XSTRATA COAL:

Tahmoor Colliery - Longwall 27

Management Plan for Potential Impacts to Sydney Water Potable Water Infrastructure

AUTHORISATION OF MANAGEMENT PLAN

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References:-

AS/NZS 4360:1999 Risk Management

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

Gale, W. and Sheppard, I. (2011). *Investigation into Abnormal Increased Subsidence above Longwall Panels at Tahmoor Colliery*. Mine Subsidence Technological Society, Proceedings of the 8th Triennial Conference on Mine Subsidence, May 2011.

CONTENTS

LIST OF TABLES, FIGURES AND DRAWINGS

Tables

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

Figures

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

Drawings

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

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 25 longwalls to the north and west of the mine's current location. It is currently mining Longwall 26.

Longwall 27 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.

Longwall 27 is approximately 283 metres wide (rib-to-rib) and approximately 3.0 kilometres long. The width of the chain pillar between Longwalls 26 and 27 is 40 metres.

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

Predicted mining-induced systematic subsidence movements were provided in Report No. MSEC355, which was prepared in support of Tahmoor Colliery's SMP Application for Longwalls 27 to 30.

A summary of the maximum predicted incremental systematic subsidence parameters, due to the extraction of each of the proposed longwalls, is provided in Table 1.1. A summary of the maximum predicted cumulative systematic subsidence parameters, after the extraction of each of the proposed longwalls, is provided in Table 1.2. A summary of the maximum predicted travelling parameters, during the extraction of each of the proposed longwalls, is provided in Table 1.3.

Table 1.1 Maximum Predicted Incremental Systematic Subsidence Parameters due to the Extraction of Each of the Proposed Longwalls 27 to 30

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)
After LW27	755	6.0	0.07	0.14
After LW28	735	5.9	0.07	0.13
After LW29	735	5.9	0.06	0.13
After LW30	725	5.8	0.06	0.13

Table 1.2 Maximum Predicted Cumulative Systematic Subsidence Parameters after the Extraction of Each of the Proposed Longwalls 27 to 30

Longwall	Maximum Predicted Cumulative Subsidence (mm)	Maximum Predicted Cumulative Tilt (mm/m)	Maximum Predicted Cumulative Hogging Curvature (1/km)	Maximum Predicted Cumulative Sagging Curvature (1/km)
After LW27	1260	6.3	0.09	0.15
After LW28	1270	6.2	0.09	0.14
After LW29	1270	6.1	0.09	0.14
After LW30	1270	6.3	0.09	0.14

The values provided in the above table are the maximum predicted cumulative systematic subsidence parameters which occur within the general SMP Area, including the predicted movements resulting from the extraction of Longwalls 22 to 30.

Table 1.3 Maximum Predicted Travelling Subsidence Parameters during the Extraction of Each of the Proposed Longwalls 27 to 30

Longwall	Maximum Predicted Travelling Tilt (mm/m)	Maximum Predicted Travelling Hogging Curvature (1/km)	Maximum Predicted Travelling Sagging Curvature (1/km)
During LW27	3.1	0.04	0.03
During LW28	3.0	0.03	0.03
During LW29	3.0	0.03	0.03
During LW30	3.0	0.03	0.03

1.3. Observed Subsidence during the mining of Longwalls 22 to 26

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 26.

In summary, there is generally a good correlation between observed and predicted subsidence, tilt and curvature. Observed subsidence was generally slightly 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. 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 Fig. 1.1, which shows observed subsidence at survey pegs located along the centreline of Longwall 24A.

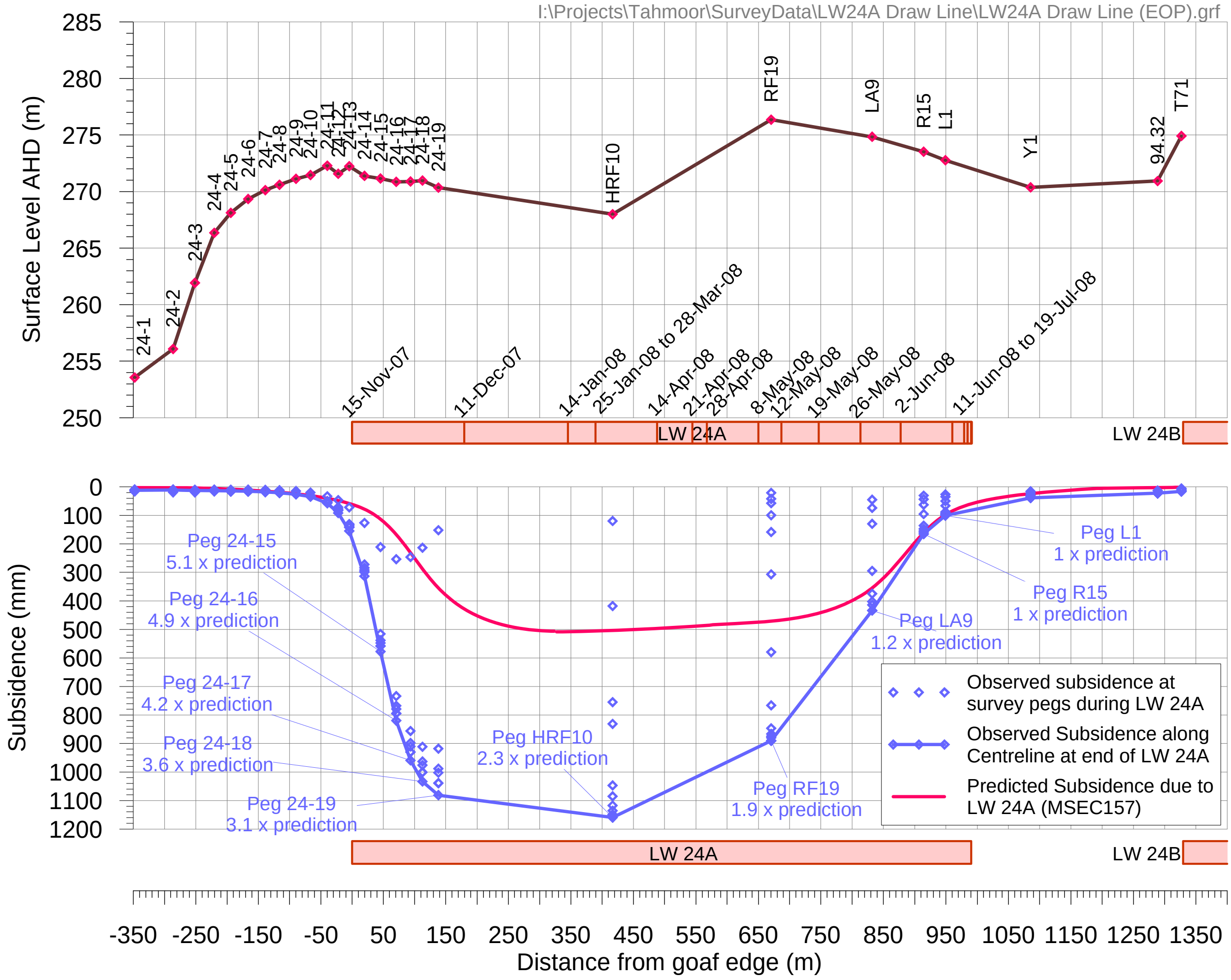

Fig. 1.1 Observed Subsidence along Centreline of Longwall 24A

It can be seen from Fig. 1.1 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 1216 mm at Peg 25-28.

