



Tahmoor Mine Extraction Plan West 1 - West 2

Historical Heritage Technical Report

Prepared for Tahmoor Coal Pty Ltd
June 2019





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Tahmoor Mine Extraction Plan, Longwalls West 1 - West 2

Historical Heritage Technical Report

Report Number

J190120 RP2

Client

Tahmoor Coal Pty Ltd

Date

27 June 2019

Version

v1 Final

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27 June 2019

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Executive Summary

This Historical Heritage Technical Report (HHTR) has been prepared by EMM Consulting Pty Limited (EMM) to support an Extraction Plan for the secondary extraction of coal from Longwalls West 1 and West 2 (LW W1–W2). The objectives of the HHTR are to identify historical (non-Aboriginal) heritage values within the LW W1–W2 Study Area and to provide for the monitoring and management of potential subsidence related environmental impacts on historical heritage sites to demonstrate that the relevant performance measures are met.

The proposed LW W1–W2 will be operating in the Tahmoor North mining area under Development Consent DA 57/93 granted on 7 September 1994 and DA 67/98 granted on 25 February 1999. This HHTR has been developed in accordance with the conditional planning approval framework for mining activities in the area to the north-west of the Main Southern Railway (the Western Domain) within Tahmoor North mining area.

There are four listed heritage sites with local significance located partially within the Study Area, comprising Queen Victoria Memorial Hospital (QVMH), Mill Hill Millers House and archaeological relics, Harmony House archaeological site and Thirlmere Way rural landscape. All of these sites are partially within the southern boundary of the Study Area; none are situated directly above the extraction area. Overall, it has been assessed that the impacts to the listed heritage sites are unlikely to very unlikely.

In addition, a series of culverts associated with the historic Picton Mittagong Loop Line have been identified. Three sandstone and two brick culverts are located within the Study Area and two additional brick culverts are within the 600 m buffer area. These sites are not heritage listed but have local significance on an individual and collective basis. The probability of subsidence impacts to most of the culverts is predicted by MSEC (2019) to be *unlikely*. The exception is a culvert at chainage 88.400 which is directly above LW W1. Impacts to this culvert are predicted to be *possible* (MSEC 2019). Some of the culverts are currently infested with weeds and all will need a careful structural assessment following weed removal. Structural reinforcement prior to the commencement of mining may be required. Any structural reinforcement should avoid damaging the fabric of the culvert or compromising its heritage values.

In order to ensure that the performance measures are met, an ongoing program will be implemented to monitor the subsidence impacts and environmental consequences of subsidence effects during extraction of LW W1–W2 on known heritage sites within the Study Area. Prior to the mining of Longwall 30, survey pegs were installed around the QVMH and Mill Hill sites to track the development of subsidence and additional survey control points will be installed and recorded for each of the Loop Line culverts. These survey pegs will continue to provide information during the extraction of LW W1-W2.

The monitoring program will record the condition of the relevant sites before mining (baseline survey and baseline check) and the condition of the relevant sites after mining (post mining initial condition and post mining secondary condition check). In the event of unpredicted impacts, the Trigger Action Response Plan (TARP), detailed in Appendix A, will be implemented.

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1 Introduction

1.1 Introduction

The Tahmoor Coal Mine (Tahmoor Mine) is an underground coal mine located approximately 80 kilometres (km) southwest of Sydney between the towns of Tahmoor and Bargo, New South Wales (NSW) (Figure 1.1). Tahmoor Mine produces up to three million tonnes of Run of Mine (ROM) coal per annum from the Bulli Coal Seam. Tahmoor Mine produces a primary hard coking coal product and a secondary higher ash coking coal product that are used predominantly for coke manufacture for steel production. Product coal is transported via rail to Port Kembla and Newcastle for Australian domestic customers and export customers.

The Tahmoor Mine has been operated by Tahmoor Coal Pty Ltd (Tahmoor Coal) since Tahmoor Mine commenced in 1979 using bord and pillar mining methods, and via longwall mining methods since 1987. Tahmoor Coal, trading as Tahmoor Coking Coal Operations (TCCO), is a subsidiary within the SIMEC Mining Division (SIMEC) of the GFG Alliance (GFG).

Tahmoor Coal has previously mined 31 longwalls to the north and west of the Tahmoor Mine's current pit top location (refer to Figure 1.2). Tahmoor Coal is currently mining Longwall 32 in accordance with Development Consents and Subsidence Management Plan Approval.

Tahmoor Coal proposes to extend underground coal mining to the northwest of the Main Southern Railway (referred to as the 'Western Domain') which will include Longwalls West 1 (LW W1) to West 4 (LW W4) at Picton and Thirlmere. The first two longwalls to be mined are LW W1 and Longwall West 2 (LW W2) (collectively referred to as LW W1W2), which will be the focus of this technical report.

The proposed LW W1W2 are located in the area referred to as the 'Western Domain' within Mining Lease (ML) 1376 and ML 1539.

1.2 Purpose

This Historical Heritage Technical Report (HHTR) has been prepared by EMM Consulting Pty Ltd (EMM) to support an Extraction Plan for the secondary extraction of coal from LW W1–W2. The objectives of the HHTR are to identify historical heritage items within the LW W1-W2 Study Area and to provide for the monitoring and management of potential subsidence related environmental impacts on historical heritage sites within the Study Area in order to demonstrate that the relevant performance measures are met.

1.3 Scope

This HHTR:

- addresses specific requirements set by DA 67/98 Condition 13H(vii)(f) (refer to Section 2.1);
- addresses related regulatory requirements (refer to Section 2.3);
- addresses the monitoring and management of potential subsidence-related impacts to historical heritage values resulting from the extraction of LW W1–W2 (refer to Section 5 and 6);
- provides a Trigger Action Response Plan (TARP) to be implemented to manage and protect known heritage values within the Study Area (refer to Section 6.3; Appendix A);

- identifies personnel responsible for the effective implementation of the TARP (refer to Appendix A); and
- Identifies a process of review and improvement (refer to Section 7).

The HHTR is primarily informed by the following:

- an Aboriginal and European Heritage Assessment prepared for LW 31–37, a previous mine plan and study area for longwalls in the Western Domain, which included the current Study Area for LW W1–W2 (Niche, 2014);
- recent archaeological survey of the Picton Mittagong Loop Line (Loop Line) within the Study Area completed by EMM in March 2019; and
- subsidence data provided by Mining Subsidence Engineering Consultants (MSEC 2019) to measure subsidence impacts and associated environmental consequences.

This HHTR has been prepared in consultation with the Office of Environment and Heritage (OEH Greater Sydney Branch).

The HHTR applies to all sites within the Study Area as shown in Figure 1.1 and Figure 3.1.

1.4 Study Area

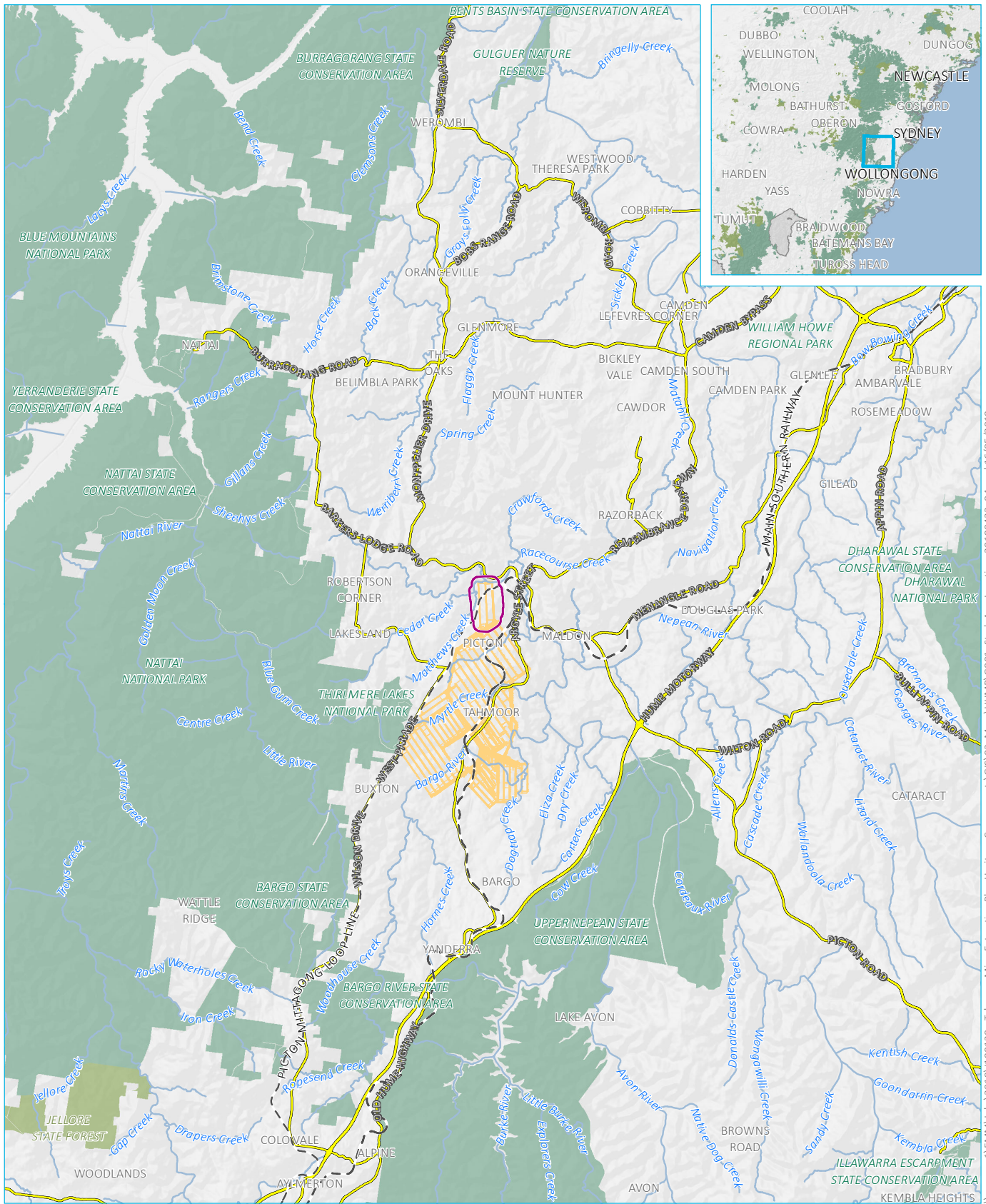
The Study Area is defined as the surface area that could be affected by the mining of LW W1-W2. The extent of the Study Area was calculated by Tahmoor Coal by combining the areas bounded by the following limits:

- a 35-degree angle of draw from the extents of LW W1–W2; and
- the predicted limit of vertical subsidence, taken as the 20 mm subsidence contour resulting from the extraction of the proposed longwalls.

