SIMEC Mining:

Tahmoor Coking Coal Operations - Longwall 32

Management Plan for Potential Impacts to Sydney Water Potable Water Infrastructure

 | REPORT NUMBER: MSEC945-03 | REVISION A

AUTHORISATION OF MANAGEMENT PLAN

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DOCUMENT REGISTER

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Apr-06	MSEC286-0403	C	Agreed plan
Aug-06	MSEC286-0403	D	Chapter 1 amended
Sep-08	MSEC286-0403	E	Updated for Longwall 25
May-10	MSEC446-03	A	Updated for Longwall 26
Sep-12	MSEC567-03	A	Updated for Longwall 27
Jan-14	MSEC646-03	A	Updated for Longwalls 28 to 30
Mar-17	MSEC862-03	A	Updated for Longwall 31
Mar-17	MSEC862-03	B	Updated following consultation with Sydney Water
Jun-18	MSEC945-03	A	Updated for Longwall 32

References:-

AS/NZS 4360:1999 Risk Management

AS/NZS ISO 31000:2009 Risk Management – Principles and guidelines

Glencore (2014) Glencore Coal Assets Australia Risk Management Matrix, Glencore, September 2014

Glencore (2018) Environmental Risk Assessment: Tahmoor Underground – Longwall 32 Surface and Subsurface Infrastructure – Potable Water Infrastructure, Tahmoor Coking Coal Operations, May 2018.

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 (2014) Tahmoor Colliery Longwalls 31 to 37 - Subsidence Predictions and Impact Assessments for Natural and Built Features in support of the SMP Application. (Report MSEC647, Revision A, December 2014), prepared by Mine Subsidence Engineering Consultants.

SCT (2018a) Structure determinations of the Nepean Fault adjacent to Tahmoor Mine, SCT Operations, Report No. TAH4817, May 2018.

SCT (2018b) Investigation into the Potential Impact of the Nepean Fault on Longwall 32 Subsidence, SCT Operations, Report No. TAH4821, May 2018.

Sydney Water (2010) Risk Criteria, Sydney Water, Issue 3, 6 July 2010

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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*
MSEC945-00-01	Monitoring over Longwall 32	B
MSEC945-03-01	Water Infrastructure – Pipe Size	A
MSEC945-03-02	Water Infrastructure – Pipe Type	A

1.1. Background

Tahmoor Coking Coal Operations is located approximately 80 km south-west of Sydney in the township of Tahmoor NSW. It is managed and operated by SIMEC Mining. Tahmoor Coking Coal Operations has previously mined 30 longwalls to the north and west of the mine's current location. It is currently mining Longwall 31.

Longwall 32 is a continuation of a series of longwalls that extend into the Tahmoor North Lease area, which began with Longwall 22. The longwall panels are located between the Bargo River in the south-east, the township of Thirlmere in the west and Picton in the north. Longwall 32 is located beneath the rural area between Tahmoor, Thirlmere and Picton, including part of the South Picton industrial area. Potable water infrastructure owned by Sydney Water is located within this area.

A summary of the dimensions of Longwall 32 is 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)
Longwall 32	2378	283	39

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

The Management Plan is a live document that can be amended at any stage of mining, to meet the changing needs of Tahmoor Coking Coal Operations and Sydney Water.

1.2. Sydney Water's Potable Water assets potentially affected by Longwall 32

A map showing the locations of Sydney Water's Potable Water infrastructure in relation to Longwall 32 is shown in Drawing No. MSEC945-03-01.

As shown in Drawing No. MSEC945-03-02, the majority of these pipelines are Cast Iron Cement Lined (CICL) and Ductile Iron Cement Lined (DICL) pipes, with sections of oPVC, uPVC and polyethylene (PE) pipeline also present.

There are a number of water pipelines that are located directly above or adjacent to Longwall 32, which generally follow the alignments of the local roads. The most significant of these are the main 200 mm CICL water main along Remembrance Drive, which feeds a reservoir at Picton. The Picton Reservoir is located near the Picton Railway Tunnel and will not be directly affected by the extraction of Longwall 32.

Longwall 32 will also extract directly beneath 150 mm diameter DICL water mains on Henry Street, Bridge Street and Redbank Place.

1.3. Consultation

1.3.1. Consultation with Sydney Water

Tahmoor Coking Coal Operations regularly consults with Sydney Water in relation to mine subsidence effects from mining. This includes consultation during the development of Subsidence Management Plans for previous Longwalls 22 to 31, and regular reporting of subsidence movements and impacts.

Details regarding consultation and engagement are outlined below:

- A risk assessment was held on 10 May 2018, which was attended by Troy Cooper from Sydney Water.
- Meeting with Troy Cooper (Sydney Water), Belinda Clayton (Tahmoor Coking Coal Operations), Matthew Montgomery (Subsidence Advisory NSW) and Daryl Kay(MSEC) in June 2018 to discuss the draft Subsidence Management Plan for Longwall 32.

Tahmoor Coking Coal Operations will continue to consult regularly with Sydney Water during the extraction of Longwall 32 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 (Mine Subsidence Board) and key infrastructure stakeholders including Wollondilly Shire Council, Endeavour Energy, Telstra and Jemena have also been consulted as part of the Subsidence Management Plan (SMP) 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. MSEC647 by Mine Subsidence Engineering Consultants (MSEC, 2014). Predictions are based on the planned configuration of Longwall 32 at Tahmoor Coking Coal Operations (as shown in Drawing No. MSEC945-03-01), 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 Coking Coal Operations and Sydney Water representatives.

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 MSEC647 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 potable water pipelines.

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 Sydney Water property are not put at risk due to mine subsidence.
- Disruption and inconvenience should be avoided or, if unavoidable, kept 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 Coking Coal Operations, Sydney Water, 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 Sydney Water 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 Sydney Water property are not put at risk due to mine subsidence.

The major items at risk are:-

- Water pipelines

The pipelines are shown in Drawings Nos. MSEC945-03-01 and MSEC945-03-02, classified by pipe size and by pipe type, respectively.

The Management Plan only covers the potable water 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

Longwall 32 only. The management plan does not include other potable water infrastructure owned by Sydney Water which lies outside the extent of this area.

This Management Plan does not include Sydney Water sewer infrastructure, which is included in separate management plans.

1.7. Proposed Mining Schedule

It is planned that Longwall 32 will extract coal working northwest from the south-eastern end. This Management Plan covers longwall mining until completion of mining in Longwall 32 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
Longwall 32	September 2018	September 2019

Please note the above Schedule is subject to change due to unforeseen impacts on mining progress. Tahmoor Coking Coal Operations will keep Sydney Water 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.

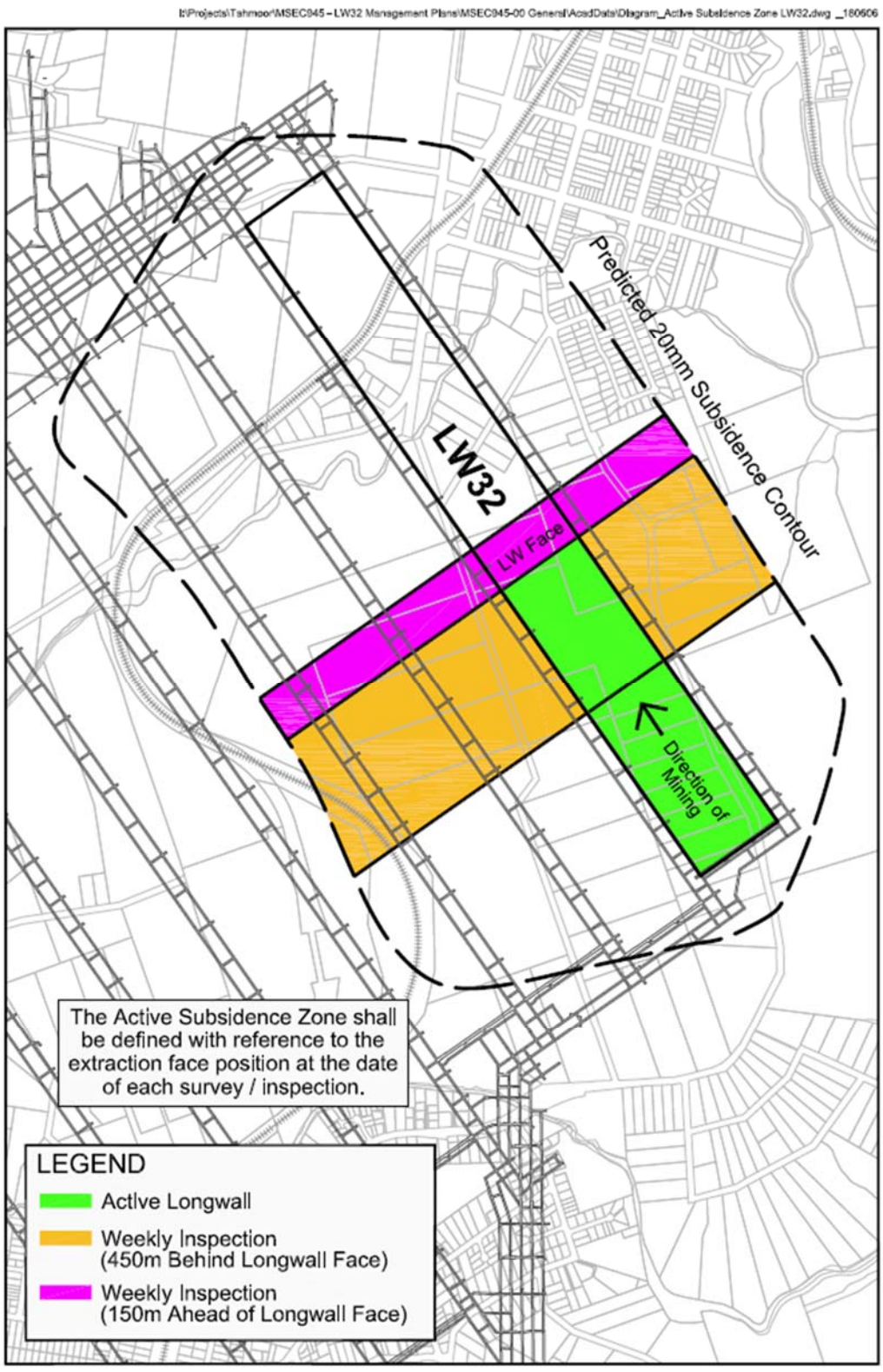

Fig. 1.1 Diagrammatic Representation of Active Subsidence Zone

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 then assess the damage to determine the cause. If the damage is determined to be attributable to mine subsidence, a scope will be prepared and compensation will be assessed.

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 Longwall 32 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. 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.'[1] The consequences of a hazard are rated from very slight to very severe.

2.2.2. Likelihood

'Used as a qualitative description of probability or frequency.'[2] The likelihood can range from very rare to almost certain.

2.2.3. Hazard

'A source of potential harm or a situation with a potential to cause loss.'[3]

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 Glencore Coal Assets Australia 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.

The identified risks were also assessed using Sydney Water's Risk Criteria, which is attached to the Appendix.

[1] AS/NZS 4360:1999 – Risk Management pp2
[2] AS/NZS 4360:1999 – Risk Management pp2
[3] AS/NZS 4360:1999 – Risk Management pp2

3.1. Maximum Predicted Conventional Subsidence Parameters

Predicted mining-induced conventional subsidence movements were provided in Report No. MSEC647, which was prepared in support of Tahmoor Coking Coal Operations' SMP Application for Longwalls 31 to 37, and includes predictions due to the extraction of Longwall 32. A summary of the maximum predicted incremental subsidence parameters due to the extraction of Longwall 32 only and the maximum predicted total conventional subsidence parameters due to the extraction of Longwalls 22 to 32, are provided in Table 3.1.

Table 3.1 Maximum Predicted Conventional Subsidence Parameters due to the Extraction of Longwall 32

Longwall	Maximum Predicted Subsidence (mm)	Maximum Predicted Tilt (mm/m)	Maximum Predicted Hogging Curvature (1/km)	Maximum Predicted Sagging Curvature (1/km)
Increment due to LW32 only	700	5.5	0.06	0.12
Total after extraction of LWs 22 to 32	1,225	6.0	0.09	0.13

The values provided in the above table are the maximum predicted conventional subsidence parameters which occur within the general longwall mining area, including the predicted movements resulting from the extraction of Longwalls 22 to 32.

The location of the maximum predicted total subsidence is not directly above Longwall 32. Predicted maximum total subsidence directly above Longwall 32 is approximately 800 mm.

3.2. Observed subsidence during the mining of Longwalls 22 to 31

The extraction of longwalls at Tahmoor Coking Coal Operations has generally resulted in mine subsidence movements that were typical of those observed above other collieries in the Southern Coalfield of NSW at comparable depths of cover.

However, observed subsidence was greater than the predicted values over Longwalls 24A and the southern parts of Longwalls 25 to 27. Monitoring during the mining of Longwalls 28 to 31 has found that subsidence behaviour has returned to normal levels.

Survey Peg ST14 on Stilton Lane is located above the centreline of Longwall 31. As shown in Fig. 3.1, subsidence developed at an equivalent magnitude to pegs located above previously extracted Longwalls 28 to 30.

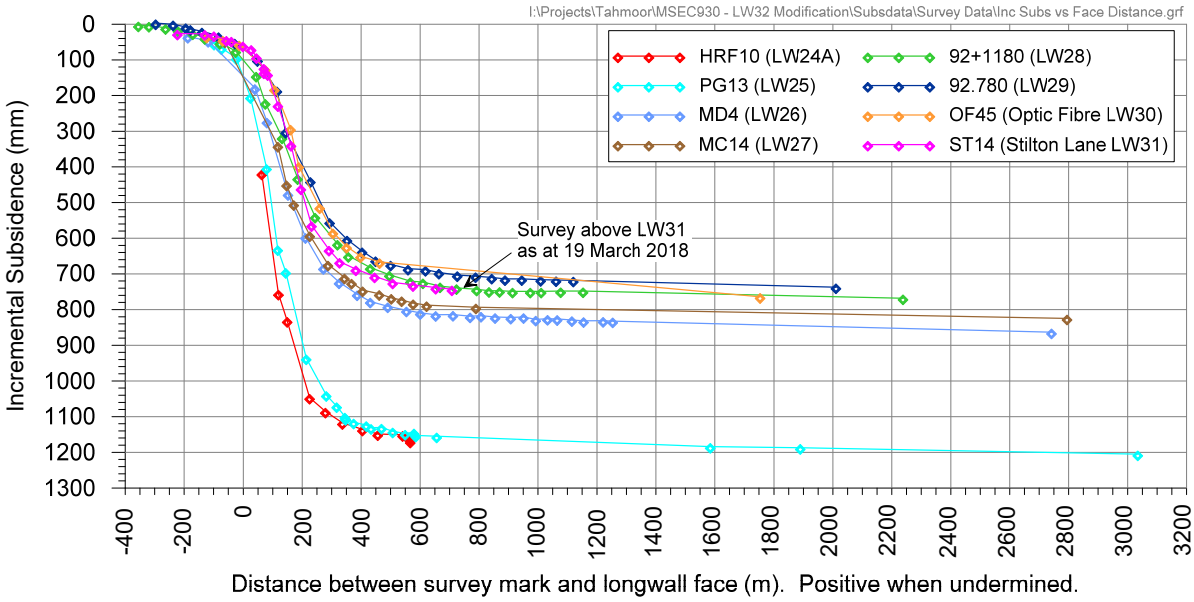

Fig. 3.1 Observed development of subsidence of survey pegs above the centrelines of Longwalls 24A to 31

Ground surveys will continue to be undertaken above Longwall 32. The survey results will be checked against predictions to confirm whether subsidence continues to develop in a normal manner during the mining of Longwall 32.

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, 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.

