

INTEGRA UNDERGROUND

GLENCORE



LW 17-20 Extraction Plan Built Features Plan

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1. Purpose

This *Built Features Management Plan* has been prepared to address predicted subsidence impacts to built features as a result of underground mining of Longwalls (LWs 17- 20) within the Middle Liddell Seam at the Integra Underground Mine (Integra Underground). Specific asset management plans have been developed as part of this *Built Features Management Plan*, including:

- Mount Owen Rail Infrastructure Asset Management Plan (**Appendix B**);
- Mount Owen Glendell Operations Key Features Asset Management Plan (**Appendix C**).

The *Built Features Management Plan* also includes '**Appendix D – Subsidence Management Protocol**'.

1.1 Objectives

The objective of the *Built Features Management Plan* is to provide adequate management of important built features within the extraction area from direct and indirect subsidence impacts.

This objective will be achieved through:

- Identifying the management strategies and processes to be adopted to reduce the identified subsidence risks;
- Describing the stakeholder consultation and engagement process to ensure any ongoing concerns regarding subsidence can be addressed;
- Outlining the proposed subsidence monitoring and reporting processes; and
- Implementing a process by which the BFMP and associated management plans can be reviewed and audited to ensure a process of feedback and continual improvement.

Schedule 3, Condition 38 of the Project Approval (PA) 08_0101 outlines the key rehabilitation objectives for the management of built features.

2. Scope

2.1 Overview

In late 2015, HV Coking Coal Pty Ltd (HVCC), a 100% Glencore-owned Company, acquired all assets associated with the Integra Underground Mine (Integra Underground), which had been placed in care and maintenance in May 2014. During this time environmental management of the site was maintained under a care and maintenance environmental management system.

Prior to HVCC's purchase of Integra Underground, the mine formed part of the larger Integra Mine Complex. This complex comprised both underground and open cut operations and operated under a single Project Approval instrument which combined the Project Approval for Integra Underground (PA 08_0101) and Integra Open Cut (PA 08_0102). Following the separation of ownership of the open cut and underground, the combined Project Approval was modified to separate the open cut and underground approvals. The underground mine now operates under PA 08_0101 as modified.

Underground operations recommenced in 2017, with development resuming in February 2017 and longwall extraction resuming in May 2017 (in accordance with the Extraction Plan as required under Condition 20 of Schedule 3 of PA 08_0101). An application for a further modification to PA 08_0101 (MOD 7) and accompanying Environmental Assessment was lodged with the Department of Planning and Environment (DPE, now Department of Planning, Industry & Environment [DPIE]) in June 2017. Subsequently, approval was granted by DPIE on 15 September 2017. The modification application was made to facilitate the construction of a water pipeline from Integra Underground to the adjacent Mt Owen Complex and the subsequent use of the pipeline to transfer mine water. The modification enables surplus mine water collected at Integra Underground to be managed at Mt Owen Glendell Operations (MGO) and within Glencore's Greater Ravensworth Area Water Sharing Scheme (GRAWSS).

An application for Modification 8 (MOD 8) to PA 08_0101 and accompanying Environmental Assessment was lodged with the DPIE in November 2017. Approval was granted by DPIE on 16 April 2018. MOD 8 allows continuation of longwall mining of the Middle Liddell Seam further to the north of the previously approved longwall panels, along with the construction and operation of ancillary surface infrastructure required to support the mining activities.

This BFMP has been submitted by HVCC to DPIE as part of an Extraction Plan application to seek approval for the secondary extraction of LW 17 to LW 20 within the Middle Liddell Seam in accordance with PA 08_0101. This *Built Features Management Plan* follows the same framework as the Integra Underground LW 15 and 16 *Built Features Management Plan* which was approved by the DPIE on 8 September 2019.

3. Planning

3.1 Development Consent

Schedule 3, Condition 20f of the PA 08_0101 (MOD 8) outlines the requirement to prepare a *Built Features Management Plan* for the Extraction Plan. The requirement states:

A Built Features Management Plan, which has been prepared in consultation with the owners of such features, to manage the potential impacts and consequences of subsidence on any built features.

Table 3-1 outlines the subsidence performance measures for built features as per Schedule 3, Condition 17 of the Project Approval.

Table 3-1 – Subsidence Performance Measure for Built Features

Aspect	Performance Measure	Indicator
Built Features		
All built features (except those fully covered by an operative contractual arrangement with another mine owner or other owner of the relevant built feature)	Safe, serviceable and repairable, unless the owner agrees otherwise in writing, including: <ul style="list-style-type: none"> Serviceability should be maintained wherever practicable; Loss of serviceability must be fully compensated; and Damage must be fully repaired or replaced, or else compensated. 	Subsidence monitoring and management to be completed in accordance with this plan and the <i>Subsidence Monitoring Program</i> . <i>Mount Owen Rail Infrastructure Asset Management Plan</i> and <i>Mount Owen Glendell Operations Key Features Asset Management Plan</i> have been developed.
Public Safety		
Public Safety	No additional risk due to mining	See <i>Public Safety Management Plan</i> , <i>Mount Owen Rail Infrastructure Asset Management Plan</i> and <i>Mount Owen Glendell Operations Key Features Asset Management Plan</i>

3.2 Extraction Plan Requirements

Table 3-2 outlines the requirements for the preparation of management plans which form part of the Extraction Plan. This Extraction Plan has been prepared to address conditions of the PA 08_0101 and structured in accordance with the *Guidelines for the Preparation of Extraction Plans* (Draft V5) (Extraction Plan Guidelines). Many of these conditions have been specifically covered in the *Mount Owen Rail Infrastructure Asset Management Plan* and *Mount Owen Glendell Operations Key Features Asset Management Plan* and have not been repeated in this *Built Features Management Plan*.

Table 3-2 – Extraction Plan – Component Plan Requirement

Requirement	Section Addressed in Document
Overview of all landscape features, heritage sites, environmental values, built features or other values to be managed under the component plan.	Covered under site Environmental Management Plans
Setting out all performance measures included in the consent or project approval relevant to the features or values to be managed under the component plan.	Table 3-1 and Appendix A - TARP
Setting out clear objectives to ensure the delivery of the performance measures and all other relevant statutory requirements (including the <i>Work Health and Safety (Mines and Petroleum Sites) Act 2013</i>).	Section 3.3 <i>Mount Owen Rail Infrastructure Asset Management Plan</i> <i>Mount Owen Glendell Operations Key Features Asset Management Plan</i>
Proposing performance indicators to establish compliance with these performance measures and statutory requirements.	Table 3-1
Describing the landscape features, heritage sites and environmental values to be managed under the component plan, and their significance. It should be noted that a full description of such features, sites and values would commonly have been provided and considered in a recent environmental impact assessment (i.e. an Environmental Assessment or EIS). Consequently, this section can be relatively brief, and focus on the presentation of appropriate figures and/or plans.	Site specific management plans: <i>Biodiversity Management Plan</i> <i>Aboriginal Cultural Heritage Management Plan</i> <i>Historic Heritage Management Plan</i> <i>Water Management Plan</i>
Fully describing all currently-predicted subsidence impacts and environmental consequences relevant to the features, sites and values to be managed under the component plan.	Section 4.1 <i>Mount Owen Rail Infrastructure Asset Management Plan</i> <i>Mount Owen Glendell Operations Key Features Asset Management Plan</i>
Fully describing all measures planned to remediate these impacts and/or consequences, including any measures proposed to ensure that impacts and/or consequences comply with performance measures and/or the mine’s commitments.	Appendix A - TARP <i>Mount Owen Rail Infrastructure Asset Management Plan</i> <i>Mount Owen Glendell Operations Key Features Asset Management Plan</i>
Describing the existing baseline monitoring network and the current baseline monitoring results, including pre-subsidence photographic surveys of key landscape features and key heritage sites which may be subject to significant subsidence impacts (such as significant watercourses, swamps and Aboriginal heritage sites).	Environmental Management Plans <i>Mount Owen Rail Infrastructure Asset Management Plan</i> <i>Mount Owen Glendell Operations Key Features Asset Management Plan</i>
Fully describing the proposed monitoring of subsidence impacts and environmental consequences.	Section 5.1 Also see <i>Subsidence Monitoring Program</i>

Requirement	Section Addressed in Document
Describing the proposed monitoring of the success of remediation measures following implementation.	Section 5.3
Fully describing adaptive management proposed to avoid repetition of unpredicted subsidence impacts and/or environmental consequences.	Section 5.4
Fully describing contingency plans proposed to prevent, mitigate or remediate unpredicted subsidence impacts and/or environmental consequences which substantially exceed predictions or which exceed performance measures.	Appendix A - TARP <i>Mount Owen Rail Infrastructure Asset Management Plan</i> <i>Mount Owen Glendell Operations Key Features Asset Management Plan</i>
Listing responsibilities for implementation of the plan.	Section 6.1

3.3 Risk Management

A risk assessment was completed for the LW 17-20 Extraction Plan Area on 4 March 2020. A copy of the full risk assessment and methodology is included as **Volume1 – Appendix A**. Medium rated risks relating to built features and additional controls are outlined in **Table 3-3**.

Table 3-3 – Risk Management – Built Features

Potential Risk & Consequence to Built Features	Suggested Additional Controls	Section Addressed in Document
Surface subsidence effects / cracking impede drainage paths, resulting in ponding of surface water in rail loop cutting.	<ul style="list-style-type: none"> Prepare Surface Water Assessment including TP1 drain. 	<ul style="list-style-type: none"> Table 4-2, line item ‘Surface Drainage’ <i>Water Management Plan (Section 9.1.2)</i>
Surface subsidence effects / cracking / horizontal movements, resulting in damage to ventilation infrastructure.	<ul style="list-style-type: none"> Prepare Built Features Management Plan for LW 17-20 (consider existing BFMP). 	<ul style="list-style-type: none"> Table 4-2, line items ‘Ventilation Shaft 3 and Associated Infrastructure’ and ‘Planned Dewatering and Ventilation Infrastructure’. <i>Mount Owen Glendell Operations Key Features Asset Management Plan.</i>
Surface subsidence effects / cracking, resulting in contour drains impacted and not functioning as designed/ remediation costs.	<ul style="list-style-type: none"> Prepare Mt Owen Asset Management Plan for LW 17-20. Review monitoring requirements. 	<ul style="list-style-type: none"> Table 4-2, line item ‘Mount Owen Active Mining Area/ Overburden Emplacement (including WOOP Dump)’ <i>Mount Owen Glendell Operations Key Features Asset Management Plan</i>
Isolated failures on highwall - rock falls, resulting in production delay/ loss of revenue/ remediation costs/ equipment damage/ personnel injury.	<ul style="list-style-type: none"> Prepare geotechnical assessment for LW 17-20 by Mt Owen Geotech Engineers. Monitoring of LW16 impacts (e.g. radar first 500m of LW16). 	<ul style="list-style-type: none"> Table 4-2, line item ‘Mount Owen Active Mining Area – North Pit’. Managed under <i>Mount Owen Glendell Operations Key Features Asset Management Plan (Appendix C)</i>.

Potential Risk & Consequence to Built Features	Suggested Additional Controls	Section Addressed in Document
<p>Isolated failures on highwall - slope failure, resulting in production delay/ loss of revenue/ remediation costs/ equipment damage/ personnel injury.</p>	<ul style="list-style-type: none"> • Prepare geotechnical assessment for LW 17-20 by Mt Owen Geotech Engineers. • Monitoring of LW16 impacts (e.g. radar first 500m of LW16). 	<ul style="list-style-type: none"> • Table 4-2, line item 'Mount Owen Active Mining Area – North Pit'. • Managed <i>under Mount Owen Glendell Operations Key Features Asset Management Plan (Appendix C)</i>.
<p>Highwall/pit integrity reduced, resulting in remediation costs.</p>	<ul style="list-style-type: none"> • Prepare geotechnical assessment for LW 17-20 by Mt Owen Geotech Engineers. • Monitoring of LW16 impacts (e.g. radar first 500m of LW16). 	<ul style="list-style-type: none"> • Table 4-2, line item 'Mount Owen Active Mining Area – North Pit'. • Managed <i>under Mount Owen Glendell Operations Key Features Asset Management Plan (Appendix C)</i>.

4. Measurement and Evaluation

4.1 Predicted Subsidence

Detailed subsidence predictions are outlined within the SCT Subsidence Assessment (2020) – **Volume 3 – Specialist Assessment 1** and the Extraction Plan Main Document.

In areas that have been filled with waste rock such as above part of the Eastern Rail Pit (ERP), subsidence is expected to be of greater magnitude than in areas of natural ground. Tilts are expected to be less than those predicted for undisturbed ground due to the softening effects of the backfill. Strains are expected to be approximately double the magnitude of strains in undisturbed ground, especially in areas where there is a free surface available for horizontal movement.

Previous monitoring indicates that the subsidence from LWs 17-20 are likely to represent typical subcritical width behaviour with the maximum subsidence controlled primarily by panel geometry consistent with consideration of the subsidence mechanics (Mills 1998).

Predictions of strains and tilts are based on the empirical relationships developed by Holla (1991) adjusted for the Integra underground site-specific subsidence monitoring results. Previous monitoring experience provides a cross-check on the values determined and the approach appears to provide a reasonable basis for estimating the maximum values likely to occur.

Table 4-1 summarises the main subsidence parameters expected above the four panels in the Extraction Plan area as a basis for developing performance indicators.

Table 4-1 – Comparison of Predicted Subsidence Parameters for Longwalls 17-20

Assessment	Max Subsidence (m)	Maximum Tilt (mm/m)	Maximum Strain Tension (mm/m)	Maximum Strain Compression (mm/m)
Natural or Undisturbed Ground				
GCUC (SCT 2006)	1.6	12	6	9
Integra Underground MOD 8 (SCT 2017c)	2.0 (2.2*)	14 (15*)	7 (8*)	10 (11*)
LW 15 and 16 Extraction Plan (SCT 2018)	2.0	14	7	10
LW 17-20 Extraction Plan (SCT 2020)	2.0	14	7	10
Disturbed or Modified Overburden (fill material or emplacement areas)				
GCUC (SCT 2006)	-	-	-	-
Integra Underground MOD8 (SCT 2017c)	2.8 (3.0*)	14 (15*)	14 (16*)	20 (22*)
LW 15 and 16 Extraction Plan	2.5	14	14	20
LW 17-20 Extraction Plan (SCT 2020)	2.5	14	14	20

* approved for Longwalls 15-19 with 330m wide voids

4.2 Subsidence Impacts and Management

Asset Management Plans have been prepared to manage some of the key infrastructure within the Extraction Plan area. These include:

- Mount Owen Rail Infrastructure Asset Management Plan (**Appendix B**); and
- Mount Owen Glendell Operations Key Features Asset Management Plan (**Appendix C**).

Other built features within the Extraction Plan Area managed under this plan (not specifically an Asset Management Plan) with key mitigation measures are outlined in **Section 4** and **Section 5**. Key built features within the Extraction Plan Area are outlined within **Figure 4-1**.

Table 4-2 outlines the key built features within the Extraction Plan Area. The impacts and descriptions have been summarised from the SCT Subsidence Report (2020).

Table 4-2 – Summary of Subsidence Impacts to Built Features

Feature	Brief Description (SCT 2020)	Impact (SCT 2020)	Management	Timing and Frequency
Public Utilities and Amenities				
Survey Control Stations	The existing state survey station identified within the Extraction Plan Area is mark SS_96126 which is positioned adjacent to the elevator conveyor for the train loadout bin.	Based on the subsidence monitoring and measurements of far-field movements from underground mining at the Integra Underground, it is likely that these marks have already undergone significant horizontal and vertical movements as a result of previous mining up to LW 15 and from nearby open cut excavations. The proposed mining of LWs 17-20 is expected to cause additional movements at these marks.	Managed as per <i>Built Features Management Plan</i> (this document). In summary: <ul style="list-style-type: none"> Notifying the asset owner (Land and Property Information) to temporarily 'decommission' a mark that is located within the extent of far-field effects around current mining by removing its coordinates from the database during the period of active mining. A notification to NSW Land Registry Services will be made regarding the proposed subsidence impacts from LW 17-20 to the relevant survey marks. Re-establishing the horizontal and vertical position once subsidence is complete. Returning the mark to service with revised coordinates. 	Timing and frequency as per the <i>Built Features Management Plan</i> (this document). In summary: See the 'Management' column.
Mine Owned Infrastructure				

Feature	Brief Description (SCT 2020)	Impact (SCT 2020)	Management	Timing and Frequency
Powerlines	<p>A single pole overhead 11kV electricity transmission line traverses the Extraction Plan Area from north to south. The sections of this powerline above LW 17-20 are positioned on natural ground surface.</p> <p>The powerline runs from the Mount Owen MIA to the southern extent of the ERP through the centre of Mt Owen Rail Line loop generally adjacent to the rail line across the causeway between TP2 and the ERP.</p> <p>In addition to water management installations at TP1, TP2, ERP and West Pit, this powerline now also supplies the pumping equipment at the sediment and stormwater dams recently constructed above LW 14 and 15 to treat run-off from the WOOP Dump and any future overflow from the ERP.</p>	<p>This powerline is expected to experience the full range of subsidence movements forecast for natural ground over LWs 17-20.</p> <p>Experience at Integra Underground from other sites indicates that single pole powerline structures are generally tolerant of subsidence movements. Subsidence monitoring of individual poles during mining indicates that maximum ground tilts and strains do not necessarily transfer fully to the pole structures due to nature of the material around the foundation of the poles.</p>	<p>Managed as per <i>Built Features Management Plan</i> (this document). Integra Underground will place conductors in roller sheaves and manage guy wire tensions at changes of direction during the period of active subsidence.</p> <p>A review of conductor clearances along the line will be undertaken to make sure the poles are spaced closely enough to maintain conductors ground clearances throughout the period of mining.</p>	<p>Timing and frequency as per the <i>Built Features Management Plan</i> (this document). In summary:</p> <ul style="list-style-type: none"> • Review of power poles prior to undermining. • Mitigation measures to be installed prior to undermining. • Sheaves will be in place prior to the longwall face approaching within half depth of each pole. • Conductor clearances review will occur prior to mining. • A program within the <i>Built Features Management Plan</i> (this document) for regular visual inspection during the period of active subsidence and appropriate remediation as required is considered suitable to manage any potential impacts.

Feature	Brief Description (SCT 2020)	Impact (SCT 2020)	Management	Timing and Frequency
<p>Mount Owen Rail Line</p>	<p>The Extraction Plan Area includes the loop of the Mount Owen Rail Line, a section of the single line as well as infrastructure associated with the rail. The rail switch (point blades or turnout) at the end of the loop is located above the eastern edge of LW 17. LWs 17-20 mine under most, but not all, of the rail loop.</p>	<p>Impacts on the rail corridor from mining LWs 17-20 are expected to be less than impacts described in GCUC Project EA and less than those detailed in the original Integra Underground Project EA for the approved multi-seam mining. The magnitudes of subsidence effects and impacts are expected to be consistent with those described in SCT (2017c) for MOD8 to PA08_0101 but over a smaller area.</p> <p>All impacts to the Mt Owen Rail Line and associated infrastructure are expected to be manageable (albeit with two sections of trackwork to be impacted in quick succession) with a similar asset management plan to that currently in place at Integra Underground for this infrastructure.</p> <p>The overburden depth along the rail line corridor from LW17-20 ranges from 480m to 500m. For the mining of LW 17-20, maximum subsidence parameters forecast for the railway corridor are vertical subsidence of 1.9m, tilt of 12mm/m with strain values of 5mm/m in tension and 8mm/m in compression.</p>	<p>Managed under <i>Mount Owen Rail Infrastructure Asset Management Plan (Volume 2, Appendix B)</i>. TARP in the <i>Mount Owen Rail Infrastructure Asset Management Plan</i> provides details of management measures. In summary, the Railway and its associated infrastructure will be monitored using ground monitoring, strain and temperature gauges, track geometry trolley and visual inspections.</p>	<p>Timing and frequency as per the <i>Mount Owen Rail Infrastructure Asset Management Plan (Volume 2, Appendix B)</i>. In summary:</p> <ul style="list-style-type: none"> • Ground monitoring – as per <i>Subsidence Monitoring Program (Appendix C)</i>. • Visual inspections – Weekly pre, during and post mining.

Feature	Brief Description (SCT 2020)	Impact (SCT 2020)	Management	Timing and Frequency
Communications Cables	Communication cables for signalling and other purposes are laid alongside the Mount Owen Rail Line. It is understood from the Australian Rail Track Corporation that the cables are most likely to be direct buried, possibly in sand, covered by at least a danger marking tape and possibly a "Vinedex" type barrier. Depth of burial could range from approximately 0.5m to greater than 1m. All the cables are understood to be PVC insulated copper cables.	The communications cables are expected to experience the full range of forecast subsidence movements during the mining of LW 17-20. These cables are expected to be tolerant to these movements consistent with experience over previous panels.	<p>Management under <i>Mount Owen Rail Infrastructure Asset Management Plan (Volume 2 Appendix B)</i>.</p> <p>In summary the potential for impacts on the signal line will be managed using the ground monitoring line along the Railway and visual inspections of the surface. An impedance test can be carried out to assess the mining-induced impacts on the cable. Alternatively, the signal line can be locally unburied, exposed and inspected if an irregular ground movement is measured. In the case of loss of signal, the control room will be notified, and the trains can be escorted along the affected section of the Railway.</p> <p>No reasonably practical elimination, substitution and engineering controls could be identified as the signal line is buried in the ground. An administrative control of implementing a monitoring and TARP has been selected.</p>	<p>Timing and frequency as per <i>Mount Owen Rail Infrastructure Asset Management Plan (Volume 2 Appendix B)</i>. In summary:</p> <ul style="list-style-type: none"> • The potential for impacts on the signal line will be managed using the ground monitoring line along the Railway and visual inspections of the surface. • An impedance test can be carried out to assess the mining-induced impacts on the cable. • Alternatively, the signal line can be locally unburied, exposed and inspected if an irregular ground movement is measured. • In the case of loss of signal, the control room will be notified and the trains can be escorted along the affected section of the Railway.