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.

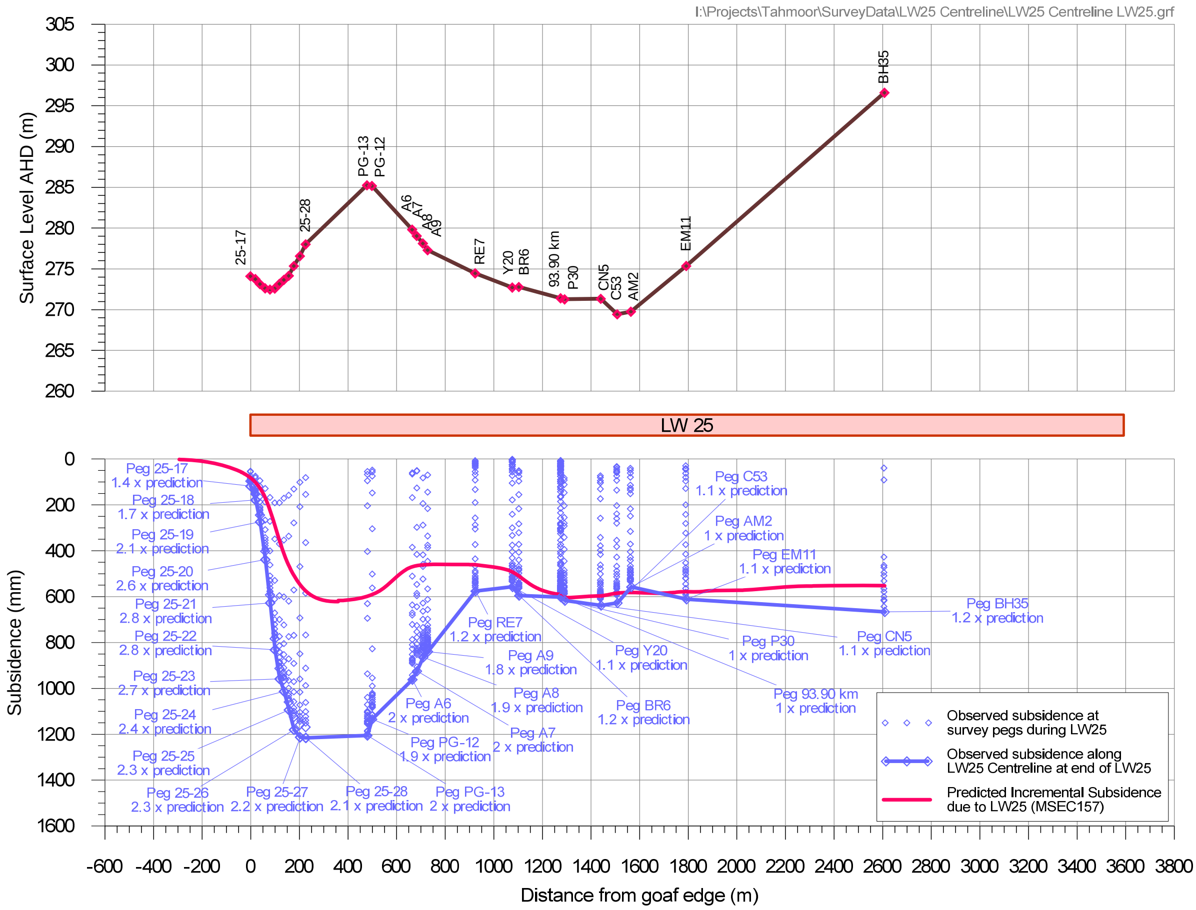

Fig. 1.2 Observed Subsidence along Centreline of Longwall 25

Observed Increased Subsidence during the mining of Longwall 26

Increased subsidence was observed during the first stages of mining Longwall 26, but at a reduced magnitude compared to the subsidence observed above Longwalls 24A and 25. These observations are shown graphically in Fig. 1.3, which shows observed subsidence at survey pegs located along the centreline of Longwall 26. The graph shows the latest survey results for each monitoring line as at August 2012. It is likely that further small increases in subsidence will be observed at these pegs when they are surveyed at the completion of Longwall 26.

It can be seen from Fig. 1.3 that observed subsidence was approximately 1.3 times the predicted maximum value, with maximum subsidence of 867 mm at Peg TM26.

Observed subsidence reduced along the panel until Peg Y40 on York Street, where it was less than prediction. Survey pegs S9, and RE27 are located within a transition zone where subsidence has gradually reduced from areas of maximum increased subsidence between Pegs TM26 and MD4 to areas of normal subsidence at Peg Y40 and beyond.

