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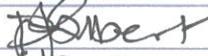
**Tahmoor North Western Domain
Longwalls West 1 and West 2**

Management Plan for Potential Impacts to Jemena Gas Infrastructure

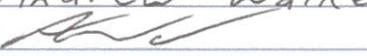


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References:-

	AS/NZS ISO 31000:2009 Risk Management – Principles and guidelines
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 (2019)	Tahmoor Coal - Longwalls W1 and W2 - Subsidence Predictions and Impact Assessments for Natural and Built Features due to the Extraction of the Proposed Longwalls W1 and W2 in Support of the Extraction Plan Application. (Report No. MSEC1019, Revision B, July 2019), prepared by Mine Subsidence Engineering Consultants.
Tahmoor Coal (2019)	Risk Assessment Report – Infrastructure. Tahmoor North – Western Domain, Longwalls West 1 and West 2, April 2019.

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Drawing No.	Description	Revision
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MSEC1045-05-01	Jemena Gas Pipelines	01

1.1. Background

Tahmoor Coal is located approximately 80 km south-west of Sydney in the township of Tahmoor NSW. It is managed and operated by SIMEC Mining. Tahmoor Coal has previously mined 31 longwalls to the north and west of the mine's current location. It is currently mining Longwall 32.

Longwalls West 1 and West 2 (LW W1-W2) are the first two longwalls to be mined in the Western Domain. The longwall panels are located to the north of the current longwall series, and to the south of Cedar and Stonequarry Creeks. Infrastructure owned by Jemena is located within this area.

A summary of the dimensions of LW W1-W2 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 W1	1875	283	-
LW W2	1685	283	39

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

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 Jemena.

1.2. Jemena assets potentially affected by LW W1-W2

A map showing the locations of Jemena infrastructure in relation to LW W1-W2 is shown in Drawing No. MSEC1045-05-01.

The gas infrastructure comprises buried 32 mm, 50 mm and 75 mm nylon (NY) pipelines along Thirlmere Way, Stonequarry Creek Road, Carramar Close, Attunga Close and Booyong Close. The pipelines are partly located above the southern end of LW W1. The total length of gas pipelines located above the longwall is approximately 650 metres.

1.3. Consultation

1.3.1. Consultation with Jemena

Tahmoor Coal regularly consults with Jemena in relation to mine subsidence effects from mining. This includes consultation during the development of subsidence management plans for previous Longwalls 22 to 32, and regular reporting of subsidence movements and impacts.

Details regarding consultation and engagement are outlined below:

- Discussion with Andrew Walker (Jemena), David Talbert (Tahmoor Coal), April Hudson (Tahmoor Coal) and Daryl Kay (MSEC) via email in August 2019 regarding the draft Subsidence Management Plan for LW W1-W2.

Tahmoor Coal will continue to consult regularly with Jemena during the extraction of LW W1-W2 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 Wollondilly Shire Council, Endeavour Energy, Sydney Water, and Telstra 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. MSEC1019 by Mine Subsidence Engineering Consultants (MSEC, 2019). Predictions are based on the planned configuration of LW W1-W2 at Tahmoor Coal (as shown in Drawing No. MSEC1045-05-01), along with available geological information and data from numerous subsidence studies for longwalls previously mined in the area.

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

The impacts of mining on surface and sub-surface features have been assessed in detail. It is recognised, however, 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 MSEC1019 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 Jemena gas infrastructure.

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 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, Jemena, relevant government agencies as required, and consultants as required.
- 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 items of Jemena infrastructure identified to be at risk due to mine subsidence and to ensure that the health and safety of people who may be present in the vicinity or on Jemena property are not put at risk due to mine subsidence. The major items at risk are:-

- Local nylon (NY) gas pipelines; and
- Gas pipelines at creek crossings.

The gas pipelines are shown in Drawing No. MSEC1045-05-01 classified by pipe size and by pipe type.

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 W1-W2 only. The management plan does not include other gas infrastructure owned by Jemena which lies outside the extent of this area.

1.7. Proposed Mining Schedule

It is planned that LW W1-W2 will extract coal working south from the northern end. This Management Plan covers longwall mining until completion of mining in LW W2 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 W1	October 2019	August 2020
LW W2	September 2020	May 2021

Please note the above schedule is subject to change due to unforeseen impacts on mining progress. Tahmoor Coal will keep Jemena 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.

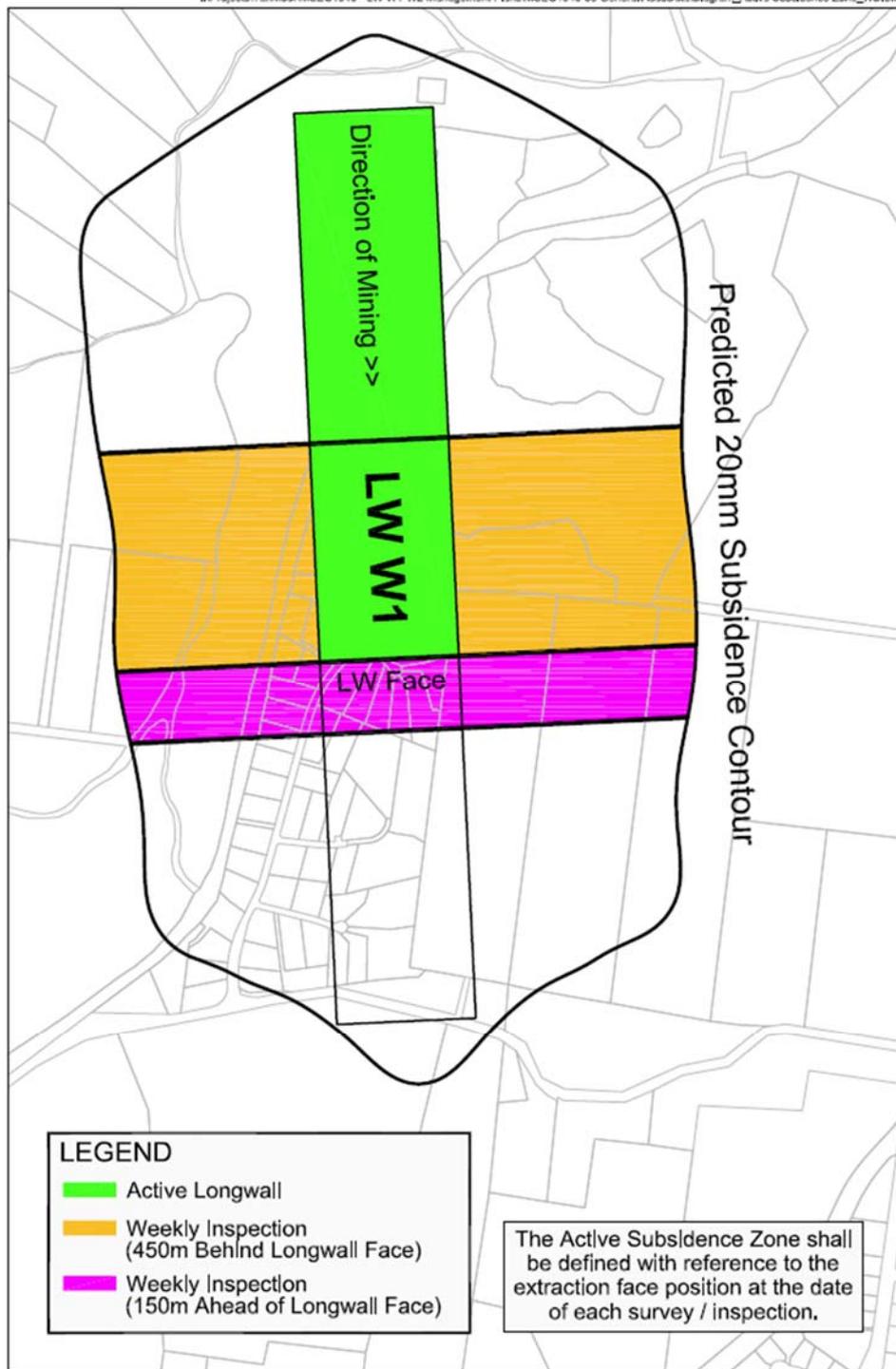


Fig. 1.1 Diagrammatic Representation of Active Subsidence Zone

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 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 W1-W2 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. MSEC1019, which was prepared in support of Tahmoor Coal's Extraction Plan for LW W1-W2. A summary of the maximum predicted total subsidence parameters due to the extraction of LW W1-W2 are provided in Table 3.1.

Table 3.1 Maximum predicted conventional subsidence parameters for LW W1-W2

Longwall	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)
After LW W1	475	3.0	0.03	0.06
After LW W2	750	5.5	0.06	0.11

The values provided in the above table are the maximum predicted conventional subsidence parameters which occur within the general mining area.

3.2. Comparison of measured and predicted subsidence for single panels

Predictions using MSEC's Incremental Profile Method have been continually tested and refined during the mining of previous Longwalls 22 to 31, as described in Report No. MSEC1019.

In this case, LW W1-W2 will be extracting in a new longwall series, which is located to the north of current LW 32.

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. MSEC1019.

Whilst a reasonable correlation between measured and predicted subsidence was found for LW 22, which was the most recently extracted single panel in the Tahmoor North lease, a study of the overall history of subsidence above single panels at Tahmoor Mine found that actual subsidence above LW W1 could be greater than predicted. There are also other cases in the Southern Coalfield where measured subsidence above a single panel has been substantially less than predicted.

It is therefore planned to monitor the development of subsidence during the early stages of extraction of LW W1 to compare observations with predictions. This will initially be achieved by regular surveys along the centreline of LW W1, followed by monitoring of subsidence along the Picton-Mittagong Loop Line and survey lines along local roads.

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 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 maximum predicted curvatures and the maximum predicted 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, instead of just providing a single predicted conventional strain.

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

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 31 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. 3.1. 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.

