



Tahmoor Colliery Longwalls 25 to 26

JEMENA ASSET MANAGEMENT

SURFACE SAFETY AND SERVICEABILITY MANAGEMENT PLAN

REVISION F



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GENERAL

AUTHORISATION OF SURFACE SAFETY AND SERVICEABILITY MANAGEMENT PLAN

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REVIEW

Date	Rev	Comments
Mar-06	A	Draft for Submission to Jemena
Jul-06	B	Agreed management plan
Aug-06	C	Chapter 1 amended, as agreed in Plan Review Meeting, 7 August 2006
Mar-08	D	Draft update to mine plan and risk control procedures
May-08	E	Agreed amended plan for Longwalls 24A to 26
Sep-08	F	Updated for Longwalls 25 to 26 and Jemena name change

REFERENCES

1	<i>AS/NZS 4360:1999 Risk Management.</i>
2	<i>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.</i>

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Drawings

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

<i>Drawing No.</i>	<i>Description</i>	<i>Rev</i>
MSEC286-040501	Gas Infrastructure	C
MSEC286-040502	Monitoring over Tahmoor North	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.

Longwalls 25 to 26 are 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 Jemena is located within these areas.

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

The Management Plan is a live document that can be amended at any stage of mining, to meet the changing needs of Tahmoor Colliery and Jemena.

1.2. Predicted Subsidence Movements

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. Limitations

This Management Plan is based on the predictions of the effects of mining on surface infrastructure as provided in Report No. MSEC157 by Mine Subsidence Engineering Consultants. Predictions are based on the planned configuration of longwalls at Tahmoor Colliery (as shown in Drawing No. MSEC286-040501), along with available geological information and data from numerous subsidence studies for longwalls previously mined in the area.

Infrastructure considered in this Plan has been identified from aerial photographs, regional maps and from discussions between Tahmoor Colliery representatives and Jemena personnel.

The impacts of mining on surface and sub-surface features have been assessed in detail. However, it is recognised that the prediction and assessment of subsidence can be relied upon only to a certain extent. The limitations of the prediction and assessment of mine subsidence are discussed in report MSEC157 by Mine Subsidence Engineering Consultants.

As discussed in the report, there is a low probability that ground movements and their impacts could exceed the predictions and assessments. However, if these potentially higher impacts are considered prior to mining, they can be managed. This Management Plan will not necessarily prevent impacts from longwall mining, but will limit the impact by establishing appropriate procedures that can be followed should evidence of increased impacts emerge.

1.4. 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 Jemena.

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.
- Establish procedures to measure, monitor, control, mitigate and repair gas infrastructure.
- 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, Jemena, Mine Subsidence Board, Department of Mineral Resources, and consultants as required.
- Establish lines of communication and emergency contacts.

1.5. 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 major natural gas pipeline
- The main gas pipeline
- The local gas pipeline
- Gas mains at creek crossings

The Management Plan only covers infrastructure that is located within the general application area, which defines the extent of land that may be affected by mine subsidence as a result of mining Longwalls 24 to 26. The management plan does not include other property owned by Jemena which lies outside the extent of the general application area.

The Plan also applies to persons employed or engaged by Tahmoor Colliery requiring them to carry out activities described by this Plan.

Impacts are considered in terms of mining directly affecting infrastructure owned by Jemena, rather than the effects from loss of services.

1.6. 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 25	August 2008	September 2009
Longwall 26	October 2009	October 2010

1.7. Definition of Active Subsidence Zone

As a longwall progresses, subsidence begins to develop at a point in front of the longwall face and continues to develop after the longwall passes. The majority of subsidence movement typically occurs within an area 150 metres in front of the longwall face to an area 450 metres behind the longwall face.

This is termed the “active subsidence zone” for the purposes of this Management Plan, where surface monitoring is generally conducted. The active subsidence zone for each longwall is defined by the area bounded by the predicted 20 mm subsidence contour for the active longwall and a distance of 150 metres in front and 450 metres behind the active longwall face, as shown by Fig. 1.1.