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. Confidence levels have been determined from the empirical strain data using the fitted GPDs. In the cases where survey bays were measured multiple times during a longwall extraction, the maximum tensile strain and the maximum compressive strain were used in the analysis (i.e. single tensile strain and single compressive strain measurement per survey bay).

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 28 at Tahmoor Coking Coal Operations, for survey bays that were located directly above goaf or the chain pillars that are located between the extracted longwalls, which has been referred to as "*above goaf*".

The histogram of the maximum observed total tensile and compressive strains measured in survey bays above goaf at Tahmoor Coking Coal Operations is provided in Fig. 3.2. The probability distribution functions, based on the fitted GPDs, have also been shown in this figure.

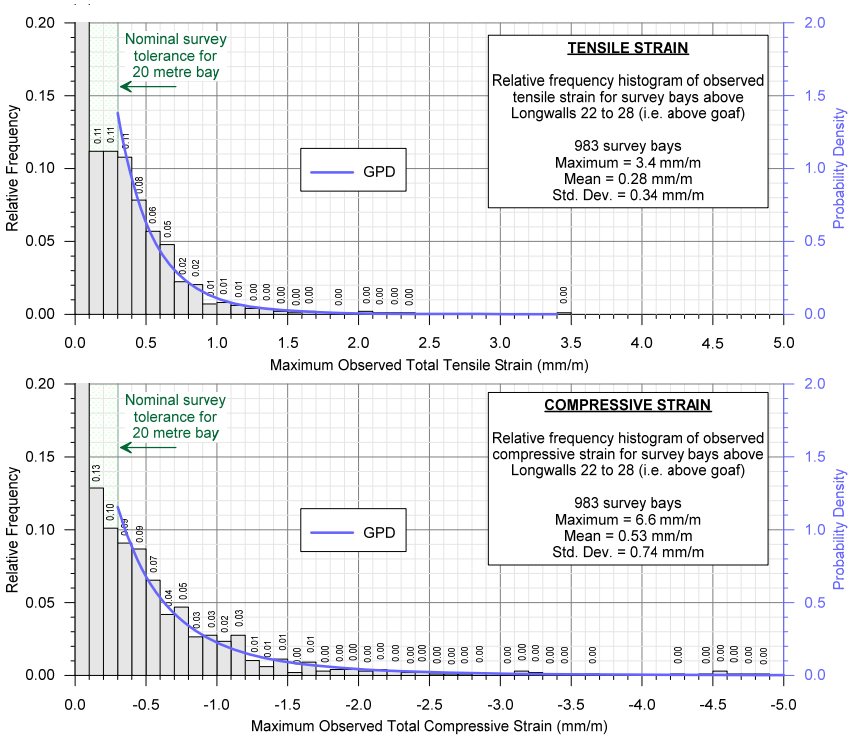

Fig. 3.2 Distributions of the measured maximum tensile and compressive strains for surveys bays located above goaf

The 95 % confidence levels for the maximum total strains that the individual survey bays *above goaf* experienced at any time during mining are 0.9 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 1.5 mm/m tensile and 3.5 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 28 at Tahmoor Coking Coal Operations, 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*".

The histogram of the maximum observed tensile and compressive strains measured in survey bays above solid coal at Tahmoor Coking Coal Operations is provided in Fig. 3.3. The probability distribution functions, based on the fitted GPDs, have also been shown in this figure.

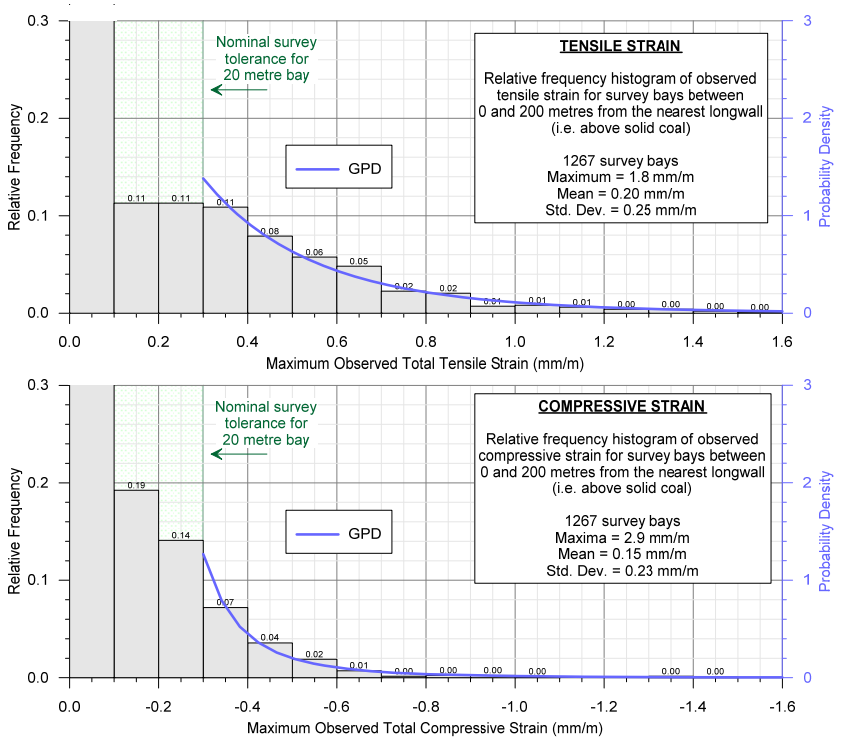

Fig. 3.3 Distributions of the measured maximum tensile and compressive strains for survey bays located above solid coal

The 95 % confidence levels for the maximum total strains that the individual survey bays *above solid coal* experienced at any time during mining are 0.6 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 are 1.1 mm/m tensile and 0.9 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 28 at Tahmoor Coking Coal Operations, is provided in Fig. 3.4.

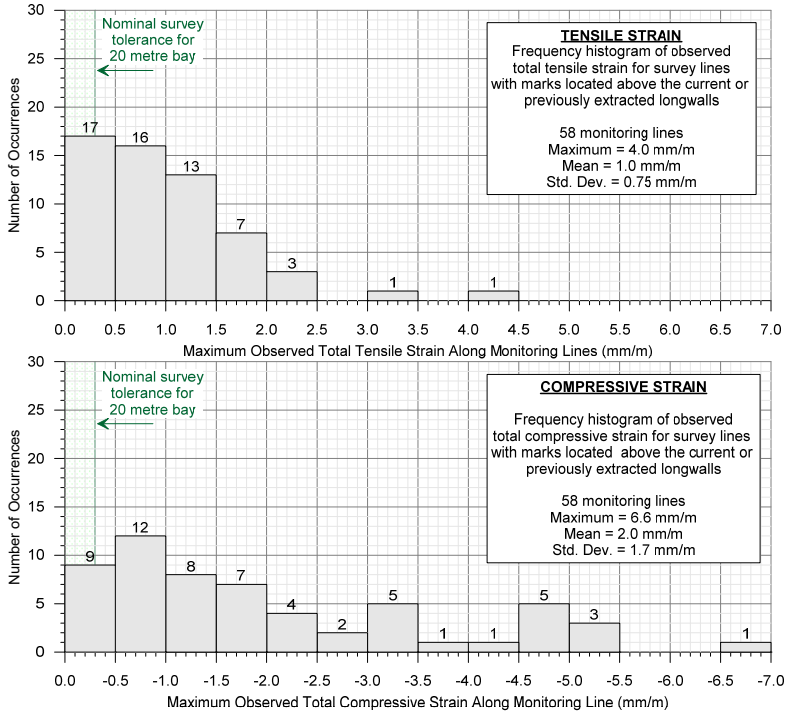

Fig. 3.4 Distributions of measured maximum tensile and compressive strains anywhere along the monitoring lines

It can be seen from Fig. 3.4, that 33 of the 58 monitoring lines (i.e. 57 %) had recorded maximum total tensile strains of 1.0 mm/m, or less, and that 53 monitoring lines (i.e. 91 %) had recorded maximum total tensile strains of 2.0 mm/m, or less. It can also be seen from this figure, that 36 of the 58 monitoring lines (i.e. 62 %) had recorded maximum compressive strains of 2.0 mm/m, or less, and that 48 of the monitoring lines (i.e. 83 %) had recorded maximum compressive strains of 4.0 mm/m, or less.

3.4. Predicted and observed valley closure across creeks

The water pipelines cross a number of creeks within the area potentially affected by the extraction of Longwall 32.

The 200 mm diameter CICL pipeline on Remembrance Drive crosses three small watercourses between Wonga Road and Koorana Road. The same pipeline also crosses Redbank Creek approximately 350 metres to the side of Longwall 32. The 160 mm diameter DICL water pipeline along Bridge Street crosses a 'hidden creek' directly above Longwall 32.

The predicted valley related effects on these locations are provided later in this Management Plan.

3.5. Geological structures

3.5.1. Identification of geological structures

Longwall 32 will be extracted alongside the Nepean Fault, which is a well-known geological feature that is an extension of the Lapstone Monocline.

Tahmoor Coking Coal Operations commissioned an engineering geologist from SCT (2018a) to undertake site inspections and mapping of the Nepean Fault. This work has provided detailed information on the nature and location of Nepean Fault, and second order geological structures associated with the fault.

The Nepean Fault is mapped as "*an en-echelon distribution of first order faults with major offsets. Ramps are developed between these en-echelon fault surfaces. Numerous first order north-south faults, each of limited extent, step across the area investigated.*" (SCT, 2018a). The commencing end of Longwall 32 is located within the fault ramp area between two of the first order faults.

SCT (2018a) further advise that the fault is sub-vertical from surface to seam, based on site investigations and geological information gathered by Tahmoor Coking Coal Operations since 2014. The cross-section provided by SCT (2018a) has been reproduced in Fig. 3.5.

In addition to the mapped first order faults, SCT has mapped second order faults, which are described as "*mainly conjugate sets of strike slip faults and splay faults being observed between the en-echelon first order faults*."

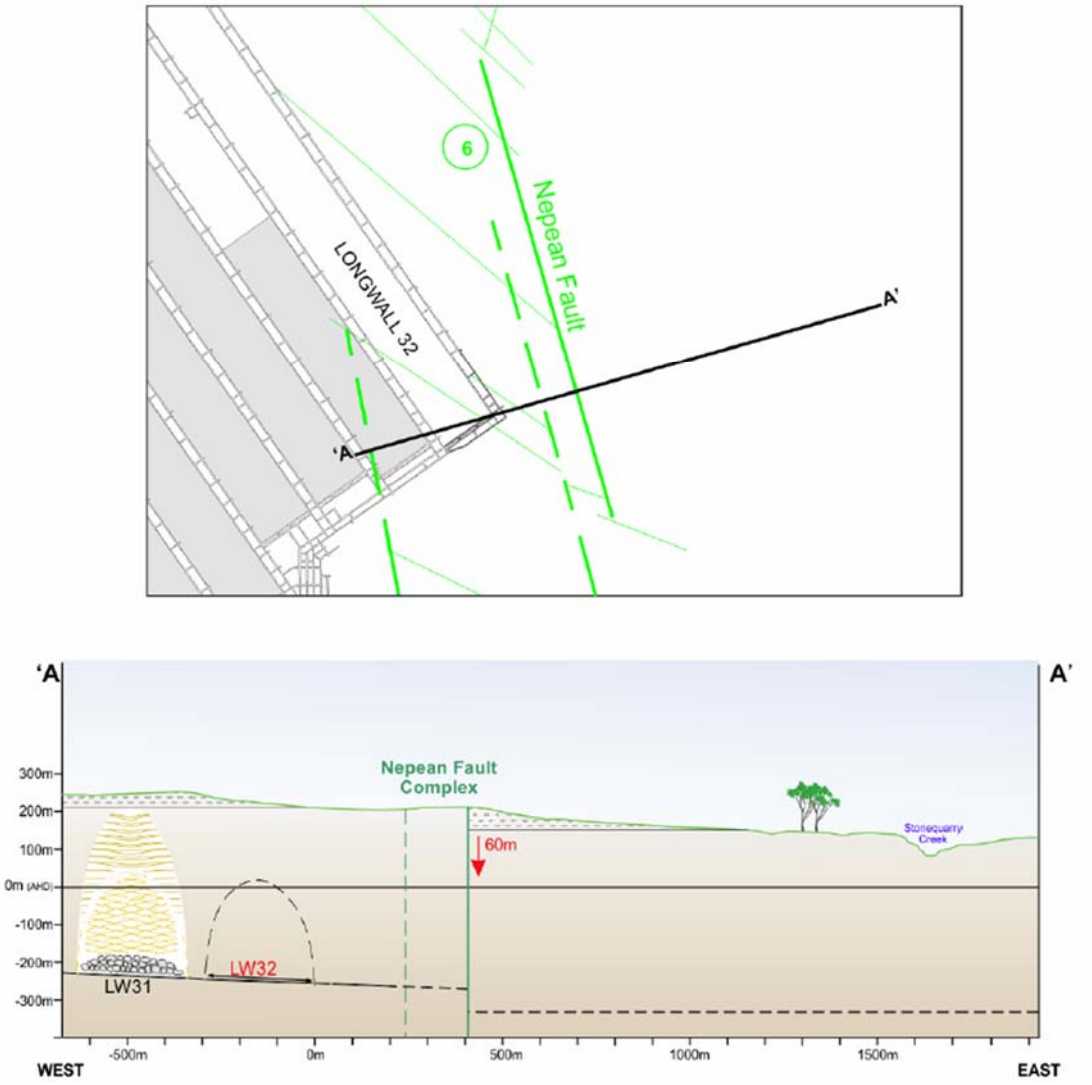

Fig. 3.5 Cross-section of Nepean Fault near Longwall 32 by SCT (2018a)

The geological structures as mapped by SCT (2018a) have been overlaid with surface features within and adjacent to Longwall 32. These are shown in Drawings Nos. MSEC945-03-01 and MSEC945-03-02.

It can be seen that the built areas within Tahmoor and Picton are located near a mapped first order Nepean Fault, which follows the escarpment along the western bank of Stonequarry Creek. Drawings Nos. MSEC945-03-01 and MSEC945-03-02 show that no Sydney Water infrastructure crosses the mapped first order fault within the area predicted to experience more than 20mm subsidence.

Sydney Water's potable water pipelines do, however, cross mapped second order geological structures, of which one intersects Remembrance Drive directly above Longwall 32.

A cross-section has been produced in Fig. 3.6 to show the location of the Nepean Fault and Longwall 32. Predicted subsidence profiles due to the extraction of Longwalls 31 and 32 are also shown in Fig. 3.6. It can be seen from Fig. 3.6 that the first order Nepean Fault structure is located away from Longwall 32.

