msec mine subsidence ENGINEERING CONSULTANTS

SIMEC

SIMEC Mining:

Tahmoor North Western Domain Longwalls West 3 and West 4

Management Plan for Potential Impacts to Wollondilly Shire Council Infrastructure

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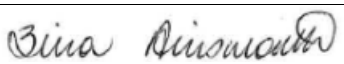
Signature:	
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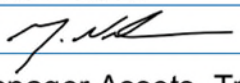
Signature:	
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DOCUMENT REGISTER

Date	Report No.	Rev	Comments
Aug-21	MSEC1173-02	A	Draft for submission to Wollondilly Shire Council
Sep-21	MSEC1173-02	B	Final following consultation with Wollondilly Shire Council

References:-

	AS/NZS ISO 31000:2009 Risk Management – Principles and guidelines
GHD Geotechnics (2017)	Glencore – Tahmoor Underground – Landslide risk assessment for identified "steep slopes" – Properties affected by retreat of LW31, GHD Geotechnics, July 2017.
MSO (2017)	Managing risks of subsidence – Guide | WHS (Mines and Petroleum Sites) Legislation, NSW Department of Planning & Environment, Resources Regulator, Mine Safety Operations, February 2017.
MSEC (2021)	Tahmoor Coal - Longwalls W3 and W4 - Subsidence Predictions and Impact Assessments for Natural and Built Features due to the extraction of the proposed Longwalls W3 and W4 in support of the Extraction Plan Application. (Report No. MSEC1112, Revision A, March 2021), prepared by Mine Subsidence Engineering Consultants.
Traffic Professionals (2018)	Traffic management plans for Tahmoor Coal near 700 Thirlmere Way, Picton.
Tahmoor Coal (2020)	Risk Assessment Report – Infrastructure. Tahmoor North – Western Domain, Longwalls West 3 and West 4, September 2020.

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LIST OF TABLES AND FIGURES

Tables

Tables are prefaced by the number of the chapter in which they are presented.

Figures

Figures are prefaced by the number of the chapter or the letter of the appendix in which they are presented.

Drawings

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

Drawing No.	***Description***	***Revision***
MSEC1173-00-01	Monitoring plan	02
MSEC1173-00-02	Far field monitoring	02
MSEC1173-02-01	Local roads, culverts and bridges	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. Tahmoor Coal has previously mined 34 longwalls to the north and west of the mine's current location.

Longwalls West 1 and West 2 (LW W1-W2) were the first two longwalls to be mined in the Western Domain, located northwest of the Main Southern Railway, and between the townships of Thirlmere and Picton. LW W1 and LW W2 have completed extraction.

Longwalls West 3 and West 4 (LW W3-W4) are the final two longwalls to be mined in the Western Domain. Infrastructure owned by Wollondilly Shire Council is located within this area.

A summary of the dimensions of LW W3-W4 are provided in Table 1.1.

Table 1.1 Longwall dimensions

Longwall	Overall void length including the installation heading (m)	Overall void width including the first workings (m)	Overall tailgate chain pillar width (m)
LW W3	1552	283	39
LW W4	1004	285	44

This Management Plan provides detailed information about how the risks associated with mining beneath the infrastructure will be managed by Tahmoor Coal and Wollondilly Shire Council.

The Management Plan is a live document that can be amended at any stage of mining, to meet the changing needs of Tahmoor Coal and Wollondilly Shire Council.

1.2. Wollondilly Shire Council assets potentially affected by LW W3-W4

A map showing the locations of Wollondilly Shire Council infrastructure in relation to LW W3-W4 is shown in Drawing No. MSEC1173-02-01. The proposed longwalls do not mine directly beneath local roads.

The main road within the Study Area is Thirlmere Way which connects Thirlmere and Picton. It crosses directly above the finishing ends of the previously extracted LW 32 and LW W1. It will not be directly mined beneath by the proposed longwalls. The total length of Thirlmere Way located within the Study Area is 0.93 km.

The local roads within the Study Area include Stonequarry Creek Road, Booyong Close, and Attunga Close, which are located within the Stonequarry Estate and partially above the southern end of LW W1. Rumker Street, Connellan Crescent and Star Street are located adjacent to LW W4. Barkers Lodge Road is located outside the mining area to the north of the proposed longwalls.

There are no bridges within the vicinity of LW W3-W4, though several bridges are predicted to experience far field movements during the mining of LW W3-W4. The majority of the bridges cross the Main Southern Railway. Risk control measures to manage potential impacts on this bridge are described in a separate management plan for the Main Southern Railway, which will be developed in consultation with the Australian Rail Track Corporation (ARTC). A copy of that management plan can be provided to Wollondilly Shire Council.

There are several road drainage culverts located in the vicinity of LW W3-W4. The culverts comprise concrete pipes with diameters ranging between 600 mm and 900 mm. Two culverts are located to the east of LW W4, one on Rumker Street and the other on Connellan Crescent. Two culverts are located on Stonequarry Creek Road directly above the previously extracted LW W1.

1.3. Consultation

1.3.1. Consultation with Wollondilly Shire Council

Tahmoor Coal regularly consults with Wollondilly Shire Council in relation to mine subsidence effects. This includes consultation during the development of subsidence management plans for previous Longwalls 22 to 32 and LW W1-W2, and regular reporting of subsidence movements and impacts.

Feedback was provided by Wollondilly Shire Council in relation to identification of Council owned buildings and preparation of a traffic management plan for Thirlmere Way, which was submitted to Council prior to the installation of survey marks and prior to influence of Longwall 31.

Wollondilly Shire Council has provided feedback prior to the commencement of LW W3. The Management Plan has been amended to include the commitment to apply and obtain an approved Road Occupancy Permit for any work within the road reserve, including survey.

Tahmoor Coal will continue to consult regularly with Wollondilly Shire Council during the extraction of LW W3-W4 in relation to mine subsidence effects from mining.

1.3.2. Consultation with Government Agencies & Key Infrastructure Stakeholders

Government agencies including the NSW Department of Planning & Environment, Resources Regulator, Mine Safety Operations, Subsidence Advisory NSW and key infrastructure stakeholders including Endeavour Energy, Sydney Water, Telstra and Jemena have also been consulted as part of the Extraction Plan approval process.

1.4. Limitations

This Management Plan is based on the predictions of the effects of mining on surface infrastructure as provided in Report No. MSEC1112 by Mine Subsidence Engineering Consultants (MSEC, 2021). Predictions are based on the planned configuration of LW W3-W4 at Tahmoor (as shown in Drawing No. MSEC1173-02-01), along with available geological information and data from numerous subsidence studies for longwalls previously mined in the area.

Infrastructure considered in this Plan has been identified from site visits and aerial photographs and from discussions between Tahmoor Coal representatives and Wollondilly Shire Council.

The impacts of mining on surface and sub-surface features have been assessed in detail. However, it is recognised that the prediction and assessment of subsidence can be relied upon only to a certain extent. The limitations of the prediction and assessment of mine subsidence are discussed in report MSEC1173 by Mine Subsidence Engineering Consultants.

As discussed in the report, there is a low probability that ground movements and their impacts could exceed the predictions and assessments. However, if these potentially higher impacts are considered prior to mining, they can be managed. This Management Plan will not necessarily prevent impacts from longwall mining, but will limit the impacts by establishing appropriate procedures that can be followed should evidence of increased impacts emerge.

1.5. Objectives

The objectives of this Management Plan are to establish procedures to measure, control, mitigate and repair potential impacts that might occur to roads, bridges and culverts.

The objectives of the Management Plan have been developed to:

- Ensure the safe and serviceable operation of all surface infrastructure. Public and workplace safety is paramount. Ensure that the health and safety of people who may be present on public property or Wollondilly Shire Council property are not put at risk due to mine subsidence;
- Avoid disruption and inconvenience, or, if unavoidable, keep to minimal levels;
- Monitor ground movements and the condition of infrastructure during mining;
- Initiate action to mitigate or remedy potential significant impacts that are expected to occur on the surface;
- Provide a plan of action in the event that the impacts of mine subsidence are greater than those that are predicted;
- Establish a clearly defined decision-making process to ensure timely implementation of risk control measures for high consequence but low likelihood mine subsidence induced hazards that involve potential serious injury or illness to a person or persons that may require emergency evacuation, entry or access restriction or suspension of work activities;
- Provide a forum to report, discuss and record impacts to the surface. This will involve Tahmoor Coal, Wollondilly Shire Council, relevant government agencies as required, and consultants as required; and
- Establish lines of communication and emergency contacts.

1.6. Scope

The Management Plan is to be used to protect and monitor the condition of the Wollondilly Shire Council infrastructure identified to be at risk due to mine subsidence and to ensure that the health and safety of people who may be present on public property or Wollondilly Shire Council property are not put at risk due to mine subsidence. The major items at risk are:

- Local roads;
- Bridges; and
- Culverts.

The Management Plan only covers infrastructure that is located within the limit of subsidence, which defines the extent of land that may be affected by mine subsidence as a result of mining LW W3-W4 only. The management plan does not include other roads, bridges and culverts owned by Wollondilly Shire Council which lie outside the extent of this area.

1.7. Proposed mining schedule

It is planned that LW W3-W4 will extract coal working south from the northern end. This Management Plan covers longwall mining until completion of mining in LW W4 and for sufficient time thereafter to allow for completion of subsidence effects. The current schedule of mining is shown in Table 1.2.

Table 1.2 Schedule of Mining

Longwall	Start Date	Completion Date
LW W3	September 2021	March 2022
LW W4	April 2022	August 2022

Please note the above schedule is subject to change due to unforeseen impacts on mining progress. Tahmoor Coal will keep Wollondilly Shire Council informed of changes.

1.8. Definition of Active Subsidence Zone

As a longwall progresses, subsidence begins to develop at a point in front of the longwall face and continues to develop after the longwall passes. The majority of subsidence movement typically occurs within an area 150 metres in front of the longwall face to an area 450 metres behind the longwall face.

This is termed the “active subsidence zone” for the purposes of this Management Plan, where surface monitoring is generally conducted. The active subsidence zone for each longwall is defined by the area bounded by the predicted 20 mm subsidence contour for the active longwall and a distance of 150 metres in front and 450 metres behind the active longwall face, as shown by Fig. 1.1.

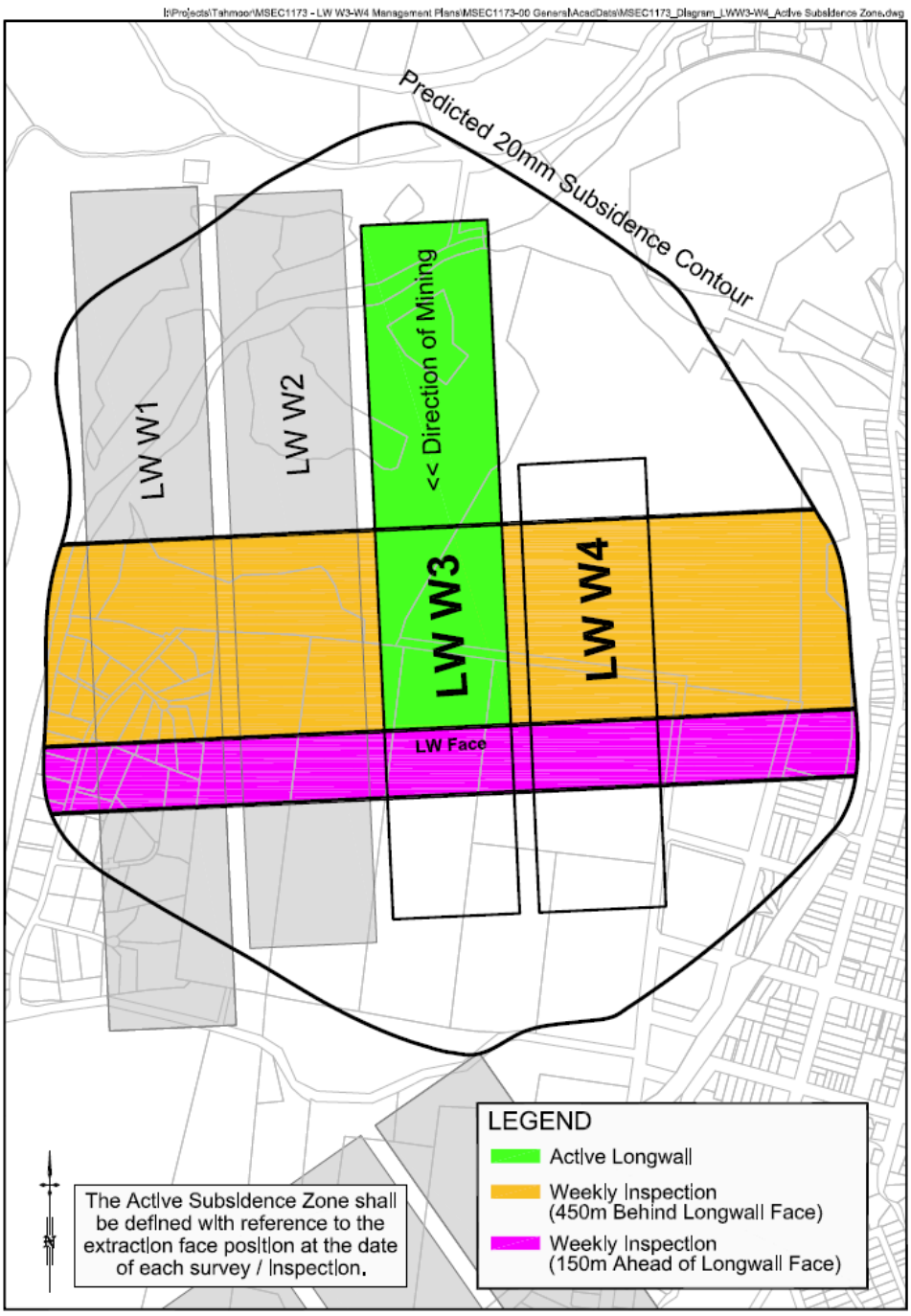

Fig. 1.1 Diagrammatic Representation of Active Subsidence Zone

1.9. Compensation

The *Coal Mine Subsidence Compensation Act 2017* (MSC Act) is administered by Subsidence Advisory NSW (Mine Subsidence Board).

Currently, under the *Coal Mine Subsidence Compensation Act 2017*, any claim for mine subsidence damage needs to be lodged with Subsidence Advisory NSW. Subsidence Advisory NSW staff will arrange for the damage to be assessed by an independent specialist assessor. If the damage is attributable to mine subsidence, a scope will be prepared and compensation will be determined. For further details please refer to *Guidelines – Process for Claiming Mine Subsidence Compensation* at www.subsideneadvisory.nsw.gov.au.

2.1. NSW Work Health & Safety Legislation

All persons conducting a business or undertaking (PCBUs), including mine operators and contractors, have a primary duty of care to ensure the health and safety of workers they engage, or whose work activities they influence or direct. The responsibilities are legislated in *Work Health and Safety Act 2011* and the *Work Health and Safety (Mines and Petroleum Sites) Act 2013* and associated Regulations (collectively referred to as the 'WHS laws').

The *Work Health and Safety (Mines and Petroleum Sites) Regulation 2014* commenced on 1 February 2015 and contains specific regulations in relation to mine subsidence.

As outlined in the Guide by the NSW Department of Trade & Investment Mine Safety:

"a PCBU must manage risks to health and safety associated with mining operations at the mine by:

- *complying with any specific requirements under the WHS laws*
- *identifying reasonably foreseeable hazards that could give rise to health and safety risks*
- *ensuring that a competent person assesses the risk*
- *eliminating risks to health and safety so far as is reasonably practicable*
- *minimising risks so far as is reasonably practicable by applying the hierarchy of control measures, any risks that it is are not reasonably practical to eliminate*
- *maintaining control measures*
- *reviewing control measures.*

The mine operator's responsibilities include developing and implementing a safety management system that is used as the primary means of ensuring, so far as is reasonably practicable:

- *the health and safety of workers at the mine, and*
- *that the health and safety of other people is not put at risk from the mine or work carried out as part of mining operations."*

Detailed guidelines have also been released by the NSW Department of Planning & Environment, Resources Regulator, Mine Safety Operations (MSO, 2017).

The risk management process has been carried out in accordance with guidelines published by the NSW Department of Planning & Environment, Resources Regulator, Mine Safety Operations (MSO, 2017). The following main steps of subsidence risk management have been and will be undertaken, in accordance with the guidelines.

1. identification and understanding of subsidence hazards
2. assessment of risks of subsidence
3. development and selection of risk control measures
4. implementation and maintenance of risk control measures, and
5. continual improvement and change management.

Each of the above steps have been or will be conducted together with the following processes.

1. consultation, co-operation and co-ordination, and
2. monitoring and review.

This Management Plan documents the risk control measures that are planned to manage risks to health and safety associated with the mining of LW W3-W4 in accordance with the WHS laws.

2.2. General

The method of assessing potential mine subsidence impacts in the Management Plan is consistent with the Australian/New Zealand Standard for Risk Management (AS/NZS ISO 31000:2009). The Standard defines the terms used in the risk management process, which includes the identification, analysis, assessment, treatment and monitoring of potential mine subsidence impacts. In this context:-

2.2.1. Consequence

'The outcome of an event expressed qualitatively or quantitatively, being a loss, injury, disadvantage or gain. There may be a range of possible outcomes associated with an event.' The consequences of a hazard are rated from negligible to catastrophic.

2.2.2. Likelihood

'Used as a qualitative description of probability or frequency.' The likelihood can range from rare to almost certain.

2.2.3. Hazard

'A source of potential harm or a situation with a potential to cause loss.'

2.2.4. Method of assessment of potential mine subsidence impacts

The method of assessing potential mine subsidence impacts combines the likelihood of an impact occurring with the consequence of the impact occurring. In this Management Plan, the likelihood and consequence are combined via the SIMEC Risk Matrix to determine an estimated level of risk for particular events or situations. A copy of the Risk Matrix is included in the Appendix of this Management Plan.

3.1. Maximum predicted conventional subsidence parameters

Predicted mining-induced conventional subsidence movements were provided in Report No. MSEC1112, which was prepared in support of Tahmoor Coal's Extraction Plan for LW W3-W4. A summary of the maximum predicted total subsidence parameters over the Study Area due to the extraction of LW W3-W4 are provided in Table 3.1.

Table 3.1 Maximum predicted conventional subsidence parameters for LW W3-W4

Longwall	Maximum predicted subsidence (mm)	Maximum predicted tilt (mm/m)	Maximum predicted hogging curvature (1/km)	Maximum predicted sagging curvature (1/km)
LW W3	950	5.0	0.06	0.10
LW W4	1025	5.0	0.06	0.10

The values provided in the above table are the maximum predicted conventional subsidence parameters which occur within the Study Area.

