



**Tahmoor Colliery**

**SUBSIDENCE MONITORING  
PROGRAMME**

**for**

**THE EXTRACTION OF  
LONGWALL 26**

**REVISION F**



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**Report Number MSEC446-00**

**September 2011**

## GENERAL

### AUTHORISATION OF SUBSIDENCE MONITORING PROGRAMME

Authorised on behalf of Tahmoor Colliery:

|            |   |
|------------|---|
| Name:      | IAN SHEPPARD  |
| Signature: |  |
| Position:  | MANAGER, ENVIRONMENT & COMMUNITY  |
| Date:      | 13 SEPTEMBER 2011   |

### REVIEW

| Date   | Report No. | Rev | Comments   |
|--------|------------|-----|--|
| Mar-11 | MSEC446-00 | A   | Draft for Longwall 26  |
| Jun-11 | MSEC446-00 | B   | Revised to include monitoring for railway infrastructure   |
| Jul-11 | MSEC446-00 | C   | Revised to include weekly surveys of Moorland Rd, Struan St, Krista Pl   |
| Aug-11 | MSEC446-00 | D   | Revised to include extra surveys across Redbank Creek, and along Main Southern Railway and Remembrance Drive   |
| Aug-11 | MSEC446-00 | E   | Timing of relative 3D surveys revised  |
| Sep-11 | MSEC446-00 | F   | Update on monitoring at Skew Culvert on Main Southern Railway, include survey marks along Hilton Park Road, which have been installed with baseline survey complete. |

## 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 25 longwalls to the north and west of the mine's current location.

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.

Subsidence Management Plan Approval for the extraction of Longwall 26 was issued in February 2011 by Industry and Investment, NSW. Condition 12 of the Approval states that the leaseholder must submit to the Principal Subsidence Engineer for approval a Subsidence Monitoring Programme.

This Subsidence Monitoring Programme has been developed in accordance with Condition 12. It describes the inspection regimes, layout of monitoring points, parameters to be measured, monitoring methods and accuracy, timing and frequencies of surveys and inspections, and recording and reporting of monitoring results.

The Subsidence Monitoring Programme is also consistent with detailed Subsidence Management Plans that have been developed by Tahmoor Colliery in consultation with stakeholders. Each of these management plans describe measures that will be undertaken to monitor subsidence movements and physical changes and/or impacts that occur during mining. The management plans include:

- *Tahmoor Colliery Longwalls 25 to 26 Natural Features Surface Safety and Serviceability Management Plan* (Revision H), as amended due to the mining of Longwall 26, February 2011.
- *Tahmoor Colliery Longwalls 25 to 26 Wollondilly Shire Council Roads, Bridges and Culverts, Surface Safety and Serviceability Management Plan* (Revision C), Report No. MSEC286, November 2008, which was reviewed by Tahmoor Colliery and Wollondilly Shire Council on 22 December 2010.
- *Tahmoor Colliery Management Plan for Potential Impacts to Potable Water Infrastructure due to the mining of Longwall 26* (Revision A), Report No. MSEC446-03, May 2010.
- *Tahmoor Colliery Management Plan for Potential Impacts to Sydney Water Sewer Infrastructure due to the mining of Longwall 26* (Revision C), Report No. MSEC446-04, February 2011.
- *Tahmoor Colliery Management Plan for Potential Impacts to Gas Infrastructure due to the mining of Longwall 26* (Revision B), Report No. MSEC446-05, June 2010.
- *Tahmoor Colliery Management Plan for Potential Impacts to Integral Energy Infrastructure due to the mining of Longwall 26* (Revision A), Report No. MSEC446-06, May 2010.
- *Management Plan Longwall Mining (LW 26) beneath Telstra Plant @ Tahmoor and Thirlmere NSW*, Colin Dove, 2011.
- *Tahmoor Colliery Longwalls 24 to 26 Rail Transport Museum Picton-Mittagong Loop Line Surface Safety and Serviceability Management Plan* (Revision A), Report No. MSEC286, May 2006.
- *Tahmoor Colliery Longwalls 24 to 26 Inghams Enterprises Pty Ltd Surface Safety and Serviceability Management Plan, Revision K (Stage 2 – Post Mitigation)*, Report No. MSEC286, March 2008, as amended on 27 March 2008 and January 2011, due to the mining of Longwall 26.
- *Tahmoor Colliery Longwalls 25 to 26 Tahmoor Town Centre Surface Safety and Serviceability Management Plan, Revision E*, Report No. MSEC286-0701, October 2008, which was reviewed by Tahmoor Colliery and Tahmoor Town Centre on 22 December 2010.

- *Tahmoor Colliery Management Plan for Potential Impacts to Department of Lands Permanent Control Marks due to the mining of Longwall 26 (Revision A), Report No. MSEC446-11, May 2010.*
- *Tahmoor Colliery Management Plan for Potential Impacts to Public, Commercial and Residential Structures due to the mining of Longwall 26 (Revision A), Report No. MSEC446-12, February 2011.*
- *Tahmoor Colliery Management Plan for Potential Impacts to No. 55-59 Remembrance Drive, Tahmoor due to the mining of Longwalls 26 to 28 (Revision B), Report No. MSEC446-13, February 2011.*
- *Tahmoor Colliery Management Plan for Potential Impacts to Pepes Ducks Infrastructure due to the mining of Longwall 26 (Revision B), Report No. MSEC446-14, March 2011.*
- *Tahmoor Colliery Management Plan for longwall mining beneath the Main Southern Railway, Revision C (Longwall 26 only), Report No. MSEC418, May 2011.*

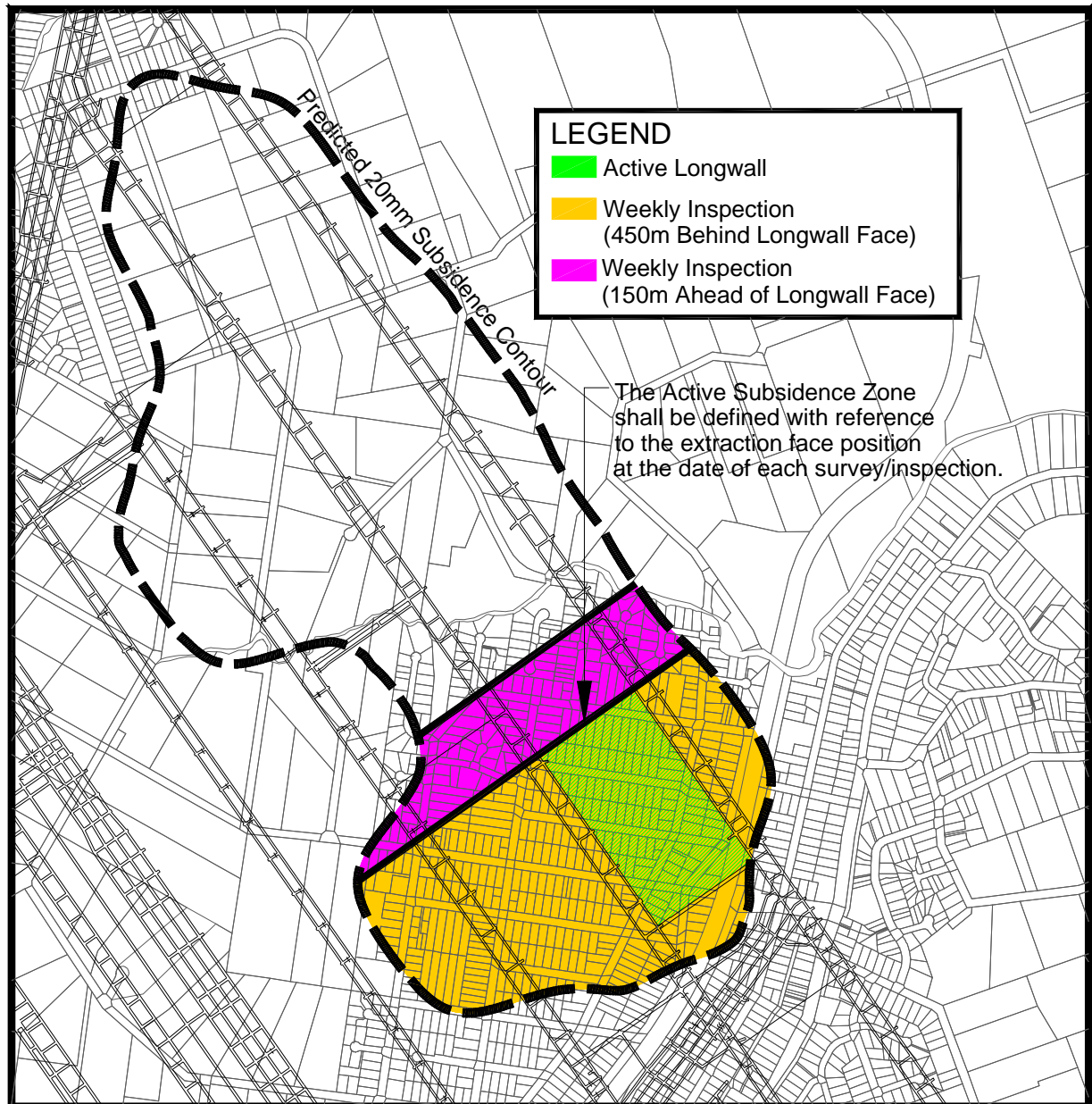
In a small number of cases, monitoring measures described in this Subsidence Monitoring Programme are in excess of commitments that have been made in the above-mentioned management plans.