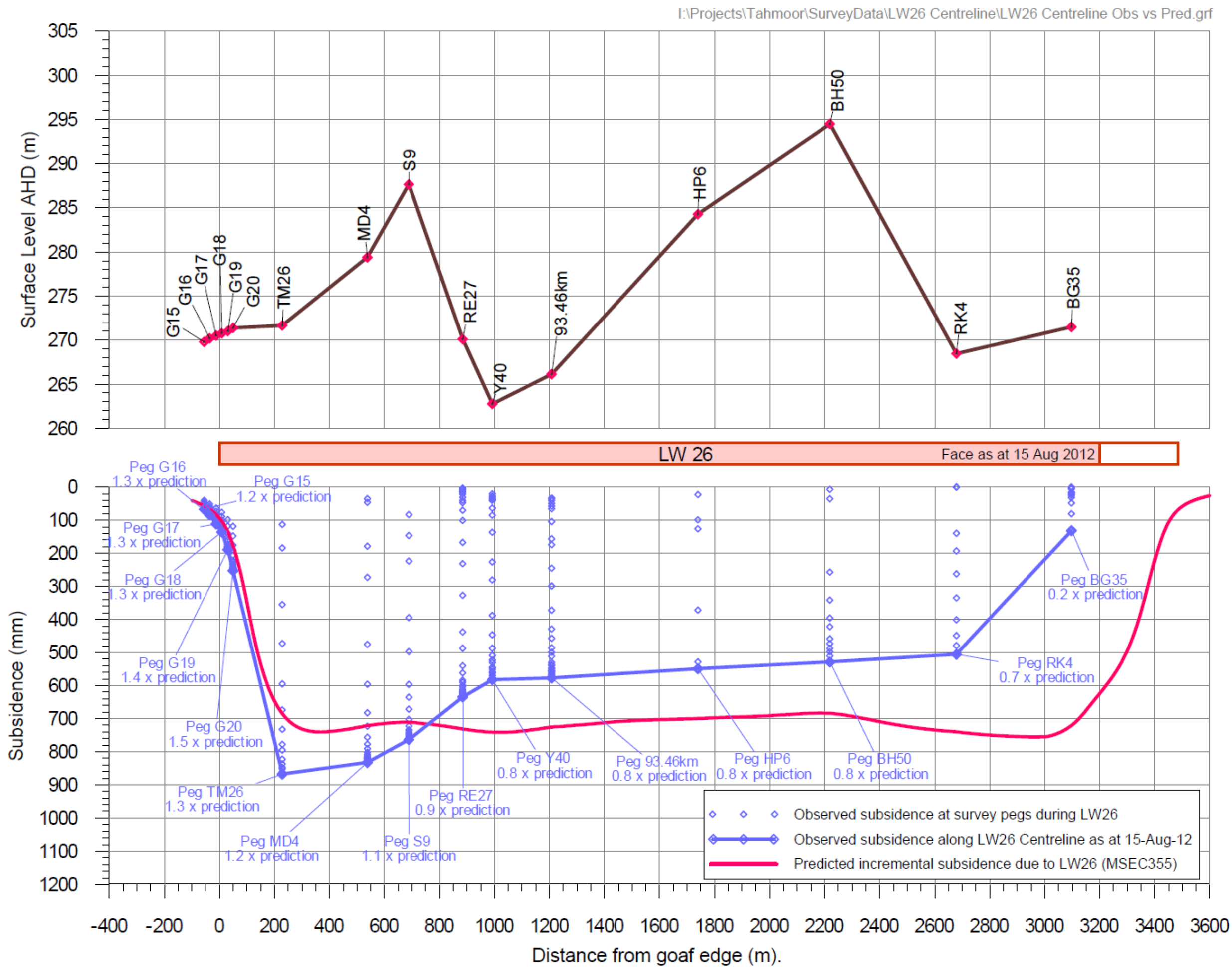

Fig. 1.3 Observed Subsidence along Centreline of Longwall 26 as at August 2012

Analysis and commentary

The cause for the increased subsidence has been investigated by Strata Control Technologies on behalf of Tahmoor Colliery (Gale and Sheppard, 2011). The investigations concluded that the increased subsidence is consistent with localised weathering of joint and bedding planes above a depressed water table adjacent to an incised gorge.

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 1.2 metres above Longwalls 24A and 25, and 900 mm above Longwall 26.
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. MSEC567-00-01 (refer Appendix), it can be seen that the transition zone is roughly consistent in width above Longwall 24A, Longwall 25 and Longwall 26. The orientation of the transition zone is also roughly parallel to the Nepean Fault and not the Bargo River.

Prior to the mining of Longwall 26, it was not yet known whether the location of the transition zone was related to the alignment of the Nepean Fault or the Bargo River as both features were aligned approximately parallel to each other adjacent to previously extracted Longwalls 24A and 25.

The Bargo River, however, abruptly turns a sharp bend near the end of Longwalls 25 and 26 and observations during the mining of Longwall 26 were able to provide a first indication that the location of the transition zone was related to the alignment of the Nepean Fault, rather than the Bargo River.

The magnitude of subsidence above Longwall 26 is reduced compared to Longwalls 24A and 25. Given that the alignment of the Nepean Fault moves away from the Bargo River above Longwall 26, it appears that the magnitude of increased subsidence is linked to the proximity of the Bargo River. This observation confirms the findings of Gale and Sheppard that the increased subsidence is linked to localised weathering of joint and bedding planes above a depressed water table adjacent to the incised gorge of the Bargo River.

In summary, it appears that the location of increased subsidence is linked to the alignment of the Nepean Fault and the magnitude of the increased subsidence is linked to the proximity to the Bargo River.

The zones have been projected above Longwalls 27 to 30 from the observed zones above Longwalls 24A and 26, as shown in Drawing No. MSEC567-00-02 (refer Appendix). The projection is based on the orientation of the Nepean Fault. It can be seen that the transition zone extends to sections of Myrtle Creek Avenue, Remembrance Drive, Myrtle Creek and the Main Southern Railway.

Given that Longwall 27 is located further away from the Bargo River than Longwall 26, it is expected that the magnitude of maximum subsidence at the commencing end of Longwall 27 will be less than 900 mm. The amount of reduction in maximum subsidence is difficult to predict. The difference in maximum subsidence between Longwalls 24A and 25 and Longwall 26 is approximately 300 mm. If maximum subsidence at the commencing end of Longwall 27 reduces a further 300 mm, the magnitude of subsidence at the commencing end will return to normal levels.

It is recognised that despite the above analysis and projections, substantially increased subsidence could develop as the mining of Longwall 27 progresses. This Management Plan has been developed to manage potential impacts if substantial additional subsidence were to occur.

1.4. 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, and 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.

The relative frequency distribution of maximum observed tensile strains and compressive strains for survey bays located directly above goaf is provided in Fig. 1.4.

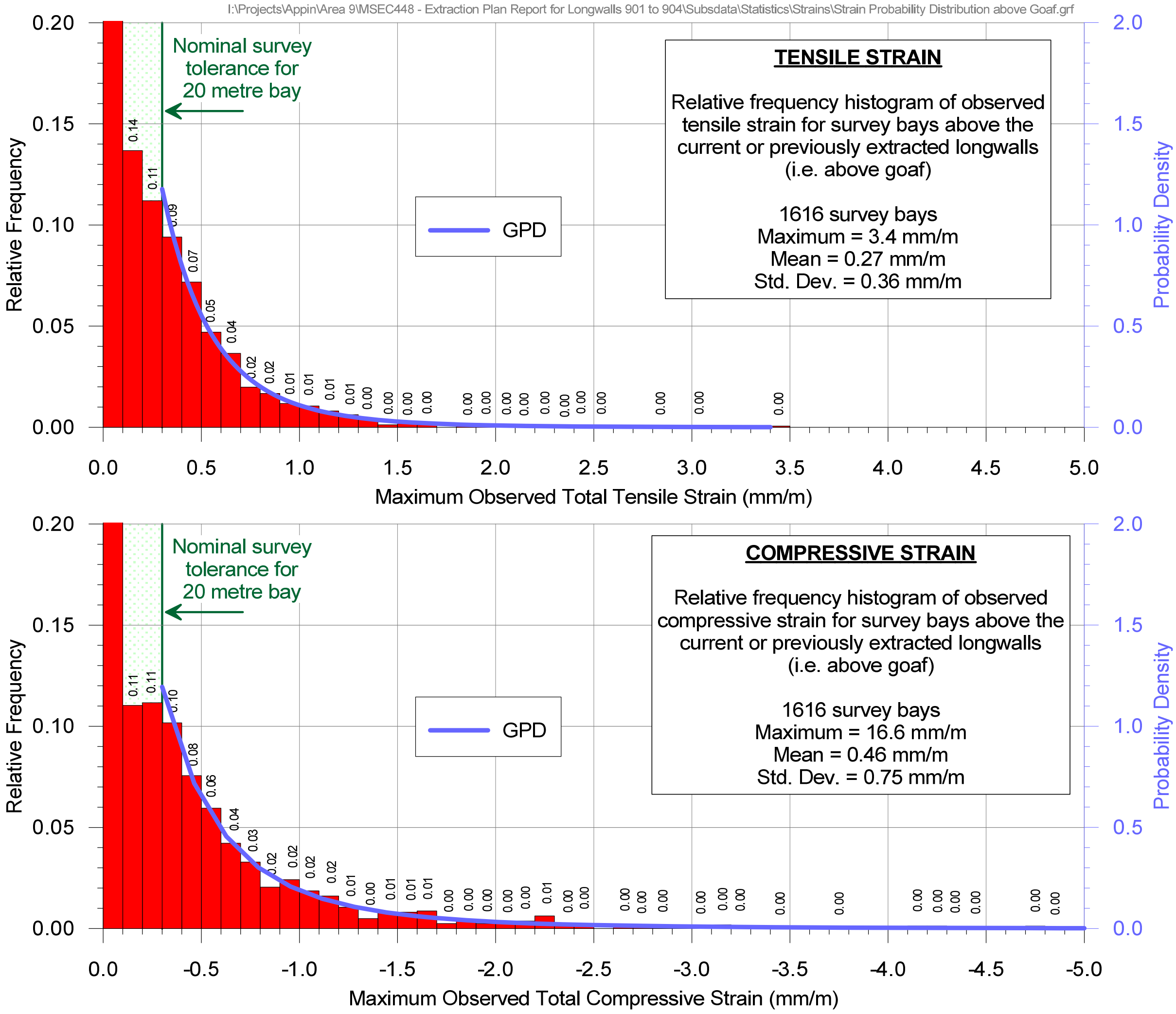

Fig. 1.4 Distributions of Measured Maximum Tensile and Compressive Strains at Any Time for Pegs Located Above Goaf in the Southern Coalfield

While not shown in Fig. 1.4, it is noted that the maximum observed compressive strain of 16.6 mm/m, which occurred along the T-Line above Appin Longwall 408, was the result of movements along a low angle thrust fault within the Cataract Tunnel. All remaining compressive strains in this dataset (which exclude valley related movements) were less than 5 mm/m.