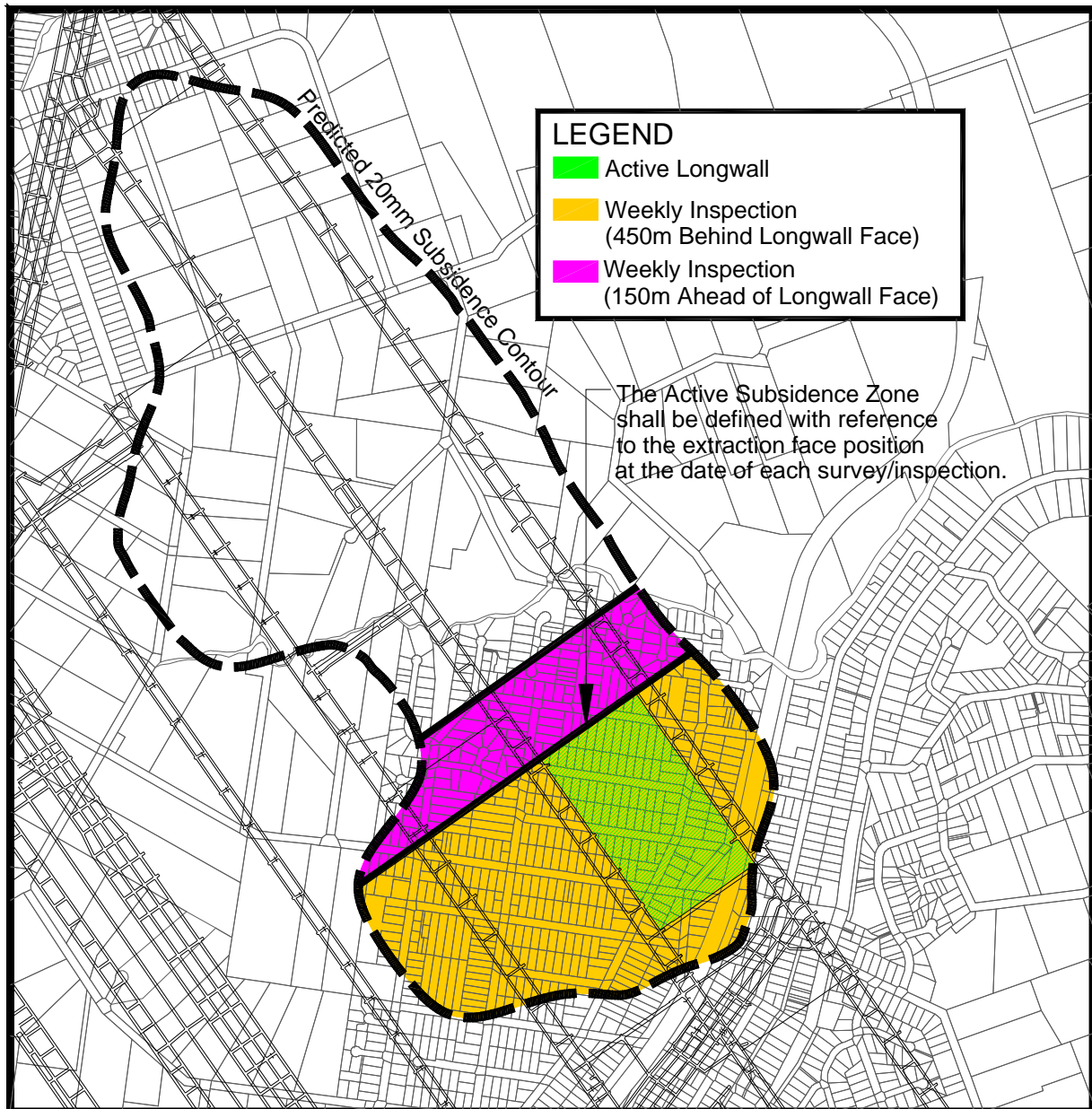


Fig. 1.1 Diagrammatic Representation of Active Subsidence Zone

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

The original risk assessment was conducted jointly by Jemena and Tahmoor Colliery in July 2006. The risks have been most recently reviewed jointly by Jemena and Tahmoor Colliery in September 2008 in light of experience gained during the mining of Longwalls 22 to 24A.

It is noted that Longwalls 22 to 24A have directly mined beneath approximately 6.0 kilometres of gas pipes and no impacts have been recorded so far.

3.1. Gas Infrastructure

The natural gas pipe lines in the area influenced by the longwall mining operation will be subjected to the full range of predicted subsidence parameters as the coal is extracted.

Jemena has an extensive gas infrastructure network within the SMP Area. The gas pipelines within the SMP Area are shown according to their pipe sizes in Drawing No. MSEC286-0405.

It can be seen from this drawing that the gas pipes range in diameter between 32 and 160 mm. The main gas pipe, which is 160 mm diameter polyethylene pipe with glued joints, is located along Remembrance Drive. Longwall 24A mined directly beneath this pipe and no impacts were observed. This gas main crosses over Myrtle Creek on the Remembrance Drive Road Bridge via a steel pipe with flanged ends. The creek crossing is not directly undermined by the proposed longwalls but is expected to experience upsidence and closure movements.

The other main gas pipe is a 75 mm diameter nylon pipe, which is located along Thirlmere Way. This pipe has experienced the full range of subsidence impacts due to Longwalls 22 to 24B. The pipe will experience fewer impacts due to the Longwall 25 as this longwall directly mines beneath only a small section of this pipe.

The majority of the gas pipes within the SMP Area are 32 mm diameter pipes which distribute gas to properties in the Tahmoor and Thirlmere urban areas.

All of the 63 mm diameter pipes within the SMP Area are located outside the predicted limit of subsidence. The majority of the 50 mm diameter pipes within the SMP Area are also located outside the predicted limit of subsidence, with the exception of approximately 100 metres of pipe near the Inghams factory on Ralfe Street.

3.2. Hazard Identification

The hazard associated with gas infrastructure is that it may be damaged as a result of mine subsidence impacts. This damage could involve rupturing of pipes and hence become a dangerous hazard to the public.

3.2.1. Major Gas Pipeline along Remembrance Drive

The main gas pipeline is a 160 mm diameter polyethylene pipe, which is laid along the eastern side of Remembrance Drive.

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

Tahmoor Colliery - LW22 to LW26 Predicted Subsidence Profiles along Remembrance Drive

