mine subsidence ENGINEERING CONSULTANTS

TAHMOOR UNDERGROUND
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GLENCORE:

Tahmoor Colliery - Longwall 30

Subsidence Monitoring Programme – Revision A

AUTHORISATION OF MANAGEMENT PLAN

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Date:	18-05-2016

DOCUMENT REGISTER

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.
Mar-12	MSEC446-00	G	Update on monitoring at Redbank Creek
Sep-12	MSEC567-00	A	Updated for Longwall 27
Oct-12	MSEC567-00	B	Final for Longwall 27
May-13	MSEC567-00	C	Updated for Main Southern Railway
May-13	MSEC567-00	D	Minor clarifications following feedback from DTIRIS
Jun-13	MSEC567-00	E	Update of locations of new monitoring points along railway corridor
Aug-13	MSEC567-00	F	Information on monitoring of Redbank Creek Culvert updated.
Mar-14	MSEC646-00	A	Draft for Longwall 28
Mar-14	MSEC646-00	B	Final for Longwall 28
Sep-14	MSEC646-00	C	Updated for Longwall 28 to include Redbank Creek Culvert and Bridge Street Overbridge
Nov-14	MSEC646-00	D	Updated for Longwall 28 following feedback from DTIRIS
Mar-15	MSEC746-00	A	Updated for Longwall 29
May-15	MSEC746-00	B	Updated re Stilton Dams
Sep-15	MSEC746-00	C	Updated for Longwall 29 to include Redbank Creek Culvert and Bridge Street Overbridge
Sep-15	MSEC746-00	D	Updated for Redbank Creek surveys
May-16	MSEC815-00	A	Updated for Longwall 30

References:-

AS/NZS 4360:1999 Risk Management

Tahmoor Colliery Longwalls 27 to 30 - The Prediction of Subsidence Parameters and the Assessment of Mine Subsidence Impacts on Natural Features and Items of Surface Infrastructure due to mining Longwalls 27 to 30 at Tahmoor Colliery in support of the SMP Application. (Report MSEC355, Revision B, July 2009), prepared by Mine Subsidence Engineering Consultants

CONTENTS

Tables

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

Figures

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

Drawings

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

Drawing No.	***Description***	***Revision***
MSEC815-00-01	Monitoring over LW30	A
MSEC747-205	Main Southern Railway – Embankment LW30	A
MSEC747-206	Main Southern Railway – Cutting LW30	A
MSEC747-208	Monitoring Plan Culvert and Embankment at 90.676 km for LW30	B
MSEC787-02	Redbank Creek Culvert Monitoring Plan	A
MSEC787-04	New Bridge Street Overbridge Monitoring Plan	A
MSEC787-05	Bridge Street Overbridge Cutting Monitoring Plan	A
MSEC815-15-02	Stilton Dams Monitoring	A

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 Glencore. Tahmoor Colliery has previously mined 29 longwalls to the north and west of the mine's current location.

Longwall 30 is a continuation of a series of longwalls that extend into the Tahmoor North Lease area, which began with Longwall 22. The longwall panels are located between the Bargo River in the south-east, the township of Thirlmere in the west and Picton in the north.

Longwall 30 is approximately 283 metres wide (rib-to-rib) and approximately 2.3 kilometres long. The width of the chain pillar between Longwalls 29 and 30 is 39 metres.

This Subsidence Monitoring Programme 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 27 to 30 – Natural Features Subsidence Management Plan* (Revision I), November 2012.
- *Tahmoor Colliery Longwalls 28 to 30 Wollondilly Shire Council Management Plan* (Revision A), Report No. MSEC646-02, March 2014.
- *Tahmoor Colliery Management Plan for Potential Impacts to Potable Water Infrastructure due to the mining of Longwalls 28 to 30* (Revision A), Report No. MSEC646-03, January 2014.
- *Tahmoor Colliery Management Plan for Potential Impacts to Sydney Water Sewer Infrastructure due to the mining of Longwalls 28 to 30* (Revision A), Report No. MSEC646-04, February 2014.
- *Tahmoor Colliery Management Plan for Potential Impacts to Gas Infrastructure due to the mining of Longwall 30* (Revision A), Report No. MSEC815-05, February 2016.
- *Management Plan Longwall Mining (LW 29 & LW30) beneath Telstra Plant @ Tahmoor and Thirlmere NSW*, Colin Dove, 2015.
- *Tahmoor Colliery Management Plan for Potential Impacts to Built Structures due to the mining of Longwalls 28 to 30* (Revision A), Report No. MSEC646-12, March 2014.
- *Tahmoor Colliery Management Plan for Potential Impacts to Items of Heritage Significance due to the mining of Longwalls 28 to 30* (Revision A), Report No. MSEC646-13, March 2014.
- *Tahmoor Colliery Management Plan for longwall mining beneath the Main Southern Railway, Revision B (Longwalls 29 to 30)*, Report No. MSEC747, June 2015.
- *Tahmoor Colliery Management Plan for longwall mining beneath the Redbank Creek Culvert and Embankment and Bridge Street Overbridge, Revision B (Longwalls 29 and 30)*, Report No. MSEC787, September 2015.

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 of and 450 metres behind the active longwall face, as shown by Fig. 1.1.

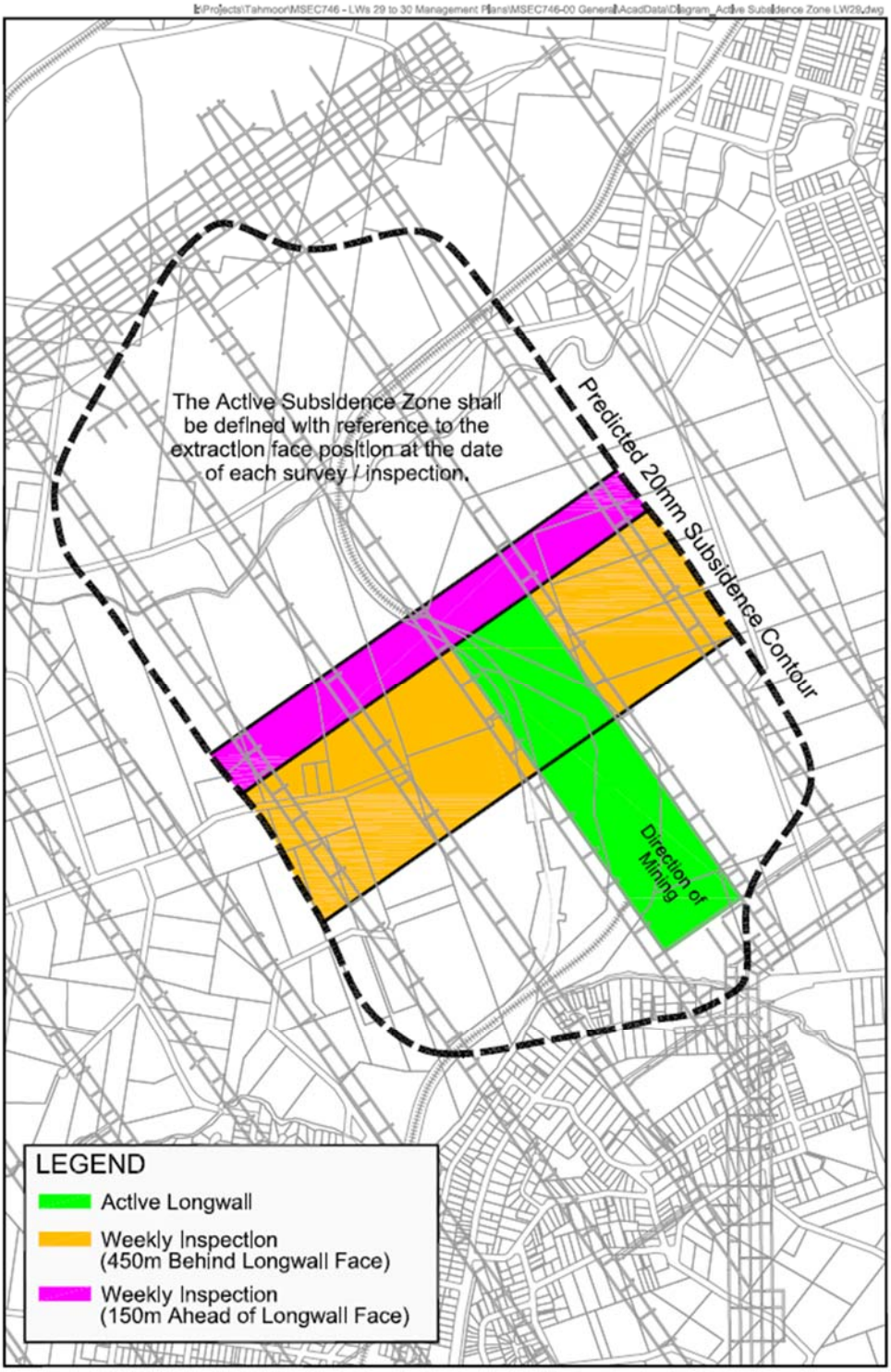


Fig. 1.1 Diagrammatic Representation of Active Subsidence Zone

1.3. Maximum Predicted Systematic Parameters

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

A summary of the maximum predicted incremental systematic subsidence parameters, due to the extraction of Longwall 30, is provided in Table 1.1. A summary of the maximum predicted cumulative systematic subsidence parameters, after the extraction of Longwall 30, is provided in Table 1.2.

Table 1.1 Maximum Predicted Incremental Systematic Subsidence Parameters due to the Extraction of Longwall 30

Longwall	Maximum Predicted Incremental Subsidence (mm)	Maximum Predicted Incremental Tilt (mm/m)	Maximum Predicted Incremental Hogging Curvature (1/km)	Maximum Predicted Incremental Sagging Curvature (1/km)
After LW30	725	5.8	0.06	0.13

Table 1.2 Maximum Predicted Cumulative Systematic Subsidence Parameters after the Extraction of Longwall 30

Longwall	Maximum Predicted Cumulative Subsidence (mm)	Maximum Predicted Cumulative Tilt (mm/m)	Maximum Predicted Cumulative Hogging Curvature (1/km)	Maximum Predicted Cumulative Sagging Curvature (1/km)
After LW30	1270	6.3	0.09	0.14

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

1.4. Observed Subsidence during the mining of Longwalls 22 to 29

The extraction of longwalls at Tahmoor Colliery has generally resulted in mine subsidence movements that were typical of those observed above other collieries in the Southern Coalfield of NSW at comparable depths of cover.

However, observed subsidence was greater than the predicted values over Longwalls 24A and the southern parts of Longwalls 25 to 27. Please refer to details provided in the LW29 Subsidence Monitoring Programme (Report No. MSEC746-00, Revision D).

Monitoring during the mining of Longwalls 28 and 29 have found that subsidence behaviour has returned to normal levels.

Ground surveys will continue to be undertaken above Longwall 30, including a survey line which runs along the longwall centreline at the commencing end. The survey results will be checked against predictions to confirm whether subsidence continues to develop in a normal manner during the mining of Longwall 30.

2.1. Layout of Monitoring Points

The layout of monitoring points is provided in Drawing No. MSEC815-00-01, which is included in Appendix A. Due to the density of survey marks, detailed layouts of monitoring points for key items of railway infrastructure are also included in Appendix A.

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 Longwall 30*, by SMEC. 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 LW29 and LW30* by Southern Rail Surveys. This specification is appended to this Subsidence Monitoring Programme.

Occasionally survey pegs become disturbed or lost. Tahmoor Colliery will replace the lost pegs unless approval for not replacing the pegs is provided by DTIRIS.

With respect to specialist monitoring undertaken within the railway corridor, including automated monitoring of rail stress, rail temperature and switch displacement, and automated total station monitoring in the vicinity of the geological fault at 92.850 km, please refer to details provided in the Railway Management Plan (Report No. MSEC747).

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 Longwall 30*, by SMEC and *Main Southern Rail Line- Survey Monitoring Plan for LW29 and LW30*, by Southern Rail Surveys. These specifications are appended to this Subsidence Monitoring Programme.

Survey results will be issued to NSW Department of Trade and Investment, Regional Infrastructure and Services, Division of Resources and Energy (DTIRIS) within 2 business days 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 Table 2.1. 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*".

In the case of the Main Southern Railway, the extent of ground surveys, track geometry surveys and track inspections along the rail corridor will grow to the north with the advancing longwall face during the mining of Longwall 30. This is described in Section 4.3 of the Railway Management Plan (Report No. MSEC747) and summarised as follows:

- Stage 1 – Early subsidence period
  - Monthly ground surveys are undertaken at survey marks nominally when the longwall face approaches to within 400 metres of each section of railway track.
- Stage 2 – Active subsidence period
  - Weekly ground surveys are undertaken at survey marks nominally when the longwall face approaches to within 200 metres of each section of railway track.
- Stage 3 – Post active subsidence period
  - Progressive reduction in monitoring and inspection frequencies and extents for the railway track, embankments, culverts and cuttings, in accordance with the Railway Management Plan
  - Progressive reduction does not commence until the longwall face has passed each section of track by more than 400 metres, and subject to a review of actual monitoring data and approval by ARTC via the governance meeting.