The relative frequency distribution of maximum observed tensile strains and compressive strains above solid coal is provided in Fig. 1.5.

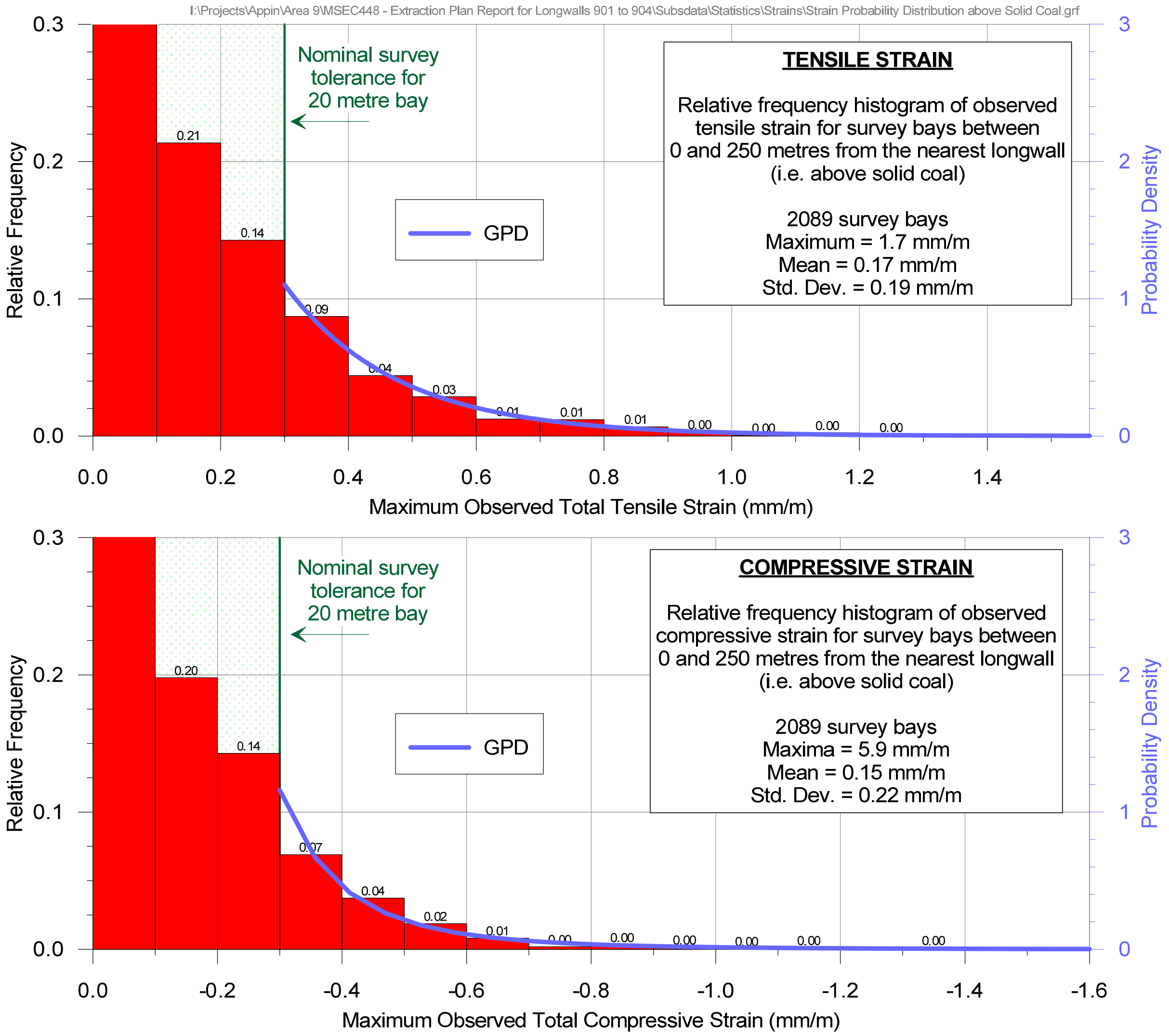

Fig. 1.5 Distributions of Measured Maximum Tensile and Compressive Strains at Any Time for Pegs Located Above Solid Coal in the Southern Coalfield

While not shown in Fig. 1.5, it is noted that the maximum observed compressive strain of 5.9 mm/m, which occurred along the T-Line above Appin Longwall 408, was the result of movements along a low angle thrust fault within the Cataract Tunnel as Longwall 408 approached the monitoring line. A maximum observed compressive strain of 3.1 mm/m was observed across the fault at the completion of Longwall 407. All remaining compressive strains in this dataset (which exclude valley related movements) were less than 5 mm/m.

1.5. 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.

1.6. 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 27 only.

1.7. 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 27 and for sufficient time thereafter to allow for completion of subsidence effects. The current schedule of mining is shown in Table 1.4.

Table 1.4 Schedule of Mining

Longwall	Start Date	Completion Date
Longwall 27	November 2012	October 2013

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. 1.6.

Fig. 1.6 Diagrammatic Representation of Active Subsidence Zone

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

3.1. Observations during Longwalls 22 to 26

Longwalls 22 to 26 have directly mined beneath approximately 3.7 kilometres of ductile iron concrete lined (DICL) pipe and 9.4 kilometres of cast iron concrete lined (CICL) pipe, with minimal impact to the distribution network reported. The reported impacts are listed below.

- 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 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.

3.2. Water Supply Infrastructure

Sydney Water has an extensive water supply network that will experience subsidence movements during the mining of Longwall 27. The water pipelines are shown according to their pipe sizes in Drawing No. MSEC567-03-01. The pipes are also shown according to their type of pipe in Drawing No. MSEC567-03-02.

It can be seen from these drawings that the water mains that may experience subsidence during the mining of Longwall 27 range in diameter between 100 and 300 mm. The larger water mains are located along Remembrance Drive. The majority of the pipes are either CICL or DICL, with some welded Steel Cement Lined directional bores.

There are also two pressure reducing valves that will experience subsidence movements during the mining of Longwall 27, with both located directly above the longwall, as shown in Drawing No. MSEC567-03-01.

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 26. The nature of the infrastructure that will experience subsidence during the mining of Longwall 27 is similar to the infrastructure above Longwalls 22 to 26.

Sydney Water and Tahmoor Colliery have developed and acted in accordance with an agreed management plan during the mining of Longwalls 22 to 26.

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

Four 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 1260 mm should have very little effect on the capacity of the system, although the ground strains and curvatures could adversely affect the pipelines.

