Tahmoor Colliery

MANAGEMENT PLAN
for
POTENTIAL IMPACTS TO POTABLE WATER INFRASTRUCTURE DUE TO THE MINING OF LONGWALL 26

Mine Subsidence Engineering Consultants
Level 1 228 Victoria Avenue – Chatswood – NSW 2067
PO Box 3047 – Willoughby North – NSW 2068
Tel. (02) 9413 3777 Fax. (02) 9413 3822
Email: enquiries@minesubsidence.com

www.minesubsidence.com

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GENERAL

AUTHORISATION OF SURFACE SAFETY AND SERVICEABILITY MANAGEMENT PLAN

Authorised on behalf of Tahmoor Colliery:

Name: IAN SHEPPARD

Signature: [signature]

Position: MANAGER ENVIRONMENT & COMMUNITY

Date: 28 - 6 - 10

Authorised on behalf of Sydney Water:

Name: DIANE ASHFORD

Signature: [signature]

Position: SOO WESTERN WATER

Date: 25/6/10

REVIEW

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Mar-06	MSEC286-0403	A	Initial Draft
Mar-06	MSEC286-0403	B	Draft for Submission to Sydney Water
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	MSEC446-06	A	Updated for Longwall 26

REFERENCES

1	*AS/NZS 4360:1999 Risk Management.*
2	*Tahmoor Colliery Longwalls 24 to 26 - The Prediction of Subsidence Parameters and the Assessment of Mine Subsidence Impacts on Surface and Sub-Surface Features due to mining Longwalls 24 To 26 at Tahmoor Colliery in support of an SMP Application.* (Report MSEC157), prepared by Mine Subsidence Engineering Consultants.
3	*Tahmoor Colliery Longwalls 27 to 30 - The Prediction of Subsidence Parameters and the Assessment of Mine Subsidence Impacts on Natural Features and Items of Surface Infrastructure due to mining Longwalls 27 to 30 at Tahmoor Colliery in support of the SMP Application. (Report MSEC355, Revision B, July 2009), prepared by Mine Subsidence Engineering Consultants.*

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Drawings

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

Drawing No.	*Description*	*Rev*
MSEC446-00-01	Observed Incremental Subsidence due to LW25 as at 19-Jan-2010	A
MSEC446-00-02	Predicted Subsidence due to LW26	A
MSEC446-03-01	Water Infrastructure – Pipe Size	A
MSEC446-03-02	Water Infrastructure – Pipe Type	A

CHAPTER 1. INTRODUCTION

1.1. Background

Tahmoor Colliery is located approximately 80 kilometres south west of Sydney in the township of Tahmoor NSW. It is managed and operated by Xstrata Coal. Tahmoor Colliery has previously mined 24 longwalls to the north and west of the mine's current location. It is currently mining Longwall 25.

Longwall 26 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. A portion of each longwall is located beneath the urban area of Tahmoor. Infrastructure owned by Sydney Water is located within these areas.

This Management Plan provides detailed information about how the risks associated with the mining beneath 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. Maximum Predicted Systematic Parameters

Prior to commencement of mining Longwalls 24 to 26, predicted subsidence was provided in Report No. MSEC157 (2006, Rev. C), which was provided in support of Tahmoor Colliery's SMP application for Longwalls 24 to 26.

A summary of the predicted maximum incremental parameters over the whole subsided area, due to the extraction of each longwall, is shown in Table 1.1.

Table 1.1 Maximum Predicted Incremental Subsidence Parameters

Subsidence Parameter	LW 22	LW 23	LW 24	LW 25	LW 26
Vertical Subsidence (mm)	503	613	596	631	636
Transverse Tilt (mm/m)	3.5	4.9	4.7	5.0	5.1
Longitudinal Tilt (mm/m)	3.0	3.8	3.5	3.7	3.7
Transverse Tensile Strain (mm/m)	0.4	0.7	0.7	0.8	0.8
Longitudinal Tensile Strain (mm/m)	0.6	0.7	0.8	0.8	0.8
Transverse Compressive Strain (mm/m)	0.9	1.6	1.5	1.7	1.7
Longitudinal Compressive Strain (mm/m)	0.6	0.8	0.6	0.6	0.8
Transverse Hogging Curvature (km^{-1})	0.03	0.05	0.05	0.05	0.05
Longitudinal Hogging Curvature (km^{-1})	0.04	0.05	0.05	0.05	0.05
Transverse Sagging Curvature (km^{-1})	0.06	0.11	0.10	0.11	0.11
Longitudinal Sagging Curvature (km^{-1})	0.04	0.05	0.04	0.04	0.05

The maximum predicted cumulative subsidence parameters, after the extraction of each longwall, are shown in Table 1.2.

Table 1.2 Maximum Predicted Cumulative Subsidence Parameters

Subsidence Parameter	LW 22	LW 23	LW 24	LW 25	LW 26
Vertical Subsidence (mm)	503	756	850	892	934
Transverse Tilt (mm/m)	3.5	5.0	4.8	5.2	5.2
Longitudinal Tilt (mm/m)	3.0	4.4	4.9	5.1	5.2
Transverse Tensile Strain (mm/m)	0.4	0.7	0.7	1.0	1.3
Longitudinal Tensile Strain (mm/m)	0.6	0.7	0.8	0.9	0.9
Transverse Compressive Strain (mm/m)	0.9	1.6	1.7	1.7	1.8
Longitudinal Compressive Strain (mm/m)	0.6	0.8	0.8	0.8	0.8
Transverse Hogging Curvature (km^{-1})	0.03	0.05	0.05	0.07	0.09
Longitudinal Hogging Curvature (km^{-1})	0.04	0.05	0.05	0.06	0.06
Transverse Sagging Curvature (km^{-1})	0.06	0.11	0.11	0.11	0.12
Longitudinal Sagging Curvature (km^{-1})	0.04	0.05	0.05	0.05	0.05

1.3. Observed Subsidence during the mining of Longwalls 22 to 25

Extensive ground monitoring within the urban areas of Tahmoor has allowed detailed comparisons to be made between predicted and observed subsidence, tilt, strain and curvature during the mining of Longwalls 22 to 25. The results were published in Report No. MSEC355, which was provided in support of Tahmoor Colliery's SMP application for Longwalls 27 to 30.

In summary, there is generally a good correlation between observed and predicted subsidence, tilt and curvature. Observed subsidence was generally slighter greater than predicted in areas that were located directly above previously extracted areas and areas of low level subsidence (typically less than 100 mm) was generally observed to extend further than predicted.

While there is generally a good correlation between observed and predicted subsidence, substantially increased subsidence has been observed above most of Longwall 24A and the southern end of Longwall 25. Subsidence was more than double the predicted amount in some locations though ground strains were within the normal range. This was a very unusual event for the Southern Coalfield.

Observed Increased Subsidence during the mining of Longwall 24A

Observed subsidence was greatest above the southern half of Longwall 24A, and gradually reducing in magnitude towards the northern half of the longwall, which was directly beneath the urban area of Tahmoor. These observations are shown graphically in **Error! Reference source not found.**, which shows observed subsidence at survey pegs located along the centreline of Longwall 24A.