As mining progresses, monitoring measures for each section of track or associated rail infrastructure will progressively migrate from Stage 1 to Stage 2 and, subject to approval by ARTC, Stage 3. An example of the staged monitoring process is provided in Fig. 2.1.

In the case of the Main Southern Railway, when Stage 3 is reached for each section of track or item of infrastructure, Tahmoor Colliery will not reduce monitoring frequencies or stop monitoring until agreed by ARTC (via recommendation by the Rail Management Group). ARTC can agree to the proposed reduction during an ARTC / Tahmoor Colliery governance meeting as recorded by minutes of the meeting and reconfirmed separately in writing or email. The NSW Department of Trade and Investment, Regional Infrastructure and Services, Division of Resources and Energy (DTIRIS) and the Office of the National Rail Safety Regulator (ONRSR) will be informed of the change separately in writing.

In the case of other infrastructure, survey and inspection frequencies will not be reduced until agreed by DTIRIS and relevant stakeholders, unless stated in the attached Table 2.1 of this Monitoring Programme.

Increased subsidence

Increased subsidence was observed at the southern or commencing ends of Longwalls 24A and 25, and to a lesser extent Longwalls 26 and 27.

Observed subsidence above the commencing ends of Longwalls 28 and 29 have returned to normal levels, and are consistent with observed subsidence elsewhere at Tahmoor.

In the case of Longwall 30, a survey line will be installed above the commencing end of Longwall 30 along the centreline. These lines will be surveyed on a weekly basis regardless of whether normal or increased subsidence develops. The survey frequency could be increased if required, based on actual monitoring data.

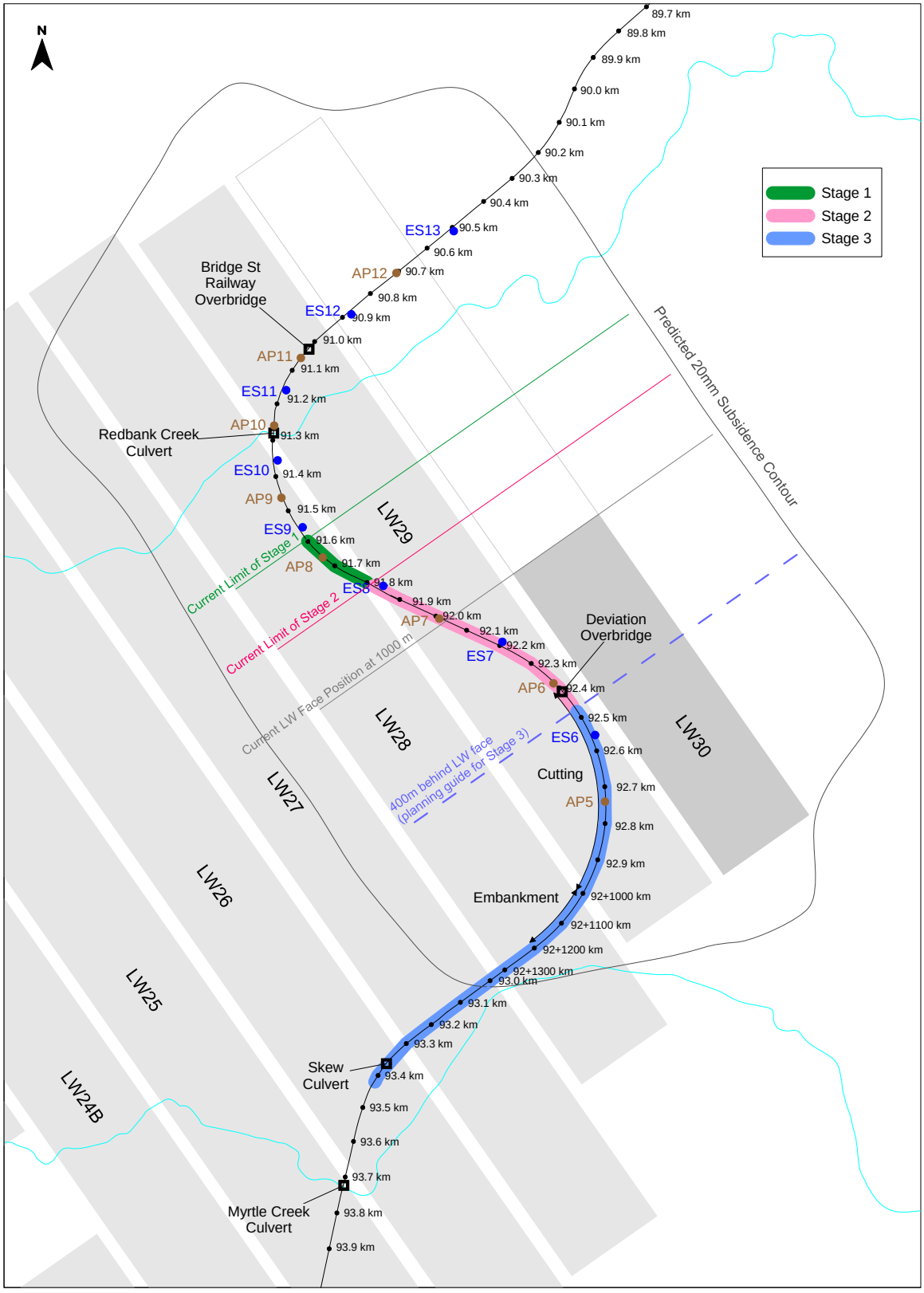


Fig. 2.1 Conceptual diagram showing stages of management during mining of Longwall 30 at 1000 metres of extraction

2.5. Surveys at Redbank Creek

Monitoring of valley closure over long bay lengths is conducted using absolute and relative 3D survey techniques. A survey line has been installed with pegs spaced approximately every 50 metres along the southern side of the valley, where the land has already been cleared. Valley closure can be calculated from changes in horizontal distance between these pegs and those located every 20 metres along Bridge Street.

A partial cross line has been installed above previously extracted Longwall 26 along a fence line, where surveyors have found a clear line of sight to Bridge Street from the southern bank. A complete cross line has also been installed within the rail corridor and at two other locations downstream of the railway crossing. These cross lines will provide information on the distribution of valley closure across Redbank Creek plus enable the surveyors to connect between the two main monitoring lines.

Following a review of valley closure data after the mining of Longwall 29, it is proposed to maintain the survey methodology adopted for Longwall 28, which is to focus weekly surveys for the section of Redbank Creek above Longwalls 29 to 31, with monthly survey above Longwalls 28 to mid panel of Longwall 32. The following surveys are proposed on either side of Redbank Creek:

- Prior to 1300m of extraction, baseline absolute 3D survey new pegs along Henry Street, new pegs extended along Bridge Street northeast of Peg BG126, and new pegs along the THC Line between Redbank Place and Remembrance Drive (Argyle Street).
- Monthly relative 3D surveys from Pegs RK11 to RK40 and from Pegs BG61 to BG126 after 1300 metres of extraction
- Weekly relative 3D surveys from Pegs RK17 to RK40 and from Pegs BG76 to BG126 after 1500 metres of extraction.
- Absolute 3D survey at completion of Longwall 30.

2.6. Surveys at the Railway Cutting

Ground survey marks have been installed in the Railway Cutting in the new Deviation.

Pegs have been installed in the cutting at the locations shown in Drawing No. MSEC747-206, and will be surveyed during the mining of Longwall 30. The surveys will be undertaken by traditional ground survey across the full monitoring site by Southern Rail Surveys.

In addition to the above, automated total station monitoring of track geometry will be undertaken in the vicinity of the fault at 92.850 km. Prisms are spaced every fourth sleeper (nominally 2.4 metres apart) as shown in Fig. 2.2.

The total stations also measure selected prisms on the cutting faces and benches at the locations shown in Fig. 2.2.

The monitoring system consists of the following features:

- Two automated total stations (TS1 and TS2). The total stations are located across the track from each other. TS1 is located on top of the bench at the Downside cutting, at the same position that manual total station surveys are undertaken by Southern Rail Surveys, and as such, it can monitor positions of survey prisms on the cutting faces and benches. TS2 is located on top of the bench at the Upside cutting and monitors survey prisms on the Down track.
- Associated loggers, cabling and other electrical and IT support systems.
- An automated weather station at TS1 to record rainfall and atmospheric pressure.
- Readings will be undertaken every 2 hours.

Further details are provided in the Railway Management Plan (Report No. MSEC747).

Photographs of the automated total station system are provided in Fig. 2.3 to Fig. 2.6.

The purposes of the automated total stations are:

- to detect potential differential subsidence movements across the identified fault near 92.850 km on the railway track and on the cutting faces
- to detect ground movements on the cutting face on the Up side in the vicinity of the fault plane, which has been stabilised by reshaping of the batter profile.

The ground surveys are part of a broader monitoring plan that includes weekly track geometry surveys and visual inspections in the vicinity of the fault, rail stress and switch displacement gauges.

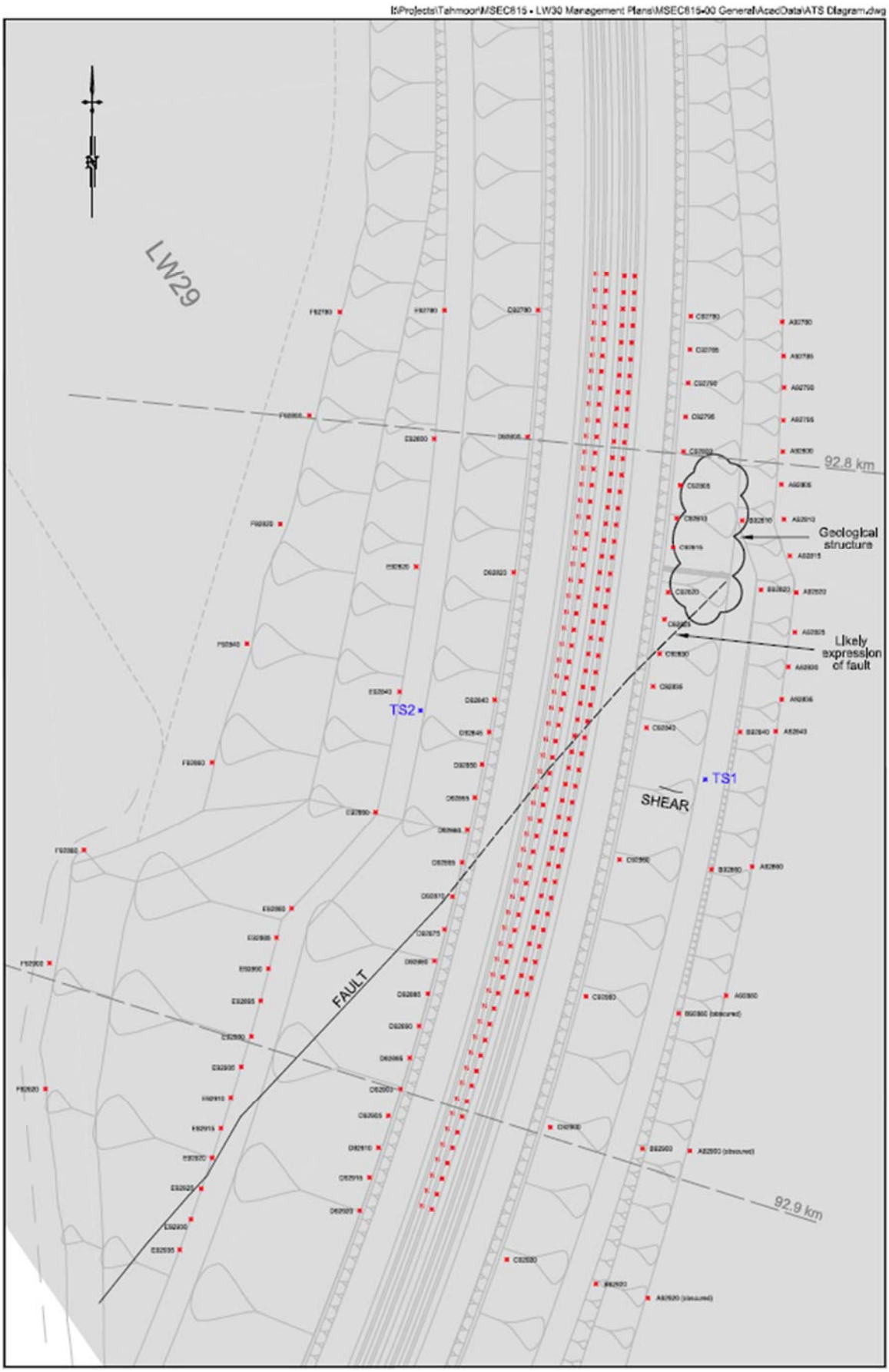


Fig. 2.2 Location of survey prisms that will be continuously monitored by Automated Total Stations in the Cutting about the geological fault at 92.850 km

Fig. 2.3 Total Station 1 with weather station

Fig. 2.4 Prisms on Up track looking south facing Total Station 1

Fig. 2.5 Typical survey prism on railway sleeper

Fig. 2.6 Total Station 1 and 2 across the railway track

2.7. Surveys at the Railway Embankment

Ground survey marks have been installed at the Railway Embankment in the new Deviation. The purpose of the surveys is to measure absolute and differential movements at the embankment, which will provide information on areas to focus on during visual inspections for signs of distress in the embankment.