Feature	Brief Description (SCT 2020)	Impact (SCT 2020)	Management	Timing and Frequency
Bettys Creek Bridges	<p>There are two bridges across Bettys Creek, one for the rail and the other for the road.</p> <p>The rail and road bridges over Bettys Creek are located above the inter-panel chain pillar between Longwalls 13 and 14 outside the Extraction Plan Area.</p>	<p>These bridges are expected to undergo vertical subsidence of 1.3m and 1.4m from the planned mining of LWs 15 and 16 respectively (SCT 2017).</p> <p>The structure of the two bridges was recently modified to accommodate the subsidence movements, including valley closure effects, from the mining of LW 13 and subsequent longwall panels (SCT 2017).</p> <p>While the Bridges are located south of and outside of the Affection Area for Longwalls 17 to 20, they have been included in the <i>Mount Owen Rail Infrastructure Asset Management Plan</i> as they could experience low level far-field movements and could be sensitive to these movements.</p> <p>Subsidence effects and impacts to these features are expected to be substantially complete after the mining of LW 16, as these bridges are beyond half depth from LWs 17-20.</p>	<p>Managed under <i>Mount Owen Rail Infrastructure Asset Management Plan (Volume 2 Appendix B)</i>.</p> <p>Existing survey marks and tell-tales can be measured, during the mining of these longwalls, if required.</p> <p>The 3D marks and tell tales will be inspected and the base line survey undertaken, prior to LW 17 reaching 100m before first rail contact, in accordance with the LW 17 Action Plan. Subsequent surveys are only required if recommended by the Technical Committee.</p>	<p>Timing and frequency as per the <i>Mount Owen Rail Infrastructure Asset Management Plan (Volume 2 Appendix B)</i>. In summary: See the 'Management' column.</p>

Feature	Brief Description (SCT 2020)	Impact (SCT 2020)	Management	Timing and Frequency
Water Supply Pipeline	<p>There are several 300mm+ diameter, flexible polyethylene pipelines delivering water across the Extraction Plan Area for LW 17-20 as part of the surface water management system. The sections of pipelines positioned above ground are unlikely to be impacted by subsidence movements from the mining of LW 17-20.</p> <p>A buried raw water supply pipe that services Mt Owen and Glendell Mines runs alongside Mt Owen Rail Line. The pipeline extends from Glennies Creek to the Mt Owen CHPP within the MIA. The pipe is understood to be welded polyethylene pipe buried to a nominal depth of 0.7m.</p> <p>A new polyethylene water pipeline was constructed in 2017 between the mine infrastructure areas of Integra Underground and Mount Owen. The pipeline traverses LW 13 and then parallels the buried raw water supply pipeline adjacent to the Mt Owen Rail Line over LWs 14-20.</p>	<p>The pipeline is expected to experience the full range of forecast subsidence movements during the mining of LW 17-20 but is expected to be tolerant to these movements consistent with experience over previous panels.</p>	<p>Managed under <i>Mount Owen Mine Key Features Asset Management Plan (Volume 2 Appendix C)</i>. In summary:</p> <ul style="list-style-type: none"> • Weekly inspections during active subsidence. • Double sleeved for high risk pipelines in environmentally sensitive areas • Differential flow monitoring for high risk pipelines in environmentally sensitive areas 	<p>Visual inspections – Weekly pre, during and post mining.</p>

Feature	Brief Description (SCT 2020)	Impact (SCT 2020)	Management	Timing and Frequency
Maintenance Road	<p>The maintenance road that services the Mount Owen Rail Line is located immediately to the east of the rail line. This road is a single lane, unsealed road not accessible to the public. Public access is restricted by locked gates.</p> <p>This road provides a connection between the MOC MIA and Forest Road along the rail corridor.</p>	<p>The road is expected to experience the full range of forecast subsidence movements during the mining of LW 17-20 but there is not expected to be any significant change in the condition of the road as a result of subsidence movements.</p> <p>There is some potential for minor cracks, compression humps and local changes in grade, both along and across the road. There is also some increased potential for ponding across the road in the centres of longwall panels following heavy rain.</p>	<p>Managed as per <i>Built Features Management Plan</i> (this document) and <i>Mt Owen Rail Infrastructure Asset Management Plan (Volume 2 Appendix B)</i>.</p> <p>A culvert located under the rail embankment in the centre of LW 14 is expected to be effective in managing ponding in this area. The use of warning signs, regular inspections, and timely remediation of any impacts are considered appropriate measures to manage potential impacts.</p>	<p>Timing and frequency as per <i>Subsidence Monitoring Program (Appendix C)</i>. In summary:</p> <ul style="list-style-type: none"> • Signage will be erected along public roads adjacent to the Extraction Plan area. • Roads and tracks within the Extraction Plan Area will be remediated if subsidence impacts are identified. • Visual inspections – Weekly pre, during and post mining.
Mount Owen Active Mining Area – North Pit	<p>The south western highwall and haul road around the rim of North Pit extend into the Extraction Plan Area. The highwall and the haul road are largely beyond half depth from the edges of LWs 17–20.</p>	<p>The subsidence assessment for PA08_0101 MOD8 presented in SCT (2017c) identified several potential interactions between the open cut mining and underground longwall panels. These include:</p> <ul style="list-style-type: none"> • highwall and slope instability in the open cut on slopes directly mined under or within 0.4 times depth to the underground mining • potential for floor heave in the floor of the open cut • potential for blasting efficiency of the surface mining to be decreased by subsidence fracturing • potential for blast vibration to affect the underground • increased potential for surface inflows into the underground mine workings • increased potential for methane emissions into the open cut. 	<p>Managed under <i>Mount Owen Glendell Operations Key Features Asset Management Plan (Volume 2 Appendix C)</i>. In summary:</p> <ul style="list-style-type: none"> • Regular face position updates sent to Mount Owen. • Mount Owen Mine Safety Management System including the Mine Inspection System manages the risk of highwall rockfalls under normal circumstances. The probability of any potential rock falls is expected to be much less than the risk of any rock falls that would be managed under normal circumstances. • A Mount Owen - Integra surface access protocol has been developed. • Monitoring and management methods undertaken by Thiess as 	<p>Timing and frequency as per <i>Subsidence Monitoring Program (Appendix C)</i>. In summary:</p> <ul style="list-style-type: none"> • Visual inspections – Weekly pre, during and post mining. • Continued regular liaison between Mount Owen and Integra Underground. • As per Mt Owen Geotechnical Principal Hazard Management Plan

Feature	Brief Description (SCT 2020)	Impact (SCT 2020)	Management	Timing and Frequency
		<p>For the mining of LWs 17–20 most of these potential interaction issues are no longer valid due the shortening of LWs 17-20 which increases the offset to the North Pit. Changes to the MTO mining schedule has also meant that surface mining has not yet progressed to areas above the goaf areas of LW 15 to LW 9 as approved in the MOCO Project (SSD-5850).</p> <p>From the list of potential interaction issues, blast vibration is likely to be the most significant impact in the short-term for Integra Underground.</p> <p>Impacts to the North Pit from the planned mining of LWs 17-20 are expected to be insignificant and much less than those outlined in <i>SCT 2017b</i> for MOD8.</p> <p>Notwithstanding the input of other specialists, any potential impacts from subsidence movements are not expected to constitute a principal hazard as defined by the <i>Work Health and Safety (Mines and Petroleum Sites) Regulation 2014</i>.</p> <p>Subsidence effects and impacts are expected to be reduced from the maxima forecast in <i>SCT (2017c)</i> due to the reduced panel lengths for LWs 15-20 and a smaller subsidence footprint. The mine plan changes are expected to result in a significant reduction in the potential for interactions with Mt Owen operations (MTO) at the North Pit, including impacts to the haul road and stability of the highwall.</p> <p>The highwall and almost all the haul road are located beyond half depth from LWs 17-20. Vertical subsidence is expected to be less</p>	<p>per the Mt Owen Geotechnical Principle Hazard Management Plan.</p> <p>Subsidence and stability monitoring of the highwall and haul road by MTO during the first 500m of LWs 15 and 16 was recommended in the subsidence assessment for LWs 15 and 16 EP SCT (2018). With the shortening of LWs 17-20 from the LWs 15-20 layout assessed in <i>SCT (2017c)</i> and the experience now available from monitoring LWs 14 and 15, the need for ongoing subsidence and stability monitoring post LW 16 has been reviewed by Mt Owen Glendell. The Mt Owen Geotechnical Principal Hazard Management Plan includes interactions between the North Pit highwall and Integra Underground.</p>	

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Feature	Brief Description (SCT 2020)	Impact (SCT 2020)	Management	Timing and Frequency
		<p>than 30mm at the small section of the haul road above the corner of LW 17 located within half depth of LWs 17-20. Horizontal movement at this location are expected to be less than 100mm. These low-level subsidence movements are expected to be imperceptible and of no practical consequence for the highwall and haul road.</p>		

Feature	Brief Description (SCT 2020)	Impact (SCT 2020)	Management	Timing and Frequency
<p>Ravensworth East – West Pit</p>	<p>The position of the southern section of the Ravensworth East - West Pit, relative to the 0.5 depth zone and Extraction Plan Area for LW 17-20, is shown on Figure 2-1.</p> <p>The southern end of the pit is currently being used for tailings emplacement and water storage. A section of the exposed southern and eastern highwall is within the Extraction Plan Area. Further to the north and still within the Extraction Plan Area, the pit is being filled with waste rock overburden material.</p>	<p>The main impacts from mining LWs 17-20 are expected to be the potential for instability of the exposed highwalls, potential for backfill instability and increased potential for water ingress to the underground workings because the overburden thickness is reduced by the depth of the West Pit.</p>	<p>Managed under <i>Mount Owen Glendell Operations Key Features Asset Management Plan (Volume 2 Appendix C)</i>. In summary:</p> <ul style="list-style-type: none"> • Regular face position updates sent to Mount Owen. • Mount Owen Mine Safety Management System including the Mine Inspection System manages the risk of highwall rockfalls under normal circumstances. The probability of any potential rock falls is expected to be much less than the risk of any rock falls that would be managed under normal circumstances. • Surveys of distributed survey pegs around the top edge of the highwall of Ravensworth East - West Pit will be undertaken to confirm the magnitude of any ground movements that may lead to subsidence impacts to the highwall and the ventilation shaft. • A Mount Owen Glendell - Integra Underground surface access protocol has been developed. 	<p>Timing and frequency as per <i>Subsidence Monitoring Program (Appendix C)</i>. In summary:</p> <ul style="list-style-type: none"> • Visual inspections – Weekly pre, during and post mining. • Continued regular liaison between Mount Owen and Integra Underground. • Survey measurements of the subsidence movements around the top edge of highwall pre and post mining of each Longwall panel (LW17-19).

Feature	Brief Description (SCT 2020)	Impact (SCT 2020)	Management	Timing and Frequency
Glendell Haul Road	<p>The Glendell haul road extends from the active Barrett Pit to the southern ROM stockpile at Mt Owen CHPP. The haul road crosses the Extraction Plan Area for LW 17-20.</p> <p>The haul road traverses around the West Pit, over the filled section of TP2 and alongside TP1, crossing the longwalls panels from the south eastern corner of LW 17 to near the centre of LW 20.</p> <p>Above the corner of LW 17 the thickness of the fill material in TP2 is estimated at 15-20m. Other sections of the haul road have been constructed with fill material to approximately 10-15m above the natural ground level.</p>	<p>The haul road is likely to experience up to 1.6m of vertical subsidence with corresponding tilts and strains. The maximum effects are expected primarily over LW 19. Increased tilt and strains from vertical and horizontal movements may cause perceptible cracking on the hard surface of the road with local changes in grade, both along and across the haul road that could affect drainage. There is also some potential for minor compression humps.</p> <p>These potential changes are more likely to affect light vehicles rather than significantly impact on the serviceability of the road for the haul truck fleet. Some increased maintenance may be required over the current and previous longwall panels during the period of active subsidence.</p> <p>The impacts of vertical subsidence may also be evident at the interface of natural ground and fill material in TP2 over LWs 17 and 18. A crack or small step may form across the haul road above LW 17. A similar crack may form along the edge of the haul road above LW 18.</p>	<p>Managed under <i>Mount Owen Glendell Operations Key Features Asset Management Plan (Volume 2 Appendix C)</i>. In summary:</p> <ul style="list-style-type: none"> Regular face position updates sent to Mount Owen. Inspections of haul road. Warning signs. A Mount Owen Glendell - Integra Underground surface access protocol has been developed. 	<p>Timing and frequency as per <i>Subsidence Monitoring Program (Appendix C)</i>. In summary:</p> <ul style="list-style-type: none"> Continued regular liaison between Mount Owen/Glendell and Integra Underground. Visual inspections – Weekly pre, during and post mining.
Eastern Rail Pit	<p>The Eastern Rail Pit (ERP) has completed coal production since the GCUC Project and Underground Project EA.</p> <p>This shallow pit was mined to a maximum depth of about 35m. The ERP is has been partially filled and capped, with only a small area of open void located above LW 14-16.</p>	<p>Any additional impacts to the ERP from the planned mining of LWs 17 – 20 are expected to be minor and manageable.</p> <p>Some additional subsidence movements are expected at the north west corner of the open void above LWs 15 and 16 from the mining of LW 17 and subsequent panels, but these will be small by comparison to the movements associated with LWs 15 and 16.</p> <p>The potential for increased inflow from the ERP into Integra Underground mine workings</p>	<p>Managed as per the <i>Mount Owen Glendell Operations Key Features Asset Management Plan (Volume 2 Appendix C)</i>. In summary:</p> <ul style="list-style-type: none"> Maintaining the pit water at a low level during periods of active undermining. As a precaution, access to any roads positioned close to the top edge of highwall will be restricted 	<p>Timing and frequency as per <i>Subsidence Monitoring Program (Appendix C)</i>. In summary:</p> <ul style="list-style-type: none"> Continued regular liaison between Mount Owen and Integra Underground. Visual inspections – Weekly pre, during and post mining.

Feature	Brief Description (SCT 2020)	Impact (SCT 2020)	Management	Timing and Frequency
	<p>The ERP does not extend over Longwalls 17–20.</p> <p>The corner of the ERP where the exposed northern and western highwalls meet is closest to LW 17 and approximately 180m from the panel edge. The highwalls at this location are currently 15m high following emplacement of approximately 15m of tailings. Most of the open void was recently mined under by LW 15 without significant impact.</p>	<p>has been assessed for LWs 15-20 in an independent study by groundwater specialists (AGE 2017) as part of the EA for MOD8 to the Integra Project approval. Any increase in groundwater flow between the surface and underground workings from the mining of LWs 17-20 is not expected to be at a rate sufficient to constitute an inrush hazard for Integra Underground.</p>	<p>during the period of active undermining.</p> <ul style="list-style-type: none"> Regular face position updates sent to Mount Owen. Mount Owen Mine Safety Management System including the Mine Inspection System manages the risk of highwall rockfalls under normal circumstances. The probability of any potential rock falls is expected to be much less than the risk of any rock falls that would be managed under normal circumstances. A Mount Owen Glendell – Integra Underground surface access protocol has been developed. 	
TP1/Mount Owen Rail Loop Tailings Dam	<p>A section of the Dam Safety NSW (DSBSW) Mt Owen Notification Area that surrounds the prescribed/declared dam referred to as Mt Owen Rail Loop Tailings Dam (TP1) is shown in Figure 2-1.</p> <p>LWs 17-20 mine within the DSNSW Notification Area for TP1 and LWs 18, 19 and 20 are planned to mine directly under the dam.</p> <p>TP1 was formed as an open cut pit to a depth of around 30m. Earth embankments at the southern end form the dam wall. The dam storage is</p>	<p>The subsidence effects from the planned mining of LWs 17-20 is not expected to have any practical or significant impact on tailings, capping or any exposed highwall edges and pit surrounds. TP1 is not expected to have any practical impacts or pose an inrush risk to the mining of LWs 17-20.</p> <p>TP1 is expected to experience the full range of subsidence effects forecast. Minor impacts may include cracking of the surface of the tailings and capping material if the capping has advanced to be above the longwalls at the time of mining these panels and changes in level that may affect where water ponds and can drain.</p> <p>The potential for increased inflow into Integra Underground mine workings has been assessed in an independent groundwater</p>	<p>Managed as per <i>Mount Owen Glendell Operations Key Features Asset Management Plan (Volume 2 Appendix C)</i>. In summary:</p> <ul style="list-style-type: none"> This includes regular inspections and subsidence monitoring. Dam Safety NSW consent and Chief Inspector of Coal Mines (CICM) approval are expected to be required for the mining of both development roadways and longwall extraction within the Mount Owen Notification Area while ever TP1 remains as a prescribed/declared dam. <p>To reduce the potential for overflow from TP1 due to surface tilting, it is</p>	<p>Dam Safety NSW and CICM approval prior to undermining.</p> <p>Timing and frequency as per <i>Subsidence Monitoring Program (Appendix C)</i>. In summary:</p> <ul style="list-style-type: none"> Continued regular liaison between Mount Owen and Integra Underground. Visual inspections – Weekly pre, during and post mining.

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Feature	Brief Description (SCT 2020)	Impact (SCT 2020)	Management	Timing and Frequency
	<p>almost completely full of tailings with only a small section of ponded water at the southern end. The capping process has started from the northern end of this dam with around 30% of the surface area completed to date. The capping is currently outside half depth from the edge of LW 20 but is likely to extend into the area of active subsidence by the time LW 20 is mined.</p>	<p>study (AGE 2017). The minimum overburden depth between the floor of TP1 and the mining horizon is approximately 450m. The height of depressurisation is estimated using the approach described by Tammetta (2012) to be 280m above the mining horizon for an assumed mining height of 3.2m. The base of the open cut void is approximately 170m above the top of the zone of depressurisation. There is expected to be very limited potential for significant inflow from TP1 through this interval. There is no potential for flows of a magnitude sufficient to constitute an inrush hazard to Integra Underground.</p> <p>The earth embankment that forms the lower end of TP1 is approximately 5m high. The ground strains expected in this area are less than 4mm/m. The earth embankment is expected to be able to accommodate this level of ground strain without perceptible impact.</p> <p>An impact assessment was undertaken by Engeny (2020) to consider the potential effects of subsidence on the grade of the TP1 drain. This assessment found that the grade for the drain will potentially be reduced by between 0.09% and 0.18% with the downstream section of the drain being more greatly affected than the upstream.</p>	<p>recommended that, as part of the <i>Built Features Management Plan</i> (this document), the area is regularly inspected, any ponded water in TP1 is drawn down to a low-level during periods of active subsidence for each panel mining directly below TP1 and potential overflow points are reviewed following the completion of each panel. Integra Underground will complete as per recommendations.</p> <p>Engeny (2020) notes that with the direction of mining of LW 19 proceeding generally from North East to South West the upstream section of the TP1 drain will be affected by subsidence prior to the downstream section. Therefore, there is potential for the subsidence impacts on the drain to be initially greater than the ultimate impact and should be monitored during the progress of the mining of the longwalls in this area.</p>	

Feature	Brief Description (SCT 2020)	Impact (SCT 2020)	Management	Timing and Frequency
Embankments and Cuttings	<p>Within the Extraction Plan Area for LW 17-20, the Mount Owen Rail Line Loop passes through and over series of cuttings and embankments. There are three railway embankments and six railway cuttings located within the affection area.</p> <p>The cuttings are generally less than 5-6m deep with embankments generally less than 2-3m high. There are several culverts through the embankments as part of the surface water management system.</p> <p>Above the longwalls, the longer cuttings are over LWs 17, 18 and 19 and the main embankment is over LW 19. There is a culvert through this low embankment positioned above the chain pillar between LWs 19-20. This culvert allows overflow from the western sediment dam for the WOOP Dump run-off to flow to the main rail loop dam via another dam within the loop. The cuttings and emplacements are expected to experience the full range of subsidence effects forecast.</p>	<p>No significant impacts are expected in the cuttings, but some cracking and minor slumping may be evident. Subsidence movements may cause some low magnitude lateral spreading and minor cracking of the rail embankments, but it is not expected to cause any significant instability of the rail foundation. No significant impacts are expected to the culvert.</p>	<p>Managed as per the <i>Mount Owen Glendell Operations Key Features Asset Management Plan (Volume 2 Appendix C)</i>. In summary Subsidence and other monitoring and regular inspections are expected to be effective in identifying any significant stability issues, as well as impacts to drainage.</p>	<p>Timing and frequency as per <i>Subsidence Monitoring Program (Appendix C)</i>. In summary:</p> <ul style="list-style-type: none"> Continued regular liaison between Mount Owen and Integra Underground. Visual inspections – Weekly pre, during and post mining.

Feature	Brief Description (SCT 2020)	Impact (SCT 2020)	Management	Timing and Frequency
<p>TP2 Ravensworth East Tailings Dam/Mount Owen Stage 5 Tailings Dam</p>	<p>The Ravensworth East Tailings Pit / Mt Owen Stage 5 Tailings Dam, also referred to as TP2, is located adjacent to the Mt Owen Rail Line between TP1 and the ERP. TP2 was originally mined to a depth of approximately 35m. TP2 is filled with waste rock from Glendell Mine. There are no tailings in this pit. The section of TP2 above LWs 17 and 18 has been substantially backfilled, capped and largely rehabilitated to a height of approximately 15m above the original ground level. A small area of the void above LWs 15 and 16 is still open and used as part of surface water management system to store and filter water. Infrastructure for pumping from the southeast corner of the storage was recently upgraded. One side of the open void, approximately 25m deep, forms the western side of the rail line causeway with the ERP forming the other side. LW 15 mined below part of this area.</p>	<p>Impacts to TP2 from planned mining of LWs 17-20 are expected to be generally insignificant and not expected to have any significant consequence. The only potential impacts relate to minor differential subsidence that may become apparent on the Glendell haul road.</p> <p>LW 15 mined below part of this area. Additional subsidence movements are expected to occur at the open void above LWs 15 and 16 when LW 17 and subsequent panels are mined.</p> <p>Forecast subsidence movements are likely to result in further settlement of the fill material and may induce cracking particularly at the crest of steeper sections of fill material. Impacts in the form of cracks, steps and potholes may form along the interface between fill material and natural ground surface around the buried perimeter of the TP2 pit. The additional settlement and impacts are generally not expected to have any significant consequence other than minor differential subsidence that may become apparent on the Glendell haul road. Other potential impacts include cracking and rock falls on the exposed highwall, slope instability in steeper parts of the emplaced material and potential for increased inflow to the underground mine workings.</p> <p>The rate of inflow from TP2 into Integra Underground mine workings has been assessed for LWs 15-20 in an independent study by groundwater specialists (AGE 2017) as part of the EA for MOD8 to the Integra Project Approval. Any increase groundwater</p>	<p>Managed as per <i>Mount Owen Glendell Operations Key Features Asset Management Plan (Volume 2 Appendix C)</i>. This includes regular inspections and subsidence monitoring.</p>	<p>Timing and frequency as per <i>Subsidence Monitoring Program (Appendix C)</i>. In summary:</p> <ul style="list-style-type: none"> Continued regular liaison between Mount Owen and Integra Underground. Visual inspections – Weekly pre, during and post mining.

