REPORT: POTABLE WATER MANAGEMENT PLAN

TAHMOOR UNDERGROUND

GLENCORE

GLENCORE:

Tahmoor Colliery – Longwall 31

Management Plan for Potential Impacts to Sydney Water Potable Water Infrastructure

AUTHORISATION OF MANAGEMENT PLAN

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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

REFERENCES

AS/NZS 4360:1999 Risk Management

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.

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Drawings

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

1.1. Background

Tahmoor Colliery is located approximately 80 km south-west of Sydney in the township of Tahmoor NSW. It is managed and operated by Glencore. Tahmoor Colliery has previously mined 29 longwalls to the north and west of the mine's current location. It is currently mining Longwall 30.

Longwall 31 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 31 is located beneath the rural area of Tahmoor and part of the South Picton industrial area, and potable water infrastructure owned by Sydney Water is located within this area.

A summary of the dimensions of Longwall 31 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 31	2448	283	39

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

1.2. Objectives

The objectives of this Management Plan are to establish procedures to measure, control, mitigate and repair potential impacts that might occur to the Sydney Water potable water infrastructure.

The objectives of the Plan have been developed to:

- Ensure the safe and serviceable operation of all surface infrastructure. Public and workplace safety is paramount. Disruption and inconvenience should be kept to minimal levels;
- Monitor ground movements and the condition of surface 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;
- Provide a forum to report, discuss and record impacts to the surface. This will involve Tahmoor Colliery, Sydney Water, relevant government agencies and consultants as required; and
- Establish lines of communication and emergency contacts.

1.3. Scope

The Management Plan is to be used to protect and monitor the condition of the Sydney Water potable water infrastructure identified to be at risk due to mine subsidence. This infrastructure located above and adjacent to Longwall 31 comprise 150 to 200 mm diameter potable water pipelines. The majority of these pipelines are Cast Iron Cement Lined (CICL) and Ductile Iron Cement Lined (DICL) pipes, with a small section of Polyethylene (PE) pipeline in Bollard Place.

The potable water pipelines are shown in Drawing No. MSEC862-03-01 grouped by pipe size and in Drawing No. MSEC862-03-02 grouped by pipe type.

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 31 only. The management plan does not include other infrastructure owned by Sydney Water that lie outside the extent of this area.

This Management Plan does not include the Sydney Water sewer infrastructure. That infrastructure is included in a separate management plan.

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1.4. Proposed mining schedule

It is planned that Longwall 31 will extract coal working north-west from the south-eastern end. This Management Plan covers longwall mining until completion of mining in Longwall 31 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 31	July 2017	July 2018

The above schedule is subject to change due to unforeseen impacts on mining progress. Tahmoor Colliery will keep Sydney Water informed of changes.

1.5. Definition of the 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 a distance of 150 m in front of the longwall face to a distance of 450 m 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 m in front and 450 m behind the active longwall face, as shown by Fig. 1.1.

Fig. 1.1 Diagrammatic representation of the active subsidence zone

1.6. Compensation

The Mine Subsidence Compensation Act 1961 (MSC Act) is administered by Subsidence Advisory NSW (Mine Subsidence Board). Currently, under the Mine Subsidence Compensation Act 1961, 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. Maximum predicted conventional parameters

Predicted mining-induced conventional subsidence movements were provided in Report No. MSEC647, which was prepared in support of Tahmoor Colliery's SMP Application for Longwalls 31 to 37, and includes prediction due to the extraction of Longwall 31.

A summary of the maximum predicted incremental conventional subsidence parameters, due to the extraction of Longwall 31 only, is provided in Table 2.1. A summary of the maximum predicted total conventional subsidence parameters, after the extraction of Longwall 31, is provided in Table 2.2.

Table 2.1 Maximum predicted incremental conventional subsidence parameters due to the extraction of Longwall 31

Longwall	Maximum predicted incremental subsidence (mm)	maximum predicted incremental tilt (mm/m)	Maximum predicted incremental hogging curvature (1/km)	Maximum predicted incremental sagging curvature (1/km)
Due to LW31	725	5.5	0.06	0.12

Table 2.2 Maximum predicted total conventional subsidence parameters after the extraction of Longwall 31

Longwall	Maximum predicted total subsidence (mm)	Maximum predicted total tilt (mm/m)	Maximum predicted total hogging curvature (1/km)	Maximum predicted total sagging curvature (1/km)
After LW31	1225	6.0	0.09	0.13

The values provided in the above table are the maximum predicted cumulative conventional subsidence parameters which occur within the general longwall mining area, including the predicted movements resulting from the extraction of Longwalls 22 to 31.

2.2. Observed subsidence during the mining of Longwalls 22 to 30

The extraction of longwalls at Tahmoor Colliery 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 30 has found that subsidence behaviour has returned to normal levels.

Ground surveys will continue to be undertaken above Longwall 31. The survey results will be checked against predictions to confirm whether subsidence continues to develop in a normal manner during the mining of Longwall 31.

2.3. Predicted strain

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

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

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

At a point, however, there can be considerable variation from the linear relationship, resulting from non-conventional movements or from the normal scatters which are observed in strain profiles. When expressed as a percentage, observed strains can be many times greater than the predicted conventional strain for low magnitudes of curvature. In this report, therefore, we have provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

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

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).

2.3.1. 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 Colliery, 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 Colliery is provided in Fig. 2.1. The probability distribution functions, based on the fitted GPDs, have also been shown in this figure.

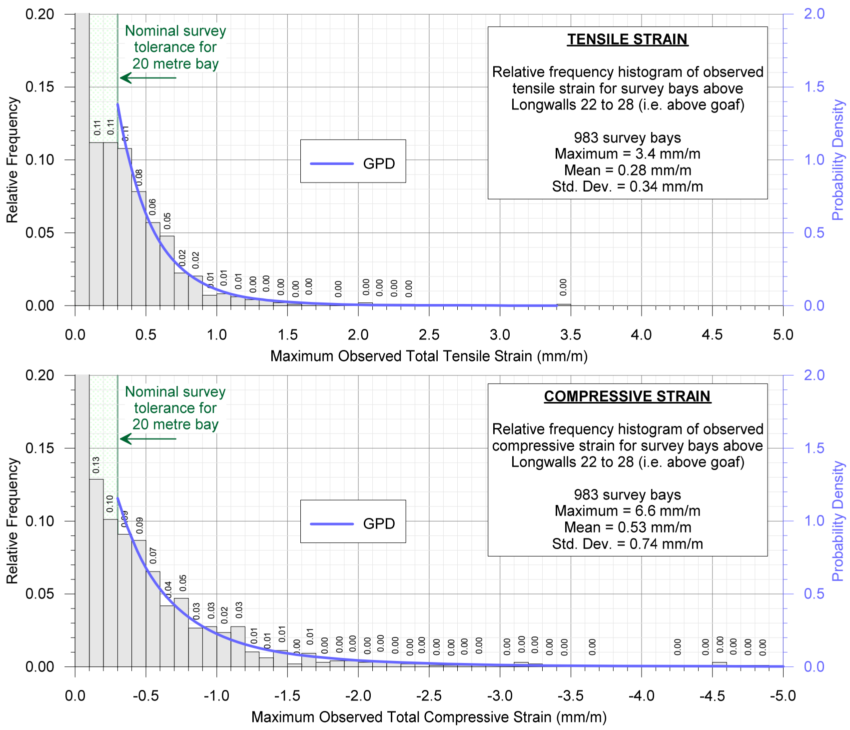

Fig. 2.1 Distributions of the measured maximum tensile and compressive strains for surveys bays located above goaf

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 Colliery, 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 Colliery is provided in Fig. 2.2. The probability distribution functions, based on the fitted GPDs, have also been shown in this figure.