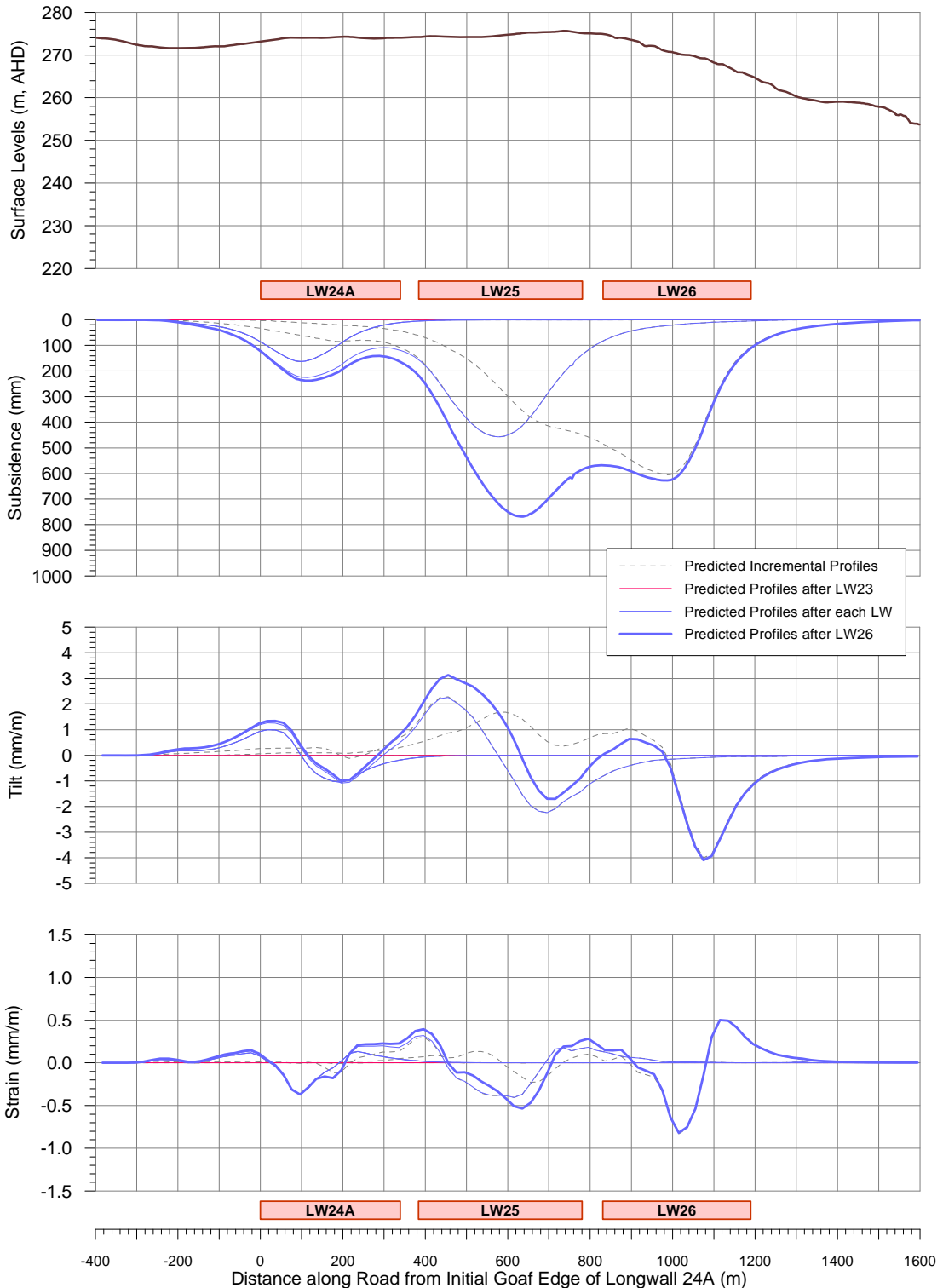


Fig. I.12 Rev B
Fig. 3.1 Predicted Subsidence Parameters along Remembrance Drive (Extract from MSEC157)

The predicted maximum strains would only apply over a relatively short section of the pipeline, and the strains would tend to balance out along the length of the pipeline. In practice, the ground strains would not be fully transferred from the ground into the pipeline, and the values quoted above are therefore unlikely to be achieved. The flexibility of the pipeline should allow it to accommodate these values of strain without adverse impacts, and protective works should not be necessary.

While the pipelines are quite flexible, the 160 mm diameter pipes are connected with socket joints that are glued together. It is unlikely that these joints will be adversely affected by the proposed longwalls.

The likelihood of impacts occurring to the pipeline is therefore assessed as **VERY RARE**.

Given that this pipe is the main gas pipeline, any leakage of the pipeline would require emergency procedures, and since there is significant surface infrastructure in the vicinity of the pipeline, the consequence of damage to the pipeline is assessed as **VERY SEVERE**.

The level of risk for this pipeline is therefore assessed as:-

VERY RARE / VERY SEVERE → MODERATE.

3.2.2. Main Gas Pipeline along Thirlmere Way

A 75 mm diameter nylon pipe is laid along Thirlmere Way. Predictions of subsidence, tilt and strain along Thirlmere Way are provided in Fig. 3.2 and are summarised in Table 3.2.

Table 3.2 Maximum Predicted Systematic Subsidence, Tilt and Strain along Thirlmere Way

Maximum Predicted Subsidence (mm)	Maximum Predicted Tilt (mm/m)	Maximum Predicted Tensile Strain (mm/m)	Maximum Predicted Compressive Strain (mm/m)
913	3.4	0.8	0.9

As shown in Fig. 3.2 and Drawing No. MSEC286-0405, the majority of ground movements along Thirlmere Way are predicted to occur as a result of mining Longwalls 22 to 24B. The gas main was directly undermined during the extraction of Longwalls 22 to 24B with no adverse impacts observed. The additional systematic subsidence caused by Longwall 25 is expected to be relatively small.

The predicted maximum strains would only apply over a relatively short section of the pipeline, and the strains would tend to balance out along the length of the pipeline. In practice, the ground strains would not be fully transferred from the ground into the pipeline, and the values quoted above are therefore unlikely to be achieved. The flexibility of the pipeline should allow it to accommodate these values of strain without adverse impacts, and protective works should not be necessary.

It is noted that there are also some black boxes (pressure regulators) installed along Thirlmere Way and these will be monitored during mining.