The locations of the survey marks are shown in Drawing No. MSEC747-205. The marks were installed during the early stages of mining Longwall 27. Due to bulk earthworks to reshape the southern end of the cutting during Longwall 28, new prisms were installed and a baseline survey completed prior to the commencement of Longwall 29.

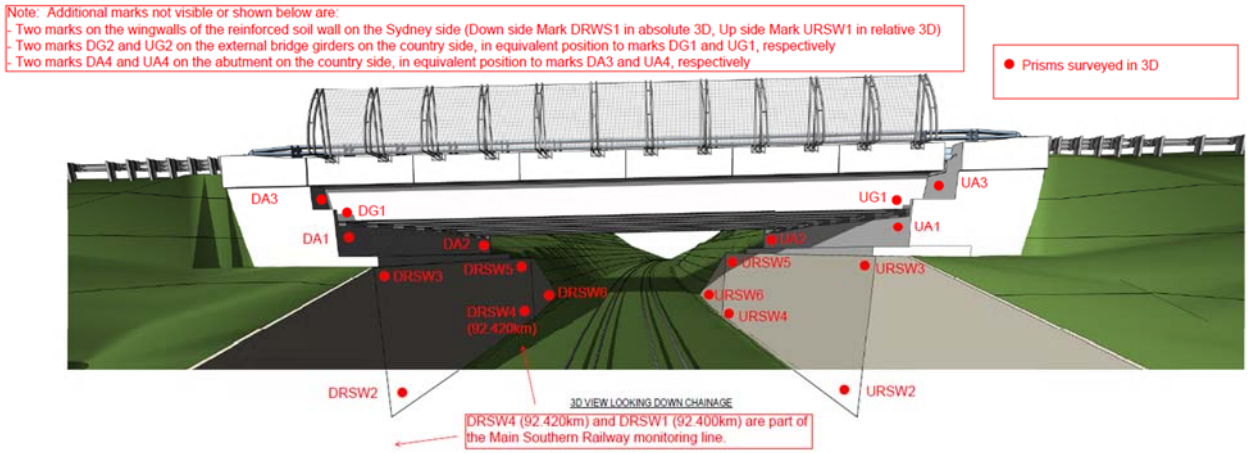
The ground surveys within the railway corridor are undertaken by Southern Rail Surveys.

The ground surveys are part of a broader monitoring plan that includes track geometry surveys, visual inspections, rail stress gauges and expansion switch displacement sensors.

2.8. Surveys of Deviation Overbridge at 92.400 km

A network of pegs have been installed and surveyed at the Deviation Overbridge at 92.400 km. A diagram showing the location of survey marks on the Deviation Overbridge is provided in Fig. 2.7. The layout of marks in plan view is shown in Drawing No. MSEC747-206. A photograph showing survey prisms is provided in Fig. 2.8.

The purpose of the surveys is to detect potential differential movements between the abutments, the reinforced soil walls, the bridge deck, the natural ground and the engineered fill between the abutments and the natural ground behind them.



Design Image courtesy GHD

Fig. 2.7 Location of monitoring points on Deviation Overbridge at 92.400 km

Fig. 2.8 Survey prisms located on abutment and bridge deck of Deviation Overbridge at 92.400 km

2.9. Monitoring and inspections at Redbank Creek Culvert (RBCC)

It is intended to maintain the management and monitoring measures for the Redbank Creek Culvert during the mining of Longwall 30, subject to a review by Tahmoor Colliery, ARTC and Rail Management Group. A description of the planned monitoring measures and inspections are described below.

2.9.1. Ground Monitoring

The following ground surveys will be undertaken by Tahmoor Colliery during mining.

- Absolute and relative 3D surveys of the RBCC and the embankment
- Absolute and relative 3D surveys of survey marks within the RBCC.
- Absolute and relative 3D surveys of the RBCC wingwalls and headwalls

Track monitoring will also be undertaken in the vicinity of the RBCC, and this is discussed in the Railway Management Plan.

2.9.2. Monitoring of the RBCC and embankment

The following monitoring will be undertaken during the mining of Longwall 30:

- Tape extensometer monitoring within the barrel of the RBCC and across the wingwalls, as per the network installed and monitored during the mining of Longwalls 27, 28 and 29. The layout of the tape extensometer marks is shown in Fig. 2.9.
- Vertical inclinometer monitoring at boreholes RBCC01 to RBCC04 as undertaken during the mining of Longwalls 27, 28 and 29. The locations are shown in Fig. 2.11.
- Horizontal extensometers across the crest of the embankment at three locations shown in Fig. 2.11. Details of the crest extensometers are shown in Fig. 2.10.
- Piezometer monitoring in the open standpipe and at the culvert inlet at the locations shown in Fig. 2.11.
- Visual inspections of the RBCC including the secondary culvert and the embankment during mining by the Track Certifier and geotechnical engineer. The geotechnical engineer will provide guidance for daily inspections by the Track Certifier.