Experience during the mining of Longwalls 22 to 26 have shown that the pipes have typically not experienced impacts except when substantial localised compressive strain was observed, usually with a noticeable bump in the subsidence profile.

The pipe joints have accommodated the majority of the mining-induced ground strains, particularly the DICL pipes with rubber ring joints, whose locations are shown in Drawing No. MSEC567-03-02. Any ground movements along the pipes are likely to be transferred to the pipe joints. There have been no impacts reported in relation to DICL pipes or pipe joints to date.

As shown in Drawing No. MSEC567-03-02, 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. All impacts reported to date have been in relation to CICL pipes.

The largest water mains that will experience the full range of subsidence movements during the mining of Longwall 27 are the 300 mm DICL pipes that run along Remembrance Drive from Emmett Street towards Picton. The pipeline changes down in size to an older 200 mm diameter CICL pipe approximately 70 metres north of the intersection of Remembrance Drive and Myrtle Creek Avenue. This section of pipe is located directly above the previously mined Longwall 26. No impacts were observed during the mining of Longwalls 24A to Longwall 26. 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 Cumulative Subsidence (mm)	Maximum Predicted Cumulative Tilt (mm/m)	Maximum Predicted Cumulative Hogging Curvature (1/km)	Maximum Predicted Cumulative Sagging Curvature (1/km)
1140	5.7	0.07	0.12

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.

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**.

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 4 impacts in 9.4 kilometres of CICL water main.

The result of damaged joints is the leakage of water into the surrounding area and/or 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 (Remembrance Drive):- **MODERATE** / **MODERATE → MODERATE**

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

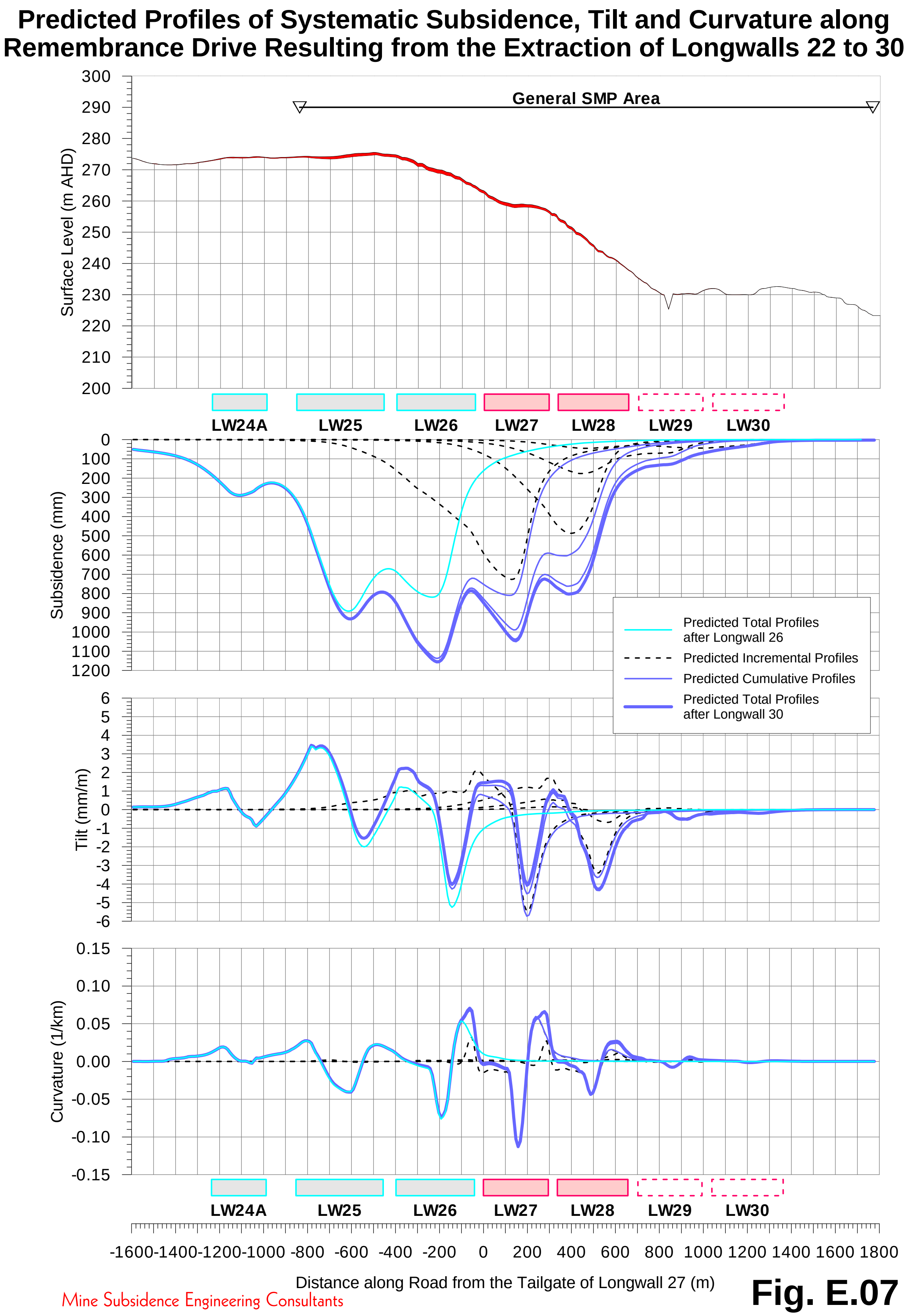

Fig. 3.1 Predicted Subsidence Parameters along Remembrance Drive (Extract from MSEC355)

3.6. Hazard 2 – Damaged Pipes

The water mains located over Longwall 27 typically consist of 100 mm, 150 mm, 200 mm and 300 mm diameter CICL pipes.

Longwalls 22 to 26 have directly mined beneath approximately 3.7 kilometres of DICL pipe and 9.4 kilometres of CICL pipe, with only 4 impacts noted to CICL pipes as described in Section 3.1.

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 4 impacts in 9.4 kilometres of water mains.

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 27, as both are located directly above 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 27 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 at Remembrance Drive, as shown in Drawing No. Drawing No. MSEC567-03-01.

The Castlereagh Street crossing has experienced approximately 250 mm of valley closure movements during the mining of Longwalls 24B to 26, with no impacts observed to the SCL pipe or the joints at each end that connect to the CICL pipes. While additional valley closure is predicted to occur at the Castlereagh Street crossing during the mining of Longwall 27, the additional amount of closure is predicted to be very small and the likelihood of impacts is considered to be **UNLIKELY**.

The Remembrance Drive crossing is located approximately 480 metres to the side of Longwall 27. The predicted subsidence movements at this offset distance are very small and the likelihood of impacts occurring at the creek crossing is considered **RARE**.

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, in the event of pipe or joint leakage. 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 Myrtle Creek crossing at Castlereagh Street can therefore be considered **UNLIKELY / SLIGHT → LOW.** The level of risk for the Remembrance Drive crossing is also considered **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 Table 3.2 below.