Feature	Brief Description (SCT 2020)	Impact (SCT 2020)	Management	Timing and Frequency
		flow between the surface and underground workings from the mining of LWs 17-20 is not expected to be at a rate sufficient to constitute an inrush hazard for Integra Underground.		
Mount Owen Active Mining Area/ Overburden Emplacement (including WOOP Dump)	<p>There are several areas of rehabilitated waste rock fill from the Glendell, Ravensworth East and Mount Owen open cut mines located within the Extraction Plan Area for LWs 17-20.</p> <p>The major emplacements are the WOOP Dump, the Glendell/ Ravensworth East area and the Glendell area. Other minor emplacements include those associated with the rehabilitation of TP2 and the ERP.</p> <p>The emplacement areas located above LWs 17–20 include parts of the WOOP Dump and TP2.</p>	<p>The Glendell/Ravensworth East and Glendell emplacement areas are further than half depth from LWs 17–20 and unlikely to be perceptibly impacted by mining these longwall panels. Total vertical subsidence of up to 2.5m with strains up to 14mm/m in tension and 20mm/m in compression are forecast.</p> <p>Cracking may develop along the crest of topographic high points allowing water ingress during periods of heavy rain. This ingress has potential to contribute to minor instability on steeper sections between contour drains on the WOOP Dump, but such instability is not expected to be significant. The drop structure on the western slope of the WOOP Dump is not expected to be significantly impacted. Some minor remediation work may be required to the contour drains, drop structure and sediment control dams, but overall, any subsidence impacts to this modified landform are expected to be manageable.</p>	<p>Managed as per <i>Mount Owen Glendell Operations Key Features Asset Management Plan (Volume 2 Appendix C)</i> including weekly inspections during active subsidence.</p>	<p>Timing and frequency as per <i>Subsidence Monitoring Program (Appendix C)</i>. In summary:</p> <ul style="list-style-type: none"> Continued regular liaison between Mount Owen and Integra Underground. Visual inspections – Weekly pre, during and post mining. Including the drop structure, access tracks and contour banks.

Feature	Brief Description (SCT 2020)	Impact (SCT 2020)	Management	Timing and Frequency
<p>Integra Underground Gas Drainage Infrastructure</p>	<p>Components of the Integra Underground gas management system either already exist or are proposed within the Extraction Plan Area for LW 17-20. Existing operational installations are currently above LW 15 and 16. The system comprises surface to seam boreholes with collar installations and surface pipeline networks for either flaring the gas to reduce greenhouse gas emissions or delivery to a central gas drainage plant for power generation. The existing gas management system is expected to be extended to cover areas above LW 17-20 wherever surface access is practical.</p>	<p>This equipment is expected to experience the full range of subsidence effects forecast. This gas drainage equipment is designed to accommodate the anticipated subsidence movements and effective, management measures are in place.</p>	<p>The <i>Integra Underground Ventilation Control Plan</i> includes TARPs to manage potential impacts to the gas drainage infrastructure. A regular network inspection regime will be undertaken.</p>	<p>Timing and frequency as per <i>Integra Underground Ventilation Control Plan</i>. In summary:</p> <ul style="list-style-type: none"> • Visual inspections – Weekly pre, during and post mining.

Feature	Brief Description (SCT 2020)	Impact (SCT 2020)	Management	Timing and Frequency
Ventilation Shaft 3 and Associated Infrastructure	A new surface to seam ventilation shaft for Integra Underground known as Shaft 3 has recently been commissioned. The surface installations for the shaft, including main fans and service boreholes, are located beyond the finish line of LW 16 on the southern edge of the Extraction Plan Area. The shaft and associated infrastructure, including service boreholes are beyond half depth from the finish line of LW 17.	<p>No significant impacts from the planned mining in LWs 17–20 are expected. Subsidence effects at the shaft site, in addition to those from mining in LWs 15 and 16, are expected to include small additional horizontal movements. Impacts are expected to be limited to additional shearing on bedding planes that may intersect the shaft and adjacent service boreholes.</p> <p>SCT understands that the shaft infrastructure has been designed to accommodate the forecast subsidence movements with provision for minor adjustments to equipment during the mining of each longwall.</p>	<p>Managed as per <i>Built Features Management Plan</i> (this document). Surveys of distributed survey pegs around the around the top edge of Ventilation Shaft 3 will be undertaken to confirm the magnitude of any ground movements that may lead to subsidence impacts to the highwall and the ventilation shaft.</p> <p>The <i>Built Features Management Plan</i> (this document) and subsidence monitoring program includes inspections for the periods of mining the last 500m in LW 17 and 18 and surveys as per recommendations by SCT.</p>	<p>Timing and frequency as per <i>Subsidence Monitoring Program (Appendix C)</i>. In summary:</p> <ul style="list-style-type: none"> • Inspections for the periods of mining the last 500m in LW 17 and 18 and monitoring as required. • Survey measurements of the subsidence movements around the top edge of highwall pre and post mining of each Longwall panel (LW17-19).
Planned Dewatering and Ventilation Infrastructure	MOD8 to Integra Underground PA08_0101 provides consent for HVCC to construct additional surface infrastructure above the northern sections of LWs 15 - 20. This additional infrastructure includes a dewatering borehole with pumping equipment and ventilation shafts with exhaust fans supplied by an 11kV powerline. This infrastructure has not been constructed.	<p>The goaf dewater borehole collar is proposed to be located near the recently constructed stormwater dam and over the northern section of LW 14/15 development roadways. The exact position of the dewatering infrastructure and planned bleeder shafts, exhaust fan installations and powerline extension are yet to be finalised.</p> <p>Integra Underground will undertake a detailed assessment of potential subsidence impacts to this infrastructure , once the final positions, longwall geometry and relative timing of mining is known.</p> <p>Subsidence effects and impacts to the planned infrastructure are expected to be manageable with appropriate assessment and design considerations.</p>	<p>Managed as per <i>Built Features Management Plan</i> (this document) and <i>Mount Owen Glendell Operations Key Features Asset Management Plan (Volume 2 Appendix C)</i> including weekly inspections as part of operations during active subsidence.</p>	<p>Timing and frequency as per <i>Subsidence Monitoring Program (Appendix C)</i>. In summary: Inspections and monitoring as determined by the detailed assessment.</p>

Feature	Brief Description (SCT 2020)	Impact (SCT 2020)	Management	Timing and Frequency
<p>Access Roads</p>	<p>There are unsealed access roads and four-wheel drive tracks for light vehicles located throughout the Extraction Plan Area for LWs 17-20.</p>	<p>The impacts from the planned mining of LW 17-20 on the tracks or roads are expected to be essentially similar to impacts previously observed over the earlier longwall panels. These previous impacts have all been minor and easily managed.</p> <p>There is some potential for cracks, compression humps and local changes in grade, both along and across the road that may result in minor ponding. These impacts would not be significantly out of context with the general nature of the terrain and other hazards that might exist unrelated to subsidence impacts. Some minor repair work may be required to smooth out irregularities, fill any open cracks that may form and restore damage.</p>	<p>Managed as per <i>Built Features Management Plan</i> (this document). In summary:</p> <ul style="list-style-type: none"> • The use of warning signs, regular inspections, and timely remediation are key controls which will be implemented to manage potential impacts. • No public access to the Extraction Plan Area. 	<p>Timing and frequency as per <i>Subsidence Monitoring Program (Appendix C)</i>. In summary:</p> <ul style="list-style-type: none"> • Visual inspections – Weekly pre, during and post mining. • Roads and tracks within the Extraction Plan Area will be remediated if subsidence impacts are identified.

Feature	Brief Description (SCT 2020)	Impact (SCT 2020)	Management	Timing and Frequency
<p>Sediment Control Dams</p>	<p>The main sediment control or run-off filtering dam located within the Extraction Plan Area is located at the base of the drop structure on the western slope of the WOOP Dump. Other similar dams for the Ravensworth East/Glendell emplacement area, stormwater collection on the eastern slope of the WOOP Dump (Dam 4) and sediment control dams for the ERP are located to the east of LW 15 and outside the Extraction Plan Area.</p> <p>The run-off dam for the WOOP Dump is located adjacent to the rail line and overflows to feed a smaller dam on natural ground within the rail loop via culverts under the maintenance road and rail line embankment. The water from these dams then flows into the Rail Loop Dam.</p>	<p>These two dams are expected to experience the full range of subsidence movements forecast for the planned mining of LWs 17-20. Minor surface cracking and changes in level are expected due to transient tilting of the surface as the planned longwalls mine under these features.</p> <p>These impacts are expected to be temporary. Minor remedial work may be required at the LWs 19-20 chain pillar and LW 20 goaf edge to adjust gradients and restore flow paths. No significant impacts to the culverts are expected.</p>	<p>Managed as per <i>Built Features Management Plan</i> (this document) and <i>Land Management Plan (Appendix I)</i>. In summary:</p> <ul style="list-style-type: none"> Inclusion of sediment control dams with regular inspections during the period of active mining. 	<p>Timing and frequency as per <i>Subsidence Monitoring Program (Appendix C)</i>. In summary:</p> <ul style="list-style-type: none"> Visual inspections – Weekly pre, during and post mining. Subsidence repair as required.

Feature	Brief Description (SCT 2020)	Impact (SCT 2020)	Management	Timing and Frequency
Surface Drainage	<p>The lowest point in the rail loop is on the western incoming track adjacent to the northern edge of the filled section of TP2 near the southern end of TP1. This point is above LW 18 and is expected to be lowered by up to 1.8m at the completion of mining LWs 18–20. This change in reduced level may affect drainage to the west and around the rim of the West Pit to the dam above the south-western corner of this pit.</p> <p>There are seven culverts that pass through the Railway formation within the Affection Area. Some culverts allow water drainage across the Railway formation and other culverts are used to pass water pipelines through the formation.</p>	<p>The drainage of the surface within the rail loop is likely to be impacted by the forecast vertical subsidence and tilt for the mining of LWs 17-20. However, impacts are expected to be minor in nature, repairable and manageable within provisions of the surface water management system for the site.</p>	<p>Managed as per <i>Water Management Plan (Appendix E)</i> and <i>Built Features Management Plan</i> (this document). In summary:</p> <ul style="list-style-type: none"> • If a suitable gradient cannot be re-established, pumping equipment in conjunction with the adjacent TP1 and TP2 installations may need to be installed at the low point to avoid temporary ponding (SCT 2020). • Integra Underground will undertake regular inspections during the period that the area is affected by active subsidence from each longwall panel (SCT 2020). <p>The components of the surface water monitoring program for the Extraction Plan Area include monitoring of:</p> <ul style="list-style-type: none"> • Surface water quality; • Channel stability; • Ponding; • Erosion; • Riparian vegetation; and • Dam (Engeny, 2020). 	<p>Timing and frequency of monitoring as per <i>Water Management Plan (Appendix E)</i> and <i>Built Features Management Plan</i> (this document). In summary:</p> <ul style="list-style-type: none"> • See the 'Management' column.

4.3 Subsidence Management Protocol

Integra Underground, in conjunction with Mount Owen Glendell Operations, has developed a subsidence management protocol. This protocol has been developed to outline the responsibilities of all parties within the Integra Underground and Mt Owen Glendell Operations regarding subsidence management. A copy of the protocol has been included as **Appendix D – Subsidence Management Protocol**.

5. Implementation

5.1 Monitoring Program

The proposed monitoring program is outlined in Subsidence Monitoring Program (**Volume 1 Appendix C**), *Mount Owen Rail Infrastructure Asset Management Plan (Appendix B)* and *Mount Owen Mine Key Features Asset Management Plan (Appendix C)*. Monitoring includes a combination of:

- Pre mining subsidence monitoring and inspections;
- During mining subsidence monitoring and inspections; and
- Post mining subsidence monitoring and inspections.

5.2 General Approach to Managing Built Features

Mount Owen Rail Infrastructure Asset Management Plan and *Mount Owen Mine Key Features Asset Management Plan* have been prepared for a series of key built features with these included as **Appendix B** and **Appendix C** to this management plan. Integra Underground's general approach to the management of built features includes:

- **Baseline Monitoring and Inspections** – Establishing baseline data for the Extraction Plan Area by completing inspections and subsidence monitoring. Liaison with key stakeholders;
- **Mitigation Measures Prior to Mining** – Mitigation measures for key infrastructure and services within the Extraction Plan area including the rail line loop;
- **Monitoring and Inspections During Mining** – Continue inspections and monitoring as mining progresses. Liaison with key stakeholders;
- **Assessment and Interpretation of Impacts** – Monitoring and inspection data is analysed to identify variations from subsidence predictions. Assessment of impacts/risks to public safety. Liaison with key stakeholders;
- **Implement Remediation Measures** – Implement actions to effectively manage any risks to public safety. Liaison with key stakeholders; and
- **Re-assessing Impacts and Review of Effectiveness of Remediation Measures** – Re-assessment of impacts through inspection and monitoring. Review of the effectiveness of remedial measures. Liaison with key stakeholders.

5.3 Monitoring of the Success of Remediation Measures

Any significant subsidence remediation completed by Integra Underground will be added to the Integra Underground rehabilitation monitoring program and reported in the Integra Underground Annual Review.

A summary of subsidence impacts and remediation will be provided in the Annual Review (**Section 6.2**). Integra Underground's Rehabilitation Monitoring Program is included in the MOP.

5.4 Adaptive Management

Integra Underground’s approach to managing subsidence and environmental impacts at the mine includes using past performance to guide and improve future monitoring and management actions.

Monitoring of the environment and the subsequent response to mining induced subsidence has been in place at Integra Underground prior to mining and has led to an improved understanding of the environment and site specific subsidence behaviour. Updated information from monitoring is then incorporated into Integra Underground’s management plans to improve preventative and remedial actions. If updates to this Extraction Plan are required, these will be submitted to the DPIE for approval.

6. Review and Improvement

6.1 Roles and Responsibilities

Detailed roles and responsibilities relating to subsidence management is outlined within Section 7.5 of the Extraction Plan Main Document.

6.2 Reporting Framework

Reporting related to the Extraction Plan is outlined within Section 7.1 and Section 8.1 of the Extraction Plan Main document. This includes reporting for:

- Annual Review;
- Reporting of impacts as per the key asset management plans; and
- Incident reporting if required.

6.3 Audit and Review

Review of the Extraction Plan and/or any of the sub-plans, and revision if necessary, shall occur where significant unpredicted impacts and/or environmental consequences are identified through the monitoring and management strategies proposed in the Extraction Plan.

Any revision to the Extraction Plan including component sub-plans must be submitted to DPIE for approval.

7. Document Information

7.1 Related Documents

This *Built Features Management Plan* forms part of the overall Extraction Plan documentation, with this including a main framework document and other management plans. A list of the full documentation is outlined in Section 2.3 the Extraction Plan Main Document.

7.2 Change Information

Full details of the document history are recorded in the document control register, by version. A summary of the current change is provided in **Table 7-1**.

Table 7-1 – Change information

Version	Date	Change Summary
1.0	August 2020	New document for LW 17 - 20.
2.0	January 2021	Updated Extraction Plan LW 17 to 20 based on DPIE feedback
3.0	February 2021	Updated Extraction Plan LW 17 to 20 based on further DPIE feedback

Appendix A - Trigger Action Response Plan

Note: TARPs for Built Features:

1. Separate Asset Management Plans cover Mount Owen Glendell Operations Key Features and Rail Infrastructure (**Appendix B, Appendix C**).
2. Surface gas infrastructure (pipework)

A.1 Feature: Access Roads

Normal State	<p><i>Subsidence as expected, no damage requiring remediation.</i></p> <p><i>Continued implementation of Subsidence Monitoring Program.</i></p> <p><i>Implementation of remedial measures.</i></p>	
Trigger Action Response Plan	Level 1 Trigger – Alert / Investigate	Level 2 Triggers – Stop – Withdrawal / Removal
	Subsidence impacts as expected. Damage requires remediation	Greater than expected subsidence or roads are temporarily not useable due to subsidence impacts
Persons affected	Action / Response	Action / Response
Environment and Community Manager	<p>Continue inspections.</p> <p>Signage and access restriction.</p> <p>Remediation of impacts.</p>	<p>Continue inspections.</p> <p>Signage and access restriction.</p> <p>Liaison with landowner and subsidence specialist.</p> <p>Remediation of impacts.</p>

A.2 Feature: Dams and Fences

Normal State	<p><i>Subsidence as expected, no damage requiring remediation.</i></p> <p><i>Continued implementation of Subsidence Monitoring Program.</i></p> <p><i>Implementation of remedial measures.</i></p>	
Trigger Action Response Plan	Level 1 Trigger – Alert / Investigate	Level 2 Triggers – Stop – Withdrawal / Removal
	<p>Subsidence impacts as expected.</p> <p>Damage requires remediation.</p>	<p>Greater than expected subsidence.</p> <p>Damage to fences causing cattle to escape.</p> <p>Loss of water or loss of dam integrity due to subsidence impacts.</p>
Persons affected	Action / Response	Action / Response
<p>Environment and Community Manager</p>	<p>Regular subsidence monitoring and inspections within the Extraction Plan area.</p> <p>Liaison with landowner.</p> <p>Provision and installation of temporary electric fencing in liaison with landowner if required.</p> <p>Remediation of impacts to fences/gates or dams if required.</p>	<p>Regular subsidence monitoring and inspections within the Extraction Plan area.</p> <p>Provision and installation of temporary electric fencing in liaison with landowner (if applicable).</p> <p>Remediation of impacts to fences/gates/dam in liaison with landowner (if applicable).</p>

Appendix B - Mount Owen Rail Infrastructure Asset Management Plan

INTEGRA UNDERGROUND

GLENCORE



Mt. Owen Railway Infrastructure Longwalls 17 to 20 Asset Management Plan

Number: INTUG-793190785-3021
Owner: Environment and Community Manager

Status: Submitted for Approval
Version: 1.0

Effective: TBA
Review: TBA

Uncontrolled unless viewed on the intranet

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Definitions and abbreviations

Affectation Area	The extent of Railway affected by mine subsidence due to Longwalls 17 to 20
ARTC	Australian Rail and Track Corporation
Bridges	Bettys Creek railway and service road bridges
CCC	Community Consultative Committee
CHPP	Coal Handling and Preparation Plant
DPI&E	Department of Planning, Industry and Environment
Integra Underground	Integra Underground Mine
MGO	Mount Owen Glendell Operations
OEH	Office of Environment and Heritage
ONRSR	Office of the National Rail Safety Regulator
Railway	Mount Owen Railway
RL	Reduced level above Australian Height Datum
RM	Rail Maintainer
RO	Rail Operator
SA NSW	Subsidence Advisory New South Wales
SFT	Stress Free Temperature
TARP	Trigger Action Response Plan
TC	Technical Committee

1. Background

The Integra Underground Mine (Integra Underground, the Mine), formally known as Glennies Creek Colliery, is located approximately 12 kilometres (km) north of Singleton in the Hunter Valley of New South Wales (NSW). The Mine was established in 1999 and commenced longwall mining in the Middle Liddell Seam in 2002, completing the extraction of Longwalls 1 to 12.

Integra Underground went into care and maintenance in May 2014. The Mine was purchased by HV Coking Coal Pty Limited, a subsidiary of Glencore Coal Pty Ltd (Glencore), in December 2015. Glencore has approval for longwall mining in the Middle Liddell and Hebden Seams (Project Approval 08_0101).

Glencore recommenced the development of first workings in January 2017 and secondary extraction started in May 2017. Integra Underground has now completed Longwalls 13 to 15 and it is currently mining Longwall 16 in the Middle Liddell Seam.

The Mount Owen Railway (the Railway) is owned by Mount Owen Glendell Operations (MGO), the operations for which it services, and is currently maintained by Laing O'Rourke. The Railway branches from the Main Northern Rail Line, north-west of the Glennies Creek Road level crossing, and proceeds in a general northerly direction to the Mount Owen Coal Handling Preparation Plant (CHPP), crossing the surface above or adjacent to the mine's previously extracted Longwalls 7 to 15. These longwalls are oriented south-west to north-east, intersecting the Railway near their finishing ends.

The Railway crosses directly above Longwall 16 as well as Longwalls 17 to 20, which are the subject of this Extraction Plan. There are two bridges (the Bridges) where the Railway and the adjacent service road cross Bettys Creek above the chain pillar between Longwalls 13 and 14. The locations of the Railway, the Bridges and the longwalls at Integra Underground are shown in **Figure 1-1**. The definition of the *Affectation Area* is provided in **Section 4.1**.