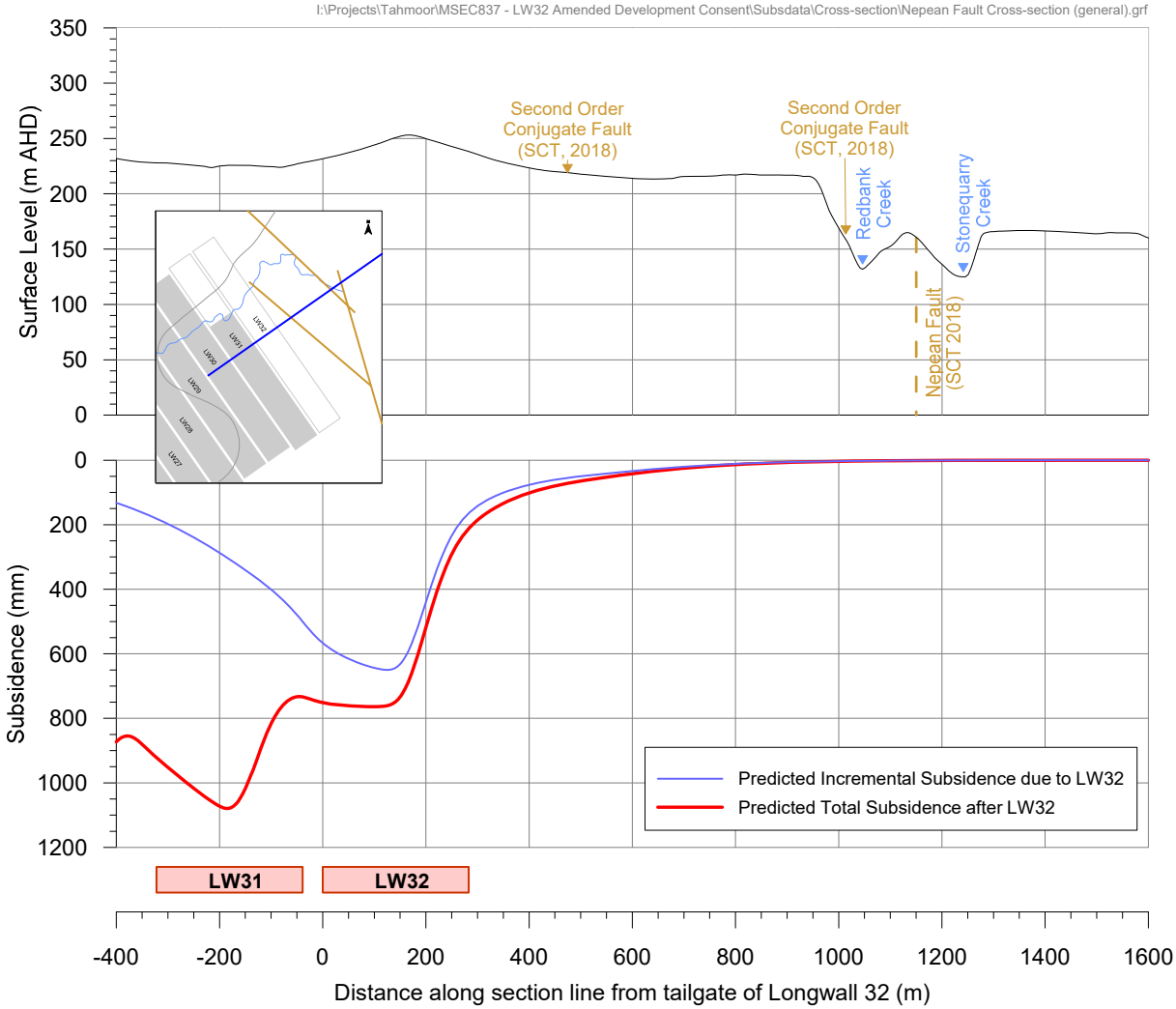

Fig. 3.6 Cross-section showing the mapped geological structures by SCT (2018a), and predicted subsidence profiles

3.5.2. Experience of subsidence movements between previously extracted longwalls and Nepean Fault at Tahmoor Coking Coal Operations

Tahmoor Coking Coal Operations has surveyed subsidence along many streets during the mining of previous Longwalls 24A to 31. Some of these monitoring lines are located over solid, unmined coal, between the extracted longwalls and the Nepean Fault.

None of the survey lines cross first order faults, though two survey lines (Stilton Dam Line and Remembrance Drive East Line) cross mapped second order conjugate faults.

A study has been completed to ascertain whether irregular subsidence have occurred along the survey lines. The information provides an indication of the likelihood of irregular movements during the extraction of Longwall 32.

The locations of the survey lines relative to the Nepean Fault and associated geological structures is shown in Fig. 3.7.

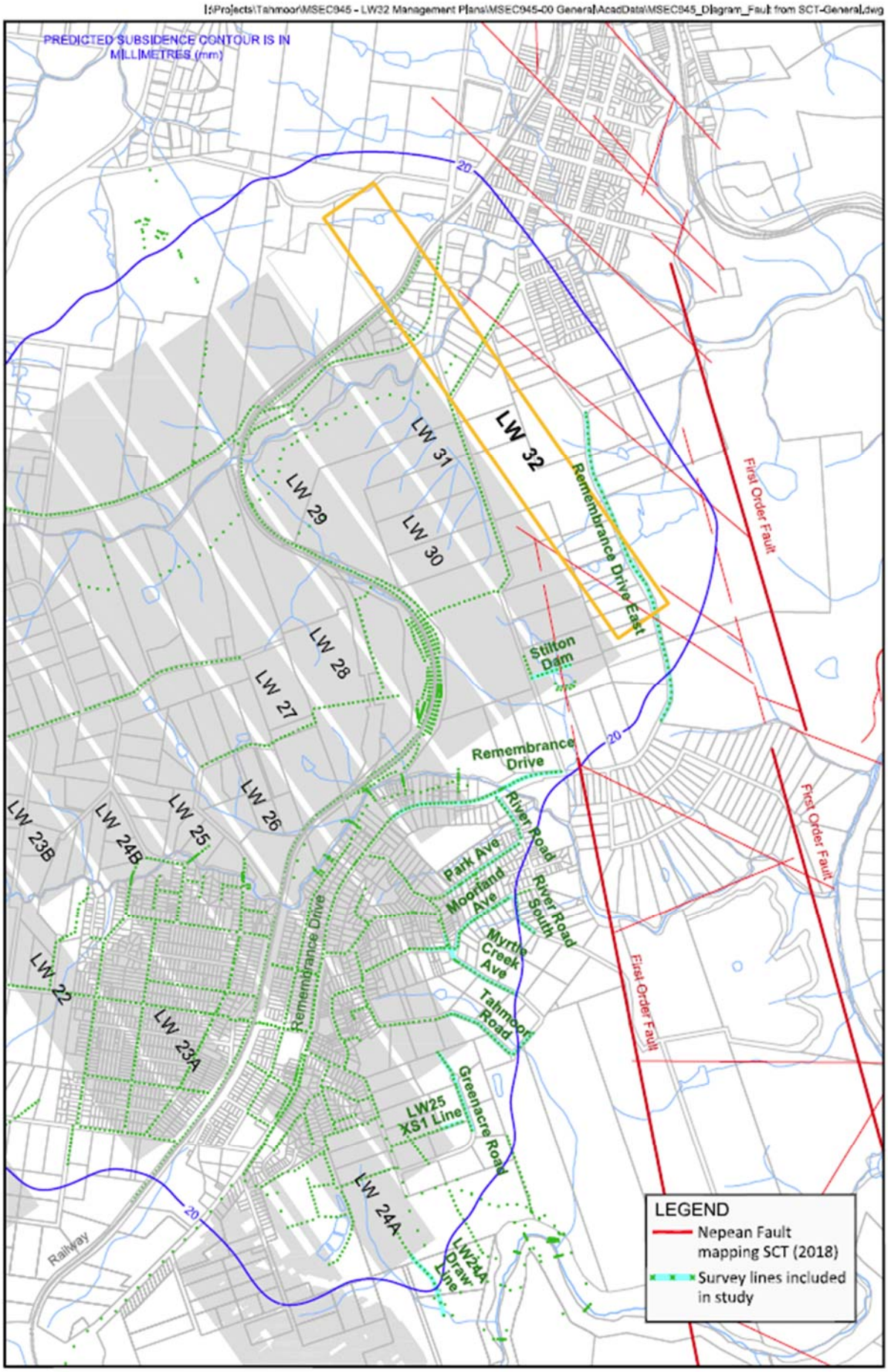

Fig. 3.7 Locations of ground survey lines in relation to the mapped geological structures by SCT (2018a)

The monitoring lines examined included.

- 900-Line, due to the extraction of LWs 12 and 13 (not shown in Fig. 3.7),
- LW24 Draw Line, due to the extraction of LWs 24A and 25
- LW25-XS1 Line, due to the extraction of LWs 25 and 26
- Greenacre Drive, due to the extraction of LWs 25 and 26
- Tahmoor Road Line, due to the extraction of LWs 25 to 27
- Myrtle Creek Avenue, due to the extraction of LWs 25 to 28
- Moorland Road, due to the extraction of LWs 25 to 28
- River Road South, due to the extraction of LWs 27 and 28
- Park Avenue, due to the extraction of LWs 25 to 28
- River Rd, due to the extraction of LWs 26 to 28
- Remembrance Drive, due to the extraction of LWs 24A to 30
- Remembrance Drive, due to the extraction of LWs 24A to 27
- Stilton Dam Northern Line, due to the extraction of LWs 29 to 31 (refer Fig. 3.10)
- Remembrance Drive East, due to the extraction of LW31 (refer Fig. 3.11)

The study found no increased subsidence, tilt or strains were measured along the survey lines that were located over unmined, solid coal areas between the extracted longwalls and the Nepean Fault.

A histogram of the maximum observed tensile and compressive strains measured along the selected survey lines for survey bays located over solid coal between previously extracted longwalls at Tahmoor and the Nepean Fault is provided in Fig. 3.8.

It can be seen from Fig. 3.8 that observed ground strains have been, on average, within survey tolerance. A pair of outlying data points are labelled in Fig. 3.8.

Pegs RE77 and RE78 are located within the base of Myrtle Creek, which is the main watercourse in the area. Whilst Myrtle Creek has experienced a small amount of valley closure at this location due to the mining of Longwalls 29 and 30, it can be seen from Fig. 3.9 that measured strains across the base of the Creek have varied greatly over time. The main reason for the variations is that the pegs are spaced only 3 metres apart, meaning that survey tolerance has a much greater influence on the measured result. Most survey bays in the Southern Coalfield are spaced apart by nominally 20 metres. The second reason is that variations have occurred after periods of heavy rainfall, where the pegs have been affected by swelling of the natural soils.

Pegs MD29 to MD30 appear to have been disturbed by construction works. The changes occurred after the completion of Longwall 26. The pegs, however, are located approximately 35 metres from the commencing end of Longwall 27, as shown in Fig. 3.9, but they experienced no changes during the mining of this longwall.

Notwithstanding these outliers, the statistics demonstrate that observed ground strains have been very small for survey pegs over solid coal, beyond the edges of the extracted longwalls at Tahmoor Coking Coal Operations.

Two survey lines (Stilton Dam Line and Remembrance Drive East Line) cross mapped second order conjugate faults. As shown in Fig. 3.10 and Fig. 3.11, observed subsidence, tilt and strain have been very low at these intersections. A very small bump was, however, observed along the Remembrance Drive East Line approximately 20 metres from the intersection point. Ground strains remained within survey tolerance at this location.

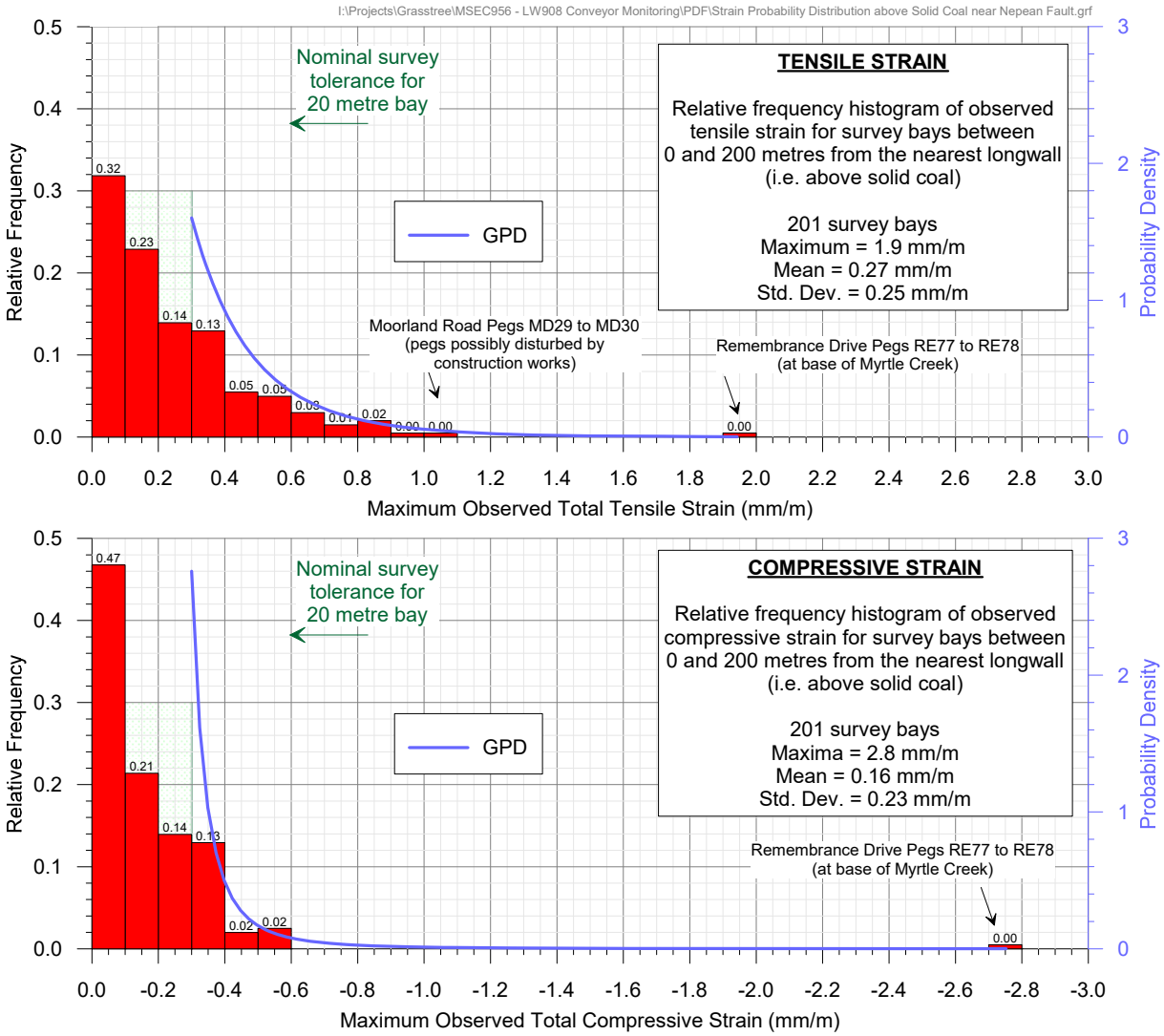

Fig. 3.8 Distributions of the Measured Maximum Tensile and Compressive Strains for Bays Located over Solid Coal between previously extracted longwalls at Tahmoor Coking Coal Operations and the Nepean Fault

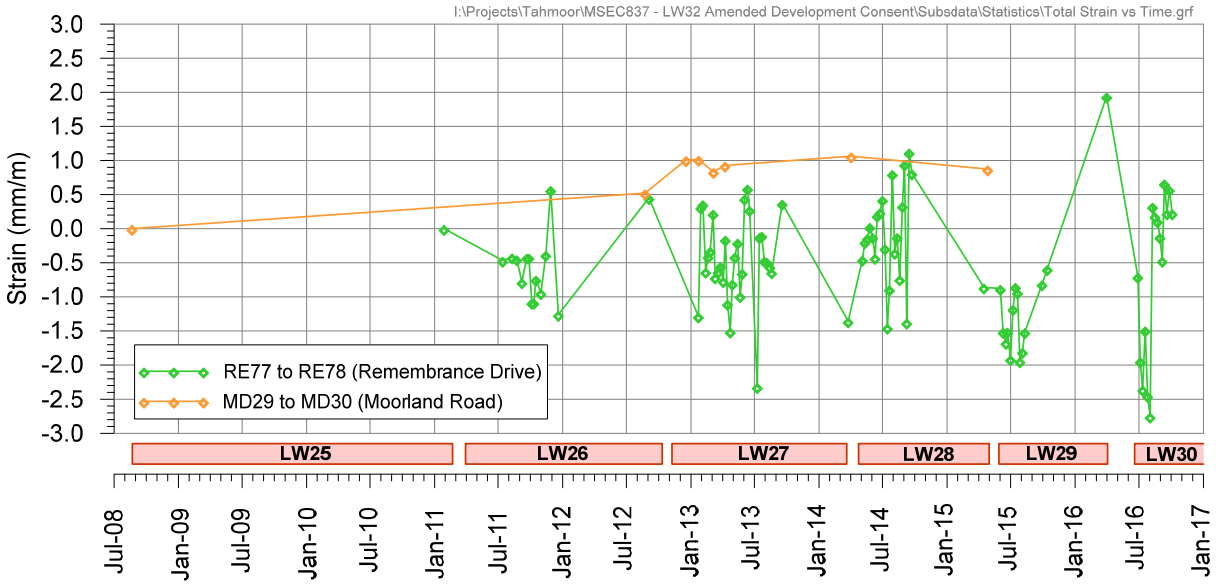

Fig. 3.9 Observed ground strains at selected sites during the mining of Longwalls 25 to 30

