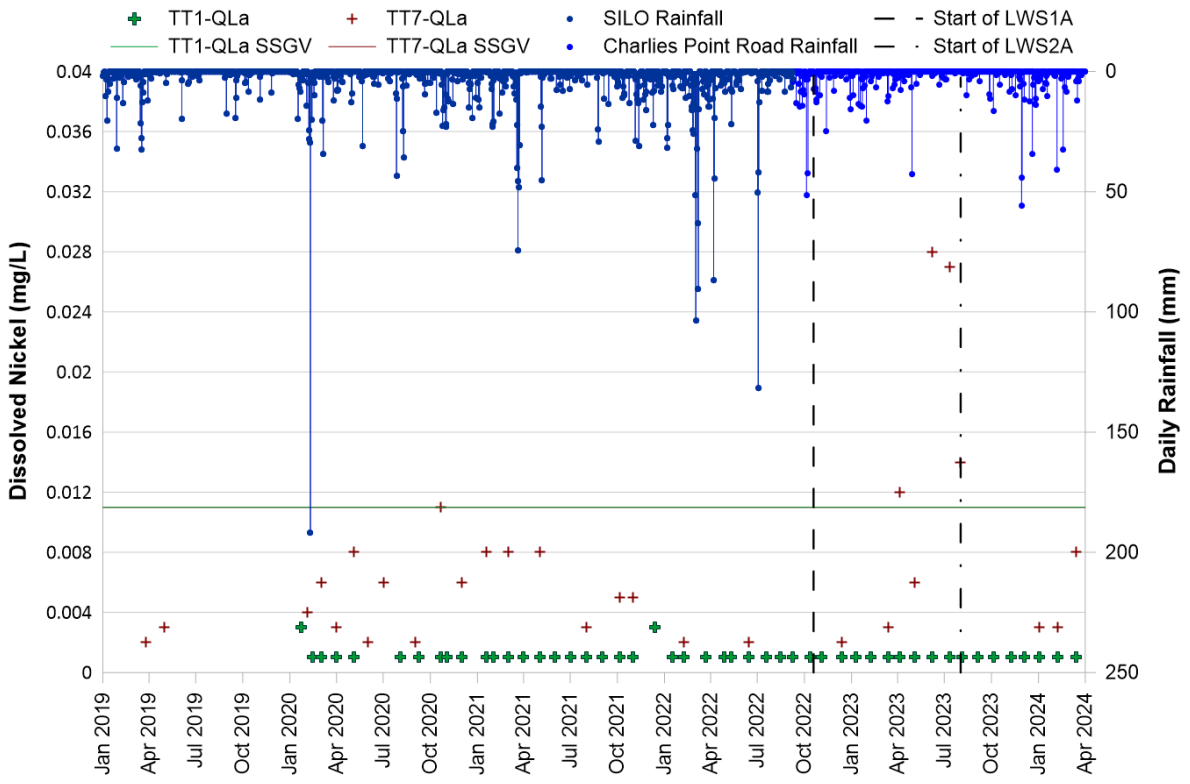



TAILINGS.WATER.WASTE.

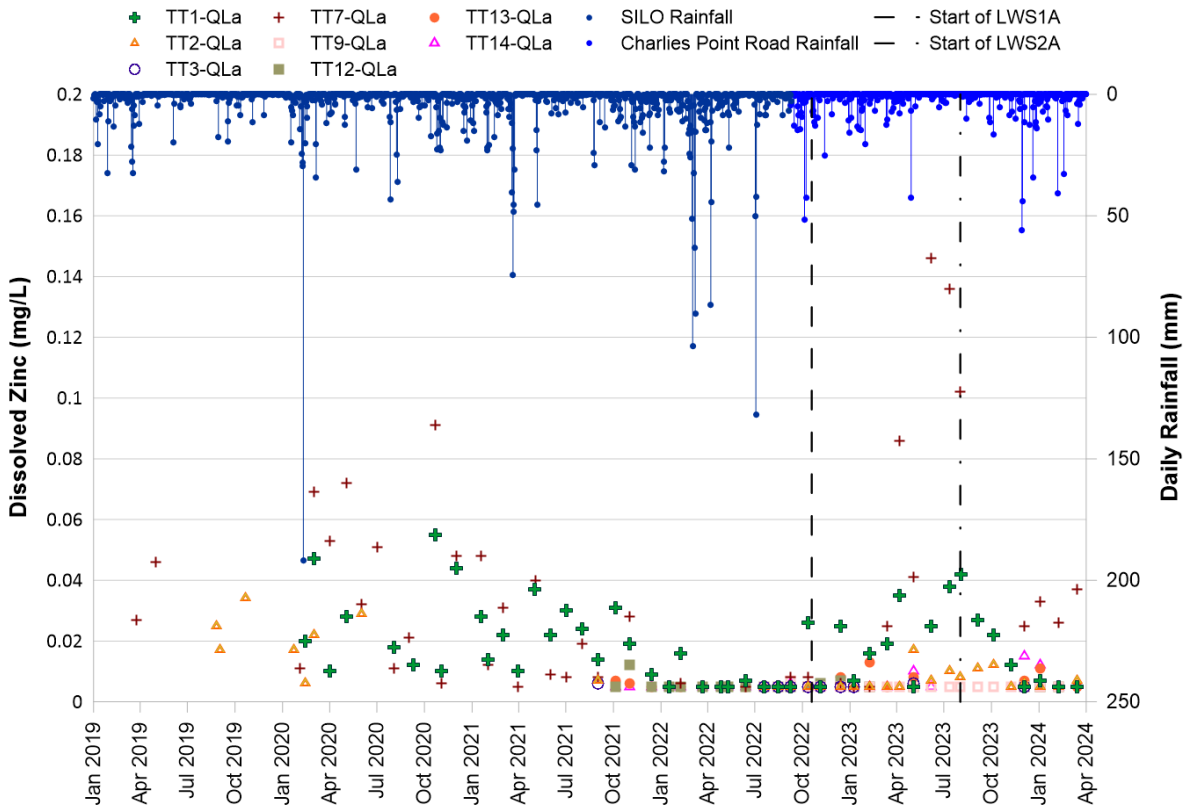
## GRAPH A10: TEATREE HOLLOW CATCHMENT - DISSOLVED NICKEL



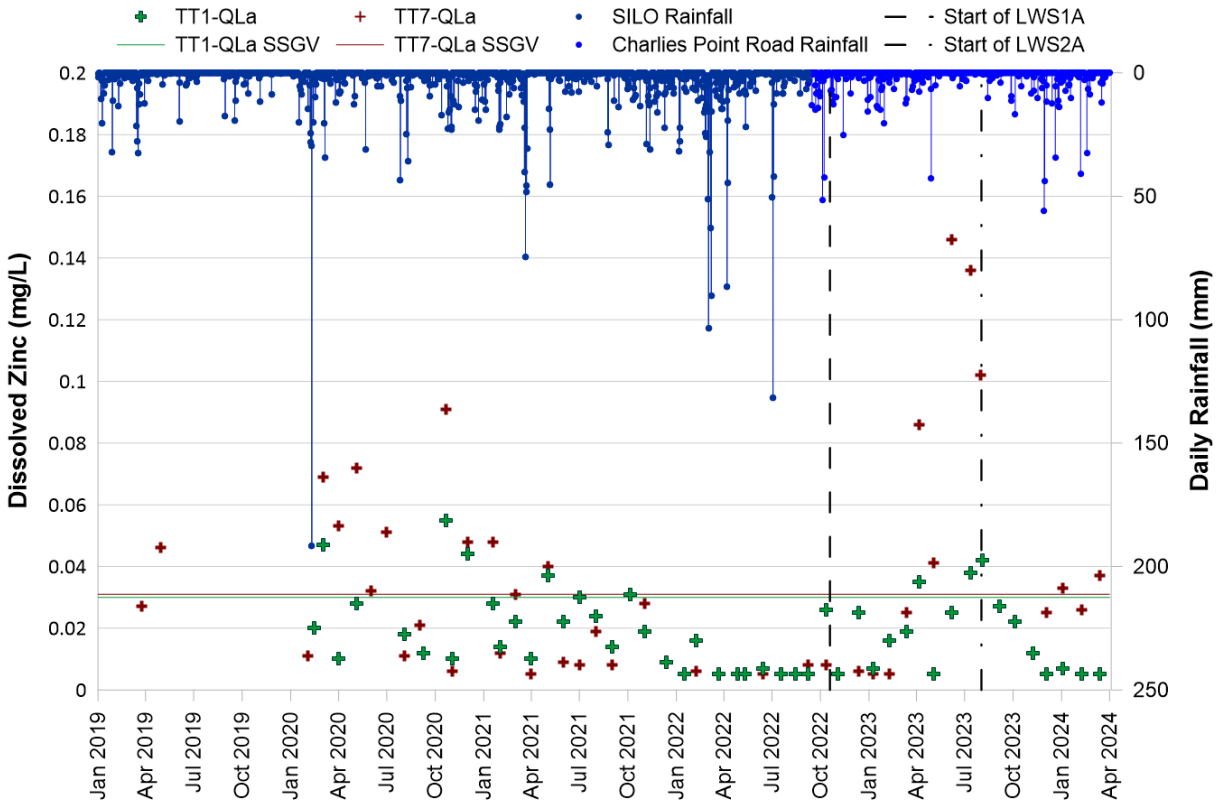

## GRAPH A11: TT1-QLa AND TT7-QLa - DISSOLVED NICKEL



## GRAPH A12: TEATREE HOLLOW CATCHMENT - DISSOLVED ZINC

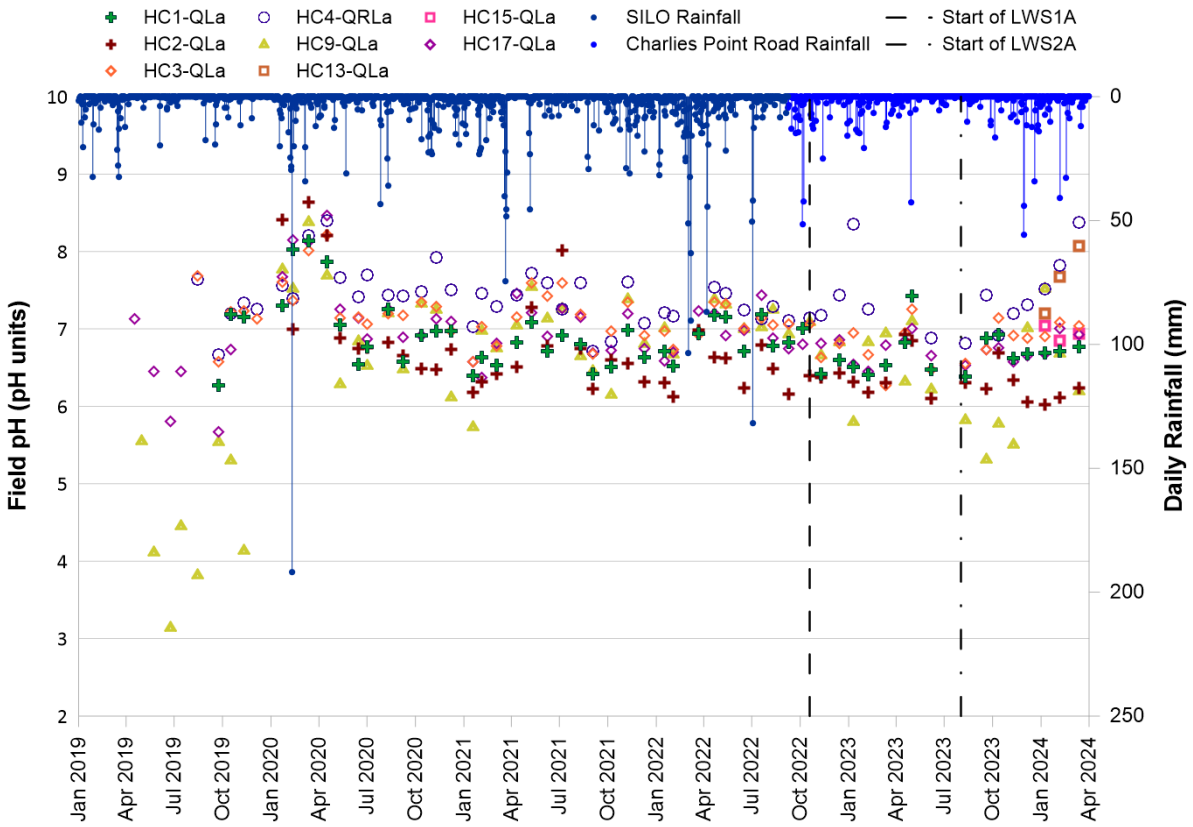



## GRAPH A13: TT1-QLa AND TT7-QLa - DISSOLVED ZINC

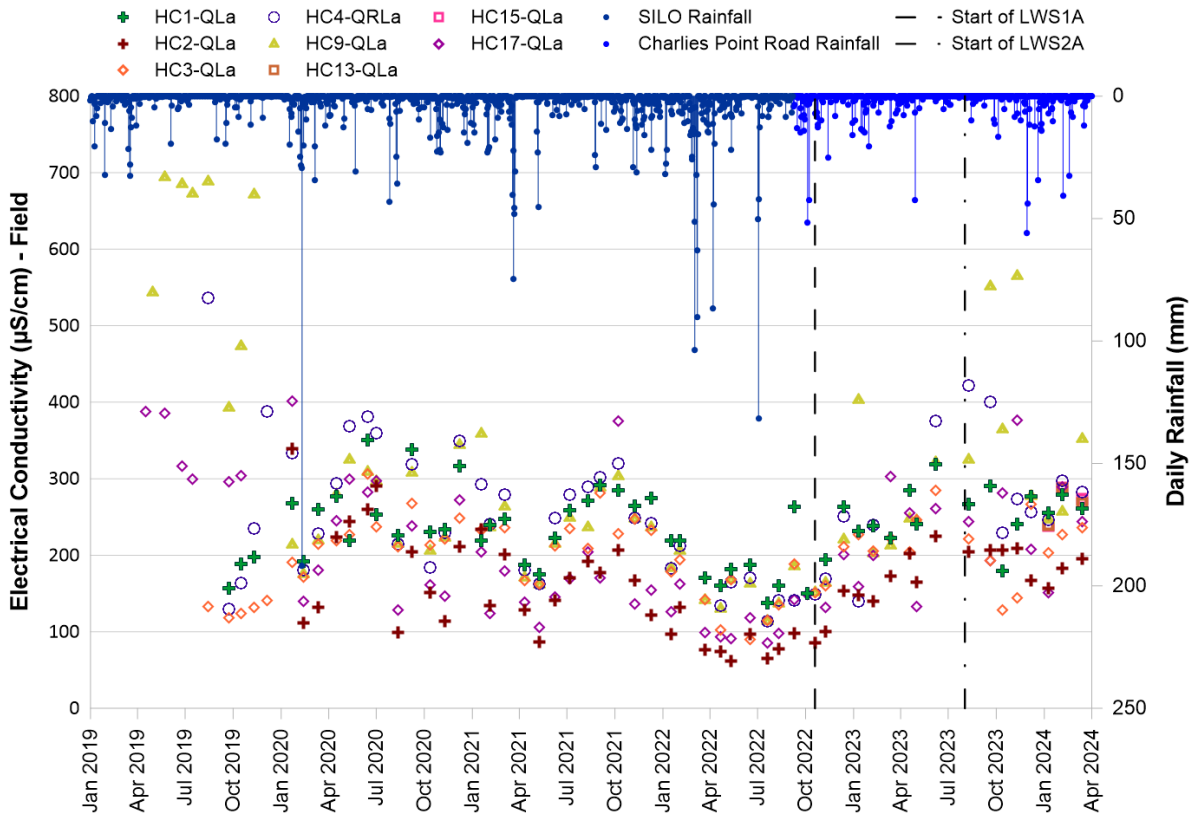



TAILINGS.WATER.WASTE.

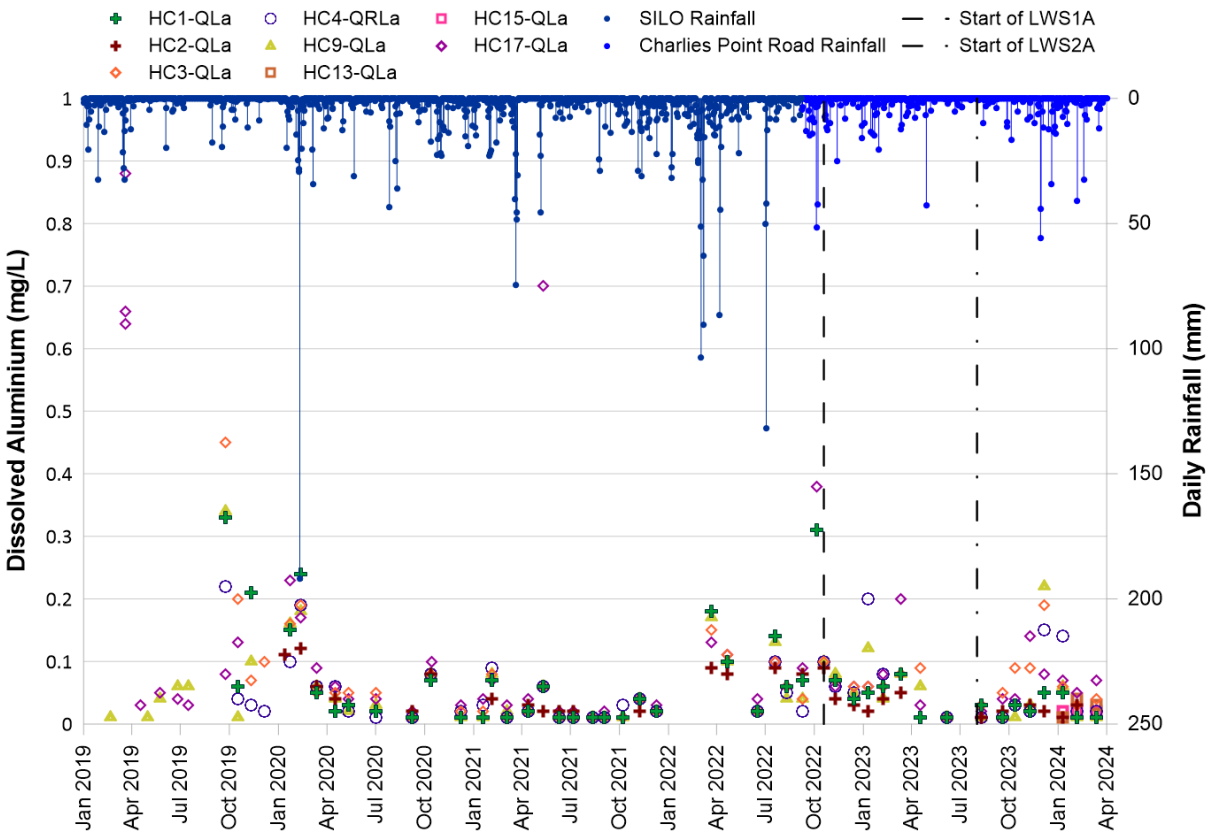
## GRAPH A14: HORNES CREEK – FIELD pH



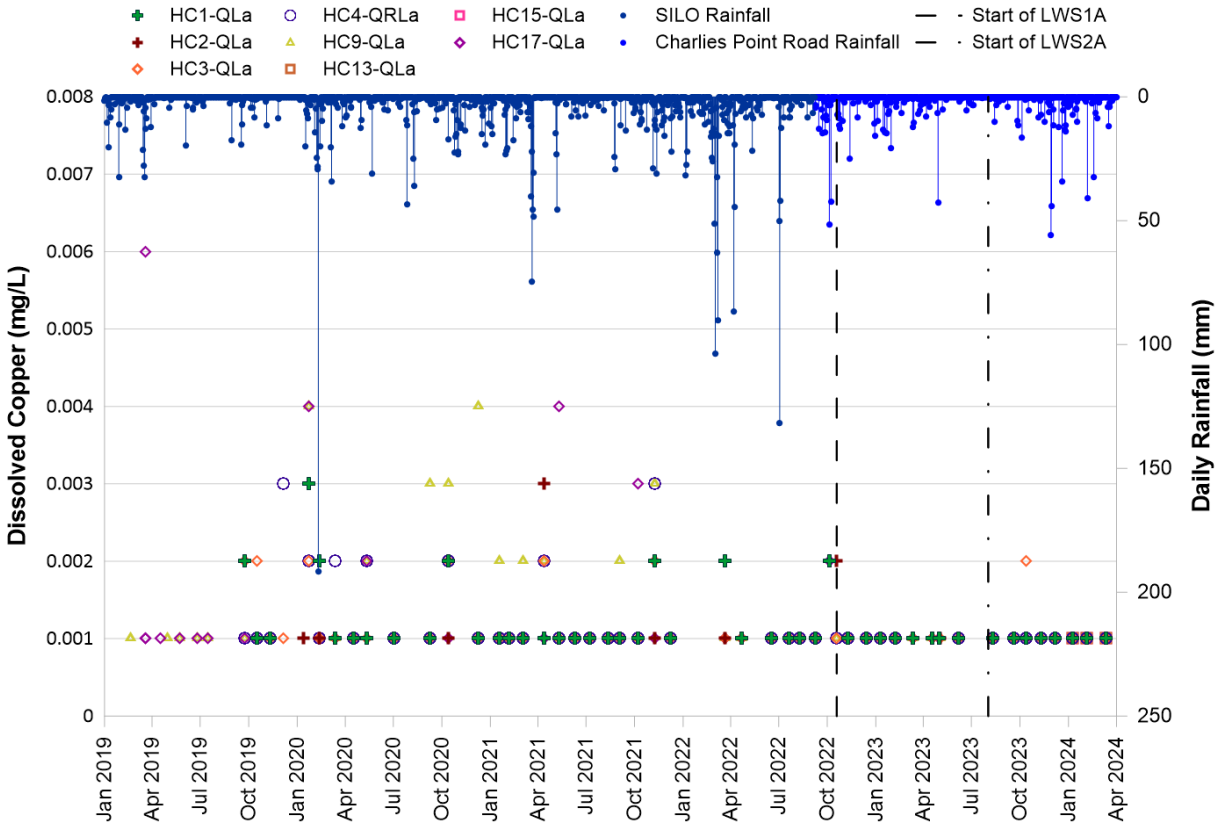

## GRAPH A15: HORNES CREEK – FIELD EC



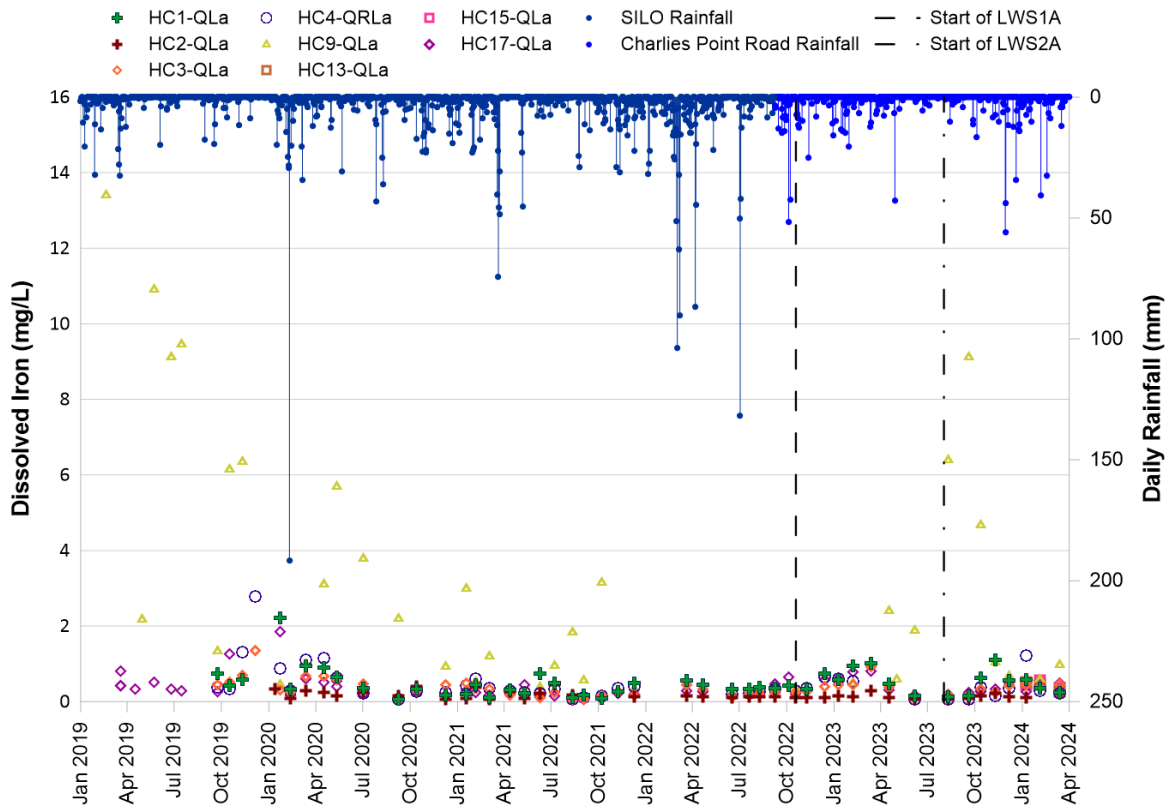
## GRAPH A16: HORNES CREEK – DISSOLVED ALUMINIUM



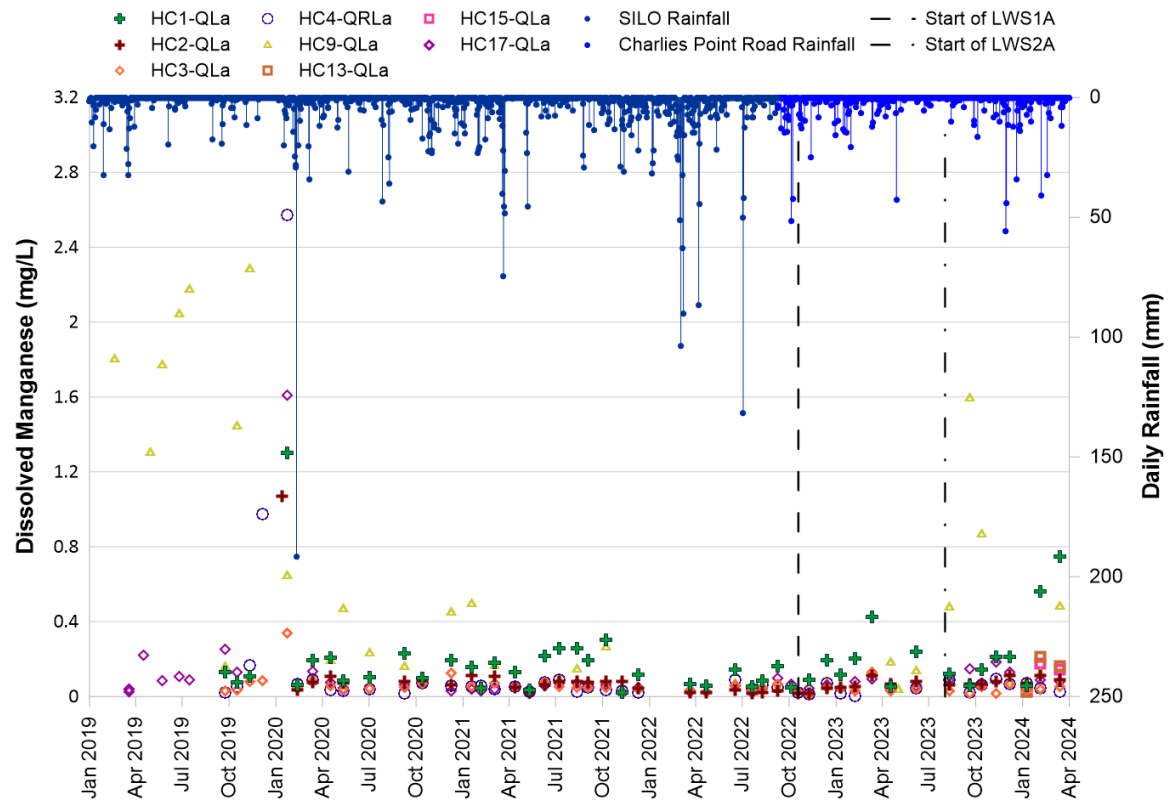

## GRAPH A17: HORNES CREEK – DISSOLVED COPPER



## GRAPH A18: HORNES CREEK – DISSOLVED IRON

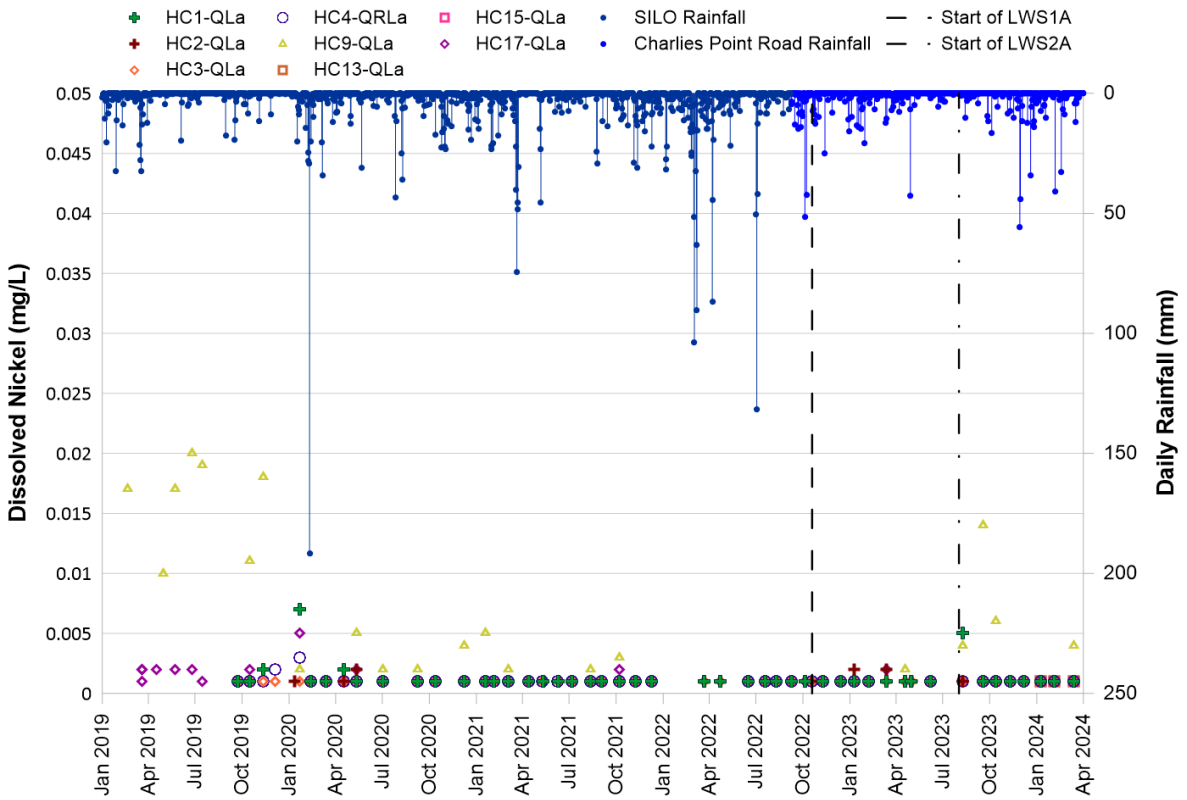



## GRAPH A19: HORNES CREEK – DISSOLVED MANGANESE

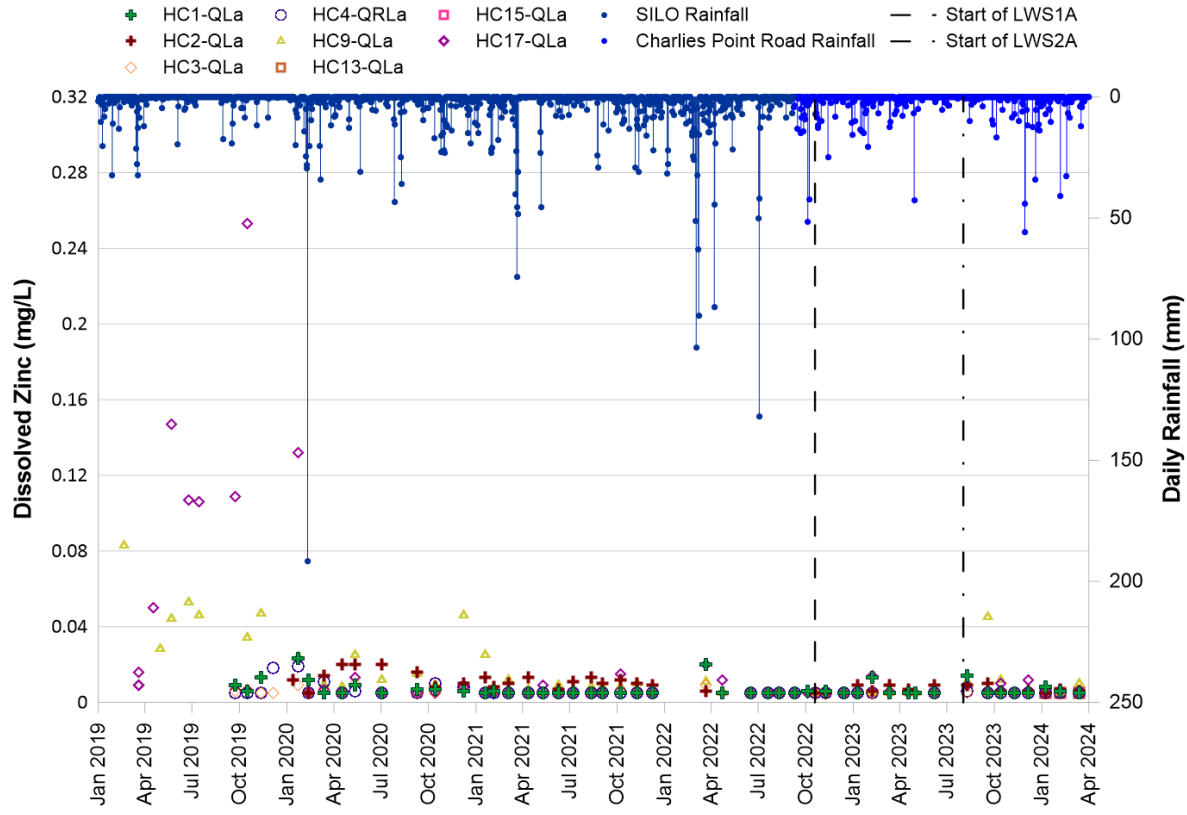



TAILINGS.WATER.WASTE.

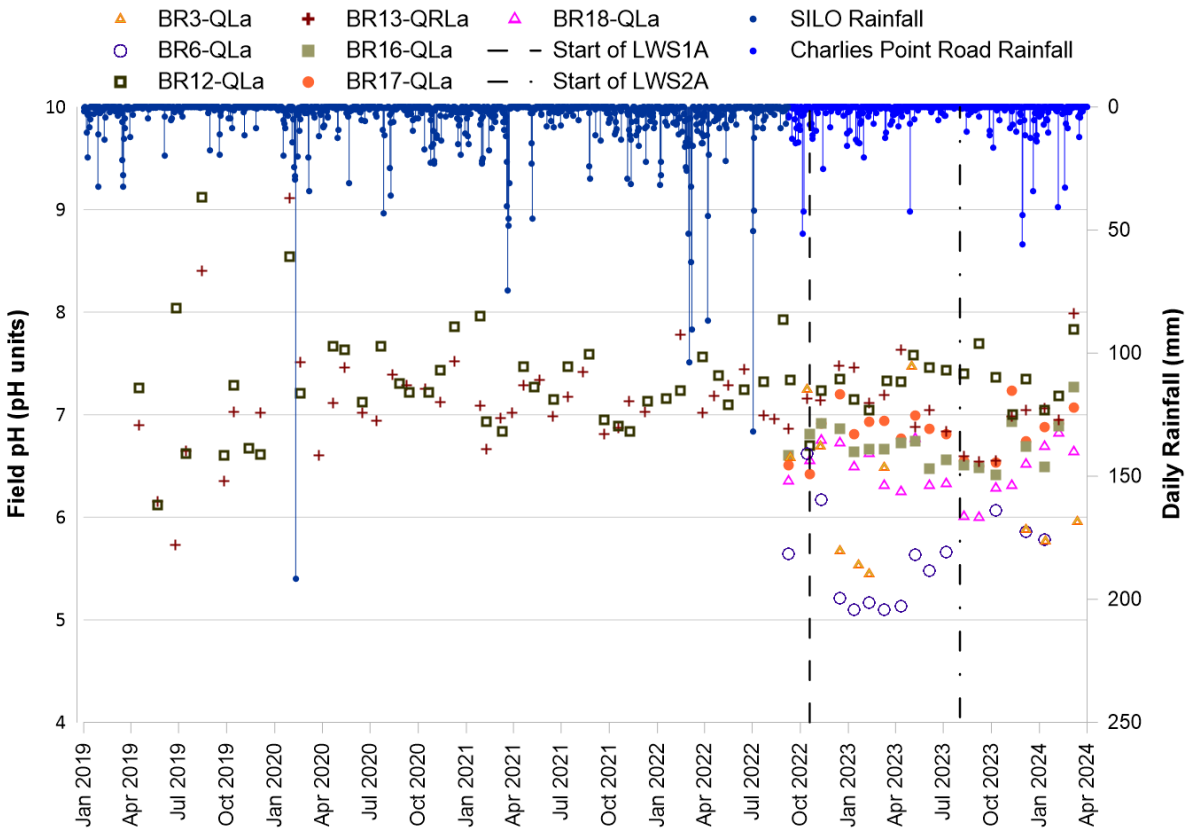
## GRAPH A20: HORNES CREEK – DISSOLVED NICKEL



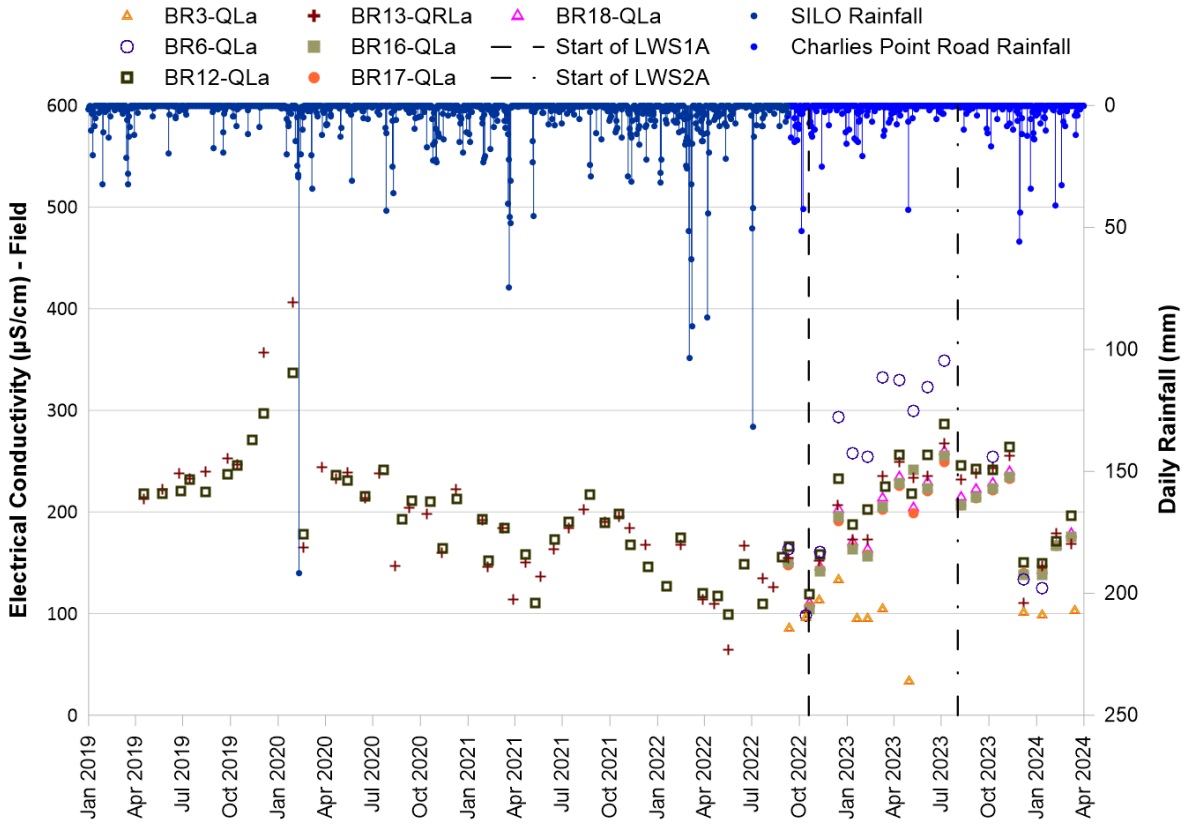

## GRAPH A21: HORNES CREEK – DISSOLVED ZINC



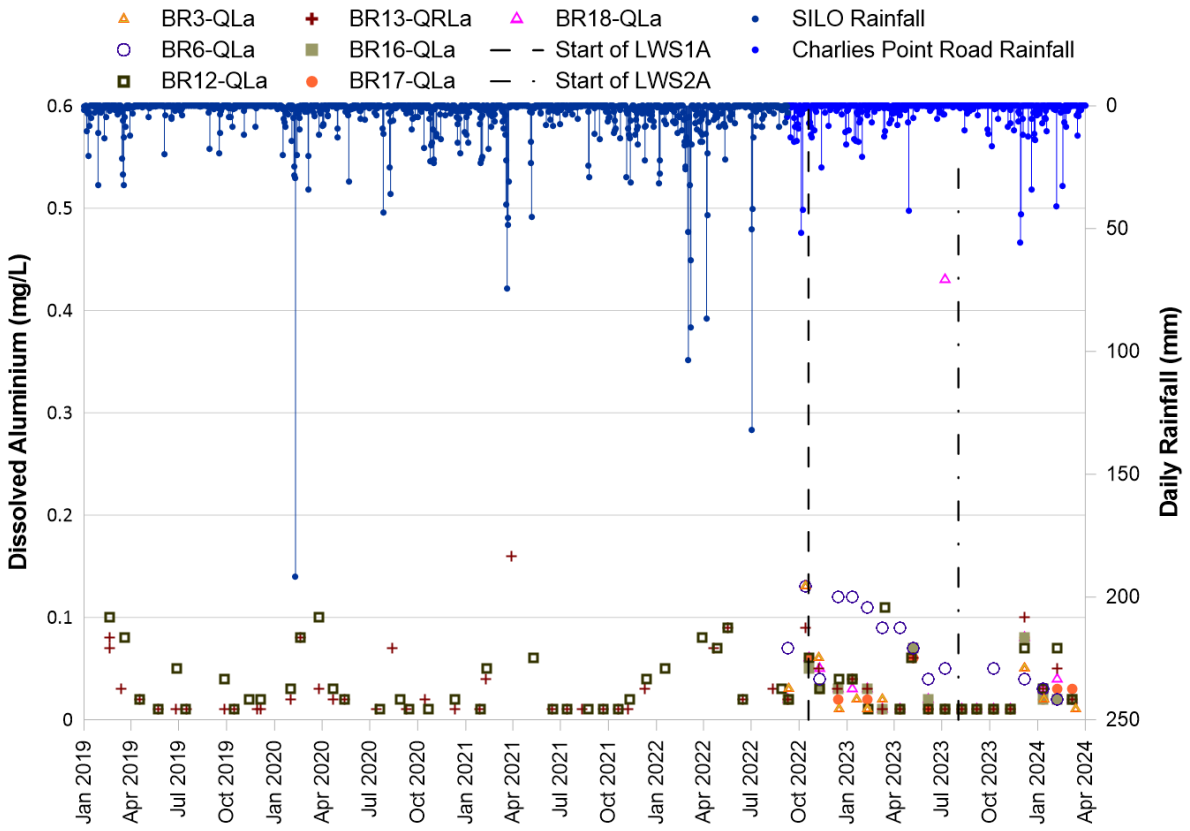
## GRAPH A22: BARGO RIVER CATCHMENT – FIELD pH



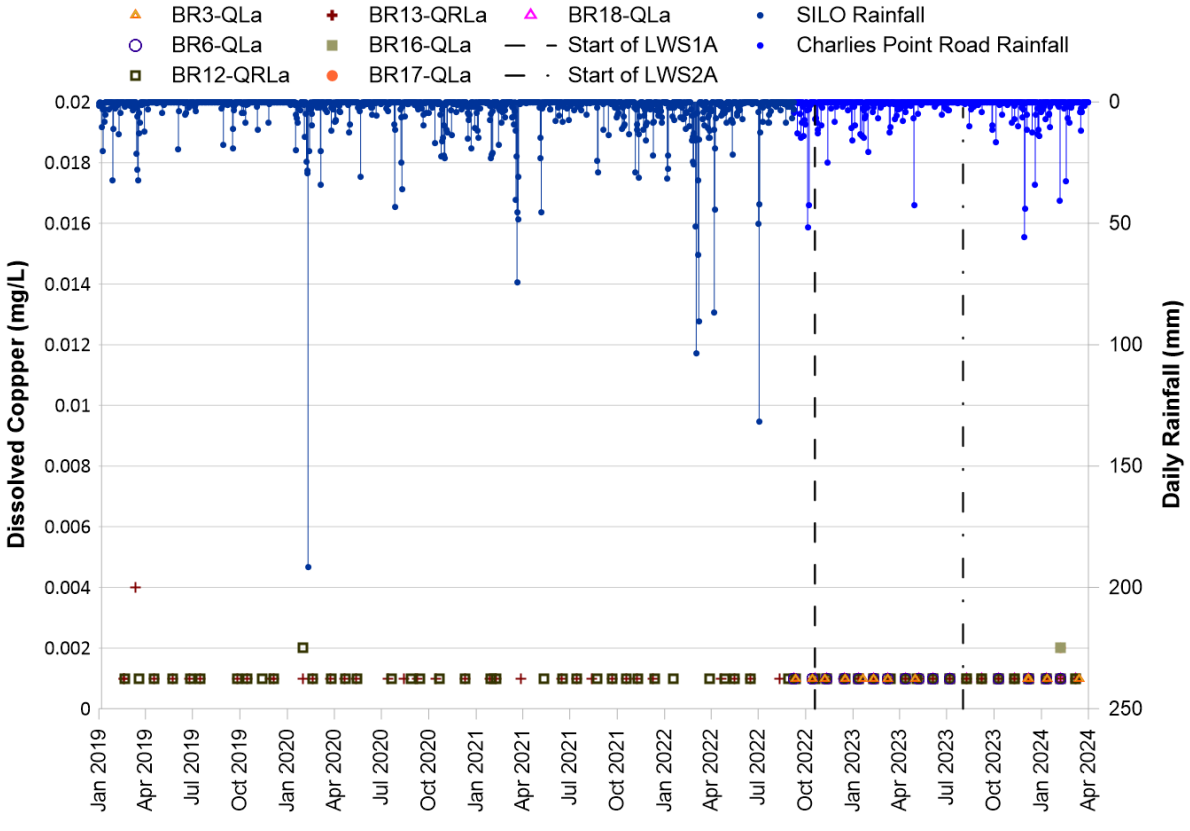

## GRAPH A23: BARGO RIVER CATCHMENT – FIELD EC



## GRAPH A24: BARGO RIVER CATCHMENT – DISSOLVED ALUMINIUM

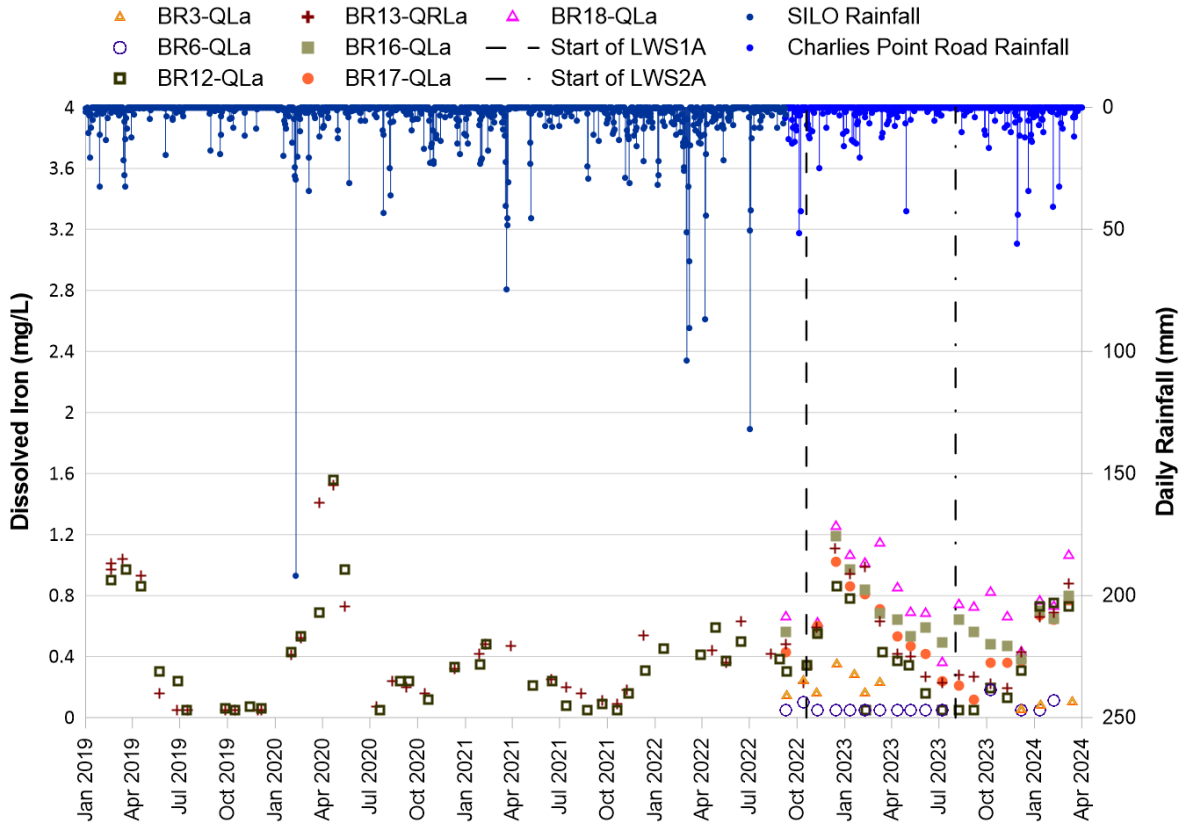



## GRAPH A25: BARGO RIVER CATCHMENT – DISSOLVED COPPER

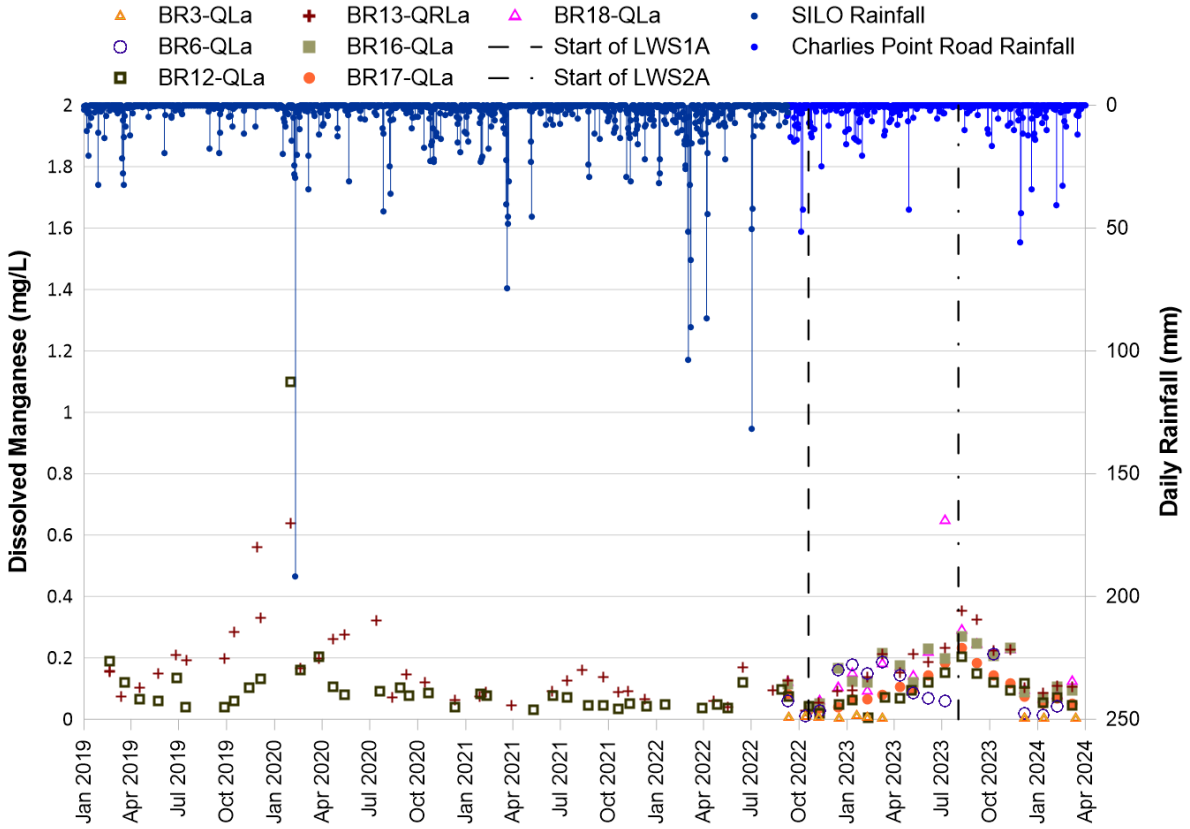



TAILINGS.WATER.WASTE.

## GRAPH A26: BARGO RIVER CATCHMENT – DISSOLVED IRON

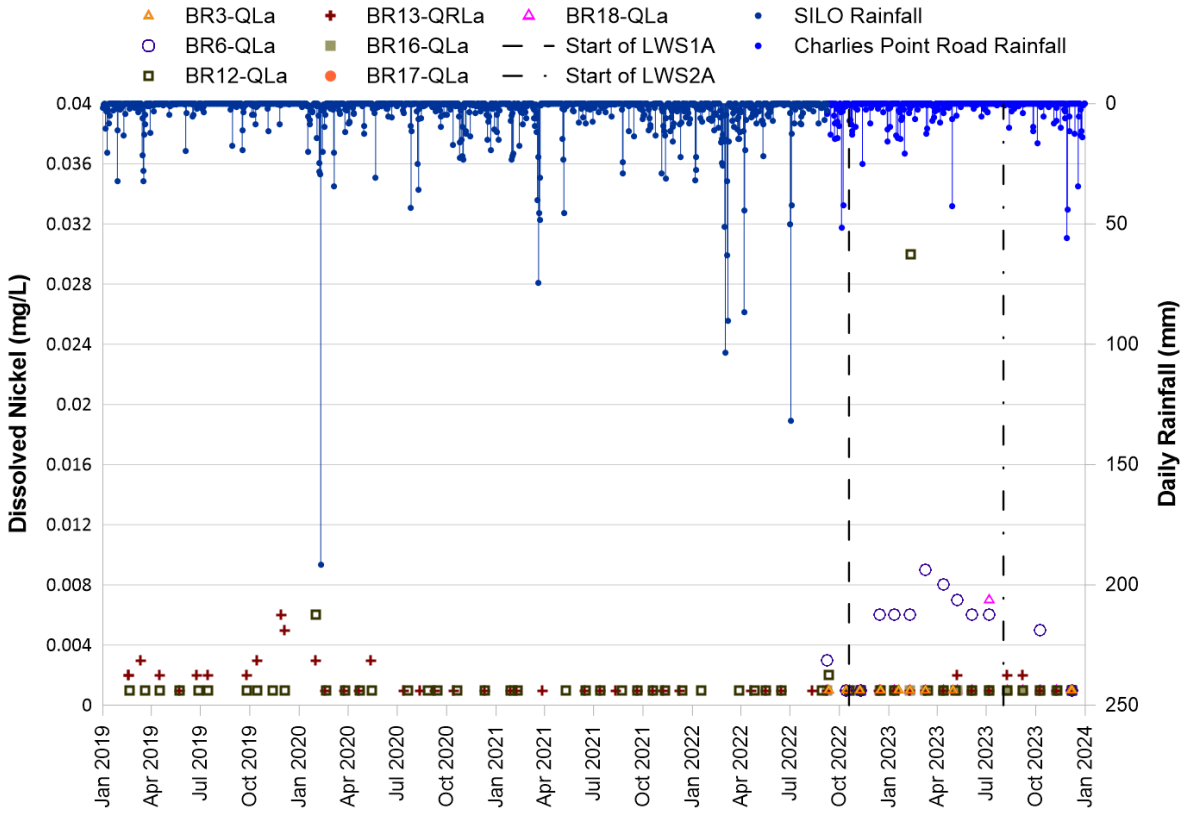



## GRAPH A27: BARGO RIVER CATCHMENT – DISSOLVED MANGANESE

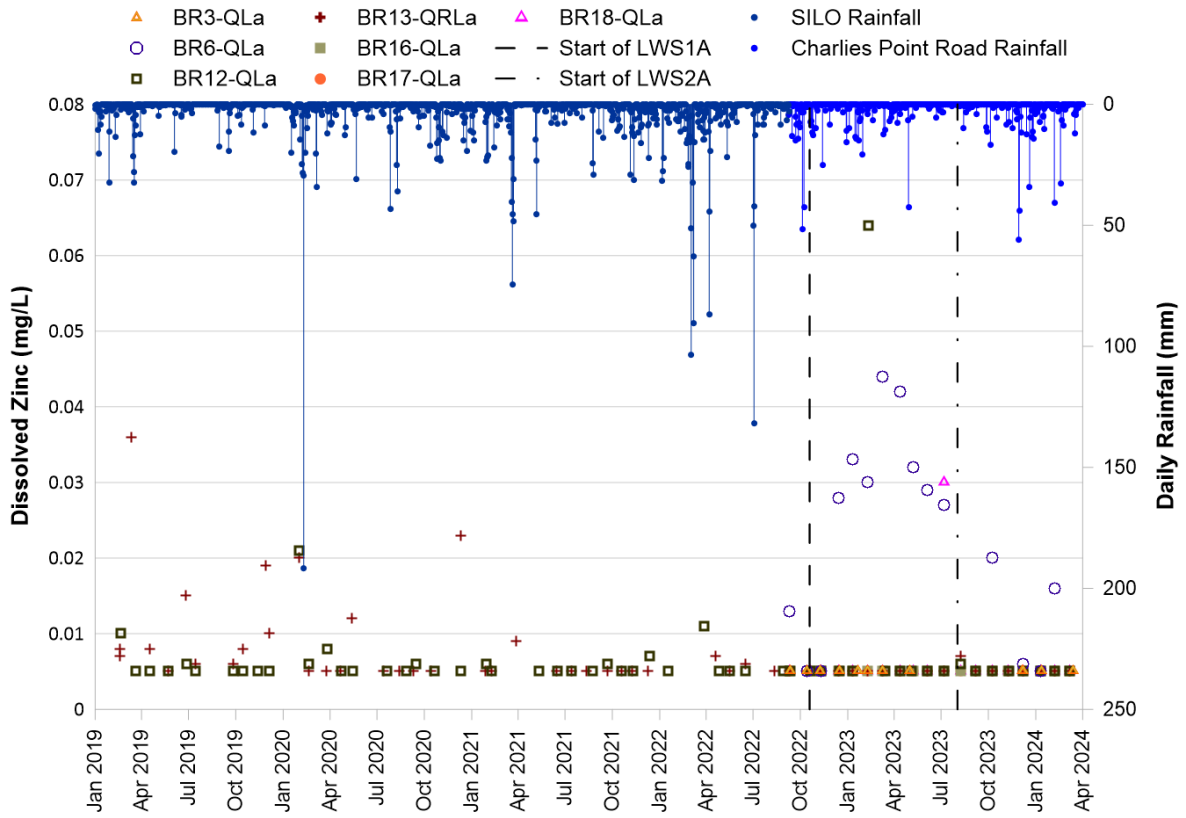



TAILINGS.WATER.WASTE.

## GRAPH A28: BARGO RIVER CATCHMENT – DISSOLVED NICKEL




## GRAPH A29: BARGO RIVER CATCHMENT – DISSOLVED ZINC

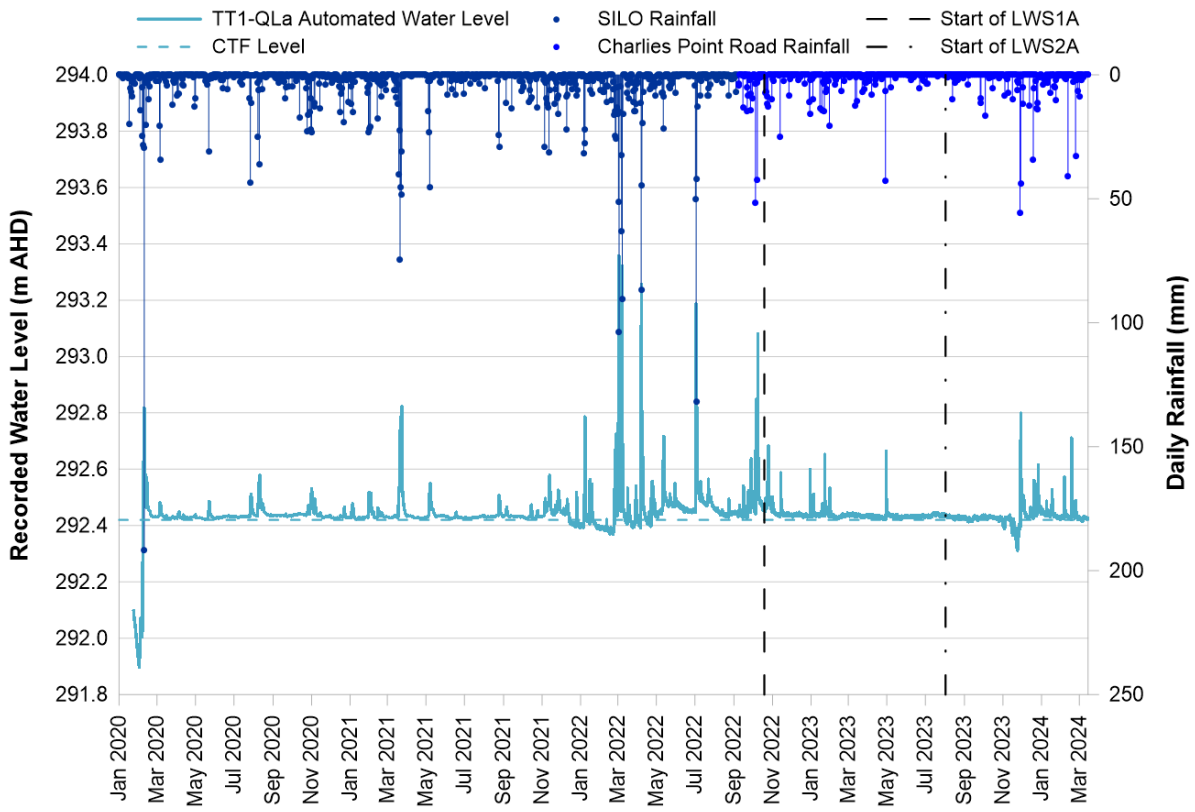



TAILINGS.WATER.WASTE.

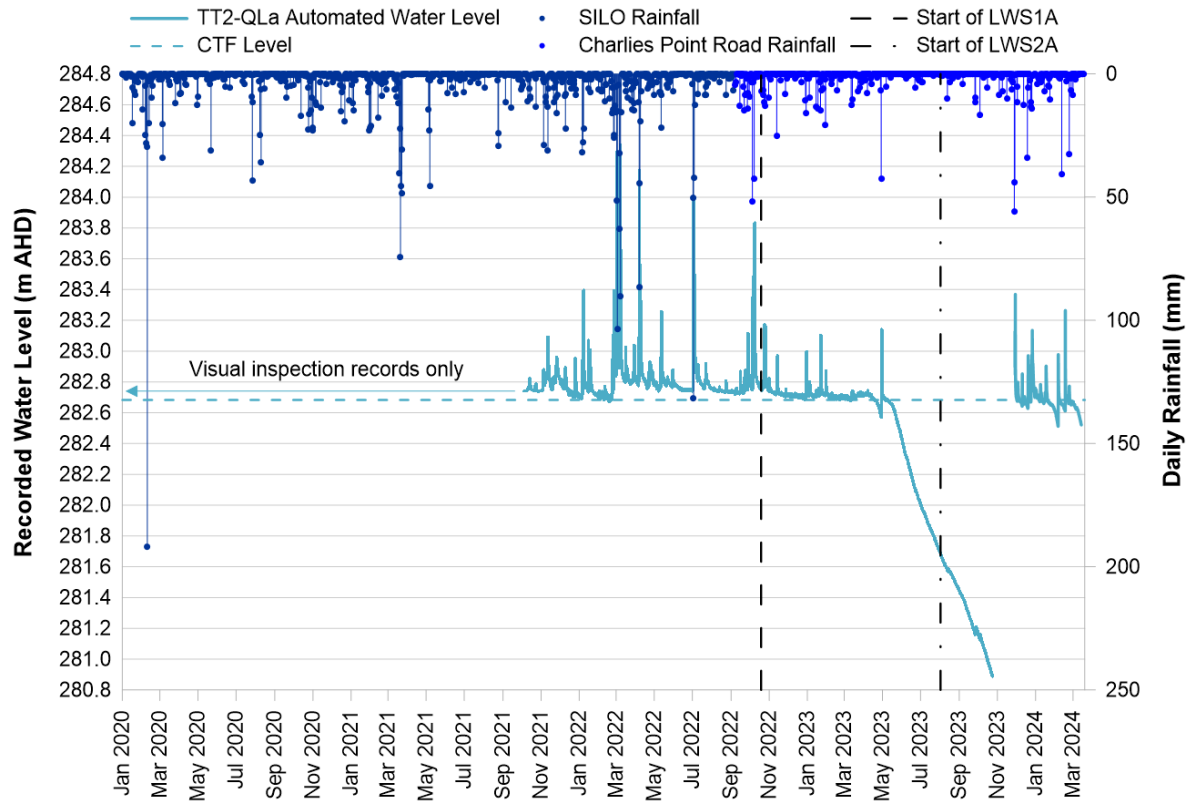
# APPENDIX B – WATER LEVEL PLOTS

TAILINGS.WATER.WASTE.

## GRAPH B1: TT1-QLa WATER LEVEL

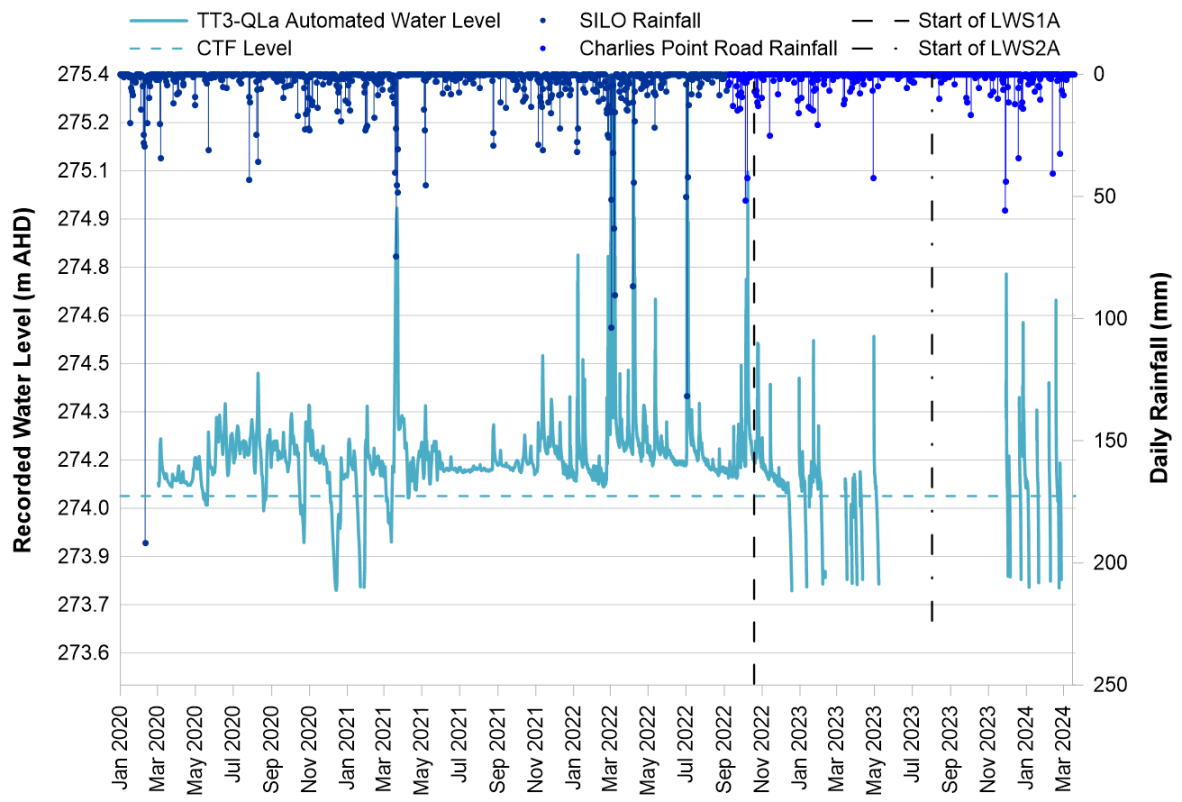



## GRAPH B2: TT2-QLa WATER LEVEL

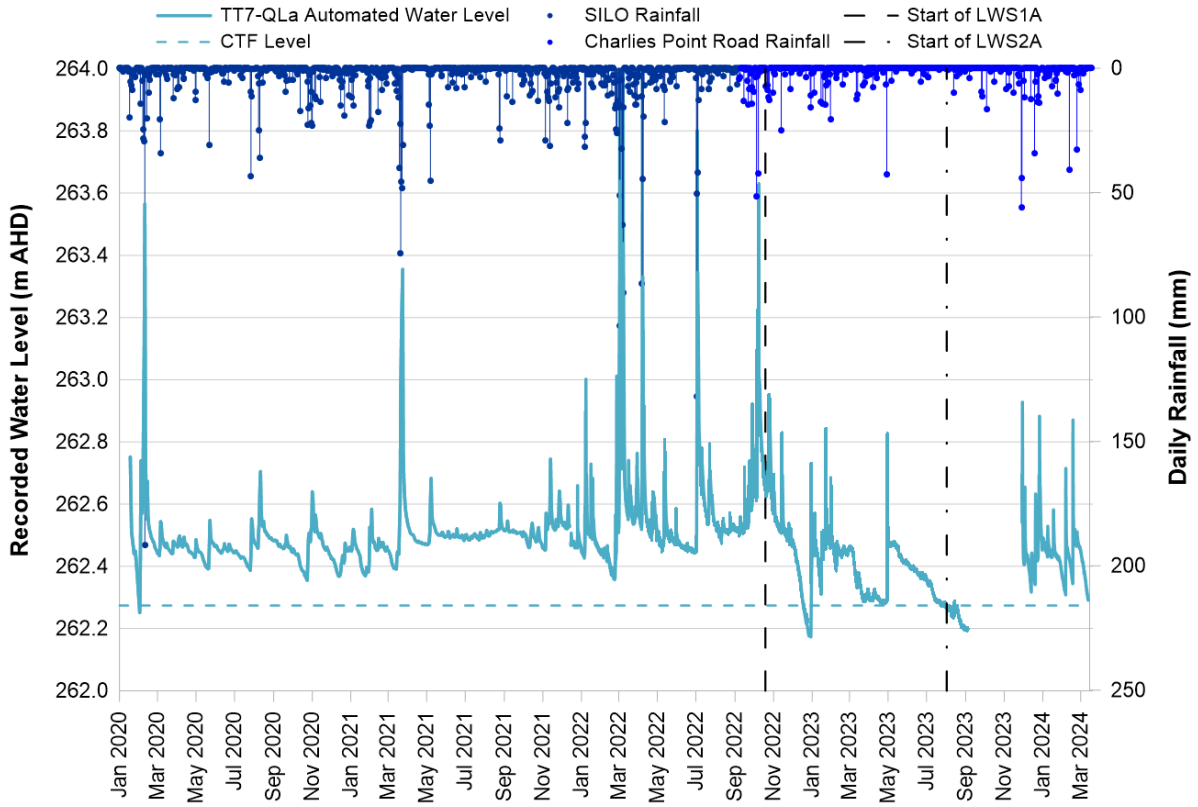



TAILINGS.WATER.WASTE.

## GRAPH B3: TT3-QLa WATER LEVEL

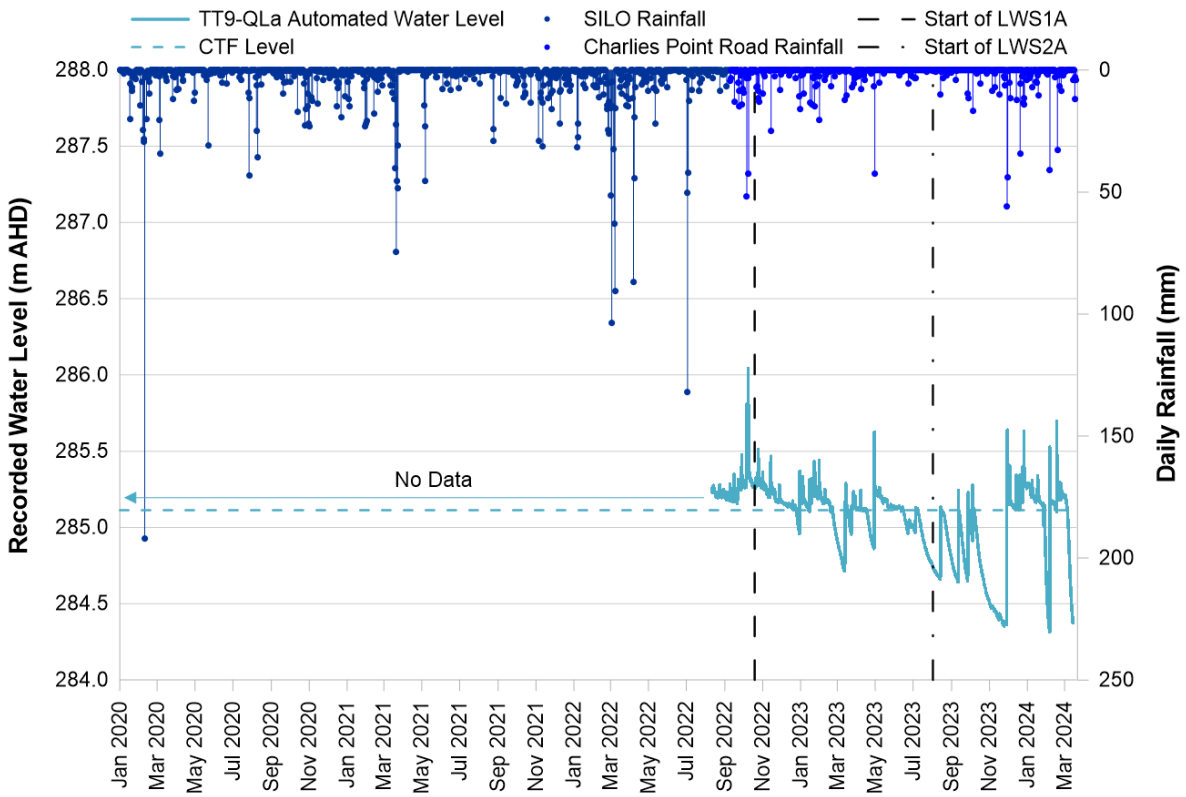



## GRAPH B4: TT7-QLa WATER LEVEL

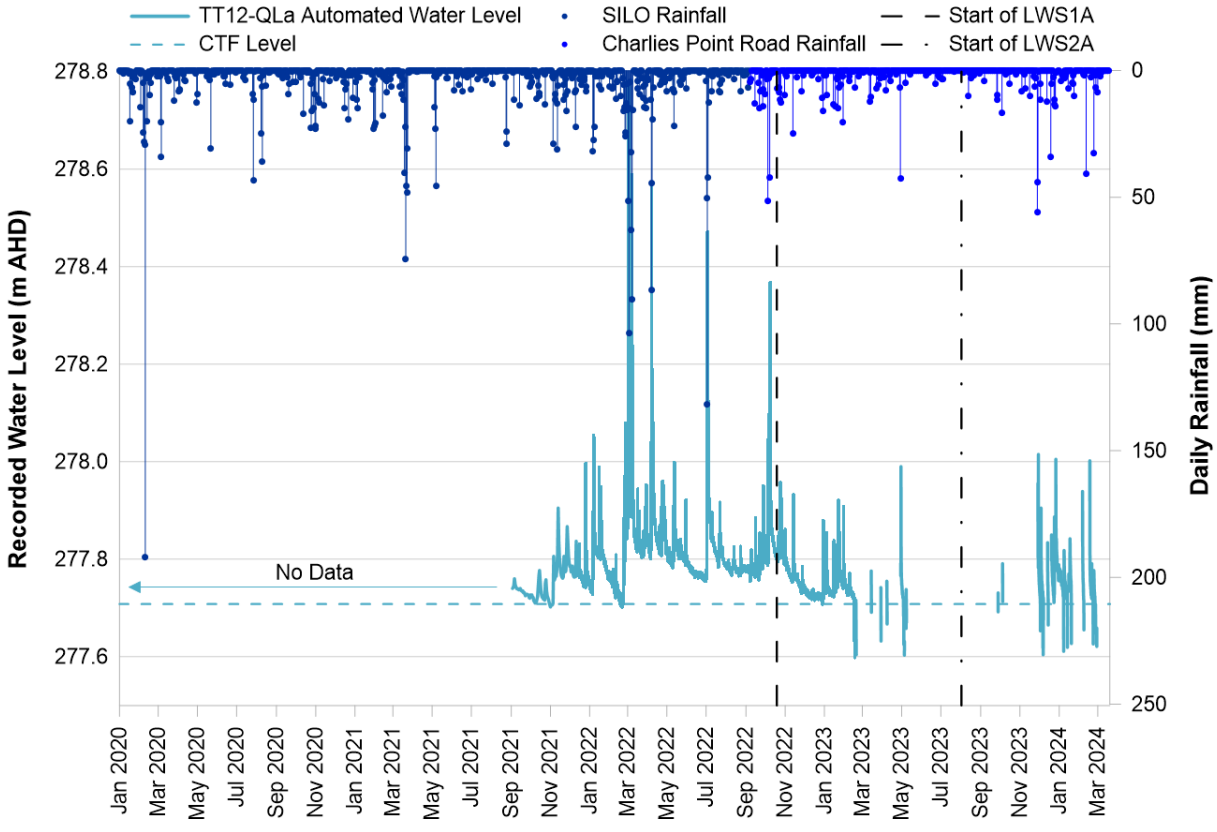



TAILINGS.WATER.WASTE.

## GRAPH B5: TT9-QLa WATER LEVEL

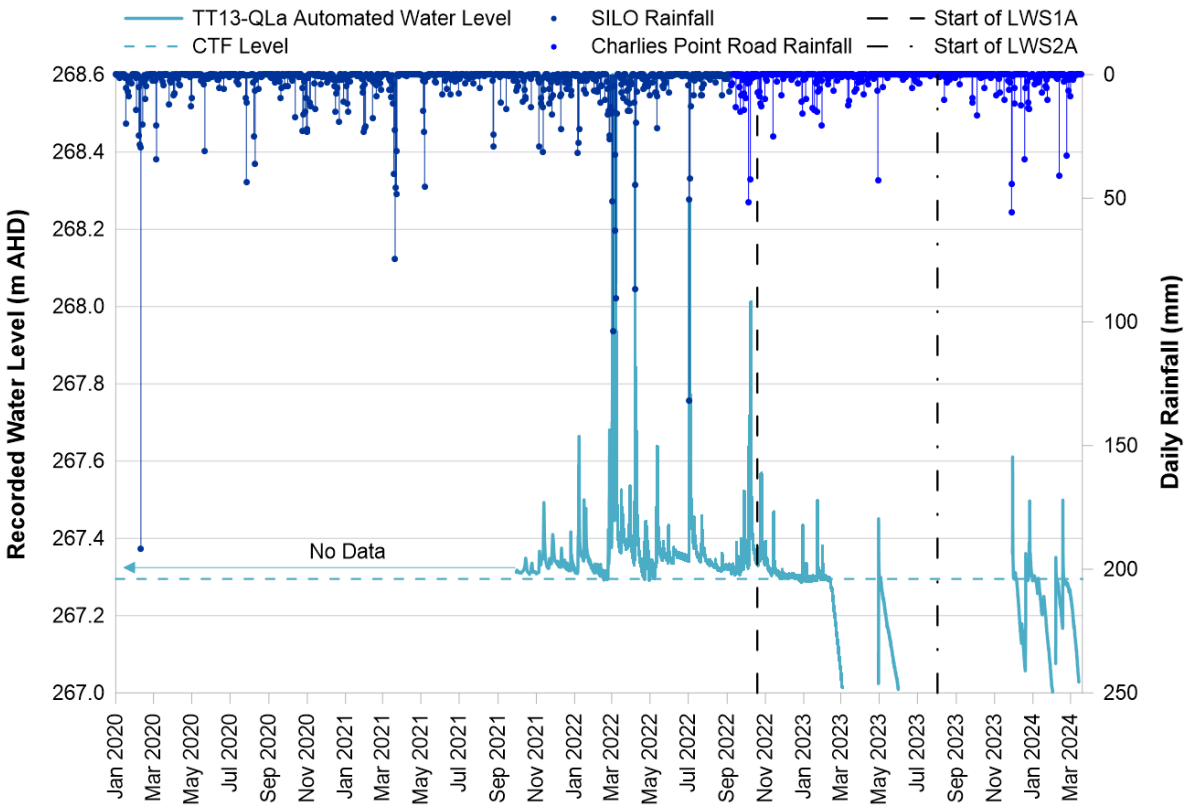



## GRAPH B6: TT12-QLa WATER LEVEL

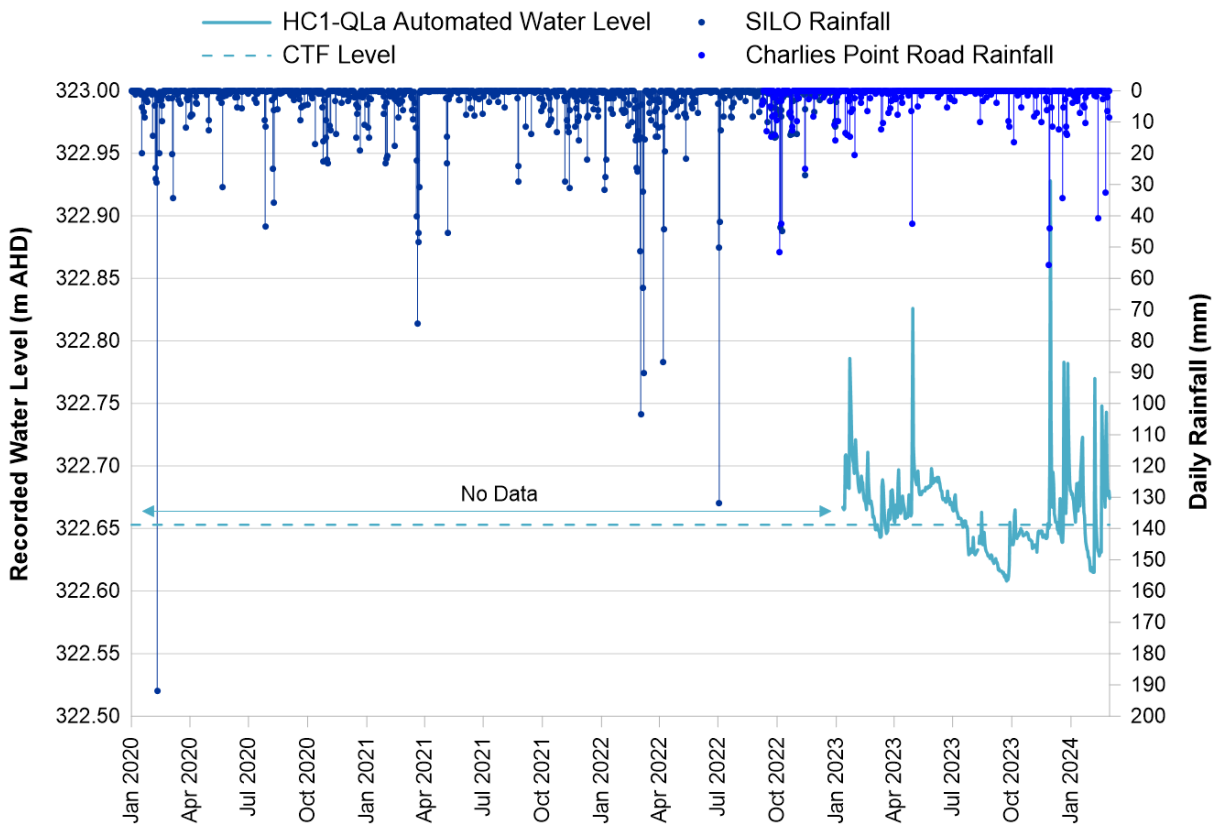



TAILINGS.WATER.WASTE.

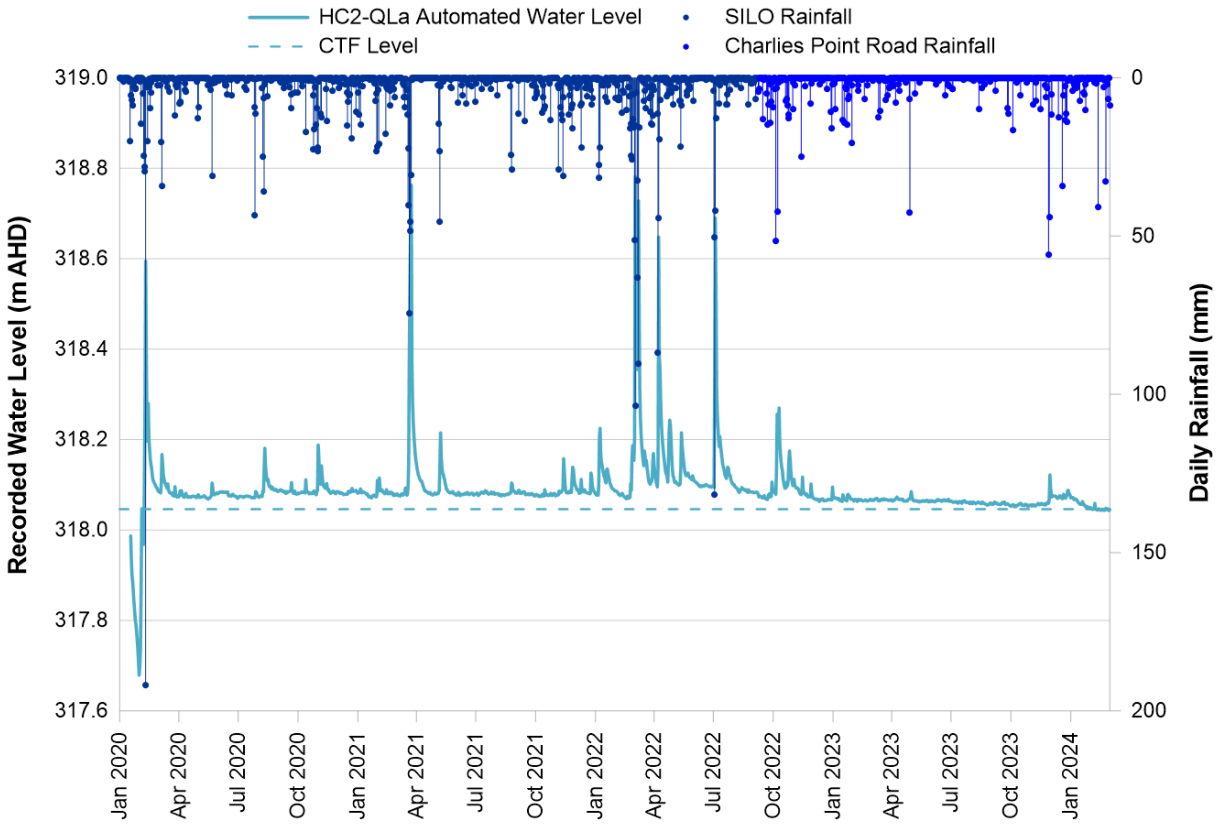
## GRAPH B7: TT13-QLa WATER LEVEL



## GRAPH B8: HC1-QLa WATER LEVEL

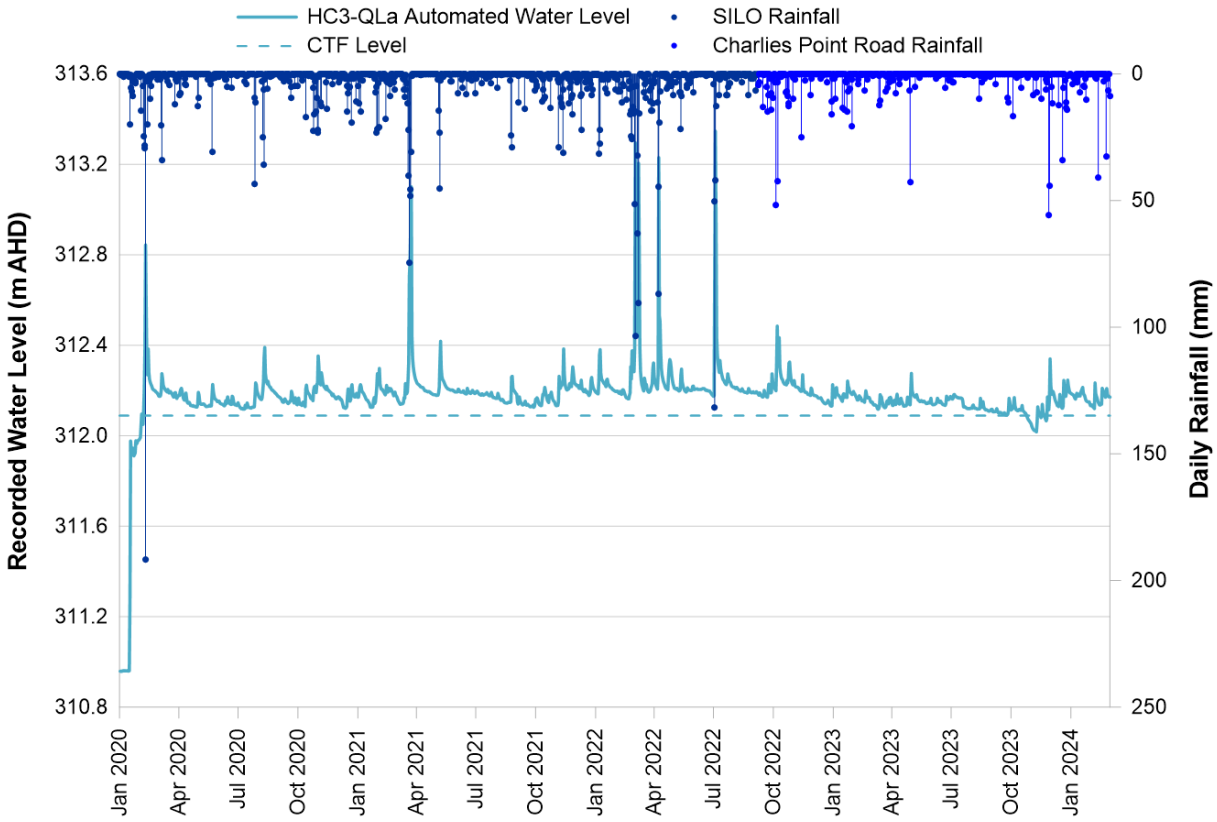



## GRAPH B9: HC2-QLa WATER LEVEL

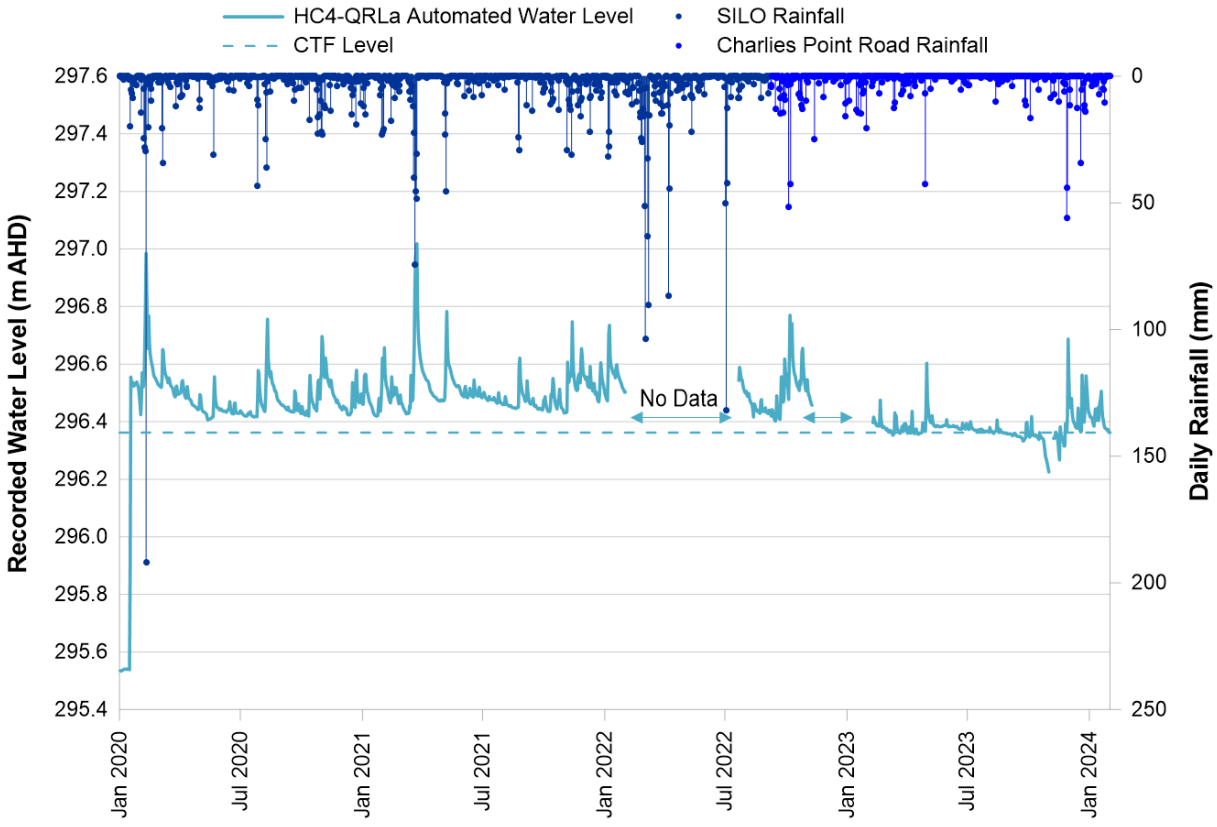



TAILINGS.WATER.WASTE.