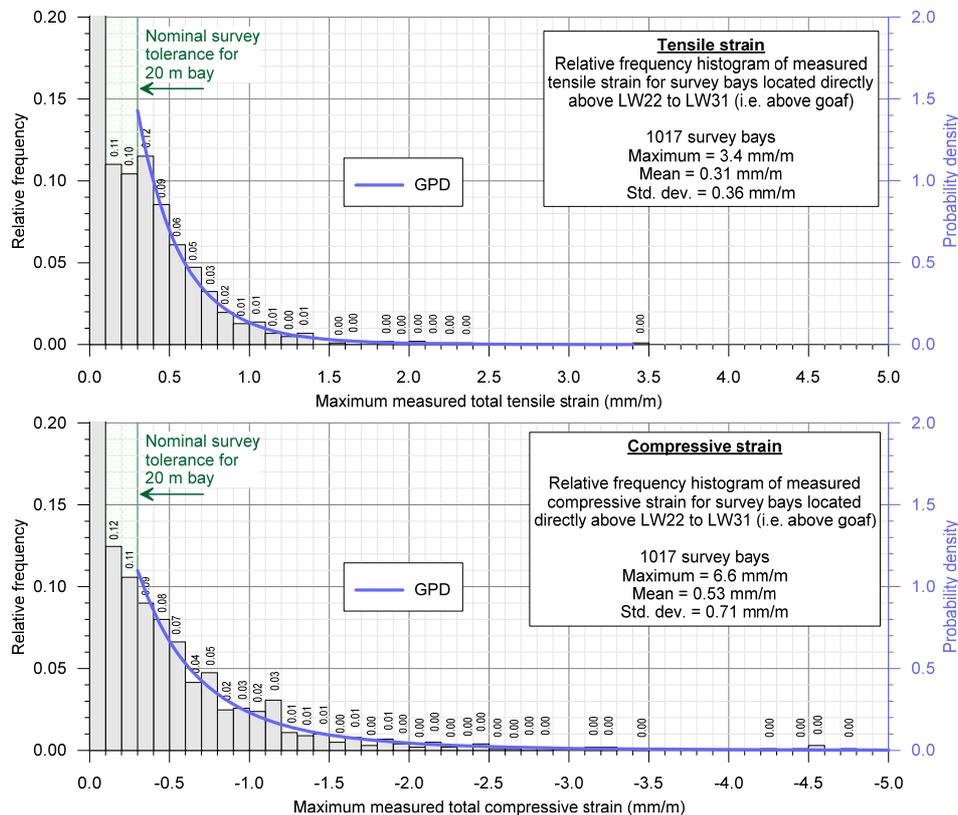


Fig. 3.1 Distributions of the maximum measured tensile and compressive strains during the extraction of previous longwalls for survey bays located above goaf

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 1.8 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 are 1.6 mm/m tensile and 3.4 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 Longwalls 22 to 31 at Tahmoor Mine, for survey bays that were located outside and within 200 metres 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. 3.2. The probability distribution functions, based on the fitted GPDs, have also been shown in this figure.

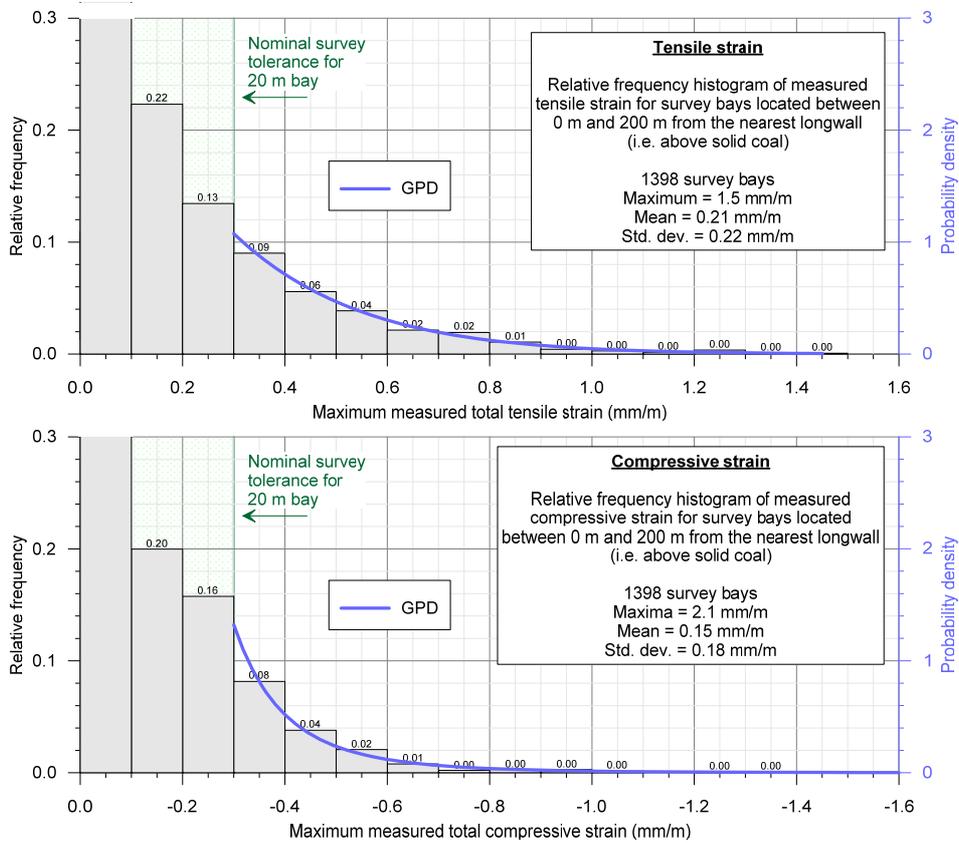


Fig. 3.2 Distributions of the maximum measured tensile and compressive strains during the extraction of previous longwalls for survey bays located above solid coal

The 95 % confidence levels for the maximum total strains that the individual survey bays *above solid coal* experienced at any time during mining are 0.7 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 are 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 observed strains along whole monitoring lines, rather than for individual survey bays. That is, an analysis of the maximum strains measured anywhere along the monitoring lines, regardless of where the strain actually occurs.

The histogram of maximum observed total tensile and compressive strains measured anywhere along the monitoring lines, at any time during or after the extraction of Longwalls 22 to 31 at the mine, is provided in Fig. 3.3.

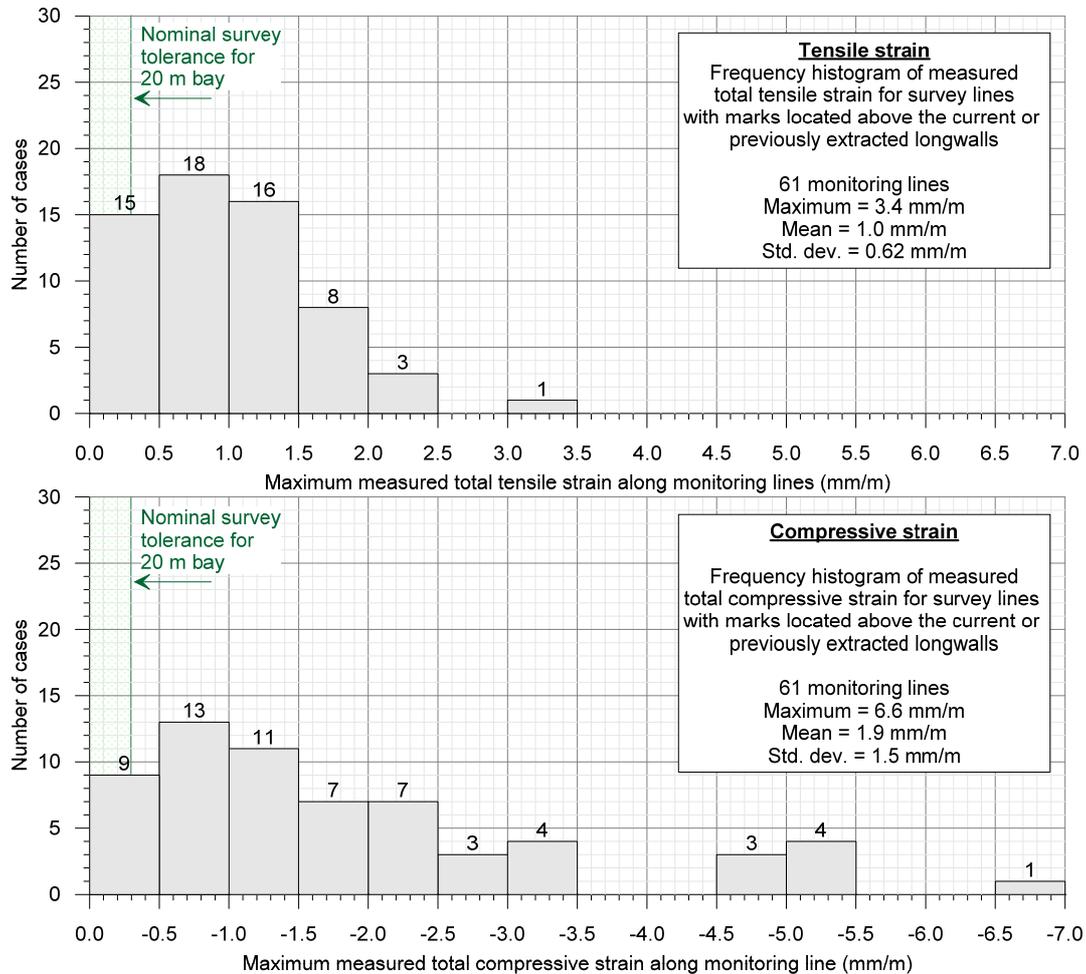


Fig. 3.3 Distributions of maximum measured tensile and compressive strains along monitoring lines during the extraction of previous longwalls at the mine

It can be seen from the above figure, that 33 of the 61 monitoring lines (i.e. 54 %) had recorded maximum total tensile strains of 1.0 mm/m, or less, and that 57 monitoring lines (i.e. 93 %) had recorded maximum total tensile strains of 2.0 mm/m, or less. It can also be seen, that 40 of the 61 monitoring lines (i.e. 66 %) had recorded maximum compressive strains of 2.0 mm/m, or less, and that 54 of the monitoring lines (i.e. 89 %) had recorded maximum compressive strains of 4.0 mm/m, or less.

3.4. Managing Public Safety

The primary risk associated with mining beneath Jemena infrastructure is public safety. Tahmoor Coal has previously directly mined beneath or adjacent to more than 1900 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.

3.4.1. Subsidence Impact Management Process for Infrastructure

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

1. Regular consultation with Jemena before, during and after mining.
2. Site-specific investigations.
3. Implementation of mitigation measures following inspections by Jemena.
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
 - 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 Jemena infrastructure experiences mine subsidence movements is shown in Fig. 3.4.