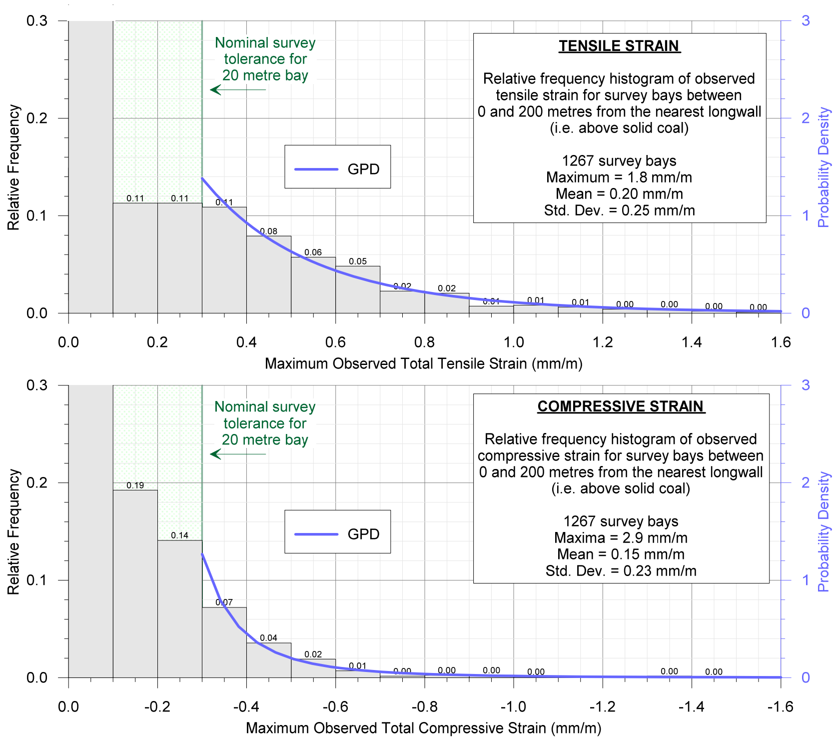

Fig. 2.2 Distributions of the measured maximum tensile and compressive strains for survey bays located above solid coal

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.

2.3.2. 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 Colliery, is provided in Fig. 2.3.

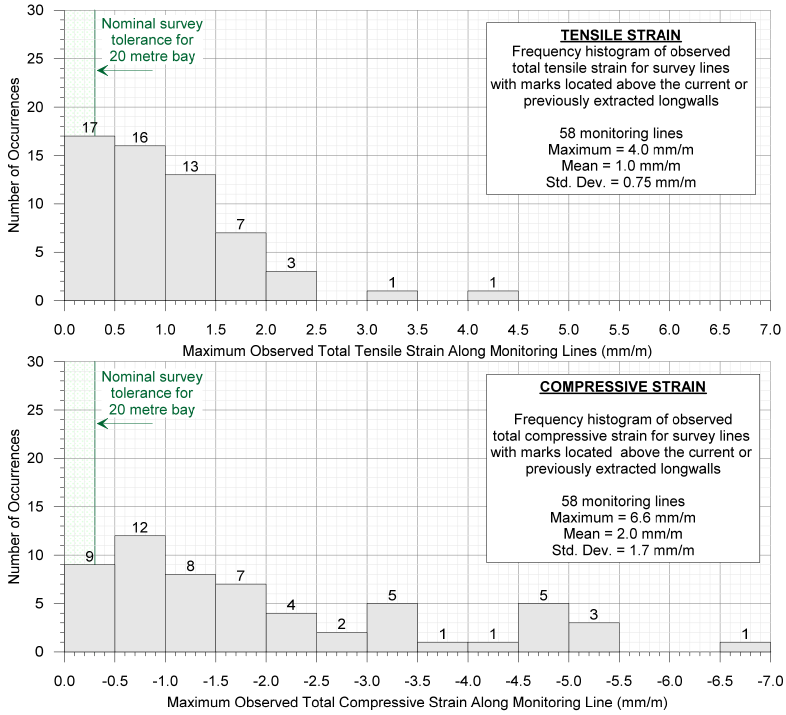

Fig. 2.3 Distributions of measured maximum tensile and compressive strains anywhere along the monitoring lines

It can be seen from Fig. 2.3, 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.

2.4. Predicted and observed valley closure across creeks

The potable water pipeline along Bridge Street crosses a ‘hidden creek’ outside and adjacent to the maingate of Longwall 31. The predicted valley related effects in this location are provided later in this Management Plan. There are no other locations identified where the potable water pipelines cross creeks within the predicted limit of vertical subsidence.

3.1. 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) Act 2013* and associated Regulations (collectively referred to as the 'WHS laws').

The Work Health and Safety (Mines) 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."*

This Management Plan documents the risk control measures that are planned to manage risks to health and safety associated with the mining of Longwall 31 in accordance with the WHS laws.

3.2. 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:

3.2.1. 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.

3.2.2. Likelihood

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

3.2.3. Hazard

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

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

3.2.4. 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 potable water pipelines located above and adjacent to Longwall 31 generally follow the alignments of the local roads. The maximum predicted subsidence parameters for these pipelines, therefore, are similar to those predicted for the roads.

The predicted profiles of conventional subsidence, tilt and curvature for the 150 mm DICL pipeline along Bridge Street are shown in Fig. 4.1. The predicted total profiles after the completion of Longwall 30 are shown as the solid cyan lines. The predicted incremental profiles due to the extraction of Longwall 31 only are shown by the black dashed lines. The predicted total profiles after the completion of Longwall 31 are shown as the solid blue lines.

A summary of the maximum predicted conventional subsidence, tilt and curvature for the potable water pipelines, after the extraction of Longwall 31, is provided in Table 4.1. The values are the maximum predicted parameters anywhere along the sections of pipelines located within the predicted limit of vertical subsidence for Longwall 31.