## GRAPH B10: HC3-QLa WATER LEVEL

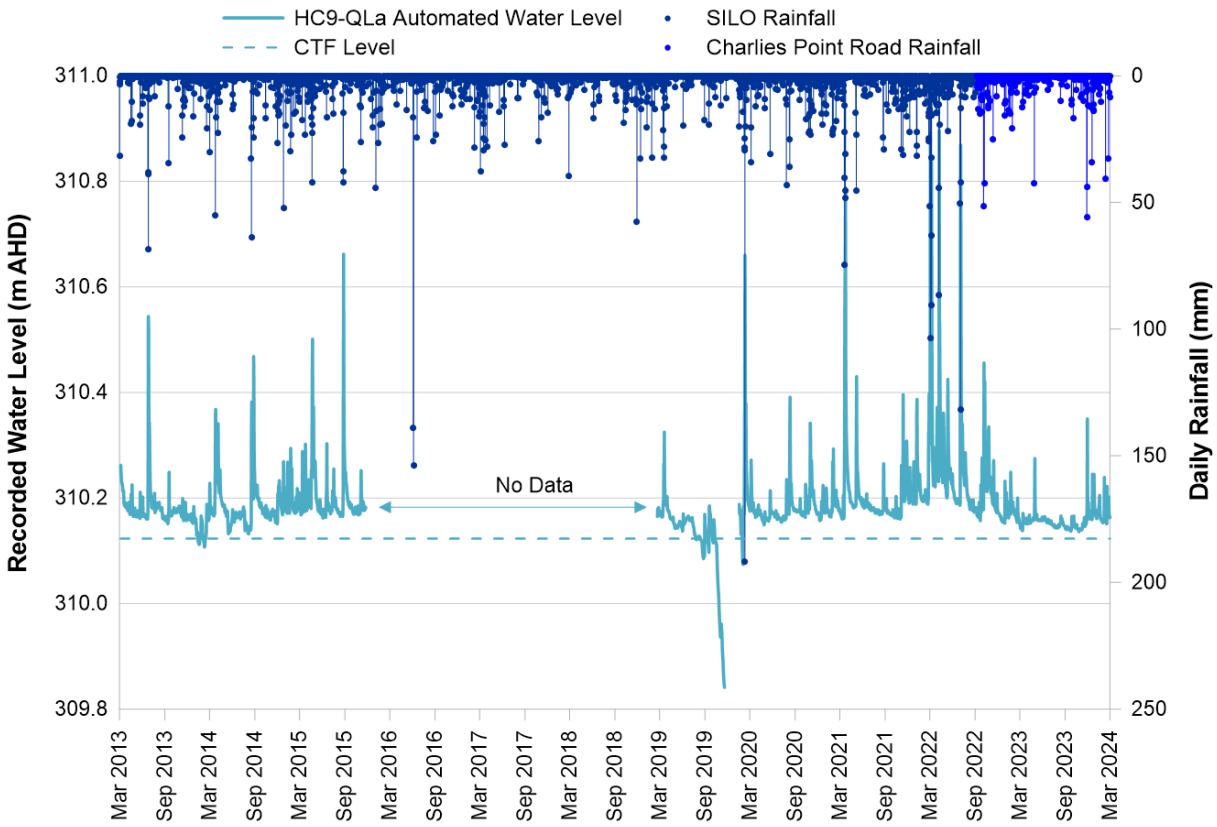



## GRAPH B11: HC4-QRLa WATER LEVEL

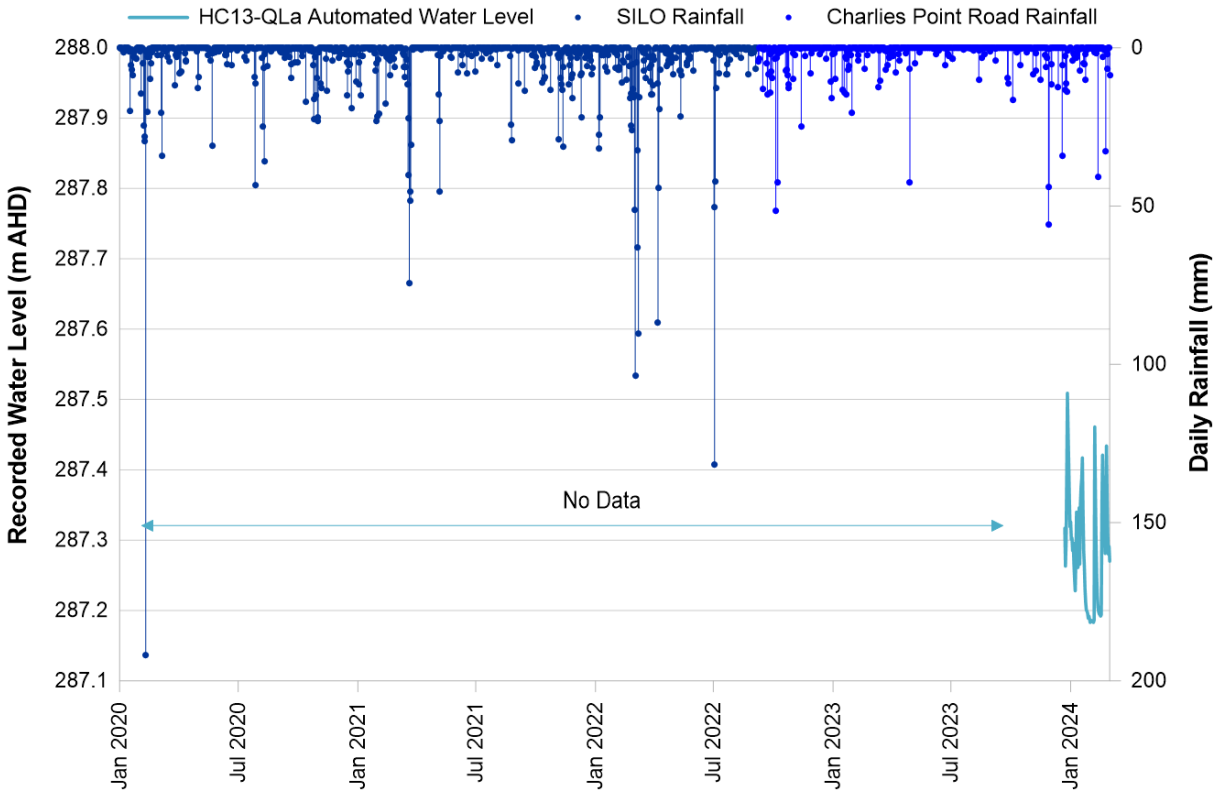



TAILINGS.WATER.WASTE.

## GRAPH B12: HC9-QLa WATER LEVEL

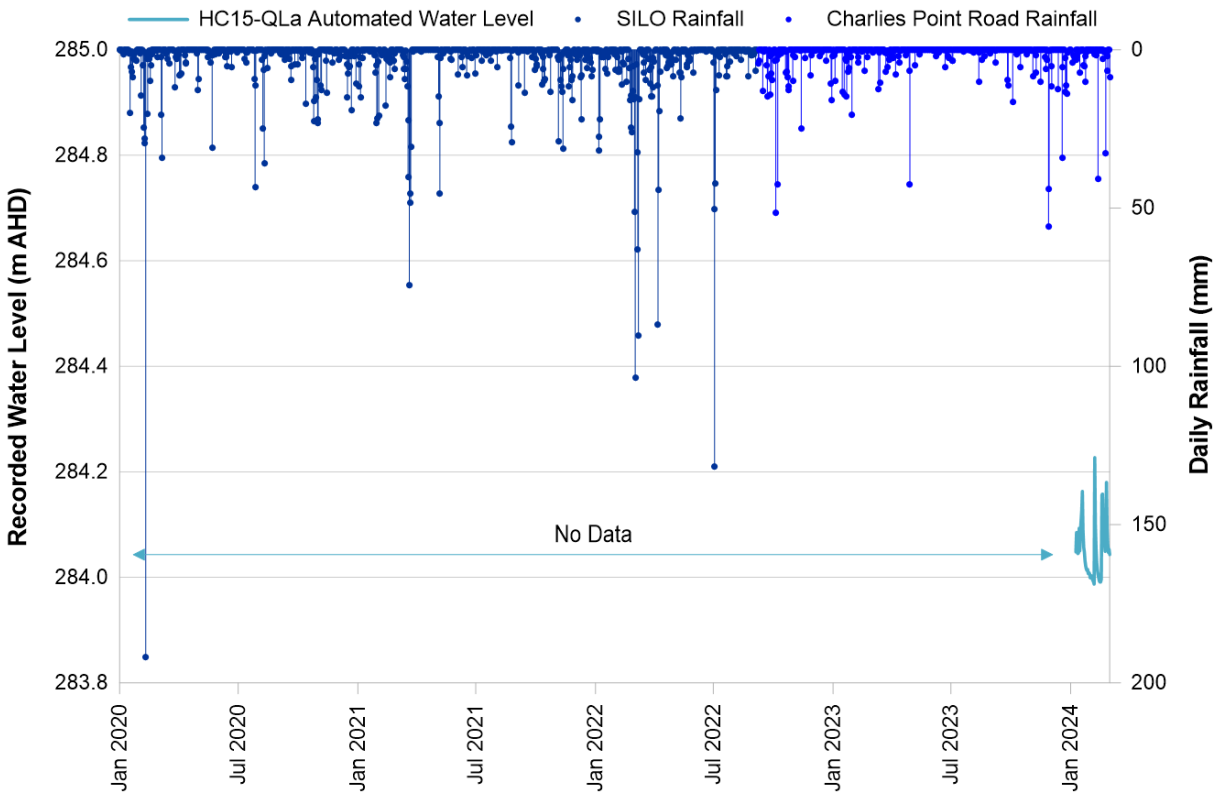



## GRAPH B13: HC13-QLa WATER LEVEL

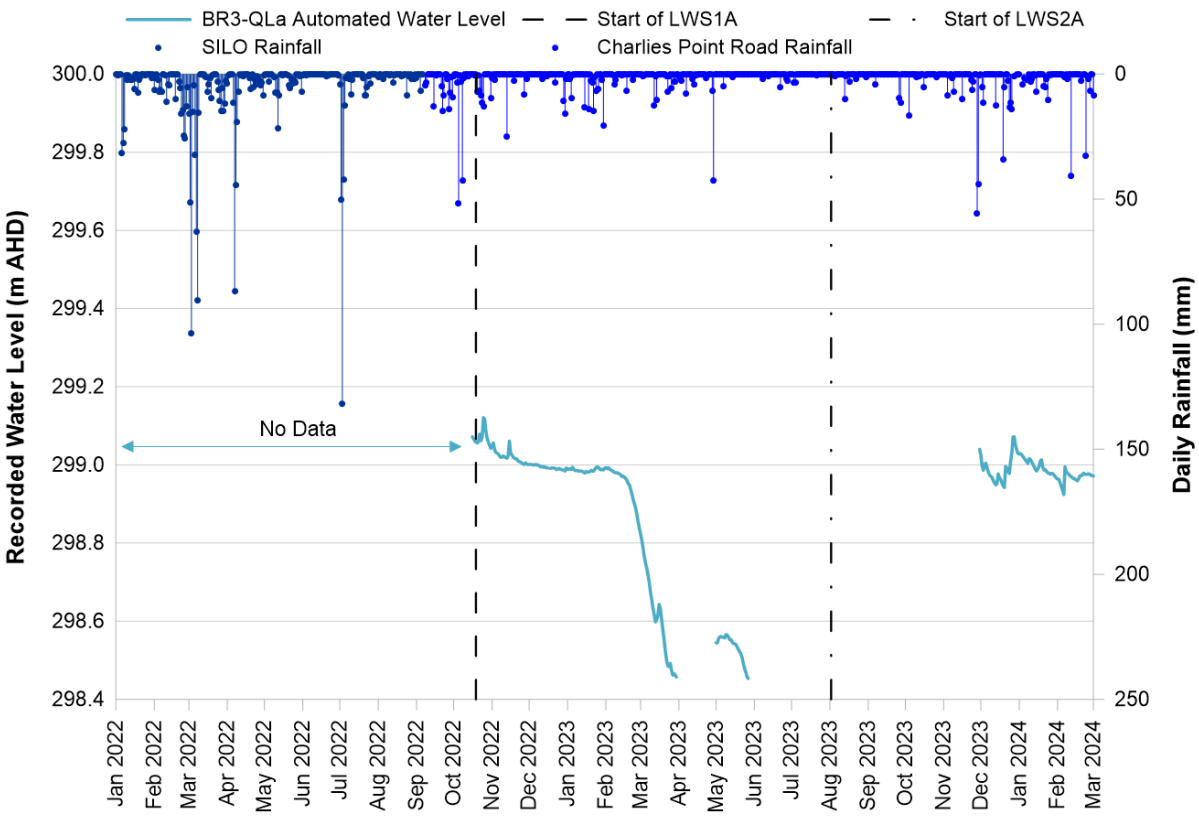



TAILINGS.WATER.WASTE.

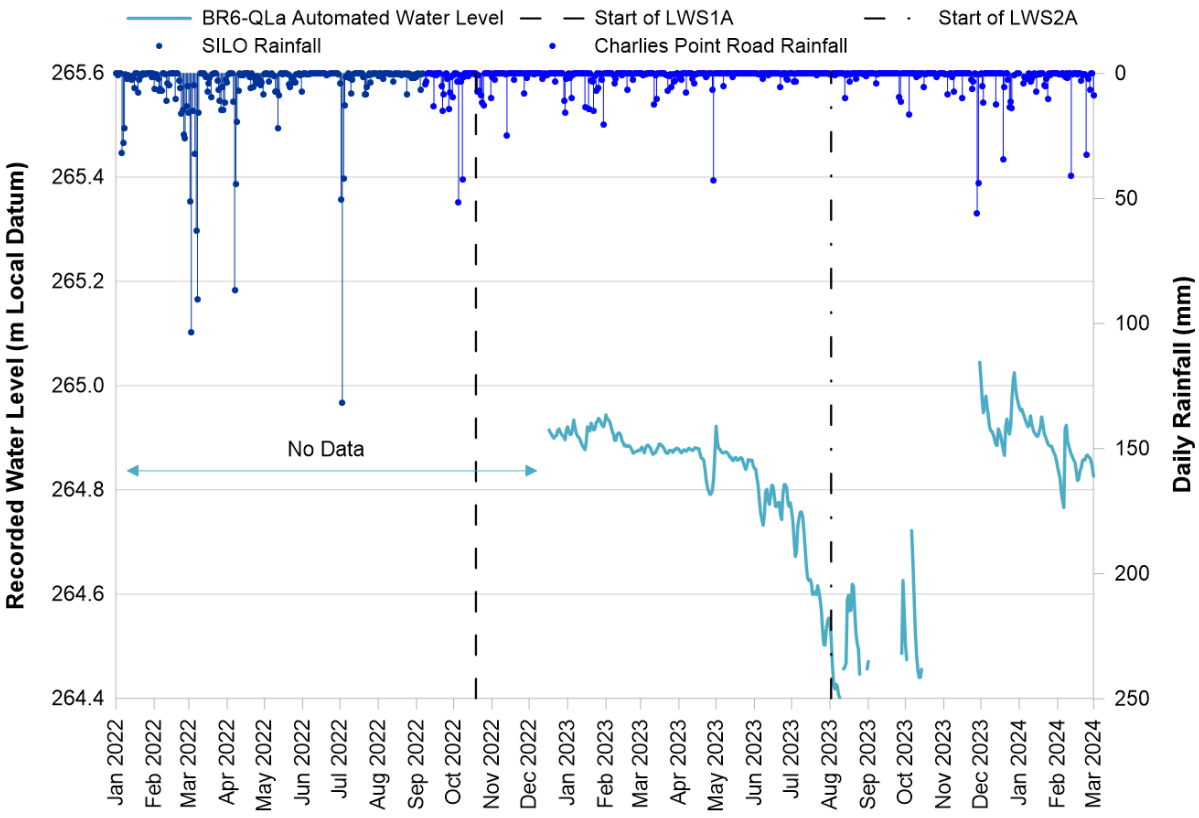
## GRAPH B14: HC15-QLa WATER LEVEL



## GRAPH B15: BR3-QLa WATER LEVEL

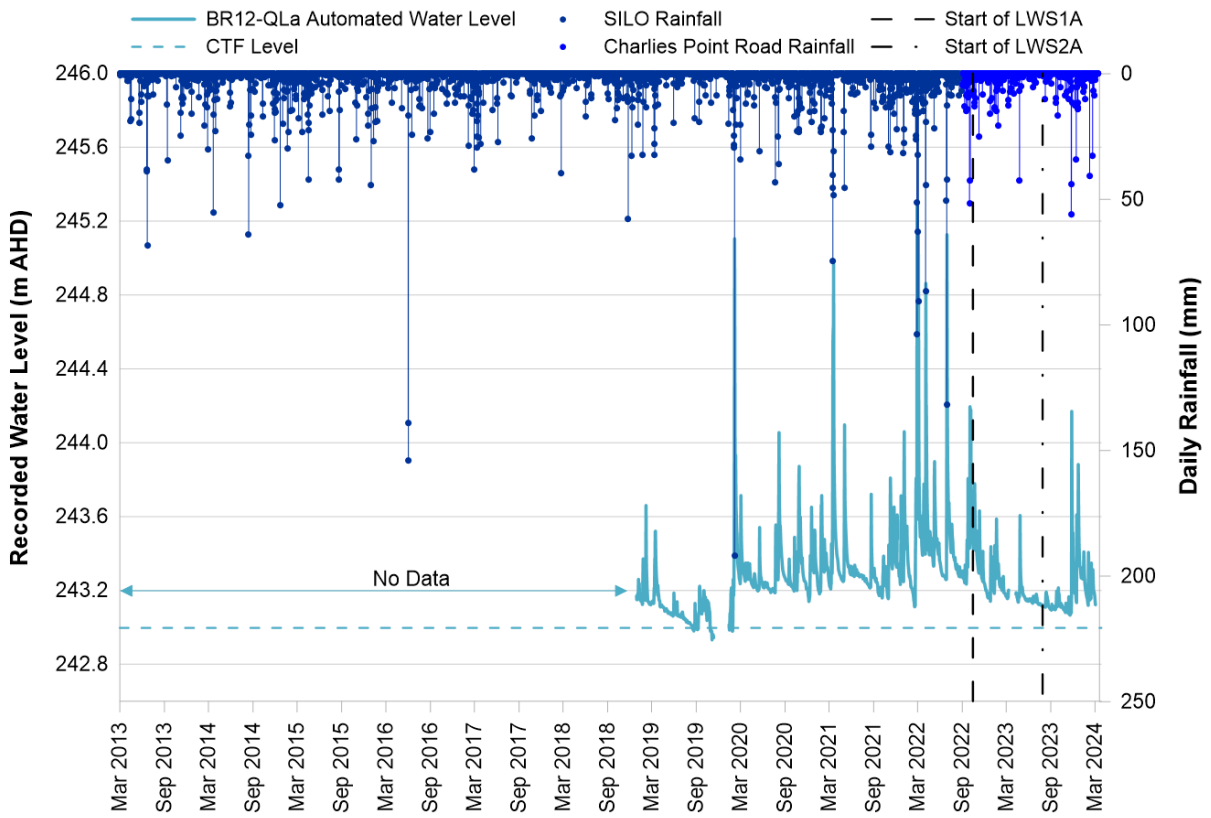



## GRAPH B16: BR6-QLa WATER LEVEL

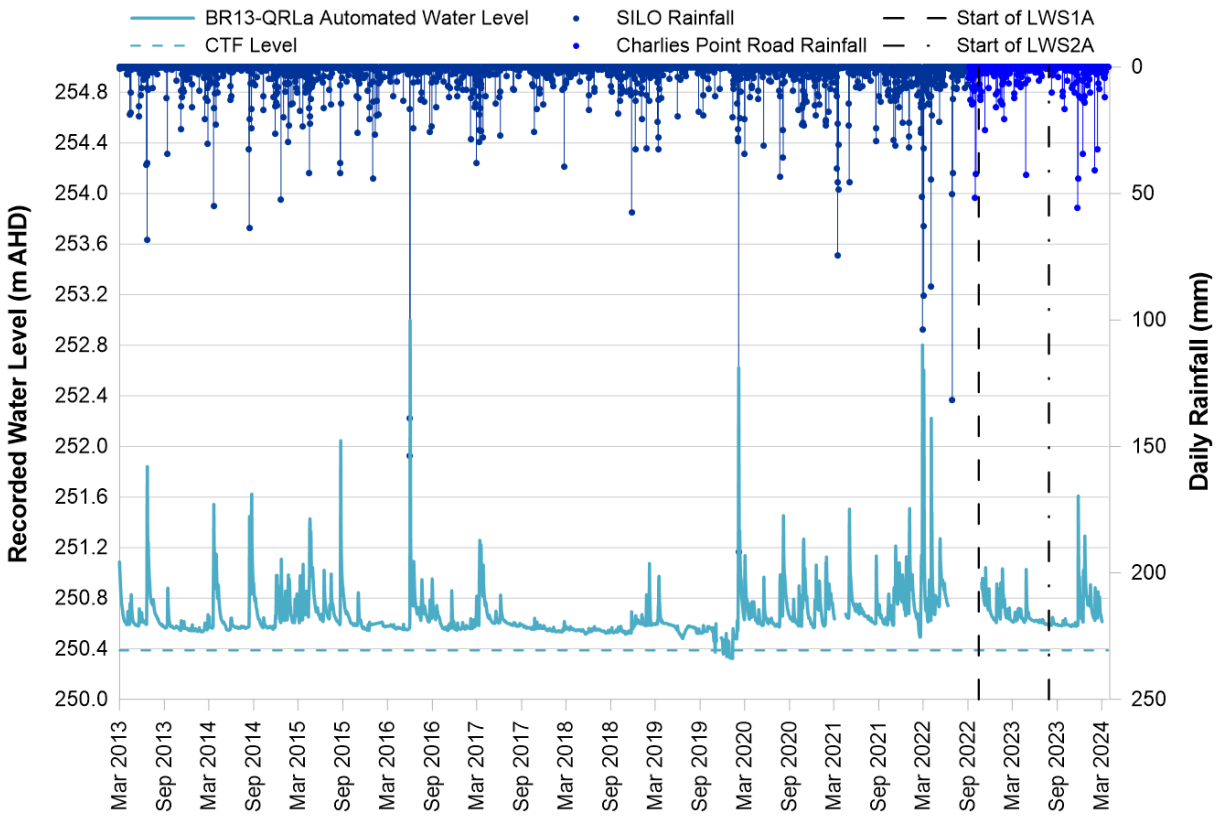



TAILINGS.WATER.WASTE.

## GRAPH B17: BR12-QLa WATER LEVEL

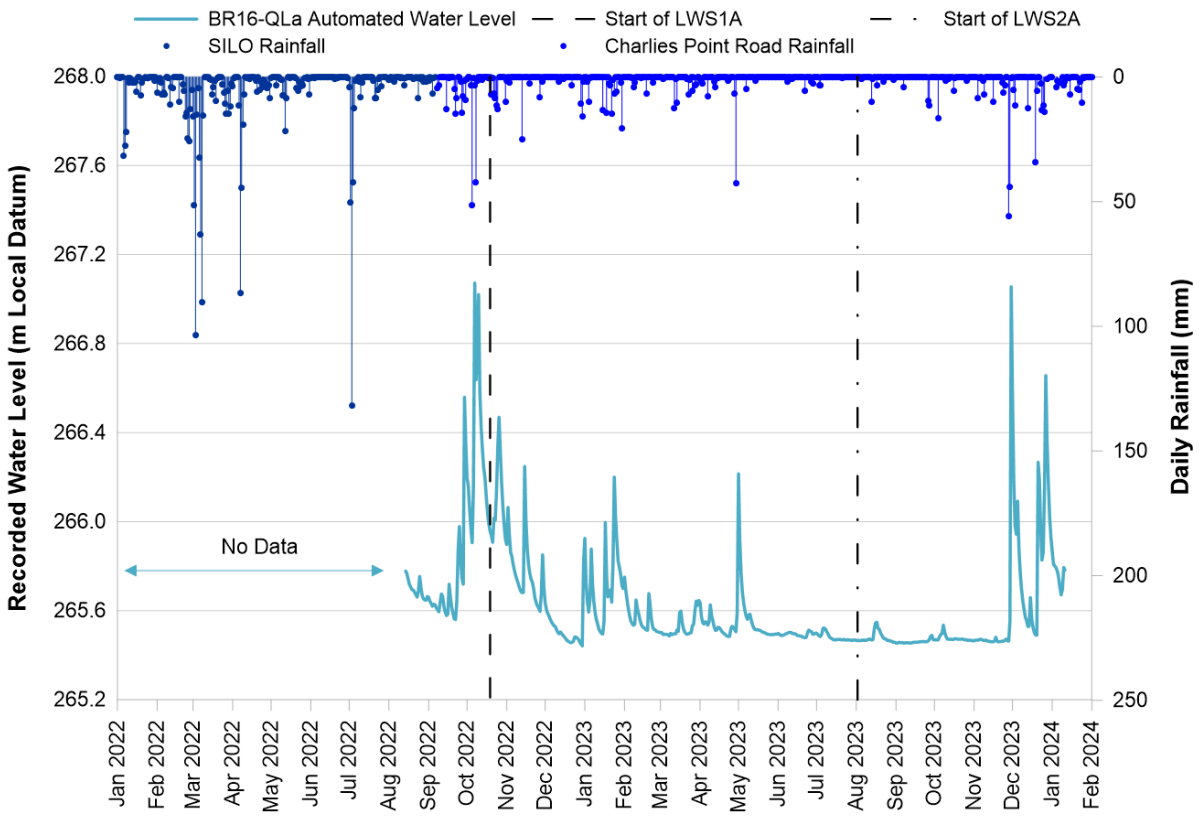



## GRAPH B18: BR13-QRLa WATER LEVEL

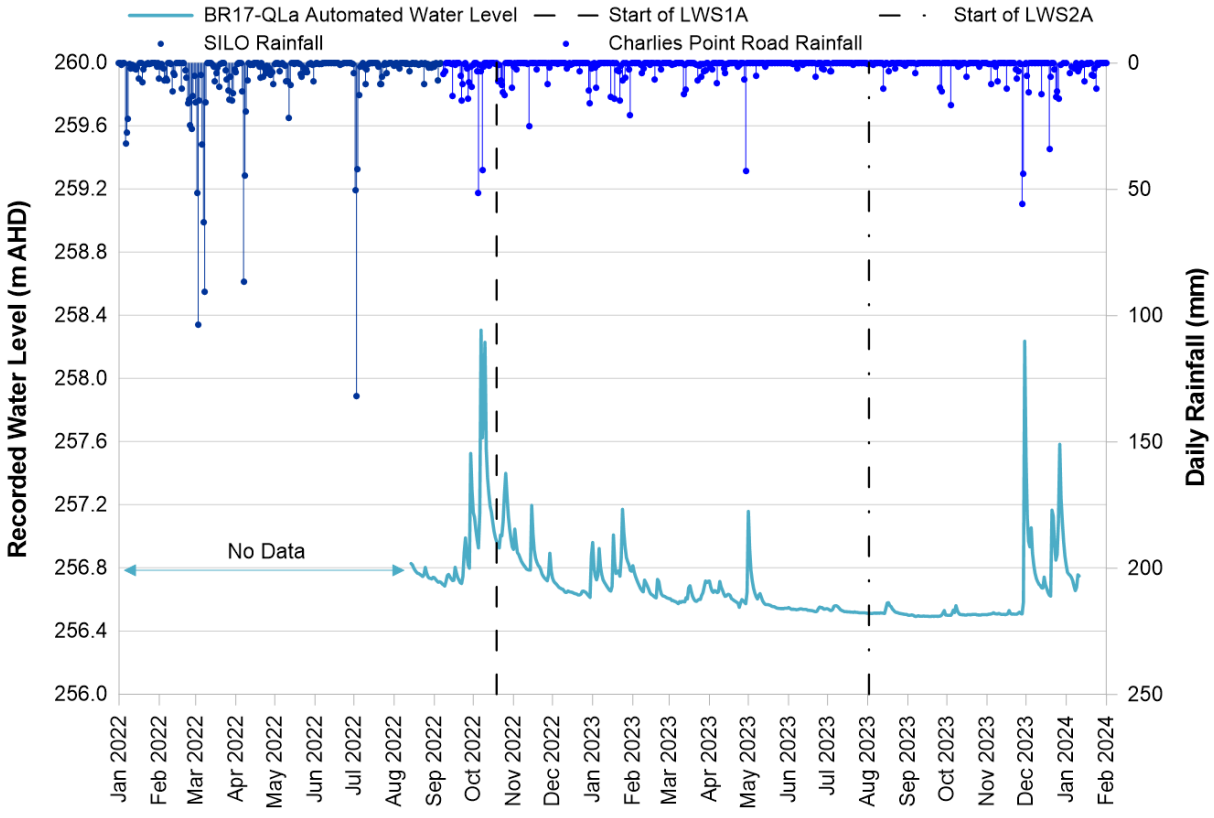



TAILINGS.WATER.WASTE.

## GRAPH B19: BR16-QLa WATER LEVEL




## GRAPH B20: BR17-QLa WATER LEVEL

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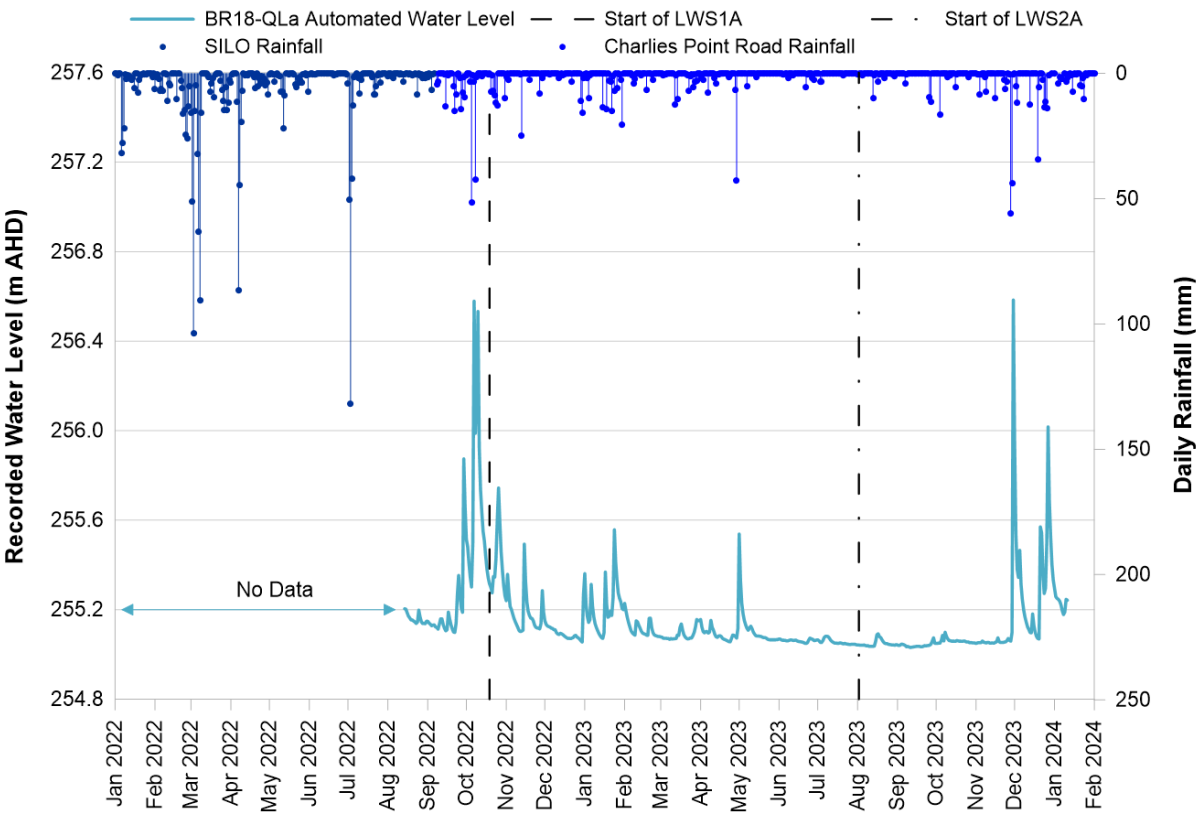
## GRAPH B21: BR18-QLa WATER LEVEL

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# APPENDIX C – TEATREE HOLLOW FLOOD STUDY

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# REPORT

**TAHMOOR COAL PTY LTD**
ABN: 97 076 663 968

**Tahmoor South SSD8445**
**Modification 3**
**Flood Study**

121171-23R002-rev0
MAY 2024

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## ATTACHMENTS

ATTACHMENT A: FLOOD EXTENT MAPS



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# 1 INTRODUCTION

A flood study of Teatree Hollow and Teatree Hollow tributary, which overlie the Tahmoor South Coal Project (the Project), has been undertaken to assess the potential effect of mining-related subsidence on the watercourse flood extent.

The previous flood study for the Project was conducted following submission of the LW S1A-S6A Extraction Plan Water Management Plan (EP WMP) (Tahmoor Coal, 2023), and subsequent approval. The A series, LW S1A-S6A, were the focus of the study detailed in ATCW (2023). The location of LW S1A-S6A are shown on **Map 1**.

The flood study has subsequently been updated to reflect the revised subsidence predictions associated with mining of the A series, including the proposed LW S7A. The revised flood study has been conducted to assess the potential cumulative effects associated with predicted subsidence on flooding of land within and adjacent to LW S1A-S7A. Specifically, areas at risk of a potential increase in flood levels due to predicted subsidence associated with mining of LW S1A-S7A have been identified.

It is noted that the upper reaches of Teatree Hollow and Teatree Hollow tributary comprise relatively flat, ill-defined channels. As such, the flood study presented herein addresses potential flooding of the defined reaches of Teatree Hollow and Teatree Hollow tributary.

The flood study presented herein was conducted for two cases: pre-mining of the A series and post-mining of the A series including LW S7A. Subsequently, the predictions reflect the potential cumulative effect of mining of LW S1A-S7A, rather than the incremental effect associated with the proposed LW S7A.

It is noted that, at the time of reporting, Tahmoor Coal had completed mining of LW S1A-S2A with mining of LW S3A progressing.



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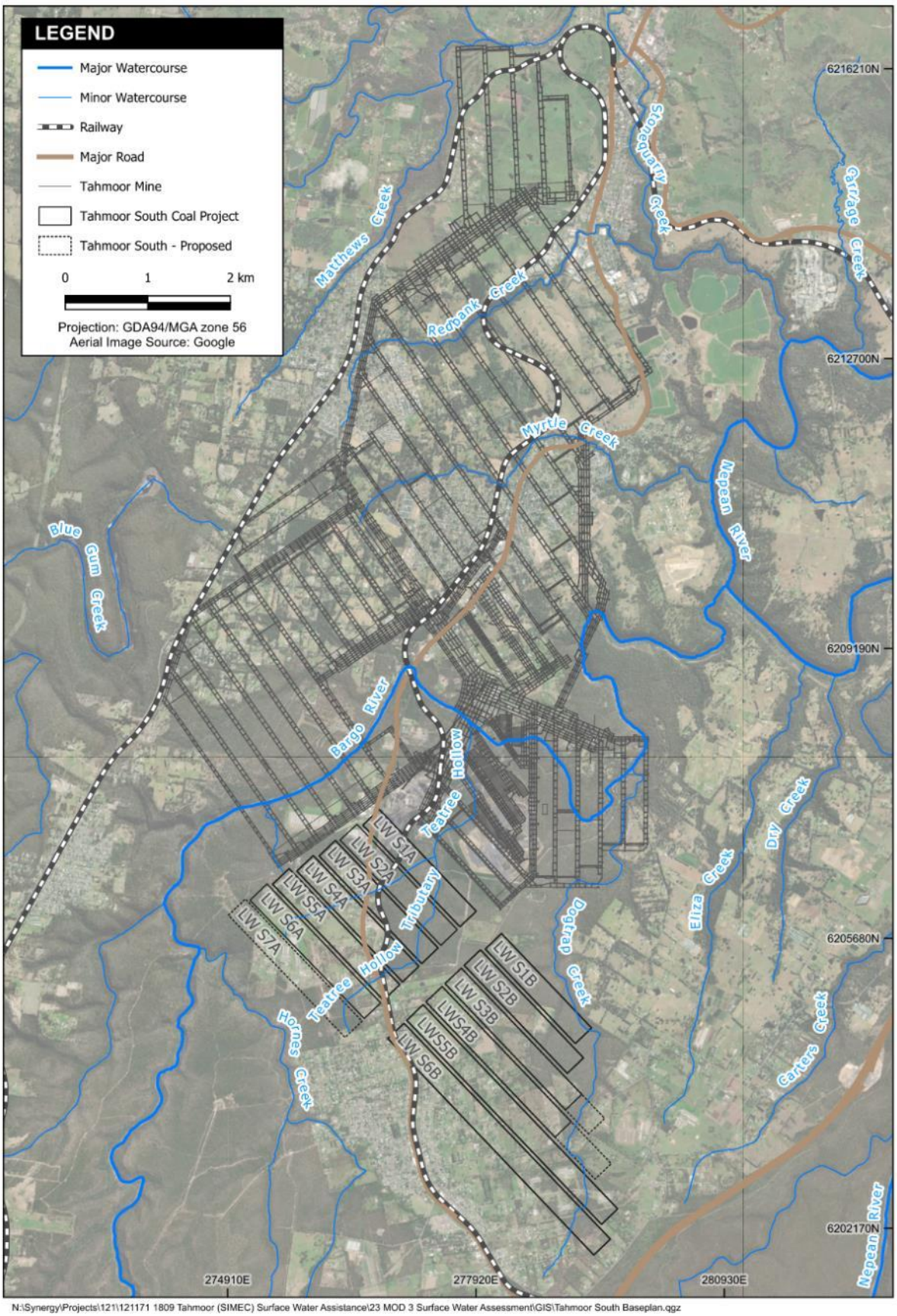
## MAP 1: TAHMOOR SOUTH PROJECT

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# 2 HYDROLOGICAL MODELLING OF WATERCOURSES

## 2.1 Overview

Modelling was undertaken in two parts: hydrological modelling of Teatree Hollow catchment and hydraulic modelling of Teatree Hollow and Teatree Hollow tributary. The hydrologic modelling of Teatree Hollow catchment was undertaken to assess flow rates and is described in the sections below. Hydraulic modelling was subsequently undertaken to predict peak flood levels, described in **Section 3.0**.

## 2.2 Hydrologic Modelling Description

To inform hydraulic modelling, hydrologic modelling of the Teatree Hollow catchment was undertaken. A total catchment of approximately 6.6 $km^2$ was modelled, subdivided into 19 sub-catchments as shown in **Map 2**. It is noted that the Tahmoor Mine pit top area was excluded from the modelled catchments.

Hydrologic modelling was undertaken using the RORB model (Laurenson et al, 2010). RORB is a widely accepted rainfall runoff routing model for simulating flood hydrographs (flow rate versus time) generated from rainfall events falling on the modelled catchment. RORB simulates flood hydrographs generated from rainfall events over a catchment using a logical network of sub-catchments which are defined from topographical mapping of the catchment and its drainage network.

Modelling was undertaken for six (6) Annual Exceedance Probabilities (AEP) events: 0.2%, 0.5%, 1%, 10%, 50% and the probable maximum precipitation (PMP) to simulate the probable maximum flood (PMF). In accordance with ARR (2019), there are 10 ‘ensemble’ temporal patterns applicable to each design rainfall event, with separate patterns for different durations. Different temporal patterns apply within each of the AEP categories. For each AEP, the RORB model was run using the ten temporal patterns for the range of applicable event durations. For each duration, the modelled hydrograph which produced the closest peak flow to the median peak flow (of 10) at the downstream boundary of the catchment was selected as the applicable hydrograph for that duration. For each AEP, the rainfall duration which gave the highest peak flow rate (i.e. the ‘critical duration’) was selected for use in subsequent hydraulic modelling. This process was repeated for all design AEPs and the PMP.



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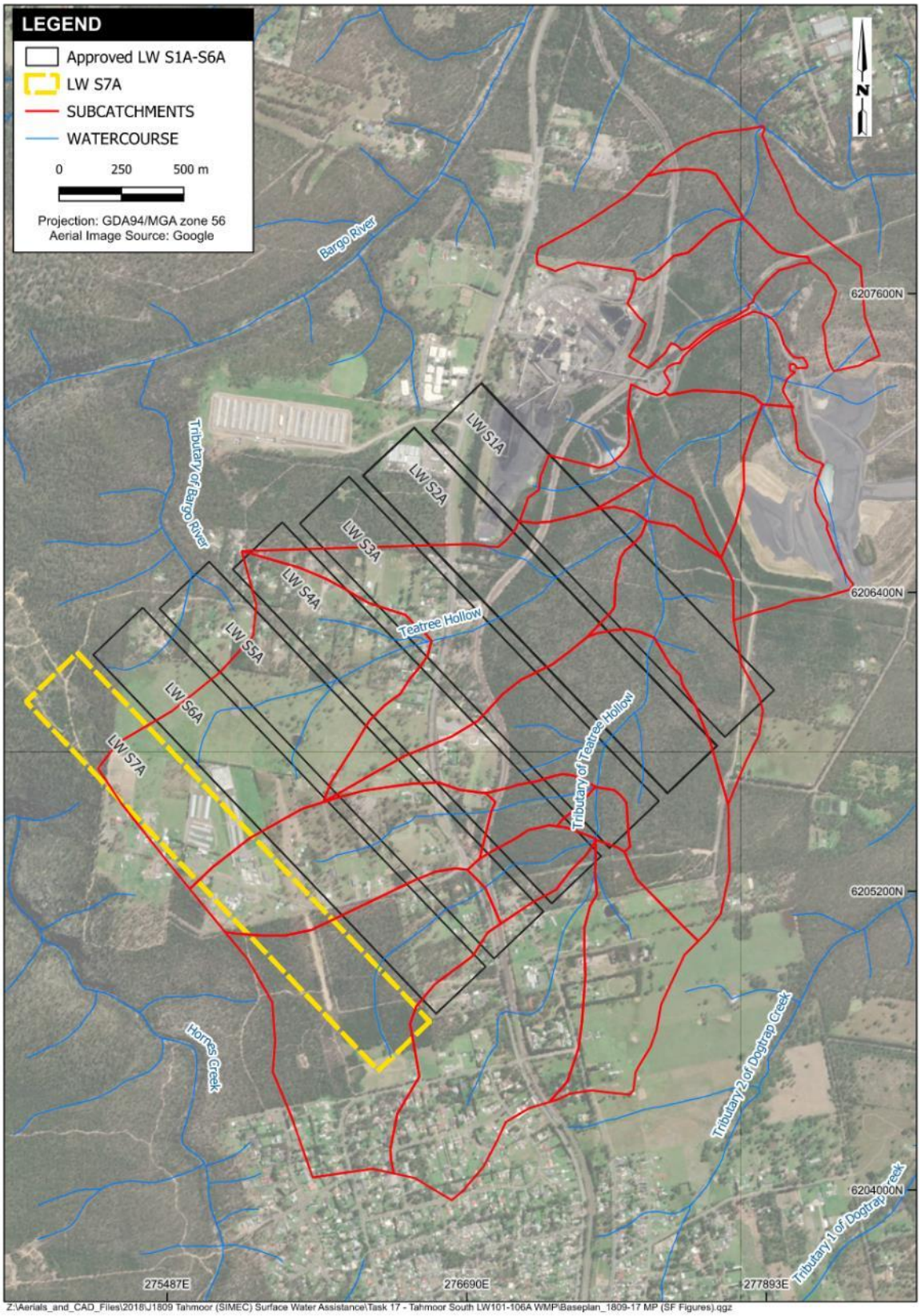
## MAP 2: HYDROLOGICAL MODEL SUB-CATCHMENT BOUNDARIES



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## 2.3 Design Rainfall Data

### 2.3.1 Infrequent to Rare Events

Design rainfall data were estimated for the Teatree Hollow catchment shown in **Map 1.** The design rainfall data were estimated using the procedures described in Australian Rainfall and Runoff: A Guide to Flood Estimation (ARR) (Ball et al., 2019). Design rainfall intensity-frequency-duration (IFD) data are summarised in **Table 1**.

**TABLE 1: DESIGN RAINFALL IFD DATA**

| Duration | AEP Design Rainfall[1] (mm) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 63.2% | 50% | 20% | 10% | 5% | 2% | 1% | 0.5% | 0.2% | 0.1% | 0.05% |
| 10 min | 10.2 | 11.6 | 16.3 | 19.9 | 23.6 | 29 | 33.4 | | | | |
| 15 min | 12.6 | 14.4 | 20.3 | 24.7 | 29.4 | 36 | 41.5 | | | | |
| 30 min | 17.2 | 19.5 | 27.3 | 33.2 | 39.3 | 48.1 | 55.4 | | | | |
| 1 hr | 22.3 | 25.2 | 35.1 | 42.3 | 49.8 | 60.5 | 69.3 | | | | |
| 2 hr | 28.5 | 32.3 | 44.7 | 53.6 | 62.8 | 75.7 | 86.2 | | | | |
| 3 hr | 33.1 | 37.6 | 52.1 | 62.4 | 72.9 | 87.6 | 99.4 | | | | |
| 6 hr | 43.1 | 49.2 | 69.1 | 83.2 | 97.3 | 116 | 131 | | | | |
| 12 hr | 56.3 | 65 | 93.3 | 113 | 134 | 160 | 180 | | | | |
| 1 day | 72.5 | 84.4 | 124 | 152 | 182 | 218 | 246 | 264 | 295 | 318 | 342 |
| 2 day | 89.3 | 104 | 155 | 194 | 234 | 282 | 319 | 355 | 405 | 445 | 484 |
| 3 day | 98.3 | 115 | 171 | 214 | 259 | 313 | 354 | 399 | 458 | 504 | 553 |
| 4 day | 104 | 121 | 180 | 225 | 273 | 329 | 373 | 421 | 484 | 534 | 589 |
| 5 day | 108 | 126 | 187 | 232 | 280 | 338 | 383 | 433 | 498 | 549 | 607 |
| 6 day | 111 | 130 | 191 | 237 | 285 | 343 | 388 | 437 | 504 | 555 | 614 |
| 7 day | 114 | 133 | 195 | 241 | 288 | 346 | 391 | 437 | 505 | 555 | 614 |

mm = millimetres

### 2.3.2 PMP Estimates

The PMP event comprises a theoretical upper bound (or worst case) rainfall event, based upon the most extreme rainfall events on record within Australia. The flood condition arising from a PMP rainfall event is referred to as the Probable Maximum Flood (PMF).

Estimation of the magnitude of the PMP event was performed as follows:

- Short duration PMP rainfall events (15 minutes to 6 hours) were estimated using the process described in The Estimation of Probable Maximum Precipitation in Australia: Generalised Short Duration Method (GSDM) (BoM, 2003).
- Long duration PMP rainfall events (24 hours to 96 hours) were estimated using the process described in Generalised Southeast Australia Method (GSAM) (BoM, 1996).

The calculated design PMP rainfall data is summarised in **Table 2**.

[1] Source: http://www.bom.gov.au/water/designRainfalls/



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**TABLE 2: DESIGN PROBABLE MAXIMUM PRECIPITATION**

| Duration | Design Rainfall for Teatree Hollow Catchment (mm) |
|---|---|
| 15 min | 153 |
| 20 min | 176 |
| 25 min | 199 |
| 30 min | 222 |
| 45 min | 280 |
| 1 hr | 330 |
| 1.5 hr | 422 |
| 2 hr | 490 |
| 2.5 hr | 546 |
| 3 hr | 591 |
| 4 hr | 678 |
| 4.5 hr | 712 |
| 5 hr | 747 |
| 6 hr | 792 |
| 9 hr | 910 |
| 12 hr | 1,000 |
| 18 hr | 1,100 |
| 1 day | 1,140 |
| 1.5 day | 1,270 |
| 2 day | 1,340 |
| 3 day | 1,400 |
| 4 day | 1,450 |

## 2.4 Flood Hydrographs

As discussed in **Section 2.2**, flood hydrographs for the Teatree Hollow catchment were generated using the rainfall routing model RORB (Laurenson, et al., 2010). The pattern of rainfall corresponding to the flood event is input to the model. Rainfall excess (i.e. the component of incident rainfall which becomes direct runoff during the flood event) is calculated using a rainfall loss model. The modelled rainfall excess is routed through a series of model conceptual storages which represent the storage effects of runoff moving across the catchment and through its drainage channel network. The “capacity” of the conceptual model storages is determined by global storage parameters (i.e. storage coefficient and storage exponent). The model conceptual storages are distributed through the model network according to the distribution of contributing catchment area and/or channel length that each conceptual storage represents.

The key model parameters used in the RORB model are summarised in **Table 3** and **Table 4**. The parameters were estimated following procedures as recommended in Ball et al (2019) and accessed from the ARR Data Hub[2]. Model calibration was not undertaken as recorded significant flood level data was not available.

[2] Source: https://data.arr-software.org



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**TABLE 3: SUMMARY OF RORB RAINFALL ROUTING MODEL PARAMETERS**

| Storage Coefficient ($k_c$) | Storage Exponent (m) |
|---|---|
| 2.82 | 0.8 |

**TABLE 4: RORB LOSS PARAMETERS**

| Design AEP | Initial Loss (mm) | Continuing Loss (mm) |
|---|---|---|
| 50% | 25 | 2.5 |
| 10% | 20 | 2.5 |
| 1% | 10 | 2.5 |
| 0.5% | 5 | 2 |
| 0.2% | 0 | 2 |
| PMF | 0 | 1 |

The RORB model was run with the design rainfall events detailed in **Section 0**. The hydrographs with the critical duration and peak flow rates were used in subsequent hydraulic modelling (refer **Section 3.0**).

The predicted peak discharge rates at the downstream end of the Teatree Hollow catchment are given in **Table 5**.

**TABLE 5: MODELLED PEAK FLOOD DISCHARGES AT CATCHMENT OUTLET**

| Parameter | AEP or PMF: | | | | | |
|---|---|---|---|---|---|---|
| | 50% | 10% | 1% | 0.5% | 0.2% | PMF |
| Critical Duration (hours) | 6 | 6 | 1.5 | 1.5 | 1.5 | 1.5 |
| Catchment Outlet Peak Flow Rate ($m^3/s$): | 10.0 | 27.1 | 53.4 | 71.5 | 93.8 | 450.5 |



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# 3 HYDRAULIC MODELLING OF LOCAL DRAINAGES

## 3.1 Model Development

### 3.1.1 Hydraulic Model Description

Hydraulic modelling was conducted using the two-dimensional numerical hydraulic model TUFLOW (BMT, 2022). TUFLOW is an industry accepted, Australian owned and commercially available software package highly suited to the investigation of flood behaviour in complex flow scenarios. TUFLOW produces predictions of flood levels, flow velocities and other hydraulic parameters in two-dimensional pace using finite simulation methods.

The hydraulic model uses sophisticated numerical processes to simulate routing of design flows through the digital elevation model (DEM) and this is more accurate and robust than the flow routing performed by the hydrological model. However, the hydrological model was used to provide inflow hydrographs for Teatree Hollow. Flood levels predicted by TUFLOW varied with time as the simulated hydrograph passed through the model domain – the modelled maximum flood levels for each modelled event were recorded and used to generate the predicted peak flood levels and extents.

A TUFLOW model was developed for Teatree Hollow and encompassed the plan extent shown in **Map 3**. The model was developed using a 2 m by 2 m horizontal grid.

### 3.1.2 Pre and Post-Subsidence Topography

The pre and post-subsidence topography (digital terrain model – DTM) used in the modelling was supplied by Tahmoor Coal. The pre-subsidence DTM for Tahmoor South was obtained from a LiDAR survey conducted in 2022. The post-subsidence topography was provided by Mine Subsidence Engineering Consultants Pty Ltd (MSEC) based on the revised subsidence predictions for the A series incorporating LW S7A.

The pre and post-subsidence longitudinal section of Teatree Hollow is shown in **Graph 1**.



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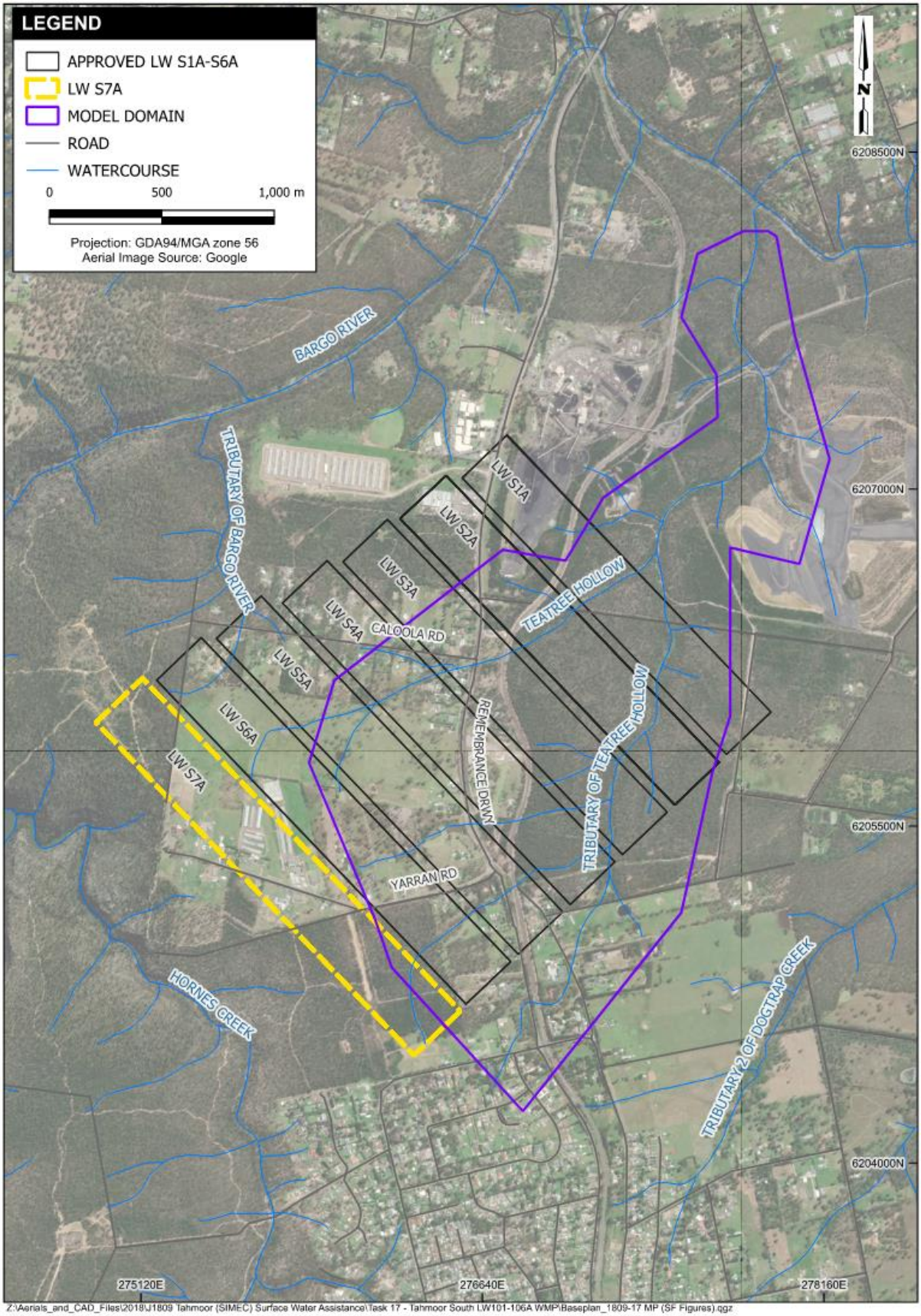
## MAP 3: HYDRAULIC MODEL EXTENT



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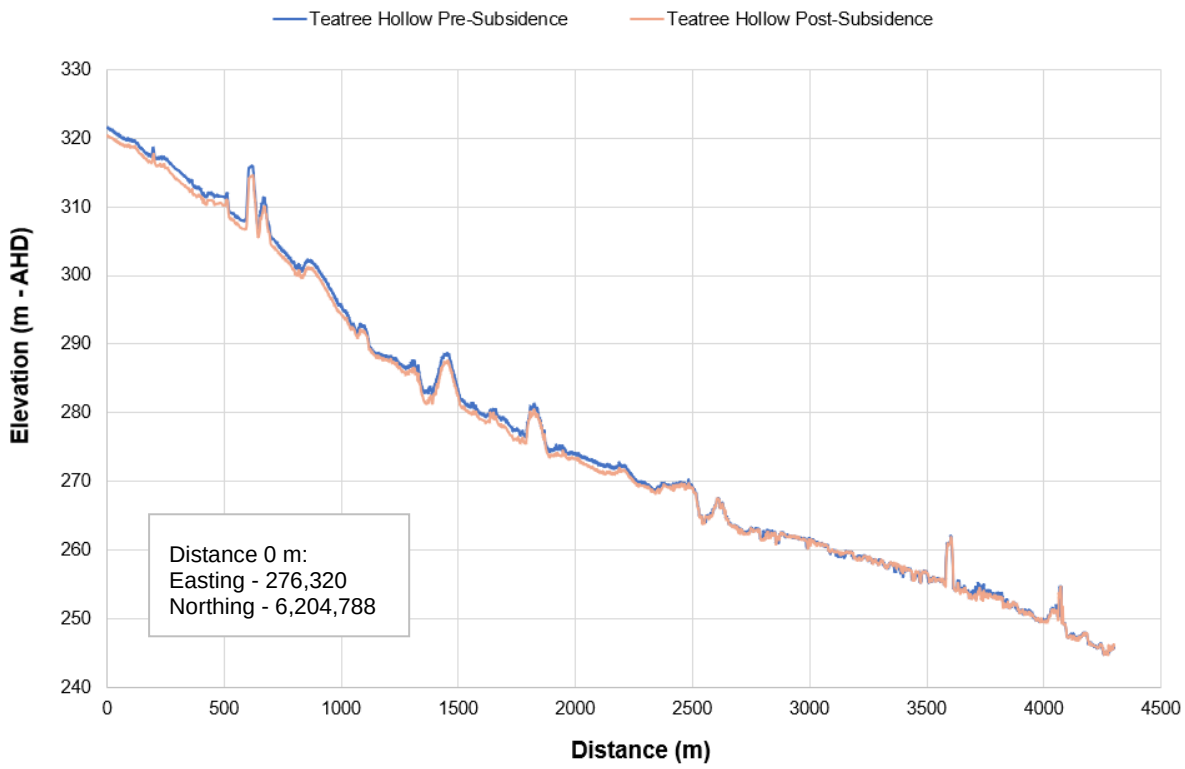
**GRAPH 1: MODELLED STREAM LONGITUDINAL SECTIONS**




### 3.1.3 Model Input Parameters

Manning's 'n' friction factors adopted in the hydraulic model to simulate energy loss due to friction were selected by matching conditions evident in photographs and site records from Gippel (2013) with published guidelines (e.g. Barnes, 1967). For the main watercourse channels, 'n' values varied between 0.03 and 0.06, with the majority of areas assigned a value of 0.05. In overbank areas a value of 0.03 was used. Whilst the resulting model is un-calibrated, it is considered sufficiently accurate to quantify the effects of subsidence on changes in flooding – being the difference between model runs conducted using the pre and post subsidence topography.

### 3.1.4 Culvert Details

Details of culvert locations, materials, geometry and sizing within the model domain were provided by Tahmoor Coal in 2022 (Tahmoor Coal, 2022, Newcastle Geotech, 2022 and Building Inspection Services, 2022). This information is re-produced in **Table 6** and was combined with the existing culvert information, previously supplied by Tahmoor Coal for earlier iterations of the hydraulic model (ATCW, 2023). The locations of the culverts are depicted on **Map 4**.



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**TABLE 6: CULVERT DETAILS**

| Culvert Number | Culvert Width (m) | Type | Material | Source |
|---|---|---|---|---|
| TS1 | 0.4 | Pipe | Concrete | Tahmoor Coal, 2022 |
| TS2 | 1.0 | Pipe | Concrete | Tahmoor Coal, 2022 |
| TS3 | 1.1 | 2 x Pipe | Concrete | Tahmoor Coal, 2022 |
| TS4 | 1.3 | 2 x Pipe | Concrete | Tahmoor Coal, 2022 |
| TS5 | 0.45 | Pipe | Concrete | Tahmoor Coal, 2022 |
| TS6 | 0.9 | Pipe | Concrete | Tahmoor Coal, 2022 |
| TS7 | 1.4 | Pipe | Concrete | Tahmoor Coal, 2022 |
| TS8 | 1.0 | Pipe | Concrete | Tahmoor Coal, 2022 |
| 98.739 | 0.9 | Pipe | Concrete | Newcastle Geotech, 2022 |
| 99.035 | 0.9 | Pipe | Concrete | Newcastle Geotech, 2022 |
| 99.338 | 1.2 | Pipe | Concrete | Newcastle Geotech, 2022 |
| 100.121 | 1.5 | Pipe | Concrete | Newcastle Geotech, 2022 |
| 100.425 | 1.5 | Pipe | Concrete | Newcastle Geotech, 2022 |
| 101 | 0.9 | Pipe | Concrete | Newcastle Geotech, 2022 |
| BIS7 | 1.8 | Pipe | Concrete | Building Inspection Services, 2022 |
| BIS8* | 1.2 | Pipe | Concrete | Building Inspection Services, 2022 |
| BIS9 | 0.9 | Box | Concrete | Building Inspection Services, 2022 |
| BIS9a | 0.9 | Box | Concrete | Building Inspection Services, 2022 |
| BIS10 | 1.2 | Pipe | Concrete | Building Inspection Services, 2022 |
| ID104 | 0.8 | Pipe | Concrete | Previous Assessment |

Note: * Due to vegetation growth the culvert could not be accessed, and the culvert diameter has been based on details from the previous hydraulic model (ATCW, 2023).



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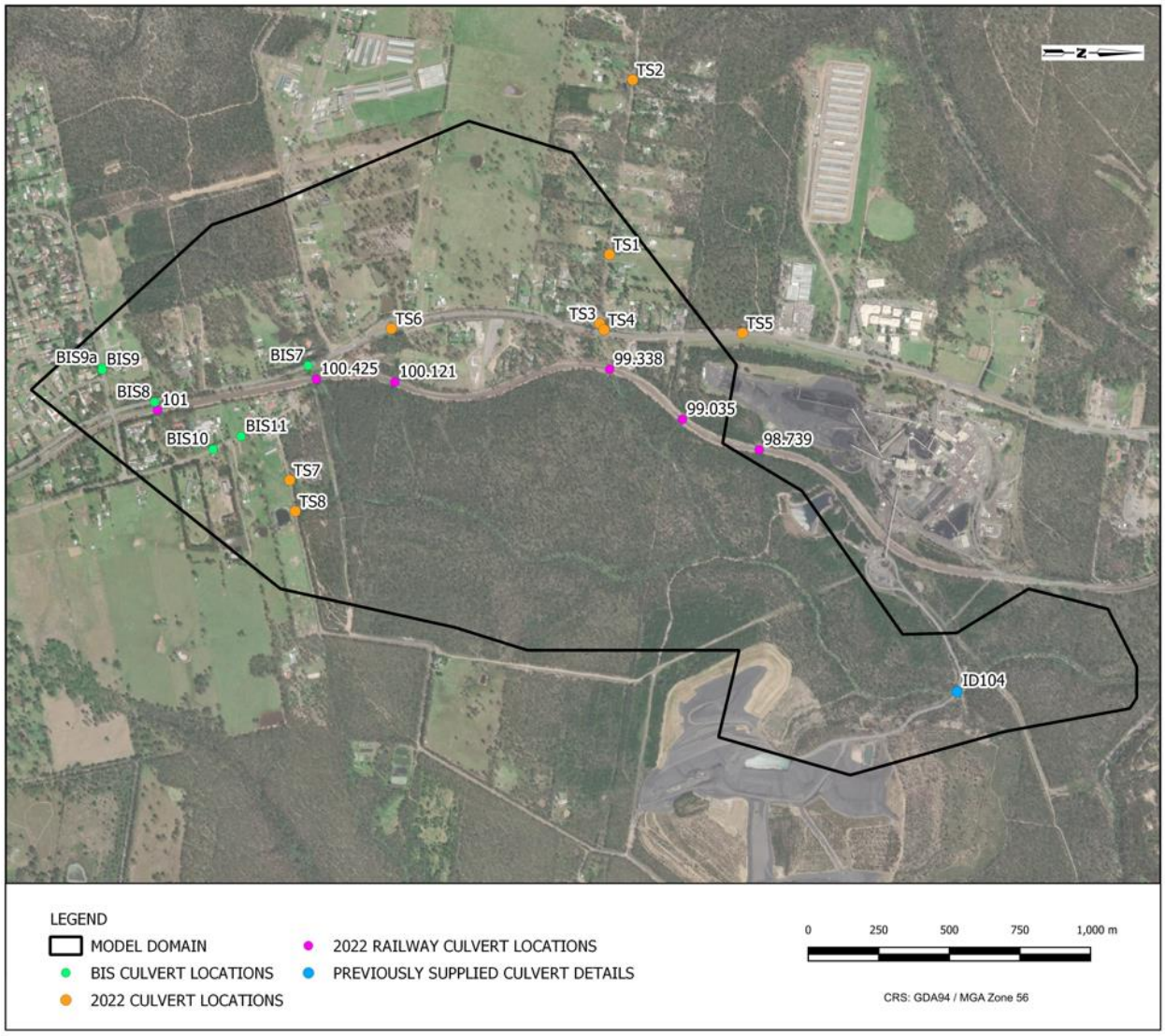
## MAP 4: CULVERT LOCATIONS




### 3.1.5 Boundary Conditions

Inflow hydrographs for contributing flows for Teatree Hollow were applied from the hydrological modelling described in **Section 2.0**. These inflow hydrographs were applied to the model as a source area at the relevant sub-catchment boundary, as indicated on **Map 5**. A boundary condition was placed on the downstream extent of the model, with a grade of 6.4% to reflect the topography, to represent flow under uniform (normal) conditions.



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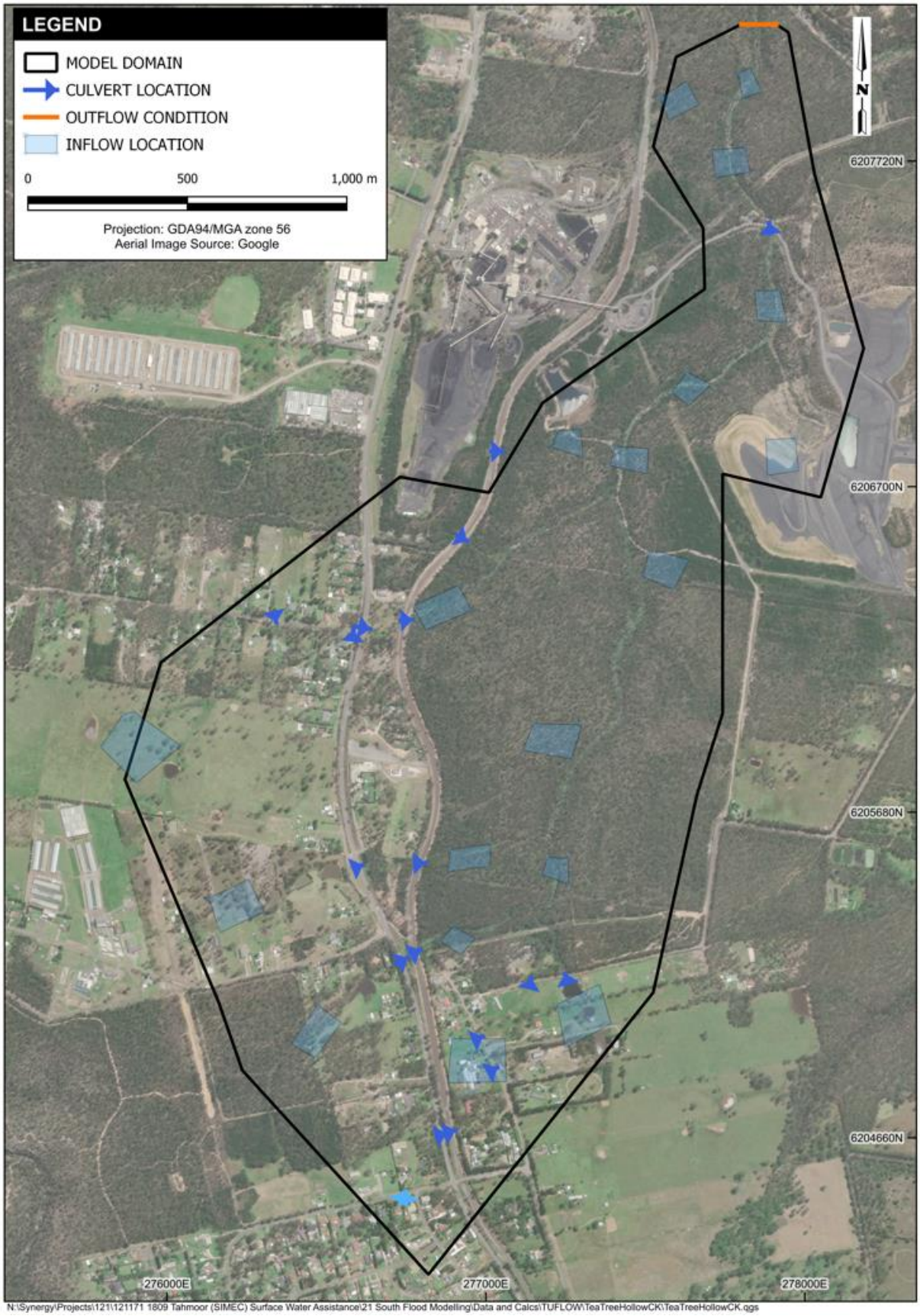
## MAP 5: HYDRAULIC MODEL LAYOUT



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## 3.2 Model Predictions

Areas inundated during the passage of the assessed flood events were output from the model and are shown as a series of maps in the sections that follow. The figures depict the maximum areas inundated during the passage of the design AEP hydrographs under existing (pre-subsidence) conditions and the additional areas that would be inundated based on the post-subsidence topography. In some locations, areas that are currently inundated during specific flood events have the potential to be less inundated based on the post-subsidence topography. These areas were found to be relatively small and have not been illustrated on the flood inundation figures.

The flood inundation maps for the 1% AEP and 50% AEP events are presented in **Section 4.2.1** and **Section 4.2.2**, with associated discussion of results. The results represent a significant but relatively common flood event (50% AEP) and a very large, relatively rare flood event (1% AEP). Additionally, the flood inundation maps for the 10%, 0.5%, 0.2% AEP and PMF are provided in **Attachment A**.

### 3.2.1 Teatree Hollow – 1% AEP Event

**Map 5** below depicts the simulated maximum areas inundated during passage of the 1% AEP event in the southern (upstream) portion of the Teatree Hollow catchment. The hydraulic model predicts that overbank flooding would occur under existing conditions at:

- areas upstream of the culverts beneath Remembrance Driveway and Caloola Road;
- the corridor between Remembrance Driveway and the railway embankment to the east of Caloola Road;
- a portion of the railway line adjacent to Teatree Hollow; and,
- to the west of Remembrance Driveway overlying LW S5A.

Further downstream, inundation is limited to the main channel areas.

As illustrated in **Map 5**, the model results of the 1% AEP event indicate overtopping of Remembrance Driveway and associated overtopping of the railway line further downstream (adjacent to Teatree Hollow). It is noted that the modelling has been undertaken in accordance with the latest best-practice industry guidelines and incorporating all available relevant information.

**Table 7** details the maximum modelled flood depth, for the pre and post-subsidence cases, for the affected areas described above. The locations for the maximum modelled depths are depicted on the illustrated result maps.

**TABLE 7: 1% AEP EVENT – MAXIMUM MODELLED DEPTHS**

| Location Number | Location | Pre-Subsidence Depth | Post-Subsidence Depth | Difference |
|---|---|---|---|---|
| 1 | Upstream of Remembrance Driveway culvert (TS4) | 3.29 m | 3.49 m | + 0.20 m |
| 2 | Corridor between Remembrance Driveway and railway embankment | 3.54 m | 3.78 m | + 0.24 m |
| 3 | West of Remembrance Driveway overlying LW S5A | 1.21 m | 1.38 m | + 0.17 m |



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The hydraulic model predicts that the effects of subsidence would result in a minor increase in areas subject to flood inundation on the western side of Remembrance Driveway and to the east of Caloola Road (red shading in **Map 6**). The largest predicted increase is on the western side of Remembrance Driveway overlying LW S5A.

**Map 7** depicts the simulated maximum areas inundated during passage of the 1% AEP event in the northern (downstream) portion of the Teatree Hollow catchment. Predicted flooding in these reaches of Teatree Hollow and tributaries is well contained within the main channel. There is negligible predicted increase in flood inundation during this event as a result of predicted subsidence changes to surface topography.



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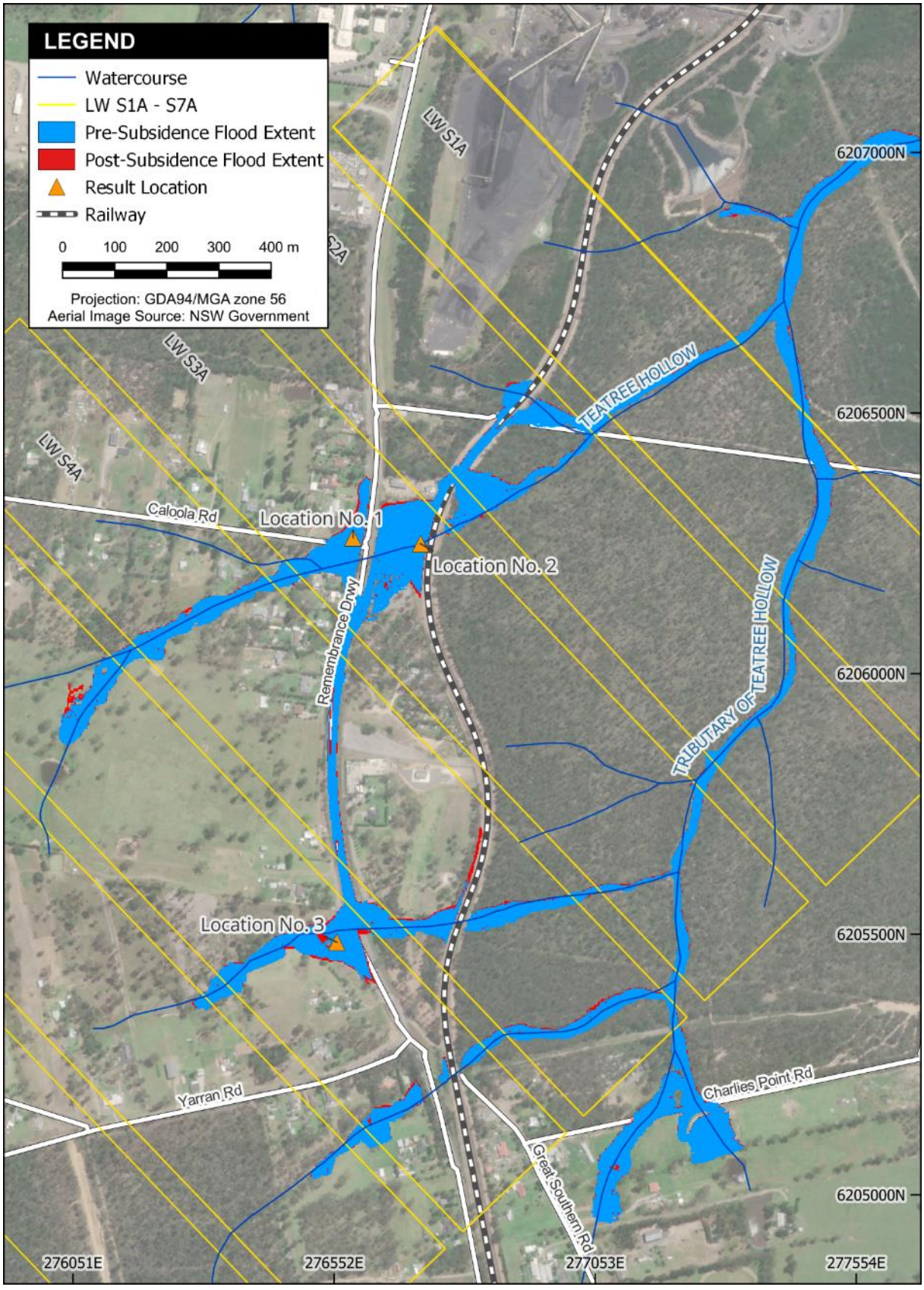
## MAP 6: EXTENT OF PREDICTED 1% AEP FLOODING – SOUTHERN (UPSTREAM) TEATREE HOLLOW CATCHMENT



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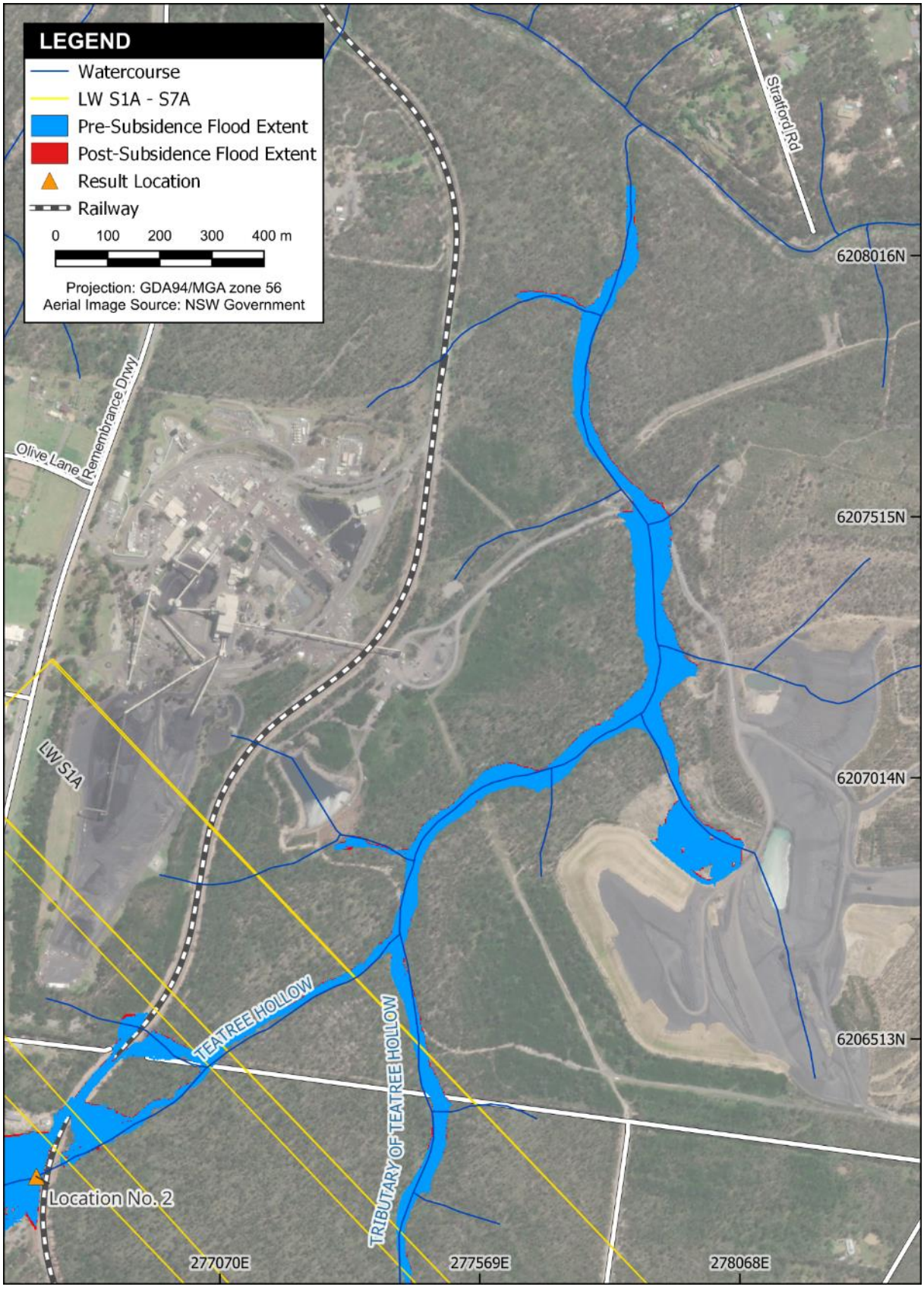
## MAP 7: EXTENT OF PREDICTED 1% AEP FLOODING – NORTHERN (DOWNSTREAM) TEATREE HOLLOW CATCHMENT



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### 3.2.2 Teatree Hollow – 50% AEP Event

**Map 8** depicts the simulated maximum areas inundated during passage of the 50% AEP event in the southern (upstream) portion of the Teatree Hollow catchment. As with the 1% AEP event, overbank flooding is predicted in areas upstream of the culverts beneath Remembrance Driveway, the corridor between Remembrance Driveway and the railway embankment and to the west of Remembrance Driveway overlying LW S5A. The predicted effects of subsidence on increasing flood inundation during passage of the 50% AEP event are minor (red shading in **Map 8**).

**Table 8** details the maximum modelled flood depth, for the pre and post-subsidence cases, for the affected areas described above. The locations for the maximum modelled depths are depicted on the illustrated result maps.

**TABLE 8: 50% AEP EVENT – MAXIMUM MODELLED DEPTHS**

| Location Number | Location | Pre-Subsidence Depth | Post-Subsidence Depth | Difference |
|---|---|---|---|---|
| 1 | Upstream of Remembrance Driveway culvert (TS4) | 1.27 m | 0.71 m | - 0.56 m |
| 2 | Corridor between Remembrance Driveway and railway embankment | 0.77 m | 0.99 m | + 0.22 m |
| 3 | West of Remembrance Driveway overlying LW S5A | 0.35 m | 0.49 m | + 0.14 m |

**Map 9** depicts the simulated maximum areas inundated during passage of the 50% AEP event in the northern (downstream) portion of the Teatree Hollow catchment. As with the 1% AEP event, predicted flooding in these reaches of Teatree Hollow and tributaries is well contained within the main channel. There is negligible detectable increase in predicted flood inundation during passage of the 50% AEP event as a result of predicted subsidence changes to surface topography.



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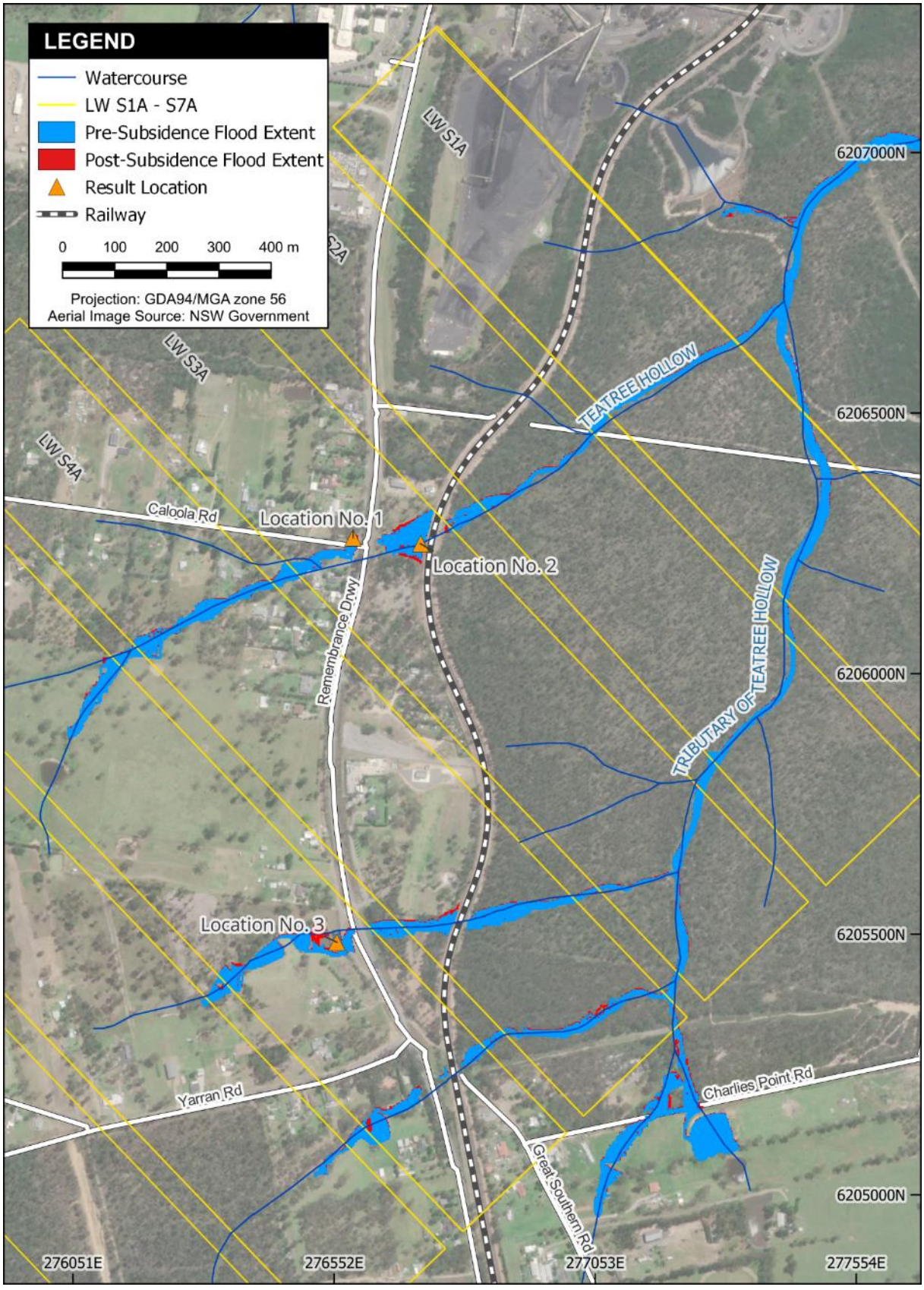
## MAP 8: EXTENT OF PREDICTED 50% AEP FLOODING – SOUTHERN (UPSTREAM) TEATREE HOLLOW



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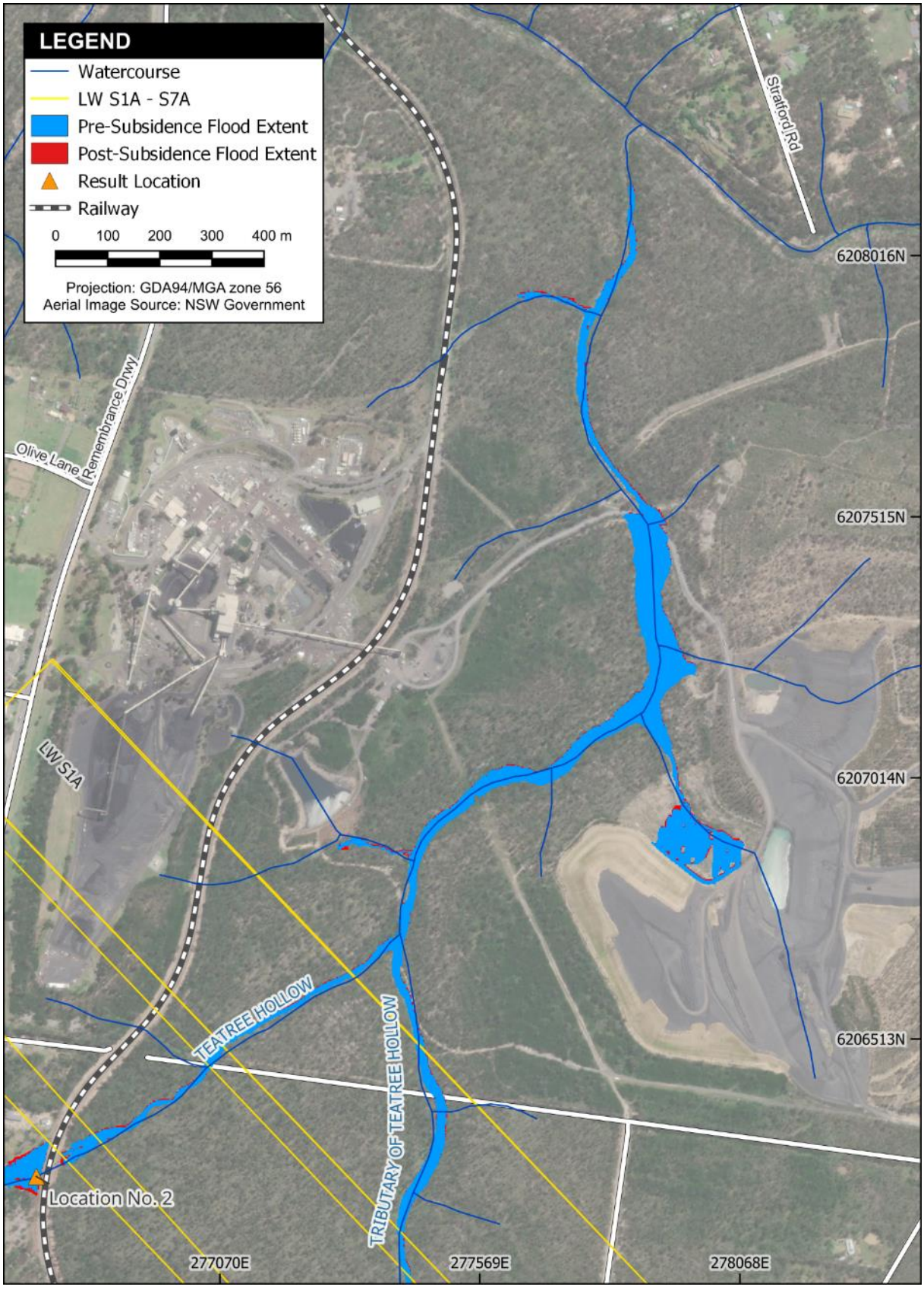
## MAP 9: EXTENT OF PREDICTED 50% AEP FLOODING – NORTHERN (DOWNSTREAM) TEATREE HOLLOW



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# 4 PREDICTED FLOOD AFFECTED PROPERTIES

## 4.1 Overview

The flood model predictions, based on the predicted post-subsidence topography for the A series including LW S7A, indicate that there is potential for mining induced subsidence to result in an increase in the 1% AEP and 50% AEP flood level at several properties within the Study Area.

The properties with a predicted increase in the 1% AEP flood extent are listed in **Table 9**. It is noted that, with the exception of Lot 360/DP130185 and Lot 12/DP130181, the dwellings of the lots listed below are not predicted to be affected by the 1% AEP event. Further details regarding the modelled affect to the identified dwellings are provided in **Section 5.2**.