3.2. Comparison of measured and predicted subsidence for LW W1-W2

Predictions using MSEC's Incremental Profile Method have been continually tested and refined during the mining of previous Longwalls 22 to 32, as described in Report No. MSEC1112.

In this case, LW W1-W2 have been extracted in a new longwall series, which is located to the north of the completed LW 32.

LW W1

Observed subsidence above single panels is typically more variable than above subsequent longwall panels in a series. The variations are due to different strengths of the overburden strata above the panel, which is supported on all four sides of the longwall.

A study on observed subsidence above previously extracted single panels at Tahmoor Mine was conducted by MSEC, with results provided in Report No. MSEC1112.

Ground surveys during the mining of LW W1 have found that subsidence has been substantially less than predicted (approximately 50%). The experience is new for Tahmoor Mine but it has been previously observed for nearby longwalls at Appin Colliery, including LW901 and the southern section of LW703.

A comparison between measured and predicted profiles of vertical subsidence along the Picton-Mittagong Loop Line are provided in Fig. 3.1 after the extraction of LW W1.

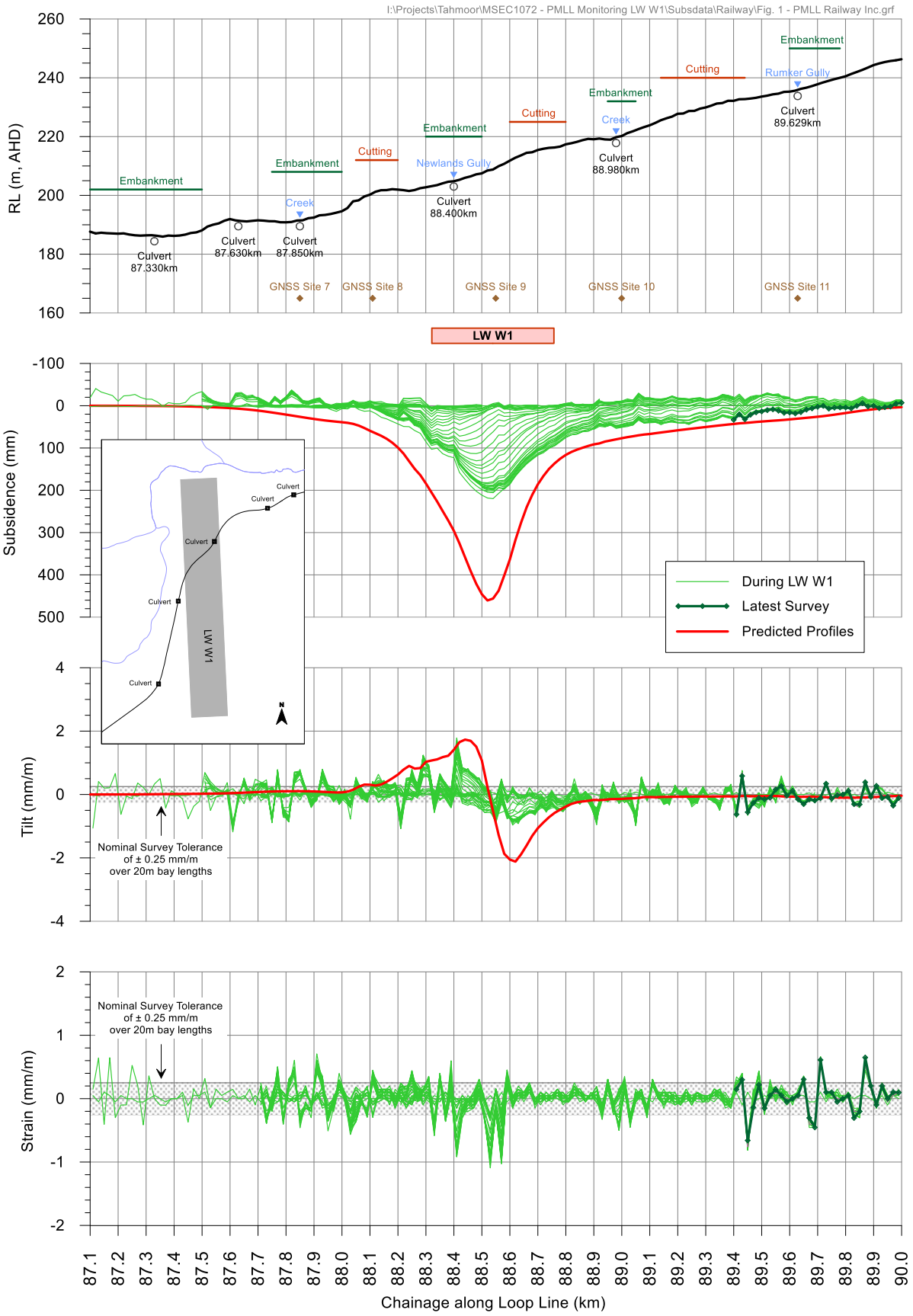

Fig. 3.1 Observed subsidence along Picton-Mittagong Loop Line during the mining of LW W1

LW W2

As of 1 June 2021, subsidence surveys above LW W2 have measured less subsidence than predicted. Observed subsidence along the Picton-Mittagong Loop Line after the extraction of LW W2 is shown in Fig. 3.2. Observed subsidence along the LW W1 W2 crossline after the extraction of LW W2 is shown in Fig. 3.3.

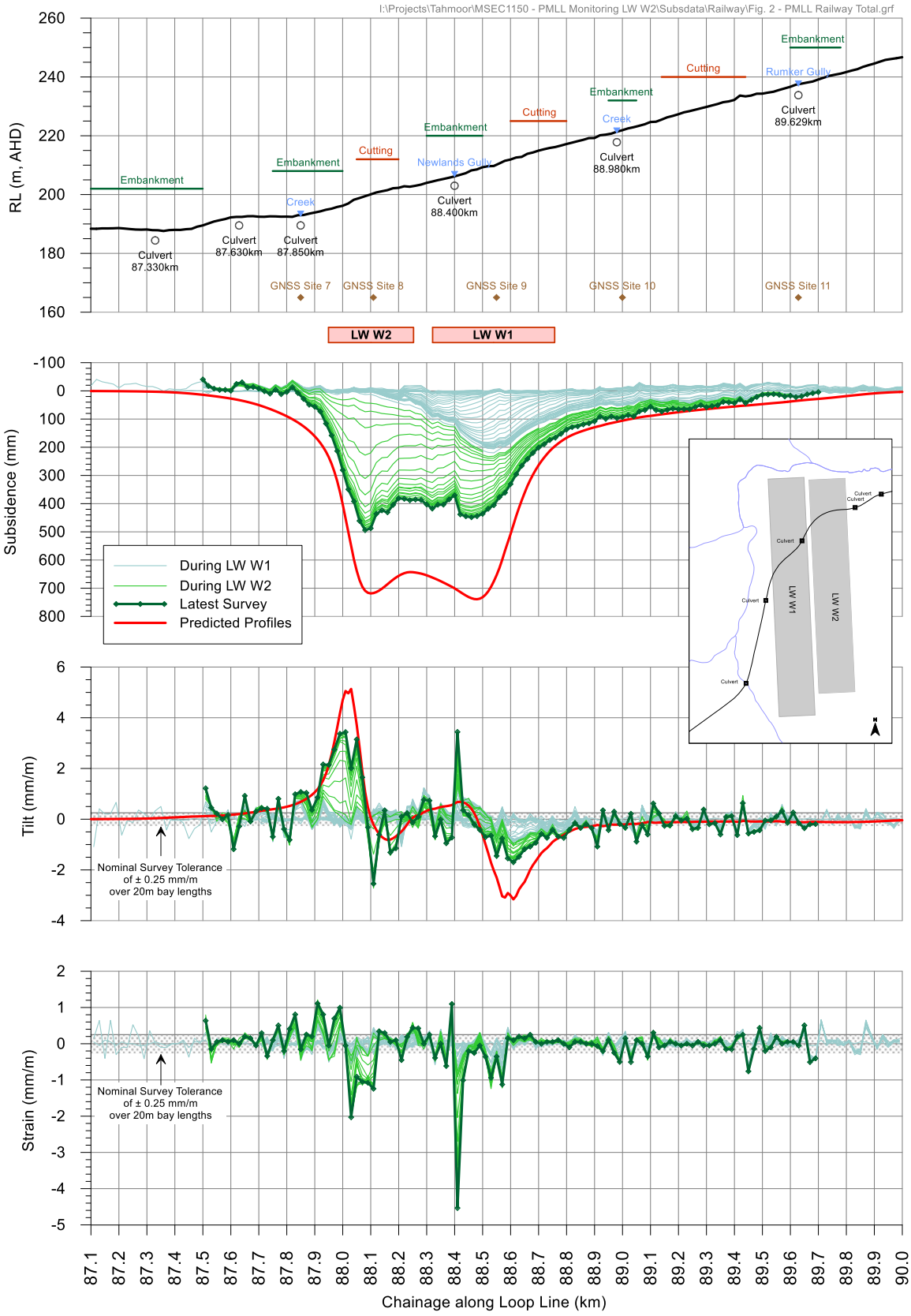

Fig. 3.2 Observed subsidence along Picton-Mittagong Loop Line during the mining of LW W1-W2

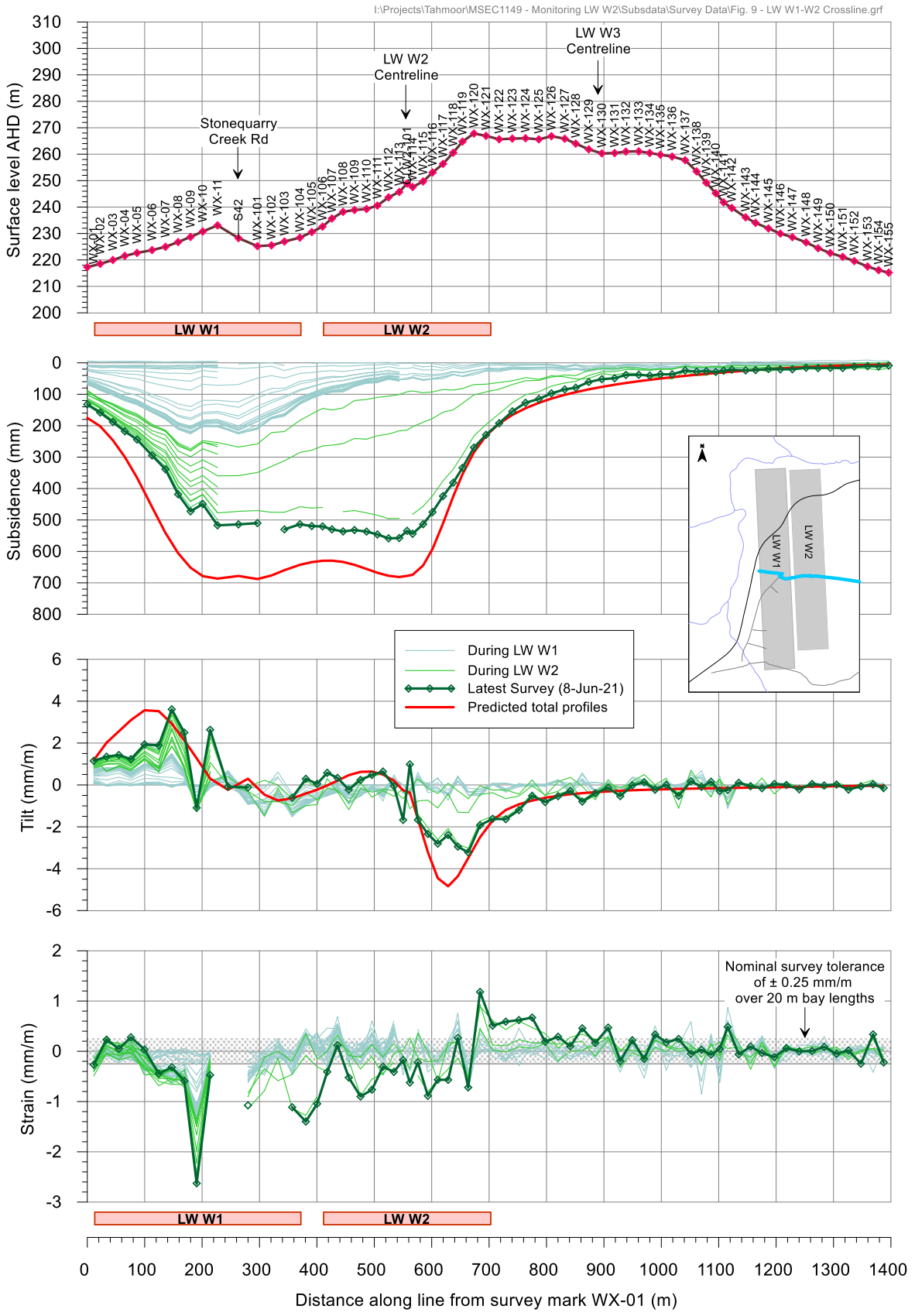

Fig. 3.3 Observed subsidence along LW W1-W2 crossline during the mining of LW W1-W2

Whilst observed subsidence above LW W1 and LW W2 was less than predicted, subsidence due to the extraction of LW W3-W4 may not follow the same pattern, and may return to normal levels. Subsidence may also be greater than predicted.

It is therefore planned to monitor the development of subsidence during the extraction of LW W3-W4 to compare observations with predictions. Measures have been developed in this Management Plan to manage potential impacts on the Stonequary Estate's sewer infrastructure, even when actual subsidence is substantially greater than the magnitudes that have been predicted above LW W3-W4.

3.3. Predicted strain

The prediction of strain is more difficult than the predictions of subsidence, tilt and curvature. The reason for this is that strain is affected by many factors, including ground curvature and horizontal movement, as well as local variations in the near surface geology, the locations of pre-existing natural joints at bedrock, and the depth of bedrock. Survey tolerance can also represent a substantial portion of the measured strain, in cases where the strains are of a low order of magnitude. The profiles of observed strain, therefore, can be irregular even when the profiles of observed subsidence, tilt and curvature are relatively smooth.

In previous MSEC subsidence reports, predictions of conventional strain were provided based on the best estimate of the average relationship between curvature and strain. Similar relationships have been proposed by other authors. The reliability of the strain predictions was highlighted in these reports, where it was stated that measured strains can vary considerably from the predicted conventional values.

Adopting a linear relationship between curvature and strain provides a reasonable prediction for the conventional tensile and compressive strains. The locations that are predicted to experience hogging or convex curvature are expected to be net tensile strain zones and locations that are predicted to experience sagging or concave curvature are expected to be net compressive strain zones. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional strains.

At a point, however, there can be considerable variation from the linear relationship, resulting from non-conventional movements or from the normal scatters which are observed in 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, we have provided a statistical approach to account for the variability, rather than providing a single predicted conventional strain.

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 effects, which are discussed separately in the impact assessments for the natural and built features provided in Chapters 5 and 6. The strains resulting from damaged or disturbed survey marks have also been excluded.

3.3.1. 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 Longwalls 22 to 32 and LW W1 at Tahmoor Mine, 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*".

A histogram of the maximum observed total tensile and compressive strains measured in survey bays above goaf at Tahmoor Mine is provided in Fig. 3.4. A number of probability distribution functions were fitted to the empirical data. It was found that a *Generalised Pareto Distribution (GPD)* provided a good fit to the raw strain data, and this is also shown in this figure.

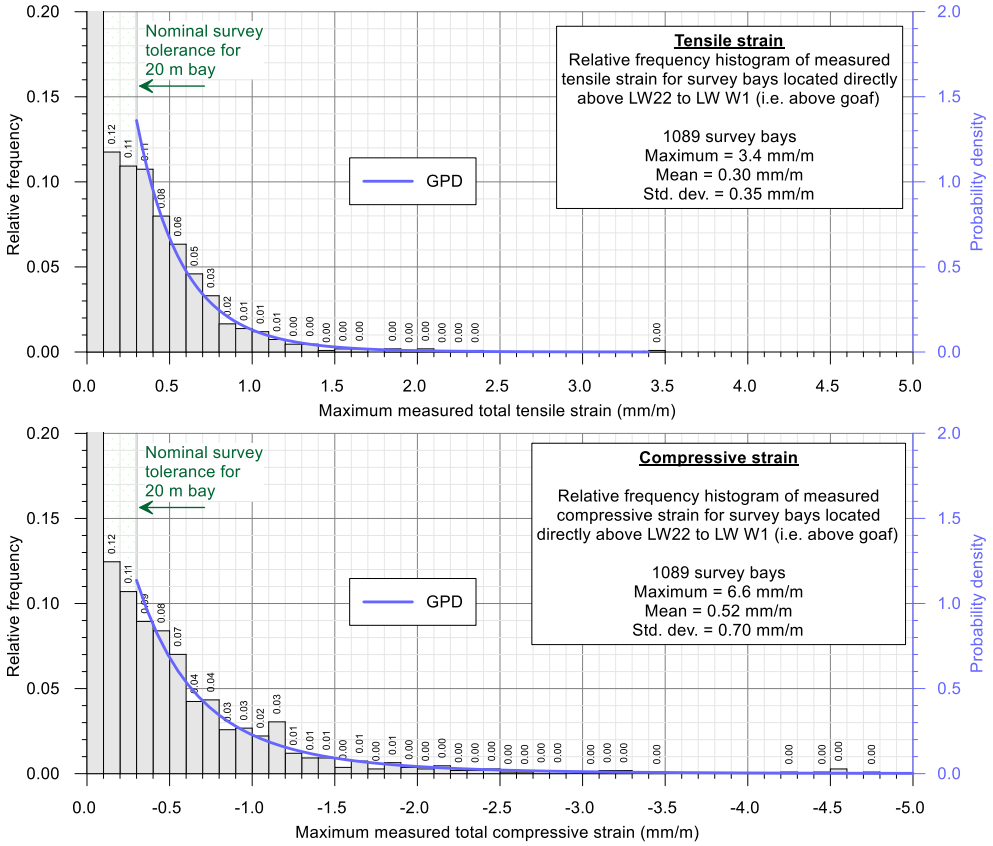

Fig. 3.4 Distributions of the maximum measured tensile and compressive strains during the extraction of previous longwalls for survey bays located above goaf

The 95 % confidence levels for the maximum total strains that the individual survey bays above goaf experienced at any time during mining were 1.0 mm/m tensile and 1.7 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 were 1.5 mm/m tensile and 3.3 mm/m compressive.

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 previous longwalls at the mine, for survey bays that were located outside and within 250 m of the nearest longwall goaf edge, which has been referred to as "*above solid coal*".