Table 4.1 Maximum predicted total conventional subsidence, tilt and curvature for the pipelines

Pipeline located adjacent to road	Longwall	Maximum predicted total subsidence (mm)	Maximum predicted total tilt (mm/m)	Maximum predicted total hogging curvature (1/km)	Maximum predicted total sagging curvature (1/km)
Bridge Street	After LW31	1225	5.5	0.09	0.13
Henry Street	After LW31	60	< 0.5	0.01	< 0.01
Remembrance Drive (between Wonga and Koorana Roads)	After LW31	50	< 0.5	0.01	< 0.01

The maximum predicted subsidence parameters for the potable water pipelines are similar to the maxima predicted for the pipelines above the previously extracted longwalls at Tahmoor Colliery. Longwalls 22 to 30 have directly mined beneath approximately 19 km CICL pipelines and approximately 5 km of DICL pipelines with only minimal adverse impacts on the distribution network. The reported adverse impacts on the potable water pipelines at Tahmoor Colliery 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 31, 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.

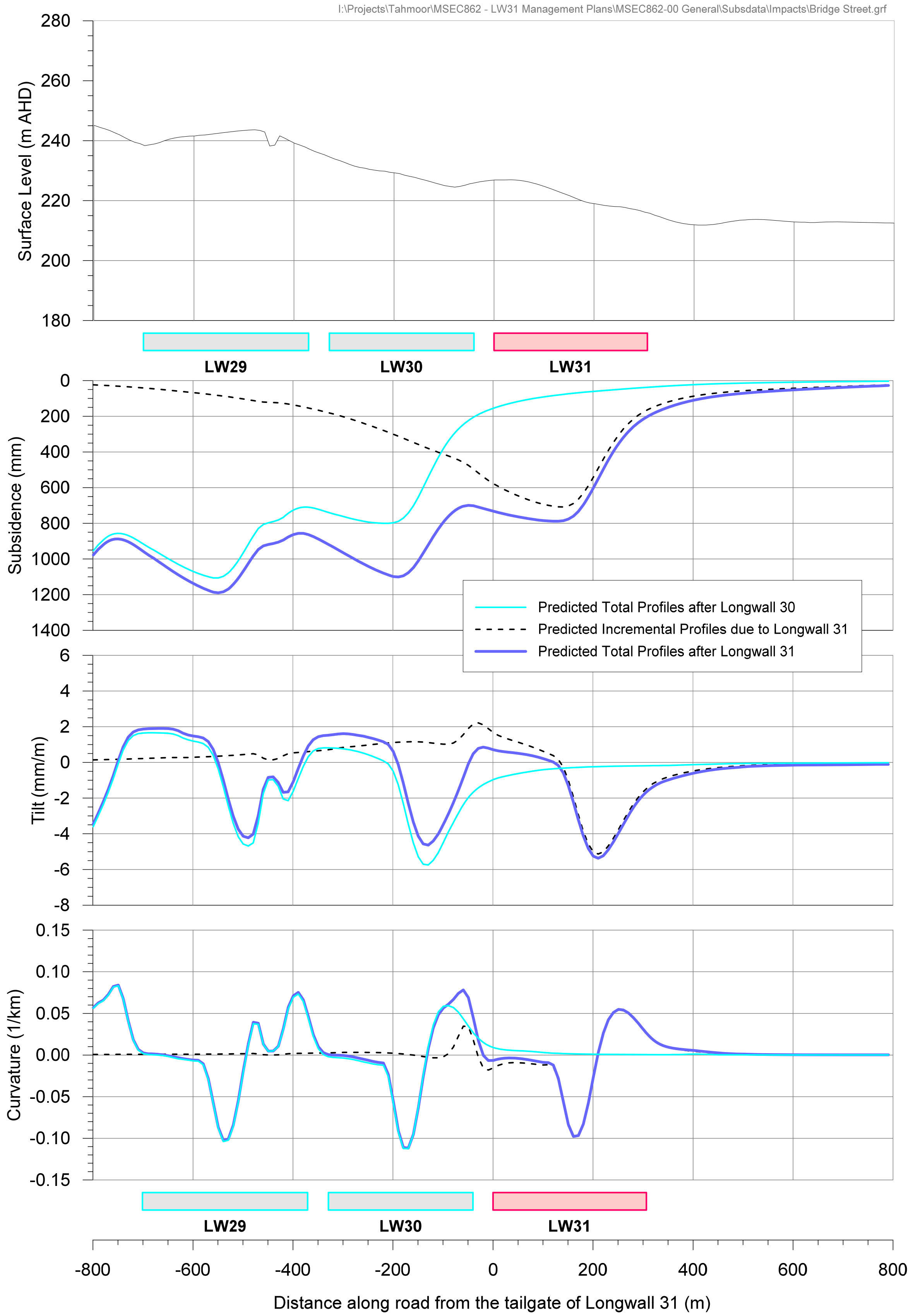

Fig. 4.1 Predicted profiles of total subsidence, tilt and curvature for the potable water pipeline along Bridge Street due to the mining of Longwalls 22 to 31

The pipeline along Bridge Street crosses a 'hidden creek' near Redbank Place, outside and adjacent to the maingate of Longwall 31, as shown in Drawing No. MSEC862-01. This pipeline could experience valley related effects in this location. The predicted closure at the creek crossing after the completion of Longwall 31 is 160 mm.

Additional studies have been undertaken to assess the likelihood of valley closure developing at this location.

- A statistical analysis of observed valley closure across creeks that are located within 100 metres of the sides of previously extracted longwalls at similar depths of cover in the Southern Coalfield.
- A study of observed valley closure of tributaries to Redbank Creek during the extraction of previous longwalls.

A statistical analysis has been undertaken of observed valley closure across creeks that have similar valley heights and locations relative to longwalls as for the hidden creek. The analysis includes creeks with valley heights up to 40 m located at distances between 50 and 150 m from the active longwall maingate. The creeks are located adjacent to the previously extracted longwalls at Tahmoor Colliery, as well as at the nearby Appin, Metropolitan, Tower and West Cliff Collieries.

The distribution of the maximum measured closure for the creeks is provided in Fig. 4.2. There is a total of 26 cases in this analysis. The maximum measured valley closure is 168 mm, which was measured across a tributary to Redbank Creek adjacent to the maingate of Tahmoor Longwall 28. The next greatest valley closure is 81 mm, which was measured at Appin Colliery.