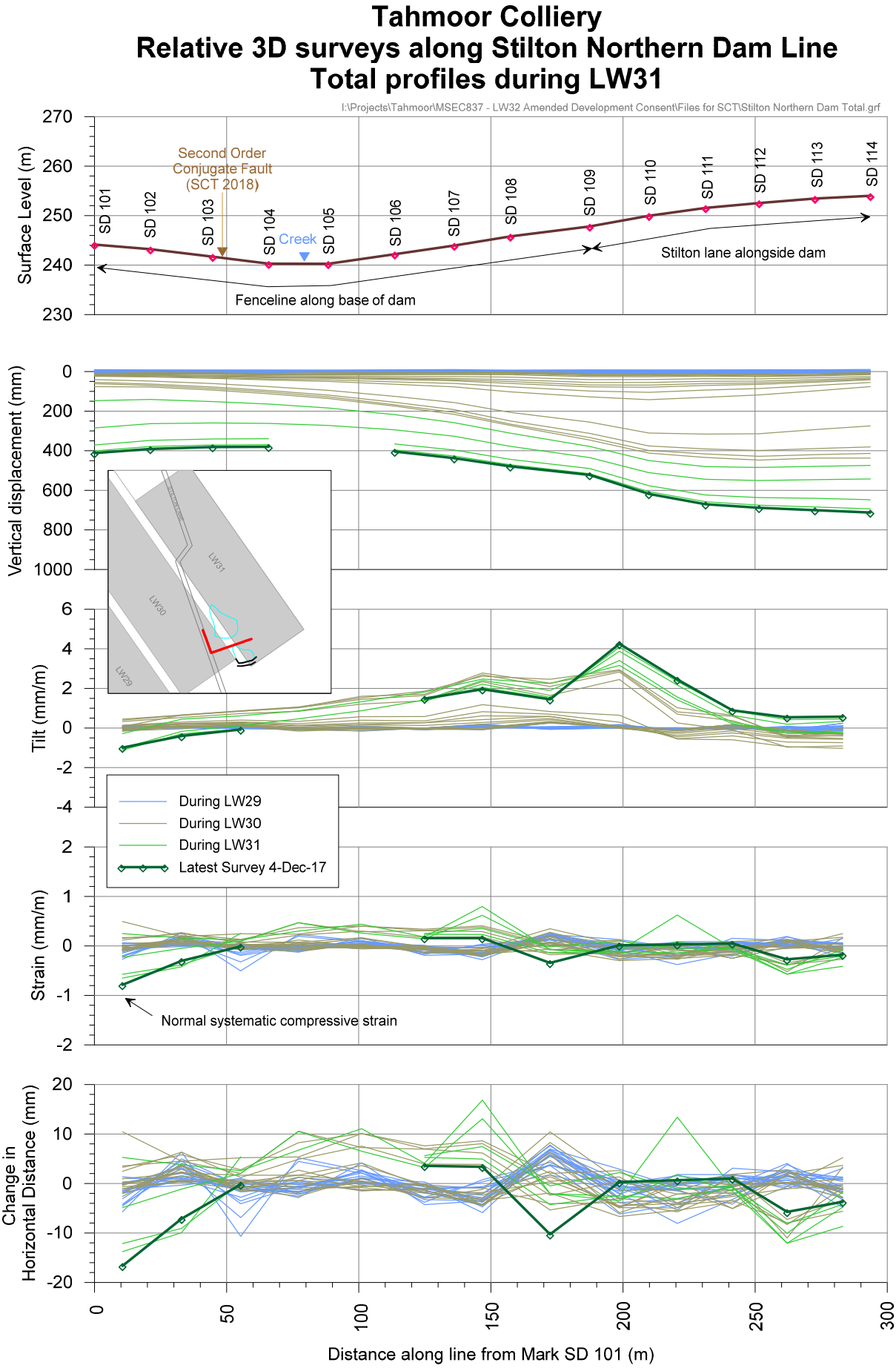

Fig. 3.10 Observed total subsidence profiles along the Stilton Northern Dam Line during the mining of Longwalls 29 to 31

Tahmoor Colliery - Longwall 31
Incremental Subsidence Profiles along Remembrance Drive East

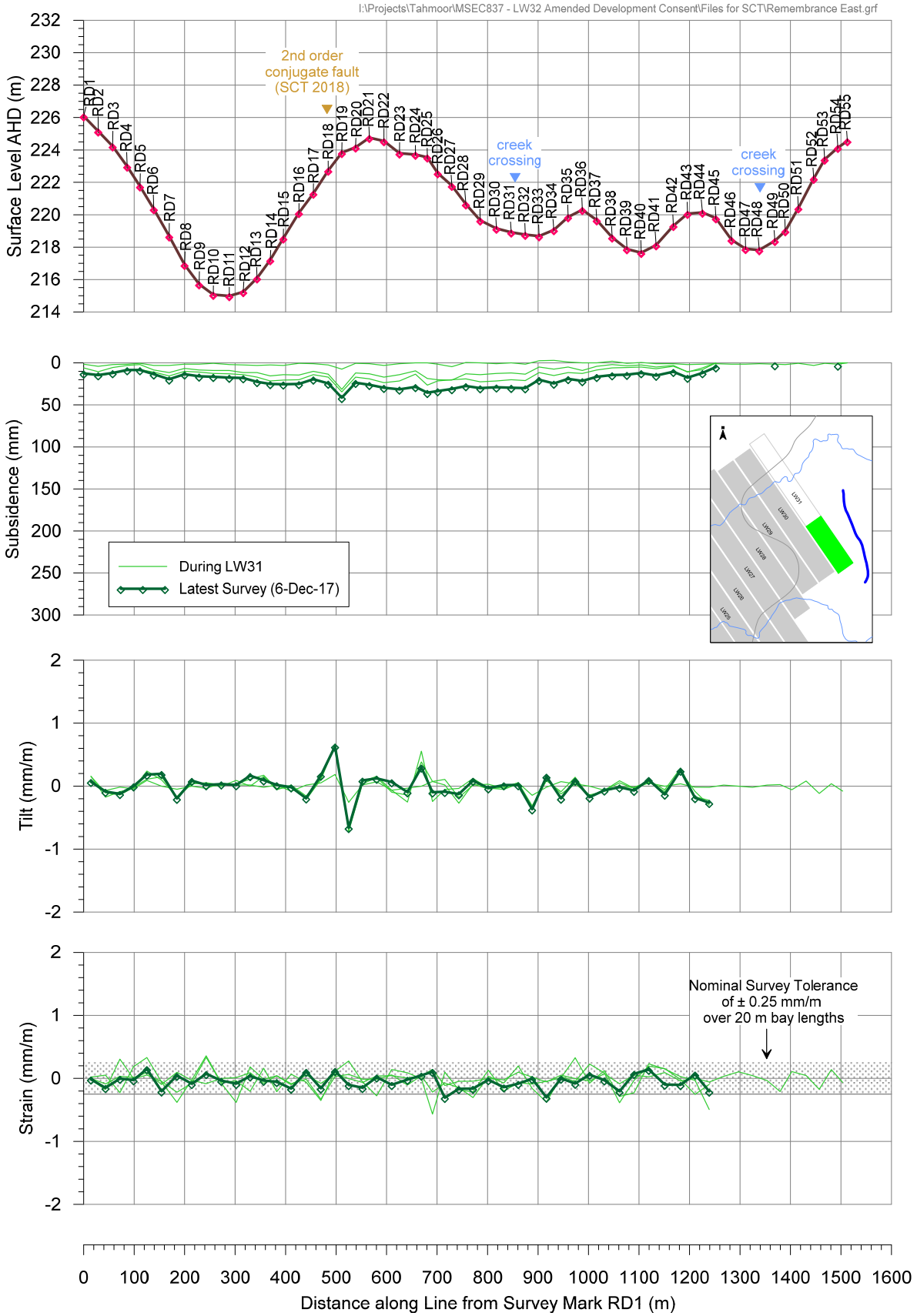

Fig. 3.11 Observed total subsidence profiles along the Remembrance Drive East Line during the mining of Longwalls 31

3.5.3. Potential effects of the Nepean Fault and associated geological structures on the development of subsidence during the extraction of Longwall 32

SCT (2018b) has undertaken a thorough and systematic review of subsidence outcomes that could reasonably be considered to be potentially significant. The following potential outcomes were investigated:

1. *"The potential for greater than predicted (abnormal) subsidence over the LW32 panel to cause greater subsidence beyond the panel edges.*
2. *The potential for unconventional subsidence movements occurring beyond the edge of LW32, including at or across the Nepean Fault.*
3. *The potential for mining-induced stress changes near the Nepean Fault to cause the fault plane to be mobilised.*
4. *The potential for movements that might occur quickly than conventional subsidence because of the presence of the fault and increase normal mining induced micro-seismic activity due to the isolating effect of the fault."*

SCT (2018b) concluded that "*none of the potential outcomes could reasonably be considered to have potential to be significant*". The conclusion is based on the following reasons (SCT, 2018b):

- The mapped planes of the first order Nepean Fault are remote from Longwall 32. Any differential vertical movement that may occur at the location of the Nepean Fault would be limited to less than a few tens of millimetres.
- Whilst increased subsidence was previously observed above the commencing ends of Longwalls 24A to 28, increased subsidence was not observed beyond the panel edges. Recent observations, including those during the mining of Longwall 31 indicate that subsidence has returned to normal levels.
- The Nepean Fault and associated fault structures are mapped as being sub-vertical. The geological structures that are recognised to be associated with unconventional subsidence are typically sub-horizontal i.e. bedding planes.
- Whilst mining induced stress changes are expected to occur on the fault because of longwall mining, they are not of a nature that would allow the fault plan to be destabilised and slip. This is because the stresses acting on the fault plane are not such that the fault is in limiting equilibrium, i.e. on the verge of instability.
- The high stresses and absence of massive strata in the Southern Coalfield of NSW mean that fracturing and downward movement occurs gradually and incrementally as the longwall retreats. Micro-seismic activity occurs regularly and so has low magnitude.

The conclusions by SCT (2018b) are supported by the results of the subsidence studies at Tahmoor Coking Coal Operations, as described in Section 3.5.2.

SCT (2018b) also advises that "*unconventional subsidence unrelated to the Nepean Fault may occur within the subject area during mining of LW32. Unconventional subsidence movements are observed at Tahmoor from time to time and therefore, may occur within the subject area*." MSEC concurs with this view, noting that the observed frequency of impacts beyond the edges of the longwalls have been infrequent and have been relatively slight in nature.

In addition to the subsidence study, an analysis of reported impacts during the mining of previous longwalls at Tahmoor Coking Coal Operations have recorded very few impacts beyond the panel edges, including in locations between the extracted longwalls and the Nepean Fault.

3.5.4. Potential effects of geological structures on the development of subsidence during the extraction of Longwall 32

Whilst the potential for significant differential movements is considered to be relatively low beyond the edges of Longwall 32, it is possible, however, that significant differential movements could occur at sites located directly above Longwall 32, including where second order geological structures associated with the Nepean Fault have been identified. Whilst no impacts have been observed at the Stilton Lane dam site in Fig. 3.10, differential movements have been observed where other geological structures have intersected the surface.

A recent example occurred at a low angle fault that intersected the Main Southern Railway in a railway cutting at Tahmoor, which was located directly above Longwall 29. The site was monitored extensively during the mining of Longwalls 28 to 31. This included three monitoring lines along the railway cutting, and survey prisms along the railway track.

The results of observed changes in vertical alignment of the pegs along the railway cutting are shown in Fig. 3.12. It can be seen that the most significant changes occurred during the mining of Longwall 29. The changes, however, developed gradually over time, allowing the railway track to be adjusted such that trains could continue to travel through the site.

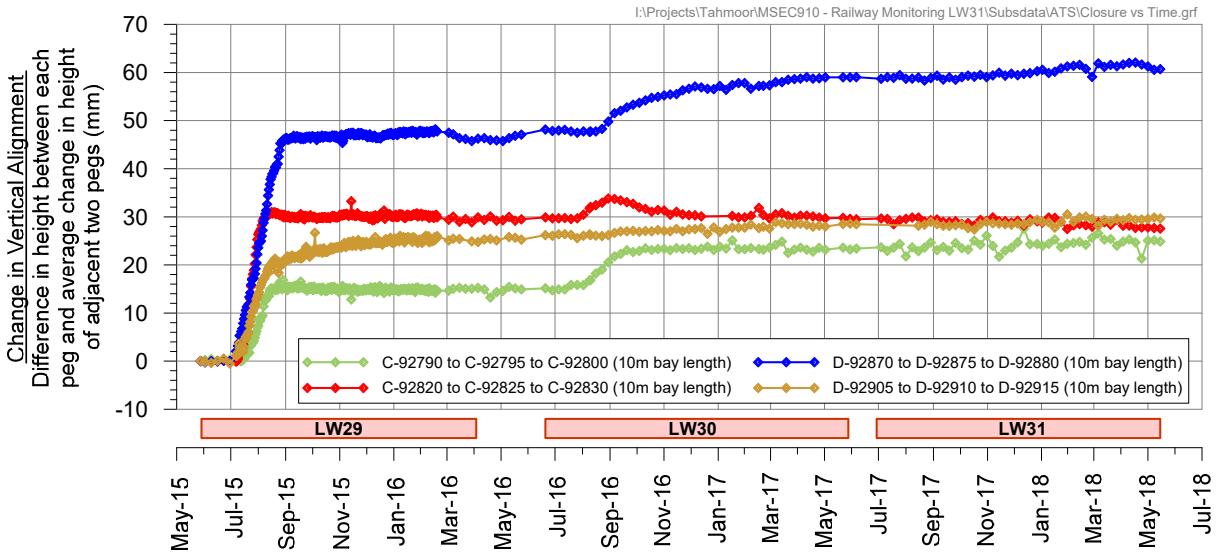

Fig. 3.12 Changes in vertical alignment across a geological fault within a railway cutting during the mining of Longwalls 29 to 31 at Tahmoor Coking Coal Operations

The observations of the gradual development of differential movements have been consistently observed during the mining of previous longwalls at Tahmoor Coking Coal Operations. While some sites have experienced severe impacts, the subsidence movements developed gradually, allowing time to repair before they became unsafe. This is discussed further in the next section.

3.6. Managing Public Safety

The primary risk associated with mining beneath Sydney Water infrastructure is public safety. Tahmoor Coking Coal Operations 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. The assessments include an inspection by a structural engineer in relation to bridges, a mine subsidence engineer, a geotechnical engineer for steep slopes, and an engineering geologist for geological structures.

3.6.1. Subsidence Impact Management Process for Infrastructure

Tahmoor Coking Coal Operations has developed and acted in accordance with a subsidence management plan to manage potential impacts during the mining of Longwalls 22 to 31. The management strategy has been reviewed and updated based on experiences gained during the mining of Longwalls 22 to 31 and the strategy for Longwall 32 includes the following process:

1. Regular consultation with Sydney Water 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.
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 Sydney Water infrastructure experiences mine subsidence movements is shown in Fig. 3.13.