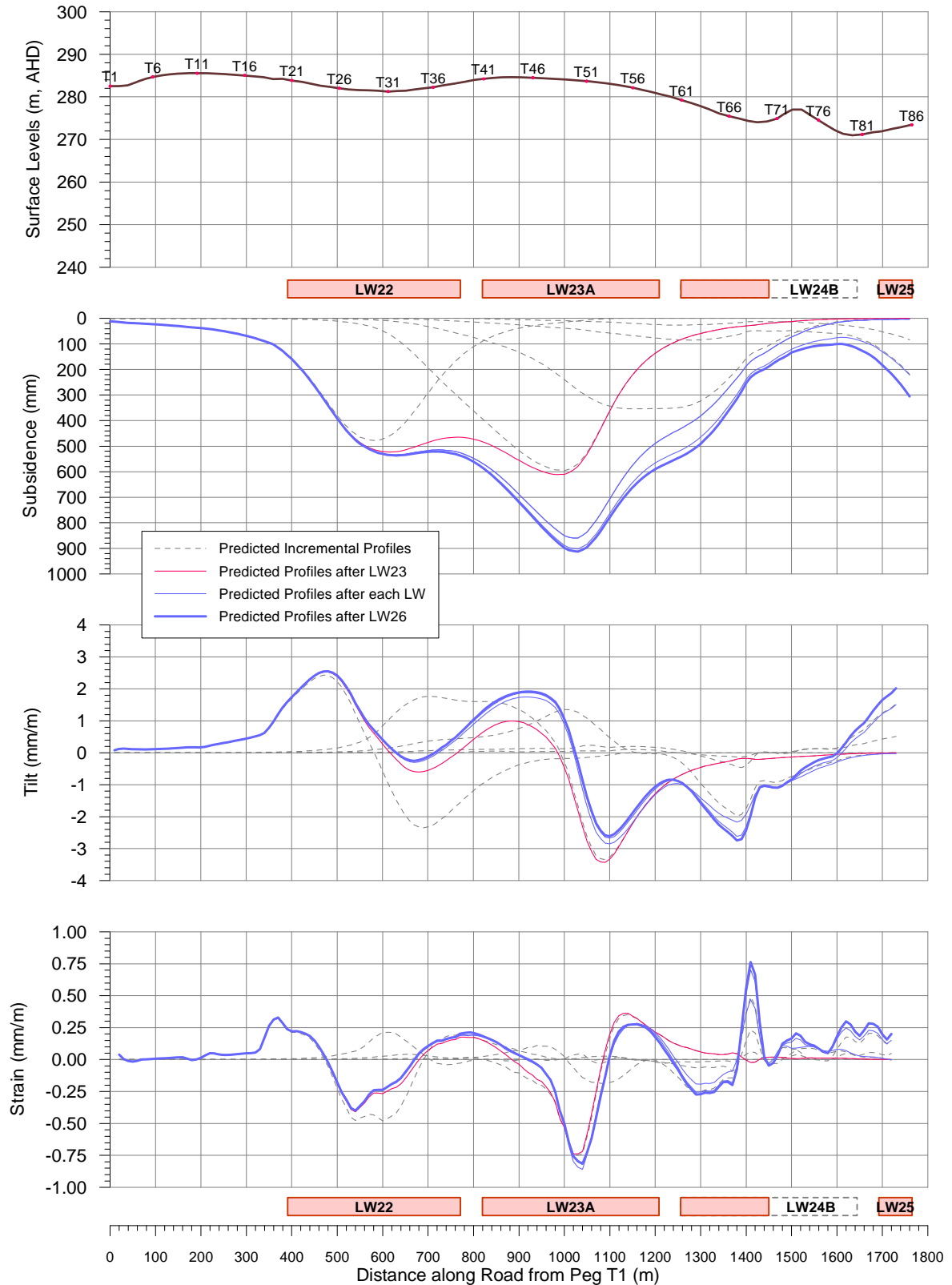
The likelihood of impacts occurring to the pipeline is therefore assessed as **VERY RARE**.

The consequence of damage to the pipeline is similar to the main gas pipeline, except that the pipe is slightly smaller in diameter, and there is slightly less surface infrastructure in the vicinity of the pipeline. The consequence of damage to the pipeline is therefore assessed as **SEVERE**.

The level of risk for this pipeline is therefore assessed as:-

VERY RARE / SEVERE → MODERATE.

Tahmoor Colliery - LW22 to LW26 Predicted Subsidence Profiles along Thirlmere Way



Mine Subsidence Engineering Consultants

Fig. I.13 Rev B

Fig. 3.2 Predicted Subsidence Parameters along Thirlmere Way (Extract from MSEC157)

3.2.3. Local Gas Pipeline

Remaining gas pipes are generally 35 mm diameter nylon pipes, which are located along most of the urban streets of Tahmoor and Thirlmere. These smaller diameter local reticulation pipes should be sufficiently flexible to accommodate the predicted levels of strain. It is noted that no impacts were observed during the extraction of Longwalls 22 to 24B.

The likelihood of damage occurring to these small pipes is therefore assessed as **VERY RARE**. The consequence of damage to these pipes is less than the main gas pipelines that run along Remembrance Drive and Thirlmere Way due to their size. The consequence of damage to these pipelines is therefore assessed as **MODERATE**.

The level of risk for this pipeline is therefore assessed as:-

VERY RARE / MODERATE → LOW.

3.2.4. Gas Mains at Creek Crossings

The gas mains cross a number of watercourses within the SMP Area. The majority of these are small watercourses and are unlikely to adversely impact on the pipelines.

However, the gas mains cross the main creeks in the SMP Area, and these sections are expected to experience closure and upsidence.

Predictions of closure, upsidence and compressive strain due to closure at the gas main creek crossings due to the extraction of Longwalls 22 to 26 are shown in Table 3.3, in accordance with the methods outlined in Report No. MSEC157.

Table 3.3 Predictions of Upsidence and Closure at Gas Main Creek Crossings

Location	Pipe Dia (mm)	Equiv. Valley Depth (m)	Maximum Cumulative Upsidence (mm)	Maximum Cumulative Closure (mm)	Maximum Compressive Strain (mm/m)
Myrtle Creek (Castlereagh St)	32	6.5	104	54	5.2
Redbank Creek (Turner St)	32	4.0	22	8	< 1.0

The timing of the predicted movements at Castlereagh Street is provided in Table 3.4.

Table 3.4 Prediction of Upsidence and Closure at Castlereagh Street Road Bridge

Stage of Mining	Equiv. Valley Depth (m)	Maximum Cumulative Upsidence (mm)	Maximum Cumulative Closure (mm)
After Longwall 23	6.5	< 5	< 5
After Longwall 24	6.5	15	15
After Longwall 25	6.5	55	38
After Longwall 26	6.5	105	55

Although the nylon gas mains are expected to experience greater movements at creek crossings, the flexibility of the pipelines should allow them to accommodate these values of strain without adverse impacts.

The level of risk is therefore assessed to be the same as for other local gas pipelines, which is:-

VERY RARE / MODERATE → LOW.

3.2.5. Summary of Risk Analysis for Gas Infrastructure

A summary of the levels of risk for the gas pipes are provided in Table 3.5.