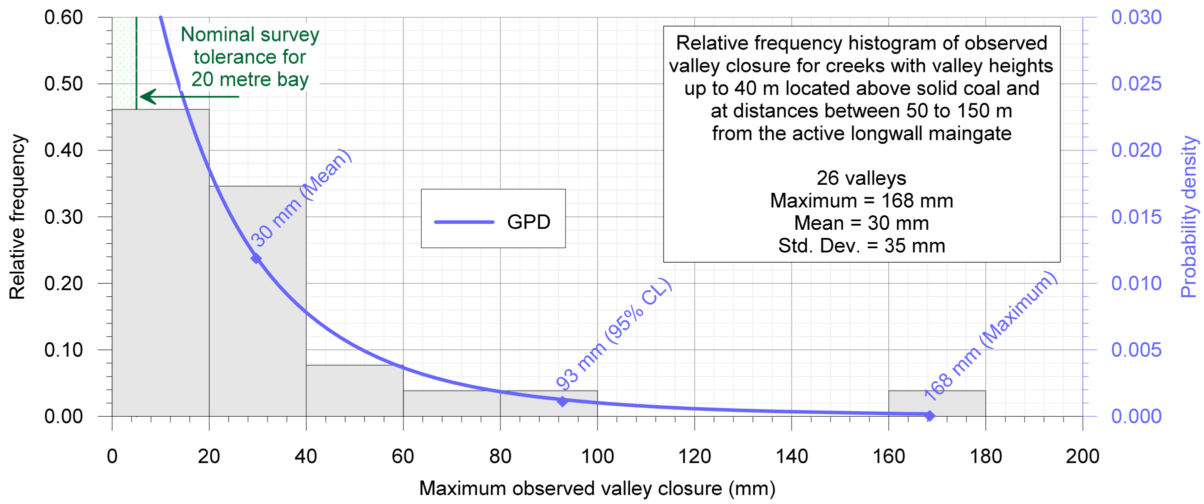

Fig. 4.2 Maximum measured valley closure for streams with valley heights up to 40 m located at distances between 50 and 150 m from the active longwall maingate

The Generalised Pareto Distribution (GPD) fitted to the raw data is shown as the blue line in Fig. 4.2. The predicted valley closure derived using the fitted GPD is 93 mm based on the 95 % confidence level and is 168 mm based on the 99 % confidence level.

The analysis indicates that the valley closure for the hidden creek due to the extraction of Longwall 31 is expected to be less than 100 mm, as measured by 25 of the 26 cases. However, valley closure similar to or greater than the predicted closure of 160 mm could occur, as for the tributary to Redbank Creek located adjacent to Tahmoor Longwall 28.

Two survey lines traverse across tributaries to Redbank Creek. A survey line along Bridge Street runs along the northern side of Redbank Creek directly above Longwalls 26 to 30 and future Longwall 31, and the results of regular surveys are shown in Fig. 4.3. The RK Line runs along the southern side of Redbank Creek directly above Longwalls 27 to 30 and future Longwall 31, and the results of regular surveys are shown in Fig. 4.4.

It can be seen that the experiences along Bridge Street have been very different from those experienced along the RK Line. Substantial compressive strains have been measured at isolated locations along the RK Line where the survey line crosses tributaries to Redbank Creek. On the other side of Redbank Creek, considerably smaller ground strains have been measured along Bridge Street where it crosses the tributaries.

Whilst the experiences along Bridge Street have been encouraging to date, it cannot be assumed that the same trend will continue above Longwall 31. The management strategies for the pipeline across the hidden creek, therefore, have been based on the potential for valley closure of 160 mm or greater.

Regular ground surveys and visual inspections will be undertaken during the extraction of Longwall 31 within the period of active subsidence. This will provide Sydney Water with prior warning of a potential water leak, upon which it may be decided to pre-emptively excavate the pipe to relieve pipe stresses. If the water pipe becomes damaged and leaks, the pipeline can be readily repaired using established methods.

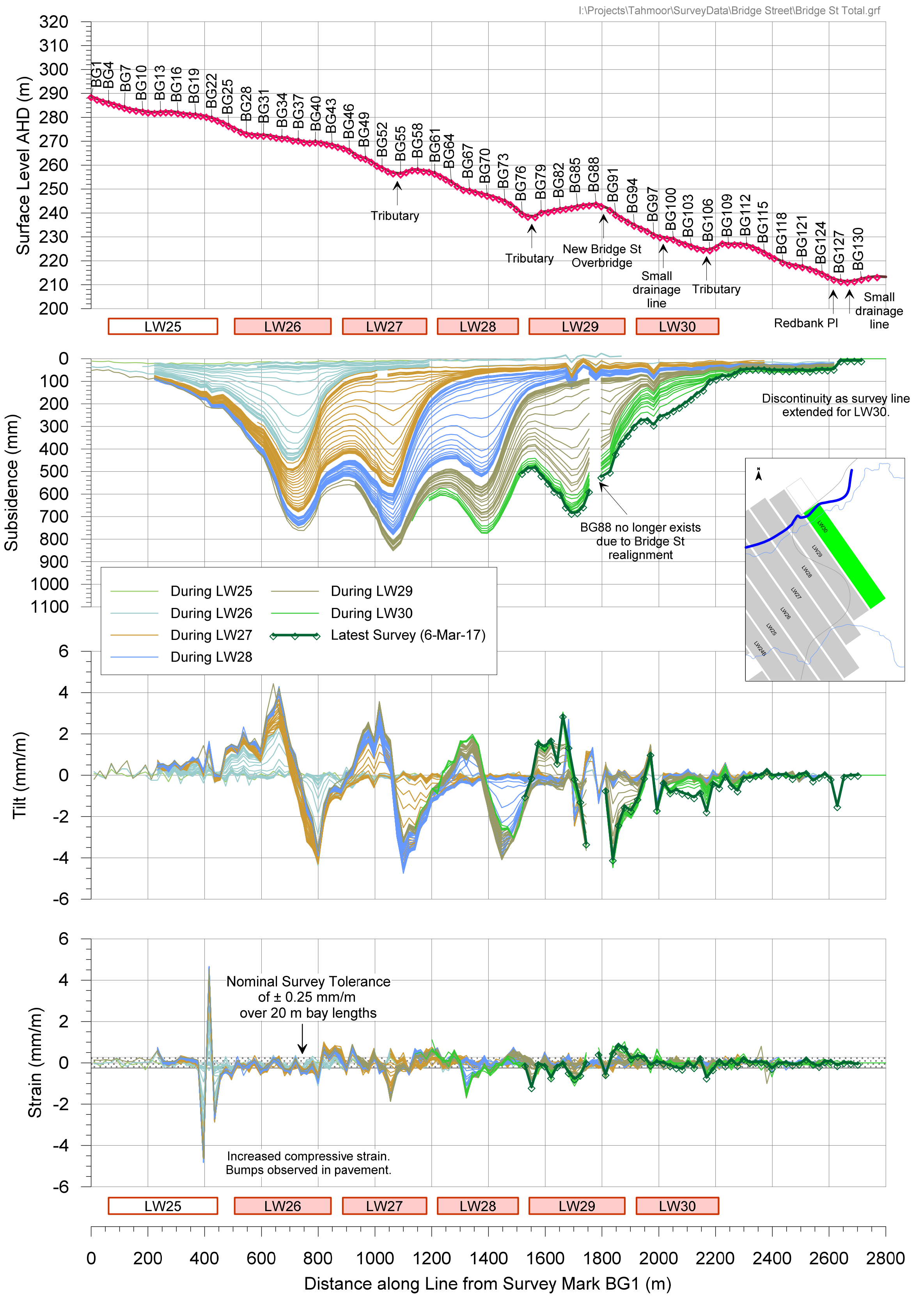

Fig. 4.3 Observed total subsidence, tilt and ground strain along Bridge Street during the mining of Longwalls 25 to 30 up to 6 March 2017