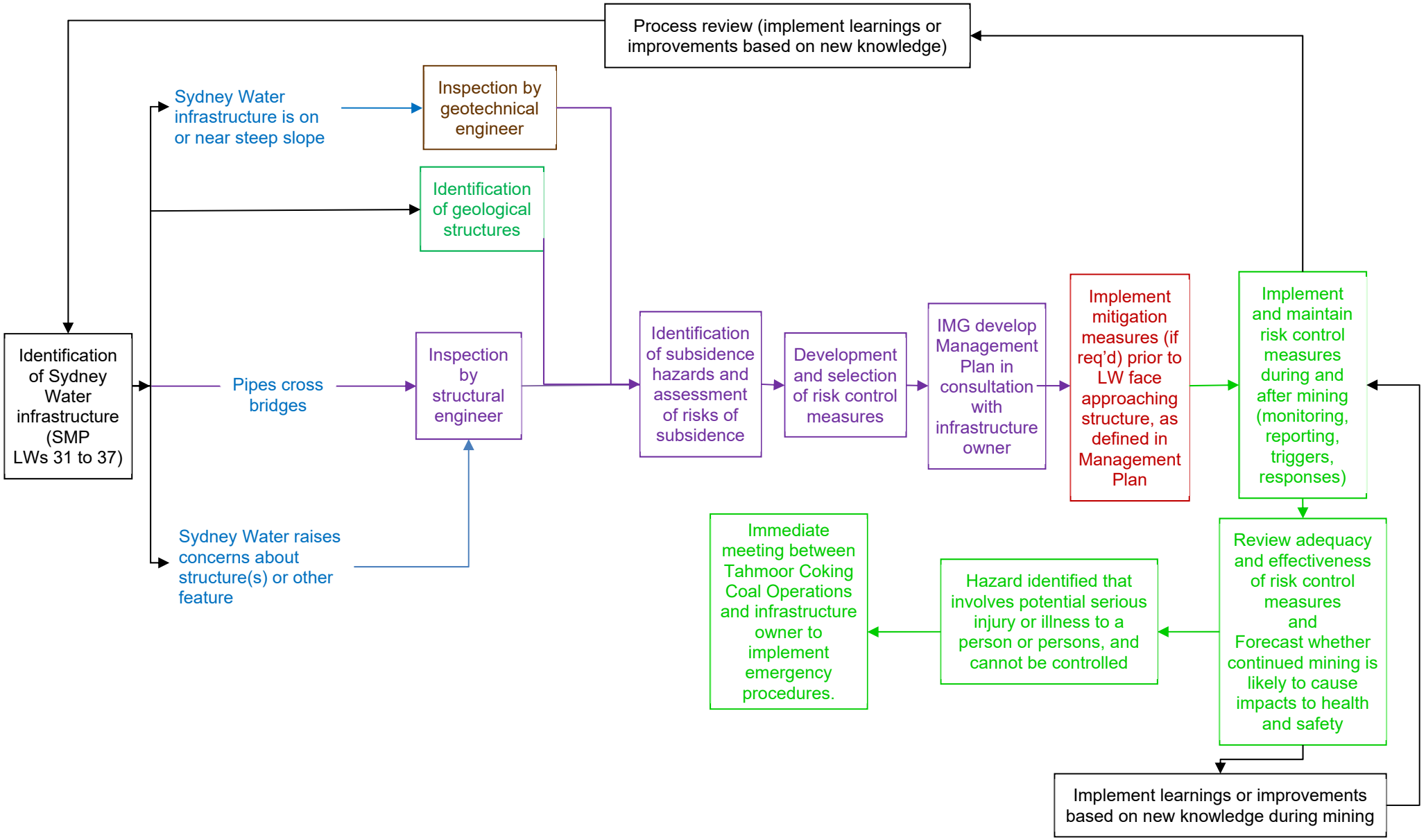

Fig. 3.13 Flowchart for Subsidence Impact Management Process

3.7. Summary of Potential Impacts

A summary of potential impacts on Sydney Water's Potable Water infrastructure is provided in Table 3.2. The summary is consistent with the risk assessment undertaken by Tahmoor Coking Coal Operations (Glencore, 2018), and was reassessed according to Sydney Water's Risk Criteria. 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
Pipeline along Remembrance Drive (above LW32)			
Leakage of the joints	POSSIBLE	MINOR	MEDIUM
Water main break and depletion of Picton Reservoir	POSSIBLE	MODERATE	MEDIUM
Reticulation network within influence of LW32			
Leakage of the joints	POSSIBLE	INSIGNIFICANT	LOW

Additional information on each potential impact is provided below.

3.8. 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 Coking Coal Operations), 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 potable water infrastructure.

Using the processes described in Section 3.6 of this Management Plan, mine subsidence hazards have been identified, investigated and analysed in a systematic manner by examining each aspect of the infrastructure, as described in Section 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.

- Main water pipeline along Remembrance Drive
- Local reticulation network
- Water pipelines at creek crossings and across mapped geological structures.

The following mine subsidence hazards were identified that could give rise to risks to health and safety due to the extraction of Longwall 32.

- Water main break leading to depletion of Picton Reservoir (refer Section 3.9)

The identification and risk assessment process took into account the location of infrastructure relative to Longwall 32 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 Coking Coal Operations 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 Sydney Water infrastructure, as discussed in Section 1.4 and Chapter 3 of this Management Plan. In this case, creeks and geological structures have been mapped that intersect water pipelines.

Tahmoor Coking Coal Operations 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 Sydney Water property in general. These are described in Chapter 4 of this Management Plan.

3.9. Potable water pipelines

There are a number of potable water pipelines that are located directly above or adjacent to Longwall 32, as shown in Drawings Nos. MSEC945-03-01 and MSEC945-03-02.

- Main 200 mm CICL and oPVC diameter water main along Remembrance Drive / Argyle Road

  This is the main road linking the townships of Tahmoor and Picton. The extraction of Longwall 32 will affect approximately 2.4 km of water main along Remembrance Drive between the southern end of the property owned by by Sydney Water's Picton Water Recycling Plant and the intersection of Argyle Street and Hill Street.

  The majority of the affected section of Remembrance Drive is located to the side of Longwall 32, which will extract directly beneath approximately 500 metres of the pipeline.

  The water main along Remembrance Drive crosses watercourses at four locations within the area predicted to be experience subsidence from the extraction of Longwall 32. The oPVC pipe crosses Redbank Creek via a buried pipe. The CICL pipe also traverses three small watercourses within the area predicted to be experience subsidence from the extraction of Longwall 32.

  The CICL water main along Remembrance Drive also crosses mapped second order geological structures associated with the Nepean Fault at two locations, as shown in Drawing No. MSEC945-03-02.

- 150 mm diameter uPVC, CICL and DICL water main along Bridge Street

  This is one of the main roads that links the townships of Thirlmere and Picton. Approximately 1.3 kilometres of pipeline may experience subsidence movements due to the extraction of Longwall 32, which will extract directly beneath approximately 350 metres of the pipeline.

  The water main crosses a tributary to Redbank Creek on Bridge Street, approximately 270 metres to the side of Longwall 32, and a tributary that is located directly above Longwall 32.

- 150 mm diameter CICL and DICL water main along Henry Street

  A short branch line of approximately 400 metres in length is located on Henry Street. The CICL section is located directly above Longwall 32, and is approximately 120 metres in length.

- Other water pipelines potentially affected by the extraction of Longwall 32

  100 mmm and 150 mm diameter water pipelines are also located along Redbank Place, Bollard Place, Rumker Street, Wood Street, Coachwood Crescent, and Wonga Road, as shown in Drawing No. MSEC945-03-01. The pipes are either of CICL, DICL or uPVC construction.

  The pipes potentially affected by Longwall 32 are located on Bridge Street, Wood Street and Coachwood Crescent.

3.9.1. Predicted subsidence movements

The potable water pipelines located above and adjacent to Longwall 32 generally follow the alignments of the local roads and, therefore, they will 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 Longwall 32 is provided in Section 3.3.

The predicted profiles of conventional subsidence, tilt and curvature for the 200 mm diameter water main along Remembrance Drive is shown in Fig. 3.14. The predicted profiles of conventional subsidence, tilt and curvature for the 150 mm diameter water main along Bridge Street is shown in Fig. 3.15. The predicted total profiles after the completion of Longwall 31 are shown in cyan. The predicted incremental profiles due to the extraction of Longwall 32 only are shown in black. The predicted total profiles after the completion of Longwall 32 are shown in blue.

A summary of the maximum predicted conventional subsidence, tilt and curvature for each of the gas pipelines, after the extraction of Longwall 32, 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 Longwall 32.

Table 3.3 Maximum predicted total conventional subsidence, tilt and curvature for the pipelines

Location	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)
200 mm diameter water main along Remembrance Drive	After LW32	300	1.5	0.02	0.01
150 mm diameter water main along Bridge Street	After LW32	1,200	4.5	0.08	0.11

Bridge Street will also experience transient tilts and curvatures as the extraction face of Longwall 32 mines directly beneath it. The maximum predicted transient movements orientated across the alignment of Bridge Street are 3.5 mm/m tilt, 0.06 km^{-1} hogging curvature and 0.08 km^{-1} hogging curvature.

The water pipelines cross a number of creeks within the area potentially affected by the extraction of Longwall 32.

The 200 mm diameter CICL pipeline on Remembrance Drive crosses three small watercourses between Wonga Road and Koorana Road. The same pipeline also crosses Redbank Creek approximately 350 metres to the side of Longwall 32. The 160 mm diameter DICL water pipeline along Bridge Street crosses a 'hidden creek' directly above Longwall 32 near Redbank Place.

The sections of pipelines that are crossing creeks are expected to experience upsidence and closure movements, as well as localised and elevated compressive strains due to these valley related movements.

A summary of the maximum predicted upsidence and closure movements at the tributary crossings, resulting from the extraction of the proposed longwalls, is provided in Table 3.4. The maximum predicted compressive strains have also been provided in this table, which are based on a statistical analysis of strains measured across drainage lines within the Southern Coalfield which have effective valley heights less than 20 metres and survey bay lengths between 15 metres and 25 metres.

Table 3.4 Maximum Predicted Total Upsidence, Closure and Compressive Strain for the Creek Crossings

Location	Maximum Predicted Total Upsidence (mm)	Maximum Predicted Total Closure (mm)	Maximum Predicted Compressive Strain (mm/m)		
			60 % Confidence Level	90 % Confidence Level	95 % Confidence Level
Crossings Located Directly above the Proposed Longwalls	300	350	2.0	5.5	7.5
Crossing Located Outside but within 200 metres of the Extents of the Proposed Longwalls	100	100	< 0.5	1.5	2.5
Crossing Located more than 200 metres from the Extents of the Proposed Longwalls	< 50	< 50	< 0.5	0.8	1.5

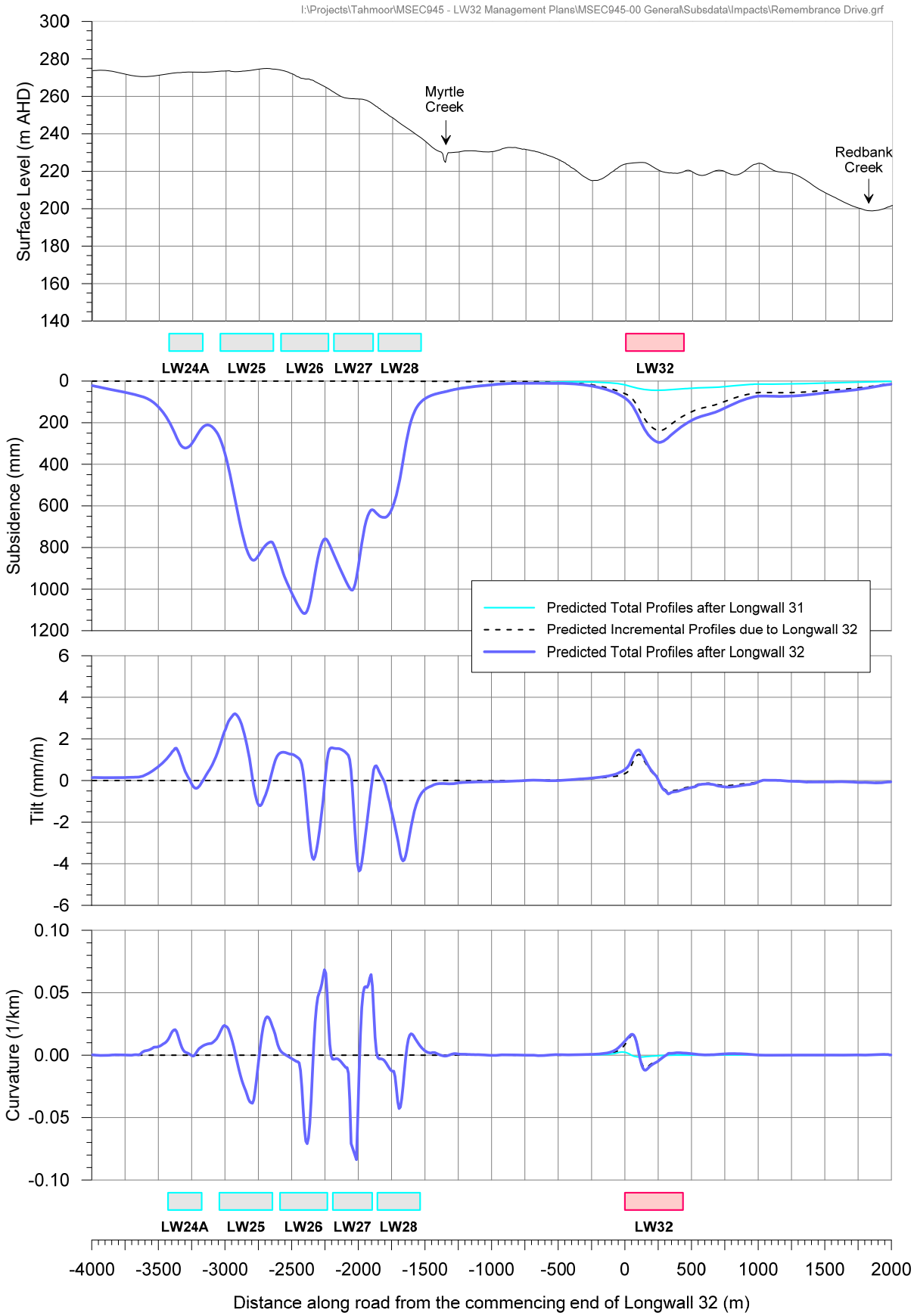

Fig. 3.14 Predicted profiles of total subsidence, tilt and curvature along Remembrance Drive due to the mining of Longwalls 22 to 32