Table 3.5 Risk Analysis Matrix for Gas Infrastructure

Risk	Likelihood	Consequence	Level of Risk
Damage to main gas pipeline on Remembrance Drive (160 mm)	VERY RARE	VERY SEVERE	MODERATE
Damage to gas pipeline on Thirlmere Way (75 mm)	VERY RARE	SEVERE	MODERATE
Damage to local reticulation pipes	VERY RARE	MODERATE	LOW
Gas mains at creek crossings	VERY RARE	MODERATE	LOW

3.3. Experience of mining Longwall 24A

Increased subsidence has been observed above Longwall 24A with no impacts to gas infrastructure. Subsidence monitoring and enhanced gas patrols were undertaken along the streets during mining. 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. 3.3, which shows observed subsidence at survey pegs located along the centreline of Longwall 24A.

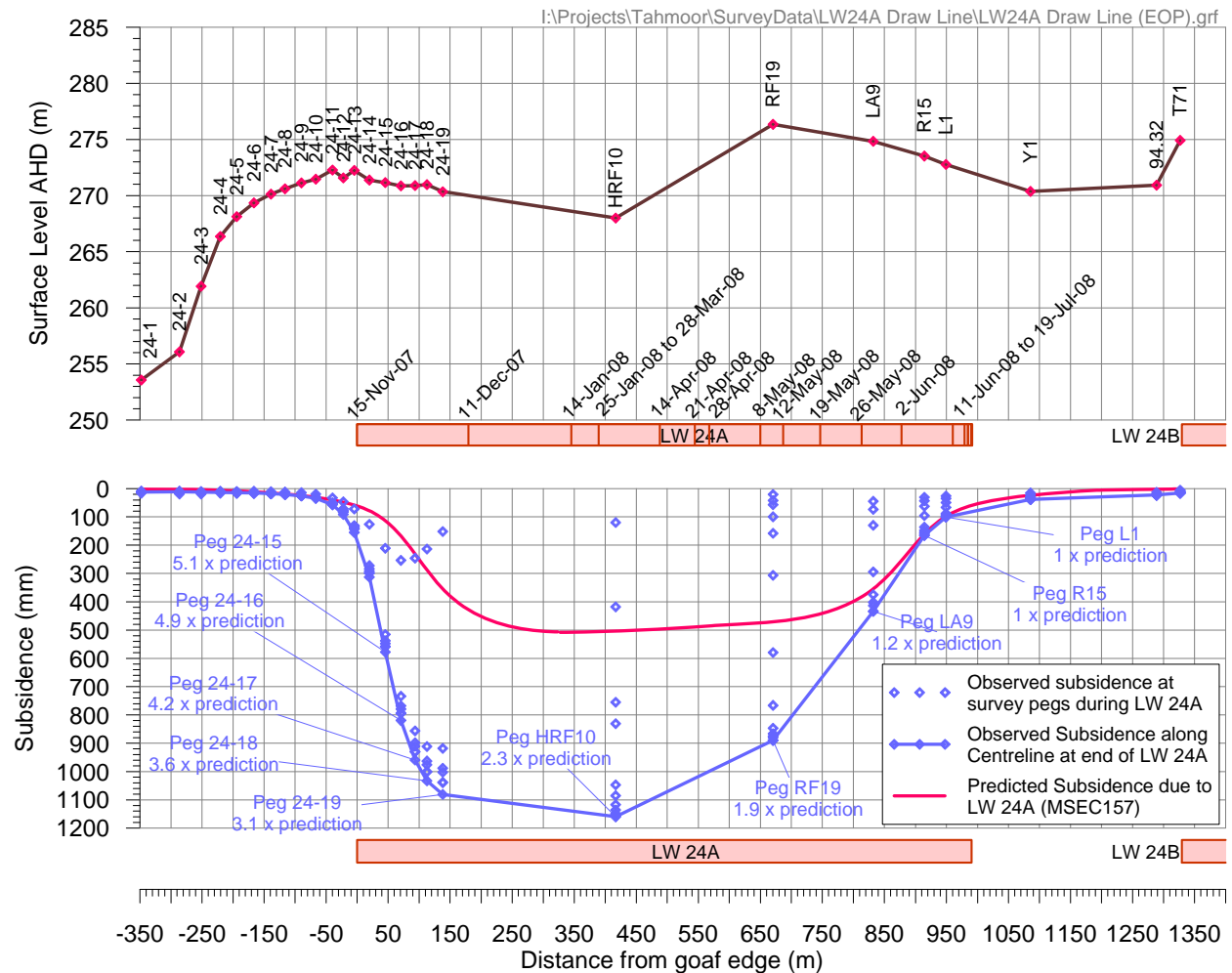


Fig. 3.3 Observed Subsidence along Centreline of Longwall 24A

It can be seen from Fig. 3.3 that while observed subsidence was substantially greater than predicted above the commencing end of the longwalls, observed subsidence compared reasonably well with predictions towards the finishing end of Longwall 24A. It is noted that the extent of the urban area of Tahmoor above Longwall 25 is located near Remembrance Drive (refer Peg R15 in Fig. 3.3).

3.4. Potential Increased Subsidence during the mining of Longwall 25

Given the experience above Longwall 24A, it is considered possible that increased subsidence could be observed above Longwall 25, particularly near the commencing (southern) end of the longwall.

It is considered that the probability of substantially increased subsidence within the urban area of Tahmoor above Longwall 25 is low for most urban areas, because subsidence movements were observed to gradually return to normal levels towards the finishing (northern) end of Longwall 24A. However, the probability is considered low to moderate that increased subsidence will be observed along the southern-most streets of Tahmoor, such as Courtland Avenue, Tanya Plan, Pandora Place and Progress Street.

Based on the experience of mining Longwall 24A, it is unlikely that there will be impacts to the gas infrastructure network if substantially increased subsidence is observed during the mining of Longwall 25. However, additional measures have been included in this management plan in the event that this occurs. This includes increased frequency of ground surveys and visual inspections.

CHAPTER 4. RISK CONTROL PROCEDURES

4.1. Gas Management Group (GMG)

The Gas Management Group (GMG) is responsible for providing advice on all technical issues relating to mine subsidence related impacts to gas infrastructure due to the mining of Longwalls 25 to 26 on which decisions are made by Jemena and Tahmoor Colliery. The GMG develops and reviews this management plan, collects and analyses monitoring results, determines potential impacts and provides advice to Jemena and Tahmoor Colliery regarding appropriate actions. The members of the GMG are highlighted in CHAPTER 8.