The Subsidence Monitoring Programme is a live document that can be amended at any stage of mining, to meet the changing needs of Tahmoor Colliery and its stakeholders.

## 1.2. Definition of Active Subsidence Zone

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

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



**Fig. 1.1 Diagrammatic Representation of Active Subsidence Zone**

### **1.3. Predicted Subsidence due to the mining of Longwall 26**

Predictions of subsidence due to the mining of Longwall 26 were updated in Report No. MSEC458 (Revision A, July 2010).

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 a projection using 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.

## CHAPTER 2. SUBSIDENCE MONITORING PROGRAMME

### 2.1. Layout of Monitoring Points

The layout of monitoring points is provided in Drawing No. MSEC446-00-03, Revision J.

The drawing also indicates the timing and frequencies of surveys for each monitoring line.

### 2.2. Monitoring Methods and Accuracy

With the exception of surveys undertaken within the railway corridor, the monitoring methods and accuracy are described in the report entitled *Specifications for Subsidence Monitoring Lines for Longwalls 25 and 26*, by Lean and Hayward. This specification is appended to this Subsidence Monitoring Programme.

With respect to surveys undertaken within the railway corridor, the monitoring methods and accuracy are described in the report entitled *Main Southern Rail Line- Survey Monitoring Plan for LW26*, by Meadows Consulting. This specification is appended to this Subsidence Monitoring Programme.

With respect to specialist monitoring undertaken within the railway corridor, including automated monitoring of rail stress, rail temperature, switch displacement, Myrtle Creek Culvert steel stress and tilt, please refer to details provided in the Railway Management Plan (Report No. MSEC418).

### 2.3. Recording and reporting of monitoring results

The recording and reporting of monitoring results is described in the report entitled *Specifications for Subsidence Monitoring Lines for Longwalls 25 and 26*, by Lean and Hayward. This specification is appended to this Subsidence Monitoring Programme.

Survey results will be issued to Industry and Investment, NSW within 48 hours of survey.

### 2.4. Inspection regimes, parameters to be measured, timing and frequencies of surveys and inspections

The inspection regimes, parameters to be measured, timing and frequencies of surveys and inspections are outlined in the attached table. The information is sorted by features that are being monitored.

To clarify, where the timing of the monitoring or inspection frequency is described as “*Monthly after x metres of extraction*”, or “*Every 200 metres of extraction after x metres of extraction*”, this means that the first survey will commence within one week of the longwall face passing “*x metres of extraction*”.

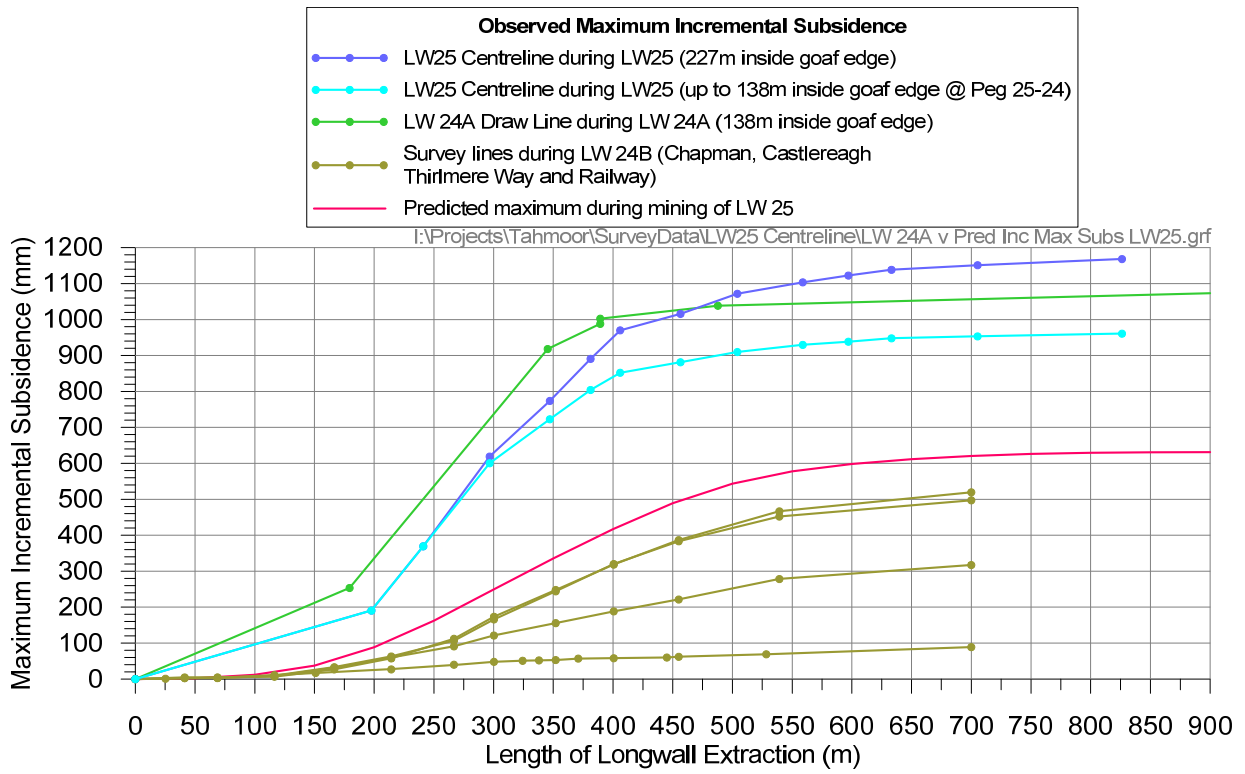
Survey frequencies will not be reduced until agreed by Industry and Investment, NSW and relevant stakeholders. Unless stated in the attached table, inspection frequencies will not be reduced until agreed by Industry and Investment, NSW and relevant stakeholders.

#### *Increased subsidence*

Increased subsidence was observed at the southern or commencing ends of Longwalls 24A and 25. It is defined as observations of subsidence that are similar in magnitude to those observed within the red zones highlighted in Drawing No. MSEC446-00-01.

It is expected that increased subsidence will be observed along Tahmoor Road, where it crosses above the centre of Longwall 26. For this reason, weekly ground surveys will be undertaken along Greenacre Drive and Tahmoor Road (Pegs TM9 to TM41), commencing after 200m of extraction as significant may have developed by this time, which was previously observed as shown in Fig. 2.1. Weekly surveys will also be undertaken along Moorland Road, Struan Street, Krista Place, Remembrance and Drive and York Street to track the development of subsidence above Longwall 26. Visual inspections will be daily for streets within the active subsidence zone.

Once it is confirmed that normal subsidence is developing, the frequency of ground surveys will reduce to the frequencies shown in Drawing No. MSEC446-00-03 and the frequency of visual inspections will reduce to twice weekly. As stated previously, monitoring and inspection frequencies will not be reduced until agreed by Industry and Investment, NSW.