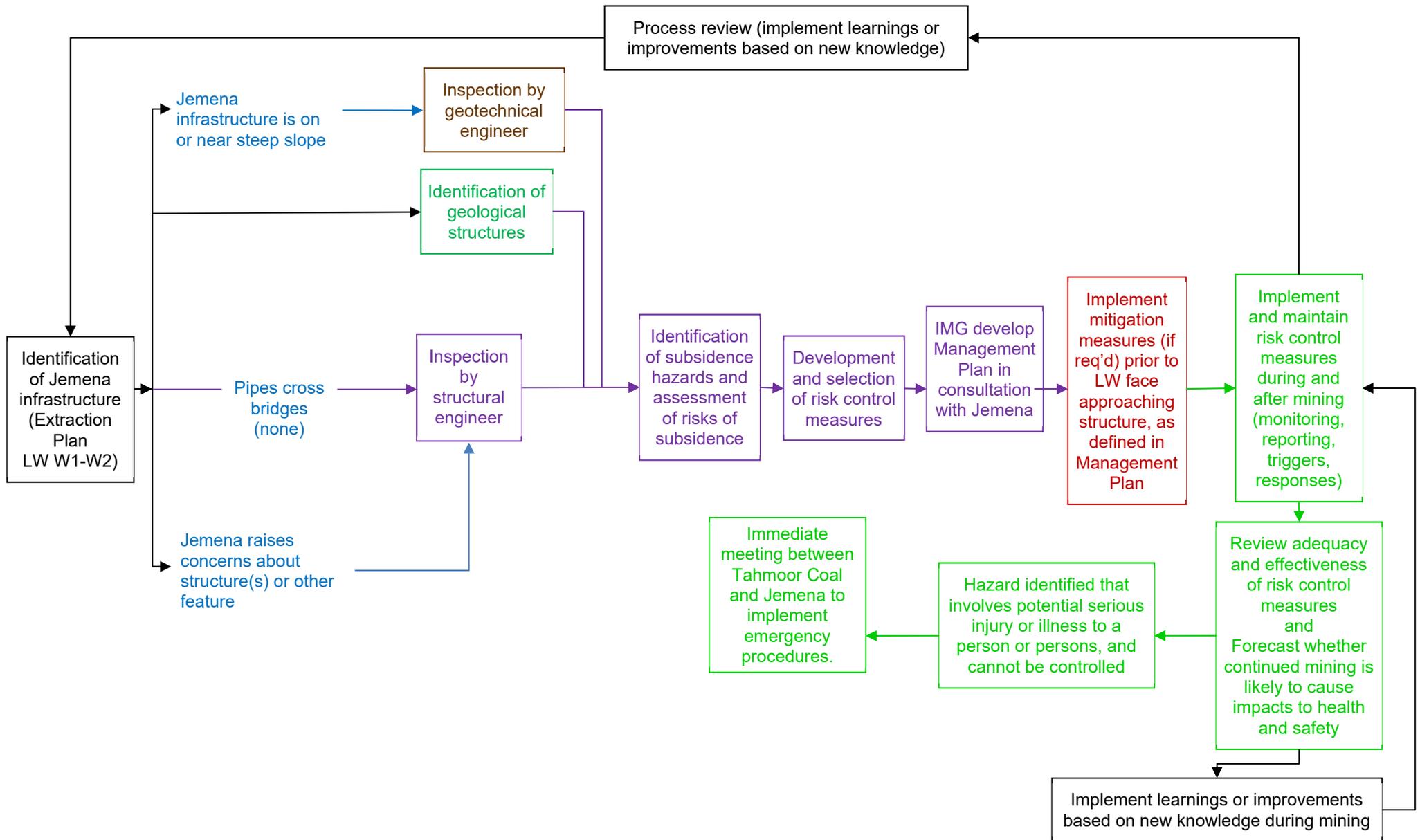


Fig. 3.4 Flowchart for Subsidence Impact Management Process

3.5. Summary of Potential Impacts

A summary of potential impacts on Jemena infrastructure is provided in Table 3.2. The summary is consistent with the risk assessment undertaken by Tahmoor Coal (2019). 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
Damage resulting in gas leak	UNLIKELY	NEGLIGIBLE	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 rise to risks to health and safety of people in the vicinity of Jemena 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 Section 3.7 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 nylon (NY) gas pipelines; and
- Gas pipelines at creek crossings.

The following mine subsidence hazards were identified that could give rise to risks to health and safety on Jemena infrastructure due to the extraction of LW W1-W2.

- Potential damage to pipes resulting in a gas leak (refer Section 3.7).

The identification and risk assessment process took into account the location of infrastructure relative to LW W1-W2 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 Coal 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 Jemena infrastructure, as discussed in Section 1.4 and Chapter 3 of this Management Plan. In this case, creeks have been mapped that intersect gas pipelines.

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 Jemena infrastructure in general. These are described in Chapter 4 of this Management Plan.

3.7. Gas pipelines

There are a number of gas pipelines that are located directly above or adjacent to LW W1-W2, as shown in Drawing No. MSEC1045-05-01.

A network of 32 mm to 75 mm diameter nylon (NY) gas pipelines are located directly above and adjacent to LW W1. The pipelines are shown in Jemena maps Mowbray Park 9A and 9C. The pipelines follow the alignments of local roads, including Thirlmere Way, Stonequarry Creek Road, Carramar Close, Attunga Close and Booyong Close. One branch also follows a driveway easement to service a property on Stonequarry Creek Road.

The 50 mm diameter pipe traverses Rumker Gully near the intersection of Thirlmere Way and also crosses small valleys along Stonequarry Creek Road at Carramar Close and Booyong Close.

On 24 April 2019, Macarthur Gas completed a pre-mining gas detection survey of pipelines that are located within the Study Area shown in Drawing No. MSEC1045-05-01. No leaks were recorded.

3.7.1. Predicted subsidence movements

The gas pipelines located above and adjacent to LW W1-W2 generally follow the alignments of the local roads.

The predicted profiles of conventional subsidence, tilt and curvature for the gas pipeline along Stonequarry Creek Road is shown in Fig. 3.5.

A summary of the maximum predicted conventional subsidence, tilt and curvature for each of the gas pipelines, after the extraction of LW W1-W2, is provided in Table 3.3. The values are the maximum predicted parameters anywhere along the sections of pipelines located within the predicted limit of vertical subsidence for LW W1-W2.

Table 3.3 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 W1	425	2.0	0.02	0.05
After LW W2	700	3.0	0.03	0.05

The gas pipelines cross small tributaries directly above LW W1, including Rumker Gully and, therefore, could experience valley related effects.

The predicted profiles of total vertical subsidence, upsidence and closure along Rumker Gully are shown in Fig. 3.6. The maximum predicted valley related effects for the pipeline crossing at Stonequarry Creek Road are 50 mm upsidence and closure.

The maximum predicted valley related effects for the pipeline crossings along Stonequarry Creek Road at Carramar Close and Booyong Close are also 50 mm upsidence and closure.

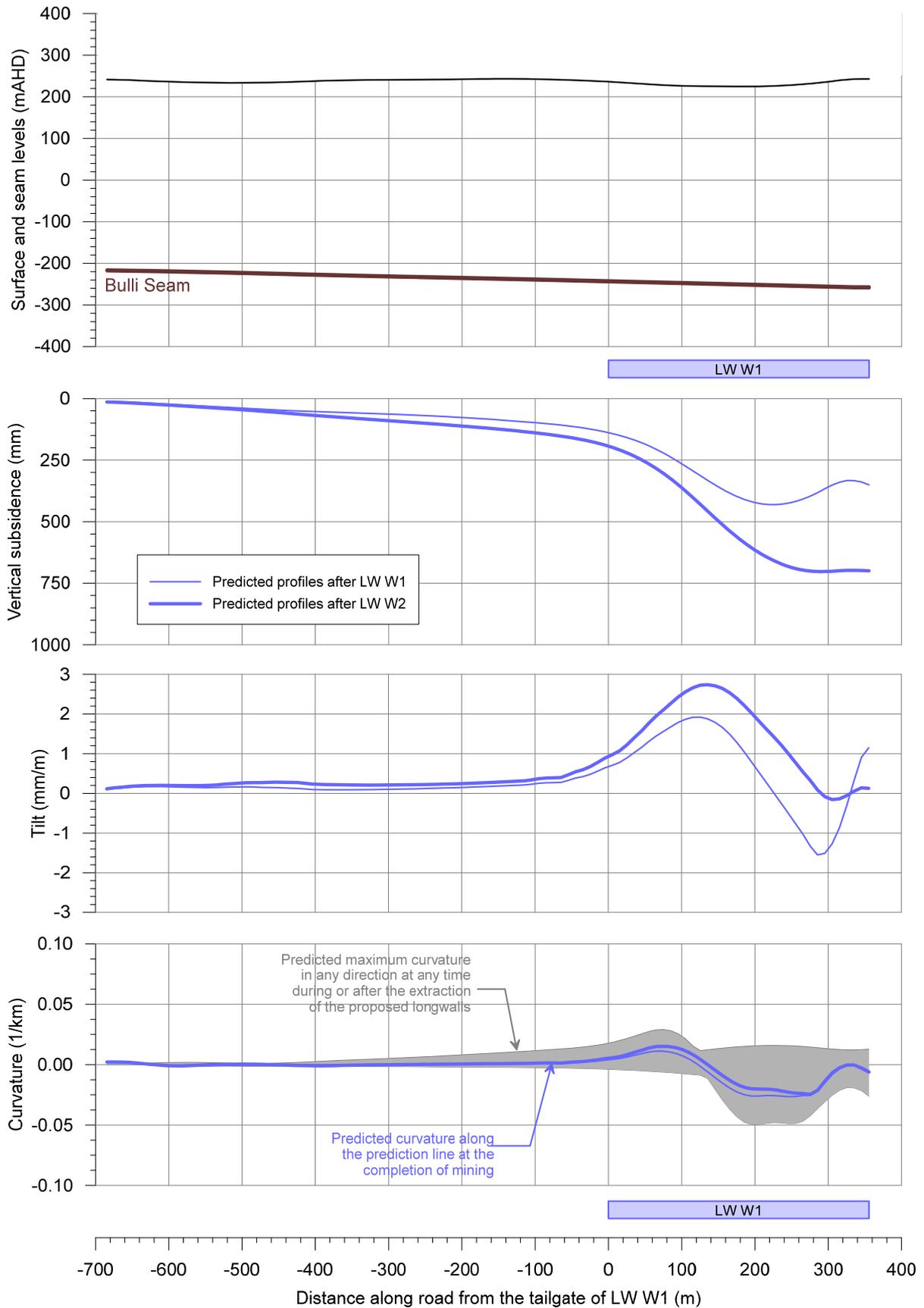


Fig. 3.5 Predicted profiles of total subsidence, tilt and curvature for the gas pipeline along Stonequarry Creek Road after the mining of LW W1-W2