**TABLE 9: PREDICTED MAX 1% AEP FLOOD DEPTH INCREASE AND AFFECTED LOTS**

| Lot/Plan | Address | Predicted Maximum Increase in 1% AEP Flood Level |
|---|---|---|
| 28/DP25735 | 35 Caloola Road, Bargo, 2574 | + 0.16 m |
| 29/DP25735 | 25 Caloola Road, Bargo, 2574 | + 0.18 m |
| 30/DP25735 | 15 Caloola Road, Bargo, 2574 | + 0.15 m |
| 31/DP25735 | 5 Caloola Road, Bargo, 2574 | + 0.34 m |
| 360/DP130185 | 3100 Remembrance Driveway, Bargo, 2574 | + 0.49 m |
| 131/DP130186 | 4 Caloola Road, Bargo, 2574 | + 0.27 m |
| 14/DP656820 | 3092 Remembrance Driveway, Bargo, 2574 | + 0.3 m |
| 15/DP656821 | 3088 Remembrance Driveway, Bargo, 2574 | + 0.14 m |
| 9/DP29287 | 30 Yarran Road, Bargo, 2574 | + 0.1 m |
| 110/DP130878 | 3180 Remembrance Driveway, Bargo, 2574 | + 0.17 m |
| 2/DP789005 | 3165 Remembrance Driveway, Bargo, 2574 | + 0.18 m |
| 11/DP130182 | 3210 Remembrance Driveway, Bargo, 2574 | + 0.16 m |
| 12/DP130181 | 1 Yarran Road, Bargo, 2574 | + 0.09 m |
| 11/DP130181 | 1 Yarran Road, Bargo, 2574 | + 0.29 m |
| A/DP156857 | 21 Great Southern Road, Bargo, 2574 | + 0.13 m |
| B/DP156857 | 29 Great Southern Road, Bargo, 2574 | + 0.25 m |



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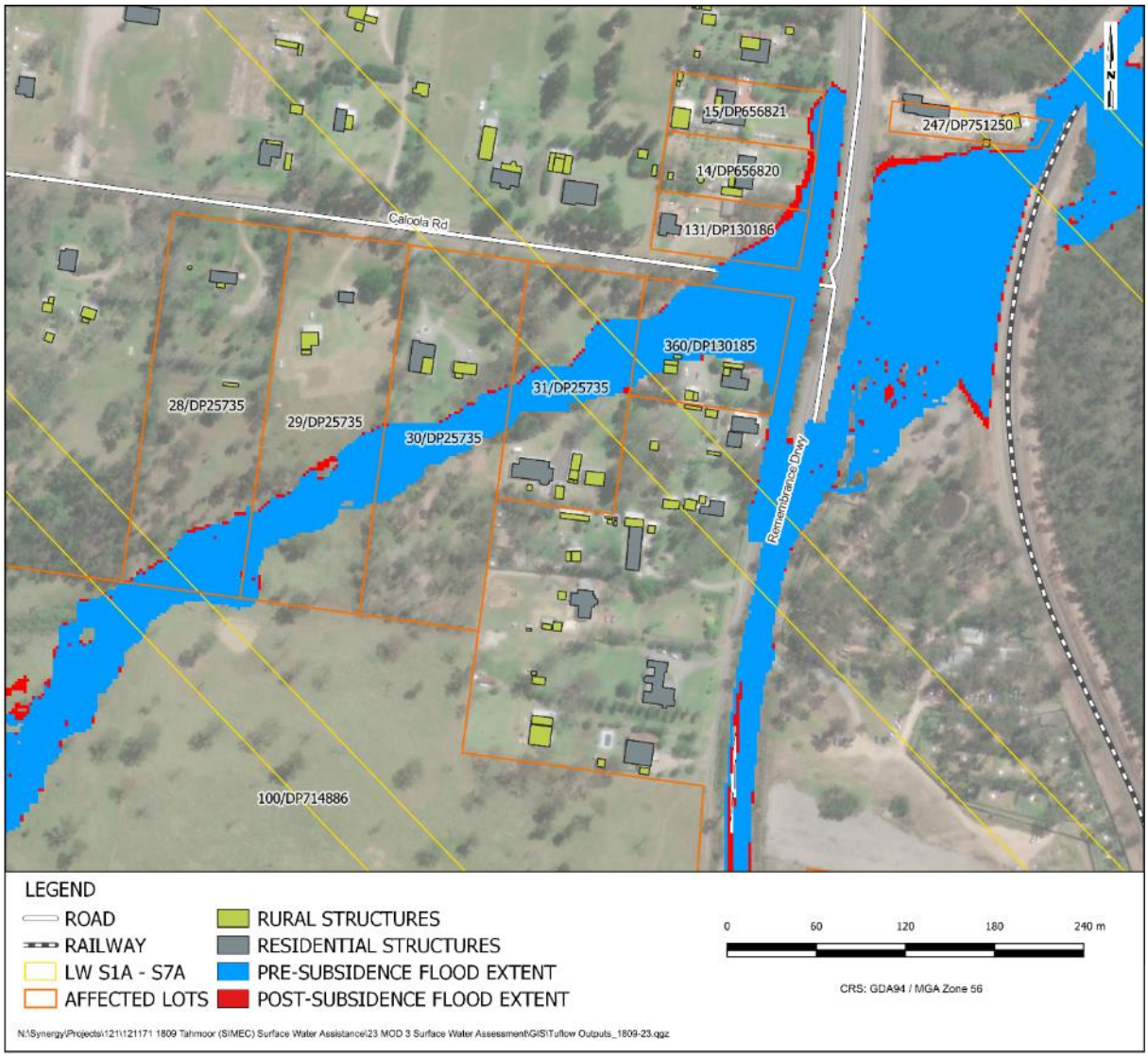
The predicted affected lots outlined in **Table 9** are depicted on **Map 10** and **Map 11.**

**MAP 10: MODELLED AFFECTED LOTS (NORTHERN AREA)**



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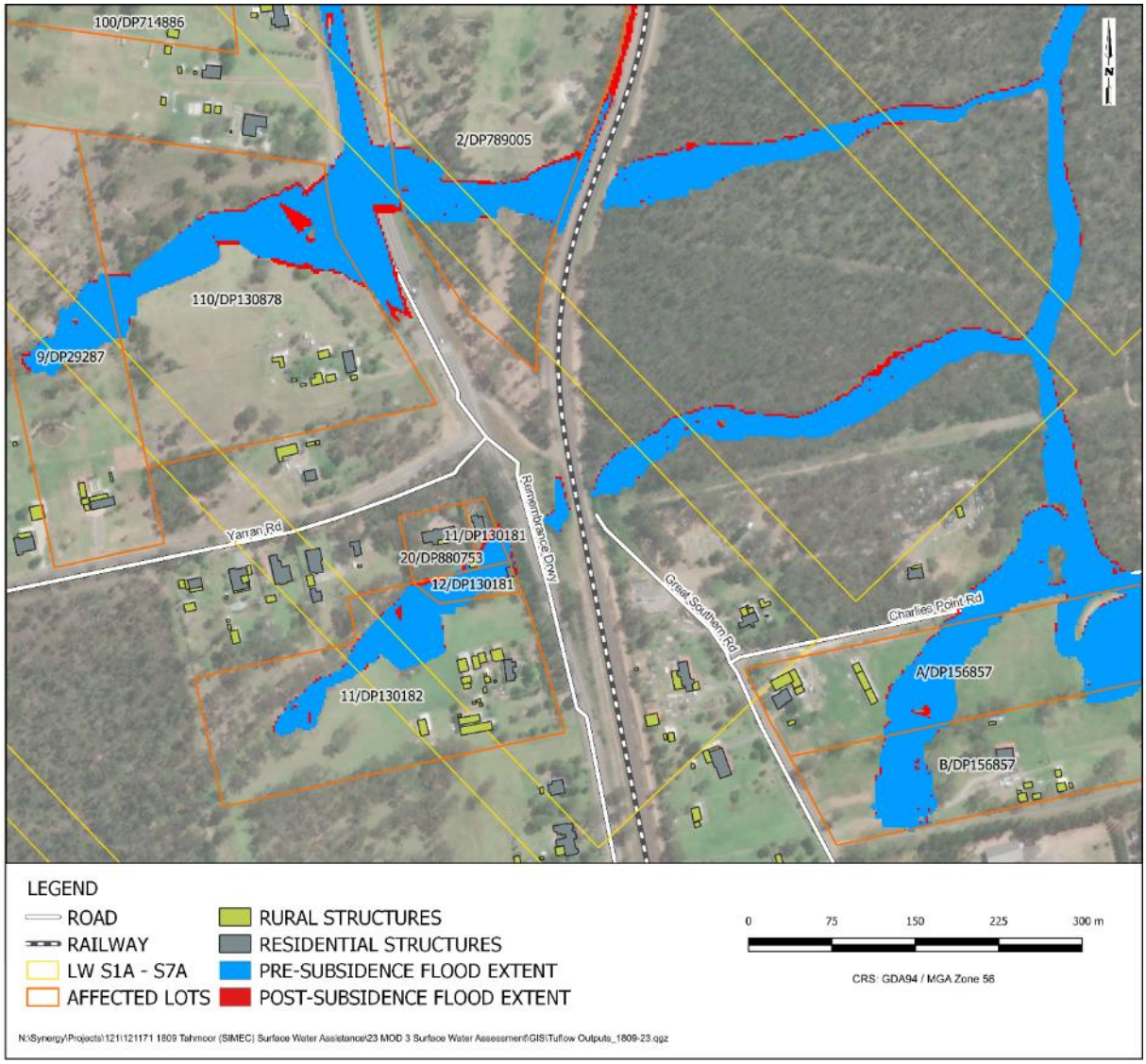
**MAP 11: MODELLED AFFECTED LOTS (SOUTHERN AREA)**




## 4.2 Flood Elevations at Affected Dwellings

### 4.2.1 Review of Lot 360/DP130185 Affects

As noted in **Table 9** and depicted on **Map 10**, modelled results for the 1% AEP flood level indicate that the western dwelling on Lot 360/DP130185 would be affected by both the pre and post-subsidence flood scenarios. It is noted that spatial structure data provided by Tahmoor categorised the western dwelling as a 'rural structure', however, it is understood to be utilized as a second dwelling on the property. Modelled flood inundation elevations for the north-western corner of the dwelling are outlined in **Table 10** for the modelled 1% AEP scenarios.



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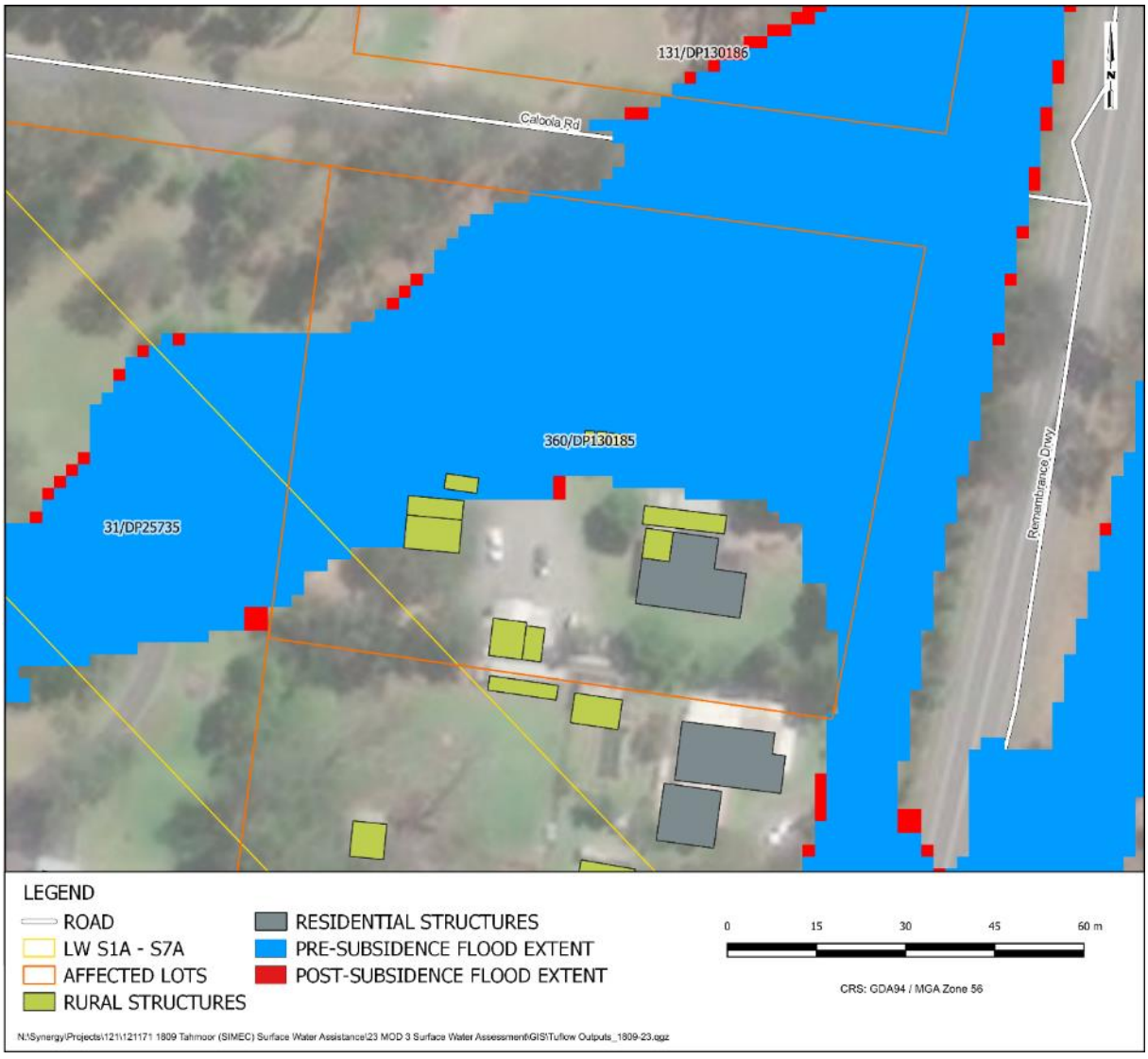
**TABLE 10: PREDICTED MAX 1% AEP FLOOD LEVEL – LOT 360/DP130185**

| Parameter | Surface Elevation | Predicted 1% AEP Flood Inundation |
|---|---|---|
| Surface Elevation – Base Survey | 301.33 m AHD | + 0.21 m |
| Pre-Subsided Flood Elevation | 301.54 m AHD | |
| Surface Elevation – Subsided | 300.47 m AHD | + 0.29 m |
| Post-Subsided Flood Elevation | 300.76 m AHD | |

The predicted flood inundation depth at the north-western corner of the western (second) dwelling is 0.21 m for the pre-subsided condition and 0.29 m for the post-subsided condition. As such, it is predicted that subsidence effects may result in an increase in the 1% AEP flood inundation of 0.08 m at the location of this dwelling. The modelled flood affect extent of Lot 360/DP130185 is shown on **Map 12**.

**MAP 12: MODELLED FLOOD EXTENT – LOT 360/DP130185**



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### 4.2.2 Review of Lot 12/DP130181 Affects

As noted in **Table 9** and depicted on **Map 11**, modelled results for the 1% AEP flood level indicate that the dwelling on Lot 12/DP130181 will be affected by both the pre and post-subsidence flood scenarios. Modelled flood inundation elevations for the north-western corner of the dwelling are outlined in **Table 11** for the modelled 1% AEP scenarios.

**TABLE 11: PREDICTED MAX 1% AEP FLOOD LEVEL – LOT 12/DP130181**

| Parameter | Surface Elevation | Predicted 1% AEP Flood Inundation |
|---|---|---|
| Surface Elevation – Base Survey | 307.97 m AHD | + 0.25 m |
| Pre-Subsided Flood Elevation | 308.22 m AHD | |
| Surface Elevation – Subsided | 307 m AHD | + 0.34 m |
| Post-Subsided Flood Elevation | 307.343 m AHD | |

Based on the modelled results the expected flood inundation at the north-western corner of the dwelling is some 0.25 m for the pre-subsided flood condition and some 0.34 m for the post-subsided flood condition. This indicates an increase in peak inundation elevations at the north-western corner of the dwelling of 0.09 m following subsidence effects. The modelled flood affect extent of Lot 12/DP130181 is shown on **Map 13**.



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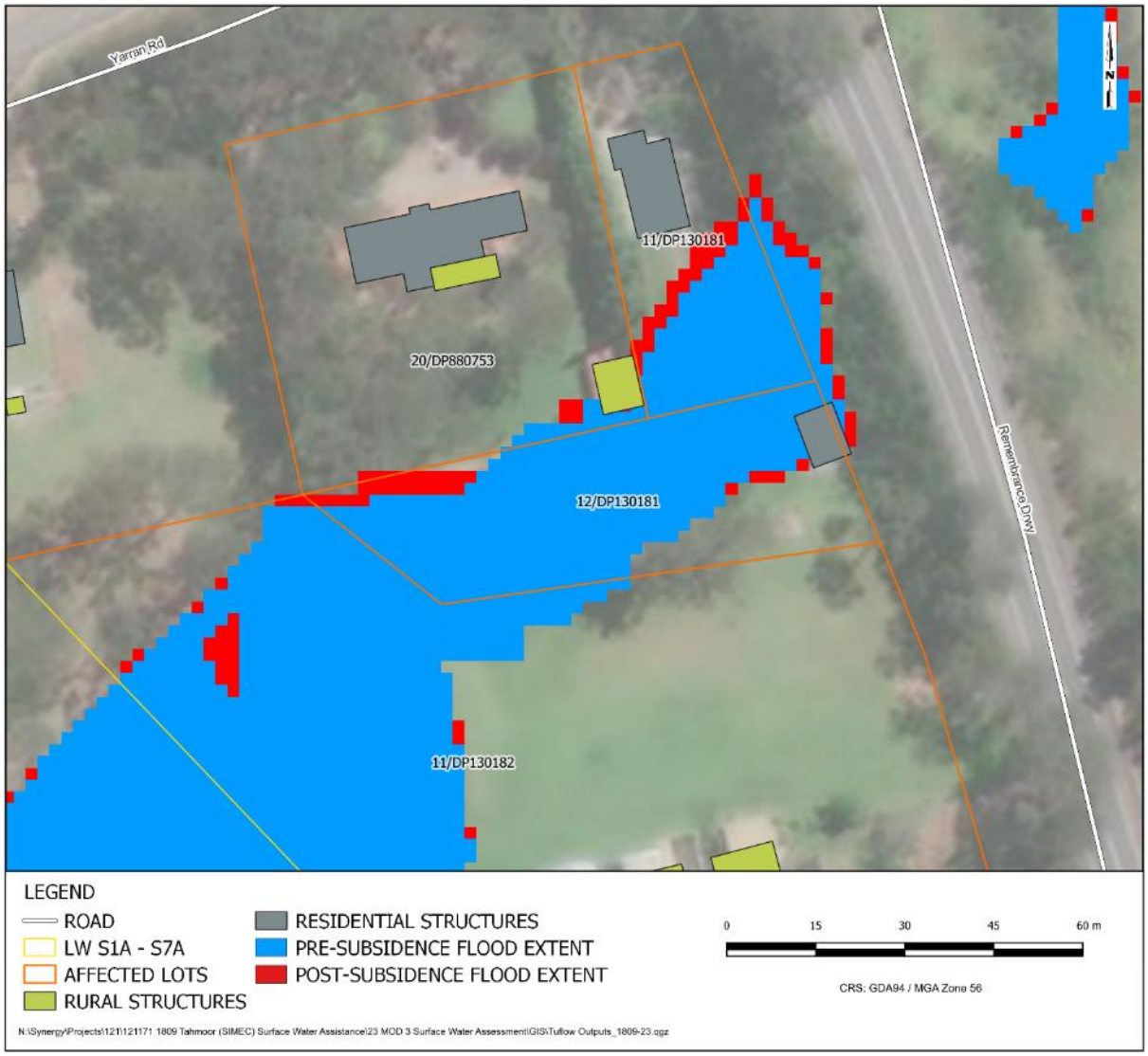
## MAP 13: MODELLED FLOOD EXTENT – LOT 12/DP130181



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# 5 SUMMARY AND RECOMMENDATIONS

The drainage lines in the Study Area, comprising Teatree Hollow and its tributaries, are naturally more susceptible to flood inundation due to the low relief terrain and low capacity primary channels in these areas. The effect of culverts and other constructed constrictions in the more urbanised upland areas could also increase the extent of flooding in these areas. In contrast flooding in the lower reaches is confined by the naturally steep, incised channel geometry.

Hydraulic model results for the 1% AEP flood event indicate that overbank flooding would occur under existing conditions at:

- areas upstream of the culverts beneath Remembrance Driveway and Caloola Road;
- the corridor between Remembrance Driveway and the railway embankment to the east of Caloola Road;
- a portion of the railway line adjacent to Teatree Hollow; and,
- to the west of Remembrance Driveway overlying LW S5A.

Further downstream, inundation is limited to the main channel areas.

The hydraulic model predicts that the effects of subsidence may result in a minor increase in areas subject to flood inundation on the western side of Remembrance Driveway in the vicinity of Caloola Road and Yarran Road and to the east of Caloola Road.

These findings are generally consistent with that presented in the EIS (HEC, 2020). As detailed in HEC (2020):

- Significant overbank flooding was predicted under existing conditions during passage of the 1% AEP event at:
    - areas upstream of the culverts beneath Remembrance Driveway and Caloola Road;
    - the corridor between Remembrance Driveway and the railway embankment;
    - a portion of the railway line adjacent to Teatree Hollow; and,
    - to the west of Remembrance Driveway overlying LW S5A (referred to as LW 105A in HEC, 2020).
- The effects of subsidence were predicted to result in an increase in areas subject to flood inundation on the western side of Remembrance Driveway during a 1% AEP event.
- The largest increase in flood inundation was predicted to occur on the western side of Remembrance Driveway overlying LW S3A (referred to as LW 103A in HEC, 2020) - area upstream of the culverts beneath Remembrance Driveway and Caloola Road.

The modelled results for the 1% AEP flood event indicate that the western (second) dwelling on Lot 360/DP130185 and the dwelling on Lot 12/DP130181 would be affected by flooding under existing conditions (pre mining of LW S1A-S7A). The model results indicate that the predicted subsidence associated with mining of LW S1A-S7A may increase the depth of inundation of the western (second) dwelling on Lot 360/DP130185 during a 1% AEP flood event by 0.08 m. The model results for the post-subsidence scenario also indicate an increase in the predicted depth of inundation at the dwelling on Lot 12/DP130181 during a 1% AEP flood event by 0.09 m.

It is recommended that the asset owners are contacted to investigate the potential for detailed survey of the property to be conducted. The detailed survey could be incorporated in the flood model to provide further confirmation of the validity of the current model predictions. It is also recommended that, should further subsidence occur during the mining of LW S1A-S2A than that predicted, the subsidence predictions for LW S3A-S7A should be updated and incorporated in revised flood modelling.

The Remembrance Driveway and railway embankment culverts should be inspected and maintained to remove blockages (i.e. debris) and ensure that the design capacity is achieved. It is also recommended that the reporting drainage channels are appropriately inspected and maintained to remain free flowing.



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## ATTACHMENT A – TEATREE HOLLOW FLOOD EXTENT MAPS

### FIGURE A1: EXTENT OF PREDICTED 10% AEP FLOODING, SOUTHERN (UPSTREAM) – TEATREE HOLLOW

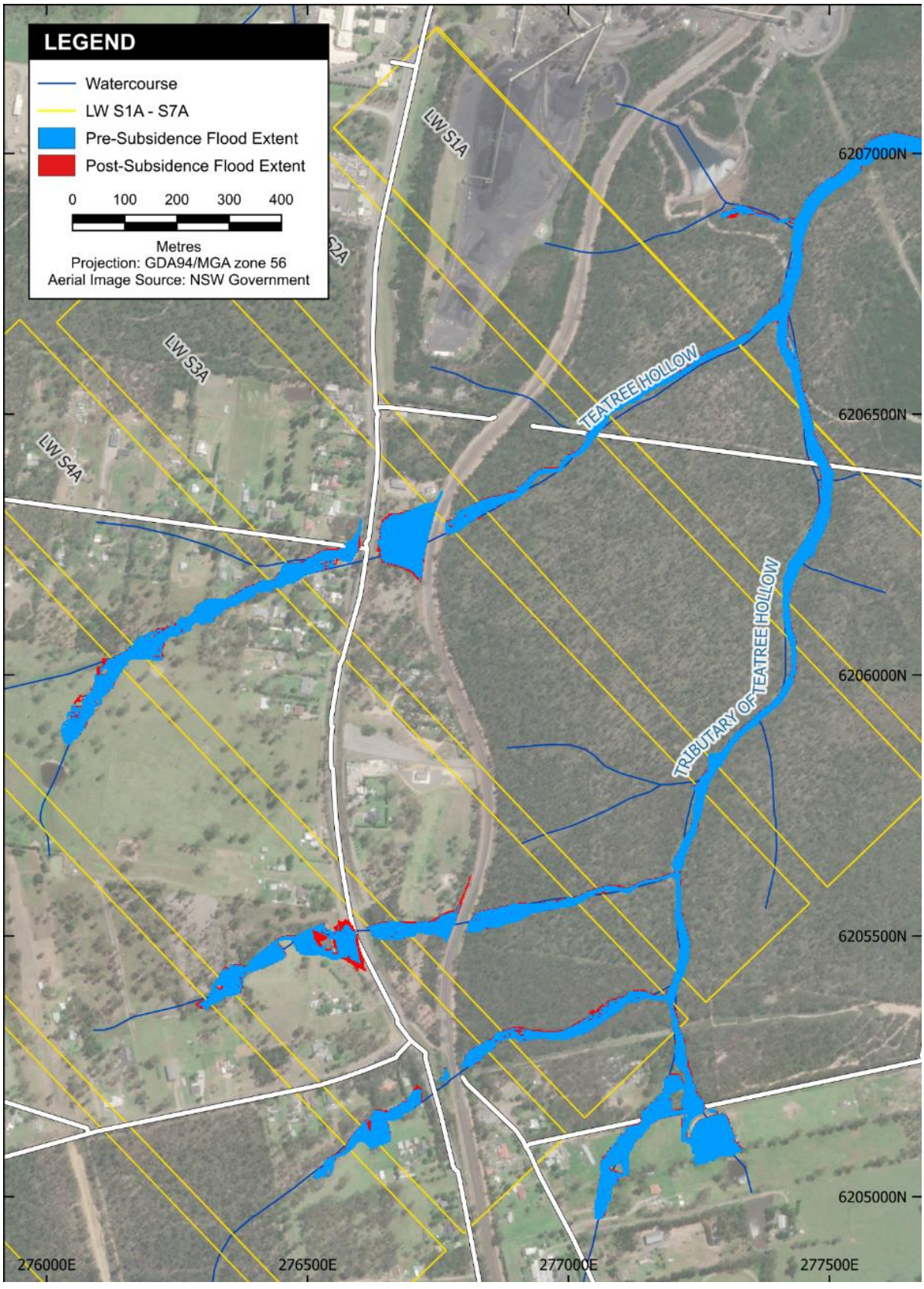


**FIGURE A2: EXTENT OF PREDICTED 10% AEP FLOODING, NORTHERN (DOWNSTREAM) - TEATREE HOLLOW**

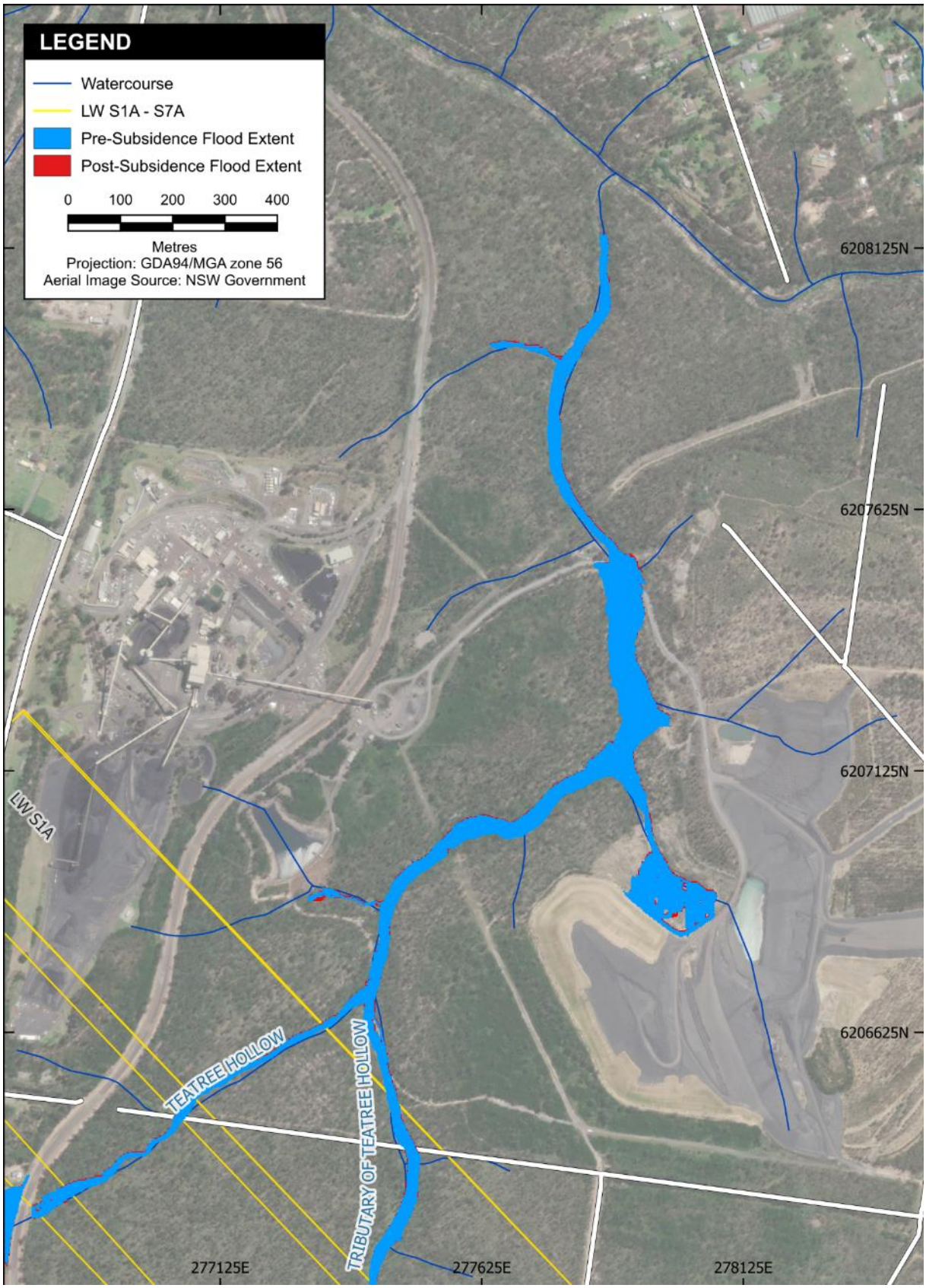


**FIGURE A3: EXTENT OF PREDICTED 0.5% AEP FLOODING, SOUTHERN (UPSTREAM) – TEATREE HOLLOW**

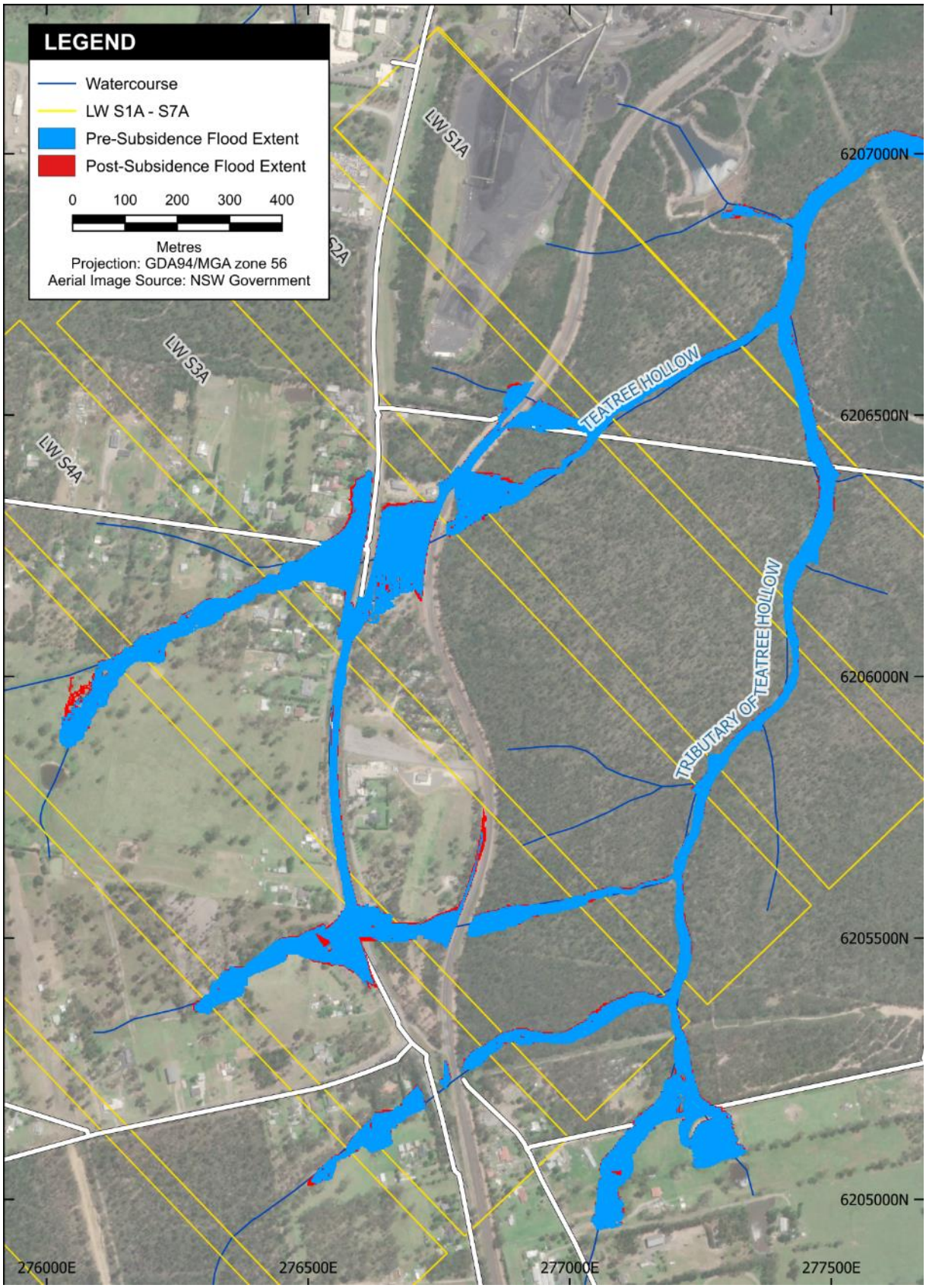


**FIGURE A4: EXTENT OF PREDICTED 0.5% AEP FLOODING, NORTHERN (DOWNSTREAM) – TEATREE HOLLOW**

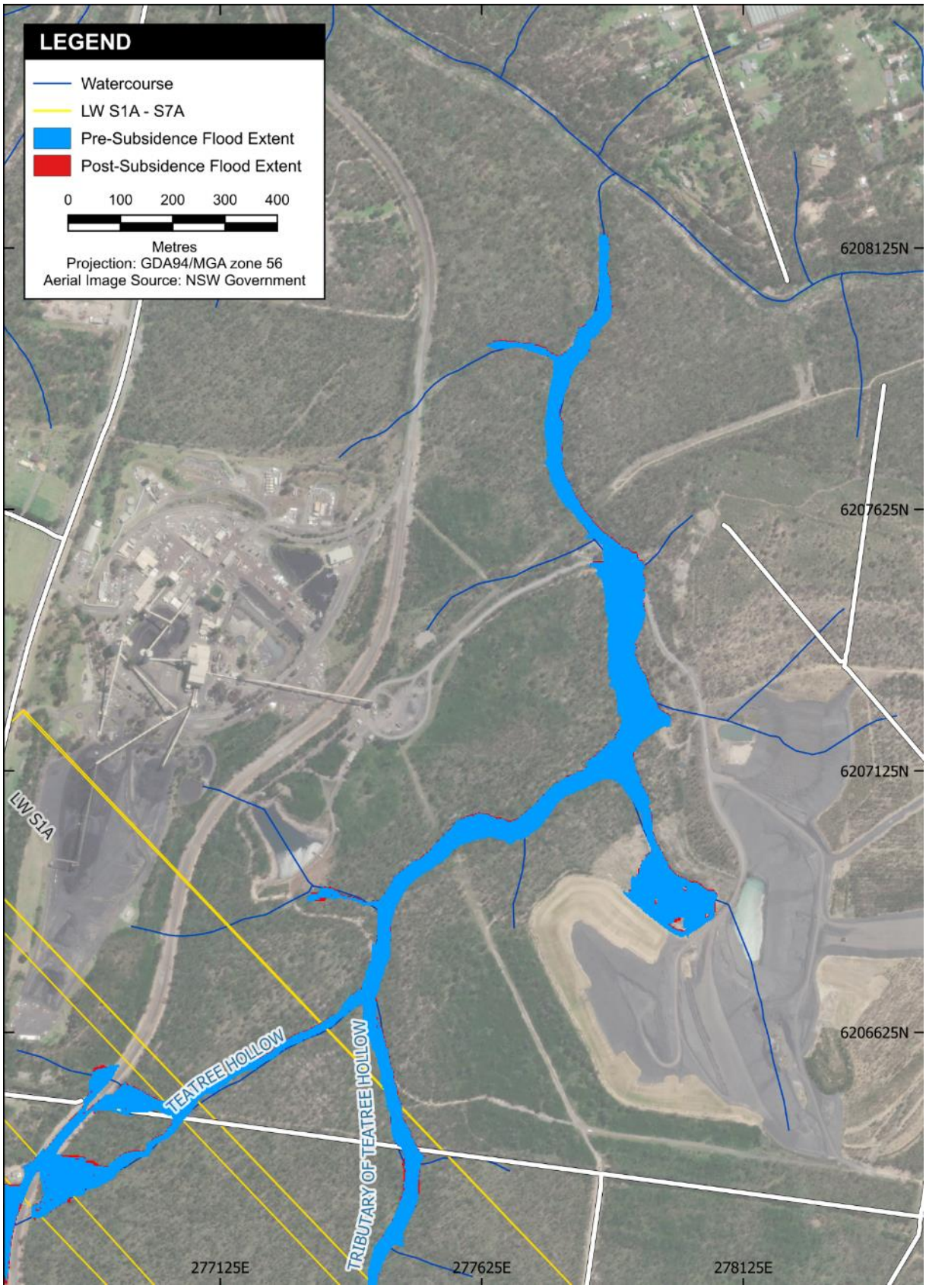


**FIGURE A5: EXTENT OF PREDICTED 0.2% AEP FLOODING, SOUTHERN (UPSTREAM) – TEATREE HOLLOW**

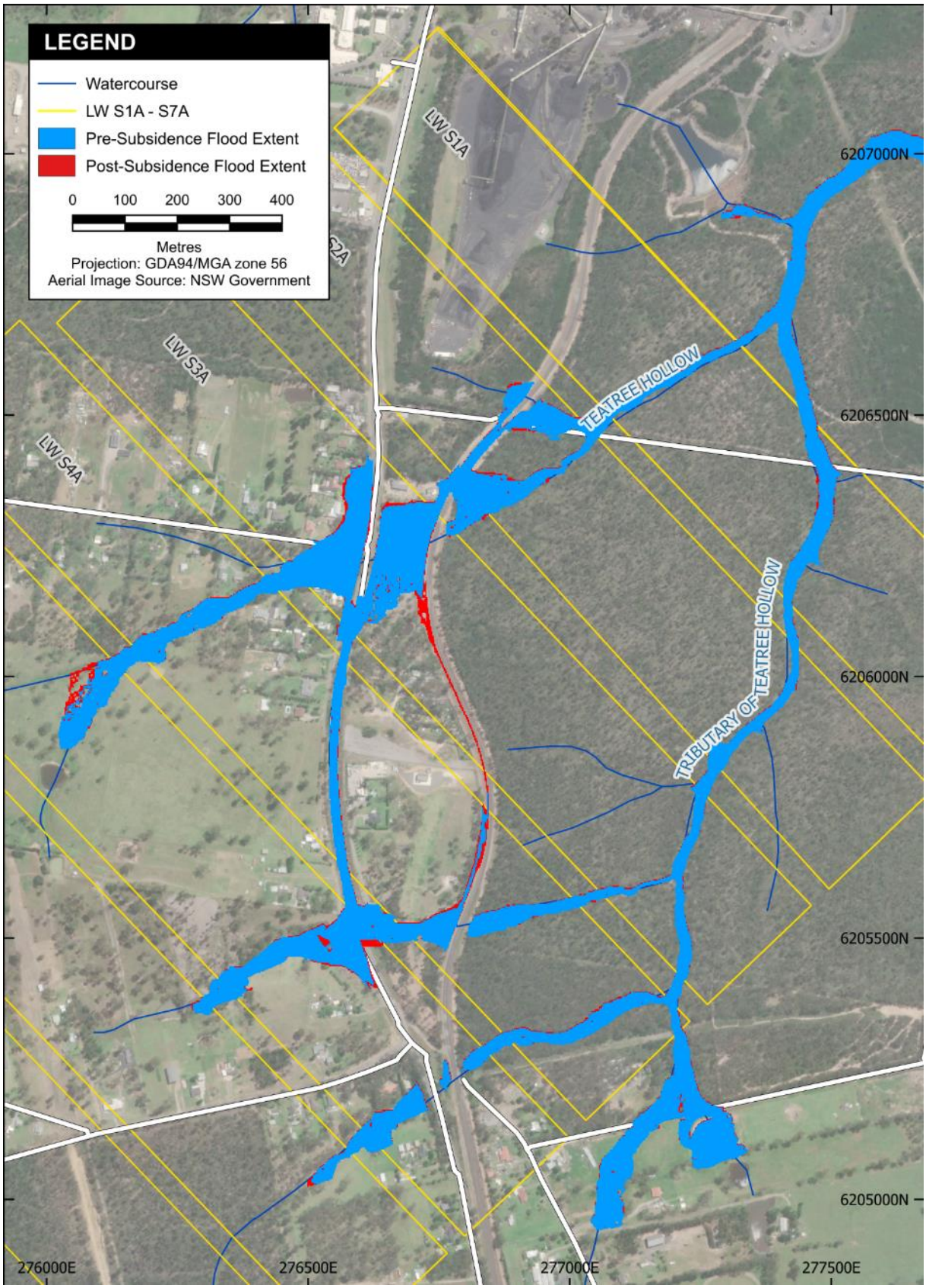


**FIGURE A6: EXTENT OF PREDICTED 0.2% AEP FLOODING, NORTHERN (DOWNSTREAM) – TEATREE HOLLOW**

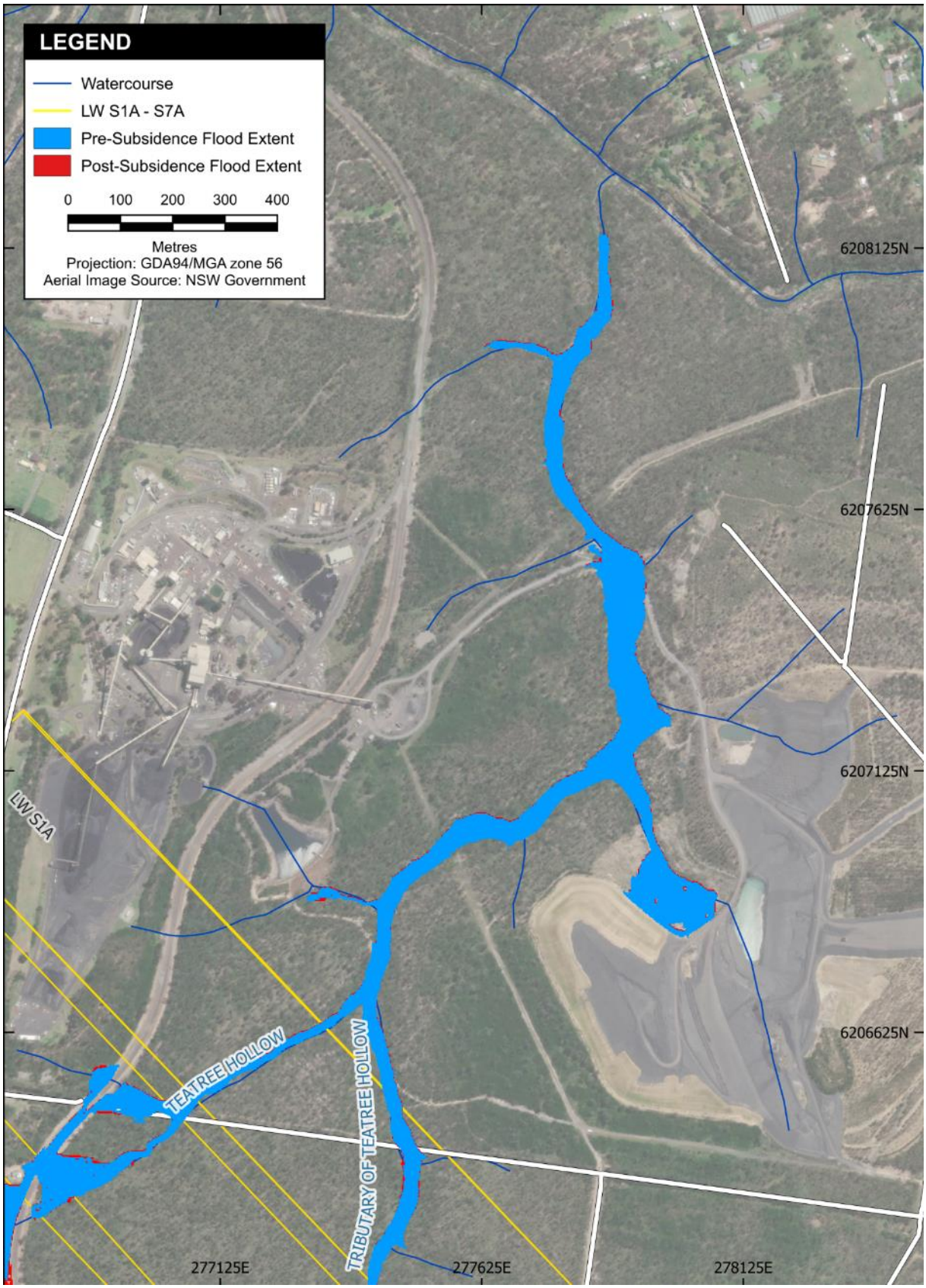


**FIGURE A7: EXTENT OF PREDICTED PMF FLOODING, SOUTHERN (UPSTREAM) – TEATREE HOLLOW**

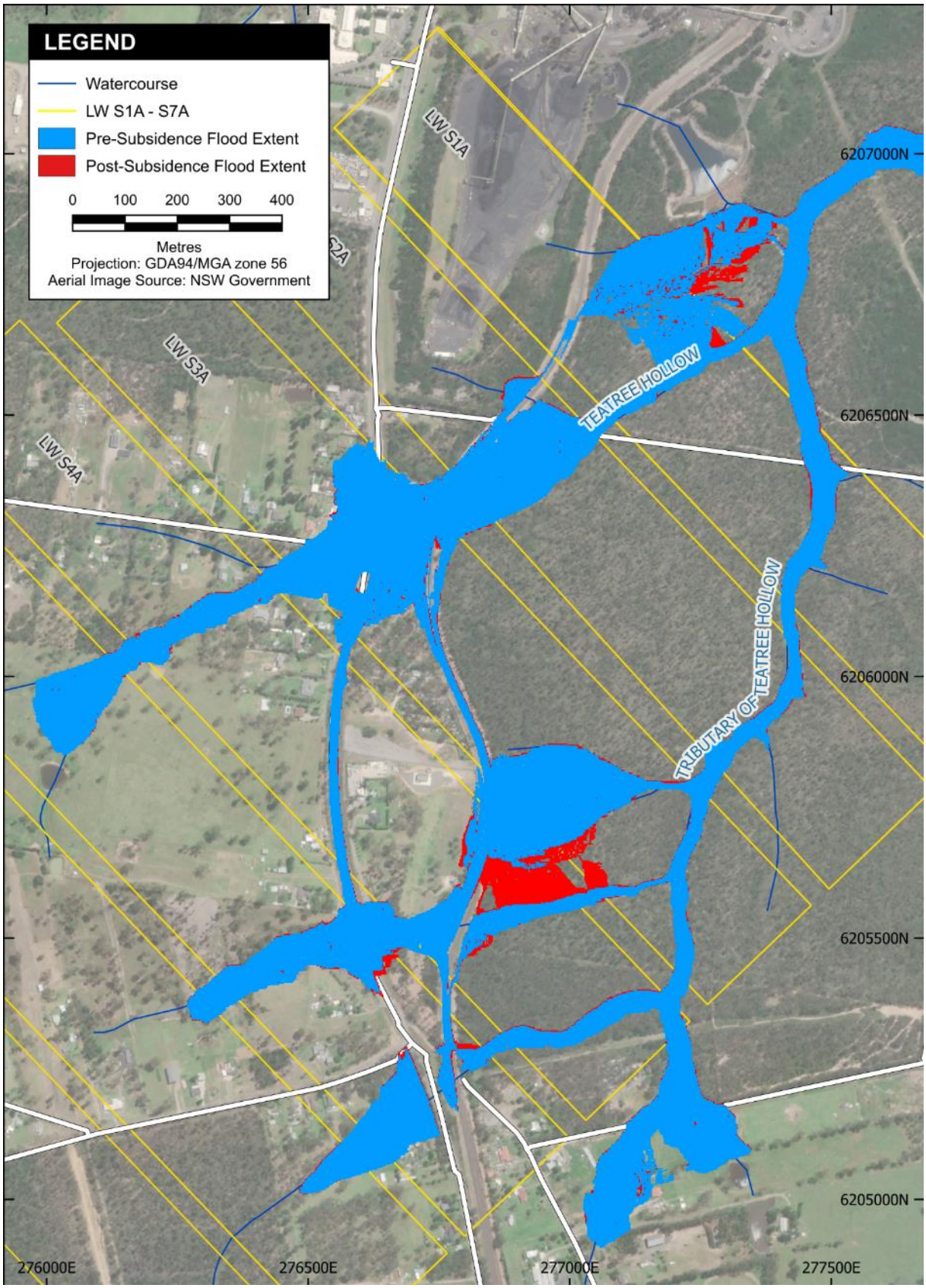
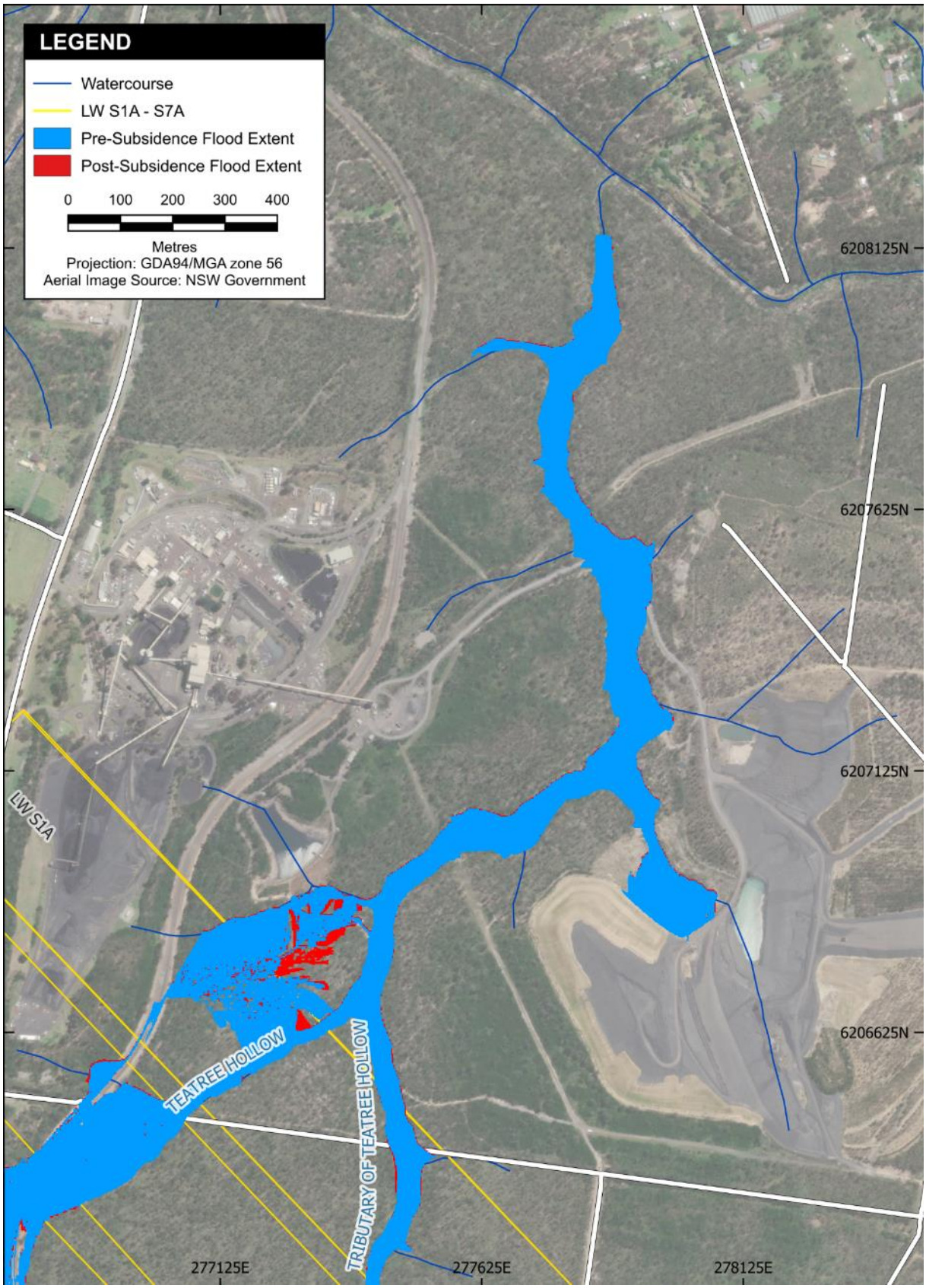


**FIGURE A8: EXTENT OF PREDICTED PMF FLOODING, NORTHERN (DOWNSTREAM) – TEATREE HOLLOW**



# Appendix G
## Groundwater impact assessment

EMM
creating opportunities

# Tahmoor South Mod 3 – LW S7A

## Groundwater Impact Assessment

### Tahmoor Coal

2975 Remembrance Driveway, Tahmoor NSW,
2574

Prepared by:

**SLR Consulting Australia**

Level 11, 176 Wellington Parade, East Melbourne
VIC 3002, Australia

SLR Project No.: 620.040109.00001

15 May 2024

Revision: V3.0

## Revision Record

| Revision | Date | Prepared By | Checked By | Authorised By |
|---|---|---|---|---|
| 3.0 | 15 May 2024 | Sharon Hulbert | Brian Rask | Brian Rask |

# Basis of Report

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

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

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# Appendices

**Appendix A Tahmoor South TARPS**

# Acronyms and Abbreviations

| | |
|---|---|
| AIP | Aquifer Interference Policy |
| ANZECC | Australian & New Zealand Environment and Conservation Council |
| BGSS | Bulgo Sandstone |
| BHCS | Bald Hill Claystone |
| BUCO | Bulli Coal Seam |
| CCL | Consolidated Coal Lease |
| CCSS | Coal Cliff Sandstone |
| EC | Electrical Conductivity |
| EIS | Environmental Impact Statement |
| EP&A | Environmental Planning and Assessment |
| EPA | Environmental Protection Authority |
| EPL | Environmental Protection Licence |
| GDE | Groundwater Dependent Ecosystems |
| GIS | Geographic information system |
| GMA | Groundwater Management Area |
| HBSS | Hawkesbury Sandstone |
| HoF | Height of fracturing |
| ICM | Illawarra Coal Measures |
| LDP | Licenced Discharge Point |
| LOP | Licenced Overflow Point |
| LTAAEL | Long-term average annual extraction limits |
| LW | Longwall |
| LW | Longwall |
| mAHD | Metres above height datum |
| ML | Mining Lease |
| ML | megalitres |
| MZ | Management Zone |
| NSW | New South Wales |
| pH | Potential of Hydrogen |
| REA | Reject Emplacement Area |
| RMS | Root mean Square |
| ROM | Run of Mill |
| SBSS | Scarborough Sandstone |
| SPCS | Stanwell Park Claystone |
| SSD | State Significant Development |

| | |
|---|---|
| SSD | State Significant Development |
| TARP | Trigger Action Response Plan |
| TDS | Total Dissolved Solids |
| TLRP | Thirlmere Lakes Research Program |
| UIS | Underground inseam |
| UNSW | University of New South Wales |
| Vic | Victoria |
| VWP | Vibrating Wire Piezometer |
| WAL | Water Access Licence |
| WBCS | Wombarra Claystone |
| WMP | Water Management Plan |
| WSP | Water Sharing Plan |
| WTP | Water treatment Plant |
| WWCO | Wongawilli Coal Seam |
| WWFM | Wianamatta Formation (group) |

# 1.0 Introduction

Tahmoor Coal Pty Ltd (Tahmoor Coal) owns and operates the Tahmoor Mine, an underground coal mine located approximately 80 kilometres south-west of Sydney in the Southern Coalfield of New South Wales (NSW). Tahmoor Mine is located within the Wollondilly and Wingecarribee local government areas (LGAs).

Tahmoor Mine operates in accordance with State Significant Development Consent (SSD 8445) granted on 23 April 2021 by the NSW Independent Planning Commission (IPC). Development consent SSD 8445 permits extraction and processing of up to 4 million tonnes per annum (tpa) of run-of-mine (ROM) coal from the Bulli Seam until 2032 using longwall mining methods. The approved longwalls authorised by SSD 8445 are shown on **Figure 1** and includes an A series of longwall panels (Longwalls South 1A-6A (LW S1A-S6A)) and a B series of longwall panels (Longwalls South 1B-6B (LW S1B-S6B)). Longwall extraction under the Tahmoor South development consent commenced on 18 October 2022. Tahmoor Coal are currently extracting coal from Longwall LW S3A.

## 1.1 Proposed Modification

Tahmoor Coal is seeking to modify SSD 8445 (Mod 3) under Section 4.55(2) of the Environmental Planning and Assessment Act 1979 (EP&A Act) to authorise:

- an additional longwall panel (LW S7A) to the approved A series longwall panel layout,
- removal of restrictions imposed by Condition A6 on the requirement for mining to be completed within 10 years following the commencement of second workings in the Tahmoor South mining area, and
- an increase in the maximum volume of ROM coal authorised by Condition A11(b) of SSD 8445 that can be extracted and processed on site from 33 million tonnes per annum (Mtpa) to 35 Mtpa.

The location of the proposed additional Longwall and the pertinent study area is shown on **Figure 2**.

### 1.1.1 Longwall S7A

Development consent SSD 8445 permits longwall mining of six panels within an ‘A-series’ and six panels within a ‘B-series’ of longwalls. The proposed longwall panel LW S7A is an additional longwall panel in the A series of longwalls and within the existing Tahmoor South Project Area.

LW S7A will extract coal between a minimum extraction height of 2.1 metres (m) and a maximum extraction height of 2.5 m. Further details of the proposed LW S7A dimensions are summarised in Table 1.

**Table 1 Longwall S7A dimensions**

| Longwall ID | Overall void length including installation heading (m) | Overall void width including first workings (m) | Overall tailgate chain pillar width (m) |
|---|---|---|---|
| LW S7A | 1,918 | 285 | 36 |

LW S7A has been included in the mine plan following a revision of the geological interpretation of the location of the Central Fault, which is located to the southwest of the Tahmoor South Project area.

## 1.2 History of Tahmoor South

An Environmental Impact Statement (EIS) was exhibited in early 2019 seeking approval for the extraction of up to 48 million tonnes (Mt) of ROM coal over a 13-year mine life. Tahmoor Coal subsequently revised the proposed mine design and submitted amended development applications on two occasions (in February and August 2020). In April 2021, Tahmoor Coal received Development Consent SSD 8445.

Development Consent SSD 8445 has been modified on two occasions:

- Modification 1 (Mod 1) was granted on 19 July 2022 and authorised an extension of time, until 31 December 2023, for the new water treatment plant to be commissioned.
- Modification 2 (Mod 2) was granted on 13 June 2023 and authorised the transfer and storage of water treatment plant brine in underground workings.

The Tahmoor South Groundwater Management Plan (SLR, 2022) received Directors Approval from the NSW Department of Planning and Environment on the 14th of April 2022.

### 1.2.1 Other Leases and Licences

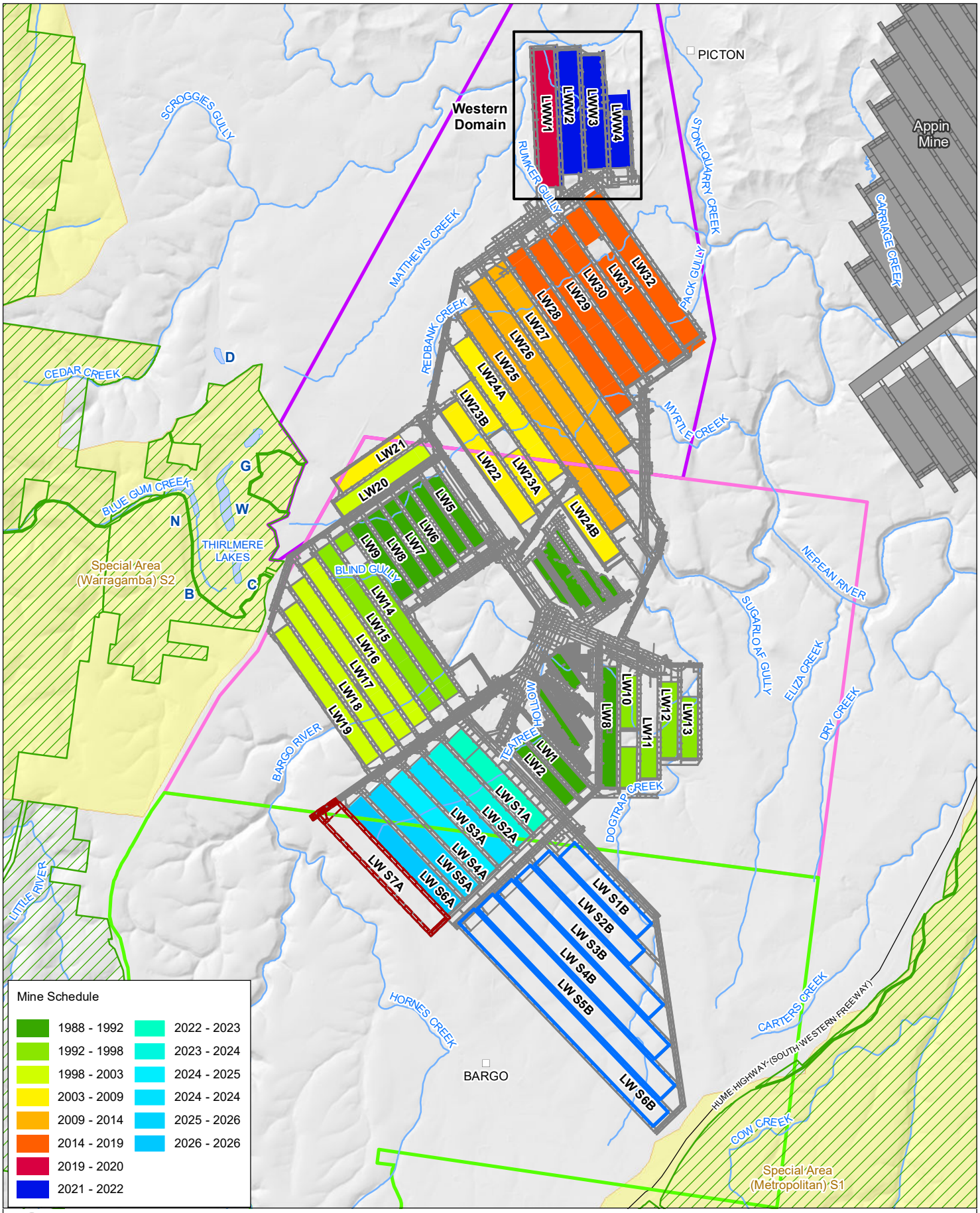
All development consents, leases, licences, and other relevant approvals are stored in the Cority Compliance Management database, which is administered by both site and Liberty GFG Corporate. A summary of the relevant mining leases is provided in **Table 2**. A summary of other approvals and licences is provided in **Table 3**.

**Table 2 Mining leases**

| Lease | Title | Granted | Expires |
|---|---|---|---|
| CCL 716 | Original Tahmoor Leases | 15/06/1990 | 13/03/2021(renewal documentation submitted, being assessed) |
| CCL 747 | Bargo Mining Lease | 23/05/1990 | 06/11/2025 |
| ML 1376 | Tahmoor North Lease | 28/08/1995 | 28/08/2016 (renewal documentation submitted, under assessment) |
| ML 1308 | Small Western lease, west of CCL716 | 02/03/1993 | 02/03/2035 |
| ML 1539 | Tahmoor North Extensions Lease | 16/06/2003 | 16/06/2024 |
| ML1642 | Pit-top and REA surface Mining Lease | 27/08/2010 | 27/08/2031 |

**Table 3 Approvals/Licences**

| Approval Title / Description | Date Of Issue | Expiry Date |
|---|---|---|
| Environmental Protection Licence 1389 | 01/05/2012 | No Expiry |
| WAL25777 | 27/10/2014 | No Expiry |
| WAL 43572 | 07/05/2021 | No Expiry |
| WAL43656 | 1/08/2022 | No Expiry |
| WAL 44608 | 8/2/2023 | No Expiry |
| SWC839757 | 10/07/2023 | No Expiry |
| XSTR200005 (Licence to store explosives) | 02/02/2017 | 02/02/2027 |

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Date: 01-May-2024
Drawn by: RB

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# TAHMOOR SOUTH MODIFICATION 3

## TAHMOOR COAL OPERATIONS

FIGURE 1

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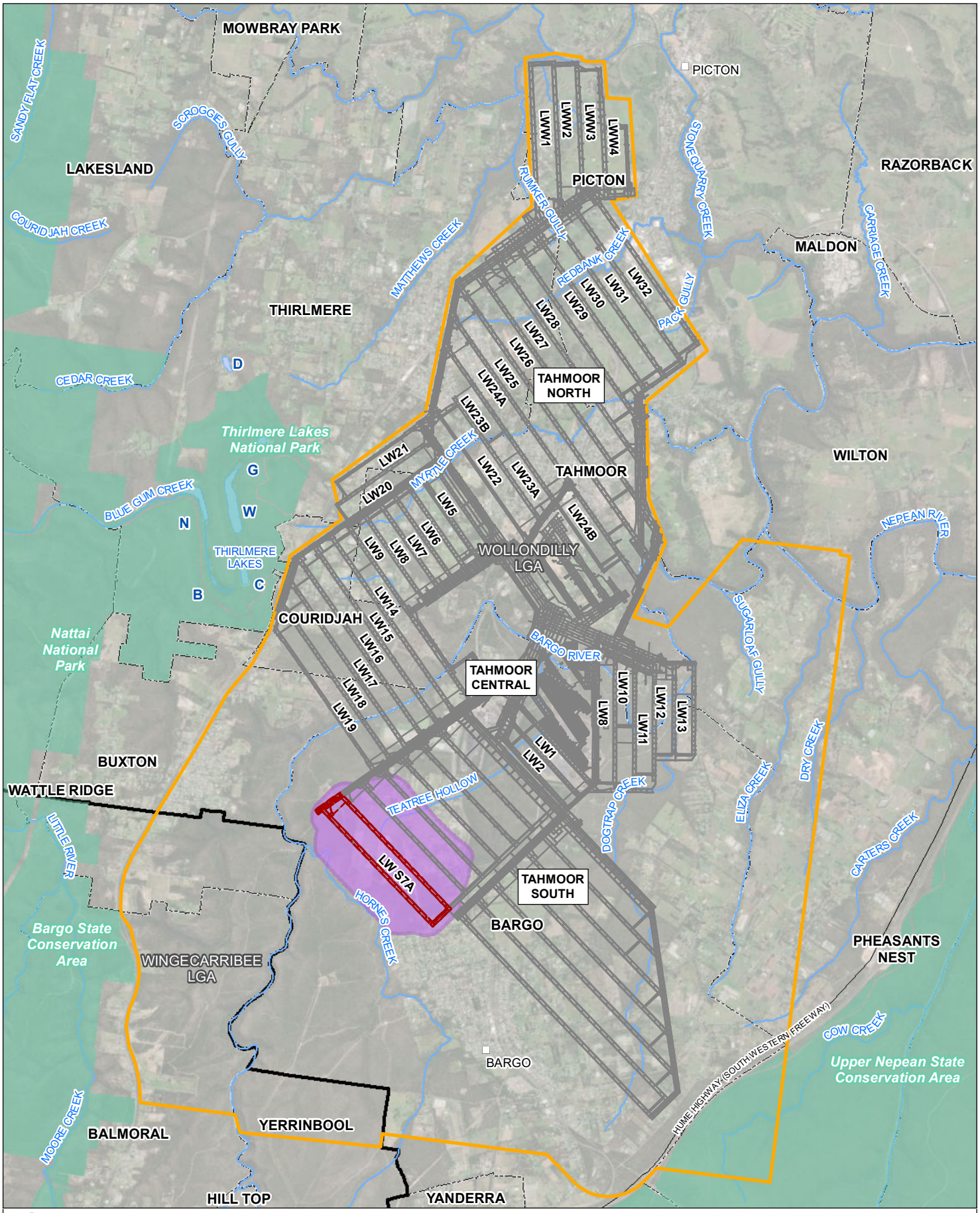


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- Minor Town
- Major Roads
- Watercourses
- Proposed LW S7A
- Mine Plan
- Tahmoor South Project Area (SSD 8445)
- Study Area
- Lakes
- National Park Estate
- Local Government Area
- Suburb

Lakes:
D = Dry Lake
G = Gandangarra
W = Werri Berri
C = Couridjah
B = Baraba
N = Nerrigorang

**TAHMOOR SOUTH MODIFICATION 3**

**PROPOSED LW S7A AND STUDY AREA**

**FIGURE 2**

SLR

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# 2.0 Statutory Requirements

A series of statutory requirements are associated with the extraction occurring at Tahmoor South LW S1A-S6A, and this modification.

## 2.1 Relevant Legislation and Policy

### 2.1.1 Water Management Act 2000

The Water Management Act 2000 is the regulatory framework for the management and control of water use within NSW. In conjunction with the Water Act 1912, it governs the licensing of water to users. Further, the Water Management Act 2000 allows for the development and implementation of Water Sharing Plans (WSPs). WSPs regulate the trade and sharing of surface and groundwaters between competing needs and users throughout NSW.

#### 2.1.1.1 Relevant Water Sharing Plans and Groundwater Management Areas

Tahmoor Mine currently extracts groundwater that drains into underground mine workings and pumps this water to the surface via three dewatering lines.

Tahmoor Mine falls within the 'Greater Metropolitan Region Groundwater Sources' WSP (NOW, 2011b), which commenced in 2011. **Figure 3** indicates the extent of this WSP, along with the various groundwater sources in this region that are regulated by the WSP. A WSP is used to manage the average long-term annual volume of water extracted from a given groundwater source.

The relevant Groundwater Source for the Tahmoor Mine is:

- Sydney Basin Nepean Groundwater Source.

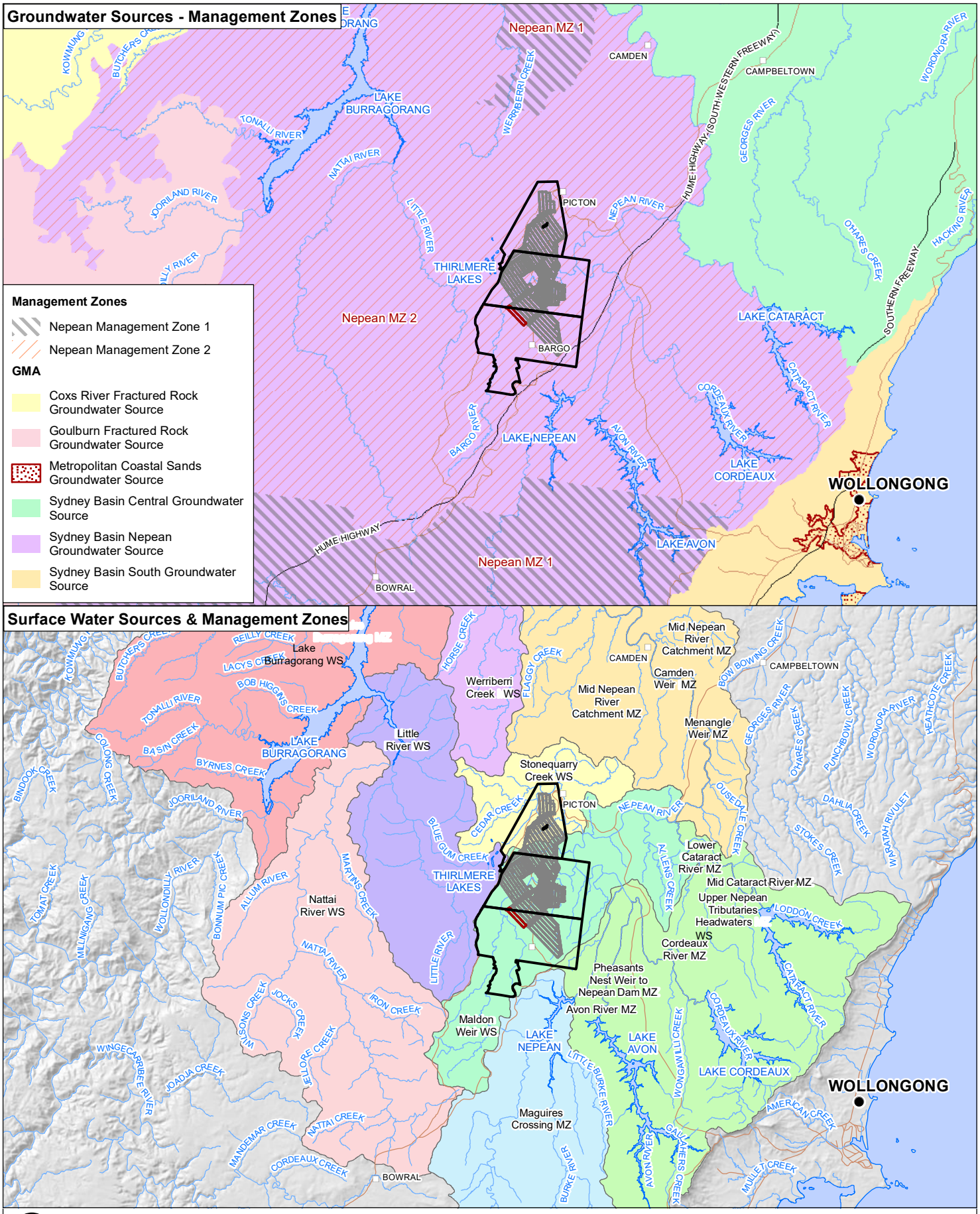
Other relevant Groundwater Sources include:

- Sydney Basin – Central, located 10 km to the east and north-east,
- Sydney Basin – South, located 15-20 km east and south-east, and
- Goulburn GMA – located over 25 km to the west and south.

The Sydney Basin Nepean Groundwater Source is further subdivided into Management Zones (MZ), as shown using hatching on **Figure 3**. The LW S7A Study Area lies within Nepean Management Zone 2, while Zone 1 covers the southern 'third' of the Groundwater Source as well as a smaller area to the west of Camden. The Sydney Basin Nepean Groundwater Source has an annualised limit on entitlement (LTAAEL) of 99,568 ML (NOW, 2011a), while current entitlement is 31,446 ML (based on the WaterNSW Water Register 2023-24 water year).

The Greater Metropolitan Region Unregulated River Water Sources 2023 WSP (NOW, 2011c) is the relevant plan for surface water for the LW S1A-S6A Study Area. Within this WSP, the Upper Nepean and Upstream Warragamba Extraction Management Unit are the relevant Units, of which the following Water Sources cover or are adjacent to the project site:

- Stonequarry Creek Water Source, and
- Maldon Weir Water Source.

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**TAHMOOR SOUTH MODIFICATION 3**

**WATER SOURCES & MANAGEMENT ZONES**

SLR

**FIGURE 3**

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### 2.1.2 NSW Aquifer Interference Policy

Underground mining generally requires the dewatering of the geological strata. In accordance with the NSW Aquifer Interference Policy (AIP), such activity is classified as an 'Aquifer Interference'. In order to meet the requirements of the 'minimal impact considerations' of the AIP, a groundwater assessment is conducted.

The AIP requires an estimation of "*all quantities of water that are likely to be taken from any water source during and following cessation of the activity and all predicted impacts associated with that activity*...". Water take and impact estimation is to be based on a "complex modelling platform" for any mining activity not subject to the Gateway process, where the model makes use of the "available baseline data that has been collected at an appropriate frequency and scale and over a sufficient period of time to incorporate typical temporal variations".

The AIP was developed to provide a framework to guide the assessment of impacts that may result following the 'take' of water from an aquifer. It outlines the requirements for obtaining licences for approved aquifer interference activities, as well as considerations for the assessment of impacts (NSW Government, 2012).

The AIP specifies 'minimal harm considerations' for highly and less productive aquifers, while also defining thresholds for water table and groundwater pressure drawdown, and changes in groundwater and surface water quality. There are separate minimal impact considerations for:

- "Highly productive" groundwater,
- "Less productive" groundwater,
- "Water supply" works,
- "High Priority" Groundwater Dependent Ecosystems (GDEs), and
- "High Priority" Culturally significant sites.

The AIP categorises groundwater source productivity (highly productive or less productive) based on characteristics of salinity and aquifer yield. Tahmoor Mine undermines the 'Highly Productive' Hawkesbury Sandstone aquifer (**Figure 3**). The Hawkesbury Sandstone aquifer is the most utilised aquifer in this region. Water sourced from the Narrabeen Group and Permian Coal Measures comprises the remaining portion of water sourced around Tahmoor Mine (HydroSimulations, 2018).

It should be noted that the categorisation of groundwater source productivity does not make any vertical distinction of aquifer productivity. This is relevant as the high yielding Hawkesbury Sandstone aquifer overlies the lower-yielding Narrabeen Group/Permian Coal Measures groundwater systems which are at greater depths.

### 2.1.3 Water Licencing

Water Access Licences (WAL) held by Tahmoor Coal for the Sydney Basin Nepean Groundwater Source, which is regulated in accordance with the Greater Metropolitan Region Groundwater Sources Water Sharing Plan under the authority of the Water Management Act 2000, are listed in the **Table 4**.

**Table 4 Tahmoor Coal water access licences**

| WAL Title | Issued | Purpose | Share |
|---|---|---|---|
| WAL 36442 | 06/12/2013 | Mining dewatering (groundwater) (Nepean Sandstone Groundwater MZ2) | 1,642ML |

| WAL Title | Issued | Purpose | Share |
|---|---|---|---|
| WAL 25777 | 27/10/2014 | Surface Water Take (Maldon Weir WS) | 5ML |
| WAL 43572 | 13/04/2021 | Incidental Surface Water Take (Stonequarry Creek WS) | 16ML |
| WAL 44608 | 8/2/2023 | Incidental Surface Water Take (Stonequarry Creek WS) | 9ML |
| WAL 43656 | 1/8/2022 | Incidental Surface Water Take (Maldon Weir WS) | 25ML |
| SWC839757 | 19/8/2022 | Incidental Surface Water Take (Maldon Weir WS) – Lease | 11ML |

### 2.1.4 Licences Discharge Points

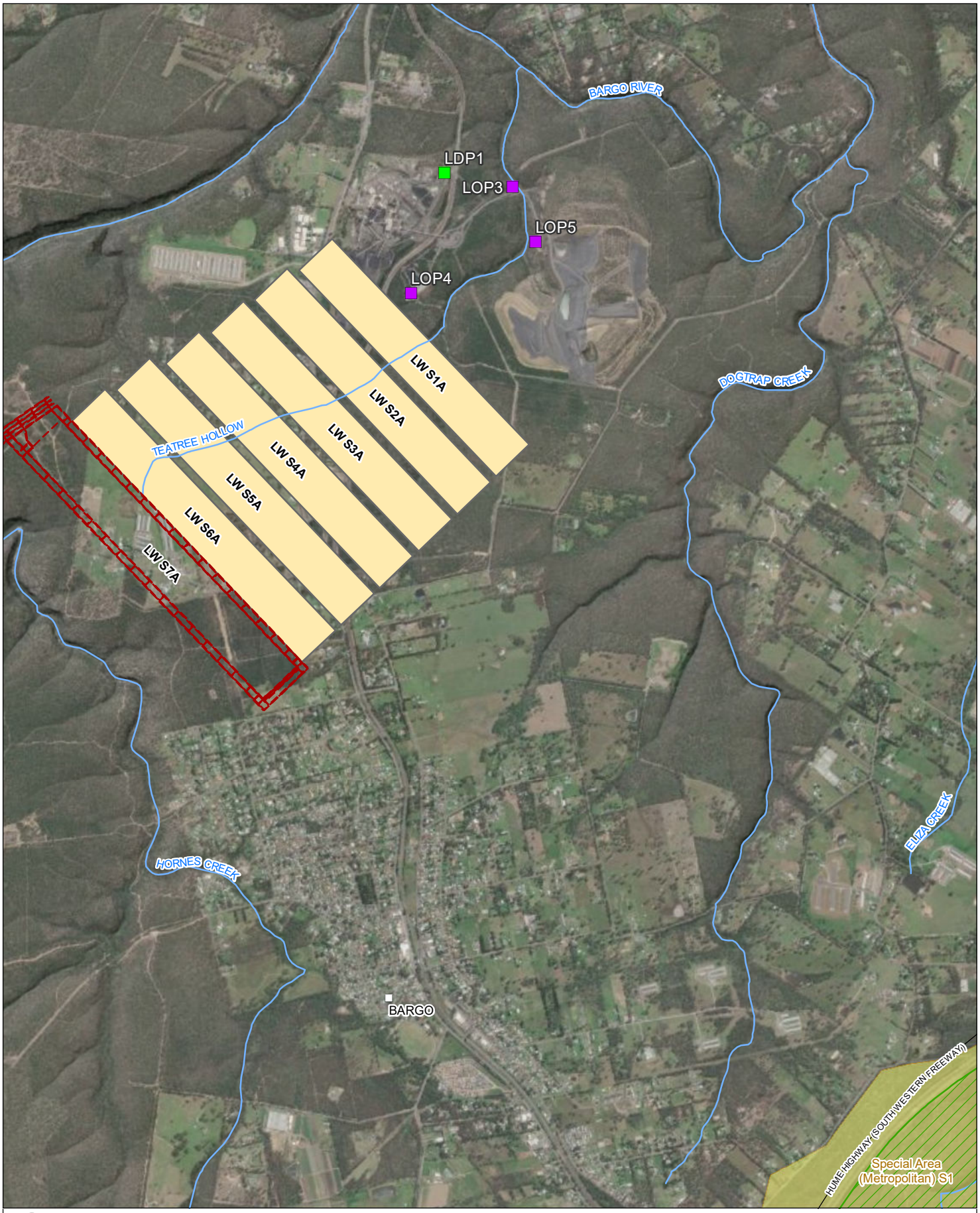
Tahmoor Coal also holds a discharge licence, issued by the NSW Environmental Protection Authority (NSW EPA). This licence, Environment Protection Licence (EPL) 1389, permits the discharge of wastewater and 'made water' from the underground mine to surface water.

In accordance with EPL 1389, Tahmoor Coal is licensed to discharge from one licenced discharge point (LDP) and three licenced overflow points (LOPs). The locations of the LDP and LOP's are shown on **Figure 4**, and described in **Table 5**.

**Table 5 EPL 1389 Licenced discharge points**

| Discharge/Overflow Point | Type of Discharge Point | Location Description | Discharge Limit |
|---|---|---|---|
| LDP1 | Discharge to waters<br>Discharge quality monitoring<br>Volume monitoring | Main water discharge – discharge drain located downstream of the final mine water treatment dam (dam M4) | 15,500 kilolitres per day during low rainfall conditions<br>Unlimited during wet weather conditions*† |
| LOP3 | Discharge to waters | Overflow from sediment dam S9 | Unlimited during wet weather conditions*† |
| LOP4 | | Overflow from sediment dam S4 | |
| LOP5 | | Overflow from sediment dam S8 | |

* Defined as more than 10 millimetres (mm) rainfall within a 24 hour period.
† Provided that all practical measures are taken to reduce potential water quality impacts

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- Discharge Point
- Overflow Point
- Minor Town
- Major Roads
- Proposed LW S7A
- WaterNSW Special Area

**Tahmoor South Mine Plan**

- Approved

SLR

# TAHMOOR SOUTH MODIFICATION 3

## LICENSED DISCHARGE POINTS AND LICENSED OVERFLOW POINTS

**FIGURE 4**

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# 3.0 Existing Environment

A summary of the hydrogeological environment is provided here for context to the overarching study. This summary is largely based on previous detailed conceptualisation summaries provided in the Tahmoor South EIS (HydroSimulations, 2018), and the Tahmoor South LW S1A-S6A Groundwater Technical Report (SLR, 2023) in support of the Water Management Plan and Extraction Plan (Tahmoor Coal, 2023).

## 3.1 Climatic Conditions

Rainfall data in the area is available from numerous sources. Bureau of Meteorology (BoM) operate two rainfall stations, Picton Council Depot (68052) and Buxton (681660) located to the north and west of Tahmoor Mine operations respectively. Tahmoor Coal operate their own rainfall station, and the SILO climate data source provide interpolated and infilled records for 0.05°x0.05° latitude and longitude tiles.

Due to the occasional gaps in the data for the BoM sites, and the relatively short record of data held by Tahmoor (the mine's record has no gaps, but started in July 2006), the SILO record for the closest 0.05°x0.05° tile near the mine (Lat: -34.25, Long: 150.60) has been adopted for this report to understand long-term trends for the record since 1900. This record has been compared against the other data sources to verify its appropriateness for this task.

Average annual rainfall is 826 mm/year, for the period 1970 to 2023. **Figure 5** presents the annual rainfall, alongside statistics, with statistically notable wet or dry years highlighted (noting 2024 is an incomplete record year). In the in the past 6 years, there have been both significantly dry and wet annual rainfall. This includes the notable drought period of mid-1017 until January 2020, followed by wetter than average conditions.

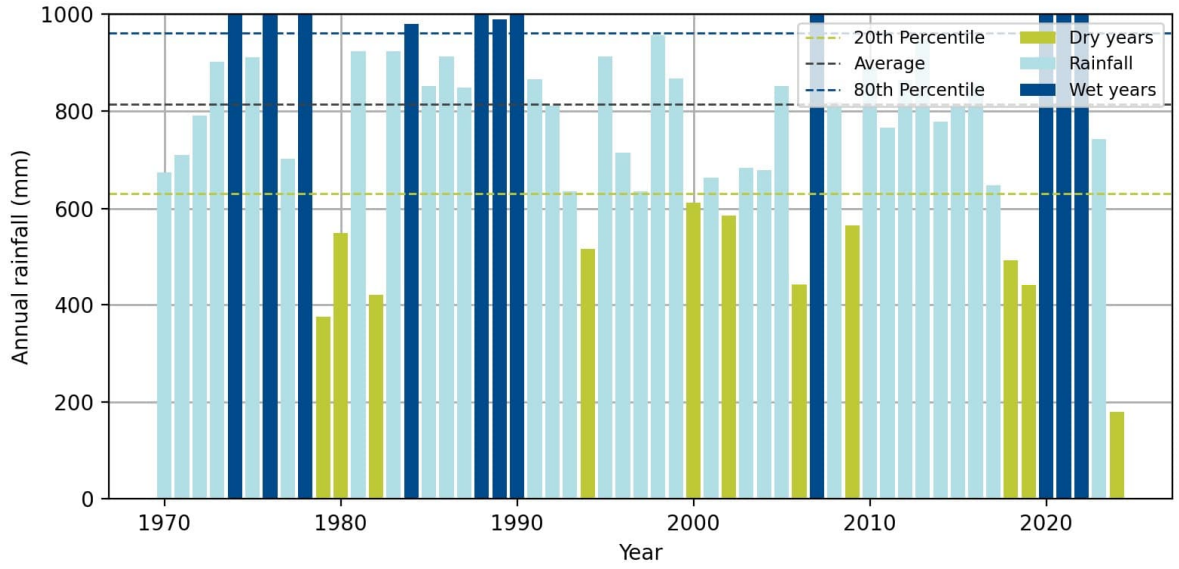



**Figure 5 Annual rainfall record and statistics**

Typically, long term records indicate that evaporation typically exceeds rainfall, occurring in all months excluding June. Rainfall is generally more consistent all year with the average total monthly rainfall ranging from 39 mm to 112 mm. The highest monthly rainfall is typically in January, February and March (averaging 84, 112 and 97 mm respectively), while July, August and September are typically the driest months (averaging 39, 47 and 43 mm respectively) for the recorded period. Evaporation and evapotranspiration show similar trends with higher rates during the summer months and lower during the winter months. The average monthly potential evaporation is highest in December (191 mm).

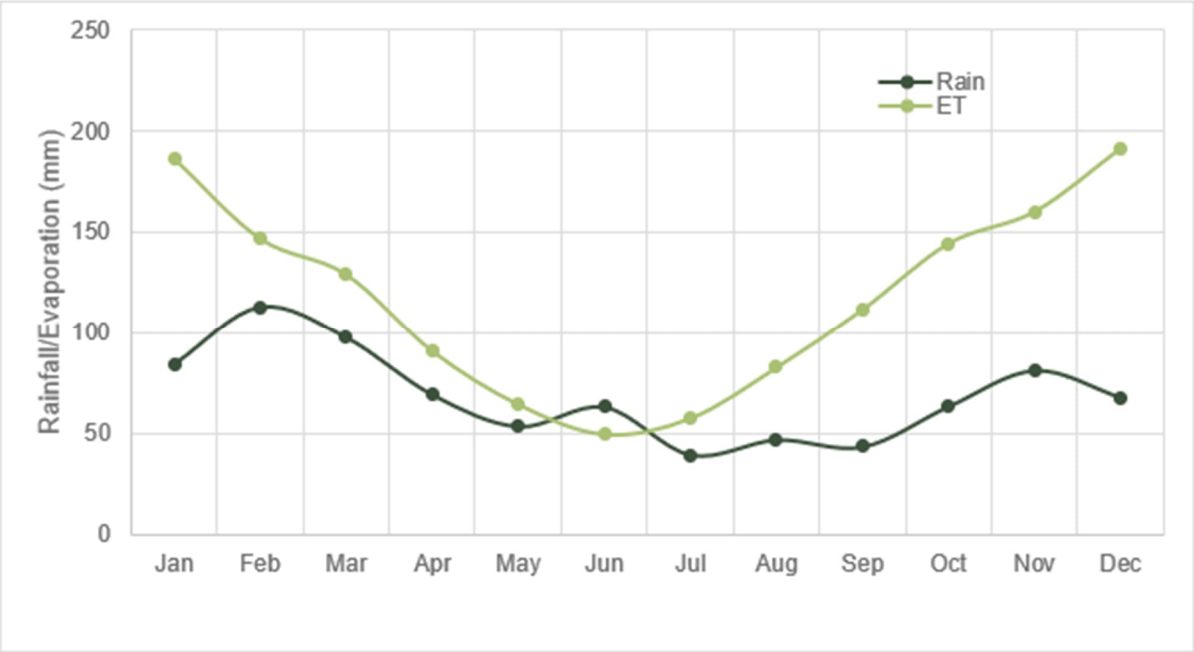
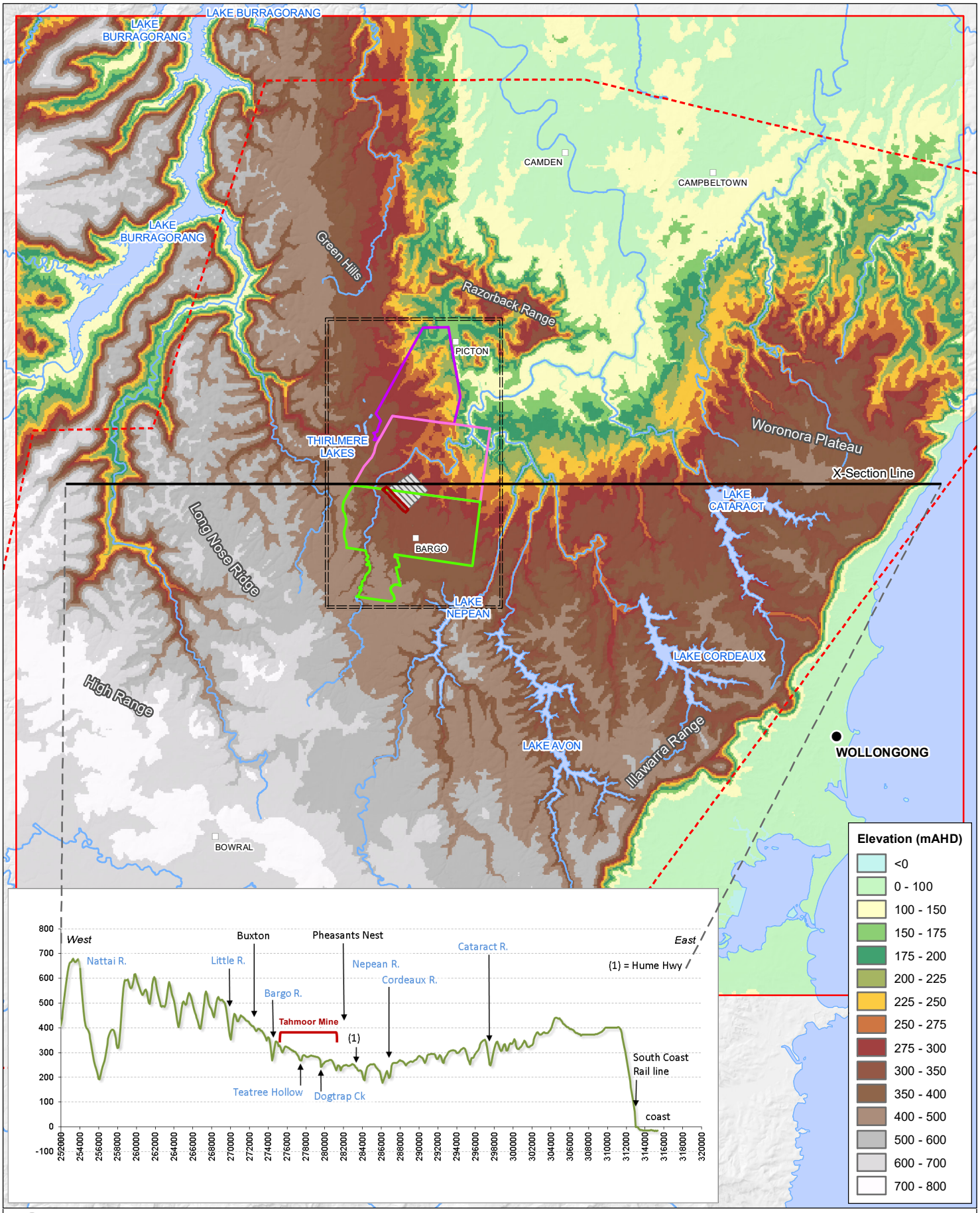



**Figure 6 Long-term monthly average rainfall and evaporation**

## 3.2 Topography

Tahmoor Mine is located approximately 20 km west of the Illawarra Escarpment. Drainage lines locally are typically deeply incised and flow in a predominantly northerly and north-easterly direction.

Surface infrastructure at Tahmoor Mine lies at an elevation of approximately 280 mAHD, and the elevation of the interfluves above the Tahmoor South Domain is typically 280 – 300 mAHD. **Figure 7** shows the local elevation contours.

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- City
- Town
- Watercourses
- Proposed LW S7A
- Lakes

**Tahmoor Coal Titles**

- MLs 1308, 1376, 1539
- CCL 716
- CCL 747

- Lidar Covarage
- Southern Coalfield (approximate)
- Study Area for Groundwater Assessment
- Tahmoor South Mine Plan

# TAHMOOR SOUTH MODIFICATION 3

## TOPOGRAPHY

SLR

FIGURE 7

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## 3.3 Surface Water

Tahmoor Mine is located within the Bargo River catchment. From its headwaters near the townships of Hill Top and Yerrinbool, the Bargo River flows in a generally north-easterly direction through incised valleys and gorges to its confluence with the Nepean River. Flows in the Bargo River upstream of the Tahmoor Mine are unregulated.

The headwaters of the Nepean River rise in the coastal ranges to the south of Tahmoor Mine. Flows in the Nepean River near Tahmoor are highly regulated by the Upper Nepean Water Supply Scheme, operated by WaterNSW, which incorporates four major water supply dams on the Cataract, Cordeaux, Avon and Nepean Rivers. Releases from the Cordeaux, Avon and Nepean Dams are made to enable withdrawal for water supply purposes from the Pheasants Nest Weir located further downstream on the Nepean River. The Nepean Dam is situated some 18 km upstream of the Bargo River confluence, while the Pheasants Nest Weir is located approximately 7 km upstream of the confluence. The Nepean River, downstream of Pheasants Nest Weir and adjacent to and downstream of the Study Area, is not part of the Sydney Drinking Water Catchment or the Special Areas[1]. The Study Area is also located outside of the Sydney Drinking Water Catchment and the Special Areas. Cow Creek is the closest watercourse to the Study Area that is located in the Sydney Drinking Water Catchment – located approximately 4.7 km south-east of the Study Area boundary.