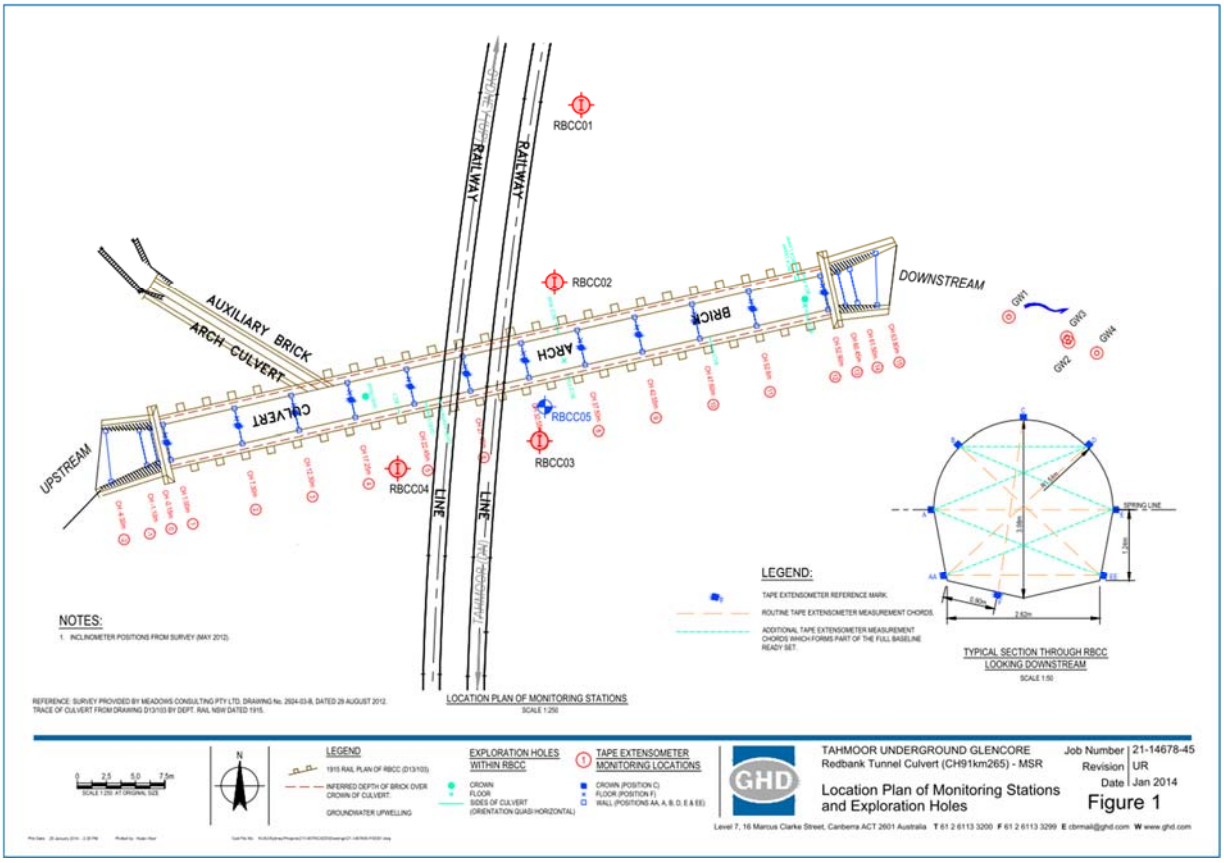


Fig. 2.9 Location of tape extensometer points within RBCC

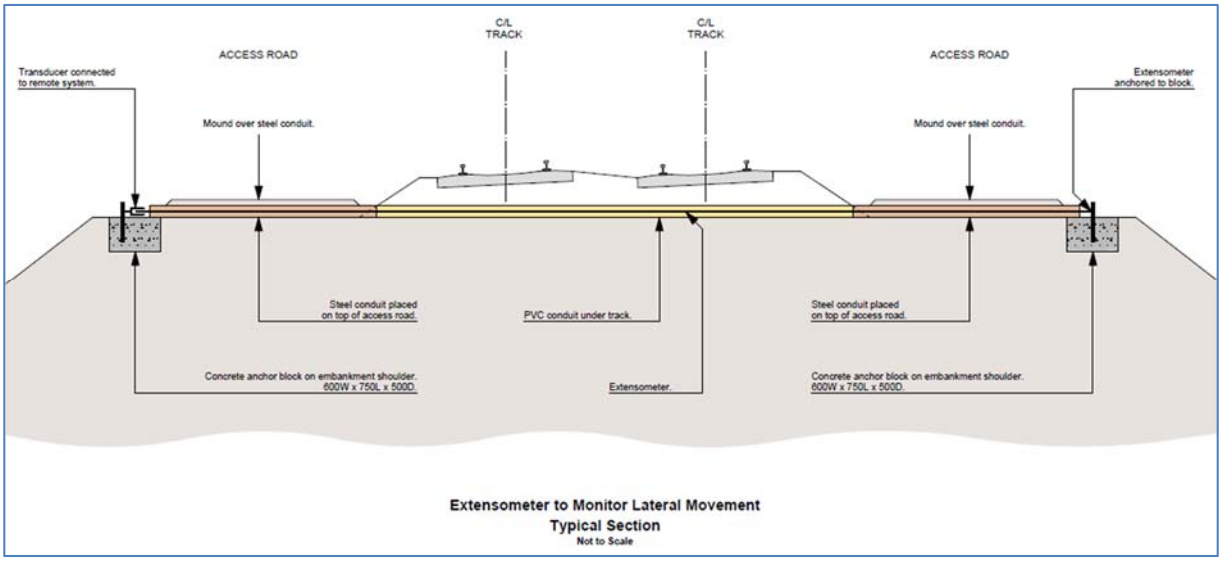


Fig. 2.10 Details of proposed extensometers across the crest of the embankment

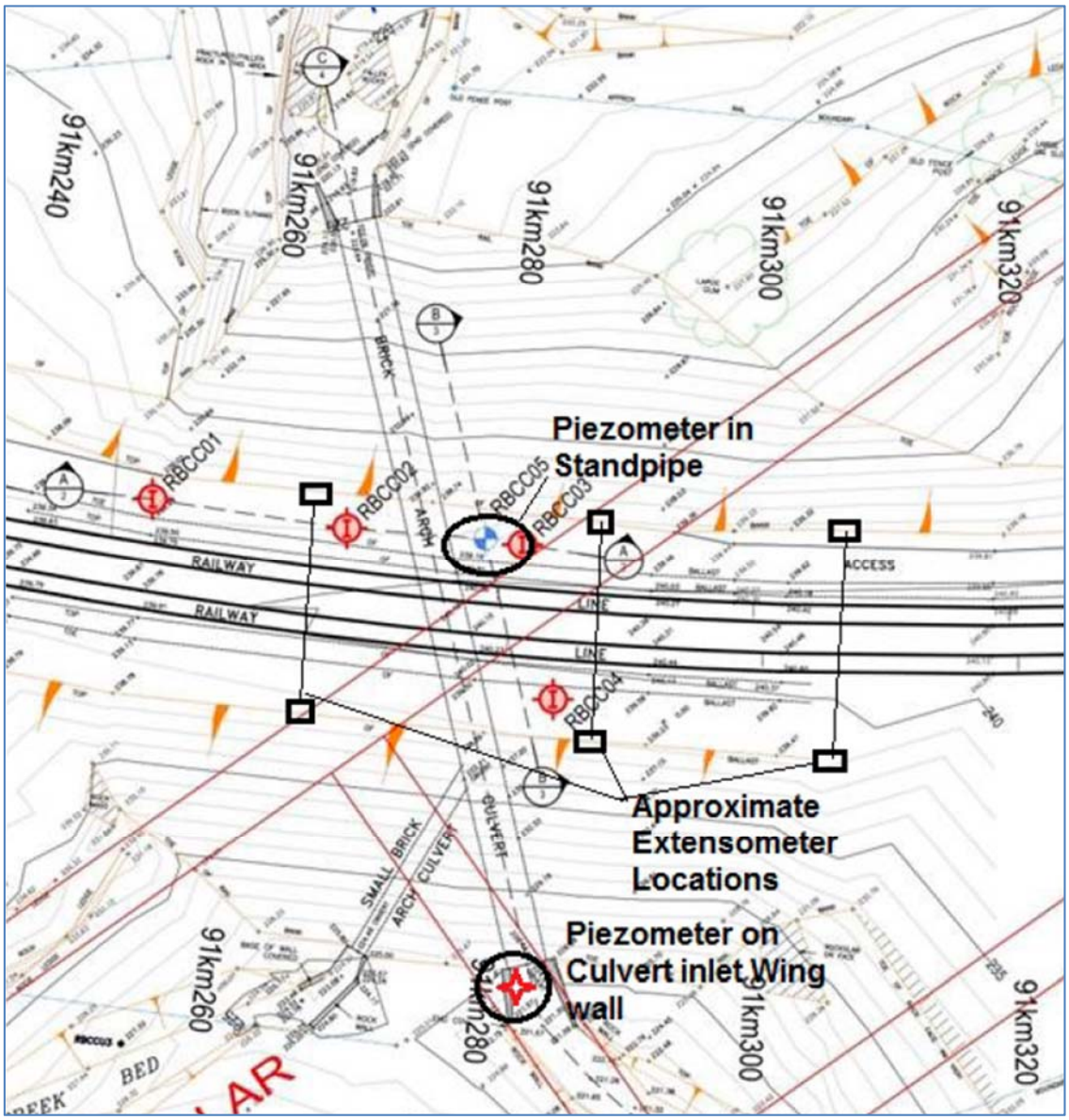


Fig. 2.11 Proposed locations of crest extensometers and piezometers at embankment

2.10. Monitoring and inspections of Bridge Street Overbridge

The following monitoring will be undertaken during the mining of Longwall 30:

- Surveys of New Overbridge and surrounding ground marks in the cutting.
  The layout of marks in plan view are shown in Drawings Nos. MSEC787-04 and MSEC787-05. A photograph showing some of the survey prisms is provided in Fig. 2.12.
- The surveys will be undertaken in absolute 3D on a monthly basis, with weekly local 3D surveys during the most active period of subsidence.
- Measurement of gap in expansion joint and vertical distance between bearing and underside of bridge deck.
- Visual inspections of the Overbridge, including bridge bearings.
- Absolute 3D and 2D surveys along a monitoring line along the railway.

Fig. 2.12 Survey prisms located on abutment and bridge deck of Deviation Overbridge at 92.400 km

2.11. Railway Culvert at 90.676 km

The culvert at 90.676 km consists of a small 1200 mm diameter masonry arch, with a 900 mm diameter concrete pipe extension on the Up side. The track above the culvert is situated on a short and stocky embankment that is 7 metres high on the Down side, with an access road on the Up side that is 2.5 metres below track level. The culvert is located directly above Longwall 30. Further details are provided in the Railway Management Plan (Report No. MSEC747).

The following monitoring will be undertaken during the mining of Longwall 30, in addition to standard surveys and inspections along the track:

- Absolute 3D surveys and relative 3D surveys along monitoring lines at crest and toe of embankment on both sides, as shown in Drawing No. MSEC747-208. Pegs spacings are generally every 20 metres, with a concentration of survey marks at the toe of the embankment where the valley is incised.
- Absolute 3D and relative 3D surveys along the brick arch culvert, with survey marks located at the spring point on both sides at the outlet, midpoint and inlet of the culvert (six survey marks in total).
- Visual inspections of the track, culvert and embankment during mining.

2.12. Bridge Street Industrial, Commercial and Business Precinct

Longwall 30 will extract to the west of properties within the Bridge Street Industrial, Commercial and Business Precinct. The closest building is located approximately 70 metres from Longwall 30. Tahmoor Colliery will develop Property Safety Management Plans (PSMPs) in consultation with landowners for properties that are located within a distance equivalent to the 35 angle of draw of Longwall 30. This includes all properties located to the west of Redbank Place prior to 1600 metres of extraction.

The properties will be inspected by a structural engineer prior to the development of PSMPs. While the PSMPs will be developed on a case by case basis, they are likely to include regular surveys and visual inspections. Details relating to proposed monitoring of each property will be provided in the PSMPs.

As shown in Drawing No. MSEC815-00-01, ground survey pegs have already been installed on either side of the closest section of the Precinct to Longwall 30, and the survey lines will be extended to the east prior to the longwall face approaching within 400 metres of the Precinct. A survey line will also be installed along Redbank Place.

Ground surveys will be undertaken along Bridge Street up to Peg BG126 on a weekly basis when the section of Bridge Street above Longwall 30 is within the active subsidence zone. Weekly 2D surveys will be undertaken up to 90.300 km on a weekly basis when this section of the Railway is within the active subsidence zone.

2.13. Surveys of Telstra Mobile Phone Tower and Optical Fibre Cable

As described in the Telstra Management Plan, the following surveys are undertaken with respect to the Telstra Mobile Phone Tower. A map of survey marks in the vicinity of the Tower is shown in Drawing No. MSEC815-00-01 and Fig. 2.13.

- Survey marks HP41, HP42 and HP43 on the Hilton Park Road survey line
- Survey marks OF1 to OF53 along the alignment of the Telstra optical fibre cable which runs from the Telstra mobile phone tower to Stilton Lane
- Changes in verticality of the Tower, using a mark at the base of the tower and a reflectorless mark near the top of the Tower.
- Tiltmeters have been installed on the base slab of the Tower.
    - The primary tiltmeters are installed in due North and due West directions.
    - Back-up secondary tiltmeters have been installed. Tiltmeter A1 points to 330 degrees clockwise from north, and Tiltmeter A2 points to 200 degrees clockwise from north. These directions match the approximate bearings of the two antennae on the Tower.
    - Data is displayed on the Lynton Surveys website.

It is understood from Telstra that the operating tolerances of the antennae are approximately 1 degree change in tilt. The predicted maximum change in tilt due to the mining of Longwalls 28 to 30 is approximately 0.3 degrees, which is well within the operating tolerances of the antennae.

No impacts have been observed during the mining of Longwalls 28 and 29, with maximum mining-induced tilts slightly less than 0.3 degrees.

In the extremely unlikely event of tilts occurring that are greater than 1 degree, the following responses can be undertaken:

a) Remote controlled adjustment of the antennae, by rotating supports that connect the antennae to the tower.

b) Manual adjustment of the antennae, if the rotation is greater than the capacity of the rotating supports.

c) Manual adjustment of the lean of the tower by adjusting the bolt cage assembly at the base of the Tower.

The locations of the survey marks in the vicinity of the mobile phone tower are shown in Drawing No. MSEC815-00-01 and Fig. 2.13.

Fig. 2.13 Location of monitoring marks in vicinity of Telstra Mobile Tower

2.14. Surveys above commencing end of Longwall 30

A short, temporary survey line will be installed above the commencing end of Longwall 30 for the purposes of confirming that initial subsidence has commenced as expected above the commencing end of the longwall. The survey line will consist of small number of pegs located above the commencing end of Longwall 30 near the longwall centreline to measure the development of initial vertical subsidence as mining commences. The survey line is temporary only and will be removed as soon as possible after approximately 800 metres of extraction has occurred, so as not to interfere with farming activities. The survey pegs will be spaced nominally every 50 metres and measure changes in height.

Tahmoor Colliery has developed measures to manage potential impacts on the Main Southern Railway in the unlikely event of delayed initial subsidence.

The proposed locations of the survey pegs are shown in Fig. 2.14.

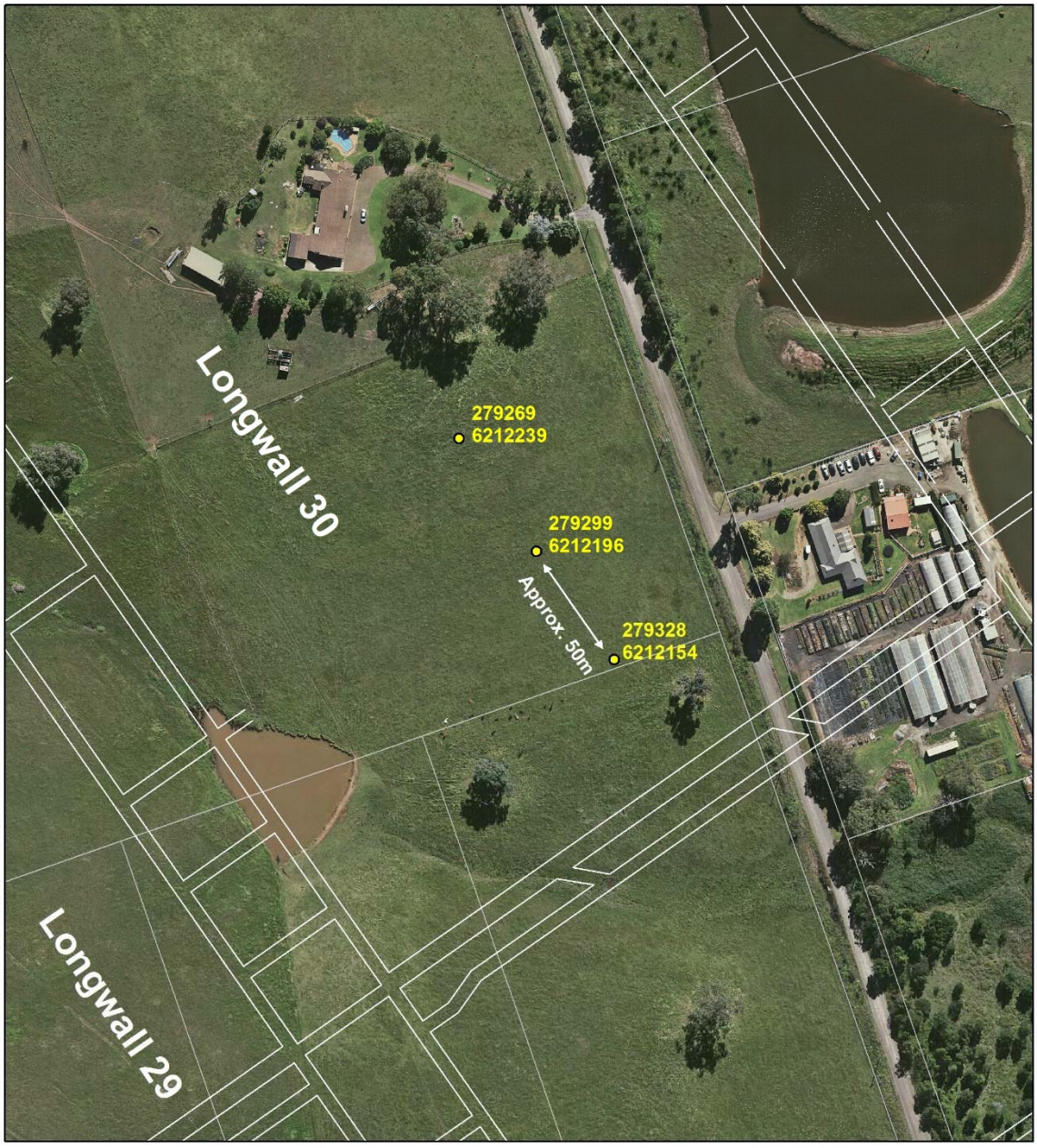


Fig. 2.14 Subsidence survey line above commencing end of Longwall 30 near the centreline

2.15. Monitoring and Inspections of Large Dams on Stilton Lane

2.15.1. No. 2290 Remembrance Drive

The property at 2290 Remembrance Drive is located off Stilton Lane above the commencing end of Longwall 30, as shown in Fig. 2.15. A large dam is located on the property (Ref. GG37a), which is located upstream of a commercial property at No. 155 Stilton Lane, which includes a house, greenhouse structures and a dam. A photograph of the dam is shown in Fig. 2.16.

Whilst the likelihood is considered to be extremely low, there is a potential for the large dam wall to experience adverse impacts from the mining of Longwall 30.

Tahmoor Colliery is currently negotiating with the owner to temporarily drain the dam to a safe water level during the period of active subsidence of Longwall 30. The negotiations are ongoing and monitoring and management measures will be implemented in the event that the dam is not drained prior to the commencement of extraction of Longwall 30. These measures will be described in a Property Subsidence Management Plan (PSMP) that will be developed for No. 155 Stilton Lane prior to the commencement of Longwall 30. The measures included in the PSMP are summarised in the following Section 2.15.2.