A histogram of the maximum observed tensile and compressive strains measured in survey bays above solid coal at Tahmoor Mine is provided in Fig. 3.5. The probability distribution functions, based on the fitted GPDs, have also been shown in this figure.

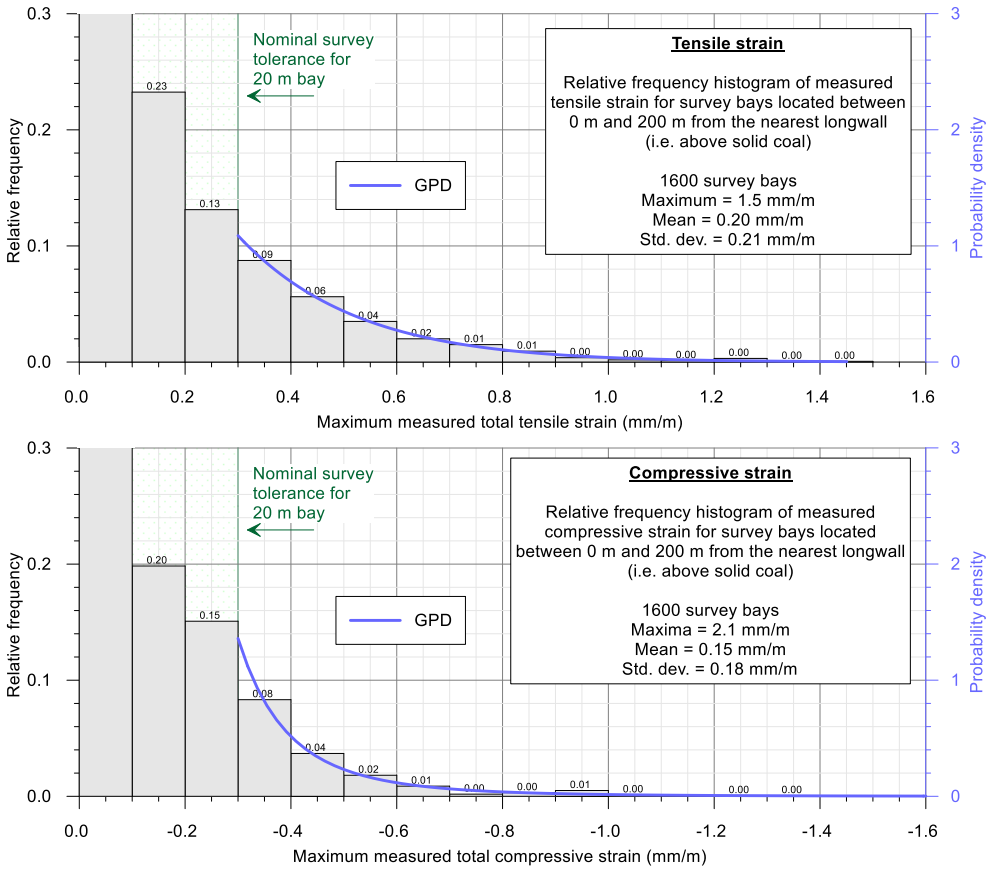

Fig. 3.5 Distributions of the maximum measured tensile and compressive strains during the extraction of previous longwalls for survey bays located above solid coal

The 95 % confidence levels for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining were 0.6 mm/m tensile and 0.5 mm/m compressive. The 99 % confidence levels for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining were 1.0 mm/m tensile and 0.8 mm/m compressive.

3.3.2. 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 strains measured 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 occurs.

A 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 the mine, is provided in Fig. 3.6.

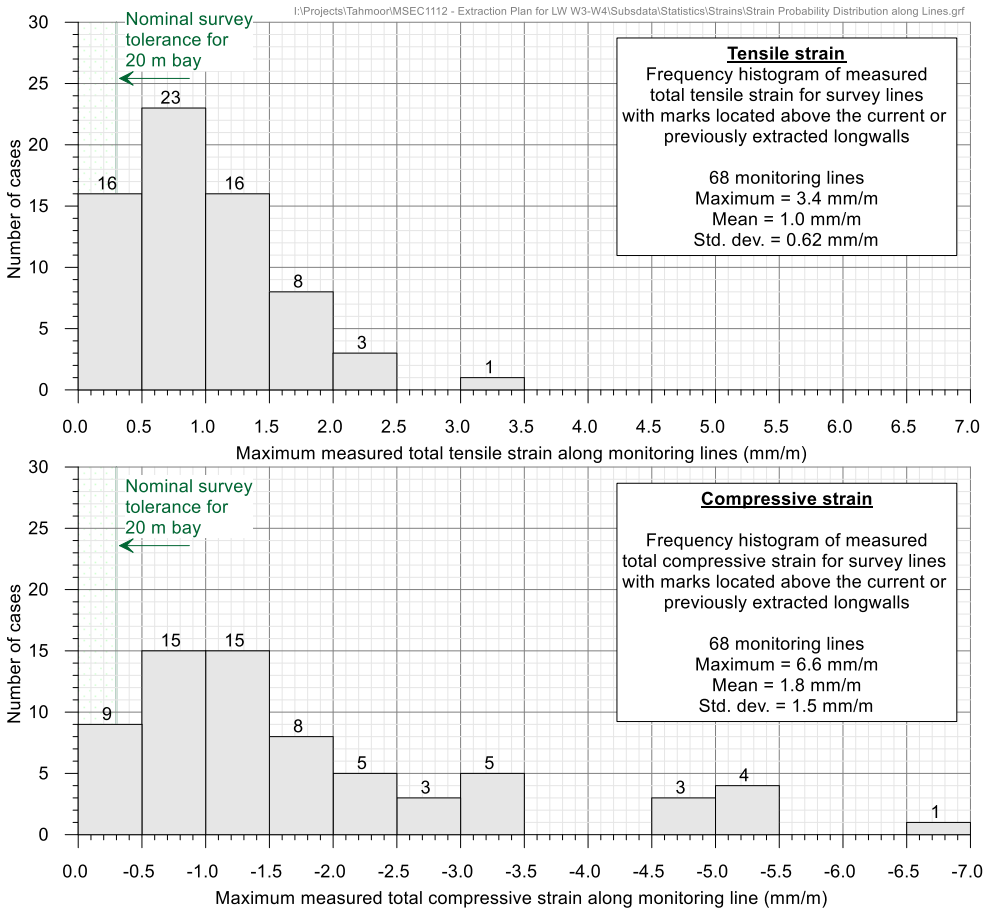

Fig. 3.6 Distributions of maximum measured tensile and compressive strains along monitoring lines during the extraction of previous longwalls at the mine

It can be seen from the above figure, that 39 of the 68 monitoring lines (i.e. 57 %) had recorded maximum total tensile strains of 1.0 mm/m or less, and that 63 monitoring lines (i.e. 93 %) had recorded maximum total tensile strains of 2.0 mm/m or less. It can also be seen, that 47 of the 68 monitoring lines (i.e. 69 %) had recorded maximum compressive strains of 2.0 mm/m or less, and that 60 of the monitoring lines (i.e. 88 %) had recorded maximum compressive strains of 4.0 mm/m or less.

3.4. Managing public safety

The primary risk associated with mining beneath Council infrastructure is public safety. Tahmoor Coal has previously directly mined beneath or adjacent to more than 2000 houses and civil structures, commercial and retail properties, the Main Southern Railway and local roads and bridges. It has implemented extensive measures prior to, during and after mining to ensure that the health and safety of people have not been put at risk due to mine subsidence. People have not been exposed to immediate and sudden safety hazards as a result of impacts that have occurred due to mine subsidence movements.

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 repair the structure.

In the case of this Subsidence Management Plan, the potential for impacts on public safety has been assessed on a case by case basis. The assessments include those of a geotechnical engineer for steep slopes.

3.4.1. Subsidence Impact Management Process for Infrastructure

Tahmoor Coal has developed and acted in accordance with subsidence management plans to manage potential impacts during the mining of Longwalls 22 to 32 and LW W1-W2. The management strategy has been reviewed and updated based on experiences gained during the mining of these longwalls and the strategy for LW W3-W4 includes the following process:

1. Regular consultation with Wollondilly Shire Council before, during and after mining;
2. Site-specific investigations;
3. Implementation of mitigation measures following inspections by a structural engineer, a mine subsidence engineer, and, if required, a geotechnical engineer or other specialist engineer; and
4. Surveys and inspections during mining within the active subsidence area:
   - Detailed visual inspections and vehicle-based inspections along the streets;
   - Ground surveys along streets; and
   - Specific ground surveys and visual inspections, where recommended by an engineer based on the inspections and assessments.

A flowchart illustrating the subsidence impact management process prior to, during and after Wollondilly Shire Council infrastructure experiences mine subsidence movements is shown in Fig. 3.7.

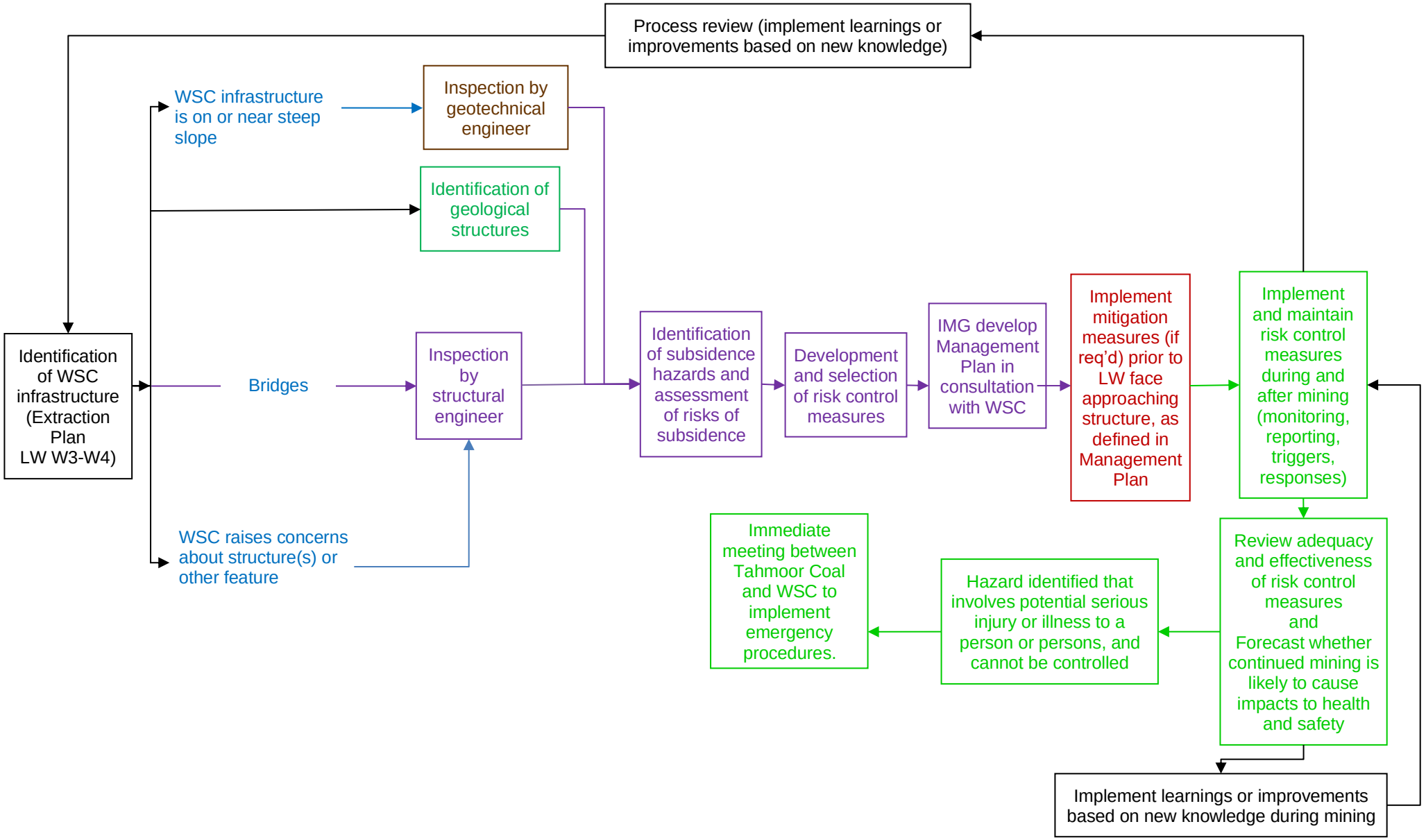

Fig. 3.7 Flowchart for Subsidence Impact Management Process

3.5. Summary of potential impacts

A summary of potential impacts on Wollondilly Shire Council infrastructure is provided in Table 3.2. The summary is consistent with the risk assessment undertaken by Tahmoor Coal (2020). The results of the risk assessment are included in the Appendix.

Table 3.2 Summary of potential mine subsidence impacts

Risk	Likelihood	Consequence	Level of potential impact
Local Roads			
Minor cracking or heaving of pavement, kerbs and gutters	RARE	MINOR	LOW
Major cracking or heaving of pavement, kerbs and gutters	RARE	MODERATE	LOW
Thirlmere Way			
Slope instability causing loss of support to road resulting in tension cracking in road surface	UNLIKELY	MINOR	LOW
Bridges			
Damage to bridges causing loss of serviceability	RARE	MINOR	LOW
Culverts and stormwater drain			
Cracking or spalling of pipework	RARE	MINOR	LOW

Additional information on each potential impact is provided below.

3.6. Identification of subsidence hazards that could give rise to risks to health and safety

Clause 34 of the Work Health and Safety Regulation (2017) requires that the duty holder (in this case Tahmoor Coal), in managing risks to health and safety, must identify reasonably foreseeable hazards that could give rise to risks to health and safety.

This section of the Management Plan summarises hazards that have been identified in Chapter 3, which could give rise to risks to health and safety of people on Council infrastructure.

Using the processes described in Section 3.4 of this Management Plan, mine subsidence hazards have been identified, investigated and analysed in a systematic manner by examining each aspect of infrastructure, as described in Sections 3.7 to 3.9 of this Management Plan. Each of the aspects below could potentially experience mine subsidence movements that give rise to risks to the health and safety of people.

- Local roads;
- Bridges; and
- Road drainage culverts.

The following mine subsidence hazards were identified that could give rise to risks to health and safety on Council infrastructure due to the extraction of LW W3-W4.

- Potential major mine subsidence damage to local roads, particularly the main roads where vehicles travel at a higher speed (refer Section 3.7);
- Potential slope instability beneath Thirlmere Way (refer Section 3.7.3); and
- Potential damage or loss of services to culverts (refer Section 3.8).

The identification and risk assessment process took into account the location of infrastructure relative to LW W3-W4 and the associated timing and duration of the subsidence event, as described in Section 1.8 of this Management Plan.

Whilst mine subsidence predictions and extensive past experiences from previous mining at Tahmoor Mine were taken into account, the identification and risk assessment process recognised that there are uncertainties in relation to predicting subsidence movements, and uncertainties in how mine subsidence

movements may adversely impact Council infrastructure, as discussed in Section 1.4 and Chapter 3 of this Management Plan. In this case, creeks have been mapped that intersect local roads, and Thirlmere Way is situated on top of a ridgeline.

Tahmoor Coal has considered the outcomes of the hazard identification and risk assessment process when developing measures to manage potential impacts on the health and safety of people, and potential impacts on Council property in general. These are described in Chapter 4 of this Management Plan.

3.7. Local roads

There are a number of local roads that are located adjacent to LW W3-W4, as shown in Drawing No. MSEC1173-02-01.

- Thirlmere Way
  One of the main roads linking the townships of Thirlmere and Picton. It will not be directly mined beneath by the proposed longwalls.
- Rumker Street, Connellan Crescent and Star Street
  These streets are located adjacent to LW W4.
- Stonequarry Creek Road
  The main road within the Stonequarry Estate to the north of Thirlmere Way. The northern end of the road is located directly above LW W1.
- Attunga Close and Booyong Close
  These streets are located directly above and adjacent to LW W1.
- Barkers Lodge Road
  A small section is located within the Study Area and may experience minor subsidence movements during the extraction of LW W3-W4.

3.7.1. Predicted subsidence movements

The main road within the Study Area is Thirlmere Way which connects Thirlmere and Picton. It crosses directly above the finishing ends of the previously extracted LW 32 and LW W1. It will not be directly mined beneath by the proposed longwalls. The total length of Thirlmere Way located within the Study Area is 0.93 km.

The local roads within the Study Area include Stonequarry Creek Road, Booyong Close, and Attunga Close, which are located within the Stonequarry Estate and partially above the southern end of LW W1. Rumker Street, Connellan Crescent and Star Street are located adjacent to LW W4. Barkers Lodge Road is located outside the mining area to the north of the proposed longwalls.

The local roads may collectively experience the full range of predicted subsidence movements, as described in Section 3.1. A discussion on the expected range of tensile and compressive strains during the mining of LW W3-W4 is provided in Section 3.3.

The predicted profiles of conventional subsidence, tilt and curvature along Thirlmere Way, Stonequarry Creek Road and Connellan Crescent are shown in Fig. 3.8, Fig. 3.9 and Fig. 3.10, respectively.

Summaries of the maximum predicted conventional subsidence, tilt and curvature for Thirlmere Way, Stonequarry Creek Road and Connellan Crescent, are provided in Table 3.3,

Table 3.4 and Table 3.5, respectively. The values are the maximum predicted parameters anywhere along the sections of roads located within the predicted limit of vertical subsidence for LW W3-W4.