A 600 m longwall buffer that encompasses an area wider than the Study Area, is also considered in order to capture sites that could experience far-field or valley related movements and could be sensitive to such movements (MSEC 2019) (Figure 1.2).

1.5 Report Authors

EMM was commissioned by Tahmoor Coal to prepare this HHTR to support an Extraction Plan for Tahmoor Mine LW W1–W2. This HHTR was prepared by Pamela Chauvel (Archaeologist) with review and input from Pamela Kottaras (Associate, National Technical Lead - Heritage). It was reviewed and approved by Nathan Garvey (Associate Director).



Source: EMM (2019); DFSI (2017); GA (2011)

- KEY**
- Study area
 - Mine plan
 - Rail line
 - Main road
 - Watercourse/drainage line
 - NPWS reserve
 - State forest

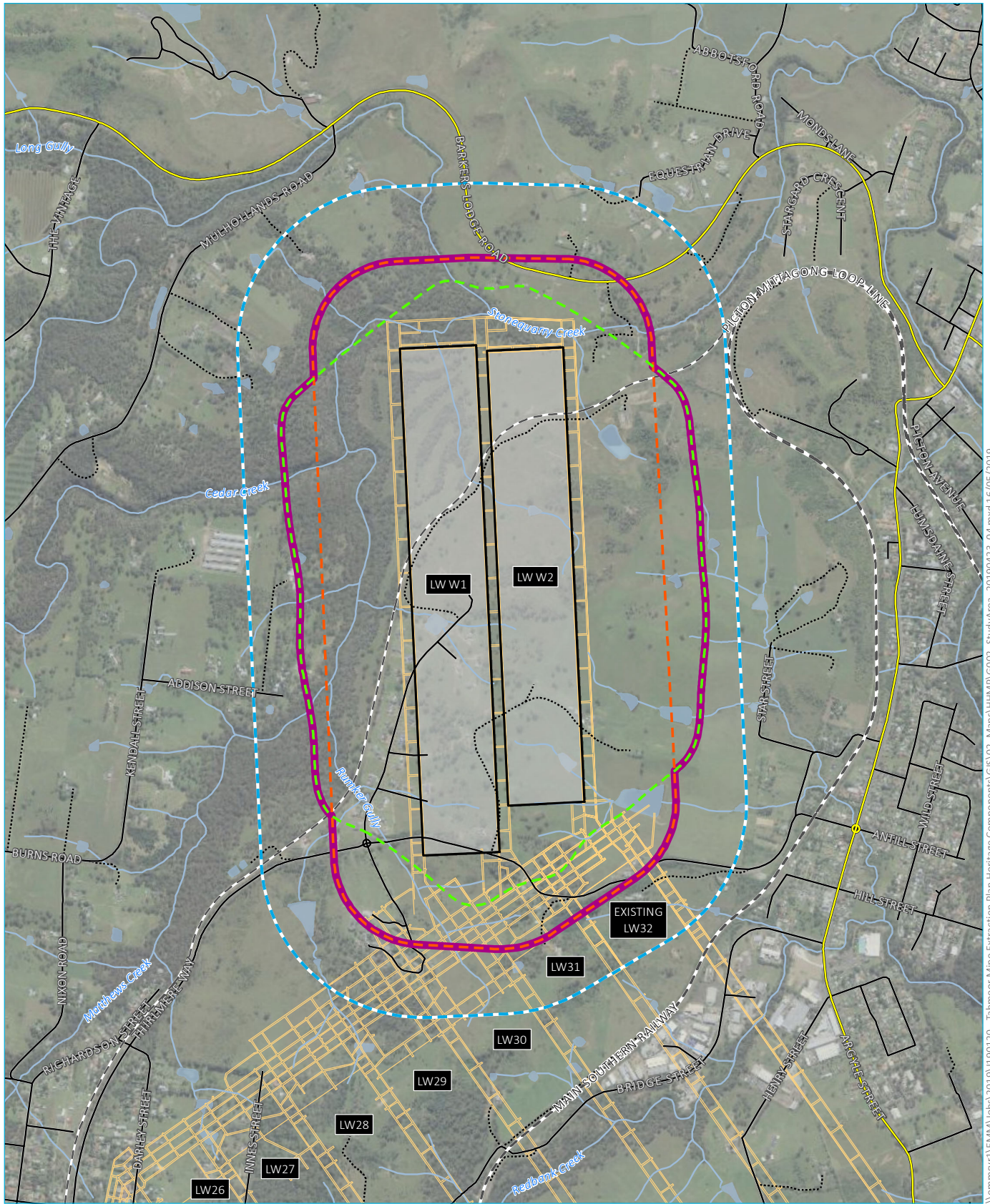


Study area location

Tahmoor coal mine extraction plan LW W1-W2
 Historical heritage technical report
 Figure 1.1



\\vemmsvr1\EMM\Jobs\2019\11\90120 - Tahmoor Mine Extraction Plan Heritage Components\GIS\02_Maps\HWP\G001_StudyAreaLocation_20190423_04.mxd 16/05/2019



Source: EMM (2019); DFSI (2017); GA (2011); SIMEC (2019)

KEY

- Study area
- Rail line
- Main road
- Local road
- Vehicular track
- Watercourse/drainage line
- Waterbody
- Longwall
- 35 degree angle of draw
- Predicted 20 mm subsidence
- Longwall buffer (600 m)
- Mine plan

Study area

Tahrnor coal mine extraction plan LW W1-W2
 Historical heritage technical report
 Figure 1.2

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2 Statutory requirements

2.1 Project approval

2.1.1 Developmental consent

Tahmoor Coal’s operations are conducted in accordance with applicable Commonwealth and State environmental, planning, mining safety, and natural resource legislation. A register of relevant environmental legislative and regulatory requirements is maintained by Tahmoor Coal in a compliance database.

The proposed LW W1–W2 will be operating in the Tahmoor North mining area DA 57/98 and DA 67/98.

DA 67/98 provides the conditional planning approval framework for mining activities in the Western Domain to be addressed within an Extraction Plan and supporting management plans. Conditions relevant to the HHTR from DA 67/98 are detailed in Table 2.1 and performance measures (as described in Table 1 of DA 67/98 Condition 13A) are detailed separately in Table 2.1.

Table 2.1 Key conditions of DA 67/98 relating to historical heritage

Condition	Condition Requirement	Section(s) Addressed								
SUBSIDENCE										
Performance Measures – Natural and Heritage Features etc.										
13A	The Applicant must ensure that extraction of Longwall 33 and subsequent longwalls does not cause any exceedances of the performance measures in Table 1. <i>Note: The Applicant will be required to define more detailed performance indicators (including impact assessment criteria) for each of these performance measures in the various management plans that are required under this consent.</i>	Section 5 and 6								
Table 1	<table border="1"> <thead> <tr> <th>Feature</th> <th>Performance Measure</th> </tr> </thead> <tbody> <tr> <td colspan="2">Heritage Sites</td> </tr> <tr> <td>Heritage sites show in the figures in Appendix 7¹</td> <td>Negligible subsidence impacts or environmental consequences. Negligible loss of heritage value.</td> </tr> <tr> <td>Other Aboriginal and heritage sites</td> <td>Negligible subsidence impacts or environmental consequences.</td> </tr> </tbody> </table>	Feature	Performance Measure	Heritage Sites		Heritage sites show in the figures in Appendix 7 ¹	Negligible subsidence impacts or environmental consequences. Negligible loss of heritage value.	Other Aboriginal and heritage sites	Negligible subsidence impacts or environmental consequences.	
Feature	Performance Measure									
Heritage Sites										
Heritage sites show in the figures in Appendix 7 ¹	Negligible subsidence impacts or environmental consequences. Negligible loss of heritage value.									
Other Aboriginal and heritage sites	Negligible subsidence impacts or environmental consequences.									
13B	Measurement and monitoring of compliance with performance measures and performance indicators in this consent is to be undertaken using generally accepted methods that are appropriate to the environment and circumstances in which the feature or characteristic is located. These methods are to be fully described in the relevant management plans and monitoring programs. In the event of a dispute over the appropriateness of proposed methods, the Secretary will be the final arbiter.	Section 5								
Extraction Plan										
13H	The Applicant must prepare an Extraction Plan for all second workings in Longwall 33 and subsequent longwalls to the satisfaction of the Secretary. Each Extraction Plan must:	Extraction Plan Main Document								