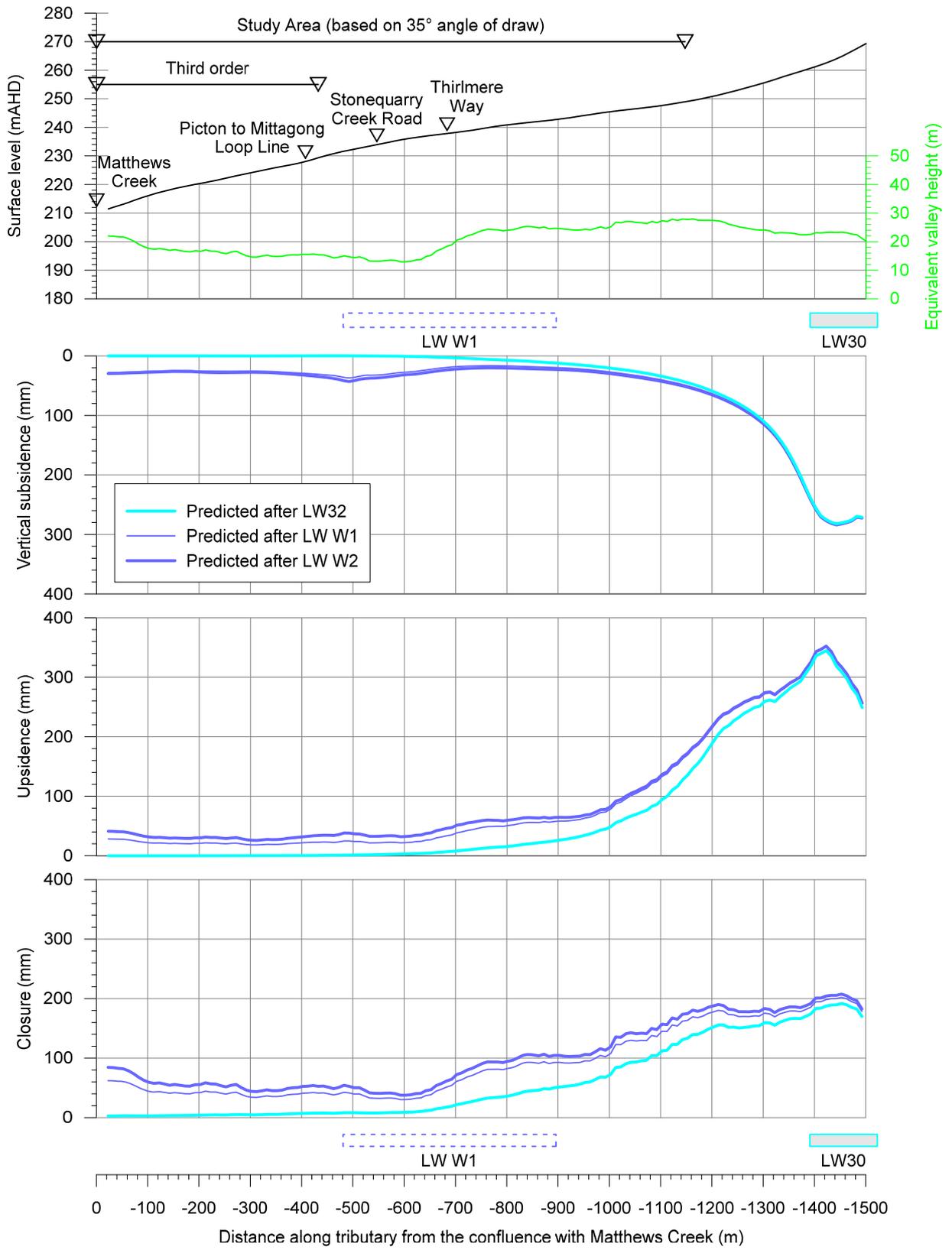


Fig. 3.6 Predicted profiles of total subsidence, upsidence and closure along Rumker Gully after the mining of LW W1-W2

3.7.2. Potential subsidence impacts on gas pipelines

Longwalls 22 to 32 have directly mined beneath approximately 19 km of gas pipelines and no adverse impacts have been reported to date. The local NY pipelines are very flexible and have demonstrated that they can withstand the full range of subsidence experienced at Tahmoor Mine.

The experiences include the extraction of Longwall 25 beneath Abelia Street, where a large compressive strain of 6.5 mm/m (over a 22 m bay length) was measured between Marks A12 and A13, coinciding with a vertical bump in the subsidence profile and a hump in the road pavement. No impacts on the local gas pipelines were reported.

It is possible, but unlikely, that minor adverse impacts could occur to the gas infrastructure that is located directly above or immediately adjacent to LW W1-W2. It is expected that the impacts would be relatively minor and that these could be readily repaired.

While no adverse impacts to the gas pipelines have been experienced to date, most vulnerable elements of the system are considered to be the rigid copper pipe connections between the gas mains and properties, and joints in the nylon pipes at T-intersections. However, there are only short sections of the local gas pipeline located directly above LW W1 and, hence, there is a limited number of rigid copper pipe connections.

Tahmoor Coal has developed and selected risk control measures in consultation, co-ordination and co-operation with Jemena in accordance with WHS legislation. The controls have been implemented during the mining of Longwalls 22 to 32.

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 damage to pipelines resulting in gas leaks during the extraction of LW W1-W2 by implementing the following measures.

- Pre-mining gas detection survey of gas pipelines potentially affected by the extraction of LW W1-W2 (completed);
- Regular ground surveys along streets located within the active subsidence zone;
- Regular visual inspections along streets located within the active subsidence zone;
- Regular consultation with the community to report potential impacts. As the gas has been odourised, the community are more likely to report gas leaks if they occur;
- Additional inspections and gas patrols if triggered by observations of increased ground strains, ground curvature or localised surface deformations;
- Exposing pipeline to relieve it of stress if triggered by monitoring results; and
- In the worst case, repair of damaged pipeline by temporary squeezing off the pipeline, and replacing the damaged section.

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 Jemena 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 landowner 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 W1-W2.

4.3. Selection of Risk Control Measures for Gas Infrastructure

Based on its own assessments, 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 health and safety of people in relation to mining-induced damage to gas infrastructure:

- Implementation of a Monitoring Plan and Trigger Action Response Plan (TARP)
As described in the Management Plan, Tahmoor Coal and Jemena 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:
 - Pre-mining gas detection survey within the area potentially affected by the extraction of LW W1-W2 (completed).
 - Local 2D surveys along local roads as shown in Drawing No. MSEC1045-00-01. These include streets along which gas pipelines are located, including Thirlmere Way, Stonequarry Creek Road, Carramar Close, Attunga Close and Booyong Close.
 - Visual inspections along the streets within the active subsidence zone.
 - Additional surveys and/or inspections, if triggered by monitoring results.
 - Regular consultation with the community to report potential impacts. As the gas has been odourised, the community are more likely to report gas leaks if they occur.
 - Gas detection patrols, if triggered by monitoring results.
 - Additional inspections and gas patrols by Jemena if triggered by observations of increased ground strains, ground curvature or localised surface deformations
 - Exposing pipeline to relieve it of stress if triggered by monitoring results
 - In the worst case, repair of damaged pipeline by temporary squeezing off the pipeline, and replacing the damaged section.
 - Follow Jemena procedures to monitor and respond to impacts.

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 W1-W2

Survey lines will be installed along the centrelines of LW W1-W2, as shown in Drawing No. MSEC1045-00-01, subject to approval for access by landowners.

The purpose of the survey lines is to establish the general magnitude and shape of surface subsidence along the centrelines of LW W1-W2. 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 central to southern end of LW W1-W2. 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 will be installed along Barkers Lodge Road, Thirlmere Way, Stonequarry Creek Road, Carramar Close, Attunga Close and Booyong Close, as shown in Drawing No. MSEC1045-00-01. The survey pegs will be surveyed during the period of active subsidence of these features during the extraction of LW W1-W2.

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

4.4.2. 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.
- Visual inspections of roads at creek crossings.

4.4.3. Gas Patrols

On 24 April 2019, Macarthur Gas completed a pre-mining gas detection survey of pipelines that are located within the Study Area shown in Drawing No. MSEC1045-05-01. No leaks were recorded.

Additional gas detection surveys can be undertaken if triggered by monitoring results.

4.4.4. Changes to Monitoring Frequencies

Monitoring frequencies will continue while Jemena infrastructure is experiencing active subsidence due to the extraction of LW W1-W2. As a general guide, monitoring is likely to continue until the longwall has moved away from a site 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 Jemena.

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 gas detection surveys
- Additional surveys and inspections
- Exposing pipeline to relieve it of stress
- Repair of impacts that create a serious public safety hazard
- In the worst case, restriction on entry, or access to, Jemena infrastructure.

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 Jemena 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 W1-W2, 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 3.7, only a gas leak 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 Jemena. Regular consultation with the community is important. As the gas has been odourised, the community are more likely to report gas leaks if they occur.

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 Jemena 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 in the vicinity of Jemena 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 Jemena will immediately meet and implement emergency procedures.

4.6. Subsidence Impact Management Procedures

The procedures for the management of potential impacts are provided in Table 4.1.

Table 4.1 Risk Control Procedures during the extraction of Tahmoor LW W1-W2

Level	Control measures	Frequency	Analysis	Trigger level	Action
1	<u>Ground inspections:</u> - 2D survey - ground inspection	<u>Ground surveys by Tahmoor Coal:</u> Monthly 2D survey along centrelines of LW W1-W2 for pegs located within active subsidence zone after the length of the extraction of LW W1 and LW W2 exceeds 200 metres Weekly surveys along Stonequarry Creek Road from 800 m extraction of LW W1-W2 until one month after completion of each LW. <i>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</i> Weekly surveys along Booyong Close, Attunga Close and Carramar Close when within active subsidence zone <u>Ground inspections by Tahmoor Coal:</u> Weekly inspection including at the creek crossings within the active subsidence zone	Tahmoor Coal surveys and provides Jemena with - ground surveys - ground movements / features reports	<u>Ground movement survey and measurements:</u> * Radius of ground curvature greater than 4 (km) * Ground strain 0 to 2 (mm/m) * Ground movements rate of change steady <u>Ground conditions monitoring:</u> - ground cracks reported - ground subsidence reported	Go to LEVEL 2 if LEVEL 1 limit is exceeded: * normal ground patrol by Jemena pipeline officer Jemena actions following receipt of reported incidents: inspects site to confirm operation of gas facilities not affected Assess potential for impacts on pipe crossings due to valley closure. Consider trigger level for Level 2.
	<u>Ground subsidence validations:</u> - Observed against predictions	On receipt of data: verify and track results against predictions	MSEC analyses and reports findings to stakeholders	- ground movements showing a <u>step change</u> indicating shear and / or <u>discontinuity</u> in humps near the gas services	* undertake additional inspection e.g. exposing and inspecting gas service as applicable to determine gas facilities integrity *based on above findings, undertake corrective action per Level 3 activities where gas services integrity affected
	<u>Baseline Gas Detection Survey:</u> (completed 24 April 2019) Undertake a pre-mining gas detection survey of pipes within the area potentially affected by the extraction of LW W1-W2.		Jemena reviews: - 2D ground surveys report - pipe integrity - ground conditions report		
2	<u>Ground inspections:</u> - 2D survey - ground inspection	Submit data within 24 hours duration Twice weekly 2D survey	Tahmoor Coal surveys and provides Jemena with - ground surveys - ground movements / features reports	<u>Ground movement survey and measurements:</u> * Radius of ground curvature 2 to 4 (km) * Ground strain 2 to 5 (mm/m) * Ground movements rate of change increasing with increasing upward trend * Subsidence is delayed (such as subsidence not developing within expectations, and/or reports of no caving underground) <u>Ground conditions monitoring:</u> - ground cracks reported - ground subsidence reported	Go to LEVEL 3 if LEVEL 2 limit is reached: * weekly ground patrol by Jemena pipeline officer Jemena actions following receipt of reported incidents: inspects site to confirm operation of gas facilities not affected
	<u>Ground subsidence validations:</u> - Observed against predictions	Twice weekly: verify and track results against predictions	MSEC analyses and reports findings to stakeholders	- ground movements showing a <u>step change</u> indicating shear and / or <u>discontinuity</u> in humps near the gas services	* based on above findings, undertake corrective action per Level 3 activities where gas services integrity affected * if no immediate corrective actions required, Jemena may put field construction on standby
			Jemena reviews: - 2D ground surveys report - pipe integrity - ground conditions report		
3	<u>Ground inspections:</u> - 2D survey - ground inspection	Submit data within 24 hours duration Daily 2D survey	Tahmoor Coal surveys and provides Jemena with - ground surveys - ground movements / features reports	<u>Ground movement survey and measurements:</u> * Radius of ground curvature less than 2 (km) * Ground strain greater than 5 (mm/m) * ground movements showing a <u>step change</u> indicating shear and / or <u>discontinuity</u> in humps near the gas services.	Jemena's field corrective actions: - mobilisation construction in the field - excavate affected area - inspect gas facilities to confirm integrity - repair and / or replace gas services as applicable to maintain supply and safe operation
	<u>Ground subsidence validations:</u> - Observed against predictions	Daily: verify and track results against predictions	MSEC analyses and reports findings to stakeholders		
			Jemena reviews: - 2D ground surveys report - pipe integrity - ground conditions report (as applicable)		

5.1. Consultation, Co-operation and Co-ordination

Substantial consultation, co-operation and co-ordination has taken place between Tahmoor Coal and Jemena 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 Jemena.