With respect to the property at No. 2290 Remembrance Drive, Tahmoor Colliery initially planned to undertake ground surveys along the top of the dam wall and along the base of the dam wall on the southern side but the landowner has not permitted access to the property. An alternative survey line has been installed along the fenceline of No. 155 Stilton Lane and along Stilton Lane, as shown in Fig. 2.15.

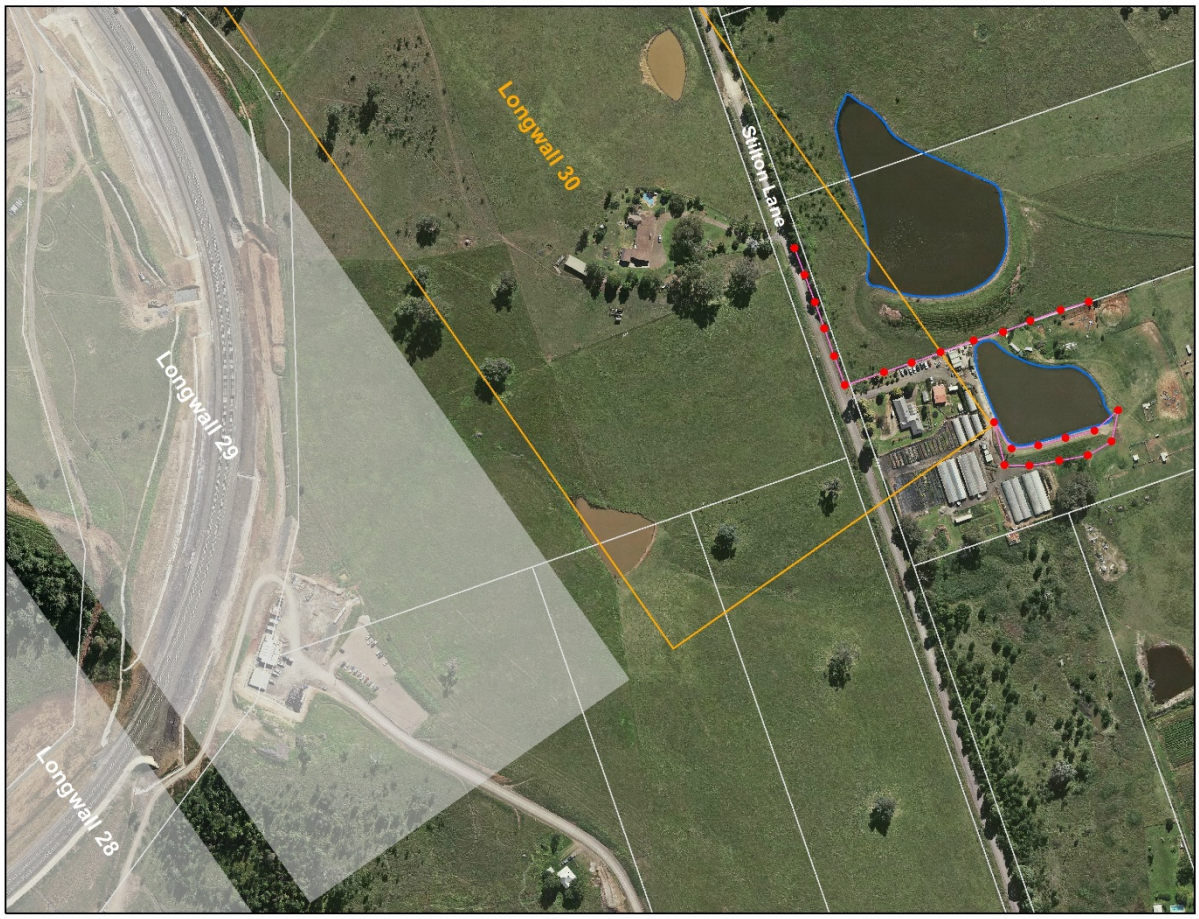


Fig. 2.15 Location of Dam GG37a relative to Longwall 30

Fig. 2.16 View of dam wall at the southern end

2.15.2. No. 155 Stilton Lane

A PSMP will be developed and agreed with No. 155 Stilton Lane prior to the commencement of Longwall 30.

The main focus of the PSMP is to introduce measures to manage the very low likelihood but potentially high consequence public safety risk of breach of the upstream dam at No. 2290 Remembrance Drive. Whilst negotiations are ongoing with the owners of this property, monitoring and management measures will be implemented in the event that the dam is not drained prior to the commencement of extraction of Longwall 30.

The PSMP will include the following monitoring and management measures in relation to the dam:

- Weekly surveys along the base of the upstream dam wall and along Stilton Lane from the commencement of Longwall 30. The frequency may be increased following a review of actual survey data.
- Daily visual inspections of the dam from the commencement of Longwall 30. The frequency may be increased following a review of actual survey data.
- Continuously monitored rainfall at the weather station located at the Deviation Cutting on the Main Southern Railway, which is located near the headwater of the catchment for the dam. An inspection will be undertaken immediately in response to an observed high intensity rainfall event.

The purpose of the ground surveys is to provide early warning of potential differential ground movements at the base of the dam. The surveys and inspections will not be required once the water levels in the dam are drained.

The PSMP will include the following monitoring and management measures in relation to the dam and structures at No. 155 Stilton Lane:

- Monthly surveys along the top of the dam wall and along the base of the dam wall on the southern side from the commencement of Longwall 30, as shown in Drawing No. MSEC815-15-02.
- Monthly ground surveys at the corners of each of the eight greenhouses on the property, as shown in Drawing No. MSEC815-15-02.

- Monthly visual inspections of the dam and structures from the commencement of Longwall 30. The frequency may be increased following a review of actual survey data.

The purpose of the ground surveys on the property is to provide information to the owner, Tahmoor Colliery and the Mine Subsidence Board in the unlikely event that impacts are visually observed to the dam and/or structures.

The surveys and inspections will be undertaken from the commencement of mining of Longwall 30 until 800 metres of extraction, unless adverse changes are observed at this time.

Additional surveys may be undertaken during the mining of Longwall 30 if impacts are reported at the site or substantial differential movements are observed from the results of the ground surveys.

2.16. Queen Victoria Memorial Gardens

Tahmoor Colliery has consulted with the operators of the Queen Victoria Memorial Gardens. Ground surveys are currently not permitted on the property, though negotiations continue. Given the offset distance of Longwall 30 from the structures, the purpose of the ground surveys is to provide information to the operator, Tahmoor Colliery and the Mine Subsidence Board in the unlikely event that impacts are visually observed to built structures on the property.

An indicative ground survey network is shown in Drawing No. MSEC815-00-01.

Table 2.1 Subsidence Monitoring Programme for Longwall 30

Feature	Survey or Inspection Regime	Parameters to be Measured	Timing and Frequency (may be increased if triggered by monitoring results)
Natural Features			
Redbank Creek	Absolute and relative 3D survey	Absolute and Local easting, northing and level to calculate valley closure (refer Section 2.5)	Baseline absolute 3D survey of new pegs along Henry Street, new pegs extended along Bridge Street northeast of Peg BG126, and new pegs along the THC Line between Redbank Place and Remembrance Drive (Argyle Street).prior to 1300m of extraction Monthly Pegs RK11 to RK40 / BG61 to BG126, commencing after 1300m of extraction Weekly Pegs RK17 to RK40 / Pegs BG76 to BG126 when within active subsidence zone, commencing after 1500m of extraction Absolute 3D at end of LW30 for all lines
	Visual inspection of Redbank Creek	-	Weekly, commencing after 1500m of extraction within active subsidence zone
Wollondilly Council Infrastructure			
Local roads	Ground surveys along streets	2D subsidence and distance	Please refer Dwg. No. MSEC815-00-01 *For street surveys with lines coloured red and labelled as "Surveys during LW30":* Weekly surveys along Remembrance Drive for pegs located within 35 degree angle of draw of LW30 (from Pegs RE76 to RE92), commencing after 200m of extraction until 800m of extraction Weekly surveys along Bridge Street within the active subsidence zone For other street survey lines, including Stilton Lane: Conduct surveys every 200m of extraction for survey pegs located within the active subsidence zone, commencing after 200m of extraction *For street surveys with lines coloured yellow and labelled as "Monitoring Lines Before & End of LW30":* Before and end of LW30
	Visual inspections of streets	-	Detailed inspection once a week within the active subsidence zone, commencing from start of LW Vehicle based inspection once a week within the active subsidence zone (on alternate day to detailed inspection), commencing after 200m of extraction
Remembrance Drive Road Bridge and Pedestrian Bridge	Conduct surveys of Bridges, and survey of ground pegs located in the valley sides between the two bridges	2D subsidence and distance	Weekly from start of LW until 800m of extraction, unless by exception, based on actual monitoring data End of LW30
	Detailed visual inspections of bridges	-	Weekly from start of LW until 800m of extraction, unless by exception, based on actual monitoring data
Potable Water Infrastructure			
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
Stilton Lane Dams			
Stilton Lane Dams	Ground survey of pegs along fenceline and on Stilton Lane alongside dam wall at No. 2290 Remembrance Drive (water levels in dam will be drained during period of active subsidence)	Local 3D survey	Weekly surveys of survey pegs after start of LW30 until 800 metres of extraction, unless by exception, based on actual monitoring data. Survey at end of LW30.
	Ground survey of pegs around top and base of dam wall at No. 155 Stilton Lane.	Local 3D survey	Monthly surveys of survey pegs after start of LW30 until 800 metres of extraction, unless by exception, based on actual monitoring data. Survey at end of LW30.
	Visual inspections of dams	-	Daily visual inspections of dam walls after start of LW30 until 800 metres of extraction, unless by exception, based on actual monitoring data. Additional inspections during high intensity rain events.
Sewer Infrastructure			
Sewer infrastructure	Ground surveys along streets	2D subsidence and distance	As described for Wollondilly Council
	Visual inspections of streets	-	As described for Wollondilly Council
	Surveys of marks along THC Line, which follows sections of the Thirlmere Carrier Pipe where it deviates away from Bridge Street	2D subsidence and distance	Install new pegs between Redbank Place and Remembrance Drive (Argyle Street) prior to 1300 m of extraction (this survey line is outside active subsidence zone of LW30) Weekly surveys when THC Line is within the active subsidence zone Survey at end of LW30.
	CCTV inspection of Thirlmere Carrier pipe	-	Thirlmere Carrier (Bridge St for pipe section directly above LWs 29 to 31) – prior to 1500m of extraction, and end of LW30

Feature	Survey or Inspection Regime	Parameters to be Measured	Timing and Frequency (may be increased if triggered by monitoring results)
Gas Infrastructure			
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	Survey and visual inspections	2D subsidence and distance	As described for Wollondilly Council
Electrical Infrastructure			
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. MSEC815-00-01.	Subsidence at base and vertical offset (or tilt)	Monthly for each pole within active subsidence zone, and for following three months thereafter End of LW30 for all poles within limit of subsidence for panel
Telecommunications Infrastructure			
Telstra infrastructure	Ground surveys along streets	2D subsidence and distance	As described for Wollondilly Council Conduct surveys every 200m of extraction of OF and Stilton Lane surveys lines where within active subsidence zone
	Visual inspections of streets	-	As described for Wollondilly Council
	Detailed visual inspections of pits and streets	-	Weekly when within active subsidence zone, and monthly at other times
	Ground survey at base of mobile phone tower above former Redbank Railway Tunnel	Subsidence and tilt of the tower	Prior to start of LW30 End of LW30
	Automated continuous tilt monitoring of mobile phone tower in two orthogonal directions.	Change in tilt	Readings every hour
	Ground survey along path of cable optical fibre cable from Mobile Phone Tower above former Redbank Railway Tunnel to Stilton Lane	2D subsidence and distance	Weekly when within active subsidence zone End of LW30
Department of Lands			
Permanent survey marks	Ground surveys along streets	2D subsidence and distance	As described for Wollondilly Council
Structures			
Houses, units, public amenities, Business and Commercial Establishments, 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, including pools	Varies depending on structure	Refer Structures Management Plan (Weekly when within active subsidence zone or as required by geotechnical or structural engineer)
Bridge Street Industrial, Commercial and Business Precinct			
Industrial, Commercial and Business Precinct	Ground surveys along Bridge Street	2D subsidence and distance	As described for Wollondilly Council
	Ground surveys along Main Southern Railway up to 90.14 km	3D, 2D and distance	As described for Main Southern Railway
	Surveys of properties within active subsidence zone	Local 3D survey	To be developed and agreed with landowners prior to 1600m of extraction as part of PSMPs.
	Visual inspections of properties within active subsidence zone	-	To be developed and agreed with landowners prior to 1600m of extraction as part of PSMPs.
	Visual inspections of streets	-	As described for Wollondilly Council