Condition	Condition Requirement	Section(s) Addressed
13H(vi)	describe in detail the performance indicators to be implemented to ensure compliance with the performance measures in Table 1 and Table 2, and manage or remediate any impacts and/or environmental consequences;	Section 5.1, 5.2 and 6
13H(vii)(f)	include a Heritage Management Plan which has been prepared in consultation with OEH and relevant stakeholders for heritage items which provides for the management of potential environmental consequences of the proposed second workings on heritage items;	This document
13H(vii)(h)	include a Trigger Action Response Plan/s addressing all features in Table 1 and Table 2, which contains:	Appendix A
	appropriate triggers to warn of increased risk of exceedance of any performance measure; and	Appendix A
	specific actions to respond to high risk of exceedance of any performance measure to ensure that the measure is not exceeded;	Section 6
	an assessment of remediation measures that may be required if exceedances occur and the capacity to implement the measures; and	Section 6.2
	adaptive management where monitoring indicates that there has been an exceedance of any performance measure in Table 1 or Table 2, or where any such exceedance appears likely; and	Section 6.1
13H(vii)(i)	Contingency Plan that expressly provides for:	
	adaptive management where monitoring indicates that there has been an exceedance of any performance measure in Table 1 and Table 2, or where any such exceedance appears likely; and	Section 6.1
	an assessment of remediation measures that may be required if exceedances occur and the capacity to implement those measures; and	Section 6.2, 6.3
	includes a program to collect sufficient baseline data for future Extraction Plans.	Section 5

Note: 1 As there is no Appendix 7 in DA 67/98 Modification 4, it is interpreted that this refers to Aboriginal heritage sites listed on the Aboriginal Heritage Information Management System, Wollondilly Local Environmental Plan 2011, State Heritage Register, and the Australian Heritage Database.

2.2 Subsidence performance measures

Performance measures for Historical heritage sites are provided in Table 1 of Condition 13A of DA 67/98 and summarised in Table 2.2. Definitions and discussion around what constitute negligible impacts is presented in Section 5.

Table 2.2 Heritage performance measures

Heritage item	Subsidence performance measures
Heritage sites shown in the figures in Appendix 7 ¹	Negligible subsidence impacts or environmental consequences; Negligible loss of heritage value
Other Aboriginal and heritage sites	Negligible subsidence impacts or environmental consequences

Note: 1 As there is no Appendix 7 in DA 67/98 Modification 4, it is interpreted that this refers to heritage sites listed on the Wollondilly Local Environmental Plan 2011, State Heritage Register, and the Australian Heritage Database.

2.3 Relevant legislation and guidelines

2.3.1 Introduction

This HHTR has been prepared in accordance with the principles of the Australia ICOMOS Burra Charter, 2013 (Burra Charter). The Burra Charter provides guidance for the conservation and management of places of cultural significance and sets a standard of practice for those who provide advice, make decisions about, or undertake works to places of cultural significance, including owners, managers and custodians.

Items of heritage significance in NSW are protected by a series of acts whose purpose it is to ensure that change is appropriately managed to ensure that significance is not lost. In NSW, the *Heritage Act 1977* (the Heritage Act), and the *Environmental Planning and Assessment Act 1979* (EP&A Act) are the primary statutory controls protecting historical heritage and archaeology within NSW. Listing on statutory registers provides legal protection for heritage items

2.3.2 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides a legal framework to protect and manage nationally and internationally important heritage places as well as places that are owned by the Commonwealth, such as defence lands and postal facilities.

2.3.3 Heritage Act 1977

The *Heritage Act 1977* (Heritage Act) is the statutory framework for the identification and conservation of relics and heritage sites listed on the State Heritage Register in NSW.

i Relics Provision

Relics are defined by the Heritage Act are “any artefact, object or material evidence which relates to the settlement of that area that comprises New South Wales, not being Aboriginal settlement, and is of State or local significance.” Relics are protected under section 139 of the Heritage Act. Where there exists the potential for relics, the land in which it is found cannot be disturbed or excavated without an excavation permit under s140, or an exception notification (s139[4]), of the Heritage Act.

ii State Heritage Register

The State Heritage Register (SHR) is a list of places and objects of particular importance to the people of NSW. When a place is listed on the SHR or is affected by an interim heritage order, approval under Section 60 of the Heritage Act is required for any major work. The purpose of this requirement is to ensure that change to significant places is managed appropriately and does not detract from the heritage significance of the place.

iii Section 170 registers

State government agencies have responsibilities under Section 170 of the Heritage Act that requires them to identify, conserve and manage heritage assets owned, occupied or managed by that agency. Each agency is required to maintain a S170 register of all heritage assets and assess the significance of each asset.

2.3.4 Environmental Planning and Assessment Act 1979

The EP&A Act establishes the framework for cultural heritage values to be formally assessed in the planning and development consent process in NSW. The EP&A Act requires that environmental impacts are considered before land development; this includes impacts on cultural heritage items and places as well as archaeological sites and deposits.

The EP&A Act requires that local governments prepare planning instruments, such as Local Environment Plans (LEPs) and Development Control Plans (DCPs) to provide guidance on the level of environmental assessment. This includes identification of heritage items, as listed on the heritage schedules of an LEP.

The Study Area is within the Wollondilly Shire Local Government Area (LGA), and therefore the *Wollondilly Local Environment Plan 2011* (WLEP) is applicable.

2.4 Consultation

2.4.1 Consultation with OEH

A meeting with representatives of OEH and representatives of Tahmoor Coal took place at the OEH Hurstville Office on 21 March 2019. The purpose of the meeting was for Tahmoor Coal to outline the proposed LW W1–W2 Extraction Plan and the proposed subsidence monitoring program for the LW W1–W2 Study Area and for OEH to provide feedback. No comments relating specifically to historical heritage were made by OEH during this meeting.

3 Existing environment

3.1 Landscape

The Study Area is located immediately to the west of the Main Southern Railway Line in Picton. It is dominated by two major landform patterns. The southern and eastern portions of the Study Area are characterised by a broad ridgeline that is generally on a north-east/south-west axis. The topography is generally hilly and undulating and the Study Area is in a rural district that has been largely cleared for pastoral grazing. The Picton Mittagong Loop Line (Loop Line) traverses the Study Area on a series of embankments and cuttings. The western and northern portions of the Study Area are characterised by the deeply incised stream channels of Matthews Creek, Cedar Creek and Stonequarry Creek.

3.2 Historical context

The Picton area was surveyed into small land grants in 1821. The Great Southern Road (renamed the Hume Highway in 1928) between Sydney and the Southern Highlands opened the area to settlers in the early nineteenth century, while the arrival of the railway in the 1860s led to a boom in the local economy.

Henry Antill was granted an estate near Picton in 1825 which he named Jarvisfield (Antill 1966). In 1841 Antill subdivided the part of his estate on the north side of Stonequarry Creek and called it the Village of Picton, after Sir Thomas Picton, one of the Duke of Wellington's generals at the Battle of Waterloo.

The success of Antill's village led the government to lay out its own town to the immediate south of Antill's village. It too was called Picton, and lots were offered for sale in 1847. However, it was Lower Picton that thrived and became the centre for trade and business and by the end of the nineteenth century Argyle St was the commercial hub.

3.3 Listed heritage sites within the Study Area

A review of the following databases was undertaken in April 2019:

- Commonwealth Heritage List (CHL);
- National Heritage List (NHL);
- SHR;
- WLEP (2011), schedule 5;
- Wingecarribee LEP (2010) schedule 5;
- NSW Department of Health s170 register;
- Rail Corp s170 register;
- Australian Rail Track Corporation (ARTC) s170 register; and
- National Trust register.

There are no heritage items within the Study Area that are listed on the CHL, NHL, SHR or National Trust registers.

Four heritage items are listed on the Wingecarribee LEP (2010), WLEP (2011) or the Department of Health S170 register. The Picton-Mittagong Loop Line Railway Line (Loop Line) is listed on the Wingecarribee LEP (2010) (I473) for the section of the line between Buxton and Mittagong, but the section of the Loop Line within the Wollondilly Shire LGA (and within the Study Area) is not listed on the WLEP.

Three heritage items within the Study Area are listed on the WLEP (2011) and have local significance. Two WLEP items (the Queen Victoria Hospital, and Harmony House archaeological site) are also listed on the Department of Health S170 register. Rural landscape - Thirlmere Way is linked to the Department of Health S170 group record for The Queen Victoria Memorial Hospital Precinct.

Details of these heritage items are listed in Table 3.1 and items are shown on Figure 3.1.