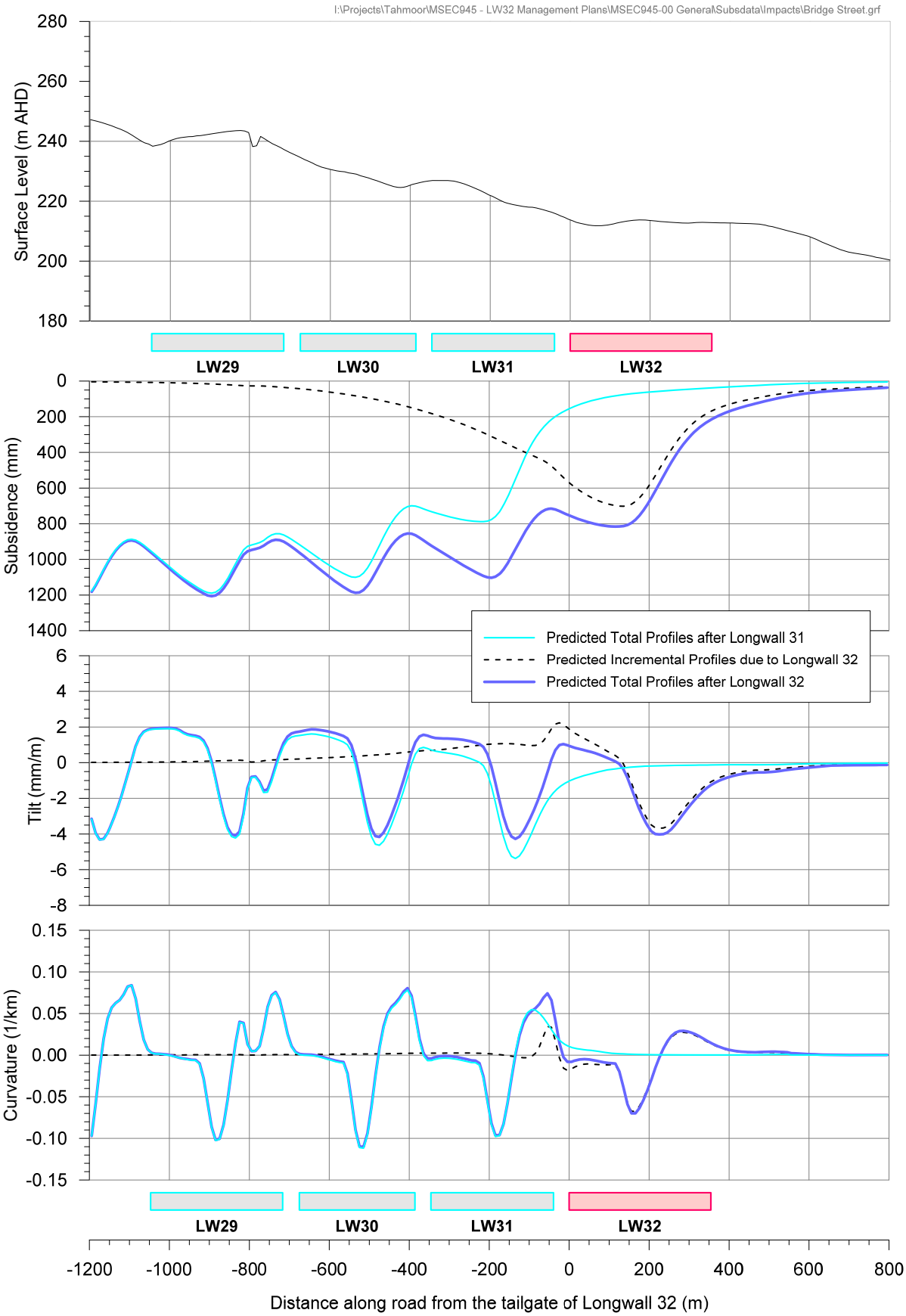

Fig. 3.15 Predicted profiles of total subsidence, tilt and curvature along Bridge Street due to the mining of Longwalls 22 to 32

3.9.2. Potential subsidence impacts on water pipelines

Longwalls 22 to 31 have directly mined beneath approximately 19 km CICL pipelines and approximately 5.4 km of DICL pipelines with only minimal adverse impacts on the distribution network. The reported adverse impacts on the potable water pipelines at Tahmoor Coking Coal Operations include:

- There was a leak in a CICL water main on Glenanne Place in June 2007 during the mining of Longwall 24B. While there was no ground survey data to quantify the ground movements, the leak coincided with damage to the road pavement and damage to a fence. It is considered that non-systematic movements developed at this location;
- A water leak was observed in a CICL water main on York Street opposite the Tahmoor Town Centre during the mining of Longwall 25. While no impacts were reported to the road pavement and no elevated ground strain was observed at the leak, a bump was observed in the subsidence profile near the location of the leak;
- A CICL water main leaked on Moorland Road during Longwall 26, where increased ground strains and a small bump in the subsidence profile were observed. The pipe was repaired the same day;
- A CICL water leak was observed on York Street on two occasions during Longwall 26, at a site where increased strain and a bump in the subsidence profile were observed. The leak was repaired each time;
- A very small number of minor leaks have also been observed to consumer connection pipes on private properties. Remedial works were undertaken and the leaks repaired; and
- There was a leak in a 100 mm diameter CICL water main on Myrtle Creek Avenue in January 2013 during the mining of Longwall 27, at a site where increased strain and a bump in the subsidence profile were observed. The leak was repaired the same day.

It is possible, but unlikely, that minor adverse impacts could occur to the potable water pipelines that are located directly above or immediately adjacent to Longwall 32, similar to those observed above the previously extracted longwalls. It is expected that the impacts would comprise relatively minor water leaks and that these could be readily repaired.

Tahmoor Coking Coal Operations has developed and selected risk control measures in consultation, co-ordination and cooperation with Sydney Water in accordance with WHS legislation. The controls have been implemented during the mining of Longwalls 22 to 31. 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 Coking Coal Operations has identified controls that will manage potential issues associated with damage to pipelines resulting in damage to potable water pipelines during the extraction of Longwall 32 by implementing the following measures.

- 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.
- Exposing pipeline to relieve it of stress if triggered by monitoring results
- In the worst case, repair of damaged pipeline.

Specific potential issues for the CICL water main pipeline along Remembrance Drive between Wonga Road and Koorana Road are described in the following sections.

3.9.3. CICL water main along Remembrance Drive between Wonga Road and Koorana Road

Whilst Longwalls 24A to 28 have previously mined directly beneath the water main with no impacts observed, Sydney Water advises that the potentially affected CICL section of the pipeline between Wonga Road and Koorana Road has a history of water leaks during times of high pressure. A renewal project is currently underway, with approximately 900 metres of pipeline between Henry Street and Wonga Road replaced with oPVC pipe.

The potential for impacts along the CICL section may, therefore, be higher than what has normally been experienced during previous mining at Tahmoor Coking Coal Operations.

The water main feeds the Picton Reservoir, which is located near the Picton Railway Tunnel. In the event of a water main break, approximately 400 customers will experience a temporary loss of water supply until the pipeline is repaired. Whilst the repairs are being undertaken, the Reservoir continues to supply approximately 2000 customers within the Picton township. In some previous instances, the time to repair the water main has been close enough to almost fully deplete the Reservoir.

Sydney Water currently reduces the potential for water main break by remotely monitoring water pressure at pressure reducing valves stationed along the pipeline. Sydney Water are notified when water pressures build up, and a maintenance crew is sent to site to reduce pressure. This standard procedure will continue

to be followed during the mining of Longwall 32. In addition to the above, valves along the section between Wonga Road and Koorana Road will be marked out on site to reduce repair times in the event of a water leak or break.

In the event of a water main break, it will also be possible to prolong the depletion of water reserves in the Picton Reservoir whilst repairs are being undertaken by supplying potable water by tanker trucks.

In addition to the above considerations, the water main along Remembrance Drive is located directly beneath the commencing end of Longwall 32, as shown in Drawing No. MSEC945-03-01. A study of past experiences at the commencement of previously extracted longwalls at Tahmoor Coking Coal Operations and other mines in the Southern Coalfield at similar depths of cover have shown that subsidence develops gradually after approximately 100 metres of extraction. The experiences include extensive and frequent surveys that have been undertaken at the commencements of Longwalls 24B, 26, 29 and 30.

In the case of Longwall 30, a specific survey line was installed to monitor the initial subsidence above the commencing end and the results, showing the gradual development of subsidence, are shown in Fig. 3.16 and Fig. 3.17.

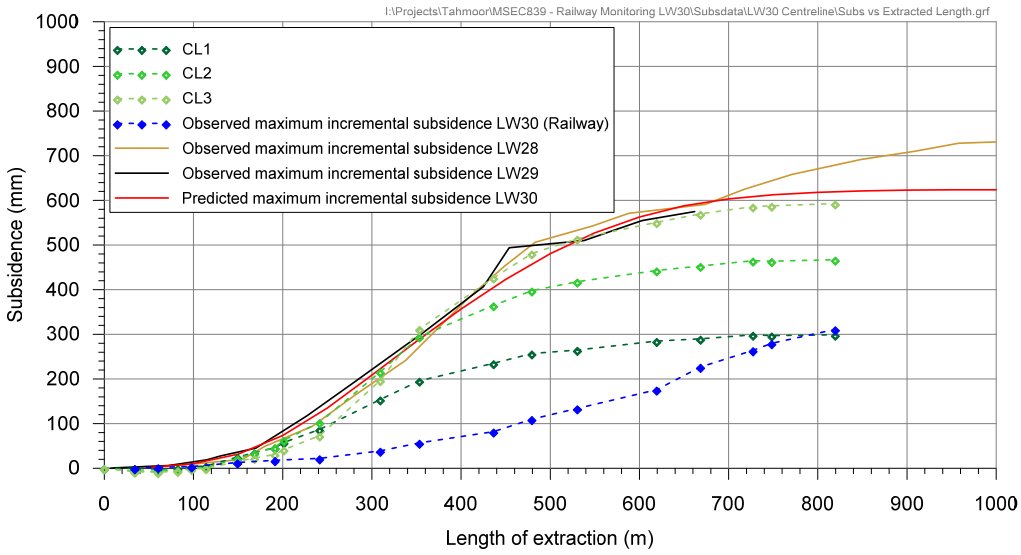

Fig. 3.16 Observed development of initial subsidence above Tahmoor Longwalls 28 to 30 relative to length of extraction

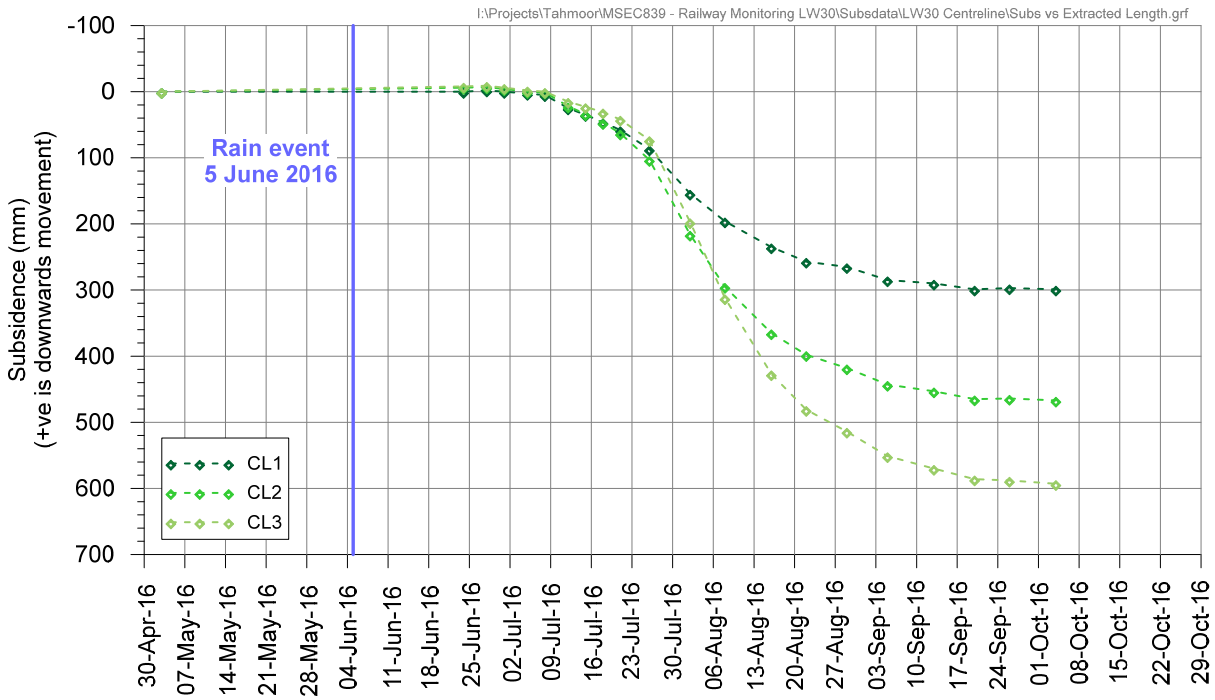

Fig. 3.17 Observed development of subsidence above the commencing end of LW 30 over time

While not supported by observations at Tahmoor Coking Coal Operations to date, it is possible, through very unlikely, that the overburden directly above the commencement end of Longwall 32 could bridge the void that initially forms after mining commences, such that initial subsidence is delayed. A potential issue could arise in this scenario in that once the overburden collapses into the void, subsidence movements could develop at a faster rate than normal and if the differential movements were adverse in nature, impacts could develop rapidly on Remembrance Drive.

In light of the site-specific conditions of the CICL section of water main along Remembrance Drive, Tahmoor Coking Coal Operations has developed and selected risk control measures in consultation, co-ordination and cooperation with Sydney Water 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 Coking Coal Operations has identified controls that will manage potential issues by implementing the following measures prior to and during the extraction of Longwall 32 along this section of pipeline.

- Mark out valve locations on site between Wonga Road and Koorana Road prior to the commencement of Longwall 32, to reduce repair times in the event of a future water leak or break.
- Commence weekly ground surveys and visual inspections along Remembrance Drive immediately upon commencement of Longwall 32.
- Report on underground caving conditions
- In the unlikely event that subsidence movements are delayed during the early stages of extraction of Longwall 32, implement additional management measures including an increase in monitoring and reporting, provision of labour, equipment and materials on site to respond if adverse movements develop.
- Follow Sydney Water procedures to monitor and respond to high water pressure levels at water reducing valves.
- Make arrangements to provide potable water by tanker trucks to the Picton Reservoir in the event of break to 200 mm diameter water main along Remembrance Drive

Tahmoor Coking Coal Operations has investigated and confirmed that the measures are feasible and effective for the site-specific conditions during the extraction of Longwall 32.

4.1. Infrastructure Management Group (SRG)

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 Sydney Water 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 8.0

4.2. Development and Selection of Risk Control Measures

Tahmoor Coking Coal Operations 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 risk control measures are described in Section 4.3.

Method B risk control measures are described in Section 4.3 to Section 4.6. Prior to selecting Method B risk control measures, Tahmoor Coking Coal Operations has investigated and confirmed that the measures are feasible and effective for the site-specific conditions during the extraction of Longwall 32.

4.3. Selection of Risk Controls for Potable Water Infrastructure

Based on the above assessments, Tahmoor Coking Coal Operations 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 potable water infrastructure.

- Implementation of a Monitoring Plan and Trigger Action Response Plan (TARP)
  As described in the Management Plan, Tahmoor Coking Coal Operations and Sydney Water 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:
    - Mark out valve locations on site between Wonga Road and Koorana Road prior to the commencement of Longwall 32, to reduce repair times in the event of a future water leak or break.
    - Local 2D surveys along local roads as shown in Drawing No. MSEC945-00-01. These include Remembrance Drive, Bridge Street and Henry Street.
    - Visual inspections along the streets within the active subsidence zone.
    - Additional surveys and/or inspections, if triggered by monitoring results.
    - In the unlikely event that subsidence movements are delayed during the early stages of extraction of Longwall 32, additional management measures may be implemented along Remembrance Drive, including an increase in monitoring and reporting, provision of labour, equipment and materials on site to respond if adverse movements develop. In the worst case scenario, a temporary speed restriction could be imposed on the road until subsidence has occurred.
    - Regular consultation with the community to report potential impacts.
    - Follow Sydney Water procedures to monitor and respond to high water pressure levels at water reducing valves.
    - Exposing pipeline to relieve it of stress if triggered by monitoring results
    - In the worst case, repair of damaged pipeline.
    - Make arrangements to provide potable water by tanker trucks to the Picton Reservoir in the event of break to 200 mm diameter water main along Remembrance Drive.

4.4. Monitoring Measures

A number of monitoring measures will be undertaken during mining.