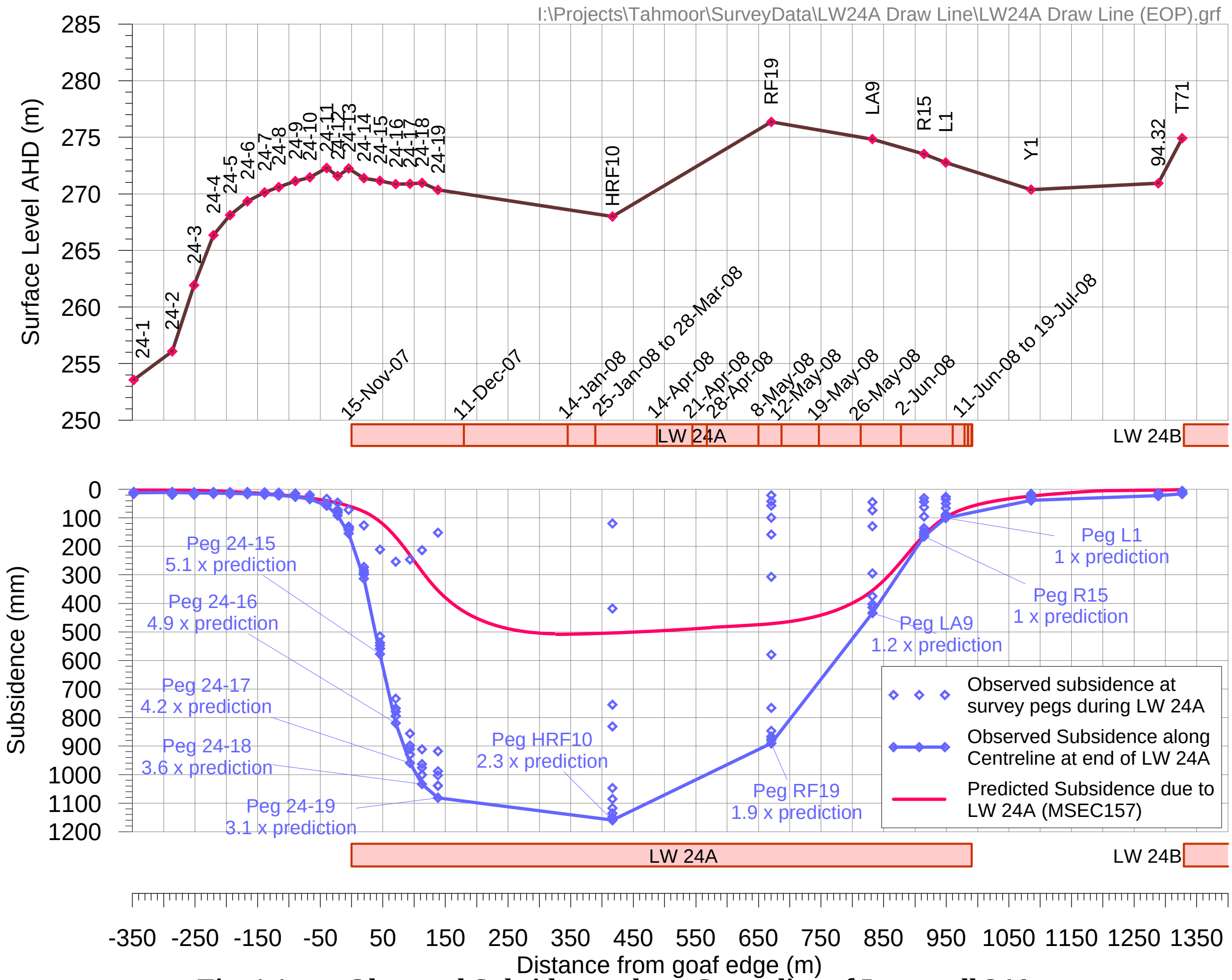


Fig. 1.1 Observed Subsidence along Centreline of Longwall 24A

It can be seen from **Error! Reference source not found.** that observed subsidence was more than twice the predicted maximum value, reaching to a maximum of 1169 mm at Peg HRF10. It is possible that actual maximum subsidence developed somewhere between Pegs HRF10 and RF19, though this was not measured. Observed subsidence was similar to prediction near Peg R15 on Remembrance Drive. Survey pegs RF19 and LA9 are located within a transition zone where subsidence gradually reduced from areas of maximum increased subsidence to areas of normal subsidence.

Observed Increased Subsidence during the mining of Longwall 25

Increased subsidence was observed during the first stages of mining Longwall 25. These observations are shown graphically in Fig. 1.2, which shows observed subsidence at survey pegs located along the centreline of Longwall 25.

It can be seen from Fig. 1.2 that observed subsidence was approximately twice the predicted maximum value, with maximum subsidence of 1168 mm at Peg 25-28 and 1187 mm at Peg PG13. Peg 25-28 was last surveyed in January 2009 and Peg PG13 was last surveyed in March 2010. It is likely that further small increases in subsidence will be observed at both pegs when they are surveyed at the completion of Longwall 25.

Observed subsidence is similar to but slightly more than predicted at Peg RE7 and is similar to prediction at Peg Y20 and at all pegs located further along the panel. Survey pegs A6, A7, A8 and A9 are located within a transition zone where subsidence has gradually reduced from areas of maximum increased subsidence to areas of normal subsidence.

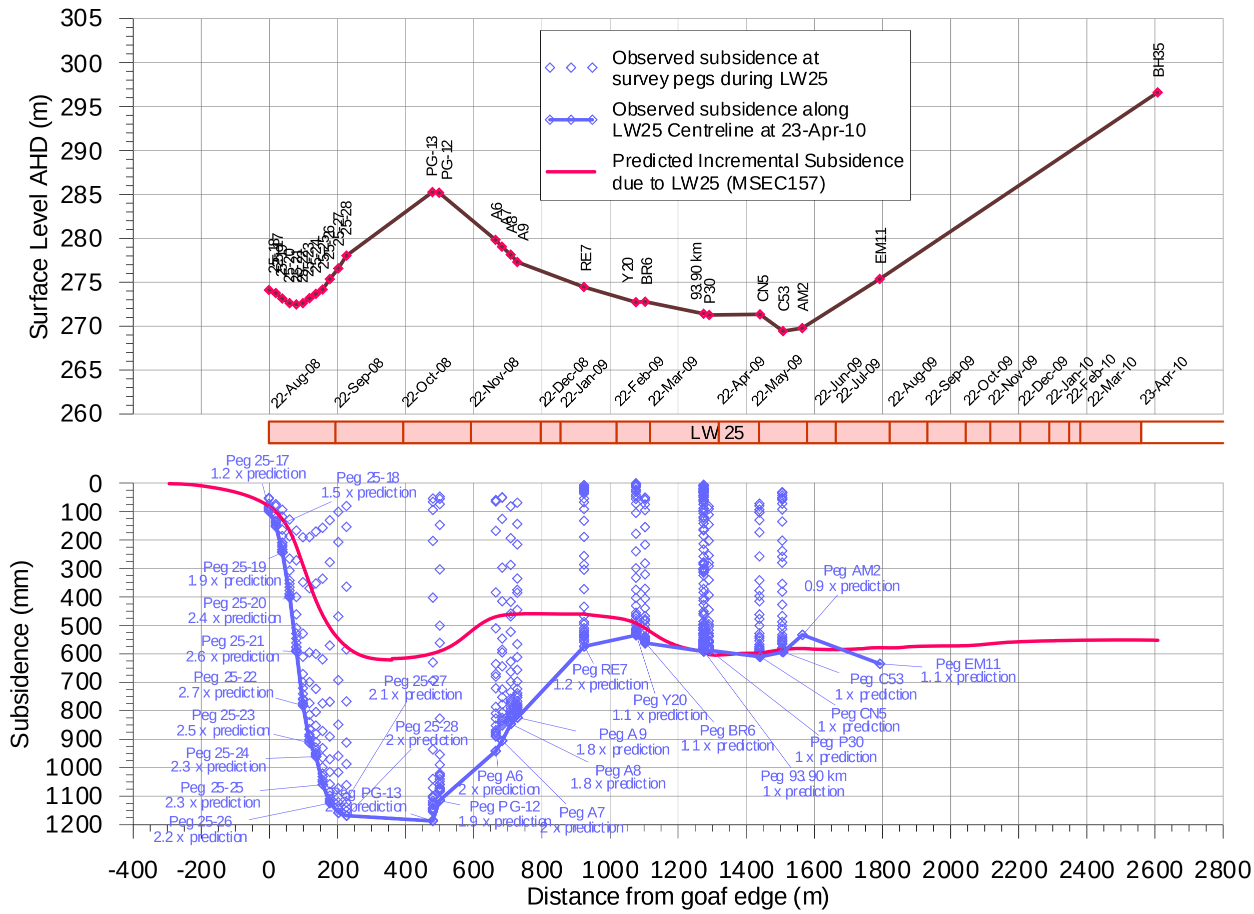


Fig. 1.2 Observed Subsidence along Centreline of Longwall 25 as at 23 April 2010

Analysis and commentary

The cause for the increased subsidence is currently not confirmed. Tahmoor Colliery has engaged a specialist in strata mechanics to provide advice on possible causes. Preliminary advice suggests a link with groundwater flows towards either the Bargo River or Nepean Fault.

In light of the above observations, the region above the extracted longwalls at Tahmoor has been partitioned into three zones:

1. Normal subsidence zone – where the observed vertical subsidence is within the normal range and correlates well with predictions
2. Maximum increased subsidence zone – where the observed vertical subsidence is substantially greater than predictions but has reached it upper limit. Maximum subsidence above the centreline of the longwalls appears to be approximately twice the magnitude of maximum normal subsidence.
3. Transition zone – where the subsidence behaviour appears to have transitioned between areas of maximum increased subsidence and normal subsidence.

When the locations of the three zones are plotted on a map, as shown in Drawing No. MSEC446-00-01, it can be seen that the transition zone is roughly consistent in width above Longwall 24A and Longwall 25. The orientation of the transition zone is also roughly parallel to both the Bargo River and the Nepean Fault.

The zones have been projected above Longwalls 26 to 30 from the observed zones above Longwalls 24A and 25, as shown in Drawing No. MSEC446-00-01. Two projections have been provided. One represents zones with similar offsets to the Bargo River and the other represents zones with similar offsets to the Nepean Fault.