- 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 Jemena 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 W1-W2.
- Convening of meetings between Tahmoor Coal and Jemena at any time as required, as discussed in Section 5.2.
- Arrangements to facilitate timely repairs, if required.
- Immediate contact between Tahmoor Coal and Jemena 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 private 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 is to:

- Detect changes, including the early detection of potential impacts on health and safety and impacts to Jemena 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 Jemena 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 Jemena.

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.
- 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.
- 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 Jemena.

7.0 RECORD KEEPING

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

8.0 CONTACT LIST

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* denotes member of Infrastructure Management Group

APPENDIX A. Drawings and Supporting Documentation

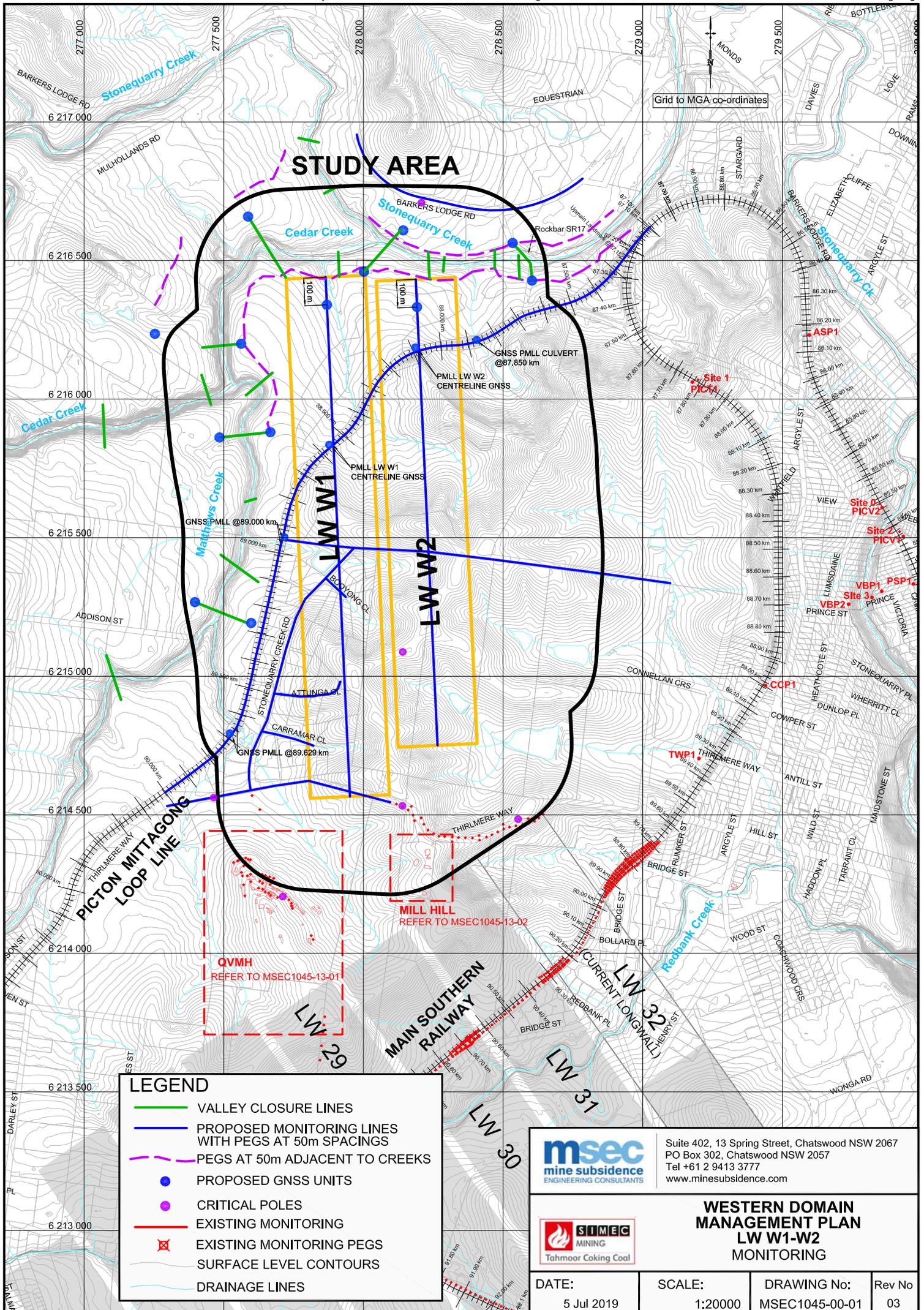
The following supporting documentation is provided in Appendix A.

Drawings

<i>Drawing No.</i>	<i>Description</i>	<i>Revision</i>
MSEC1045-00-01	Monitoring over LW W1-W2	03
MSEC1045-05-01	Jemena Gas Pipelines	01

Supporting Documentation

Tahmoor Coal (2019)	Risk Assessment Report – Infrastructure. Tahmoor North – Western Domain, Longwalls West 1 and West 2, April 2019.
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STUDY AREA

Grid to MGA co-ordinates

LEGEND

- VALLEY CLOSURE LINES
- PROPOSED MONITORING LINES WITH PEGS AT 50m SPACINGS
- - - PEGS AT 50m ADJACENT TO CREEKS
- PROPOSED GNSS UNITS
- CRITICAL POLES
- EXISTING MONITORING
- ⊠ EXISTING MONITORING PEGS
- SURFACE LEVEL CONTOURS
- DRAINAGE LINES

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**WESTERN DOMAIN
 MANAGEMENT PLAN
 LW W1-W2
 MONITORING**

DATE: 5 Jul 2019	SCALE: 1:20000	DRAWING No: MSEC1045-00-01	Rev No: 03
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**WESTERN DOMAIN
 MANAGEMENT PLAN LW W1-W2
 GAS INFRASTRUCTURE**

DATE: 27 Jun 2019	SCALE: 1:12500	DRAWING No: MSEC1045-05-01	Rev No 01
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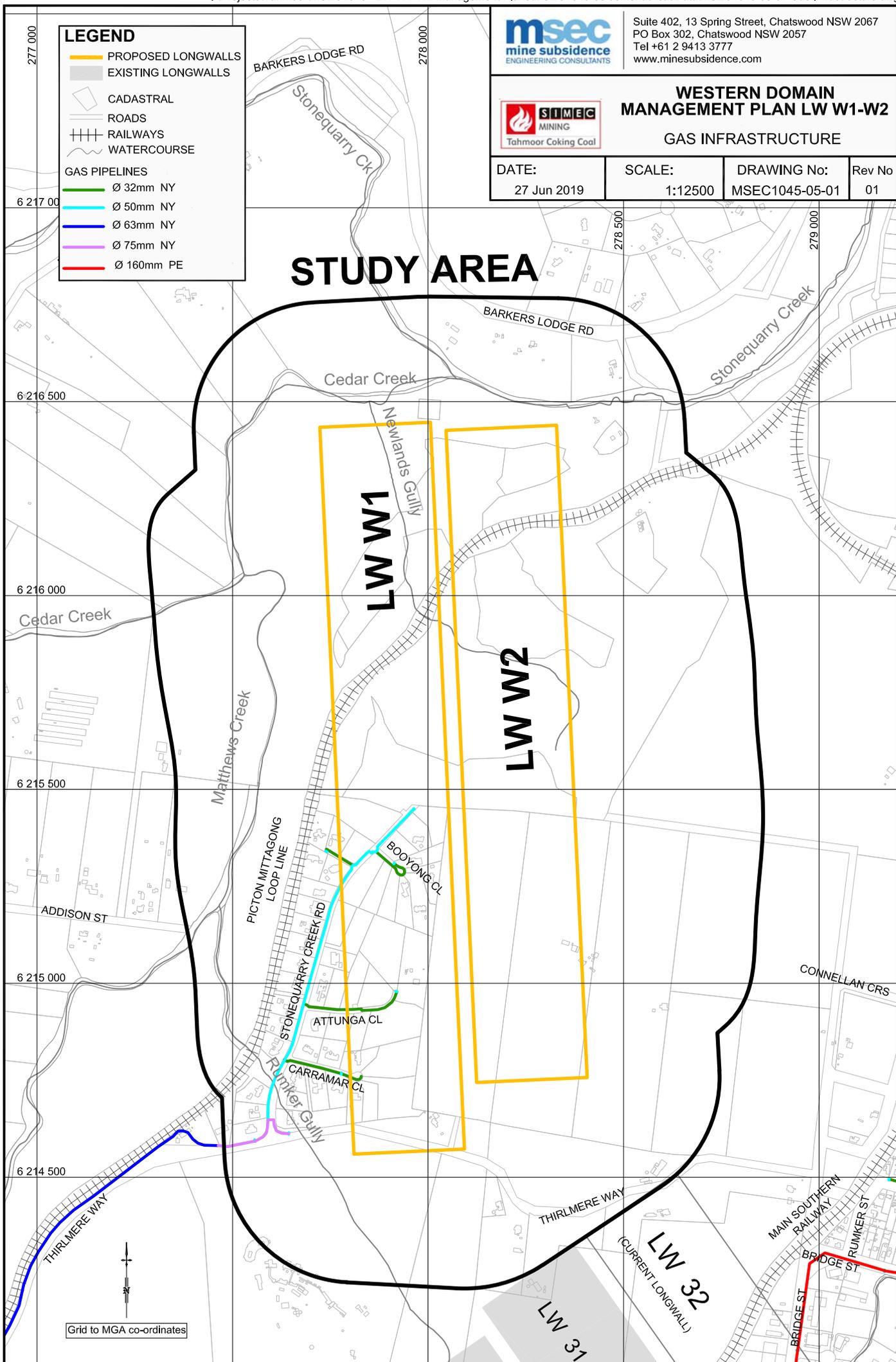
LEGEND

- PROPOSED LONGWALLS
- EXISTING LONGWALLS
- CADASTRAL
- ROADS
- RAILWAYS
- WATERCOURSE

GAS PIPELINES

- Ø 32mm NY
- Ø 50mm NY
- Ø 63mm NY
- Ø 75mm NY
- Ø 160mm PE

STUDY AREA





SIMEC

MEMBER OF



Tahmoor Coal Pty Ltd

RISK ASSESSMENT REPORT -

INFRASTRUCTURE

Tahmoor North – Western Domain
Longwalls West 1 and West 2

Date Held: 26 March 2019

April 2019

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PREPARED BY:	April Hudson Approvals Coordinator Tahmoor Coking Coal Operations – SIMEC Mining
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1 Introduction

1.1 Background

Tahmoor Coal is located approximately 80 kilometres south-west of Sydney in the township of Tahmoor NSW. It is managed and operated by SIMEC Mining. Tahmoor Coal has previously mined 31 longwalls to the north and west of the mine's current pit top location. It is currently mining Longwall 32, in accordance with current Development Consent (DA 67/98) and Subsidence Management Plan Approval for the extraction of Longwall 32.