The Nepean River flows into the Warragamba River near Wallacia at which point it is referred to as the Hawkesbury-Nepean River. The Hawkesbury-Nepean catchment is one of the largest coastal catchments in NSW with an area of some 21,400 square kilometres ($km^2$) from its mouth in Broken Bay on the northern side of the Sydney Metropolitan area.

The Study Area is located predominantly within the Teatree Hollow catchment which is a sub-catchment of the Bargo River. Small portions of the Study Area and 600 m buffer are also located within the Hornes Creek, Dogtrap Creek and Bargo River catchments. The lower reaches of Teatree Hollow, Dogtrap Creek and the Bargo River have, to varying degrees, experienced subsidence-related effects due to historical mining operations at Tahmoor Mine.

These watercourses are presented on **Figure 8**.

### 3.3.1 Bargo River

The Bargo River catchment area is approximately 130 $km^2$. The Bargo River has intermittent flow in its upstream reaches which, to some degree, are regulated by the Picton Weir located at the Hornes Creek confluence, approximately 14 kilometres (km) upstream of the Nepean River confluence. Downstream of the Tahmoor Mine pit top (i.e. downstream of the Teatree Hollow confluence) flow is perennial due to persistent licensed discharges from Tahmoor Mine.

The lower 4 km of the river pass through the Bargo River Gorge, which is characterized by steep rock faces up to 110 m high. The river consists of a sequence of pools, glides and rock bars across sandstone bedrock, with occasional boulder fields and cobblestone riffles. The Bargo River flows into the Nepean River approximately 9 km downstream of the Teatree Hollow confluence. The headwaters of a second order tributary of the Bargo River overlie the western edge of the approved LW S5A. The baseline geomorphology survey identified that the Bargo River tributary was generally in good geomorphic condition (i.e. essentially natural with intact form and process) (Fluvial Systems, 2013). Sites where the redirection of surface

[1] The Special Areas comprise undisturbed areas around WaterNSW Drinking Water storages and infrastructure. Public access and activities are restricted to protect water quality in these areas.

flow to the subsurface was observed, presumed to be associated with historical mining-induced bed fracturing, were classified as having moderate geomorphic condition (Fluvial Systems, 2013).

### 3.3.2 Teatree Hollow

The headwaters of Teatree Hollow rise in the northern part of the Bargo Township with the main watercourse flowing generally north-northeast to the Bargo River. Downstream of the Bargo Township, Teatree Hollow predominantly traverses bushland to the confluence with the Bargo River.

Teatree Hollow is a third order stream from the eastern edge of the approved LW S1A to the confluence with the Bargo River and has a total catchment area of approximately 8 $km^2$. A third order tributary joins with Teatree Hollow at the eastern edge of the approved LW S1A. This tributary overlies the Study Area but is a lower order stream (first or second order) upstream of LW S2A.

The baseline geomorphology survey (Fluvial Systems, 2013) identified that the upper to mid reach of Teatree Hollow and the mid to lower reach of Teatree Hollow Tributary were predominantly in good geomorphic condition while the mid to lower reach of Teatree Hollow and the upper reach of Teatree Hollow Tributary were predominantly in moderate geomorphic condition. The sites of moderate geomorphic condition related to minor culvert or track crossings, low riparian vegetation cover or discharge from the LDPs (Fluvial Systems, 2013). The upper reaches of Teatree Hollow and Teatree Hollow Tributary were characterised by a low relief landscape, with a dominant bed material of mud (cohesive clay/silt/sand) and notable grass coverage (Fluvial Systems, 2013). In the mid to lower reaches, the landscape was characterised as high relief with dominant bed material of mud, sand, boulders and/or exposed bedrock and little low flow channel grass coverage.

In accordance with EPL 1389, Tahmoor Coal is licensed to discharge to Teatree Hollow from one LDP and three LOPs.

### 3.3.3 Dogtrap Creek

Dogtrap Creek has a total catchment area of approximately 13.6 $km^2$. Dogtrap Creek has its headwaters in the southern part of the Bargo Township, above LW S1B-S6B and east of the REA to the Bargo River, and approximately 1 km east of the nearest part of LW S1A. Dogtrap Creek is a third order stream from approved LW S4B to the confluence with the Bargo River and has a total catchment area of approximately 13.6 $km^2$. Two second order tributaries join with Dogtrap Creek at the northern edge of approved LW S1B.

The outcomes of the geomorphology survey concluded that the majority of Dogtrap Creek and its tributaries were in good geomorphic condition with some sites in the upper reaches of Dogtrap Creek and its tributaries characterised as moderate geomorphic condition.

### 3.3.4 Hornes Creek

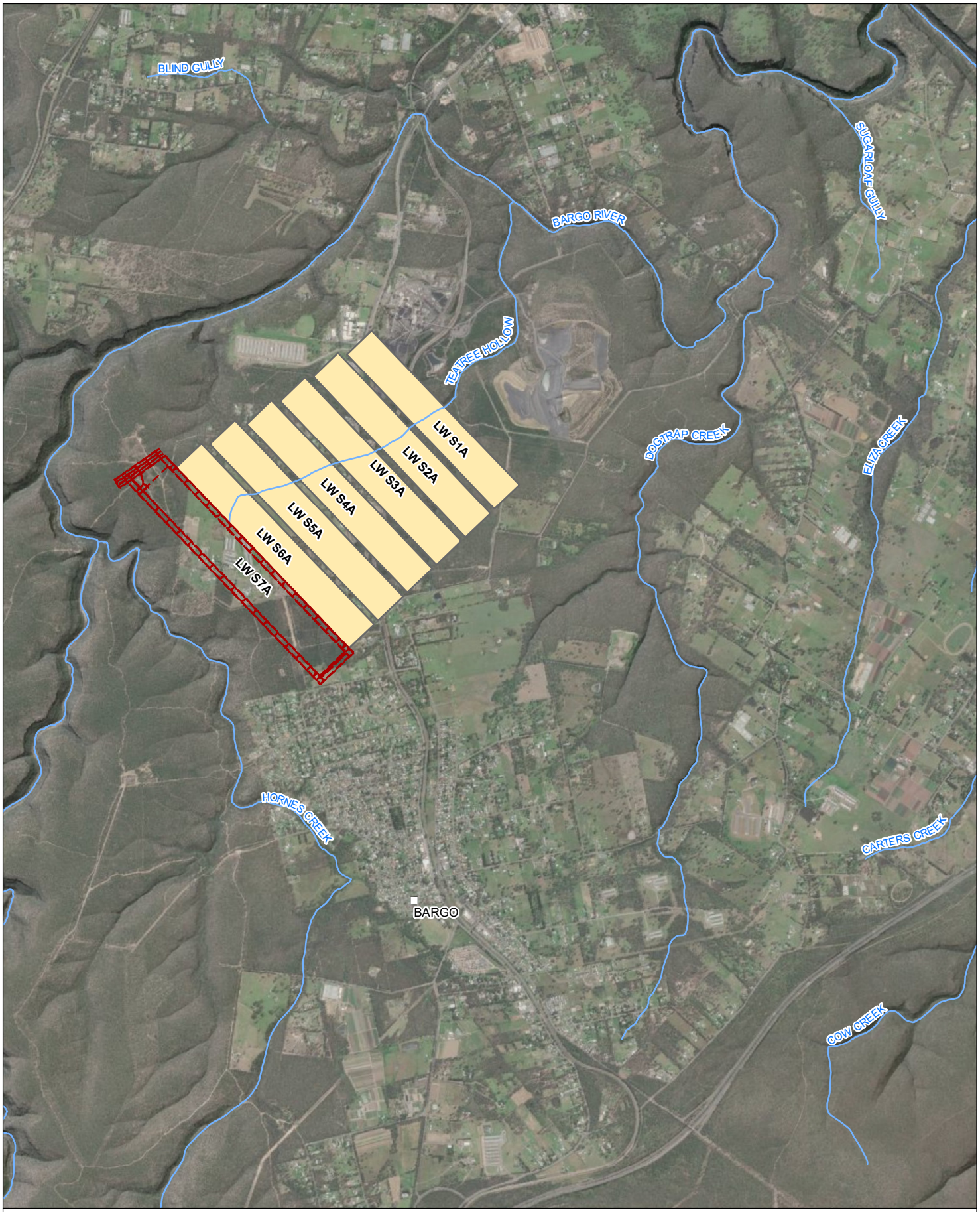
Hornes Creek catchment is located to the south-southwest of the Study Area. The catchment area of Hornes Creek is approximately 19.3 $km^2$ which comprises predominantly bushland, rural-residential area and residential area associated with the Bargo township. Hornes Creek is a fourth order stream adjacent to the Study Area and at its confluence with the Bargo River (Fluvial Systems, 2013).

The baseline geomorphology survey (Fluvial Systems, 2013) identified that Hornes Creek was generally in good geomorphic condition.

### 3.3.5 Thirlmere Lakes

Although located beyond the Study Area of the Tahmoor South Conceptualisation, the five lakes of the Thirlmere Lakes are nominated High Priority GDEs and within a World Heritage Area and consequently incorporated in this study for completeness. These lakes are formed in the alluvium along Blue Gum Creek, to the west of historical Tahmoor mine longwalls. The nearest of the Thirlmere Lakes is at least 3.5 km from the Study Area.

The Thirlmere Lakes Research Program (TLRP), a NSW government initiative, commenced in 2018 and was completed in 2022. This program aimed to provide a detailed understanding of the hydrological dynamics, water sources and water flow pathways. The summation report, “Thirlmere Lakes – A Synthesis of Current Research” was released in late March 2022, by NSW Department of Planning and Environment (DPE), with the final suite of reports published in 2023. Further discussion pertaining to the Thirlmere Lakes is provided in Section **6.3.2.1**.

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Minor Town
Watercourses
Proposed LW S7A

**Tahmoor South Mine Plan**

Approved

# TAHMOOR SOUTH MODIFICATION 3

## WATERCOURSES

SLR

**FIGURE 8**

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# 4.0 Geology

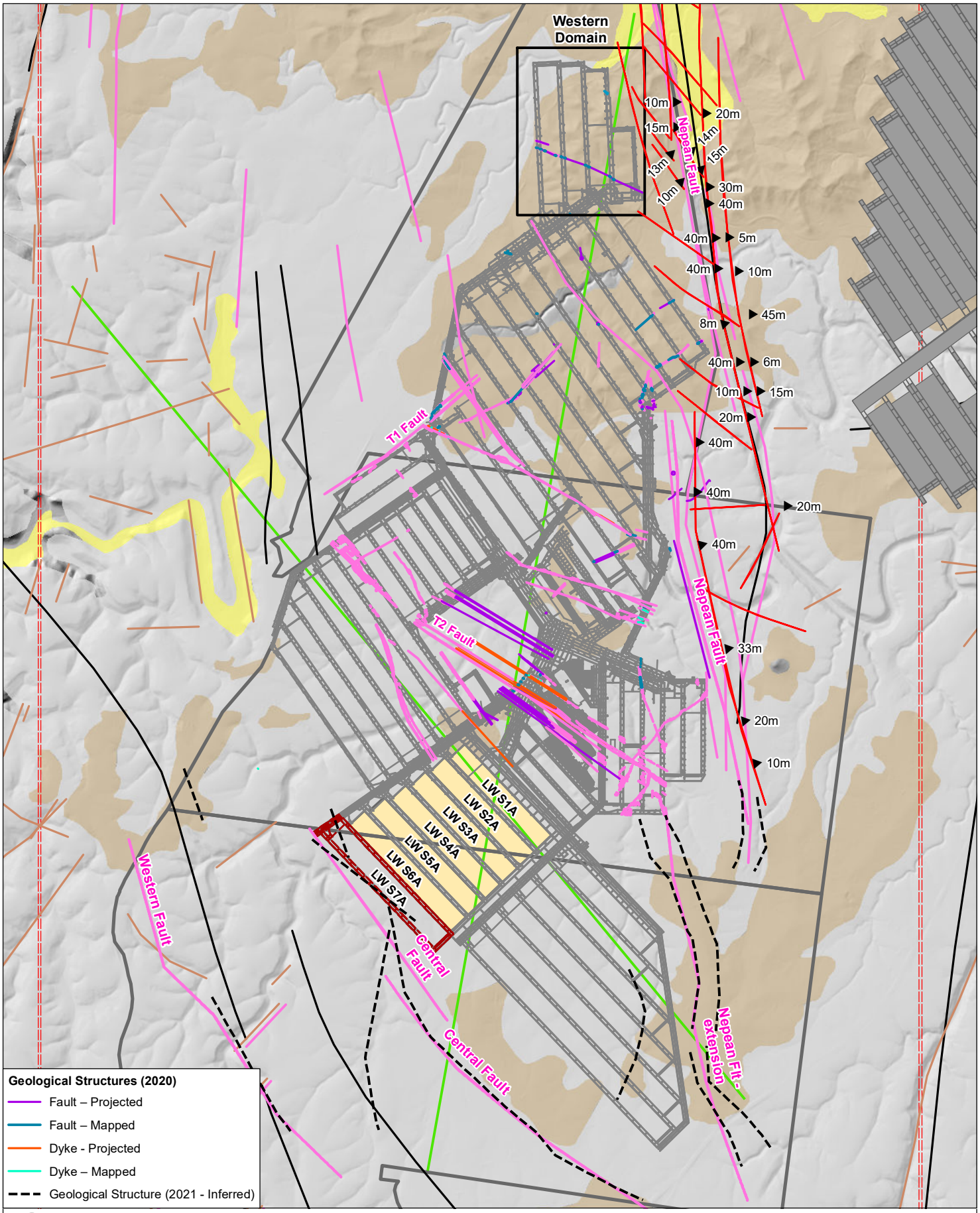
## 4.1 Stratigraphic Setting

Tahmoor Mine is situated within the Southern Coalfield in the sedimentary Sydney Basin (UOW, 2012). **Figure 9** presents the outcropping geology and structural features at and around Tahmoor Mine and **Table 6** describes the regional stratigraphic sequence.

**Table 6 Regional stratigraphic profile**

| Period | Stratigraphic Unit | | Description |
|---|---|---|---|
| Quaternary | Alluvium and colluvium and other sediments in floodplains, alluvial fans, and high terraces (Qal, Tal, Qs) | | Alluvial and residual deposits comprising quartz and lithic fluvial sand, silt and clay. |
| Triassic | Wianamatta Group | Camden Sub-group | Shale with sporadic thin lithic sandstone. |
| | | Liverpool Sub-group: Bringelly Shale (Rwb), Minchinbury Sandstone and Ashfield Shale (Rwa) | Dark green and black shales with thin graywacke-type sandstone lenses. Calcareous graywacke-type sandstone and black mudstones and silty shales with sideritic mudstone bands. |
| | Hawkesbury Sandstone (Rh) | | Consists of thickly bedded or massive quartzose sandstone (with grey shale lenses up to several metres thick). |
| | Narrabeen Group | Newport Formation | Interbedded grey shales and sandstones |
| | | Garie Formation | Cream to brown, massive, characteristically oolitic claystone |
| | | Bald Hill Claystone | Brownish-red coloured “chocolate shale”, a lithologically stable unit |
| | | Bulgo Sandstone | Strong, thickly bedded, medium to coarse-grained lithic sandstone with occasional beds of conglomerate or shale |
| | | Stanwell Park Claystone | Greenish-grey mudstones and sandstones |
| | | Scarborough Sandstone | Mainly of thickly bedded sandstone with shale and sandy shale lenses up to several metres thick |
| | | Wombarra Claystone | Similar properties to the Stanwell Park Claystone |
| | | Coal Cliff Sandstone | Basal shales and mudstones that are contiguous with the underlying Bulli Coal seam. Absent in much of the Tahmoor area. |
| Permian | Illawarra Coal Measures | | Interbedded shales, mudstones, lithic sandstones and coals, including the: |
| | | | Bulli Coal seam (2-4 m thick); |
| | | | Eckersley Formation, including the Balgownie Seam (5-10 m below Bulli Coal seam), Loddon Sandstone and Lawrence Sandstone. |
| | | | Wongawilli Coal seam (8-10 m thick). |
| | | | Kembla Sandstone |
| | Shoalhaven Group | | |

Two regional geological cross-sections have been provided, **Figure 10** and **Figure 11**, showing the configuration of the stratigraphic units in two planes across the region (south-north and east-west). The location of the cross sections is presented on **Figure 9**. The cross sections depict how the different units are configured and vary in thickness and geometry across the region.




**Geological Structures (2020)**

- Fault – Projected
- Fault – Mapped
- Dyke - Projected
- Dyke – Mapped
- Geological Structure (2021 - Inferred)

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- Faults (locally mapped)
- Southern CF Structure
- Southern CF Fold
- Local Geological model Extent

**Nepean Fault Complex (SCT, 2020)**

- Offset, Estimated
- Surface Trace

- Cross Section
- Proposed LW S7A
- Mine Plan
- Tahmoor Coal Titles
- Alluvium
- Wianamatta Formation
- Hawkesbury Sandstone
- Existing Mine

**Tahmoor South Mine Plan**

- Approved

**TAHMOOR SOUTH MODIFICATION 3**

**OUTCROPPING GEOLOGY AND STRUCTURAL FEATURES AT TAHMOOR**

SLR

**FIGURE 9**

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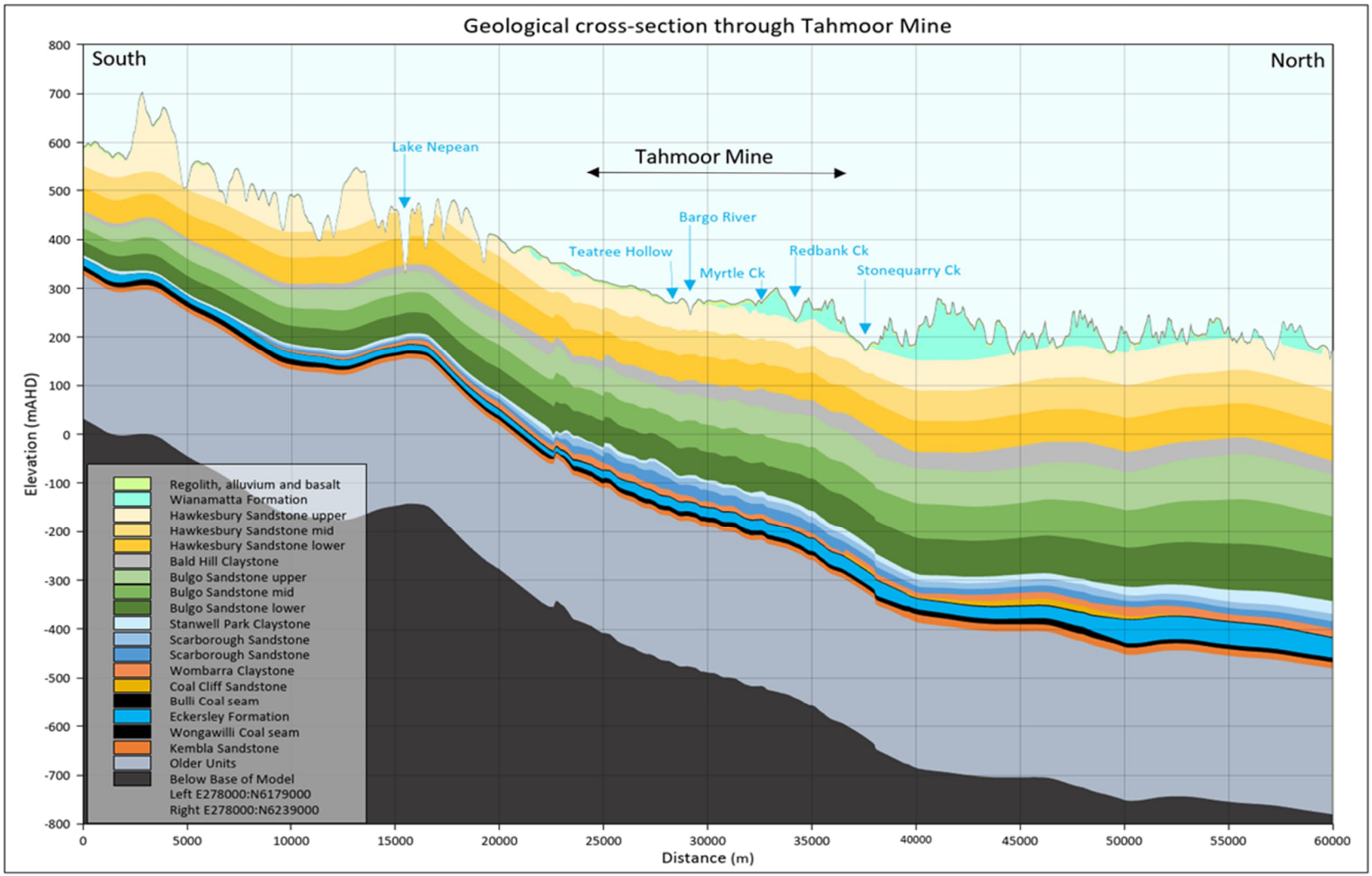



**Figure 10 Geological cross section: South to North**

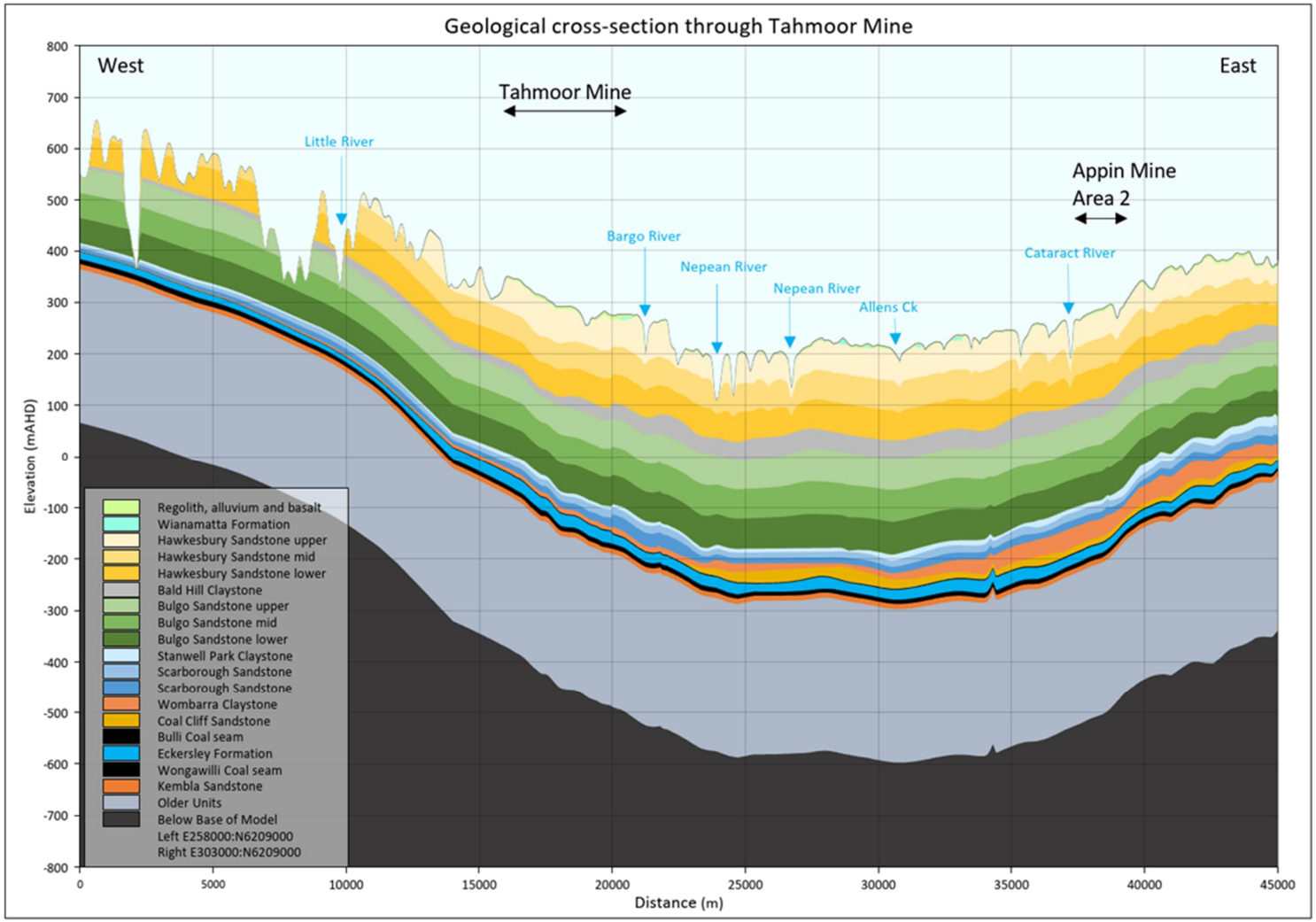



**Figure 11 Geological cross section: West to East**

### 4.1.1 Alluvium

Generally, there is limited extent of surficial alluvium in this region, with no occurrences in the vicinity of the Study Area.

However, regionally, small areas of alluvium exist along Stonequarry Creek (located north of mining operations) and near Blue Gum Creek and Thirlmere Lakes Alluvium at Thirlmere Lakes (located beyond the Study Area)

The general stratigraphy of the Thirlmere Lakes Alluvium, as described by DPE (2022) is as follows:

- The upper ~15 m across all surveyed lakes and sills is represented by unconsolidated alluvial/colluvial sediments.
- The upper 2–3 m of the sills are typically unsaturated sand, which generally overlay clay.
- Across the lakes, the upper 4–5 m horizon comprised saturated clay.
- In the areas to the north and east of the lakes system along the Boundary and Slades Road, the shallow dipping layers were observed to a depth of 5–6 m with a very gentle dip gradient to the south-west and north-east, typical of the HBSS constraining sediment depths.

### 4.1.2 Wianamatta Group

The Wianamatta Group (WMFM), composed of carbonaceous shales, overlies the HBSS and outcrops to the north of Tahmoor South Mine. The WMFM is composed of the Liverpool Subgroup which includes the Bringelly Shale Formation, Minchinbury Sandstone and Ashfield Shale Formations. Around the mine, the Wianamatta Group are present as hill cappings overlying the HBSS, particularly in the northern region of the Tahmoor Coal leases.

### 4.1.3 Hawkesbury Sandstone

The HBSS is present beneath the WMFM and alluvium, except for where it may have been eroded away along valleys to expose the underlying Narrabeen Group (HydroSimulations, 2018). In the Study Area, Triassic HBSS dominates the outcrop area and it is also the dominant outcropping stratigraphic unit more regionally (**Figure 9**).

The unit is indicated to be greater than 150 m thick in the north of the mine, where recently drilled investigation bores show it to be up to 170 m thick (i.e. WD01; SCT, 2020). Above Tahmoor South, recent drilling shows thickness of 165 m (i.e. TSC01; SCT, 2020). The minor variation in thickness, is evident on south-north cross section, **Figure 10**.

The HBSS sequence has a greater resistance to erosion due to the high silica content compared to the WMFM. As such, soil production on the HBSS is low and sandstone is the common bed material for the watercourses in this region (UOW, 2012), with the WMFM typically appearing as capping material at higher elevations.

### 4.1.4 Narrabeen Group

The Narrabeen Group is present across the Tahmoor Mine site beneath the HBSS. The unit consists of a sequence of interbedded sandstone, claystone, and siltstone. Locally, the main units are the Bald Hill Claystone (BHCS), which is approximately 10 m thick (varying from

approximately 2-30m across the Tahmoor mining lease), and the Bulgo Sandstone (BGSS) which is a thick (140-220 m) sandstone/siltstone sequence.

### 4.1.5 Illawarra Coal Measures

The ICM are present across the Tahmoor Mine site beneath the Narrabeen Group. The formation contains the units of primary economic interest in the Sydney Basin, and consist of interbedded sandstones, shale and coal seams with a total thickness of approximately 200 m to 300 m.

The Bulli (BUCO) and Wongawilli Coal (WWCO) seams are the main deposits of economic significance in this region. The BUCO seam is targeted by Tahmoor Coal as well as the neighbouring Appin Mine. As summarised in **Table 6,** the coal seams belong the Sydney Subgroup of the Permian-aged ICM (UOW, 2012). The BUCO is the youngest coal seam of the ICM and is approximately 2-4 m thick. The BUCO is separated by approximately 8-38 m from the older Wongawilli Seam by the Eckersley Formation. The Wongawilli Seam is approximately 8-10 m thick around Tahmoor Mine.

The coal seams outcrop to the east of Tahmoor Mine, where coal seams are truncated (eroded) along the Illawarra Escarpment, as well as being likely to outcrop approximately 20 km to the west of Tahmoor Mine along the Nattai River valley.

# 5.0 Structural Geology

Regionally the stratigraphy is dissected by several fault, folds and dykes of volcanic origin, varying in age from Jurassic to Tertiary. The location of these regional features, as identified by structural mapping carried out by Tahmoor Coal, are shown regionally on **Figure 9**, and locally to the study area on **Figure 12**. Key regional structural features are discussed in greater detail below. The Central Fault is in closest proximity to the proposed LW S7A.

## 5.1 Nepean Fault

The Nepean Fault is comprised of a series of north-south trending faults. As noted in Tahmoor Coal (2019), “The Nepean Fault encountered at Tahmoor Mine is part of the regional Nepean Fault system. This system is the southern extension of the Lapstone Monocline, and at Tahmoor, it consists of closely spaced sub-vertical en-echelon faults in a zone up to 400 m wide.” Mapping confirms that this fault extends 10 km along the eastern edge of the Tahmoor Mine footprint. It is approximately 3.5 km at its closest point, from the proposed LW S7A.

The Nepean Fault is a significant high angle structural feature that is known to be transmissive. Mine workings that intersect this zone can produce more water than areas that are located away from this zone. Tahmoor Coal (2019) described this as “the only hydraulically charged geological structure encountered during mining to date”.

Increases in inflow have been observed in mine workings as a result of intersection or proximity of the Nepean Fault zone, noting that previous workings at Tahmoor Mine have intersected or approached to within approximately 100 m of the secondary splays (typically oriented northwest-southeast), such as at LW 31 and LW32 in the north of the Tahmoor mining area. However, the main north-south trending faults have not been intersected by previous workings, and the closest approach by longwalls was at LW 32 (approximately 340 m west) and at LW 13 (approximately 480 m west) of such major faults. Available mapping of this structure indicates that it is 1.5 km east of LW S1A at its closest point, and further from the other “A” longwalls (LW S2A-S6A). This structural feature is closer to longwalls of the future “B” longwalls (LW S1B-S6B).

## 5.2 Central Fault

The Central Fault, which trends NW-SE, is adjacent to the proposed LW S7A. The alignment of the Central Fault is essentially congruent with the course of Hornes Creek, suggesting that the creek might exist at this location due to the influence of this structural feature. At its nearest, the Central Fault is approximately 120 m from LW S7A at its closest point.

## 5.3 Other Structural Features

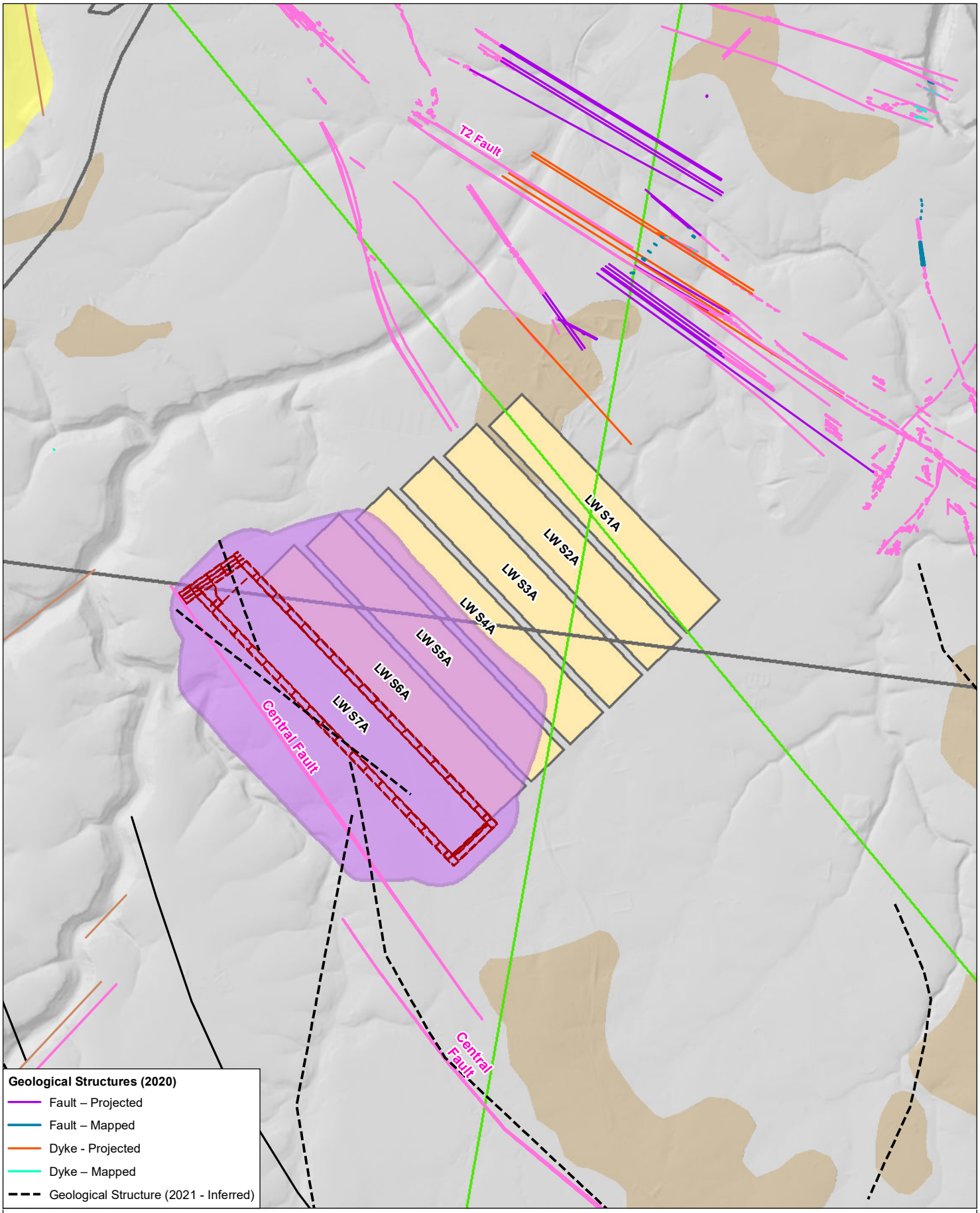
Other structural features of note include:

- The ‘T1’ and ‘T2’ faults which are present at the western edge of the previously extracted Tahmoor longwalls between the mine and the Thirlmere Lakes. These faults lie essentially 2.8 km to the north of proposed LW S7A.
- The Camden Syncline, which plunges from south to north, is located approximately 3.3 km east of the eastern-most Tahmoor South longwall panels, and approximately coincident with the Nepean River at this point.
- Bargo Fault, heading predominantly west, which diverges from the Nepean Fault and crosses the mined area of Tahmoor North. At its nearest, this feature is approximately 4 km from the Study Area.

- The Western Fault located further to the southeast than the Central Fault, approximately 2.6 km from proposed LW S7A.
- Victoria Park Fault, located west of the Tahmoor North longwalls 26-31.
- Other smaller faults mapped within the extent of the historical Tahmoor Mine workings.

Dyke and sill intrusions identified from surface mapping and drilling records, include a large sill at the southern edge of Tahmoor South. Tahmoor South geologists have conducted underground inseam drilling (UIS) within the Bulli Coal seam through the entire block of LW S1A. No significant structural features have been identified. The main feature identified has been a small dyke, detailed as (J. Reid, personal communication, 26th of April 2022):

- Indicative thickness (inseam drilling intersection) – 1m up to <6m.
- Indicative length (inseam drilling intersection) – approx. 900m (System of potential sills and dyke).
- Dyke was soft and fullseam height.
- Minimal water was reported when cutting through it.




**Geological Structures (2020)**
- Fault – Projected
- Fault – Mapped
- Dyke - Projected
- Dyke – Mapped
- Geological Structure (2021 - Inferred)

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| Scale: | 1:30,000 at A4 |
| Project Number: | 620.040109.0001 |
| Date: | 07-May-2024 |
| Drawn by: | RB |

- Faults (locally mapped)
- Southern CF Structure
- Southern CF Fold
- Local Geological model Extent
- Cross Section
- Proposed LW S7A
- Tahmoor Coal Titles
- Alluvium
- Wianamatta Formation
- Hawkesbury Sandstone

**Tahmoor South Mine Plan**
- Approved

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# TAHMOOR SOUTH MODIFICATION 3

## OUTCROPPING GEOLOGY AND STRUCTURAL FEATURES, STUDY AREA

FIGURE 12

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# 6.0 Hydrogeology

This section provides a summary of the hydrogeological characteristics both regionally, and as they pertain to the Study Area, including groundwater characteristics and groundwater use (both environmental and anthropogenic).

## 6.1 Hydrogeological Units and Flow Characteristics (levels, recharge, discharge)

### 6.1.1 Alluvium

There is no occurrence of alluvium within the Study Area. The alluvium associated with the Thirlmere Lakes occurs approximately 3.5 km from Tahmoor Mine.

#### 6.1.1.1 Groundwater Levels and Flow

The limited extent of the alluvium does not constitute it as a significant regional groundwater resource. It has isolated and localised flow regimes.

#### 6.1.1.2 Recharge and Discharge

The primary mechanism for recharge is via direct rainfall infiltration. Discharge occurs via loss through evapotranspiration. Interaction with surface water features allows both recharge and discharge dependent on the hydraulic profile between the surface water and groundwater features, which is variable across the alluvium.

The alluvial aquifer as it pertains to Thirlmere Lakes is discussed further in Section **6.3.2.1**.

### 6.1.2 Wianamatta Group

The WMFM formation predominantly comprises shales having poor permeability and water quality, and therefore is not considered a major groundwater resource in the area and does not occur above or near the Study Area.

The shales can lead to the development of springs in areas near the contact with the HBSS, however, no significant springs have been mapped or located in the vicinity of the Tahmoor South Mine (see Section **6.3.3** for further detail).

### 6.1.3 Hawkesbury Sandstone

The HBSS is the primary aquifer around Tahmoor Mine and the Study Area and falls within the *Sydney Basin Nepean Sandstone Groundwater Source* classified as being ‘Highly Productive’ by the NSW Government based on considerations of bore yield and groundwater quality.

This unit forms a porous rock aquifer of moderate resource potential, tending to higher resource potential in areas where secondary porosity (jointing and fracturing) is more developed, such as in structural zones like the Lapstone Monocline and Nepean Fault zones. Where thin mudstone intervals exist, limited vertical flow may occur, resulting in lateral flow along the mudstone bands and emergences of groundwater where they crop out at surface.

The HBSS appears to differentiate with depth, with nested bores suggesting distinct behaviour between the ‘upper’ HBSS and the ‘lower’ HBSS. As a very thick aquifer, these differences are considered when assessing potential impacts with the differentiation lending to ease of assessment of potential impacts, rather than considering the aquifer as a whole.

Groundwater flows at shallow depths, which can be referred to as the water table aquifer, and deeper, up to approximately 200 metres below ground level (mBGL) is suggested to be dominated by flow through fractures, while at greater depths groundwater flow is controlled mainly by the porosity of the rock matrix (Commonwealth of Australia, 2014)

#### 6.1.3.1 Groundwater Levels and Flow

Shallow groundwater levels in the HBSS constitute the water table aquifer. The depth to groundwater is typically shallower to the north of the Tahmoor Mine operations, and deeper to the south, around Tahmoor South and LW S7A.

Typical depth to groundwater in the study area is approximately 40 to 50 metres below ground level (mbgl).

**Figure 13** presents a depth to groundwater contour map for the Tahmoor South domain based on October 2022 observation data collected from the Tahmoor South Monitoring network. The map correlates with the historical conceptual model, indicating groundwater is close to the surface in the incised valleys of the major watercourses.

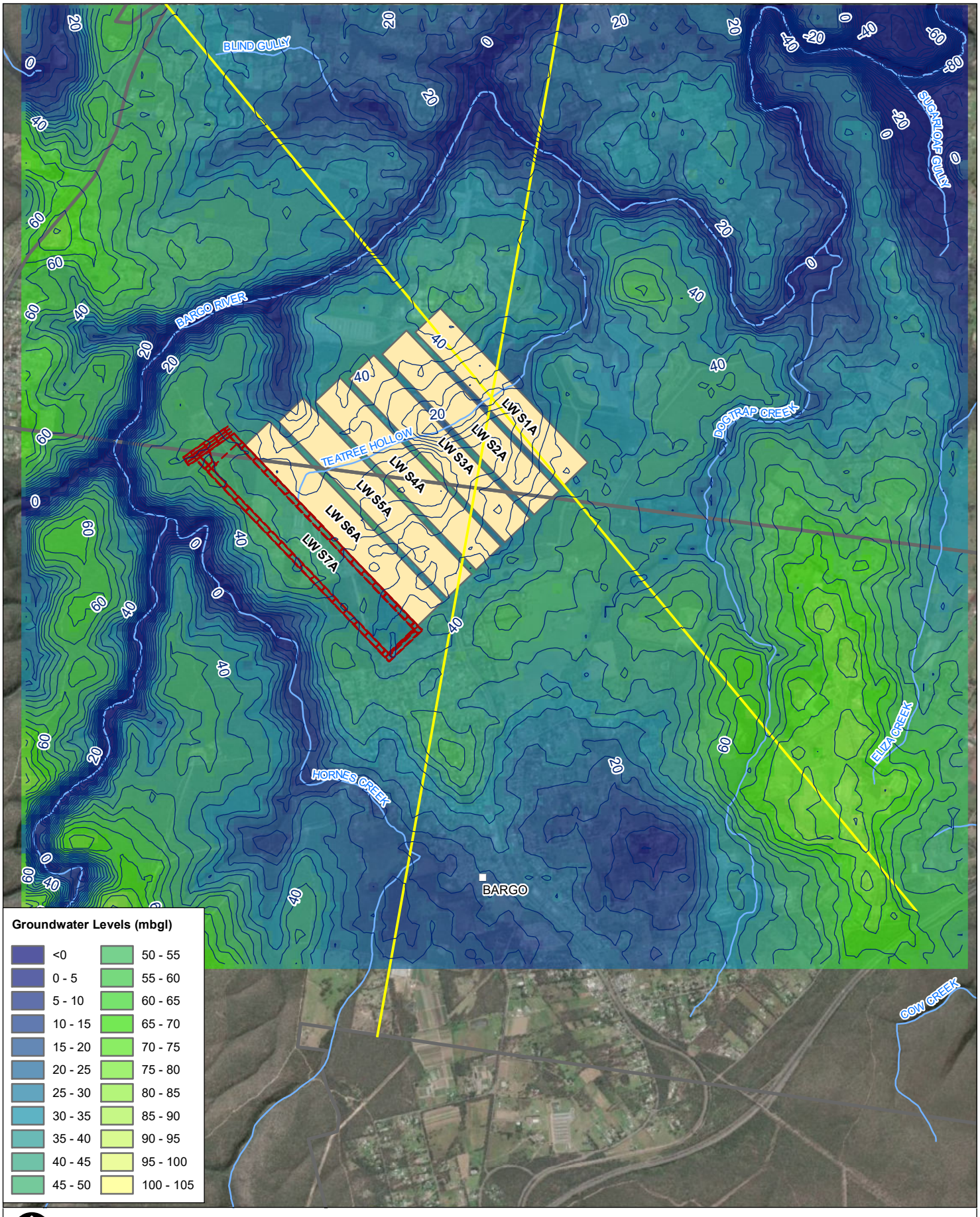
Groundwater flow is typically commensurate with topography and surface drainage, flowing from south-west to north-east.

Groundwater elevation in the upper HBSS at the regional scale is presented in **Figure 14**, whilst that for the lower HBSS is shown in **Figure 15**.

#### 6.1.3.2 Groundwater Recharge and Discharge

The dominant mechanism for recharge to the groundwater system is through diffuse infiltration of rainfall through the soil profile and subsequent deep drainage to underlying groundwater systems.

Discharge occurs via baseflow and evapotranspiration from the shallow water table. Further, springs emanating from the Illawarra Escarpment to the east of the study area are a notable discharge mechanism for the HBSS.




0 0.5 1 km

Minor Town
Watercourses
Groundwater Contour
Proposed LW S7A
Tahmoor Coal Titles
**Tahmoor South Mine Plan**
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| Scale: | 1:40,000 at A4 |
| Project Number: | 620.040109.0001 |
| Date: | 03-May-2024 |
| Drawn by: | RB |

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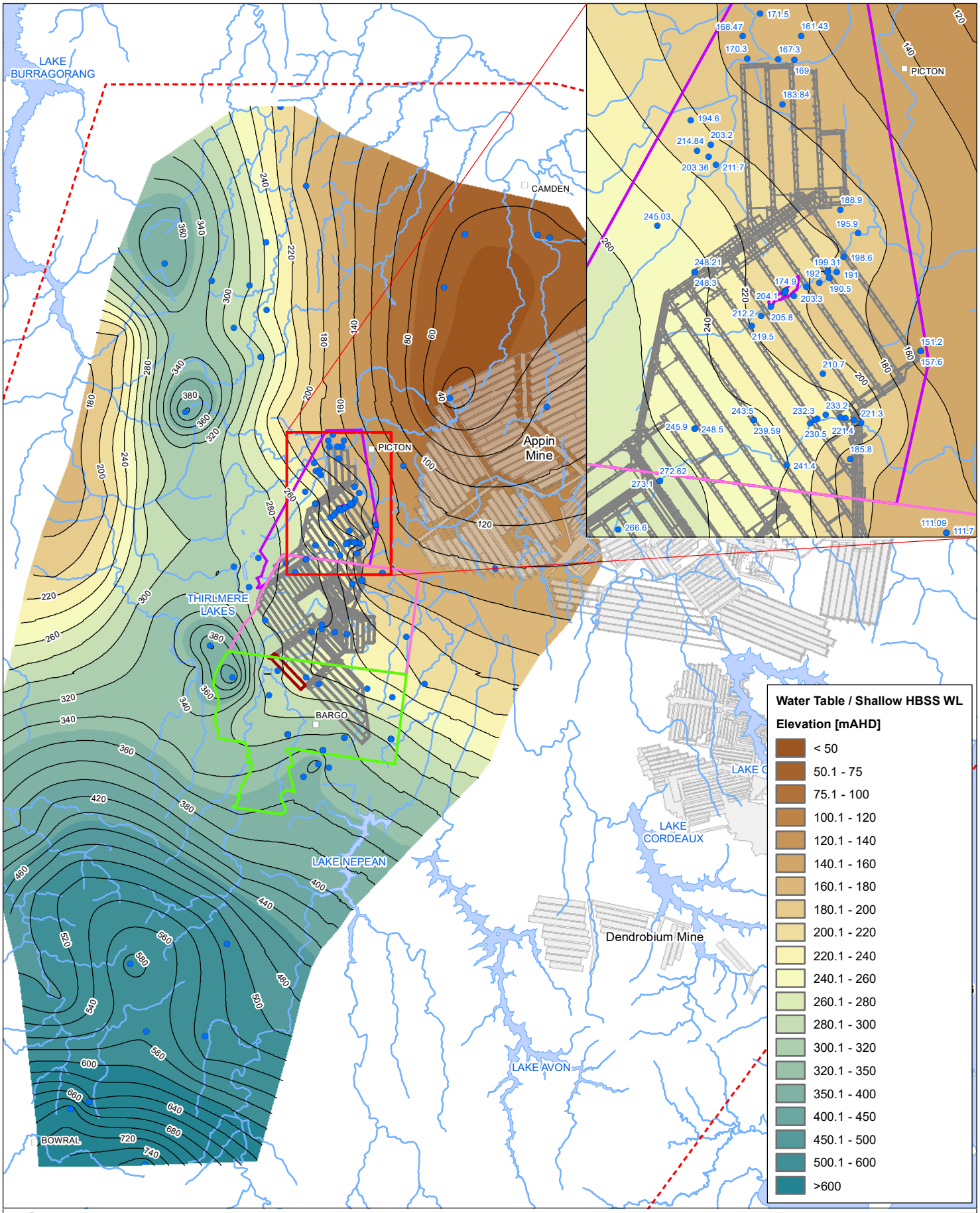
**TAHMOOR SOUTH MODIFICATION 3**

**DEPTH TO GROUNDWATER**

**FIGURE 13**

\\au.slr.local\Corporate\Projects-SLR\640-MEL\640-MEL\620.040109.00001 Tahmoor South Modification 3 G\06 SLR Data\01 CADG\SIG\Impact Assessment\620040109 TAHMOOR IAR F13 Depth to Groundwater.mxd




0 2.5 5 km

| | |
|---|---|
| Coordinate System: | GDA 1994 MGA Zone 56 |
| Scale: | 1:250,000 at A4 |
| Project Number: | 620.040109.0001 |
| Date: | 03-May-2024 |
| Drawn by: | RB |

Bores (RWL)
City
Town
Water Table (regional)
Watercourses
Proposed LW S7A
Mine Plan
Lakes
Southern Coalfield (approximate)

**Tahmoor Coal Titles**

MLs 1308, 1376, 1539
CCL 716
CCL 747

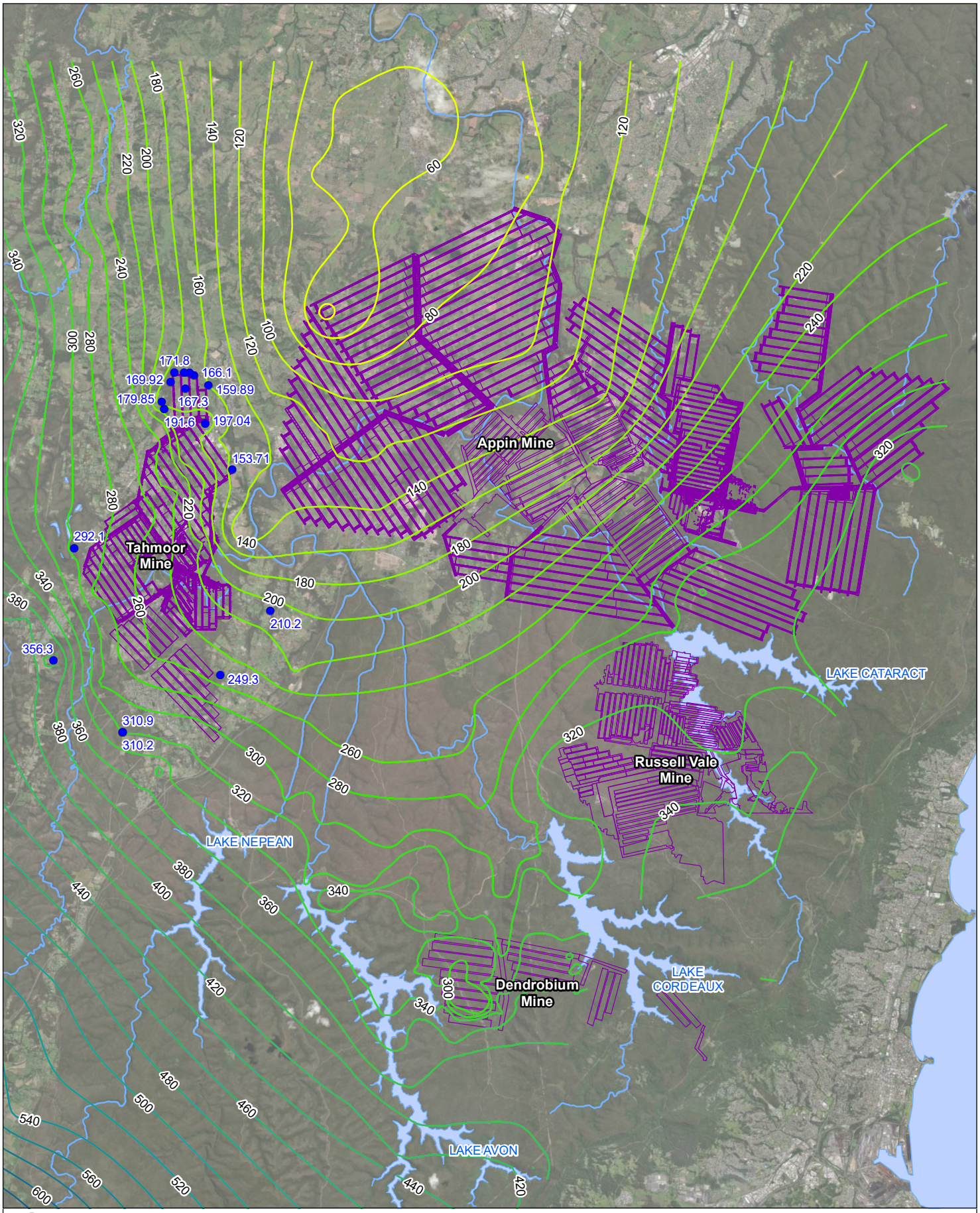
**TAHMOOR SOUTH MODIFICATION 3**

**REGIONAL WATER TABLE ELEVATION**

SLR

**FIGURE 14**

\\au.slr.local\Corporate\Projects-SLR\640-MEL\640-MEL\620.040109.00001 Tahmoor South Modification 3 G\06 SLR Data\01 CADGIS\GIS\Impact Assessment\620040109 TAHMOOR IAR F14 Regional Water Table Elevation.mxd




Bore (RWL)
Groundwater Level (mAHD)
Existing Mine
Watercourses
Watercourse Area

| | |
|---|---|
| Coordinate System: | GDA 1994 MGA Zone 56 |
| Scale: | 1:200,000 at A4 |
| Project Number: | 620.040109.0001 |
| Date: | 07-Sep-2023 |
| Drawn by: | AS |

**TAHMOOR SOUTH MODIFICATION 3**

**INTERPRETED GROUNDWATER LEVEL ELEVATION IN THE LOWER HAWKESBURY SANDSTONE**

SLR

**FIGURE 15**

H:\Projects-SLR\640-MEL\620.040109.00001 Tahmoor South Modification 3 G\06 SLR Data\01 CADG\SIG\S\620040109 F16_Groundwater_Elevation_Hawkesbury_Sandstone.mxd

### 6.1.4 Narrabeen Group

The main hydrostratigraphic units of the Narrabeen Group are the BGSS, a thick (140-220 m) sandstone/siltstone sequence, and the Scarborough Sandstone (typically 30 – 100 m thick) sandstone/siltstone sequence, which both have minor aquifer potential. The BHCS, Stanwell Park Claystone and Wombarra Claystone are considered aquitards. These units are shown, in stratigraphic order, in **Figure 10** and **Figure 11**,

Recent investigations into the structural integrity of the BHCS were conducted as part of the current Thirlmere Lakes enquiry found that the BHCS is a poor aquitard that is likely to become leaky, or cease acting as an aquitard when fractured (either naturally or anthropogenically) (UNSW, 2021; DPE, 2022). Recent drilling investigations completed as part of these studies (GW049046 and GW099003 nearer Dendrobium Mine and to the east of Tahmoor South), show the BHCS to have a thickness of around 6 m.

### 6.1.5 Illawarra Coal Measures

The Illawarra Coal Measures are not targeted for groundwater use due to depth to the hydrostratigraphic unit and the poor quality.

## 6.2 Groundwater Quality

Knowledge of the groundwater quality across the hydrostratigraphic units is variable, and dependent of the number of bores screening the unit. Majority of bores regionally, and all locally, screen the HBSS. **Figure 16** provides a snapshot of the number of bores with groundwater salinity information available, and what bracket this salinity data falls within, for each geological unit.

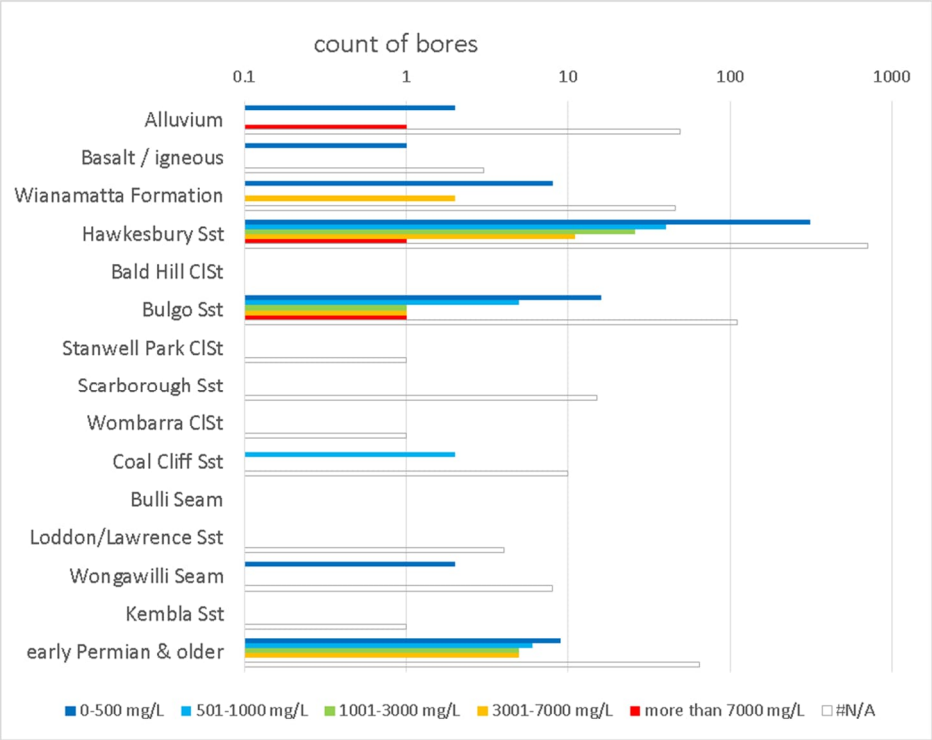



**Figure 16 Summary of groundwater salinity data**

### 6.2.1 Alluvium and Wianammatta Formation

Groundwater in the Alluvium and Wianamatta Formation are of mixed quality. It is likely that evaporative concentration of salts could occur in alluvial aquifers, especially in clayey facies. The marine origin and low permeability of the Wianamatta Shales tends to lead to higher salinities in this unit.

### 6.2.2 Hawkesbury Sandstone

Groundwater quality in the HBSS variable, although overall groundwater salinity is suitable for stock and domestic purposes and most irrigation.

#### 6.2.2.1 Regional HBSS Quality

Water quality statistics for historical data for bores across Tahmoor Mine are shown **Table 7**. The monitored bores are divided into regions to demonstrate local typical salinity across the broader Tahmoor mining area. Division into these regions was selected to represent the varying salinity profile across different mine areas:

- Already impacted areas (Redbank/Myrtle)
- Not impacted/or in proximity of the current mining (Western Domain)
- Historic mine areas (Tahmoor North, excluding Redbank/Myrtle bores)

Western Domain bores typically show no impact to salinity from recent mining and provide a reasonable representation of baseline (pre-mining) groundwater quality, and exhibit an 80$^{th}$ percentile salinity of 1,054 µS/cm. Tahmoor North is representative of historical mining, and the Creek regions have known impact via mining due to fracturing and upwelling of deeper groundwater. The background salinity in these areas is higher, with the 80$^{th}$ percentile ranging between 4,600 – 5, 750 µS/cm.

Of interest, all background concentrations of Zinc (Zn) are significantly higher than the ANZECC 2000 Freshwater Trigger, of 0.008 mg/L.

The table present the 80$^{th}$ percentile value at each site (or 20$^{th}$ and 80$^{th}$ for pH).

**Table 7 Water quality statistics**

| Parameter | Unit | Hawkesbury Sandstone Groundwater Area (background groundwater) | | | |
|---|---|---|---|---|---|
| | | Myrtle Creek | Redbank Creek | Tahmoor North | Western Domain |
| pH | - | 5.75 - 6.85 | 6.06 - 10.47 | 5.32 - 6.55 | 6.30 - 8.19 |
| EC | µS/cm | 5,750 | 4,600 | 5,164 | 1,054 |
| TDS | mg/L | - | 2,250 | 2,798 | 590 |
| Al (diss) | mg/L | - | 0.05 | 0.072 | 0.04 |
| Cu (diss) | mg/L | - | 0.001 | 0.004 | 0.001 |
| Ni (diss) | mg/L | - | 0.01 | 0.136 | 0.005 |
| As (diss) | mg/L | - | 0.01 | 0.01 | 0.005 |
| Ba (diss) | mg/L | - | 0.962 | 0.528 | 0.17 |
| Sr (diss) | mg/L | - | 6 | 1 | 0.18 |
| Fe (diss) | mg/L | - | 81 | 75.8 | 21 |
| Mn (diss) | mg/L | - | 2.2 | 5.28 | 1.1 |

| Parameter | Unit | Hawkesbury Sandstone Groundwater Area (background groundwater) | | | |
|---|---|---|---|---|---|
| | | Myrtle Creek | Redbank Creek | Tahmoor North | Western Domain |
| Zn (diss) | mg/L | - | 0.044 | 0.646 | 0.25 |
| Fe (tot) | mg/L | - | 155 | 155 | 37 |
| Cl | mg/L | - | 1120 | 1800 | 325 |
| F | mg/L | - | 0.242 | 0.552 | 0.874 |
| SO4 | mg/L | - | 44 | 86 | 23 |
| HCO3 | mg/L | - | 210 | 110 | 150 |
| Total N | Mg/L | | 4.3 | 0.92 | 2.9 |

#### 6.2.2.2 Local HBSS Quality

**Table 8** describes the salinity and pH of the Tahmoor South monitoring bores as of June 2023, showing a range from 163 µS/cm to 3,582 µS/cm, with a median salinity of approximately 1,100 µS/cm. pH ranges from 4.01 to 11.46, with a median pH value of 5.88, with all except four bores indicating acidic conditions.

**Table 8 Tahmoor South salinity and pH summary (June 2023)**

| Bore ID | EC (µS/cm) | pH |
|---|---|---|
| P51A | 162.9 | 5.18 |
| P51B | 1378 | 10.66 |
| P52 | 1257 | 5.88 |
| P53A | 1018 | 6.36 |
| P53B | 988 | 7.47 |
| P53C | 1144 | 6.66 |
| P54A | N/A (dry) | N/A (dry) |
| P54B | N/A (dry) | N/A (dry) |
| P55A | 1772 | 5.57 |
| P55B | 1402 | 5.68 |
| P55C | 1273 | 6.16 |
| P56A | 953 | 5.41 |
| P56B | 1135 | 11.46 |
| P56C | 929 | 8.15 |
| REA4 | 282 | 6.88 |
| GW104659 | 573.2 | 5.79 |
| GW109257 | 793 | 4.21 |
| GW112473 | 551.7 | 4.36 |
| GW105395 | 3582 | 5.84 |
| GW104323 | 1279 | 4.01 |
| GW104008 | 1584 | 5.88 |

### 6.2.3 Narrabeen Group

The minimal groundwater quality data available for the Narrabeen Group indicates regional variability. The limited data availability does not allow analysis of potential trends across the site.

### 6.2.4 Illawarra Coal Measures

The Illawarra Coal Measures is recognised as a hosting water of poor quality. Publicly available data from AGL's Camden Gas Project indicated an average Total Dissolved Solids (TDS) of around 11,000 mg/L and a range of 3,200-27,500 mg/L (Parsons Brinckerhoff, 2013).

## 6.3 Groundwater Use (Environmental)

### 6.3.1 Surface Water-Groundwater Interaction

Surface water-groundwater interactions within proximity to the Study Area is presented in this section, including:

- Teatree Hollow (within the study area), and
- Bargo River and Dogtrap Creek (adjacent to the Study Area).

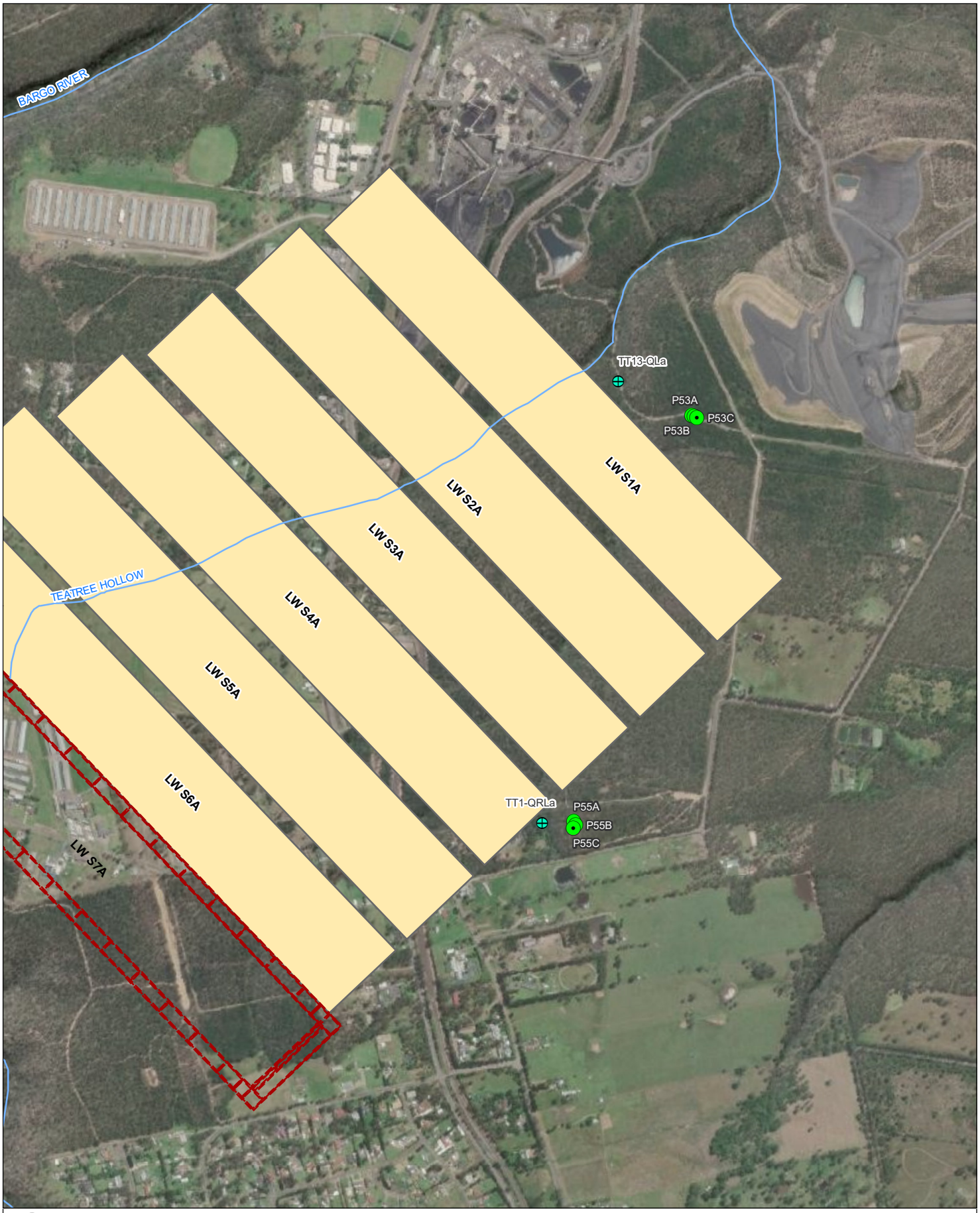
#### 6.3.1.1 Teatree Hollow

The tributary of Teatree Hollow that overlies the study area is considered a lower order stream than Teatree Hollow, being a first or second order stream upstream of LW S2A.

As part of the Tahmoor South monitoring regime, nested groundwater and surface water monitoring sites were installed to assess for potential groundwater – surface water interactions and any potential changes to baseline conditions due to extraction activities.

These sites are monitoring bores P55A-C, which are associated with surface water monitoring site TT1-QRLa, and P53A-C which are associated with surface water monitoring site TT13-QRLa. The locations of these sites are presented on **Figure 17**.

Utilising observation data and lidar data, cross sections were developed to review the potential for groundwater – surface water connectivity. These are presented in **Figure 18** and **Figure 19**. Conceptually, the groundwater level at both sites is notably lower than the base of the Creek, indicating the potential for baseflow contribution to this section of tributary is limited. The system either acts as a losing stream, or a potentially disconnected system.




0 250 500 m

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| Coordinate System: | GDA 1994 MGA Zone 56 |
| Scale: | 1:15,000 at A4 |
| Project Number: | 620.040109.0001 |
| Date: | 15-May-2024 |
| Drawn by: | AS |

Surface Water Monitoring Site

**Groundwater Monitoring Network**

OSP

Watercourses

Proposed LW S7A

**Tahmoor South Mine Plan**

Approved

**TAHMOOR SOUTH MODIFICATION 3**

**GROUNDWATER AND SURFACE WATER MONITORING SITES (TEATREE HOLLOW & TRIBUTARY**

**FIGURE 17**

H:\Projects-SLR\640-MEL\620.040109.00001 Tahmoor South Modification 3 G\06 SLR Data\01 CADG\SIG\S\Impact Assessment\620040109 TAHMOOR IAR F17 Groundwater and Surface Water Monitoring Sites.mxd

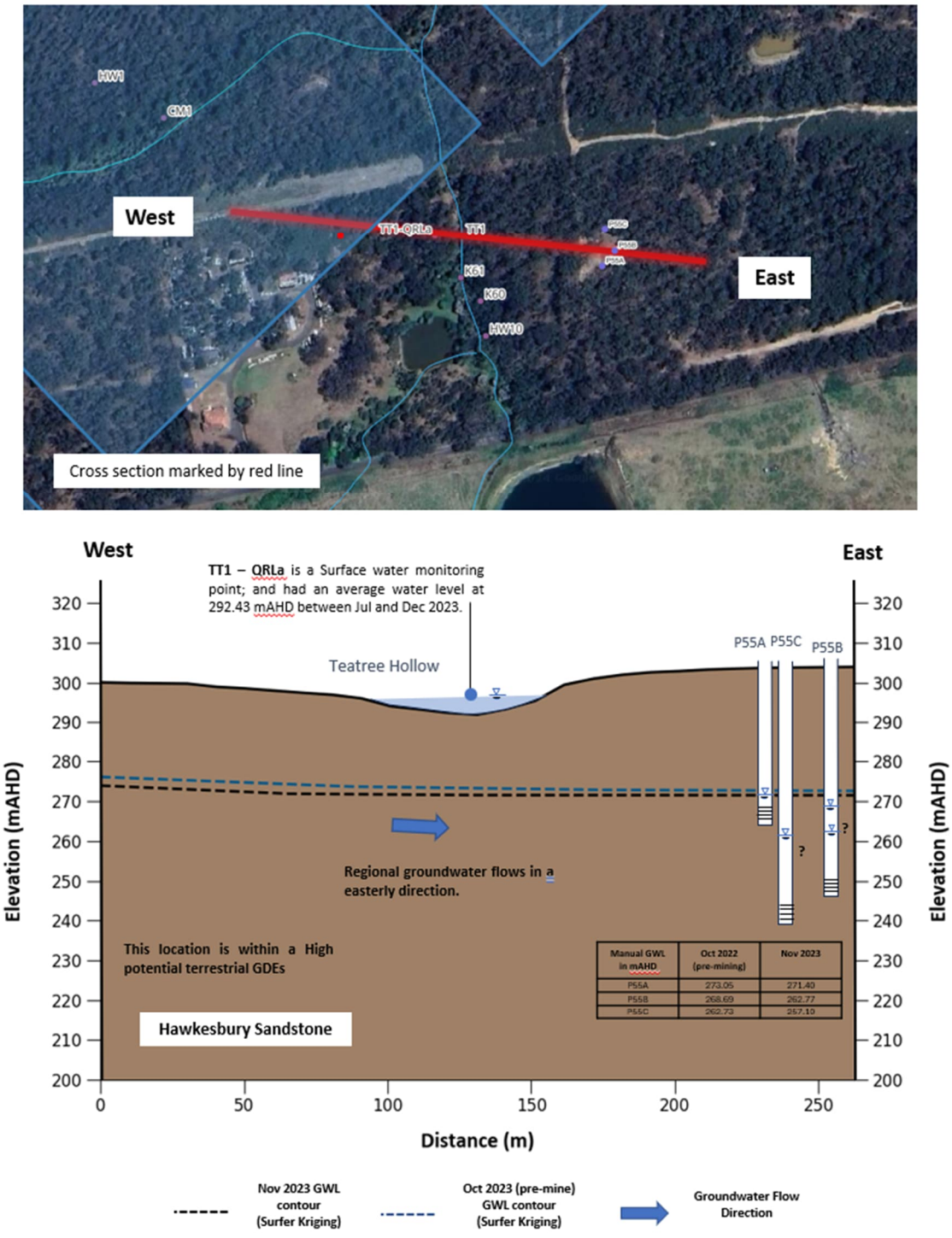



**Figure 18 Cross-sectional conceptual model for TT1-QRLa and P55.**

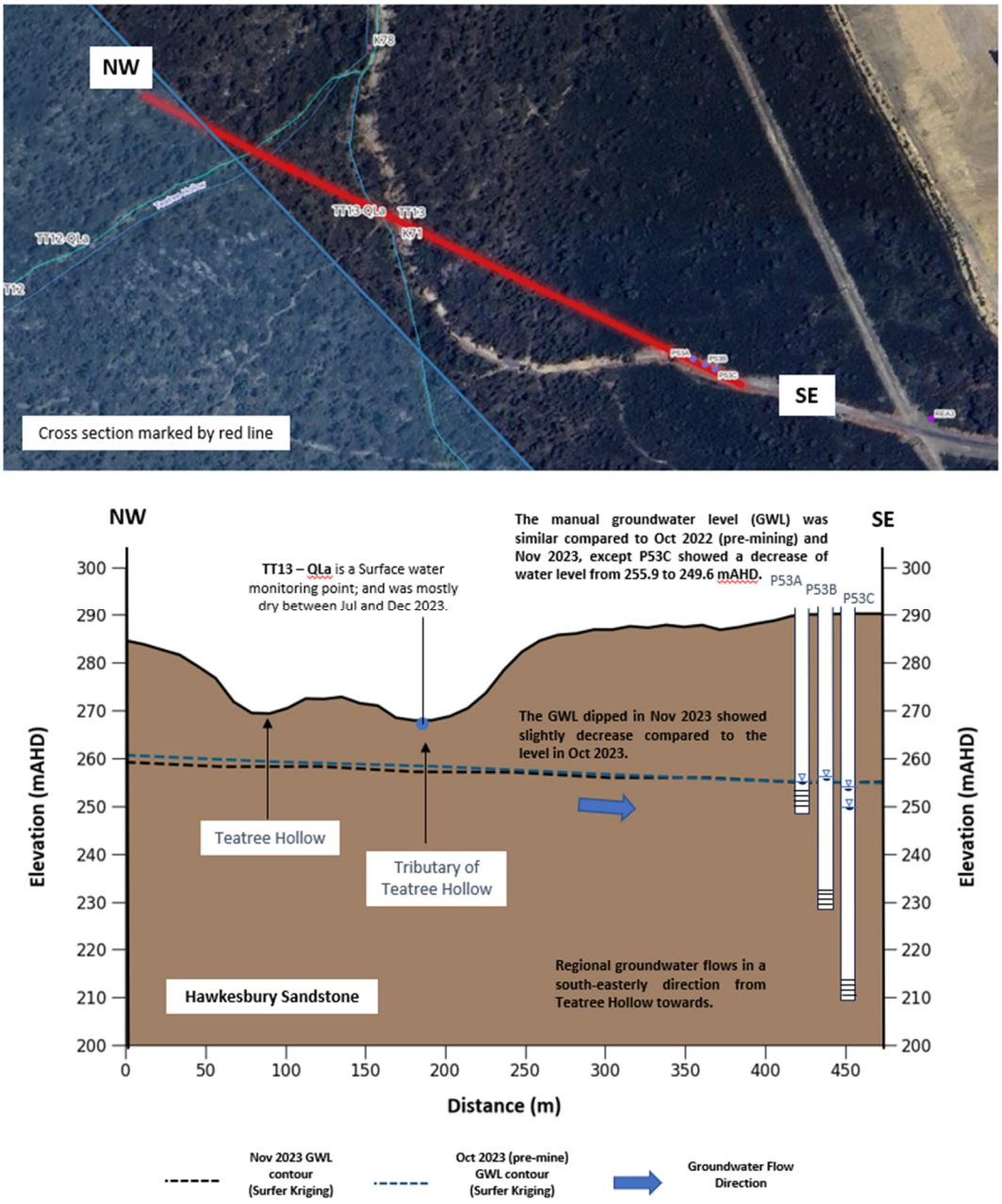



**Figure 19 Cross-sectional conceptual model for TT1-QRLa and P53.**

#### 6.3.1.2 Groundwater-Surface Water Interactions Adjacent to Tahmoor South

As discussed in the Tahmoor South EIS (HydroSimulations, 2020) flow differentials can be used to infer losing or gaining conditions.

**Figure 20** displays daily flows and calculated differentials at Tahmoor South surface water locations Bargo River and Dogtrap Creek. Due to the relatively small distances between gauges the differences are assumed to only represent any losses to and gains from groundwater between these combinations of gauges. This assumes that evaporation and surface water use and inflows from other sources (such as other ungauged tributaries) are negligible. **Figure 20** shows that while both Bargo River and Dogtrap Creek generally experience gaining conditions, they both lose water to the underlying HBSS aquifer for significant periods of time. This is supported by the fact flow losses are expected to be underestimated due to a lack of accounting for inflows from several small ungauged tributaries between gauging stations, particularly along the Bargo River between Site 1 (SW-01) and Site 13 (SW-13). There are few licensed groundwater abstractions along or near to this reach of the river and hence unaccounted groundwater usage impacts on stream flows are not expected to compromise this water balance analysis. The loses could be natural, however are likely due to historical mining at Tahmoor.

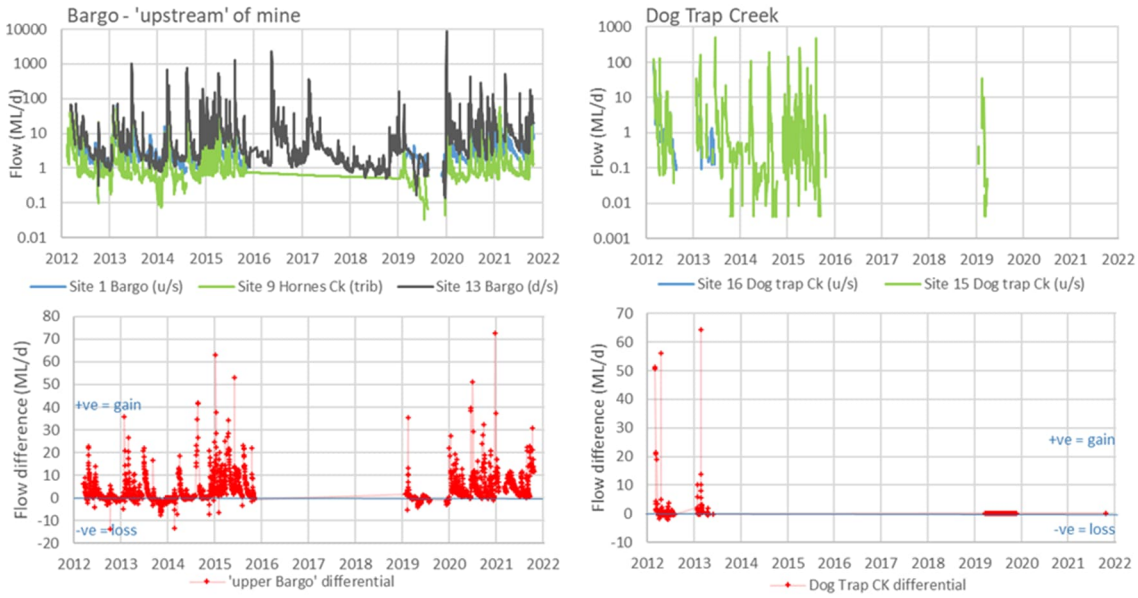



**Figure 20 Flow differentials along Bargo River and Dogtrap Creek**

### 6.3.2 Groundwater Dependent Ecosystems

The Thirlmere Lakes are the closest 'High Priority' Groundwater Dependent Ecosystem to Tahmoor Mine, located 3.5 km from the Study Area.

#### 6.3.2.1 Thirlmere Lakes

The Thirlmere Lakes is a group of 5 waterways in the Greater Blue Mountains World Heritage Area:

- Lake Gandangarra,
- Lake Werri Berri,

- Lake Couridjah,
- Lake Baraba, and
- Lake Nerrigorang.

The Thirlmere Lakes Inquiry was commissioned by the NSW Government in 2011, and known as the Thirlmere Lakes Research Program (TLRP). It aimed to provide a detailed understanding of the hydrological dynamics, water sources and water flow pathways. The summation report, "Thirlmere Lakes – A Synthesis of Current Research" was released in late March 2022. The five major research focus areas of the TLRP were:

- geological mapping and geophysical surveys of the Thirlmere Lakes area (UNSW Lead Researcher Dr Martin Andersen),
- environmental isotope investigations into periodic and recent water losses from Thirlmere Lakes (ANSTO Lead Researcher Dr Dioni Cendón),
- geomorphology, sub-surface characteristics and long-term perspectives on filling and drying of Thirlmere Lakes (UoW Lead Researcher Dr Tim Cohen),
- surface water–groundwater interactions (UNSW Lead Researcher Dr Martin Andersen), and
- developing an understanding of the flow of water into and out of the lakes (UNSW Lead Researcher Associate Professor Will Glamore).

The following provides a series of basic findings pertaining to the conceptualisation of the Lakes.

- Ongoing monitoring of local groundwater bores showed:
    - Monitoring of these bores illustrates the sensitivity of shallow (~15 metres below ground level) groundwater levels to significant rainfall events.
    - There was also a clear separation between the shallow bores (~15 metres depth) and the deeper bores (~100 metres depth) in terms of water level.
- Due to differing responses between each lake and their differing absolute surface water elevation it can be inferred that each lake is individually nested within its own shallow low-permeable sediments,
- Groundwater input (i.e. discharge to the lakes and/or contributions to underlying sediments) is undoubtedly a critical factor for the lakes system. Even during this exceptionally dry period with lowered water tables, there is direct evidence of nearby discharge into Blue Gum Creek and inferred discharge into or flow below Lake Baraba. Every lake showed evidence of multiple loss mechanisms including recharge to groundwater, and
- Mine waters exhibit starkly different chemistry (Na-HCO3 type) from the lakes (Na-Cl and/or humic), exhibiting evolved groundwater beyond that typically found in the deep wells around the lakes that are in shallower strata. Mine samples also show no evidence of evaporated stable water isotopes found in lake signatures. There is no chemical or isotopic evidence linking groundwater in the mine directly to surface water in the lakes at present.

Review of all five released reports support the historically adopted conceptualisation that the lakes had variable but low connectivity to local groundwater, and minimal connectivity to regional groundwater. With falling lake water levels, it was observed that the downward flow is likely to be decreasing as the surface water gets confined to areas over low-permeable material in the lake beds such as peat and clay.

### 6.3.3 Springs

Literature indicates that it is likely that the Hawkesbury Sandstone may contain springs that have developed in saturated and perched aquifers within the unit (HydroSimulations, 2018). Further, the shales of the Wianamatta Group can lead to the development of springs in areas near the contact with the HBSS.

No significant springs or soaks have been mapped or located in the vicinity of the Project. Field investigations carried out by Brienen Environment & Safety (2022) supported this finding. A further hydrogeological desktop study reviewing recent water levels, topography and state GDE mapping supported the conclusion that the presence of springs is unlikely (SLR, 2023). This report identified two potential locations for field review, which was undertaken in January 2024, by Niche Environment and Heritage, who found no evidence of springs.

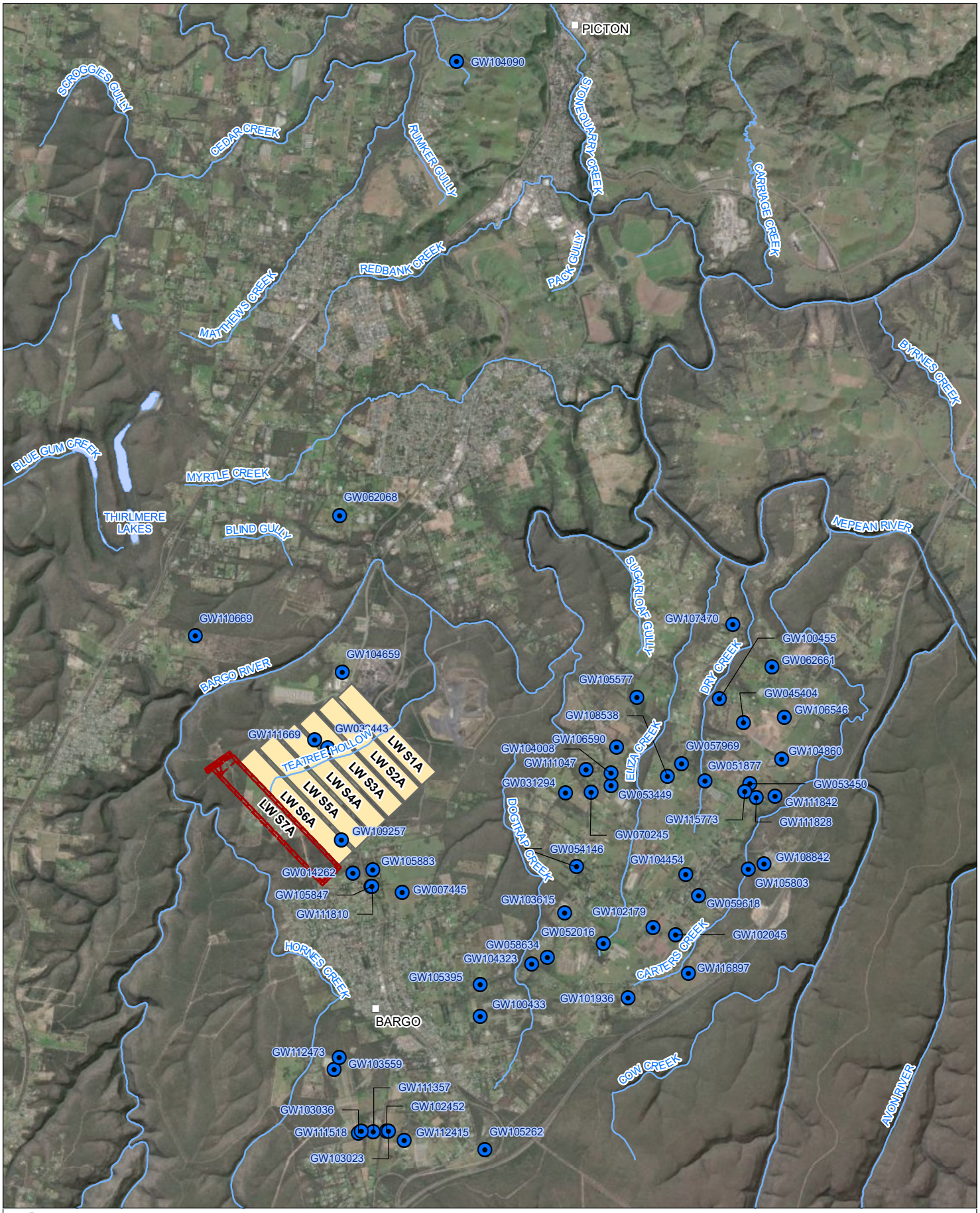
## 6.4 Groundwater Use (Anthropogenic)

The Hawkesbury Sandstone is a productive aquifer utilised by landholders for subsidiary water supply. A review of the NSW government's online database to identify registered groundwater bores locally to the study area identified approximately 50 bores. These bores are presented in **Table 9**, and their location shown on **Figure 21**.

**Table 9 Summary of private bores located within 10 km of LW S7A**

| Bore ID | Easting | Northing | Bore Depth (m) | Distance from LW S7A Panel (km) |
|---|---|---|---|---|
| GW007445 | 277454 | 6204323 | 134.1 | 0.9 |
| GW014262 | 276764 | 6204587 | 48.8 | 0.2 |
| GW031294 | 279732 | 6205706 | 90.2 | 3.3 |
| GW032443 | 276415 | 6206336 | 130.1 | 1.0 |
| GW045404 | 282217 | 6206689 | 53.3 | 6.0 |
| GW051877 | 281673 | 6205875 | 92 | 5.2 |
| GW052016 | 280259 | 6203604 | 110 | 3.8 |
| GW053449 | 280369 | 6205813 | 105 | 3.9 |
| GW053450 | 282303 | 6205837 | 120 | 5.8 |
| GW054146 | 279886 | 6204676 | 104 | 3.3 |
| GW057969 | 281350 | 6206116 | 108 | 5.0 |
| GW058634 | 279479 | 6203419 | 122 | 3.1 |
| GW059618 | 281587 | 6204277 | 117 | 5.0 |
| GW062068 | 276581 | 6209579 | 150 | 3.6 |
| GW062661 | 282609 | 6207469 | 126.5 | 6.6 |
| GW070245 | 280090 | 6205714 | 97.5 | 3.6 |
| GW100433 | 278540 | 6202588 | 126 | 2.8 |
| GW100455 | 281877 | 6207020 | 96 | 5.8 |
| GW101936 | 280604 | 6202851 | 126 | 4.4 |
| GW102045 | 281266 | 6203733 | 120 | 4.8 |
| GW102179 | 280953 | 6203826 | 153 | 4.4 |

| Bore ID | Easting | Northing | Bore Depth (m) | Distance from LW S7A Panel (km) |
|---|---|---|---|---|
| GW102452 | 277234 | 6200992 | 120.5 | 3.5 |
| GW103023 | 277261 | 6200993 | 165 | 3.5 |
| GW103036 | 276840 | 6200964 | 132.5 | 3.5 |
| GW103559 | 276504 | 6201854 | 190 | 2.6 |
| GW103615 | 279720 | 6204034 | 103 | 3.2 |
| GW104008 | 280368 | 6205982 | 140 | 4.0 |
| GW104090 | 278208 | 6215913 | 150.5 | 10.1 |
| GW104323 | 279259 | 6203318 | 109 | 3.0 |
| GW104454 | 281410 | 6204568 | 66 | 4.8 |
| GW104659 | 276617 | 6207391 | 132 | 1.9 |
| GW104860 | 282745 | 6206178 | 204.3 | 6.3 |
| GW105262 | 278609 | 6200731 | 104 | 4.3 |
| GW105395 | 278543 | 6203037 | 90 | 2.5 |
| GW105577 | 280728 | 6207041 | 162 | 4.8 |
| GW105803 | 282278 | 6204644 | 140 | 5.7 |
| GW105847 | 277020 | 6204404 | NA | 0.5 |
| GW105883 | 277040 | 6204629 | NA | 0.4 |
| GW106546 | 282785 | 6206765 | 116 | 6.5 |
| GW106590 | 280442 | 6206344 | 150 | 4.2 |
| GW107470 | 282069 | 6208057 | 132 | 6.4 |
| GW108538 | 281155 | 6205941 | 66 | 4.7 |
| GW108842 | 282500 | 6204716 | 174 | 5.9 |
| GW109257 | 276603 | 6205052 | 120 | 0.3 |
| GW110669 | 274565 | 6207896 | 132 | 1.7 |
| GW111047 | 280015 | 6206037 | 120 | 3.7 |
| GW111357 | 277051 | 6200982 | 144 | 3.5 |
| GW111518 | 276882 | 6200987 | 150 | 3.5 |
| GW111669 | 276232 | 6206450 | 120 | 1.0 |
| GW111810 | 277034 | 6204407 | 142 | 0.5 |
| GW111828 | 282391 | 6205638 | 205 | 5.9 |
| GW111842 | 282654 | 6205664 | 240 | 6.1 |
| GW112415 | 277479 | 6200865 | 139 | 3.7 |
| GW112473 | 276577 | 6202010 | 138 | 2.4 |
| GW115773 | 282232 | 6205725 | 81.87 | 5.7 |
| GW116897 | 281442 | 6203190 | 160 | 5.1 |

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| Coordinate System: | GDA 1994 MGA Zone 56 |
| Scale: | 1:70,000 at A4 |
| Project Number: | 620.040109.0001 |
| Date: | 03-May-2024 |
| Drawn by: | RB |

Minor Town
Private Bores
Watercourses
Proposed LW S7A
Lakes

**Tahmoor South Mine Plan**

Approved

**TAHMOOR SOUTH MODIFICATION 3**

**PRIVATE BORES**

SLR

**FIGURE 21**

\\au.slr.local\Corporate\Projects-SLR\640-MEL\640-MEL\620.040109.00001 Tahmoor South Modification 3 G\06 SLR Data\01 CADG\SIG\SImpact Assessment\620040109 TAHMOOR IAR F21 Private Bores.mxd

## 6.5 Hydraulic Parameters

### 6.5.1 Hydraulic Conductivity

Geological formations are not homogenous in nature, and in this sedimentary environment are generally made up of layers of alternating sediments. This means that analysis of available permeability of hydraulic conductivity testing must take account of the influence of the different units and lithologies on horizontal and vertical flow.

Available data for hydraulic conductivities for the main lithological units relevant to Tahmoor are presented on **Figure 22** and **Figure 23**, and summarised and tabulated in **Table 10**. Data has been sourced from packer testing with some available from core testing, conducted at Tahmoor, Appin and Dendrobium Mines. Packer testing primarily tests horizontal hydraulic conductivity (Kh) but can also be useful in characterising the likely vertical hydraulic conductivity (Kv) in sedimentary units.

**Figure 22** shows that there is generally not a large contrast between mean Kh for units termed as claystone and sandstone. The large range of observed Kh values are likely due to testing of more clay/sand rich layers. **Figure 23** shows that these units termed claystone generally have lower Kv, however these units are on average less than 10 m thick and more difficult to characterise.

Data shows that there is an overall decreasing trend of hydraulic conductivity with depth. The trend shows that Kh decreases with depth both overall (pre- and post-mining) and for each formation. Decreasing hydraulic conductivity with depth is expected due to overburden pressure reducing secondary porosity (essentially fracture or defect aperture) via compression.