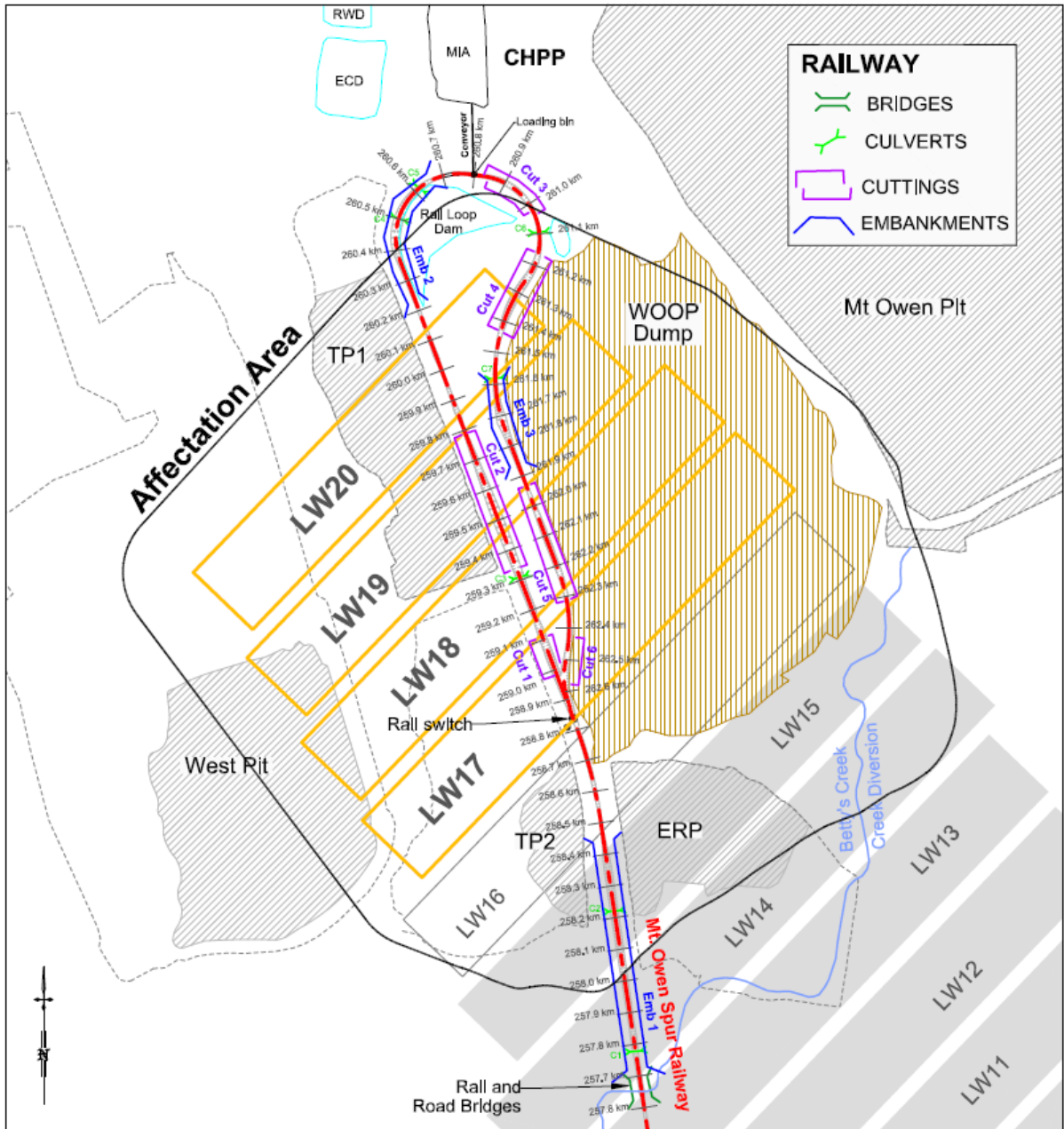


Figure 1-1 Mount Owen Railway and the Longwalls at Integra Underground

1.1 Scope

Integra Underground has approved Mount Owen Railway and Bettys Creek Bridges Asset Management Plans for Longwalls 13 and 14 and Longwalls 15 and 16. This *Mount Owen Railway Infrastructure Asset Management Plan* (the *Asset Management Plan*) addresses the Railway and its associated infrastructure with respect to the extraction of Longwalls 17 to 20. The surface infrastructure covered in this management plan includes the:

- Railway (i.e. track, sleepers and ballast);
- Bridges (i.e. Railway and service road bridges across Bettys Creek);
- Railway switch;
- Embankments and cuttings;
- Drainage culverts;
- Coal loading infrastructure (i.e. train load out bin (TLO) and reclaim conveyor);
- Signal line; and
- Service road.

The Asset Management Plan describes the preventive measures, monitoring, management and remediation measures for the Railway and its associated infrastructure for Longwalls 17 to 20.

1.2 Objectives

The objectives of this Asset Management Plan are to establish procedures to measure, control, mitigate and repair potential impacts that might occur on the Railway and its associated infrastructure due to the extraction of Longwalls 17 to 20. The Management Plan has been developed to:

- Maintain the safe and serviceable operation of the Railway (public and workplace safety is paramount);
- Disruption and inconvenience to business should be avoided or, if unavoidable, kept to minimal levels;
- Monitor ground movements and the condition of the Railway and its associated infrastructure during longwall mining;
- Establish procedures to measure, monitor, control, mitigate and repair the Railway and its associated infrastructure;
- Initiate action to mitigate or remedy potential significant impacts that are expected to occur on the Railway and its associated infrastructure;
- Provide a plan of action in the event that the impacts of mine subsidence are greater than those predicted;
- Establish a clearly defined decision-making process to ensure timely implementation of risk control measures for high consequence but low likelihood hazards; and
- Establish lines of communication and emergency contacts.

1.3 Requirements of the management plan

1.3.1 Legal framework

Integra Underground has approval for longwall mining in the Middle Liddell and Hebden Seams (PA 08-0101, as modified) subject to a number of conditions. The commitments in relation to the Railway are provided in Table 10 and Appendix 7 of the Project Approval, which have been reproduced in **Table 1-1** and **Table 1-2**.

Table 1-1 – Extract of Table 10 of Project Approval 08_0101 – Schedule 3 Condition 17

Built features	Subsidence performance measures
All built features (except those fully covered by an operative contractual arrangement with another mine owner or other owner of the relevant built feature)	Safe, serviceable and repairable, unless the owner agrees otherwise in writing, including: <ul style="list-style-type: none"> • serviceability should be maintained wherever practicable; • loss of serviceability must be fully compensated; and • damage must be fully repaired or replaced, or else compensated

Table 1-2 – Extract of Appendix 7 of the Development Consent – Statement of commitments

Desired outcome	Existing or proposed actions	Timing
TRANSPORT		
Management of rail infrastructure	A new Mt. Owen Rail Spur Management Plan will be prepared in consultation with GMO [MGO], and will include monitoring, stakeholder consultation and mitigation measures.	Prior to the commencement of proposed longwall mining in the affected area

This Asset Management Plan for the Railway and its associated infrastructure forms part of the Integra Underground Extraction Plan for Longwalls 17 to 20.

1.3.2 NSW Work Health and Safety Legislation

All persons conducting a business or undertaking (PCBUs), including mine operators and contractors, have a primary duty of care to ensure the health and safety of workers they engage, or whose work activities they influence or direct. The responsibilities are legislated in the *Work Health and Safety Act 2011* (WH&S Act) and the *Work Health and Safety (Mines and Petroleum Sites) Act 2013* and associated Regulations, collectively referred to as the 'WHS laws'.

The *Work Health and Safety (Mines and Petroleum Sites) Regulation 2014* commenced on the 1 February 2015 and contains specific regulations in relation to mine subsidence. As outlined in the Guide by the NSW Department of Trade & Investment Mine Safety (now the Department of Planning, Industry and Environment - Resources Regulator):

“a PCBU must manage risks to health and safety associated with mining operations at the mine by:

- *complying with any specific requirements under the WHS laws*
- *identifying reasonably foreseeable hazards that could give rise to health and safety risks*
- *ensuring that a competent person assesses the risk*
- *eliminating risks to health and safety so far as is reasonably practicable*
- *minimising risks so far as is reasonably practicable by applying the hierarchy of control measures, any risks that it is are not reasonably practical to eliminate*
- *maintaining control measures*
- *reviewing control measures.*

The mine operator's responsibilities include developing and implementing a safety management system that is used as the primary means of ensuring, so far as is reasonably practicable:

- *the health and safety of workers at the mine, and*
- *that the health and safety of other people is not put at risk from the mine or work carried out as part of mining operations.”*

Detailed guidelines have also been released by the NSW Department of Planning, Industry and Environment, Resources Regulator, Mine Safety Operations.

Clause 67 of Part 2, Division 5, Subdivision 3 of the WH&S Act states:

“67 Subsidence

(1) In complying with clause 9, the mine operator of an underground coal mine must manage risks to health and safety associated with subsidence at the mine.

(2) Without limiting subclause (1), the mine operator must ensure that:

(a) so far as is reasonably practicable, the rate, method, layout, schedule and sequence of mining operations do not put the health and safety of any person at risk from subsidence, and

(b) monitoring of subsidence is conducted, including monitoring of its effects on relevant surface and subsurface features, and

(c) any investigation of subsidence and any interpretation of subsidence information is carried out only by a competent person, and

(d) all subsidence monitoring data is provided to the regulator in the manner and form and at the times required by the regulator, and

(e) so far as is reasonably practicable, procedures are implemented for the effective consultation, co-operation and co-ordination of action with respect to subsidence between the mine operator and relevant persons conducting any business or undertaking that is, or is likely to be, affected by subsidence.”

Clause 128 of Part 6 of the WH&S Act states:

“128 Duty to notify regulator of certain incidents

(5) In this clause:

***high potential incident** means any of the following:*

(m) any indication from monitoring data of the development of subsidence which may result in any incident referred to in clause 179 (a) (xvi) or (xvii),”

Clause 179 of Part 13 of the WH&S Act states:

“179 Dangerous incidents

For the purposes of section 14 (c) of the WHS (Mines) Act, each of the following is prescribed as a dangerous incident:

(a) an incident in relation to a workplace that exposes a worker or any other person to a serious risk to a person’s health or safety emanating from an immediate or imminent exposure to:

(xvi) a failure of ground, or of slope stability control measures, or

(xvii) rock falls, instability of cliffs, steep slopes or natural dams, occurrence of sinkholes, development of surface cracking or deformations or release of gas at the surface, due to subsidence,”

This Asset Management Plan documents the risk control measures that are planned to manage risks to health and safety associated with the Railway and its associated infrastructure due to the extraction of Longwalls 17 to 20.

1.4 Authors

This Asset Management Plan has been prepared by Mine Subsidence Engineering Consultants (MSEC) in consultation with representatives of:

- Integra Underground Mine (Integra Underground);
- Mount Owen Glendell Operations (MGO);
- SCT Operations (SCT);
- Pidgeon Civil Engineering (PCE);
- Lynton Surveys (LS);
- Laing O’Rourke (LO);
- ALS Global (ALS);
- Pacific National (PN); and
- Freightliner (FL).

1.5 Document control

This Asset Management Plan may be reviewed, updated and refined based on the experience from longwall mining and additional information that is obtained during the project. This document is uncontrolled unless the electronic version is viewed on the intranet.

2. Mining methods and resource recovery

2.1 Mining methods

The planned mining method is a continuation of the current system employed at Integra Underground, namely continuous miner development (first workings) supporting longwall extraction (second workings).

Secondary extraction will be by retreating longwall methods. The existing longwall equipment is capable of operating in the height range of 1.8 m to 3.1 m and of negotiating the expected geological conditions. The minimum extraction height is 2.6 m.

Integra Underground has completed, to date, the extraction of Longwalls 1 to 15 and it has an approved Extraction Plan to mine Longwall 16 in the Middle Liddell Seam. A summary of the dimensions of these longwalls is provided in **Table 2-1**.

Table 2-1 - Geometry of the completed and approved longwalls

Longwall	Overall void length including installation heading (m)	Overall void width including first workings (m)	Overall tailgate chain pillar width (m)
LW1	760	95	-
LW2	1465	145	30
LW3	1975	165	30
LW4	2010	150	33
LW5	1955	145	35
LW6	2055	240	35
LW7	2220	257	35
LW8	2340	257	38
LW9	2355	257	40
LW10	1910	257	43
LW11	2015	257	45
LW12	2290	257	48
LW13	2095	257	50
LW14	2025	257	50
LW15	1835	257	50
LW16	1765	257	50

The lengths of longwall extraction excluding the installation headings are approximately 8 m less than the overall void lengths. The longwall face widths excluding the first workings are approximately 10 m less than the overall void widths.

This Asset Management Plan covers the extraction of Longwalls 17 to 20 in the Middle Liddell Seam. A summary of the dimensions of these longwalls is provided in **Table 2-2**.

Table 2-2 – Geometry of Longwalls 17 to 20

Longwall	Overall void length including installation heading (m)	Overall void width including first workings (m)	Overall tailgate chain pillar width (m)
LW17	1680	257	50
LW18	1635	257	50
LW19	1465	257	50
LW20	1315	257	50

The lengths of longwall extraction excluding the installation headings are approximately 8 m less than the overall void lengths. The longwall face widths excluding the first workings are 247 m.

2.1.1 Mining schedule

A summary of the proposed mining schedule for Longwalls 17 to 20 and the estimated active subsidence periods for the Railway is provided in **Table 2-3**.

Table 2-3 – Proposed mining schedule for Longwalls 17 to 20

Longwall	Estimated start date	Estimated completion date	Estimated period of active subsidence for the Railway
LW17	January 2021	August 2021	Apr 2021 ~ Jul 2021
LW18	September 2021	April 2022	Nov 2021 ~ Feb 2022
LW19	May 2022	October 2022	Jun 2022 ~ Aug 2022
LW20	December 2022	June 2023	Dec 2022 ~ Mar 2023

As mine scheduling can be impacted by many factors, the dates listed in **Table 2-3** are indicative only.

3. Site conditions of the application area

3.1 Surface topography

The natural surface near the Railway has been modified by the open cut pits and emplacement areas on the MGO site. The locations of these features are shown in **Figure 1-1**.

The Mount Owen Rail Loop Tailings Pit (TP1) is located on the western side of the Railway loop directly above the proposed Longwalls 18 to 20. The dam wall is located on the southern side of this pit and directly above the proposed Longwall 18. TP1 is a declared dam that is managed in accordance with the regulations outlined by Dams Safety NSW.

The Ravensworth East Pit (TP2) is also located on the western side of the Railway and the loop directly above the approved Longwalls 15 to 18. This pit has been largely infilled with spoil, with the remaining void located above the approved Longwalls 15 and 16 only.

The Eastern Rail Pit (ERP) is located on the eastern side of the Railway above approved Longwalls 15 and 16. This pit has been infilled with spoil close to the natural surface level. The Western Out Of Pit (WOOP) Dump is located on the eastern side of the Railway and the loop above Longwalls 16 to 18.

The surface level contours at the mine have been generated from a Light Detection and Ranging (LiDAR) survey of the area and these are shown in **Figure 3-1**. The survey was carried out on the 28 December 2019 and it shows the natural and modified surface based on the open cut pits and the emplacement areas at that time.

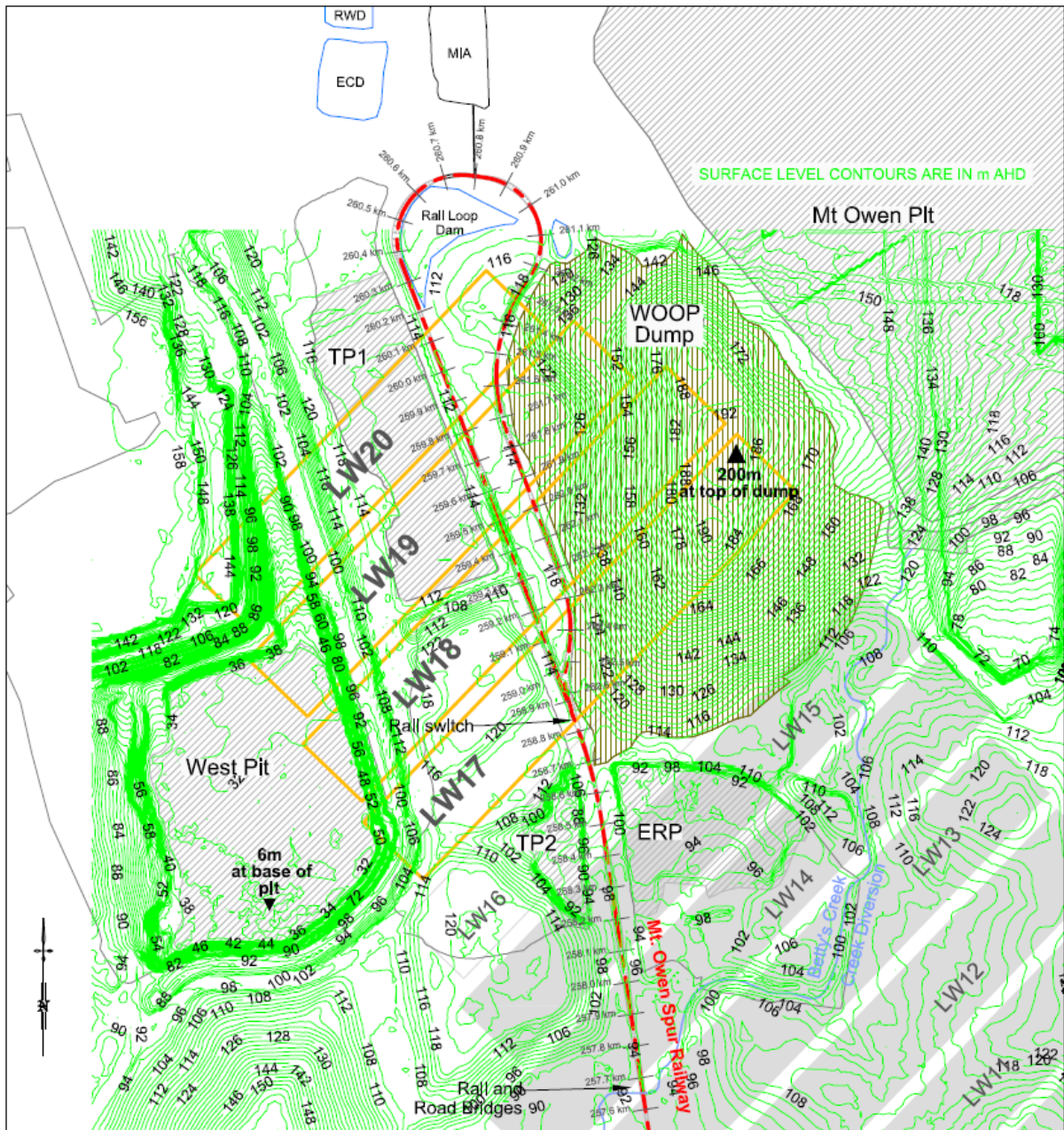


Figure 3-1 Surface level contours

The topographical high point in the area is the top of the WOOP Dump, with an elevation of approximately 200 metres above Australian Height Datum (m AHD). The topographical low point is in the base of the Mt. Owen Pit with an elevation of approximately -100 m AHD. The base of West Pit has an elevation of approximately 6 m AHD.

The surface above Longwalls 17 to 20 has been largely modified by the open cut pits and emplacement areas. The surface levels (natural or modified) directly above these longwalls vary from a minimum of approximately 30 m AHD above the finishing (i.e. south-western) end of Longwall 19, in the base of West Pit, and a maximum of approximately 200 m AHD above the commencing (i.e. north-eastern) end of Longwall 17, at the top of the WOOP Dump.

3.2 Seam information

The longwalls at Integra Underground are being extracted from the Middle Liddell Seam. The depths of cover contours are shown in **Figure 3-2**. The contours show the depth of the seam below the natural and modified surface based on the open cut pits and the emplacement areas at that time.

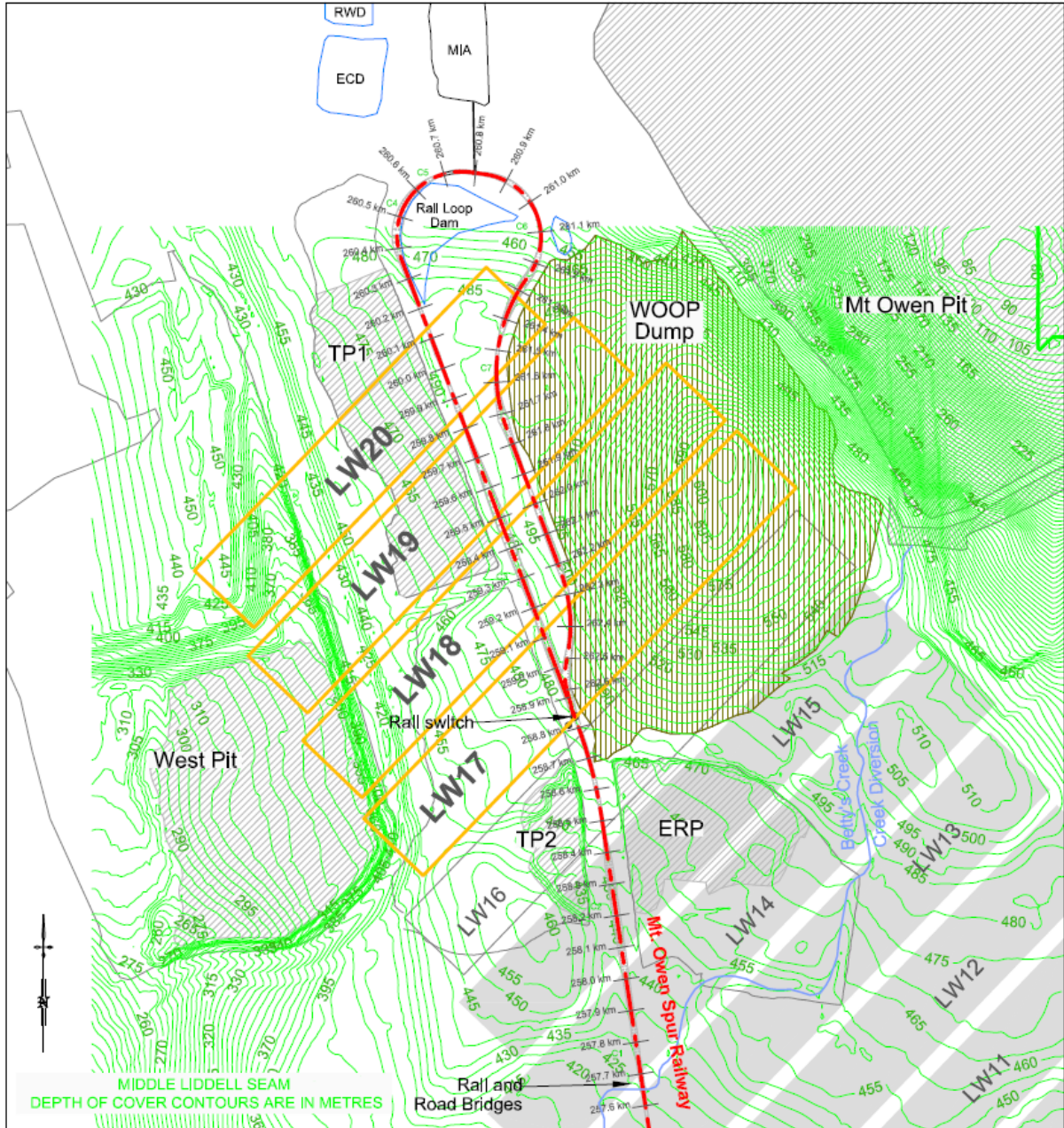


Figure 3-2 Depth of cover contours for the Middle Liddell Seam

The depths of cover in the mining area vary between a minimum of 270 m above Longwall 1 and a maximum of approximately 600 m above Longwall 17. The maximum depth of cover occurs beneath the WOOP dump and, therefore, it includes approximately 80 m depth of emplaced materials.