4.2. Avoidance and Mitigation Measures

Given the results of the risk assessment and nature of the gas infrastructure, which have been constructed with flexible materials and buried beneath the surface in urban areas, it is considered impractical and unnecessary to implement avoidance and mitigation measures to the gas infrastructure that will experience mine subsidence movements as a result of the mining of Longwalls 25 to 26.

Further confidence is drawn from the experience of mining Longwalls 22 to 24A, where no impacts have been experienced, even where predicted subsidence movements have been exceeded.

Mitigation measures will be considered to potentially reduce the risk of impact to the exposed steel gas main that runs along the Remembrance Drive Bridge over Myrtle Creek, but implementation is not required until the mining of Longwalls 27 and 28.

4.3. Monitoring Plan

A number of monitoring measures will be undertaken during mining.

4.3.1. Ground Monitoring Lines

Ground surveys of level and strain distance will be conducted along monitoring lines that are generally located in streets during mining.

General Ground Monitoring

As a general guide, the frequency of ground monitoring within urban areas is every 200 metres of longwall extraction for all survey marks that are located within the active subsidence zone. The timing of surveys within rural areas is determined by the location of street monitoring lines, where a survey has been scheduled to occur when the longwall face has passed each monitoring line by approximately 200 metres.

At the completion of each longwall, surveys will be undertaken along the full length of each monitoring line, which is expected to have experienced some subsidence movements as a result of mining the longwall.

Ground Monitoring along Remembrance Drive

Weekly surveys of level and strain distance will be undertaken along Remembrance Drive when this road is within the active subsidence zone. In the case of Longwall 25, for example, weekly monitoring will begin when the extraction length of Longwall 25 is approximately 600 metres.

Ground Monitoring within Urban Area above Longwall 25

Subsidence surveys will be undertaken along the LW25 Centreline at weekly intervals during the early extraction of Longwall 25 to determine whether increased subsidence is developing during the mining of Longwall 25.

Monitoring lines have been installed along all streets within the urban area above Longwall 25, as shown in Drawing No. MSEC286-040502, and an initial survey has been conducted.

If monitoring shows that more than 700 mm of subsidence is observed along the LW25 Centreline monitoring line, level surveys will begin for each of these survey marks when each mark is within 50 metres of the longwall face and levels will be surveyed weekly until movements cease or return to normal subsidence levels. Baseline strain distances have also been measured and strain distances will be surveyed in the event of an impact to any surface infrastructure or where non-systematic movements have been observed in the level survey. Monitoring frequencies can be reduced if subsidence reduces to normal, expected levels if agreed by Jemena and the Department of Primary Industries.

Monitoring of Remembrance Drive Bridge over Myrtle Creek

Monitoring of the Remembrance Drive Bridge over Myrtle Creek will be undertaken following the completion of Longwall 25 and completion of Longwall 26.

4.4. Visual Inspections

Visual inspections will be undertaken within the active subsidence zone during mining.

If monitoring shows that the mining of Longwall 25 is resulting in more than 900 mm of subsidence, visual inspections will be undertaken within the urban areas once the longwall face is directly beneath the urban area and will continue on a daily basis until movements cease. Special attention will be paid to check for any gas leakage at local connections.

4.5. Jemena Gas Patrols

Jemena pipeline officers conduct routine gas patrols in the Tahmoor area, which can be quickly increased in frequency in response to increased subsidence, curvature or strains.

4.6. Triggers and Responses

Trigger levels have been developed by Jemena based on the capacity of the gas services to tolerate ground movements. Trigger levels for each monitoring parameter are described in the risk control procedures.

Control Measures and Response for Tahmoor Colliery LW 25 on Jemena AGN Gas Facilities