**Fig. 2.1 Observed maximum subsidence with length of extraction of Longwalls 24A and 25**

**Table 2.1 Subsidence Monitoring Programme for Longwall 26**

| <b>Feature</b>          | <b>Survey or Inspection Regime</b>  | <b>Parameters to be measured</b> | <b>Timing and Frequency<br/>(may be increased if triggered by monitoring results)</b>   |
|-------------------------|---|----------------------------------|---|
| <b>Natural Features</b> |   |                                  |   |
| Bargo Gorge             | Greenacre Drive survey line<br>(for angle of draw)  | 2D subsidence and distance       | Weekly, commencing after 200m of extraction<br>End of LW26  |
| Myrtle Creek            | York St (Y64) survey line   | 2D subsidence and distance       | Weekly, commencing after 850m of extraction<br>End of LW26  |
|                         | York St (Y67) survey line   | 2D subsidence and distance       | Initial survey prior to 700m of extraction<br>(site inspection and preliminary locations of pegs determined)<br>Weekly, commencing after 850m of extraction<br>End of LW26                                      |
|                         | Castlereagh-Myrtle survey line  | 2D subsidence and distance       | Weekly, commencing after 1000m of extraction<br>End of LW26   |
|                         | Elphin-Myrtle survey line   | 2D subsidence and distance       | Every 200m of extraction, commencing after 1250m of extraction<br>End of LW26   |
|                         | Elphin Street survey line   | 2D subsidence and distance       | Every 200m of extraction, commencing after 1350m of extraction<br>End of LW26   |
|                         | Huen Place survey line  | 2D subsidence and distance       | Every 200m of extraction, commencing after 1350m of extraction<br>End of LW26   |
|                         | Visual inspection of Myrtle Creek   | -                                | Weekly, commencing after 800m of extraction   |
| Redbank Creek           | Bridge St survey lines<br>(locations indicative only, subject to<br>landowner approval and site inspection) | 2D subsidence and distance       | Initial baseline surveys prior to 2000m of extraction<br>Weekly for both lines above LW26 and line above chain pillar<br>between LWs 26 & 27, commencing after 2700m of extraction<br>End of LW26 for all lines |
|                         | Visual inspection of Redbank Creek  | -                                | Weekly, commencing after 2650m of extraction  |

| Feature   | Survey or Inspection Regime           | Parameters to be measured  | Timing and Frequency<br>(may be increased if triggered by monitoring results)  |
|---|---------------------------------------|----------------------------|--|
| <b>Wollondilly Council Infrastructure</b>               |                                       |                            |  |
| Local roads   | Ground surveys along streets          | 2D subsidence and distance | <p><i>Frequencies</i><br/>As per Dwg. No. MSEC446-00-03, and End of LW26</p> <p><i>Timing</i><br/>For Greenacre Drive, Tahmoor Rd (Pegs TM9 to TM41), Progress St, Abelia St: commencement after 200m of extraction.<br/>For Remembrance Drive, York St (from Larkin St to Bradbury St): commencement after 300m of extraction.<br/>For Remembrance Drive (Larkin St to Peg RE50), For York St (Larkin St to Peg Y52): commencement after 600m of extraction<br/>For other street survey lines: commencement after LW face has approached within 150m of each survey line.</p> |
|   | Visual inspections of streets         | -                          | Daily for roads within active subsidence zone, commencing after 200m of extraction and continuing until normal subsidence is observed to be developing, after which twice weekly inspections will be undertaken.   |
| Culvert on Bridge Street (Brundah Rd) over Myrtle Creek | Survey of culvert                     | 2D subsidence and distance | Every 200m of extraction, commencing after 1350m of extraction<br>End of LW26  |
|   | Visual inspections                    | -                          | Twice a week when culvert is within active subsidence zone   |
| Castlereagh St Bridge                                   | Bridge surveys                        | 2D subsidence and distance | Weekly, commencing after 1000m of extraction<br>End of LW26  |
|   | Castlereagh Street Pegs C54 to C62    | 2D subsidence and distance | Weekly, commencing after 1000m of extraction<br>End of LW26  |
|   | Castlereagh-Myrtle survey line        | 2D subsidence and distance | Weekly, commencing after 1000m of extraction<br>End of LW26  |
|   | Detailed visual inspections of bridge | -                          | Weekly, commencing after 1000m of extraction<br>End of LW26  |

| Feature  | Survey or Inspection Regime                                | Parameters to be measured                        | Timing and Frequency<br>(may be increased if triggered by monitoring results)                |
|--|--|--|--|
| <b>Potable Water Infrastructure</b>                      |  |  |  |
| Potable water infrastructure                             | Ground surveys along streets                               | 2D subsidence and distance                       | As described for Wollondilly Council   |
|  | Visual inspections of streets                              | -  | As described for Wollondilly Council   |
| Water main crossing Myrtle Creek near Castlereagh Street | Visual inspections   | -  | Twice a week when crossing is within active subsidence zone                                  |
| <b>Gas Infrastructure</b>                                |  |  |  |
| Gas infrastructure                                       | Ground surveys along streets                               | 2D subsidence and distance                       | As described for Wollondilly Council   |
|  | Visual inspections of streets                              | -  | As described for Wollondilly Council   |
| Remembrance Drive Bridge over Myrtle Creek               | Structure survey   | 2D subsidence and distance                       | End of LW26  |
| <b>Electrical Infrastructure</b>                         |  |  |  |
| Electrical infrastructure                                | Ground surveys along streets                               | 2D subsidence and distance                       | As described for Wollondilly Council   |
|  | Visual inspections of streets                              | -  | As described for Wollondilly Council   |
| Critical power poles                                     | Power pole surveys, as shown in Drawing No. MSEC446-00-03. | Subsidence at base and vertical offset (or tilt) | Monthly for each pole with active subsidence zone.   |
| <b>Telecommunications Infrastructure</b>                 |  |  |  |
| Telstra infrastructure                                   | Ground surveys along streets                               | 2D subsidence and distance                       | As described for Wollondilly Council   |
|  | Visual inspections of streets                              | -  | As described for Wollondilly Council   |
|  | Detailed visual inspections of pits and streets            | -  | Weekly when active subsidence zone is within Tahmoor urban area, and monthly at other times. |

| Feature                           | Survey or Inspection Regime  | Parameters to be measured   | Timing and Frequency<br>(may be increased if triggered by monitoring results)   |
|-----------------------------------|--|---|---|
| <b>Sewer Water Infrastructure</b> |  |   |   |
| Sewer infrastructure              | Ground surveys along streets   | 2D subsidence and distance  | As described for Wollondilly Council  |
|                                   | Visual inspections of streets  | -   | As described for Wollondilly Council, plus<br>Daily within rail corridor when within active subsidence zone             |
|                                   | Relative level surveys of sewer pipes behind Struan Street and Tahmoor Road  | Local 2D survey (not linked to datum) of changes in vertical height and horizontal distance | Weekly, commencing when LW face has approached within 50 m of each survey line (after 500m of extraction)               |
|                                   | Valley closure and relative vertical height difference at Huen Place and Brundah Rd pipe crossings over Myrtle Creek   | Local 2D survey (not linked to datum) of changes in vertical height and horizontal distance | Weekly, commencing after 1350m of extraction<br>End of LW26   |
|                                   | Survey of ground pegs installed around the perimeter of Pumping Station SP1045   | 2D subsidence and distance  | Weekly, commencing after 1150m of extraction<br>End of LW26   |
|                                   | Automated continuous tilt monitoring of chamber wall (9 tiltmeters, consisting of 3 vertical lines in three radial locations, placed at top, base and mid-point) | Vertical tilt   | Ongoing, every 10 minutes   |
|                                   | Automated monitoring for high water level in manhole pit upstream of damaged horizontal bore behind Amblecote Place  | Float switch, triggered once the rising water level moves the float                         | Install prior to 1000m of extraction.<br>Monitor continuously   |
|                                   | CCTV inspection of Tahmoor and Thirlmere Carrier pipes   | -   | Tahmoor Carrier (York St) – prior to 700m of extraction<br>Thirlmere Carrier (Bridge St) – prior to 2800m of extraction |
|                                   | CCTV inspections of damaged horizontal bore behind Amblecote Place   | -   | Every 100m of LW advance, commencing when LW face has approached within 200 m of bore (after 1000m of extraction)       |
|                                   | Maintenance inspections of bypass pipe and pumping system for damaged horizontal bore behind Amblecote Place   | -   | Weekly during active subsidence or as required by Sydney Water  |