The depths of cover above Longwalls 17 to 20 vary between 335 m at the finishing (i.e. south-western) end of Longwall 19, beneath the base of West Pit, and approximately 600 m at the commencing (i.e. north-eastern) end of Longwall 17, beneath the top of the WOOP dump. The depth of rock above the commencing end of Longwall 17, excluding the emplaced materials, is approximately 520 m.

The Middle Liddell Seam generally dips from the south-west to the north-east. The gradient within the extents of Longwalls 17 to 20 is approximately 1 in 10 (i.e. 10%). The seam thickness within the extents of these longwalls varies between 2.5 and 3.2 m. The minimum extraction height of the longwall mining equipment is 2.6 m.

The surface and seam levels along the alignment of the Railway and loop (in a clockwise direction) are illustrated in **Figure 3-3**. The depths of cover along the Railway within the extents of Longwalls 17 to 20 vary between 475 m and 500 m. The seam thickness beneath the Railway within the extents of these longwalls varies between 3.0 m and 3.5 m.

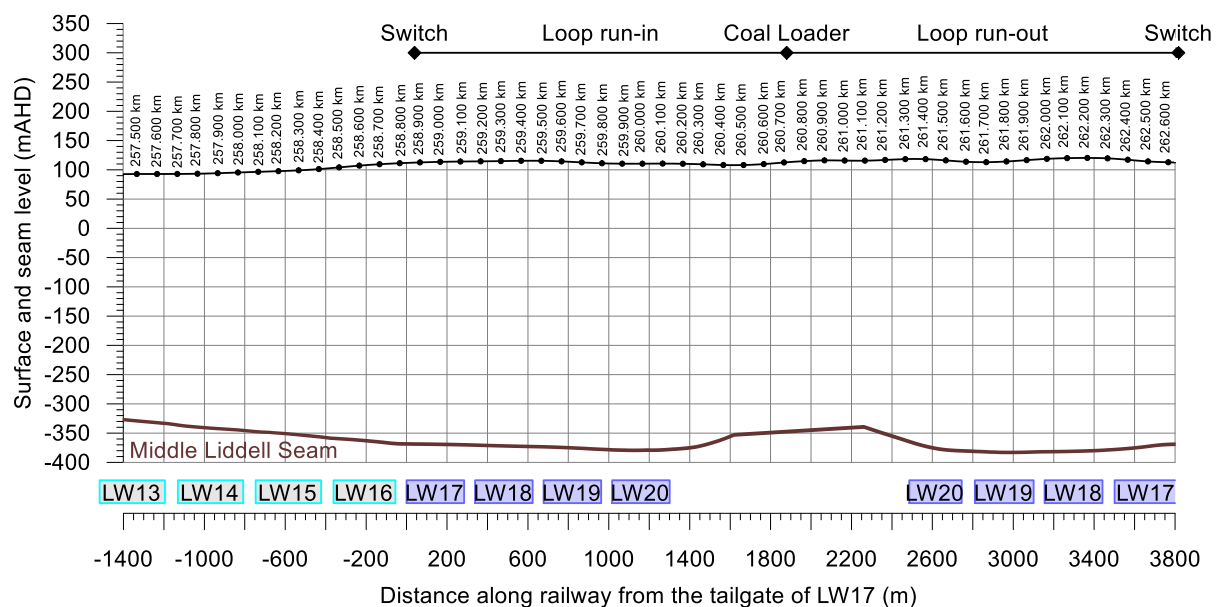


Figure 3-3 Surface and seam levels along the Railway

3.3 Seam roof and floor

The strata immediately overlying the Middle Liddell seam at the mine were deposited in a lower delta plain environment and comprise relatively thin layers (i.e. less 2 m) of fine to medium grained sandstone, laminites and mudstone.

A pattern of sandstone channels (active channel fill facies) has been mapped in the roof of the previous longwalls and is expected to persist into Longwalls 17 to 20. These channels vary in thickness and in strength.

The immediate roof of the Middle Liddell Seam is usually a silty mudstone or fine sandstone, normally of moderate to high strength and self-supporting, and generally requiring only a low level of primary support. Roof deformation is generally less than 8 mm.

Additional support is implemented around geological structures, weak roof, lithology changes and active longwall gate roads, or as required. Specific geological characteristics that have an ongoing impact on roof conditions include: variability of the stratigraphy above the seam; the undulating nature of the seam; discontinuous stone lenses in the upper section of the seam; and occasional zones of jointing and minor faulting.

The floor of the Middle Liddell Seam comprises up to 1.5 m laminated and thinly bedded mudstone. As the mine proceeds down dip, the floor is expected to become softer as coal laminations and bands become more abundant below the seam.

In the previous longwalls, up to 0.5 m floor heave has been experienced in the tailgate roadways up to 30 m ahead of the face, and to a lesser extent in the maingate. Since the increase in pillar dimensions, little to no floor heave has been mapped outbye of the longwall face. This is expected to continue for Longwalls 17 to 20.

3.4 Overburden lithology

The Middle Liddell Seam lies within the Vane Subgroup of the Wittingham Coal Measures, which are late Permian within the Singleton Supergroup. The seam is overlain by sediments assigned to the Foybrook and Bulga Formations of the Vane Subgroup, the Archerfield Sandstone and the Burnamwood Formation of the Jerrys Plains Subgroup. These sediments are deltaic in origin and comprise conglomerate, sandstone, laminite, mudstone and coal, with the exception of the Bulga Formation and Archerfield Sandstone which are marine sandstones or laminites.

A typical stratigraphic section showing the immediate overburden of the Middle Liddell Seam is provided in **Figure 3-4**.

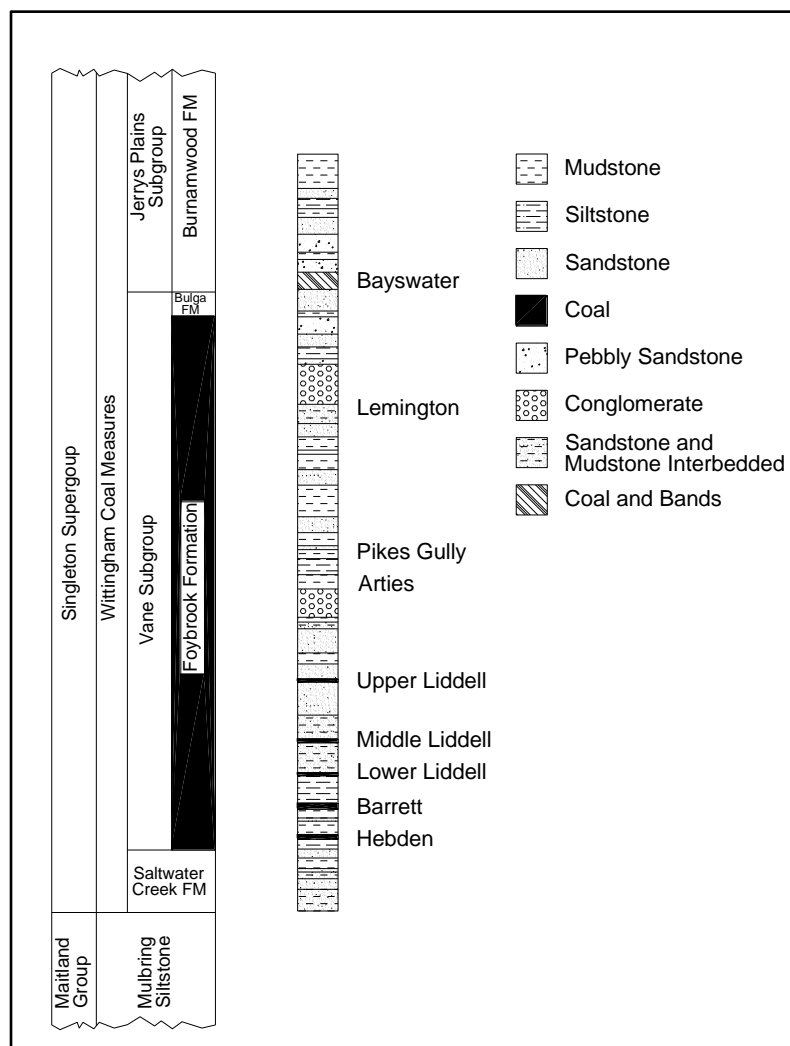


Figure 3-4 Typical stratigraphic section

The overburden of the Middle Liddell Seam comprises a varied sequence of conglomerates, sandstones, laminites, mudstones and coal deposited in a river-dominated deltaic environment. The principal features of the overburden are: non-tabular bed geometry; gradational horizontal and vertical changes as well as abrupt variations such as channel sandstones and conglomerates; and coal seam splitting and coalescence. Geomechanical testing of the overburden strata shows that it is generally of high strength, with the mean Unconfined Compressive Strength (UCS) of the tested samples varying between 54 MPa and 100 MPa.

Quaternary alluvium is present along the alignments of the main streams, such as Bettys Creek, and have overall depths up to 12 m. The sediments comprise loams overlying silty and clayey sands with occasional cleaner sand zones, with basal gravels overlying weathered coal measures.

3.5 Geological structures

Several geological structured zones have been mapped that trend almost due north and north of north-west. Sub-vertical joints within these zones trend sub-parallel to the zone direction. Joint spacing may be as little as 0.5 m. There is low cohesion on joint planes causing difficult conditions on development, which may be worsened where an orthogonal joint set is developed. Strike-slip movement and brecciated zones have been recorded in some structured zones.

Coal cleat is sub-parallel to the drivage directions. Minor jointing, faulting and occasional dykes have been intersected during development and longwall extraction to date.

The Hebden Thrust Fault is located north-east of the longwalls and within the Mount Owen Pit. This north-west to south-east trending structure consists of a steeply dipping roll of the overburden strata rather than a defined fault in this area (SCT, 2020).

Recent exploration drilling and verification from underground mining has proven the seam gradients in proximity to the Hebden Thrust Fault are unsuitable for longwall mining. This has resulted in reduced lengths for Longwalls 15 to 20 from that approved in PA 08 0101 Modification 8 (MOD8) and for the Longwalls 17 to 20 Extraction Plan.

To the west of the mining area, faulting of greater than seam thickness occurs adjacent to the hinge line bounding the western flank of the Rixs Creek Syncline, is known from seismic surveys. There are no other known geological structures interpreted from exploration data within the extents of Longwalls 17 to 20, but minor north to north-east trending faults and dykes are possible.

3.6 Horizontal in situ stress

The horizontal stresses are relatively low for a mine of this depth with an estimated ratio to the vertical stresses of 1~1.5 to 1 ($\sigma_h : \sigma_v$). To date, minimal to no guttering has been observed in primary and secondary extraction.

4. Characterisation of the Railway and its associated infrastructure

4.1 Affectation area

The *Affectation Area* is defined as the extent of the Railway that is likely to be affected by the mining of Longwalls 17 to 20. The extent of the Affectation Area has been calculated by combining the areas bounded by the following limits:

- A 26.5° angle of draw from the extents of Longwalls 17 to 20; and
- The predicted limit of vertical subsidence, taken as the 20 mm subsidence contour, resulting from the extraction of Longwalls 17 to 20.

The built features associated with the Railway that are expected to experience either far-field horizontal movements or valley related movements, and which could be sensitive to these effects, have also been included in the Management Plan.

The depth of cover along the alignment of the Railway and above Longwalls 17 to 20 varies between 475 m and 500 m. The 26.5° angle of draw line, therefore, extends a horizontal distance ranging between 238 m and 250 m outside of the extents of these longwalls.

The predicted limit of vertical subsidence, taken as the predicted total 20 mm subsidence contour, has been determined using the calibrated Incremental Profile Method (refer to **Section 5**). The predicted 20 mm subsidence contour is located within the 26.5° angle of draw line adjacent to the maingate of Longwall 20. The predicted 20 mm subsidence contour due to Longwalls 17 to 20 only is located outside of the angle of draw line and south-east of the tailgate of Longwall 17.

The Affectation Area extends along the alignment of the Railway to a distance of 810 m from the tailgate of Longwall 17. This area continues almost to the northern extent of the railway loop. For completeness, the entire railway loop has been included as part of the Affectation Area. A summary of the extents of the Affectation Area is provided in **Table 4-1**. The Affectation Area is also shown in plan in **Figure 1-1**.

Table 4-1 - Extents of the Affectation Area

Location	Position along the alignment of Railway	MGA Position	Kilometrage (km)
Start (southern extent)	810 m south of the Longwall 17 tailgate	E321165, N6410675	258.025
Mid-length of railway loop (northern extent)	300 m north of the Longwall 20 maingate	E320700, N6413170	260.800
End of railway loop (at switch)	End of the railway loop directly above Longwall 17	E320995, N6411500	262.650

The extent of the Affection Area along the alignment of the Railway is shown in **Figure 4-1**. The railway infrastructure are indicated in this figure and are also shown in plan in **Figure 1-1**.

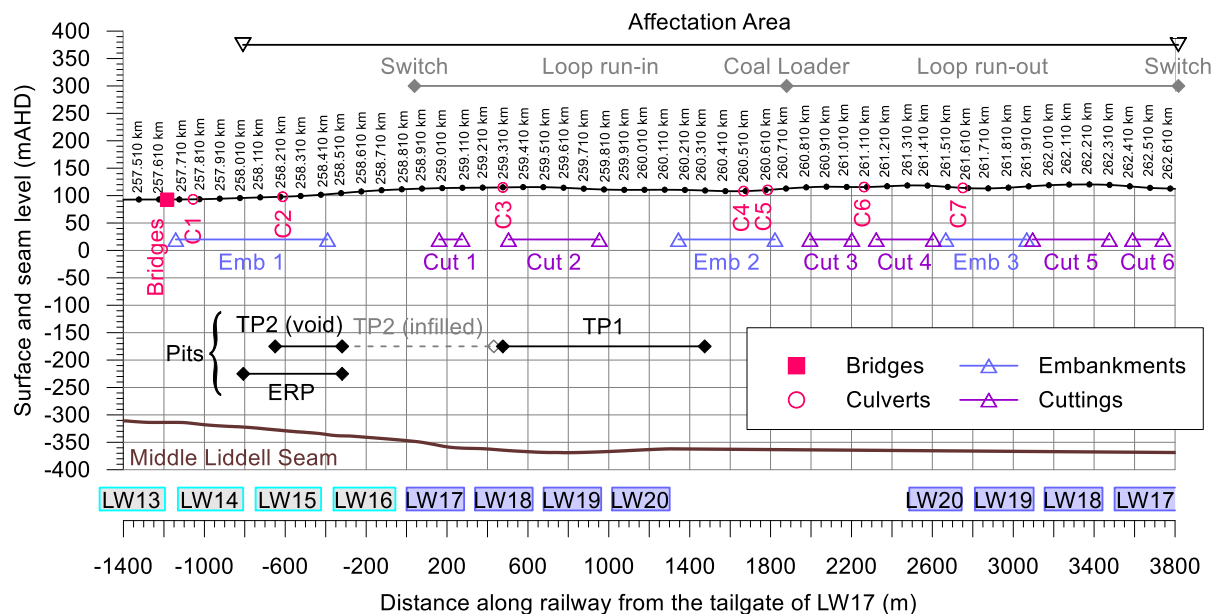


Figure 4-1 Extent of the Affection Area along the Railway

The surface infrastructure associated with the Railway that are located within or near to the Affection Area include the:

- Railway (i.e. track, sleepers and ballast);
- Bridges (i.e. Railway and service road bridges across Bettys Creek);
- Railway switch;
- Embankments and cuttings;
- Drainage culverts;
- Train load out bin (TLO) and reclaim conveyor;
- Signal line; and
- Service road.

The descriptions of the built features are provided in the following sections.

4.2 Railway

The Mount Owen Railway (the Railway) is a private siding connecting to the Main Northern Railway at Rail Chainage 253.958 km, north-west of the Glennies Creek Road level crossing, and runs for approximately 8.6 km until it loops back upon itself. The Railway is owned by the MGO and is used to transport coal from the MGO Coal Handling and Preparation Plant (CHPP).

The Railway crosses directly above Longwalls 17 to 20 between kilometrages 258.835 km and 260.135 km running into the railway loop, and between kilometrages 261.320 km and 262.650 km running out of the railway loop. The total length of the Railway located directly above these longwalls is approximately 2.6 km.

The Railway was built and commissioned in 1996. According to Teal (2005), the private siding was designed to State Rail Authority of NSW (SRA) *Practices and Procedures Manual C2203* with the following comments relevant to the section of Railway within the Affection Area:

- Train movements are clockwise around the loop;
- The loop provides for a 1490 m train length either side of the loading bin; and
- The Railway was designed as a Class 1 siding in accordance with SRA standard TS1301, comprising 53 kg/m rail, on timber sleepers, with 250 mm ballast depth below sleepers, maximum axle loads of 25 tonnes, speed limit of 50 km/h with 15 km/h in the loop, sleeper spacing of 600 mm, minimum shoulder ballast of 400 mm, Pandrol fastenings and minimum curve radius 160 m.

The section of Railway within the Affection Area comprises continuously welded rail fastened to concrete sleepers atop the ballast and formation. The train loading is periodic, that is periods of intense activity may be followed by periods of relatively low activity (days / weeks). The maximum capacity of the Railway is up to 12 coal trains per day.

Photographs of the section of Railway located above Longwalls 17 to 20 is provided in **Figure 4-2**. These photographs have been taken looking north above Longwall 17, with the loop run-in shown on the left-hand side and the loop run-out shown on the right-hand side.



Figure 4-2 Mt. Owen Railway

4.3 Bridges

There are two bridges (the Bridges) where the Railway and the adjacent service road cross Bettys Creek above the chain pillar between Longwalls 13 and 14. While the Bridges are located south of and outside of the Affection Area for Longwalls 17 to 20, they have been included in this Asset Management Plan as they could experience low level far-field movements can could be sensitive to these movements.

The Bridges comprise single-span prestressed concrete decks with lengths of approximately 13 m. The two decks are supported on common reinforced concrete wingwall abutments. The southern abutment is founded on rock and the northern abutment is founded concrete piles socketed into rock (URS, 2012).

Photographs of the Bridges are provided in **Figure 4-3** (Railway) and **Figure 4-4** (service road).



Figure 4-3 Railway bridge



Figure 4-4 Service road bridge

Mitigation works were carried out on the Bridges prior to active subsidence from Longwall 13. These works were designed to accommodate the predicted mine subsidence movements due to mining in both the Middle Liddell and Hebden Seams. The design parameters for the Bridges are described in **Section 7.2**.

4.4 Railway switch

A railway switch is located at the southern end of the Railway loop which directs trains into and out of the loop. The switch is at railway chainage 258.840 km just north of the tailgate of Longwall 17. A photograph of the railway switch is provided in **Figure 4-5**.



Figure 4-5 Railway switch at southern end of Railway loop

4.5 Embankments, cuttings and culverts

There are three railway embankments located within the Affection Area. A summary of these embankments is provided in **Table 4-2**.

Table 4-2 – Railway embankments within the Affection Area

Reference	Location	Kilometrages	Approximate size	Photograph
Emb 1	Directly above LW14 and LW15	257.69 km to 258.44 km	750 m long x ≈ 4 m high	Figure 4-6
Emb 2	North of LW20	260.18 km to 260.66 km	480 m long x ≈ 4 m high	Figure 4-7
Emb 3	Directly above LW19 and LW20	261.50 km to 261.90 km	400 m long x ≈ 3 m high	Figure 4-8

Photographs of the railway embankments are provided in the following figures.



Figure 4-6 Railway embankment – Emb 1



Figure 4-7 Railway embankment – Emb 2



Figure 4-8 Railway embankment – Emb 3

There are six railway cuttings located within the Affection Area. A summary of these cuttings is provided in **Table 4-3**. The cuttings have been numbered in a clockwise direction around the Railway loop.

Table 4-3 – Railway cuttings within the Affection Area

Reference	Location	Kilometrages	Approximate size	Photograph
Cut 1	Above LW17 (loop run-in)	258.99 km to 259.11 km	120 m long x ≈ 4 m high	Figure 4-9
Cut 2	Above LW18 and LW19 (loop run-in)	259.34 km to 259.79 km	450 m long x ≈ 6 m high	Figure 4-10
Cut 3	North of LW20	260.83 km to 261.04 km	210 m long x ≈ 5 m high	Figure 4-11
Cut 4	Above LW20 (loop run-out)	261.16 km to 261.44 km	280 m long x ≈ 4 m high	Figure 4-12
Cut 5	Above LW19 (loop run-out)	261.93 km to 262.31 km	380 m long x ≈ 3 m high	Figure 4-13
Cut 6	Above LW17 (loop run-out)	262.42 km to 262.57 km	150 m long x ≈ 3 m high	Figure 4-14

Photographs of the railway cuttings are provided in the following figures.