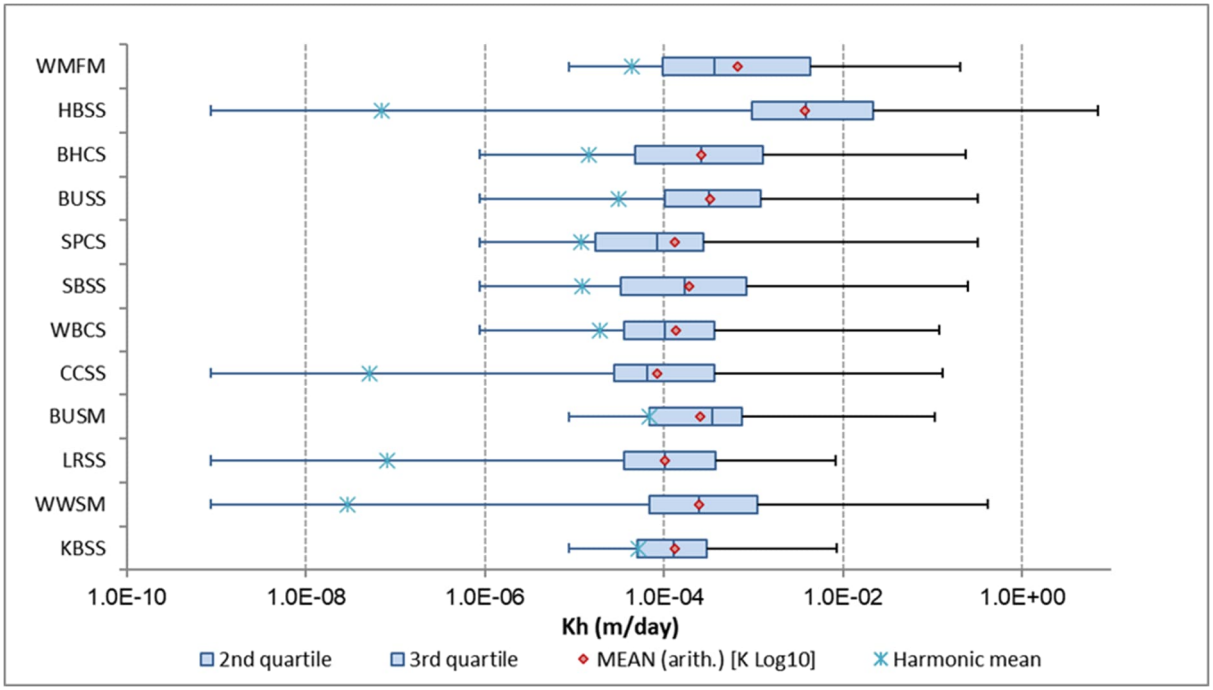



**Figure 22 Box and whisker plot of horizontal conductivity for each formation**

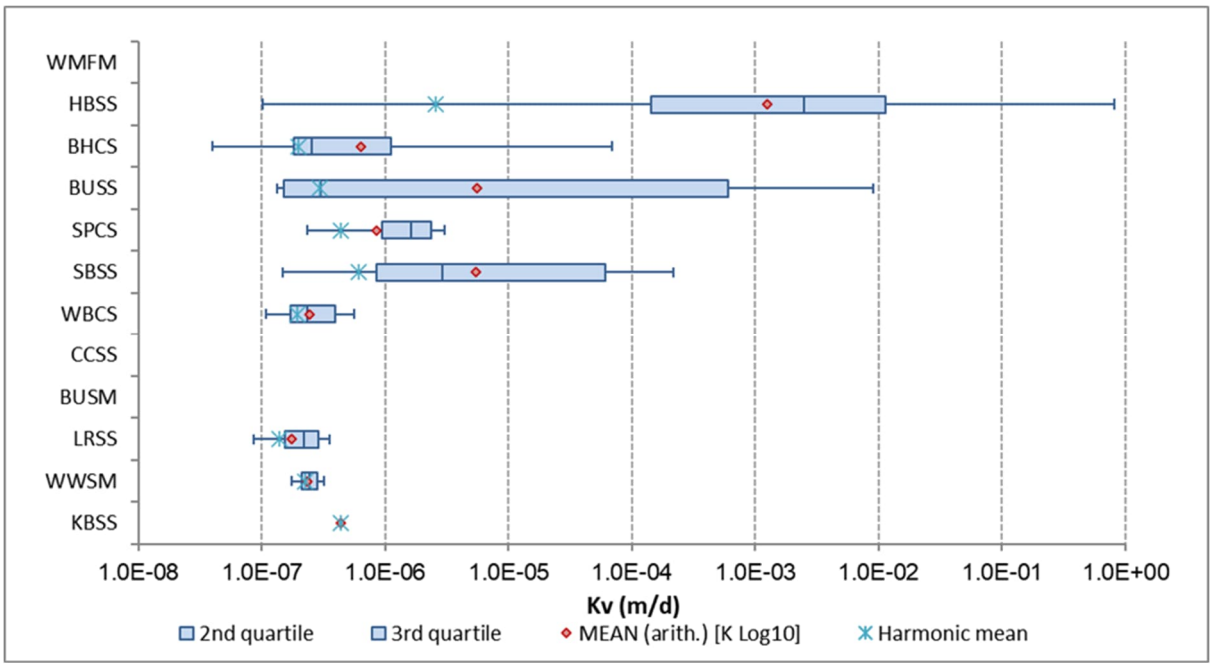



**Figure 23 Box and whisker plot of vertical hydraulic conductivity for each formation**

**Table 10 Hydraulic conductivity data summary**

| Unit | Horizontal, Kh (m/d) | | | | Vertical, Kv (m/d) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Packer, Arithmetic mean | Packer, 5th Perc. | Packer, Max | Packer, Population | Packer, Harmonic mean | Core testing, Arithmetic | Core, Min | Core, Max | Core, Population |
| WMFM | 6.70E-04 | 8.64E-06 | 2.03E-01 | 18 | 4.44E-05 | na | na | na | 0 |
| HBSS | 3.73E-03 | 7.99E-05 | 7.07E+00 | 820 | 7.08E-08 | 1.25E-03 | 1.01E-07 | 0.817849 | 40 |
| BHCS | 2.64E-04 | 5.12E-06 | 2.33E-01 | 164 | 1.44E-05 | 6.34E-07 | 3.94E-08 | 6.85E-05 | 20 |
| BUSS | 3.30E-04 | 8.64E-06 | 3.20E-01 | 657 | 3.08E-05 | 5.54E-06 | 1.34E-07 | 0.00905 | 13 |
| SPCS | 1.34E-04 | 8.64E-06 | 3.20E-01 | 44 | 1.20E-05 | 8.42E-07 | 2.33E-07 | 3.04E-06 | 2 |
| SBSS | 1.90E-04 | 3.57E-06 | 2.51E-01 | 118 | 1.23E-05 | 5.47E-06 | 1.48E-07 | 0.000219 | 5 |
| WBCS | 1.36E-04 | 6.45E-06 | 1.21E-01 | 93 | 1.94E-05 | 2.41E-07 | 1.07E-07 | 5.57E-07 | 3 |
| CCSS | 8.40E-05 | 2.78E-06 | 1.30E-01 | 59 | 5.08E-08 | na | na | na | 0 |
| BUSM | 2.57E-04 | 1.26E-05 | 1.06E-01 | 52 | 6.83E-05 | na | na | na | 0 |
| LRSS | 1.02E-04 | 8.59E-06 | 8.29E-03 | 95 | 8.18E-08 | 1.74E-07 | 8.64E-08 | 3.51E-07 | 2 |
| WWSM | 2.48E-04 | 8.93E-06 | 4.15E-01 | 68 | 2.94E-08 | 2.34E-07 | 1.73E-07 | 3.17E-07 | 2 |
| KBSS | 1.33E-04 | 1.40E-05 | 8.55E-03 | 34 | 5.15E-05 | 4.34E-07 | 4.34E-07 | 4.34E-07 | 1 |

Arithmetic mean is best for describing 'average' Kh, noting that given the range in K over several orders of magnitude, average Log10 K is reported.
Harmonic mean is best for estimating 'representative Kv (Domenico and Schwartz, 1998).

### 6.5.2 Storage Properties

There is currently no field data concerning aquifer storage properties at Tahmoor Mine for specific yield (Sy) or specific storage (Ss), although there is some core testing of porosity. Groundwater specific storage varies by orders of magnitude, is difficult to quantify, and prone to significant uncertainty (Rau et al, 2018).

HydroSimulations (2020) reports that there are three measurements of total porosity (n) (which would be the highest possible specific yield) available from core tests at bore TBC037 including:

- Two measurements from the HBSS, where n = 5.3% and 11%.
- One measurement from the BHCS, where n = 4%.

Data collected elsewhere in the Sydney Basin provides a Sy estimate of between 1 and 2% for the HBSS (Tammetta and Hewitt, 2004), appearing to confirm that Sy is lower than the total n stated above. Storage properties are expected to decrease depth due to a reduction in porosity from overburden pressure, as well as being influenced by strata lithology.

Alluvium is expected to possess a specific yield in the range of 0.03 to 0.2, i.e. 3-20% (HydroSimulations, 2020).

There is no site specific data available from Tahmoor mine to estimate specific storage. Pumping test data collected within the Sydney Basin, for intervals between ground surface and 300 m depth provide a specific storage estimate of 1.5E-6 m-1 (Commonwealth of Australia, 2014).

Useful estimates of specific storage can also be made based on Young's Modulus and porosity, based on calculations in Mackie (2009). Calculations for this site suggest that for coal, Ss generally lies in the range 5E-6 m-1 to 5E-5 m-1, and interburden from 1.7E-6 (unfractured, fresh rock) to 8E-6 (fractured rock). These values are consistent with the appropriate range of Ss stated by Rau et al (2018).

### 6.5.3 Fracturing above Longwalls

#### 6.5.3.1 Fracturing Overview

Near-surface fracturing or "surface cracking" can occur due to horizontal tension at the edges of a subsidence trough. The depth of cracking from the surface will typically be less than 20 m; McNally and Evans (2007) stated this is usually but not always transitory. Water loss from surface features (e.g. watercourses, wetlands) into the cracks is unlikely to continue downwards towards the goaf and most will return to surface somewhere down-gradient. This has occurred in earlier mining at Tahmoor, e.g. along the Bargo River and Redbank Creek.

Investigations along Redbank Creek and Myrtle Creek have been carried out in boreholes to characterise the near surface-strata adjacent to the creeks impacted by the subsidence associated with longwall mining. These investigations involved the observations of borehole conditions and water flows, measurements of borehole diameter to identify voids and open fractures, and lugeon packer tests to measure hydraulic conductivity (SCT, 2020b).

These investigations along Redbank Creek concluded that the presence of open fractures in all boreholes coincided with intervals of increased hydraulic conductivities. Groundwater flow was observed out of these fractures in some bores (e.g. P10 and P19). However, no

correlation or patterns were established between fracturing and depth below the creek bed at these targeted areas. Comparable findings were reported by SCT (2020a) along Myrtle Creek, with groundwater flows observed out of open fractures at P18, P21, P23 and P25 but no clear correlation between the zones of increased hydraulic conductivities and the depth below the creek bed was established.

Leakage of surface water into the surface cracking zone can result in the water quality of any re-emergent water being inferior to that of surface flow in an undisturbed environment (McNally and Evans, 2007). Effects of mining-induced subsidence have occurred at Tahmoor Mine, e.g. along Redbank (GeoTerra, 2019) and Myrtle Creeks.

An assessment conducted by Morrison et al. (2019) found that the quality of surface waters in areas directly above extracted longwall panels was degraded in the direct vicinity of surface cracking features along Redbank Creek, with higher salinity and metal concentrations measured compared to an unaffected reference site.

In many cases, metals concentrations decline downstream of the undermined sections, e.g. iron (Fe), nickel (Ni), cobalt (Co), but others remain at elevated levels, e.g. manganese (Mn), barium (Ba), strontium (Sr), noting that the sampling was conducted in dry conditions with minimal runoff present. The decline in some metals is attributed to oxidation and precipitation.

#### 6.5.3.2 Fracturing above Longwall West 2 – Western Domain

Height of fracturing (HOF) and depressurisation above the Longwall West 2 Panel at Western Domain was assessed in 2023.

Two fully cored boreholes were drilled over Longwall West 2, one was drilled before mining, and one was drilled after extraction of the longwall panel had ceased. A comparison of the pre and post mining geotechnical and hydrological ground conditions from these two bore holes was undertaken by SCT (2023). The comparison found that a reduction in pore pressure begins in the Hawkesbury Sandstone/Newport formation between 326m and 286m above the mining horizon (200m and 240m below the surface), and that the pore pressure continues to reduce until the measured height of depressurisation, located in the Bulgo Sandstone, between 196m and 171m above the mining horizon (330m and 355m below the surface) (SCT, 2023).

The interpreted Longwall West 2 caving zones, measured height of depressurisation and piezometric profiles are summarised in **Figure 24**.

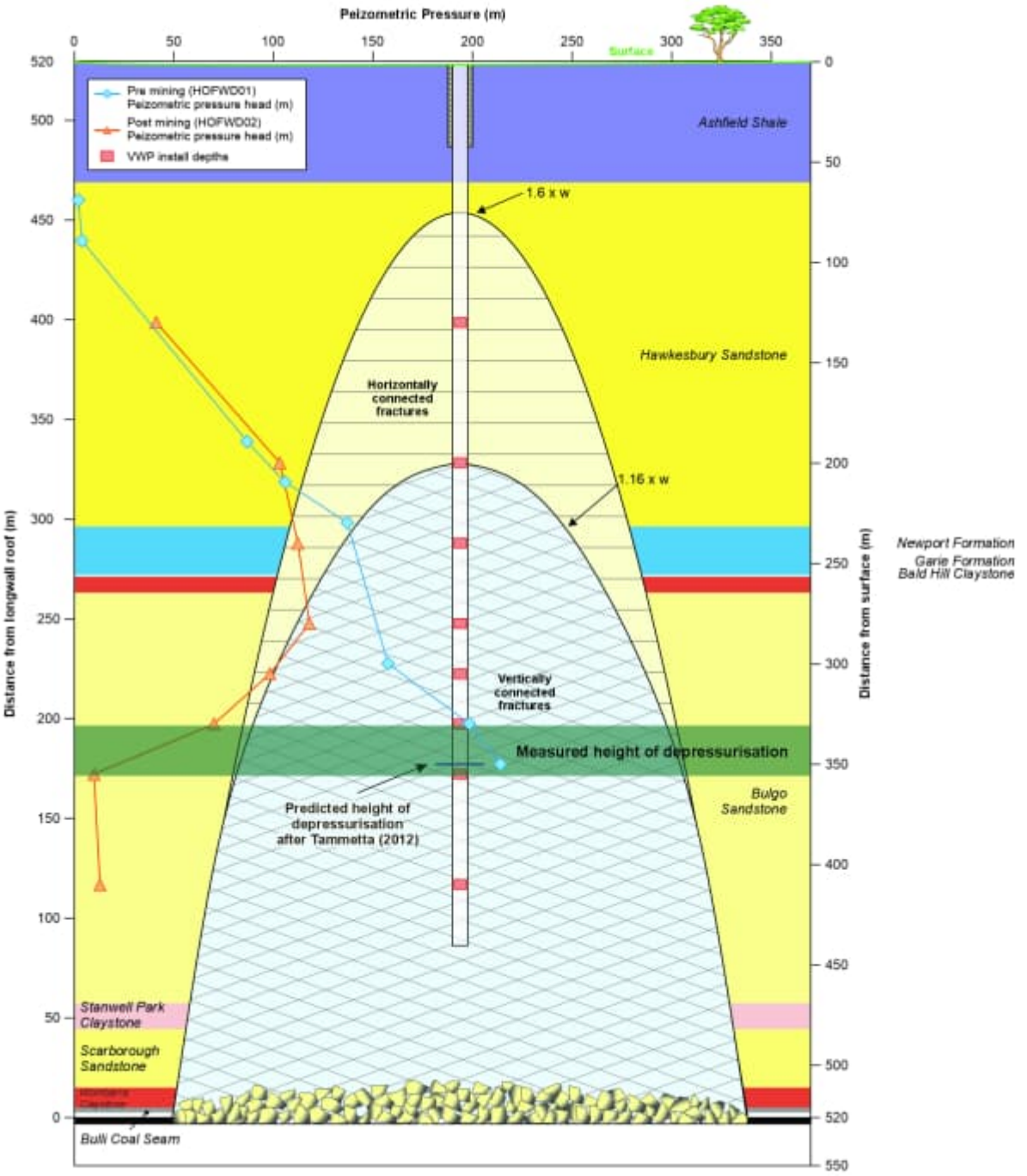



**Figure 24 Fracturing above Longwall West 2 – Western Domain (SCT, 2023)**

Packer testing in the pre- and post- mining holes again demonstrate the altered hydraulic properties (**Figure 25**). The Ashfield Shale showed a large variation in hydraulic conductivity both pre and post mining. The Hawkesbury Sandstone shows a general increase in hydraulic conductivity although this is not a consistent response. This is primarily due to to

bedding plane separation cause by the longwall caving process, with the bedding plane separations not always intersected by the test intervals.

The Newport Formation, Bald Hill Claystone and Bulgo Sandstone also showed a general increase in hydraulic conductivity of two orders of magnitude between the pre and post mining holes.

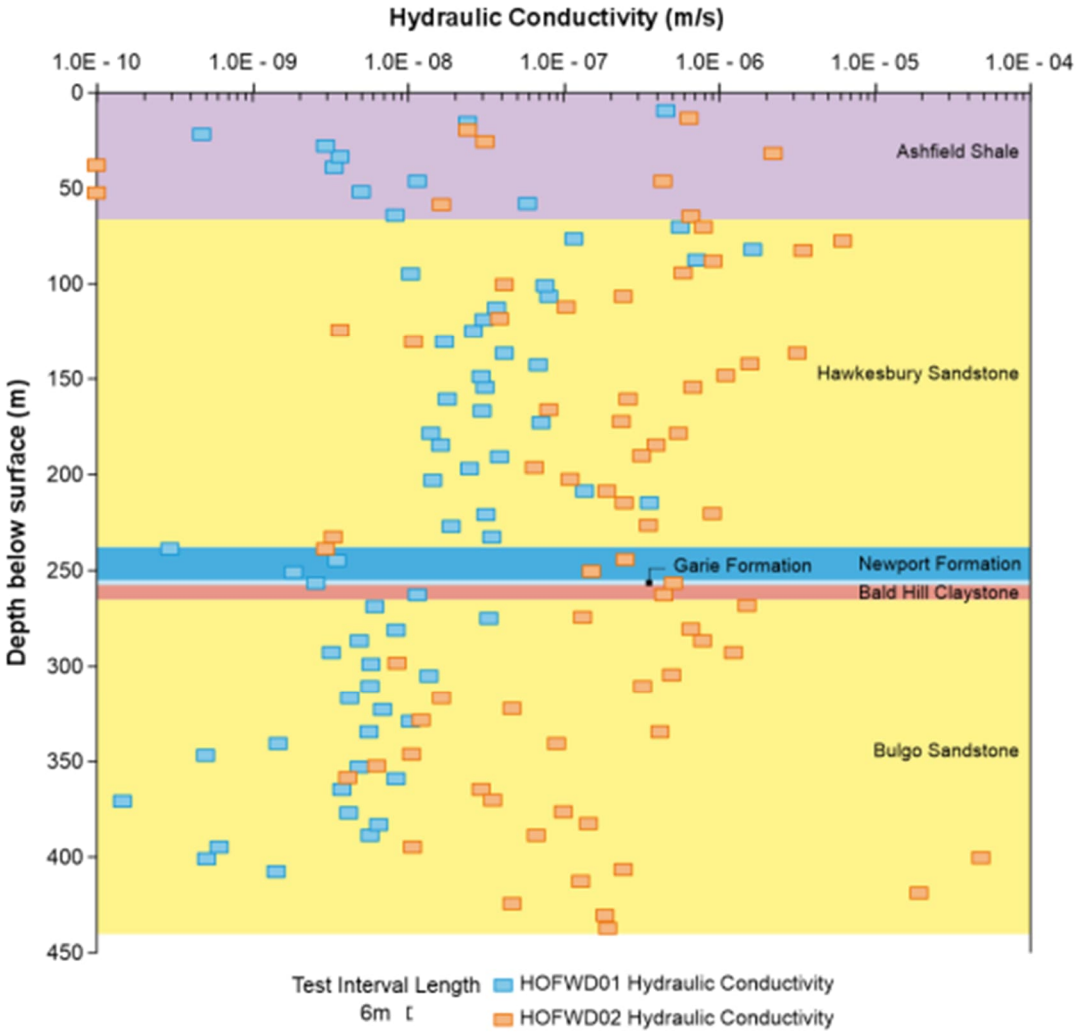



**Figure 25 Hydraulic conductivity comparison pre- and post- mining (SCT, 2023)**

## 6.6 Additional Features

### 6.6.1 On-site Water Storages

Approximately 20 earthen water storage structures and 2 concrete water storage tanks, with an estimated combined storage capacity of 149 ML, have been identified across Tahmoor Mine. To comply with the Consent conditions, an assessment of the potential for leakage

from the surface water storages to groundwater has been completed via two studies undertaken in 2022 (SLR, 2022a and SLR, 2022b).

Based on visual inspections, the surface storage water structures were generally found to have limited connectivity to groundwater outside of the structure themselves (SLR, 2022a). The unlined nature of all the water storages (with exception to the potable water tanks) offers the most likely path of connectivity to groundwater. The surrounding geology indicates all storages are founded on residual soils or bedrock with favourable jointing and bedding (SLR, 2022a). There was no observed evidence of geological features that may act as conduits for surface water/groundwater connectivity, however underlying subsidence and cracking maybe evident in the base of storage structures that cannot be observed (SLR, 2022a).

Based on a qualitative of trends in concentration for the tested analytes in the Pit Top Area and Rejects Emplacement Area (REA), an impact from surface water on groundwater quality in these areas was not indicated (SLR, 2022b).

0 0.25 0.5 km

Piezometers Locations

Ponds

| | |
|---|---|
| Coordinate System: | GDA 1994 MGA Zone 56 |
| Scale: | 1:18,000 at A4 |
| Project Number: | 620.040109.0001 |
| Date: | 03-May-2024 |
| Drawn by: | RB |

**TAHMOOR SOUTH MODIFICATION 3**

**ON-SITE WATER STORAGE FACILITIES**

SLR

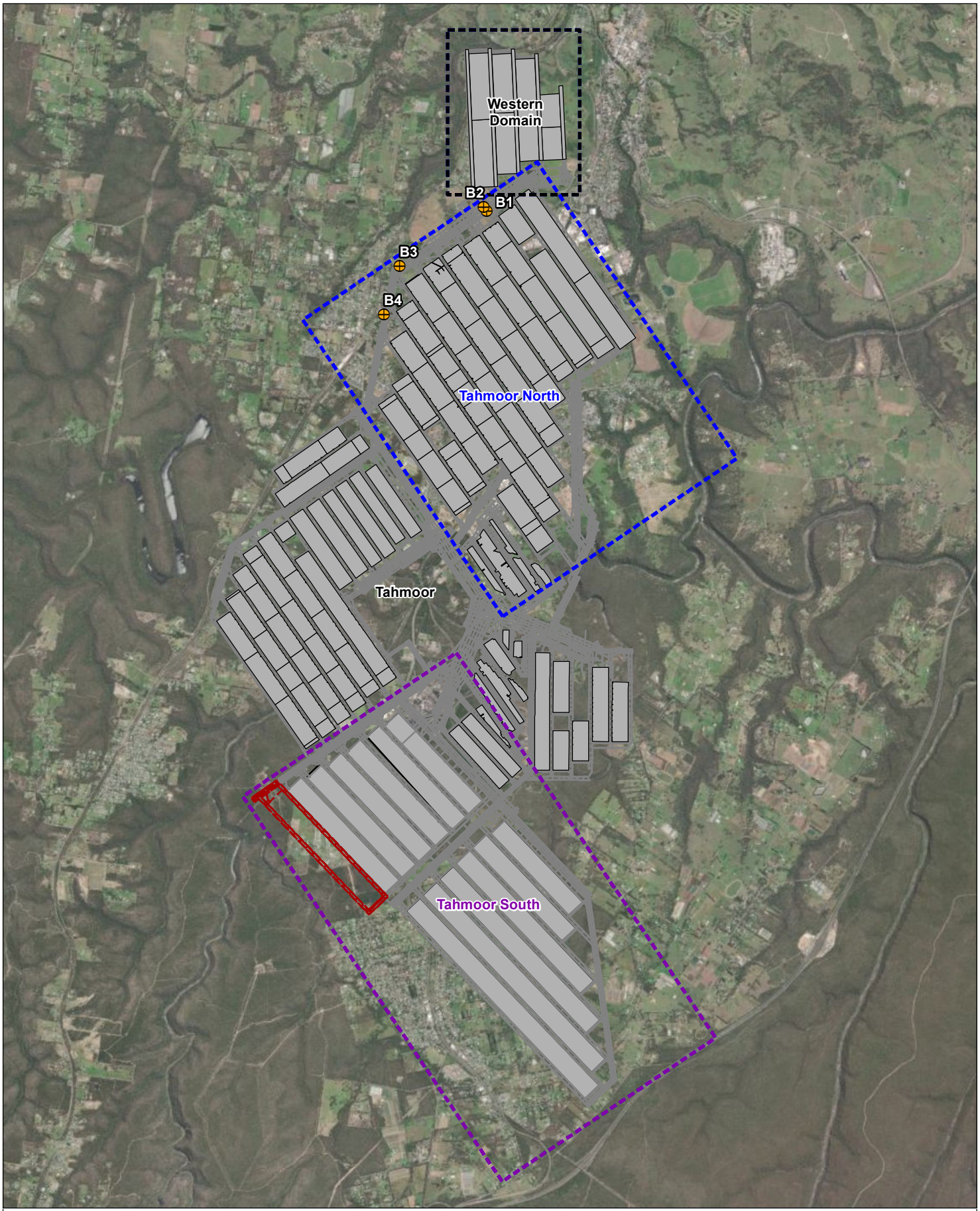
**FIGURE 26**

\\au.slr.local\Corporate\Projects-SLR\640-MEL\620.040109.00001 Tahmoor South Modification 3 G\06 SLR Data\01 CADG\SIG\SIG\Impact Assessment\620040109 TAHMOOR IAR F26 On-site Water Storage Facilities.mxd

### 6.6.2 Underground Brine Disposal

Brine will be produced on site as a by-product of the water treatment plan (WTP). Brine will be disposed of underground, in historical GOAF areas, as approved as part of Modification #2. The brine will be discharged from a brine transfer pipeline at release points in the Tahmoor North underground workings, shown on **Figure 27**.

The disposal of the brine is to be permanent. Predicted water volumes and estimated Total Dissolved Solids (TDS) for the brine were produced via the site Water and Salt Balance Modelling (ATC Williams, 2022). The brine storage is predicted to commence in 2024 with the current approved total brine storage volume of 690 ML and expected TDS of approximately 16,770 mg/L (SLR, 2023).




0 1 2 km

Release Point

Proposed LW S7A

Mine Plan

| | |
|---|---|
| Coordinate System: | GDA 1994 MGA Zone 56 |
| Scale: | 1:70,000 at A4 |
| Project Number: | 620.040109.0001 |
| Date: | 03-May-2024 |
| Drawn by: | RB |

SLR

**TAHMOOR SOUTH MODIFICATION 3**

**BRINE RELEASE POINTS**

**FIGURE 27**

\\au.slr.local\Corporate\Projects-SLR\640-MEL\620.040109.00001 Tahmoor South Modification 3 G\06 SLR Data\01 CADG\SIG\Impact Assessment\620040109 TAHMOOR IAR F27 Brine Release Points.mxd

# 7.0 Conceptual Hydrogeological Model

The geology of the region includes minor units of Quaternary and Tertiary Alluvials, associated primarily with the Thirlmere Lakes. The Triassic Wianammatta Group form a capping unit, discontinuous across the region. Neither of these units are present within the study area. The primary regional outcropping geology, and that of the study area, is the Triassic Hawkesbury Sandstone. The HBSS is underlain by the Tertiary Narrabeen Group and subsequently, the Permian Illawarra Coal Measures, containing the target coal for extraction.

The HBSS is considered a highly productive aquifer and hosts majority (excluding the Thirlmere Lakes) of the identified anthropogenic and environmental receptors. Groundwater flow is typically from the south-west to the north-east, and quality, although variable, is mostly suitable for stock and domestic use, and most irrigation. The HBSS forms the water table aquifer in the study area, with depth to groundwater approximately 40 metres below natural surface, whilst varying between approximately 0 to 70 metres below natural surface more regionally. Recharge occurs primarily via direct rainfall infiltration, and discharge via outcrop at the Illawarra Escarpment, direct evapotranspiration and baseflow to waterways.

Waterways in the region are typically incised into the HBSS, with the Bargo River being the most significant in the region. The upper tributaries of Teatree Hollow fall within the study area, and do not intersect the local groundwater table.

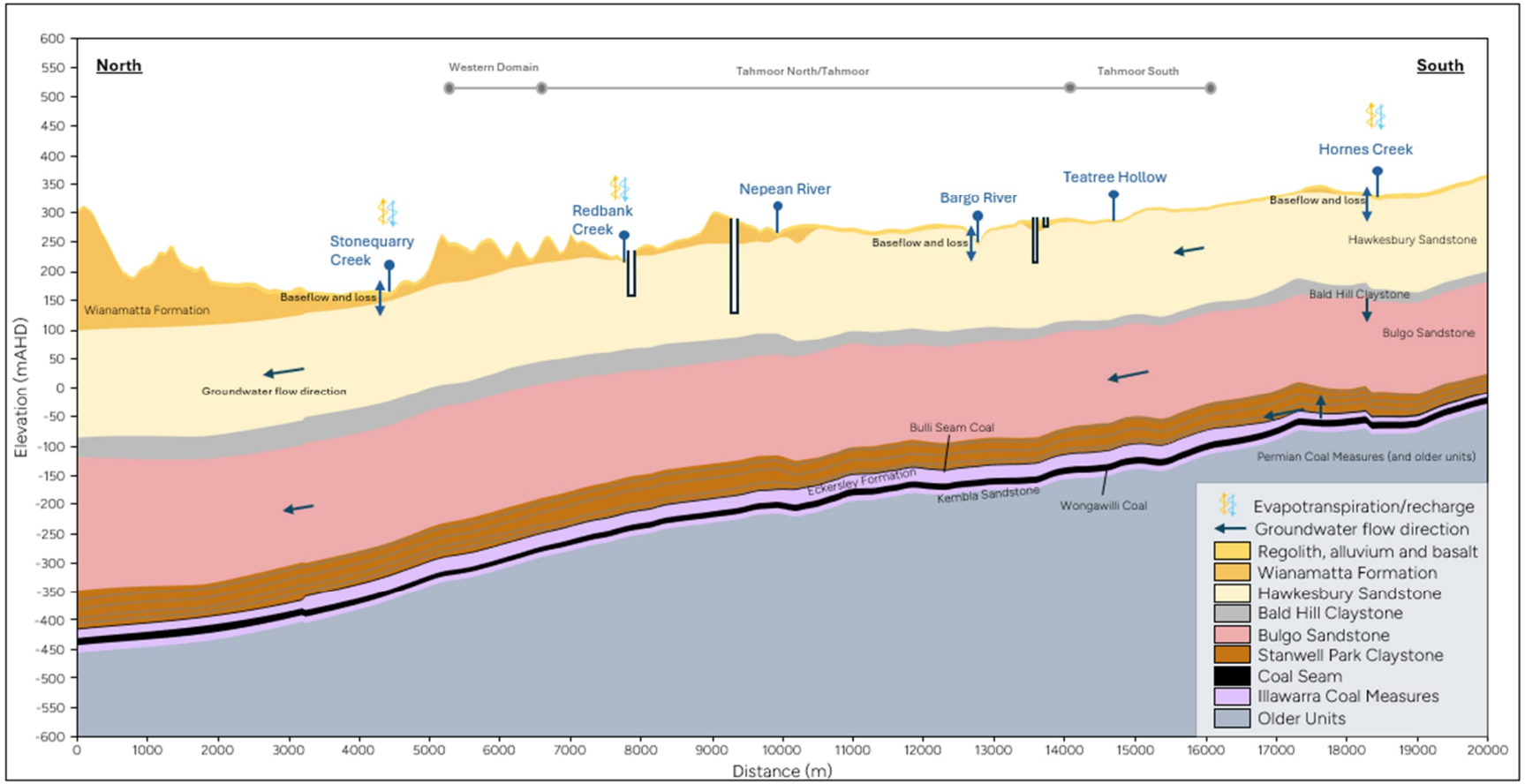



**Figure 28 Hydrogeological Conceptualisation Cross-section**

# 8.0 Numerical Groundwater Modelling Background

To facilitate the assessment of potential impacts from the proposed modification, specifically here, the additional of LW S7A, Tahmoor Coal engaged SLR to update the numerical groundwater model and run predictive scenarios.

The full Numerical Groundwater Modelling Technical Report (SLR, 2024) has been produced, and can be read collectively with this document. Provided here is a summary of the groundwater flow model highlighting key amendments, re-calibration statistics, and basics of the solute transport model design.

Concurrently to this work, the numerical groundwater model is undergoing Independent Peer Review. **Figure 29** presents the modelling methodology adopted, inclusive of peer review input points.

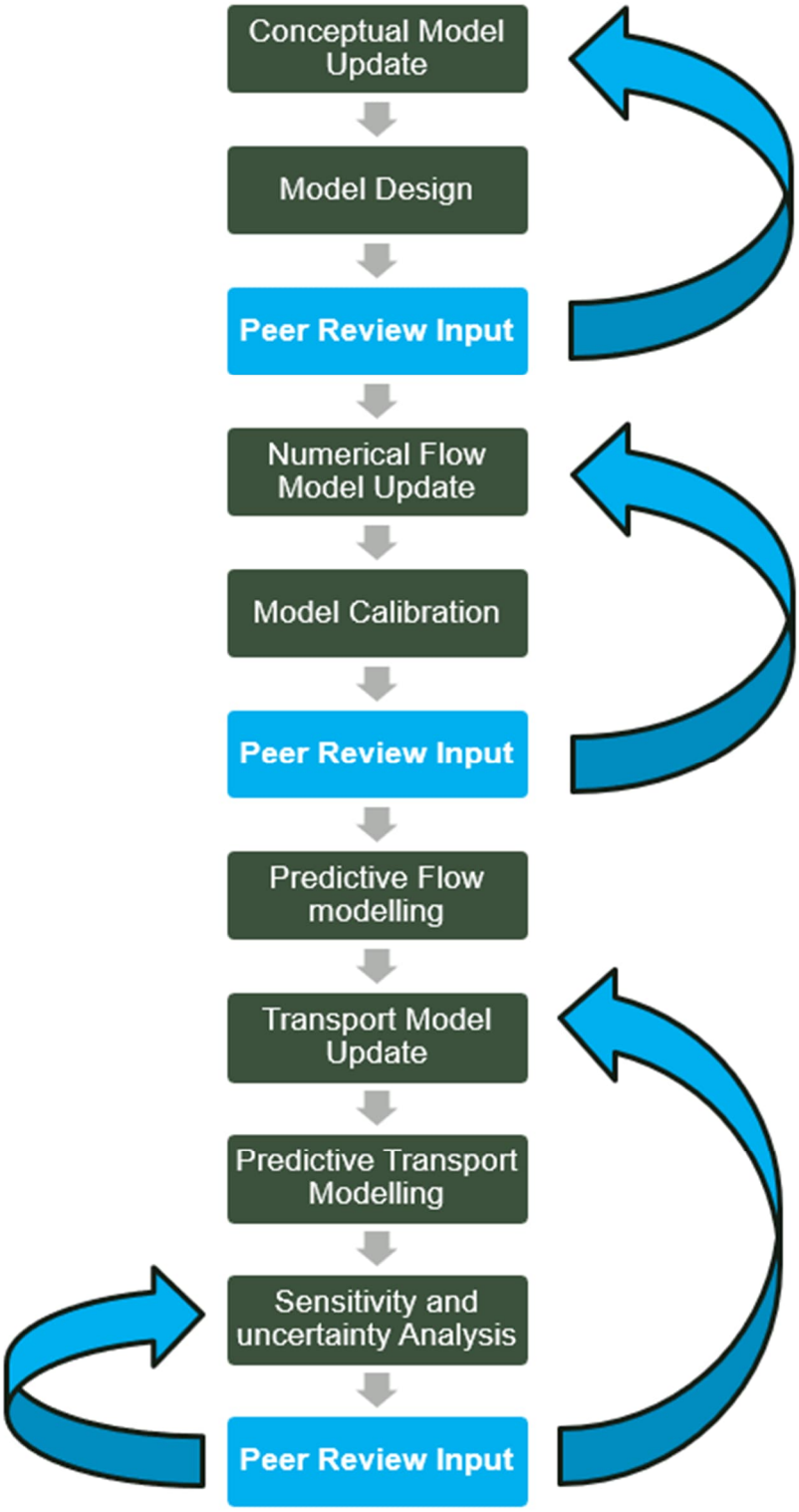



**Figure 29 Modelling methodology**

## 8.1 Groundwater Flow Model Design and Update

### 8.1.1 Existing Southern Coalfield Model

SLR were commissioned by Tahmoor Coal in 2021 to undertake a groundwater model rebuild for the Tahmoor Mine operations, as a part of the requirements in the Tahmoor South Groundwater Management Plan. This was dictated by the Tahmoor Coal SSD 8845 Consent Conditions, specifically that the groundwater model re-build and recalibration must be completed within 2 years of the commencement of development under the consent. This regional model, which is referred to as the Southern Coalfields Model, comprises Tahmoor North and Tahmoor South (SIMEC), Appin (South32), Metropolitan (Peabody) and Dendrobium (South32) mines in one model domain. The construction of this regional model was facilitated by the signed data- share agreement between the Tahmoor Coal and South 32.

The numerical model was built using Geographic Information Systems (GIS) in conjunction with MODFLOW-USG-Transport (Panday, 2023). MODFLOW-USG is one of the most recent versions of the MODFLOW code (McDonald and Harbaugh, 1988) developed by the USGS.

### 8.1.2 Model Update Summary

A model update was required to simulate the additional mining at Longwall S7A. The model was also updated to reflect the latest conceptual model updates. A summary of these updates is provided in the following sub-sections.

#### 8.1.2.1 Conceptual Model Updates

The baseline conditions and hydrogeological conceptual model presented in **Section 3.0** through **Section 7.0** reflect current understanding.

New data incorporated into the model update included:

- height of fracturing study above Western Domain (SCT, 2023),
- water storages seepage investigation (SLR, 2022a and SLR, 2022b),
- brine storage transport modelling (SLR, 2023a), and
- springs assessment (SLR, 2023b and Niche Environment and Heritage, 2024).

The finding of the water storage seepage investigations, and the springs assessments provided further data to support existing conceptualisation and made no marked changes.

The brine storage modelling presented a new scenario of on-site water management which is further investigated herein.

Although the height of fracturing study was relatively consistent with the modelling assumptions, the differences were deemed sufficient to warrant a model recalibration.

#### 8.1.2.2 Model Grid Refinement

The existing model grid refinement was designed to consider the currently approved longwall mining at Tahmoor South, with a maximum cell edge length of 50 m where longwalls have been proposed.

The area of the model where the proposed Longwall S7A sits contains cells of up to 200 m edge length in the existing model grid (**Figure 30**) and required refinement to be considered suitable for subsidence, inflow, and mass transport simulations. The model grid was also refined in areas where potential additional longwalls at Tahmoor South have been identified by Tahmoor Coal (i.e. LW S7B-S8B, **Figure 30**).

#### 8.1.2.3 Model Packages Updates

The following package updates were required:

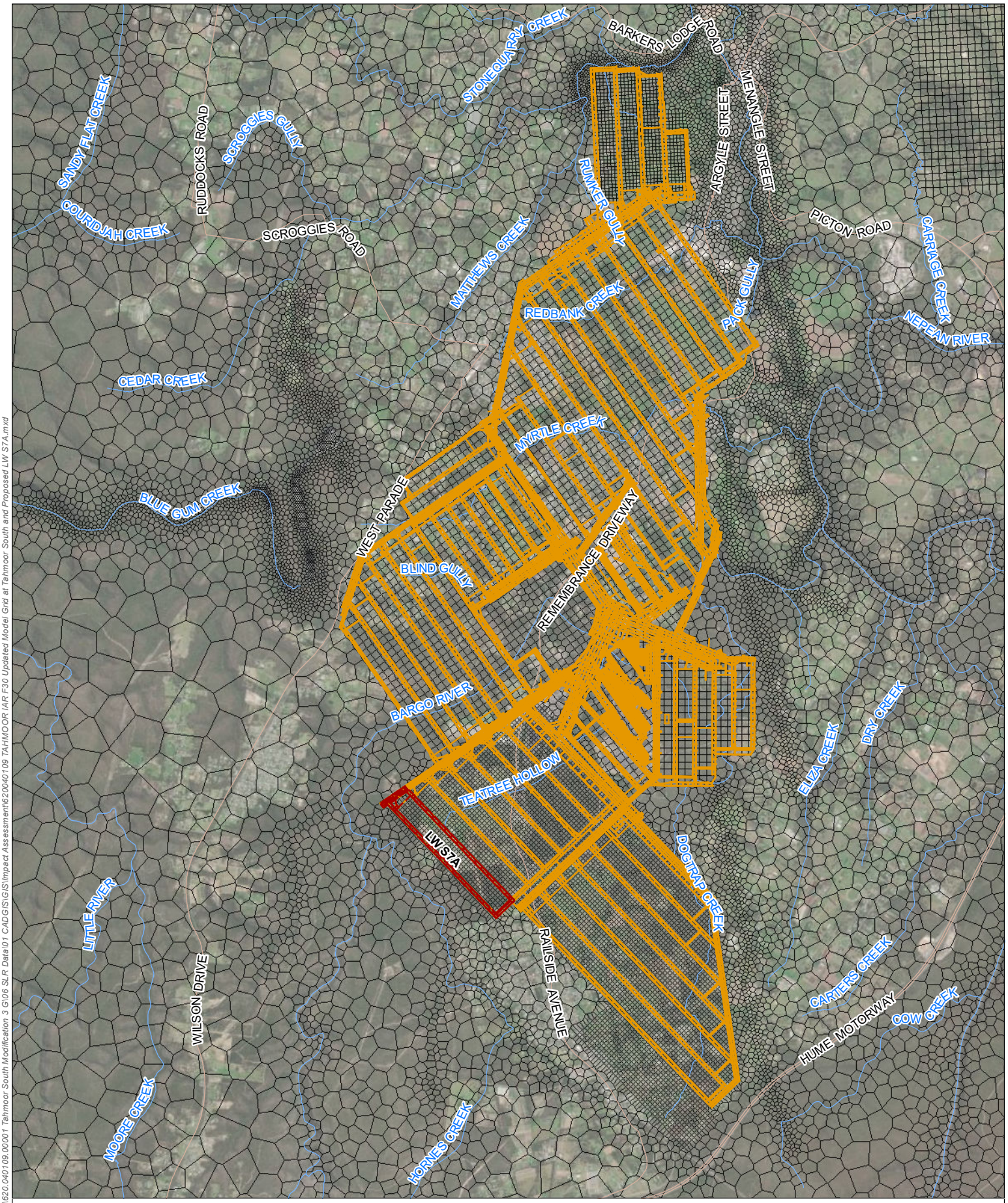
- Drain (DRN): The drain package was updated to reflect mining at Longwall S7A,
- Time-Varying-Material (TVM): Subsidence associated with the proposed Longwall S7A was simulated using the Time-Varying-Material (TVM) package. The recent fracturing study (SCT, 2023) was also incorporated by modifying the fracturing height and assumptions (refer to **Section 6.5.3**), and
- Recharge (RCH) and Evapotranspiration (EVT): These two packages were updated with the latest available data for rainfall and evaporation.

#### 8.1.2.4 Calibration Dataset Update

The calibration data set was updated to include monitored water levels and mine inflows at Tahmoor Mine for the period Jan 2022 – August 2023. The dataset for the other mines was not updated as part of this project. The latest update to the Dendrobium Mine and Appin Mine water level and mine inflow dataset was carried out in August 2022.

### 8.1.3 Independent Review of the Model Design

Independent review of the model design was completed, and comments returned to SLR on the 5$^{th}$ December 2023. Comments were addressed, and the model design accepted by the independent reviewer.




0 1 2 km

| | |
|---|---|
| Coordinate System: | GDA2020 MGA Zone 56 |
| Scale: | 1:70,000 at A4 |
| Project Number: | 620.040109.00001 |
| Date: | 03-May-2024 |
| Drawn by: | RB |

- Proposed LW S7A
- Mine Plan
- Roads
- Watercourses
- Model Grid

SLR

**TAHMOOR SOUTH MODIFICATION 3**

**UPDATED MODEL GRID AT TAHMOOR SOUTH AND PROPOSED LW S7A**

**FIGURE 30**

\\au.slr.local\Corporate\Projects-SLR\640-MEL\620.040109.00001 Tahmoor South Modification 3 GIS\06 SLR Data\01 CAD\GIS\GIS\Impact Assessment\620040109 TAHMOOR IAR F30 Updated Model Grid at Tahmoor South and Proposed LW S7A.mxd

## 8.2 Groundwater Flow Model Calibration Summary

The calibration dataset included a combination of targets as listed below:

- Groundwater elevation (mAHD),
- Changes in measured groundwater levels (i.e. drawdown\recovery, natural fluctuations), and
- Historic mine inflow rates at Tahmoor and Dendrobium mines.

### 8.2.1 Summary Calibration Statistics

The acceptable value for the calibration criterion depends on the magnitude of the change in heads over the model domain. If the ratio of the RMS error to the total head change in the system is small, the errors are considered small in relation to the overall model response(s). The ratio of RMS to the total head loss (SMRS) for entire dataset is 5.6%, while SRMS for Tahmoor only is 3.2%. While there is no recommended universal SRMS error, the AGMG suggests that setting Scaled RMS targets such as 5% or 10% may be appropriate in some circumstances (Barnett et al, 2012).

### 8.2.2 Independent Review of the Calibration

Independent review of the groundwater flow model calibration was completed, with the reviewer providing comments for actions, and a statement confirming the calibration was completed to a standard satisfactory for use for predictive scenario modelling, as follows;

> *"I am also comfortable that the calibration has been carried out in a rigorous and appropriate manner and the results indicate the model provides a reasonable representation of the groundwater responses that have accompanied historic mining…" (B. Barnett, via email, 28th March, 2024).*

## 8.3 Groundwater Solute Transport Model Design

A contaminant transport simulation was preformed using the transport functionality in MODLOW USG - Transport. The version of MODFLOW USG – Transport V2.0.3. was used, which includes three packages to simulate mass contaminant transport: The Block Centred Transport (BCT) package, which defines the transport parameters for the model (e.g., dispersion and porosity), the Dual Density Flow (DDF) package which defines the density of the different fluids simulated and the Well (WEL) package, which defines the location (i.e. node), mass concentration and flux of the injected fluids.

The Modelling Technical Report (SLR, 2024) describes the following design features in detail:

- timing,
- well package (WEL) – flow and transport,
- output control (OC) – flow and transport,
- block centred transport (BCT) – transport only,
- time-variant material (TWM) – flow and transport, and
- dual density flow (DDF) – transport only.

Two scenarios were simulated for this assessment. In both cases, salinity increase was assessed using TDS as the solute. Brine Injection schedule, including injection rates and TDS concentration were provided by ATCW (2024):

- **Approved conditions**: Based on the approved mining flow model, which includes approved injection rates for brine. Approved TDS concentration at injections point were added for the transport simulation.
- **MOD3:** Based on the MOD3 mining flow model, which includes the additional mining of longwall panel LW S7A and modified injection rate for brine. Estimated TDS concentration at injections points were added for the transport simulation.

The estimated TDS is greater for the MOD3 scenario, but the total volume deposited is less. The total mass of salt deposited is thus slightly less for the MOD3 scenario when compared with the approved scenario (**Table 11**).

**Table 11 Brine Injection Details**

| Model | Brine Storage Period Start | Brine Storage Period End | Daily Average Brine Disposal Rate (ML/day) | Total Brine Disposal (ML) | Brine TDS (mg/L) | Total Brine Disposal Mass (t) |
|---|---|---|---|---|---|---|
| Approved | Jan 2024 | Sep 2032 | 0.21 | 690 | 16,770 | 11,200 |
| MOD3 | Jan 2024 | Sep 2032 | 0.14 | 474 | 21,985 | 10,420 |

It is noted that the concentrations presented are referred to as “incremental to background” because they are in addition to the background TDS concentrations. When comparing the approved and cumulative scenario, concentration is simply referred as “incremental” and in this case, it refers to the added concentration due to the MOD3 project.

# 9.0 Groundwater Flow Model Predictions

Predictive modelling presented herein has been conducted in support of the Modification application for LW S7A. As such transient predictive modelling was used to simulate the proposed LW S7A extraction as well as mining at other approved and foreseeable mines within the model domain. The predictive mining portion of the model comprises quarterly stress periods, starting from October 2023 to April 2033 (conclusion of extraction at LW S7A). The predictive recovery starts from the end of mining up to 2200 (**Table 12**).

Transient predictive models have been developed for three model scenarios:

- **Null mining** – No mining simulated at Tahmoor or surrounding mines,
- **Approved** – All currently approved mining at Tahmoor and all approved and foreseeable mining at surrounding mines, and
- **Modification 3 (MOD3)** – All approved and foreseeable mining including Tahmoor South LW S7A.

Extraction is simulated as progressing quarterly, with MODFLOW Drain cells simulating the mining applied to the base of the target coal seam (i.e. the Bulli seam). After the Drains were removed, the MODFLOW Time Varying Materials (TVM) package was used to assign fracture properties to the cells above the longwalls.

**Table 12 Model timing**

| Stress Period | Date Start | Date End | Mining Period | Max Stress Period Length (day) | Max Time Step Length (day) |
|---|---|---|---|---|---|
| 1 - 67 | Jan 1969 | Oct 2023 | Historical | 1,826 | 913 |
| 67 - 106 | Oct 2023 | Apr 2033 | Predictive - Mining | 91 | 45 |
| 206 - 310 | Apr 2033 | Jul 2200 | Predictive - Recovery | 20,000 | 913 |

## 9.1 Water Balance

**Table 13**, **Table 14** and **Table 15** provide average flow rates for water transfer into and out of the predictive models (October 2023 until October 2200 period) for the three predictive scenarios. All scenarios maintained mass balance errors below 0.1 % for all time steps throughout the simulations. The low error achieved indicates that the predictive model is stable(Barnett et al., 2012).

The tables show there was no change in recharge and EVT in all the scenarios. Groundwater outflow from the model mostly occurs via drain cells, used to simulate the escarpment and underground mining activity in the model. **Table 13** and **Table 14** show that LW S7A extraction resulted in an increase in the average drain outflow of 0.02 ML/d (4.82 ML/day in the MOD3 scenario against 4.80 ML/day in the Approved scenario).

In all three predictive scenarios, groundwater leaves the model through regional groundwater flow (GHB). The net flux into the model increased from an average of -1.06 ML/day in the Null scenario to -0.87 ML/day in both the MOD3 and Approved scenarios. This difference is likely due to the presence of mining near the boundaries of the model and the resulting drawdown from those mining activities.

The outflow from Escarpment decreased from 1.73 ML/day in the Null scenario to 1.47 ML/day in both the MOD3 and Approved scenarios. This decrease in flow is likely due to the coal seam depressurisation induced by mining simulated in the model.

**Table 15** shows negative River flux (-47.12 ML/day) in the Null scenario indicating flow from the groundwater system to rivers. **Table 13** and **Table 14** shows that in the Approved scenario and the MOD3 scenario, the net river exchange flux (RIV) is -38.87 ML/day, which indicates that mining results in less flux from the groundwater system to watercourses. This also shows that, on average, there are no incremental impact to watercourses > 0.01 ML/d regionally. This is further discussed in **Section 9.5.1**.

**Table 13 Average simulated water balance over the prediction period – MOD3**

| Component | Inflow (ML/d) | Percent of Total Inflow (%) | Outflow (ML/d) | Percent of Total Inflow (%) | Net flux (ML/d) |
|---|---|---|---|---|---|
| Rainfall Recharge (RCH) | 107.24 | 73.98 | 0.00 | 0.00 | 107.24 |
| Evapotranspiration (EVT) | 0.00 | 0.00 | 53.67 | 37.21 | -53.67 |
| Rivers/Creeks/Lakes (RIV) | 18.89 | 13.03 | 57.76 | 40.05 | -38.87 |
| Escarpment (DRN) | 0.00 | 0.00 | 1.47 | 1.02 | -1.47 |
| Mining (DRN | 0.00 | 0.00 | 3.35 | 2.33 | -3.35 |
| Ocean Constant Head (CHD) | 0.56 | 0.39 | 1.32 | 0.92 | -0.76 |
| Wells (WEL) | 0.01 | 0.01 | 0.62 | 0.43 | -0.62 |
| Regional GW Flow (GHB) | 14.36 | 9.91 | 15.23 | 10.56 | -0.87 |
| Storage | 3.90 | 2.69 | 10.80 | 7.49 | -6.90 |

**Table 14 Average simulated water balance over the prediction period - Approved**

| Component | Inflow (ML/d) | Percent of Total Inflow (%) | Outflow (ML/d) | Percent of Total Inflow (%) | Net flux (ML/d) |
|---|---|---|---|---|---|
| Rainfall Recharge (RCH) | 107.24 | 74.01 | 0.00 | 0.00 | 107.24 |
| Evapotranspiration (EVT) | 0.00 | 0.00 | 53.68 | 37.24 | -53.68 |
| Rivers/Creeks/Lakes (RIV) | 18.89 | 13.03 | 57.76 | 40.08 | -38.87 |
| Escarpment (DRN) | 0.00 | 0.00 | 1.47 | 1.02 | -1.47 |
| Mining (DRN | 0.00 | 0.00 | 3.33 | 2.31 | -3.33 |
| Ocean Constant Head (CHD) | 0.56 | 0.39 | 1.32 | 0.92 | -0.76 |
| Wells (WEL) | 0.01 | 0.01 | 0.62 | 0.43 | -0.62 |
| Regional GW Flow (GHB) | 14.36 | 9.91 | 15.23 | 10.57 | -0.87 |
| Storage | 3.85 | 2.66 | 10.73 | 7.45 | -6.88 |

**Table 15 Average simulated water balance over the prediction period - Null**

| Component | Inflow (ML/d) | Percent of Total Inflow (%) | Outflow (ML/d) | Percent of Total Inflow (%) | Net flux (ML/d) |
|---|---|---|---|---|---|
| Rainfall Recharge (RCH) | 107.24 | 78.01 | 0.00 | 0.00 | 107.24 |
| Evapotranspiration (EVT) | 0.00 | 0.00 | 55.99 | 40.73 | -55.99 |
| Rivers/Creeks/Lakes (RIV) | 15.24 | 11.08 | 62.36 | 45.36 | -47.12 |
| Escarpment (DRN) | 0.00 | 0.00 | 1.73 | 1.26 | -1.73 |
| Mining (DRN) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ocean Constant Head (CHD) | 0.55 | 0.40 | 1.37 | 0.99 | -0.82 |
| Wells (WEL) | 0.00 | 0.00 | 0.61 | 0.44 | -0.61 |
| Regional GW Flow (GHB) | 14.19 | 10.32 | 15.24 | 11.09 | -1.06 |
| Storage | 0.26 | 0.19 | 0.18 | 0.13 | 0.08 |

## 9.2 Predicted Groundwater Levels

Predicted depth to the groundwater table at the end of recovery for the MOD3, Approved and Null scenarios, is presented respectively in **Figure 31**, **Figure 32** and **Figure 33**. The figures show the depth to groundwater varies between 0 m to nearly 70 m and varies spatially at Tahmoor Mine, as per the results for the current calibrated groundwater conditions. The depth to water is generally greatest within the active or historical mine areas.

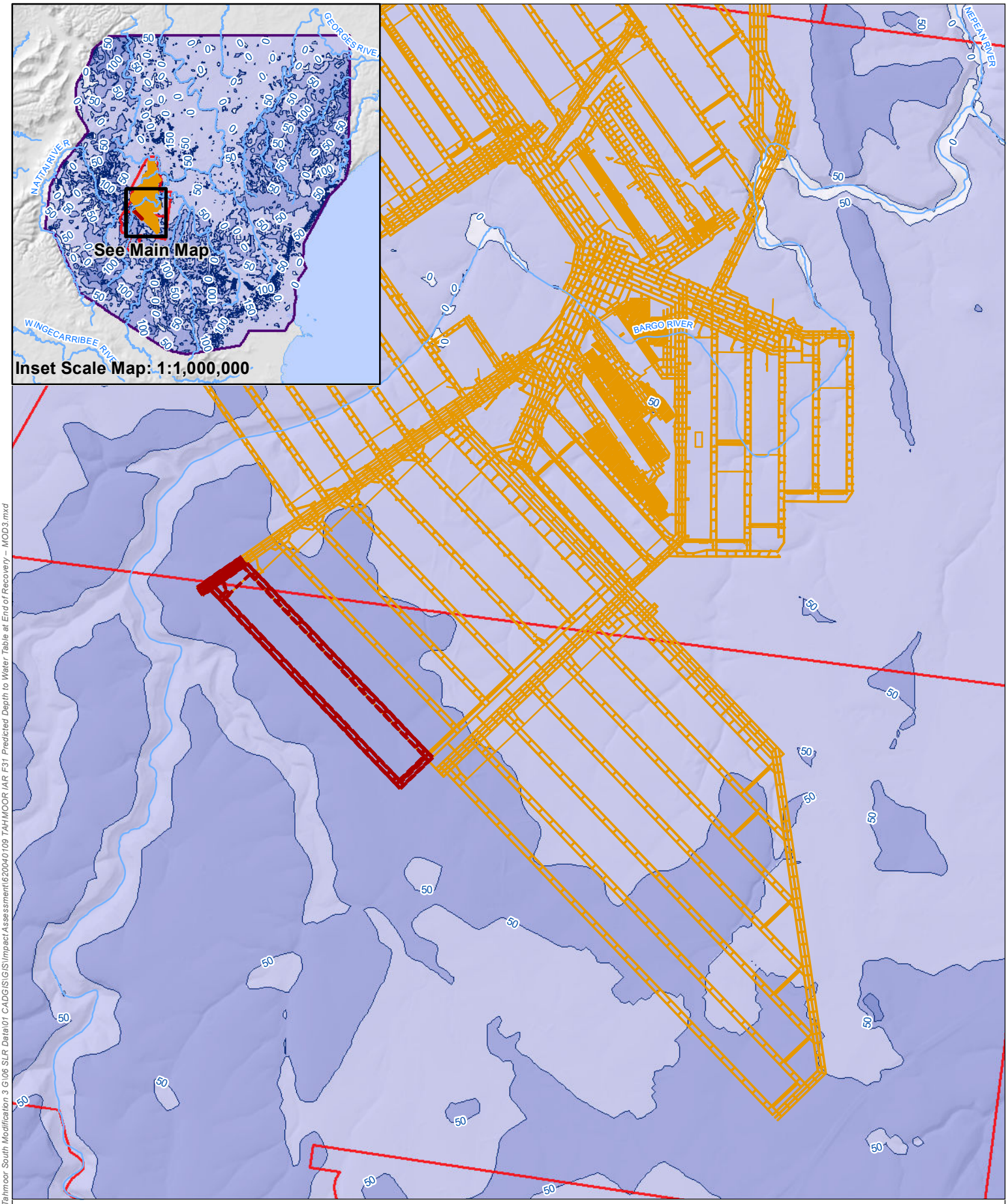
In the Buli seam, the general groundwater flow after recovery remains toward the north and northeast for the approved and cumulative scenarios (**Figure 34** and **Figure 35**). Regionally, groundwater flow in the Buli seam is influenced by depressurisation from surrounding mines (i.e. Appin) that have not recovered to pre-mining condition. **Figure 36** show the predicted groundwater elevation within the Bulli Seam at the end of the recovery period for the Null scenario.

At Tahmoor North, groundwater levels within the underground working are predicted to recover higher than in the Null scenario while at Tahmoor South, groundwater levels within the underground working are predicted to recovery lower than in the Null scenario. This is likely due to the combination of the below factors:

- The Brine injection within Tahmoor North,
- The slope of the working, which are toward the north and create a hydraulic gradient toward Tahmoor North, and
- Fracturing above the underground mine that allows enhanced recharge to the mine working.

The difference in recovery level between north and south can be observed for the cumulative scenario at piezo TNC28 and TNC29 (**Figure 37**), located within the area of brine disposal (Tahmoor North); and at piezo TBC18 and TBC24, located at Tahmoor South and west of Tahmoor (**Figure 38**). The hydrographs indicate that groundwater levels have fully recovered by 2200 at Tahmoor North (**Figure 37**) and Tahmoor South (**Figure 38**).

Post mining equilibrium levels within the mine working at TNC_28 and TNC_29 indicates an upward vertical hydraulic gradient, between the mine and the water table (**Figure 37**).




0 0.5 1 km

| | |
|---|---|
| Coordinate System: | GDA 1994 MGA Zone 56 |
| Scale: | 1:40,000 at A4 |
| Project Number: | 620.040109.00001 |
| Date: | 06-May-2024 |
| Drawn by: | RB |

Watercourse
Proposed LW S7A
Mine Plan
Depth to Water Table (m)
Tahmoor Coal
Model Domain

**Depth to Water Table (m)**

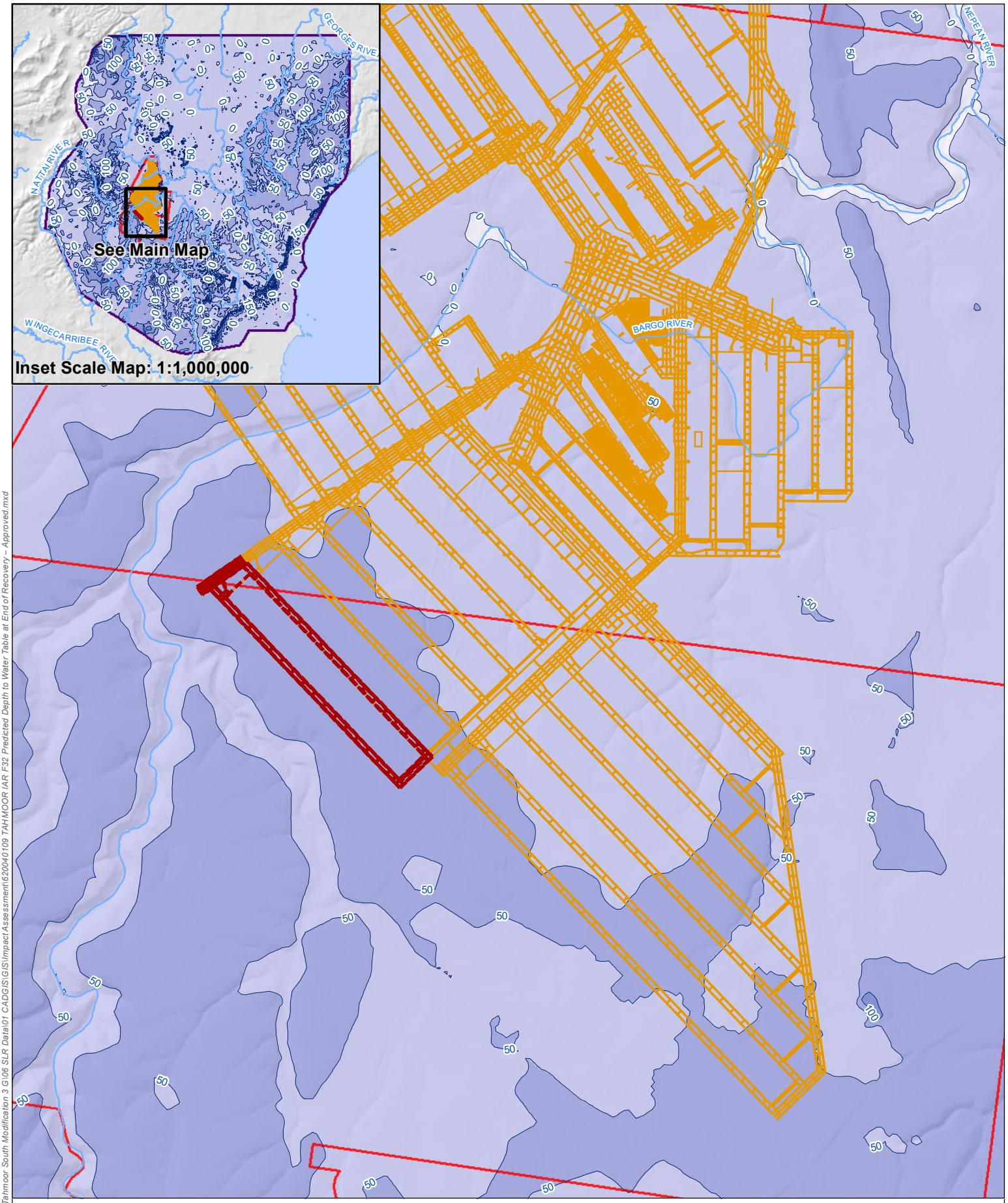
- < 0
- 0 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- 250 - 300

**TAHMOOR SOUTH MODIFICATION 3**

**PREDICTED DEPTH TO WATER TABLE AT END OF RECOVERY – MOD3**

**FIGURE 31**

H:\Projects-SLR\640-MEL\620.040109.00001 Tahmoor South Modification 3 GIS\06 SLR Data\01 CAD\GIS\GIS\Impact Assessment\620040109 TAHMOOR IAR F31 Predicted Depth to Water Table at End of Recovery – MOD3.mxd




0 0.5 1 km

| | |
|---|---|
| Coordinate System: | GDA 1994 MGA Zone 56 |
| Scale: | 1:40,000 at A4 |
| Project Number: | 620.040109.00001 |
| Date: | 06-May-2024 |
| Drawn by: | RB |

SLR

- Watercourse
- Proposed LW S7A
- Mine Plan
- Depth to Water Table (m)
- Tahmoor Coal
- Model Domain

**Depth to Water Table (m)**

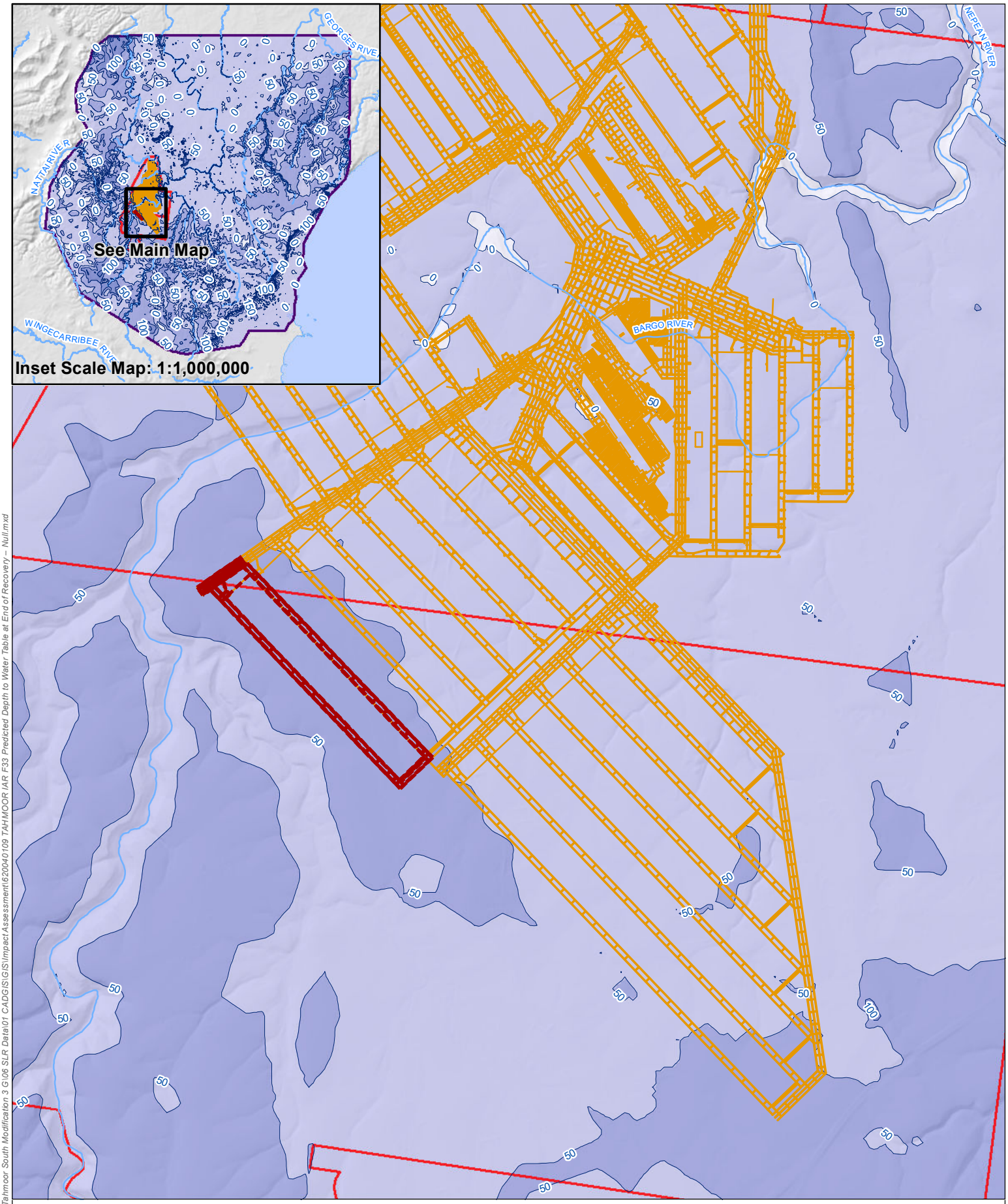
- < 0
- 0 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- 250 - 300

**TAHMOOR SOUTH MODIFICATION 3**

**PREDICTED DEPTH TO WATER TABLE AT END OF RECOVERY – APPROVED**

**FIGURE 32**

H:\Projects-SLR\640-MEL\620.040109.00001 Tahmoor South Modification 3 GIS\06 SLR Data\01 CADGIS\GIS\Impact Assessment\620040109 TAHMOOR IAR F32 Predicted Depth to Water Table at End of Recovery – Approved.mxd




0 0.5 1 km

| | |
|---|---|
| Coordinate System: | GDA 1994 MGA Zone 56 |
| Scale: | 1:40,000 at A4 |
| Project Number: | 620.040109.00001 |
| Date: | 06-May-2024 |
| Drawn by: | RB |

SLR

- Watercourse
- Proposed LW S7A
- Mine Plan
- Depth to Water Table (m)
- Tahmoor Coal
- Model Domain

**Depth to Water Table (m)**

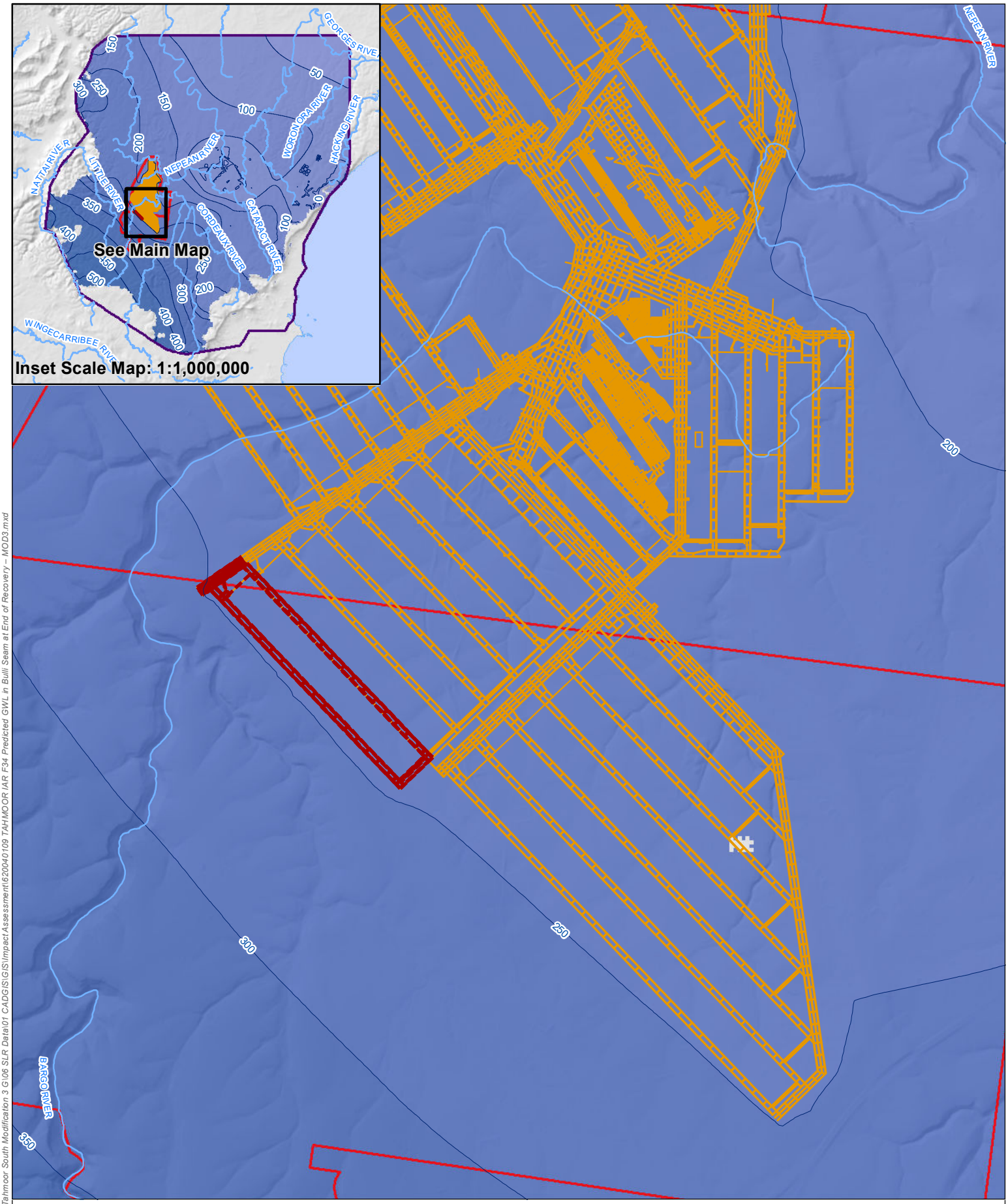
- < 0
- 0 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- 250 - 300

**TAHMOOR SOUTH MODIFICATION 3**

**PREDICTED DEPTH TO WATER TABLE AT END OF RECOVERY – NULL**

**FIGURE 33**

H:\Projects-SLR\640-MEL\620.040109.00001 Tahmoor South Modification 3 GIS\06 SLR Data\01 CAD\GIS\GIS\Impact Assessment\620040109 TAHMOOR IAR F33 Predicted Depth to Water Table at End of Recovery – Null.mxd




0 0.5 1 km

| | |
|---|---|
| Coordinate System: | GDA 1994 MGA Zone 56 |
| Scale: | 1:40,000 at A4 |
| Project Number: | 620.040109.00001 |
| Date: | 03-May-2024 |
| Drawn by: | RB |

SLR

- Watercourse
- Proposed LW S7A
- Mine Plan
- Groundwater Contour (mAHD)
- Tahmoor Coal Title
- Model Domain

**Groundwater Levels (mAHD)**

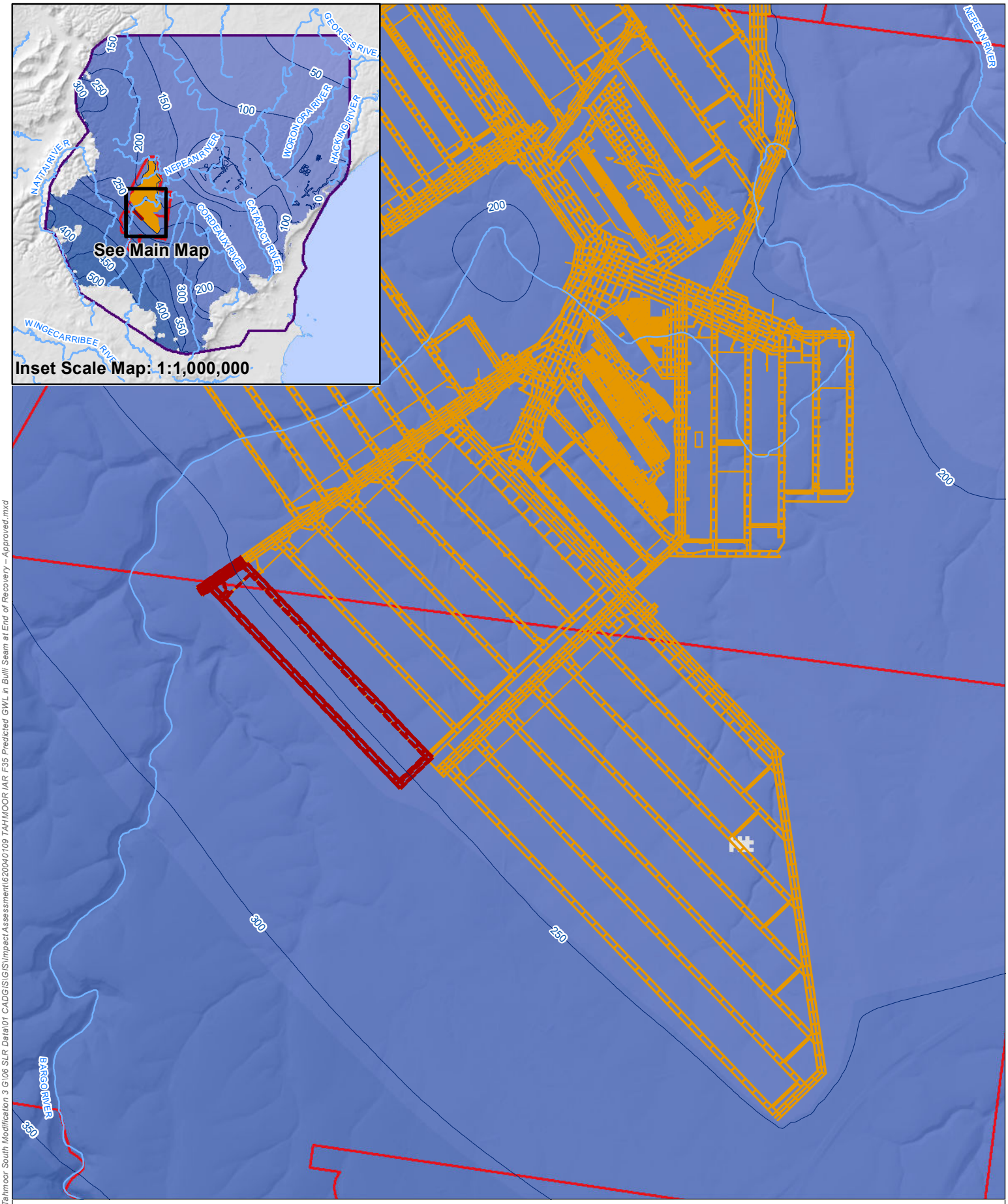
| | | |
|---|---|---|
| -445 - -400 | -100 - -50 | 250 - 300 |
| -400 - -350 | -50 - 0 | 300 - 350 |
| -350 - -300 | 0 - 50 | 350 - 400 |
| -300 - -250 | 50 - 100 | 400 - 450 |
| -250 - -200 | 100 - 150 | 450 - 500 |
| -200 - -150 | 150 - 200 | 500 - 550 |
| -150 - -100 | 200 - 250 | |

**TAHMOOR SOUTH MODIFICATION 3**

**PREDICTED GROUNDWATER LEVELS IN BULLI SEAM AT END OF RECOVERY – MOD3**

**FIGURE 34**

H:\Projects-SLR\640-MEL\620.040109.00001 Tahmoor South Modification 3 GIS\06 SLR Data\01 CADGIS\GIS\ImpactAssessment\620040109 TAHMOOR IAR F34 Predicted GWL in Bulli Seam at End of Recovery – MOD3.mxd




| | |
|---|---|
| Coordinate System: | GDA 1994 MGA Zone 56 |
| Scale: | 1:40,000 at A4 |
| Project Number: | 620.040109.00001 |
| Date: | 06-May-2024 |
| Drawn by: | RB |

Watercourse
Proposed LW S7A
Mine Plan
Groundwater Contour (mAHD)
Tahmoor Coal Title
Model Domain

**Groundwater Levels (mAHD)**

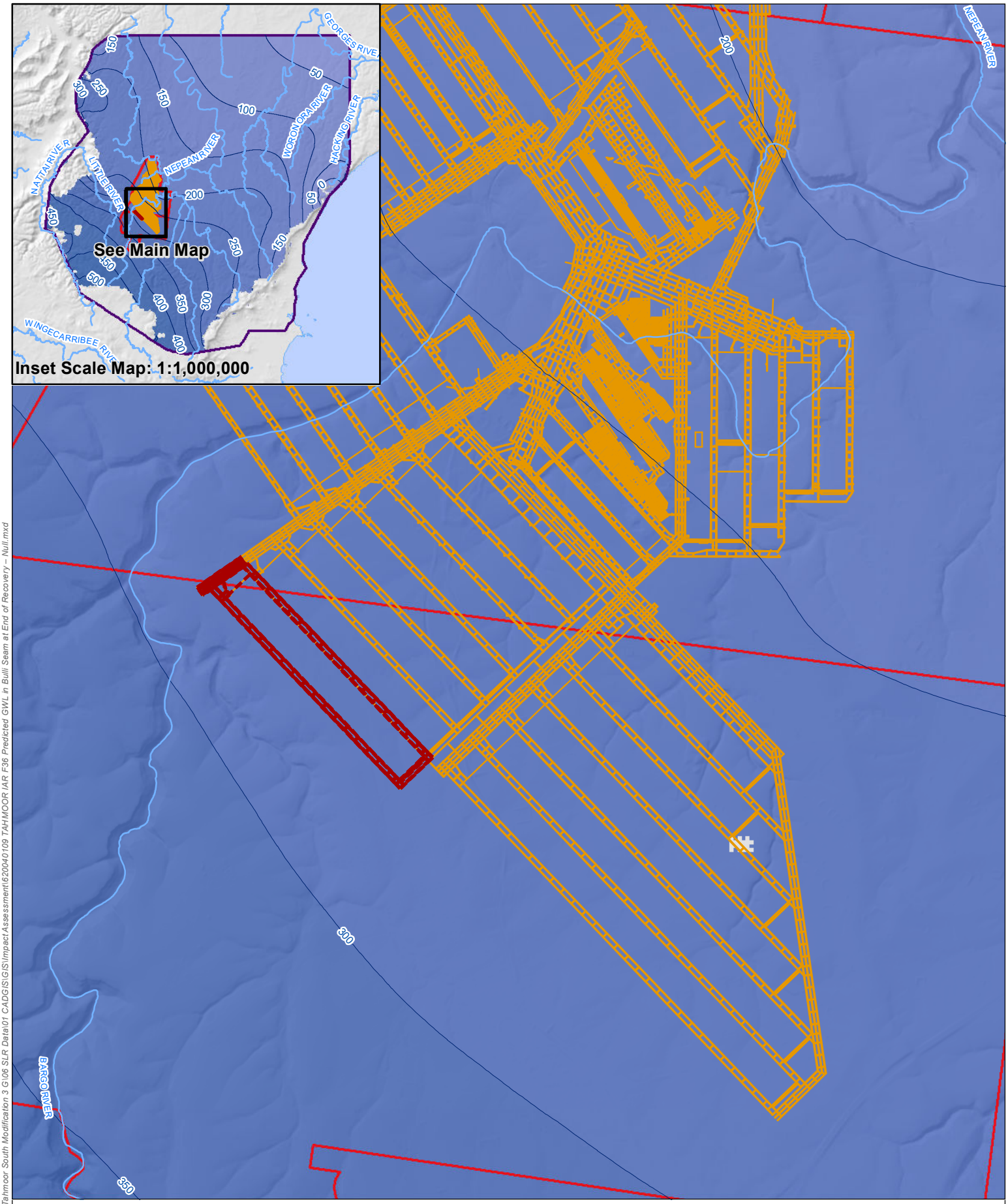
| | | |
|---|---|---|
| -445 - -400 | -100 - -50 | 250 - 300 |
| -400 - -350 | -50 - 0 | 300 - 350 |
| -350 - -300 | 0 - 50 | 350 - 400 |
| -300 - -250 | 50 - 100 | 400 - 450 |
| -250 - -200 | 100 - 150 | 450 - 500 |
| -200 - -150 | 150 - 200 | 500 - 550 |
| -150 - -100 | 200 - 250 | |

**TAHMOOR SOUTH MODIFICATION 3**

**PREDICTED GROUNDWATER LEVELS IN BULLI SEAM AT END OF RECOVERY – APPROVED**

**FIGURE 35**

H:\Projects-SLR\640-MEL\620.040109.00001 Tahmoor South Modification 3 GIS\06 SLR Data\01 CADGIS\GIS\ImpactAssessment\620040109 TAHMOOR IAR F35 Predicted GWL in Bulli Seam at End of Recovery – Approved.mxd




| | |
|---|---|
| Coordinate System: | GDA 1994 MGA Zone 56 |
| Scale: | 1:40,000 at A4 |
| Project Number: | 620.040109.00001 |
| Date: | 06-May-2024 |
| Drawn by: | RB |

- Watercourse
- Proposed LW S7A
- Mine Plan
- Groundwater Contour (mAHD)
- Tahmoor Coal Title
- Model Domain

**Groundwater Levels (mAHD)**

| | | |
|---|---|---|
| -445 - -400 | -100 - -50 | 250 - 300 |
| -400 - -350 | -50 - 0 | 300 - 350 |
| -350 - -300 | 0 - 50 | 350 - 400 |
| -300 - -250 | 50 - 100 | 400 - 450 |
| -250 - -200 | 100 - 150 | 450 - 500 |
| -200 - -150 | 150 - 200 | 500 - 550 |
| -150 - -100 | 200 - 250 | |

SLR

**TAHMOOR SOUTH MODIFICATION 3**

**PREDICTED GROUNDWATER LEVELS IN BULLI SEAM AT END OF RECOVERY – NULL**

**FIGURE 36**

H:\Projects-SLR\640-MEL\620.040109.00001 Tahmoor South Modification 3 GIS\06 SLR Data\01 CAD\GIS\GIS\Impact Assessment\620040109 TAHMOOR IAR F36 Predicted GWL in Bulli Seam at End of Recovery – Null.mxd

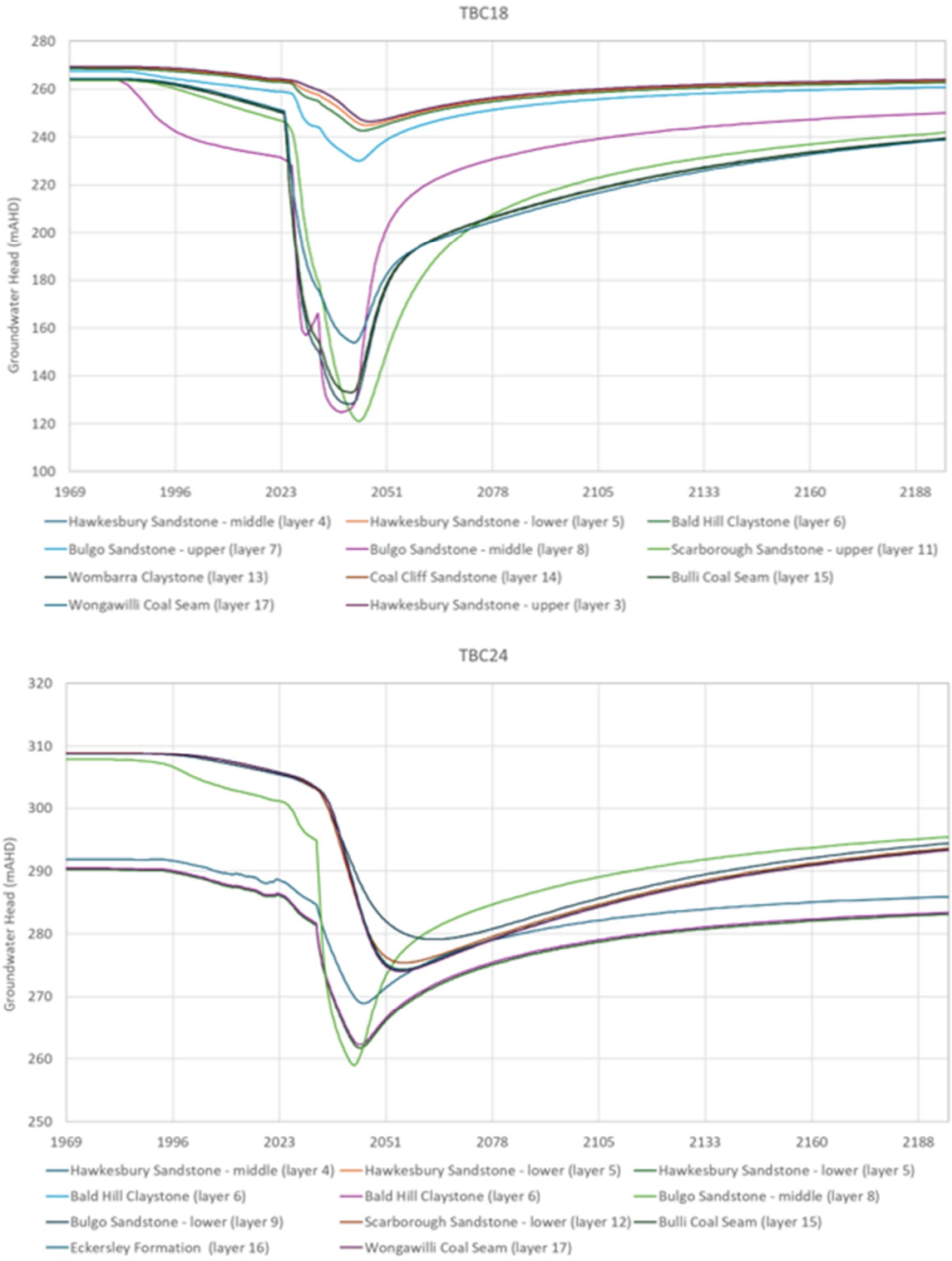



**Figure 37 Hydrographs – simulated recovery at selected Tahmoor South piezometers**

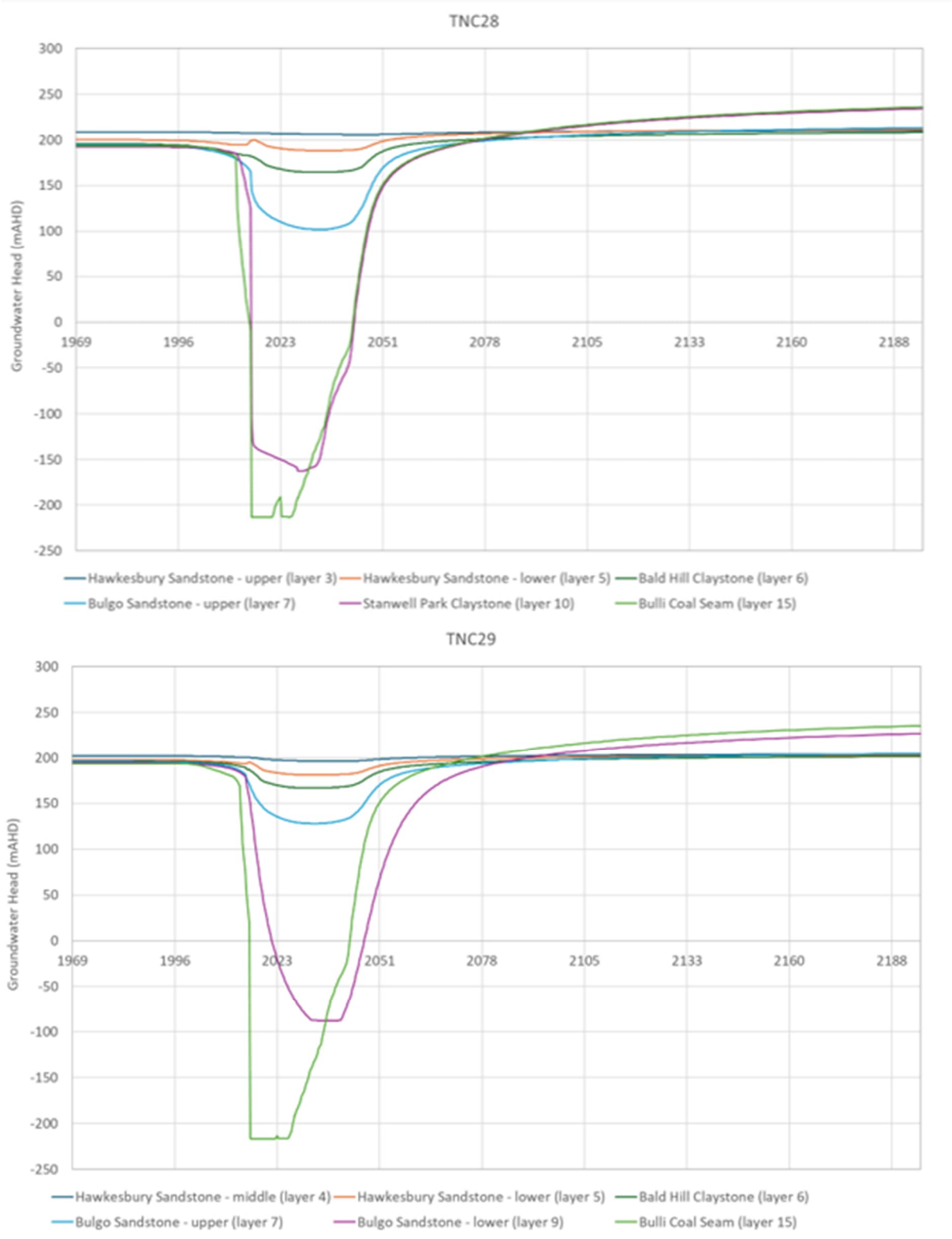



**Figure 38 Hydrographs – simulated recovery at selected Tahmoor North piezometers**

## 9.3 Predicted Maximum Drawdowns

The process of mining reduces groundwater levels and pressures in surrounding geological units. The extent of the zone affected is dependent on the properties of the aquifers/aquitards and is referred to as the zone of depressurisation in a confined aquifer and zone of drawdown within unconfined aquifers, including the water table. Depressurisation and drawdown are greatest at the working coalface and reduces with distance from the mine. The predicted drawdowns due to LW S7A extraction only (incremental effects) and the predicted drawdowns due to LW S7A extraction and all the neighbouring mining operations (the 'Cumulative' mining effects) were modelled. Only incremental impacts, due solely to the extraction of LW S7A are presented here, with cumulative impacts provided in the Modelling Technical Report (SLR, 2024).