Table 3.3 Maximum predicted total conventional subsidence, tilt and curvature for Thirlmere Way

Longwall	Maximum predicted total subsidence (mm)	Maximum predicted total tilt (mm/m)	Maximum predicted total hogging curvature (1/km)	Maximum predicted total sagging curvature (1/km)
After LW W3	100	< 0.5	0.01	< 0.01
After LW W4	100	< 0.5	0.01	< 0.01

Table 3.4 Maximum predicted total conventional subsidence, tilt and curvature for Stonequarry Creek Road

Longwall	Maximum predicted total subsidence (mm)	Maximum predicted total tilt (mm/m)	Maximum predicted total hogging curvature (1/km)	Maximum predicted total sagging curvature (1/km)
After LW W3	750	3.0	0.03	0.05
After LW W4	775	3.0	0.03	0.05

Table 3.5 Maximum predicted total conventional subsidence, tilt and curvature for Connellan Crescent

Longwall	Maximum predicted total subsidence (mm)	Maximum predicted total tilt (mm/m)	Maximum predicted total hogging curvature (1/km)	Maximum predicted total sagging curvature (1/km)
After LW W1	30	< 0.5	< 0.01	< 0.01
After LW W2	175	1.0	0.02	< 0.01

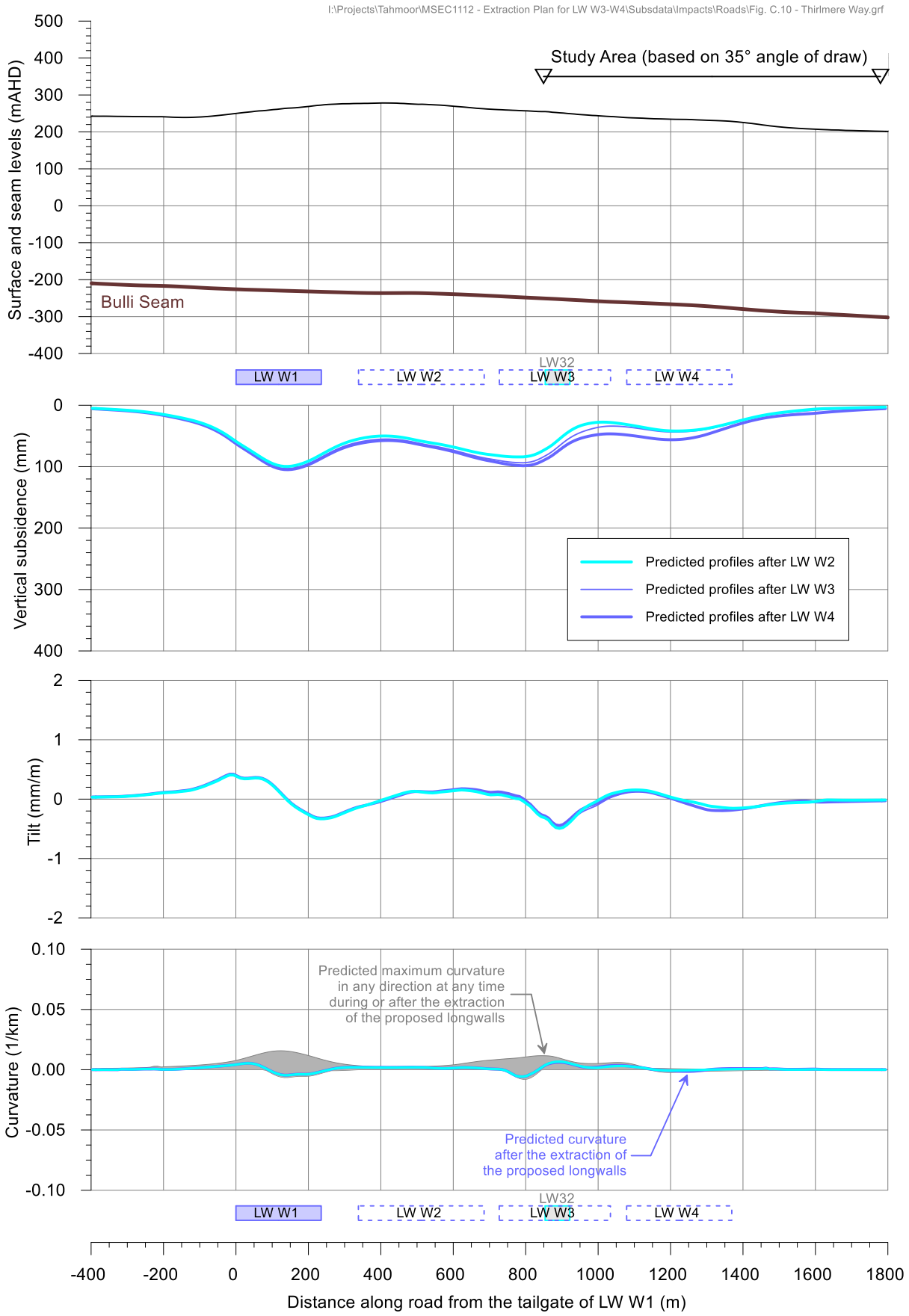

Fig. 3.8 Predicted profiles of total subsidence, tilt and curvature along Thirlmere Way after the mining of LW W3-W4

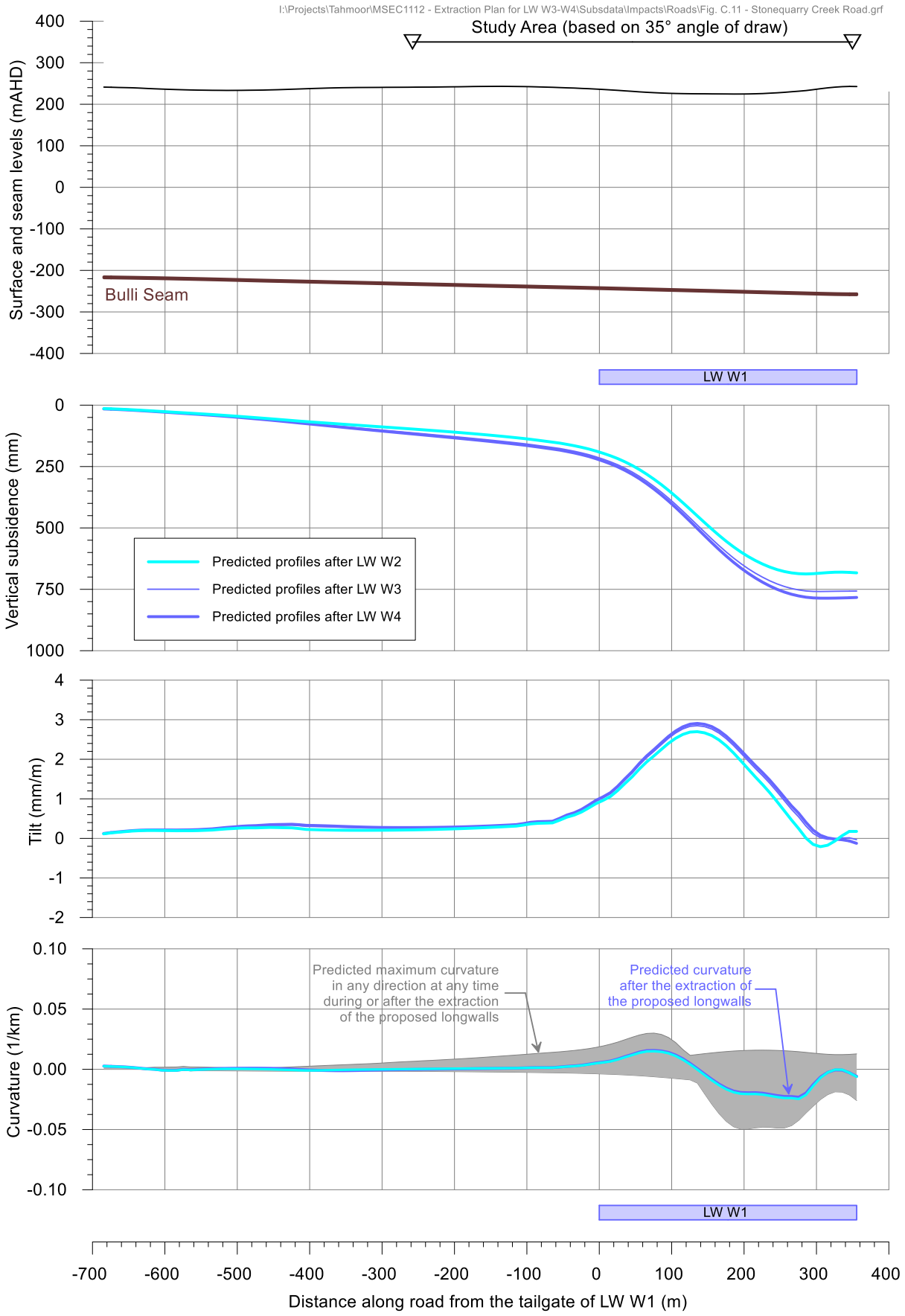

Fig. 3.9 Predicted profiles of total subsidence, tilt and curvature along Stonequarry Creek Road after the mining of LW W3-W4

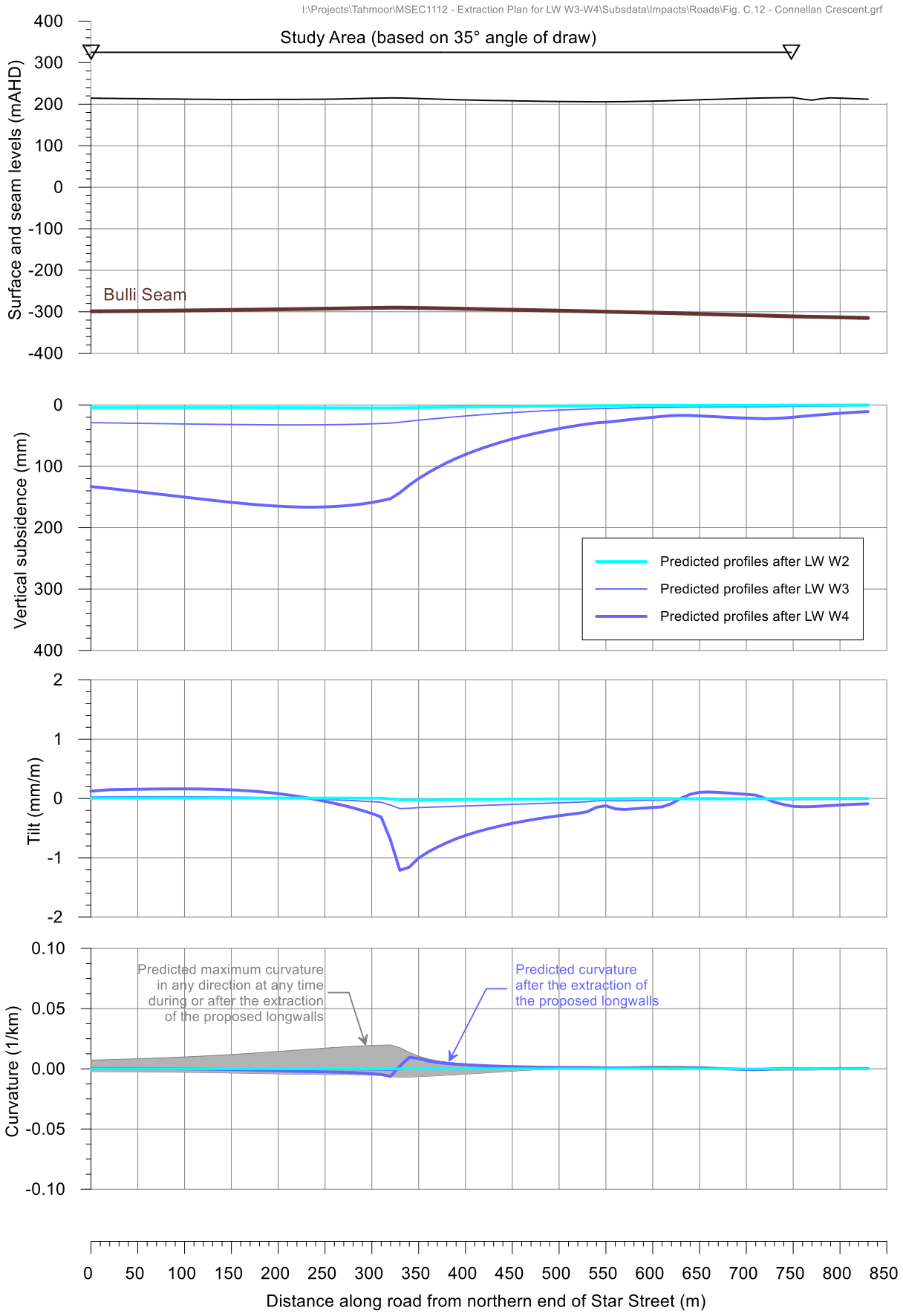

Fig. 3.10 Predicted profiles of total subsidence, tilt and curvature along Connellan Crescent after the mining of LW W3-W4

3.7.2. Potential subsidence impacts on local roads

Extensive monitoring of road pavements has been undertaken during the extraction of Longwalls 22 to 32 and LW W1-W2 at Tahmoor Mine. This includes a network of ground monitoring lines and weekly visual inspections in areas that are experiencing active subsidence. Approximately 28 km of asphaltic pavement lie directly above the extracted longwalls and a total of 52 impact sites have been reported. The observed rate of impact equates to an average of one impact for every 540 m of pavement. The impacts have not presented a public safety risk, and the majority of the impacts have been minor in nature.

Impacts have also been observed to concrete kerbs, gutters and drainage pits. The impacts are most commonly focussed around driveway laybacks and involve cracking, spalling or buckling.

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 the roads in safe and serviceable condition.

Traffic signs and other road infrastructure have not previously experienced impacts due to mine subsidence.

Minor impacts were observed to local roads above LW W1-W2. The impacts included cracking in isolated locations, particularly where local roads had been constructed over natural creek lines. Impacts also occurred to concrete kerbs, particularly where stormwater drains had been retrofitted after the kerbs had been formed. Impacts were also observed to the covers of some stormwater drains that are located directly above natural creek lines.

Given that LW W3-W4 do not mine directly beneath the local roads, it is unlikely that further impacts will occur during the mining of the proposed longwalls.

Photographs courtesy BIS

Fig. 3.11 Impacts on local roads and kerbs during LW W1

3.7.3. Thirlmere Way

Thirlmere Way runs along the side of a ridge near the southern (i.e. finishing) end of LW W1-W3, with steep slopes located above and below the road. The same section of road has experienced subsidence movements during the mining of LW 31, 32, W1 and W2 with no impacts observed.

Despite the experiences observed to date, it is possible that surface cracking or slippage could develop on the side of the ridge due to the extraction of LW W3 and that these may intersect with Thirlmere Way. A cross-section through Thirlmere Way and the ridgeline above the finishing end of LW W1 is provided in Fig. 3.12.

Thirlmere Way narrows in this section, with no shoulders on either side of the pavement, limiting the access for monitoring and undertaking repairs. The traffic along this section of road, therefore, will need to be managed to allow surveys and inspections to be undertaken and undertake any required remediation works.

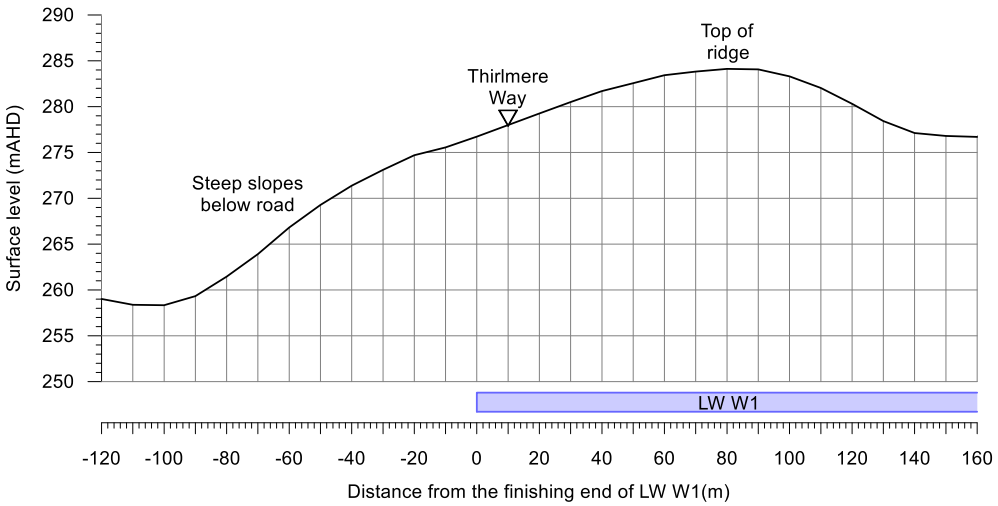

Fig. 3.12 Cross-section through Thirlmere Way and the ridgeline above LW W1

Tahmoor Coal engaged geotechnical engineer GHD Geotechnics to undertake a geotechnical assessment of the steep slopes along Thirlmere Way (GHD Geotechnics, 2017). The existing conditions along Thirlmere Way were appraised using RMS methodology (RMS Guide to Slope Risk Management, Version 4), where ARL1 is a high risk, and ARL5 is low.

- A scenario of approximately 20m^3 of rock or soil debris flowing onto the road from the cuttings was assessed as ARL3.
- A scenario of loss of embankment edge leading to step in the road pavement was assessed as assessed as ARL4.

The assessments were repeated taking into account the potential effects from subsidence. The assessments did not change from the current condition.

Prior to the influence of LW 31, survey marks T101 to T127 were installed and surveyed along Thirlmere Way where steep slopes are located above and below the road. The survey line was extended to Peg T159 to monitor changes during the mining of LW32. A map showing the locations of survey pegs is provided in Fig. 3.13.

Weekly surveys were conducted each longwall approached the road. The results of surveys are shown in Fig. 3.14. It can be seen that low level subsidence was observed during and after the mining of LWs 31 and 32. Additional residual subsidence developed at survey marks T101 to T127 during the period of time between the cessation of surveys for LW31 and the recommencement of surveys for LW32. Mining-induced tilts and strains remained very small. The survey line was extended to the west prior to the influence of LW W1. The results of surveys during the mining of LW W1-W2 are shown in Fig. 3.15, where it can be that very minor subsidence, tilts and strains were observed.

Six survey pegs were installed on the opposite side of Thirlmere Way from the main survey line to monitor changes in horizontal distances across the pavement. A map showing the locations of the six cross sections is provided in Fig. 3.13. The results of surveys during the mining of LWs 31, 32, W1 and W2 are shown in Fig. 3.16. It can be seen that some changes were observed during the period of time between the cessation of surveys for LW31 and the recommencement of surveys for LW32. Minor changes have generally been observed since surveys recommenced for LW32, LW W1 and LW W2.

No impacts have been observed to the pavement to date.