Figure 4-9 Railway cutting – Cut 1



Figure 4-10 Railway cutting – Cut 2



Figure 4-11 Railway cutting – Cut 3



Figure 4-12 Railway cutting – Cut 4



Figure 4-13 Railway cutting – Cut 5



Figure 4-14 Railway cutting – Cut 6

There are seven culverts that pass through the Railway formation within the Affection Area. Some culverts allow water drainage across the Railway formation and other culverts are used to pass water pipelines through the formation. A summary of these culverts is provided in **Table 4-4**.

Table 4-4 – Railway culverts within the Affection Area

Reference	Location	Kilometrage	Type	Photograph
C1	Above LW14	257.78 km	Single circular	Figure 4-15
C2	Above LW15	258.22 km	Single circular	Figure 4-15
C3	Above LW18	259.31 km	Pit with single circular	Figure 4-16
C4	300 m north of LW20 maingate	260.50 km	Single circular	Figure 4-17
C5	325 m north of LW20 maingate	260.62 km	Single circular	Figure 4-17
C6	200 m north-east of LW20 end	261.10 km	Single circular	Figure 4-18
C7	Above tailgate chain pillar of LW20	261.58 km	Single circular	Figure 4-18

Drainage culvert C3 is located at the low point along the Railway loop and allows water on the eastern side to pass beneath the formation to the drainage channel on the western side located between TP1 and TP2.

Photographs of the drainage culverts are provided in the following figures.



Figure 4-15 Concrete culverts C1 (left-hand side) and C2 (right-hand side)



Figure 4-16 Concrete culvert C3



Figure 4-17 Concrete culverts C4 (left-hand side) and C5 (right-hand side)



Figure 4-18 Concrete culverts C6 (left-hand side) and C7 (right-hand side)

4.6 Coal loading infrastructure

The coal loading infrastructure is located at the northern end of the Railway loop. The facility comprises the coal loading bin and conveyor, building enclosure and associated services. The infrastructure is located outside of the mining area at a minimum distance of 290 m from the maingate of Longwall 20. While the coal loading infrastructure is located outside the Affection Area, it has been included in this Asset Management Plan, as it will experience far-field horizontal movements and it could be sensitive to these effects.

The locations of the coal loading infrastructure are shown in **Figure 1-1**. Photographs of this infrastructure are provided in **Figure 4-19** to **Figure 4-21**.



Figure 4-19 Coal loading bin and inground pit



Figure 4-20 Coal conveyor



Figure 4-21 Building enclosure with fuel and wash facilities

4.7 Associated and nearby infrastructure

4.7.1 Signal line

There are three types of cable that run parallel to the Railway within the easement, comprising power, signalling control and communications. All three cables have been included as the signal line for the purposes of this Management Plan. The cables are owned, operated and maintained by the Australian Rail and Track Corporation (ARTC).

The cables are most likely to be direct buried, possibly in sand, covered by at least a danger marking tape and possibly a 'vinedex' type barrier. Depth of burial could vary from approximately 0.5 m to greater than 1.0 m. All of the cables are of the PVC insulated copper type.

The power cables carry 120 V AC and consist of two single cores of 19/1.78 mm double insulated cable with a vermin-proof outer jacket. The signalling control cable consists of 50 cores of 7/0.50 mm double insulated cable, armoured by a copper sheath, with a vermin-proof outer jacket.

4.7.2 Service road

A service road runs along the eastern side of the Railway, within the easement, and allows access for monitoring and maintenance purposes. The single lane road is unsealed. The speed limit along the road is 40 km/h under the *Transport Principal Hazard Management Plan*.

5. Subsidence predictions

5.1 Prediction methodology

The predicted subsidence effects for Longwalls 10 to 17 at Integra Underground were provided by SCT Operations (SCT, 2006). The subsidence predictions were subsequently updated in 2017 (SCT, 2017a) for the Longwalls 13 and 14 Extraction Plan based on the available subsidence monitoring data at the completion of Longwall 12.

The subsidence predictions at the mine were then reviewed and revised in late-2017 (SCT, 2017b) in support of the MOD8 application for Longwalls 15 to 20, and in late-2018 (SCT, 2018) for the Longwalls 15 and 16 Extraction Plan.

As required by the Extraction Plan process, revised predictions of subsidence effects and impacts for Longwalls 17 to 20 were prepared in mid-2020 (SCT, 2020). The forecast of subsidence behaviour includes consideration of the latest available monitoring data from the mining of Longwalls 13 to 15.

The subsidence predictions for the Railway were also provided by Mine Subsidence Engineering Consultants (MSEC) for Longwalls 10 to 17 (MSEC, 2011). The Incremental Profile Method (IPM) was initially calibrated for the local mining conditions using the ground monitoring data from Longwalls 7 to 9 at the Integra Underground. The method was further refined based on the ground monitoring data from Longwalls 10 to 13 which mined directly beneath or adjacent to the Railway.

The predictions provided by MSEC (2011) represent the *expected* case that provide the estimate of the actual movements. The predictions provided by SCT (2006, 2017b and 2020) represent a *maximum* or *conservative* case that provide more allowance for the uncertainty with mine subsidence predictions.

The subsidence predictions obtained using the IPM were used to manage the mine subsidence movements for the Railway due to Longwalls 7 to 15 at the Integra Underground. The latest subsidence predictions provided by MSEC, therefore, have been used in this Management Plan for Longwalls 17 to 20. However, the management strategies and recommendations provided in this plan also consider the predictions provided by SCT.

5.2 Comparison of measured and predicted

The IPM was calibrated using the ground monitoring lines from the Integra Underground. The monitoring data available at that time (MSEC, 2011) comprised the B-Line (Longwalls 1 to 8), H-Line and H⁺-Line (Longwalls 8 and 9), L-Line (Longwalls 7 and 8), M-Line (Longwalls 7 to 10), R-Line (Longwalls 8 and 9) and S-Line (Longwall 8). The locations of the monitoring lines are shown in **Figure 5-1**.

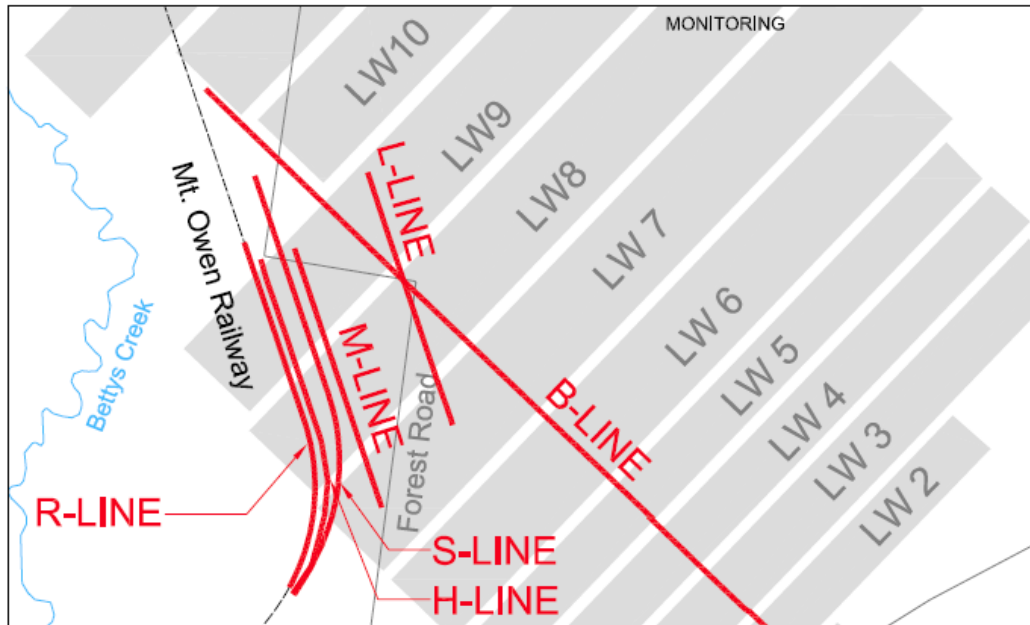


Figure 5-1 Locations of the ground monitoring lines at the Integra Underground

The comparison between the profiles of measured (green) and predicted (red) total vertical subsidence along the B-Line due to Longwalls 1 to 8 is provided in **Figure 5-2**.

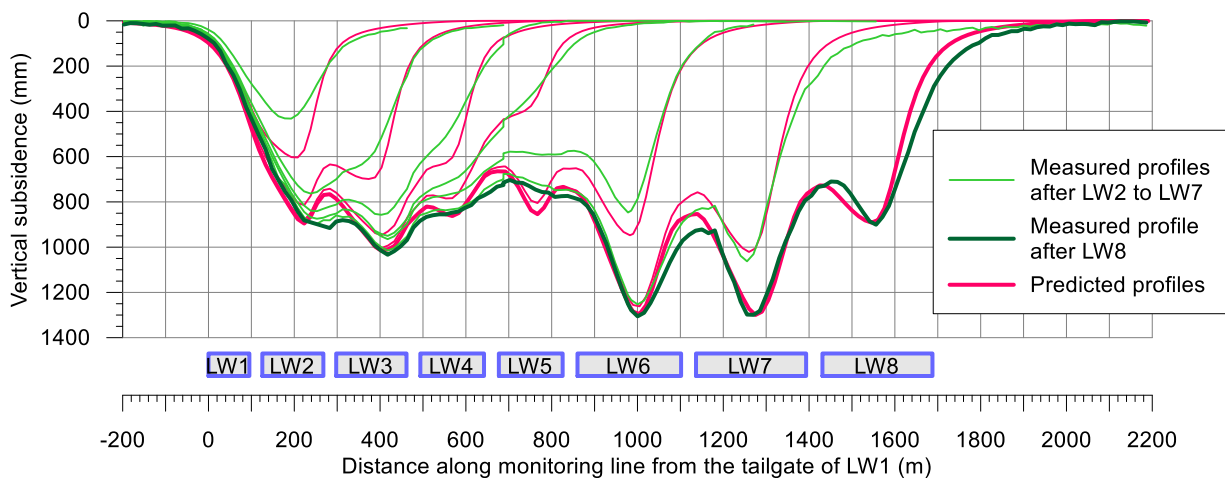


Figure 5-2 Comparison of the profiles of measured and predicted vertical subsidence along the B-Line

The profiles of measured vertical subsidence reasonably match the predicted profiles along the B-Line. The maximum measured vertical subsidence above each of the longwalls and above each of the chain pillars are similar to the maximum predicted values. The measured vertical subsidence is slightly greater than that predicted on the longwall maingate sides. In consequence, the measured tilts are slightly less than the predicted tilts.

The comparison between the profiles of measured (green) and predicted (red) total vertical subsidence along the Railway is provided in **Figure 5-3**. The measured movements have been combined from the ground surveys along the H-Line for Longwall 8, the H⁺-Line for Longwalls 9 and 10 and the PH-Line for Longwalls 12 to 15. The predicted profiles are based on those obtained from the IPM.

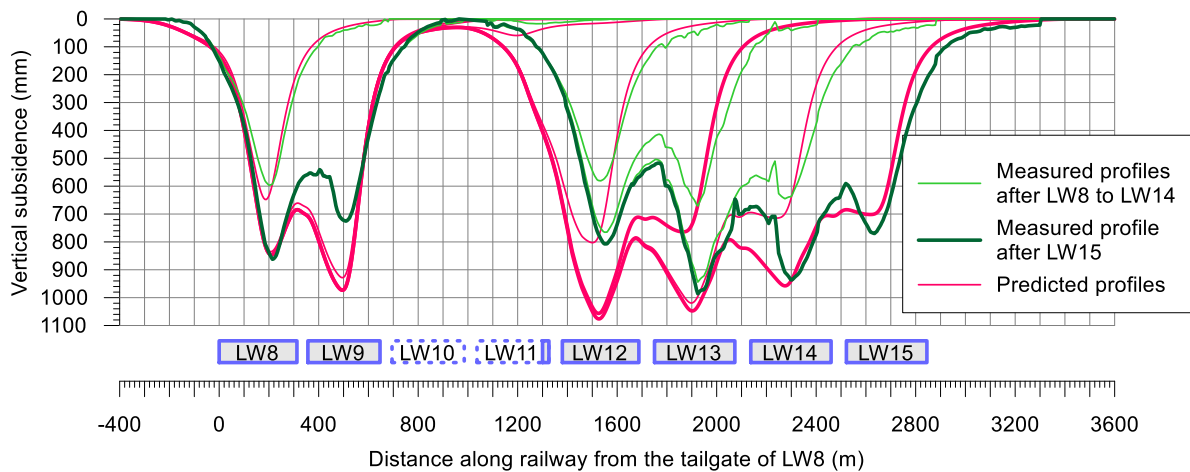


Figure 5-3 Comparison of the profiles of measured and predicted vertical subsidence along the Railway

The profiles of measured vertical subsidence reasonably match those predicted along the Railway for Longwalls 8 to 15. The maximum measured vertical subsidence is slightly greater than the predicted values above Longwall 8 which could be partially due to the longwall end effects. The maximum measured vertical subsidence above Longwalls 8 to 14 are similar to or less than the maximum predicted values.

The maximum measured vertical subsidence above Longwall 15 is slightly greater than predicted; however, the exceedance is less than $\pm 15\%$ to $\pm 25\%$ which is normally considered the accuracy of subsidence prediction methodologies for maximum vertical subsidence. The measured vertical subsidence is slightly greater than that predicted on the longwall maingate sides, resulting in the measured tilts being slightly less than the predicted tilts.

It is considered that the calibrated IPM provides reasonable predictions above the mining area based on the comparisons with those measured along the monitoring lines for Longwalls 1 to 15 at the Integra Underground. However, consideration has been given to the slightly greater vertical subsidence that has been measured above the longwall maingate sides.

Low-level vertical subsidence was measured further than that predicted from the maingates of the active longwalls. The comparison between the measured and predicted limits of vertical subsidence, taken as 20 mm vertical subsidence and the 26.5° angle of draw, for Longwalls 12 to 15 is provided in **Table 5-1**. The distances have been taken along the alignment of the PH-Line.

Table 5-1 – Comparison between the measures and predicted limits of vertical subsidence

Longwall	Measured distance from the active longwall maingate (m)	Predicted distance from the active longwall maingate (m)	Difference (m)
LW12	350	270	80
LW13	335	275	60
LW14	345	275	70
LW15	355	275	80

The measured limits of vertical subsidence were 60 m to 80 m further from the active longwall maingates compared with the predicted limits of vertical subsidence. This low-level subsidence is generally not associated with any measurable tilts, curvatures or strains. However, a localised uplift and changes in the vertical and horizontal mid-ordinate deviations were observed during Longwall 13 approximately 160 m north of the maingate.

The extents of ground monitoring for Longwalls 17 to 20 have considered the difference between the measured and predicted limits of vertical subsidence from the active longwall maingate, as described in **Section 8.1.1**.

5.3 Predicted subsidence parameters

The predicted subsidence parameters for the Railway and its associated infrastructure have been based on the latest predictions obtained using the IPM (MSEC, 2011). The management strategies and recommendations provided in this Management Plan also consider the predictions provided by SCT (2006, 2017b and 2020).

5.3.1 Railway

The profiles of predicted vertical subsidence, tilt and curvature along the alignment of the Railway are shown in **Figure 5-4**. The predicted total profiles along the alignment of the Railway at the completion of Longwall 16 are shown as the cyan lines. The predicted total profiles along the alignment of the Railway after the extraction of each of the Longwalls 17 to 20 are shown as the blue lines. The range of predicted curvatures in any direction, at any time during or after the extraction of the longwalls, is shown by the grey shading.

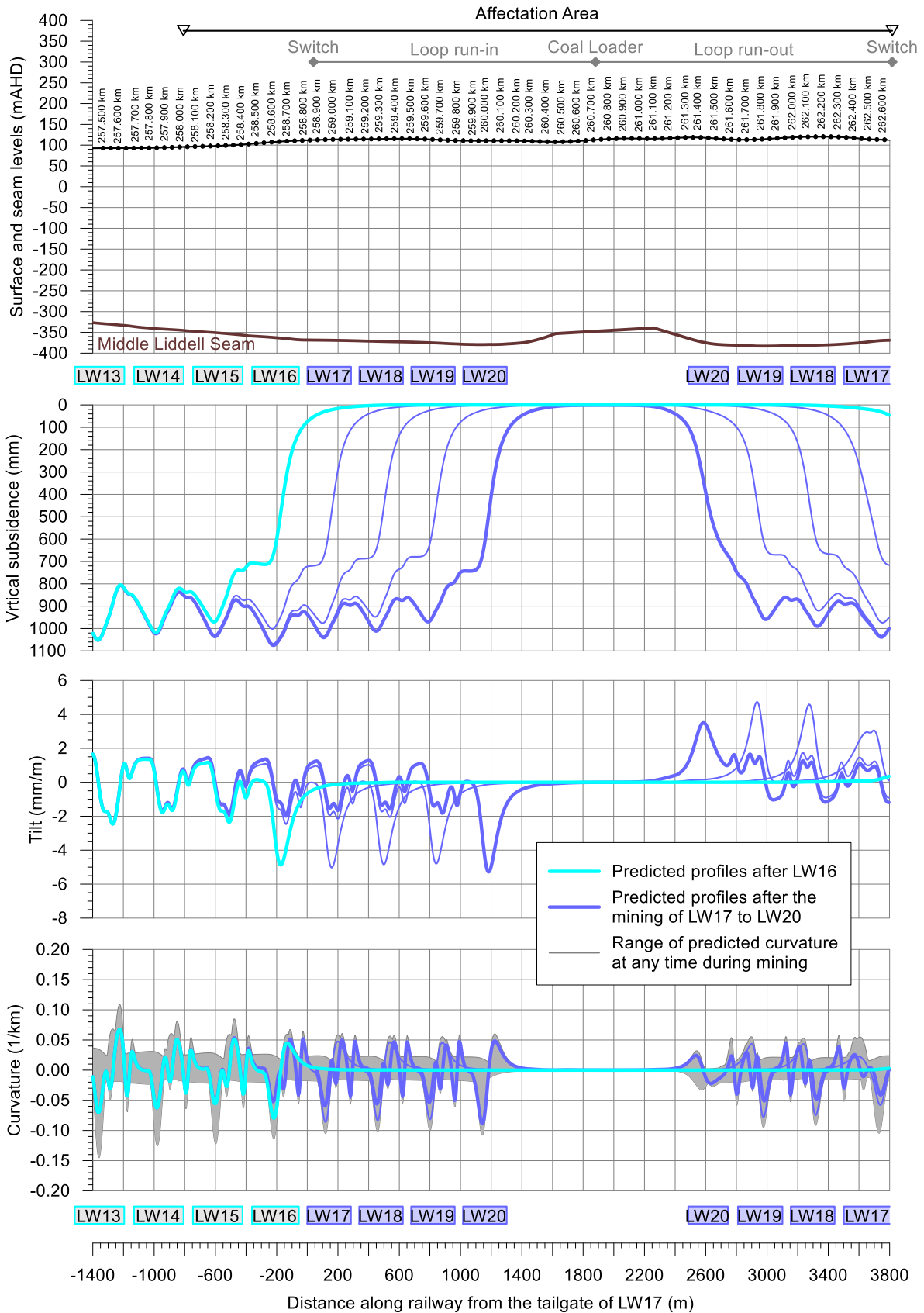


Figure 5-4 Profiles of predicted total vertical subsidence, tilt and curvature along the Railway

A summary of the maximum predicted total vertical subsidence, tilt and curvature for the Railway is provided in **Table 5-2**. The values in this table represent the maximum accumulated movements within the Affection Area due to the extraction of the series of longwalls.

Table 5-2 – Maximum predicted total vertical subsidence, tilt and curvature for the Railway

Longwall	Maximum predicted total vertical subsidence (mm)	Maximum predicted total tilt along alignment (mm/m)	Maximum predicted total tilt across alignment (mm/m)	Maximum predicted total hogging curvature along alignment (km ⁻¹)	Maximum predicted total sagging curvature along alignment (km ⁻¹)
LW16	975	5.0	3.0	0.05	0.08
LW17	1050	5.0	4.5	0.05	0.09
LW18	1050	5.0	2.5	0.05	0.08
LW19	1100	5.0	2.5	0.05	0.08
LW20	1100	5.5	2.5	0.05	0.09

The maximum predicted total vertical subsidence for the Railway after the completion of Longwall 20 is 1100 mm and it represents 39 % of the extraction height of 2.8 m. The maximum predicted total tilts are 4.5 mm/m (i.e. 0.55 % or 1 in 180) along the alignment and 4.5 mm/m (i.e. 0.45 % or 1 in 220) across the alignment of the Railway.

The maximum predicted total curvatures along the alignment of the Railway are 0.05 km⁻¹ hogging and 0.09 km⁻¹ sagging, which represent minimum radii of curvature of 20 km and 11 km, respectively. The maximum predicted total curvatures for the Railway, regardless of the direction, are 0.08 km⁻¹ hogging and 0.12 km⁻¹ sagging, which represent minimum radii of curvature of 13 km and 8 km, respectively.

The Railway will be maintained during and after the extraction of each of the longwalls. The management of the Railway, therefore, considers the incremental (i.e. additional) movements due to the extraction of each longwall.

A summary of the maximum predicted incremental vertical subsidence, tilt and curvature for the Railway is provided in **Table 5-3**. The values in this table represent the maximum additional movements for the Railway due to the extraction of each of the longwalls.

Table 5-3 – Maximum predicted incremental vertical subsidence, tilt and curvature for the Railway

Longwall	Maximum predicted incremental vertical subsidence (mm)	Maximum predicted incremental tilt along alignment (mm/m)	Maximum predicted incremental tilt across alignment (mm/m)	Maximum predicted incremental hogging curvature along alignment (km ⁻¹)	Maximum predicted incremental sagging curvature along alignment (km ⁻¹)
LW17	675	5.0	4.5	0.05	0.09
LW18	650	4.5	3.0	0.05	0.08
LW19	650	4.5	2.0	0.04	0.08
LW20	675	5.0	2.0	0.05	0.09

The maximum predicted incremental tilts are 5.0 mm/m (i.e. 0.50 % or 1 in 200) along the alignment and 4.5 mm/m (i.e. 0.45 % or 1 in 220) across the alignment of the Railway. The maximum predicted incremental curvatures along the alignment of the Railway are 0.05 km⁻¹ hogging and 0.09 km⁻¹ sagging, which represent minimum radii of curvature of 20 km and 11 km, respectively.