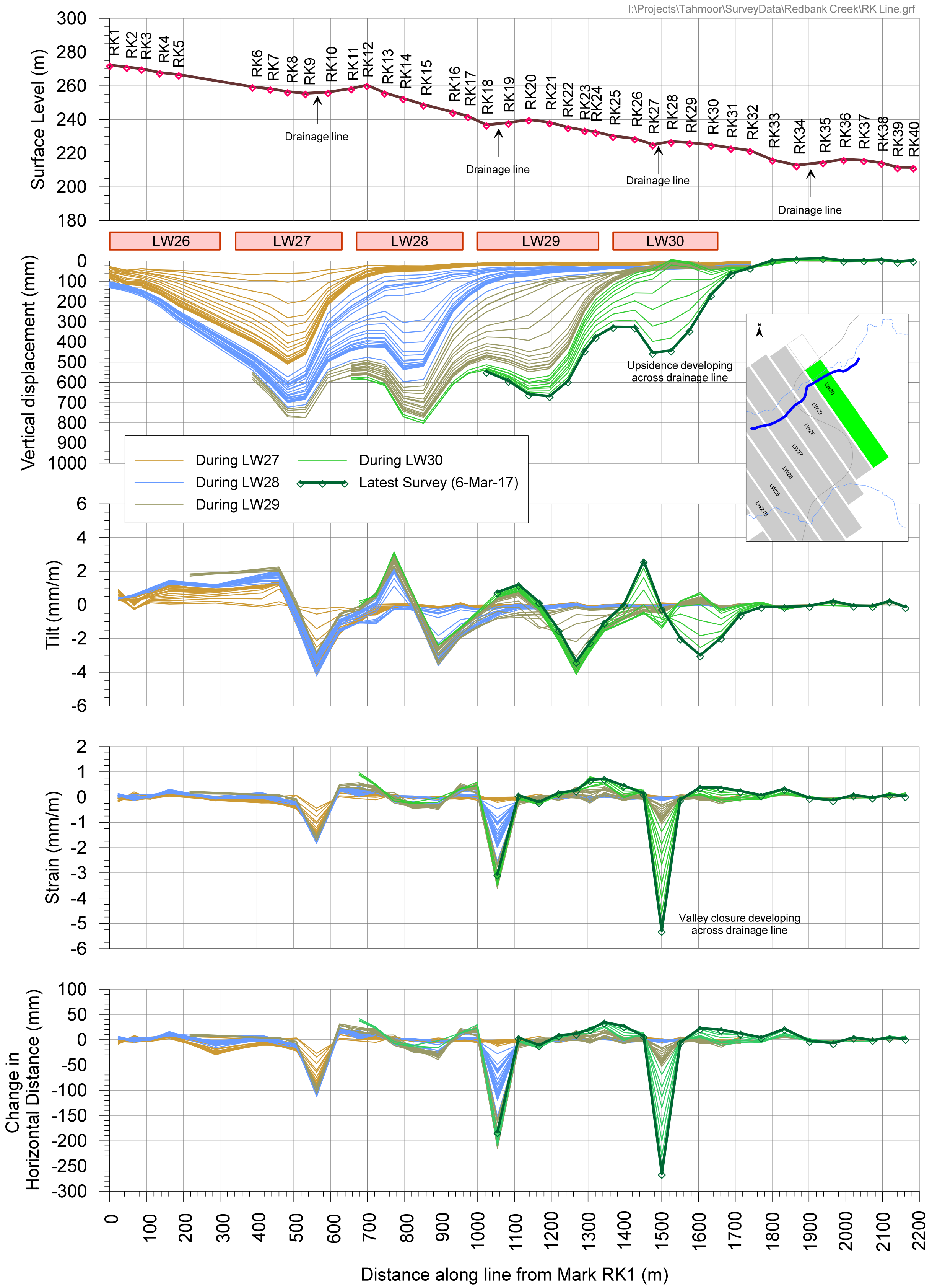

Fig. 4.4 Observed total subsidence, tilt, ground strain and changes in horizontal distances along the RK Line during the mining of Longwalls 27 to 30 up to 6 March 2017

5.0 RISK ASSESSMENT

The risks to the potable water pipelines due to mine subsidence are leakage of the joints and damage of the pipeline segments. The potential for impacts are greater where the pipelines are located directly above Longwall 31 and at the creek crossings.

The risks have been assessed for the section of pipeline along Bridge Street, which comprises a 150 mm DICL pipeline, where it is located directly above Longwall 31 and where it crosses the hidden creek outside and adjacent to the maingate of this longwall. This risks have also been assessed for the remaining pipelines located outside the extents of Longwall 31. There are no pressure reducing vales located within the predicted limit of vertical subsidence.

A summary of the assessed levels of potential impacts on the Sydney Water potable water infrastructure is provided in Table 5.1. The summary is consistent with the risk assessment undertaken by Tahmoor Colliery (Glencore, 2017), which is included in the Appendix.

Table 5.1 Summary of the risk assessment

Risk	Likelihood	Consequence	Level of potential impact
Pipeline along Bridge Street (above LW31)			
Leakage of the joints	Unlikely	Negligible	Low
Damage to pipeline	Rare	Minor	Low
Pipeline along Bridge Street (at hidden creek)			
Leakage of the joints	Possible	Negligible	Low
Damage to pipeline	Possible	Minor	Medium
Other pipelines outside of LW31			
Leakage of the joints	Rare	Negligible	Low
Damage to pipeline	Rare	Minor	Low

6.1. Infrastructure Management Group

The Infrastructure Management Group (IMG) is responsible for taking the necessary actions required to manage the risks that are identified from monitoring the infrastructure. The IMG's key members are Tahmoor Colliery, Sydney Water and Mine Subsidence Engineering Consultants. Subsidence Advisory NSW (Mine Subsidence Board) acts as an observer.