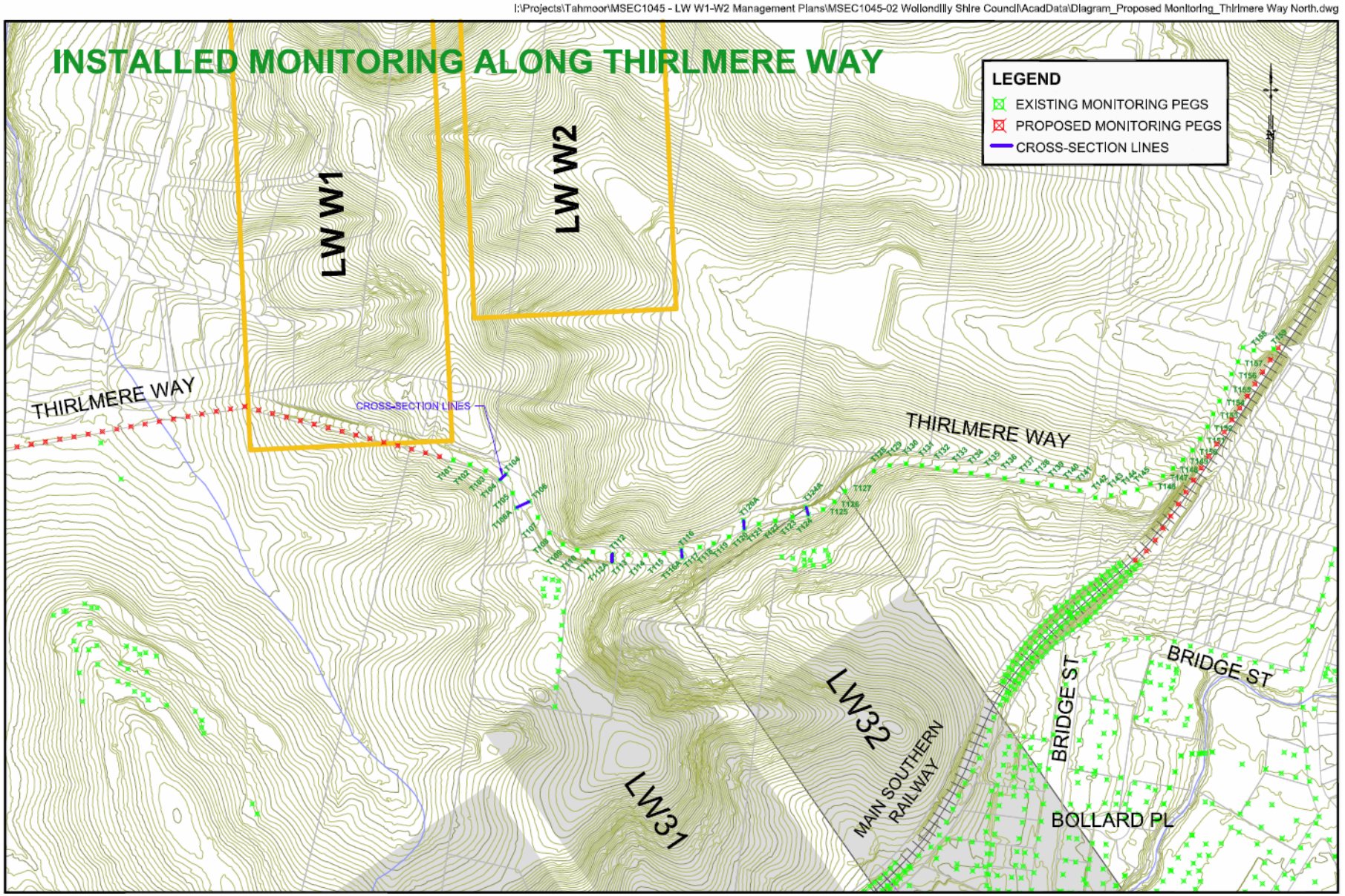

Fig. 3.13 Installed and proposed extension of survey lines along Thirlmere Way

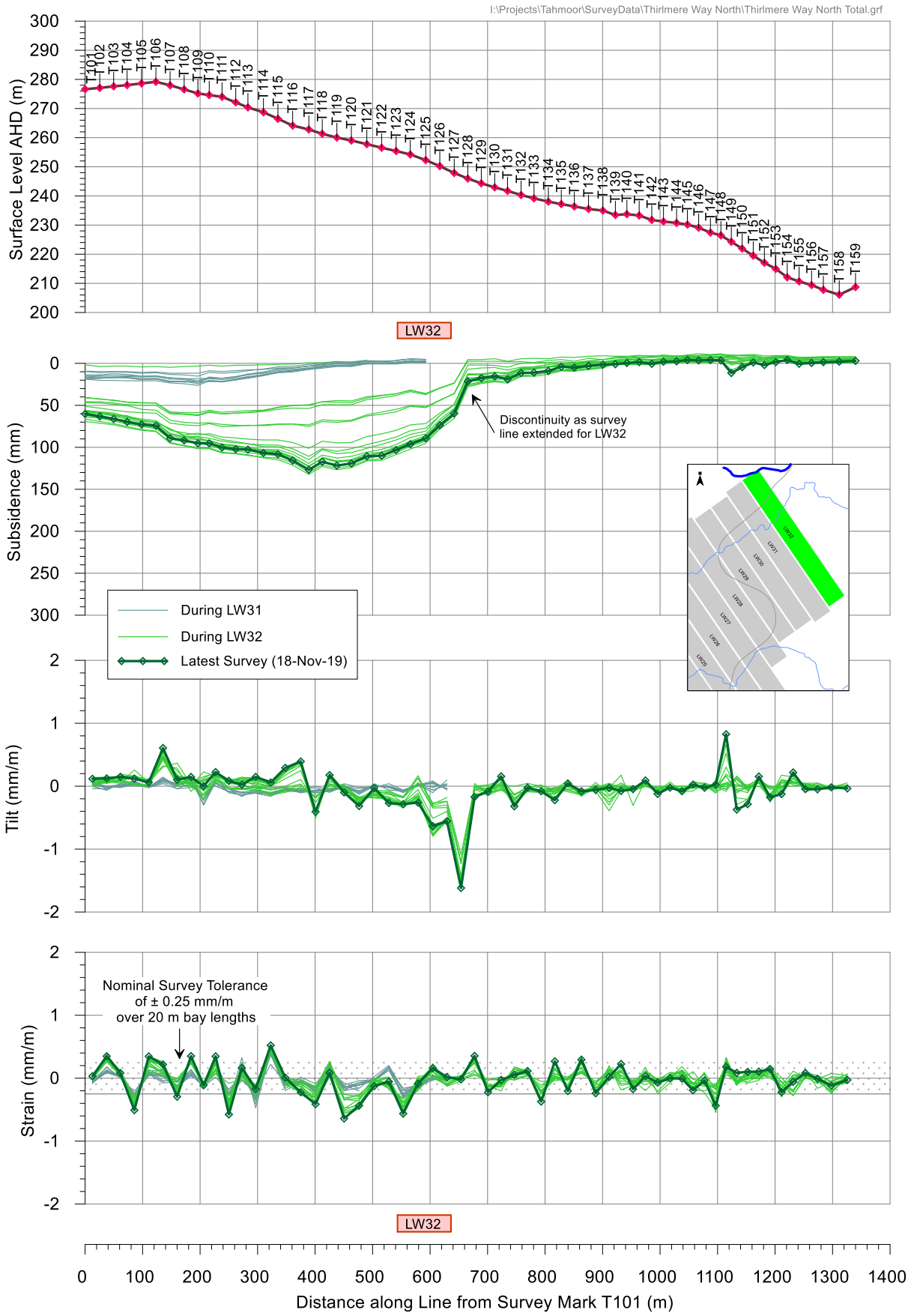

Fig. 3.14 Observed subsidence along Thirlmere Way during the mining of LWs 31 and 32

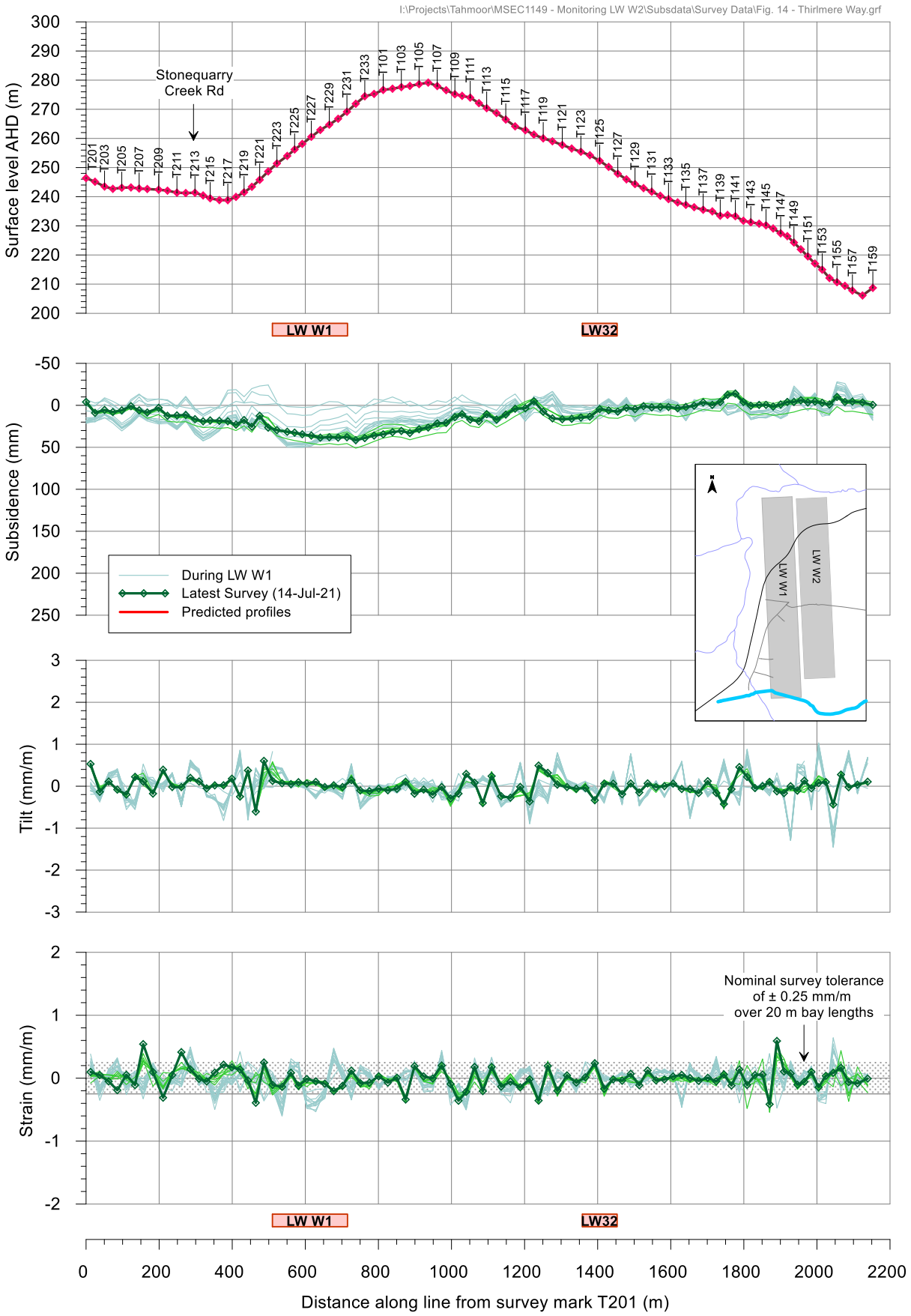

Fig. 3.15 Observed subsidence along Thirlmere Way during the mining of LW W1-W2

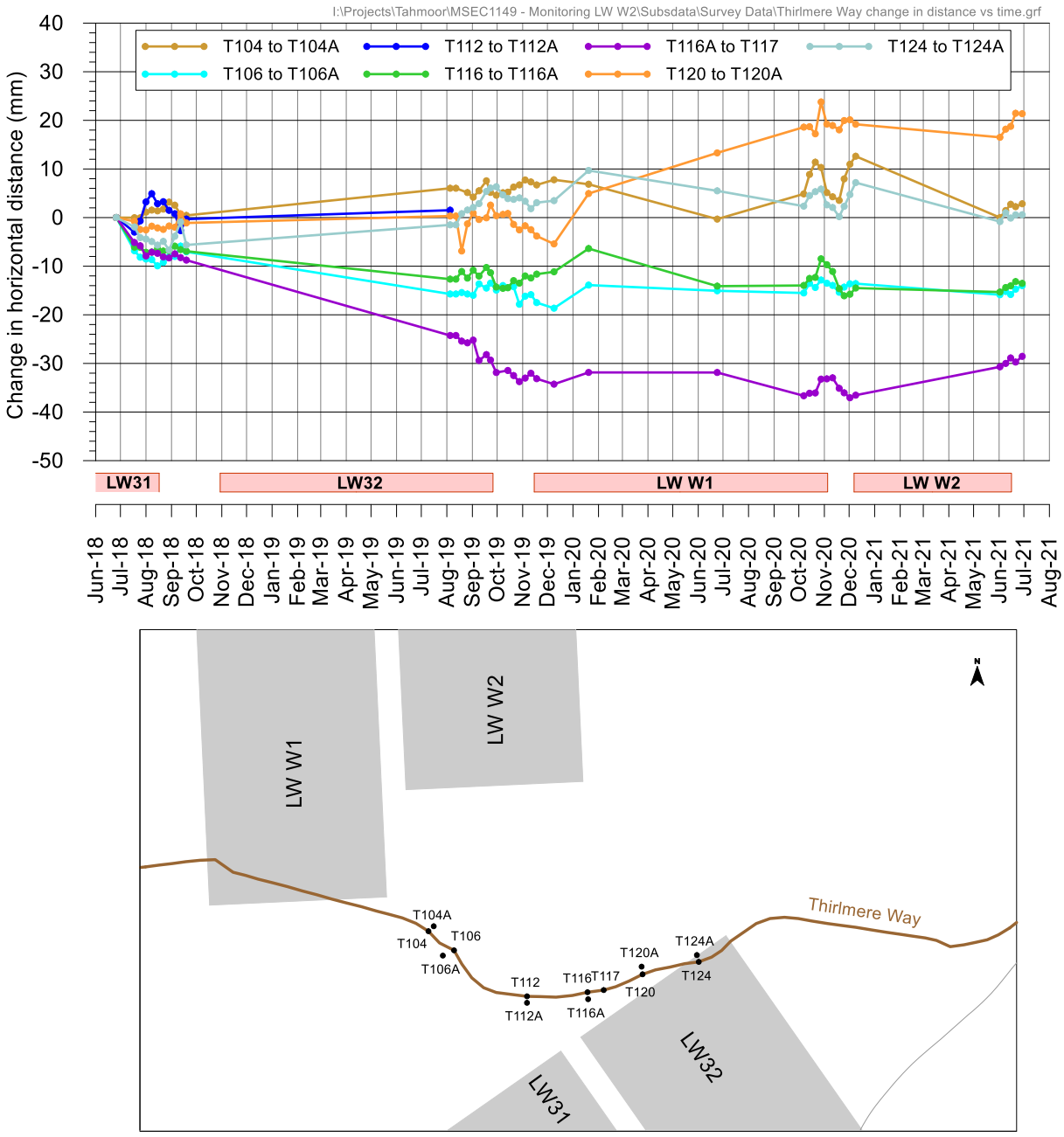

Fig. 3.16 Observed changes in distance across Thirlmere Way during the mining of LWs 31 to LW W2 as at 14 July 2021

Tahmoor Coal has developed and selected risk control measures in consultation, co-ordination and co-operation with Wollondilly Shire Council in accordance with WHS legislation. In this instance, there are no reasonably practicable controls which could eliminate, substitute or isolate the identified risks, nor engineering controls that could put in place a structure or item that prevents or minimises risks. Tahmoor Coal has identified controls that will manage potential issues associated with the identified risks, as described by GHD Geotechnics:

- Local 2D survey of subsidence along Thirlmere Way with locations of pegs shown in Fig. 3.13;
- Local 2D survey of changes in horizontal distance at six cross-sections across the Thirlmere Way road pavement where the steep slopes are present. The locations of the installed cross-sections are shown in Fig. 3.13;
- Visual inspections along Thirlmere Way;
- Additional surveys and/or inspections, if triggered by monitoring results;
- Repair of pavement if damage is observed;
- As a last resort, temporary closure of Thirlmere Way if a hazard has been identified that involves potential serious injury or illness to a person or persons and cannot be controlled; and
- Development of traffic management plan to manage traffic in the event that mining-induced damage develops along the road and requires repair.

With the implementation of the above management strategy, Tahmoor Coal will ensure that the health and safety of people along Thirlmere Way will not be put at risk due to differential mine subsidence movements due to the extraction of LW W3-W4.

A traffic management plan (Traffic Professionals, 2018) has been developed for the installation and continued monitoring of survey pegs. Visual inspections of the pavement can be undertaken whilst the surveys are conducted. The traffic management plan has been appended to this Management Plan.

3.8. Road drainage culverts

There are four road drainage culverts located above and in the vicinity of LW W3-W4. The culverts are single reinforced concrete pipes (RCP) with diameters of 600 mm and 900 mm.

A summary of these culverts is provided in Table 3.6.

Table 3.6 Road drainage culverts located within the Study Area

Road	Culvert ref.	Location	Size and type
Stonequarry Creek Road	SC-C2	480 m west of LW W3	Single RCP 600 mm dia.
	SC-C3	540 m west of LW W3	Single RCP 900 mm dia.
Connellan Crescent	CR-C1	220 m east of LW W4	Single RCP 900 mm dia
Rumker Street	RU-C1	160 m southeast of LW W4	Single RCP 900 mm dia

A summary of the maximum predicted conventional subsidence, tilt and curvature for road drainage culverts is provided in Table 3.7. The values are the maximum predicted values within 20 m of each of the culverts at any time during or after the extraction of LW W3-W4.

Table 3.7 Maximum predicted total conventional subsidence, tilt and curvature for road drainage culverts

Culvert	Maximum predicted total vertical subsidence (mm)	Maximum predicted total tilt (mm/m)	Maximum predicted total hogging curvature (km^{-1})	Maximum predicted total sagging curvature (km^{-1})
CR-C1	< 20	< 0.5	< 0.01	< 0.01
RU-C1	< 20	< 0.5	< 0.01	< 0.01
SC-C2	625	3.5	0.02	0.05
SC-C3	700	2.5	0.02	0.05

Culverts SC-C2 and SC-C3 are located on small tributaries directly above the previously extracted LW W1. The maximum predicted valley-related effects for culverts SC-C2 and SC-C3 along Stonequarry Creek Road north of Booyong Close are 25 mm upsidence and 50 mm closure.

Culvert CR-C1 is located on Tributary 1 to Redbank Creek. The maximum predicted valley-related effects for Culvert CR-C1 are 50 mm upsidence and 50 mm closure.

3.8.1. Potential subsidence impacts on road drainage culverts

The maximum predicted tilt for Culverts SC-C2 and SC-C3 is 3.5 mm/m (i.e. 0.35 %, or 1 in 285). It is unlikely that the mining-induced tilts would result in adverse impacts on the serviceability of these culverts, as the changes in grade are less than 1 %. If the flow of waters through any of the culverts were adversely affected, due to the extraction of LW W3-W4, these could be remediated by re-levelling the affected culverts.

The predicted curvatures and strains could be of sufficient magnitudes to result in cracking in the culverts or the headwalls. It is unlikely, however, that these movements would adversely impact on the stabilities or structural integrities of the culverts.

The drainage culverts are located along the tributaries and therefore could experience valley-related effects. The drainage culverts are orientated along the alignments of the tributaries and, therefore, the upsidence and closure movements are orientated perpendicular the main axes of the culverts and unlikely to result in adverse impacts.