Table 3.1 Listed heritage sites within the Study Area

WLEP	Department of Health S170 Register	Address	Distance from Longwalls	Significance
Mill Hill, Millers House and archaeological relics (I210)		675 Thirlmere Way, Picton	Partially within the southern boundary of the Study Area. 230 m from LW W1.	Local
Queen Victoria Hospital (I265)	Queen Victoria Hospital Precinct. S170 register individually lists the following items: <ul style="list-style-type: none"> • Chalets (seven items); • Cultural landscape; • Daycare Centre; • Goodlet House; • Library and Diversional Therapy; • Nursing Administration; • Polyclinic; • Remnant native landscape; • Repatriation Chalet; • Tennis Court; • The Grove; • Visitors Chalet; and • Workshop and stores. 	Thirlmere Way, Picton	Within this complex of buildings, four structures are within the southern boundary of the Study Area: <ul style="list-style-type: none"> • Goodlet House (c.1886), the original sanatorium building is approximately 320 m south west of LW W1; • The main modern three-storey building is approximately 310 m from LW W1; • Building V04bh1 is adjacent to Goodlet House (east); and • Building V04ag1 is approximately 320 m from LW W1. 	Local
Harmony House Archaeological site (A14)	Artefacts	220 Bridge St, Thirlmere (Thirlmere Way, Picton)	Partially within the southern boundary of the Study Area.	Local
	Rural Landscape – Thirlmere Way	Thirlmere Way, Picton	Partially within the southern boundary of the Study Area.	Local

1. Building prefixes correlate to those used by MSEC (2019).

3.4 Heritage Assessment (Niche 2014)

In 2014 Niche Environment and Heritage (Niche) completed an Aboriginal and European Heritage Assessment for a previous mine plan and study area for longwalls in the Western Domain, which included the current Study Area for LW W1–W2 (Niche 2014).

In addition to the historical sites listed on the heritage registers, Niche identified a sandstone culvert associated with the historic Picton Mittagong Loop Line (chainage 88.980 km) as part of their European Heritage Assessment (Niche 2014).

3.5 Overview of listed heritage sites within the Study Area

This section provides a brief summary of each of the listed heritage items (additional information can be found in Niche 2014). Heritage items in the Study Area relate to the following phases of historical development in the local area:

- establishment and early settlement of Thirlmere Way c.1840 on the outskirts of 'Stonequarry' (Picton) on Stonequarry Creek;
- construction of the Picton-Mittagong Railway line c.1867;
- provision of private health services for tuberculosis patients c.1880;
- late nineteenth century and early twentieth century subdivision and occupation of Thirlmere Way, Picton and the Old Hume Highway, Tahmoor; and
- duplication of the Southern Railway Line between Picton and Mittagong via Bargo c.1919.

3.5.1 Queen Victoria Memorial Hospital

The Queen Victoria Memorial Hospital (QVMH) at Picton was established in 1886 as probably the first tuberculosis sanatorium in New South Wales and possibly Australia. The hospital represents an important development in health care in New South Wales. In 1959 the role of hospital changed from being solely for treatment of tuberculosis to that of care for the elderly as it continues to be today.

The site comprises a large complex of buildings which has been altered and added to over the years. Four buildings lie within the Study Area, including the original sanatorium building Goodlet House (c.1886). The three-storey brick building has a hipped slate main roof and flat metal deck roof over the later additions including brick side wings, enclosed verandahs and extension of the ground floor level.

Buildings within the Study Area include part of Goodlet House; the Visitor's Chalet, a single storey, post WWII weatherboard building; the modern three-storey building currently used as a nursing home and an adjacent ancillary building (Table 3.1).

3.5.2 Mill Hill, Miller's house and archaeological relics

The Mill Hill Windmill and House is one of a set of mills constructed locally by the Larkin family. The flour mill at Picton was in use from 1842-47. While there are no above-ground remains of the mill, the surface indications are that this site has archaeological potential. The Miller's House, a single storey weatherboard cottage, survives on the site and one of the only identified miller's houses still existing in the district.

3.5.3 Harmony House archaeological site

Harmony House was built (c.1882) as the original country retreat dwelling of Colonel John Hay Goodlet. Between 1907-1912 it was used as a children's hospital for state wards. For the next twenty years it became a boarding house before being demolished in 1933.

The site was included on the WLEP in 2016 (Report of Planning and Economy to the Ordinary Meeting of Council, 15 February 2016). The archaeological site is also listed on the Department of Health S170 Register as 'Artefacts' comprising "early brick wall foundations and other building fabric of Harmony House and underground beehive water reservoir with original cap."

3.5.4 Rural Landscape, Thirlmere Way

The rural landscape provides the picturesque setting for the QVMH precinct. As the setting for the early hospital, it formed the basis, and an integral part, of the patient's treatment at the hospital. It is a good example of pasture improvement on a working farm, providing food for the hospital (Tropman & Tropman 2004). The site dates from c.1882 with a dam added in 1910 and further modifications between 1920-1930. The boundary of this item is defined as the setting for the QVMH.

3.6 Site inspection

3.6.1 Methods and rationale

As Niche had already assessed the listed heritage items within the Study Area (Niche 2014), the focus of the site visit was to inspect the Loop Line directly above the northern ends of LW W1–W2.

The total length of the Loop Line located directly above the proposed longwalls is 0.83 km and the total length located within the Study Area is 2.2 km (MSEC 2019, p.78). In particular, the aim of the site visit was to inspect the Loop Line culverts that were not included in the 2014 assessment by Niche.

EMM inspected the Loop Line on 29 March 2019 accompanied by a representative of Heritage Rail. Details of each culvert were recorded with digital tablets using site recording forms created by EMM on the Survey123 application for ArcGIS (Esri© software). Where access permitted, both sides of each culvert were inspected. Weeds and overgrown vegetation prevented a full inspection of some of the culverts (Plate 3.1) and detailed inspection will be required after the removal of vegetation and prior to extraction commencing.

Where access was possible, additional photographs were taken of the culverts with a scale rod (Plate 3.2) and close-up photographs of existing damage to the structures (Plate 3.3).



Plate 3.1 Sandstone culvert, chainage 88.400, overgrown with weeds and brambles. View west.



Plate 3.2 Brick culvert (chainage 87.630). View north west.

3.6.2 Historical background to the Loop Line

The Picton-Mittagong Line was opened in February 1867 as an extension to the Main South Line that opened in 1863 and terminated at Picton. It was built under the supervision of John Whitton, Engineer in Charge for the New South Wales Railways from 1856 to 1898. The line was a single track with steep gradients up to 1 in 30.

The dominant material used to build infrastructure along the railway line was sandstone. The sandstone viaduct on Stonequarry Creek at Picton cost £10,437 and arched culverts of beautifully cut stone were used on the line (Bayley 1974, p.6). A contract plan for a standard culvert design on the line shows that the culverts were constructed of sandstone blocks and were to be almost circular in shape with wing walls (Niche 2014).

In 1919, a new deviation line was constructed on an alignment to the east of the original line. The original alignment, which became known as the “Picton to Mittagong Loop Line” passed through the Mushroom Tunnel (east of the Study Area) and along an embankment (now disused). A brick culvert is located in the old embankment (at chainage 87.300).

3.6.3 Results

Three sandstone and two brick culverts were recorded on the Loop Line within the Study Area. Two additional brick culverts were recorded outside the Study Area but within the 600 m buffer. The sandstone culverts are likely to date to the construction of the original line in 1863 and the brick culverts to additional works in 1919. The location of all the culverts is shown on Figure 3.1.

The culverts were found to be generally in fair to good condition except for the sandstone culvert at chainage 88.980 which has been subject to ‘restoration’ work resulting in damage to the sandstone, specifically exfoliation and more rapid deterioration of the sandstone (Plate 3.3).

While cracking of the brick culverts along the Loop Line was mostly confined to the mortar, the brick culvert at chainage 87.300 under the disused embankment for the original railway alignment displayed additional cracking to the bricks themselves around the entrance to the culvert (Plate 3.4).

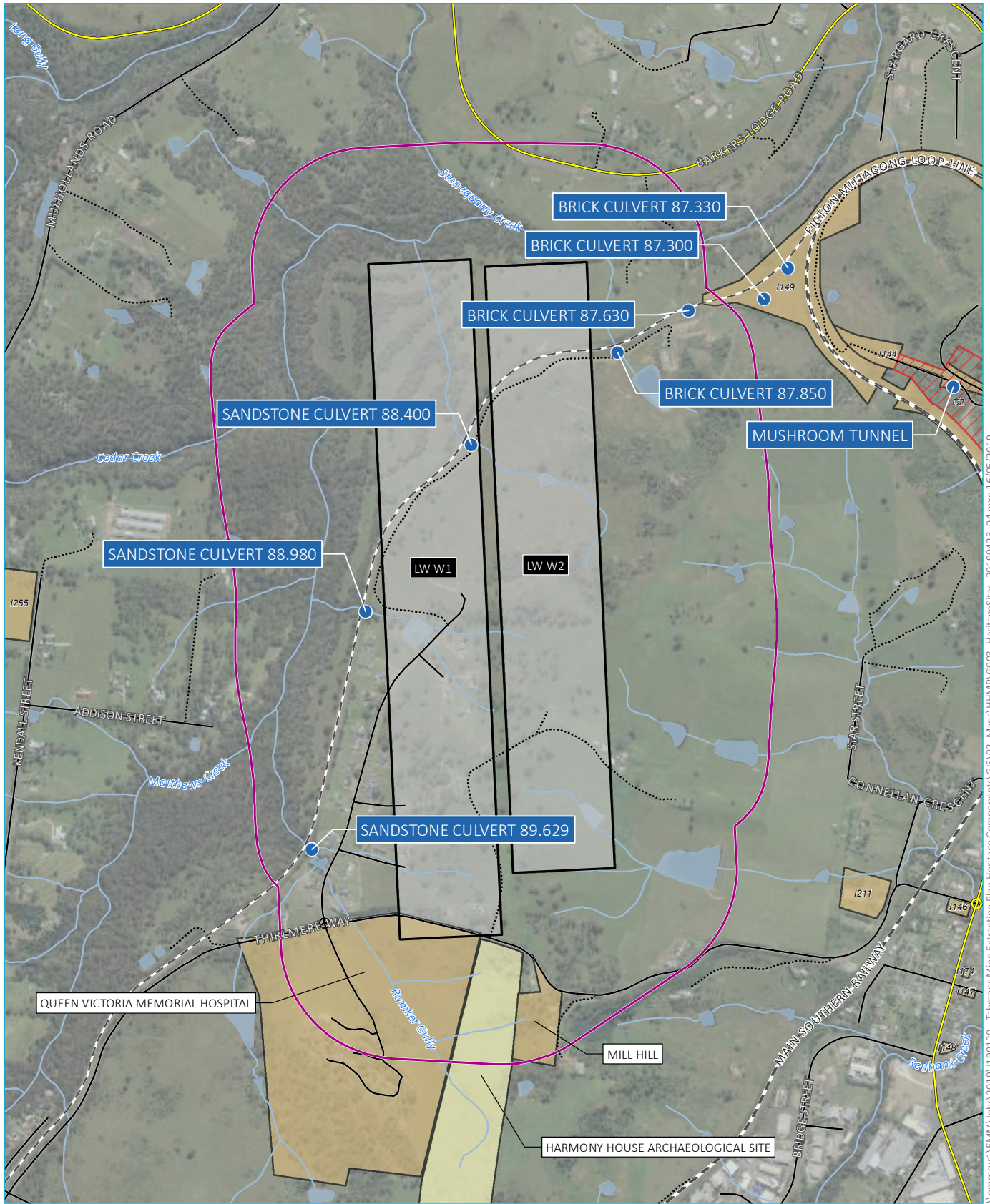
Table 3.2 presents a summary of the culverts and their current conditions.