6.2. Mitigation measures

There are no recommended mitigation measures for the Sydney Water potable water infrastructure prior to active subsidence.

6.3. Monitoring measures

Monitoring lines have been installed along all streets within the urban area above and adjacent to Longwall 31, as shown in Drawing No. MSEC862-00-01. The monitoring lines have been initially surveyed to provide a baseline reference. Monitoring of street survey lines will be conducted for every 200 metres of longwall travel as a minimum for marks located within the active subsidence zone. Visual inspections along Bridge Street will be carried out during the active subsidence period.

A monitoring report will be provided after the surveys have been carried out.

6.4. Risk control procedures

The risk control procedures are provided in Table 7.1. The procedures include responses if triggered by the monitoring results.

7.0 RISK CONTROL PROCEDURES

Table 7.1 Risk Control Procedures for potable water infrastructure

Infrastructure	Hazard / Impact	Risk	Trigger	Control procedure/s	Frequency	By whom?
Potable water infrastructure	Impacts to Sydney Water potable water infrastructure	Low / Medium	None	Conduct surveys along monitoring lines to provide some early warning for potentially damaging subsidence events.	Every 200 metres of longwall face movement within the active subsidence zone	Tahmoor Colliery (SMEC / MSEC)
				Conduct visual inspection for surface deformations along Bridge Street above longwall and at hidden creek	Weekly when within the active subsidence zone	Tahmoor Colliery
				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 active subsidence	Tahmoor Colliery
			Non-conventional ground movement detected	Notify Sydney Water	Within 24 hours	Tahmoor Colliery
				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 Colliery and Sydney Water	Tahmoor Colliery
			Leakage of water observed	Notify all stakeholders, including Sydney Water, Tahmoor Colliery, Subsidence Advisory NSW and DRE	Within 24 hours	Sydney Water or Tahmoor Colliery
				Repair leak.	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 Colliery and Sydney Water	Tahmoor Colliery

8.0 MANAGEMENT PLAN REVIEW MEETINGS

The monitoring of Sydney Water potable water infrastructure which forms an integral part of this Management Plan will be carried out by Tahmoor Colliery. IMG Meetings will be held between Tahmoor Colliery and Sydney Water for discussion and resolution of issues raised in the operation of the Management Plan. The frequency of meetings shall be as agreed by the parties.

A secretary will be appointed at the IMG Meeting. All documentation, distribution of meeting minutes and organising of meeting times will be undertaken by the secretary.

IMG Meetings will discuss any incidents reported in relation to the relevant surface feature, 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 risk is identified for a particular surface feature, 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 surface feature.

9.0 AUDIT AND REVIEW

All Management Plans within this document have been agreed between parties. The Management Plan will be reviewed following extraction of the longwall.

Should an audit of the Management Plan be required during that period, an auditor shall be appointed by the Tahmoor Colliery to review the operation of the Management Plan and report at the next scheduled Plan Review Meeting.

Other factors that may require a review of the Management Plan are:

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

10.0 RECORD KEEPING

The secretary will keep and distribute regular minutes of each Plan Review Meeting for each surface feature. The minutes will include reports on the condition of the relevant surface feature, the progress of mining, the degree of mine subsidence that has occurred, comparisons between observed and predicted ground movements, agreements reached between parties, and a log of incidents that have occurred on the surface feature.

11.0 CONTACT LIST

Organisation	Contact	Phone	Email / Mail	Fax
NSW Department of Trade and Investment, Regional Infrastructure and Services, Division of Resources and Energy (DTIRIS)	Gang Li	(02) 4931 6644 0409 227 986	gang.li@ industry.gov.au	(02) 4931 6790
	Phil Steuart	(02) 4931 6648	phil.steuart@industry.gov.au	(02) 4931 6790
	Ray Ramage	(02) 4931 6645 0402 477 620	ray.ramage@ industry.gov.au	(02) 4931 6790
Subsidence Advisory NSW (Mine Subsidence Board)	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	(02) 8412 0222
Glencore Tahmoor Coal – Environment and Community Manager	Ian Sheppard	(02) 4640 0100	Ian.Sheppard@glencore.com.au	(02) 4640 0140
Glencore Tahmoor Coal – Approvals and Community Coordinator	Belinda Treverrow*	(02) 4640 0133 0458 627 752	Belinda.L.Treverrow@glencore.com.au	(02) 4640 0140
Sydney Water	Emergency Line	13 20 90		
Sydney Water – Systems Delivery Officer Area Team West	Charlie Kawtal*	(02) 8763 8616	charlie.kawtal@sydneywater.com.au	(02) 8763 8661

* denotes member of Infrastructure Management Group

APPENDIX A.

Please refer to the following documents:

- Drawing No. MSEC862-00-01 Monitoring over Longwall 31
- Drawing No. MSEC862-03-01 Potable Water – Pipe Size
- Drawing No. MSEC862-03-02 Potable Water – Pipe Type
- Glencore (2017) Risk assessment for Potable Water Infrastructure

I:\Projects\Tahmoor\MSEC862 - LW31 Management Plans\MSEC862-00 General\AcadData\MSEC862-00-01 Monitoring LW31.dwg