1.4. Predicted Subsidence due to the mining of Longwall 26

Predictions of vertical subsidence above Longwall 26 have been amended in light of the observations of increased subsidence above Longwalls 24A and 25. The predictions have been amended in the following manner:

1. Increased subsidence develops above the commencing (southern) end of Longwall 26 in a similar manner as was observed during the mining of Longwall 25. Observed subsidence contours have been developed using observed subsidence data as at 19 January 2010, as shown in Drawing No. MSEC446-00-01.
2. Subsidence transitions between increased and normal subsidence as per the projection using offsets to the Nepean Fault, as shown in Drawing No. MSEC446-00-02. This projection is more conservative than the projection that used offsets to the Bargo River.
3. Normal subsidence develops above the remainder of Longwall 26. Predicted subsidence is the same as those provided in Report No. MSEC355.

The predicted subsidence contours due to the mining of Longwall 26 are shown in Drawing No. MSEC446-00-02.

1.5. Predicted Strain

The prediction of strain is more difficult than the predictions of subsidence, tilt and curvature. The reasons for this are that strain is affected by many factors, including ground curvature and horizontal movement, as well as local variations in the near surface geology, the locations of joints at bedrock, the depth of bedrock. The measurements are also affected by survey tolerance. The profiles of observed strain can, therefore, be irregular even when the profiles of observed subsidence, tilt and curvature are relatively smooth.

Strains measured above goaf

The survey database has been analysed to extract maximum tensile and compressive strains that have been measured at any time during the mining of Longwalls 22 to 25 as at May 2009, for pegs that were located directly above goaf or the chain pillars that are located between the extracted longwalls.

The frequency distribution of maximum observed tensile strains and compressive strains above goaf is provided in Fig. 1.3.

Strains measured above solid coal

The survey database has been analysed to extract maximum tensile and compressive strains that have been measured at any time during the mining of Longwalls 22 to 25 as at May 2009, for pegs that were located directly above solid coal within 200 metres of the nearest goaf edge. Solid coal is defined as both the coal that has not been extracted by longwalls.

The frequency distribution of maximum observed tensile strains and compressive strains above solid coal is provided in Fig. 1.4.

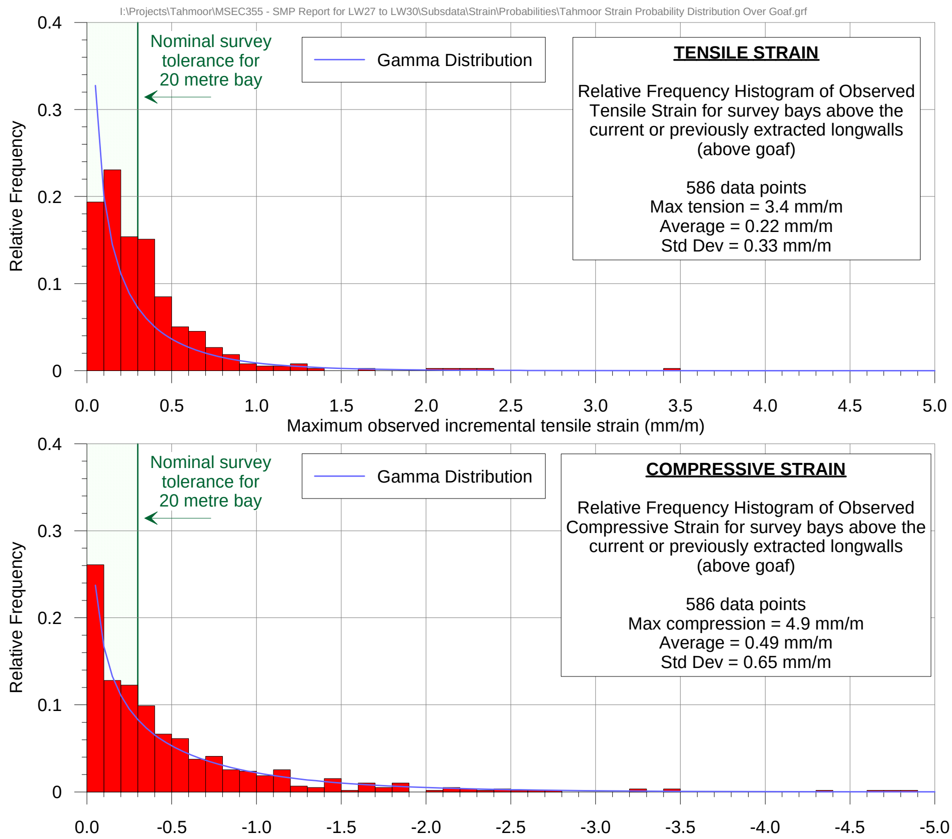


Fig. 1.3 Distributions of Measured Maximum Tensile and Compressive Strains at any time during the mining of Longwalls 22 to 25 as at May 2009 for pegs located Above Goaf.

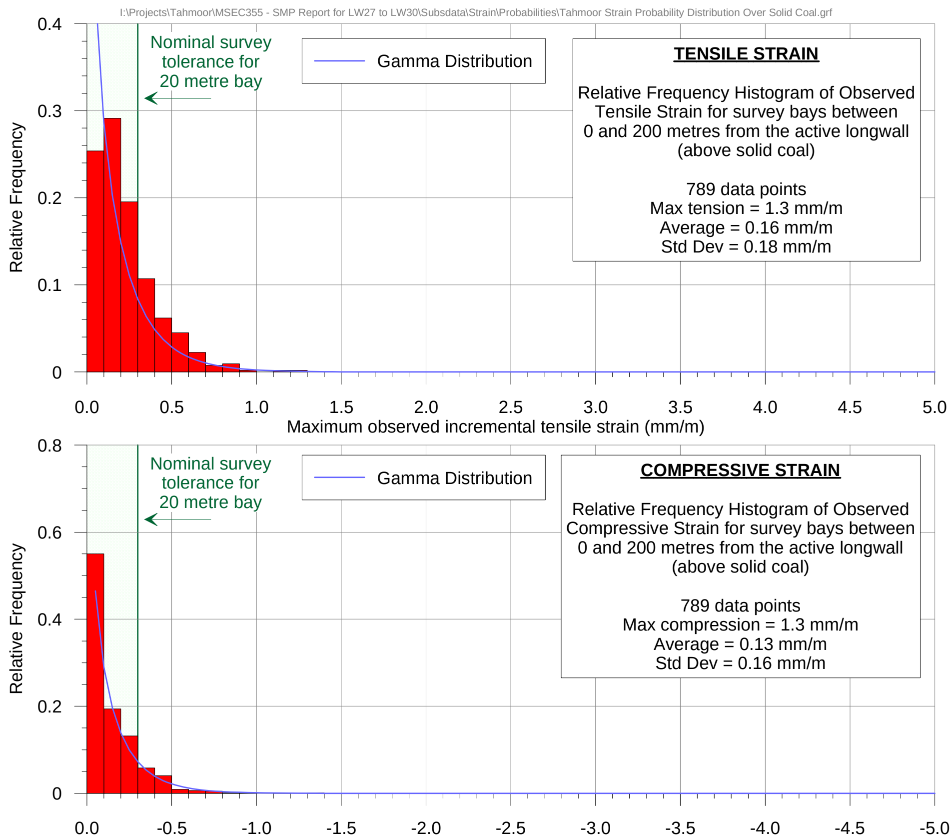


Fig. 1.4 Distributions of Measured Maximum Tensile and Compressive Strains at any time during the mining of Longwalls 22 to 25 as at May 2009 for pegs located Above Solid Coal

1.6. Objectives

The objectives of this Management Plan are to establish procedures to measure, control, mitigate and repair potential impacts that might occur on surface infrastructure owned by Sydney Water.

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. 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, Mine Subsidence Board, Industry and Investment, NSW, and consultants as required.
- Establish lines of communication and emergency contacts.

1.7. Scope

The Management Plan is to be used to protect and monitor the condition of the items of infrastructure identified to be at risk due to mine subsidence. The major items at risk are the water mains.

The Management Plan describes measures that will be undertaken as a result of mining Longwall 26 only.

1.8. Proposed Mining Schedule

It is planned that each longwall will extract coal working northwest from the southeastern ends. This Management Plan covers longwall mining until completion of mining in Longwall 26 and for sufficient time thereafter to allow for completion of subsidence effects. The current schedule of mining is shown in Table 1.3.

Table 1.3 Schedule of Mining

Longwall	Start Date	Completion Date
Longwall 26	February 2011	December 2012

1.9. 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. 1.5.