Tahmoor Coal proposes to extend underground coal mining to the north-west of the Main Southern Railway, which will include Longwalls West 1 to West 4 (**LW W1-W4**) at Picton (refer to **Figure 1-1**). Mining of Longwalls West 1 and West 2 (**LW W1-W2**) is expected to commence in November 2019, and first workings of development headings for LW W1 have commenced.

Under Condition 13H of the Development Consent (DA 67/980, as modified), an Extraction Plan is required for all second workings from LW W1 and subsequent longwalls. The first Extraction Plan to be prepared will cover LW W1-W1, which are located in the Tahmoor North Lease area. The Extraction Plans will be required to be approved by the NSW Department of Planning and Environment (**DPE**), and relevant Infrastructure Management Plans are required to be approved by the relevant infrastructure owners.

The Extraction Plan shall address the Study Area for LW W1-W2, which is comprised of both the predicted 20 mm Total Subsidence Contour and the 35° Angle of Draw Line (refer to **Figure 1-1**).

The Extraction Plan will provide detailed information on how the risks associated with mining under the Study Area will be managed by Tahmoor Coal during and following the extraction of LW W1-W2.

A Risk Assessment Workshop was held at the Administration Building at the Tahmoor Coking Coal Operations (**TCCO**) site on 26 March 2019 to determine the major infrastructure risks associated with LW W1-W2 that may impact on achieving timely approval for the commencement of LW W1-W2 extraction, as well as the completion of extraction of LW W1-W2.

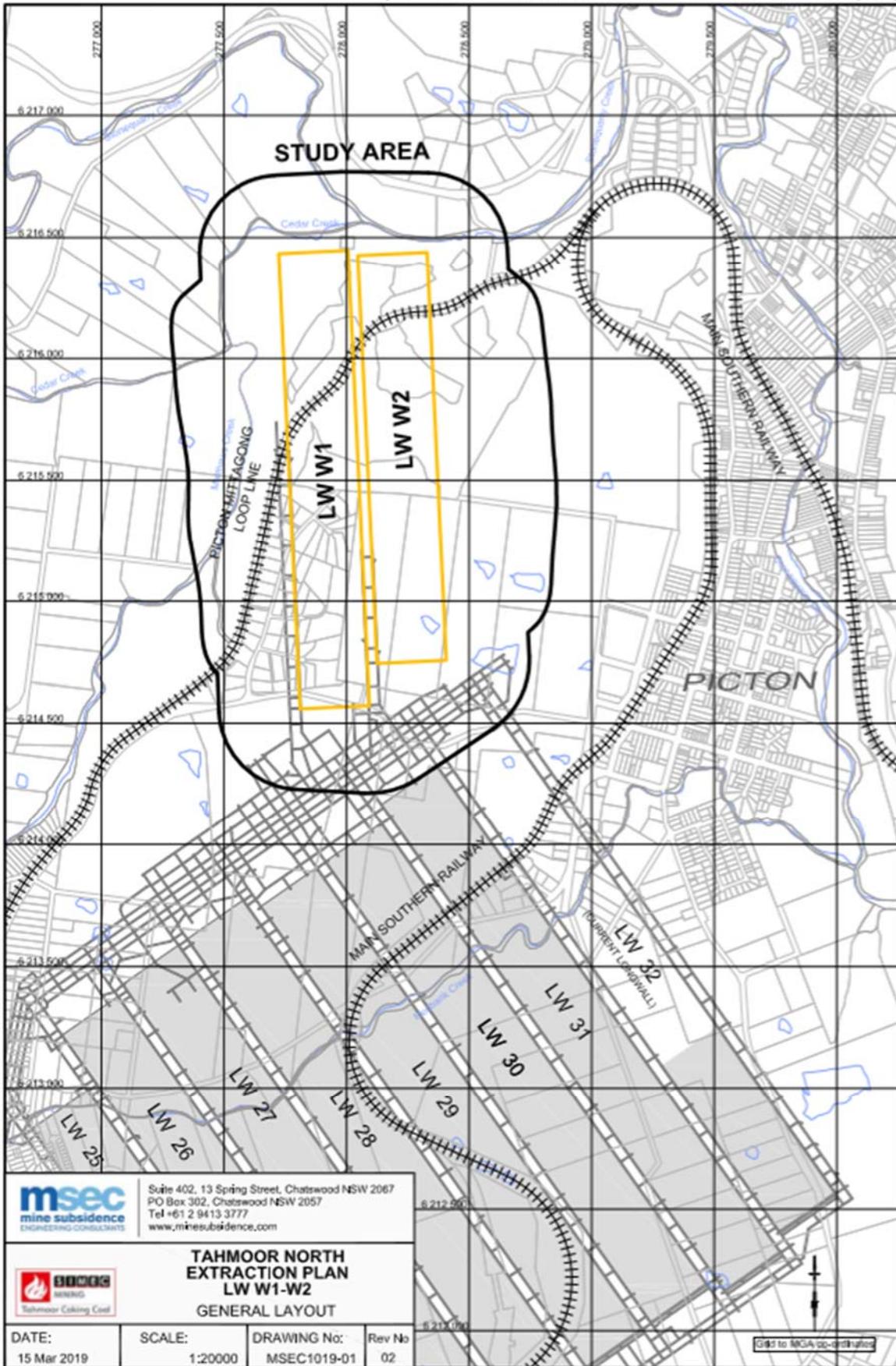


Figure 1-1 Study Area for LW W1-W2

1.2 Methodology

This risk assessment was completed using the Workplace Risk Assessment and Control methodology (**WRAC**).

It was compiled by a team of specialist personnel including:

- Compliance Officer and Risk Assessment Facilitator, Tahmoor Coal: Diana Harris;
- Environment and Community Manager, Tahmoor Coal: Ron Bush;
- Approvals Coordinator, Tahmoor Coal: April Hudson;
- Subsidence Engineer, MSEC: Daryl Kay;
- Structural Engineer, JMA Solutions: John Matheson; and
- Building Inspector, Building Inspection Services: Adam Walker.

The 12 step Risk Management process which forms part of the Tahmoor Coking Coal Operations Risk Management Standard has been adhered to in this risk assessment.

The risk matrix has been used to prioritise risk treatments.

Prior to this risk assessment any previous risk assessments, safety alerts and High Potential Risk incidents have been sourced and put forward for consideration within the risk assessment workshop.

1.3 Outcome

This risk assessment identified a total of 29 risks / hazards (refer to **Figure 1-2**), which included:

- 13 medium risks and 16 low risks;
- One risk that was satisfactory and did not require any further risk control, and 28 risks that required further improvement;
- Risk consequences included:
 - Two risks with environmental impact consequences;
 - Seven risks with health and safety consequences; and
 - 20 risks with property damage consequences.

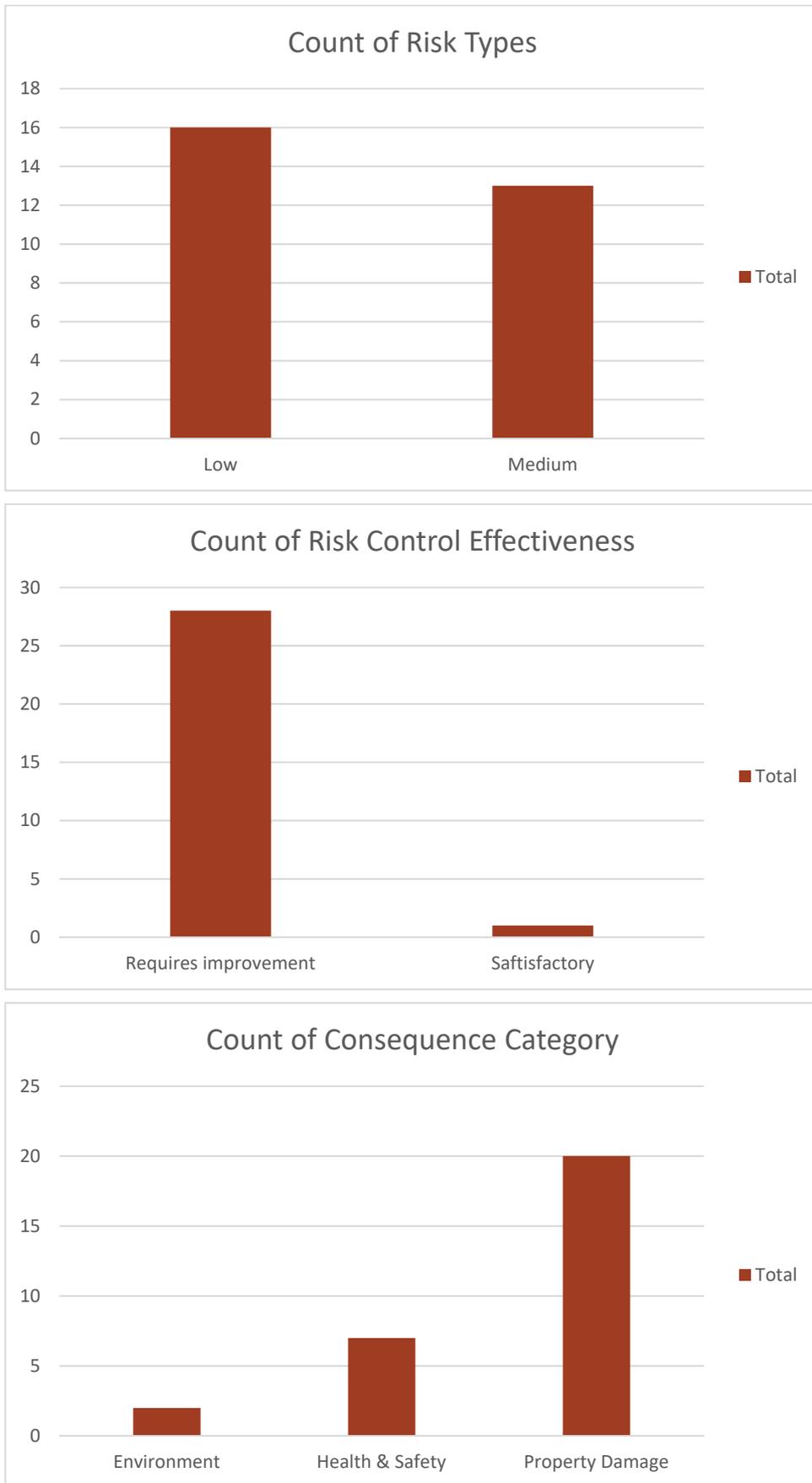


Figure 1-2 Graphs of Risk Type, Risk Control Effectiveness and Consequence Category

1.4 Further Actions

Further actions as identified in the Risk Assessment are identified in **Table 1-1**.