4.4.1. Ground Surveys along streets

Survey marks have been placed along streets within the urban area above and adjacent to Longwall 32., as shown in Drawing No. MSEC945-00-01. The survey pegs will be surveyed during the period of active subsidence of these features during the extraction of Longwall 32.

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 Coking Coal Operations who is familiar with mine subsidence impacts. The inspector will undertake the following:

- Visual inspections along streets within the active subsidence zone.
- Visual inspections at pipeline crossings under creeks.

4.4.3. Changes to Monitoring Frequencies

Monitoring frequencies will continue while Sydney Water infrastructure is experiencing active subsidence due to the extraction of Longwall 32. 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 Coking Coal Operations based on engineering assessments and consultation with Sydney Water.

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.
- Exposing pipeline to relieve it of stress
- Repair of impacts that create a serious public safety hazard.
- Provide potable water by tanker trucks to the Picton Reservoir in the event of break to 200 mm diameter water main along Remembrance Drive.

The risk control measures described in this Management Plan have been developed to ensure that the health and safety of people on potable water 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 Longwall 32, 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 3.8, only a water main break leading to depletion of the Picton Reservoir could possibly 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 Sydney Water.

As documented in Section 4.6, Tahmoor Coking Coal Operations 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 Coking Coal Operations will be present on site on a more frequent basis to survey or inspect the affected site, and that Sydney Water 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 potable water 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 Coking Coal Operations or by people on public property, Tahmoor Coking Coal Operations and Sydney Water 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 Coking Coal Operations Longwall 32

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Potable water infrastructure	Impacts to Sydney Water potable water infrastructure	Medium / Low	None	Mark out valve locations on site between Wonga Road and Koorana Road prior to the commencement of LW32, to reduce repair times in the event of a future water leak or break.	Prior to start of LW32	Sydney Water
				Make arrangements to provide potable water by tanker trucks to the Picton Reservoir in the event of break to 200 mm diameter water main along Remembrance Drive	Prior to start of LW32	Sydney Water
				Install and initial survey additional survey pegs for Longwall 32 in accordance with Drawing No. MSEC945-00-01	Prior to LW face approaching within 400m of survey pegs	Tahmoor Coking Coal Operations (SMEC)
				Conduct surveys along Remembrance Drive / Argyle Street *Initial extent from Survey Peg RD1 to Peg RD32 and then extend to the north to include pegs within the active subsidence zone. After 800 m of extraction, reduce extent to the south beyond active subsidence zone unless ongoing adverse movements are observed*	Weekly from start of LW32 until 2200 m of extraction unless ongoing adverse movements are observed	Tahmoor Coking Coal Operations (SMEC)
				Conduct surveys along Henry Street / Stilton Lane, Bridge Street, Redbank Place, Bollard Place, Wonga Street, Wood Street and Coachwood Crescent	Weekly for pegs located within active subsidence zone	Tahmoor Coking Coal Operations (SMEC)
				Conduct visual inspections for surface deformations and water leaks along local roads within active subsidence zone	Weekly from start of LW32	Tahmoor Coking Coal Operations
				Inform Sydney Water Call Centre of mining in area and possible issues.	Completed	Sydney Water
				Notify residents of potential mine subsidence impacts and contact numbers.	Prior to start of LW32	Tahmoor Coking Coal Operations
				Analyse and report results to IMG	Weekly from start of LW32	Tahmoor Coking Coal Operations
				IMG discuss results and consider whether any additional management measures are required	Weekly from start of LW32	Tahmoor Coking Coal Operations
			Non-conventional ground movement detected	Notify Sydney Water	Within 24 hours	Tahmoor Coking Coal Operations
				Infrastructure Management Group (IMG) meets to consider whether any additional management measures should be undertaken, including: - increasing the frequency of surveys and visual inspections in vicinity of the non-conventional movement; - investigating for potential of damage occurring to Sydney Water infrastructure; and/or - relieving stresses on the pipes by locally excavating and exposing the pipes in the affected area.	As agreed between Tahmoor Coking Coal Operations and Sydney Water	IMG
			Leakage of water observed	Notify all stakeholders, including Sydney Water, Tahmoor Coking Coal Operations, Subsidence Advisory NSW and DRE	Within 24 hours	Tahmoor Coking Coal Operations
				Repair leak.	As per Sydney Water procedures	Sydney Water
				Provide alternative water supply to customers	As required	Tahmoor Coking Coal Operations
				Provide potable water by tanker trucks to the Picton Reservoir in the event of water main break	As per Sydney Water procedures	Sydney Water
				Consider increasing the frequency of surveys and visual inspections in vicinity of water leak, if appropriate.	As agreed between Tahmoor Coking Coal Operations and Sydney Water	Tahmoor Coking Coal Operations
			A hazard has been identified that involves potential serious injury or illness to a person or persons on public property or, or in vicinity of potable water infrastructure and cannot be controlled	IMG, Tahmoor Coking Coal Operations and Sydney Water meet to decide whether any additional management measures are required, including: - emergency evacuation of hazardous area - demarcation to prevent people entering hazardous area	Immediately	Tahmoor Coking Coal Operations and Sydney Water
				Notify SRG of trigger exceedance and any management decisions undertaken (incl Subsidence Advisory NSW, DRE)	Within 24 hours of decision	Tahmoor Coking Coal Operations

Delayed initial subsidence, potentially leading to rapidly developing adverse impacts on water pipelines along Remembrance Drive	Impacts to Sydney Water potable water infrastructure	Medium / Low	None	Follow procedures above for commencing surveys and visual inspections from start of LW32	-	Tahmoor Coking Coal Operations
				Report on underground mining conditions at longwall start	Weekly at start of LW32 until verification of goafing at commencing end	Tahmoor Coking Coal Operations
			Subsidence is delayed (such as subsidence not developing within expectations, and/or reports of no caving underground)	IMG meet and consider whether any additional management measures are required, which may include: - increase monitoring and reporting procedures, including placing inspectors on Remembrance Drive full time (24hours day, 7 days a week) if necessary - place labour, equipment and materials on standby for immediate response, - consider whether to recommend meeting between Tahmoor Coking Coal Operations and Sydney Water to review and discuss current and projected actions The IMG will take into account the following information: - monitoring data, including the rate of development (if any) of subsidence and whether irregular subsidence has developed - comparison between observed and predicted subsidence for the current length of extraction - reports on underground conditions - condition of Remembrance Drive	Within 24 hours	IMG

5.1. Consultation, Co-operation and Co-ordination

Substantial consultation, co-operation and co-ordination has taken place between Tahmoor Coking Coal Operations and Sydney Water 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 Coking Coal Operations and Sydney Water.

- Reporting of observed impacts to Tahmoor Coking Coal Operations either during the weekly visual inspection or at any time directly to Tahmoor Coking Coal Operations.
- 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 Sydney Water 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 Longwall 32.
- Convening of meetings between Tahmoor Coking Coal Operations and Sydney Water at any time as required, as discussed in Section 5.2.
- Arrangements to facilitate timely repairs, if required.
- Immediate contact between Tahmoor Coking Coal Operations and Sydney Water 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 Sydney Water 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 structures on the property.

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 Sydney Water infrastructure;
- Verify the risk assessments previously conducted;
- Ensuring the effectiveness and reliability of risk control measures; and
- Supporting continual improvement and change management.

IMG meetings may be held between Tahmoor Coking Coal Operations and Sydney Water 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 Coking Coal Operations and Sydney Water.

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 Coking Coal Operations to review the operation of the Management Plan and report at the next scheduled Plan Review Meeting.

7.0 RECORD KEEPING

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

8.0 CONTACT LIST

Organisation	Contact	Phone	Email / Mail	Fax
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@finance.nsw.gov.au	(02) 4677 2040
Mine Subsidence Engineering Consultants (MSEC)	Daryl Kay*	(02) 9413 3777 0416 191 304	daryl@minesubsidence.com	-
SIMEC Mining Tahmoor Coking Coal Operations Environment and Community Manager	Ron Bush	(02) 4640 0156 0437 266 998	Ron.Bush@glencore.com.au	(02) 4640 0140
SIMEC Mining Tahmoor Coking Coal Operations Approvals and Community Coordinator	Belinda Clayton	(02) 4640 0133 0436 331 630	Belinda.L.Clayton@glencore.com.au	(02) 4640 0140
Sydney Water	Emergency Line	13 20 90		
Sydney Water – Systems Delivery Officer Area Team West	Troy Cooper*	(02) 8763 8622	troy.cooper@sydneywater.com.au	(02) 8763 8661

* 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*
MSEC945-00-01	Monitoring over Longwall 32	B
MSEC945-03-01	Water Infrastructure – Pipe Size	A
MSEC945-03-02	Water Infrastructure – Pipe Type	A

Supporting Documentation

Glencore (2014)	Glencore Coal Assets Australia Risk Management Matrix, Glencore, September 2014
Glencore (2018)	Environmental Risk Assessment: Tahmoor Underground – Longwall 32 Surface and Subsurface Infrastructure – Potable Water Infrastructure, Tahmoor Coking Coal Operations, May 2018.
SCT (2018a)	Structure determinations of the Nepean Fault adjacent to Tahmoor Mine, SCT Operations, Report No. TAH4817, May 2018.
SCT (2018b)	Investigation into the Potential Impact of the Nepean Fault on Longwall 32 Subsidence, SCT Operations, Report No. TAH4821, May 2018.
Sydney Water (2010)	*Risk Criteria*, Sydney Water, Issue 3, 6 July 2010

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SIMEC MINING Tahmoor Coking Coal

TAHMOOR COKING COAL OPERATIONS

TAHMOOR NORTH - LW32

MONITORING OVER LW32

DATE:	SCALE:	DRAWING No:	Rev No
8 Jun 2018	as shown	MSEC945-00-01	B

277 500 278 000 278 500 279 000 279 500 280 000 280 500

0m 250m 500m
SCALE

6 214 600
6 214 500
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Refer Embankment 89.80km diagram for details (MSEC943-10)

WEATHERBOARD COTTAGE

THIRLMERE WAY

ARGYLE ST

RUMKER ST

BRIDGE ST

FAIRLEY RESIDENCE

Refer Mill Hill for details (MSEC945-13-02)

Refer individual diagrams for details of Commercial area (MSEC945-19)

BOLLARD PL

WOOD ST

COACHWOOD CR

Refer Embankment 90.252km diagram for details (MSEC943-09)

Refer Picton High School for details (MSEC945-12)

REDBANK PL

HENRY ST

Refer Embankment 90.676km diagram for details (MSEC943-08)

Refer Wonga Rd industrial properties for details (MSEC945-19)

WONGA ST

PREDICTED 20mm SUBSIDENCE CONTOUR DUE TO LW32

Refer Bridge St Cutting & Overbridge 91.00km diagram for details (MSEC943-07)

Refer Redbank Creek Culvert diagram for details (MSEC943-06)

LW 32

LW 31

LW 30

LW 29

LW 28

LW 27

LW 26

35° ANGLE OF DRAW LW32

STILTON LN

REMEMBRANCE DRIVEWAY

BRIDGE ST

MAIN SOUTHERN RAILWAY

Refer Railway diagram for details (MSEC943-03)

Refer Heritage Items - Koorana Homestead for details (MSEC945-13-01)

Refer Deviation Overbridge 92.41km diagram for details (MSEC943-05)

Refer Deviation Cutting diagram for details (MSEC943-05)

Dam removed 2016

Refer Picton Water Recycling diagram for details (MSEC945-18)

Refer No155 Stilton Lane diagram for details (MSEC45-15)

Myrtle Creek Bridge

MYRTLE CREEK

LEGEND

- Existing Monitoring Lines
- Surveys During LW32
- Critical Power Poles
- Specific Structure Inspections

Refer to Management Plans for Timing & Frequencies

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TAHMOOR COKING COAL OPERATIONS

TAHMOOR NORTH - LW32

SYDNEY WATER - POTABLE WATER PIPE SIZE

DATE:	SCALE:	DRAWING No:	Rev No
6 Jun 2018	as shown	MSEC945-03-01	01

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ANTIL
RUMKER ST
ARGYLE ST
HILL ST
WILD ST
TARRANT CL
HADDON PL
BRIDGE ST
BRIDGE ST
WOOD ST
BOLLARD PL
REDBANK PL
CONCHWOOD CRS
STONEQUARRY CK
HENRY ST
WONGA RD
REDBANK CREEK
LW 30
LW 31
LW 32
LW 29
LW 28
LW 26
MAIN SOUTHERN RAILWAY
STILTON LN
REMEMBRANCE DRIVEWAY
PREDICTED 20mm SUBSIDENCE CONTOUR DUE TO LW32
35° ANGLE OF DRAW LW32
FIRST ORDER FAULT
FIRST ORDER FAULT
FIRST ORDER FAULT
FIRST ORDER FAULT
HILTON PARK RD
TAHMOOR HOUSE CT
MYRTLE CREEK
KENT RD
KOORANA RD
PARK AVE
CHIVERS PL
SUFFOLK PL
MOORLAND RD
YORK ST
KRISTA PL
TRUAN ST
CYCLEWAY
AMBLECOTE PL
CONNOR PL
LEIHA PL
PARK ST

LEGEND:
- 100 mm Ø
- 150 mm Ø
- 180 mm Ø
- 200 mm Ø
- 300 mm Ø
- Pressure Reducing Valve

Pressure Reducing Valve
Pressure Reducing Valve

Grid to MGA co-ordinates

LEGEND
- Nepean Fault mapping SCT (2018)

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SIMEC MINING Tahmoor Coking Coal

TAHMOOR COKING COAL OPERATIONS

TAHMOOR NORTH - LW32

SYDNEY WATER - POTABLE WATER PIPE TYPE

DATE:	SCALE:	DRAWING No:	Rev No
6 Jun 2018	as shown	MSEC945-03-02	01

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CONNELLAN CRS THIRLMERE WAY THIRLMERE WAY ANTIL THILL ST ARGYLE ST RUMKER ST BRIDGE ST HADDON PL TARRANT CL WILD ST BOLLARD PL WOOD ST CONGAWOOD CRS REDBANK PL BRIDGE ST HENRY ST WONGA RD STONEQUARRY CK REDBANK CREEK LW 31 LW 30 LW 29 LW 28 LW 27 LW 32 35° ANGLE OF DRAW LW32 MAIN SOUTHERN RAILWAY STILTON LN REMEMBRANCE DRIVEWAY PREDICTED 20mm SUBSIDENCE CONTOUR DUE TO LW32 FIRST ORDER FAULT FIRST ORDER FAULT FIRST ORDER FAULT HILTON PARK RD TAHMOOR HOUSE CT MYRTLE CREEK KENT RD KOORANA RD PARK AVE CHIVERS PL SUFFOLK PL MOORLAND RD YORK ST KRISTA PL CYCLEWAY TRUAN ST AMBLECOTE PL CONNOR PL LEIHA PL PARK ST ATTUNGA CL AMAR CL

LEGEND
Nepean Fault mapping SCT (2018)

LEGEND:
CICL
DICL
uPVC
mPVC
oPVC
PE
Pressure Reducing Valve

Pressure Reducing Valve
Pressure Reducing Valve

N

Grid to MGA co-ordinates

Appendix A - Glencore Coal Assets Australia Risk management Matrix

GLENCORE COAL ASSETS AUSTRALIA RISK MATRIX

CONSEQUENCE [potential foreseeable outcome of the event]

	Health & Safety	Environment	Financial Impact	Image & Reputation / Community	Legal & Compliance
5 Catastrophic	• Multiple fatalities • Multiple cases of permanent total disability / health effects	• Environmental damage or effect (permanent; >10 years) • Requires major remediation	• >$600M investment return • >$100M operating profit • >$20M property damage	• Negative media coverage at international level • Loss of multiple major customers or large proportion of sales contracts • Loss of community support • Significant negative impact on the share price	• Major litigation / prosecution at Glencore corporate level • Nationalisation / loss of licence to operate
4 Major	• Fatality or permanent incapacity / health effects	• Long-term (2 to 10 years) impact • Requires significant remediation	• $60-600M investment return • $20-100M operating profit • $2-20M property damage	• Negative media coverage at national level • Scrutiny from government and NGOs • Complaints from multiple “final” customers • Loss of major customer • Loss of community support • Negative impact on share price	• Major litigation / prosecution at Division level
3 Moderate	• Lost time / disabling injury / occupational health effects / multiple medical treatments	• Medium-term (<2 years) impact • Requires moderate remediation	• $6-60M investment return • $2-20M operating profit • $200K-2M property damage	• Negative media coverage at local / regional level over more than one day • Complaint from a “final” customer • Off-spec product • Community complaint resulting in social issue	• Major litigation / prosecution at Operation level
2 Minor	• Medical Treatment Injury (MTI) / occupational health effects • Restricted Work Injury (RWI)	• Short-term impact • Requires minor remediation	• $600K-6M investment return • $200K-2M operating profit • $10-200K property damage	• Complaint received from stakeholder or community • Negative local media coverage	• Regulation breaches resulting in fine or litigation
1 Negligible	• First Aid Injury (FAI) / illness	• No lasting environmental damage or effect • Requires minor or no remediation	• <$600K investment return • <$200K operating profit • <$10K property damage	• Negligible media coverage	• Regulation breaches without fine or litigation

LIKELIHOOD [of the event occurring <u>with that consequence</u>]

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 Glencore	May occur several times per year OR Expected to occur OR Has occurred several times within Glencore
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**	Divisional / Functional / Operational / Asset Leadership	• 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**	Divisional / Functional / Operational / Asset Leadership	• Glencore SafeWork 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**	Divisional / Functional / Operational / Asset Leadership	• 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	• install additional HARD and SOFT controls if necessary to achieve ALARP. • Capital expenditure may be justified.
1 to 6	**Low Risk**	Operational / Asset Leadership	• Install additional controls if necessary to achieve ALARP. • Capital expenditure is not usually justified.