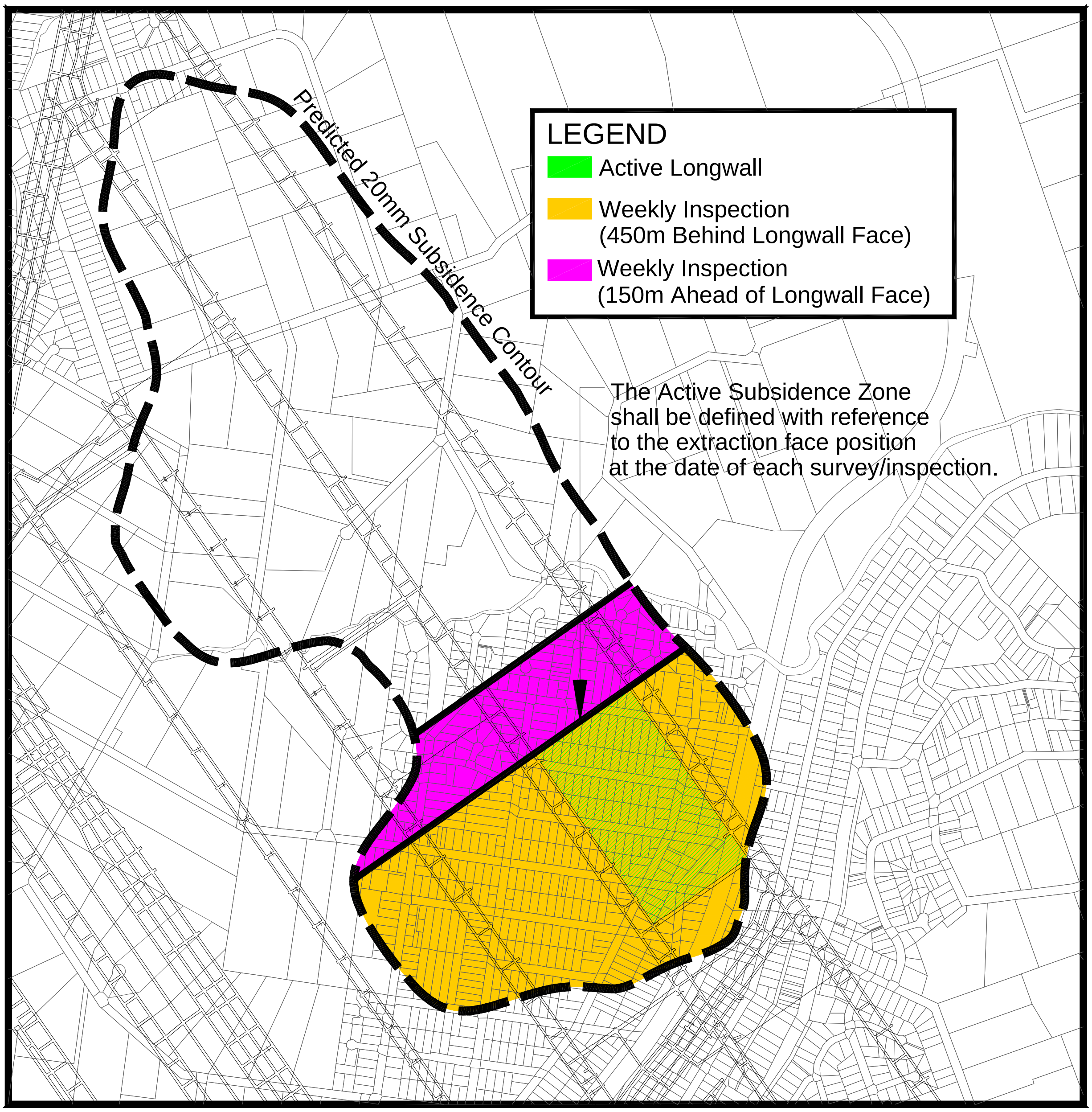


Fig. 1.5 Diagrammatic Representation of Active Subsidence Zone

CHAPTER 2. RISK MANAGEMENT METHOD

2.1. General

The Australian/New Zealand standard for Risk Management defines the terms used in the risk management process, which includes the identification, analysis, assessment, treatment and monitoring of risk. In this context:-

2.1.1. 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.

2.1.2. Likelihood

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

2.1.3. Hazard

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

2.1.4. Risk

'The chance of something happening that will have an impact upon objectives. It is measured in terms of consequences and likelihood.'[4] The risk combines the likelihood of an impact occurring with the consequence of the impact occurring. The risk is rated from very low to extreme. In this study, the likelihood and consequence are combined via the qualitative risk analysis matrix shown in Table 2.1, to determine an estimated level of risk for particular events or situations.

The Risk Analysis Matrix is similar to the example provided in AS/NZS 4360:1995, Appendix D, p.25.

Table 2.1 Qualitative Risk Analysis Matrix

LIKELIHOOD	CONSEQUENCES				
	Very Slight	**Slight**	**Moderate**	**Severe**	**Very Severe**
Almost Certain	Low	Moderate	High	Extreme	Extreme
Likely	Low	Moderate	High	Very High	Extreme
Moderate	Low	Low	Moderate	High	Very High
Unlikely	Very Low	Low	Moderate	High	High
Rare	Very Low	Very Low	Low	Moderate	High
Very Rare	Very Low	Very Low	Low	Moderate	Moderate

This Management Plan adopts a common system of nomenclature to summarise each risk analysis, which is **"LIKELIHOOD / CONSEQUENCE → LEVEL OF RISK".**

For example, if the likelihood of a risk is assessed as "**UNLIKELY**", and the consequence of a risk is assessed as "**SEVERE**", the risk analysis would be summarised as **"UNLIKELY / SEVERE → HIGH"**.

[1] AS/NZS 4360:1999 – Risk Management pp2
[2] AS/NZS 4360:1999 – Risk Management pp2
[3] AS/NZS 4360:1999 – Risk Management pp2
[4] AS/NZS 4360:1999 – Risk Management pp3

CHAPTER 3. RISK ASSESSMENT

3.1. Observations during Longwalls 22 to 25

Longwalls 22 to 24A have directly mined beneath approximately 960 metres of DICL pipe and 2.7 kilometres of CICL pipe, with only one impact to the distribution network reported. This was a leak in a cast iron water main on Glenanne Place in June 2007. 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 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.

A water leak was also observed on York Street opposite the Tahmoor Town Centre during the mining of Longwall 25. The cause of the leak is currently unknown. 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.

3.2. Water Supply Infrastructure

Sydney Water has an extensive water supply network that will experience subsidence movements during the mining of Longwall 26. The water pipelines are shown according to their pipe sizes in Drawing No. MSEC446-03-01. The pipes are also shown according to their type of pipe in Drawing No. MSEC446-03-02.

It can be seen from these drawings that the water mains that may experience subsidence during the mining of Longwall 26 range in diameter between 100 and 300 mm. The larger water mains are located along Remembrance Drive. The majority of the pipes are either Cast Iron or Ductile Iron Cement Lined pipes, with some welded Steel Cement Lined directional bores.

There are also two pressure reducing valves that may experience subsidence during the mining of Longwall 26, though none are located directly above Longwall 26, as shown in Drawing No. MSEC446-03-01.

3.3. Review of Risk Assessment and Management Measures

The range of subsidence movements is predicted to be similar to those experienced during the mining of Longwalls 22 to 25. The nature of the infrastructure that will experience subsidence during the mining of Longwall 26 is similar to the infrastructure above Longwalls 22 to 25.

Sydney Water and Tahmoor Colliery have developed and acted in accordance with an agreed management plan during the mining of Longwalls 22 to 25.

Given that no significant impacts have been experienced to date, Sydney Water and Tahmoor Colliery consider that there is no need to amend the risk assessment or the management measures that have been developed in previously agreed management plans.

3.4. Hazard Identification

Five hazards have been identified that are associated with mine subsidence impacts on the water mains:-

1. The hazard that the joints are damaged as a result of mining induced ground strains.

2. The hazard that the pipes are damaged as a result of mining induced ground strains.

3. The hazard that valves, hydrants and chambers are damaged as a result of mining induced ground strains.

4. The hazard that there is damage to the water mains at creek crossings.

The likelihood and consequence of each hazard and the associated level of risk are discussed in the following sections.

3.5. Hazard 1 – Damaged Joints

Since the water mains are pressure mains, the predicted maximum subsidence of 934 mm should have very little effect on the capacity of the system, although the ground strains and curvatures could adversely affect the pipelines.

The maximum predicted ground strains within the subsidence bowl due to the proposed longwalls are 1.3 mm/m tensile and 1.8 mm/m compressive. These levels of strains would be readily accommodated by the DICL pipes with rubber ring joints, which are shown in Drawing No. MSEC446-03-02. Any ground movements along the pipes are likely to be transferred to the pipe joints.

The maximum predicted strain of 1.8 mm/m will result in movements of up to 5.4 mm at the joints, if the strain is applied along the full length of a 3 metre pipe, or 10 mm for a 5.5 metre pipe. In reality, the peak strain is localised and the differential movement will be taken up by a number of joints, reducing the maximum movement at the joints. It is also unlikely that all of the ground strains will transfer into the pipes as the sand bedding will allow the pipes to slide as the ground moves beneath them. The maximum predicted ground curvature of 8.3 kilometres will result in a lateral deviation at the joints of less than 2 mm for a 450 mm diameter pipe.