Feature	Survey or Inspection Regime	Parameters to be Measured	Timing and Frequency (may be increased if triggered by monitoring results)
Main Southern Railway			
Railway Track	3D ground survey along rail corridor *Full length start and end of LW = 90.00 km to 94.28 km* *Initial extent for monthly survey = 92.38 km to 93.11 km and then extend to the north to include pegs that are at least 400 metres in front of the longwall face, up to 90.14km.*	Subsidence, changes in easting and northing (MGA coordinates)	Monthly from start of LW Full length at end of LW
	2D ground survey along rail corridor *Full length start and end of LW = 90.00 km to 94.28 km* *Initial extent for Stage 2 Weekly survey = 92.38 km to 93.11 km and then extend to the north to include pegs that are at least 200 metres in front of the longwall face, up to 90.14 km.*	2D subsidence and distance	Weekly from start of LW Full length at end of LW
	Conduct 3D ground survey of survey lines along tops, benches and base of cuttings. Pegs every 20m, with additional pegs located where monitoring lines intersect identified geological structures (Refer Drawing No. MSEC747-206 for peg locations).	Subsidence, changes in easting and northing (MGA coordinates)	Monthly from start of LW30 End of LW
	Survey of vertical subsidence above commencing end along Longwall 30 centreline	2D subsidence and distance	Weekly at start of LW30 until 800m of extraction unless adverse changes observed
	Long bay length ground surveys *Initial extent for Stage 2 Weekly survey = 92.38 km to 92+1300 km and then extend to the north to include long bays that are at least 200 metres in front of the longwall face, up to 90.14 km.*	2D distance	Weekly at start of LW30 (Stage 2) For AP10 (92.260 km) to ES10 (91.360 km) only across Redbank Creek, commence weekly surveys after 1000 m
	Continuously monitor rail stress, rail temperature and switch displacement *Full extent = 90.100 km to 93.110 km* *Initial active subsidence monitoring extent = 92.380 km to 93.110 km (alarmed at LW start)* *Activate alarms during Stage 2 only to include gauges that are at least 200 metres in front of the longwall face, up to 90.160 km*	Rail stress, rail temperature and switch displacement	Gauges installed from 90.460 km to 93.110 km Install and commission new gauges from 90.100 km to 90.460 km prior to LW approaching within 400 m Readings every 5 minutes Alarmed at start of LW30 (Stage 2)
	Continuously monitor rail stress, rail temperature and switch displacement *Residual subsidence monitoring = at least one working gauge every 120 m along each rail from 93.145 km to 93.376 km (southern end may be shortened based on future assessment)*	Rail stress and rail temperature	Every 5 minutes
	Track geometry surveys using Amber track mounted device or equivalent *Full length start and end of LW = 90.00 km to 94.28 km* *Initial extent for monthly and weekly survey = 92.38 km to 93.11 km and then extend to the north to include track that is at least 200 metres in front of the longwall face, up to 90.14 km*	Superelevation (cant), twist, gauge	Weekly at start of LW30 (Stage 2)
	Continuously monitor track geometry by Automated Total Station in Deviation Cutting for track located near fault at 92.850 km (refer Fig. 2.2 for locations of prisms)	Local 3D survey: Changes in easting, northing and height relative to total stations	Every 2 hours Alarmed at start of LW30 (Stage 2)
	Track inspection by qualified track certifier *The extent of visual inspections is the same as the extent of track geometry surveys.*	The inspection will check ARTC infrastructure within the rail corridor, including the track, track expansion system, integrity of monitoring systems, culverts, cuttings, embankments and fences	Daily from start of LW30 (Stage 2)

Feature	Survey or Inspection Regime	Parameters to be Measured	Timing and Frequency (may be increased if triggered by monitoring results)
Culverts and embankments	Conduct 3D ground survey of embankment monitoring lines at 92+1340 km and 92+1180 km, monitoring line along the toe of the embankment on the Down side, and monitoring line along the noise wall (Refer Drawing No. MSEC747-205 for peg locations)	Subsidence, changes in easting and northing (MGA coordinates)	Absolute 3D Monthly from start of LW
	Conduct 2D survey of MXB and MXC survey lines across Myrtle Creek	2D subsidence and distance	Monthly from start of LW
	Survey changes in level and horizontal distance between survey marks installed at the inlet and outlet of the new Deviation concrete pipes after installation	2D subsidence and distance	Start of LW End of LW
	Measure gaps between the pipe joints of the new Deviation concrete pipes after installation	Steel tape or calliper	Baseline survey complete
	Absolute 3D surveys along monitoring lines along crest and toe of embankment at 90.676 km on both sides of track, and inside brick arch culvert at outlet, midpoint and inlet	Subsidence, changes in easting and northing (MGA coordinates)	Absolute 3D monthly after 1450m (~400m from LW face) Relative 3D weekly after 1650m (~200m from LW face)
Deviation Overbridge at 92.400 km	3D survey of abutment and bridge deck at locations shown in Fig. 2.7. *Note: Pegs DRSW1 and DRSW4 on base of reinforced soil wall on Down side will also be surveyed in absolute 3D as part of the main railway corridor survey line.*	2D survey: subsidence and distance 3D survey: subsidence, changes in easting and northing (MGA coordinates)	Absolute 3D Monthly from start of LW Local 3D weekly after 450m
	Visual inspection of bridge, including bearings	-	Monthly after 250m Weekly after 450m
Redbank Creek Culvert and Embankment	Absolute 3D survey of prisms on culvert, wingwalls and embankment	Subsidence, changes in easting and northing (MGA coordinates)	Monthly after 1300m
	Local 3D survey of prisms on culvert and embankment	Local 3D survey: Changes in easting, northing and height relative to total stations	Weekly after 1500m
	Tape extensometer monitoring across width and height of culvert	Changes in distance	Monthly after 1300m Weekly after 1500m
	Vertical inclinometer monitoring at boreholes RBCC01 to RBCC04	Change in vertical tilt (and therefore horizontal shear of inclinometers)	Monthly after 1300m Weekly after 1500m
	Extensometer monitoring across crest of Embankment	Change in distance	Every 15 minutes Operating after 1300m (Stage 1) Alarmed after 1500m (Stage 2)
	Monitoring of piezometers at open standpipe and culvert inlet	Change in water level	Every 15 minutes Operating after 1300m (Stage 1) Alarmed after 1500m (Stage 2)
	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, cuttings, embankments and fences *The extent of visual inspections is the same as the extent of track geometry surveys as defined in the Railway Management Plan No. MSEC747*	-	As per Railway Management Plan No. MSEC747
	Visual inspection of Embankment by geotechnical engineer	-	Monthly after 1300m Weekly after 1500m

Feature	Survey or Inspection Regime	Parameters to be Measured	Timing and Frequency (may be increased if triggered by monitoring results)
New Bridge Street Railway Overbridge at 91.03 km	Absolute and relative 3D surveys of the Overbridge and adjacent cutting	2D survey: subsidence and distance 3D survey: subsidence, changes in easting and northing (MGA coordinates)	Absolute 3D monthly after 1450m Relative 3D weekly after 1650m
	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, cuttings, embankments and fences *The extent of visual inspections is the same as the extent of track geometry surveys as defined in the Railway Management Plan No.* MSEC747	-	As per Railway Management Plan No. MSEC747

APPENDIX A. DRAWINGS

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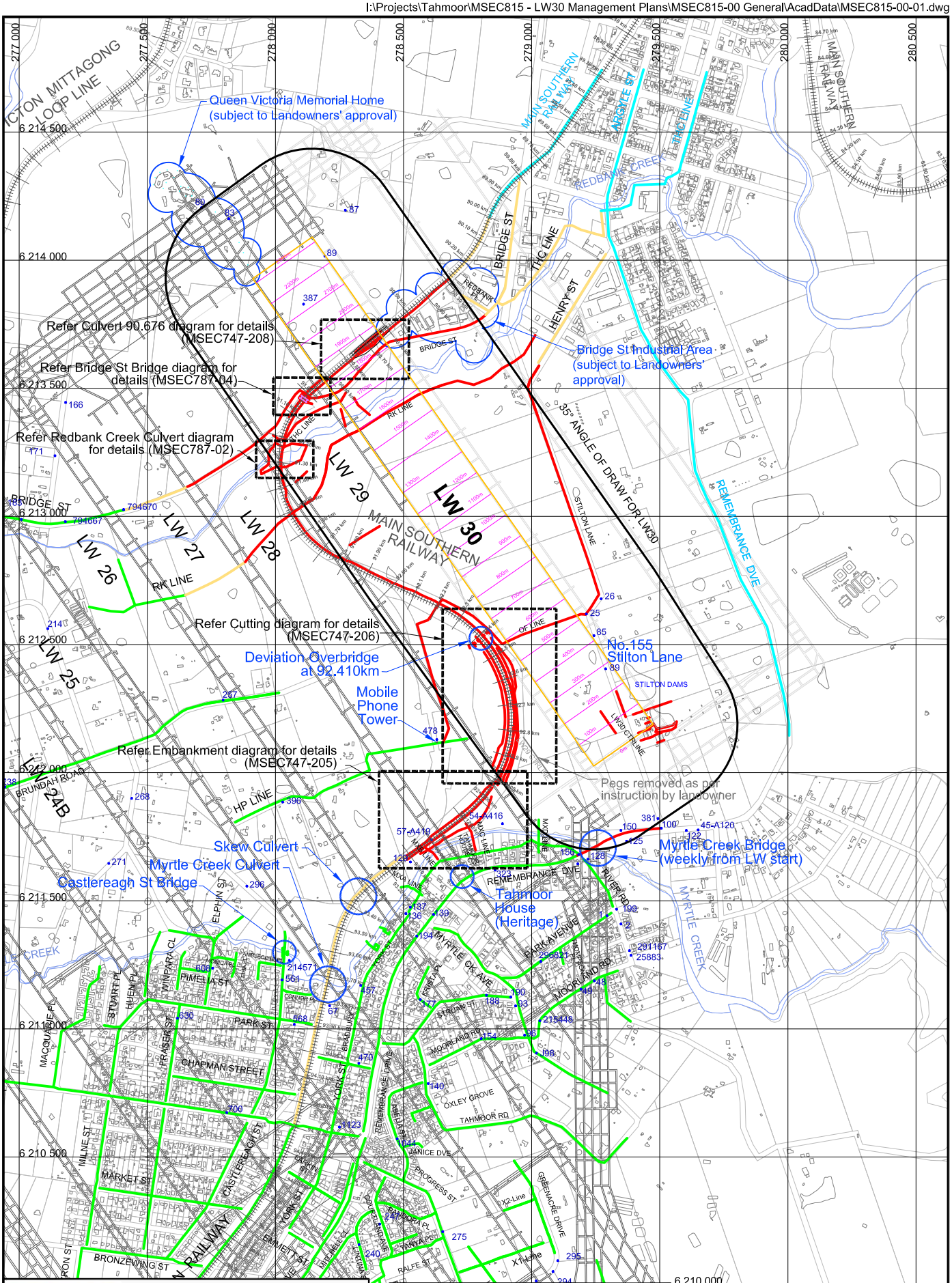

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TAHMOOR UNDERGROUND GLENCORE

TAHMOOR COLLIERY

TAHMOOR NORTH MONITORING OVER LW30

LEGEND

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

Refer to Management Plans for Timing & Frequencies

Grid to MGA co-ordinates

DATE:	SCALE:	DRAWING No:	Rev No
18 May 2016	1:20000	MSEC815-00-01	A

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TAHMOOR COLLIERY

TAHMOOR UNDERGROUND GLENCORE

TAHMOOR NORTH - LW29 to LW30
MAIN SOUTHERN RAILWAY
EMBANKMENT FOR LW30

DATE:	SCALE:	DRAWING No:	Rev No
26 Mar 2015	1:2000	MSEC747-205	A

LEGEND

- ANCHOR POINTS
- SWITCHES
- STRAIN GAUGES
- MONITORING PEGS

LW29
LW28
LW27
92+1000 km
92+1100 km
92+1200 km
93.00 km
92+1300 km
93.10 km
MXC Line
MXB Line
92.980
92+1040
92+1040 NW
92+1060 NW
92+1080 NW
DEM92+1060
AP4 (92+1100km)
92+1100
92+1100 NW
DEM92+1080
92+1120 NW
92+1140 NW
DEM92+1100
X92+1180-U1
92+1160
X92+1180-U2
92+1160
92+1160 NW
DEM92+1120
P92+1200-U1
92+1180 NW
X92+1180- D1A
X92+1180- D1
X92+1180- D2
DEM92+1140
92+1200 NW
X92+1180-D3
92+1220
92+1220 NW
DEM92+1160
P92+1200-D1
92+1240 NW
X92+1180-D4
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92+1260 NW
DEM92+1220
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X92+1340-D1
P92+1340-D2
93.005 NW
X92+1340-D3
DEM92+1340
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DEM93010
93.050
DEM93030
93.040 NW
93.060 NW
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DEM93050
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93.100 NW
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93.179