| Feature                       | Survey or Inspection Regime  | Parameters to be measured                                  | Timing and Frequency<br>(may be increased if triggered by monitoring results)                    |
|-------------------------------|--|--|--|
| <b>Rail Transport Museum</b>  |  |  |  |
| Picton-Mittagong Loop Line    | Visual inspection of track and ballast   | -  | Prior to operating trains as per Rail Transport Museum procedures                                |
| <b>Inghams Infrastructure</b> |  |  |  |
| Inghams Infrastructure        | Ground surveys of East-West, North-South and Dam Lines                                   | 2D subsidence and distance                                 | Monthly after commencement of LW   |
|                               | Detailed visual inspections of plant   | -  | Every 6 months during mining of LW26   |
|                               | Check of sub-floor ventilation below High-Rise Freezer                                   | -  | Once per year during mining of LW26  |
| <b>Tahmoor Town Centre</b>    |  |  |  |
| Tahmoor Town Centre           | Ground surveys of Remembrance Drive, York St (from Larkin St to Bradbury St) outside TTC | 2D subsidence and distance                                 | Weekly, commencing after 300m of extraction<br>End of LW26                                       |
|                               | Basement width and length surveys (incl diagonal)  | 2D distance  | Weekly, commencing after 300m of extraction<br>End of LW26                                       |
|                               | Building perimeter survey  | 2D subsidence and distance                                 | End of LW26  |
|                               | Relative 3D baseline grid survey of all basement columns and perimeter walls             | Local 3D survey  | End of LW26  |
|                               | Top of basement column surveys   | 2D subsidence and distance, plus vertical offset (or tilt) | End of LW26  |
|                               | Detailed visual inspections of TTC, including crack width monitoring                     | -  | Weekly, commencing after 300m of extraction<br>Twice weekly, commencing after 470m of extraction |
| <b>Department of Lands</b>    |  |  |  |
| Permanent survey marks        | Ground surveys along streets   | 2D subsidence and distance                                 | As described for Wollondilly Council   |

| <b>Feature</b>  | <b>Survey or Inspection Regime</b>                                   | <b>Parameters to be measured</b> | <b>Timing and Frequency<br/>(may be increased if triggered by monitoring results)</b>              |
|---|--|----------------------------------|--|
| <b>Structures</b>   |  |                                  |  |
| Houses, units,<br>public amenities,<br>Business and<br>Commercial<br>Establishments,<br>pools | Ground surveys along streets   | 2D subsidence and distance       | As described for Wollondilly Council   |
|   | Visual inspections of streets  | -                                | As described for Wollondilly Council   |
|   | Visual inspections of specific structures,<br>including pools        | Varies depending on structure    | Refer Structures Management Plan<br>(Weekly to once every 200m when within active subsidence zone) |
| <b>No. 55-59 Remembrance Drive, Tahmoor</b>   |  |                                  |  |
| 55-59<br>Remembrance<br>Drive, Tahmoor  | Ground surveys along Remembrance and<br>York Street outside property | 2D subsidence and distance       | Weekly, commencing after 600m of extraction  |
|   | Visual inspection of house from kerbside                             | -                                | Weekly, commencing after 750m of extraction until 1350m of<br>extraction                           |
| <b>Pepes Ducks</b>  |  |                                  |  |
| Pepes Ducks   | Greenacre Drive survey line, and<br>Tahmoor Rd (Pegs TM9 to TM41)    | 2D subsidence and distance       | Weekly, commencing after 200m of extraction<br>End of LW26   |

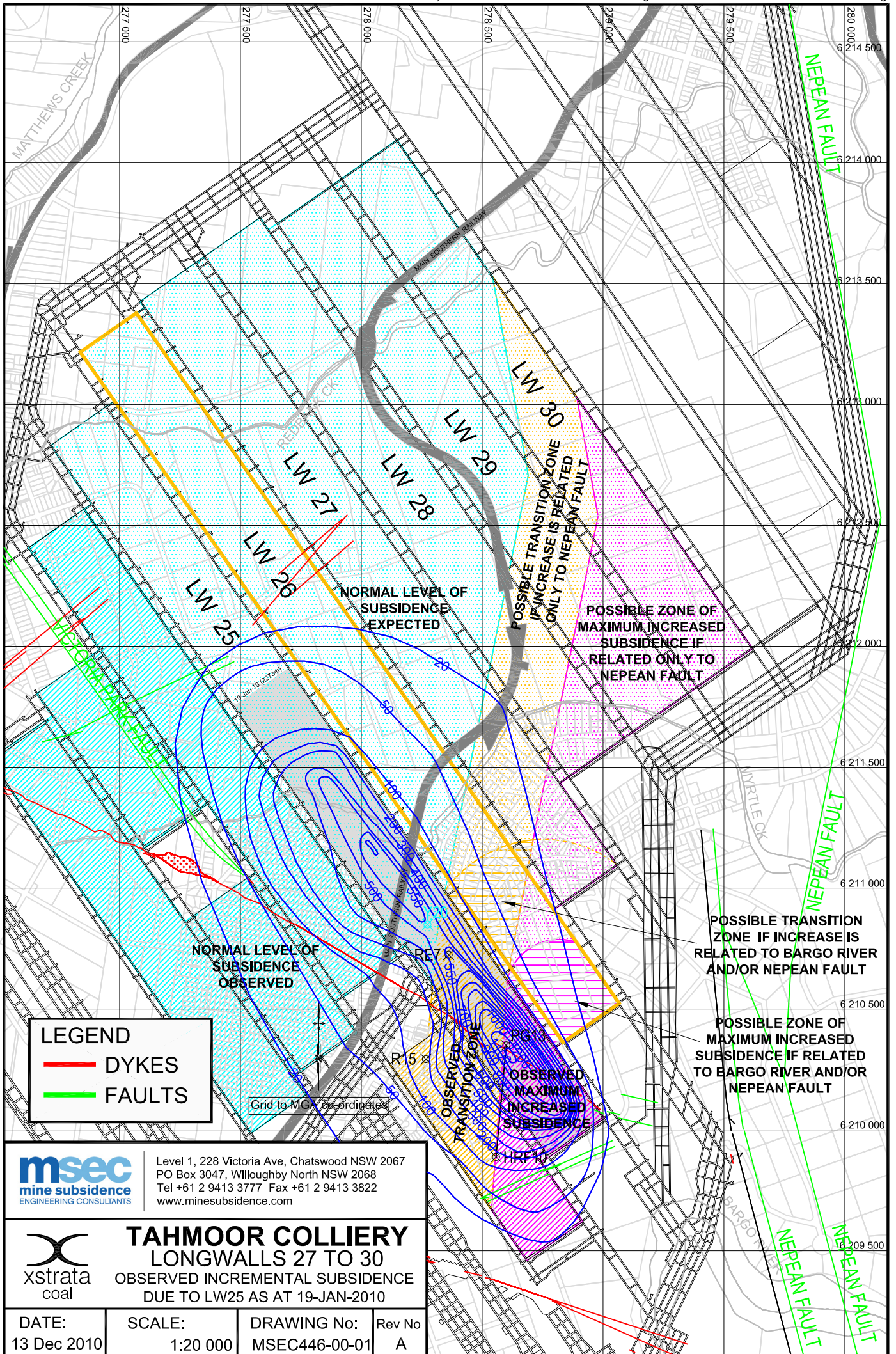
| Feature                      | Survey or Inspection Regime  | Parameters to be measured   | Timing and Frequency<br>(may be increased if triggered by monitoring results)  |
|------------------------------|--|---|--|
| <b>Main Southern Railway</b> |  |   |  |
| Railway track                | 3D ground survey along rail corridor, including above and inside Redbank Railway Tunnel<br><i>Full length = 92.260 km to 94.700 km</i>         | Subsidence, changes in easting and northing (MGA coordinates)                       | Full length monthly after 600m of extraction (~340m from track)<br>End of LW26   |
|                              | 2D ground survey along rail corridor<br><i>Full length = 92.260 km to 94.700 km</i><br><i>Weekly = 92.760 km to 94.480 km</i>                  | 2D subsidence and distance  | Full length prior to start of LW26<br>Weekly after 800m of extraction, (~190m from track)<br>Full length at end of LW26  |
|                              | Second 2D ground survey along rail corridor<br><i>Extent of survey is based on active zone of ground movement from previous survey results</i> | 2D subsidence and distance  | Weekly after 1000m of extraction at alternate day to Weekly 2D survey so that the 2D/3D survey frequency is twice a week.<br>Survey will not be undertaken if there has been less than 10m of LW progress within 3 days of the previous Weekly 2D survey |
|                              | Conduct 2D ground surveys of monitoring lines along streets in Tahmoor.<br><i>Includes, in particular Remembrance Drive and York Street</i>    | 2D subsidence and distance  | As described for Wollondilly Council plus the following:<br>For Remembrance Drive (Pegs RE50 to RE85):<br>3D monthly after 600m of extraction, relative 3D survey tied into previous monthly absolute 3D survey fortnightly after 1000m of extraction    |
|                              | Rail creep surveys of expansion switches, anchor points and CWR track  | Rail creep (differential horizontal longitudinal movement between rails and ground) | Monthly after 600m of extraction<br>Weekly after 800m of extraction  |
|                              | 2D long bay length surveys between anchor points, expansion switches and two additional 100 metre long bays beyond the last anchor points      | 2D distance   | Monthly after 600m of extraction<br>Weekly after 800m of extraction  |
|                              | Continuously monitor rail stress, rail temperature and switch displacement (strain gauges installed from 92.965 km to 94.475 km)               | Rail stress, rail temperature and switch displacement                               | Every 5 minutes  |