Previous experience of mining beneath culverts in the NSW coalfields, at similar depths of cover, indicates that the incidence of impacts is low. Impacts have generally been limited to cracking in the concrete headwalls which can be readily remediated. In some cases, however, cracking in the culvert pipes occurred which required the culverts to be replaced.

There have been no reports of impacts to road drainage culverts during the mining of Longwalls 22 to 32, with the exception of a culvert headwall on Bridge Street during the mining of Longwall 31. The low incidence of impacts is understandable as the culverts are typically constructed of jointed circular concrete pipes, which are able to tolerate substantial differential ground movements. While it is possible that the culverts could experience physical impacts such as cracking, the probability is considered low.

No impacts have been observed to road culverts during the mining of LW W1-W2. The pit covers on Stonequarry Creek Road at Culverts SC-C2 and SC-C3 have experienced some minor cracking, which has been temporarily repaired, as shown in Fig. 3.11.

Given that LW W3-W4 do not mine directly beneath the local roads, it is unlikely that further impacts will occur to road culverts during the mining of the proposed longwalls.

The potential impacts on the drainage culverts could be managed by visual inspection and, where required, any affected culverts can be repaired or replaced.

Tahmoor Coal and Wollondilly Shire Council have developed and acted in accordance with agreed risk management plans to manage potential impacts to roads drainage culverts during the mining of Longwalls 22 to 32 and LW W1-W2. The management plans provide for visual monitoring of the culverts.

Survey lines will be installed along the local roads and monitoring data will be used to determine whether the culverts have experienced significant differential subsidence movements. If any adverse impacts were to occur as the result of mining, the affected culverts could be repaired or replaced.

3.9. Bridges

LW W3-W4 do not extract directly beneath any bridges, though some bridges are predicted to experience far field subsidence movements during the mining of LW W3-W4, including:

- Bridge Street Overbridge over Main Southern Railway
  This bridge has been mined directly beneath by Longwall 29 and has experienced additional subsidence movements during the extraction of Longwalls 30 to 32 and LW w1-W2. The rail bridge is located 1.3 km southwest of the proposed LW W3. Risk control measures to manage potential impacts on this bridge are described in a separate management plan for the Main Southern Railway, which has been developed in consultation with the Australian Rail Track Corporation, ARTC. A copy of the management plan can be provided to Wollondilly Shire Council.

  Survey marks have been placed on the bridge abutments and the bridge deck on both sides. They have been regularly surveyed during the mining of Longwalls 30 to 32 and LW W1-W2. The survey marks will be re-surveyed at the completion of LW W3-W4.

- Thirlmere Way Rail Underbridge beneath Main Southern Railway
  The bridge is located approximately 545 metres to the southeast of LW W3 and approximately 245 metres to the southeast of LW W4. It is predicted to experience less than 20 mm vertical subsidence and minor absolute and differential horizontal movements during the extraction of LW W3-W4. Risk control measures to manage potential impacts on this bridge are described in a separate management plan for the Main Southern Railway, which has been developed in consultation with ARTC. A copy of that management plan can be provided to Wollondilly Shire Council.

  Survey marks have been placed across the base of the bridge abutment on both sides. A ground survey mark has been installed adjacent to the bridge and its absolute position has been surveyed on a monthly basis during the mining of Longwalls 31 and 32 and LW W1-W2. The survey marks will continue to be surveyed on a monthly basis during the mining of LW W3-W4.

- Connellan Crescent Overbridge over Main Southern Railway
  The bridge is located approximately 730 metres from LW W3 and 400 metres from LW W4. It is predicted to experience less than 20 mm vertical subsidence and minor absolute and differential horizontal movements during the extraction of LW W3-W4. Risk control measures to manage potential impacts on this bridge are described in a separate management plan for the Main Southern Railway, which has been developed in consultation with the Australian Rail Track Corporation (ARTC). A copy of that management plan can be provided to Wollondilly Shire Council.

  Survey marks have been placed across the base of the bridge abutment on both sides. A ground survey mark has been installed adjacent to the bridge and its absolute position has been surveyed on a monthly basis during the mining of Longwalls 31 and 32 and LW W1-W2. The survey marks will continue to be surveyed on a monthly basis during the mining of LW W3-W4.

- Argyle Street Underbridge beneath Main Southern Railway
  The bridge is located approximately 930 metres from LW W3 and 700 metres from LW W4. It is predicted to experience less than 20 mm vertical subsidence and minor absolute and differential horizontal movements during the extraction of LW W3-W4. Risk control measures to manage potential impacts on this bridge are described in a separate management plan for the Main Southern Railway, which has been developed in consultation with the Australian Rail Track Corporation, ARTC. A copy of that management plan can be provided to Wollondilly Shire Council.

  Survey marks have been placed across the base of the bridge abutment. A ground survey mark has been installed adjacent to the bridge and its absolute position has been surveyed on a monthly basis Longwalls 31 and 32 and LW W1-W2. The survey marks will continue to be surveyed on a monthly basis during the mining of LW W3-W4.

- Victoria Road Bridge over Stonequarry Creek
  The bridge is owned and maintained by Transport for NSW (TfNSW) and is located approximately 980 m from LW W3 and approximately 700 m from LW W4. Whilst it is extremely unlikely that the Bridge will experience mining-induced movements, it is located over a section of Stonequarry Creek that runs along the alignment of the Nepean Fault and may, therefore, experience minor absolute and differential horizontal movements during the extraction of LW W3-W4.

  Survey marks have been placed at the ends of the Bridge and at the base of the intermediate trussed piers on both sides. Ground survey marks have been installed at each end of the Bridge and their absolute position has been surveyed on a monthly basis during the mining of Longwalls 31 and 32 and LW W1-W2. The absolute position of the Bridge is continuously monitored by a GNSS unit that is mounted near the eastern abutment. Monitoring will continue during the mining of LW W3 and LW W4.

- Remembrance Drive Road Bridge and Footbridge over Redbank Creek
  The bridges is located approximately 820 metres from LW W3 and 660 metres from LW W4. The road bridge is a two lane, reinforced precast concrete arch structure, of BEBO arch design, with precast concrete spandrel walls. The bridge is a clear single span of approximately 9 metres. The bridge surface is sealed with asphalt, and there is a steel guardrail crash barrier on each side.

  The adjacent footbridge over Redbank Creek is a separate structure, which has a single span of approximately 10 metres. The bridge is formed from reinforced pretensioned double T concrete bridge girders, supported on reinforced concrete plinths on rock (JMA, 2018). The balustrades are built from proprietary steel fence sections.

  Prior to the influence of Longwall 32, survey marks were installed at the base of the road bridge arch above the water line on both sides, on top of the bridge deck on both sides at mid-span, and along the top of the spandrel walls on both sides of the bridge at abutments and mid-span.

  The survey marks will be re-surveyed at the completion of LW W3-W4. The bridges can be repaired in the unlikely event that impacts are observed.

- Abbotsford Bridge on Barkers Lodge Road over Stonequarry Creek
  The bridge is located approximately 900 m from LW W3 and 1320 metres from LW W4. The road bridge is a two lane, reinforced concrete bridge. Whilst it is extremely unlikely that the Bridge will experience mining-induced movements, it is located over a section of Stonequarry Creek that runs along the alignment of geological structures associated with the Nepean Fault and may, therefore, experience minor absolute and differential horizontal movements during the extraction of LW W3-W4.

  Survey marks have been placed at the ends of the Bridge and at the base of the intermediate piers on both sides. A ground survey mark has been installed at the Bridge and its absolute position has been surveyed on a monthly basis during the mining of LW W1-W2.

4.1. Infrastructure Management Group (IMG)

The Infrastructure Management Group (IMG) is responsible for taking the necessary actions required to manage the risks that are identified from monitoring the infrastructure and to ensure that the health and safety of people who may be present on public property or Wollondilly Shire Council property are not put at risk due to mine subsidence. The IMG develops and reviews this management plan, collects and analyses monitoring results, determines potential impacts and provides advice regarding appropriate actions. The members of the IMG are highlighted in Chapter 8.

4.2. Development and selection of risk control measures

Tahmoor Coal has developed and selected risk control measures in consultation, co-ordination and co-operation with the infrastructure owner in accordance with WHS legislation. In accordance with Clauses 35 and 36 in Part 3.1 of the Work Health and Safety regulation (2017) and the guidelines (MSO, 2017), a hierarchy of control measures has been considered and selected where reasonably practicable, using the following process:

1. Eliminate risks to health and safety so far as is reasonably practicable, and
2. If it is not reasonably practicable to eliminate risks to health and safety – minimise those risks so far as is reasonably practicable, by doing one or more of the following:
   (a) substituting (wholly or partly) the hazard giving rise to the risk with something that gives rise to a lesser risk
   (b) isolating the hazard from any person exposed to it,
   (c) implementing engineering controls.
3. If a risk then remains, minimise the remaining risk, so far as is reasonably practicable, by implementing administrative controls.
4. If a risk then remains, the duty holder must minimise the remaining risk, so far as is reasonably practicable, by ensuring the provision and use of suitable personal protective equipment.

A combination of the controls set out in this clause may be used to minimise risks, so far as is reasonably practicable, if a single control is not sufficient for the purpose.

There are primarily two different methods to control the risks of subsidence, namely:

- Method A – Selection of risk control measures to be implemented prior to the development of subsidence, (Items 1 and 2 above), and
- Method B – Selection of risk control measures to be implemented during the development of subsidence (Items 3 and 4 above).

Method A and B risk control measures are described in Section 4.3 to Section 4.6. Prior to selecting Method B risk control measures, Tahmoor Coal has investigated and confirmed that the measures are feasible and effective for the site-specific conditions during the extraction of LW W3-W4.

4.3. Selection of risk control measures for council infrastructure

Based on its own assessments, and the assessments by the structural engineer, and the geotechnical engineer, Tahmoor Coal considered Method A and Method B risk control measures, in accordance with the process described in Section 4.2.

Elimination

In this instance, no reasonably practicable controls could be identified that would eliminate the identified risks.

Substitution

In this instance, no reasonably practicable controls could be identified that will change the environment so the hazards could be substituted for hazards with a lesser risk.

Isolation

In this instance, no reasonably practicable controls could be identified to isolate a hazard from any person exposed to it.

Engineering Controls

In this instance, no reasonably practicable engineering controls could be identified to put in place a structure or item that prevents or minimises risks.

Administrative Controls

The following Administrative Controls were identified and selected that will put in place procedures on site to minimise the potential of impacts on the safety of people in relation to mining-induced damage to Wollondilly Shire Council infrastructure.

- Implementation of a Monitoring Plan and Trigger Action Response Plan (TARP)
  As described in the Management Plan, Tahmoor Coal and Wollondilly Shire Council has developed and implemented a management strategy of detecting early the development of potential adverse subsidence movements in the ground, so that contingency response measures can be implemented before impacts on the safety and serviceability develop. The TARP includes the following:
    - Local 2D surveys along local roads as shown in Drawing No. MSEC1173-00-01. These include Barkers Lodge Road, Thirlmere Way, Stonequarry Creek Road, Attunga Close, Booyong Close and Connellan Crescent;
    - Local 2D survey of changes in horizontal distance at six cross-sections across the Thirlmere Way road pavement where the steep slopes are present;
    - Visual inspections along streets within the active subsidence zone;
    - Surveys of road bridges as part of the far field monitoring network;
    - Additional surveys and/or inspections, if triggered by monitoring results;
    - Repair of pavement, culverts or bridges if damage is observed;
    - Development of a traffic management plan for Thirlmere Way to manage traffic in the event that mining-induced damage develops along the road and requires repair; and
    - As a last resort, temporary closure of Thirlmere Way if a hazard has been identified that involves potential serious injury or illness to a person or persons and cannot be controlled.

4.4. Monitoring measures

A number of monitoring measures will be undertaken during mining.

4.4.1. Ground Surveys along streets and centrelines of LW W3-W4

A survey line has been installed along the centreline of LW W3. A survey line has been installed along the centreline of LW W4, as shown in Drawing No. MSEC1173-00-01.

The purpose of the survey lines is to establish the general magnitude and shape of surface subsidence along the centrelines of LW W3-W4. The observed subsidence movements will be used to provide early subsidence information to inform Tahmoor Mine and affected stakeholders prior to built surface features experiencing active subsidence, the majority of which are located at the northern end of LW W3. The information will assist Tahmoor Mine and affected stakeholders in considering whether any additional measures are required to manage potential impacts on the built features.

The information will also be used by Tahmoor Mine as part of its ongoing review of subsidence effects on natural features.

The survey lines will consist of pegs spaced nominally every 20 metres, where access is available, noting that the centrelines pass through private property and building structures. Surveys will measure levels and horizontal distances between adjacent pegs.

Survey lines have been installed along Barkers Lodge Road, Thirlmere Way, Stonequarry Creek Road, Attunga Close, Booyong Close and Connellan Crescent, as shown in Drawing No. MSEC1173-00-01. The survey pegs will be surveyed during the period of active subsidence of these features during the extraction of LW W3-W4.

The surveys measure changes in height and changes in horizontal distances between adjacent pegs.

Any work within the road reserve, including survey, must be done under an approved Road Occupancy Permit (under Section 138 of the Roads Act) via an application to Council. Tahmoor Coal will ensure that its surveyors will apply to Council prior to conducting surveys within the road reserves.

4.4.2. Far-field Surveys

Tahmoor Coal has installed a far-field monitoring survey network to investigate the potential for differential horizontal movements across the Nepean Fault at the following locations:

- Thirlmere Way Rail Underbridge (89.326 km);
- Connellan Crescent Railway Overbridge (89.080 km);
- Argyle Street Rail Underbridge (86.13 km);
- Picton Viaduct (85.42 km);
- Prince Street Overbridge (85.17km);
- Picton Tunnel (87.85 km);
- Victoria Road Bridge over Stonequarry Creek; and
- Abbotsford Bridge on Barkers Lodge Road over Stonequarry Creek.

The locations of the structures and far field survey marks are shown in Drawing No. MSEC1173-00-02. Two pegs have been installed at each of the Picton Viaduct and Victoria Road Bridge as these structures span the surface expression of the Nepean Fault.

Absolute 3D surveys

Ground pegs have been installed at the above locations, with baseline absolute 3D surveys conducted on 19 December 2017. The pegs have been surveyed in absolute 3D on a monthly basis during the extraction of LW W1 and LW W2, and will continue to be surveyed monthly during the extraction of LW W3-W4.

Continuous GNSS monitoring

Global Navigation Satellite System (GNSS) units are fixed survey stations that continuously measure their absolute horizontal and vertical positions in real time.

In addition to the absolute 3D ground survey pegs, continuous GNSS monitoring units were installed at the following four sites during the extraction of Longwall 31:

- Picton Viaduct at 85.42 km – two units;
- Picton Tunnel at 87.85 km; and
- Victoria Road Bridge over Stonequarry Creek.

The two units at the Picton Viaduct have been installed in the ground at each end of the Viaduct, as this structure spans the surface expression of the Nepean Fault. The locations are shown in Drawing No. MSEC1173-00-02.

The GNSS system will record an average reading for each day and the data will be reviewed weekly during active subsidence. A more regular review of the data will be considered if significant absolute or differential movements are observed.

Monitoring will continue during the extraction of proposed LW W3-W4.

Bridge structure surveys

In addition to the far field monitoring program, monthly surveys have been conducted on prisms that have been mounted on piers, abutments and bridge decks. This includes the Thirlmere Way Underbridge, Connellan Crescent Overbridge, Argyle Street Underbridge, the Picton Viaduct, Prince Street Underbridge and Victoria Road Bridge.

Risk control measures to manage potential impacts on the railway structures are described in a separate management plan for the Main Southern Railway, which has been developed in consultation with the Australian Rail Track Corporation (ARTC). A copy of the management plan can be provided to Wollondilly Shire Council.

Rick control measures to manage potential impacts on the Victoria Bridge are described in a separate management for the Victoria Bridge, which has been developed in consultation with Transport for New South Wales. A copy of the management plan can be provided to Wollondilly Shire Council.

4.4.3. Visual inspections

Visual inspections will be undertaken during the period of active subsidence by an experienced inspector appointed by Tahmoor Coal who is familiar with mine subsidence impacts. The inspector will undertake the following:

- Visual inspections along streets within the active subsidence zone, and
- Visual inspections of culverts.

4.4.4. Structural inspections

Structural inspections will be undertaken by John Matheson if required by the IMG.

4.4.5. Changes to monitoring frequencies

Monitoring frequencies will continue while Wollondilly Shire Council infrastructure is experiencing active subsidence due to the extraction of LW W3-W4. As a general guide, monitoring is likely to continue until the longwall has moved away from the property by a distance of approximately 450 metres. Monitoring, however, may continue if ongoing adverse impacts are observed.

4.5. Triggers and Responses

Trigger levels have been developed by Tahmoor Coal based on engineering assessments and consultation with Wollondilly Shire Council.

Trigger levels for each monitoring parameter are described in the risk control procedures in Table 4.1.

Immediate responses, if triggered by monitoring results, may include:

- Increase in survey and inspection frequencies if required by the IMG;
- Additional surveys and inspections;
- Repair of impacts that create a serious public safety hazard; and
- In the worst case, restriction on entry, or access to, Wollondilly Shire Council infrastructure. This will be conducted in accordance with the Traffic Management Plan in consultation with Wollondilly Shire Council.

The risk control measures described in this Management Plan have been developed to ensure that the health and safety of people in the vicinity of council infrastructure are not put at risk due to mine subsidence. It is also an objective to avoid disruption to services, or if unavoidable, keep disruption and inconvenience to minimal levels.

With respect to the extraction of LW W3-W4, no potential hazards have been identified that could reasonably give rise to the need for an emergency response. Of the potential hazards identified in Section 3.6, only a steep slope on Thirlmere Way could possibly result in severe impacts that could give rise to the need for an emergency response. The likelihood is considered extremely remote and would require substantial differential subsidence movements to develop before such an event occurs.

As discussed in Section 3.1, mine subsidence movements will develop gradually and there will be ample time to identify the development of potentially adverse differential subsidence movements early, consider whether any additional management measures are required, and repair or adjust affected surface features, in close consultation with Wollondilly Shire Council.

As documented in Section 4.6, Tahmoor Coal and the IMG will review and assess monitoring reports and consider whether any additional management measures are required on a weekly basis. If potentially adverse differential subsidence movements are detected, it is anticipated that a focussed inspection will be undertaken in the affected area, and a decision will likely be made to increase the frequency of surveys and/or inspections. Additional management measures may also be implemented. It is therefore expected that, as a potential adverse situation escalates, Tahmoor Coal will be present on site on a more frequent basis to survey or inspect the affected site, and that Wollondilly Shire Council will be consulted on a more frequent basis.