Plate 3.3 Damage to sandstone culvert, chainage 88.980.



Plate 3.4 Cracking on north entrance to culvert at chainage 87.300. View south.



Source: EMM (2019); DFSI (2017); GA (2011)

KEY

- Study area
- Longwall
- Rail line
- Main road
- Local road
- Vehicular track
- Watercourse/drainage line
- Waterbody
- Historical heritage survey site
- Listed heritage sites
- Conservation Area - General
- Item - General
- Item - Archaeological

Heritage sites within the study area

Tahmor coal mine extraction plan LW W1-W2
 Historical heritage technical report
 Figure 3.1



\\emmsvr1\EMM\Jobs\2019\1190120 - Tahmor Mine Extraction Plan Heritage Components\GIS\02_Maps\HHWP\G003_HeritageSites_20190423_04.mxd 16/05/2019

3.6.4 Assessment of significance – Loop Line culverts

The culverts have local significance as individual items and as a group. The sandstone culverts located along the Loop Line have historical significance as part of the works and structures constructed to overcome the challenging terrain during the construction of the Southern Railway during the 1860s, while the brick culverts which were added in 1919, have historical significance as part of the story of the development of the railway in NSW and the changing construction techniques.

The sandstone culverts in the Study Area are larger, although similar in design to, the Couridjah railway culvert located on the Loop Line approximately 10 km south of Picton and listed on the Rail Corp S170 register. The stonework used in the culverts exhibits a high degree of technical skill that is found in many other government works of the same period, such as the Picton Viaduct.

The brick culverts, added as part of the section built to join onto the Main Southern Railway, also demonstrate technical skill and the standards applied to government infrastructure programs during this period.

Table 3.2 Culverts inspected during the site visit

Chainage	Item	Construction date	Notes	Dimensions	Significance
87.300	Brick culvert	c.1919	Located beneath the disused embankment for the original railway alignment. Bricks cracked at northern headwall.	Entrance 1.2 m high	Local
87.330	Brick culvert	c.1919	Drainage channels of rendered brick have been constructed on either side of the embankments in order to funnel water into the culvert. Cracking is along the mortar only and the condition of the bricks is good. Only the south east side of the culvert was inspected.	1.2 m diameter	Local
87.630	Brick culvert	c.1919	Concrete skin on base and rubble at the mouth. Mortar tuck pointed. Headwall and abutment in good condition. Recent embankment to the south-east means water is largely diverted away from the culvert.	Entrance dimensions 3.2 m x 1.5 m	Local
87.850	Brick culvert	c.1919	Overgrown with brambles, difficult to assess.	1.535 m diameter	Local
88.400	Sandstone culvert	c.1867	Overgrown with weeds, difficult to assess. Only the east side was inspected.	2.44 m diameter	Local
89.629	Sandstone culvert	c.1867	Very little cracking or dilapidation of sandstone or mortar. Brick wingwalls and headwall (c.1919) on the upstream side to support vehicle track (Plate 3.5). Southern wingwall has been undercut by erosion and has some cracking.	3.062 m diameter	Local
88.980	Sandstone culvert	c.1867	Poorly “restored” as part of the Stonequarry Estate Development, resulting in exfoliation of sandstone blocks particularly on the roof of the culvert	2.44 m diameter	Local



Plate 3.5 Sandstone culvert with the later addition of brick wingwalls and head wall (chainage 89.629). View west.

4 Predicted subsidence impacts and environmental consequences

4.1 Potential subsidence impacts and environmental consequences

4.1.1 Longwall mining

Longwall mining is a method of underground coal mining that involves the extraction of large rectangular 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 zone (IESC 2014). These horizontal movements result in tensile strains, leading to cracking of the ground surface, and compressive strains when the distance between two points decreases, pushing the ground upwards.

The prediction of impacts to heritage sites is determined first by adequate surveys to determine the existence and significance of heritage sites within the Study Area. The design and configuration of buildings and the materials of which they are built will determine the effects which mining subsidence will have upon them. In addition, the levels of impact due to curvature and strain will vary considerably throughout the longwall area (EIS 1998: p.85-6). Structures which are most susceptible to subsidence-induced damage are those with more rigid foundations or built directly on bedrock.

4.1.2 Overview

Four listed historical heritage sites are located partly within the Study Area. In addition, three sandstone culverts (unlisted) and two brick culverts (unlisted) that are part of the historical Loop Line are located within the Study Area. Mine Subsidence Engineering Consultants (MSEC) prepared a subsidence assessment for the historical sites within the Study Area on 3 April 2019. The likelihood of damage occurring at the sites was assessed on criteria which consider theoretical cracking limits caused by strains and tilts. The following section summarises the predicted subsidence impacts to historical heritage sites within the Study Area. A summary of all historical heritage sites within the Study Area and the predictions for impacts to these sites is presented at the end of this chapter in Table 4.2.

If the subsidence impact performance measures are exceeded, Tahmoor Coal will implement the TARP (Appendix A). In the event of any subsidence impact, appropriate management, remediation and mitigation measures will be undertaken in accordance with relevant approvals.

4.1.3 Listed historical heritage sites

i Mill Hill, Miller's House and archaeological site

The Miller's House is located around 100 m from the end of previously extracted LW31. No impacts were observed during the mining of LW31. The house is located approximately 230 m south-east from LW W1 and 370 m south from LW W2.

The single storey weatherboard house sits on brick and steel piers, and is therefore inherently structurally flexible, making it less prone to subsidence impact. The structure is predicted to experience 80 mm vertical subsidence, the majority of which are predicted to be or have been experienced during the mining of LW31 and LW32. It is not expected to experience any substantial tilts, curvatures or strains as a part of the mining of LW W1-W2.

It is expected, therefore, that the house would experience *nil* or *minor* impacts resulting from the extraction of the proposed longwalls. It has been assessed that the potential for adverse impacts on these structures is *unlikely*. Furthermore, impacts on the structure are likely to be limited to the external cladding or internal finishes, which can be more readily repaired (MSEC 2019).

ii Queen Victoria Memorial Home

The QVMH property comprises a total of 46 buildings, one pool and 12 dams. The LW W1 is approximately 320 m north east of Goodlet House (the original building) and 310 m north east of the new three-storey main building at their closest points.

The predictions of vertical subsidence at the QVMH are relatively small. The property is located between longwall panels, LW 22–32 and LW W1–W2. Additional vertical settlement has previously been observed during mining but previous experience has found that this is not accompanied by any significant tilts, curvatures or strains, i.e. less than 0.5 mm/m which is in the order of survey tolerance (MSEC 2019).

The structures are predicted to experience up to 20 mm vertical subsidence due to LW W1–W2. Whilst the structures could experience low-level vertical subsidence, they are not expected to experience measurable tilts, curvatures or conventional strains. It has been assessed that the potential for adverse impacts on these structures is *unlikely* (MSEC 2019).

iii Harmony House archaeological site

Mapping in the QVMH Cultural Management Plan (Tropman and Tropman 2004 p.76) indicates that the archaeological curtilage of the Harmony House ruins, including the location of the nineteenth century brick footings and the underground water reservoir, are located towards the centre of the lot, approximately 350 m south of LW W1. Therefore, as the property boundaries are outside of the proposed mining area, and the archaeological site is approximately 350 m outside the Study Area, it is predicted to experience vertical subsidence of less than 20 mm. While the site could experience a low-level of vertical subsidence, it is not expected to experience significant tilts, curvatures or conventional strains.

The likelihood of adverse impacts on the archaeological site is therefore considered to be *very unlikely* (MSEC, 2019).

iv Rural Landscape, Thirlmere Way

The rural landscape on Thirlmere Way is partly above the southern end of LW W1. The vertical subsidence transitions from the maximum values directly above LW W1 to slightly reduced values of 200-300 mm over a distance of 320 m and are therefore not visually perceptible.

Cracking or heaving in the surface soils could result from curvatures and strains but these are expected to be isolated and minor due to the high depth of cover at Tahmoor Mine. Cracks would typically be less than 25 mm. It is therefore *unlikely* that impacts from subsidence would reduce the visual aesthetics or historical heritage value of the land (MSEC 2019).