The development of the maximum predicted incremental vertical subsidence for the Railway due to the extraction of Longwalls 17 to 20 are illustrated in **Figure 5-5** to **Figure 5-8**, respectively. The start and end of active subsidence are shown in these figures. The start of active subsidence occurs when the predicted vertical subsidence is 20 mm and the end of active subsidence has been taken when 95 % of the final maximum subsidence has been achieved. The estimated periods of active subsidence for Longwalls 17 to 20 are provided in **Table 2-3**.

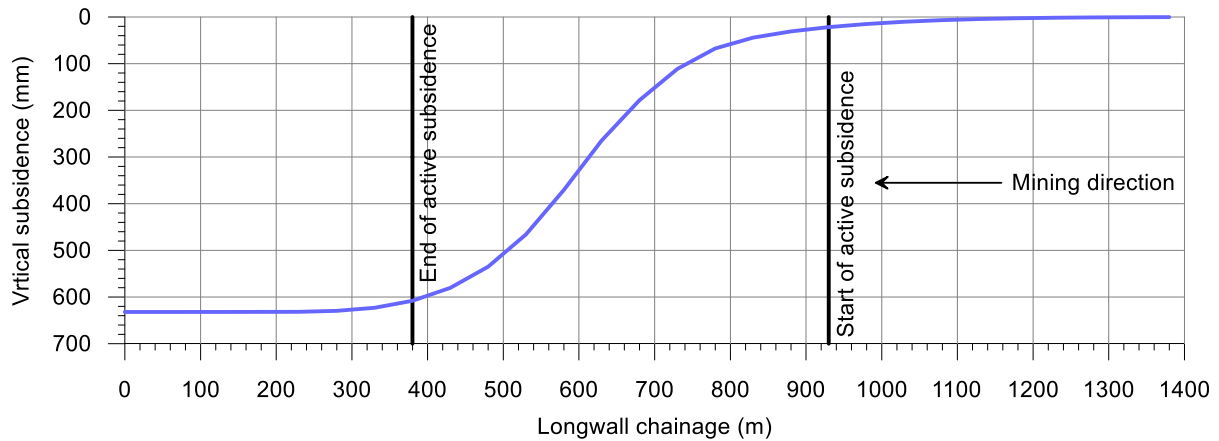


Figure 5-5 Development of maximum predicted incremental vertical subsidence for Longwall 17

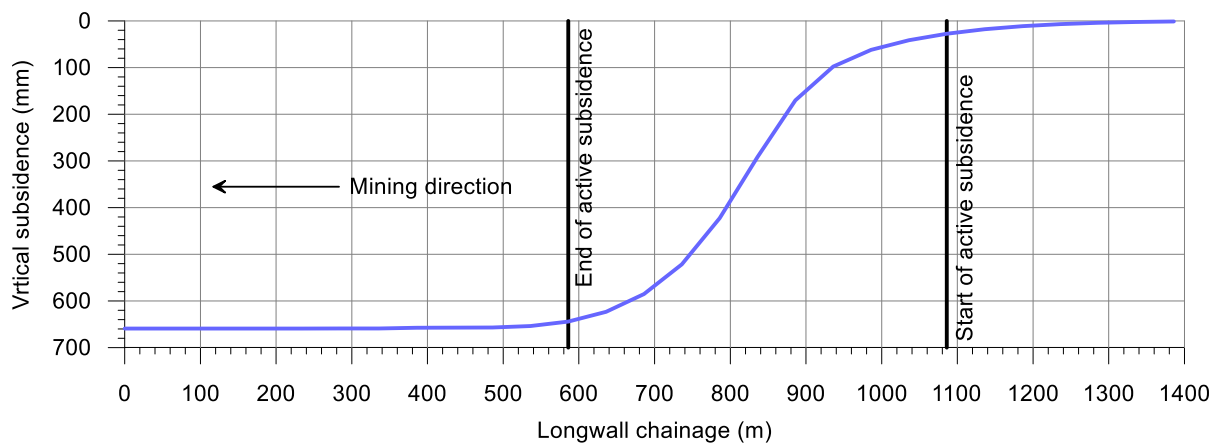


Figure 5-6 Development of maximum predicted incremental vertical subsidence for Longwall 18

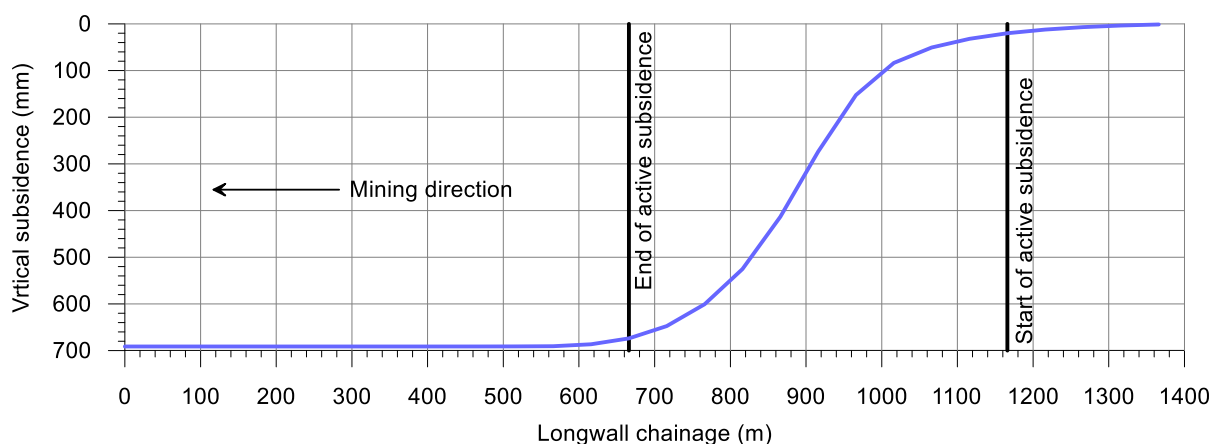


Figure 5-7 Development of maximum predicted incremental vertical subsidence for Longwall 19

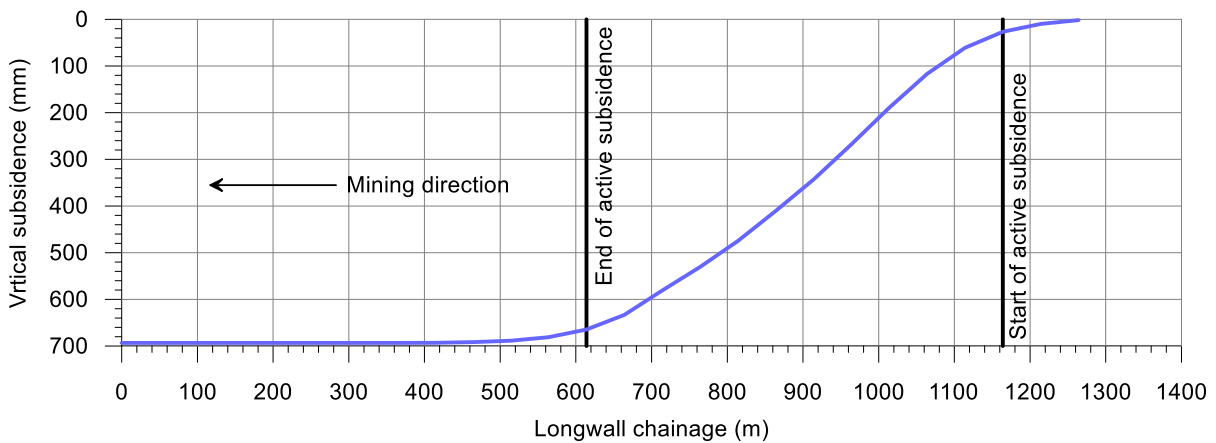


Figure 5-8 Development of maximum predicted incremental vertical subsidence for Longwall 20

The potential for impacts on the Railway are governed by the differential horizontal movements. The differential horizontal movements along the alignment of the Railway have been quantified by the changes over 100 m long bays and the changes over standard bays (i.e. normal strain). The differential movements across the alignment of the Railway have been quantified by horizontal mid-ordinate deviation, which is an indicator for horizontal shear.

The predicted profiles of the incremental changes in 100 m long bay lengths along the alignment of the Railway due to the extraction of Longwalls 17 to 20 are provided in **Figure 5-9** to **Figure 5-12**, respectively.

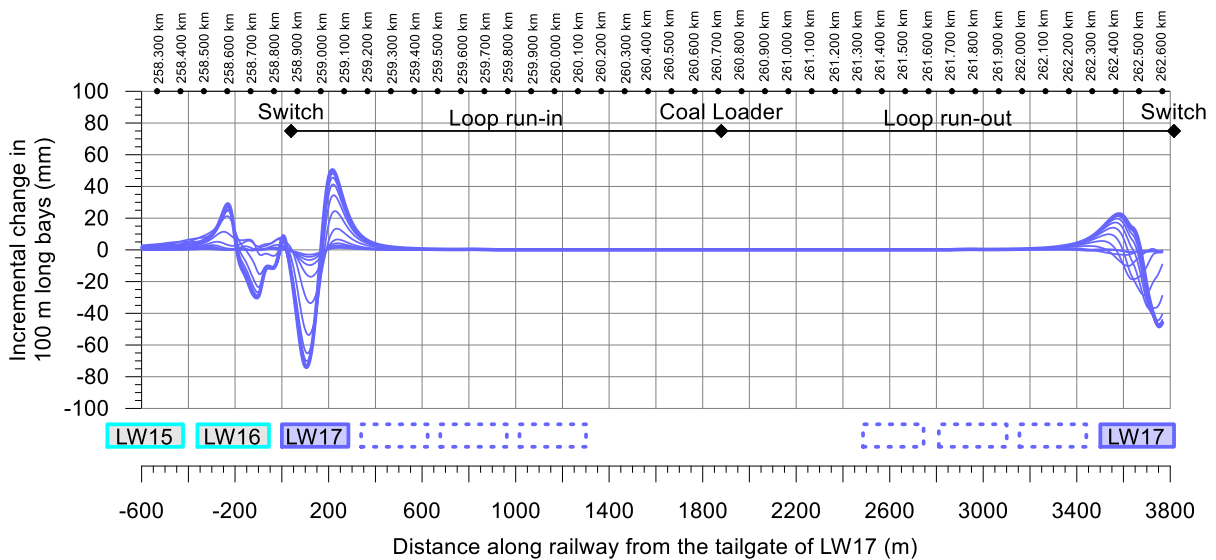


Figure 5-9 Profiles of predicted incremental changes in 100 m long bay lengths due to LW17

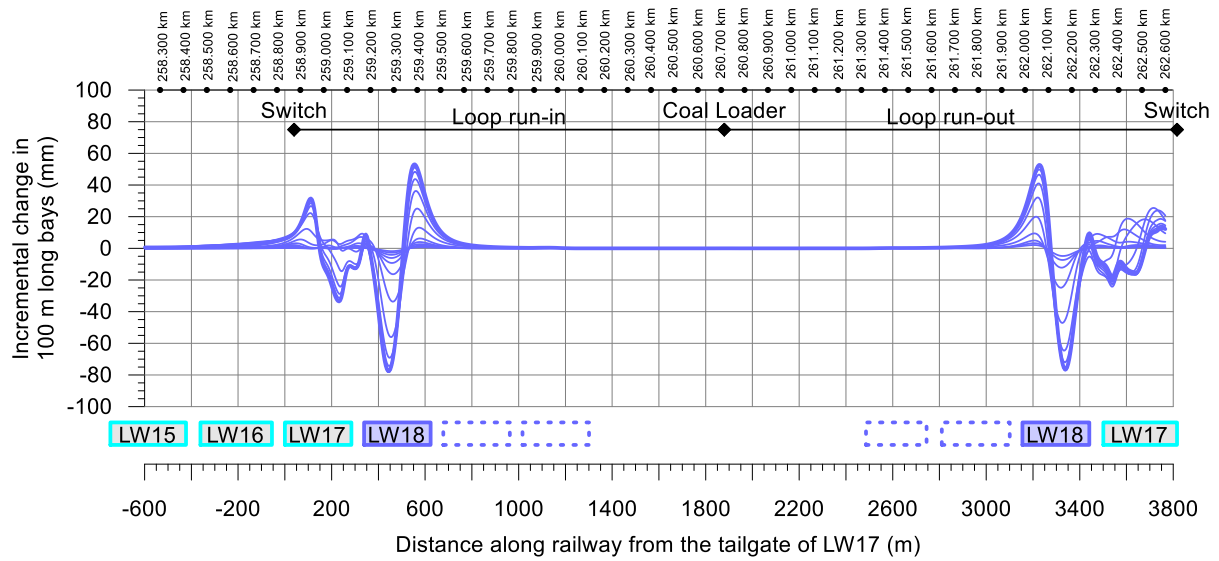


Figure 5-10 Profiles of predicted incremental changes in 100 m long bay lengths due to LW18

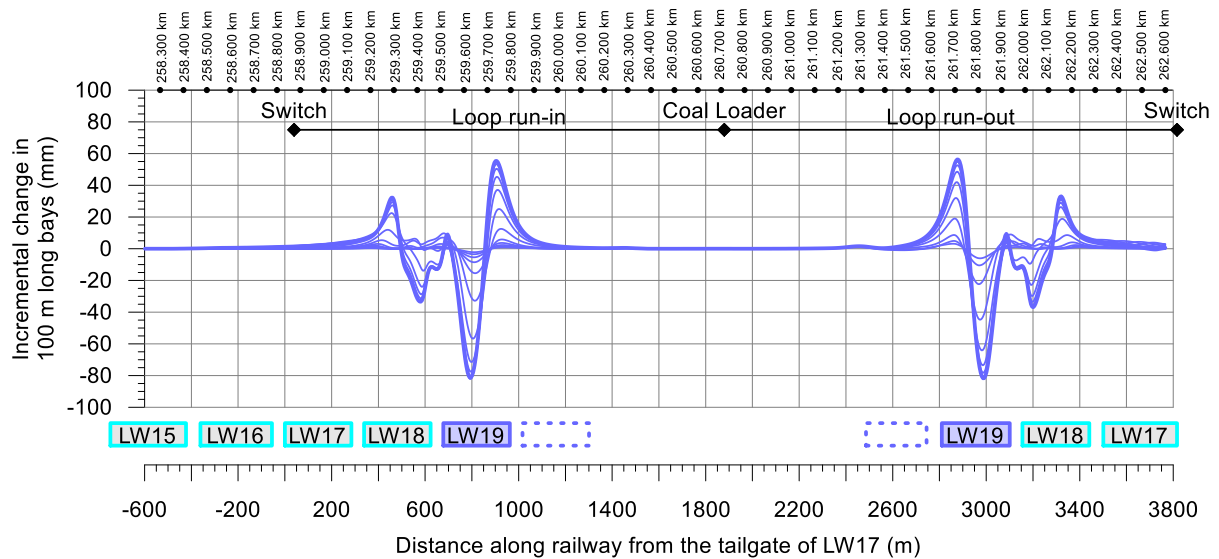


Figure 5-11 Profiles of predicted incremental changes in 100 m long bay lengths due to LW19

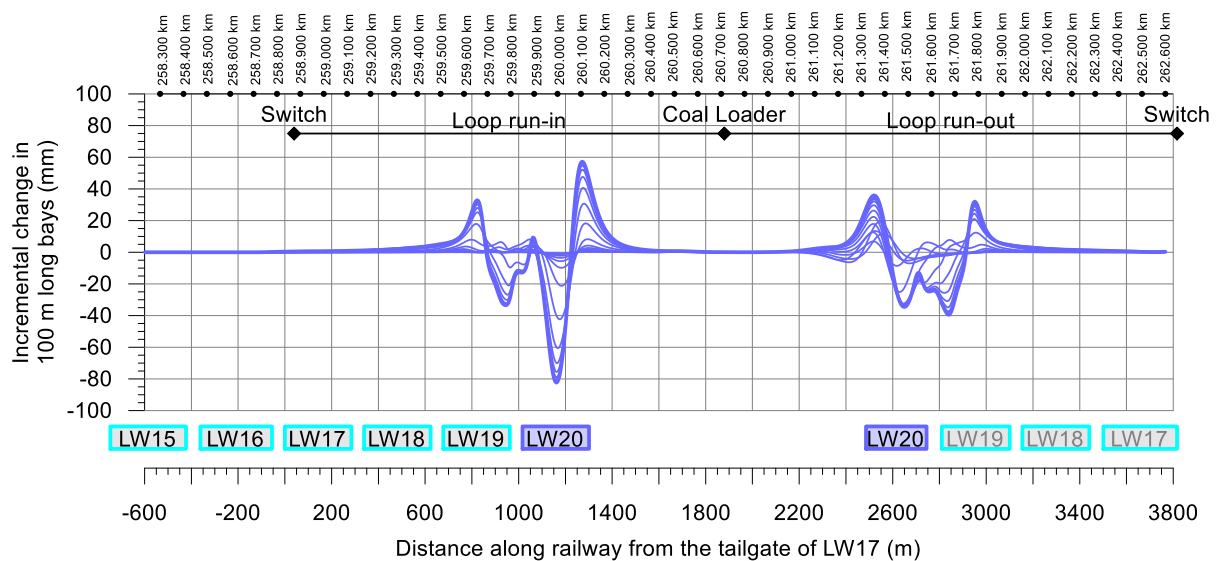


Figure 5-12 Profiles of predicted incremental changes in 100 m long bay lengths due to LW20

A summary of the maximum predicted incremental changes in 100 m long bay lengths along the alignment of the Railway is provided in **Table 5-4**. The values in this table represent the maximum additional movements for the Railway due to the extraction of each of the longwalls.

Table 5-4 – Maximum predicted incremental changes in 100 m long bay lengths for the Railway

Longwall	Maximum predicted incremental extension (mm)	Maximum predicted incremental contraction (mm)
LW17	+50	-75
LW18	+55	-80
LW19	+60	-85
LW20	+60	-85

The prediction of strain is more difficult than the predictions of vertical subsidence, tilt and curvature. The reason being strain is affected by many factors, including curvature and horizontal movement, as well as local variations in the near-surface geology, the locations of joints at bedrock, the depth of bedrock and the localised response of the near-surface strata. The profiles of measured strain, therefore, can be irregular even when the profiles of measured vertical subsidence, tilt and curvature are relatively smooth.

The range of potential strains for the Railway has been determined based on a statistical analysis of the monitoring data from the previously extracted Longwalls 6 to 15. The monitoring lines include the B-Line, H-Line, H⁺-Line, L-Line, M-Line, PH-Line, PM-Line and S-Line.

The histograms of the maximum measured incremental tensile and compressive strains measured in survey bays located above the previously extracted longwalls is provided in **Figure 5-13**. The probability distribution functions, based on the fitted Generalised Pareto Distributions (GPDs), have also been shown in this figure.

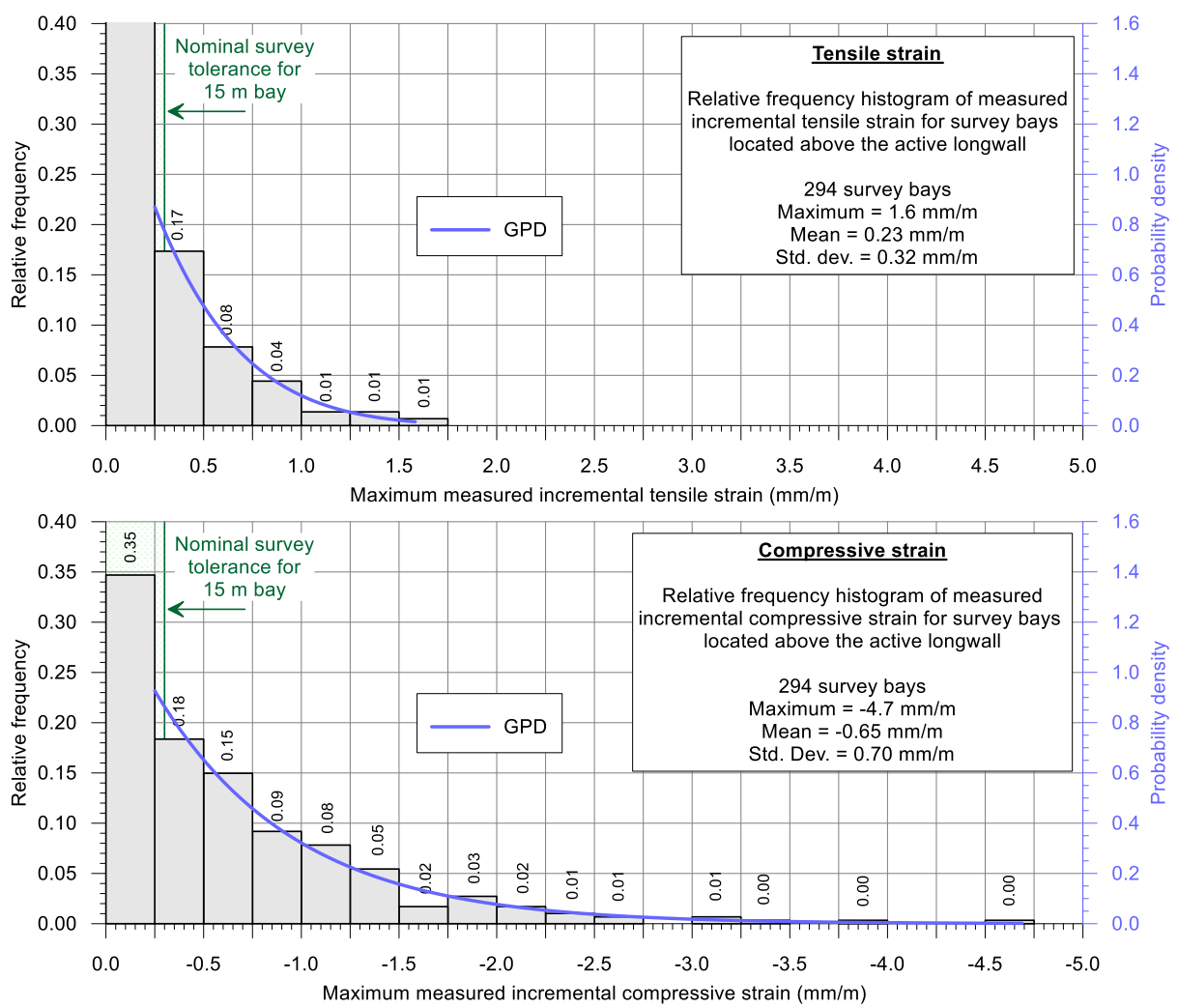


Figure 5-13 Distributions of the measured maximum incremental tensile and compressive strains for survey bays located directly above the active longwall

Confidence levels have been determined from the empirical strain data using the fitted GPDs. In the cases where survey bays were measured multiple times during a longwall extraction, the maximum tensile strain and the maximum compressive strain were used in the analysis (i.e. single tensile strain and single compressive strain measurement per survey bay).