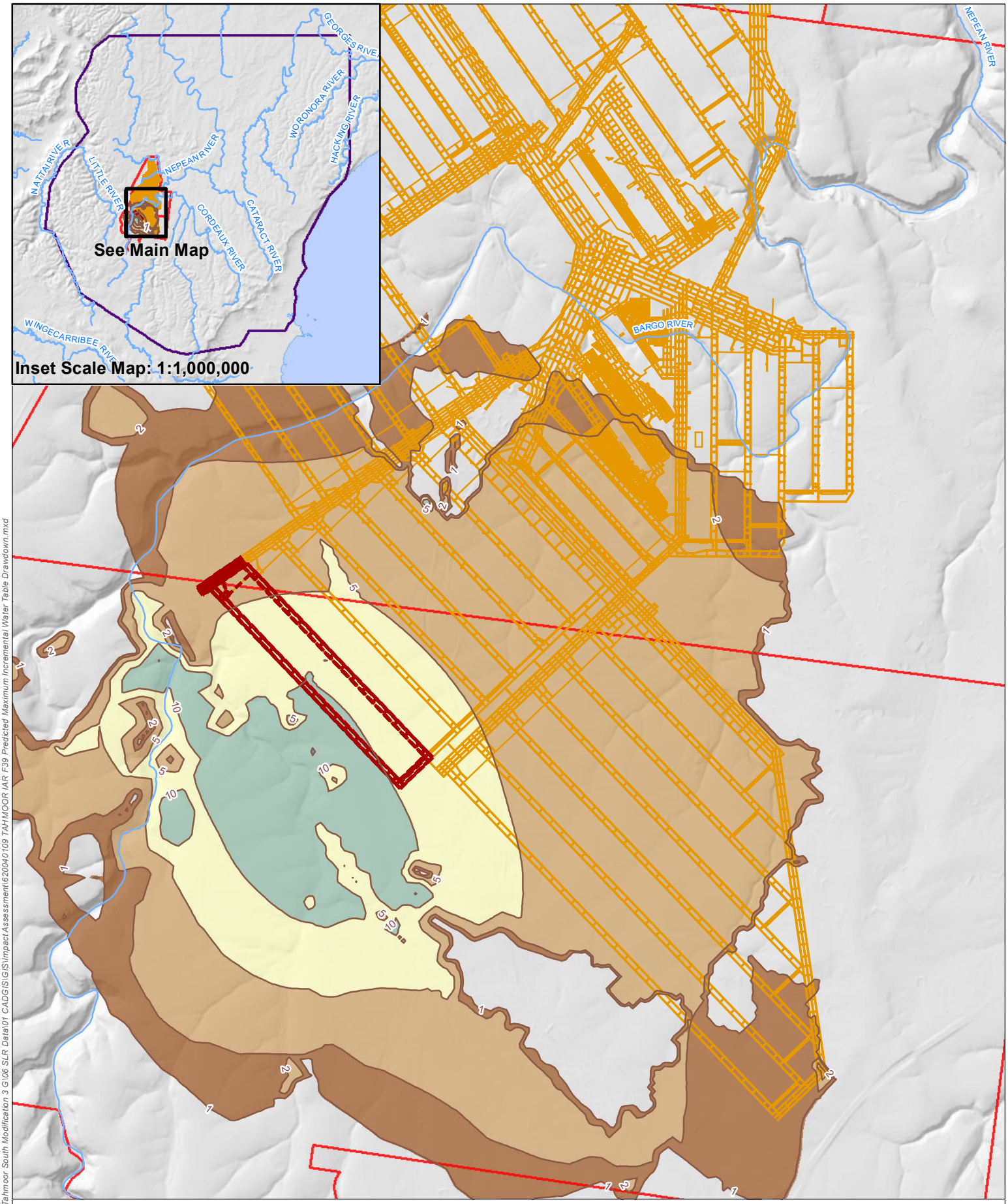
### 9.3.1 Incremental Drawdown

Maximum incremental drawdown due to LW S7A extraction was obtained by comparing the maximum drawdown for the approved scenario (i.e. maximum difference in groundwater levels between the Approved scenario and the null scenario) and the MOD3 scenario (i.e. maximum difference in groundwater levels between the MOD3 scenario and the null scenario). The maximum drawdown is a combination of the maximum drawdown values recorded at each cell at any time from the start of the calibration period (2009) to the end of recovery (2200).

Predicted maximum drawdown due to LW S7A extraction (incremental drawdown) is presented in **Figure 39**, **Figure 40** and **Figure 41**. **Figure 39** shows the predicted maximum water table drawdown due to LW S7A extraction. The water table has been selected because it is the groundwater system that is connected to most environmental (surface) features. The maximum water table drawdown is < 20 m in the immediate vicinity of LW S7A and reduces to < 5m across much of the Tahmoor South footprint. The maximum 1 m drawdown contour line is contained within the mining leases.

**Figure 40** show the predicted maximum drawdown in lower Hawkesbury Sandstone, which is the source of much of the local groundwater extraction by bores. **Figure 40** show the maximum drawdown extends radially from the LW S7A footprint. The drawdown contours are similar in extent to the water table drawdown and are mostly contained within the mining leases.

**Figure 41** shows the extent of the maximum predicted 10 m depressurization contour is approximately 2 km to the south and 2 km to the east LW S7A. The figure shows the maximum extent to the west of the panels in that area. The cone of depression is predicted to be steepest around the mine area.




0 0.5 1 km

| | |
|---|---|
| Coordinate System: | GDA 1994 MGA Zone 56 |
| Scale: | 1:40,000 at A4 |
| Project Number: | 620.040109.00001 |
| Date: | 06-May-2024 |
| Drawn by: | RB |

Watercourse
Proposed LW S7A
Mine Plan
Drawdown Contour (m)
Tahmoor Coal
Model Domain

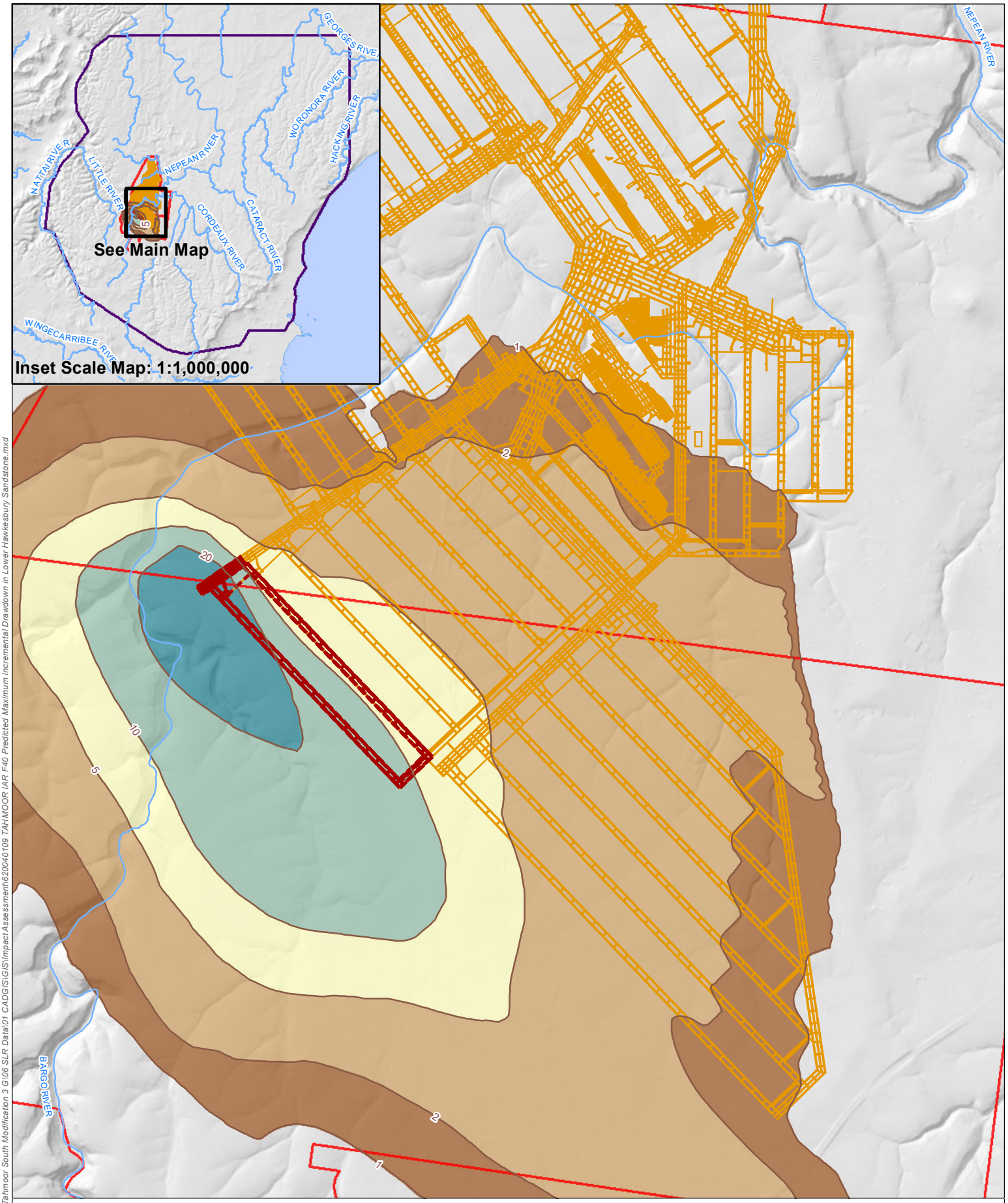
**Drawdown (m)**
1 - 2
2 - 5
5 - 10
10 - 20
20 - 50

**TAHMOOR SOUTH MODIFICATION 3**

**PREDICTED MAXIMUM INCREMENTAL WATER TABLE DRAWDOWN**

**FIGURE 39**

H:\Projects-SLR\640-MEL\620.040109.00001 Tahmoor South Modification 3 G\06 SLR Data\01 CADG\SIG\SI\Impact Assessment\620040109 TAHMOOR IAR F39 Predicted Maximum Incremental Water Table Drawdown.mxd




H:\Projects-SLR\640-MEL\620.040109.00001 Tahmoor South Modification 3 G\06 SLR Data\01 CADG\SIG\SI\Impact Assessment\620040109 TAHMOOR IAR F40 Predicted Maximum Incremental Drawdown in Lower Hawkesbury Sandstone.mxd

0 0.5 1 km

| | |
|---|---|
| Coordinate System: | GDA 1994 MGA Zone 56 |
| Scale: | 1:40,000 at A4 |
| Project Number: | 620.040109.00001 |
| Date: | 06-May-2024 |
| Drawn by: | RB |

SLR

- Watercourse
- Proposed LW S7A
- Mine Plan
- Drawdown Contour (m)
- Tahmoor Coal
- Model Domain

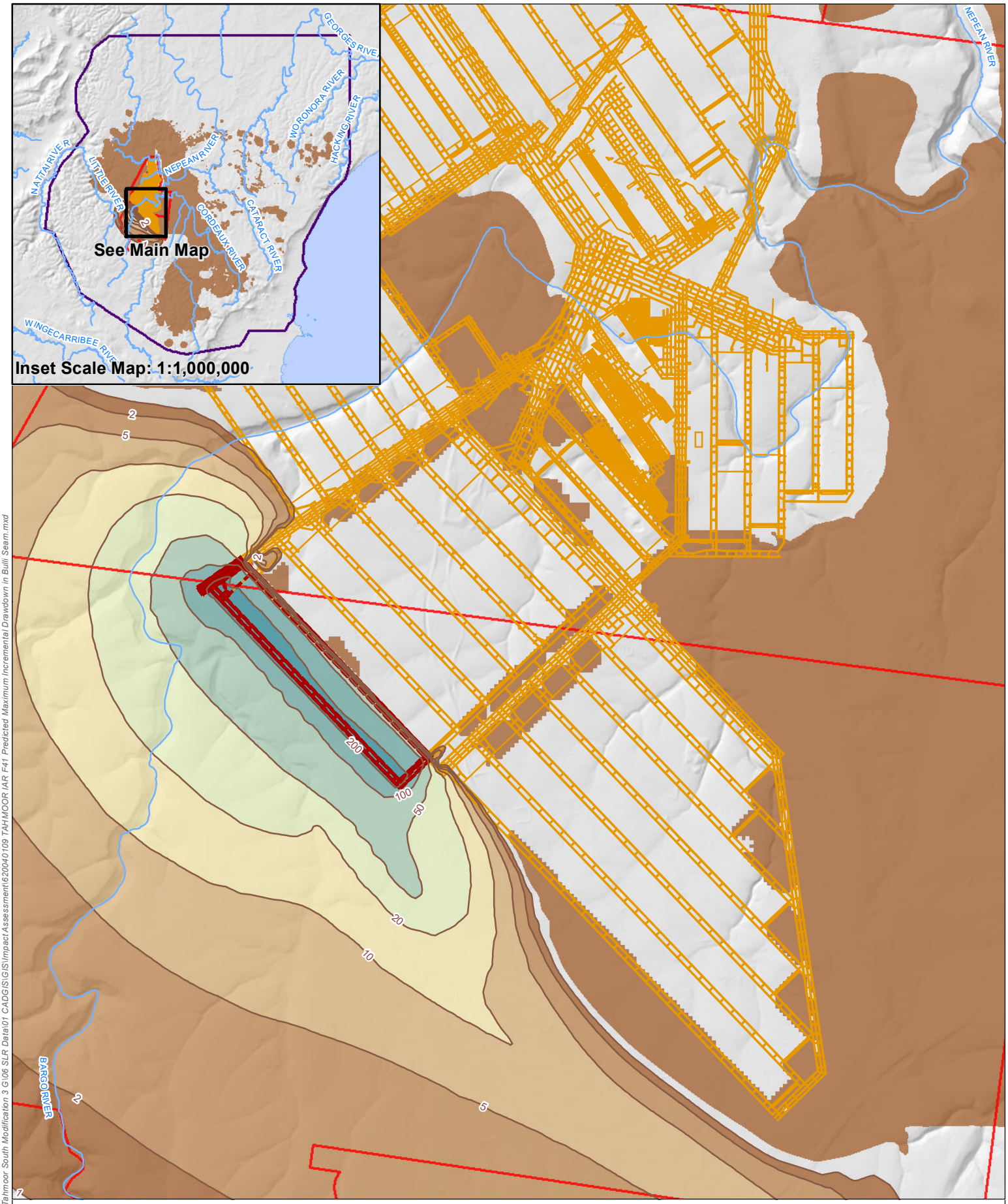
**Drawdown (m)**

- 1 - 2
- 2 - 5
- 5 - 10
- 10 - 20
- 20 - 50

**TAHMOOR SOUTH MODIFICATION 3**

**PREDICTED MAXIMUM INCREMENTAL DRAWDOWN IN LOWER HAWKESBURY SANDSTONE**

**FIGURE 40**




0 0.5 1 km

| | |
|---|---|
| Coordinate System: | GDA 1994 MGA Zone 56 |
| Scale: | 1:40,000 at A4 |
| Project Number: | 620.040109.00001 |
| Date: | 06-May-2024 |
| Drawn by: | RB |

Watercourse
Proposed LW S7A
Mine Plan
Drawdown Contour (m)
Tahmoor Coal
Model Domain

**Drawdown (m)**

| | |
|---|---|
| 1 - 2 | 20 - 50 |
| 2 - 5 | 50 - 100 |
| 5 - 10 | 100 - 200 |
| 10 - 20 | 200 - 300 |

**TAHMOOR SOUTH MODIFICATION 3**

**PREDICTED MAXIMUM INCREMENTAL DRAWDOWN IN BULLI SEAM**

**FIGURE 41**

H:\Projects-SLR\640-MEL\620.040109.00001 Tahmoor South Modification 3 GIS\06 SLR Data\01 CADGIS\GIS\Impact Assessment\620040109 TAHMOOR IAR F41 Predicted Maximum Incremental Drawdown in Bulli Seam.mxd

## 9.4 Predicted Groundwater Interception

Predicted mine pit inflow volumes have been calculated as time weighted averages of the outflow reported by MODFLOW 'ZoneBudget' utility for model Drain cells.

The inflows to the simulated Tahmoor South workings are presented in **Figure 42 .**As shown, cumulative inflows to underground operations are predicted to reach a maximum peak of 0.88 ML/day at the beginning of 2027. Inflow rates increase and decrease gradually from 2024 until the cessation of mining for the A series, in Oct 2027, where inflows to Tahmoor South reach a steady rate of approximately 0.10 ML/day.

The incremental inflow rate due to LW S7A starts as LW S7A becomes operational. As shown, incremental inflows to underground operations are predicted to reach a maximum peak of 0.81 ML/day at the beginning of 2027. It is estimated that the incremental inflow reaches a steady state rate of 0.05 ML/day.

**Table 16** presents the pit inflows per water year (1st July through 30th June) for the approved Tahmoor South A-series (LW S1A – S6A), the incremental water year interception for LW S7A, and the total volume.

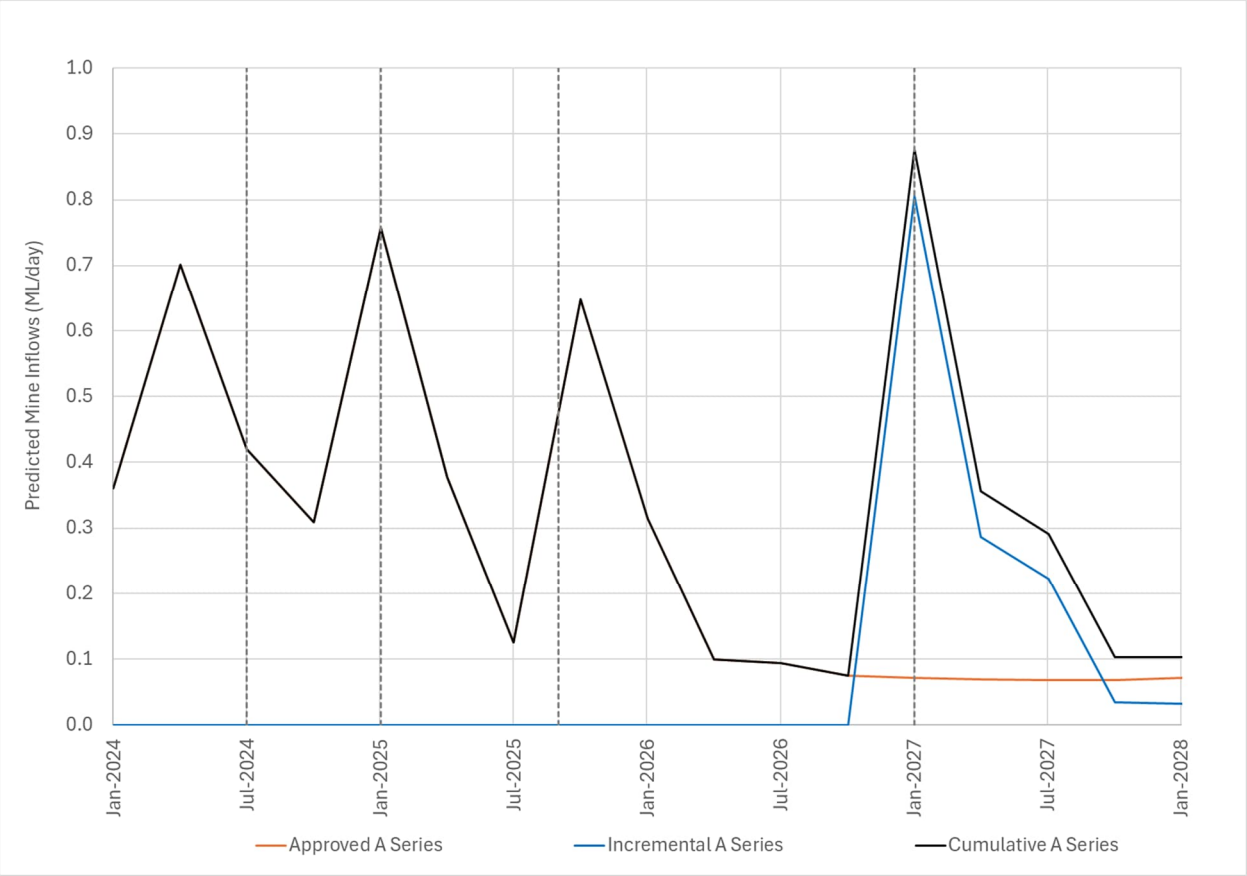



**Figure 42 Predicted mine pit inflows for longwall series A (approved, incremental, and cumulative)**

**Table 16 Mine pit inflows**

| Water Year | A series (ML/Year) | LW S7A (ML/year) | Total (ML/Year) |
|---|---|---|---|
| 2024-2025 | 170.3 | 0.0 | 170.3 |
| 2025-2026 | 108.3 | 0.0 | 108.3 |
| 2026-2027 | 28.3 | 99.7 | 128 |
| 2027-2028 | 25.9 | 29.2 | 55.1 |
| 2028-2029 | 38.3 | 11.0 | 49.3 |
| 2029-2030 | 52.9 | 13.0 | 65.9 |
| 2030-2031 | 63.8 | 15.8 | 79.6 |
| 2031-2032 | 70.5 | 18.0 | 88.5 |
| 2032-2033 | 73.5 | 18.9 | 92.4 |

## 9.5 Incidental Water Impacts

### 9.5.1 Loss of Flow in Streams

Mining activities resulting in a reduction in water levels and/or pressures, can result in a change in gradient between the aquifer and the watercourse, which may reduce the rate at which baseflow occurs or induce additional leakage via increased hydraulic gradients. This effect can be amplified in areas above longwall panels, where surface cracking may increase the permeability of the stream bed and the near-surface strata.

Estimates of predicted baseflow were calculated using the MODFLOW 'ZoneBudget' utility. The change in baseflow due to LW S7A extraction were calculated by comparing the net river flow in the MOD3 scenario against the Approved scenario. The cumulative loss of baseflow was calculated by comparing the MOD3 scenario against the Null scenario (i.e. no mining scenario).

**Table 17** presents a summary of the predicted maximum baseflow loss at several creeks directly related to the LW S7A extraction. Overall, the model predicts insignificant change in baseflow due to LW S7A extraction. The impact in ML/d represents the maximum baseflow impact from any time in the predictive run. The sub-catchments most affected by the Tahmoor South mining operation were predicted to be Dogtrap Creek (0.003 ML/day loss in baseflow). Stonequarry Creek is shown as negative due to a slight increase in baseflow during the recovery period.

**Table 17** shows cumulative baseflow losses due to mining are much greater with Bargo River, Myrtle Creek Nepean River, Dog Trap Creek and Tea Tree Hollow Creek predicted to experience the largest loss in baseflow (between 0.002 to 0.003 ML/day). The most recent estimation of baseflow loss was carried out by HEC (2022), which suggested a range of between 0.2 to 1.4 ML/day of inflow loss in Redbank Creek. **Table 17** shows the predicted inflow loss from the groundwater model is close to the lower bound of baseflow loss estimation for the HEC (2022) study. Compared to the 2020 EIS study, the current model predicts less loss of baseflow in most of the creeks and rivers. Although some rivers are experiencing a loss of baseflow during mining, certain areas, such as Dogtrap Creek,

Stonequarry Creek, and Hornes Creek, might show a small gain in baseflow after recovery due to fracturing.

**Table 17 Maximum predicted baseflow impacts in local watercourses**

| Watercourse | Site Used for Assessment | LW S7A extraction Impact (ML/day) | Cumulative Impact (ML/day) |
|---|---|---|---|
| Eliza Creek | SW-18 | <0.001 | 0.015 |
| Carters Creek | SW-23 | <0.001 | 0.01 |
| Dogtrap Creek | SW-15 | 0.003 | 0.018 |
| Teatree Hollow | SW-22 | 0.002 | 0.02 |
| Cow Creek | SW-24 | <0.001 | 0.003 |
| Stonequarry Creek | 212053 | -0.002 | 0.025 |
| Bargo River | SW-1 | <0.001 | 0.014 |
| Bargo River | SW-13 | 0.002 | 0.034 |
| Bargo River | SW-14 | 0.002 | 0.056 |
| Hornes Creek | SW-9 | 0 | 0.002 |
| Nepean River | SW-21 | <0.001 | 0.144 |
| Matthews Creek | | <0.001 | 0.01 |
| Cedar Creek | | <0.001 | 0.003 |
| Redbank Creek | | <0.001 | 0.007 |
| Avon River | | <0.001 | 0.02 |
| Cordeaux River | | <0.001 | 0.05 |
| Rumker Gully | | <0.001 | <0.001 |
| Myrtle Creek | | <0.001 | 0.02 |
| Dry Creek | | <0.001 | 0.006 |

### 9.5.2 Predicted Potential change in Lake-Aquifer Interaction at Thirlmere Lakes

The connection between shallow groundwater (water table aquifers) and surface water features is governed by the permeability of the aquifer material of any surficial sediments (lake-bed materials), and any head separation between the water body and the underlying aquifer. Declines in groundwater levels due to mining can result in changes in the groundwater-surface water interaction between the lake system and the local groundwater system.

As discussed in **Section 9.3**, the model did not predict drawdown > 1 m to extend to the Thirlmere Lakes as a result of LW S7A extraction. Therefore, negligeable changes (<0.001 ML/d) in the lake leakages to the groundwater system were predicted (**Table 18**). This is consistent with recent findings from the NSW Government Thirlmere Lakes Research Program (TLRP) that found that the historical mining at Tahmoor North (which is much

closer to the lakes than LW S7A) had likely only a negligible to very minor effect on the lake water balance, and consistent with the conclusions of the Tahmoor South EIS.

For the cumulative mining, **Table 18** shows the average reduction in leakage at the Thirlmere Lakes in the predictive space. As shown in the table the largest loss of leakage was predicted for Lake Werri Berri (0.07 ML/day).

**Table 18 Predicted change in Lake Leakage due to mining**

| Lake | LW S7A extraction Impact (ML/day) | LW S7A extraction Impact (% change from approved scenario) | Cumulative Impact (ML/day) |
|---|---|---|---|
| Gandangarra | <0.001 | < 1% | 0.06 |
| Baraba | <0.001 | < 1% | <0.001 |
| Nerrigorang | <0.001 | -2% | 0.05 |
| Werri Berri | 0.001 | < 1% | 0.07 |
| Couridjah | <0.001 | < 1% | 0.02 |

### 9.5.3 Influence on Alluvium

The main alluvial resources in the area includes alluvium associated with Thirlmere Lakes. There were no drawdowns > 1 m predicted in the Thirlmere Lakes alluvium in response to LW S7A extraction. Incremental impact on the alluvium baseflow was estimated at 0.004 ML/d, which represent a negligible change (0.5 %) from the approved scenario.

The loss of flow in alluvium due to the cumulative mining was calculated by comparing the alluvial flows between the Null scenario and LW S7A scenario. The predicted loss of flow in the Thirlmere Lakes alluvium was 0.3 ML/day which is likely to due to the mining activities in Tahmoor North and Western Domain.

## 9.6 Predicted Drawdown in Private Bores

**Table 19** presents a list of the bores identified in the project bore census (CES, 2022) and presents the simulated drawdown impact at each. The location of the bore investigated in the bore census are shown in *Figure 3-9* of the conceptual report (SLR, 2022), and discussed in Section **6.4**. It should be noted that the drawdown values in **Table 19** are the maximum impact at any given point in time in the predictive model. These tables are restricted to listing those bores that were modelled in the 2020 ESI study as being potentially impacted upon (cumulative or otherwise) more than the AIP criterion of 2 m maximum cumulative drawdown.

As shown in **Table 19**, there are 13 bores with maximum predicted drawdown of greater than 2 m due to LW S7A extraction.

**Table 19 Modelled maximum impact on private groundwater bores from the project bore census.**

| Bore | Easting | Northing | Model Layer | LW S7A extraction Impact (m) | Cumulative Mining Impact (m) |
|---|---|---|---|---|---|
| GW109257 | 276603.8 | 6205057.0 | 5 | 7.74 | 31.78 |

| Bore | Easting | Northing | Model Layer | LW S7A extraction Impact (m) | Cumulative Mining Impact (m) |
|---|---|---|---|---|---|
| GW032443 | 276427.0 | 6206329.0 | 5 | 3.97 | 30.88 |
| GW104323 | 276241.6 | 6206412.0 | 4 | 3.95 | 22.23 |
| GW014262 | 276764.0 | 6204587.0 | 3 | 7.74 | 28.69 |
| GW111810 | 277035.4 | 6204405.0 | 5 | 6.51 | 32.65 |
| GW104659 | 276616.0 | 6207392.0 | 5 | <2 | 26.77 |
| GW007445 | 277437.0 | 6204264.0 | 5 | 5.38 | 33.10 |
| GW103615 | 279634.6 | 6204110.0 | 4 | 3.17 | 23.25 |
| GW110669 | 274570.4 | 6207928.0 | 5 | 2.88 | 25.74 |
| GW058634 | 279446.1 | 6203408.0 | 4 | 3.08 | 24.09 |
| GW111669 | 279262.7 | 6203321.0 | 4 | 3.16 | 24.21 |
| GW102179 | 279262.7 | 6203321.0 | 5 | 3.01 | 36.13 |
| GW105395 | 278546.8 | 6203033.0 | 4 | 3.90 | 25.52 |
| GW111047 | 280015.0 | 6206037.0 | 5 | <2 | 7.04 |
| GW031294 | 279732.0 | 6205706.0 | 4 | <2 | 6.78 |
| GW070245 | 280043.3 | 6205645.0 | 4 | <2 | 6.10 |
| GW102344 | 280250.8 | 6206554.0 | 4 | <2 | 6.36 |
| GW053449 | 280369.0 | 6205813.0 | 4 | <2 | 5.82 |
| GW104008 | 280359.0 | 6205978.0 | 5 | <2 | 5.90 |
| GW106590 | 280442.0 | 6206344.0 | 5 | <2 | 6.15 |
| GW054146 | 279879.6 | 6204679.0 | 4 | <2 | 5.29 |
| GW105577 | 280728.0 | 6207041.0 | 5 | <2 | 4.25 |
| GW108538 | 281155.0 | 6205941.0 | 4 | <2 | 4.53 |
| GW062068 | 276572.8 | 6209556.0 | 5 | 6.14 | 30.37 |
| GW057969 | 281351.1 | 6206122.0 | 4 | <2 | 4.24 |
| GW051877 | 281673.0 | 6205875.0 | 4 | <2 | 4.12 |
| GW100455 | 281877.0 | 6207020.0 | 4 | <2 | 3.16 |

# 10.0 Groundwater Solute Transport Model Predictions

## 10.1 Post Closure Mass Balance

The mass balance for TDS indicates that the total injected mass through the wells is 10,580 tonnes (MOD3) and 11,898 tonnes (approved). The predicted mass to be injected is 10,420 tonnes (MOD3) and 11,200 tonnes (approved) (see **Table 20**). This is a conservative assumption due to approximations in the quarterly injection schedule.

At post closure equilibrium, the only active components are mass storage and river leakage. Mass storage is by far the largest contributor, showing that on average 30.6 kg/d (cumulative) and 36.2 kg/d (approved) of mass is exchanged within the model cells. 4 kg/d of TDS is removed through the river cells for the cumulative model (**Table 20**) and 4.1 kg/d for the approved model (**Table 21**). Thus, the cumulative model predicts a reduction in TDS discharge to the river.

**Table 20 TDS mass balance – post closure (SP 310) – MOD3**

| Package | Total in (kg) | Total out (kg) | SP 310 rate in (kg/d) | SP 310 rate out (kg/d) |
|---|---|---|---|---|
| Mass Storage | $3.23 \times 10^{+07}$ | $4.27 \times 10^{+07}$ | 30.60 | 26.6 |
| Constant Head Mass Flux | 0.00 | 0.00 | 0.00 | 0.00 |
| Wells Mass Flux | $1.06 \times 10^{+07}$ | 0.00 | 0.00 | 0.00 |
| General Head Boundary Mass Flux | 0.00 | 0.00 | 0.00 | 0.00 |
| Drains Mass Flux | 0.00 | 0.00 | 0.00 | 0.00 |
| River Leakage Mass Flux | 0.00 | $1.95 \times 10^{+05}$ | 0.00 | 4.00 |
| Evapotranspiration Mass Flux | 0.00 | 0.00 | 0.00 | 0.00 |
| Recharge Mass Flux | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | $4.29 \times 10^{+07}$ | $4.29 \times 10^{+07}$ | 30.60 | 30.60 |
| % Error | <0.1% | | <0.1% | |

**Table 21 TDS mass balance – post closure (SP 310) - approved**

| Package | Total in (kg) | Total out (kg) | SP 310 rate in (kg/d) | SP 310 rate out (kg/d) |
|---|---|---|---|---|
| Mass Storage | $3.50 \times 10^{+07}$ | $4.67 \times 10^{+07}$ | 36.17 | 32.04 |
| Constant Head Mass Flux | 0.00 | 0.00 | 0.00 | 0.00 |
| Wells Mass Flux | $1.19 \times 10^{+07}$ | 0.00 | 0.00 | 0.00 |
| General Head Boundary Mass Flux | 0.00 | 0.00 | 0.00 | 0.00 |
| Drains Mass Flux | 0.00 | 0.00 | 0.00 | 0.00 |
| River Leakage Mass Flux | 0.00 | $1.90 \times 10^{+05}$ | 0.00 | 4.13 |
| Evapotranspiration Mass Flux | 0.00 | 0.00 | 0.00 | 0.00 |

| Package | Total in (kg) | Total out (kg) | SP 310 rate in (kg/d) | SP 310 rate out (kg/d) |
|---|---|---|---|---|
| Recharge Mass Flux | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | $4.69x10^{+07}$ | $4.69x10^{+07}$ | 36.17 | 36.17 |
| % Error | <0.1% | | <0.1% | |

## 10.2 TDS Concentrations

Maximum incremental changes to background salinity levels (as TDS) during the recovery period (i.e. from end of mining to 550 years post mining) are shown for the HBSS upper (outcropping) (Layer 3), HBSS Lower (Layer 5), SBSS (Layer 11) and the mine working/Bulli Seam (Layer 42) in **Figure 43** (MOD3 scenario) and **Figure 44** (approved scenario).

At the mine working elevation (i.e. Bulli Seam elevation) the plume migrates horizontally from the underground workings towards the Bulli seam (Layer 15), see **Figure 43** (MOD3 scenario) and **Figure 44** (approved scenario).

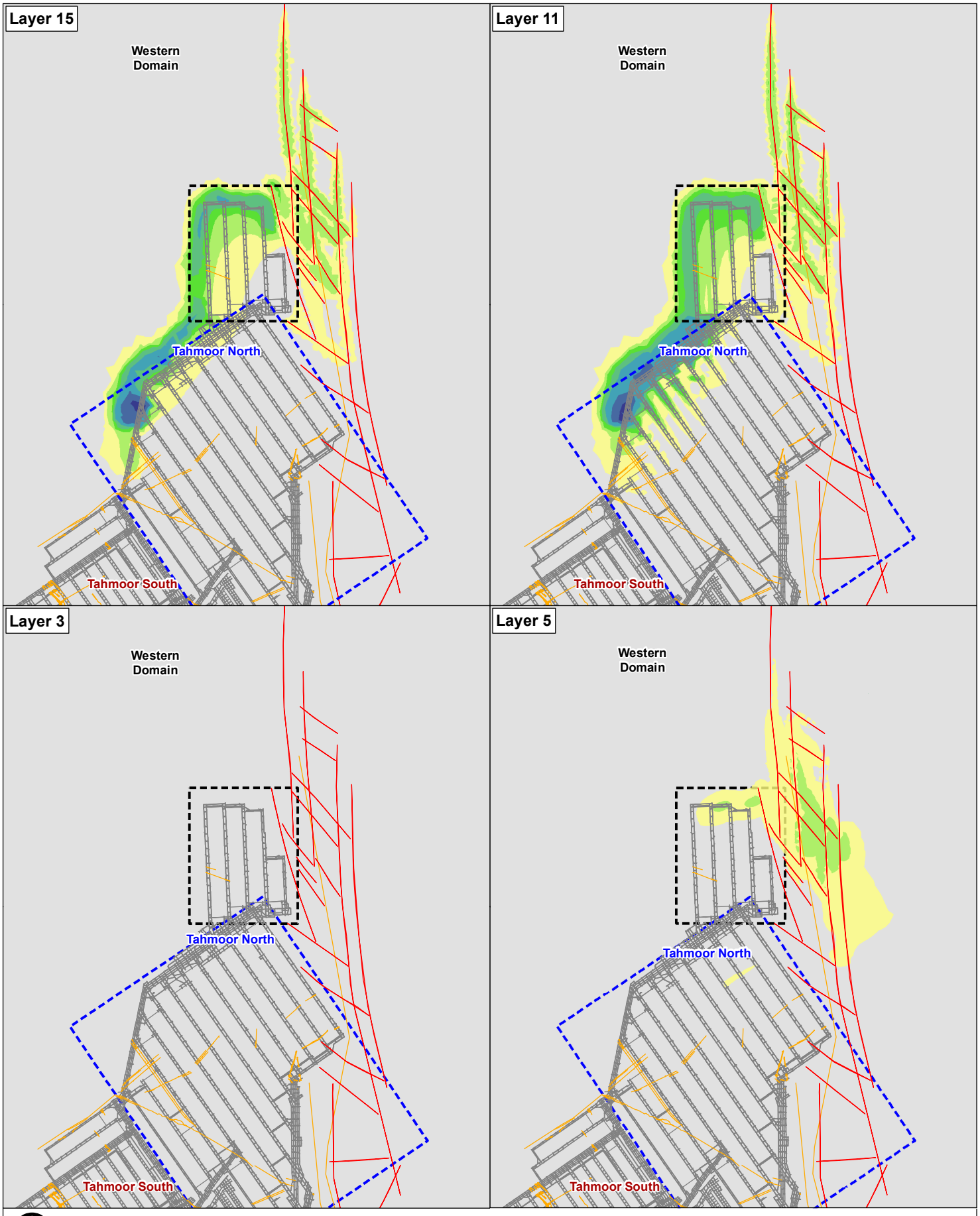
Upward migration of the plume is strictly confined to the faults and the mine workings, within the Western Domain goaf area and the northern part of the Nepean Fault complex being the main pathways to the HBSS.

The diluted plume front starts migrating to the HBSS approximately 220 years post-mining (Layer 5 - in **Figure 43** and **Figure 44**) due to the development of an upward vertical gradient. After 550 years post-mining, the salinity plume in the HBSS is only present in the Western Domain and within the northern area of the Nepean Fault complex, in concentration < 200 mg/L in the lower HBSS (Layer 5 in **Figure 43** and **Figure 44**) and < 20mg/L in the middle and upper HBSS ((Layer 4 and Layer 3 in **Figure 43** and **Figure 44**).

It is noted that the plume in the HBSS starts decreasing after 500 years as it migrates and gets diluted and dispersed along the flow path (**Figure 45**).

A cross section along the northern Nepean Fault complex, where the highest concentration is present in the HBSS is shown on **Figure 46**. The cross section shows that at outcrop (i.e. Layer 3), the maximum incremental TDS in the HBSS is less than 10 mg/L, which is less than natural variations experienced at monitoring bores within the Western Domain. In layer 1 (Regolith, alluvium and basalt), which is associated with rivers and creeks bed, simulated concentrations are also less than 10 mg/L, thus the impacts to waterways are predicted to be negligible. There are no private bores located in areas where the maximum incremental TDS is predicted to be > 10 mg/L (i.e. lower HBSS for the northern tip of the Western Domain goaf area and the northern part of the Nepean Fault complex).

Consequently, the model does not predict impacts to GDEs or private bores.




0 1 2 km

| | |
|---|---|
| Coordinate System: | GDA 1994 MGA Zone 56 |
| Scale: | 1:85,000 at A4 |
| Project Number: | 620.040109.00001 |
| Date: | 12-Apr-2024 |
| Drawn by: | AS |

Mine Plan
Faults
Geological Structures (2019)
Tahmoor North
Tahmoor South
Western Domain

**Max Incremental TDS Concentration (mg/L)**

- 10 - 100
- 100 - 250
- 250 - 500
- 500 - 1000
- 1000 - 2500
- 2500 - 5000
- 5000 - 10000

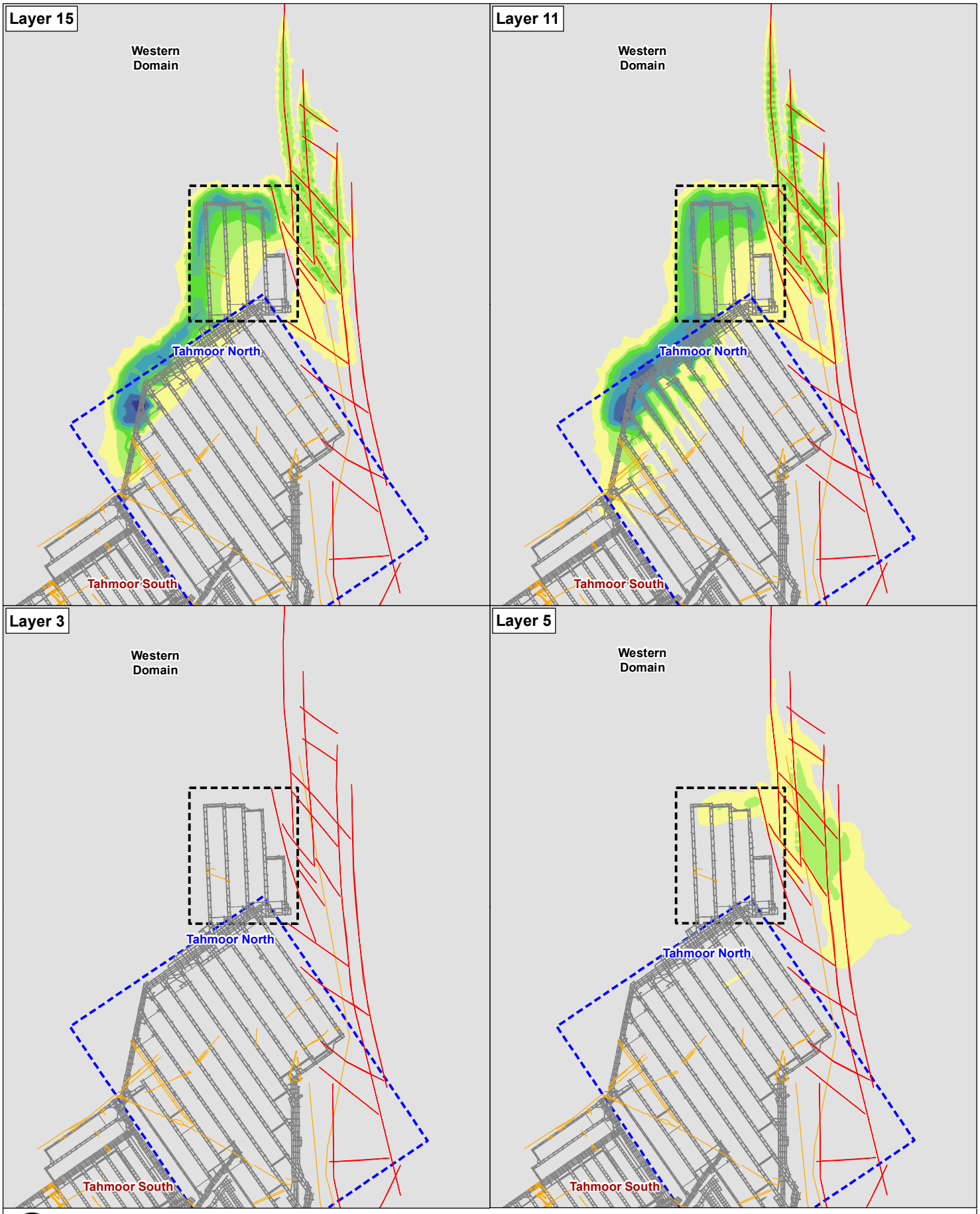
# TAHMOOR SOUTH MODIFICATION 3

## SALINITY (TDS) PLUME PROGRESSION POST MINING EQUILIBRIUM MOD3 SCENARIO

SLR

**FIGURE 43**

\\au.slr.local\corporate\Projects-SLR\640-MEL\620.040109.00001 Tahmoor South Modification 3 G\06 SLR Data\01 CAD\GIS\GIS\Groundwater Modelling\620040109 TAHMOOR GW MOD F08-01 Salinity (TDS) Plume Progression – MOD3 Scenario.mxd




0 1 2 km

| | |
|---|---|
| Coordinate System: | GDA 1994 MGA Zone 56 |
| Scale: | 1:85,000 at A4 |
| Project Number: | 620.040109.00001 |
| Date: | 12-Apr-2024 |
| Drawn by: | AS |

Mine Plan
Faults
Geological Structures (2019)
Tahmoor North
Tahmoor South
Western Domain

**Max Incremental TDS Concentration (mg/L)**

- 10 - 100
- 100 - 250
- 250 - 500
- 500 - 1000
- 1000 - 2500
- 2500 - 5000
- 5000 - 10000

# TAHMOOR SOUTH MODIFICATION 3

## SALINITY (TDS) PLUME PROGRESSION POST MINING EQUILIBRIUM APPROVED SCENARIO

SLR

**FIGURE 44**

\\au.slr.local\corporate\Projects-SLR\640-MEL\620.040109.00001 Tahmoor South Modification 3 G\06 SLR Data\01 CAD\GIS\GIS\Groundwater Modelling\620040109 TAHMOOR GW MOD F08-02 Salinity (TDS) Plume Progression – Approved Scenario.mxd

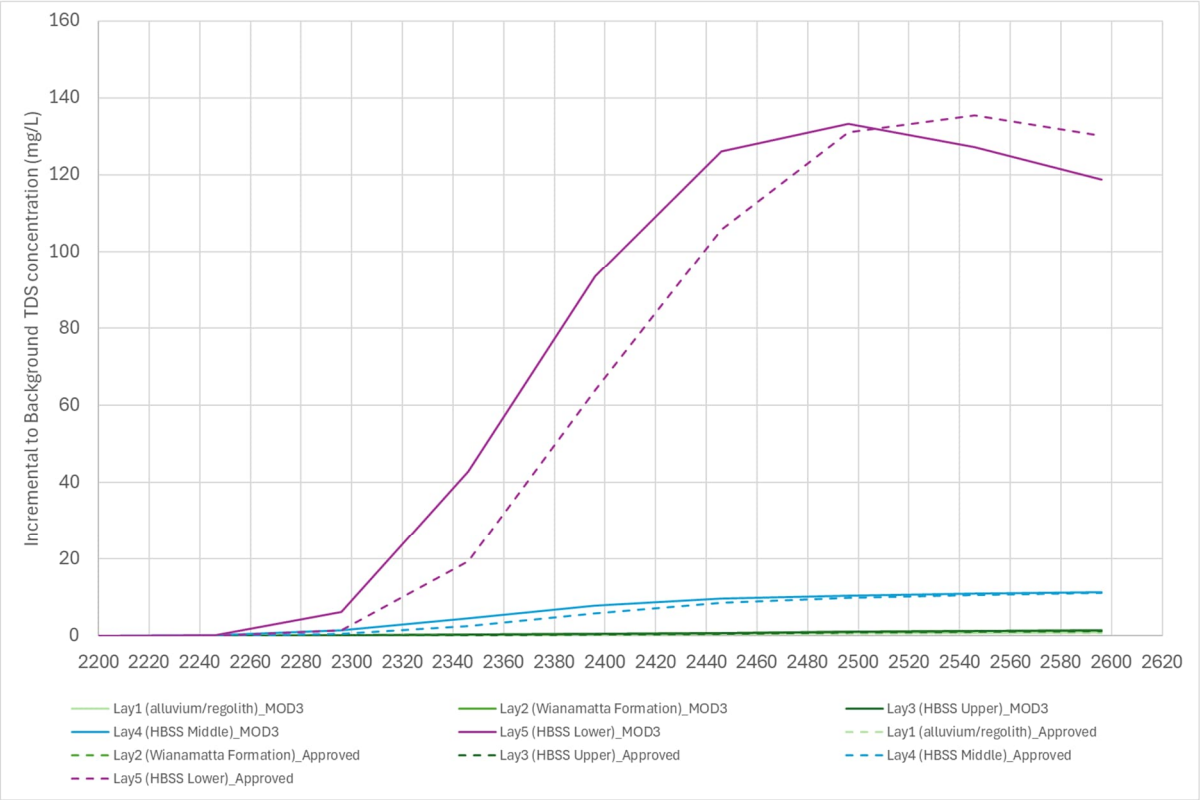



**Figure 45 TDS time-series – Western Domain / Stonequarry Creek**

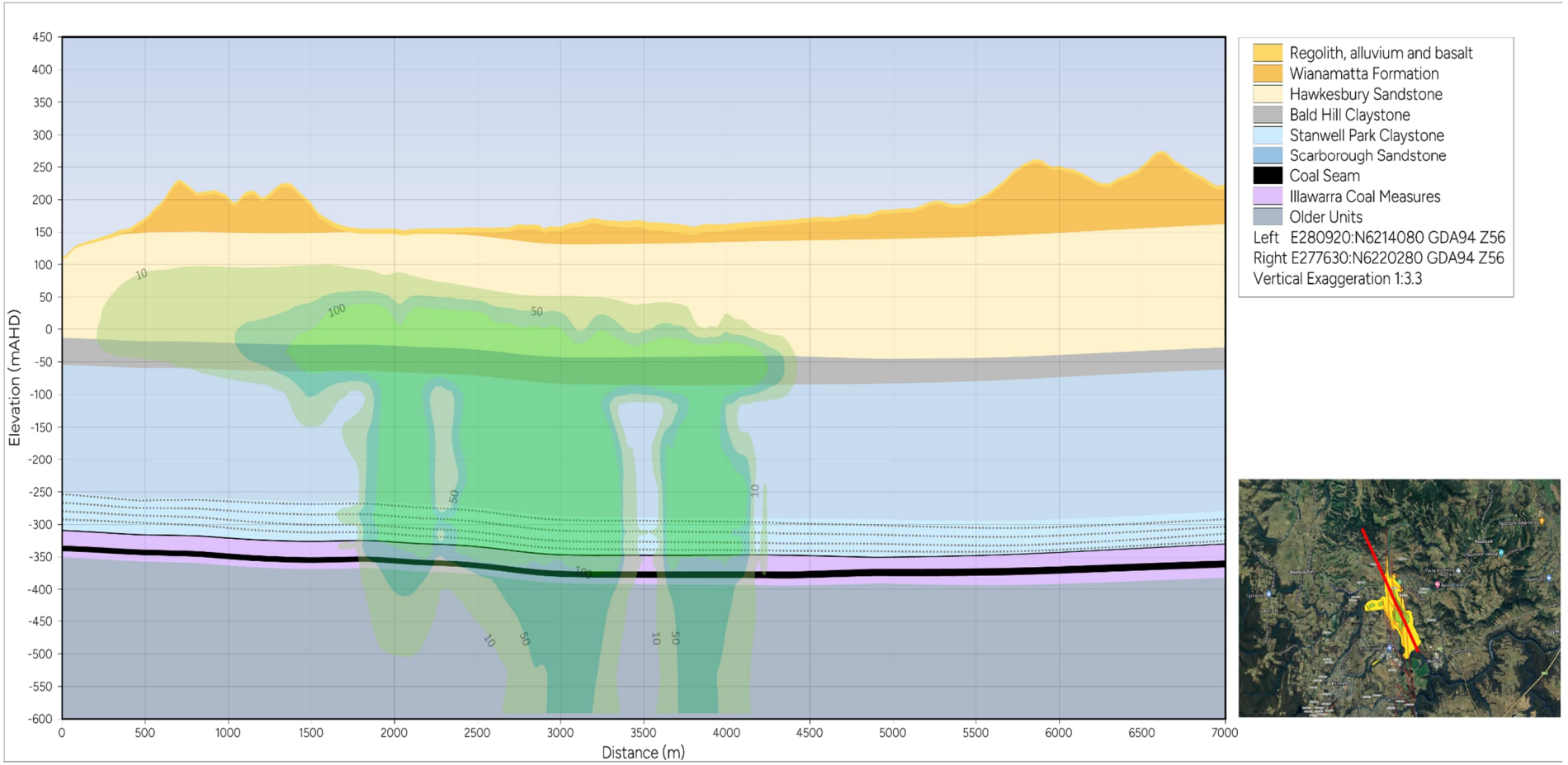



**Figure 46 TDS – Nepean Fault North – 550 years post mining (MOD3 scenario)**

## 10.3 Summary of findings

There is a limited difference in total mass injected between the approved and MOD3 scenarios (7% less mass for the MOD3 scenario). Mapped TDS concentrations are similar between both scenarios. TDS mass discharge to surface water feature is slightly less in the MOD3 scenario when comparted to the approved scenario. Consequently, the transport modelling documented in this report did not predict any incremental impacts associated with new brine injection schedule.

The transport modelling work predicts that the Project is not expected to impact on environmental receptors. Solutes are likely to migrate upward following recovery and the development of an upward hydraulic gradient between the mine and the water table. Preferential pathways for solute migration are the goaf areas of the Western Domain and the eastern fault lines.

The model predicts that solutes at concentrations of potential concern may reach the lower HBSS but will remain near the mine boundary, primarily within the Western Domain and the eastern fault lines area. Solutes reaching the middle and upper HBSS were assessed to be too low in concentration to present a risk to environmental receptors.

### 10.3.1 NSW AIP

As discussed in Section **2.1.2**, the NSW AIP, as it pertains specifically to groundwater quality for Highly Productive Fractured Aquifer, is pertinent to this study, primarily the following minimal impact considerations:

- Any change to the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.
- If condition 1 is not met, then appropriate studies will need to demonstrate to the Ministers satisfaction that the change in groundwater quality will not prevent the long-term viability of the groundwater dependent ecosystem significant site or affected water supply work.

As the groundwater modelling indicates that after 550 years post mining, the salinity plume is only present directly above the Western Domain and the eastern fault lines area, in concentration < 200 mg/L in the lower HBSS, whilst in the upper (outcropping) HBSS the maximum incremental TDS in the HBSS is less than 10 mg/L, there is no discernible change in the beneficial use of the groundwater. The predicted changes in the upper HBSS are within the natural variations experienced at monitoring bores within the Western Domain.

In layer 1 (Regolith, alluvium and basalt), which is associated with rivers and creeks bed, simulated concentrations are also less than 10 mg/L, thus the impacts to waterways are predicted to be negligible. There are no private bores located in areas where the maximum incremental TDS is predicted to be > 10 mg/L.

# 11.0 Monitoring and Management Regimes

## 11.1 Groundwater Monitoring Network

A targeted groundwater monitoring network has been developed and approved for the current approved operations at Tahmoor South. The network answers to the requirement of the Consent Conditions and EIS Commitments in addition to the providing monitoring pertinent to the key receptors identified. The Tahmoor South Monitoring Network currently consists of a series of multi-level Vibrating Wire Piezometers (VWPs), Open standpipes (OSPs) and private bores. The open standpipes can be used for monitoring water levels manually or with an automated datalogger (installed in 10 sites to date), as well as for collection of water samples for groundwater quality monitoring purposes. The VWPs are grouted and therefore can only be used for monitoring groundwater pressures but do allow for multiple instruments to be installed at different depths within a single borehole.

Groundwater monitoring has commenced across all Tahmoor South monitoring sites for both groundwater levels and groundwater quality. Groundwater monitoring is undertaken in accordance with the relevant Australian Standards legislation and EPA approved methods for sampling, including (but not limited to):

- NSW DECC (2004) Approved Methods for Sampling and Analysis of Water Pollutants in New South Wales.
- AS/NZS 5667.1:1998 Water Quality – Sampling – Guidance on the Design of Sampling Programs, Sampling Techniques, and the Preservation and Handling of Samples.
- AS/NZS 5667.11:1998 Water Quality - Sampling - Guidance on Sampling of Groundwaters.

Analytes included in the groundwater quality monitoring suite, are;

- Electrical conductivity (EC), Total Dissolved Solids (TDS), Dissolved Oxygen (DO);
- Nutrients (Total N, Total P);
- Major Ions (Ca, Cl, K, Na, $SO_4$, $HCO_3$, F);
- Total Alkalinity, Bicarbonate Alkalinity, Carbonate Alkalinity, Hydroxide Alkalinity; and
- Total (Fe, Mn) and dissolved metals (Fe, Mn, Cu, Pb, Zn, Ni, Al, As, Se, Li, Sr, Co).

This monitoring network is summarised in **Table 22** and **Table 23** and presented on **Figure 47**.

**Figure 47** also shows the predicted maximum drawdown to occur in the water table. The spatial distribution of the network is suitable for monitoring this drawdown.

Overall, the monitoring network is suitable to monitor for potential impacts from the incremental increase due to the extraction of LW S7A. There is no additional monitoring required.

**Table 22 Tahmoor South groundwater monitoring network**

| ID | Type | Easting | Northing | Aquifer Monitored |
|---|---|---|---|---|
| P50A | OSP | 274203.785 | 6209099.692 | HBSS |

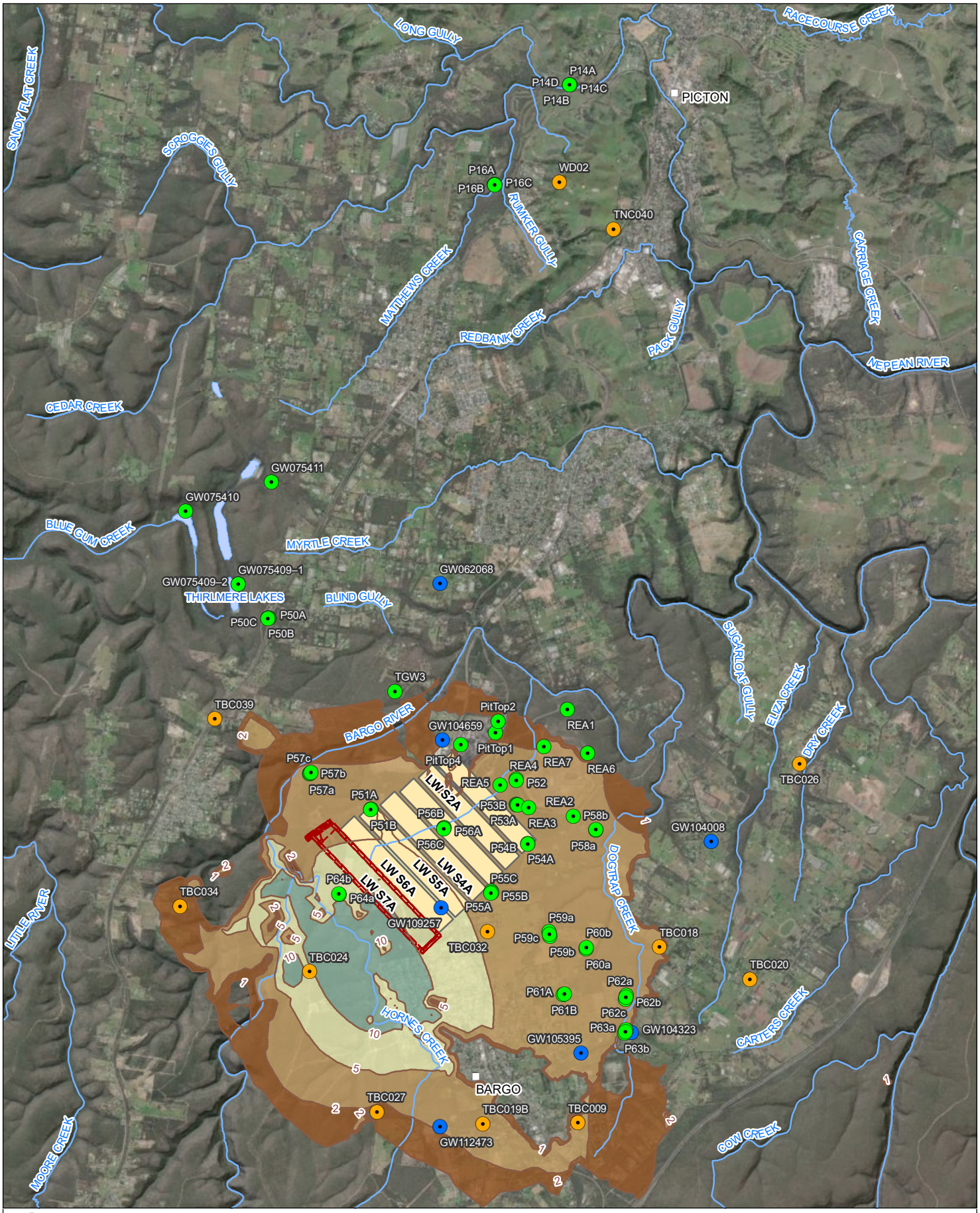
| ID | Type | Easting | Northing | Aquifer Monitored |
|---|---|---|---|---|
| P50B | OSP | 274191.154 | 6209101.903 | HBSS |
| P50C | OSP | 274181.203 | 6209095.28 | HBSS |
| P51A | OSP | 275623 | 6206431.71 | HBSS |
| P51B | OSP | 275620.6 | 6206419.68 | HBSS |
| P52 | OSP | 277649.841 | 6206848.299 | HBSS |
| P53A | OSP | 277649.91 | 6206496.48 | HBSS |
| P53B | OSP | 277658.61 | 6206492.5 | HBSS |
| P53C | OSP | 277665.8 | 6206489.23 | HBSS |
| P54A | OSP | 277809.68 | 6205951.98 | HBSS |
| P54B | OSP | 277806.92 | 6205944.68 | HBSS |
| P55A | OSP | 277297.77 | 6205283.12 | HBSS |
| P55B | OSP | 277303.32 | 6205270.96 | HBSS |
| P55C | OSP | 277296.45 | 6205262.51 | HBSS |
| P56A | OSP | 276645.55 | 6206175.36 | HBSS |
| P56B | OSP | 276639.18 | 6206166.92 | HBSS |
| P56C | OSP | 276637.06 | 6206154.37 | HBSS |
| P61A | OSP | 278303.67 | 6203846.01 | HBSS |
| P61B | OSP | 278319.91 | 6203848.48 | HBSS |
| REA4 | OSP | 277650.772 | 6206835.256 | HBSS |
| GW062068 | Private Bore | | | HBSS |
| GW104008 | Private Bore | 280367.872 | 6205979.363 | HBSS |
| GW104323 | Private Bore | 279255.685 | 6203320.523 | HBSS |
| GW104659 | Private Bore | 276617.689 | 6207394.512 | HBSS |
| GW105395 | Private Bore | 278547.393 | 6203031.514 | HBSS |
| GW109257 | Private Bore | 276601.479 | 6205057.613 | HBSS |
| GW112473 | Private Bore | 276584.649 | 6202001.573 | HBSS |
| TBC009 | VWP | 278511 | 6202058 | HBSS, BHCS, BGSS, WBCS, BUCO, WWCO |
| TBC018 | VWP | 279645 | 6204509 | HBSS, BHCS, BGSS, WBCS, BUCO, WWCO |
| TBC020 | VWP | 280909 | 6204059 | HBSS, BHCS, BGSS, WBCS, BUCO, WWCO |
| TBC024 | VWP | 274763 | 6204163 | HBSS, BHCS, BGSS, WBCS, BUCO, WWCO |
| TBC026 | VWP | 281603 | 6207068 | HBSS, BHCS, BGSS, WBCS, BUCO, LRSS, WWCO |
| TBC027 | VWP | 275708 | 6202210 | HBSS, BHCS, BGSS, WBCS, BUCO, WWCO |
| TBC032 | VWP | 277244 | 6204725 | HBSS, BHCS, BGSS, WBCS, BUCO, WWCO |
| TBC034 | VWP | 272956 | 6205076 | HBSS, BHCS, BGSS, WBCS, BUCO, WWCO |
| TBC039 | VWP | 273445 | 6207688 | HBSS, BACS, BGSS |
| TBC019B | VWP | 277182.99 | 6202043.11 | HBSS, BHCS, BGSS |
| GW075409–1 | OSP | 273772 | 6209569 | Thirlmere Lakes Alluvium |
| GW075409–2 | OSP | 273772 | 6209569 | Thirlmere Lakes Alluvium |
| GW075410 | OSP | 273034 | 6210587 | Thirlmere Lakes Alluvium |

| ID | Type | Easting | Northing | Aquifer Monitored |
|---|---|---|---|---|
| GW075411 | OSP | 274232 | 6210996 | Thirlmere Lakes Alluvium |
| P14A | OSP | 278398.395 | 6216535.939 | Alluvium/colluvium |
| P14B | OSP | 278392.634 | 6216534.283 | HBSS |
| P14C | OSP | 278397.198 | 6216541.805 | HBSS |
| P14D | OSP | 278391.419 | 6216540.042 | HBSS |
| P16A | OSP | 277350.491 | 6215146.748 | HBSS |
| P16B | OSP | 277349.931 | 6215140.441 | HBSS |
| P16C | OSP | 277347.341 | 6215135.266 | HBSS |
| TNC040 | VWP | 279003.56 | 6214520.88 | WMFM,HBSS, BGSS,BUCO |
| WD02 | VWP | 278245.463 | 6215178.271 | HBSS, BACS, BGSS |
| TGW3 | OSP | 275956 | 6208076 | HBSS |
| P64a | OSP | 275177.27 | 6205234.86 | HBSS |
| P64b | OSP | 275171.68 | 6205255.5 | HBSS |
| P57a | OSP | 274763.04 | 6206922.92 | HBSS |
| P57b | OSP | 274771.63 | 6206937.57 | HBSS |
| P57c | OSP | 274782.19 | 6206944.85 | HBSS |
| P58a | OSP | 278757.09 | 6206140.16 | HBSS |
| P58b | OSP | 278759.26 | 6206147.33 | HBSS |
| P59a | OSP | 278106.34 | 6204718.99 | HBSS |
| P59b | OSP | 278120.56 | 6204654.39 | HBSS |
| P59c | OSP | 278113.25 | 6204685.73 | HBSS |
| P60a | OSP | 278621.74 | 6204479.97 | HBSS |
| P60b | OSP | 278626.55 | 6204501.99 | HBSS |
| P62a | OSP | 279182.94 | 6203830.66 | HBSS |
| P62b | OSP | 279171.13 | 6203782.13 | HBSS |
| P62c | OSP | 279179.28 | 6203810.48 | HBSS |
| P63a | OSP | 279179.6 | 6203354.73 | HBSS |
| P63b | OSP | 279161.26 | 6203310.52 | HBSS |
| P63c | OSP | 279171.29 | 6203330.85 | HBSS |

## Table 23 REA and pit-top piezometers

| Bore ID | Easting | Northing | Status | Targeted Aquifer | Type | Depth |
|---|---|---|---|---|---|---|
| REA1 | 278362.3 | 6207826.8 | Active | REA | OSP | 54.8 |
| REA2 | 278441.2 | 6206332.2 | Active | REA | OSP | 58 |
| REA3 | 277820.7 | 6206453.4 | Active | REA | OSP | 41 |
| REA4 | 277650.8 | 6206835.2 | Active | REA | OSP | 57.5 |
| REA5 | 277424.2 | 6206769.0 | Active | REA | OSP | 7.2 |
| REA6 | 278643.3 | 6207214.8 | Active | REA | OSP | 46.3 |
| REA7 | 278035.1 | 6207307.3 | Active | REA | OSP | 43 |

| Bore ID | Easting | Northing | Status | Targeted Aquifer | Type | Depth |
|---|---|---|---|---|---|---|
| PitTop1 | 277357.6 | 6207494.9 | Active | pit-top | OSP | 55.04 |
| PitTop2 | 277396.0 | 6207663.2 | Active | pit-top | OSP | 6.85 |
| PitTop4 | 276872.2 | 6207331.6 | Active | pit-top | OSP | 33.7 |




0 1 2 km

| | |
|---|---|
| Coordinate System: | GDA 1994 MGA Zone 56 |
| Scale: | 1:70,000 at A4 |
| Project Number: | 620.040109.0001 |
| Date: | 06-May-2024 |
| Drawn by: | RB |

Minor Town
Watercourses
Proposed LW S7A
Lakes

**Tahmoor South Mine Plan**

Approved

**Groundwater Monitoring Network**

OSP
Private Bore
VWP

Drawdown Contour (m)

**Drawdown (m)**

1 - 2
2 - 5
5 - 10
10 - 20
20 - 50

# TAHMOOR SOUTH MODIFICATION 3

## TAHMOOR SOUTH GROUNDWATER MONITORING NETWORK AND MAXIMUM WATER TABLE DRAWDOWN

FIGURE 47

H:\Projects-SLR\640-MEL\620.040109.00001 Tahmoor South Modification 3 G\06 SLR Data\01 CADG\SIG\S\Impact Assessment\620040109 TAHMOOR IAR F47 Tahmoor South Groundwater Monitoring Network and Maximum Water Table Drawdown.mxd

## 11.2 Groundwater Management Plan and Water Management Plan

The Groundwater Management Plan (GWMP) and site Water Management Plan (WMP) are designed in accordance with the Consent Conditions and provide for adaptive and ongoing management of the groundwater. Key elements of the Plans as they pertain to this Modification are discussed in greater detail in the following sub-sections.

### 11.2.1 Trigger Action Response Plans (TARPS)

TARPs for Tahmoor South were established in the Tahmoor South Water Management Plan (WMP) (Tahmoor Coal, 2022) to manage and protect surface water and groundwater within the vicinity of Tahmoor South.

Six TARPs (WMP8 – WMP13) address various components of the groundwater system, and these are presented in **Appendix A**. Tahmoor South groundwater monitoring sites are captured in the following TARPs:

- WMP8 Shallow Groundwater Level (Open Standpipes and Private Bores),
- WMP9 Shallow Groundwater Pressure (Vibrating Wire Piezometer (VWP) Sensors <200 m Depth),
- WMP10 Groundwater Pressure Deep (VWP Sensor >200 m Depth, excluding monitoring the Bulli Coal Seam),
- WMP11 Groundwater Quality (Open Standpipes and Private Bores),
- WMP12 Groundwater-Surface Water Interaction, and
- WMP13 Groundwater Monitoring Bores for Thirlmere Lakes.

These TARPS are developed such that they will capture potential impacts from this Modification. It is not envisaged that amendments to the TARPs are required.

However, resulting on the update of the groundwater model, the trigger levels will require revision where they are dependent on model predictions (i.e. WMP10 is dependent on model drawdown predictions to establish trigger levels).

### 11.2.2 Private Bore Ameliorative Actions

The monitoring network described above, provides water level and quality data at an adequate spatial and temporal scale to undertake investigations into potential impacts to existing groundwater users. The TARPS provide pathways for enacting ameliorative action as required. These remain fit-for-purpose with the proposed Modification.

The existing make-good actions for private bores, as it is currently detailed in the Tahmoor South WMP, is reproduced in the following sub-section to present the detail.

#### 11.2.2.1 Make Good Process

In accordance with Condition B26 – B29 of the Tahmoor South Domain Consent (SSD 8445), where a mining related impact has occurred at a private bore, Tahmoor Coal will implement a make good process.

Tahmoor Coal has been implementing this process during the life of Tahmoor/Tahmoor North. The process allows for bore owners to apply to Tahmoor Coal if they believe their bore's level or water quality has declined triggering an assessment into the potential cause (i.e. mining related). If it is deemed that the mine is responsible, then remedial action would be implemented, potentially deepening and/or replacing bores and wells, and/or providing an alternative water source to affected users.

The make good process would be staged by Tahmoor Coal in accordance with the proposed mining schedule and the results of predictive groundwater modelling. Contact has been made with landholders whose registered bores are predicted to incur a drawdown of greater than 2 m, as per the NSW Aquifer Interference Policy (AIP) criterion, or whose bores are at risk of subsidence related impacts. Following this initial contact with landholders, where access was granted a baseline field survey has been completed to verify bore details – location, depth, condition of bore and pump, standing water levels, groundwater quality and usage (where possible). Survey findings have been provided to the landholder so that they have the same baseline information as Tahmoor Coal. This information has provided both parties with a thorough understanding of the current bore condition and a reference point for comparison with subsequent bore assessments as mining progresses. The verified bore data has also been included in the recent update of the groundwater model.

In the event that a mining-related impact to a private bore has been confirmed and any further potential impacts are understood (based on groundwater modelling), the landholder and Tahmoor Coal would negotiate a make good agreement. This agreement would include specific make good mitigation measures and outline a potential timeframe for undertaking these measures, if required. The make good agreement would include and consider the conditions of any development consents, the provisions of the AIP and the NSW Coal Mine Subsidence Compensation Act 2017.

There are several make good options that may be adopted, based on the details and characteristics of an individual bore and the extent of mining-induced impacts. These mitigation measure options include:

- Bore maintenance where physical adjustments and regular maintenance of the bore(s) are required to return them to pre-mining conditions. This could include re-establishment of saturated thickness in the affected bore(s) through extending the depth of the pump, or deepening of the bore(s) to return yield to pre-mining conditions;
- Replacement of bore(s) to provide a yield at least equivalent to the yield of the affected bore prior to mining. This may be required where deepening of an existing bore is not possible (e.g. the bore has partially collapsed or the bore hole is not straight or vertical);
- Provision of access to an alternative source of water or compensatory water supply. This option may be offered while other measures are being undertaken and could include connection to the town water supply or the provision of on-site storage (e.g. dam or water tanks); or
- Compensation to reflect increased water extraction costs (e.g. due to lowering pumps or installation of additional or alternative pumping equipment).

Equivalent water supply should be provided (at least on an interim basis) as soon as practicable after the loss is identified, unless otherwise agreed with the landowner. The

burden of proof that any loss of water supply is not due to mining impacts rests with Tahmoor Coal, in accordance with Condition B27 of SSD 8445.

If there is a dispute as to whether the loss of water is to be attributed to the development or the measures to be implemented, or there is a dispute about the implementation of these measures, then either party may refer the matter to the Planning Secretary for resolution, in accordance with Condition B28 of SSD 8445. If Tahmoor Coal is unable to provide an alternative long-term supply of water, compensation will be provided to the affected landowner, to the satisfaction of the Planning Secretary.

### 11.2.3 Numerical Groundwater Model Update

As per the Consent Conditions, the groundwater model is to be validated periodically via comparison of monitoring results with modelled predictions. It is stated that '*Re-calibration will occur as necessary, and an independent review of the model will occur every three years*'.

This model update has undertaken a re-calibration to the most recent available data, and is undergoing full peer review. Again, aligned with completion of model re-calibration the trigger levels dependent on modelling outputs will be reviewed and updated as necessary.

## 11.3 Water Access Licence Requirements – Groundwater Take

The objective of the Water Management Act 2000 (WM Act) is to enable sustainable and integrated management of the state's water for the benefit of both present and future generations. The WM Act recognises the need to allocate and provide water for the environment while providing security to stock and domestic users and licence holders.

As discussed in **Section 2.1**, Tahmoor Mine falls within the 'Greater Metropolitan Region Groundwater Sources' WSP (NOW, 2011b), which commenced in 2011. A WSP is used to manage the average long-term annual volume of water extracted from a given groundwater source.

The relevant Groundwater Source for the Tahmoor Mine is:

- Sydney Basin Nepean Groundwater Source.

The Sydney Basin Nepean Groundwater Source is further subdivided into Management Zones (MZ), of which the LW S7A Study Area lies within Nepean Management Zone 2.

Tahmoor Coal is required to licence the predicted volume of water taken from both groundwater and surface water sources in accordance with the NSW Aquifer Interference Policy (AIP) (NoW 2012) and the WM Act.

The NSWP AIP (NoW 2012) states:

> *A water licence is required under the Water Management Act 2000 (unless an exemption applies or water is being taken under a basic landholder right) where any act by a person carrying out an aquifer interference activity causes:*
>
> - *the removal of water from a water source; or*
> - *the movement of water from one part of an aquifer to another part of an aquifer; or*

- *the movement of water from one water source to another water source, such as:*
  - *from an aquifer to an adjacent aquifer; or*
  - *from an aquifer to a river/lake; or*
  - *from a river/lake to an aquifer.*

Consequently, licencing is required for the s water directly taken from a source and water inadvertently or indirectly intercepted as a result of mining activities.

For groundwater licencing, this 'direct' and 'indirect' take is predicted via the groundwater modelling. The 'direct' take is the water intercepted during active mining, and typically brought to the surface. The 'indirect' take can be described as the groundwater flux into the historical voids (i.e. post-mining during recovery, as water levels re-equilibrate there will be a volume of flux into the void space). This groundwater is not removed from the aquifer.

Direct water take, for the current approved extraction at Tahmoor South A-series (LW S1A – 6SA), and for the proposed LW S7A was discussed in Section **9.4**. The predicted direct water interception for this extraction is reproduced here in **Table 24**.

**Table 24 Predicted direct water interception**

| Water Year | A series (ML/Year) | LW S7A (ML/year) | Total (ML/Year) |
|---|---|---|---|
| 2024-2025 | 170 | 0 | 170 |
| 2025-2026 | 109 | 0 | 108 |
| 2026-2027 | 28 | 100 | 128 |
| 2027-2028 | 26 | 29 | 55 |
| 2028-2029 | 38 | 11 | 49 |
| 2029-2030 | 53 | 13 | 66 |
| 2030-2031 | 64 | 16 | 80 |
| 2031-2032 | 71 | 18 | 89 |
| 2032-2033 | 73 | 19 | 92 |

In order to facilitate the understanding of ongoing water licence requirements, the predictive groundwater flow model was run for the EIS approved A-series and B-series extraction. The 'direct' take for all mining at Tahmoor South is provided in **Table 25**.

**Table 25 Predicted direct take for all Tahmoor South mining**

| Water Year | A-Series Direct take (ML) | B-Series Direct take (ML) | LW S7A_Direct take (ML) | Net Direct take (ML) |
|---|---|---|---|---|
| 2024-2025 | 170 | 130 | 0 | 301 |
| 2025-2026 | 109 | 99 | 0 | 208 |
| 2026-2027 | 28 | 277 | 100 | 405 |
| 2027-2028 | 26 | 243 | 29 | 298 |

| Water Year | A-Series Direct take (ML) | B-Series Direct take (ML) | LW S7A_Direct take (ML) | Net Direct take (ML) |
|---|---|---|---|---|
| 2028-2029 | 38 | 346 | 11 | 396 |
| 2029-2030 | 53 | 324 | 13 | 389 |
| 2030-2031 | 64 | 210 | 16 | 290 |
| 2031-2032 | 71 | 313 | 18 | 401 |
| 2032-2033 | 73 | 184 | 19 | 276 |

The maximum predicted 'direct take during extraction at Tahmoor South is 406 ML/year in 2026 – 2027.

The predicted 'indirect' or 'passive' water flux into historical voids is provided in **Table 26**. The maximum flux within the aquifer is expected in 2024-25 at 2,250 ML/year.

**Table 26 Predicted indirect water flux to historical voids (cumulative and incremental (LW S7A))**

| Water Year | Cumulative Passive Take (ML/yr) | Incremental Passive Take (ML/yr) |
|---|---|---|
| 2024-2025 | 2250.5 | 0.6 |
| 2025-2026 | 2110.5 | 4.3 |
| 2026-2027 | 1917.3 | 54.6 |
| 2027-2028 | 1788.8 | 77.1 |
| 2028-2029 | 1571.4 | 29.8 |
| 2029-2030 | 1502.1 | 38.3 |
| 2030-2031 | 1452.5 | 42.9 |
| 2031-2032 | 1213.4 | 46.9 |
| 2032-2033 | 1970.5 | 162.2 |
| 2033-2034 | 2858.5 | 420.9 |
| 2034-2035 | 2356.8 | 326.2 |
| 2035-2036 | 1882.2 | 183.6 |
| 2036-2037 | 1607.8 | 216.9 |
| 2037-2038 | 1470.5 | 179.2 |
| 2038-2039 | 1348.9 | 165.8 |
| 2039-2040 | 1248.5 | 157.4 |
| 2040-2041 | 1228.9 | 201.2 |
| 2041-2042 | 1003.7 | <10 |
| 2042-2043 | 291.9 | <10 |
| 2043-2044 | 49.9 | <10 |
| 2044-2045 | 44.4 | <10 |
| 2045-2046 | 42.3 | <10 |
| 2046-2047 | 39.5 | <10 |
| 2047-2048 | 37.0 | <10 |

| Water Year | Cumulative Passive Take (ML/yr) | Incremental Passive Take (ML/yr) |
|---|---|---|
| 2048-2049 | 32.4 | <10 |
| 2049-2050 | 28.7 | <10 |
| 2050-2051 | 25.5 | <10 |
| 2051-2052 | 29.2 | <10 |
| 2052-2053 | 23.8 | <10 |
| 2053-2054 | 25.4 | <10 |
| 2054-2055 | 22.2 | <10 |
| 2055-2056 | 19.2 | <10 |
| 2056-2057 | 16.4 | <10 |
| 2057-2058 | 15.8 | <10 |
| 2058-2059 | 14.7 | <10 |
| 2059-2060 | 12.3 | <10 |
| 2060-2061 | 11.5 | <10 |
| 2061-2062 | 11.8 | <10 |
| 2062-2063 | 11.5 | <10 |
| 2063-2064 | 11.8 | <10 |
| 2064-2065 | 11.4 | <10 |
| 2065-2066 | 11.3 | <10 |
| 2066-2067 | 10.5 | <10 |
| 2067-2068 | <10 | <10 |

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# Appendix A Tahmoor South TARPS

## Tahmoor South Mod 3 – LW S7A

### Groundwater Impact Assessment

**Tahmoor Coal**

SLR Project No.: 620.040109.00001

15 May 2024

WMP8 Shallow Groundwater Levels (Open standpipes and private bores)

| Performance Measure and Indicator, TARP Objective and Assessment Criteria | Monitoring Program | Management | | |
|---|---|---|---|---|
| | | Trigger | Action | Response |
| <u>Performance Measure Feature</u><br>No performance measure relevant.<br><br><u>TARP Objective</u><br>This TARP defines levels of deviation in groundwater level from 'normal' or baseline conditions and the actions to be implemented in response to each level deviation.<br>This TARP supports TARP WMP13, where groundwater levels as they pertain to groundwater dependent ecosystems (GDEs) (Thirlmere Lakes) are covered.<br><br><u>Assessment Criteria</u><br>Bore specific trigger values based on baselines data for each reporting level. | <u>Locations</u><br>Open standpipes<br>Existing sites:<br>P51a, P51b, P52, REA4, P53a, P53b, P53c, P54a, P54b, P54c, P55a, P55b, P55c, P56a, P56b, P56c<br><br>Proposed sites:<br>P50a, P50b, P50c, P57a, P57b<br><br>Private bores<br>GW109257, GW104008, GW112473, GW104659, GW062068, GW105395, GW104323<br><br>All monitoring locations are shown in Figure 23 of the Water Management Plan.<br><br><u>Monitoring Frequency</u><br>Pre-mining<br>Monthly manual measurements of water level.<br><br>During Mining<br>Monthly manual measurements of water level.<br><br>Post-mining<br>Quarterly manual measurements of water level for 12 months following the completion of LW S6A, or as required in accordance with a Rehabilitation Management Plan. | **Normal Condition** | | |
| | | • Groundwater level remains consistent with baseline variability and pre-mining trends with reductions in groundwater level less than two meters. | • Continue monitoring and review of data as per monitoring program. | • No response required. |
| | | **Level 1** | | |
| | | • Greater than 2 m water level reduction[1] for a period of 6 months following the commencement of extraction. | For Private Bores and Open Standpipe Monitoring Bores<br>• *Actions as required for Normal Condition.*<br>• Undertake an investigation to assess cause and determine if mining related.<br>• Undertake investigation to demonstrate if the decline will impact the long-term viability of the affected water supply works.<br>• Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, surface water level results).<br>The investigation will be commenced/completed as efficiently as practicable.<br>If the changes have been confirmed to be related to mining effects:<br>For Private Bores:<br>• Initiate negotiations with impacts landowners as soon as practicable. Consider all reasonable and feasible options for remediation as relevant (e.g. extending the depth of the bore, establishment of additional bores, etc - as per Section 6.2.1.4 of the Water Management Plan. "<br>For Open Standpipe Monitoring Bores<br>• For monitoring sites relevant to Thirlmere Lakes or associated with surface water monitoring sites, initiate groundwater – surface water interaction TARP. | For Private Bores and Open Standpipe Monitoring Bores<br>• Report trigger exceedance to DPE and key stakeholders.<br>• Report trigger exceedance and investigation outcomes in Six Monthly Subsidence Impact Report and Annual Review.<br>If the changes have been confirmed to be related to mining effects:<br>For Private Bores:<br>• Provide DPE and key stakeholders with proposed corrective management actions (CMAs) for consultation (e.g. extending the depth of the bore, establishment of additional bores, compensation to affected landowners as detailed in Section 6.2.1.4 of the Water Management Plan).<br>• Implement CMAs, subject to land access (finalise negotiations and implement the agreed "make-good" arrangements)<br>• Monitor and report on success of CMAs in Six Monthly Subsidence Impact Report and Annual Review. |
| | | **Level 2** | | |
| | | • Water level declines below the average between the 'maximum modelled drawdown' (Level 3 trigger) and the '2 m drawdown' (Level 1 trigger)[1] for a period of greater than 6 months following the commencement of extraction.<br>AND<br>• The reduction in water level is determined not to be controlled by climatic or external anthropogenic factors. | For Private Bores and Open Standpipe Monitoring Bores<br>• *Actions as stated in Level 1.*<br>• Consider increasing monitoring and review of data at sites where Level 2 has been reached, subject to land access. Reasons for not increasing monitoring frequency could include solid identification causation that do not require further monitoring (e.g. singular anthropogenic impact resulting in water level change).<br>• Compare against base case and deterministic model scenarios[2].<br>• Review Water Management Plan and modify if necessary.<br>For Private Bores:<br>• Review CMAs in light of findings from further investigations and consider additional reasonable and feasible options. | For Private Bores and Open Standpipe Monitoring Bores<br>• *Responses as stated in Level 1.*<br>• Advise DPE and key stakeholders of any required amendments to Water Management Plan.<br>For Private Bores:<br>• Provide findings of CMA review to DPE and key stakeholders for consultation.<br>• Implement additional CMAs, subject to land access. |
| | | **Level 3** | | |
| | | • Water level reduction greater than the maximum modelled drawdown[1] for a period of 6 months following the commencement of extraction.<br>AND<br>• The reduction in water level is determined not to be controlled by climatic or external anthropogenic factors. | For Private Bores and Open Standpipe Monitoring Bores<br>• *Actions as stated in Level 2.*<br>• Increase monitoring and review of data frequency for sites where Level 3 has been reached, subject to land access.<br>• Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing, other catchment changes, effect unrelated to mining or the prevailing climate). | For Private Bores and Open Standpipe Monitoring Bores<br>• *Responses as stated in Level 2.*<br>For Private Bores:<br>• Develop a Rehabilitation Management Plan in consultation with DPE and key stakeholders.<br>• Implement Rehabilitation Management Plan, subject to land access. |

Notes:
[1] Level 1, 2 and 3 triggers for water level reduction is provided in Table 6-3 in Appendix E of the Water Management Plan.
[2] "Deterministic" model scenario refers to the predictive scenario modelling utilised to determine the trigger level.

WMP9 Shallow Groundwater Pressures (VWP sensors < 200 m)

| Performance Measure and Indicator, TARP Objective and Assessment Criteria | Monitoring Program | Management | | |
|---|---|---|---|---|
| | | Trigger | Action | Response |
| Performance Measure Feature<br>No performance measure relevant.<br><br>TARP Objective<br>This TARP defines levels of deviation in groundwater level from 'normal' or baseline conditions and the actions to be implemented in response to each level deviation.<br><br>Assessment Criteria<br>Bore specific trigger values based on baselines data for each reporting level. | Locations<br>TBC032, TBC033, TBC009, TBC018, TBC0039<br>Monitoring of all VWP < 200 m depth intakes.<br><br>Reference Sites: TBC024, TBC027, TBC034, TBC038<br><br>All monitoring locations are shown in Figure 23 of the Water Management Plan.<br><br>Monitoring Frequency<br>Pre-mining<br>VWPs sensors take pressure readings hourly. The system is now telemetered so data is streamed continuously and can be accessed at any point in time.<br><br>During Mining<br>VWPs sensors take pressure readings hourly. The system is now telemetered so data is streamed continuously and can be accessed at any point in time.<br><br>Post-mining<br>Monitoring of data (streamed continuously) for 12 months following the completion of LW S6A. | Normal Condition | | |
| | | • No observable mining induced change at VWP intakes.<br>• Greater than 5 m water level reduction in VWP intakes[1] following the commencement of extraction for a period of less than six months | • Continue monitoring and review of data as per monitoring program. | • No response required. |
| | | Level 1 | | |
| | | • Greater than 5 m water level reduction in VWP intakes[1] following the commencement of extraction for a period of greater than six months | • *Actions as required for Normal Condition.*<br>• Undertake an investigation to assess cause and determine if mining related, commence/complete as soon as practicable.<br>• Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, surface water level results). | • Report trigger exceedance to DPE and key stakeholders.<br>• Report trigger exceedance and investigation outcomes in Six Monthly Subsidence Impact Report and Annual Review. |
| | | Level 2 | | |
| | | • Water level declines below the calculated Level 2 trigger – being the average of Level 1 (the '5 m drawdown'[1]) and Level 3 (the 'maximum modelled drawdown') – following the commencement of extraction for a period of greater than six months.<br>AND<br>• The reduction in water level is determined not to be controlled by climatic or external anthropogenic factors. | • *Actions as stated in Level 1.*<br>• Review deeper VWP data at monitored sites. Determine whether additional review of data is required. Determine if review of additional existing VWP sites is required. Reasons for not increasing frequency of data review could include solid identification causation that do not require further monitoring (e.g. singular anthropogenic impact resulting in water level change).<br>• Compare against base case and deterministic model scenarios[2].<br>• Review Water Management Plan and modify if necessary. | • *Responses as stated in Level 1.*<br>• Advise DPE and key stakeholders of any required amendments to Water Management Plan. |
| | | Level 3 | | |
| | | • Water level reduction greater than the maximum modelled drawdown[1] following the commencement of extraction for a period of greater than six months.<br>AND<br>• The reduction in water level is determined not to be controlled by climatic or external anthropogenic factors. | • *Actions as stated in Level 2.*<br>• Increase review of data frequency for sites where Level 3 has been reached.<br>• Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing, other catchment changes, effect unrelated to mining or the prevailing climate). Commence/complete as soon as practicable<br>• Undertake investigative to review model results in conjunction with field data. | • *Responses as stated in Level 2.* |

Notes:
[1] Level 1, 2 and 3 triggers for water level reduction is provided in Table 6-4 in Appendix E of the Water Management Plan).
[2] "Deterministic" model scenario refers to the predictive scenario modelling utilised to determine the trigger level.