| Feature                                  | Survey or Inspection Regime   | Parameters to be measured  | Timing and Frequency<br>(may be increased if triggered by monitoring results)   |
|--|---|--|---|
| <b>Main Southern Railway (continued)</b> |   |  |   |
| Railway track<br>(continued)             | Track geometry surveys using Amber track mounted device or equivalent from 92.260 km to 94.700 km   | Superelevation (cant), twist, gauge  | Monthly after 600m of extraction<br>Weekly after 800m of extraction<br>Twice weekly after 1000m of extraction   |
|  | Track inspection by qualified track certifier   | The inspection will check ARTC infrastructure within the rail corridor, including the track, track expansion system, integrity of monitoring systems, culverts, Stock Tunnel, cuttings, embankments and fences | Twice weekly after start of LW26<br>Daily after 900m of extraction (~115m from track)<br>Twice weekly after substantial completion of mine subsidence movements when agreed by ARTC and I&I   |
| Myrtle Creek Culvert and Skew Culvert    | 2D and 3D survey monitoring lines upstream, downstream and above Myrtle Creek Culvert and Skew Culvert  | 3D survey: subsidence, changes in easting and northing (MGA coordinates)<br>2D survey: subsidence and distance   | <u>Myrtle Creek Culvert:</u> 3D monthly after 600m of extraction, weekly 2D upstream & downstream after 800m of extraction.<br><u>Skew Culvert:</u> 3D monthly after 800m of extraction, weekly 2D upstream & downstream after 1000m of extraction. |
|  | Local 3D survey of points inside Myrtle Creek Culvert and wingwalls.<br>Local 3D survey of points inside steel liner of Skew Culvert and wingwalls. | Local easting, northing and level  | <u>Myrtle Creek Culvert:</u><br>monthly after 600m, weekly after 800m.<br><u>Skew Culvert:</u><br>monthly after 800m, weekly after 1000m  |
|  | Tape extensometer monitoring in Myrtle Creek Culvert and Skew Culvert   | Changes in distance  | <u>Myrtle Creek Culvert:</u><br>monthly after 600m, weekly after 800m.<br><u>Skew Culvert:</u><br>monthly after 800m, weekly after 1000m  |
|  | Continuously monitor structural steel stress and tiltmeters in Myrtle Creek Culvert   | Steel stress, changes in tilt  | Hourly  |
|  | Conduct survey of settlement plates above Myrtle Creek Culvert  | Changes in height  | Weekly after 800m of extraction   |
|  | Visual inspection of track, culvert, headwalls and embankment of Myrtle Creek Culvert and Skew Culvert  | -  | Weekly after 800m of extraction   |

| Feature                                  | Survey or Inspection Regime  | Parameters to be measured  | Timing and Frequency<br>(may be increased if triggered by monitoring results)  |
|--|--|--|--|
| <b>Main Southern Railway (continued)</b> |  |  |  |
| Redbank Railway Tunnel                   | 3D survey of survey pegs inside tunnel and above tunnel  | Subsidence, changes in easting and northing (MGA coordinates)  | Monthly after 600m of extraction,  |
|  | Relative 3D survey of pegs above tunnel (Pegs 92.260km to 93.100km)<br><i>(Note this is an addition to Railway Management Plan following consultation with Industry &amp; Investment, NSW)</i>   | Subsidence, changes in easting and northing, tied into previous monthly absolute 3D survey           | Weekly after 850m of extraction  |
|  | Conduct 3D ground surveys along Remembrance Drive (Pegs RE50 to RE85)<br><i>(Note this is an addition to Railway Management Plan following consultation with Industry &amp; Investment, NSW)</i> | Subsidence, changes in easting and northing (MGA coordinates)  | Monthly after 600m of extraction<br>Fortnightly relative 3D survey tied into previous monthly absolute 3D survey after 1000m of extraction |
|  | Continuously measure fixed prisms inside tunnel with Automated Total Station   | Local easting, northing and level  | Hourly   |
|  | Tape extensometer surveys across base of tunnel  | Changes in distance  | Weekly after 600m of extraction  |
|  | Inclinometer surveys at tunnel (I-RBT4) and 2 locations I-TD2 & I-TD3  | Changes in vertical tilt at approx. 0.5 metre intervals along the borehole                           | Monthly (ongoing)<br>Weekly after 1500m of extraction  |
|  | Visual inspection of Tunnel and portals  | -  | Weekly after 1500m of extraction   |
|  | Detailed detection of new cracks by laser scan   | Local easting, northing and level at very fine resolution, capable of detecting cracks at 1 mm width | Baseline dilapidation survey<br>Monthly after 600m   |
|  | Structure clearance surveys  | Distance   | Before and after LW26  |

| Feature                                  | Survey or Inspection Regime   | Parameters to be measured  | Timing and Frequency<br>(may be increased if triggered by monitoring results)   |
|--|---|--|---|
| <b>Main Southern Railway (continued)</b> |   |  |   |
| Stock Tunnel                             | 3D survey of survey pegs above Stock Tunnel   | Subsidence, changes in easting and northing (MGA coordinates)                              | Monthly after 600m of extraction,   |
|  | Relative 3D survey of pegs above Stock Tunnel<br>(Pegs 92.260km to 93.100km)<br><i>(Note this is an addition to Railway Management Plan following consultation with Industry &amp; Investment, NSW)</i> | Subsidence, changes in easting and northing, tied into previous monthly absolute 3D survey | Weekly after 1200m of extraction  |
|  | Tape extensometer across base of tunnel<br><i>(Note this is an addition to Railway Management Plan following consultation with Industry &amp; Investment, NSW)</i>                                      | Changes in distance  | Baseline survey prior to 1000m of extraction  |
|  | Visual inspection   | -  | Twice weekly after start of LW26<br>Daily after 900m of extraction (~115m from track)<br>Twice weekly after substantial completion of mine subsidence movements when agreed by ARTC and I&I |
| Thirlmere Way Overbridge                 | 2D structure surveys of abutment and wingwalls of Overbridge  | 2D subsidence and distance   | Monthly after 800m of extraction  |
|  | Measure gap across deck of Overbridge above expansion joint   | Changes in distance  | Monthly after 800m of extraction  |
|  | Detailed building inspection of Overbridge by qualified building inspector  | -  | Monthly after 800m of extraction  |
| Tahmoor Railway Station                  | Platform clearance surveys  | Changes in distance  | Monthly after 800m of extraction  |