Table 1-1 Table of Further Actions

Treatment plans/tasks	Task Owner	Due Date
Develop Endeavour Energy Management Plan including TARP	April Hudson	10-Oct-2019
Endeavour Energy to complete Critical Poles Audit	April Hudson	10-Oct-2019
SMEC to complete survey of critical poles	April Hudson	10-Oct-2019
Building Inspection Services to complete baseline tilt measurement of poles	April Hudson	10-Oct-2019
Develop Sydney Water Potable Water Management Plan including TARP	April Hudson	10-Oct-2019
Develop Stonequarry Creek Estate Water Management Plan including TARP	April Hudson	10-Oct-2019
Develop Jemena Management Plan including TARP and contact details for Jemena	April Hudson	10-Oct-2019
Complete baseline gas detection survey (Macarthur Gas)	April Hudson	10-Oct-2019
Develop Telecommunications Management Plan including TARP	April Hudson	10-Oct-2019
Develop Wollondilly Shire Council Management Plan including TARP	April Hudson	10-Oct-2019
Develop traffic control plan for emergency repairs	April Hudson	10-Oct-2019
Develop Spatial Services Management Plan including TARP	April Hudson	10-Oct-2019
Notify Spatial Services via POSI application of predicted subsidence movements of the permanent survey control marks	Ron Bush	10-Oct-2019
Ongoing monitoring and review of far field monitoring network, including GNSS network	April Hudson	10-Oct-2019
Develop Built Structures Management Plan including TARP for emergency evacuation procedures	April Hudson	10-Oct-2019
Prepare QVMH Management Plan including TARP	April Hudson	10-Oct-2019
Consultation plan to be developed	Samantha Beresford	10-Oct-2019
Prepare Mill Hill Management Plan including TARP	April Hudson	10-Oct-2019

2 Objective

The purpose of the Risk Assessment was to:

- Ensure the required infrastructure management plans for the proposed longwalls are approved and in place in a timely manner to manage infrastructure impacts during mining;
- Ensure the safe and serviceable operation of all surface infrastructure and structures in the Study Area;
- Ensure that the health and safety of people who may be present in the Study Area are not put at risk due to mine subsidence; and
- Assist in the establishment of procedures to measure, monitor, control, mitigate and repair infrastructure in the Study Area.

The Risk Assessment will also be used to:

- Develop, review and improve the treatment plans / tasks identified as a result of the identified risks;
- Provide a basis to determine whether the identified risk management measures are sufficient to address the identified risks;
- Meet the statutory requirements of legislation and regulation that relate to impacts to infrastructure; and
- Identify those processes requiring a more detailed level of risk assessment due to the Potential Maximum Consequence (**PMC**) level of risk.

3 Context

3.1 Scope

The risk assessment considered the areas below:

- Management of infrastructure owned by Endeavour Energy (electrical), Sydney Water (potable water only), Stonequarry Creek Estate Sewerage Plant (sewer), Jemena (gas), Telstra (telecommunications), NBN (telecommunications), Wollondilly Shire Council (roads, culverts and bridges), Spatial Services (survey control marks);
- Impacts to rural properties and structures such as built structures, pools, septic tanks, and farm dams; and
- Historical heritage buildings including Queen Victoria Memorial Home and Mill Hill.

3.2 Internal Context

This risk assessment was conducted for the Environment and Community Department of Tahmoor Coal to help identify the risks to infrastructure associated with LW W1-W2.

The risk assessment was conducted in accordance with the Risk Management Standard, utilising a cross-section of site personnel, relevant civil works experts, and an internal facilitator.

3.3 External Context

The risk assessment process is completed to satisfy Tahmoor Coking Coals requirements in relation to WHS and in compliance to Mining regulations and conditions and is completed in consultation with key stakeholders.

Key Stakeholders include:

- Tahmoor Coking Coal management;
- NSW Department of Planning and Environment (Planning, Resources and Geoscience);
- Resources Regulator (Subsidence, Environment);
- NSW Office of Environment and Heritage;
- Subsidence Advisory NSW;
- NSW Environment Protection Authority;
- NSW Department of Primary Industries (Agriculture);
- Dam Safety Committee;
- Crown Lands Division;
- NSW Roads and Maritime Services;
- WaterNSW;
- NSW State Emergency Services;
- Wollondilly Shire Council;
- Other utility providers including Endeavour Energy (electrical), Sydney Water (potable water only), Stonequarry Creek Estate Sewerage Plant (sewer), Jemena (gas), Telstra (telecommunications), NBN (telecommunications), Wollondilly Shire Council (roads, culverts and bridges), Spatial Service (survey control marks);
- Heritage stakeholders; and
- Landowners.

The external context for this Risk Management Process included consideration of:

- NSW Department of Planning and Environment as the approver of the Extraction Plan;
- NSW *Work Health and Safety (Mines and Petroleum Sites) Regulations 2014*;
- AS/NZS ISO 31000:2009 Risk Management - Principles and Guidelines; and
- Risk Management Handbook for the Mining Industry (MDG1010).

3.4 Exclusions / Assumptions

The participants in the risk assessment agreed to the following exclusions:

- Community effects will be managed as per Tahmoor Coal procedures and EMS (dust, lighting and noise);
- A detailed risk assessment for rail operational risks associated with LW W1-W2 will be conducted separately; and
- A broad risk assessment focusing on approvals, environmental and general infrastructure risks has been completed for LW W1-W2 on 12 February 2019 (CMO ID 201902202). Consideration of infrastructure risks addressed in this previously completed risk assessment were excluded.

These considerations included:

- Infrastructure Owner do not approve Infrastructure Management Plan;
- Failure to implement Infrastructure Management Plan actions;
- Greater than predicted subsidence in Study Area;
- Stress to landowner/business owner;
- Formation of Community Action Group; and
- Land owners do not sign Land Access Agreements.

The participants in the risk assessment agreed to the following assumptions:

- All plant and equipment is fit for purpose;
- Personnel are competent and authorised;
- Inspection systems are in place and effective;
- People (employees, contractors) do present themselves fit for work;
- The appropriate PPE is utilised where required; and
- Observations and learnings from Longwall 32.

4 Issue / Reason for Review

The risk assessment was completed to identify significant implications relating to approval, environmental and infrastructure risks, and to identify the controls necessary to effectively manage these risks.

5 Risk Analysis Method

5.1 Risk Management Standard

All risk assessments are conducted in accordance with Tahmoor Coking Coal Operations Risk Management Standard.

The Tahmoor Coking Coal Operations Risk Management Standard is based on the *ISO31000:2009 Risk Management – Principles and Guidelines International Standard*.

5.2 Risk Management Process

The risk management process is set out in the 12 Steps Risk Management Process (refer to **Figure 5-1**).

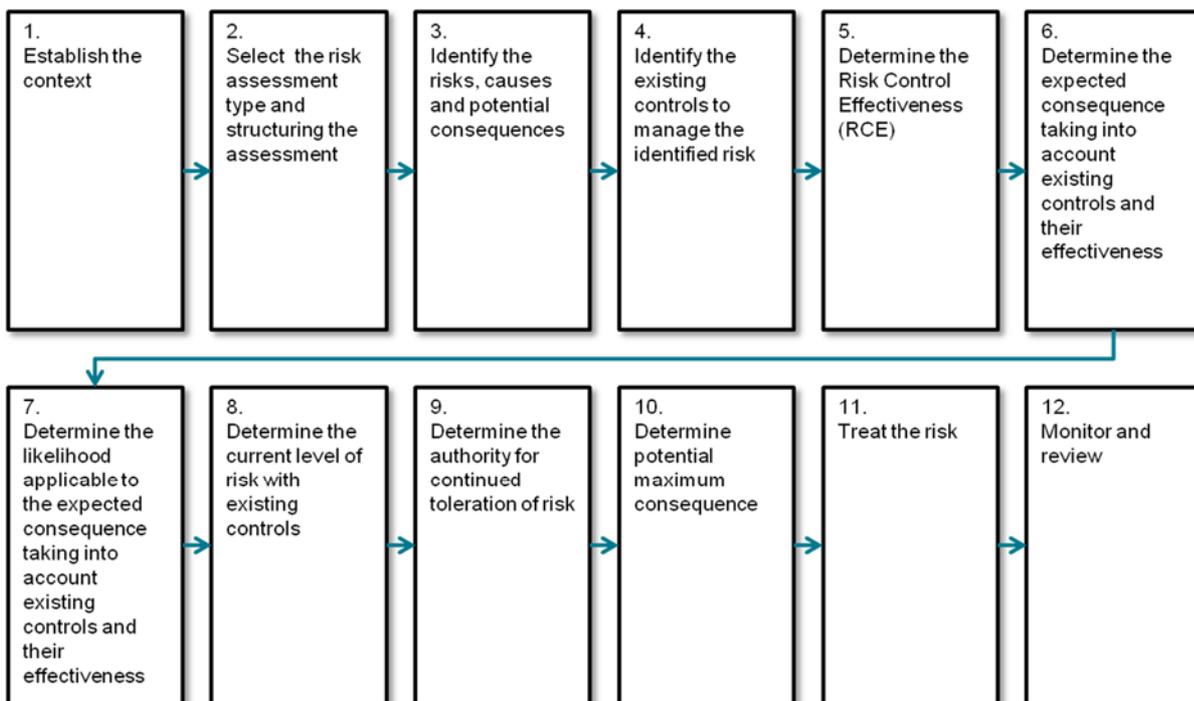


Figure 5-1 The 12 Steps Risk Management Process

5.3 Risk Matrix

The analyses of the risks identified in the workshop have undergone categorisation by the use of the risk matrix outlined within the Tahmoor Coking Coal Operations Risk Management Standard.