WMP10 Groundwater level/pressure Deep VWPs (> 200 m)

| Performance Measure and Indicator, TARP Objective and Assessment Criteria | Monitoring Program | Management | | |
|---|---|---|---|---|
| | | Trigger | Action | Response |
| Performance Measure Feature<br>No performance measure relevant.<br><br>TARP Objective<br>This TARP defines levels of deviation in groundwater level from 'normal' or baseline conditions and the actions to be implemented in response to each level deviation.<br><br>Assessment Criteria<br>Bore specific trigger values based on modelled data for each reporting level.<br>Model layers utilised to define predicted drawdown for each VWP logger provided in Table below. | Locations<br>TBC009, TBC0018, TBC020, TBC026, TBC032, TBC033, TBC039<br><br>Reference sites: TBC024, TBC027, TBC034, TBC038<br><br>Monitoring of all VWP > 200 m depth intakes excluding those monitoring the Bulli Coal Seam.<br><br>All monitoring locations are shown in Figure 23 of the Water Management Plan.<br><br>Monitoring Frequency<br>Pre-mining<br>VWPs sensors take pressure readings hourly. The system is now telemetered so data is streamed continuously and can be accessed at any point in time.<br><br>During Mining<br>VWPs sensors take pressure readings hourly. The system is now telemetered so data is streamed continuously and can be accessed at any point in time.<br><br>Post-mining<br>Monitoring of data (streamed continuously) for 12 months following the completion of LW S6A. | Normal Condition | | |
| | | • Observed data does not exceed modelled impacts predicted drawdown by greater than 30 metres[1].<br>• Observed drawdown exceeds the modelled predicted drawdown[1], by greater than 30 metres for of less than three consecutive months | • Continue monitoring and review of data as per monitoring program. | • No response required. |
| | | Level 1 | | |
| | | • Observed drawdown exceeds the modelled predicted drawdown[1], by greater than 30 metres for greater than three consecutive months. | • *Actions as required for Normal Condition.*<br>• Undertake an investigation to assess cause and determine if mining related, to be commenced/completed as soon as practicable.<br>• Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, surface water level results). | • Report trigger exceedance to DPE and key stakeholders.<br>• Report trigger exceedance and investigation outcomes in Six Monthly Subsidence Impact Report and Annual Review. |
| | | Level 2 | | |
| | | • Observed drawdown is exceeds modelled predicted drawdown[1], by more than 30 metres greater than 6 consecutive months.<br>• | • *Actions as stated in Level 1.*<br>• Determine suitability of increasing frequency of data review at sites where Level 2 has been reached. Reasons for not increasing monitoring frequency could include solid identification causation that do not require further monitoring (e.g. singular anthropogenic impact resulting in water level change).<br>• Review data in conjunction with VWP data from additional existing VWP sites.<br>• Compare against base case and deterministic model scenarios[2].<br>• Review Water Management Plan and modify if necessary. | • *Responses as stated in Level 1.*<br>• Inclusion of more regional VWPs into data review to determine likely extent and depth of depressurisation.<br>• Advise DPE and key stakeholders of any required amendments to Water Management Plan. |
| | | Level 3 | | |
| | | • Observed drawdown exceeds modelled predicted drawdown[1] by 30 m, for 12 consecutive months or more. | • *Actions as stated in Level 2.*<br>• Increase review of data frequency for sites where Level 3 has been reached.<br>• Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing, other catchment changes, effect unrelated to mining or the prevailing climate). To be commenced/completed as soon as practicable.<br>• Review base case and deterministic model scenarios[2] in conjunction with water pressure data and report findings. | • *Responses as stated in Level 2.* |

Notes:
[1] Predicted drawdown refers to the drawdown as generated by the groundwater model and varies over time as extraction progresses. Observed drawdown will be plotted on a monthly basis against the predicted drawdown to determine if a trigger has occurred. Therefore, as the predicted drawdown will be constantly changing according to extraction progression, it is not possible to set a specific trigger limit.
[2] "Deterministic" model scenario refers to the predictive scenario modelling utilised to determine the trigger level.

| Sensor | Model Layer | Model Geology | | Sensor | Model Layer | Model Geology |
|---|---|---|---|---|---|---|
| TBC09_322 | 8 | BUSS Mid | | TBC26_344 | 8 | BUSS Mid |
| TBC09_343 | 8 | BUSS Mid | | TBC26_409 | 13 | WBCS |
| TBC09_357 | 12 | SBSS Lower | | TBC26_432 | 15 | Bulli Seam |
| TBC09_381 | 10 | SPCS | | TBC26_440 | 16 | Eckersley |
| TBC09_391 | 15 | Bulli Seam | | TBC26_460 | 16 | Eckersley |
| TBC09_397 | 17 | Wongawilli | | TBC32_200 | 8 | BUSS Mid |
| TBC18_282 | 8 | BUSS Mid | | TBC32_237 | 8 | BUSS Mid |
| TBC18_366 | 8 | BUSS Mid | | TBC32_257 | 8 | BUSS Mid |
| TBC18_377 | 13 | WBCS | | TBC32_294 | 8 | BUSS Mid |
| TBC18_404 | 15 | Bulli Seam | | TBC32_314 | 8 | BUSS Mid |
| TBC18_426 | 17 | Wongawilli | | TBC33_247 | 8 | BUSS Mid |
| TBC18_432 | 17 | Wongawilli | | TBC33_306 | 8 | BUSS Mid |
| TBC20_211 | 8 | BUSS Mid | | TBC33_363 | 11 | SBSS Upper |

| | | | | | | |
|---|---|---|---|---|---|---|
| TBC20_293 | 8 | BUSS Mid | | TBC33_384 | 16 | Eckersley |
| TBC20_375 | 8 | BUSS Mid | | TBC33_408 | 16 | Eckersley |
| TBC20_397 | 13 | WBCS | | TBC39_243 | 8 | BUSS Mid |
| TBC20_411 | 7 | BUSS Upper | | TBC39_299 | 8 | BUSS Mid |
| TBC20_434 | 17 | Wongawilli | | TBC39_354 | 11 | SBSS Upper |
| TBC20_439 | 4 | HBSS Mid | | TBC39_375 | 16 | Eckersley |
| TBC26_211 | 8 | BUSS Mid | | TBC39_402 | 16 | Eckersley |
| TBC26_278 | 8 | BUSS Mid | | | | |

## WMP11 Groundwater Quality (open standpipes and private bores)

<table>
<tr><th rowspan="2">Performance Measure and Indicator, TARP Objective and Assessment Criteria</th><th rowspan="2">Monitoring Program</th><th colspan="3">Management</th></tr>
<tr><th>Trigger</th><th>Action</th><th>Response</th></tr>
<tr><td rowspan="8"><u>Performance Measure Feature</u><br>No performance measure relevant.<br><br><u>TARP Objective</u><br>This TARP defines levels of deviation in groundwater level from ‘normal’ or baseline conditions and the actions to be implemented in response to each level deviation.<br>This TARP supports TARP WMP13, where groundwater quality as it pertains to groundwater dependent ecosystems (GDEs) (Thirlmere Lakes) is covered.<br><br><u>Assessment Criteria</u><br>Bore specific trigger values based on baselines data for each reporting level.</td><td rowspan="8"><u>Locations</u><br>Open standpipes<br>Existing sites:<br>P51a, P51b, P52, REA4, P53a, P53b, P53c, P54a, P54b, P55a, P55b, P55c, P56a, P56b, P56c<br><br>Proposed sites:<br>P50a, P50b, P50c, P57a, P57b<br><br>Private bores<br>GW109257, GW104008, GW112473, GW104659, GW062068, GW105395, GW104323<br><br>All monitoring locations are shown in Figure 23 of the Water Management Plan.<br><br><u>Monitoring Frequency</u><br>Pre-mining<br>Monthly water quality sampling.<br><br>During Mining<br>Monthly water quality sampling<br><br>Post-mining<br>Quarterly water quality sampling.<br><br>Water Quality sample parameters:<br>Field Parameters<br>PH<br>EC<br>TDS<br>DO<br><br>Laboratory Analysis<br>Total alkalinity as CaCO3, HCO3, CO3, DOC<br>Dissolved Major Cations (Ca, K, Na, Mg, F, Cl, SO4)<br>Dissolved Metals (Al, As, Ba, Co, Cu, Pb, Li, Mn, Ni, Se, Sr, Zn, Fe)<br>Total Metals (Al, As, Ba, Co, Cu, Pb, Li, Mn, Ni, Se, Sr, Zn, Fe)<br>Total Nitrogen<br>Total Phosphorus<br>Ionic Balance (Total Anions and Total Cations)</td><td>Normal Condition</td><td></td><td></td></tr>
<tr><td>• No observable changes in salinity, pH or metals outside of the baseline variability.</td><td>• Continue monitoring and review of data as per monitoring program.</td><td>• No response required.</td></tr>
<tr><td>Level 1</td><td></td><td></td></tr>
<tr><td>• Observed salinity and/or metals or pH outside of defined trigger levels[1] for 3 consecutive months or more. The effect does not persist after a significant rainfall recharge event.<br>AND<br>• A similar trend or response is noted at other monitored bores or private groundwater bores.</td><td>For Private Bores and Open Standpipe Monitoring Bores<br>• Actions as required for Normal Condition.<br>• Undertake an investigation to assess cause and determine if mining related.<br>• Undertake investigation to demonstrate if the change in quality will impact the long-term viability of the affected water supply works.<br>• Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, surface water level results).<br>If the changes have been confirmed to be related to mining effects:<br>For Private Bores:<br>• Initiate negotiations with impacted landholders as soon as practicable. Consider all reasonable and feasible options for remediation as relevant. This could include potential for implementation of make-good provisions as per Section 6.2.1.4 of the Water Management Plan for affected private bore owners (e.g. provision of access to an alternative source of water).<br>For Open Standpipe Monitoring Bores<br>• For monitoring sites relevant to Thirlmere Lakes or associated with surface water monitoring sites, initiate groundwater – surface water interaction TARP.</td><td>For Private Bores and Open Standpipe Monitoring Bores<br>• Report trigger exceedance to DPE and key stakeholders.<br>• Report trigger exceedance and investigation outcomes in Six Monthly Subsidence Impact Report and Annual Review.<br>If the changes have been confirmed to be related to mining effects:<br>For Private Bores:<br>• Provide DPE and key stakeholders with proposed corrective management actions (CMAs) for consultation (e.g. provision of access to an alternative source of water as detailed in Section 6.2.1.4 of the Water Management Plan).<br>• Implement CMAs, subject to land access.<br>• Monitor and report on success of CMAs in Six Monthly Subsidence Impact Report and Annual Review.</td></tr>
<tr><td>Level 2</td><td></td><td></td></tr>
<tr><td>• Observed salinity and/or metals or pH outside of defined trigger levels[1], for 3 consecutive months or more. The effect persists after a significant rainfall recharge event.<br>AND<br>• The change in water quality is determined not to be controlled by climatic or external anthropogenic factors.</td><td>For Private Bores and Open Standpipe Monitoring Bores<br>• Actions as stated in Level 1.<br>• Consider increasing monitoring and review of data at sites where Level 2 has been reached, subject to land access. Reasons for not increasing monitoring frequency could include solid identification causation that do not require further monitoring (e.g. singular anthropogenic impact resulting in water quality change).<br>• Review Water Management Plan and modify if necessary.<br>For Private Bores:<br>• Review CMAs in light of findings from further investigations and consider additional reasonable and feasible options.</td><td>For Private Bores and Open Standpipe Monitoring Bores<br>• Responses as stated in Level 1.<br>• Advise DPE and key stakeholders of any required amendments to Water Management Plan.<br>For Private Bores:<br>• Provide findings of CMA review to DPE and key stakeholders for consultation.<br>• Implement additional CMAs, subject to land access.</td></tr>
<tr><td>Level 3</td><td></td><td></td></tr>
<tr><td>• Observed salinity and/or metals or pH outside of defined trigger levels[1], for greater than 6 consecutive months.<br>AND<br>• The change in water quality is determined not to be controlled by climatic or external anthropogenic factors.</td><td>For Private Bores and Open Standpipe Monitoring Bores<br>• Actions as stated in Level 2.<br>• Increase monitoring and review of data frequency for sites where Level 3 has been reached, subject to land access.<br>• Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing, other catchment changes, effect unrelated to mining or the prevailing climate).<br>• Undertake investigative report to demonstrate if the water quality change will impact the long-term viability of any affected water supply works.</td><td>Private Bores and Open Standpipe Monitoring Bores<br>• Responses as stated in Level 2.<br>For Private Bores:<br>If ascertained impact is due to mining activities and has potential to impact long-term viability of supply for private groundwater bores:<br>• Develop a Rehabilitation Management Plan in consultation with DPE and landowner.<br>• Implement Rehabilitation Management Plan, subject to land access.</td></tr>
<tr><td colspan="5">Notes:<br>[1] Defined trigger levels for groundwater quality are listed in Table 6-5 of Appendix E of the Water Management Plan.</td></tr>
</table>

## WMP12 Groundwater – surface water Interaction

| Performance Measure and Indicator, TARP Objective and Assessment Criteria | Monitoring Program | Management | | |
|---|---|---|---|---|
| | | Trigger | Action | Response |
| <u>Performance Measure Feature</u><br>No performance measure relevant.<br><br><u>TARP Objective</u><br>This TARP defines levels of deviation in surface water - groundwater interactions from 'normal' conditions and the actions to be implemented in response to each level deviation.<br>The instigation of this TARP will be dictated by triggers exceedances in pertinent groundwater or surface water sites requiring further investigation of groundwater – surface water interactions.<br><br>Where groundwater – surface water connectivity indicates in a gaining stream, there is potential for groundwater supporting riparian vegetation. Consequently, Riparian vegetation in these situations could be a Groundwater Dependent Ecosystem (GDE), and the pertinent Performance Measure applicable:<br>Negligible impacts including:<br>• Negligible change in groundwater levels; and<br>• Negligible change in groundwater quality.<br><br>Riparian GDEs are addressed through the Riparian Vegetation TARP (BMP3). Consultation through the ERG will link this TARP (WMP12) to BMP3 via actions in BMP3 to consider groundwater – surface water relationships when pertinent.<br><br><u>Assessment Criteria</u><br>Bore specific trigger values based on baselines data for each reporting level. For this TARP, the aligned groundwater and surface water sites would be considered collectively to interpret potential changes/impacts to groundwater – surface water interaction. | <u>Locations</u><br>Open standpipes<br>P51a, P51b, P52, REA4, P53a, P53b, P53c<br>P54a, P54b, P54c, P55a, P55b, P55c<br><br>The aligned surface water and groundwater sites are as follows:<br>• P51a, P51b with surface water site BR2-Qla<br>• P52, REA4 with surface water site-TT14-QLa<br>• P53a, P53b, P53c with surface water site-TT14-Qla<br>• P54a, P54b, P54c with surface water site TT3-QLa<br>• P55a, P55b, P55c with surface water site TT1-QRLa<br><br>All monitoring locations are shown in Figure 23 of the Water Management Plan.<br><br><u>Monitoring Frequency</u><br>Pre-mining<br>Monthly manual measurements of water level and water quality.<br><br>During Mining<br>Monthly manual measurements of water level and water quality.<br><br>Post-mining<br>Quarterly manual measurements of water level for 12 months following the completion of LW S6A, or as required in accordance with a Rehabilitation Management Plan. | **Normal Condition** | | |
| | | • Observed (or inferred where not immediately neighbouring a surface water site) groundwater and surface water interaction remains consistent with baseline variability and/pre-mining trends, and decrease in groundwater inflow not persisting after significant rainfall recharge events. | • Continue monitoring and review of data as per monitoring program. | • No response required. |
| | | **Level 1** | | |
| | | • Observed (or inferred where not immediately neighbouring a surface water site) groundwater levels at surface water monitoring site decline below Level 1 (in TARP WMP8) following the commencement of extraction. | • *Actions as required for Normal Condition.*<br>• Undertake an investigation to assess cause and determine if mining related.<br>• Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, surface water level results). | • Report trigger exceedance to DPE and key stakeholders.<br>• Report trigger exceedance and investigation outcomes in Six Monthly Subsidence Impact Report and Annual Review.<br>If the changes have been confirmed to be related to mining effects:<br>• Provide DPE and key stakeholders with proposed corrective management actions (CMAs) for consultation (e.g. extending the depth of the bore, establishment of additional bores, compensation to affected landowners as detailed in Section 6.2.1.4 of the Water Management Plan).<br>• Implement CMAs, subject to land access.<br>• Monitor and report on success of CMAs in Six Monthly Subsidence Impact Report and Annual Review. |
| | | **Level 2** | | |
| | | • Observed (or inferred where not immediately neighbouring a surface water site) groundwater levels at aligned surface water monitoring site decline below Level 2 (in TARP WMP8) following the commencement of extraction.<br>AND<br>• The reduction in water level is determined not to be controlled by climatic or external anthropogenic factor. | • *Actions as stated in Level 1.*<br>• Increase frequency of data review to fortnightly at sites where Level 2 has been reached, subject to land access. Reasons for not increasing frequency could include solid identification causation that do not require further monitoring (e.g. singular anthropogenic impact resulting in water level change).<br>• Compare against base case and deterministic model scenarios[1].<br>• Review manual water level measurements for additional monitoring sites to identify potential spatial trends in water level decline.<br>• Review surface water data to assess for surface water level decline at relevant site.<br>• Review CMAs in light of findings from further investigations and consider additional reasonable and feasible options.<br>• Review Water Management Plan and modify if necessary. | • *Responses as stated in Level 1.*<br>• Provide findings of CMA review to DPE and key stakeholders for consultation.<br>• Implement additional CMAs, subject to land access.<br>• Advise DPE and key stakeholders of any required amendments to Water Management Plan, including reporting on relationship of observations to baseline and deterministic model scenarios, as necessary. |
| | | **Level 3** | | |
| | | • Inferred groundwater levels at surface water monitoring site decline below Level 3 (in TARP WMP8) following the commencement of extraction.<br>AND<br>• The reduction in water level is determined not to be controlled by climatic or external anthropogenic factor. | • *Actions as stated in Level 2.*<br>• Increase frequency of data review for sites where Level 3 has been reached, subject to land access.<br>• Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing, other catchment changes, effect unrelated to mining or the prevailing climate). Report to be commenced and completed as soon as practicable. | • *Responses as stated in Level 2.*<br>• Develop a Rehabilitation Management Plan in consultation with DPE and key stakeholders.<br>• Implement Rehabilitation Management Plan, subject to land access. |

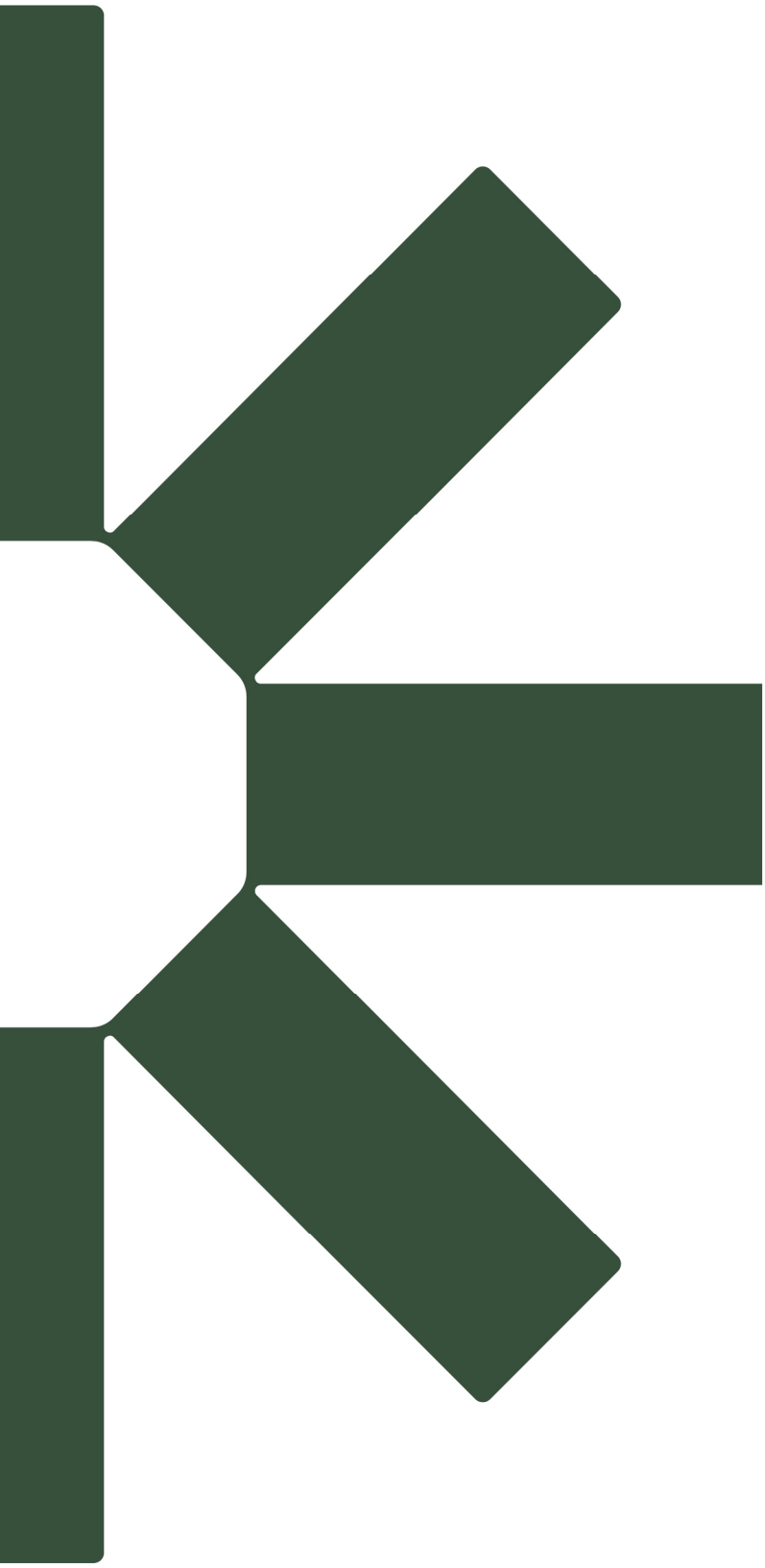
Notes:
[1] "Deterministic" model scenario refers to the predictive scenario modelling utilised to determine the trigger level.

WMP13 Groundwater Bore Monitoring for Thirlmere Lakes

<table>
<tr><th rowspan="2">Performance Measure and Indicator, TARP Objective and Assessment Criteria</th><th rowspan="2">Monitoring Program</th><th colspan="3">Management</th></tr>
<tr><th>Trigger</th><th>Action</th><th>Response</th></tr>
<tr><td rowspan="4"><u>Performance Measure Feature</u><br>GDEs including Thirlmere Lakes[1].<br><br><u>Performance Measure</u><br>Negligible impacts including:<br>• Negligible change in groundwater levels; and<br>• Negligible change in groundwater quality.<br><br><u>Performance Indicator</u><br>The performance measure will be considered to be exceeded if the groundwater levels or groundwater quality decline below Level 3 (in the relevant groundwater TARP triggers for water level and water quality – TARP WMP8 or WMP11) following the commencement of extraction, and the investigation outcomes indicate a mining related impact based on monitoring data for the Thirlmere Lakes.<br><br><u>TARP Objective</u><br>This TARP defines levels of deviation at Thirlmere Lakes from ‘normal’ conditions and the actions to be implemented in response to each level deviation.<br><br><u>Assessment Criteria</u><br>Bore specific trigger values based on baselines data for each reporting level.</td><td rowspan="4"><u>Locations</u><br>“Early warning” bores<br>Existing sites:<br>GW062068, GW104659, TBC039 (sensor at 65 metres in Hawkesbury Sandstone (HBSS))<br>Proposed sites:<br>P50a, P50b, P50c<br><br>Thirlmere Lakes bores (not trigger bores)<br>Existing sites:<br>GW075409–1, GW075409–2, GW075410, GW075411 (paired with gauging station 212066)<br><br>All monitoring locations are shown in Figure 23 of the Water Management Plan.<br><br><u>Monitoring Frequency (for “early warning” bores)</u><br>Pre-mining<br>Monthly manual measurements of water level and water quality.<br><br>During Mining<br>Monthly manual measurements of water level and water quality.<br><br>Post-mining<br>Quarterly manual measurements of water level for 12 months following the completion of LW S6A, or as required in accordance with a Rehabilitation Management Plan.<br><br>Water Quality sample parameters:<br><table><tr><th>Field Parameters</th></tr><tr><td>PH<br>EC<br>TDS<br>DO</td></tr><tr><th>Laboratory Analysis</th></tr><tr><td>Total alkalinity as CaCO3, HCO3, CO3, DOC<br>Dissolved Major Cations (Ca, K, Na, Mg, F, Cl, SO4)<br>Dissolved Metals (Al, As, Ba, Co, Cu, Pb, Li, Mn, Ni, Se, Sr, Zn, Fe)<br>Total Metals (Al, As, Ba, Co, Cu, Pb, Li, Mn, Ni, Se, Sr, Zn, Fe)<br>Total Nitrogen<br>Total Phosphorus<br>Ionic Balance (Total Anions and Total Cations)</td></tr></table></td><td colspan="3">Normal Condition</td></tr>
<tr><td>• Groundwater levels and quality remain consistent with baseline variability and/pre-mining trends, and changes in groundwater levels/quality not persisting after significant rainfall recharge events.</td><td>• Continue monitoring and review of data as per monitoring program.</td><td>• No response required.</td></tr>
<tr><td colspan="3">Level 1</td></tr>
<tr><td>• Level 1 trigger of TARP WMP8 for a minimum of two “early warning” bores.<br>OR<br>• Level 1 trigger of TARP WMP11 for a minimum of two “early warning” bores.</td><td>• Actions as required for Normal Condition.<br>• Undertake an investigation to assess cause and determine if mining related.<br>• Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, surface water level results).<br>If the changes have been confirmed to be related to mining effects:<br>• Consider all reasonable and feasible options for remediation as relevant (e.g. extending the depth of the bore, establishment of additional bores). This could include potential for implementation of make-good provisions as per Section 6.2.1.4 of the Water Management Plan for affected private bore owners.<br>• For monitoring sites relevant to Thirlmere Lakes or associated with surface water monitoring sites, initiate groundwater – surface water interaction TARP.</td><td>• Report trigger exceedance to DPE and key stakeholders.<br>• Report trigger exceedance and investigation outcomes in Six Monthly Subsidence Impact Report and Annual Review.<br>If the changes have been confirmed to be related to mining effects:<br>• Provide DPE and key stakeholders with proposed corrective management actions (CMAs) for consultation (e.g. extending the depth of the bore, establishment of additional bores, compensation to affected landowners as detailed in Section 6.2.1.4 of the Water Management Plan).<br>• Implement CMAs, subject to land access.<br>• Monitor and report on success of CMAs in Six Monthly Subsidence Impact Report and Annual Review.</td></tr>
<tr><td colspan="3">Level 2</td></tr>
<tr><td>• Level 2 trigger of TARP WMP8 for a minimum of three bores “early warning” bores<br>OR<br>• Level 2 trigger of TARP WMP11 for a minimum of three bores (“early warning” bores and Thirlmere Lakes bores).</td><td>• Actions as stated in Level 1.<br>If the changes have been confirmed to be related to mining effects:<br>• Consider increasing monitoring and review of data at sites where Level 2 has been reached, subject to land access. Reasons for not increasing monitoring frequency could include solid identification causation that do not require further monitoring (e.g. singular anthropogenic impact resulting in water level change).<br>Review Thirlmere Lakes monitoring bore data<br>• Compare against base case and deterministic model scenarios[2].<br>• Review manual water level measurements for additional monitoring sites to identify potential spatial trends in water level decline.<br>• Review surface water data to assess for surface water level decline at relevant site.<br>• Review CMAs in light of findings from further investigations and consider additional reasonable and feasible options.<br>• Review Water Management Plan and modify if necessary.<br>• Undertake an investigation to determine if an exceedance of the performance measure is likely. To be commenced/completed as soon as practicable.</td><td>• Responses as stated in Level 1.<br>• Provide findings of CMA review to DPE and key stakeholders for consultation.<br>• Implement additional CMAs, subject to land access.<br>• Advise DPE and key stakeholders of any required amendments to Water Management Plan.<br>• If relevant, notify DAWE of any predictions of an exceedance of a performance measure within two business days.</td></tr>
<tr><td colspan="3">Exceeds Performance Measure</td></tr>
<tr><td>• Level 3 trigger of TARPs WMP8 for a minimum of four bores “early warning” bores)<br>OR<br>• Level 3 trigger of TARPs WMP11 for a minimum of four bores (“early warning” bores and Thirlmere Lakes bores).<br>AND<br>• Review of Thirlmere Lakes bores indicated potential impacts resulting from extraction</td><td>• Actions as stated in Level 2.<br>If the changes have been confirmed to be related to mining effects:<br>• Increase monitoring and review of data frequency for sites where Level 3 has been reached, subject to land access.<br>• Investigate reasons for the performance measure exceedance. To be commenced/completed as soon as practicable.<br>• Review predictions of subsidence impacts and environmental consequences associated with further longwall extraction based on the outcomes of the investigation.<br>• Consider modifying mine plan.</td><td>• Responses as stated in Level 2.<br>• Submit a report to DPE (in accordance with Condition E4 of SSD 8445) within 14 days of the exceedance occurring (or other timeframe agreed by DPE) describing remediation options and any preferred remediation measures or other course of action.<br>• Implement any reasonable remediation measures as directed by DPE, subject to land access.<br>• Notify DAWE of any detection or predictions of an exceedance of a performance measure within two business days.<br>• Submit an Impact Response Plan to DAWE (in accordance with Condition 11 of the DAWE Consent for the Tahmoor South Project).<br>• Update numerical groundwater model and re-run predictive scenarios to determine the likely extent and depth of depressurisation in the vicinity</td></tr>
</table>

| | | | | |
|---|---|---|---|---|
| | | | | of Thirlmere Lakes, and to determine whether any additional management actions are required such as modifying the mine plan |

Notes:
[1] It is noted that the only Groundwater Dependent Ecosystem (GDE) pertinent to the Tahmoor South Project is that of Thirlmere Lakes[2] "Deterministic" model scenario refers to the predictive scenario modelling utilised to determine the trigger level.



Making Sustainability Happen

# Appendix H
## Water licensing review

EMM
creating opportunities

# Tahmoor South Mod 3

## Water Licensing Review

Prepared for Tahmoor Coal Pty Ltd

May 2024

# Tahmoor South Mod 3

# Water Licensing Review

Tahmoor Coal Pty Ltd

E230438 RP3

May 2024

| Version | Date | Prepared by | Approved by | Comments |
|---|---|---|---|---|
| 1 | 20 May 2024 | L Hammersley | J Wearne | Final |
| | | | | |
| | | | | |

Approved by

**James Wearne**
Associate, Approvals and Environment
20 May 2024

Level 3 175 Scott Street
Newcastle NSW 2300

This report has been prepared in accordance with the brief provided by Tahmoor Coal Pty Ltd and has relied upon the information collected at the time and under the conditions specified in the report. All findings, conclusions or recommendations contained in the report are based on the aforementioned circumstances. The report is for the use of Tahmoor Coal Pty Ltd and no responsibility will be taken for its use by other parties. Tahmoor Coal Pty Ltd may, at its discretion, use the report to inform regulators and the public.

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# 1 Introduction

## 1.1 Background

Tahmoor Coal Pty Ltd (Tahmoor Coal) owns and operates the Tahmoor Mine, an underground coal mine located approximately 80 kilometres (km) south-west of Sydney in the Southern Coalfield of New South Wales (NSW). Tahmoor Mine is located within the Wollondilly and Wingecarribee local government areas (LGAs) (refer to Figure 1.1). The Tahmoor Mine comprises of the mining areas Tahmoor Central, Tahmoor North and more recently Tahmoor South.

Tahmoor Mine operates in accordance with State significant development consent (SSD 8445) granted on 23 April 2021 by the NSW Independent Planning Commission (IPC). Development consent SSD 8445 permits extraction and processing of up to 4 million tonnes per annum (tpa) of run-of-mine (ROM) coal from the Bulli Seam until 2032 using longwall mining methods. The approved longwalls authorised by SSD 8445 are shown on Figure 1.2 and includes an A series of longwall panels (Longwalls South 1A-6A (LW S1A-S6A)) and a B series of longwall panels (Longwalls South 1B-6B (LW S1B-S6B)). Longwall extraction under the Tahmoor South development consent commenced on 18 October 2022. Tahmoor Coal are currently extracting coal from Longwall LW S3A.

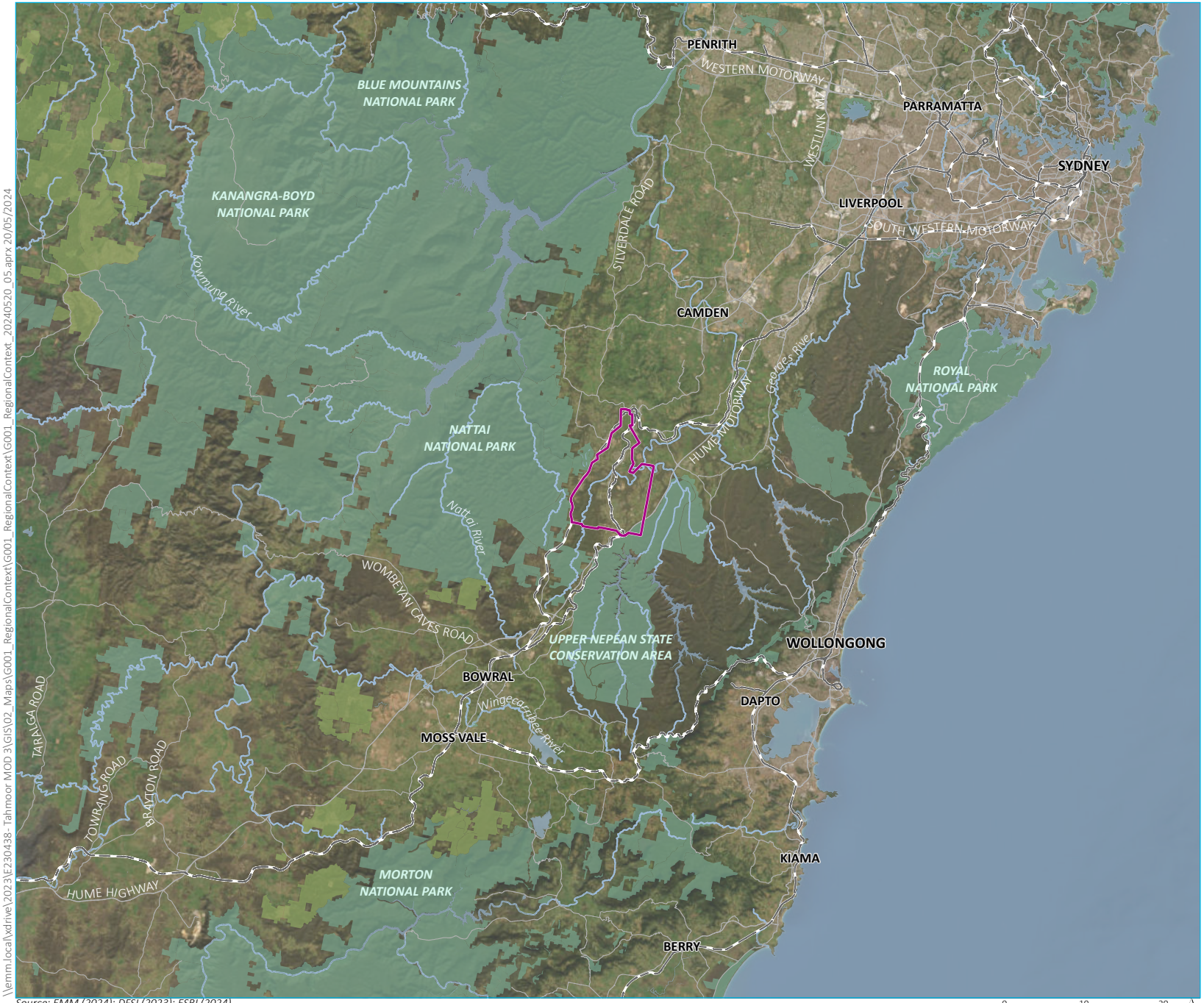
Development consent SSD 8445 has been modified on two occasions:

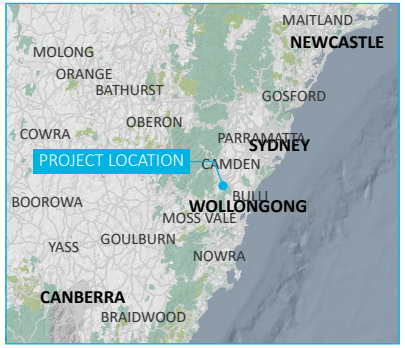
- Modification 1 (Mod 1) was granted on 19 July 2022 and authorised an extension of time, until 31 December 2023, for the new water treatment plant to be commissioned.
- Modification 2 (Mod 2) was granted on 13 June 2023 and authorised the transfer and storage of water treatment plant brine in underground workings.

## 1.2 Proposed modification

Tahmoor Coal is seeking to modify SSD 8445 (Mod 3) under Section 4.55(2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to authorise:

- an additional longwall panel (LW S7A) to the approved A series longwall panel layout
- removal of restrictions imposed by Condition A6 on the requirement for mining to be completed within 10 years following the commencement of second workings in the Tahmoor South mining area
- an increase in the maximum volume of ROM coal authorised by Condition A11(b) of SSD 8445 that can be extracted and processed on site from 33 million tonnes per annum (Mtpa) to 35 Mtpa.




KEY

Tahmoor South project area (SSD 8445)

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody
- NPWS reserve
- State forest

Regional locality

Tahmoor South Mod 3
Water Licensing Review
Figure 1.1

EMM
creating opportunities

*Source: EMM (2024); DFSI (2023); ESRI (2024)*

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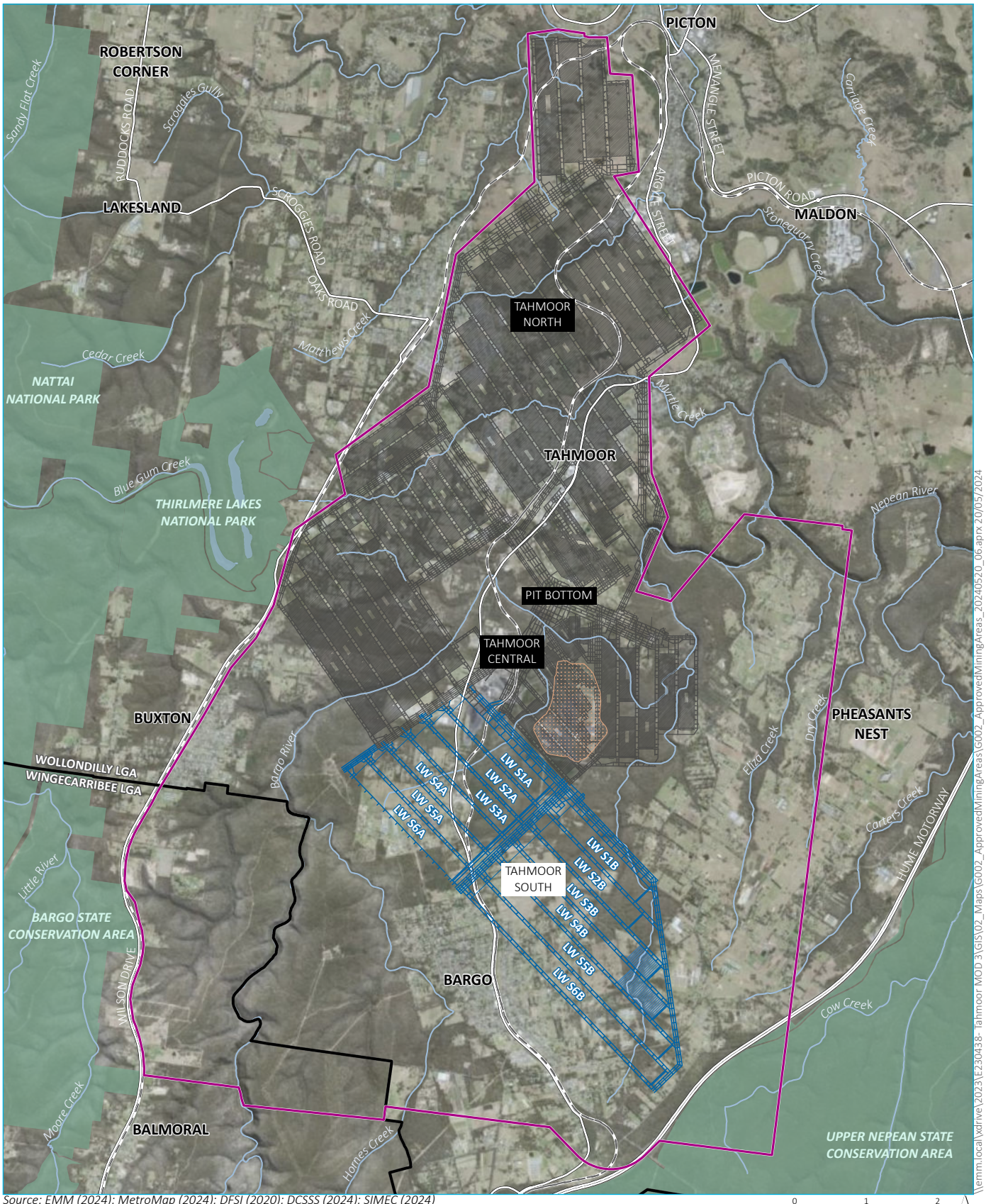


Source: EMM (2024); MetroMap (2024); DFSI (2020); DCSSS (2024); SIMEC (2024)

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KEY

- Tahmoor South project area (SSD 8445)
- Extraction subject to secondary approval
- Existing underground working
- Tahmoor South approved mine working
- Approved reject emplacement area footprint

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody
- NPWS reserve
- Local government area

Existing and approved mining areas

Tahmoor South Mod 3
Water Licensing Review
Figure 1.2

EMM
creating opportunities

A summary of the approved project and modifications proposed is provided in Table 1.1 and illustrated in Figure 1.3.

**Table 1.1 Proposed modification summary table**

| Element | Approved project | Project with proposed modification |
|---|---|---|
| Project area | The Tahmoor South project area is illustrated in Figure 1.1. | No change. |
| Mining areas | As shown on Figure 1.2. | Include mining of LW S7A as shown in Figure 1.3. |
| Extraction and processing rate | Up to 4 Mtpa of ROM coal per annum.<br>33 Mt of ROM coal over the life of the project. | No change to annual extraction limit.<br>Increase in life of mine ROM coal extraction limit from 33 Mt to 35 Mt. |
| Mine life | Until 31 December 2033, or until 10 years from the commencement of second workings, whichever is the sooner. | Mining operations carried out until 31 December 2033.<br>Remove restriction 'or until 10 years from the commencement of second workings, whichever is the sooner' from condition A6. |
| Mining method | Longwall mining method. | No change. |
| Coal reject management | Continued use of existing REA, where reject material may be emplaced up to a maximum height of RL 320 m. | No change. |
| Transportation by rail | A maximum of four laden trains may leave the site in any 24-hour period. | No change. |
| Transportation by road | A maximum of 200,000 t per annum of material (including ROM coal, product coal, and coal reject material) may be transported to and from the site by road, at a rate of:<br>• 3,000 t per day<br>• 16 truck movements per hour<br>• 158 truck movements in total per day. | No change. |
| Mine water management | Mine water is collected in underground sumps and pumped from the mine to the existing water management system at the surface facilities area.<br>Treated mine water is reused underground or for other non-potable uses or discharged via the existing LDP1 to Tea Tree Hollow. | No change. |
| Disposal of brine | Transfer of brine from the water treatment plant (WTP) underground for storage in the Western Domain mining area. | Continued transfer of brine from WTP operations for duration of additional mining. |
| Operating hours | Underground mining operations:<br>• 24 hours a day, 7 days a week.<br>Road transportation:<br>• between 7.00 am to 6.00 pm Monday to Saturday.<br>Construction activities at the surface facilities site and ventilation shaft site:<br>• between 7.00 am to 6.00 pm Monday to Friday<br>• 8.00 am to 1.00 pm Saturday<br>• no construction activities on Sundays or public holidays unless the Planning Secretary agrees otherwise.<br>Drilling activities at the ventilation shaft sites may be undertaken 24 hours a day, 7 days a week. | No change. |

**Table 1.1 Proposed modification summary table**

| Element | Approved project | Project with proposed modification |
|---|---|---|
| Rehabilitation | • Progressive rehabilitation.<br>• Final rehabilitation and closure in accordance with a Rehabilitation Strategy and Rehabilitation Management Plan. | No change. |
| Workforce | Ongoing employment for approximately 400 full time equivalent (FTE) employees. | No change. |

### 1.2.1 Longwall S7A

Development consent SSD 8445 permits longwall mining of six panels within an 'A-series' and six panels within a 'B-series' of longwalls. The proposed longwall panel LW S7A is an additional longwall panel in the A series of longwalls and within the existing Tahmoor South Project Area.

LW S7A will extract coal between a minimum extraction height of 2.1 metres (m) and a maximum extraction height of 2.5 m. Further details of the proposed LW S7A dimensions are summarised in Table 1.2.

**Table 1.2 Longwall S7A dimensions**

| Longwall ID | Overall void length including installation heading (m) | Overall void width including first workings (m) | Overall tailgate chain pillar width (m) |
|---|---|---|---|
| LW S7A | 1,918 | 285 | 36 |

LW S7A has been included in the mine plan following a revision of the geological interpretation of the location of the Central Fault, which is located to the south west of the Tahmoor South Project area.

### 1.2.2 ROM extraction

Condition A11(b) of SSD 8445 authorises a maximum of 33 Mt of ROM coal to be extracted and processed on site over the life of the development. The extraction of LW S7A will add approximately 2 Mt of coal to the total volume of coal extracted over the life of the development.

Tahmoor Coal seeks to increase the maximum volume of coal authorised to be extracted over the life of the development from 33 Mt to 35 Mt.

### 1.2.3 Reject management

The additional 2 Mt of ROM coal extracted from LW S7A, will produce an associated 0.6 MT of reject material.

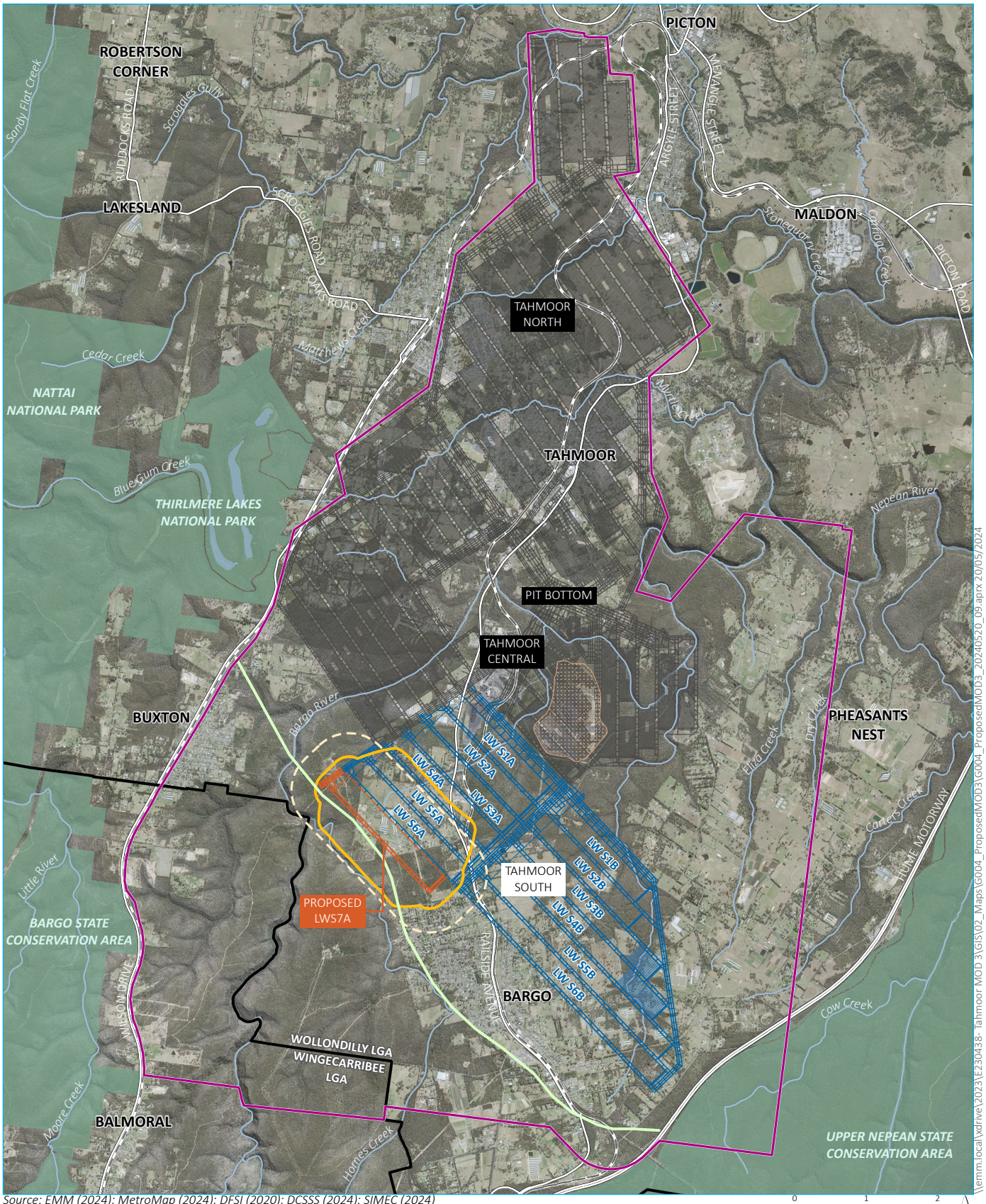
This reject material is proposed to be stored within the existing footprint and approved heights of Tahmoor Coal's existing REA.

## 1.3 Purpose of report

As a component of the modification application, EMM Consulting Pty Ltd (EMM) was commissioned by Tahmoor Coal to prepare a water licensing review. The purpose of this review is to:

- outline the existing water entitlements held by Tahmoor Coal

- summarise the water take predictions for the Tahmoor mining operation based on the surface water and groundwater assessments for the Modification 3 project
- identify and outline the pathway to secure the necessary water licence entitlements (if required) for the Modification 3 project.




Source: EMM (2024); MetroMap (2024); DFSI (2020); DCSSS (2024); SIMEC (2024)

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KEY

- Tahmoor South project area (SSD 8445)
- LW S7A study area
- Extraction subject to secondary approval
- Offset boundary (600m)
- Approved reject emplacement area footprint
- Existing underground working
- Tahmoor South approved mine working
- Proposed LWS7A

Existing environment

- Rail line
- Major road
- Central fault
- Named watercourse
- Named waterbody
- NPWS reserve
- Local government area

Proposed modification

Tahmoor South Mod 3
Water Licensing Review
Figure 1.3

EMM
creating opportunities

# 2 Regulatory framework

## 2.1 *Water Management Act 2000*

The *Water Management Act 2000* (WM Act) is based on the principles of ecologically sustainable development and the need to share and manage water resources for future generations. The WM Act recognises that water management decisions must consider economic, environmental, social, cultural and heritage factors. It recognises that sustainable and efficient use of water delivers economic and social benefits to the state of NSW. The WM Act provides for water sharing between different water users, including environmental, basic landholder rights and licence holders. The licensing provisions of the WM Act apply to areas where a statutory WSP has commenced, with WSPs in force in all but a very few small coastal areas of the state.

WSPs are statutory documents that apply to one or more water sources. They define the rules for sharing and managing water resources within water source areas. WSPs describe the basis for water sharing and document the water available and how it is shared between environmental, extractive and other uses. The WSPs establish environmental water rules, the long term average annual limits on water extraction from each water source, and how water is made available for different categories of extractive uses such as local water utilities, domestic and stock, basic landholder rights, irrigation and industrial uses. WSPs also establish trading rules and mandatory conditions that apply to licences and approvals.

The key regulation made under the WM Act is the Water Management (General) Regulation 2018 (WM Regulation). The regulation specifies important procedural and technical matters related to the administration of the WM Act and also specifies exemptions from licence and approval requirements under the WM Act.

## 2.2 Aquifer interference policy

The NSW Aquifer Interference Policy (AIP) (DPI 2012) sets out the role and requirements of the Minister administering the WM Act in the water licensing and assessment processes for aquifer interference activities. The WM Act defines an aquifer interference activity as an activity involving any of the following:

- penetration of an aquifer
- interference with water in an aquifer
- obstruction of the flow of water in an aquifer
- taking of water from an aquifer in the course of carrying out mining, or any other activity prescribed by the regulations, or
- disposal of water taken from an aquifer in the course of carrying out mining, or any other activity prescribed by the regulations.

The AIP (DPI 2012) specifically refers to ‘take’ that is ‘required to allow for the effective and safe operation of an activity, for example dewatering to allow mining’, regardless of whether the take will be used. The take, use and incidental interception of groundwater must be licensed. The AIP states that, unless specifically exempt, a water access licence (WAL) is required under the WM Act where any act by a person carrying out an aquifer interference activity causes:

- the removal of water from a water source
- the movement of water from one part of an aquifer to another part of an aquifer

- the movement of water from one water source to another water source, such as:
  - from an aquifer to an adjacent aquifer
  - from an aquifer to a river/lake, or
  - from a river/lake to an aquifer.

The AIP specifies that the project licensing requirement should consider adjacent and overlying water sources. Should the project cause water to inflow and subsequently take from an adjacent water source, a licence for that volume is required from that adjacent water source.

## 2.3 Basic landholder rights

There are three types of basic landholder rights in NSW under the WM Act:

- domestic and stock rights
- harvestable rights
- native title rights.

### 2.3.1 Domestic and stock rights

Owners or occupiers of a landholding are entitled to take water from a river, estuary or lake which fronts their land or from an aquifer which is underlying their land for domestic consumption and stock watering, without the need for a licence. However, a water supply work approval is required to construct a dam or a groundwater bore.

Domestic and stock rights is not applicable to the project.

### 2.3.2 Harvestable rights

Owners or occupiers of a landholding are entitled to collect a proportion of the runoff from their property in one or more dams located on a minor non-permanent stream or unmapped stream and use the water without the need for a licence or water supply work or water use approvals. Harvestable Rights Orders are published in the NSW Government Gazette and specify the rules relating to harvestable rights.

Tahmoor Mine is located within the coastal draining catchments harvestable rights area. In this harvestable rights area, landholders may capture, store and use up to 10% of the average regional runoff for their property.

Harvestable rights dams may be located on non-permanent minor streams (first and second order streams), hillsides and gullies. Dams cannot be located:

- on or within 40 m of a third order or higher order stream
- on a declared floodplain (note that no floodplains are currently declared in the coastal-draining catchments harvestable rights area)
- within 3 km upstream of a wetland of international importance (listed under the Ramsar Convention).

A minor stream is a first or second order stream defined using the Strahler system of stream ordering with reference to the WM Regulation hydroline spatial data published on the NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW) website.

The total capacity of all dams on a property allowed under the harvestable right is called the maximum harvestable right dam capacity (MHRDC). An MHRDC calculator is available on the WaterNSW website, which considers location, rainfall and variations in rainfall patterns.

If the total capacity of applicable dams on a property exceeds the maximum harvestable right volume, a licence and water use approval is required to authorise the take and use of water for the volume in excess of the maximum harvestable right volume. In addition, a water supply work approval is required for dams that exceed the maximum harvestable right volume.

Water captured and stored in a harvestable rights dam can be used for any purpose. However, landholders must not move water from a harvestable rights dam to any other type of dam on the landholding, including an excluded works dam (refer Section 2.4) or a turkey's nest dam.

Dams identified as excluded works in clauses 1 to 4 of Schedule 1 of the WM Regulation (refer Section 2.4) and dams that cannot capture runoff (i.e. turkey's nest dams) are excluded from harvestable rights calculations.

### 2.3.3 Native title rights

Anyone who holds native title with respect to water, as determined under the Commonwealth *Native Title Act 1993*, can take and use water without a licence, water supply work approval (unless the work is a dam or bore) or water use approval. The native title to water and any purpose for which it can be used - such as for personal, domestic and non-commercial communal purposes – is outlined in the specific native title determination.

Native title rights are not applicable to the project as there is no native title determination in respect of water in the project area.

## 2.4 Excluded works exemptions

Water taken from or by means of an excluded work specified in Schedule 1 of the WM Regulation do not require a WAL to take water from a water source or water supply work or water use approvals. Dams that are solely for the capture, containment or recirculation of drainage, consistent with best management practice or required by a public authority (other than Landcom or the Superannuation Administration Corporation or any of their subsidiaries) to prevent the contamination of a water source, that are located on a minor stream (as defined by the WM Regulation hydroline spatial data), are considered to be excluded works under Schedule 1, clause 3 of the WM Regulation.

## 2.5 Water sharing plans

The following WSPs, extraction management units (EMUs), water sources and management zones are relevant to the project.

- *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2023:*
    - Upper Nepean and Upstream Warragamba EMU:
        - Maldon Weir Water Source – contains rules relating to surface water take from Teatree, Bargo, Hornes, and Dogtrap creeks.
- *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2023:*
    - Sydney Basin Nepean Groundwater Source, Nepean Management Zone 2 – contains the rules relating to groundwater extraction from the fractured rock aquifer at the project site.

The rules for the water sources relevant to the project are summarised in Table 2.1.

## Table 2.1 Summary of water sharing plan rules

| Rules | Maldon Weir Water Source | Sydney Basin Nepean Groundwater Source |
|---|---|---|
| Limits on the availability of water (average) | • The standard long-term average annual extraction limit (LTAAEL) volume for Upper Nepean and Upstream Warragamba EMU is yet to be determined. LTAAEL is the sum of:<br>– the average of annual extractions from July 1993 to June 1999 under entitlements issued under the *Water Act 1912*, Parts 2 and 9, excluding entitlements held by the former Sydney Catchment Authority that were replaced by major utility access licences on 1 July 2011<br>– an estimate of annual extractions in the exercise of native title rights and domestic and stock rights as of 1 July 2011<br>– an estimate of the annual volume of water available for extraction from harvestable rights dams under the 2006 Harvestable Rights Order as of 1 July 2011<br>– all access licence share components granted under the WM Regulation, Schedule 4, Part 2, Division 9, Subdivision 2 authorising the taking of water from a water source, including a tidal pool, for which no entitlement was required under the *Water Act 1912*.<br>• LTAAEL for major utility licences held by WaterNSW:<br>– Upper Nepean and Upstream Warragamba EMU: 581,000 megalitres per year (ML/year). | • LTAAEL – 64,785 ML/year<br>• Domestic and stock rights – 5,776 ML/year<br>• Aquifer access – 31,356 ML/year |
| Current WALs | • 662.5 unit shares (unregulated river WALs).<br>• 6.5 ML/year (domestic and stock WALs). | • 31,446.4 unit shares (aquifer access licences, all management zones)<br>• 13 ML/year (domestic and stock [Town Water Supply] WALs, all management zones) |
| Rules for managing licences | Unregulated river WALs:<br>• Carryover unused water allocations up to 1 ML per unit share of WAL.<br>• The maximum water account debt in any three consecutive water years is the volume of water allocated to the account over those three years plus or minus any water allocations traded in or out. | For AALs:<br>• Carryover unused water allocation up to a maximum of 0.1 ML per share of the WAL |
| Trading rules | • Not permitted into water source.<br>• Permitted within water source, subject to assessment. | • Not permitted into water source.<br>• Trading within groundwater source, from Management Zone 2 to Management Zone 1 is prohibited if the trade will increase the total licensed entitlement for the management zone.<br>• Trading within management zones permitted subject to assessment. |

# 3 Existing licences and approvals

A summary of the existing WALs held by Tahmoor Coal is provided in Table 3.1 and their associated approvals are provided in Table 3.2.

**Table 3.1 Summary of existing water access licences**

| Licence | Category | Entitlement (units) | Tenure type | Water sharing plan | Water source | Management zone | Nominated works | Comments/purpose |
|---|---|---|---|---|---|---|---|---|
| WAL25777 | Unregulated river | 5 | Continuing | Greater Metropolitan Region Unregulated River Water Sources 2023 | Maldon Weir | – | 10WA103026 | |
| WAL43572 | Unregulated river | 16 | Continuing | | Stonequarry Creek | – | 10MW119329 | |
| WAL43656 | Unregulated river | 25 | Continuing | | Maldon Weir | – | 10MW119329 | |
| | | 11 | Temporary trade | | | | | Trade reference - SWC839757 |
| WAL44608 | Unregulated river | 9 | Continuing | | Stonequarry Creek | – | 10MW119329 | |
| WAL43658 | Unregulated river | 0 | Continuing | | Stonequarry Creek | – | 10MW119329 | |
| WAL43631 | Unregulated river | 0 | Continuing | | Little River | – | 10MW119329 | |
| WAL43655 | Unregulated river | 0 | Continuing | | Maguires Crossing | – | 10MW119329 | |
| WAL43657 | Unregulated river | 0 | Continuing | | Upper Nepean Rivers | Pheasants Nest Weir to Nepean Dam Management Zone | 10MW119329 | |
| WAL43659 | Unregulated river | 0 | Continuing | | Upper Nepean Rivers | Upper Nepean Rivers Management Zone | 10MW119329 | |
| WAL36442 | Aquifer | 1,642 | Continuing | Greater Metropolitan Region Groundwater Sources 2023 | Sydney Basin Nepean Groundwater Source | Nepean Management Zone 2 | 10WA118745 | |

**Table 3.2 Summary of existing approvals**

| Approval number | Approval kind | Expiry date | Associated WAL | Work description | Use purpose | Location | Comments |
|---|---|---|---|---|---|---|---|
| 10WA118745 | Water supply works | 30/6/2025 | WAL36442 | Three bores for groundwater extraction | – | Lot 162, DP 1054184 | Mine dewatering |
| 10WA103026 | Water supply works | 24/9/2024 | WAL25777 | Diversion Works – pumps, Pumping plant | – | Lot 42, DP 751250 | |
| 10MW119329 | Miscellaneous works approval | 20/8/2120 | WAL43572, WAL43656, WAL44608, SWC839757, WAL43658, WAL43631, WAL43655, WAL43657, WAL43659 | Project elements as described within SSD8445 | – | Project area associated with SSD8445 | |

# 4 Project water requirements

## 4.1 Overview

Tahmoor Coal is required to licence surface water and groundwater that is directly taken for use or where groundwater take results in induced flow from the surface water source to an underlying groundwater source as a result of groundwater drawdown in accordance with the WM Act and AIP. Activities associated with the take of water at Tahmoor Mine and potentially requiring licensing have been identified as:

- pit top operation, including the interception of surface water runoff by the water management system
- underground mining, including:
    - dewatering of mine workings
    - reduction in streamflow due to general lowering of the groundwater table which reduces baseflow contribution
    - induced leakage from surface water sources to underlying groundwater
    - subsidence-induced cracking, which may result in the diversion of surface flow into underlying groundwater systems.

These activities are discussed further in the following sections.

## 4.2 Surface facilities water management system

The existing surface facilities water management system at Tahmoor Mine are described by ATCW (2024) as part of the Modification 3 Surface Water Assessment. The storages that form the water management system at Tahmoor Mine are excluded works under the definition discussed in Section 2.4, as the storages function solely as water quality control structures by capturing sediment-laden and coal-contact runoff and retaining sediment to prevent pollution of the downstream receiving environment. All storages are located on minor streams (i.e. first or second order watercourses) and have been designed and are managed in accordance with *Managing Urban Stormwater: Soils and Construction – Volume 2E Mines and Quarries* (DECC 2008).

Water stored within the water management system is beneficially reused to supply operational activities such as underground mining, the coal handling and processing plant, dust suppression and washdown. The majority of excess water is treated by a WTP prior to discharge to Tea Tree Hollow via a licensed discharge point approved under Environment Protection Licence (EPL) 1389.

Tahmoor Mine currently occupies 278 ha[1] associated with their surface facilities. The Maximum Harvestable Right Calculator provided by WaterNSW was used to determine the maximum harvestable right for the site of 26.4 ML, which is equivalent to an average regional runoff rate of 0.09 megalitres per hectare (ML/ha).

The water storages that form the water management system at Tahmoor Mine are not included within the harvestable rights calculations, as they fulfil the definition of dams that are solely for the capture, containment or recirculation of drainage, consistent with best management practice to prevent the contamination of a water source, that are located on a minor stream. There are no other water storage structures located within the landholding that are not associated with the management of the mine's surface facilities.

[1] Based on land ownership/lease data provided by Tahmoor Coal on 18 December 2020.

There is therefore no licensing required for the capture or use of surface water within the water management system at Tahmoor Mine.

## 4.3 Underground mining operations

### 4.3.1 Groundwater modelling

A numerical groundwater model was originally developed for Tahmoor Mine by SLR/HydroSimulations (2020) to predict the total volume of water intercepted during underground mining operations and the ultimate sources of that water. This model is regularly updated with new data, improved conceptualisation, and revised mine plans, as well as periodic updates to modelling methods.

As part of Modification 3, the existing groundwater model was revised (SLR 2024) to include the proposed mine plan and also included updates to the conceptual model. A summary of these updates is provided by SLR (2024).

The groundwater model is validated periodically via comparison of monitoring results (e.g. measured groundwater levels/pressures) with modelled predictions. Updated calibration of the model occurs as necessary (i.e. when there is a notable deviation between measured and modelled predictions) and an independent review of the model is undertaken every three years. Following each round of model re-calibration, surface water and groundwater take predictions will be reviewed against the model predictions and revised as necessary.

### 4.3.2 Water take components

#### i Inflows to mine workings

Groundwater inflows into the active underground mine workings (Tahmoor South) will be directed to the surface to allow mining to occur, and then recycled and reused for mining operations. Groundwater inflows also occur to inactive areas of completed underground mining which are being allowed to fill (Tahmoor North) – this is referred to as passive take. The hydrogeological model predicts that inflows to areas of underground mine workings will occur for a number of years following the end of mining, until the groundwater system reaches equilibrium (SLR 2024).

Groundwater take associated with inflows into the active and inactive underground mine workings occurs from the Nepean Management Zone 2 of the Sydney Basin Nepean Groundwater Source. Groundwater inflow to active mine workings within Tahmoor South are predicted to have generally reduced in the most recent modelling revisions completed for the project compared to the previous predictions.

The groundwater take required to be licensed predicted by hydrogeological modelling is presented in Table 4.1 for the proposed project, total active underground mine workings (Tahmoor South, including proposed project), total passive take (Tahmoor North) and the total predicted take (all Tahmoor operations, including proposed project). The active underground mining operations are expected to be complete by the 2033-34 water year.

**Table 4.1 Predicted groundwater take from mining operations at Tahmoor Mine (SLR 2024)**

| Water year | For LW S7A mining (ML) | Total active groundwater take (ML) | Total passive groundwater take (ML) |
|---|---|---|---|
| 2024-2025 | 0 | 301 | 2,251 |
| 2025-2026 | 0 | 208 | 2,111 |
| 2026-2027 | 100 | 405 | 1,917 |
| 2027-2028 | 29 | 298 | 1,789 |

**Table 4.1 Predicted groundwater take from mining operations at Tahmoor Mine (SLR 2024)**

| Water year | For LW S7A mining (ML) | Total active groundwater take (ML) | Total passive groundwater take (ML) |
|---|---|---|---|
| 2028-2029 | 11 | 396 | 1,571 |
| 2029-2030 | 13 | 389 | 1,502 |
| 2030-2031 | 16 | 290 | 1,453 |
| 2031-2032 | 18 | 401 | 1,213 |
| 2032-2033 | 19 | 276 | 1,971 |
| 2033-2034 | 0 | 0 | 2,858 |
| 2034-2035 | 0 | 0 | 2,357 |
| 2035-2036 | 0 | 0 | 1,882 |
| 2036-2037 | 0 | 0 | 1,608 |
| 2037-2038 | 0 | 0 | 1,471 |
| 2038-2039 | 0 | 0 | 1,349 |
| 2039-2040 | 0 | 0 | 1,249 |
| 2040-2041 | 0 | 0 | 1,229 |
| 2041-2042 | 0 | 0 | 1,004 |
| 2042-2043 | 0 | 0 | 292 |
| 2043-2044 | 0 | 0 | 50 |
| 2044-2045 | 0 | 0 | 44 |
| 2045-2046 | 0 | 0 | 42 |
| 2046-2047 | 0 | 0 | 40 |
| 2047-2048 | 0 | 0 | 37 |
| 2048-2049 | 0 | 0 | 32 |
| 2049-2050 | 0 | 0 | 29 |
| 2050-2051 | 0 | 0 | 25 |
| 2051-2052 | 0 | 0 | 29 |
| 2052-2053 | 0 | 0 | 24 |
| 2053-2054 | 0 | 0 | 25 |
| 2054-2055 | 0 | 0 | 22 |
| 2055-2056 | 0 | 0 | 19 |
| 2056-2057 | 0 | 0 | 16 |
| 2057-2058 | 0 | 0 | 16 |
| 2058-2081 | 0 | 0 | <15 |

#### ii Changes to adjacent water sources

The take of water associated with the underground workings results in:

- direct take from of mine workings located within Nepean Management Zone 2
- minor throughflow from the adjacent groundwater zone, Nepean Management Zone 1
- leakage from overlying surface water systems.

The Tahmoor Mine groundwater take comprises:

- inflow to the active mining areas (removal of water from the Sydney Basin Nepean Groundwater Source) and includes the reduction in groundwater available for baseflow contribution to surface water systems (reduced movement of water from the Sydney Basin Nepean Groundwater Source to streams).

The Tahmoor Mine surface water take comprises:

- increased river leakage, caused by the lowering of the groundwater table below the surface water level of the stream (take from the Maldon Water Source). Methodologies for estimating this take is further discussed in ATCW (2024) and SLR (2024).
- reduction in stream flow due to subsidence-induced surface cracking, which results in enhanced leakage from the stream into underlying groundwater systems (increased movement of water from the various surface water sources to the Sydney Basin Nepean Groundwater Source). Methodologies for estimating this take is further discussed in SLR (2024).

### 4.3.3 Results

Table 4.2 presents the maximum annual surface water and groundwater take associated with the proposed modification and the cumulative take associated with the entire Tahmoor Mine operation, as presented by ATCW (2024) and SLR (2024). Water sources for which the modelled maximum take is less than 2 ML/year have not been reported as regional groundwater modelling is not accurate to this degree and take of this magnitude cannot be accurately measured or detected in hydrological systems.

**Table 4.2 Estimated maximum water take by water source (SLR 2024 and ATCW 2024)**

| Water sharing plan | Water source | Management zone | Estimated maximum water take (ML/year)[1] | |
|---|---|---|---|---|
| | | | For LW S7A mining | Cumulative |
| Greater Metropolitan Region Groundwater Sources WSP | Sydney Basin Nepean Groundwater Source | Nepean Management Zone 2 | 100 | Active take – 405[2]<br>Passive take – 2,859[2] |
| Greater Metropolitan Region Unregulated River Water Sources WSP | Maldon Weir | – | 3 | 26 |

1. Estimated take has been rounded up to the nearest 1 ML.
2. The peak active groundwater take is expected to occur in 2026-2027. The peak groundwater inflow to the underground mining area is predicted to occur in 2033-2034 at the completion of mining, which will comprise entirely of passive take.

## 4.4 Required entitlement

Tahmoor Coal's water entitlement requirements have been determined based on the information presented in Sections 4.2 and 4.3 and modelling results provided by SLR (2024). Table 4.3 provides a summary of Tahmoor Coal's secured entitlement, estimated maximum water take and additional entitlement requirements in each relevant water source.

Tahmoor Coal has currently secured water entitlement within the Sydney Basin Nepean Groundwater Source (Nepean Management Zone 2) and Maldon Weir Water Source. Based on the groundwater modelling undertaken by SLR (2024), Tahmoor Coal currently holds sufficient entitlement to account for all surface water take in water sources associated with the modification. If the predicted passive take groundwater volumes are required to be licensed, additional groundwater entitlement may be required. Additional entitlement of up to 1,217 ML is predicted to be required by the 2033-34 water year.

## Table 4.3 Summary of water licence requirements based on estimated maximum water take

| Water sharing plan | Water source | Management zone | Entitlement held by Tahmoor Coal | Estimated maximum water take[1] | | Additional entitlement potentially required |
|---|---|---|---|---|---|---|
| | | | | For LW S7A mining | Cumulative | |
| Greater Metropolitan Region Groundwater Sources WSP | Sydney Basin Nepean Groundwater Source | Nepean Management Zone 2 | 1,642 units | 100 ML/year | Active take – 405 ML/year<br>Passive take – 2,859 ML/year | 1,217 units |
| Greater Metropolitan Region Unregulated River Water Sources WSP | Maldon Weir | – | 30 units + 11 units leased | 3 ML/year | 26 ML/year | 0 units |

1. Water sources for which the modelled maximum take is less than 2 ML/year have not been reported or recommended as having entitlement purchased. Regional groundwater modelling is not accurate to this degree and take of this magnitude cannot accurately be measured or detected in hydrological systems. Estimated take has been rounded up to the nearest 1 ML.

# 5 Water access licensing opportunities

## 5.1 Water availability

As previously stated, the Sydney Basin Nepean Groundwater Source has an LTAAEL of 64,785 ML and is subdivided into two management zones. The water made available in the 2023/2024 water year was 31,446.4 ML (WaterNSW 2024). These volumes would indicate that there is some spare allocation capacity in the groundwater source; however, the volume of 'unassigned water' is not publicly available and requires confirmation with government. Trading of groundwater is commonly undertaken in these groundwater sources, but no trade from Nepean Management Zone 2 into Nepean Management Zone 1 can occur (but trade may occur from Nepean Management Zone 1 into Nepean Management Zone 2).

There are currently 239 WALs held in Nepean Management Zone 1 with a total share component of 12,405 unit and 159 WALs held in Nepean Management Zone 2 with a total share component of 19,012.4 units. Additionally, there are three WALs with a total of 29 units within the Sydney Basin Nepean Groundwater Source that do not have a management zone assigned. Within the Nepean Management Zone 2, Tahmoor Coal currently holds 9% of the total share component held and requires an additional 7% of the remaining total share component in the management zone.

## 5.2 Controlled allocation orders

The NSW Government has in recent years released controlled allocation orders (CAOs) in some water systems that are deemed to have water available for allocation. A CAO is a mechanism for granting new WALs in water sources with 'unassigned' water. Unassigned water is the portion of the extraction limit specified by the WSP that has not already been allocated to water users by way of an entitlement or unlicensed statutory right. A controlled allocation process is competitive and is announced by Ministerial Order published in the NSW Government Gazette from time to time. Relevant information, such as applicable water sources, amounts of water made available and minimum prices, are specified in the Order.

CAOs are typically made annually around the middle of the calendar year. There is no guarantee that an offer for all (or any) of the volume tendered for by the interested party will be accepted. It is also not known how much water will be made available in future CAOs.

There have been seven CAOs since 2009, with water typically only released in groundwater sources. Table 5.1 presents the results of controlled allocations for the Sydney Basin Nepean Groundwater Source.

**Table 5.1 Results of previous controlled allocation orders for Sydney Basin Nepean Groundwater Source**

| Year | Unit shares made available | Total shares issued | Quantity of shares issued | Price paid per unit share |
|---|---|---|---|---|
| 2013 | 3,865 | – | – | – |
| 2014 | 3,767 | 51 | 25 | $800 |
| | | | 6 | $900 |
| | | | 10 | $900 |
| | | | 10 | $910 |
| 2017 | 14,935 | 410 | 5 | $1,300 |
| | | | 100 | $1,060 |

**Table 5.1 Results of previous controlled allocation orders for Sydney Basin Nepean Groundwater Source**

| Year | Unit shares made available | Total shares issued | Quantity of shares issued | Price paid per unit share |
|---|---|---|---|---|
| | | | 15 | $800 |
| | | | 10 | $800 |
| | | | 10 | $800 |
| | | | 270 | $651 |

## 5.3 Water trading market

Entering the water trading market is generally the accepted and most successful pathway to securing water entitlement or allocation. The trading market is well established in the Sydney Basin Nepean Groundwater Source. Trades can be on a temporary (similar to leasing) or permanent basis. Permanent trades attract a premium price, with temporary trades more responsive to seasonal variations and demand. The most common trades (known as 'dealings' under the WM Act) include:

- entitlement trade (also known as a 'permanent trade'), which entitles the new owner to accrue all future allocations made to the traded licence or part thereof:
  - licence transfer, which involves a change in ownership of the licence (s.71M)
  - assignment of share component, which involves the sale or transfer of all or part of the entitlement of a licence (s.71Q)
- allocation assignment (also known as a 'temporary trade'), which is a 'one off' sale or transfer of all or part of the water allocation held in the vendor's water licence account to the purchaser's water licence account (s.71T).

Water trading activity for the aquifer entitlement and allocations in the Sydney Basin Nepean Groundwater Source between November 2011 and April 2024 is presented in Figure 5.1. Temporary trades (water allocation assignment trades) and permanent trades (share assignment trades and licence transfers) recorded by the NSW Water Register (WaterNSW 2024) are presented.

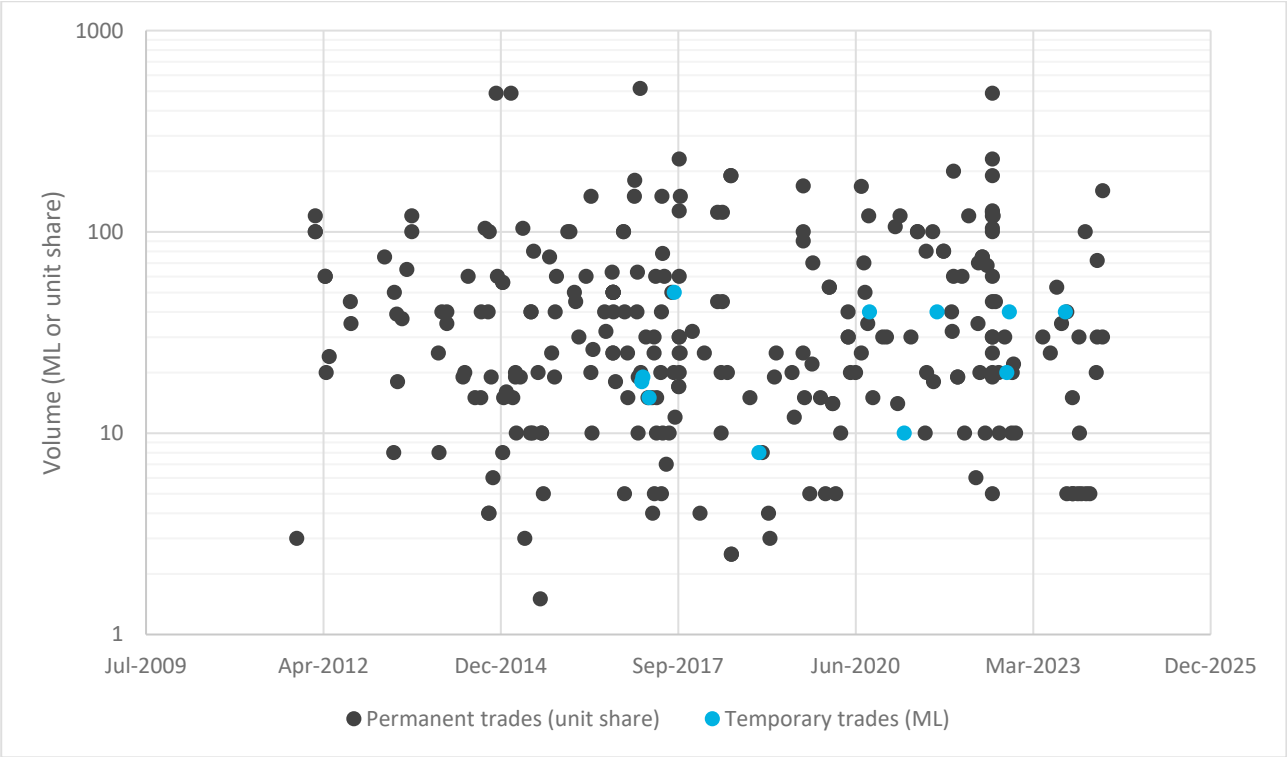


**Figure 5.1** **Water trading activity for aquifer entitlement in the Sydney Basin Nepean Groundwater Source**

Figure 5.1 shows that permanent trading of aquifer entitlement is well established in the Sydney Basin Nepean Groundwater Source, with over 265 permanent trades recorded over the previous 12 years. Most trades have been between 1 and 500 unit shares. Temporary trades of aquifer allocation have occurred less frequently and primarily occurred in Nepean Management Zone 1.

Figure 5.2 presents the historical water availability and usage in the Sydney Basin Nepean Groundwater Source over the past five water years, obtained from the NSW Water Register (WaterNSW 2024). This figure indicates that much of the aquifer water allocations made to individual water accounts is not used, with water use as low as 0.5% of total allocations in the 2020-21 water year. This suggests that there is sufficient depth in the trading market to secure the allocation necessary for the project.

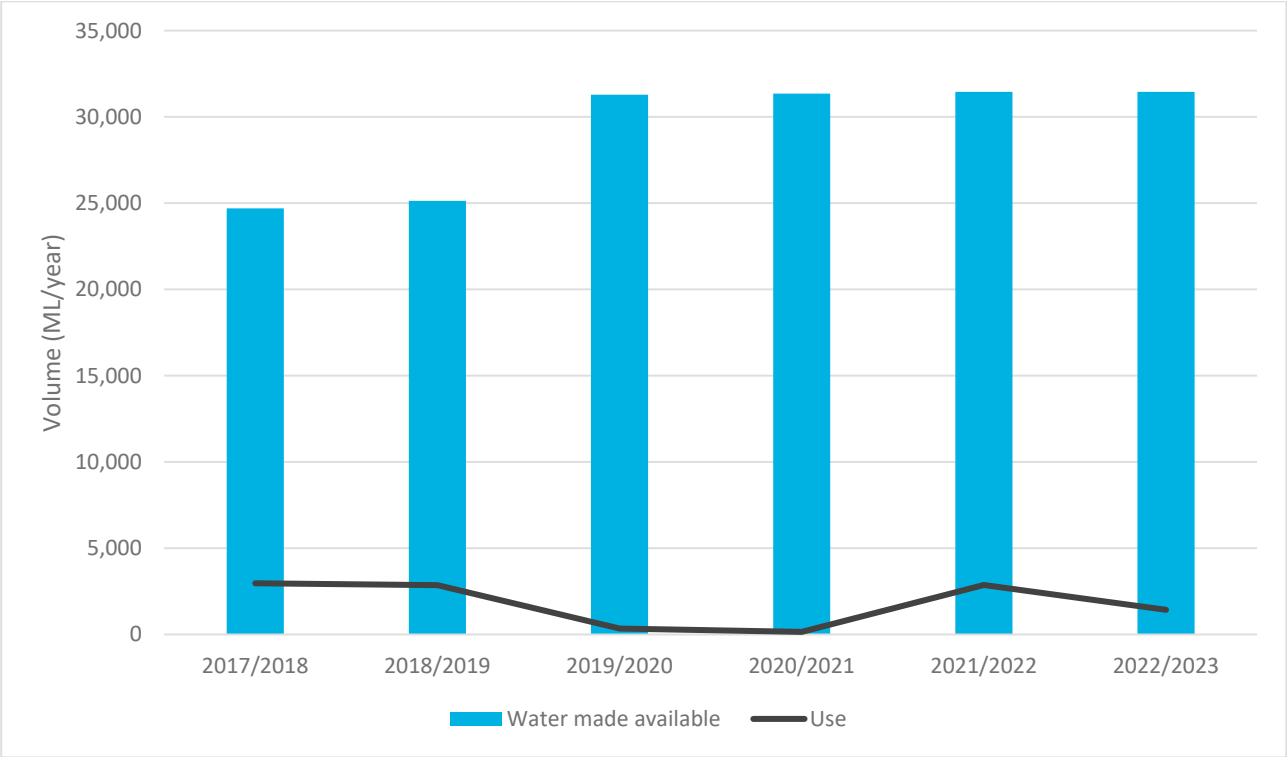


**Figure 5.2** **Historical availability and usage in the Sydney Basin Nepean Groundwater Source**

# 6 Closing

Mining associated with the addition of longwall LW S7A is predicted to take water from the Sydney Basin Nepean Groundwater Source (Nepean Management Zone 2) and Maldon Weir Water Source. Based on the groundwater modelling undertaken by SLR (2024) used to estimate water licensing requirements, Tahmoor Coal has sufficient existing entitlements to account for all predicted active groundwater take from approved and proposed mining operations. Tahmoor Coal may require additional entitlement in the Sydney Basin Nepean Groundwater Source (Nepean Management Zone 2) to account for passive take of groundwater inflows currently occurring into inactive mining areas. If the predicted passive take groundwater volumes are required to be licensed, an additional entitlement of up to

Sufficient surface water entitlement is held by Tahmoor Coal to account for the predicted surface water take associated with the proposed modification in the Maldon Weir Water Source.

Surface water and groundwater monitoring is undertaken at Tahmoor Mine to assist in the ongoing review of the conceptual understanding and compliance reporting of water take. Monitoring results are used to inform groundwater modelling estimates of inflows into the mine workings as well as river leakage and baseflow reduction.

Within the Sydney Basin Nepean Groundwater Source (Nepean Management Zone 2), Tahmoor Coal currently holds 9% of the total share component held and requires an additional 7% of the remaining total share component in the management zone. Historical availability and usage of water in this water source indicates that much of the water is held in individual accounts and not actually used. Additionally, the water trading market in this water source is well established and liquid, representing few risks to the project in terms of securing sufficient entitlement and/or allocation to fulfil water licensing requirements.

If the water take estimates are revised in the future to exceed the entitlement held by Tahmoor Coal in any water source, additional water entitlement or allocation in the relevant water sources will be traded with existing licence holders.

# References

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WaterNSW (2024) *NSW Water Register*, https://waterregister.waternsw.com.au/water-register-frame

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# Appendix I
## Greenhouse gas assessment

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# Tahmoor South Modification 3

## Greenhouse gas assessment

Prepared for Tahmoor Coal

April 2024

# Tahmoor South Modification 3

## Greenhouse gas assessment

Tahmoor Coal

E230438 RP4

April 2024

| Version | Date | Prepared by | Approved by | Comments |
|---|---|---|---|---|
| V1 | 2 April 2024 | Amie Gilbert | Scott Fishwick | Final |
| | | | | |
| | | | | |

Approved by

**Scott Fishwick**
National technical lead – air quality and climate
2 April 2024

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This report has been prepared in accordance with the brief provided by Tahmoor Coal and has relied upon the information collected at the time and under the conditions specified in the report. All findings, conclusions or recommendations contained in the report are based on the aforementioned circumstances. The report is for the use of Tahmoor Coal and no responsibility will be taken for its use by other parties. Tahmoor Coal may, at its discretion, use the report to inform regulators and the public.

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# 1 Introduction

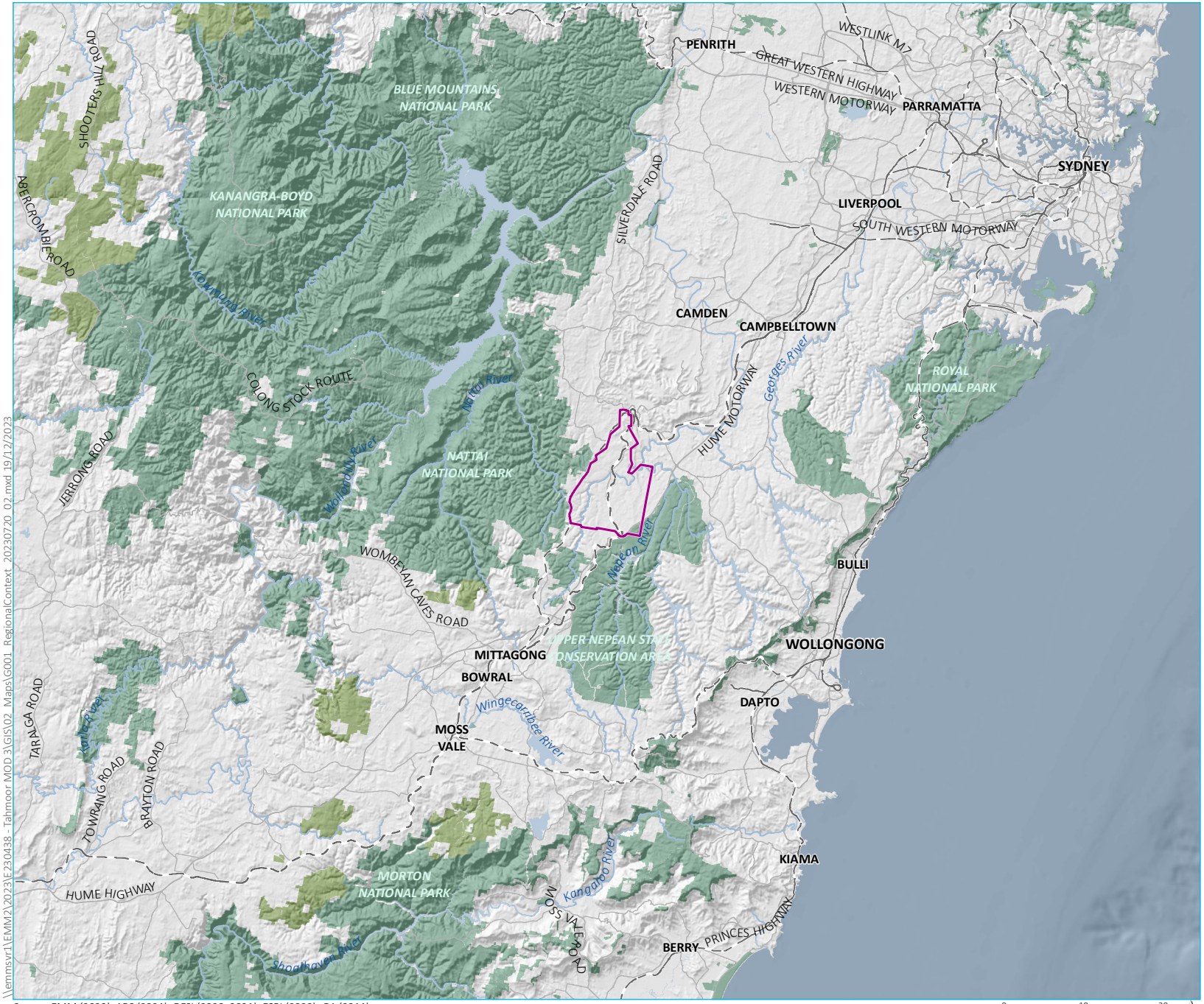
## 1.1 Background

Tahmoor Coal Pty Ltd (Tahmoor Coal) owns and operates the Tahmoor Mine (the mine), an underground coal mine located approximately 80 kilometres (km) south-west of Sydney in the Southern Coalfields of New South Wales (NSW). Tahmoor Colliery is located within the Wollondilly and Wingecarribee local government areas (LGAs), as shown in Figure 1.1.

The mine operates in accordance with State significant development consent (SSD 8445) granted on 23 April 2021 by the NSW Independent Planning Commission (IPC). Development consent SSD 8445 permits extraction and processing of up to 4 million tonnes per annum (tpa) of run-of-mine (ROM) coal from the Bulli Seam until 2032 using longwall mining methods. The approved longwalls authorised by SSD 8445 are shown on Figure 1.2 and includes an A series of longwall panels (LW S1A-S6A) and a B series of longwall panels (LW S1B-S6B). Longwall extraction under the Tahmoor South development consent commenced on 18 October 2022. Tahmoor Coal are currently extracting coal from LW S2A.

Development consent SSD 8445 has been modified on two occasions:

- Modification 1 (Mod 1) was granted on 19 July 2022 and authorised an extension of time, until 31 December 2023, for the new water treatment plant to be commissioned.
- Modification 2 (Mod 2) was granted on 13 June 2023 and authorised the transfer and storage of water treatment plant brine in underground workings.



KEY

- Tahmoor South project area (SSD 8445)
- Rail line
- Major road
- River
- Named waterbody
- NPWS reserve
- State forest

Regional locality

Tahmoor South Coal Project
Greenhouse Gas Assessment
Figure 1.1

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Source: EMM (2023); ABS (2021); DFSI (2020, 2021); ESRI (2023); GA (2011)

0 10 20 km
GDA 1994 NSW Lambert
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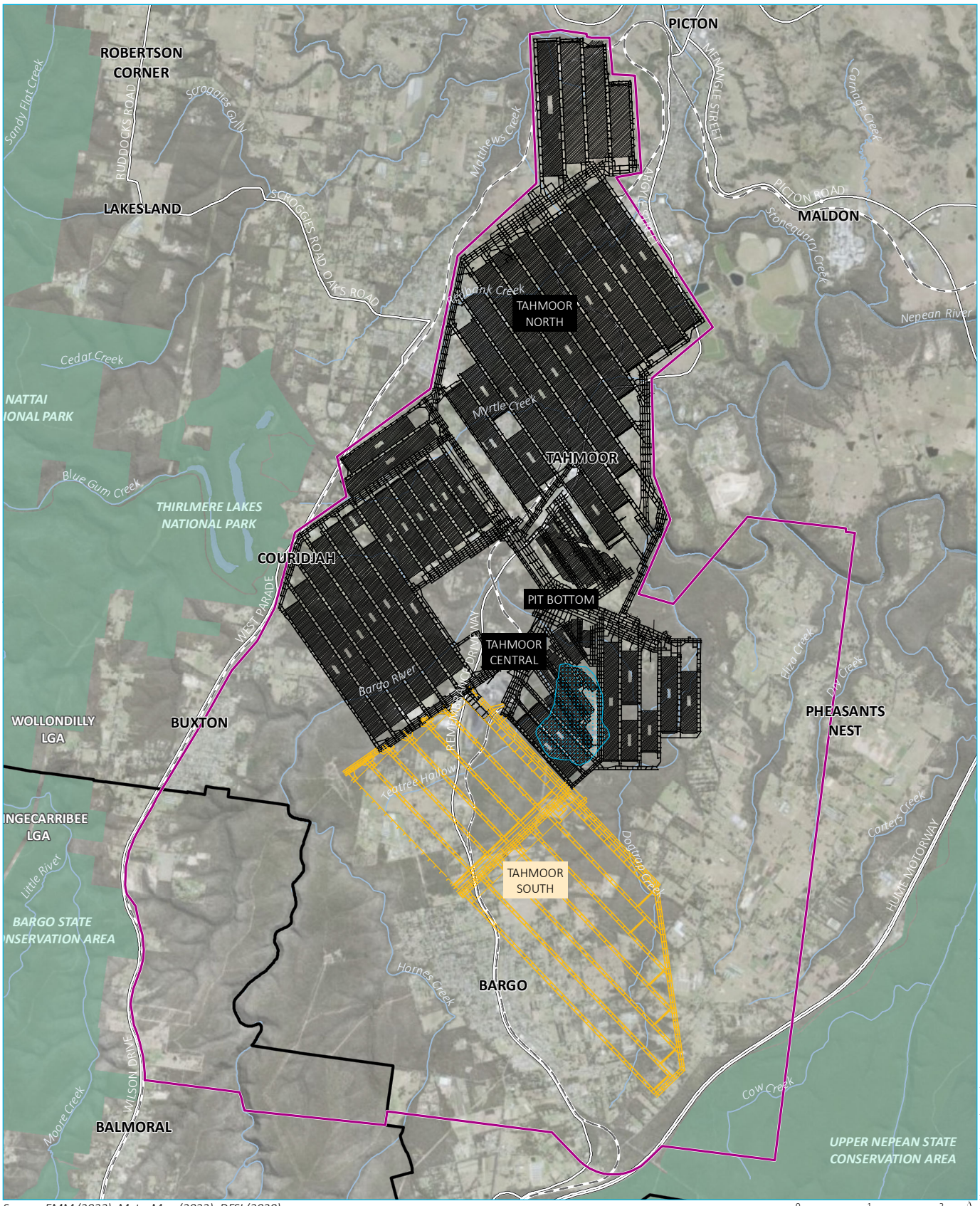


Source: EMM (2023); MetroMap (2023); DFSI (2020)

0 1 2 km

GDA 1994 MGA Zone 56

N

KEY

- Tahmoor South project area (SSD 8445)
- Tahmoor South approved mine workings
- Existing underground workings
- Approved reject emplacement area footprint

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody
- NPWS reserve
- Local government area

Existing and approved mining area

Tahmoor South Coal Project
Greenhouse Gas Assessment
Figure 1.2

EMM creating opportunities

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## 1.2 Proposed modification overview

Tahmoor Coal is seeking to modify SSD 8445 (Mod 3) (the project) under Section 4.55(2) of the Environmental Planning and Assessment Act 1979 (EP&A Act) to authorise:

- an additional longwall panel (LW S7A) to the approved A series longwall panel layout
- removal of restrictions imposed by Condition A6 on the requirement for mining to be completed within 10 years following the commencement of second workings in the Tahmoor South mining area
- an increase in the maximum amount of ROM coal authorised by Condition A11(b) of SSD 8445 that can be extracted and processed on site over the life of the mine from 33 million tonnes (Mt) to 35 Mt.

A summary of the approved project and modifications proposed are provided in Table 1.1.