## **Appendix A - Drawings**

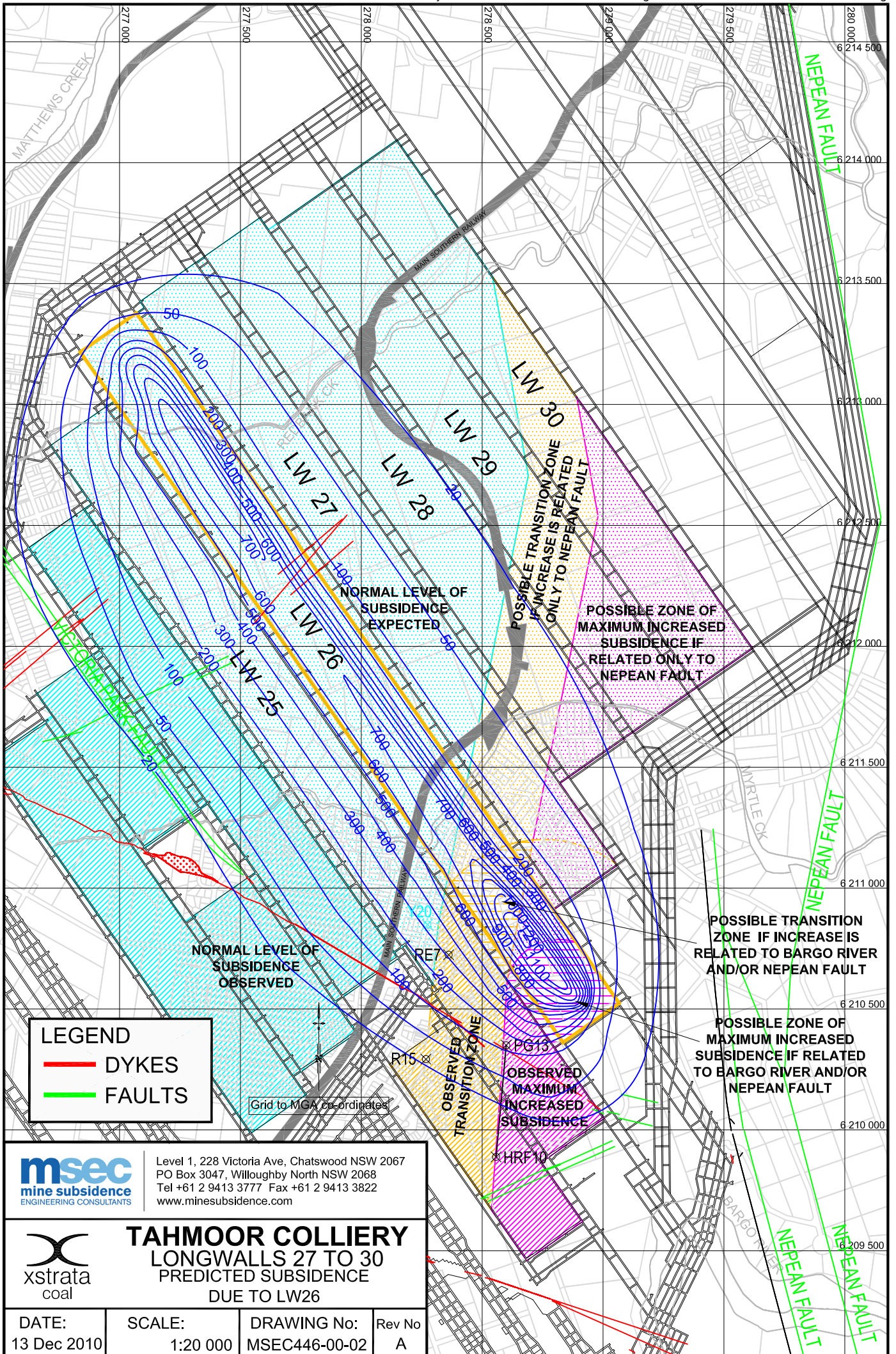


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**TAHMOOR COLLIERY  
LONGWALLS 27 TO 30  
OBSERVED INCREMENTAL SUBSIDENCE  
DUE TO LW25 AS AT 19-JAN-2010**

|                      |                    |                              |             |
|----------------------|--------------------|------------------------------|-------------|
| DATE:<br>13 Dec 2010 | SCALE:<br>1:20 000 | DRAWING No:<br>MSEC446-00-01 | Rev No<br>A |
|----------------------|--------------------|------------------------------|-------------|



**LEGEND**

- DYKES
- FAULTS

Grid to MGA coordinates

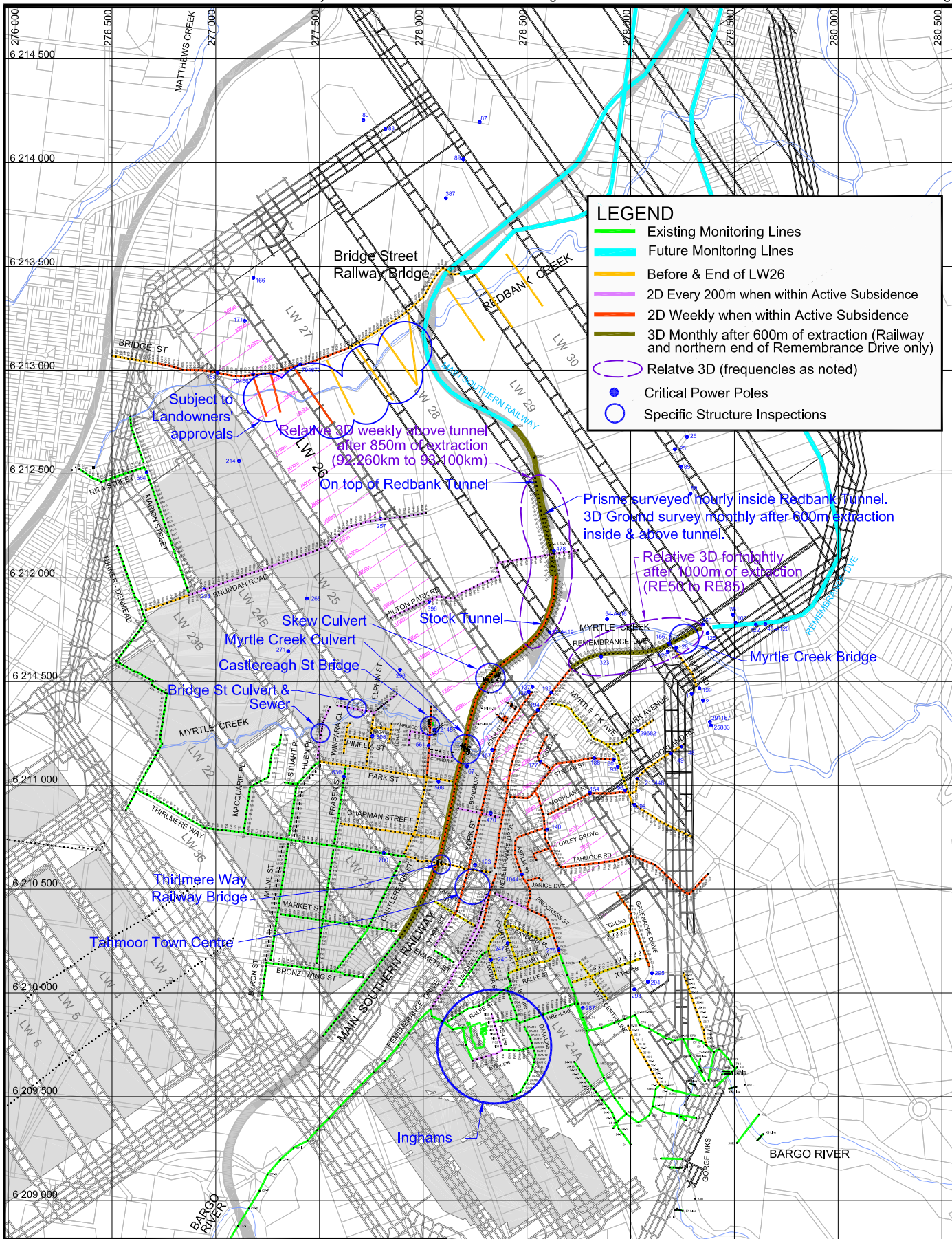


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**TAHMOOR COLLIERY**  
**LONGWALLS 27 TO 30**  
**PREDICTED SUBSIDENCE**  
**DUE TO LW26**

|                      |                    |                              |             |
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| DATE:<br>13 Dec 2010 | SCALE:<br>1:20 000 | DRAWING No:<br>MSEC446-00-02 | Rev No<br>A |
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**LEGEND**