4.1.4 Culverts along the Loop Line (not listed)

The Loop Line crosses directly above the northern and western ends of LW W1–W2. Two brick and three sandstone culverts are situated along the section of this railway line within the Study Area. Two additional brick culverts are located outside the Study Area but within the 600 m buffer.

The maximum predicted total tilt at the loop line culverts is 1.5 mm/m (i.e. 0.15 %, or 1 in 670). It is not expected that mining-induced conventional tilts will have adverse impacts on the drainage flows in the culverts, as the changes in grade are predicted to be less than 1%. The maximum predicted curvature is 0.01 km⁻¹ hogging, which is extremely small.

The main risk identified with the brick arch and stone culverts is the potential for these culverts to experience some cracking and spalling of the masonry, or the dislodgement of bricks or stones as a result of the extraction of LW W1–W2. Cracking may occur in the masonry arches or in the headwalls. Overall, the probability of subsidence impacts to most of the culverts is predicted by MSEC (2019) to be *unlikely*. The exception is the culvert at chainage 88.400 which is directly above LW W1 (Plate 3.1). Impacts to this culvert are predicted to be *possible* (MSEC 2019).

Consulting engineers, John Matheson and Associates (JMA Solutions) conducted a preliminary inspection of the culverts within the Study Area in April 2019. They advised that it was likely that the culvert floors and headwalls had been built into bedrock foundation and this could have implications for culvert behaviour under the impact of valley closure. With regard to the culvert at chainage 88.400 where impacts are predicted to be *possible*, JMA Solutions assessed it as unlikely that significant excavation of the creek bed was carried out to construct this culvert and therefore there may not be any near-vertical rock faces near the culvert, concealed by the embankment, that would increase the vulnerability of this culvert to impacts from subsidence. Nevertheless, they advised that it would be prudent for a geotechnical engineer to confirm this.

A summary of predicted subsidence impacts for each of the culverts has been provided by MSEC (2019) and is presented in Table 4.1.

Table 4.1 Predicted subsidence impacts for the historical culverts within the Study Area

Item	Location in relation to longwalls	Maximum predicted vertical subsidence (mm)	Maximum predicted tilt (mm/m)	Maximum predicted hogging curvature (1/km)	Maximum predicted sagging (1/km)	Maximum predicted upsidence (mm)	Maximum predicted closure
Brick culvert 87.630	270m east of LW W2	40	< 0.5	< 0.01	< 0.01	20	30
Brick culvert 87.850	70m east of LW W2	150	1.0	< 0.01	< 0.01	125	250
Sandstone culvert 88.400	Directly above LW W1	725	1.5	0.02	0.02	80	125
Sandstone culvert 88.980	60 m west of LW W1	125	1.0	0.01	< 0.01	50	80
Sandstone culvert 89.629	250 m west of LW W1	40	< 0.5	< 0.01	< 0.01	40	60

4.2 Summary of subsidence impacts and environmental consequences

A summary of the predicted impacts of subsidence on historical heritage sites is provided in Table 4.2.

Table 4.2 Historical heritage sites within LW W1-W2 Study Area and predicted probability of impact

Site name	Site type	Significance	Location in relation to LWs	Predicted probability of impact
Queen Victoria Memorial Hospital	Complex of built structures	Local	Goodlet House is approximately 320 m from LW W1.	Very unlikely
Mill Hill, Miller's House and archaeological relics	Built structures and archaeological relics	Local	230 m from LW W1.	Unlikely
Harmony House archaeological site	Archaeological relics	Local	Location of archaeological relics are approximately 300 m south of LW W1.	Very unlikely
Rural Landscape – Thirlmere Way	Landscape	Local	Partly above the southern end of LW W1.	Unlikely
Brick culvert 87.630	Built structure	Local	270 m east of LW W2.	Unlikely
Brick culvert 87.850	Built structure	Local	70 m east of LW W2.	Unlikely
Sandstone culvert 88.400	Built structure	Local	Directly above LW W1.	Possible
Sandstone culvert 88.980	Built structure	Local	60 m west of LW W1.	Unlikely
Sandstone culvert 89.629	Built structure	Local	250 m west of LW W1	Unlikely

4.3 Historical heritage sites within the 600 m buffer

There are two historical heritage sites outside the Study Area but within the 600 m longwall buffer of the extents of LW W1–W2: the brick arch Picton Rail Tunnel and the stone arch Mushroom Tunnel.

The potential for impacts on the tunnels does not result from absolute far-field horizontal movements, but rather from differential horizontal movements over the lengths of the structures. The potential for differential horizontal movements at the Picton Rail and Mushroom Tunnels has been assessed by MSEC by statistically analysing the available 3D monitoring data from the Southern Coalfield.

The Picton Rail Tunnel and Mushroom Tunnel are predicted to experience negligible vertical subsidence. However, the tunnels could experience small far-field horizontal movements and could be sensitive to these movements. Incremental far-field horizontal movements of around 75 mm have been measured at distances of 800 m from previously extracted longwalls in the Southern Coalfield.

Tahmoor Coal is currently monitoring the position of the Picton Tunnel as part of its far field monitoring program, which is reviewed regularly. This will continue during the mining of LW W1–W2 (MSEC 2019).

The probability of subsidence impacts to the two brick culverts outside the Study Area but within the 600 m buffer is predicted by MSEC (2019) to be *unlikely*.

An assessment of potential impacts to historical heritage items within the 600 m buffer is provided in Table 4.3.

Table 4.3 Historical heritage Items within the 600 m buffer

Item	Listing	Address	Distance from LW	MSEC Predictions / impact assessment
Mushroom Tunnel (former Mainline Railway Tunnel)	WLEP 2011 (I144)	229 Argyle St, Picton	750 m east of LW W2	Negligible vertical subsidence. Could experience small far-field horizontal movements.
Picton Tunnel – part of the Picton Railway Station Group	WLEP 2011 (I181)	Main Southern Railway, Picton	825 m east of LW W2	Negligible vertical subsidence. Could experience small far-field horizontal movements.
Brick culvert 87.300	Not listed	Mittagong Picton Loop Line	160 m east of LW W2	Unlikely
Brick culvert 87.330	Not listed	Mittagong Picton Loop Line	550 m east of LW W2	Unlikely

5 Subsidence Monitoring program

5.1 Performance measures and indicators

Performance measures for heritage are provided in Table 1 of Condition 13A of DA 67/98 and summarised in relation to historical heritage sites in Table 5.1.

For the purpose of this HHTR, negligible as referred to in this section is defined as being so small and insignificant as to not be worth considering. Based on the predicted subsidence impacts (MSEC 2019) the performance measures (negligible subsidence impacts) for the listed historical heritage sites within the Study Area will be achieved. One of unlisted heritage sites, the sandstone culverts (chainage 88.400) is at possible risk of subsidence impacts, however, with appropriate mitigation measures, negligible loss of heritage values will be achieved.

Table 5.1 Historical heritage subsidence performance measures and performance indicators

Historical sites	Subsidence performance measures	Probability of subsidence impact	Performance indicators
Queen Victoria Memorial Hospital	Negligible subsidence impacts or environmental consequences Negligible loss of heritage value	Very unlikely	This performance indicator will be considered to be triggered if: <ul style="list-style-type: none"> subsidence monitoring identifies cracking of external brick work or other physical impacts to the historical heritage values of the building, measurable tilt and internal damage, or cracks in foundations.
Mill Hill, Miller’s House and archaeological relics	Negligible subsidence impacts or environmental consequences Negligible loss of heritage value	Unlikely	This performance indicator will be considered to be triggered if: <ul style="list-style-type: none"> subsidence monitoring identifies damage to external cladding or internal finishes.
Harmony House archaeological site	Negligible subsidence impacts or environmental consequences Negligible loss of heritage value	Very unlikely	No performance indicators are currently established as impacts are predicted to be negligible. However, if the pre-mining assessment identifies that the cistern is located within the Study Area, this will need to be re-evaluated.
Rural landscape – Thirlmere Way	Negligible subsidence impacts or environmental consequences Negligible loss of heritage value	Unlikely	No performance indicators are currently established as impacts are predicted to be negligible.
Sandstone culverts	Negligible subsidence impacts or environmental consequences	Impacts to the culvert at chainage 88.400 is possible Impacts to the other culverts is unlikely.	This performance indicator will be considered to be triggered if: <ul style="list-style-type: none"> subsidence monitoring identifies visible perceptible impacts such as subsidence induced cracking, exfoliation, block movement or block fall.
Brick culverts	Negligible subsidence impacts or environmental consequences	Unlikely	This performance indicator will be considered to be triggered if: <ul style="list-style-type: none"> subsidence monitoring identifies visible perceptible impacts such as subsidence induced cracking, exfoliation, brick movement or brick fall.

A monitoring program will be implemented to confirm if impacts remain within predictions and identify any management or mitigation measures as required. To establish compliance with the performance measures, a TARP has been developed (Appendix A) outlining adaptive management where monitoring indicates that any performance measures have been exceeded or if exceedance seems likely.

5.2 Subsidence monitoring program

While the extraction of LW W1–W2 may potentially result in impacts on the culverts, these can be managed through early detection via monitoring and early response through the implementation of the TARP (Appendix A).

An ongoing monitoring program will be implemented to monitor the impacts and consequences of subsidence effects during extraction of LW W1–W2 on known historical heritage sites within the Study Area. The monitoring program will record the condition of the relevant sites before mining (baseline recording and baseline check) and the condition of the relevant sites after mining (post mining initial condition and post mining secondary condition check).