Notwithstanding the above, if a hazard has been identified that involves potential serious injury or illness to a person or persons on public property or council infrastructure, and cannot be controlled, the immediate response is to remove people from the hazard. If such a situation is observed or is forecast to occur by either Tahmoor Coal or by people on public property, Tahmoor Coal and Wollondilly Shire Council will immediately meet and implement emergency procedures as detailed in the Traffic Management Plan.

4.6. Subsidence Impact Management Procedures

The procedures for the management of potential impacts to Wollondilly Shire Council infrastructure are provided in Table 4.1.

Table 4.1 Risk Control Procedures during the extraction of Tahmoor LW W3-W4

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Local roads	Cracking, heaving or stepping of the pavements or unsealed surfaces	Medium / Low	None	Conduct geotechnical assessment of slopes along Thirlmere Way	Complete	GHD Geotechnics
				Prepare traffic management plan for installation and measurement of survey pegs on Thirlmere Way to satisfaction of WSC	Complete	Tahmoor Coal
				Prepare traffic management plan for repair of pavements along Thirlmere Way to satisfaction of WSC	Complete	Tahmoor Coal
				Apply to Council and obtain an approved Road Occupancy Permit under Section 138 of the Roads Act prior to conducting works in the road reserve, including survey.	Complete	Tahmoor Coal
				Install Initial Goaf GNSS unit (located approximately 100 m inside the commencing end of LW W3-W4)	Prior to commencement of LW W3, install GNSS unit above start position of LW W3. Continuous readings, with data averaged over 24 hours and recorded once per day until end of LW W3. Prior to commencement of LW W3, relocate GNSS unit above start of LW W4. Continuous readings, with data averaged over 24 hours and recorded once per day until end of LW W3.	Tahmoor Coal (Unit Zero)
				2D survey lines along centrelines of LW W3-W4	Baseline survey above LW W3 complete. Monthly survey for pegs located above LW W3 within active subsidence zone after 20 mm of vertical subsidence is measured by the Initial Goaf GNSS unit, or the length of the extraction of LW W3 exceeds 200 m, whichever occurs first. Install and baseline survey above LW W4 for at least 600 m of extraction prior to commencement of LW W4. Install and baseline survey remaining pegs prior to LW W4 approaching within 400 m of pegs. Monthly survey for pegs located within active subsidence zone after 20 mm of vertical subsidence is measured by the Initial Goaf GNSS unit, or the length of the extraction of LW W3 and LW W4 exceeds 200 m, whichever occurs first. Full length at end of LW W3-W4.	Tahmoor Coal (SMEC)
				2D survey line across LW W1-W4	Baseline survey complete. Monthly survey during LW W3 and LW W4 during period of active subsidence and continue if ongoing adverse movements are observed.	Tahmoor Coal (SMEC)
				Conduct survey along Barkers Lodge Road	Baseline survey complete. End of LW W3 and LW W4.	Tahmoor Coal (SMEC)
				Conduct surveys along Connellan Crescent	Install and baseline survey prior to LW W3 approaching within 400m of street. Weekly surveys within active subsidence zone during the mining of LW W3-W4 and continue if adverse movements are observed. Full length at end of LW W3-W4.	Tahmoor Coal (SMEC)
				Conduct surveys along Stonequarry Creek Road *Survey extending to the south to include pegs within the active subsidence zone, then reducing extent to the north beyond active subsidence zone unless ongoing adverse movements are observed*	Baseline surveys complete Weekly surveys within active subsidence zone during the mining of LW W3-W4 and continue if adverse movements are observed. Full length at end of LW W3-W4.	Tahmoor Coal (SMEC)
				Conduct surveys along Booyong Close	Baseline surveys complete Weekly surveys within active subsidence zone during the mining of LW W3-W4 and continue if adverse movements are observed. Full length at end of LW W3-W4.	Tahmoor Coal (SMEC)
				Conduct surveys along Attunga Close	Baseline surveys complete Weekly surveys within active subsidence zone during the mining of LW W3-W4 and continue if adverse movements are observed. Full length at end of LW W3-W4.	Tahmoor Coal (SMEC)

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
				Conduct ground monitoring and visual inspection of Thirlmere Way, verges and the steep slope adjacent longwall finishing end. Survey includes local 2D survey along Thirlmere Way and local 2D survey of changes in horizontal distance at six cross-sections across the Thirlmere Way road pavement.	Baseline survey complete. Weekly surveys within active subsidence zone during the mining of LW W3-W4 and continue if adverse movements are observed. Full length at end of LW W3-W4.	Tahmoor Coal (SMEC)
				Conduct visual inspections for surface deformations along local roads within active subsidence zone	Weekly within active subsidence zone during period of active subsidence and continue if ongoing adverse movements are observed.	Tahmoor Coal
				Analyse and report results to IMG	Weekly during LW W3 after 20 mm of vertical subsidence is measured by the Initial Goaf GNSS unit, or the length of the extraction of LW W3 exceeds 200 metres, whichever occurs first.	Tahmoor Coal
				IMG discuss results and consider whether any additional management measures are required	Weekly during LW W3 after 20 mm of vertical subsidence is measured by the Initial Goaf GNSS unit, or the length of the extraction of LW W3 exceeds 200 metres, whichever occurs first.	Tahmoor Coal
Local roads	Cracking, heaving or stepping of the pavements or unsealed surfaces	Medium / Low	Impacts occur to pavement	Notify all stakeholders, including WSC, Tahmoor Coal, Subsidence Advisory NSW and Resources Regulator	Within one week	Tahmoor Coal / WSC
				IMG, Tahmoor Coal and WSC meet to decide whether any additional management measures are required, including: - increase in frequency of surveys and visual inspections - increase in monitoring reporting - repair pavement in accordance with Traffic Management Plans	As required (target within 48 hours)	Tahmoor Coal / WSC
				Repair road in consultation with WSC	As required	Tahmoor Coal
			A hazard has been identified that involves potential serious injury or illness to a person or persons on public property or, or WSC property and cannot be controlled	IMG, Tahmoor Coal and WSC meet to decide whether any additional management measures are required, including: - emergency evacuation of hazardous area - demarcation to prevent people entering hazardous area, including diversion of traffic	Immediately	Tahmoor Coal / WSC
				Notify SRG of trigger exceedence and any management decisions undertaken (incl Subsidence Advisory NSW, Resources Regulator)	Within 24 hours of decision	Tahmoor Coal
Drainage culverts	Cracking or spalling	Low	None	Conduct ground surveys along streets, which cross over the culverts	Refer local roads section	Tahmoor Coal (SMEC)
				Conduct visual inspection for impacts	Visual inspection once a week of culverts within the active subsidence zone	Tahmoor Coal
			Impacts occur	Notify all stakeholders, including WSC, Tahmoor Coal, Subsidence Advisory NSW and Resources Regulator	Within one week	Tahmoor Coal / WSC
				Repair culvert in consultation with WSC	As required	Tahmoor Coal

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Bridges	Damage to Bridges	Low	None	GNSS network on Main Southern Railway and Victoria Road Bridge over Stonequarry Creek	Continuous readings, with data averaged over 24 hours and recorded once per day	Tahmoor Coal
				Surveys at Thirlmere Way Rail Underbridge (89.326km)	Installed and baseline surveyed. Monthly after 200 m extraction of LW W3-W4. Absolute 3D survey at end of LW W3-W4.	Tahmoor Coal
				Surveys at Connellan Crescent Railway Overbridge (89.080km)	Installed and baseline surveyed. Monthly after 200 m extraction of LW W3-W4. Absolute 3D survey at end of LW W3-W4.	Tahmoor Coal
				Surveys at Argyle Street Rail Underbridge (86.13 km)	Monthly after 200 m extraction of LW W3-W4. Absolute 3D survey at end of LW W3-W4.	Tahmoor Coal
				Surveys at Prince Street Overbridge (85.17km)	Installed and baseline surveyed. Monthly after 200 m extraction of LW W3-W4. Absolute 3D survey at end of LW W3-W4.	Tahmoor Coal
				Surveys at Victoria Road Bridge over Stonequarry Creek	Installed and baseline surveyed. Monthly Absolute 3D survey during LW W1-W2	Tahmoor Coal
				Surveys at Bridge Street Overbridge (91.030km)	Installed and baseline surveyed. Monthly after 200 m extraction of LW W3-W4. Absolute 3D survey at end of LW W3-W4.	Tahmoor Coal
				Surveys at Remembrance Drive Road Bridge and Footbridge over Redbank Creek	Local 3D survey of installed survey marks on bridge abutments, bridge deck and spandrel walls End of LW W3 and LW W4.	Tahmoor Coal
				Surveys at Abbotsford Bridge on Barkers Lodge Road over Stonequarry Creek	Installed and baseline surveyed. Monthly after 200 m extraction of LW W3-W4. Absolute 3D survey at end of LW W3-W4.	Tahmoor Coal
				Manage potential impacts on railway bridges in accordance with Railway Management Plan, and potential impacts on Victoria Bridge in accordance with Victoria Bridge Management Plan.	-	Tahmoor Coal
			Impacts occur to WSC managed bridges	Notify all stakeholders, including Wollondilly Shire Council, Tahmoor Coal, Subsidence Advisory NSW and DRE	Within one week	Tahmoor Coal / WSC
				Conduct structural inspection	Within 48 hours	Tahmoor Coal
				Tahmoor Coal and WSC meet to decide whether any additional management measures are required, including: - increase in frequency of surveys and visual inspections - increase in monitoring reporting - repair bridge	As required (target within 48 hours)	Tahmoor Coal / WSC
				Repair bridges, pavement approaches, and/or footpath approaches in consultation with WSC	As required	Tahmoor Coal

5.1. Consultation, co-operation and co-ordination

Substantial consultation, co-operation and co-ordination has taken place between Tahmoor Coal and Wollondilly Shire Council prior to the development of this Management Plan, as detailed in Section 1.3.1.

The following procedures will be implemented during and after active subsidence of the property to ensure the continued effective consultation, co-operation and co-ordination of action with respect to subsidence between Tahmoor Coal and Wollondilly Shire Council.

- Reporting of observed impacts to Tahmoor Coal either during the weekly visual inspection or at any time directly to Tahmoor Coal;
- Distribution of monitoring reports, which will provide the following information on a weekly basis during active subsidence:
    - Position of longwall;
    - Summary of management actions since last report;
    - Summary of consultation with Wollondilly Shire Council since last report;
    - Summary of observed or reported impacts, incidents, service difficulties, complaints;
    - Summary of subsidence development;
    - Summary of adequacy, quality and effectiveness of management process;
    - Any additional and/or outstanding management actions; and
    - Forecast whether there will be any subsidence impacts to the health and safety of people due to the continued extraction of LW W3-W4.
- Convening of meetings between Tahmoor Coal and Wollondilly Shire Council at any time as required, as discussed in Section 5.2;
- Arrangements to facilitate timely repairs, if required; and
- Immediate contact between Tahmoor Coal and Wollondilly Shire Council if a mine subsidence induced hazard has been identified that involves potential serious injury or illness to a person or persons on public property or Wollondilly Shire Council property and may require emergency evacuation, entry restriction or suspension of work activities.

5.2. IMG meetings

The IMG undertakes reviews and, as necessary, revises and improves the risk control measures to manage risks to health and safety, and potential impacts to infrastructure.

The reviews are undertaken weekly during the period of active subsidence based on the results of the weekly surveys and visual inspections and summarised in the monitoring reports, as described in Section 5.1.

The purpose of the reviews are to:

- Detect changes, including the early detection of potential impacts on health and safety and impacts to council infrastructure;
- Verify the risk assessments previously conducted;
- Ensure the effectiveness and reliability of risk control measures; and
- Support continual improvement and change management.

IMG meetings may be held between Tahmoor Coal and Wollondilly Shire Council for discussion and resolution of issues raised in the operation of the Management Plan. The frequency of IMG Meetings will be as agreed between Tahmoor Coal and Wollondilly Shire Council.

IMG Meetings will discuss any incidents reported in relation to the relevant infrastructure, the progress of mining, the degree of mine subsidence that has occurred, and comparisons between observed and predicted ground movements.

It will be the responsibility of the meeting representatives to determine whether the incidents reported are due to the impacts of mine subsidence, and what action will be taken in response.

In the event that a significant mine subsidence impact is observed, any party may call an emergency IMG Meeting, with one day's notice, to discuss proposed actions and to keep other parties informed of developments in the monitoring of the infrastructure.

6.0 AUDIT AND REVIEW

This Management Plan has been agreed between parties and can be reviewed and updated to continually improve the risk management systems based on audit, review and learnings from the development of subsidence during mining and manage changes in the nature, likelihood and consequence of subsidence hazards.

The review process will be conducted to achieve the following outcomes:

- Gain an improved understanding of subsidence hazards based on ongoing subsidence monitoring and reviews, additional investigations and assessments as necessary, ongoing verification of risk assessments previously conducted, ongoing verification of assumptions used during the subsidence hazard identification and risk assessment process, ongoing understanding of subsidence movements and identified geological structures at the mine;
- Revise risk control measures in response to an improved understanding of subsidence hazards;
- Gain feedback from stakeholders in relation to managing risks, including regular input from business or property owners;
- Ensure on-going detection of early warnings of changes from the results of risk assessments to facilitate corrective or proactive management actions or the commencement of emergency procedures in a timely manner; and
- Ensure timely implementation of a contingency plan in the event that the implemented risk control measures are not effective.

Some examples where review may be applied include:

- Observation of greater impacts on surface features due to mine subsidence than was previously expected;
- Observation of fewer impacts or no impacts on surface features due to mine subsidence than was previously expected; and
- Observation of significant variation between observed and predicted subsidence.

Should an audit of the Management Plan be required during that period, an auditor shall be appointed by Tahmoor Coal to review the operation of the Management Plan and report at the next scheduled Plan Review Meeting. The Management Plan shall be audited for compliance with ISO 31000, or alternative standard agreed with Wollondilly Shire Council.

7.0 RECORD KEEPING

Tahmoor Coal will keep and distribute minutes of any IMG Meeting.

8.0 CONTACT LIST

Organisation	Contact	Phone	Email / Mail
NSW Department of Planning and Environment – Resources Regulator	Phil Steuart	(02) 4063 6484	phil.steuart@planning.nsw.gov.au
	Gang Li	(02) 4063 6429 0409 227 986	gang.li@planning.nsw.gov.au
	Ray Ramage	(02) 4063 6485 0442 551 293	ray.ramage@planning.nsw.gov.au
Subsidence Advisory NSW	Matthew Montgomery	(02) 4677 1967 0425 275 564	Matthew.Montgomery@customerservice.nsw.gov.au
Mine Subsidence Engineering Consultants (MSEC)	Daryl Kay*	(02) 9413 3777 0416 191 304	daryl@minesubsidence.com
SIMEC Mining Tahmoor Coal Project Manager	Ross Barber*	(02) 4640 0028 0419 466 143	ross.barber@simecgfg.com
SIMEC Mining Tahmoor Coal Approvals Specialist	April Hudson*	(02) 4640 0022 0466 380 992	April.Hudson@simecgfg.com
Wollondilly Shire Council Manager - Works	Nafizul Akash	(02) 4677 1100	nafizul.akash@wollondilly.nsw.gov.au
Wollondilly Shire Council Manager – Infrastructure, Strategy and Planning	Mike Nelson*	(02) 4677 1180	mike.nelson@wollondilly.nsw.gov.au

* denotes member of Infrastructure Management Group

APPENDIX A. Drawings and Supporting Documentation

The following supporting documentation is provided in Appendix A.

Drawings

Drawing No.	*Description*	*Revision*
MSEC1173-00-01	Monitoring plan	02
MSEC1173-00-02	Far field monitoring	01
MSEC1173-02-01	Local roads, culverts and bridges	01

Supporting Documentation

Traffic Professionals (2018) Traffic management plans for Tahmoor Coal near 700 Thirlmere Way, Picton.