Table 3.2 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	MODERATE (CICL)	MODERATE	MODERATE
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 Valves, Hydrants and Chambers	RARE	MODERATE	LOW
Myrtle Creek crossing at Castlereagh Street and Remembrance Drive	UNLIKELY (Castlereagh) RARE (Remembrance)	SLIGHT	LOW

Infrastructure	Hazard / Impact	Risk	Trigger	Control Procedure/s	Frequency	By Whom?
Potable Water Infrastructure	Impacts to Sydney Water infrastructure	**VERY LOW TO MODERATE**	None	Conduct surveys along survey lines, other than Remembrance Drive.	Every 200 metres of extraction after start of LW, ***OR*** Weekly surveys where increased subsidence observed	Tahmoor Colliery (SMEC Urban)
				Conduct surveys along Remembrance Drive (Thirlmere Way to River Road)	Weekly after 350m of extraction	Tahmoor Colliery (SMEC Urban)
				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
				Monitor water main at Myrtle Creek crossing near Castlereagh Street	Twice a week when the creek crossing is within active subsidence area	Tahmoor Colliery
				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 DTIRIS	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

5.0 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 and Sydney Water 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.

6.0 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.

7.0 RECORD KEEPING

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

8.0 CONTACT LIST

Organisation	Contact	Phone	Email / Mail	Fax
NSW Department of Trade and Investment, Regional Infrastructure and Services, Division of Resources and Energy (DTIRIS)	Phil Steuart	(02) 4931 6648	phil.steuart@industry.gov.au	(02) 4931 6790
	Gang Li	(02) 4931 6644 0409 227 986	gang.li@ industry.gov.au	(02) 4931 6790
	Ray Ramage	(02) 4931 6645 0402 477 620	ray.ramage@ industry.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
Xstrata Coal Tahmoor Colliery – Environment and Community Manager	Ian Sheppard	(02) 4640 0156 0408 444 257	isheppard@xstratacoal.com.au	(02) 4640 0140
Xstrata Coal Tahmoor Colliery – Community Coordinator	Belinda Clayton	(02) 4640 0133 0428 260 899	bclayton@xstratacoal.com.au	(02) 4640 0140
Sydney Water	Emergency Line	132 090		
Sydney Water – Potable Water	Dianne Ashford	(02) 8763 8623 0418 637 366	diane.ashford@sydneywater.com.au	

APPENDIX A. DRAWINGS

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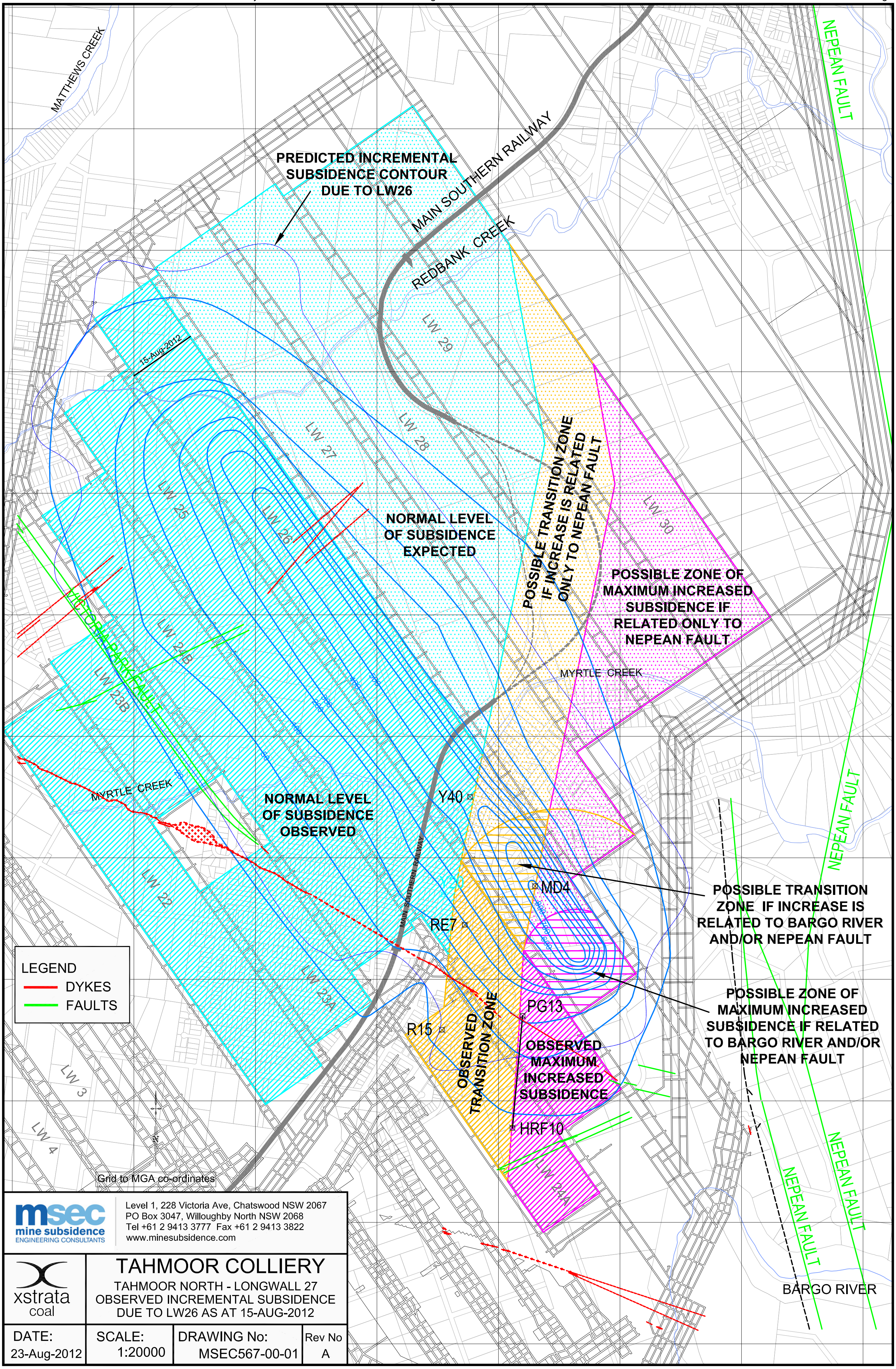