Monitoring will be implemented for any additional historical heritage sites identified prior to or during extraction of LW W1–W2, which are determined to be at risk of subsidence impacts. Assessment and monitoring measures will be developed in consultation with a heritage consultant or archaeologist.

Each monitoring component is further outlined in the following sections.

Table 5.2 Monitoring program for historical heritage

Item	Monitoring component	Monitoring		
		Prior to extraction	During extraction	Post mining
Queen Victoria Memorial Hospital	Visual inspection. Survey control points	Pre-mining condition and structural assessment as per the QVMH management plan with attention to period specific decorative features.	Regular monitoring as per the QVMH management plan.	Conducted at the completion of LW W2: <ul style="list-style-type: none"> • visual inspection; and • assessment as per the QVMH management plan.
Mill Hill, Miller’s House and archaeological relics	Visual inspection	Pre-mining condition and structural assessment as per the Mill Hill management plan.	Regular monitoring as per the Mill Hill management plan.	Conducted at the completion of LW W2: <ul style="list-style-type: none"> • visual inspection; and • assessment as per the Mill Hill management plan.
Harmony House archaeological site	No monitoring is required	NA ¹	NA ¹	NA ¹
Rural Landscape - Thirlmere	No monitoring is required	NA ¹	NA ¹	NA ¹

Table 5.2 Monitoring program for historical heritage

Item	Monitoring component	Monitoring		
		Prior to extraction	During extraction	Post mining
Loop Line sandstone culverts	Visual inspection. Baseline recording: <ul style="list-style-type: none"> • photographs; • annotated drawings; and • survey control points. Structural assessment of culverts, with particular attention given to 89.629 and 88.980.	Weeds and vegetation cleared from around culverts. Baseline recording of the site before mining, noting any existing cracks or damage. Install a monitoring system, which will monitor ground movements on and around the culverts.	Monthly visual inspection by Tahmoor Coal during the period of active subsidence for each longwall.	Visual inspection conducted by a heritage specialist at the completion of each longwall.
Loop Line brick culverts	Visual inspection. Baseline recording: <ul style="list-style-type: none"> • photographs; • annotated drawings; and • survey control points. 	Weeds and vegetation cleared from around culverts. Baseline recording of the site before mining, noting any existing cracks or damage. Install a monitoring system, which will monitor ground movements on and around the culverts.	Monthly visual inspection by Tahmoor Coal during the period of active subsidence for each longwall.	Visual inspection conducted by a heritage specialist at the completion of each longwall.

1 N/A indicates that no monitoring is required.

5.2.1 Visual inspection

i Queen Victoria Memorial Hospital

The QVMH site was inspected and recorded by Niche (2014) and an agreed risk management plan was developed to manage potential impacts to the QVMH property during the mining of LW 30–32 (directly to the south of LW W1–W2) (MSEC 2017). This management plan will be reviewed and updated in order for continuation of this monitoring by Tahmoor Coal and QVMH.

Visual inspections of this site will be undertaken in accordance with the current management plan (MSEC 2017) and if issues are noted, Tahmoor Coal will be notified for further action.

If historical heritage issues are identified during routine monitoring of the QVMH site, the TARP will be put into action and mitigation measures as outlined in the QVMH management plan (MSEC 2017; section 4) put in place.

ii Mill Hill site

The Mill Hill, Millers House and Archaeological Relics site was assessed by Niche (2014) and a management plan developed to manage potential impacts to the Mill Hill site during the mining of LW 31–32 (MSEC 2018). Baseline photographic survey of the site was completed as part of the inspections carried out for the structural and heritage assessments (JMA 2018 and Niche 2018). This management plan will be reviewed and updated in order for continuation of this monitoring by Tahmoor Coal

As mine subsidence movements will develop gradually, with regular monitoring the development of irregular or adverse mine subsidence movements will be observed. The management plan prepared by MSEC (2018) will be updated specifically for LW W1-W2, and where mine subsidence events are noted, management measures or repairs will be developed in consultation with the owner of the property (MSEC 2018; p.23).

iii Harmony House archaeological site

The archaeological relics of Harmony House archaeological site are located outside the Study Area and risk to these relics is deemed to be negligible. Therefore, no monitoring is required.

iv Rural landscape – Thirlmere Way

The rural landscape – Thirlmere Way was assessed by Niche (2014) and, as subsidence impacts were deemed unlikely, no management measures were recommended during the mining of LW 31–32. Similarly, the risk of impact from the extraction of LW W1-W2 is deemed to be negligible to the heritage value of this rural landscape. Therefore, no monitoring is required.

v Loop Line culverts

The sandstone and brick culverts will be cleared of vegetation and debris prior to mining and weeds removed carefully where roots are growing out of the structure. The culverts will then be reinspected, photographed and recorded in accordance with the measures set out in Table 5.2.

5.2.2 Structural assessment – Loop Line culverts

Careful structural assessment by an engineer is required for all of the culverts. Culvert 88.400 is considered to be more vulnerable to impacts because of its location directly above LW W1 while three culverts have specific pre-existing issues that need to be addressed.

i Culvert 88.400

This culvert is predicted by MSEC to be at possible risk of subsidence impacts. It is currently infested with weeds (Plate 3.1) and it is recommended that a comprehensive structural assessment be conducted and a plan developed for possible mitigation stabilisation works. Any structural reinforcement or stabilisation installed prior to the commencement of mining should avoid damaging the fabric of the culvert or compromising its historical heritage values.

ii Culvert 89.629

The headwalls of culvert 89.629 (Plate 3.5) may need to be reinforced prior to mining or subsequently repaired as required.

iii Culvert 88.980

Culvert 88.980 (Plate 3.3) is in poorer condition than the other sandstone culverts due to previous attempts at restoration including the application of paint which has resulted in increased exfoliation of the sandstone (Plate 3.3). In addition, JMA Solutions (2019) noted the severe loss of wall thickness in some blocks along the roof of the culvert, most likely caused by salt-laden groundwater permeating through the barrel of the culvert. This has resulted in expansive salt crystallization within the surface stone and subsequent exfoliation. This culvert will need an assessment by a structural engineer prior to the commencement of mining and monitoring during mining.

iv Culvert 87.300

Culvert 87.300 is (Plate 3.4) is located outside the Study Area and is considered to be at low risk of impact from longwall mining of LW W1-W2. Nevertheless, cracking of the fabric on the north entrance to the culvert is not only along the mortar between the bricks but also through some of the bricks themselves and will need to be monitored and potentially reinforced (see section 6.2.2).

5.2.3 Baseline recording – Loop Line culverts

Baseline recording of the culverts will be carried out prior to the commencement of mining in order to assist with ongoing monitoring and assessment of whether impacts from mining have occurred. This will be achieved through survey control points. A final assessment and recording will be completed at the completion of subsidence.

The results of the baseline recording will be used for comparisons to determine any impact from mining. To this end, the baseline recording will:

- assess the structure's pre-mining condition;
- mitigate the risk of potential impact through more detailed archival recording; and
- provide a set of baseline records for the monitoring program.

i Photography

Photographs will be taken with the appropriate scale and will include:

- the wider context of the site, showing the landscape and setting at long range and medium scales;
- details of the structure's features; and
- close up photographs of pre-existing cracks and damage, and their location noted on the plan drawings.

ii Annotated plans

Sketched plans of each culvert will be used to mark the position of pre-existing cracks, joints and areas of seepage prior to the commencement of mining extraction and to provide a cross reference for the photographs.

5.2.4 Survey control points

i QVMH

Prior to the mining of Longwall 30, survey pegs were installed around the main three-story buildings and throughout the complex in order to track the development of subsidence, if any.

Building V04ag to the east of Goodlet House will need survey pegs installed.

These survey pegs will continue to provide information for monitoring of the QVMH buildings within the Study Area during the extraction of LW W1-W2.

ii Mill Hill

Survey points were installed around Miller's House prior to the extraction of LW31 and LW32. These survey pegs will continue to provide information for monitoring of the Miller's House during the extraction of LW W1-W2. Ongoing monitoring will continue as per the updated management plan for Mill Hill for the extraction of LW W1-W2 (MSEC 2018).

iii Loop Line culverts

A surveyor will be appointed by Tahmoor Coal to record survey control points on each of the Loop Line culverts. The number and location of the survey points will provide sufficient points of reference to later monitor the extent and effects of subsidence.

6 Subsidence Management Strategies

6.1 Adaptive management

A TARP has been developed using the performance indicators for management of historical heritage items (Appendix A). The TARP applies only to the Extraction Plan Study Area for LW W1–W2.

The TARP outlines the assigned level of risk for each performance indicator:

- Level 1: Normal;
- Level 2: Within Prediction; and
- Level 3: Exceeds Prediction.

Where performance indicators trigger a level of risk (Levels 1 to 3 with escalating corresponding risk), a response, or a contingency plan that outlines the adaptive management measures for each level of risk, is required as outlined in the TARP.

In the event of any exceedance of performance indicators, Tahmoor Coal will, at the earliest opportunity:

- investigate to determine if the exceedance is related to non-mining factors or is a consequence of mining activities;
- take all reasonable steps to ensure that the exceedance ceases and does not reoccur;
- consider all reasonable and feasible options for remediation (where relevant);
- submit a report to the relevant Government authority describing those options and any preferred remediation measures or other course of action; and
- implement remediation measures.