Table 3-3 - Risk Control Effectiveness (RCE)

RCE	Guide
Poor or no existing controls	• Significant control gaps or no credible control; • Either controls do not treat root causes, are non-existent or, if they exist, they are ineffective; • Management has no confidence that any degree of control is being achieved due to poor control design; • Very limited or no operational effectiveness.
Require improvement	• Most controls are designed correctly and are in place and effective; • Controls may only treat some of the root causes of the risk, and/or are not currently effective and/or there may be an over-reliance on “reactive” controls; • Management has doubts about operational effectiveness and reliability; • More work is required to improve operating effectiveness.
Satisfactory	• Controls are well designed and appropriate for the risk; • Controls are largely “preventative” and address the root causes; • Management believes that they are effective and reliable at all times; • Nothing more to be done except review and monitor the existing controls.

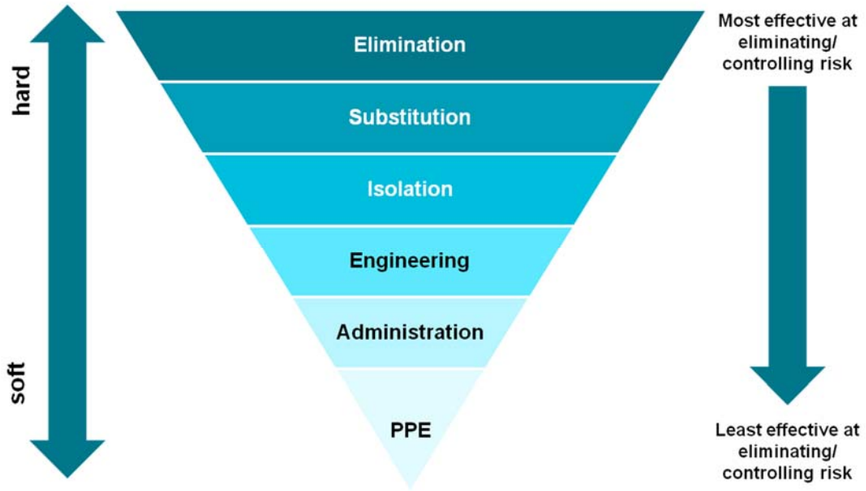

Figure 3-4 – Hierarchy of control

Table 3-4 - Priority for risk treatment authority for continued toleration of risk (applicable for risk assessment level 3 and 4)

Current risk rank	Action	Timing for authority	Authority for continued toleration of current level of risk
23 to 25	The activity must be stopped immediately until action to reduce the level of risk to less than 23 is undertaken or authority to continue is received.	Immediately to within 24 hours.	CE/COO Notification to CE prior to granting of authority to continue
17 to 22	The activity must be stopped immediately until action to reduce the level of risk to less than 17 is under taken or authority to continue is received.	The activity must be stopped immediately until action to reduce the level of risk to less than 17 is under taken or authority to continue is received.	Directors/COO Notification to COO prior to granting of authority to continue
10 to 16	Take action to reduce the level of risk to less than 10 or authority to continue is received.	Within 1 month.	General Managers / Operations Managers / Project Managers
7 to 9	Take action to reduce the level of risk to less than 7 or authority to continue is received.	Within 1 month.	Superintendents/ Managers / Project Team
1 to 6	Tolerable risk unless circumstances change	Ongoing control as part of a management system.	N/A

Risk Criteria

Level of Risk Matrix

	Very Likely	Likely	Unlikely	Very Unlikely
Catastrophic	1	1	2	3
Severe	1	2	3	4
Moderate	2	3	4	5
Minor	3	4	5	6
Insignificant	4	5	6	6

Likelihood Descriptions

Levels	Description
Very Likely	The event could happen > 90% of the time within a 12-month period.
Likely	The event could happen 50% - 90% of the time within a 12-month period.
Unlikely	The event could happen 10% - 50% of the time within a 12-month period.
Very Unlikely	The event could happen < 10% of the time within a 12-month period.

Consequence Categories

Assessment	Financial [1]	Political / Reputation	Environment	Safety (Sydney Water & Public Safety)	Customers	Public Health	Performance [2]	Compliance
Catastrophic Very High impact with very significant consequences	Corporate: > $100m cost increase >$250m revenue loss Project: Cost overrun >= 50% of project budget	Widespread loss of confidence by Govt and community. Sustained key adverse media.	Large scale, irreversible, adverse impact to environment.Very significant impact on threatened species or critical habitat eg sustained dry weather overflow in protected bushland.	Fatality, amputation of limb, person on life support, other immediately life threatening incidents. Widespread serious injuries or illnesses.	Complete disruption to services > 1 week; Affects > 30% of SWC customers.	Widespread illness / fatalities.	Very significant and unmananagable disruption of critical processes. Majority of key objectives and/or KPIs cannot be achieved. Very significant impact on resource use and/or benefits not realised.	Significant compliance breach - may result in: Operating Licence sanction. High-impact prosecution eg Tier 1 POEO Act offence or Workcover criminal offence..
Severe High impact with major consequences	Corporate: > $50m - $100m cost increase >$100m - $250m revenue loss Project: Cost overrun > 20% and < 50% of project budget	Considerable Govt and community concern. Key adverse media.	Large scale, long-term (>2 years), adverse impact to environment.Significant impact on areas of high heritage or ecological value (aquatic or terrestrial) eg spillage of raw sewage or chemicals into a waterway resulting in a major aquatic life kill; Water quality impacts to Special or Protected waters.	A serious injury or long term illness, or lost time injury (minimum 1 day lost per injury).	Partial disruption > 2 days; Affects 10% to 30% of Customers; Widespread complaints.	Serious illness requiring hospitalisation.	Major disruption to critical processes. Key objectives and KPIs cannot be achieved. Significant impact on resource use and/or benefits not realised.	Compliance breach - may result in severe enforcement action, regulatory sanction or prosecution eg Tier 2 POEO Act offence or Workcover prosection..
Moderate Noticeable impact with clearly visible consequences	Corporate: > $10m - $50m cost increase > $50m - $100 revenue loss Project: Cost overrun > 10% and < 20% of project budget	Some public concern raised. Adverse local media.	Small scale, medium-term (1-2 years), impact to environment eg native vegetation that provides habitat for important species is cleared or damaged within a National Park; spillage of partially treated sewage into a waterway.	Significant near miss incident; Injury or illness requiring medical treatement.	Unreliable Services; Increase in number of Complaints; Multiple and repeat customer Complaints;. 5% to 10% of customers affected.	Deterioration in water quality parameters. Reportable event. Increase in illness.	Non-performance of critical processes. Objectives and KPIs cannot be achieved. Noticable impact on resource use and/or benefits not realised.	Compliance breach - may result in Ministerial requirement, enforceable undertaking or statutory fine eg POEO Act or Workcover Penalty Infringement Notice.
Minor Minor impact with some consequences	Corporate: > $5m - $10m cost increase > $25m - $50m revenue loss Project: Cost overrun > 5% and < 10% of project budget	Minor public concern.	Small scale, short-term (<1 year), reversible impact to environment that is contained & readily remediated eg minor damage to a heritage building.	Illness or injury requiring first aid eg minor burns, abrasions, sprains.	Some customer complaints.	Deterioration in water quality parameters. Reportable event. No increase in illness.	Limited non-performance of critical processes, objectives and KPIs. Limited impact on resource use and/or benefits not realised.	Compliance breach -may result in minor corrective action or business requirement.
Insignificant Very minor impact with unimportant consequences	Corporate: < $5m cost increase <$25m revenue loss Project: Cost overrun < 5% of project budget	Minimal public concern.	Temporary, reversible, environmental degradation, quickly contained & immediately restored eg no discernable change.	Near misses incidents.	Isolated customer complaints.	Non-reportable event.	Very minor non-performance of critical processes, objective and KPIs. Very minor impact on resource use and/or benefits not realised.	Technical compliance breach with limited material impact.

1 Financial limits for projects are a guide only. Actual amounts should be set at an appropriate level (based on business case value) for each individual project prior to conducting a risk assessment.

2 Performance category descriptions are a guide only and may be further enhanced by divisional procedures.

Required Management Actions

Risk Rating	Level	Report to	Level	Management Action	Timeframe	
					Corporate (strategic, divisional, non-project operational)	**Project [1]**
1	Very High	Division Head / appropriate level manager	Intolerable	Immediate action to eliminate risk or reduce to acceptable level.	Implementation: Immediate Review: Weekly	
2 & 3	High	Division Head / appropriate level manager	Conditionally tolerable	Conditionally tolerable if all reasonably practical measures to treat the level of risk are implemented. Where reasonably practical measures can be applied, additional action required to reduce level of residual risk.	Implementation: 6 months Review: Quarterly	Implementation: 3 months Review: Key Project Milestones
4 & 5	Medium	Senior Manager / appropriate level manager	Conditionally tolerable	Conditionally tolerable if all reasonably practical measures to treat the level of risk are implemented. Maintain watching brief, 6-monthly review by management. Where reasonably practical measures can be applied, longer term additional action required to reduce level of residual risk.	Implementation: 12 months Review: 6 monthly	Implementation: 6 months Review: Key Project Milestones
6	Low	Immediate Supervisor	Tolerable	All reasonably practical measures to reduce level of risk have been implemented – monitoring action required.	N/A	N/A

[1] Timeframes for management actions related to projects are a guide only and should be revised based on the length and complexity of the project.

Control Effectiveness Criteria

Definition of Control

"An existing process, policy, device, practice or other action that acts to minimize negative impacts or enhance positive opportunities" (AS/NZS 4360:2004)

Control Elements

For a control to be effective it must have the following elements:

- Relevance — Direct relationship to risk reduction, pertinent
- Independence — Not dependent upon other controls or a combination of controls to reduce risk
- Integrity — Soundness of operation, unimpaired, in perfect condition

Category	Indicative Risk Reduction	Safety Example	Business Example
Very Effective	Will reduce likelihood or consequence by 3 cells ie. Reduces risk by > 97 %	Elimination, Substitution and Engineering Controls	A full automated system directly addressing the risk
Effective	Will reduce likelihood or consequence by 2 cells ie. Reduces risk by 60 to 97 %		A well implemented system requiring considerable staff input
Partly Effective	Will reduce likelihood or consequence by 1 cell ie. Reduces risk by 40 to 60 %	Administrative controls: • Training • Documented procedures • Signs	A well implemented paper based process. Tailored training specific to reduce risk
Only effective in combination	A pair of controls will reduce likelihood or consequence by 1 cell ie. Reduces risk by 20 to 40 %		General training, infrequently used procedures and awareness programs
Minimal risk reduction	Only many controls will reduce likelihood or consequence by 1 cell ie. Reduces risk by < 20 %	Personal Protective Equipment	Interdependent, irrelevant or low integrity controls

Environmental Risk Assessment: Tahmoor Underground - Longwall 32 Surface and Subsurface Infrastructure

	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					
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	Date Assessment carried out	Action# (CURA/ Xstrasafe)
Tahmoor Underground	Equipment	Pipeline along Remembrance Drive (above LW32)	Potable Water Infrastructure	Leakage of the joints	Reduced water supply requiring emergency repair or replacement of pipework	Subsidence Impact	Ground survey along Remembrance Drive - weekly (EC) Visual inspections - weekly (AC) TARP including excavation and relief of stress or repair of pipeline if required (EC) Analysis and reporting Consultation, coordination and cooperation with Sydney Water Potable Pressure reducing valves monitored by Sydney Water for reduction in water pressure (AC)	2	Community / Reputation	2	C	8	2	Community / Reputation	Infrastructure Management Plan for LW32 (including TARP). Follow up with Sydney Water regarding review renewal project and determine if any plans in place for renewal in area above Longwall 32.	Belinda Clayton	31-Jul-18	Sydney Water Risk Criteria Consequence = Minor Likelihood = Unlikely Level of Risk = Medium (5)	10-May-18	
Tahmoor Underground	Equipment	Pipeline along Remembrance Drive (above LW32)	Potable Water Infrastructure	Water main break and depletion of Picton reservoir	Loss water supply requiring emergency repair or replacement of pipework	Subsidence Impact	Ground survey along Remembrance Drive - weekly (EC) Visual inspections - weekly (AC) TARP including excavation and relief of stress or repair of pipeline if required (EC) Analysis and reporting Consultation, coordination and cooperation with Sydney Water Potable Pressure reducing valves monitored by Sydney Water for reduction in water pressure (AC)	2	Community / Reputation	3	C	13	3	Community / Reputation	Infrastructure Management Plan for LW32 (including TARP). Follow up with Sydney Water regarding review renewal project and determine if any plans in place for renewal in area above Longwall 32. Temporary tanker supply to reservoir to be included in Infrastructure Management Plan.	Belinda Clayton	31-Jul-18	Sydney Water Risk Criteria Consequence = Moderate Likelihood = Unlikely Level of Risk = Medium (4)	10-May-18	
Tahmoor Underground	Equipment	Reticulation network	Potable Water Infrastructure	Leakage of the joints	Reduced water supply requiring emergency repair or replacement of pipework	Subsidence Impact	Ground survey along local streets - weekly (EC) Visual inspections - weekly (AC) TARP including excavation and relief of stress or repair of pipeline if required (EC) Analysis and reporting Consultation, coordination and cooperation with Sydney Water Potable	2	Community / Reputation	1	C	4	4	Community / Reputation	Infrastructure Management Plan for LW32 (including TARP). Follow up with Sydney Water regarding review renewal project and determine if any plans in place for renewal in area above Longwall 32.	Belinda Clayton	31-Jul-18	Sydney Water Risk Criteria Consequence = Insignificant Likelihood = Unlikely Level of Risk = Low (6)	10-May-18	
						Subtotal CountA (ignoring hidden values)														