	Control Measures	Frequency	Analysis	Trigger Level	Action
LEVEL 1	<p>Ground Inspections:</p> <ul style="list-style-type: none"> - 2D survey - Ground inspection 	<p><u>Ground Surveys by Tahmoor Colliery:</u> Submit data within 24 hours duration 2D survey: Start LW, every 200m within urban area For Longwall 25, every week within urban area if subsidence is greater than 900 mm <u>Ground Inspections by Tahmoor Colliery:</u> Twice a week within active subsidence zone For Longwall 25, daily within urban area if subsidence is greater than 900 mm <u>Remembrance Drive Bridge over Myrtle Creek</u> Structure survey after the mining of Longwall 25 and Longwall 26</p>	<p>Tahmoor surveys and provides Jemena with</p> <ul style="list-style-type: none"> - ground surveys - ground movements / features reports 	<p><u>Ground Movement Survey & Measurements</u> * Radius of Ground Curvature: greater than 4 (km); * Ground Strain: 0 to 2 (mm/m); * Ground movements - rate of change steady</p> <p><u>Ground Conditions Monitoring</u> - ground cracks reported - ground subsidence reported;</p> <p>- ground movements showing a <u>step change</u> indicating shear and/or <u>discontinuity</u> in humps near the gas services</p>	<p>Go to LEVEL 2 if LEVEL 1 limit is exceeded:</p> <ul style="list-style-type: none"> * Normal ground patrol by Jemena pipeline officer <p>Jemena actions following receipt of reported incidents: * Inspects site to confirm operation of gas facilities not affected;</p> <p>* Undertake additional inspection eg exposing and inspecting gas services as applicable to determine gas facilities integrity; * Based on above findings, undertake corrective action per Level 3 activities where gas services integrity affected</p>
	<p>Ground Subsidence Validations</p> <ul style="list-style-type: none"> - Observed Against Predictions 	<p>Weekly, verify and tracking results against predictions</p>	<p>MSEC analyses and reports findings to stakeholders</p>		
				<p>Jemena reviews:</p> <ul style="list-style-type: none"> - 2D ground surveys report - pipe integrity - ground conditions report 	
LEVEL 2	<p>Ground Inspections:</p> <ul style="list-style-type: none"> - 2D survey - Ground inspection 	<p>Submit data within 24hours duration</p> <p>Twice weekly 2D survey</p>	<p>Tahmoor surveys and provides Jemena with</p> <ul style="list-style-type: none"> - ground surveys - ground movements / features reports 	<p><u>Ground Movement Survey & Measurements</u> * Radius of Ground Curvature: 2 to 4 (km); * Ground Strain: 2 - 5 (mm/m); * Ground movements - rate of change increasing with increasing upward trend</p> <p><u>Ground Conditions Monitoring</u> - ground cracks reported - ground subsidence reported;</p> <p>- ground movements showing a <u>step change</u> indicating shear and/or discontinuity in humps near the gas services</p>	<p>Go to LEVEL 3 if LEVEL 2 limit is reached:</p> <ul style="list-style-type: none"> * Weekly ground patrol by Jemena pipeline officer <p>Jemena actions following receipt of reported incidents: * Inspects site to confirm operation of gas facilities not affected;</p> <p>* Undertake additional inspection eg exposing and inspecting gas services as applicable to determine gas facilities integrity; * Based on above findings, undertake corrective action per Level 3 activities where gas services integrity affected * If no immediate corrective actions required, Jemena may put field construction on Standby</p>
	<p>Ground Subsidence Validations</p> <ul style="list-style-type: none"> - Observed Against Predictions 	<p>Twice weekly, verify and tracking results against predictions</p>	<p>MSEC analyses and reports findings to stakeholders</p>		
				<p>Jemena reviews:</p> <ul style="list-style-type: none"> - 2D ground surveys report - pipe integrity - ground conditions report 	
LEVEL 3	<p>Ground Inspections:</p> <ul style="list-style-type: none"> - 2D survey - Ground inspection 	<p>Submit data within 24hours duration</p> <p>Daily 2D Survey</p>	<p>Tahmoor surveys and provides Jemena with</p> <ul style="list-style-type: none"> - ground surveys - ground movements / features reports 	<p><u>Ground Movement Survey & Measurements</u> * Radius of Ground Curvature: less than 2 (km); * Ground Strain: > 5 (mm/m); * ground movements showing a <u>step change</u> indicating shear and/or <u>discontinuity</u> in humps near the gas services</p>	<p><u>Jemena's field corrective actions:</u></p> <ul style="list-style-type: none"> - <u>Mobilisation construction in the field</u> - <u>excavate affected area</u> - <u>inspect gas facilities to confirm integrity;</u> - <u>repair and/or replace gas services as applicable to maintain supply and safe operation</u>
	<p>Ground Subsidence Validations</p> <ul style="list-style-type: none"> - Observed Against Predictions 	<p>Daily, verify and tracking results against predictions</p>	<p>MSEC analyses and reports findings to stakeholders</p>		
				<p>Jemena reviews:</p> <ul style="list-style-type: none"> - 2D ground surveys report - pipe integrity - ground conditions report (as applicable) 	

CHAPTER 5. GMG 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. GMG Meetings will be held between Tahmoor Colliery, Jemena, the Mine Subsidence Board and / or the Department of Mineral Resources for discussion and resolution of issues raised in the operation of the Management Plan. The frequency of the GMG Meetings will be monthly unless agreed otherwise between representatives of the GMG.

GMG 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 GMG 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 GMG Meeting.

CHAPTER 8. CONTACT LIST

Organisation	Contact (* GMG member)	Phone	Email / Mail	Fax
Jemena Control Centre	Emergency Contact	131909		
Jemena	Meng Cheng*	(02) 9397 9200 0407 574 582	meng.cheng@jemena.com.au	
Department Primary Industries (Mineral Resources Division)	Phil Steuart	(02) 4931 6648	phil.steuart@dpi.nsw.gov.au	(02) 4931 6790
Department Primary Industries (Mineral Resources Division)	Gang Li*	(02) 4931 6644 0409 227 986	gang.li@dpi.nsw.gov.au	(02) 4931 6790
Department Primary Industries (Mineral Resources Division)	Ray Ramage	(02) 4931 6645 0402 477 620	ray.ramage@dpi.nsw.gov.au	(02) 4931 6790
Mine Subsidence Board	Darren Bullock*	(02) 4577 1967 0425 275 567	d.bullock@minesub.nsw.gov.au	(02) 4677 2040
Mine Subsidence Engineering Consultants (MSEC)	Daryl Kay*	(02) 9413 3777 0416 191 304	daryl@minesub.com	(02) 9413 3822
Sunrise Building and Property Services (SBPS)	John Schwarz	(02) 4883 9030 0400 390058	sunbuilding@bigpond.com.au	(02) 4883 9738
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 and SMP Coordinator	David Clarkson*	(02) 4640 0133 0428 114 614	dclarkson@xstratacoal.com.au	(02) 4640 0140