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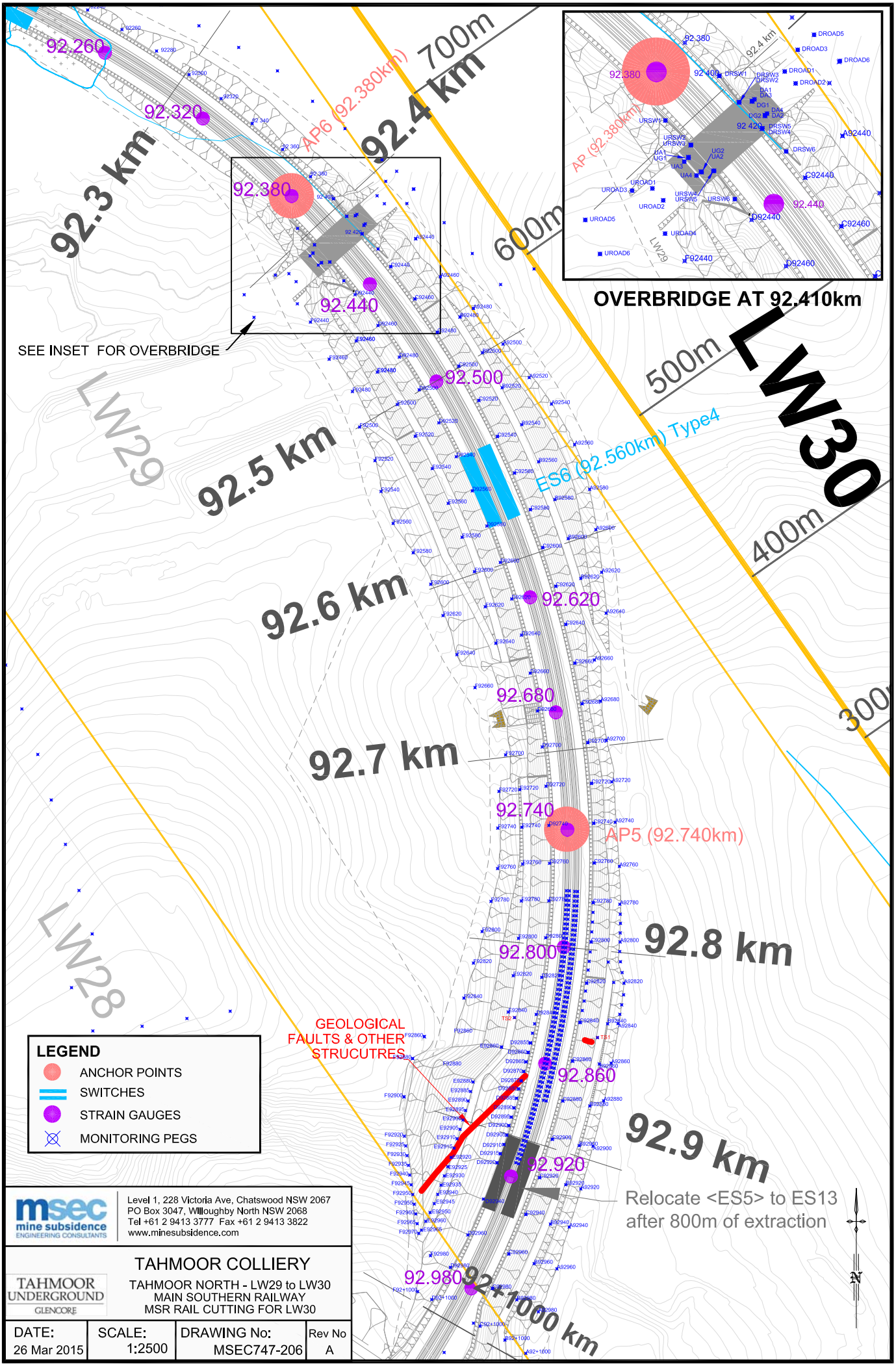

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TAHMOOR UNDERGROUND GLENCORE

TAHMOOR COLLIERY

TAHMOOR NORTH - LW29 to LW30
MAIN SOUTHERN RAILWAY
MSR RAIL CUTTING FOR LW30

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TAHMOOR COLLIERY

TAHMOOR UNDERGROUND GLENCORE

TAHMOOR NORTH - LW29 to LW30
MAIN SOUTHERN RAILWAY
CULVERT AT 90.676KM - LW30

DATE:	SCALE:	DRAWING No:	Rev No
5 May 2016	1:2000	MSEC747-208	B

LEGEND

- ANCHOR POINTS
- SWITCHES
- STRAIN GAUGES
- EXISTING MONITORING PEGS
- INSIDE CULVERT AT SPRING POINTS

Culvert 90.676 km

90.580 90.640 90.700 90.760 90.820

90k 540 90k 560 90k 580 90k 600 90k 620 90k 640 90k 660 90k 680 90k 700 90k 720 90k 740 90k 760 90k 780 90k 800 90k 820 90k 840 90k 860 90k 880 90k 900

ES13 (90.520km) Type4 install prior to 1650m (after rail has been straightened)

AP12 (90.700km)

ES12 (90.880km) Type4

90.60 km 90.70 km 90.80 km

1900m 1800m 1700m

LW30

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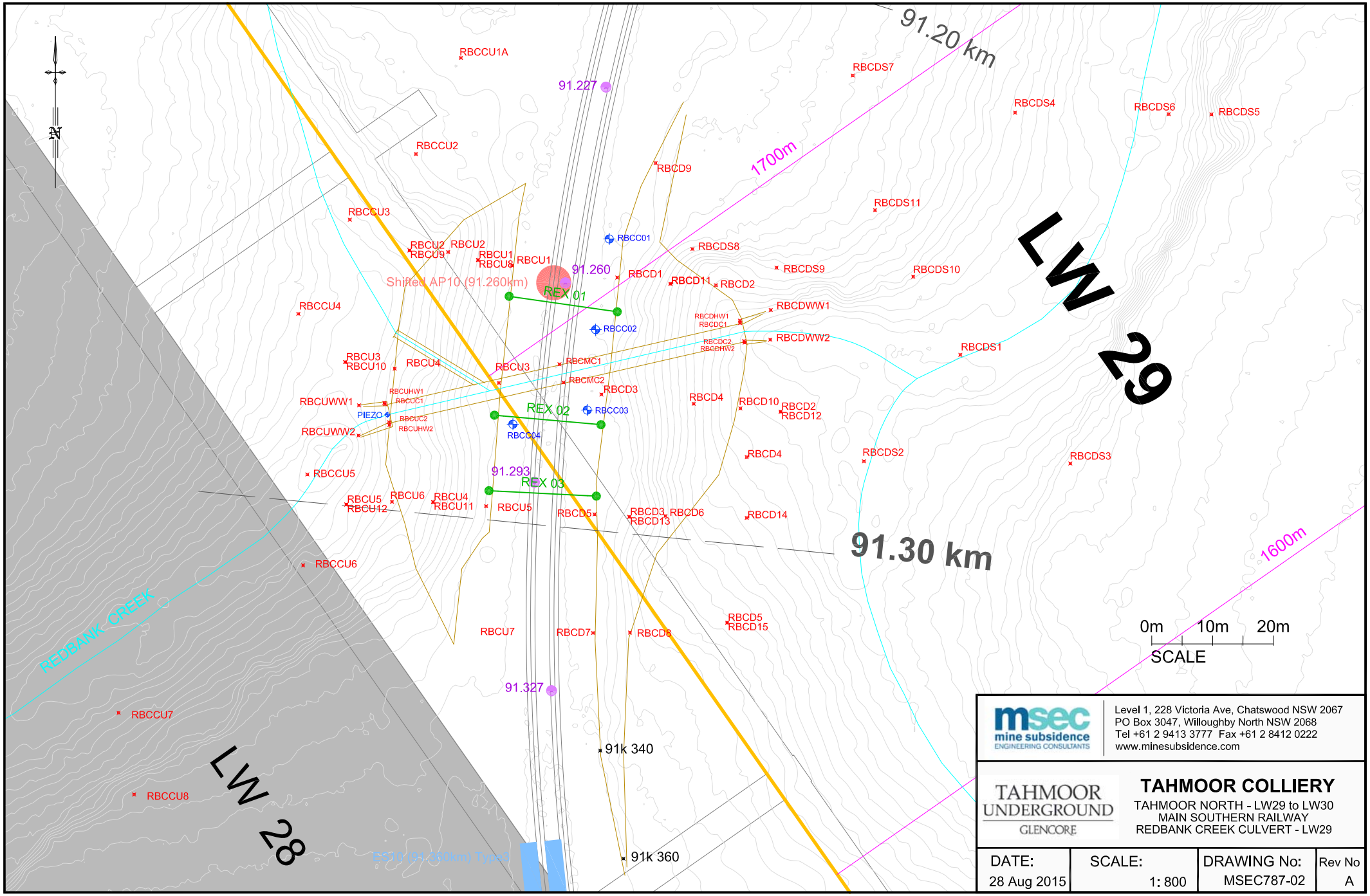

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TAHMOOR UNDERGROUND GLENCORE

TAHMOOR COLLIERY

TAHMOOR NORTH - LW29 to LW30
MAIN SOUTHERN RAILWAY
REDBANK CREEK CULVERT - LW29

DATE:	SCALE:	DRAWING No:	Rev No
28 Aug 2015	1: 800	MSEC787-02	A

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TAHMOOR UNDERGROUND GLENCORE

TAHMOOR COLLIERY

TAHMOOR NORTH - LW29 to LW30
MAIN SOUTHERN RAILWAY
BRIDGE ST RAIL NEW OVERBRIDGE
MONITORING

DATE:	SCALE:	DRAWING No:	Rev No
28 Aug 2015	as shown	MSEC787-04	A

LEGEND
- ANCHOR POINTS
- SWITCHES
- STRAIN GAUGES
- EXISTING MONITORING PEGS
- NEW MONITORING PEGS

BG88 91.00 km D91000 B90980 A90980 BG89 C91000 D91010 91.000 C91010 C91010b B91000 A91000 B91010b B91010 LW29 BG87 BBU1 BBUR1 BBUA1 (Old Bridge) BBUG1 BBURSW1 C91020 C91020b BG90 BG91 BBUR2 BBUA2 BBURSW2 B91020b B91020 BBUG2 BBUA3 BBURSW3 BBDA1 BBDRSW1 BBDG1 BG86 C91040 C91040b BBDR1 1800m BBDRSW2 BBDA2 BBDRSW3 BBDG2 B91040b B91040 BBDA3 91 040 Bridge St realignment BBDR2 BG85 D91060 C91060 Main Southern Railway BBD1 AP11 (91.060km) 91.060 B91060 A91060 91 060 Bridge Street D91080 C91060

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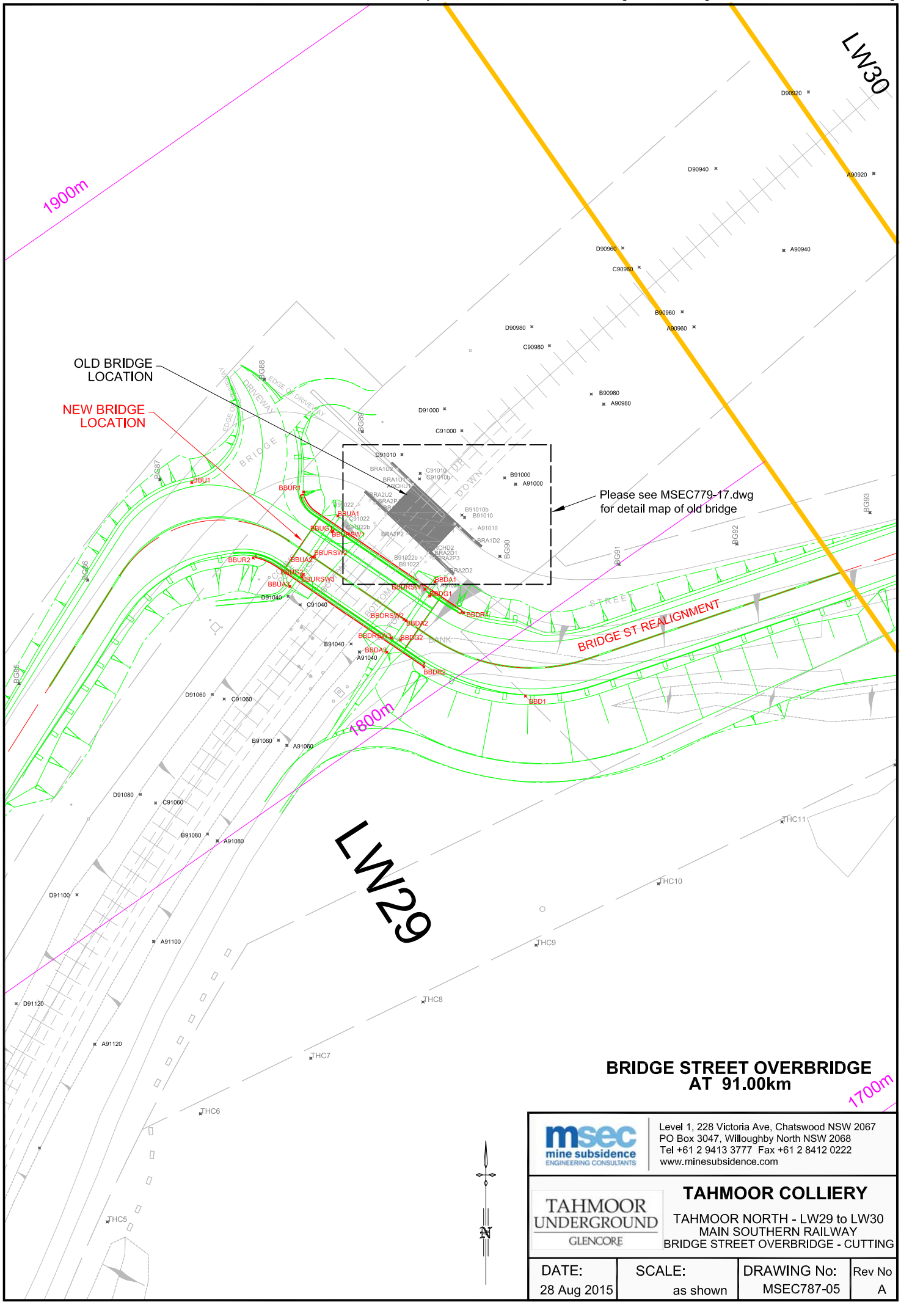