Standard rubber ringed joints in PVC pipes can typically tolerate a longitudinal movement of up to 20 mm and an angular deviation of up to 1^{o} without experiencing adverse impacts. If the pipes have been constructed with extra length sockets, the joints are likely to tolerate a longitudinal movement of up to 40 mm and an angular deviation of up to 3^{o} without experiencing adverse impacts. It is likely that the pipes would be able to accommodate the movements even if the ground movements were double the predicted movements. These comments are made on the assumption that the pipes were installed at mid-socket depth, so that both tensile and compressive movements can be accommodated. Clearly, if the pipes were not installed correctly, the ability of the joints to accommodate the movements would be reduced.

As shown in Drawing No. MSEC446-03-02, there are a number of CICL pipes, which are typically older and may contain caulked lead joints. These pipes and joints are less flexible and more vulnerable to adverse impacts when compared to those with rubber ring joints. Sydney Water has advised that the incidence of breakage to its mains during the extraction of Longwalls 22 to 24 does not appear to have been directly related to the mining activity, with the exception of the broken pipe on Glenanne Place. The breakages appear to have been more influenced by seasonal temperature variations, as breakages more commonly occur during the warmer summer months.

The largest water mains that will experience the full range of subsidence movements during the mining of Longwall 26 are the 300 mm DICL pipes that run along Remembrance Drive from Emmett Street towards Picton. This section of pipe is located directly above the previously mined Longwall 25. No impacts were observed during the mining of Longwall 24A or Longwall 25. Predictions of subsidence, tilt and strain along Remembrance Drive are provided in Fig. 3.1 and are summarised in Table 3.1.

Table 3.1 Maximum Predicted Systematic Subsidence, Tilt and Strain along Remembrance Drive

Maximum Predicted Subsidence (mm)	Maximum Predicted Tilt (mm/m)	Maximum Predicted Tensile Strain (mm/m)	Maximum Predicted Compressive Strain (mm/m)
768	4.1	0.5	0.8

Based on the above experiences, it is concluded that it is unlikely that the pipe joints will be broken by systematic (normal) mine subsidence movements. Non-systematic localised ground strains and curvatures higher than predicted can occur where compressive ground strains cause the underlying strata to buckle. It is considered that the broken CICL pipe on Glenanne Place was caused by non-systematic subsidence movement. The remaining 960 metres of DICL and 2.7 kilometres of CICL pipe to have been directly mined beneath by Longwalls 22 to 24 have not experienced impacts, even though non-systematic movements have developed near water mains.

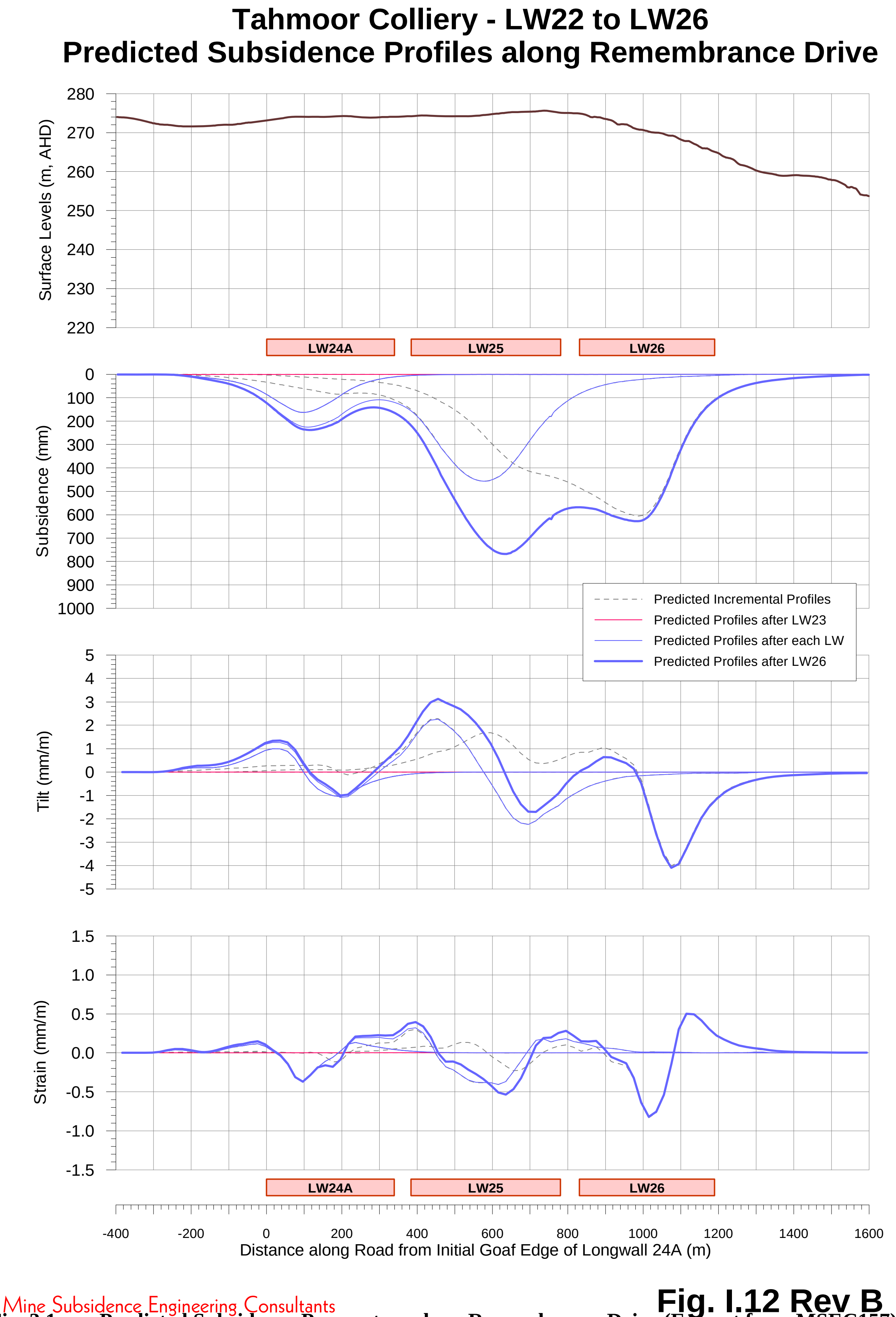


Fig. 3.1 Predicted Subsidence Parameters along Remembrance Drive (Extract from MSEC157)

On the basis of the above comments, the likelihood of the joints in the CICL pipes being damaged by systematic mining impacts can therefore be considered **MODERATE**. However, the likelihood of the larger diameter CICL pipes (greater than 150 mm dia) is considered **RARE**, as they will experience only small additional amounts of subsidence as a result of mining Longwall 26.

DICL pipes are more readily able to tolerate mine subsidence movements compared to CICL pipes by virtue of the rubber ringed joints. No DICL pipes have experienced impacts to date. The likelihood of the joints in the DICL pipes being damaged by systematic mining impacts can therefore be considered **UNLIKELY**.

Non-systematic localised ground strains and curvatures higher than predicted can occur where compressive ground strains cause the underlying strata to buckle, however, the likelihood of this anomalous behaviour occurring at any particular site can be considered **RARE**. The observed frequency of impacts to date from any mine subsidence movements has so far been 1 impact in 3.7 kilometres of water main.

The result of damaged joints is the leakage of water into the surrounding area and localised erosion. In the case of the smaller 100 and 150 mm diameter pipes, the damaged joints can be repaired at a relatively low financial cost and the inconvenience to Sydney Water customers is limited to a relatively small number of properties. The consequence can therefore be considered **SLIGHT**. In the case of the pipes that are larger than 150 mm in diameter, the inconvenience to customers is greater and the consequence can be considered **MODERATE**.

The level of risk can therefore be considered:-

For 100 and 150 mm dia pipes:- **MODERATE** (CICL) or **UNLIKELY** (DICL) / **SLIGHT → LOW**

For CICL pipes with dia > 150 mm:- **RARE / MODERATE → LOW**

For DICL pipes with dia > 150 mm:- **UNLIKELY / MODERATE → LOW**

3.6. Hazard 2 – Damaged Pipes

The water mains located over Longwall 26 typically consist of 100 mm, 150 mm, 200 mm and 300 mm diameter Cast Iron Cement Lined (CICL) pipes. A number of 100 mm diameter Ductile Iron Cement Lined (DICL) pipes are also located over Longwall 26. The pipe lengths and are not known, therefore a standard pipe length of 5.5 metres has been assumed for this analysis.