msec
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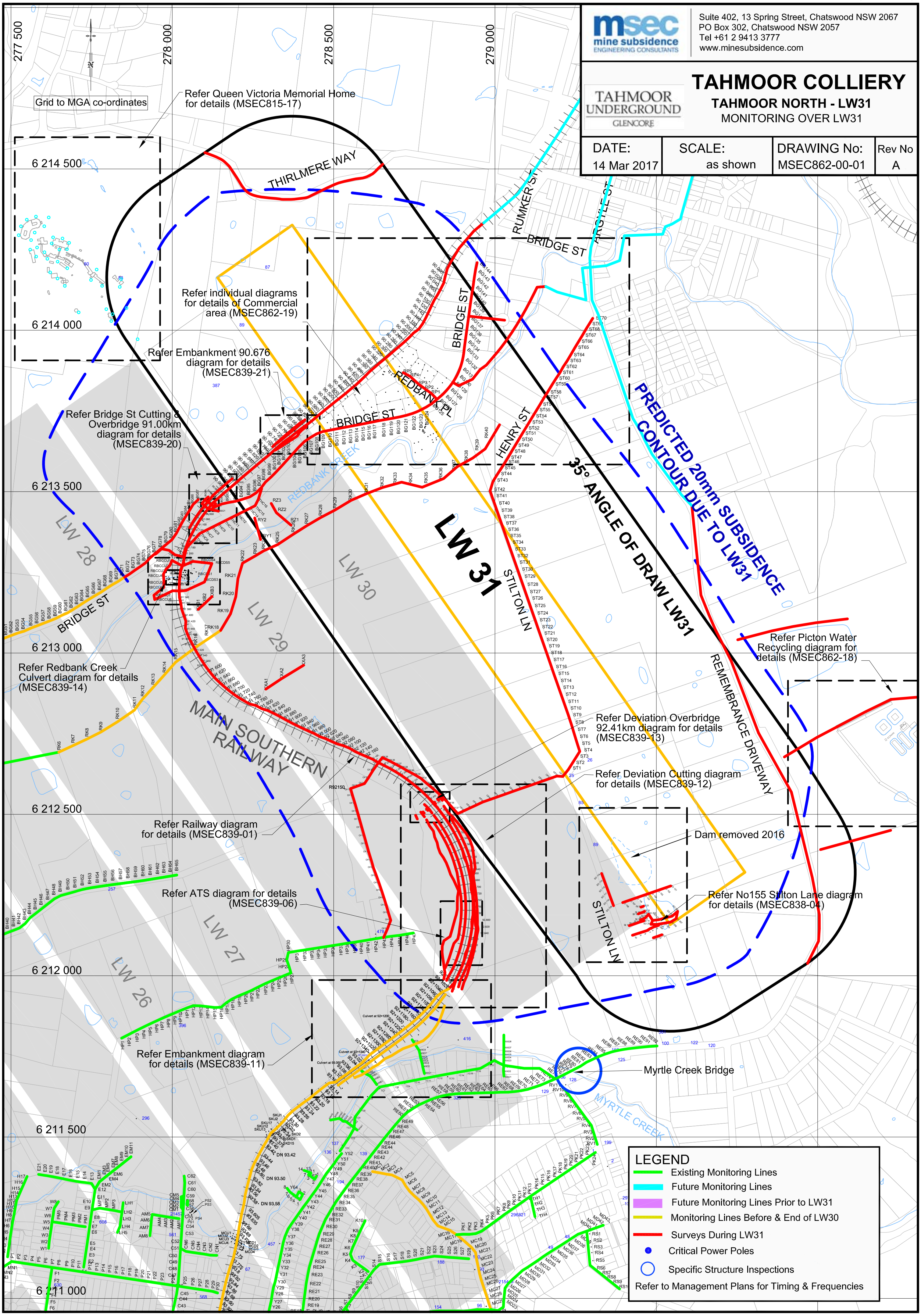
TAHMOOR UNDERGROUND
GLENCORE

TAHMOOR COLLIERY

TAHMOOR NORTH - LW31

MONITORING OVER LW31

DATE:	SCALE:	DRAWING No:	Rev No
14 Mar 2017	as shown	MSEC862-00-01	A



LEGEND

- Existing Monitoring Lines
- Future Monitoring Lines
- Future Monitoring Lines Prior to LW31
- Monitoring Lines Before & End of LW30
- Surveys During LW31
- Critical Power Poles
- Specific Structure Inspections

Refer to Management Plans for Timing & Frequencies

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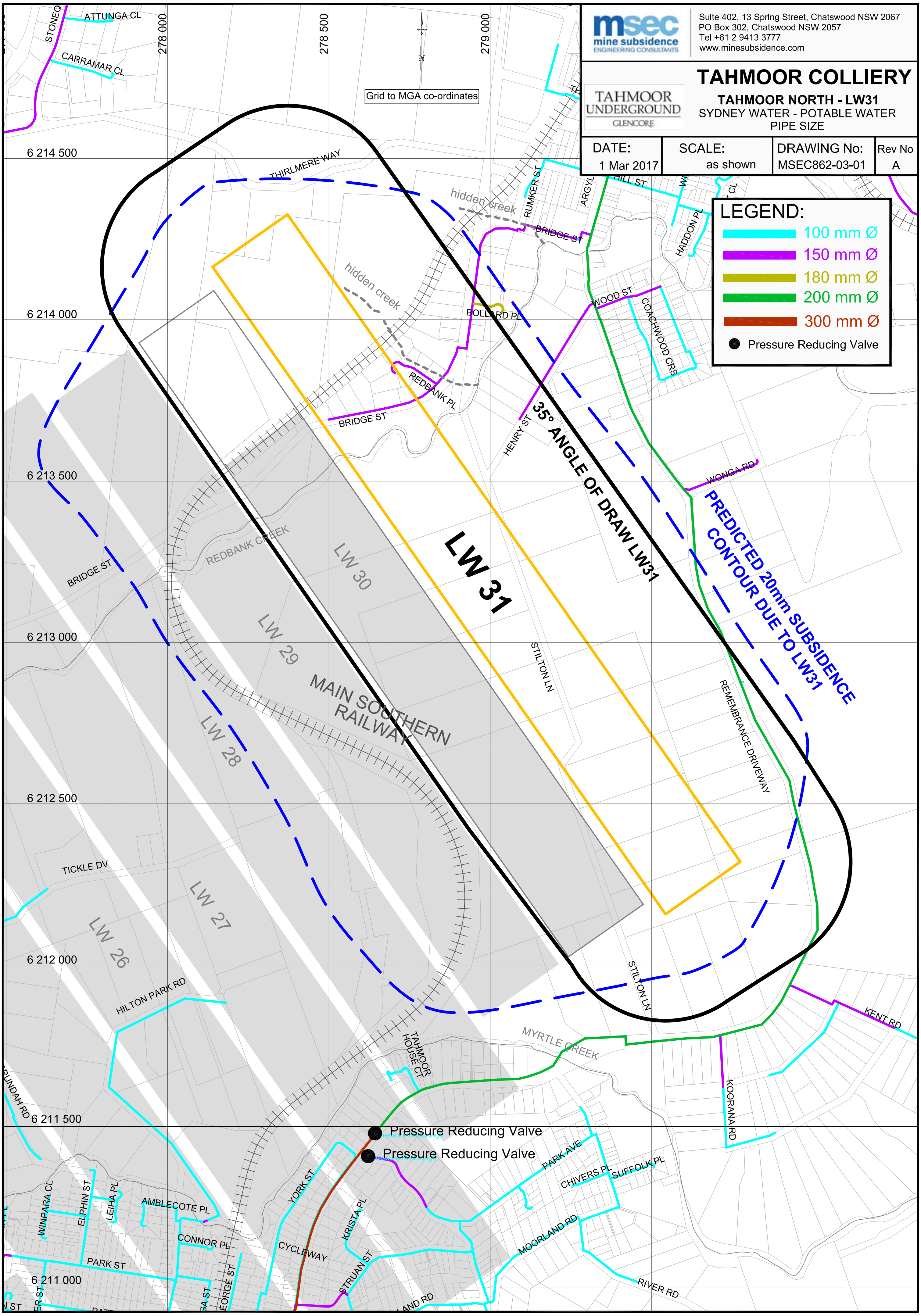