6.2 Remediation measures

6.2.1 Impacts generally

If an impact to a historical heritage item occurs, the type of remediation that is undertaken will be dependent on:

- the nature of the damage;
- the scale of the damage;
- the impact on the historical heritage values of the site; and
- expert advice regarding practical and historically sympathetic remediation measures.

Therefore, remediation measures, if needed, will be assessed on a case by case basis in the light of these considerations in order to ensure that performance measures are met and that there are no negative outcomes to historical heritage values.

6.2.2 Specific remediation measures for the culverts

If needed, management strategies for the culverts will be put in place to maintain their integrity during active subsidence, or to remediate them after the completion of active subsidence. The following measures have been employed to reinforce other culverts above longwall mining domains and could be considered, if needed, in consultation with a structural engineer with historical heritage experience:

- installation of steel reinforcement structures within the culvert opening;
- installation of steel reinforcement within the masonry itself; or
- installation of a sleeve within the culvert opening.

MSEC (2019) advised that that potential impacts on the Loop Line culverts can be managed during the extraction of LW W1–W2 with an appropriate management plan in place, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur (MSEC 2019; p85-6).

6.3 Trigger Action Response Plan

The TARP (Appendix A) provides a description of performance indicators to be implemented to ensure compliance with negligible subsidence impacts or environmental consequences to sites of historical heritage and considers the management or remediation of any impacts and/or environmental consequences relating to historical heritage sites.

The purpose of the TARP is to provide:

- appropriate triggers to warn of increased risk of exceedance of any performance measures;
- specific actions to respond to high risk exceedance of any performance measure to ensure that the measure is not exceeded;
- an assessment of remediation measures that may be required if exceedances occur and the capacity to implement the measures; and
- adaptive management where monitoring indicates that there has been an exceedance of any performance measure, or where any such exceedance appears likely.

6.4 Unexpected finds procedures

Additional historical heritage assessments are not recommended at this point as impacts are not anticipated to historical heritage items in the vicinity. Due to the nature of the extraction activities, it is unlikely relics will be uncovered however, if they are, the following steps will be taken:

- no further harm to the object;
- immediately cease all work at the particular location;
- secure the area so as to avoid further harm to the relic; and
- contact an archaeologist for further information and advice.

In the event that known or suspected human skeletal remains are encountered within the Study Area, refer to the procedure outlined in the Aboriginal Heritage Technical Report, Section 6.3.3.

7 Review and improvement

7.1 Overview

This section of the HHTR describes the key elements of implementation, including reporting requirements, reviews and key responsibilities specifically relevant to this Historical Heritage Technical Report.

Further details of the general reporting and review requirements, and key responsibilities are provided in Section 6 of the Extraction Plan main document.

7.1.1 Reporting requirements

In accordance with DA 67/98 Condition 48 or as triggered by the TARP, if an incident occurs relating to heritage material whereby performance measures are exceeded and harm to historical heritage is threatened or caused, a letter report will be issued within one week of the event, notifying DPE, Wollondilly Shire Council, the Heritage Division of OEH and any other relevant agencies.

The detailed report that will be provided to DPE will be sent within seven days of the incident including details of the actions being undertaken to prevent recurrence.

7.2 Review and auditing

Any additional historical heritage sites identified during extraction of LW W1–W2, which are determined to be at risk of subsidence impact, will also need to be monitored. Assessment and monitoring measures will be developed in consultation with a heritage consultant or archaeologist and this HHTR updated accordingly.

Where new historical heritage sites are discovered, they must be added to the inventory in this HHTR within three months of the find, including an assessment of potential impacts from subsidence.

Any changes made to this HHTR will be made in consultation with the DPE, and a copy of the revised management plan will be supplied to the Secretary of the DPE for approval.

Abbreviations

Abbreviation

CHL	Commonwealth Heritage List
DCP	Development control plan
DoP	Department of Planning
DPE	Department of Planning and Environment
EIS	Environmental Impact Statement
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
EP&A Act	<i>NSW Environmental Planning and Assessment Act 1979</i>
HHTR	Historical Heritage Technical Report
LEP	Local Environment Plan
LW	longwalls
MSEC	Mining Subsidence Engineering Consultants
Niche	Niche Environment and Heritage
NHL	National Heritage List
NPW Act	National Parks and Wildlife Act 1974
OEH	Office of Environment and Heritage
SHR	State Heritage Register
SIMEC	SIMEC Mining Division
SMP	Subsidence Management Plan
TCCO	Tahmoor Coking Coal Operations
TARP	Trigger Action Response Plan
WLEP	Wollondilly Local Environment Plan
WSC	Wollondilly Shire Council

Glossary

Term	Definition
35-degree angle of draw	Used to define the limits of the subsidence trough. It is the angle between two lines drawn from the edge of the mine workings, one a vertical line and the other a line to the limit of vertical displacement.
20 mm subsidence contour	A limiting value for vertical displacement which is attributable to mining
Closure	The reduction in the horizontal distance between the valley sides. The magnitude of closure, which is typically expressed in the units of millimetres (mm), is the greatest reduction in distance between any two points on the opposing valley sides.
Curvature	The rate of change of tilt and is calculated as the change in tilt between two adjacent sections of the tilt profile divided by the average length of those sections.
Far field movements	The measured horizontal movements at pegs that are located beyond the longwall panel edges and over solid unmined coal areas.
Riparian zone	Area of land adjacent to a river or stream
Strain	Determined by calculating the horizontal change in length of a section of subsidence profile and dividing this by the initial horizontal length of the section. It includes both tensile strains over the sides of the panel and compressive strains towards the bottom of the subsidence trough.
Study Area	Surface area enclosed by a 35-degree angle of draw from the limit of the proposed longwall mining extension (LW W1–W2) and by the predicted 20 mm subsidence contour resulting from the extraction of the proposed longwalls (MSEC, 2019 in draft). The Study Area is shown in Figure 1.1
Subsidence	Deformation of the ground mass surrounding a mine due to the mining activity, including all mining-induced ground movements, vertical and horizontal displacement, tilt, strain and curvature.
Tilt	Calculated as the change in subsidence between two points divided by the distance between those points. The maximum tilt occurs at the point of inflection in the subsidence trough where the subsidence is roughly equal to one half of the predicted maximum subsidence.
Upsidence	Mining-induced relative upward vertical displacement of the ground surface or subsurface strata, generally observable at the bottom of valleys.

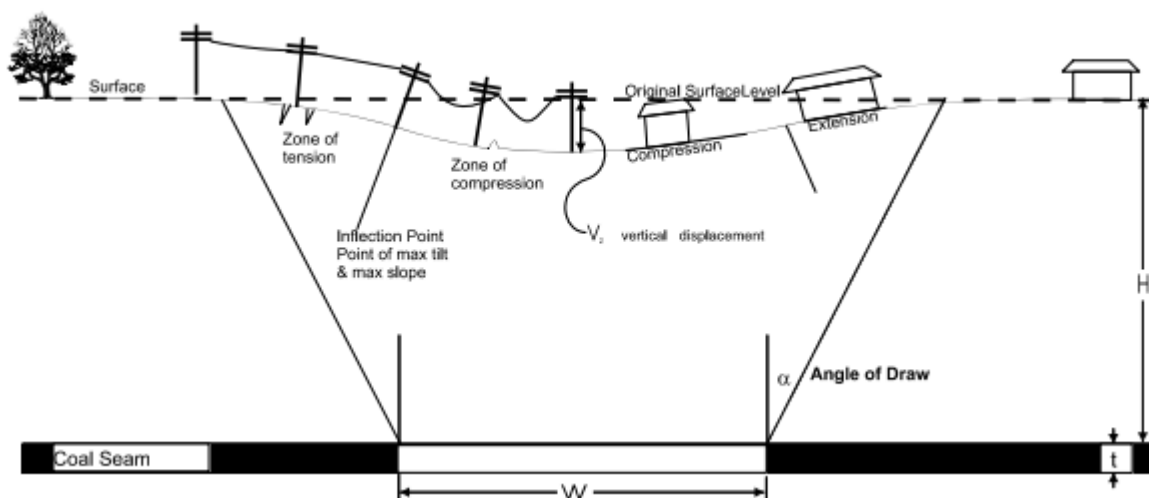


Plate 7.1 Angle of draw and surface subsidence in flat topography (NSW DoP 2008 p.48)

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Appendix A

Trigger Action Response Plan

A.1 Trigger Action Response Plan

Feature	Management	
	Trigger	Action
Historical heritage (Culverts only. For QVMH and Mill Hill refer to the QVMH and Mill Hill Management Plans prepared for LW W1-W2)	Normal	<ul style="list-style-type: none"> Historical heritage site monitoring indicates no detectable environmental consequences Continue monitoring and management of sites in accordance with Section 5 of this HHTR.
	Within Prediction	<ul style="list-style-type: none"> Historical heritage site monitoring indicates no detectable environmental consequences Continue monitoring and management of sites in accordance with Section 5 of this HHTR.
	Exceeds Prediction	<ul style="list-style-type: none"> Historical heritage site monitoring indicates environmental consequences to heritage site(s). Convene Tahmoor Coal Environmental Response Group to review response. Co-ordinate a site inspection with a structural engineer and qualified archaeologist or heritage architect. Notify DPE and OEH within one week of the event. Investigate exceedance of subsidence prediction. Continue monitoring and management of sites in accordance with this HHTR (Section 5 and 6). Investigate and implement any additional management measures (section 6) as required in consultation with OEH and DPE. Review mine design/predictions against mine criteria. Review monitoring program and modify if necessary.