- Existing Monitoring Lines
- Future Monitoring Lines
- Before & End of LW26
- 2D Every 200m when within Active Subsidence
- 2D Weekly when within Active Subsidence
- 3D Monthly after 600m of extraction (Railway and northern end of Remembrance Drive only)
- Relative 3D (frequencies as noted)
- Critical Power Poles
- Specific Structure Inspections

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**xstrata**  
coal

**TAHMOOR COLLIERY**  
MONITORING OVER  
TAHMOOR NORTH  
LONGWALL 26

|                    |                   |                              |              |
|--------------------|-------------------|------------------------------|--------------|
| DATE:<br>12-Sep-11 | SCALE:<br>1:25000 | DRAWING No:<br>MSEC446-00-03 | Rev No:<br>J |
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6 208 500  
6 208 000

BARGO RIVER

MERMAID POOL

GORGE RMS

Grid to MGA co-ordinates

## **Appendix B – Survey Specification by Lean & Hayward**

## **SPECIFICATIONS FOR SUBSIDENCE MONITORING LINES FOR LONGWALL 26.**

### 1. General Requirements

- 1.1. All surveys will be provided to the Tahmoor Colliery Mining Survey as digital Excel file/s.
- 1.2. *Survey and Drafting Directions for Mine Surveyors 2007(NSW Coal)* In particular *Section 3. (Survey Procedures)* will be complied with (see. [www.dpi.nsw.gov.au/minerals](http://www.dpi.nsw.gov.au/minerals) and use search).

### 2. Required Surveys

- 2.1. Levels to Australian Height datum (AHD) on each station of the subsidence line. (In order to obtain subsidence.)
- 2.2. Measured distance between each station of the subsidence line. (In order to obtain strains.)
- 2.3. MGA Co-ordinates of each station of subsidence lines where possible. (In order to obtain horizontal movement).
- 2.4. Valley closure stations at (or substitute stations placed in 'open-sky' positions) close to the top of the northern side of Bargo River Gorge shall be MGA coordinated. (In order to obtain horizontal movement before & after mining.)

### 3. Establishment

- 3.1. Each line will be established and initial readings taken prior to the influence of mine subsidence affecting the subsidence line; a minimum distance of 1000m from longwall extraction may be used as a guide. This timeframe will be nominated by Tahmoor Colliery and installation time frames agreed.
- 3.2. Care is to be taken that bench marks and control stations (GPS base stations) will be unaffected by ground movement (subsidence & horizontal movement) from future mining or current Longwall extraction. The location of these bench marks and control stations should be confirmed with Tahmoor Colliery before use.
- 3.3. In addition to 3.2. Control stations (GPS base stations) used for measurement of upsidence and valley closure at the top and bottom of Bargo River Gorge shall be minimum 1km from Bargo River Gorge.

### 4. Surveying Methods

- 4.1. ICSM SP1 refers to The Inter-Governmental Committee on Surveying and Mapping Special Publication 1 "Standards and Practices for Control Surveys".  
(see <http://www.icsm.gov.au/icsm/publications/sp1/sp1v1-7.pdf> )
- 4.2. One, or a combination of, the following survey methods may be used and target accuracy must be achieved. Primarily EDM survey methods will be used where possible. Other survey methods are included herein in the event that they are required in specific circumstances. Conventional subsidence method is currently only planned to be used around Ingham's plant buildings due to access limitations.
- 4.3. EDM Methods ~ For both Subsidence & Strain and Three Dimensional Survey Traversing
  - 4.3.1. Conventional Theodolite/EDM levelling traverse for measuring subsidence & strain.
  - 4.3.2. Additional survey for three dimensional location of subsidence marks by conventional Theodolite/EDM traverse adjusted between GPS Baseline(s).
  - 4.3.3. Height Datum to be carried through traverse by height traversing.

- 4.3.4. Maximum traverse line length 150 metres.
- 4.3.5. Maximum intermediate line length 80 metres.
- 4.3.6. Target at each subsidence station to generally be either a handheld miniprism or prism & fixed pole with dual-support for stability.

#### 4.4. Conventional Subsidence Method.

- 4.4.1. Distances between stations (In order to obtain strains.) measured by a standardised steel band with corrections made for sag and temperature.
- 4.4.2. Alternatively, particularly in steep terrain or where there are objects on ground between stations that prevent steel band measurement. Distances between stations (In order to obtain strains.) measured by EDM.
- 4.4.3. Subsidence will be measured to the target accuracy and will start and finish on datum unaffected by ground movement (subsidence).
- 4.4.4. Levels will be measured with a digital level, lengths of back sights and foresights are to be equal and no more than 50m.
- 4.4.5. The digital level will be tested to prove it is in adjustment immediately prior to use.
- 4.4.6. This method is currently only planned to be used around Ingham's plant buildings due to access limitations.

#### 4.5. GPS Survey Control for Three Dimensional Survey of Subsidence Lines:

- 4.5.1. Establishment of Site GPS Base Stations. Site Base Stations located not closer than 2 kilometres from active subsidence.
- 4.5.2. Site GPS Base Stations are to be monitored periodically (typically start and end of Long Walls) by connection to an established stable 'outer' network of GPS Stations.
- 4.5.3. GPS Baselines are to be surveyed relative to a Site GPS Base Station. Baselines are then used for the adjustment of Theodolite/EDM traverse lines locating subsidence marks in three dimensions (MGA~AHD).

#### 4.6. Bargo River Gorge:-

- 4.6.1. Bargo river gorge is heavily vegetated. Relative survey is carried out both for Valley closure across the top of the gorge and also over selected rockbars within the gorge.
- 4.6.2. Relative movement of valley closure and upside is measured, where possible, by theodolite/EDM survey from stations placed at the top of the northern side of the Gorge.
- 4.6.3. Where relative survey from the top to the bottom of the gorge is impossible, due to terrain considerations, valley closure and rockbar surveys are carried out independently of each other.
- 4.6.4. Valley Closure is measured to fixed reflectors placed in rock on the southern side of the Gorge.
- 4.6.5. Relative survey, where possible, from the top to the bottom of the gorge is carried out by theodolite/EDM. Height differences and slope/horizontal distances are measured in both directions and in both theodolite faces.
- 4.6.6. Valley closure stations (or substitute stations placed in 'open-sky' positions) close to the top of the northern side of Bargo River Gorge shall be surveyed for MGA coordinates relative to Site GPS Base Station. (In order to obtain horizontal movement before & after mining.)

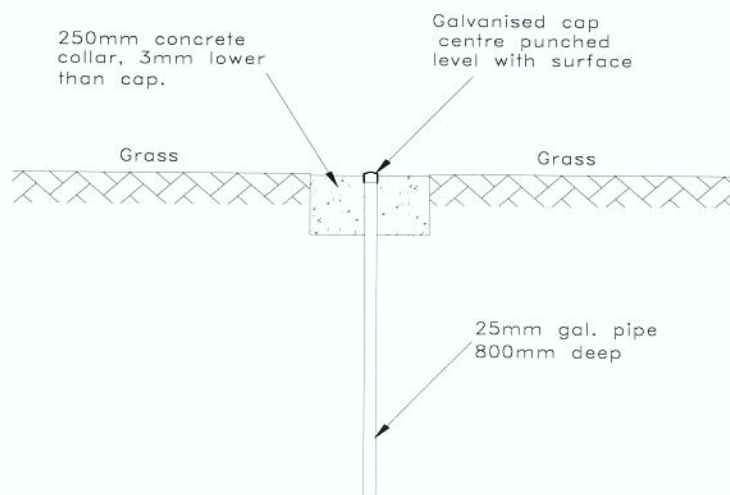
#### 5. Target Accuracies

- 5.1. Target Accuracies for monitoring surveys shall be as follows:
  - Differential Levelling (Digital Level) - 1.5mm per kilometre of double run.
  - Differential Levelling (Theodolite) to an accuracy of  $\pm 5$ mm.
- 5.1.1. Strain distances measured to an accuracy of  $\pm 5$ mm (Strain 0.25mm/m over a 20 m bay) for measurement by EDM/theodolite traverse & to an accuracy of  $\pm 2.5$ mm (Strain 0.13mm/m over a 20 m bay) for measurement by steel band.
- 5.1.2. Traversing shall be minimum Class D or LC as prescribed in ICSM SP1 or better.