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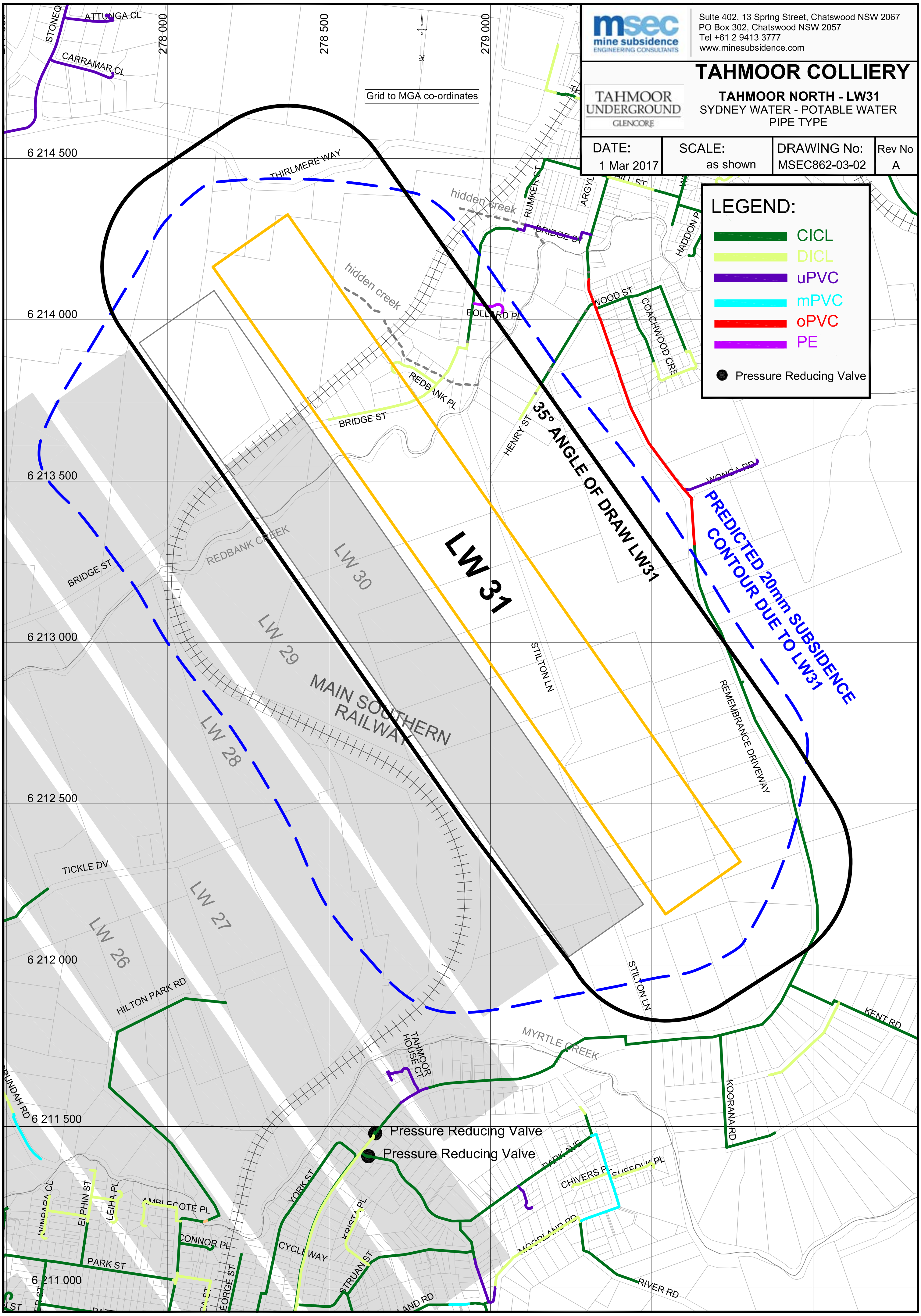

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TAHMOOR COLLIERY

TAHMOOR UNDERGROUND GLENCORE

TAHMOOR NORTH - LW31
SYDNEY WATER - POTABLE WATER PIPE TYPE

DATE:	SCALE:	DRAWING No:	Rev No
1 Mar 2017	as shown	MSEC862-03-02	A

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 with that consequence]

Basis of Rating	E - Rare	D - Unlikely	C - Possible	B - Likely	A – Almost Certain
LIFETIME OR PROJECT OR TRIAL OR FIXED TIME PERIOD OR NEW PROCESS / PLANT / R&D	Unlikely to occur during a lifetime OR Very unlikely to occur OR No known occurrences in broader worldwide industry	Could occur about once during a lifetime OR More likely NOT 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.

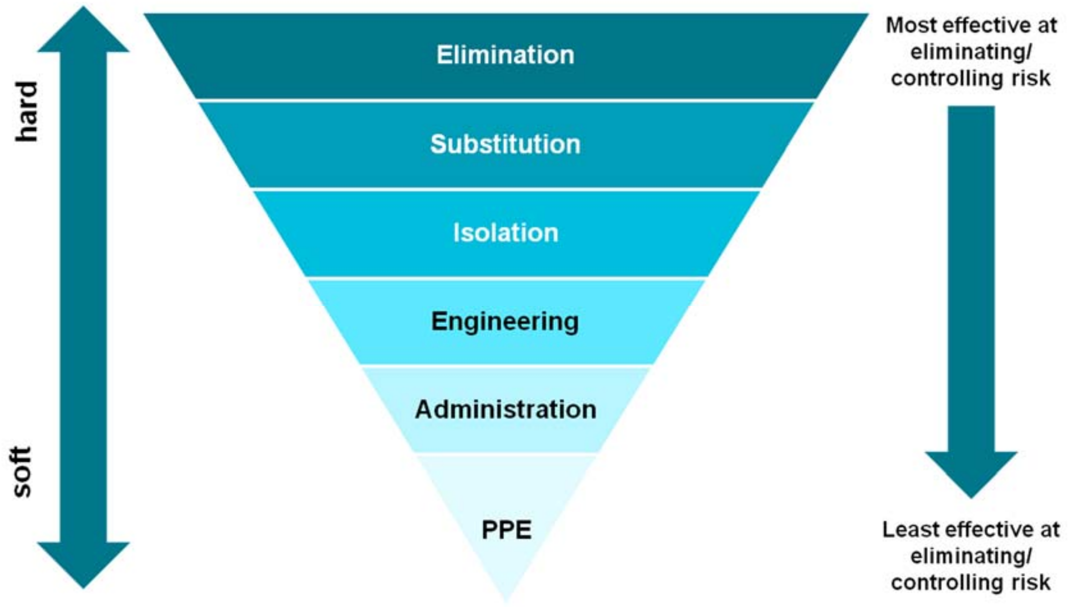

Figure 3-4 – Hierarchy of control

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