Appendix A - Glossary of Terms and Definitions

Glossary of Terms and Definitions

Angle of draw	The angle of inclination from the vertical of the line connecting the goaf edge of the workings and the limit of subsidence (which is usually taken as 20 mm of subsidence).
Chain pillar	A block of coal left unmined between the longwall extraction panels.
Cover depth (H)	The depth from the surface to the top of the seam. Cover depth is normally provided as an average over the area of the panel.
Critical area	The area of extraction at which the maximum possible subsidence of one point on the surface occurs.
Curvature	The change in tilt between two adjacent sections of the tilt profile divided by the average horizontal length of those sections.
Extracted seam	The thickness of coal that is extracted. The extracted seam thickness is thickness normally given as an average over the area of the panel.
Effective extracted seam thickness (T)	The extracted seam thickness modified to account for the percentage of coal left as pillars within the panel.
Face length	The width of the coalface measured across the longwall panel.
Goaf	The void created by the extraction of the coal into which the immediate roof layers collapse.
Goaf end factor	A factor applied to reduce the predicted incremental subsidence at points lying close to the commencing or finishing ribs of a panel.
Horizontal displacement	The horizontal movement of a point on the surface of the ground as it settles above an extracted panel.
Inflection point	The point on the subsidence profile where the profile changes from a convex curvature to a concave curvature. At this point the strain changes sign and subsidence is approximately one half of S max.
Incremental subsidence	The difference between the subsidence at a point before and after a panel is mined. It is therefore the additional subsidence at a point resulting from the excavation of a panel.
Overlap adjustment factor	A factor that defines the ratio between the maximum incremental subsidence of a panel and the maximum incremental subsidence of that panel if it were the first panel in a series.
Panel	The plan area of coal extraction.
Panel length (L)	The longitudinal distance along a panel measured in the direction of (mining from the commencing rib to the finishing rib.
Panel width (Wv)	The transverse distance across a panel, usually equal to the face length plus the widths of the roadways on each side.
Panel centre line	An imaginary line drawn down the middle of the panel.
Pillar	A block of coal left unmined.
Pillar width (Wpi)	The shortest dimension of a pillar measured from the vertical edges of the coal pillar, i.e. from rib to rib.
Strain	The change in the horizontal distance between two points divided by the original horizontal distance between the points.
Sub-critical area	An area of panel smaller than the critical area.
Subsidence	The vertical movement of a point on the surface of the ground as it settles above an extracted panel.
Super-critical area	An area of panel greater than the critical area.
Tilt	The difference in subsidence between two points divided by the horizontal distance between the points.
Uplift	An increase in the level of a point relative to its original position.
Upsidence	A reduction in the expected subsidence at a point, being the difference between the predicted subsidence and the subsidence actually measured.

Appendix B – Drawings and Illustrations



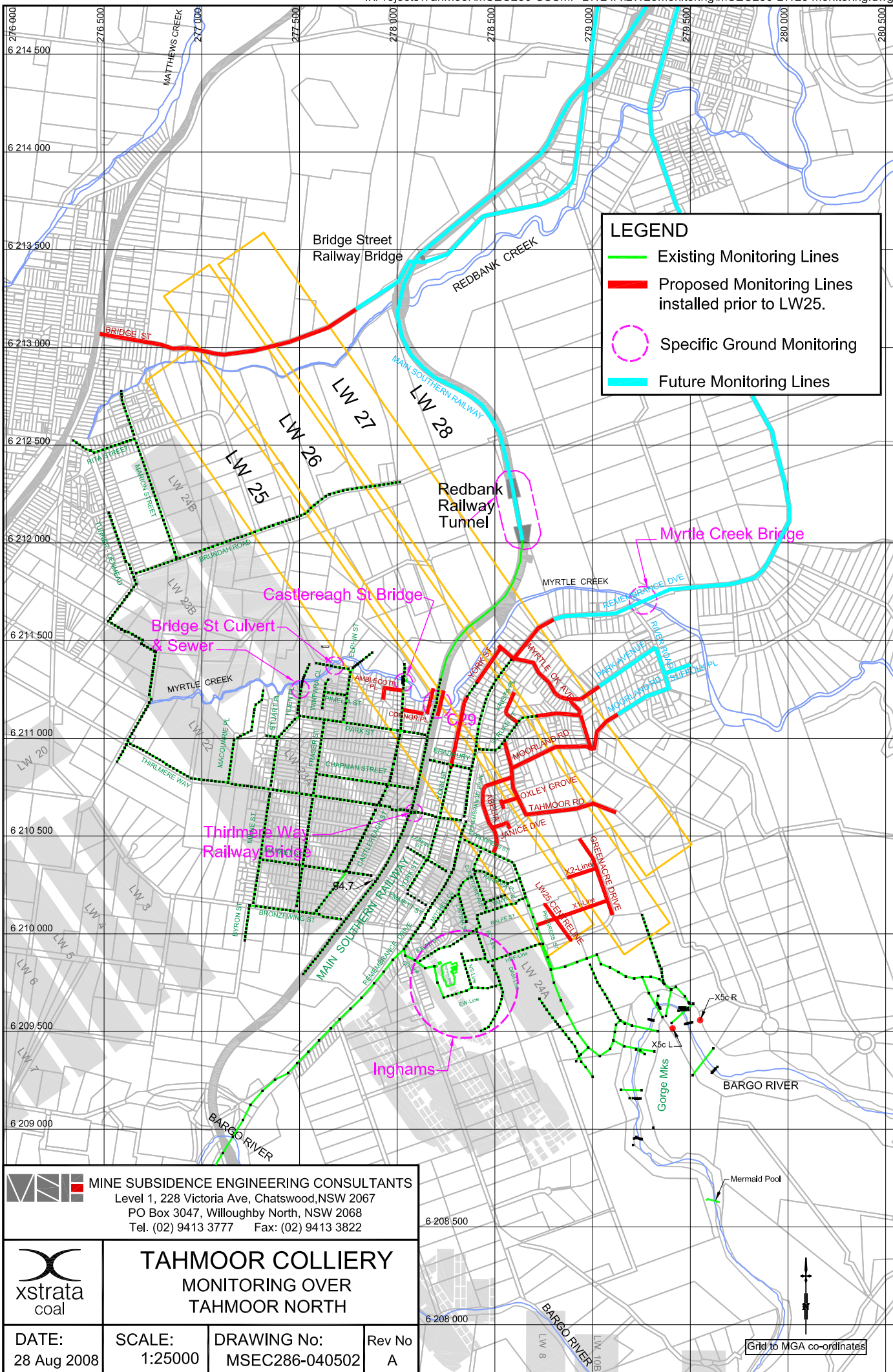
LEGEND:

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

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 24 - 26
 GAS INFRASTRUCTURE

DATE: 4 Mar 08	SCALE: 1:25000	DRAWING No: MSEC286-040501	Rev No C
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LEGEND

- Existing Monitoring Lines
- Proposed Monitoring Lines installed prior to LW25.
- Specific Ground Monitoring
- Future Monitoring Lines

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 PO Box 3047, Willoughby North, NSW 2068
 Tel. (02) 9413 3777 Fax: (02) 9413 3822

	TAHMOOR COLLIERY		
	MONITORING OVER TAHMOOR NORTH		
DATE: 28 Aug 2008	SCALE: 1:25000	DRAWING No: MSEC286-040502	Rev No A

Grid to MGA co-ordinates