## Table 1.1 Proposed modification summary table

| Element | Approved project | Project with proposed Mod 3 |
|---|---|---|
| Project area | The Tahmoor South project area is illustrated in Figure 1.1. | No change. |
| Mining areas | As shown on Figure 1.2. | Include mining of LW S7A as shown in Figure 1.3. |
| Extraction rate and processing rate | Up to 4 Mtpa of ROM coal per annum.<br>33 Mt of ROM coal over the life of the project. | No change to annual extraction limit<br>Increase in life of mine ROM coal extraction limit from 33 Mt to 35 Mt. |
| Mine life | Until 31 December 2033, or until 10 years from the commencement of second workings, whichever is the sooner. | Mining operations carried out until 31 December 2033.<br>Remove restriction 'or until 10 years from the commencement of second workings, whichever is the sooner' from condition A6. |
| Mining method | Longwall mining method. | No change. |
| Coal reject management | Continued use of existing reject emplacement area (REA), where reject material may be emplaced up to a maximum height of RL 320 m. | No change. |
| Transportation by rail | A maximum of 4 laden trains may leave the site in any 24-hour period. | No change. |
| Transportation by road | A maximum of 200,000 t per annum of material (including ROM coal, product coal, and coal reject material) may be transported to and from the site by road, at a rate of:<br>• 3,000 t per day<br>• 16 truck movements per hour<br>• 158 truck movements in total per day. | No change. |
| Mine water management | Mine water is collected in underground sumps and pumped from the mine to the existing water management system at the surface facilities area.<br>Treated mine water is reused underground or for other non-potable uses or discharged via the existing LDP1 to Tea Tree Hollow. | No change. |
| Disposal of brine | Transfer of brine from the WTP underground for storage in the Western Domain mining area. | Continued transfer of brine from WTP operations for duration of additional mining. |
| Operating hours | Underground mining operations:<br>• 24 hours a day, 7 days a week.<br>Road transportation:<br>• between 7.00 am to 6.00 pm Monday to Saturday.<br>Construction activities at the surface facilities site and ventilation shaft site:<br>• between 7.00 am to 6.00 pm Monday to Friday<br>• 8.00 am to 1.00 pm Saturday<br>• no construction activities on Sundays or public holidays unless the Planning Secretary agrees otherwise.<br>Drilling activities at the ventilation shaft sites may be undertaken 24 hours a day, 7 days a week. | No change. |

**Table 1.1 Proposed modification summary table**

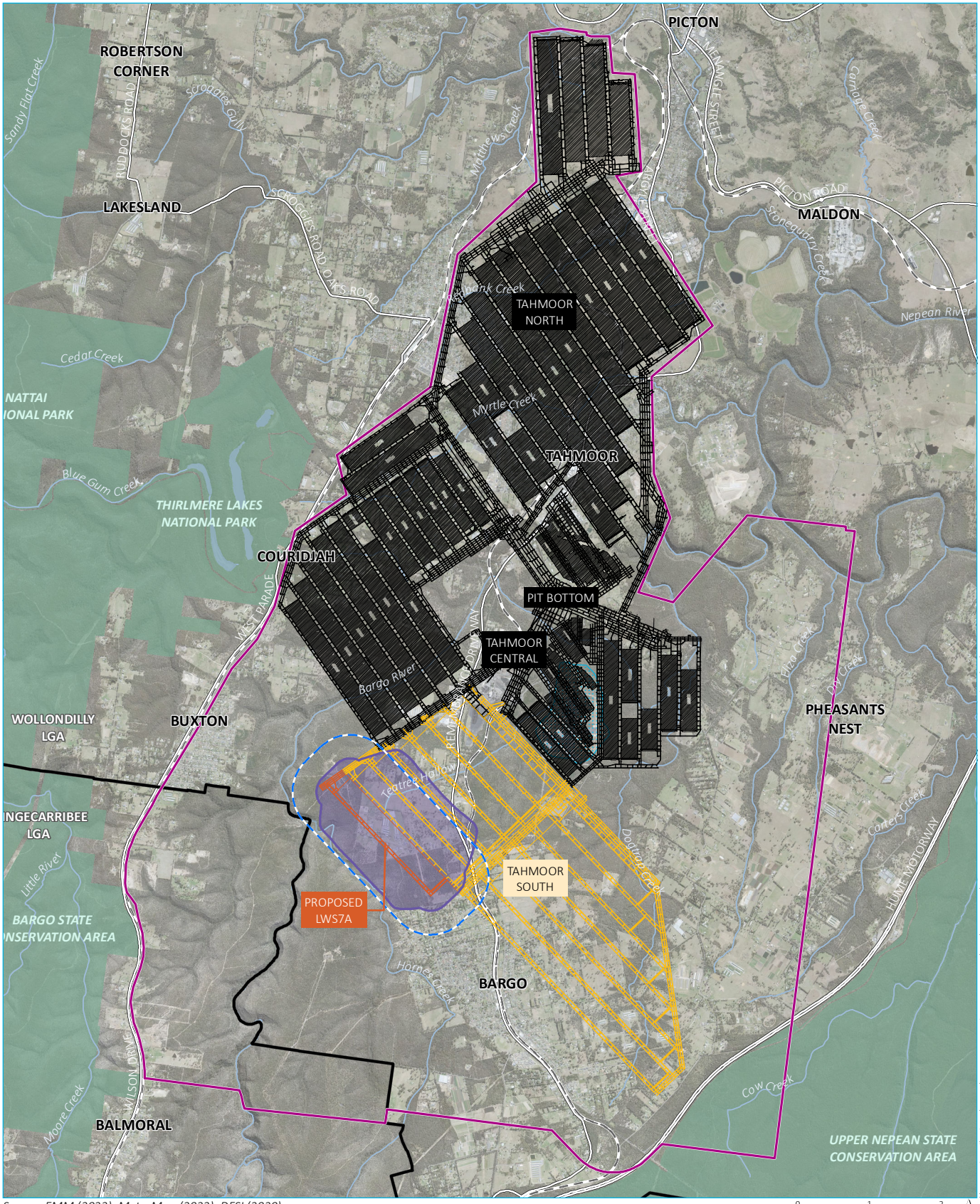
| Element | Approved project | Project with proposed Mod 3 |
|---|---|---|
| Rehabilitation | Progressive rehabilitation.<br>Final rehabilitation and closure in accordance with a Rehabilitation Strategy and Rehabilitation Management Plan. | No change. |
| Workforce | Ongoing employment for approximately 400 full time equivalent (FTE) employees. | No change. |

## 1.3 Purpose of this report

EMM Consulting Pty Ltd (EMM) has been engaged by Tahmoor Coal to produce this greenhouse gas (GHG) assessment to support the Modification Report. It provides estimates of 'Scope 1', 'Scope 2' and 'Scope 3' emissions for continued operations at the mine with proposed modifications, accounting for the proposed changes to the mine under the project (i.e. additional LW S7A). The study also provides a comparison of quantified GHG emissions with NSW and national emission inventories.

As detailed in Table 1.1, a key feature of the project is the increase in life of mine ROM coal extraction limit from 33 Mt to 35 Mt. However, the project does not seek to increase the approved maximum annual ROM extraction rate of 4 Mtpa, and there are no other significant changes to existing approved operations associated with the project that would alter the annual GHG emissions potential of the mine. On this basis, the project does not represent a significant change for GHG emissions from the mine relative to existing approved operations.

The purpose of this GHG assessment is to update GHG calculations to reflect the most recent annual GHG reporting information by Tahmoor Coal and projected annual ROM coal mining rates, and provide context of mine emissions against changing State and Federal legislation and policies.




Source: EMM (2023); MetroMap (2023); DFSI (2020)

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GDA 1994 MGA Zone 56

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KEY

- Tahmoor South project area (SSD 8445)
- Study area
- Offset boundary (600m)
- Approved reject emplacement area footprint
- Tahmoor South approved mine workings
- Existing underground workings

Existing environment

- Rail line
- Major road
- Named watercourse
- Named waterbody
- NPWS reserve
- Local government area

Proposed modification

Tahmoor South Coal Project
Greenhouse Gas Assessment
Figure 1.3

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# 2 Legislative setting

## 2.1 International context

### 2.1.1 Intergovernmental Panel on Climate Change (IPCC)

The Intergovernmental Panel on Climate Change (IPCC) in the United Nations body for assessing the science in relation to climate change. The IPCC prepares comprehensive Assessment Reports about the state scientific, technical and socio-economic knowledge on climate change, its impacts and future risks, and options for reducing the rate at which climate change is taking place. This first assessment report of the IPCC served as the basis for negotiating the United Nations Framework Convention on Climate Change (UNFCC). The IPCC released its Sixth Assessment Report (AR6) in 2022/2023. The IPCC also produces a variety of guidance documents and recommendation methodologies for GHG emissions inventories.

### 2.1.2 United Nations Framework Convention on Climate Change (UNFCCC)

The UNFCCC entered into force in March 2004 and provides the basis for concerted international action to mitigate climate change and to adapt to its impacts. With 198 Parties, the Convention has nearly universal membership. The Conference of the Parties to the Convention (COP) are used to advance the implementation of the Convention.

The objective of the Convention is to stabilise GHG emissions 'at a level that would prevent dangerous anthropogenic interference with the climate system'. It states that 'such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner'[1].

The UNFCCC:

- Puts the onus on developed countries to lead to way in reducing GHG emissions
- Direct funds to climate change activities in developing countries
- Receives regular reports from developed countries on climate change policies and measures
- Recognises adaptation to climate change.

### 2.1.3 Kyoto Protocol

The Kyoto Protocol was adopted in 1997 and was entered into force in 2005, There are currently 192 Parties to the Kyoto Protocol.

Building in the UNFCCC, the Kyoto protocol commits industrialised countries and economies to transition to reduce GHG emissions in accordance with agreed individual targets. These targets add up to an average 5% emission reduction compared to 1990 levels over the first commitment period (2008 – 2012).

The Doha Amendment to the Kyoto Protocol was adopted for a second commitment period (2013 – 2020) and entered into force in December 2020. Under the second commitment period, Parties will reduce GHG emissions by at least 18% below 1990 levels. Under the second commitment period, Australia negotiated two emission reduction targets: an unconditional target of 5-15% below 2000 emission levels by 2020, plus a conditional target of 25% below 2000 emission levels by 2020 (DCCEEW 2023a).

[1] https://unfccc.int/process-and-meetings/the-convention/what-is-the-united-nations-framework-convention-on-climate-change

### 2.1.4 Paris Agreement

At the 2015 United Nations Climate Change Conference (COP21) held in Paris in December 2015, Parties to the UNFCCC reached the Paris Agreement, a global climate change agreement aimed at reducing GHG emissions in order to limit global temperature rise this century to between 1.5-2°C above pre-industrial levels.

Under the Paris Agreements, all Parties are required to put forward GHG emissions reduction targets through Nationally Determined Contributions (NDCs). All Parties are required to report on national emissions, with a review of targets set to occur every five years from 2020.

Australia ratified the Paris Agreement in November 2016. Australia's target under the Paris Agreement is to reduce GHG emissions by 26-28% below 2005 levels by 2031. In 2022 Australia updated the target to reduce GHG emissions by 43% below 2005 levels by 2030 (DCCEEW 2023a).

## 2.2 Australian Context

### 2.2.1 The National Greenhouse and Energy Reporting Scheme

The National Greenhouse and Energy Reporting (NGER) scheme, established by the *National Greenhouse and Energy Reporting Act 2007* (NGER Act), is a single national framework for reporting information about greenhouse gas emissions, energy production and energy consumption.

Facilities or corporations must report under the NGERs scheme if the emit GHG emissions or produce/consume energy at or above the following thresholds:

- greater than 25 kilotonnes (kt) GHG emissions (as $CO_2$-e) or produced/consume greater than 100 terajoules (TJ) of energy (facility level)
- greater than 125 kt of GHG emissions (as $CO_2$-e) or produce/consume greater that 500 TJ of energy (corporate level).

Tahmoor Coal currently reports annual GHG emissions under the NGER scheme.

The NGER Act is underpinned by the National Greenhouse and Energy Reporting Regulations 2008 and the National Greenhouse and Energy Reporting (Measurement) Determination 2008. The Measurement Determination provides methods, criteria and measurement standard for calculating GHG emissions and energy data and covers Scope 1 and Scope 2 emissions (emission scopes are discussed further in Section 3.1) and energy production and consumption.

The Measurement Determination has been updated for 2020-21 onwards to include:

- the global warming potentials (GWPs) prescribed by the IPCC in its Firth Assessment Report (AR5)
- updating Scope 2 emissions factors; for each state.

### 2.2.2 The Safeguard Mechanism

The Safeguard Mechanism is the Australian Government's policy for reducing GHG emissions at Australia's largest industrial facilities, and is enacted through the NGER Act and other legislation[2]. The Safeguard Mechanism was first legislated in 2014 and has been in place since 2016. It was reformed in 2023 to ensure that the facilities it covers will contribute to meeting the targets.

[2] https://www.dcceew.gov.au/climate-change/emissions-reporting/national-greenhouse-energy-reporting-scheme/safeguard-mechanism

There are currently around 220 Safeguard Facilities across the mining, manufacturing, transport, oil, gas and waste sectors. These facilities produce around 28% of Australia's GHG emissions. The Safeguard Mechanism sets legislated limits—known as baselines—on the GHG emissions of these facilities. These baselines will decrease on a trajectory that is consistent with achieving Australia's GHG emission-reduction targets of 43% below 2005 levels by 2030 and net zero by 2050. The baselines will decrease gradually from 1 July 2023. The decline rate will be set at 4.9 per cent each year to 2030.

In general terms, the Safeguard Mechanism applies to facilities with Scope 1 emissions[3] of more than 100,000 tonnes of $CO_2$-e per year.

It is acknowledged that the Safeguard Mechanism provides minimum requirements for the highest emitting facilities, but does not preclude the need for NSW EPA and the consent authority to properly understand the potential GHG impacts of proposed new or significantly modified developments, and to ensure that all proponents are adequately avoiding, minimising and managing their GHG emissions over all stages of the development.

### 2.2.3 New South Wales – Climate Change Policy Framework

The NSW Climate Change Policy Framework (NSW OEH 2016a) outlines the NSW Government objective of net-zero emissions by 2050 and to increase climate change resilience in NSW. The intent of the framework is to maximise the economic, social and environmental wellbeing of NSW in the context of climate change, and current and emerging policy settings and actions to address climate change. The framework sets out seven policy directions for the NSW government to respond to climate change. The Premier and the Minster for the Environment's Draft Climate Change Fund Strategic Plan (NSW OWH 2016b), sets out priority investment areas and potential actions for up to $500 million of new funding from the Climate Change Fund for five years from 2017 to 2022. It organises potential actions into three priority investment areas:

- accelerating advanced energy – aims to provide greater investment certainty for private sector, accelerating new technology to reduce future costs and helping communities make informed decisions on a net-zero emissions future
- national leadership in energy efficiency – focuses on building energy productivity and lowering energy prices
- preparing for a changing climate – aims to reduce costs to public and private assets that arise from climate change, reduce impacts om health and wellbeing, particularly in vulnerable communities and manage impacts of climate change on natural resources, ecosystems and communities.

Further to the NSW Climate Change Policy Framework, the NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW, then DPIE) released the Net Zero Plan Stage 1: 2020-2030, dated 14 March 2020, which provides greater detail on initial strategies for the state to meet net zero emissions by 2050 by delivering a 35% cut in emissions by 2030 compared to 2005 levels, and has since been updated in 2021 and 2022 which set further targets to reduce NSW emissions by 50% below 2005 levels by 2030. The plan outlines initiatives to balance economic growth, job creation and emission reduction.

[3] The threshold applies to actual (gross) emissions from a facility, and does not take into account any offset or displaced emissions.

# 3 Greenhouse gas assessment

## 3.1 Introduction

The estimation of GHG emissions for the project was based on the *National Greenhouse Accounts Factors Workbook* (NGAF) (DCCEW 2023). The methodologies in the NGAF workbook follow a simplified approach, equivalent to the 'Method 1' approach outlined in the *National Greenhouse and Energy Reporting (Measurement) Technical Guidelines* (DoE 2014). The Technical Guidelines are used for the purpose of reporting under the Commonwealth *National Greenhouse and Energy Reporting Act 2007* (the NGER Act).

For accounting and reporting purposes, GHG emissions are defined as 'direct' and 'indirect' emissions. Direct emissions (also referred to as Scope 1 emissions) occur within the boundary of an organisation and as a result of that organisation's activities. Indirect emissions are generated as a consequence of an organisation's activities but are physically produced by the activities of another organisation (DCCEEW 2023a). Indirect emissions are further defined as Scope 2 and Scope 3 emissions. Scope 2 emissions occur from the generation of the electricity purchased and consumed by an organisation. Scope 3 emissions occur from all other upstream and downstream activities, for example the downstream extraction and production of raw materials or the upstream use of products and services.

Scope 3 is an optional reporting category (Bhatia et al 2010) and should not be used to make comparisons between organisations, for example in benchmarking GHG intensity of products or services. Typically, only major sources of Scope 3 emissions are accounted and reported by organisations. Specific Scope 3 emission factors are provided in NGAF for the consumption of fossil fuels and purchased electricity, making it straightforward for these sources to be included in a GHG inventory, even though they are a relatively minor source.

Examples of Scope 1, 2 and 3 emissions are provided in Figure 3.1.

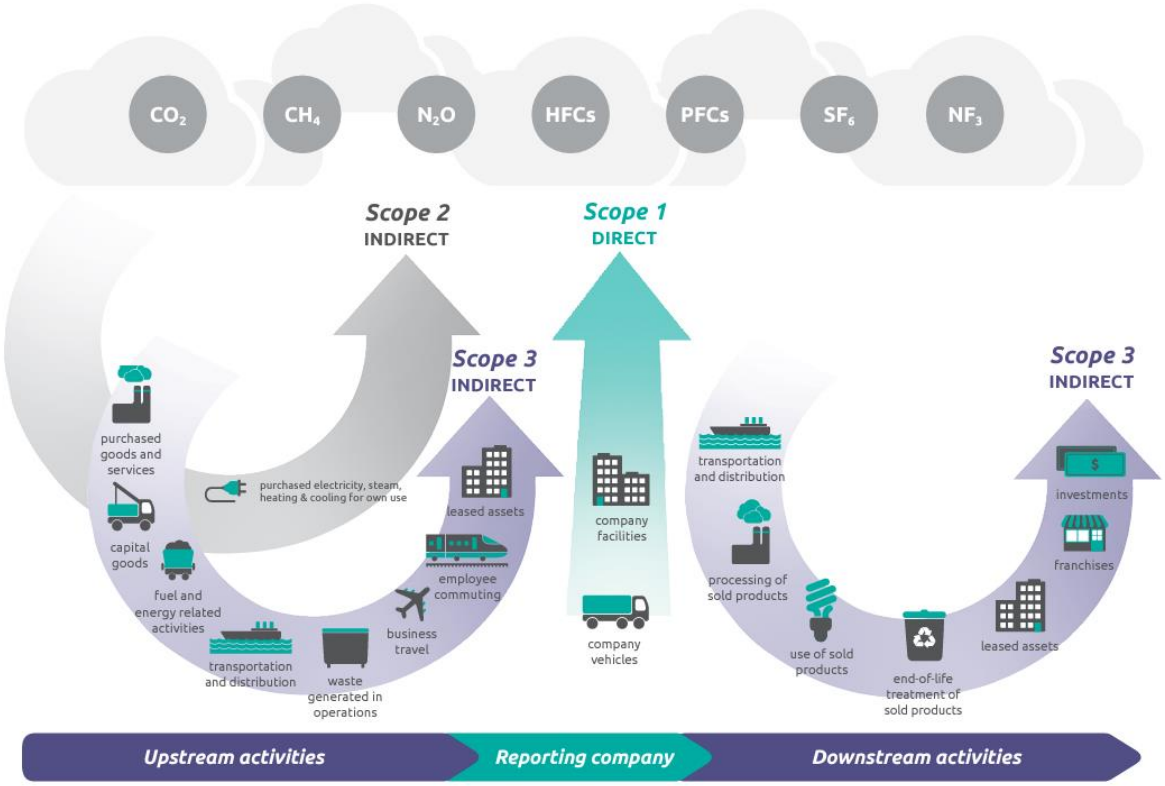


**Figure 3.1 Overview of GHG emission scopes (WRI & WBCSD 2013)**

In this assessment, GHG emissions are presented as carbon dioxide equivalents ($CO_2$-e) and include emissions of carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$) and sulfur hexafluoride ($SF_6$), calculated based on the global warming potentials (GWPs) adopted by the Parties to the UNFCCC and its Kyoto Protocol.

## 3.2 Emissions sources

The GHG emission sources included in this assessment are listed in Table 3.1 and represent the most significant sources associated with the project.

GHG emissions from the project have been estimated using the methodologies outlined in the NGAF, using fuel energy contents and Scope 1, 2 and 3 emission factors for fuel combustion, fugitive emissions from mining and post-mining sources, flaring of captured waste gas, electricity use, $SF_6$ consumption, diversion of waste mine gas to the third party owned Waste Coal Mine Gas Power Plant (WCMGPP), transportation of product coal to market and product coal combustion by end users.

**Table 3.1 Scope 1, 2 and 3 emission sources**

| Scope 1 | Scope 2 | Scope 3 |
|---|---|---|
| Direct emissions from fuel combustion (diesel). | Indirect emissions associated with the consumption of purchased electricity. | Indirect upstream emissions from the extraction, production and transport of diesel. |
| Direct emissions from fuel combustion (unleaded petrol). | - | Indirect upstream emissions from the extraction, production and transport of unleaded petrol. |
| Direct emissions from the use of oils and greases. | - | Indirect upstream emissions from the extraction, production and transport of oil and greases. |
| Direct emissions from flaring of mine waste gas | - | Indirect upstream emissions from electricity lost in delivery in the transmission and distribution network. |
| Emissions of mine ventilation air methane (VAM) from ventilation shafts. | - | Indirect downstream emissions from product coal combustion. |
| Fugitive emissions from stockpiled coal. | | Indirect downstream emissions associated with product transportation (rail and shipping) |
| Direct emissions from the use of sulfur hexafluoride ($SF_6$). | - | Indirect downstream emissions associated with the combustion of captured waste gas by WCMGPP |

## 3.3 Activity data

Activity data for the mine have been provided by Tahmoor Coal in the form of NGER Scheme declarations for the financial years (FY) 2018 to 2022. Total extracted ROM coal for these reporting years have also been provided. In the absence of projected future year energy consumption data for the mine, consumption intensity factors were derived based on the FY18 to FY22 NGER scheme declarations. These intensity factors were then combined with projected annual ROM coal extraction rates for the life of mine, as provided by Tahmoor Coal, to estimate future fuel/energy consumption rates for the mine (Table 3.2).

Similarly, waste gas extraction rates and reported emissions from mine VAM and fugitive emissions from stockpiles were sourced from FY18 to FY22 NGER scheme declaration forms and compared against the corresponding ROM coal extraction rates to quantify emission intensity factors (Table 3.3).

**Table 3.2 Historical consumption data for the 2018-2022 period**

| Year | ROM Coal (t) | Diesel (L) | Unleaded Petrol (L) | Oils (L) | Lubricants (L) | Electricity (kWh) | $SF_6$ ($CO_2$-et/t) |
|---|---|---|---|---|---|---|---|
| FY18 | 2,416,042 | 1,020,811 | 6,669 | - | - | 98,792,591 | 164 |
| FY19 | 2,362,111 | 1,014,829 | 6,534 | 142,211 | 10,300 | 101,599,419 | 336 |
| FY20 | 1,971,256 | 1,289,215 | 1,701 | 147,975 | 6,279 | 108,202,157 | 336 |
| FY21 | 2,900,384 | 1,405,676 | 647 | 162,820 | 5,678 | 120,867,320 | 452 |
| FY22 | 2,298,116 | 1,554,146 | 648 | 158,135 | 5,110 | 115,512,171 | 558 |
| **Total** | **11,947,909** | **6,284,677** | **16,199** | **611,141** | **27,367** | **544,973,658** | **1,845** |
| **Intensity factor (Usage/t ROM)** | | **0.53** | **0.0014** | **0.065** | **0.003** | **46.15** | **0.00016** |

**Table 3.3 Historical gas extraction, flaring and fugitive emission data for the 2018-2022 period**

| Year | ROM Coal (t) | Coal seam gas captured for WCMGPP energy generation ($m^3$) | Flaring emissions (t $CO_2$-e) | Mine VAM emissions (t $CO_2$-e) | Post-mining activities (fugitives from stockpiles) (t $CO_2$-e) |
|---|---|---|---|---|---|
| FY18 | 2,416,042 | 16,574,887.0 | 55,524 | 1,296,470 | 41,073 |
| FY19 | 2,362,111 | 19,110,783.0 | 51,968 | 1,165,033 | 40,156 |
| FY20 | 1,971,256 | 19,254,224.0 | 47,400 | 1,154,282 | 33,511 |
| FY21 | 2,900,384 | 18,474,300.2 | 57,258 | 996,693 | 55,107 |
| FY22 | 2,298,116 | 21,803,021.5 | 59,844 | 856,238 | 43,664 |
| **Total** | **11,947,909** | **95,217,216** | **271,994** | **5,468,716** | **213,511** |
| **Intensity factor (unit/t ROM coal)** | | **8.12** | **0.023** | **0.37** | **0.019** |

For all parameters, with the exception of mine VAM emissions and post-mining activities, the derived intensity factor is the average of the past five years of NGER scheme reporting periods.

For mine VAM emissions, the intensity factor has been derived based on FY22 only, with the following justification given:

- The FY18 to FY22 NGER scheme declarations account for activities at both Tahmoor North and Tahmoor South operations for each reporting year.
- Relative to Tahmoor South, the Tahmoor North mining area featured higher $CH_4$ seam gas content.
- Mining operations were completed at Tahmoor North in quarter 1 FY22 and associated mining areas have since been sealed, leading to an observed reduction in mine VAM emissions.
- Tahmoor Coal therefore expect that the mine VAM emissions recorded and reported for FY22 are the most representative of future Tahmoor South longwall operations.

For post-mining fugitive emissions associated with stockpiled coal, the emission factor of 0.019 t $CO_2$-e/t ROM coal was applied, consistent with *Method 1 – post-mining activities related to gassy mines* (Subdivision 3.2.2.4 of the NGER Determination (2008) (as amended in 2023).

The derived energy and fuel consumption rates for the project by year are presented in Table 3.4. The derived gas extraction and flaring rates for the project by year are presented in Table 3.4.

Tahmoor Coal estimate that ROM coal extraction from LW S7A will represent 2 Mt of the total 35 Mt that will be extracted from the Tahmoor South area, equating to approximately 6% of total life of mine ROM coal extraction from the mine. Further, Tahmoor Coal estimate that the duration of mining LW S7A will represent approximately 7% of the total future mining duration for the life of the mine.

For the purpose of this assessment, it has been assumed that 7% of total life of mine GHG emissions are associated with the project. This approach assumes that fugitive emission generation, associated energy consumption (diesel consumption, electricity, etc) are directly linear with ROM extraction rate, no matter where operations occur for in the mine. LW S7A is planned to be extracted following extraction in LW S6A and prior to relocating to the 'B-series' of longwalls. Extraction in LW S7A is anticipated to commence in January 2027.

## Table 3.4 Projected energy and fuel consumption – life of mine

| Year | ROM coal (t) | Primary coking (t) | Secondary coking (t) | Electricity (kWh) | Diesel (L) | $SF_6$ (t) | Unleaded petrol (L) | Oils (L) | Lubricants (L) |
|---|---|---|---|---|---|---|---|---|---|
| FY24 | 2,518,066 | 1,470,094 | 72,137 | 116,198,211 | 1,343,172 | 392 | 3,472 | 163,812 | 211 |
| FY25 | 3,941,724 | 2,322,062 | 130,345 | 181,894,078 | 2,102,571 | 614 | 5,435 | 256,428 | 382 |
| FY26 | 3,600,134 | 2,149,464 | 145,133 | 166,131,101 | 1,920,362 | 561 | 4,964 | 234,206 | 425 |
| FY27 | 3,845,099 | 2,505,196 | 135,238 | 177,435,213 | 2,051,029 | 599 | 5,302 | 250,142 | 396 |
| FY28 | 3,186,803 | 2,220,649 | 127,190 | 147,057,629 | 1,699,885 | 496 | 4,394 | 207,317 | 373 |
| FY29 | 3,057,388 | 2,209,007 | 142,616 | 141,085,676 | 1,630,854 | 476 | 4,216 | 198,898 | 418 |
| FY30 | 2,668,377 | 1,943,613 | 165,210 | 123,134,448 | 1,423,350 | 416 | 3,679 | 173,591 | 484 |
| FY31 | 3,643,677 | 2,663,298 | 255,455 | 168,140,424 | 1,943,588 | 568 | 5,024 | 237,039 | 749 |
| FY32 | 3,411,562 | 2,449,670 | 256,479 | 157,429,316 | 1,819,775 | 531 | 4,704 | 221,939 | 752 |
| FY33 | 3,460,124 | 2,563,671 | 246,497 | 159,670,250 | 1,845,679 | 539 | 4,771 | 225,098 | 723 |
| **Total** | **33,332,955** | **22,496,724** | **1,676,301** | **1,538,176,346** | **17,780,264** | **5,193** | **45,962** | **2,168,471** | **4,915** |

## Table 3.5 Projected gas extraction, flaring and fugitive emissions – life of mine

| Year | ROM coal (t) | Coal seam gas captured for third part energy generation ($m^3$) | Flaring emissions (t $CO_2$-e) | Mine VAM emissions (t $CO_2$-e) | Post-mining activities (fugitives from stockpiles) (t $CO_2$-e) |
|---|---|---|---|---|---|
| FY24 | 2,518,066 | 20,434,278 | 57,820 | 938,188 | 47,843 |
| FY25 | 3,941,724 | 31,987,362 | 90,510 | 1,468,618 | 74,892 |
| FY26 | 3,600,134 | 29,215,331 | 82,666 | 1,341,347 | 68,402 |
| FY27 | 3,845,099 | 31,203,239 | 88,291 | 1,432,617 | 73,057 |
| FY28 | 3,186,803 | 25,861,125 | 73,175 | 1,187,347 | 60,549 |
| FY29 | 3,057,388 | 24,810,915 | 70,204 | 1,139,130 | 58,090 |
| FY30 | 2,668,377 | 21,654,065 | 61,271 | 994,191 | 50,699 |
| FY31 | 3,643,677 | 29,568,684 | 83,666 | 1,357,570 | 69,230 |
| FY32 | 3,411,562 | 27,685,060 | 78,336 | 1,271,089 | 64,819 |
| FY33 | 3,460,124 | 28,079,144 | 79,451 | 1,289,182 | 65,742 |
| **Total** | **33,332,955** | **270,499,203** | **765,389** | **12,419,279** | **633,323** |

## 3.4 Emission estimates – life of mine

The following emission factors and input data have been used to estimate GHG emissions from the project:

- diesel consumption on-site (Scope 1) – diesel oil factor from Table 8 of NGAF (2023) and annual projected use
- unleaded petrol consumption (Scope 1) - automotive gasoline/petrol (other than for use as fuel in an aircraft) factor from Table 8 of NGAF (2023) and annual projected use
- oil and grease consumption (Scope 1) – petroleum-based greases factor from Table 8 of NGAF (2023) and annual projected use
- mine VAM emissions (Scope 1) – emission factor calculated using reported Scope 1 mine VAM emissions and corresponding ROM coal extraction rate as reported in Tahmoor Coal's NGER scheme reporting for FY22 and then applied to the annual ROM coal for the project.
- waste gas flaring emissions (Scope 1) – emission factor calculated using reported Scope 1 coal mine waste gas flared emissions and ROM coal reported in Tahmoor Coal's NGER reporting for FY18 to FY22, and then applied to the annual projected ROM coal for the life of the mine
- fugitive emissions from stockpiled coal (Scope 1) – emission factor calculated using Scope 1 post-mining activity emission factor of 0.019 t $CO_2$-e/t ROM coal, and then applied to the annual projected ROM coal for the life of the mine
- electricity consumption (Scope 2) – NSW/ACT emission factors between 2024 and 2035 from Table 45 of *Australia's emissions projections 2022* (DCCEEW 2022) and annual projected use
- electricity consumption (Scope 3) – NSW/ACT emission factors between 2024 and 2035, derived from Table 46 of (DCCEEW 2023) and annual projected use
- diesel consumption on-site (Scope 3) – diesel oil factor from Table 8 of NGAF (2023) and annual projected use
- unleaded petrol consumption (Scope 3) - automotive gasoline/petrol (other than for use as fuel in an aircraft) factor from Table 8 of NGAF (2023) and annual projected use
- oil and grease consumption (Scope 3) – petroleum-based greases factor from Table 8 of NGAF (2023) and annual projected use
- product coal combustion (Scope 3) – coking coal energy content and Scope 1 emission factor (as Scope 3) taken from Table 4 of NGAF (2023) combined with annual project coal totals
- combustion of waste gas by WCMGPP (Scope 3) - coal mine waste gas that is captured for combustion Scope 1 emission factor (as Scope 3) taken from Table 5 of NGAF (2023), combined with annual gas capture rates
- transportation of product coal by rail (Scope 3) – emission factor for freight train from UK Department for Energy Security and Net Zero (UKDESNZ) 2023 2023 GHG conversion factors and a one way distance from site to Port Kembla of 120 km, combined with annual project coal totals

- transportation of product coal by ship (Scope 3) - emission factor for shipping by bulk carrier from UKDESNZ 2023 GHG conversion factors and a one way distance from Port Kembla Port of Dahej, India of 13,750 km, combined with annual project coal totals.

Calculated annual Scope 1 and 2 GHG emissions by source type over the life of the mine are presented in Table 3.6, while calculated annual Scope 3 GHG emissions by source type are presented in Table 3.7. The life of mine emission totals and annual average emission totals by scope are presented in Table 3.8. Details of the GHG emissions calculations are provided in Appendix A.

## Table 3.6 Annual Scope 1 and 2 GHG emissions – life of mine

| Year | Annual Scope 1 emissions (t $CO_2$-e/year) | | | | | | | | Annual Scope 2 emissions (t $CO_2$-e/year) |
|---|---|---|---|---|---|---|---|---|---|
| | Diesel | Unleaded petrol | Oil and grease | Mine VAM | Flares | $SF_6$ | Post mining activities | Total | Electricity |
| FY24 | 3,640 | 8 | 88 | 938,188 | 57,820 | 392 | 47,843 | 1,047,979 | 68,557 |
| FY25 | 5,697 | 13 | 139 | 1,468,618 | 90,510 | 614 | 74,893 | 1,640,483 | 94,585 |
| FY26 | 5,204 | 12 | 127 | 1,341,347 | 82,666 | 561 | 68,403 | 1,498,318 | 64,791 |
| FY27 | 5,558 | 12 | 135 | 1,432,617 | 88,291 | 599 | 73,057 | 1,600,269 | 51,456 |
| FY28 | 4,606 | 10 | 112 | 1,187,347 | 73,175 | 496 | 60,549 | 1,326,297 | 41,176 |
| FY29 | 4,419 | 10 | 107 | 1,139,130 | 70,204 | 476 | 58,090 | 1,272,436 | 38,093 |
| FY30 | 3,857 | 9 | 94 | 994,191 | 61,271 | 416 | 50,699 | 1,110,536 | 23,396 |
| FY31 | 5,267 | 12 | 128 | 1,357,570 | 83,666 | 568 | 69,230 | 1,516,440 | 18,495 |
| FY32 | 4,931 | 11 | 120 | 1,271,089 | 78,336 | 531 | 64,820 | 1,419,838 | 9,446 |
| FY33 | 5,001 | 11 | 122 | 1,289,182 | 79,451 | 539 | 65,742 | 1,440,049 | 3,193 |
| **Total** | **48,180** | **107** | **1,172** | **12,419,279** | **765,389** | **5,193** | **633,326** | **13,872,645** | **413,189** |
| **Annual average** | **4,818** | **11** | **117** | **1,241,928** | **76,539** | **519** | **63,333** | **1,387,264** | **41,319** |

## Table 3.7 Annual Scope 3 GHG emissions – life of mine

| Year | Annual Scope 3 emissions (t $CO_2$-e/year) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Diesel | Unleaded petrol | Oil and grease | Electricity | Combustion of product coal by end user | Combustion of captured gas by third party | Product transport (Rail to Port Kembla) | Product transport (Shipping to Port of Dahej) | Total |
| FY24 | 897 | 8 | 115 | 4,648 | 4,257,945 | 43,757 | 5,143 | 74,937 | 4,387,449 |
| FY25 | 1,404 | 13 | 179 | 7,276 | 6,770,853 | 68,496 | 8,178 | 119,162 | 6,975,561 |
| FY26 | 1,282 | 12 | 164 | 4,984 | 6,335,153 | 62,561 | 7,651 | 111,494 | 6,523,301 |
| FY27 | 1,370 | 12 | 175 | 5,323 | 7,289,975 | 66,817 | 8,805 | 128,298 | 7,500,775 |
| FY28 | 1,135 | 10 | 145 | 2,941 | 6,482,148 | 55,378 | 7,829 | 114,081 | 6,663,668 |
| FY29 | 1,089 | 10 | 139 | 4,233 | 6,492,596 | 53,129 | 7,842 | 114,265 | 6,673,302 |
| FY30 | 950 | 9 | 122 | 1,231 | 5,822,251 | 46,369 | 7,032 | 102,467 | 5,980,431 |
| FY31 | 1,298 | 12 | 166 | 1,681 | 8,058,384 | 63,317 | 9,733 | 141,822 | 8,276,413 |
| FY32 | 1,215 | 11 | 156 | 1,574 | 7,471,406 | 59,284 | 9,024 | 131,491 | 7,674,161 |
| FY33 | 1,233 | 11 | 158 | 1,597 | 7,758,593 | 60,128 | 9,371 | 136,546 | 7,967,635 |
| **Total** | **11,873** | **107** | **1,518** | **35,488** | **66,739,305** | **579,236** | **80,607** | **1,174,563** | **68,622,697** |
| **Annual average** | **1,187** | **11** | **2,404** | **3,549** | **6,673,931** | **57,924** | **8,061** | **117,456** | **6,862,270** |

### Table 3.8 Estimated GHG emissions – life of mine

| Source | Life of mine GHG emissions (t $CO_2$-e) by scope | | | |
|---|---|---|---|---|
| | Scope 1 | Scope 2 | Scope 3 | Total |
| Diesel combustion | 48,180 | - | 11,873 | 60,053 |
| Unleaded petrol combustion | 107 | - | 107 | 213 |
| Oil and grease consumption | 1,172 | - | 1,518 | 2,690 |
| $SF_6$ use | 5,193 | - | - | 5,193 |
| Mine VAM emissions | 12,419,279 | - | - | 12,419,279 |
| Flaring of captured gas | 765,389 | - | - | 765,389 |
| Post-mining | 633,326 | - | - | 633,326 |
| Electricity consumption | - | 413,189 | 24,041 | 351,453 |
| Combustion of captured gas by third party | - | - | 579,236 | 579,236 |
| Product transport (Rail to Port Kembla) | - | - | 80,607 | 80,607 |
| Product transport (Shipping to Port of Dahej) | - | - | 1,174,563 | 1,174,563 |
| Product coal combustion | - | - | 66,739,305 | 66,739,305 |
| **Total** | **13,872,645** | **413,189** | **68,622,697** | **82,908,530** |
| **Annual average** | **1,387,264** | **41,319** | **6,862,270** | **8,290,853** |
| **Project total (7%)** | **971,085** | **28,923** | **4,803,589** | **5,803,597** |

The significance emission source groups to total annual Scope 1 GHG emissions is presented in Figure 3.2. It can be seen that emissions from mine VAM contribute approximately 90% of total Scope 1 GHG emissions from the mine. Discussion on mitigation measures at the mine is provided in Chapter 4.

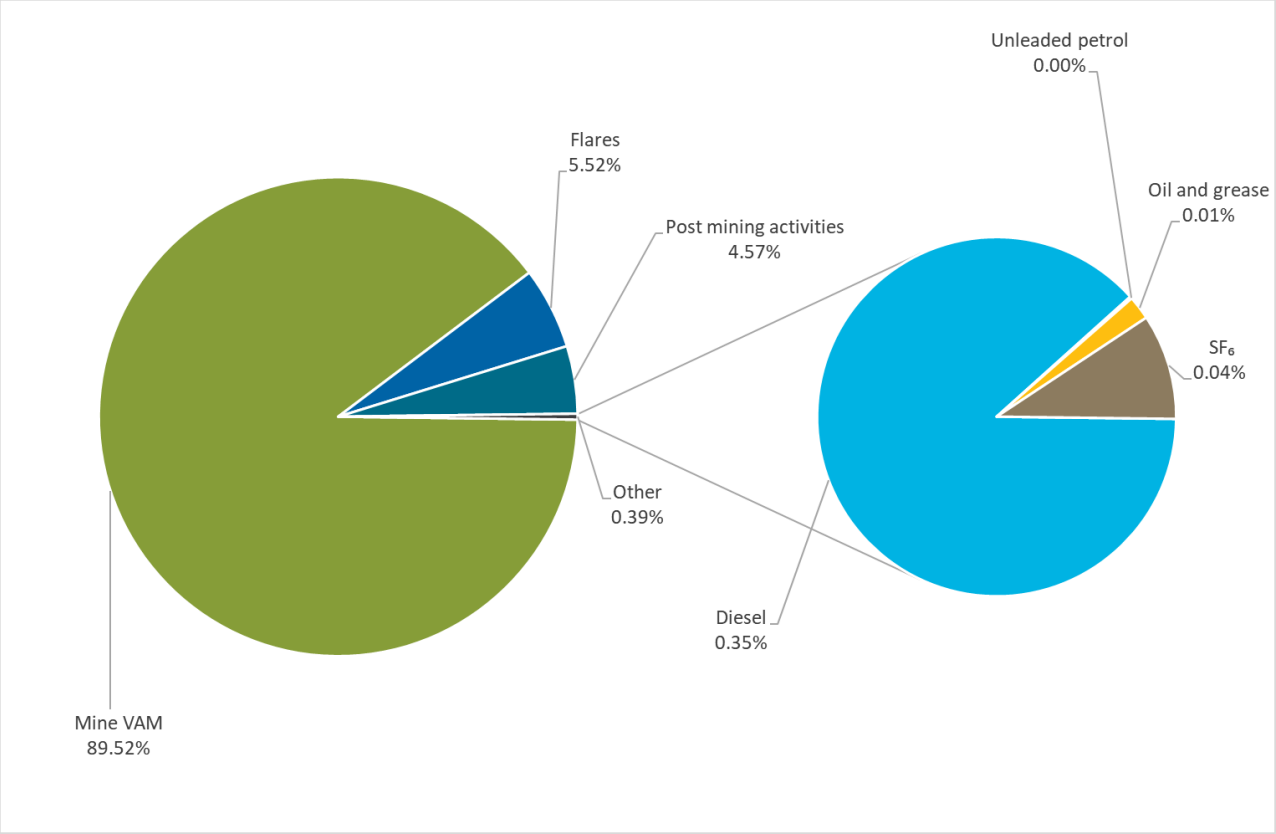


**Figure 3.2 Source contribution to annual Scope 1 GHG emissions (life of mine average)**

The significance of mine emissions relative to State and National GHG emissions has been determined by comparing annual average GHG emissions against the most recent available total GHG emissions inventories (calendar year 2021[4]) for NSW (132,049 kt $CO_2$-e) and Australia (464,770 kt $CO_2$-e).

Depending on the period of time over which coal is extracted as part of the mine, relative to the National Greenhouse Gas Inventory for 2021, the annual average GHG emissions (Scope 1 and 2) generated by the mine's operations are estimated to represent 1.08% of total GHG emissions for NSW and 0.31% of total GHG emissions for Australia.

As stated, it is estimated that the project represents approximately 6%-7% of total life of mine GHG emissions. The significance of project emissions to any given year will depend on the amount of operations occurring in LW S7A.LW S7A is planned to be extracted following extraction in LW S6A and prior to relocating to the 'B-series' of longwalls. Extraction in LW S7A is anticipated to commence in January 2027.

4 https://ageis.climatechange.gov.au/

# 4 GHG emissions mitigation measures

As outlined in *Air quality and greenhouse gas management plan – Tahmoor South site* (SIMEC 2022), Tahmoor Coal is committed to the ongoing management and reduction of GHG emissions generated by the mine. Tahmoor Coal monitors and reports GHG emissions and energy usage the under the NGER scheme.

As presented in Section 3.4, GHG emissions from the mine are principally associated with mine VAM released from the underground workings via the upcast ventilation shaft.

The US-EPA (2019) identify that regenerative thermal oxidation (RTO) is the only commercially operational technology capable of using VAM as a primary fuel at $CH_4$ concentrations below 1.5 percent. Historical monitoring records of mine ventilation emissions recorded by Tahmoor Coal show that $CH_4$ content of VAM from the mine has been <0.5% since 2020. As operations have moved from Tahmoor North into Tahmoor South, the VAM concentration has decreased to the range of 0.16 to 0.35%. Forecast modelling indicates that the $CH_4$ concentration will be around a similar range as the mine progresses further to the south west.

Wasimi et. al. (2022) make the following notes regarding VAM abatement technology:

- RTO is the only VAM abatement technology currently implemented in the USA and China on a commercial scale.
- In Australia, RTO is tested at a small scale only.
- The high temperature operation of RTOs connected to underground coal mines present a risk of explosion and the RTO plants installed overseas do not satisfy the Australian mining standards and industry expectations for safety, and therefore RTO technology implemented overseas cannot be directly implemented here.
- Other oxidation technologies have been proposed and/or are currently being further developed for VAM abatement, however further research and development is needed to make these technologies viable for adoption in the industry.

It is understood that the Newcastle Institute for Energy and Resources, a research branch of the University of Newcastle, has developed a 100-metre-long facility located in Western Sydney designed to test VAM abatement systems and components (such as capture ducts, mitigation measures and thermal oxidisers) under a variety of operating scenarios, including controlled $CH_4$ and coal dust explosions. A planned outcome of the testing is the development technical and safety guidelines needed to deploy VAM abatement technologies across the sector.

Tahmoor Coal commit to the ongoing investigation of viable technology options to control mine VAM emissions.

In the absence of mine VAM abatement technology, the reduction of fugitive $CH_4$ emissions by both flaring and diversion of waste mine gas to the third party owned WCMGPP is identified as a key management approach for the mine, and the effectiveness of these measures is further discussed in Section 4.1.

The project features conventional underground mining techniques, which are largely dependent of the use of both electricity and diesel-powered equipment.

Mitigation measures discussed in this section are focused on the project's Scope 1 and 2 emissions.

The current and proposed GHG management measures to reduce Scope 1 and 2 emissions include the following:

- sealing off panels once mining activities are completed and are no longer required for future mining purposes, thus restricting fugitive $CH_4$ and $CO_2$ emissions
- continual $CH_4$ and $CO_2$ monitoring and detection

- maximising energy efficiency for run of mine operations including planning mine layout to minimise haul distances and therefore fuel use
- reducing fugitive $CH_4$ emissions using the following abatement measures:
  - flaring
  - $CH_4$ recycled through third party power generation (i.e. at the existing WCMGPP), when available
  - using ventilation control devices in sections of the mine not in use enabling them not to be ventilated (unless required for safety purposes).
- use of electric winder as the primary method of materials transport for the mine
- ensuring maintenance, calibration and record keeping is undertaken on the main ventilation shaft and fans, to allow calculations of greenhouse gas emissions
- tracking electricity bills and fuel usage
- installation of energy efficient technology where feasible
- engagement in projects related to reduction of GHG emissions, innovations and technologies
- internal company GHG emissions and energy consumption reduction targets

Tahmoor South will continue to reduce Scope 3 emissions to the greatest extent possible by continuing to sell coal to customers with end users located in countries that are Parties to the Paris Agreement, or countries with equivalent domestic policies for reducing GHG emissions.

## 4.1 Gas capture, drainage and energy generation

As previously mentioned, gas drainage and capture are currently implemented at the mine and is an integral part of managing GHG emissions from the mine. Gas is drawn progressively from the coal seam ahead of longwall development (pre-mining) by vacuum and piped to the onsite gas plant located at the surface via the underground pipe network.

Gas management infrastructure at the mine consists of the following:

- Tahmoor Coal mine gas plant
- Tahmoor Coal mine gas plant vent
- Tahmoor Coal mine flare plant
- third party operated WCMGPP, when available.

The collected gas is tested for $CH_4$ concentration and is processed via one of the following options available at the mine:

- if the gas has sufficient $CH_4$ concentrations, it will be directed to the WCMGPP to be used in electricity generation
- if the gas has insufficient $CH_4$ concentrations for electricity generation, or in circumstances where the WCMGPP is not operational, the gas is flared at the onsite flare plant

- if the gas has insufficient $CH_4$ to be flared, it will be vented to the atmosphere via the gas vent stack at the gas plant.

Tahmoor Coal will continue to utilise the WCMGPP and gas flare plant and upgrade and/or replace them with additional or replacement plants as required.

The volume of gas capture (in $m^3$) for either flaring or distribution to the WCMGPP, along with the equivalent ROM coal tonnage, were extracted from the FY18 and FY22 NGER scheme documentation. To illustrate the effectiveness of the flaring and combustion of captured gas by WCMGPP in reducing Scope 1 GHG emissions from the mine, the potential uncontrolled emissions associated with venting the captured gas directly to atmosphere were quantified. The annual Scope 1 emissions inventory totals presented in Table 3.6 were revised, with untreated venting of captured gas replacing flaring emissions. The annual Scope 1 emissions totals for the mine with controlled captured gas and with uncontrolled gas are presented in Figure 4.1.

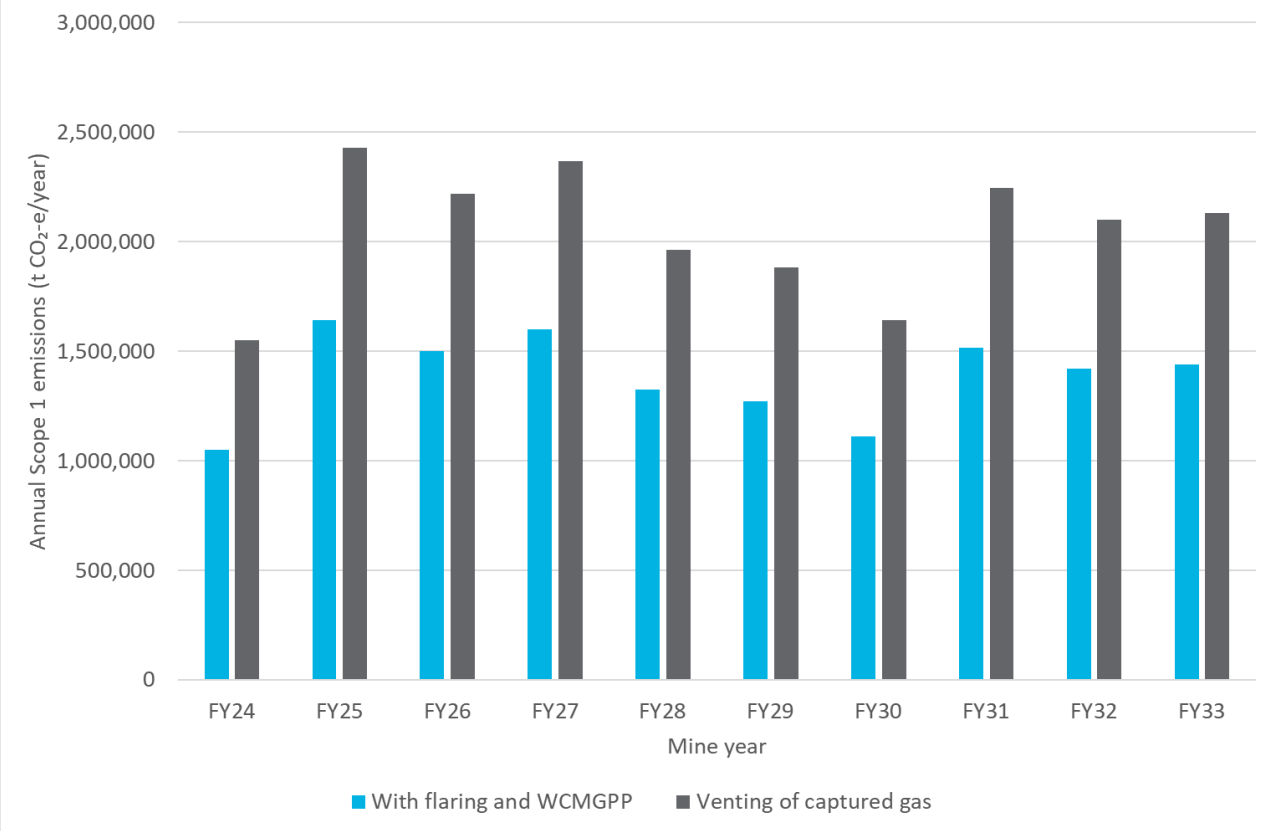


**Figure 4.1 Comparison of annual Scope 1 emissions – existing controls for captured gas vs uncontrolled venting of captured gas**

It can be seen from in Figure 4.1 that the treatment of captured gas through either flares or the WCMGPP results in a reduction of total mine annual Scope 1 emissions of approximately 48% relative to the uncontrolled venting of captured gas. It is noted that emissions from the combustion of captured gas by the WCMGPP are treated as Scope 3 emissions from the mine.

Details of the uncontrolled GHG emissions calculations are provided in Appendix A (Section A.11).

## 4.2 Mitigation measure review

Table 4.1 provides an overview of best practice GHG management measures that can be applied at underground coal mines such as Tahmoor South. The table indicates whether a mitigation measure is either currently

implemented or is proposed for implementation for the project and includes comments on the likely effectiveness. It is not possible to confirm the extent of the effectiveness of the mitigation measures for the following reasons:

- some mitigation measures are still in development
- there is a lack of literature available to specify effectiveness
- effectiveness can vary widely depending on several factors such as the specific circumstances of a mine, the quality of the mitigation approach, and the terrain/landscape.

Given the above, an indicative effectiveness of the proposed mitigation measures for the project has been provided based on available information.

## Table 4.1 Best practice GHG emissions mitigation measures for underground coal mines

| Measure | Currently implemented for the project | Detail, comment or justification | Effectiveness of measure |
|---|---|---|---|
| **$CH_4$ management** | | | |
| **$CH_4$ capture and utilisation** – capture and utilisation of $CH_4$ as an energy source. | Yes | Gas drained during pre-mining and post mining operations are captured and directed to the Gas Extraction Plant located on the surface at Tahmoor Coal. The gas is then sent to the third party owned on-site WCMGPP where it is used for power generation, when available. | As shown above, treatment of captured gas by flaring or the WCMGPP serves to reduce total Scope 1 GHG emissions from the mine by approximately 48% relative to a scenario where 100% of the captured gas is vented to the atmosphere. |
| **Optimising ventilation** – $CH_4$ is removed as far as possible to reduce emissions to air. | Yes | Gas is drained, captured and directed to the Gas Extraction Plant located on the surface at Tahmoor Coal. Tahmoor Coal has adopted a strategy whereby the maximum level of gas available is provided to the WCMGPP, with only the excess gas flared. | As above. |
| **$CH_4$ drainage** – extraction of $CH_4$ from coal seams prior to mining. | Yes | Gas is drained using in-seam gas drilling techniques to capture and direct the pre-mining and post-mining gas to the Gas Extraction Plant located on the surface at Tahmoor Coal. | As above. |
| **Sealing** – sealing off abandoned or inactive areas, thus preventing $CH_4$ and other gases from entering active mining areas. | Yes | Once mining activities within districts are completed and are no longer required for future mining, panels are sealed off.<br>Operations at Tahmoor North were completed in Q1 FY22 and panels have since been sealed. | Sealing (e.g. closing unused mine entries or boreholes) can reduce the initial methane emission rate. However, it is less effective at preventing emissions over time and further action (e.g. drainage) may be needed to prevent these emissions in future (US Department of the Interior 1994). |
| **Degasification** – use of degasification techniques such as drilling boreholes to extract $CH_4$ from coal seams. | Yes | Pre-mining and post mining gas is collected from the in-seam and cross-measure boreholes and is drawn by vacuum via the underground pipe network to the Gas Extraction Plant at the surface. | As above. |

## Table 4.1 Best practice GHG emissions mitigation measures for underground coal mines

| Measure | Currently implemented for the project | Detail, comment or justification | Effectiveness of measure |
|---|---|---|---|
| **$CH_4$ monitoring and detection** – monitoring used to detect high $CH_4$ concentrations early enabling measures to be implemented to prevent prolonged releases. | Yes | Tahmoor South utilise real-time $CH_4$ monitoring systems in accordance with the latest legislation and standards. | Considered an effective way to understand $CH_4$ releases, as operators can introduce measures to ensure that unexpected high $CH_4$ emissions are not prolonged. The monitoring should allow mine operators to identify operational conditions under which $CH_4$ emissions are high, and to respond with targeted measures to control or reduce any $CH_4$ release. This may include altering mining operations or the ventilation strategy. |
| **Mining fleet** | | | |
| **Electricity-powered mining equipment** – investigate use of electricity-powered mining equipment. | Yes | Much of the equipment used to mine coal is powered by electricity, including the coal haulage systems.<br>The use of electric equipment will be periodically reviewed in line with market availability. | The use of electric mining equipment can be effective at reducing Scope 1 emissions, as it can effectively reduce emissions to zero from each source. Consequently however, this could increase Scope 2 emissions if the electricity is not from a renewable source.<br>The effectiveness of this measure at the project would be limited, as coal is transported via conveyors rather than hauled using diesel equipment. Diesel combustion at the project only accounts for 0.3% of total Scope 1 GHG emissions. |
| **Equipment maintenance** – equipment is serviced and maintained according to manufacturers' specifications. | Yes | Equipment will be maintained as per original equipment manufacturers' recommendations. | These measures relate to the minimisation of diesel emissions through application of standard good practice when using diesel equipment. Ensuring that diesel equipment is well maintained acts as a preventative measure as it maintains performance for the future.<br>If the correct protocols are in place and staff are adequately trained, these measures will be effective in reducing GHG emissions from diesel vehicles and equipment. |
| **Equipment checks** – performing pre-start inspections at each shift on mobile plant and vehicles. | Yes | Pre-start inspections will be conducted on operating mobile plant and vehicles during/before each shift. | |
| **Vehicle idling** – minimise idling of vehicles. | Yes | Minimisation of idling vehicles will be built into appropriate operational management plans and training packages. | |

## Table 4.1 Best practice GHG emissions mitigation measures for underground coal mines

| Measure | Currently implemented for the project | Detail, comment or justification | Effectiveness of measure |
|---|---|---|---|
| **Energy use** | | | |
| **Use of renewable electricity** – investigate sourcing all purchased electricity from certified renewable electricity providers. | Yes | Tahmoor Coal's parent company, GFG Alliance, has a goal to be carbon neutral by 2030, which includes a strong focus on increasing renewable energy across its operations. Tahmoor Coal installed solar panels at its Administration Building in FY24. It is not currently feasible to implement 100% renewable energy at Tahmoor Coal, however, the operation is continuing to look for opportunities to increase renewable energy. | The use of renewable energy sources at the project will only have a small impact in reducing GHG emissions, as electricity consumption accounts for 2.3% of the project's Scope 1 and 2 emissions. However, an adoption of 100% renewable energy would result in zero Scope 2 emissions for the project. |
| **On-site renewable energy source** – installation of renewable energy source (e.g. solar farm or solar panels) on-site to generate electricity required for operations. | Yes | Tahmoor Coal installed solar panels at its Administration Building in FY24 to reduce the requirement for the purchase of electricity from the grid. Tahmoor Coal is looking into additional on-site renewable energy sources. The general constraints of the surrounding land use, topography and vegetation makes on-site renewable energy challenging. | - |
| **Energy and fuel use** – tracking electricity bills and fuel usage. | Yes | Electricity and fuel usage is and will continue to be tracked on a monthly basis. | Tracking of energy and fuel use can provide valuable data to guide decision-making, identify inefficiencies and inform further emission-reduction strategies. |
| **General measures** | | | |
| **Employee training and awareness** – training programs for employees on best practices to reduce GHG emissions. | Yes | This will continue to be included in the site induction program. | Employee training and awareness of operations and how they affect GHG emissions can be an effective tool leading to behavioural, and operational changes, and innovation in technologies. |
| **Research and development** – research innovations in $CH_4$ capture and emission-reduction, including collaboration with the industry, universities and other operations. | Yes | Tahmoor Coal commit to the ongoing investigation of a viable technology to control mine VAM emissions. At present in Australia, mine VAM control technologies are still in development. There are no known technologies that can destruction VAM at $CH_4$ concentrations below 0.3%. | Largely unknown. However, outcomes may lead to advancements in $CH_4$ capture and storage, monitoring techniques, emission control technologies and innovations in energy sources. |

**Table 4.1 Best practice GHG emissions mitigation measures for underground coal mines**

| Measure | Currently implemented for the project | Detail, comment or justification | Effectiveness of measure |
|---|---|---|---|
| **Energy efficient technology** - investigate the feasibility of installing and utilising energy efficient technologies, such as the use of LED lights on fixed plant and buildings. | Yes | To be used where feasible. | This is an effective means of reducing emissions from these sources, but the overall reduction may be limited given the relatively small number of energy sources that could include energy efficient technology. |
| **Parent company targets** – set internal GHG emissions targets. | Yes | GFG Alliance, of which Tahmoor Coal forms part of, aims to be carbon neutral by 2030.<br>As a part of the GFG Alliance, combining upstream and downstream steel manufacturing, SIMEC is focussed on developing large scale green energy capacity to support their low-carbon metals and industrial strategy (GREENSTEEL). To achieve this SIMEC is actively pursuing growing the capacity to generate green energy through existing and pending assets including through hydro-electricity, wind power, biodiesel and waste-to-energy technologies. | Setting internal GHG emissions targets is an effective measure to reduce emissions. It holds the project operators accountable through data transparency, and encourages innovation in mining techniques and emission-reduction strategies. |

# 5 GHG emission reduction targets

## 5.1 State emission targets

In Table 5.1, the projected annual Scope 1 emissions of the project are compared against the projected emissions from the NSW Net Zero Emissions Dashboard[5]. The Dashboard provides emissions for three cases:

- **actual** emissions up to 2020, based on the national inventory report
- **base case** emissions under a business-as-usual scenario up to 2050, without Stage 1 of the Net Zero Plan, committed funding under Stage 2 and Stage 3 of the Net Zero Plan plus related Government policies and programs
- **current policy** emissions up to 2050, taking into account under Stage 1 of the Net Zero Plan, committed funding under Stage 2 and Stage 3 of the Net Zero Plan plus related Government policies and programs.

Table 5.1 shows that, depending on the year, the project emissions are up to 1.44% of NSW base case emissions, and up to 2.58% of the current policy emissions.

In a given year in NSW, the reduction in emissions from the base case to the current policy case ranges from 13 Mt $CO_2$-e to 53 Mt $CO_2$-e. When summed over all years from 2025 to 2050, the total reduction is 1,006 Mt $CO_2$-e. The total emissions of the project over this period are 13.9 Mt $CO_2$-e. In other words, the project would increase the required emission reduction in NSW over the project's operational period by 1.38%.

[5] https://www.seed.nsw.gov.au/net-zero-emissions-dashboard

**Table 5.1 Comparison with NSW Net Zero Emissions Dashboard (Scope 1 emissions)**

| Year | NSW Base case ($Mt CO_2$-e/year) | NSW Current policy ($Mt CO_2$-e/year) | Project ($Mt CO_2$-e/year) | Project as % of NSW Base case (%) | Project as % of NSW Current policy (%) |
|---|---|---|---|---|---|
| 2024 | 115.12 | 106.72 | 1.05 | 0.91% | 0.98% |
| 2025 | 114.08 | 101.34 | 1.64 | 1.44% | 1.62% |
| 2026 | 112.42 | 96.77 | 1.50 | 1.33% | 1.55% |
| 2027 | 112.91 | 89.45 | 1.60 | 1.42% | 1.79% |
| 2028 | 111.56 | 79.27 | 1.33 | 1.19% | 1.67% |
| 2029 | 111.49 | 75.18 | 1.27 | 1.14% | 1.69% |
| 2030 | 109.63 | 71.55 | 1.11 | 1.01% | 1.55% |
| 2031 | 106.39 | 65.68 | 1.52 | 1.43% | 2.31% |
| 2032 | 104.96 | 60.84 | 1.42 | 1.35% | 2.33% |
| 2033 | 103.54 | 55.91 | 1.44 | 1.39% | 2.58% |
| 2034 | 102.46 | 50.90 | - | - | - |
| 2035 | 101.53 | 48.33 | - | - | - |
| 2036 | 85.16 | 44.61 | - | - | - |
| 2037 | 82.95 | 42.07 | - | - | - |
| 2038 | 82.59 | 40.16 | - | - | - |
| 2039 | 80.65 | 36.93 | - | - | - |
| 2040 | 80.32 | 32.22 | - | - | - |
| 2041 | 79.02 | 32.03 | - | - | - |
| 2042 | 76.40 | 31.69 | - | - | - |
| 2043 | 68.54 | 28.36 | - | - | - |
| 2044 | 66.81 | 27.86 | - | - | - |
| 2045 | 65.73 | 27.81 | - | - | - |
| 2046 | 64.44 | 26.83 | - | - | - |
| 2047 | 63.48 | 27.35 | - | - | - |
| 2048 | 62.83 | 26.94 | - | - | - |
| 2049 | 62.02 | 27.31 | - | - | - |
| 2050 | 61.02 | 26.96 | - | - | - |

## 5.2 National emissions targets

Australia's GHG emissions reduction targets are presented in the Commonwealth Department of Climate Change, Energy, the Environment and Water's (DCCEEW) document *Australia's Emissions Projections 2023*[6]. Under the updated Nationally Determined Contributions (NDC), Australia has committed to the following:

6 https://www.dcceew.gov.au/sites/default/files/documents/australias-emissions-projections-2023.pdf

- a single-year commitment of reducing GHG emissions to 43% below 2005 by 2030
- a multi-year emissions budget for the period 2021-2030 of 4,353 Mt $CO_2$-e.

The DCCEEW report notes that under the 'baseline scenario', Australia is projected to achieve a 37% reduction on 2005 levels by 2030. However under a 'with additional measures scenario', Australia is projected to achieve a 42% reduction on 2005 levels by 2030. In terms of Australia's emissions budget, the baseline scenario indicates emissions will be approximately 1% above the budget. Under the 'with additional measures' scenario, Australia's emissions are projected to be approximately 1% below the budget.

As shown in Table 5.1, the project is expected to contribute up to 1.64 Mt $CO_2$-e of Scope 1 emissions per year, or 9.50 Mt $CO_2$-e between 2021 and 2030. This equates to 0.218% of the 2021-2030 emissions budget.

Under the 'baseline scenario' Australia is projected to be 0.896% above the multi-year emissions budget target. With the contribution of the mine, Australia would be 1.114% above the multi-year emissions budget target.

Under the 'with additional measures scenario' Australia is projected to be 0.712% below the multi-year emissions budget target. With the contribution of the mine, Australia be 0.494% below the multi-year emissions budget target.

It is noted that both comparisons assume that emissions from the mine were not already included in the projections, which is considered highly conservative for an existing operational mining operation.

## 5.3 Safeguard Mechanism

The project will be subject to the Safeguard Mechanism emission caps which are currently applied to mine. On the basis of presented Scope 1 emissions in Table 3.6, the mine will continue to emit above the threshold of 100,000 t of $CO_2$-e per year throughout the life of the mine.

The Safeguard baseline is yet to be calculated, however, the currently estimate is that the site specific emissions intensity will be 0.5454 t $CO_2$-e per t ROM coal for the mine. As stated in Section 2.2.1, the baseline will decrease gradually from 1 July 2023 at a defined rate of 4.9 per cent each year to 2030.

In order to meet emission mitigation obligations under the Safeguard Mechanism, Tahmoor will continue to implement existing GHG mitigation measures (as documented in Table 4.1), along with investigate opportunities to reduce emissions through viable VAM control technology (if developed), increased extraction and utilisation of seam gas or offset emissions through financial contribution to reputable offset schemes.

# 6 Conclusion

EMM has been engaged by Tahmoor Coal to produce this GHG assessment to support the Modification Report. The assessment calculates estimates of Scope 1, 2 and 3 GHG emissions for continued operations at the mine with the proposed modifications and includes a comparison with NSW and national inventories.

Annual average GHG emissions (Scope 1 and 2) generated by the project represents 1.08% of total GHG emissions for NSW and 0.31% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2021.

It is estimated that the project represents approximately 6%-7% of total life of mine GHG emissions. The significance of project emissions to any given year will depend on the amount of operations occurring in LW S7A. LW S7A is planned to be extracted following extraction in LW S6A and prior to relocating to the 'B-series' of longwalls. Extraction in LW S7A is anticipated to commence in January 2027.

Tahmoor Coal employ a number of industry best practice mitigation measures at the mine to minimise its GHG emissions. These measures include methods designed to reduce the potential for fugitive $CH_4$ release, principally pre-mining gas drainage and capture, treatment of waste gas by onsite flare units and the diversion of waste coal mine gas to the third party WCMGPP for electricity generation purposes.

Despite these control measures, mine VAM is the primary uncontrolled emission source at the mine, contributing approximately 90% of annual Scope 1 GHG emissions. Tahmoor Coal are committed to investigating and implementing VAM control technology should a functional and commercially viable option become available.

The mine would continue to emit above the established Safeguard Mechanism threshold of 100,000 t $CO_2$-e/year throughout the life of the project. The existing Safeguard baseline for Tahmoor would apply to the mine moving forward, with associated reductions in baseline of 4.9 percent per year to be considered in future emission reduction strategies. Tahmoor Coal will also continue to report emissions under the NGER scheme.

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# Abbreviations

| | |
|---|---|
| AR5 | (IPCC) Fifth Assessment Report |
| AR6 | (IPCC) Sixth Assessment Report |
| $CH_4$ | methane |
| $CO_2$-e | carbon dioxide equivalent |
| DCCEEW | Commonwealth Department of Climate Change, Energy, the Environment and Water |
| DPIE | Department of Planning, Industry and Environment |
| GHG | greenhouse gas |
| GWP | global warming potential |
| IPCC | Intergovernmental Panel on Climate Change |
| kW | kilowatt |
| LGA | local government area |
| LW | long wall |
| Mtpa | million tonnes per annum |
| MW | megawatt |
| $N_2O$ | nitrous oxide |
| NDC | Nationally Determined Contributions |
| NGAF | National Greenhouse Accounts Factors |
| NGER | National Greenhouse and Energy Reporting |
| NSW | New South Wales |
| REA | rejects emplacement area |
| ROM | run of mine |
| $SF_6$ | sulfur hexafluoride |
| SSD | State Significant Development |
| tpa | tonnes per annum |
| UNFCCC | United Nations Framework Convention on Climate Change |
| WBCSD | World Business Council for Sustainable Development |
| WRI | World Resources Institute |

# Appendix A

## Greenhouse gas calculation data

EMM
creating opportunities

## A.1 On-site diesel consumption

GHG emissions from on-site diesel consumption were estimated using the following equation:

$$E_{ij} = \frac{Q_i \times EC_i \times EF_{ijoxec}}{1000}$$

Where:

| | | | |
|---|---|---|---|
| $E_{ij}$ | = | Emissions of GHG from diesel combustion | (t $CO_2$-e) |
| $Q_i$ | = | Quantity of fuel | (kL) |
| $EC_i$ | = | Energy content of fuel | (GJ/kL)[7] |
| $EF_{ijoxec}$ | = | Emission factor (scope 1 or 3) for diesel consumption | (kg $CO_2$-e/GJ)[8] |

As described in Section 3.3, the quantity of diesel consumption for the Project years was estimated using the intensity factor of 0.44 L of diesel/t ROM coal.

The GHG emission factor and energy content for diesel was sourced from the NGAF (DCCEEW 2023b). These are presented in Table A.1.

The estimated scope 1 and 3 GHG emissions from diesel consumption over the life of the project is presented in Table A.2.

**Table A.1 Diesel GHG emission factors**

| Fuel type | Energy content (GJ/kL) | Scope 1 Emission factors (kg $CO_2$-e/GJ) | | | Scope 3 Emission Factor (kg $CO_2$-e/GJ) |
|---|---|---|---|---|---|
| | | $CO_2$ | $CH_4$ | $N_2O$ | $CO_2$ |
| Diesel | 38.6 | 69.9 | 0.1 | 0.2 | 17.3 |

7 GJ = gigajoules

8 kg $CO_2$-e/GJ = kilograms of carbon dioxide equivalents per gigajoule

**Table A.2 Estimated $CO_2$-e (tonnes) for on-site diesel consumption**

| Period | Diesel use (L) | Emissions (t $CO_2$-e) | | |
|---|---|---|---|---|
| | | Scope 1 | Scope 3 | Total |
| FY24 | 1,343,172 | 3,640 | 897 | 4,537 |
| FY25 | 2,102,571 | 5,697 | 1,404 | 7,101 |
| FY26 | 1,920,362 | 5,204 | 1,282 | 6,486 |
| FY27 | 2,051,029 | 5,558 | 1,370 | 6,927 |
| FY28 | 1,699,885 | 4,606 | 1,135 | 5,741 |
| FY29 | 1,630,854 | 4,419 | 1,089 | 5,508 |
| FY30 | 1,423,350 | 3,857 | 950 | 4,807 |
| FY31 | 1,943,588 | 5,267 | 1,298 | 6,564 |
| FY32 | 1,819,775 | 4,931 | 1,215 | 6,146 |
| FY33 | 1,845,679 | 5,001 | 1,233 | 6,234 |
| **Total** | **17,780,264** | **48,180** | **11,873** | **60,053** |

## A.2 Unleaded petrol consumption

GHG emissions from unleaded petrol consumption were estimated using the following equation:

$$E_{ij} = \frac{Q_i \times EC_i \times EF_{ijoxec}}{1000}$$

Where:

| | | | |
|---|---|---|---|
| $E_{ij}$ | = | Emissions of GHG from gasoline combustion | (t $CO_2$-e) |
| $Q_i$ | = | Quantity of fuel | (kL) |
| $EC_i$ | = | Energy content of fuel | (GJ/kL) |
| $EF_{ijoxec}$ | = | Emission factor (scope 3) for gasoline consumption | (kg $CO_2$-e/GJ) |

As described in Section 3.3, the quantity of unleaded petrol consumption for the project years was estimated using the intensity factor of 0.008 L of unleaded petrol/t ROM coal.

The GHG emission factor and energy content for unleaded petrol was sourced from the NGAF (DCCEEW 2023b). These are presented in Table A.3.

The estimated Scope 1 and 3 GHG emissions from unleaded petrol for the life of the project is presented in Table A.4.

## Table A.3 Unleaded petrol GHG emission factors

| Fuel type | Energy content (GJ/kL) | Scope 1 Emission factors (kg $CO_2$-e/GJ) | | | Scope 3 Emission Factor (kg $CO_2$-e/GJ) |
|---|---|---|---|---|---|
| | | $CO_2$ | $CH_4$ | $N_2O$ | $CO_2$ |
| Diesel | 34.2 | 67.4 | 0.2 | 0.2 | 67.8 |

## Table A.4 Estimated $CO_2$-e (tonnes) for unleaded petrol consumption

| Period | Unleaded petrol use (L) | Emissions (t $CO_2$-e) | | |
|---|---|---|---|---|
| | | Scope 1 | Scope 3 | Total |
| FY24 | 3,472 | 8 | 8 | 16 |
| FY25 | 5,435 | 13 | 13 | 25 |
| FY26 | 4,964 | 12 | 12 | 23 |
| FY27 | 5,302 | 12 | 12 | 25 |
| FY28 | 4,394 | 10 | 10 | 20 |
| FY29 | 4,216 | 10 | 10 | 20 |
| FY30 | 3,679 | 9 | 9 | 17 |
| FY31 | 5,024 | 12 | 12 | 23 |
| FY32 | 4,704 | 11 | 11 | 22 |
| FY33 | 4,771 | 11 | 11 | 22 |
| **Total** | **45,962** | **107** | **107** | **213** |

## A.3 Oil and grease consumption

GHG emissions from oil and grease consumption were estimated using the following equation:

$$E_{ij} = \frac{Q_i \times EC_i \times EF_{ijoxec}}{1000}$$

Where:

| | | | |
|---|---|---|---|
| $E_{ij}$ | = | Emissions of GHG from oil/grease use | (t $CO_2$-e) |
| $Q_i$ | = | Quantity of oil/grease | (kL) |
| $EC_i$ | = | Energy content of oil/grease | (GJ/kL) |
| $EF_{ijoxec}$ | = | Emission factor (scope 1 or 3) for oil/grease use | (kg $CO_2$-e/GJ) |

The GHG emission factor and energy content for oil and grease were sourced from the NGAF (DCCEEW 2023). These are presented in Table A.5.

The estimated Scope 1 and 3 GHG emissions from oil and grease consumption over the life of project is presented in Table A.6.

### Table A.5 Oil/grease GHG emission factors

| Fuel type | Energy content (GJ/kL) | Scope 1 Emission factors (kg $CO_2$-e/GJ) | Scope 3 Emission Factor (kg $CO_2$-e/GJ) |
|---|---|---|---|
| | | $CO_2$ | $CO_2$ |
| Oil/grease | 38.6 | 69.9 | 17.3 |

### Table A.6 Estimated $CO_2$-e (tonnes) for oil/grease consumption

| Period | Oil and grease use (L) | Emissions (t $CO_2$-e) | | |
|---|---|---|---|---|
| | | Scope 1 | Scope 3 | Total |
| FY24 | 164,024 | 88 | 115 | 203 |
| FY25 | 256,811 | 139 | 179 | 318 |
| FY26 | 234,632 | 127 | 164 | 290 |
| FY27 | 250,539 | 135 | 175 | 310 |
| FY28 | 207,690 | 112 | 145 | 257 |
| FY29 | 199,316 | 107 | 139 | 247 |
| FY30 | 174,075 | 94 | 122 | 215 |
| FY31 | 237,788 | 128 | 166 | 294 |
| FY32 | 222,691 | 120 | 156 | 276 |
| FY33 | 225,821 | 122 | 158 | 280 |
| **Total** | 2,173,386 | 1,172 | 1,518 | 2,690 |

## A.4 Emissions from mine VAM

Emissions will be generated from mine VAM at the mine.

Annual emission intensity factors were calculated using ROM coal tonnages and Scope 1 ventilation shaft emissions from NGER scheme reporting for Tahmoor Coal for the years between FY18 and FY22. These values and the emissions intensity factors are presented in Table A.7.

For mine VAM emissions, the intensity factor has been derived based on FY22 only, with the following justification given:

- The FY18 to FY22 NGER scheme declarations account for activities at both Tahmoor North and Tahmoor South operations for each reporting year.
- Relative to Tahmoor South, the Tahmoor North mining area featured higher $CH_4$ seam gas content.
- Mining operations were completed at Tahmoor North in quarter 1 FY22 and associated mining areas have since been sealed, leading to an observed reduction in mine VAM emissions.
- Tahmoor Coal therefore expect that the mine VAM emissions recorded and reported for FY22 are the most representative of future Tahmoor South longwall operations.

**Table A.7 Emissions intensity for mine ventilation air**

| Year | ROM coal (t) | Ventilation shaft (t $CO_2$-e) Scope 1 emissions | Emissions intensity factor (Scope 1 emissions: ROM coal) |
|---|---|---|---|
| FY18 | 2,416,042 | 1,296,470 | 0.537 |
| FY19 | 2,362,111 | 1,165,033 | 0.493 |
| FY20 | 1,971,256 | 1,154,282 | 0.586 |
| FY21 | 2,900,384 | 996,693 | 0.344 |
| FY22 | 2,298,116 | 856,238 | 0.373 |
| | | **Emissions intensity** | **0.373** |

The estimated Scope 1 emissions from fugitive mine ventilation air is presented in Table A.8.

**Table A.8 Estimated $CO_2$-e (tonnes) for mine ventilation air**

| Period | ROM coal (t) | Emissions (t $CO_2$-e) |
|---|---|---|
| | | Scope 1 |
| FY24 | 2,518,066 | 938,188 |
| FY25 | 3,941,724 | 1,468,618 |
| FY26 | 3,600,134 | 1,341,347 |
| FY27 | 3,845,099 | 1,432,617 |
| FY28 | 3,186,803 | 1,187,347 |
| FY29 | 3,057,388 | 1,139,130 |
| FY30 | 2,668,377 | 994,191 |
| FY31 | 3,643,677 | 1,357,570 |
| FY32 | 3,411,562 | 1,271,089 |
| FY33 | 3,460,124 | 1,289,182 |
| **Total** | **33,332,955** | **12,419,279** |

## A.5 Flaring of coal mine waste gas

Direct emissions will be generated from the flaring of mine waste gas.

An average emission intensity factor was calculated using ROM coal tonnages and Scope 1 mine waste gas flaring emissions from NGER reporting for Tahmoor Coal between 2018 and 2022. These values and the average emissions intensity used in the calculations are presented in Table A.9.

**Table A.9 Emissions intensity for mine waste gas flaring**

| Year | ROM coal (t) | Coal mine waste gas flared (t $CO_2$-e) scope 1 | Emissions intensity factor (Scope 1 emissions: ROM coal) |
|---|---|---|---|
| FY18 | 2,416,042 | 55,524 | 0.023 |
| FY19 | 2,362,111 | 51,968 | 0.022 |
| FY20 | 1,971,256 | 47,400 | 0.024 |
| FY21 | 2,900,384 | 57,258 | 0.020 |
| FY22 | 2,298,116 | 59,844 | 0.026 |
| | | **Average emissions intensity** | **0.023** |

The estimated Scope 1 emissions from the combustion of mine waste gas by flaring is presented in Table A.10.

## Table A.10 Estimated $CO_2$-e (tonnes) for mine waste gas flaring

| Period | ROM coal (t) | Emissions (t $CO_2$-e) |
|---|---|---|
| | | Scope 1 |
| FY24 | 2,518,066 | 57,820 |
| FY25 | 3,941,724 | 90,510 |
| FY26 | 3,600,134 | 82,666 |
| FY27 | 3,845,099 | 88,291 |
| FY28 | 3,186,803 | 73,175 |
| FY29 | 3,057,388 | 70,204 |
| FY30 | 2,668,377 | 61,271 |
| FY31 | 3,643,677 | 83,666 |
| FY32 | 3,411,562 | 78,336 |
| FY33 | 3,460,124 | 79,451 |
| **Total** | **33,332,955** | **765,389** |

## A.6 Sulfur hexafluoride ($SF_6$)

Emissions of $SF_6$ may be released at the project through the use of gas in insulated switch gear and circuit breaker applications.

GHG emissions from $SF_6$ are typically estimated using the following equation:

$$E_{jk} = \frac{Stock_{jk} \times GWP}{J_{jk}}$$

Where:

| | | | |
|---|---|---|---|
| $E_{jk}$ | = | Emissions of gas type | (t $CO_2$-e) |
| $Stock_{jk}$ | = | Stock of gas type | (t $CO_2$-e) |
| GWP | = | Global Warming Potential | |
| $L_{jk}$ | = | default leakage rates for a year of gas type | |

The default leakage gas rate for $SF_6$ as given in the NGAF is 0.0089. The GWP value given in the NGAF for SF6 is 23,500.

As described in Section 3.3, the GHG emissions associated with $SF_6$ leakage for the project years was estimated using the intensity factor of 0.12 t $CO_2$-e /t ROM coal.

The estimated Scope 1 GHG emissions from $SF_6$ over the lifetime of the project is presented in Table A.11.

**Table A.11 Estimated $CO_2$-e (tonnes) for $SF_6$**

| Period | ROM coal (t) | Emissions (t $CO_2$-e) |
|---|---|---|
| | | Scope 1 |
| FY24 | 2,518,066 | 392 |
| FY25 | 3,941,724 | 614 |
| FY26 | 3,600,134 | 561 |
| FY27 | 3,845,099 | 599 |
| FY28 | 3,186,803 | 496 |
| FY29 | 3,057,388 | 476 |
| FY30 | 2,668,377 | 416 |
| FY31 | 3,643,677 | 568 |
| FY32 | 3,411,562 | 531 |
| FY33 | 3,460,124 | 539 |
| **Total** | **33,332,955** | **5,193** |

## A.7 Post-mining activities

Fugitive $CH_4$ emissions will be generated from post-mining activities as a part of the project.

The default emission factor for fugitive GHG emissions from post-mining activities as given in *Method 1 – post-mining activities related to gassy mines (Subdivision 3.2.2.4 of the NGER Determination (2008) (as amended in 2023)* is 0.019.

The estimated Scope 1 GHG emissions from post-mining activities over the lifetime of the project is presented in Table A.12.

**Table A.12 Estimated $CO_2$-e (tonnes) for post-mining activities**

| Period | ROM coal (t) | Emissions (t $CO_2$-e) |
|---|---|---|
| | | Scope 1 |
| FY24 | 2,518,066 | 47,843 |
| FY25 | 3,941,724 | 74,893 |
| FY26 | 3,600,134 | 68,403 |
| FY27 | 3,845,099 | 73,057 |
| FY28 | 3,186,803 | 60,549 |
| FY29 | 3,057,388 | 58,090 |
| FY30 | 2,668,377 | 50,699 |
| FY31 | 3,643,677 | 69,230 |
| FY32 | 3,411,562 | 64,820 |
| FY33 | 3,460,124 | 65,742 |
| **Total** | **33,332,955** | **633,326** |

## A.8 Electricity use

GHG emissions associated with electricity consumption were estimated using the following equation:

$$E_{CO_2-e} = \frac{Q \times EF}{1000}$$

Where:

| | | | |
|---|---|---|---|
| $E_{CO2-e}$ | = | Emissions of GHG from electricity consumption | (t $CO_2$-e) |
| $Q_i$ | = | Quantity of electricity | (MWh)[9] |
| EF | = | Emission factor (scope 2 or 3) for electricity consumption | (kg $CO_2$-e/kWh)[10] |

As described in Section 3.3, the quantity of electricity consumption for the project years was estimated using the intensity factor of 36.9 kWh of electricity consumption/t ROM coal.

The GHG emission factors for electricity used in NSW/ACT were sourced from DCCEEW (2023) and are presented in Table A.13. The resulting GHG emissions for electricity use are given in Table A.14.

**Table A.13 Electricity GHG emission factors**

| Year | Emission Factors (kg $CO_2$-e/MWh) | |
|---|---|---|
| | Scope 2 | Scope 3 |
| 2024 | 0.59 | 0.63 |
| 2025 | 0.52 | 0.56 |
| 2026 | 0.39 | 0.42 |
| 2027 | 0.29 | 0.32 |
| 2028 | 0.28 | 0.30 |
| 2029 | 0.27 | 0.30 |
| 2030 | 0.19 | 0.20 |
| 2031 | 0.11 | 0.11 |
| 2032 | 0.06 | 0.06 |
| 2033 | 0.02 | 0.02 |

[9] MWh = megawatt hours

[10] kg $CO_2$-e/kWh = kilograms of carbon dioxide equivalents per kilowatt hour

## Table A.14 Estimated $CO_2$-e (tonnes) for electricity

| Period | Electricity consumption (kWh) | Emission Factors (kg $CO_2$-e/MWh) | |
|---|---|---|---|
| | | Scope 2 | Scope 3 |
| FY24 | 116,198,211 | 68,557 | 4,648 |
| FY25 | 181,894,078 | 94,585 | 7,276 |
| FY26 | 166,131,101 | 64,791 | 4,984 |
| FY27 | 177,435,213 | 51,456 | 5,323 |
| FY28 | 147,057,629 | 41,176 | 2,941 |
| FY29 | 141,085,676 | 38,093 | 4,233 |
| FY30 | 123,134,448 | 23,396 | 1,231 |
| FY31 | 168,140,424 | 18,495 | 1,681 |
| FY32 | 157,429,316 | 9,446 | 1,574 |
| FY33 | 159,670,250 | 3,193 | 1,597 |
| **Total** | **1,538,176,346** | **413,189** | **35,488** |

## A.9 Energy production from product coal

GHG emissions associated with energy production coal were estimated using the following equation:

$$E_{CO_2-e} = \frac{Q \times EC \times EF}{1000}$$

Where:

| | | | |
|---|---|---|---|
| $E_{CO2-e}$ | = | Emissions of GHG from electricity consumption | (t $CO_2$-e) |
| Q | = | Quantity of coal burnt | (t) |
| EC | = | Energy Content Factor for bituminous coal | (GJ/t) |
| EF | = | Emission factor for bituminous coal combustion | (kg $CO_2$-e/GJ) |

GHG emission factors for fuel combustion were sourced from NGAF (DDCEEW 2023). These are presented in Table A.15. The Scope 1 emissions factors were used to calculate Scope 3 emissions from the burning of product coal per Appendix 4 of NGAF.

The estimated Scope 3 GHG emissions from energy production from product coal for the life of the project are presented in Table A.16.

**Table A.15 Fuel combustion GHG emission factors**

| Fuel type | Energy content (GJ/kL) | Scope 1 Emission factors (kg $CO_2$-e/GJ) | | |
|---|---|---|---|---|
| | | $CO_2$ | $CH_4$ | $N_2O$ |
| Coking coal | 30.0 | 91.8 | 0.03 | 0.2 |

**Table A.16 Estimated $CO_2$-e (tonnes) for energy production from product coal**

| Period | Product coal (t) | Emissions (t $CO_2$-e) |
|---|---|---|
| | | Scope 3 |
| FY24 | 1,542,231 | 4,257,945 |
| FY25 | 2,452,408 | 6,770,853 |
| FY26 | 2,294,597 | 6,335,153 |
| FY27 | 2,640,434 | 7,289,975 |
| FY28 | 2,347,839 | 6,482,148 |
| FY29 | 2,351,623 | 6,492,596 |
| FY30 | 2,108,823 | 5,822,251 |
| FY31 | 2,918,753 | 8,058,384 |
| FY32 | 2,706,149 | 7,471,406 |
| FY33 | 2,810,168 | 7,758,593 |
| **Total** | **24,173,025** | **66,739,305** |

## A.10 Gas capture for third party WCMGPP

A proportion of captured mine waste gas is diverted to the WCMGPP for energy generation. These emissions are accounted for as Scope 3 emissions from the mine.

An average intensity factor was calculated using ROM coal tonnages and volume of coal mine waste gas captured ($m^3$) for combustion by WCMGPP from NGER scheme reporting for Tahmoor Coal between FY18 and FY22. These values and the average emissions intensity used in the calculations are presented in Table A.17.

**Table A.17 Emissions intensity for volume of gas captured**

| Year | ROM coal (t) | Gas capture ($m^3$) | Emissions intensity factor (volume of gas capture: ROM coal) |
|---|---|---|---|
| FY18 | 2,416,042 | 16,574,887 | 6.86 |
| FY19 | 2,362,111 | 19,110,783 | 8.09 |
| FY20 | 1,971,256 | 19,254,224 | 9.77 |
| FY21 | 2,900,384 | 18,474,300 | 6.37 |
| FY22 | 2,298,116 | 21,803,022 | 9.49 |
| | | **Average emissions intensity** | **8.12** |

GHG emission factors for captured gas combustion were sourced from Table 5 of the NGAF (2023). These are presented in Table A.18.

Estimated GHG emissions from the combustion of captured gas at third party power station are presented in Table A.19.

**Table A.18 Gas capture energy content and emissions factor**

| Emission type | Energy content ($GJ/m^3$) | Emission factor (kg $CO_2$-e/GJ) |
|---|---|---|
| Gas capture for combustion | 0.0377 | 56.8 |

**Table A.19 Estimated $CO_2$-e (tonnes) for third party combustion of captured gas**

| Period | ROM coal (t) | Gas capture ($m^3$) | Scope 3 combustion emissions at third party WCGMPP (t $CO_2$-e) |
|---|---|---|---|
| FY24 | 2,518,066 | 20,434,278 | 43,757 |
| FY25 | 3,941,724 | 31,987,362 | 68,496 |
| FY26 | 3,600,134 | 29,215,331 | 62,561 |
| FY27 | 3,845,099 | 31,203,239 | 66,817 |
| FY28 | 3,186,803 | 25,861,125 | 55,378 |
| FY29 | 3,057,388 | 24,810,915 | 53,129 |
| FY30 | 2,668,377 | 21,654,065 | 46,369 |
| FY31 | 3,643,677 | 29,568,684 | 63,317 |
| FY32 | 3,411,562 | 27,685,060 | 59,284 |
| FY33 | 3,460,124 | 28,079,144 | 60,128 |
| **Total** | **33,332,955** | **270,499,203** | **579,236** |

## A.11 Uncontrolled venting of gas emissions

In order to estimate potential emissions from the uncontrolled venting of captured gas, the following steps were taken:

- total captured gas ($m^3$) listed in Table A.10 and Table A.19 were summed
- a $CH_4$:$CO_2$ split of 53%:47% was assumed based on site monitoring data for FY18 to FY22
- the $m^3$ of gas was converted to tonnes using density values of 1.873 kg/$m^3$ $CO_2$ and 0.72 kg/$m^3$ for $CH_4$[11]
- to calculate a $CO_2$-e tonnage per year, a global warming potential of 28 was assigned to $CH_4$ (NGAF 2023)
- total annual $CO_2$-e emissions from venting were calculated and presented in Table A.20.

[11] https://www.lindedirect.com/resources/technical-information/physical-properties-of-gases

## Table A.20 Estimated $CO_2$-e (tonnes) for venting of captured gas

| Period | Gas capture ($m^3$) total | Vented $CH_4$ ($m^3$) | Vented $CO_2$ ($m^3$) | Vented $CH_4$ (t) | Vented $CO_2$ (t) | Vented total (t $CO_2$-e) | Total Scope 1 emissions with venting (t $CO_2$-e) | Total Scope 1 emissions flaring with (t $CO_2$-e) |
|---|---|---|---|---|---|---|---|---|
| FY24 | 49,823,905 | 26,627,493 | 12,396,907 | 19,172 | 23,219 | 560,030 | 1,550,189 | 1,047,979 |
| FY25 | 77,993,226 | 41,682,082 | 19,405,840 | 30,011 | 36,347 | 876,658 | 2,426,631 | 1,640,483 |
| FY26 | 71,234,318 | 38,069,904 | 17,724,126 | 27,410 | 33,197 | 800,687 | 2,216,339 | 1,498,318 |
| FY27 | 76,081,338 | 40,660,307 | 18,930,135 | 29,275 | 35,456 | 855,168 | 2,367,146 | 1,600,269 |
| FY28 | 63,055,923 | 33,699,108 | 15,689,224 | 24,263 | 29,386 | 708,760 | 1,961,881 | 1,326,297 |
| FY29 | 60,495,246 | 32,330,600 | 15,052,090 | 23,278 | 28,193 | 679,977 | 1,882,210 | 1,272,436 |
| FY30 | 52,798,052 | 28,216,972 | 13,136,917 | 20,316 | 24,605 | 593,460 | 1,642,725 | 1,110,536 |
| FY31 | 72,095,883 | 38,530,352 | 17,938,496 | 27,742 | 33,599 | 810,371 | 2,243,145 | 1,516,440 |
| FY32 | 67,503,134 | 36,075,840 | 16,795,754 | 25,975 | 31,458 | 758,747 | 2,100,249 | 1,419,838 |
| FY33 | 68,464,010 | 36,589,363 | 17,034,834 | 26,344 | 31,906 | 769,548 | 2,130,145 | 1,440,049 |
| **Total** | **659,545,034** | **352,482,022** | **164,104,323** | **253,787** | **307,367** | **7,413,405** | **20,520,661** | **13,872,645** |

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