A copy of the risk matrix from Tahmoor Coking Coal Operations Risk Management Standard is provided in **Appendix A**.

5.4 Hierarchy of Controls

During the risk management process additional treatments and controls have been categorised using the hierarchy of controls table (refer to **Figure 5-2**).

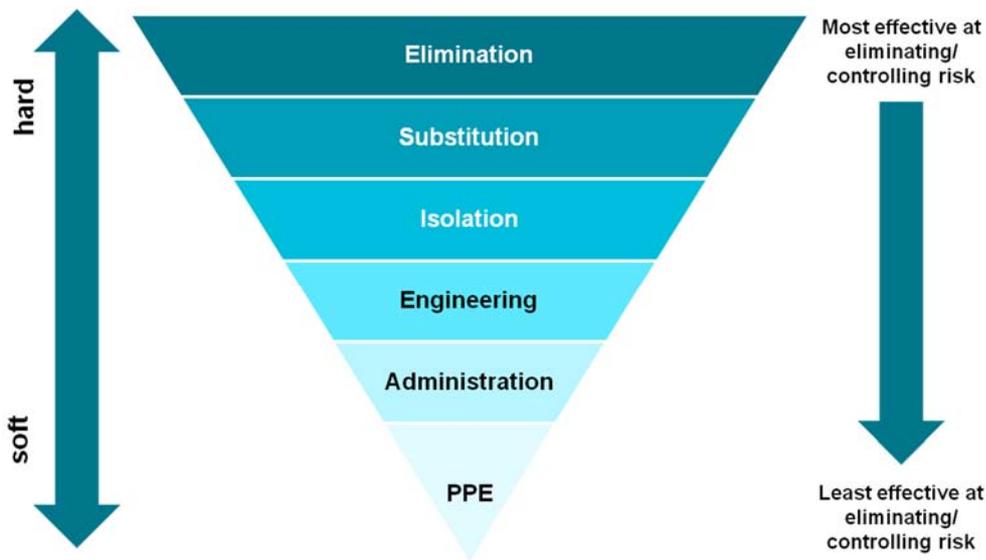


Figure 5-2 Hierarchy of Controls

5.5 Risk Assessment Team Members

Participating risk assessment team members are listed in **Table 5-1**.

Table 5-1 Participating Risk Assessment Team Members

Name	Position	Organisation	Qualifications	Related Experience
Ron Bush	Environment & Community Manager	SIMEC	BSc (Geol), GCEng, GD GW, MPlan, MProDev, MEng	30yrs
Diana Harris	Facilitator – Compliance Officer	SIMEC	Cert IV OH&S, G3 Risk Management	4yrs
April Hudson	Approvals Coordinator	SIMEC	B Env Sci (Hons)	9yrs
John Matheson	Structural Engineer	JMA Solutions	BE Struct (Hons)	20yrs
Daryl Kay	Subsidence Engineer	MSEC	BE, LLB	16yrs
Adam Walker	Building Inspector	Building Inspection Services	Cert IV Building	30yrs

A copy of the signed attendance sheet is attached in **Appendix B**.

6 Risk Assessment Register

The Risk Assessment Register is attached within **Appendix C**.

7 Treatment Plan

A treatment plan is provided in **Section 1.4.1**.

8 Risk Assessment Review Period

A review period for the risk assessment has not been identified.

Appendix A – Risk Matrix

RISK MATRIX

CONSEQUENCE [potential foreseeable outcome of the event]

	Health & Safety	Environment	Financial Impact	Image & Reputation / Community	Legal & Compliance
5 Catastrophic	<ul style="list-style-type: none"> Multiple fatalities (5 or more fatalities in a single incident) Multiple cases (5 or more) of Permanent Damage Injuries or Diseases that result in permanent disabilities in a single incident 	<ul style="list-style-type: none"> Unconfined and widespread Environmental damage or effect (permanent; >10 years) Requires major remediation 	<ul style="list-style-type: none"> >\$600M investment return >\$100M operating profit >\$20M property damage 	<ul style="list-style-type: none"> Loss of multiple major customers or large proportion of sales contracts Sustained campaign by one or more international NGOs resulting in physical impact on the assets or loss of ability to operate Security incident resulting in multiple fatalities or major equipment damage Formal expression of significant dissatisfaction by government Grievance from internal or external stakeholder alleging human rights violation resulting in multiple fatalities 	<ul style="list-style-type: none"> Major litigation / prosecution at SIMEC corporate level Nationalisation / loss of licence to operate
4 Major	<ul style="list-style-type: none"> Single incident resulting in: Less than 5 Fatalities Permanent Damage Injury or Disease that results in a permanent disability- less than 5 cases in a single incident 	<ul style="list-style-type: none"> Long-term (2 to 10 years) impact Requires significant remediation 	<ul style="list-style-type: none"> \$60-600M investment return \$20-100M operating profit \$2-20M property damage 	<ul style="list-style-type: none"> Security/ stakeholder incident resulting in single loss of life or equipment damage Grievance from internal or external stakeholder alleging human rights violation resulting in single fatality or serious injuries Topic of broad societal concern and criticism Negative media coverage at international level resulting in a Corporate statement within 24 hours Investigation from government and/ or international (or high-profile) NGOs Complaints from multiple "final" customers Loss of major customer Negative impact on share price 	<ul style="list-style-type: none"> Major litigation / prosecution at Department level
3 Moderate	<ul style="list-style-type: none"> Lost Time Injury (LTI) Lost Time Disease (LTD) Permanent Disabling Injury (PDI) Permanent Disabling Disease (PDD) Single incident that results in multiple medical treatments 	<ul style="list-style-type: none"> Medium-term (<2 years) impact (typically within a year) Requires moderate remediation 	<ul style="list-style-type: none"> \$6-60M investment return \$2-20M operating profit \$200K-2M property damage 	<ul style="list-style-type: none"> Negative media coverage at national level over more than one day Complaint from a "final" customer Off-spec product Local Stakeholder action resulting in national societal scrutiny 	<ul style="list-style-type: none"> Major litigation / prosecution at Operation level
2 Minor	<ul style="list-style-type: none"> Medical Treatment Injury (MTI) Medical Treatment Disease (MTD) Restricted Work Injury (RWI) Restricted Work Disease (RWD) 	<ul style="list-style-type: none"> Near source Short-term impact (typically <week) Requires minor remediation 	<ul style="list-style-type: none"> \$600K-6M investment return \$200K-2M operating profit \$10-200K property damage 	<ul style="list-style-type: none"> Negative local/ regional media coverage Complaint received from an internal or external stakeholder 	<ul style="list-style-type: none"> Regulation breaches resulting in fine or litigation
1 Negligible	<ul style="list-style-type: none"> First Aid Injury (FAI) or illness (not considered disease or disorder) 	<ul style="list-style-type: none"> Near source and confined No lasting environmental damage or effect (typically <day) Requires minor or no remediation 	<ul style="list-style-type: none"> <\$600K investment return <\$200K operating profit <\$10K property damage 	<ul style="list-style-type: none"> Negligible media interest 	<ul style="list-style-type: none"> Regulation breaches without fine or litigation

LIKELIHOOD [of the event occurring with that consequence]

Basis of Rating	E - Rare	D - Unlikely	C - Possible	B - Likely	A – Almost Certain
LIFETIME OR PROJECT OR TRIAL OR FIXED TIME PERIOD OR NEW PROCESS / PLANT / R&D	Unlikely to occur during a lifetime OR Very unlikely to occur OR No known occurrences in broader worldwide industry	Could occur about once during a lifetime OR More likely <u>NOT</u> to occur than to occur OR Has occurred at least once in broader worldwide industry	Could occur more than once during a lifetime OR As likely to occur as not to occur OR Has occurred at least once in the mining / commodities trading industries	May occur about once per year OR More likely to occur than not occur OR Has occurred at least once within Tahmoor Mine	May occur several times per year OR Expected to occur OR Has occurred several times within Tahmoor Mine
5 Catastrophic	15 (M)	19 (H)	22 (H)	24 (H)	25 (H)
4 Major	10 (M)	14 (M)	18 (H)	21 (H)	23 (H)
3 Moderate	6 (L)	9 (M)	13 (M)	17 (H)	20 (H)
2 Minor	3 (L)	5 (L)	8 (M)	12 (M)	16 (M)
1 Negligible	1 (L)	2 (L)	4 (L)	7 (M)	11 (M)

Consequence Category	Consequence Type	Ownership	Action
Cat. 5	Catastrophic Hazard	Department / Functional / Operational / Asset Leadership	<ul style="list-style-type: none"> Quantitative or semi-quantitative risk assessment required. Capital expenditure will be justified to achieve ALARP ('As Low As Reasonably Practicable'). Catastrophic Hazard Management Plans (CHMP) must be implemented where practical, Crisis Management Plans (CMP) tested and Catastrophic Event Recovery Plans (CERP) developed.
Cat. 4 (Health & Safety consequence)	Fatal Hazard	Department / Functional / Operational / Asset Leadership	<ul style="list-style-type: none"> Fatal Hazard Protocols or appropriate management plans must be applied. Capital expenditure will be justified to achieve ALARP.
Risk Rank	Risk Rating	Ownership	Action
17 to 25	High Risk	Department / Functional / Operational / Asset Leadership	<ul style="list-style-type: none"> Install additional HARD and SOFT controls to achieve ALARP. Capital expenditure will be justified to achieve ALARP.
7 to 16	Medium Risk	Operational / Asset Leadership	<ul style="list-style-type: none"> install additional HARD and SOFT controls if necessary to achieve ALARP. Capital expenditure may be justified.
1 to 6	Low Risk	Operational / Asset Leadership	<ul style="list-style-type: none"> Install additional controls if necessary to achieve ALARP. Capital expenditure is not usually justified.

Appendix B – Risk Assessment Attendance Sheet

Team Members and Qualifications:					Tahmoor Underground - Process	
Name (Print & Sign)	Position	Company/Site	Years in Industry	Related Qualifications	Related Experience	ADDITIONAL
Facilitator Details						
Diana Harris	Compliance Officer	Tahmoor	29	Cert IV OHS, G3 risk mgmt		
DARIL KAY	MINE SUBSIDENCE ENGINEER	MSEC	17	CIVIL ENG/LAW	Subsidence	
JOHN MATTHESON	DIRECTOR JMA SOLUTIONS	JMA SOLUTIONS	37	BE (MORSS)	STRUCTURAL	
Adam Walker	Director BIS	Building Inspection Services	30	Cert IV Building	Building Consultant	
Ron Bush	Environment + Community Manager	Tahmoor	30	BSc (Geol), MPlan, MPract, MEng	Approvals	<i>Ron Bush</i>
April Hudson	Approvals Coordinator	Tahmoor	9	B. Env Sci (Hons)	Approvals.	<i>April Hudson</i>

Appendix C – Risk Assessment Register