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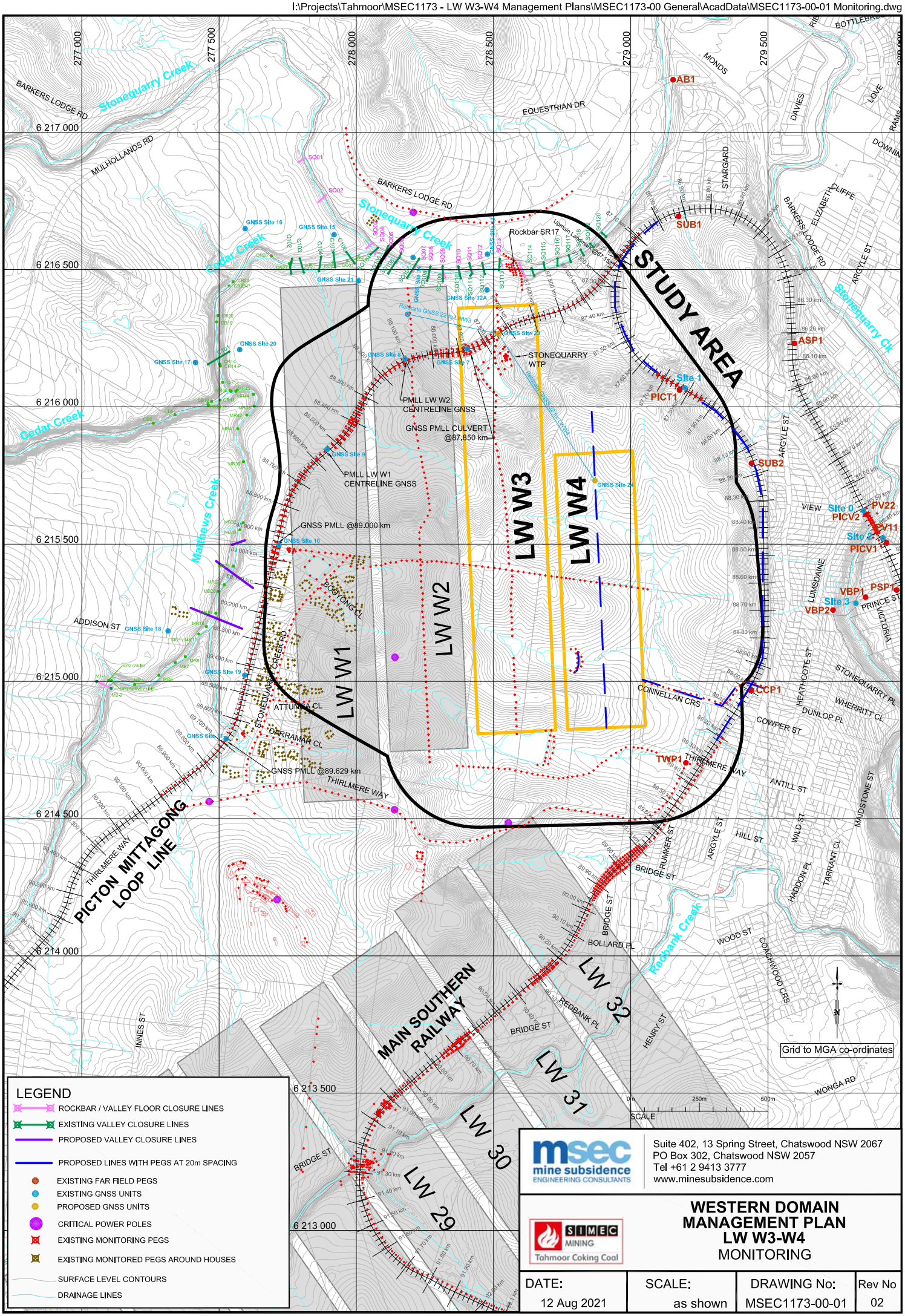

LEGEND

- ROCKBAR / VALLEY FLOOR CLOSURE LINES
- EXISTING VALLEY CLOSURE LINES
- PROPOSED VALLEY CLOSURE LINES
- PROPOSED LINES WITH PEGS AT 20m SPACING
- EXISTING FAR FIELD PEGS
- EXISTING GNSS UNITS
- PROPOSED GNSS UNITS
- CRITICAL POWER POLES
- EXISTING MONITORING PEGS
- EXISTING MONITORED PEGS AROUND HOUSES
- SURFACE LEVEL CONTOURS
- DRAINAGE LINES

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SIMEC MINING
Tahmoor Coking Coal

WESTERN DOMAIN MANAGEMENT PLAN LW W3-W4 MONITORING

DATE:	SCALE:	DRAWING No:	Rev No
12 Aug 2021	as shown	MSEC1173-00-01	02

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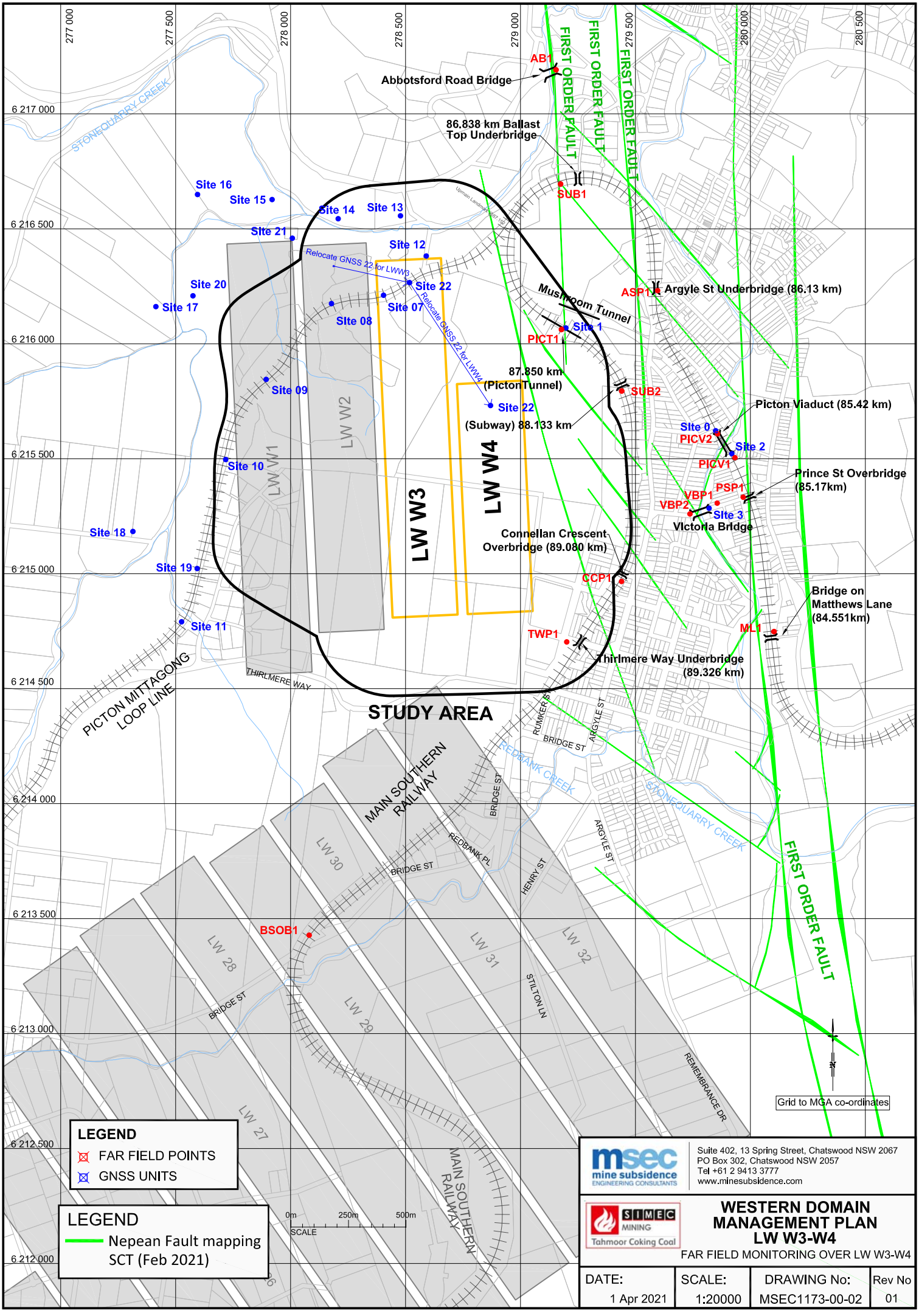

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SIMEC MINING Tahmoor Coking Coal

WESTERN DOMAIN MANAGEMENT PLAN LW W3-W4

FAR FIELD MONITORING OVER LW W3-W4

DATE:	SCALE:	DRAWING No:	Rev No
1 Apr 2021	1:20000	MSEC1173-00-02	01

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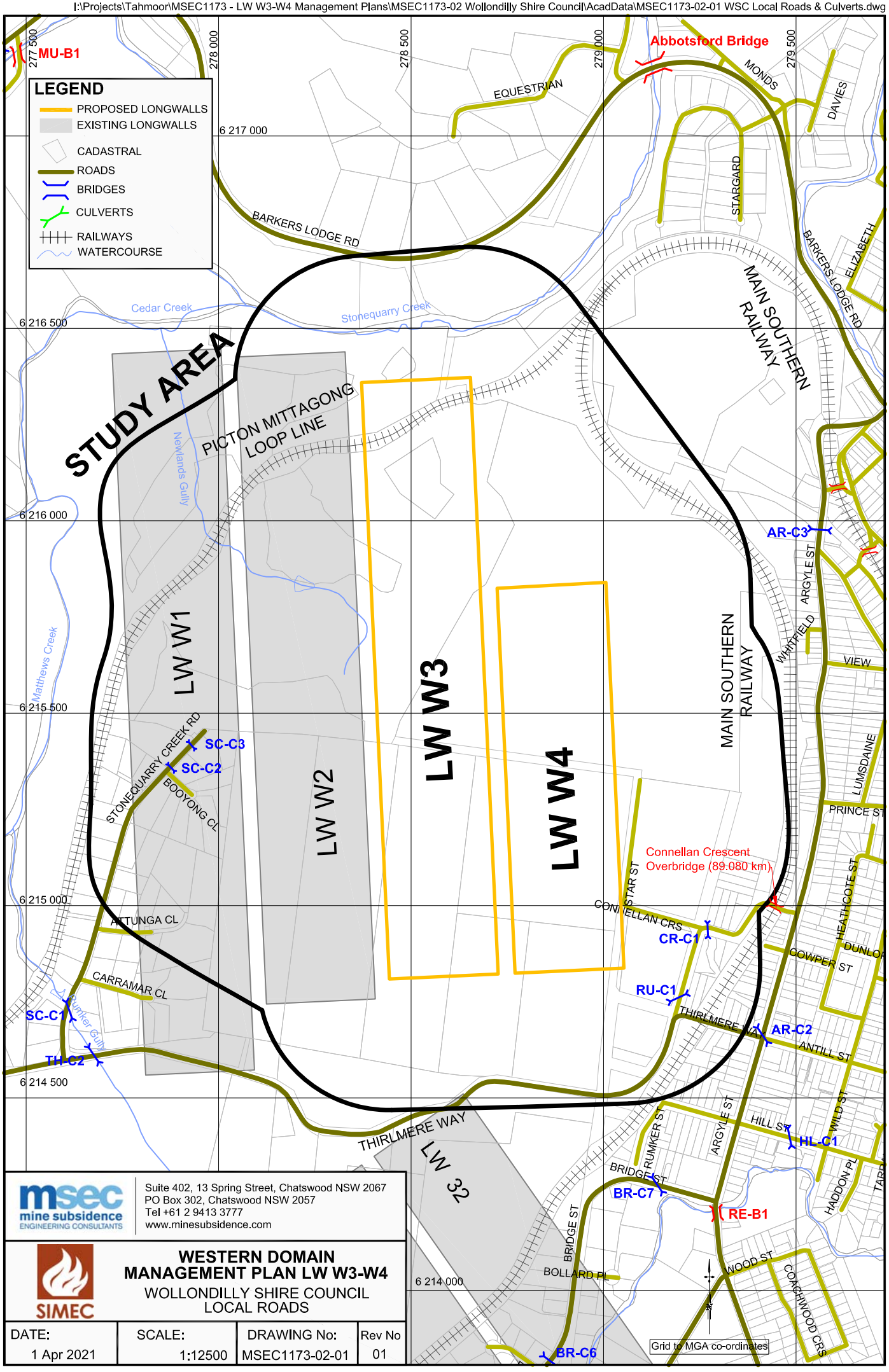

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SIMEC

WESTERN DOMAIN MANAGEMENT PLAN LW W3-W4

WOLLONDILLY SHIRE COUNCIL LOCAL ROADS

DATE:	SCALE:	DRAWING No:	Rev No
1 Apr 2021	1:12500	MSEC1173-02-01	01

Major Project Risk Assessment: Tahmoor Underground - Extraction Plan LW W3-W4

	Step 2: Assess Type; Key Elements-These change depending on TYPE of Risk Assessment	Step 3: Identify the risks, causes and potential consequences	Step 4: Identify the existing controls to manage the identified risks	Step 5: Determine RCE	Steps 6, 7 & 8: Determine the Expected Consequence / Likelihood applicable to the Expected Consequence / Current level of risk	Step 10: PMC	Step 11: Treat the Risks

☑ Appendix B

Site	Type of Risk Assessment	Key Element (CURA Context/Category)	Sub Key Element (If applicable)	Risk Description - Something happens.....	Consequence - resulting in:	Causes - Caused by	Existing Control Description	Risk Control Effectiveness	Expected Consequence Category	Expected Risk Consequence	Risk Likelihood	Current Risk Rating	Potential Maximum Consequence	Potential Maximum Category	Treatment plans/tasks (Description)	Task Owner	Due Date	Comments
Tahmoor Underground	Major Project	Built Infrastructure	Council Infrastructure	Minor cracking or heaving of pavement, kerbs and gutters	Slight damage to road, requiring repair. Reduced maintenance life	Subsidence	* Management Plans prepared for previous longwalls (AC) * Previous ground survey and visual inspection as part of LW 22-W2 management (AC) * Previous consultation, coordination and cooperation with Wollondilly Shire Council (AC)	2	Property Damage	2	E	3	2	Property Damage	Complete Wollondilly Shire Council Management Plan including TARP	April Hudson	01-Sep-21	
Tahmoor Underground	Major Project	Built Infrastructure	Council Infrastructure	Major cracking or heaving of pavement, kerbs and gutters	Extensive damage to road, requiring emergency repair and extension rehabilitation	Subsidence	* Management Plans prepared for previous longwalls (AC) * Previous ground survey and visual inspection as part of LW 22-W2 management (AC) * Previous consultation, coordination and cooperation with Wollondilly Shire Council (AC)	2	Property Damage	3	E	6	3	Property Damage	Complete Wollondilly Shire Council Management Plan including TARP	April Hudson	01-Sep-21	
Tahmoor Underground	Major Project	Built Infrastructure	Council Infrastructure	Slope instability causing loss of support to road	Tension cracking in road surface requiring repair or damage to roadway barriers (Tension to cables)	Subsidence	* Management Plans prepared for previous longwalls (AC) * Previous ground survey and visual inspection as part of LW 31-W2 management (AC) * Previous consultation, coordination and cooperation with Wollondilly Shire Council (AC) * Pre mining Geotechnical assessment conducted for LW 32 (EC) * Traffic management plan for any work on Thirlmere Way to satisfaction of WSC (AC)	2	Health & Safety	2	D	5	2	Health & Safety	Complete Wollondilly Shire Council Management Plan including TARP	April Hudson	01-Sep-21	
Tahmoor Underground	Major Project	Built Infrastructure	Council Infrastructure	Damage to bridges	Loss of serviceability	Subsidence	* Management Plans prepared for previous longwalls (AC) * Previous ground survey and visual inspection as part of LW W1-W2 management (AC) * Previous consultation, coordination and cooperation with Wollondilly Shire Council (AC) * Survey's currently on bridges (AC)	2	Financial	2	E	3	2	Financial	Complete structural engineering review of bridges	April Hudson	01-Sep-21	
Tahmoor Underground	Major Project	Built Infrastructure	Council Infrastructure	Damage to culverts and stormwater infrastructure	Reduced maintenance life; sealing / localised repair or loss of serviceability requiring emergency repair and/or replacement of culverts	Subsidence	* Management Plans prepared for previous longwalls (AC) * Previous ground survey and visual inspection as part of LW 22-W2 management (AC) * Previous consultation, coordination and cooperation with Wollondilly Shire Council (AC)	2	Property Damage	2	E	3	2	Property Damage	Complete Wollondilly Shire Council Management Plan including TARP	April Hudson	01-Sep-21	
5	5			5	5	Subtotal CountA (ignoring hidden values)		5				5	5					

Tahmoor Underground	Broad Brush											#N/A						
Tahmoor Underground	Life of Mine											#N/A						
Tahmoor Underground	Business																	
Tahmoor Underground	Major Project											#N/A						
Tahmoor Underground	Environmental/Health/Process											#N/A						
Tahmoor Underground	Equipment											#N/A						

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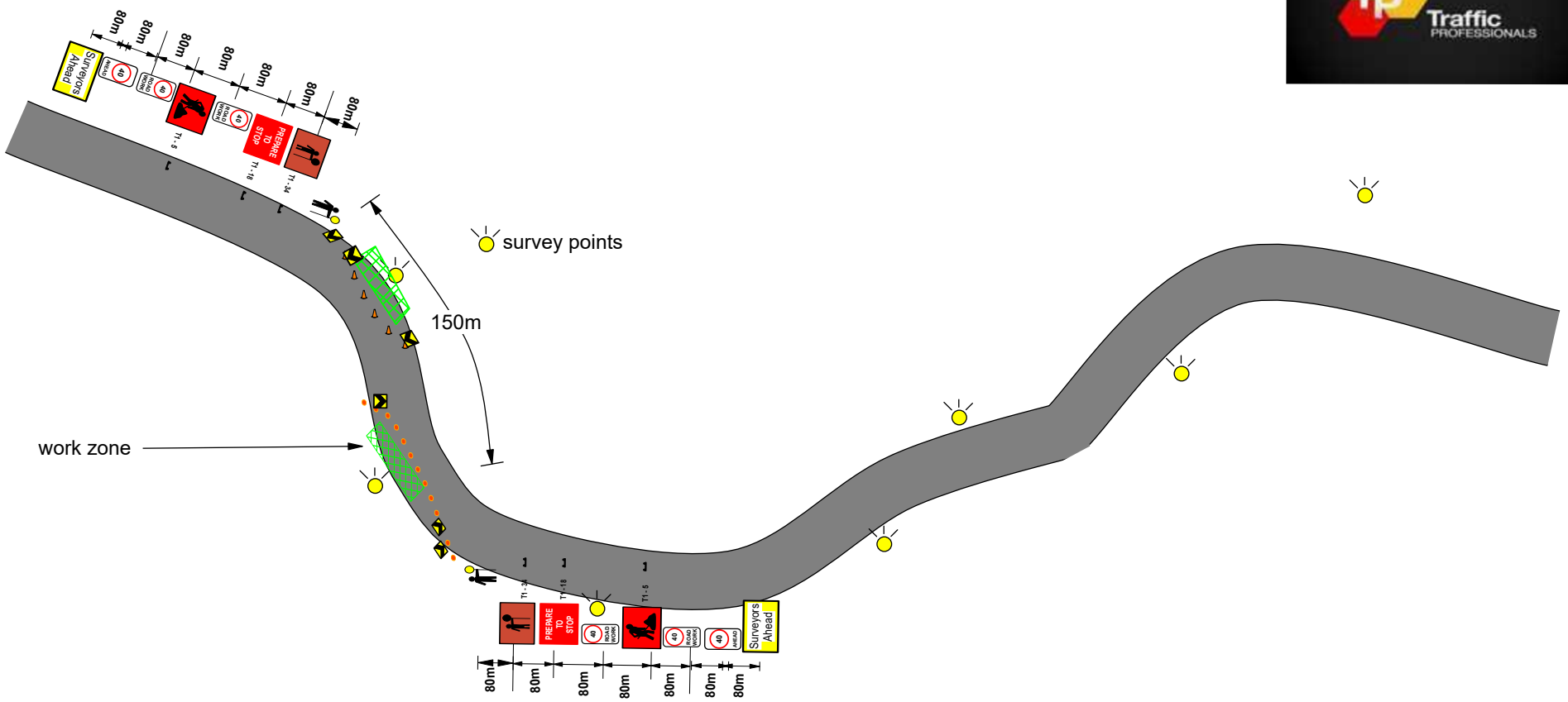

Date: 26.02.18 **Author:** David Del Tufo #36366734 EXP 29/11/19 **Project:** Tahmoor Coal - 700 Thirlmere Way, Picton

Comments:

2 Lane - 2 way- Closure of one lane - Short Term . Modified TCP 83

TCP compliant with RMS TCAWS 2010 and AS 1742.3. Sign size A & B. Delineation of traffic cones is 3m Taper and 10m workzone.

1. Existing speed at 60 and 80km/hr. Work zone approx 300m.
2. See Traffic Control at Work Sites, Section 3.2.1, Duplication of signs. Workers within 1.2m of live traffic.
3. Works are for marking survey points, installing survey pegs and maintenance of survey pegs.
3. Multiple sites to set up. Sign setups are not to scale.