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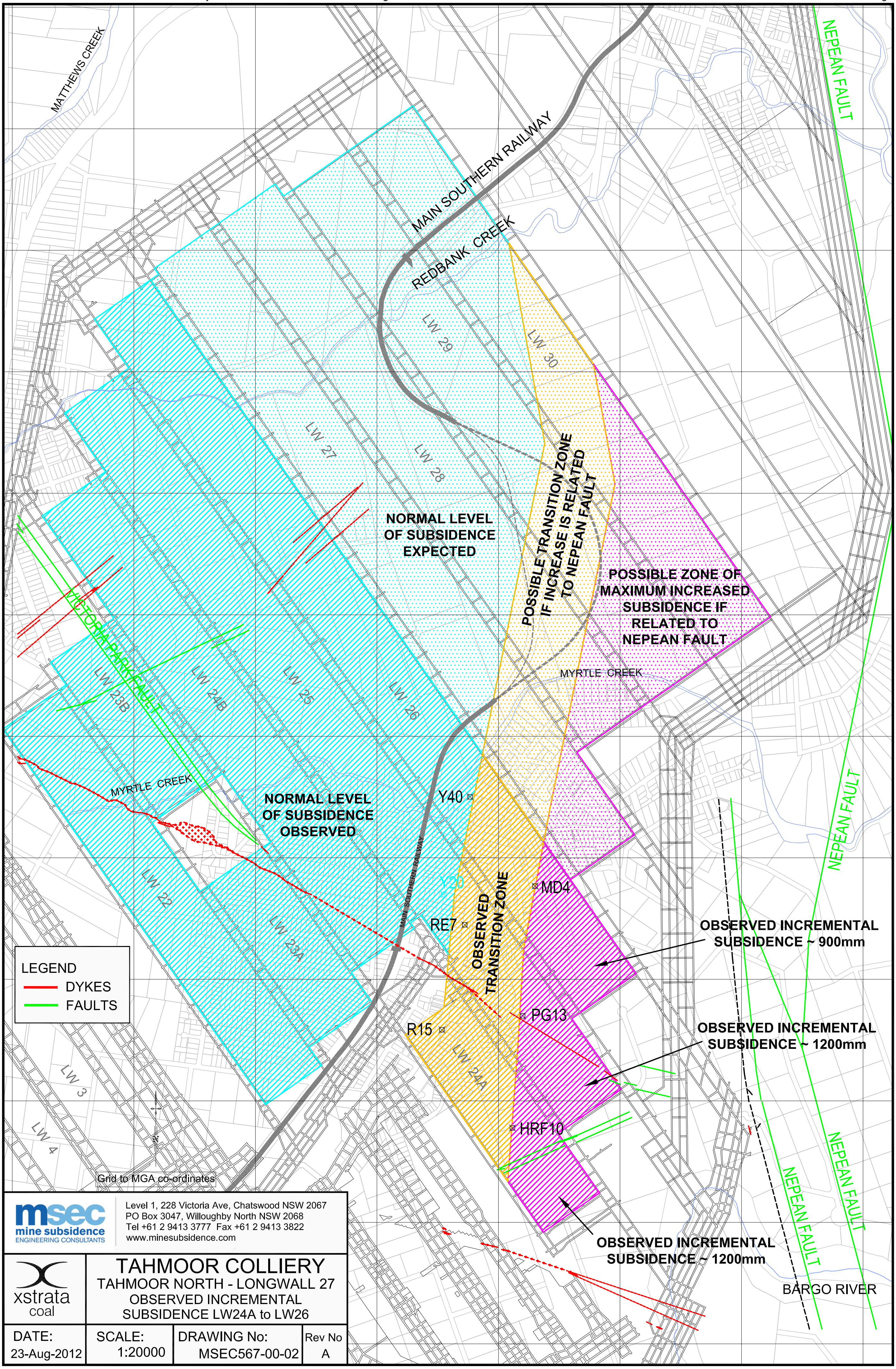

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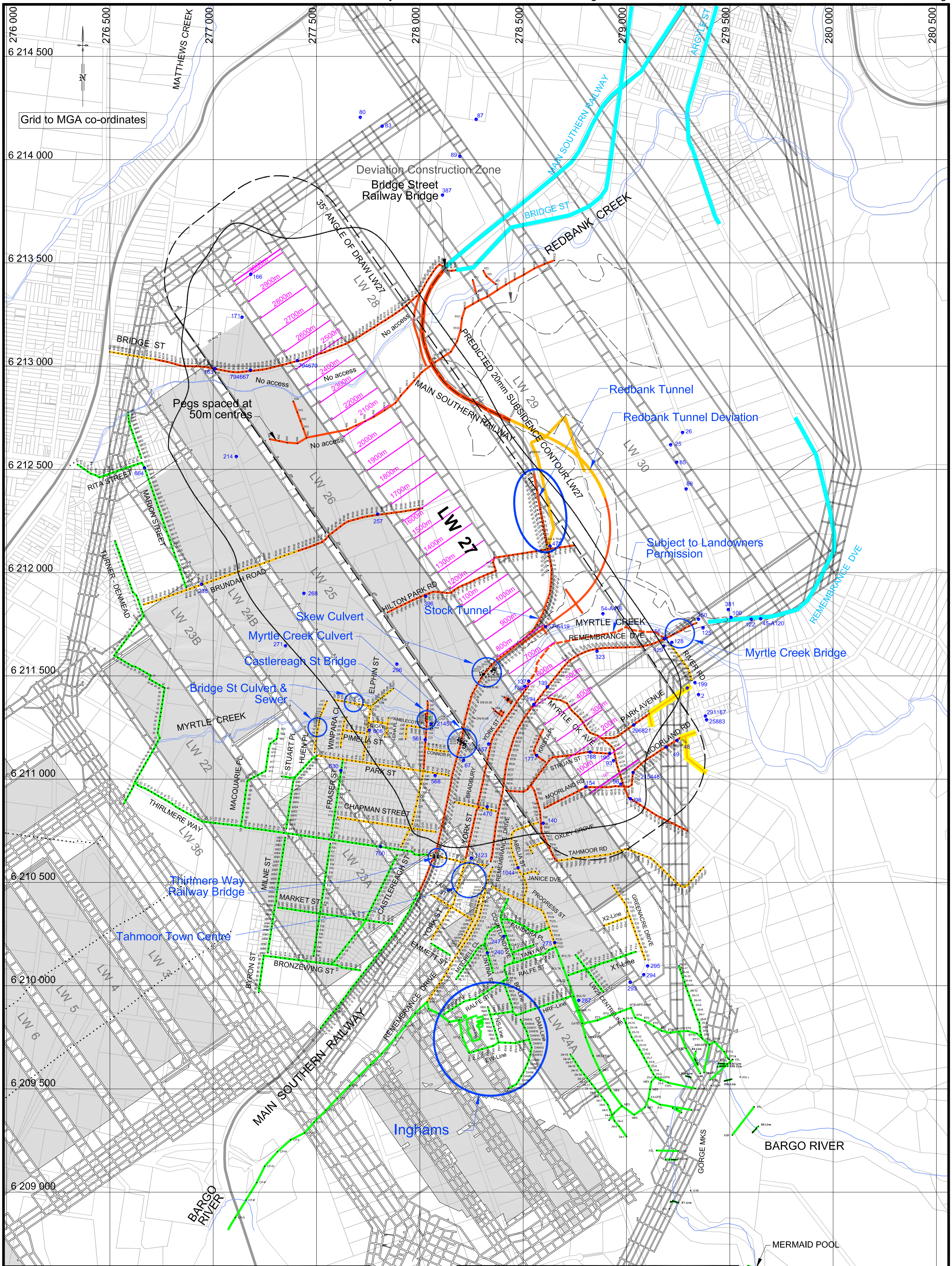

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xstrata coal

TAHMOOR COLLIERY

TAHMOOR NORTH - LONGWALL 27 MONITORING OVER LW27

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LEGEND

- Existing Monitoring Lines
- Future Monitoring Lines
- Future Monitoring Lines Prior to LW27
- Monitoring Lines Before & End of LW27
- Surveys During LW27
- Critical Power Poles
- Specific Structure Inspections