BRIDGE STREET OVERBRIDGE AT 91.00km

msec mine subsidence ENGINEERING CONSULTANTS

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TAHMOOR UNDERGROUND GLENCORE

TAHMOOR COLLIERY

TAHMOOR NORTH - LW29 to LW30
MAIN SOUTHERN RAILWAY
BRIDGE STREET OVERBRIDGE - CUTTING

DATE:	SCALE:	DRAWING No:	Rev No
28 Aug 2015	as shown	MSEC787-05	A

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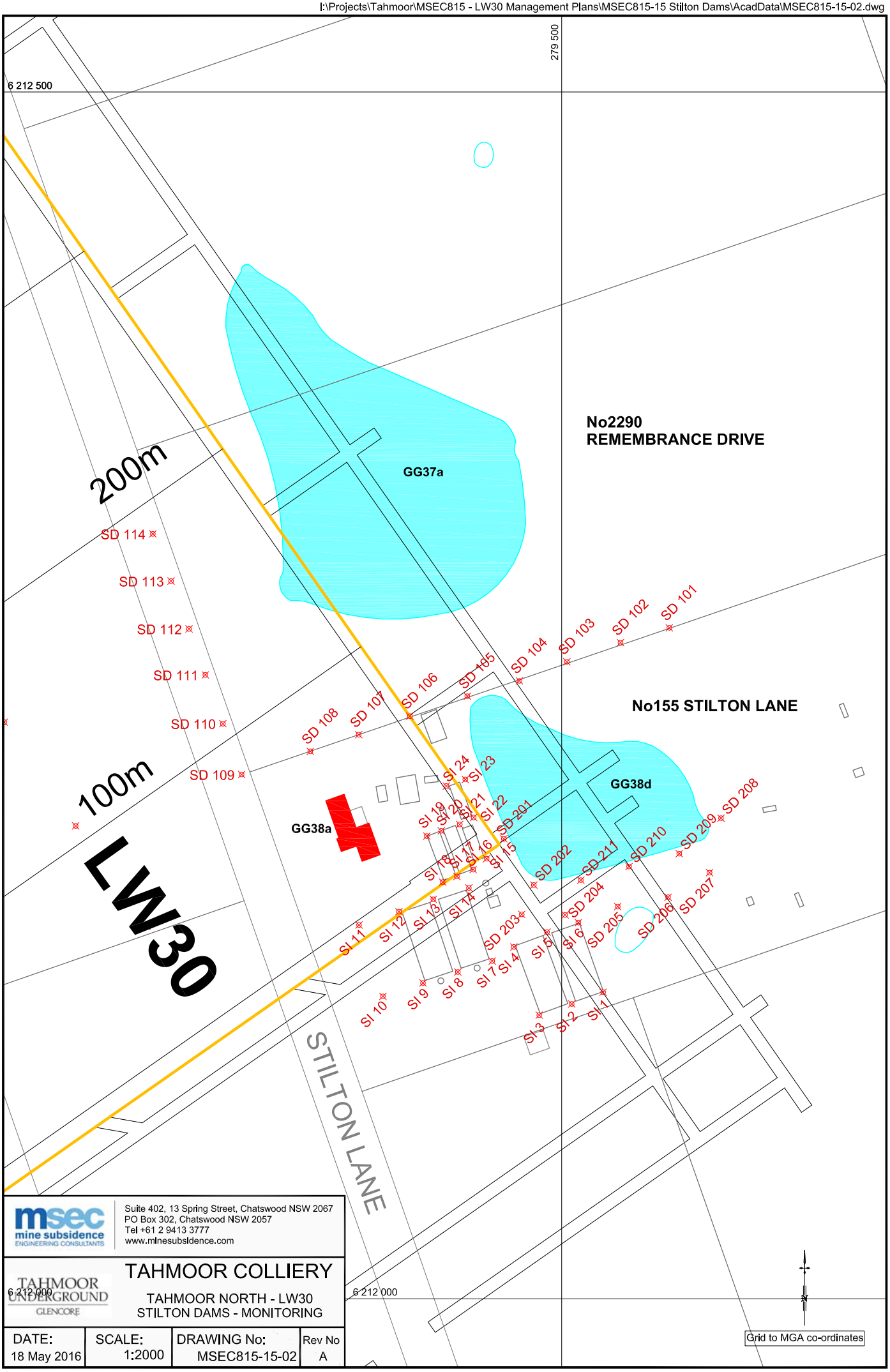

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TAHMOOR UNDERGROUND GLENCORE

TAHMOOR COLLIERY

TAHMOOR NORTH - LW30
STILTON DAMS - MONITORING

DATE:	SCALE:	DRAWING No:	Rev No
18 May 2016	1:2000	MSEC815-15-02	A

Grid to MGA co-ordinates

APPENDIX B.
SURVEY SPECIFICATION BY SMEC

TAHMOOR UNDERGROUND
GLENCORE

SMEC
Local People. Global Experience.

SPECIFICATIONS FOR SUBSIDENCE MONITORING LINES FOR LONGWALL 30

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 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. Relative co-ordinates of subsidence line stations where required. (In order to obtain relative horizontal movement).

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 GPS control 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.

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.

   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.

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Campbelltown NSW 2560
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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.

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

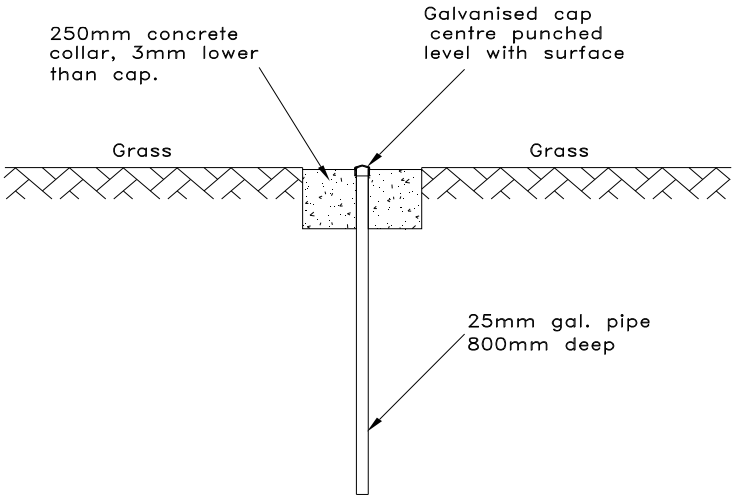
4.5.1. Establishment of Site GPS Base Stations. Site Base Stations located not closer than 2 kilometres from active subsidence.
4.5.2. Site GPS Base Stations are to be monitored periodically by connection to an established stable 'outer' network of GPS Stations.
4.5.3. GPS Baselines are to be surveyed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

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 ±5mm.
5.1.1. Strain distances measured to an accuracy of ±5mm (Strain 0.25mm/m over a 20 m bay) for measurement by EDM/theodolite traverse & to an accuracy of ±2.5mm (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 ± 20mm or better (Relative two dimensional accuracy of ± 5mm).

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.



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.

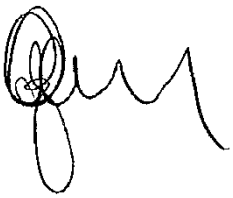
8. Reports

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 and XML file showing subsidence results of current survey. This is to be supplied electronically.
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 & XML files be used as a template.

Yours faithfully,
SMEC Australia Pty Ltd
per .. **Gary Warren**
Senior Registered Surveyor
PO Box 232
Campbelltown NSW 2560
Ph: 02 4640 8222
gus.warren@smec.com



Tahmoor Colliery Contacts:

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Community & SMP Coordinator
Tahmoor Colliery
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Belinda.L.Treverrow@glencore.com.au

APPENDIX C.
SURVEY SPECIFICATION BY SOUTHERN RAIL SURVEYS

TAHMOOR UNDERGROUND
GLENCORE

Southern Rail Surveys Pty Ltd

PO Box 3078

Exeter, NSW, 2579

Main Southern Rail Line- Survey Monitoring Plan for LW29 and LW30

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 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).

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.

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 Totalstation survey methods will be used where possible. Other survey methods are included herein in the event that they are required in specific circumstances.

   4.3. Totalstation 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 nominally 150 metres.
      4.3.5. Maximum intermediate line length nominally 80 metres.
      4.3.6. Target at each subsidence station to generally be a fixed miniprism.

TAHMOOR UNDERGROUND
GLENCORE

Southern Rail Surveys Pty Ltd

PO Box 3078

Exeter, NSW, 2579

4.4. GPS Survey Control for Three Dimensional Survey of Subsidence Lines (in conjunction with SMEC Urban):

4.4.1. Establishment of Site GPS Base Stations. Site Base Stations located not closer than 2 kilometres from active subsidence.
4.4.2. 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.
4.4.3. GPS Baselines are to be surveyed relative to a Site GPS Base Station. Baselines are then used for the adjustment of Theodlite/EDM traverse lines locating subsidence marks in three dimensions (MGA~AHD).

4.5. Culvert pipe joints:

4.5.1. Culvert pipe joints will be measured by calliper.

5. Target Accuracies

5.1. Target Accuracies for monitoring surveys by total station shall be as follows:
- 2.0 second angular resolution
- ±2mm and 2 ppm distance

5.2. Strain distances measured to an accuracy of ±5mm (Strain 0.25mm/m over a 20 m bay) for measurement by EDM/theodolite traverse.
5.3. Traversing shall be minimum Class D or LC as prescribed in ICSM SP1 or better.
5.4. Co-ordinates derived from horizontal movement surveys (by traverse &/or GPS) shall have an absolute accuracy of ± 10mm or better (Relative two dimensional accuracy of ± 5mm).
5.5. Rail creep surveys shall be measured to an accuracy of ±3mm
5.6. Long bay surveys shall be measured to an accuracy of ±3mm
5.7. 2D Bridge surveys across the arches shall be measured to an accuracy of ±3mm

6. Survey Instrument Calibration

6.1. In accordance with the Surveying and Spatial Information Regulation 2012 the survey instruments associated with this project will be calibrated annually.
6.2. A calibration certificate will be supplied to Tahmoor Colliery.

7. Subsidence Station Placement

7.1. Survey marks in the ground are a combination of galvanized pipe/star picket flush with the ground or raised star picket (driven at least 800 mm's into ground) with fixed prism or steel spigot.
7.2. The noise wall survey marks are fixed prisms attached to steel supporting beams.
7.3. The Deviation Overbridge survey marks are fixed prisms attached to the concrete bridge elements.
7.4. The base and bench survey marks with cutting are steel rod, drilled and epoxy anchored with a fixed prism.

Proposed track kilometrage range and monitoring frequencies are defined in the Tahmoor LW29 and LW30 Railway Subsidence Management Plan.

TAHMOOR UNDERGROUND
GLENCORE

Southern Rail Surveys Pty Ltd

PO Box 3078

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8. 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 LW29 and LW30 Railway Subsidence Management Plan for survey frequencies.

9. Reports

The following information shall be included in the report:

9.1. Date of survey.
9.2. Name, location and RL of bench mark and or GPS Base station used.
9.3. 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.
9.4. Excel table and XML file showing subsidence results of current survey. This is to be supplied electronically.
9.5. Any other relevant information required by the Surveyor.

Survey results will nominally be reported within 24 hours of the completion of survey. Results will be forwarded electronically in Excel spreadsheets (.xls and .xml files) to relevant parties.

10. Additional Information
Tahmoor Colliery will provide an AutoCAD file of the Mine Workings if required.
Tahmoor Colliery will provide an Excel & XML files be used as a template.

John Rolles
Registered Surveyor
Southern Rail Surveys Pty Ltd
30 March 2015

Tahmoor Colliery Contacts:

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