- 5.1.3. Co-ordinates derived from horizontal movement surveys (by traverse &/or GPS) shall have an absolute accuracy of  $\pm 20\text{mm}$  or better (Relative two dimensional accuracy of  $\pm 5\text{mm}$ ).
- 5.1.4. The horizontal distance between the Bargo Gorge valley closure monitoring points will be surveyed to an accuracy of  $\pm 5\text{ mm}$ . The relative vertical height between the points will be surveyed to an accuracy of  $\pm 10\text{ mm}$ .
- 5.1.5. The surveys along the rockbar monitoring lines along the base of the Bargo gorge will be surveyed to an accuracy of  $\pm 3\text{ mm}$  (horizontal or vertical) from the local datum. The datum will be connected to AHD where possible from survey marks at the tops of the Gorge to an accuracy of  $\pm 10\text{ mm}$ . The survey marks at the tops of the Gorge are connected to AHD along monitoring lines that extend beyond the subsidence area, in accordance with Section 5.1.1.

## 6. Subsidence Station Placement

- 6.1. Installation. Subsidence stations are to be installed level or below the ground and in such a way so as not to become a danger or hazard (to the public, railway employees or other persons).
- 6.2. Location. Subsidence stations are to be installed in locations that will not be damaged or run over by vehicles. Where subsidence stations are located in a position near where vehicles or other equipment may access, the location of the subsidence station should be clearly indicated with an adjacent stake or other warning marker.
- 6.3. Spacing. All subsidence stations are to be placed at nominal 20 metre intervals and in a straight line where possible.
- 6.4. Line length. The subsidence line will cover the area affected by mining and shall be specified by Tahmoor Colliery.
- 6.5. Station type. The subsidence stations are generally to be 20mm diameter galvanised pipe, approximately 800mm length, driven into the ground, capped and centre punched (or rivet placed), together with a concrete collar (as shown below).  
Where an area of bitumen or concrete needs to be crossed marks may be installed as a galvanized iron nail, ramset nail or drill hole.  
Mini prisms or equivalent, attached permanently to rock, can be used for the Bargo River Gorge.



- 6.6. Placement in footpaths and locations of Utility/Service providers. Utilities and services are not to be damaged by the subsidence stations.
- 6.6.1. Railway Corridor. The location of utilities and services needs to be ascertained from the appropriate rail authority and confirmed prior to installation of the subsidence survey line.

7. Monitoring frequency

The lines will be established and surveyed initially before subsidence affects the line.

Various timing for resurvey frequency may be requested by the Tahmoor Colliery based on the requirements of the Subsidence Management Plans. The frequency may be 3 monthly, 1 monthly, bi-weekly, weekly or daily.

A final survey will be completed at the end of each longwall before the area is affected by extraction of the next adjacent longwall.

Please refer to Tahmoor Colliery Subsidence Management Plans for survey frequencies.

8. Reports

The following information shall be included in the report:

- 8.1. Date of survey.
- 8.2. Name, location and RL of bench mark and or GPS Base station used.
- 8.3. When requested a summary stating maximum values of subsidence, tensile(+ve) strain, compressive(-ve) strain and horizontal movement of the current survey. Reports can also state if any visual subsidence impacts were observed.
- 8.4. Excel table showing subsidence results of current survey. This is to be supplied as digitally.
- 8.5. Single graph showing subsidence of all resurveys. This is to be supplied as a digital Excel file.
- 8.6. Single graph showing strain of all resurveys. This is to be supplied as a digital Excel file.
- 8.7. Any other relevant information required by the Surveyor.

9. Additional Information

Tahmoor Colliery will provide an AutoCAD file of the Mine Workings if required.

Tahmoor Colliery will provide an Excel file to be used as a template.

Yours faithfully,  
**Lean & Hayward Pty Limited**  
**Gary Warren**  
**Registered Surveyor**  
PO Box 232  
Campbelltown NSW 2560  
Ph: 02 4640 8222  
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**Tahmoor Colliery Contacts:**

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Community & SMP Coordinator  
Tahmoor Colliery  
Tel 02 4640 0133  
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## **Appendix C – Survey Specification by Meadows Consulting**

**11 April 2011**

## **Main Southern Rail Line- Survey Monitoring Plan for LW26**

This document defines the Survey Monitoring Plan for the Main Southern Rail Line at Tahmoor with regard to the mining of Longwall 26 for Tahmoor Coal Pty Ltd.

This plan has been developed in consultation with the rail monitoring sub-committee, taking into account the concurrent monitoring activities planned for the rail corridor (strain gauges, expansion switches, manual and mechanized track inspection etc.). The survey measurements are designed to supplement these tasks and support the overall monitoring regime.

Corridor survey marks are galvanised pipe or star picket, flush to ground, set in concrete on Up side of track. Currently installed from 92.260 km to 95.300 km. A second survey mark has been installed to improve survey efficiency. This mark is a star picket driven until 0.5 metres above ground level, with a steel spigot on top for placement of the survey prism. These secondary marks run from 92.760 km to 94.600 km.

Proposed monitoring frequencies and methodologies are defined in Table below.

### **Surveys**

#### **Main South Rail Line**

1. Absolute 3D position (reported in MGA coordinates/ AHD heights) of all rail corridor marks (at 20 metre nominal centres) prior to longwall commencement and at completion. Monthly 3D surveys cover 92.260 km to 94.700 km. Surveys performed using static differential GPS techniques and conventional traversing.
2. Absolute 2D subsidence and strain line survey of established monitoring stations in rail corridor at 20 metre nominal centres - 92.260 km to 94.700 km. Levels and strains determined by Leica TCRA 1102 total station.

3. Longitudinal rail creep at anchor points and expansion switch bearer movement. In conjunction measure long bays between each expansion switch and intermediate anchor points. Measurements determined by Leica TCRA 1102 total station.

### **Redbank Tunnel**

Absolute 3D position (reported in MGA coordinates/ AHD heights) of rail corridor marks, placed inside and above tunnel. Surveys performed using static differential GPS techniques and conventional traversing.

### **Myrtle Creek Culvert and Skew Culvert**

Absolute 3D monitoring of upstream, downstream and above survey marks. Surveys performed using static differential GPS techniques and conventional traversing.

2D monitoring of upstream and downstream survey marks. Levels and strains determined by Leica TCRA 1102 total station.

Relative 3D monitoring of strengthening ribs inside culvert, wing-wall supports and brick headwall using fixed prisms for Myrtle Creek. Relative 3D monitoring of survey points inside steel liner for skew culvert. Prisms/survey marks monitored with TCRA 1102 total station.

### **Thirlmere Way Overbridge**

Monitoring planned for overbridge is consistent with that undertaken for Longwall 25, namely subsidence, abutment/ wingwall tilts, and abutment strain measurements. Existing control points in structure are to be used. The measurements are undertaken with spirit level and Leica TCRA 1102 total station.

### **Tahmoor Platform**

Clearance surveys conducted at nominated locations for both Up and Down Platforms. Surveys measure offset clearance to platform, comparing measured values with design requirements.

## **SURVEY REPORTING**

Survey results will nominally be reported within 24 hours of the completion of survey. Results will be forwarded electronically in Excel spreadsheets to relevant parties.

John Rolles  
Meadows Consulting



| Location  | Description   | Frequency  | Targeted Accuracy / Survey Methodology   |
|---|---|--|--|
| <p><u>Thirlmere Way Overbridge</u></p> <p><u>Tahmoor Platform</u></p> | <p>Relative 3D monitoring of fixed prisms on supporting structures and headwall/steel liner</p> <p>Subsidence monitoring. Tilt and strain monitoring of Abutments and Wingwalls</p> <p>Clearance monitoring</p> | <p>- Monthly once LW26 has extracted 600m (800m for skew culvert)</p> <p>- Weekly once LW26 has extracted 800m (1000m for skew culvert)</p> <p>- End of LW26</p> <p>- Monthly once LW26 has extracted 800m</p> <p>- Monthly once LW26 has extracted 800m</p> | <p>Relative 3D +/- 2 mm with TCRA 1102 total station</p> <p>Vertical +/- 2 mm with digital level</p> <p>Tilts with extended spirit level +/- 2 mm</p> <p>Strains with steel tape +/- 3 mm.</p> <p>Offset measurements +/- 3 mm with steel tape</p> |