Longwalls 22 to 24A have directly mined beneath approximately 960 metres of DICL pipe and 2.7 kilometres of CICL pipe, with only one noticeable impact recorded. This was a leak in a CICL pipe on Glenanne Place in June 2007.

The likelihood of the pipes being damaged by systematic mining impacts can therefore be considered **RARE**. Non-systematic localised strains and curvatures higher than predicted can occur where compressive strains cause the underlying strata to buckle, however, the likelihood of this anomalous behaviour occurring can be considered **RARE**. The observed frequency of impacts to date from any mine subsidence movements has so far been 1 impact in 3.7 kilometres of water main.

The result of damaged water mains is the leakage of water into the surrounding area and localised erosion. In the case of the smaller 100 and 150 mm diameter pipes, the damaged joints can be repaired at a relatively low financial cost and the inconvenience to Sydney Water customers is limited to a relatively small number of properties. The consequence can therefore be considered **SLIGHT**. In the case of the pipes that are larger than 150 mm in diameter, the inconvenience to customers is greater and the consequence can be considered **MODERATE**.

The level of risk can therefore be considered:-

For 100 and 150 mm dia pipes:- **RARE** / **SLIGHT → VERY LOW**

For pipes with dia > 150 mm:- **RARE** / **MODERATE → LOW**

3.7. Hazard 3 – Damaged Valves, Hydrants and Chambers

Two pressure reducing valves may experience subsidence movements during the mining of Longwall 26, though both are located to the side the longwall.

Pipes around fixed valves and hydrants are more susceptible to mine subsidence movements as the valves and hydrants act as an anchor while the pipes slide as the ground moves beneath them. This creates greater movements at the first few pipe joints around valves and hydrants.

While these movements can usually be accommodated in the pipe joints it is noted that monitoring for leaks should be more vigilant around valves and hydrants during the mining period. If a large number of breakages are observed during mining, further breakages could be prevented by introducing more flexible joints around valves and hydrants.

Given that no impacts have been observed to the valves, hydrants and chambers to date, , the likelihood of impacts occurring during the mining of Longwall 26 is considered **RARE**.

The valves and chamber are typically connected to large water mains and the consequence of impacts occurring is therefore considered **MODERATE**.

The level of risk can therefore be considered **RARE / MODERATE → LOW**

3.8. Hazard 4 – Damage to the Water Mains at Creek Crossings

The water mains cross Myrtle Creek near Castlereagh Street and these pipe sections are expected to experience closure and upsidence.

Predictions of closure and upsidence at the water main creek crossing due to the extraction of Longwalls 22 to 30 are shown in Table 3.2, in accordance with the methods outlined in Report No. MSEC355.

Table 3.2 Predictions of Upsidence and Closure at Water Main Creek Crossings

Location	Pipe Dia (mm)	Pipe Type	Equiv. Valley Depth (m)	Maximum Cumulative Upsidence (mm)	Maximum Cumulative Closure (mm)
Myrtle Creek (Castlereagh St)	100	SCL	7.5	235	205

The SCL creek crossing near Castlereagh Street is well equipped to accommodate upsidence and closure movements as the joints, if any, are likely to be fully welded. The main concern for this section of water main are the joints on each end of the water main, which are likely to experience closure near the creek and opening at the top of the creek valley. It is noted that the pipes on either side of the creek crossing are CICL pipes, which may be less tolerant these additional non-systematic movements.

The water main creek crossing is located directly above the previously extracted Longwall 25. No impacts have been observed during the mining of Longwall 25.

The likelihood of impacts occurring at the creek crossing on Castlereagh Street is therefore considered **MODERATE**. The pipes on Castlereagh Street are 100 mm in diameter. In the event of pipe or joint leakage, potable water will enter Myrtle Creek. Although the water has been treated, it is considered that the addition of potable water will not pose a significant environmental risk to the ecology of Myrtle Creek. It is therefore considered that the level of consequence for leakage of these joints and pipes is the same as those discussed previously in this management plan, which is **SLIGHT**.

The level of risk for the Redbank Creek crossing at Turner Street can therefore be considered **VERY RARE / MODERATE → LOW.**

The level of risk for the Myrtle Creek crossing at Castlereagh Street can therefore be considered **MODERATE / SLIGHT → LOW.**

3.9. Summary of Risk Analysis for Sydney Water Infrastructure

A summary of the level of risk for the water mains associated with damaged joints, damaged pipes and damage to associated items is provided in the Table below.

Table 3.3 Risk Analysis Matrix for Water Mains

Risk	Likelihood	Consequence	Level of Risk
Damaged Joints for 100 and 150 mm dia pipes	MODERATE (CICL) UNLIKELY (DICL)	SLIGHT	LOW
Damaged Joints for pipes with dia > 150 mm	RARE (CICL) UNLIKELY (DICL)	MODERATE	LOW
Damaged Pipes for 100 and 150 mm dia pipes	RARE	SLIGHT	VERY LOW
Damaged Joints for pipes with dia > 150 mm	RARE	MODERATE	LOW
Damaged Valves, Hydrants and Chambers	RARE	MODERATE	LOW
Myrtle Creek crossing	MODERATE	SLIGHT	LOW

CHAPTER 4. RISK CONTROL PROCEDURES

Infrastructure	Hazard / Impact	Risk	Trigger	Control Procedure/s	Frequency	By Whom?
Potable Water Infrastructure	Impacts to Sydney Water infrastructure	**VERY LOW TO LOW**	None	Conduct surveys along survey lines, including Remembrance Drive.	Every 200 metres of longwall face movement, ***OR*** Weekly surveys where increased subsidence observed	Tahmoor Colliery (L&H)
				Conduct visual inspection for surface deformations along Remembrance Drive and Thirlmere Way	Twice a week when the roads are within active subsidence area, ***OR*** Daily during active subsidence where increased subsidence observed	Tahmoor Colliery (SBPS)
				Monitor water main at Myrtle Creek crossing near Castlereagh Street	Twice a week when the creek crossing is within active subsidence area	Tahmoor Colliery (SBPS)
				Inform Sydney Water Call Centre of mining in area & possible issues.	Completed	Sydney Water
				Notify residents of potential mine subsidence impacts and contact numbers.	Prior to mine subsidence impacts	Tahmoor Colliery
			Non-systematic movement detected	Notify Sydney Water	Within 24 hours	Tahmoor Colliery
				Consider increasing the frequency of surveys and visual inspections in vicinity of the non-systematic movement.	As agreed between Tahmoor Colliery and Sydney Water	Tahmoor Colliery
				Consider investigating for potential of damage occurring to Sydney Water infrastructure.	Within one week	Tahmoor Colliery
			Leakage of water observed	Notify all stakeholders, including Sydney Water, Tahmoor Colliery, Mine Subsidence Board and Industry and Investment, NSW	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

CHAPTER 5. MANAGEMENT PLAN REVIEW MEETINGS

The monitoring of natural surface features and surface infrastructure which forms an integral part of this Management Plan will be carried out by Tahmoor Colliery. Management Plan Review Meetings will be held between Tahmoor Colliery, Sydney Water, the Mine Subsidence Board and / or Industry and Investment, NSW for discussion and resolution of issues raised in the operation of the Management Plan. The frequency of the Plan Review Meetings will be once a longwall unless requested by any party.

Plan Review 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 Plan Review 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.

CHAPTER 6. AUDIT AND REVIEW

All Management Plans within this document have been agreed between parties. The Management Plan will be reviewed following extraction of each 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.
- Observation of significant variation between observed and predicted subsidence.

CHAPTER 7. RECORD KEEPING

Tahmoor Colliery will keep and distribute minutes of any Management Plan Review Meeting.