Refer to Management Plans for Timing & Frequencies

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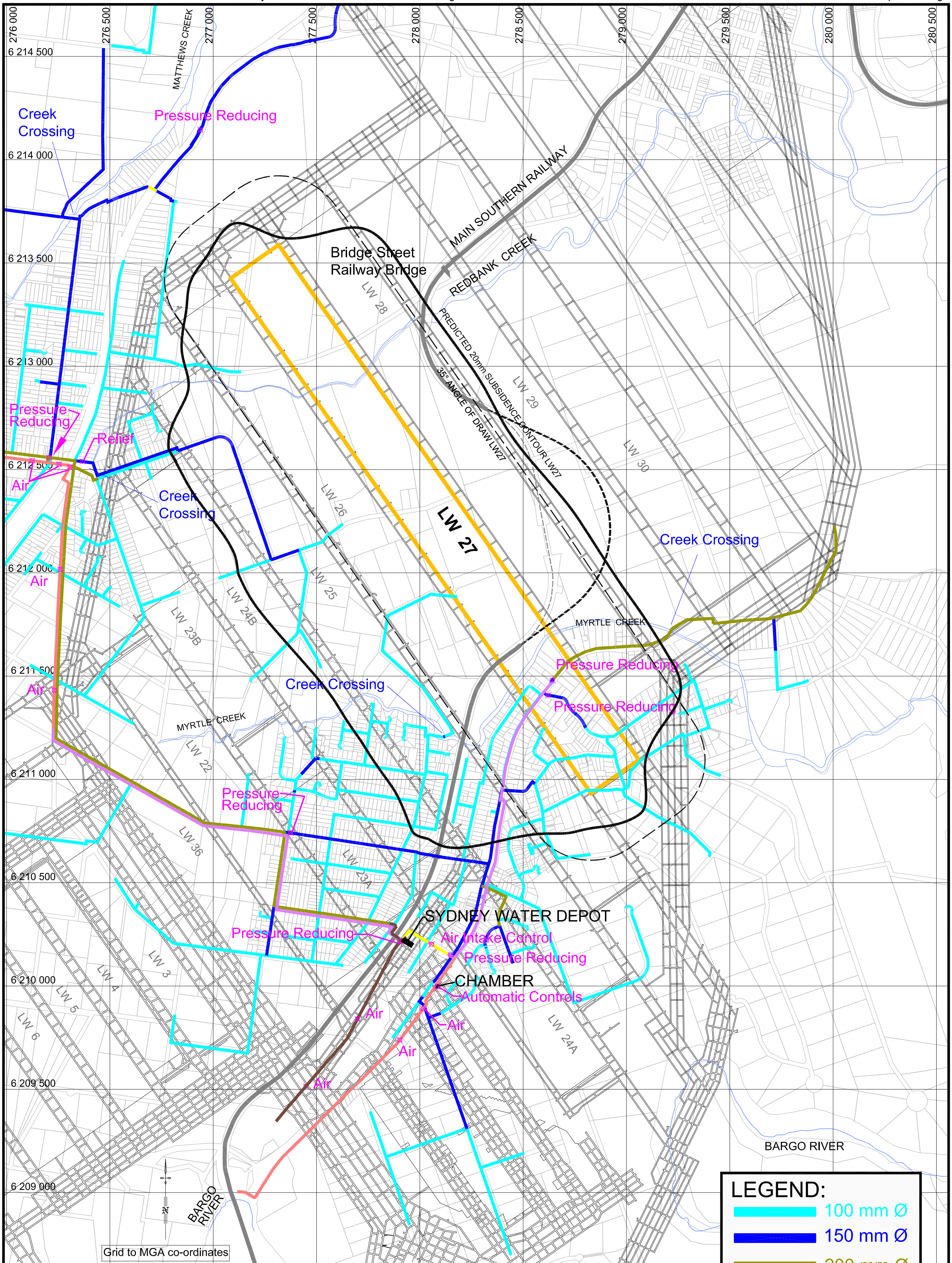

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TAHMOOR COLLIERY

TAHMOOR NORTH - LONGWALL 27
WATER INFRASTRUCTURE
SW POTABLE WATER - PIPE SIZE

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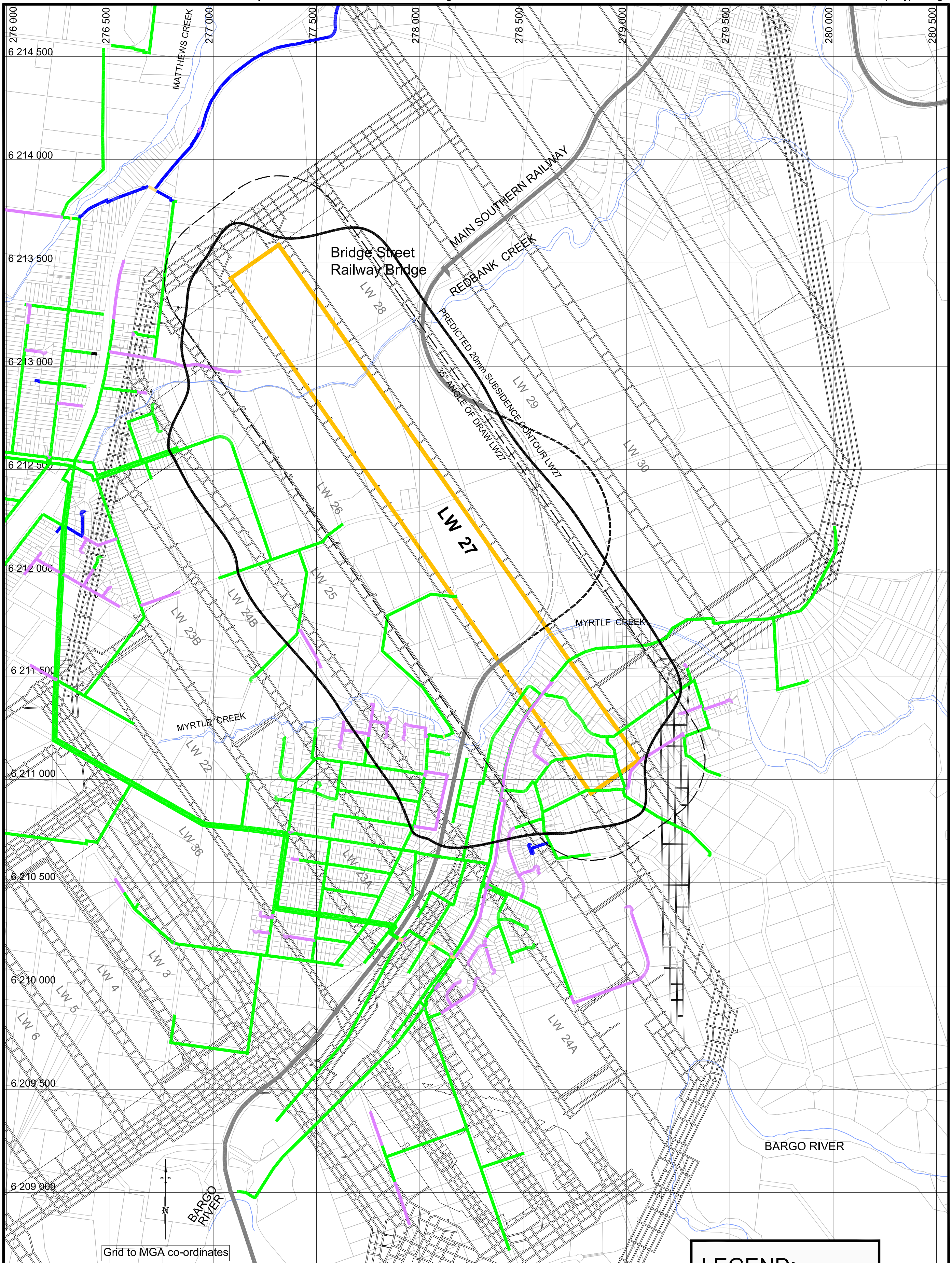

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TAHMOOR COLLIERY
TAHMOOR NORTH - LONGWALL 27
WATER INFRASTRUCTURE
SW POTABLE WATER - PIPE TYPE

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