CHAPTER 8. CONTACT LIST

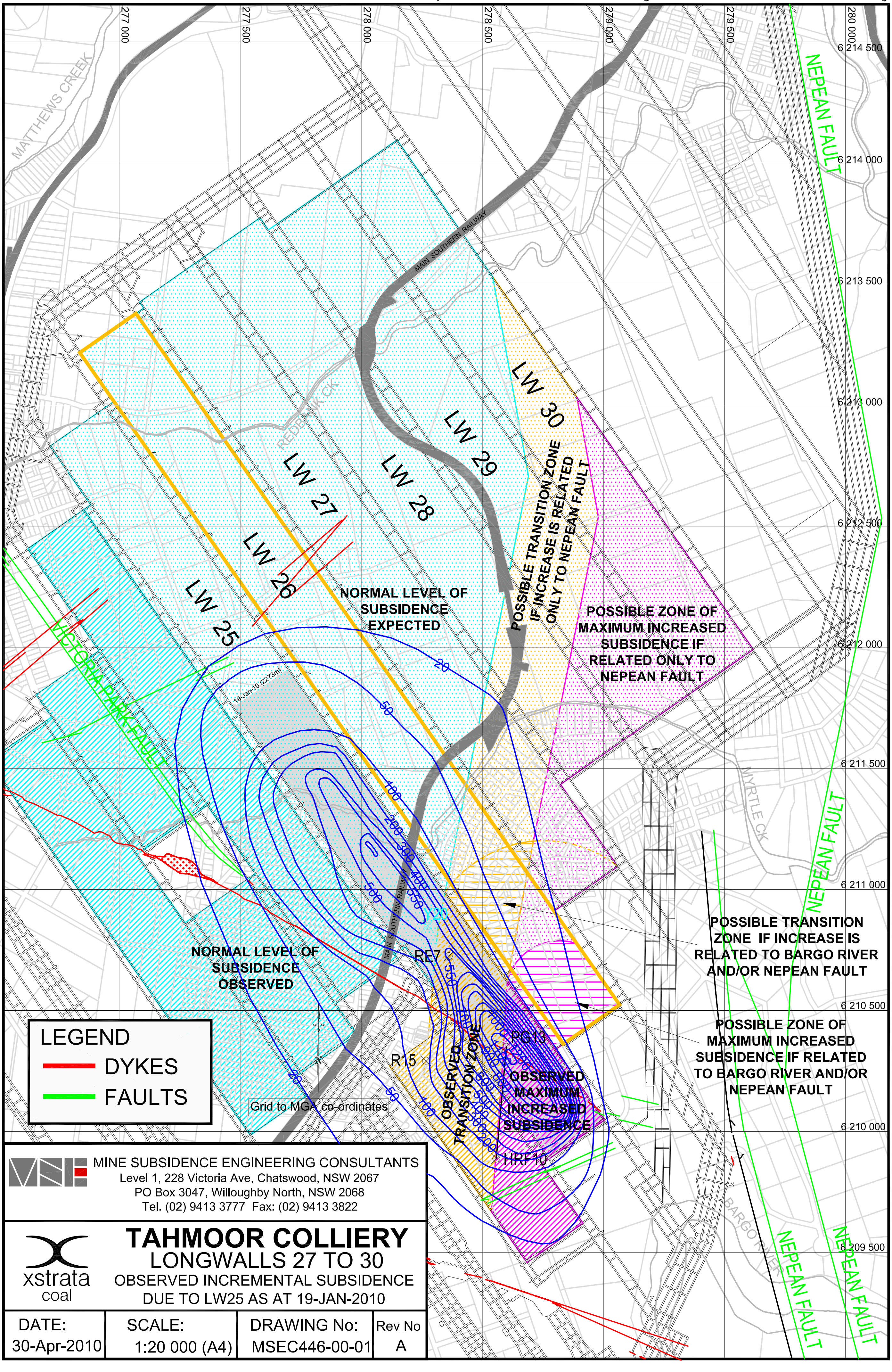
Organisation	Contact	Phone	Email / Mail	Fax
Industry and Investment, NSW	Phil Steuart	(02) 4931 6648	phil.steuart@dpi.nsw.gov.au	(02) 4931 6790
Industry and Investment, NSW	Gang Li	(02) 4931 6644 0409 227 986	gang.li@dpi.nsw.gov.au	(02) 4931 6790
Industry and Investment, NSW	Ray Ramage	(02) 4931 6645 0402 477 620	ray.ramage@dpi.nsw.gov.au	(02) 4931 6790
Mine Subsidence Board	Darren Bullock	(02) 4677 1967	d.bullock@minesub.nsw.gov.au	(02) 4677 2040
Mine Subsidence Engineering Consultants (MSEC)	Daryl Kay	(02) 9413 3777	daryl@minesubsidence.com	(02) 9413 3822
Sunrise Building and Property Services (SBPS)	John Schwarz	(02) 4883 9030 0400 390058	sunbuilding@westnet.com.au	(02) 4883 9738
Tahmoor Colliery	Belinda Clayton	(02) 4640 0133	bclayton@xstratacoal.com.au	(02) 4640 0140
Xstrata Coal Tahmoor Colliery – Environment and Community Manager	Ian Sheppard	(02) 4640 0156 0408 444 257	isheppard@xstratacoal.com.au	(02) 4640 0140
Sydney Water	Emergency Line	132 090		
Sydney Water – Potable Water	Dianne Ashford	(02) 9828 2180 0418 637 366	diane.ashford@sydneywater.com.au	(02) 9828 8454

Appendix

Please find enclosed the following documents:

- Drawings

I:\Projects\Tahmoor\MSEC446-LW26 ManagementPlans\AcadData\MSEC446-00-01.dwg



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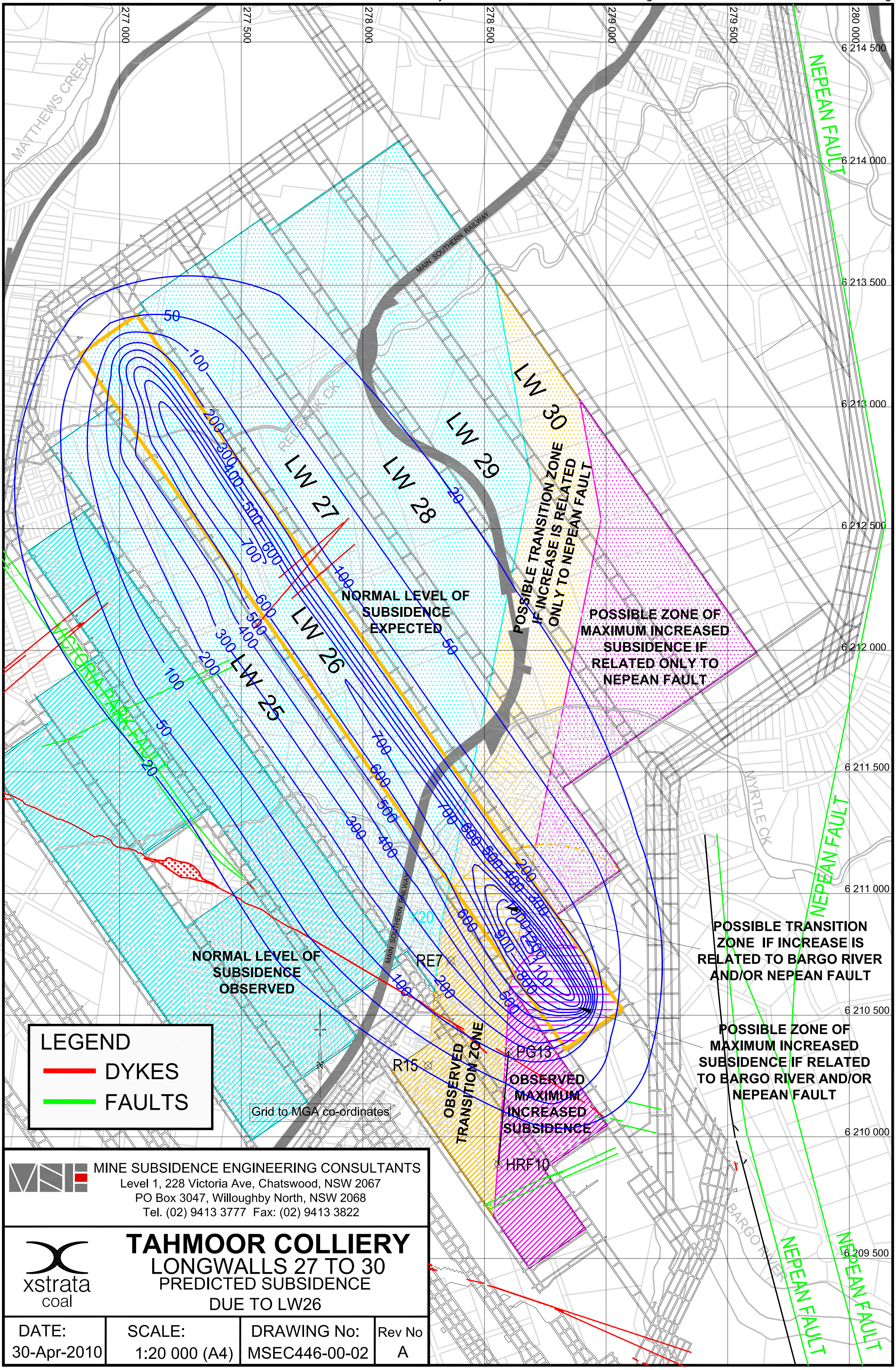

MINE SUBSIDENCE ENGINEERING CONSULTANTS
Level 1, 228 Victoria Ave, Chatswood, NSW 2067
PO Box 3047, Willoughby North, NSW 2068
Tel. (02) 9413 3777 Fax: (02) 9413 3822

xstrata coal

TAHMOOR COLLIERY
LONGWALLS 27 TO 30
PREDICTED SUBSIDENCE
DUE TO LW26

DATE:	SCALE:	DRAWING No:	Rev No
30-Apr-2010	1:20 000 (A4)	MSEC446-00-02	A

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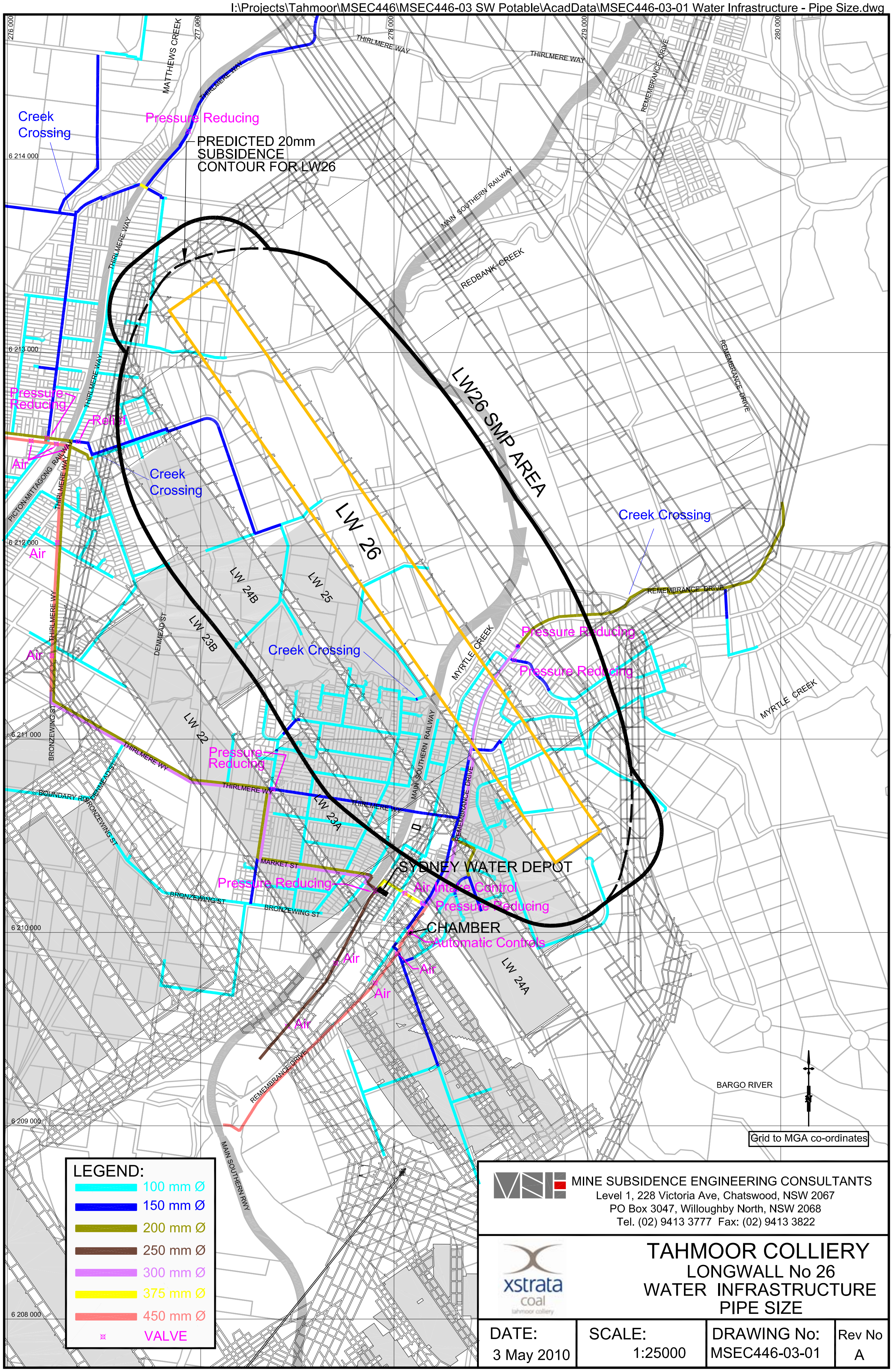

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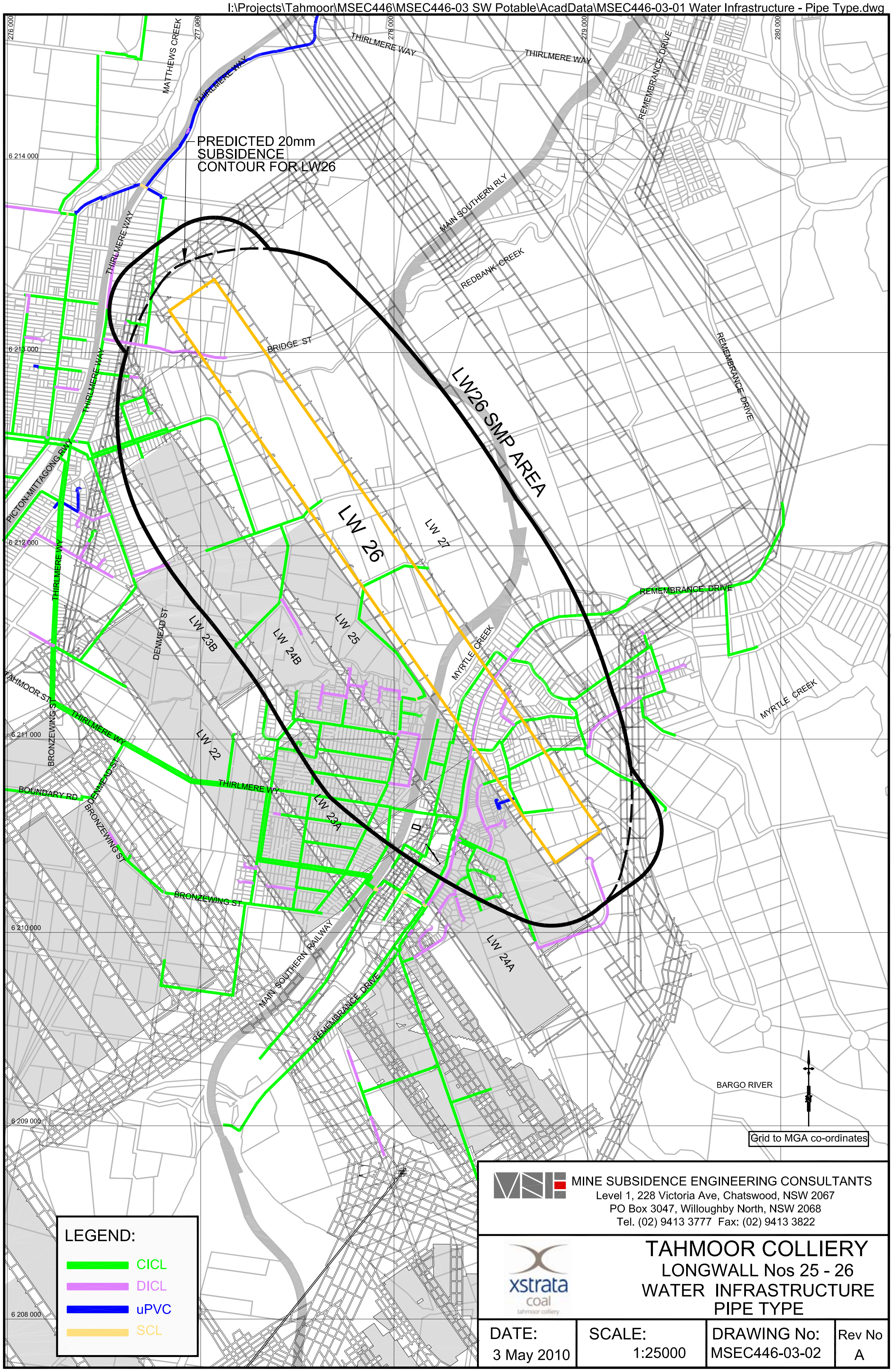
Level 1, 228 Victoria Ave, Chatswood, NSW 2067
PO Box 3047, Willoughby North, NSW 2068
Tel. (02) 9413 3777 Fax: (02) 9413 3822

xstrata coal

TAHMOOR COLLIERY
LONGWALL No 26
WATER INFRASTRUCTURE
PIPE SIZE

DATE:	SCALE:	DRAWING No:	Rev No
3 May 2010	1:25000	MSEC446-03-01	A



MINE SUBSIDENCE ENGINEERING CONSULTANTS
Level 1, 228 Victoria Ave, Chatswood, NSW 2067
PO Box 3047, Willoughby North, NSW 2068
Tel. (02) 9413 3777 Fax: (02) 9413 3822

TAHMOOR COLLIERY
LONGWALL Nos 25 - 26
WATER INFRASTRUCTURE PIPE TYPE

DATE:	SCALE:	DRAWING No:	Rev No
3 May 2010	1:25000	MSEC446-03-02	A