The 95 % confidence levels for the maximum incremental strains that the individual survey bays experienced at any time during mining are 0.9 mm/m tensile and 2.0 mm/m compressive. The 99 % confidence levels for the maximum incremental strains that the individual survey bays experienced at any time during mining are 1.3 mm/m tensile and 3.1 mm/m compressive.

Non-conventional movements can develop due to a number of factors including valley related effects (i.e. stream crossings), variations in the local geology, or for no known cause (i.e. anomalies). These are characterised by a localised uplift in the vertical subsidence profile combined with an elevated compressive strain, although other combinations have been observed. The histograms of strain provided in **Figure 5-13** show the range of measured strains based on both conventional and non-conventional anomalous movements.

The maximum measured strain for the monitoring lines Integra Underground is 4.7 mm/m compressive, which was measured along the H⁺-Line between Marks H054 to H055 (at approximately 256.020 km) during the extraction of Longwall 9. This localised and elevated compressive strain appears to be the result of closure movements across a small watercourse.

The development of the incremental compressive strain between Marks H054 to H055 during the extraction of Longwall 9 is illustrated in **Figure 5-14**. The maximum rate of development of compressive strain for this survey bay was 0.9 mm/m per week, or 1.7 mm/m per 50 m face advance, based on the tri-weekly surveys.

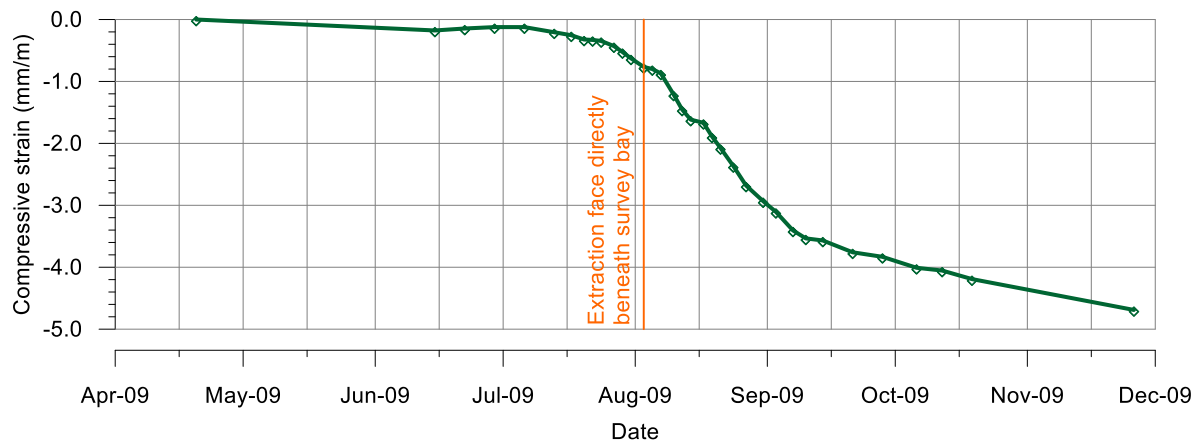


Figure 5-14 Development of strain between Marks H054 and H055 during Longwall 9

Non-conventional movements can be identified from the ground monitoring at early stages of development. It is expected that non-conventional ground movements along the Railway could be identified prior to their magnitudes exceeding the predicted strains based on conventional ground movements, based on the maximum rate of development of strain measured at the Mine.

The histogram of the maximum measured incremental horizontal mid-ordinate deviation measured in survey marks located above the previously extracted longwalls is provided in **Figure 5-15**. The probability distribution function based on the fitted GPDs has also been shown in this figure. Horizontal mid-ordinate deviation is an indicator for horizontal shear.

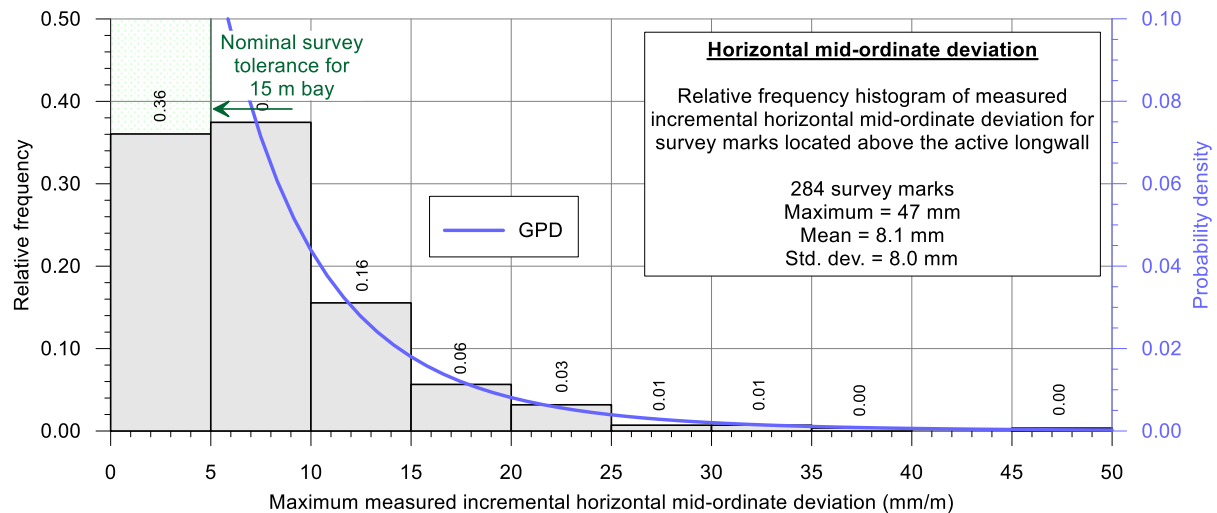


Figure 5-15 Distribution of the measured maximum incremental horizontal mid-ordinate deviations for survey marks located directly above the active longwall

Confidence levels have been determined from the empirical strain data using the fitted GPD. The 95 % and 99 % confidence levels for the maximum incremental horizontal mid-ordinate deviations at any time during mining are 22 mm and 36 mm, respectively.

Further discussions on the maximum measured horizontal and vertical mid-ordinate deviations at the Integra Underground are provided in **Section 7.1**.

5.3.2 Bridges

The predicted subsidence effects for the Bridges were originally provided by SCT (2006) and by MSEC (2011). The predictions were then later refined based on the detailed review of ground monitoring data from the Mine (MSEC, 2014). The two Bridges are located adjacent to each other and, therefore, the same predicted subsidence parameters have been adopted for each bridge.

The vertical and horizontal movements at the Bridges were monitored during the extraction of Longwall 13 to 15. The maximum measured vertical subsidence, based on the survey dated 5 May 2020, of 752 mm was less than the predicted value of 770 mm at the completion of Longwall 15.

The maximum measured differential horizontal movements between the Bridge abutments and across the Bridge joints were +13 mm and +11 mm, respectively. The measured movements were less than half the monitoring review triggers. The maximum measured shear between the Bridge abutments of 5 mm was considerably less than the monitoring review trigger. The measured step and twist between the Bridge abutments were not measurable.

The Bridges are located approximately 950 m south of the tailgate of Longwall 17 and they are outside of the Affection Area. At this distance, the maximum predicted additional vertical subsidence due to the mining of Longwalls 17 to 20 is less than 20 mm. While the Bridges could experience very low levels of additional vertical subsidence, they are not expected to experience measurable tilts, curvatures or strains.

5.3.3 Railway switch

The switch is located at railway chainage 258.840 km just north of the tailgate of Longwall 17. A summary of the maximum predicted total vertical subsidence, tilt and curvature for the railway switch is provided in **Table 5-5**. The values in this table represent the maximum accumulated movements due to the extraction of the existing, approved and proposed longwalls.

Table 5-5 – Maximum predicted total vertical subsidence, tilt and curvature for the railway switch

Longwall	Maximum predicted total vertical subsidence (mm)	Maximum predicted total tilt along main axis (mm/m)	Maximum predicted total tilt across main axis (mm/m)	Maximum predicted total hogging curvature in any direction (km ⁻¹)	Maximum predicted total sagging curvature in any direction (km ⁻¹)
LW16	100	0.5	< 0.5	0.01	< 0.01
LW17	725	< 0.5	< 0.5	0.02	0.02
LW18	950	1.0	< 0.5	0.02	0.02
LW19	1000	1.0	0.5	0.02	0.02
LW20	1000	1.5	0.5	0.02	0.02

The maximum predicted total tilt for the railway switch is 1.5 mm/m (i.e. 0.15 % or 1 in 667). The maximum predicted total curvatures are 0.02 km⁻¹ hogging and sagging, which represents a minimum radius of curvature of 50 km.

The distributions of the measured strains at Integra Underground are illustrated in **Figure 5-13**. The maximum predicted strains based on the 95 % confidence levels are 0.9 mm/m tensile and 2.0 mm/m compressive. The maximum predicted strains based on the 99 % confidence levels are 1.3 mm/m tensile and 3.1 mm/m compressive.

5.3.4 Embankments, cuttings and culverts

The embankments, cuttings and culvers follow the alignment of the Railway and loop within the Affection Area. The predicted subsidence effects for these features, therefore, will be similar to those predicted at similar locations along the Railway.

A summary of the maximum predicted total vertical subsidence, tilt and curvature for the embankments is provided in **Table 5-6**. The values in this table represent the maximum accumulated movements due to the extraction of the existing, approved and proposed longwalls.

Table 5-6 - Maximum predicted total vertical subsidence, tilt and curvature for the embankments

Embankment	Maximum predicted total vertical subsidence (mm)	Maximum predicted total tilt along alignment (mm/m)	Maximum predicted total tilt across alignment (mm/m)	Maximum predicted total hogging curvature in any direction (km ⁻¹)	Maximum predicted total sagging curvature in any direction (km ⁻¹)
Emb 1	1050	2.0	1.5	0.08	0.13
Emb 2	80	1.0	< 0.5	0.01	< 0.01
Emb 3	950	2.0	1.5	0.06	0.10

Emb 1 is located above Longwalls 14 to 15 and, therefore, the majority of the predicted subsidence effects for this embankment develop due to these approved longwalls. The predicted additional subsidence effects for Emb 1, due to the mining of Longwalls 17 to 20, are 150 mm vertical subsidence, 2.0 mm/m tilt, 0.01 km⁻¹ hogging curvature and less than 0.01 km⁻¹ sagging curvature.

Emb 2 is located north of Longwall 20 and, therefore, the majority of the predicted subsidence effects for this embankment develop due to this proposed longwall. Emb 3 is located above Longwalls 19 and 20 and, therefore, the majority of the predicted subsidence effects for this embankment develop due to these proposed longwalls.

A summary of the maximum predicted total vertical subsidence, tilt and curvature for the cuttings is provided in **Table 5-7**. The values in this table represent the maximum accumulated movements due to the extraction of the existing, approved and proposed longwalls.

Table 5-7 - Maximum predicted total vertical subsidence, tilt and curvature for the cuttings

Cutting	Maximum predicted total vertical subsidence (mm)	Maximum predicted total tilt along alignment (mm/m)	Maximum predicted total tilt across alignment (mm/m)	Maximum predicted total hogging curvature in any direction (km ⁻¹)	Maximum predicted total sagging curvature in any direction (km ⁻¹)
Cut 1	1000	1.5	1.0	0.06	0.03
Cut 2	975	2.0	1.0	0.06	0.10
Cut 3	< 20	< 0.5	< 0.5	< 0.01	< 0.01
Cut 4	400	3.5	1.5	0.03	0.03
Cut 5	1000	1.5	0.5	0.06	0.09
Cut 6	1050	1.0	1.5	0.05	0.10

A summary of the maximum predicted total vertical subsidence, tilt and curvature for the culverts is provided in **Table 5-8**. The values in this table represent the maximum accumulated movements due to the extraction of the existing, approved and proposed longwalls.

Table 5-8 - Maximum predicted total vertical subsidence, tilt and curvature for the culverts

Culvert	Maximum predicted total vertical subsidence (mm)	Maximum predicted total tilt along alignment (mm/m)	Maximum predicted total tilt across alignment (mm/m)	Maximum predicted total hogging curvature in any direction (km ⁻¹)	Maximum predicted total sagging curvature in any direction (km ⁻¹)
C1	975	1.5	1.0	0.03	0.02
C2	1050	1.5	1.0	0.03	0.12
C3	1000	1.5	0.5	0.02	0.10
C4	< 20	< 0.5	< 0.5	< 0.01	< 0.01
C5	< 20	< 0.5	< 0.5	< 0.01	< 0.01
C6	< 20	< 0.5	< 0.5	< 0.01	< 0.01
C7	700	1.5	1.0	0.05	0.02

C1 and C2 are located above Longwalls 14 to 15 and, therefore, the majority of the predicted subsidence effects for these culverts develop due to these approved longwalls. The predicted additional subsidence effects for C1 and C2, due to the mining of Longwalls 17 to 20, are 60 mm vertical subsidence, 0.5 mm/m tilt and less than 0.01 km⁻¹ hogging and sagging curvature.

C4 and C5 are located well outside the mining area and, therefore, are predicted to experience less than 20 mm vertical subsidence. While these two culverts could experience very low levels of vertical subsidence, they are not expected to experience measurable tilts, curvatures or strains.

5.3.5 Coal loading infrastructure

A summary of the maximum predicted total vertical subsidence, tilt and curvature for the coal loading infrastructure is provided in **Table 5-9**. The values in this table represent the maximum accumulated movements due to the extraction of the existing, approved and proposed longwalls.

Table 5-9 - Maximum predicted total vertical subsidence, tilt and curvature for the coal loading infrastructure

Location	Maximum predicted total vertical subsidence (mm)	Maximum predicted total tilt along alignment (mm/m)	Maximum predicted total tilt across alignment (mm/m)	Maximum predicted total hogging curvature in any direction (km ⁻¹)	Maximum predicted total sagging curvature in any direction (km ⁻¹)
Coal loading infrastructure	< 20	< 0.5	< 0.5	< 0.01	< 0.01

The maximum predicted vertical subsidence for the coal loading infrastructure is less than 20 mm. While the infrastructure could experience very low levels of vertical subsidence, it is not expected to experience tilts, curvatures or strains that are measurable using traditional ground monitoring.

The coal loading infrastructure will experience horizontal movements towards the mining area. The measured incremental horizontal movements versus the distance from the maingate of the active longwall at Integra Underground are shown in **Figure 5-16**. The mean and 95 % confidence level based on the monitoring data from Integra Underground are also shown in this figure.

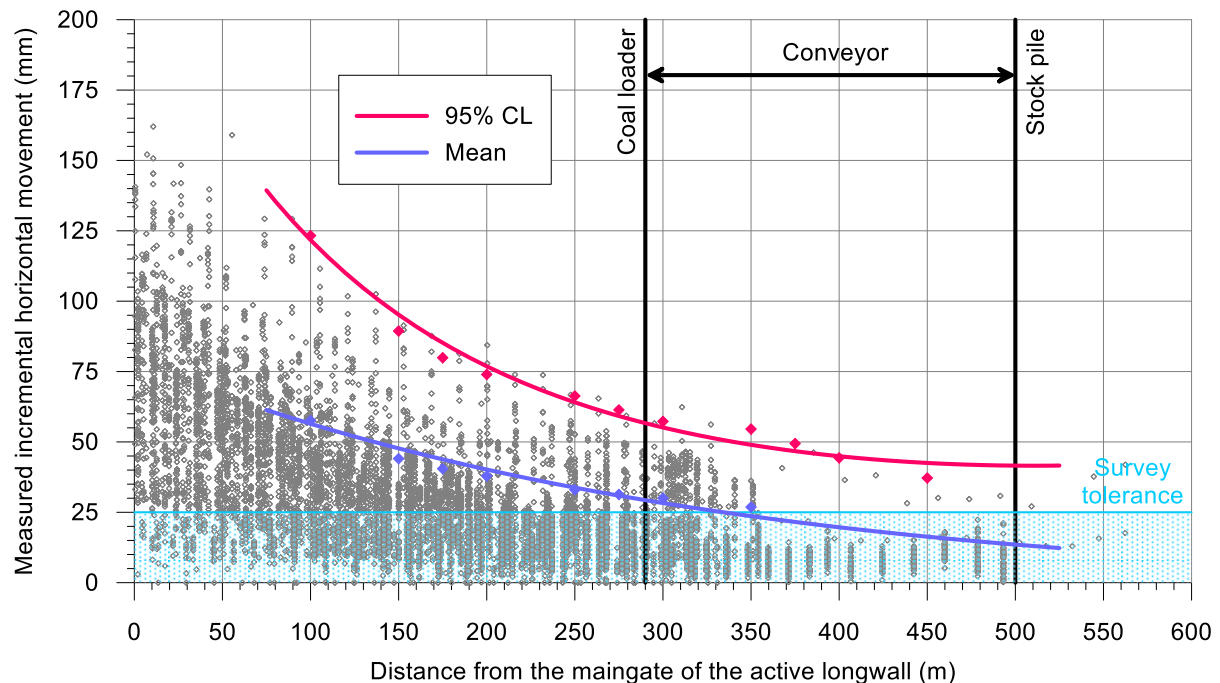


Figure 5-16 Measured incremental far-field horizontal movements at Integra Underground

The locations of the coal loading infrastructure relative to the mining area are shown by the black lines in **Figure 5-16**. The coal loader is located 290 m from the north-east corner of Longwall 20 and the stockpile is located at a minimum distance of 500 m from this proposed longwall.

The coal loader is predicted to experience an incremental horizontal movement of up to 60 mm, due to the mining of Longwall 20, based on the 95 % confidence level. The structure is also predicted to experience incremental horizontal movements in the order of 20 mm to 40 mm due to the mining of each of the Longwalls 17 to 19. The predicted total absolute horizontal movement for the coal loader, due to the mining of Longwalls 17 to 20, is in the order of 150 mm.

Far-field horizontal movements tend to be bodily movements towards the mining area that are generally not associated with measurable strains. However, the conveyor could experience low level differential horizontal movements over its length and it could be sensitive to these movements.

A summary of the measured total differential horizontal over long bays, at distances ranging between 300 m and 500 m from previously extracted longwalls at Integra Underground, is provided in **Table 5-10**. The values have been provided for 50 m, 100 m and 200 m long bays.

Table 5-10 – Measured differential horizontal movements over long bay lengths at Integra Underground

Type	Measured differential horizontal movements over long bays		
	50 m bay length	100 m bay length	200 m bay length
Mean	5	8	13
95 % confidence level	13	18	25

The conveyor is predicted to experience a total differential horizontal movement of 25 mm between the coal loader and the southern end of the stockpile (i.e. over a length of approximately 200 m bay) based on the 95 % confidence level.

5.3.6 Associated infrastructure

The signal line and service road follow the alignment of the Railway and loop within the Affection Area. The maximum predicted subsidence parameters for these features, therefore, are the same as those provided for the Railway.

A summary of the maximum predicted total vertical subsidence, tilt and curvature for the Railway is provided in **Table 5-11**. The values in this table represent the maximum accumulated movements within the Affection Area due to the extraction of the series of longwalls.

Table 5-11 - Maximum predicted total vertical subsidence, tilt and curvature for the Railway infrastructure

Longwalls	Maximum predicted total vertical subsidence (mm)	Maximum predicted total tilt in any direction (mm/m)	Maximum predicted total hogging curvature in any direction (km^{-1})	Maximum predicted total sagging curvature in any direction (km^{-1})
LW17 to LW20	1100	5.5	0.08	0.12

The maximum predicted total curvatures for the Railway infrastructure, regardless of the direction, are 0.08 km^{-1} hogging and 0.12 km^{-1} sagging, which represent minimum radii of curvature of 13 km and 8 km, respectively. These values are greater than the curvatures provided in **Table 5-2** for the Railway, as they represent the maximum values along the alignment of the Railway only.

The distributions of the measured strains at Integra Underground are illustrated in **Figure 5-13**. The maximum predicted strains based on the 95 % confidence levels are 0.9 mm/m tensile and 2.0 mm/m compressive. The maximum predicted strains based on the 99 % confidence levels are 1.3 mm/m tensile and 3.1 mm/m compressive.

6. Consultation

Consultation with relevant stakeholders and technical experts has been undertaken as a key component of the development of this Asset Management Plan in accordance with the Extraction Plan Guidelines and the Guidelines for Best Practice Community Consultation in the NSW Mining and Extractive Industries.

6.1 Identification of stakeholders and experts

A detailed list of the stakeholders and experts involved in the consultation process and the development of this Management Plan is provided below:

- Integra Underground Mine (Integra Underground) – Proponent;
- Mt. Owen Glendell Operations (MGO) – Railway and Bridge owner;
- Laing O'Rourke (LO) – Railway maintainer;
- Pacific National (PN) – Railway operator;
- Freightliner (FL) – Railway operator;
- Australian Rail and Track Corporation (ARTC) – Operator of the Main Northern Railway;
- Office of the National Rail Safety Regulator (ONRSR) – Railway Regulator;
- Department of Planning, Industry and Environment – Resources Regulator (RR) – Mining regulator;
- SCT Operations (SCT) – Subsidence predictions for Integra Underground;
- Mine Subsidence Engineering Consultants (MSEC) – Subsidence predictions for the MGO;
- Pidgeon Civil Engineering (PCE) – Railway engineer;
- Lynton Surveys (LS) – Ground and track monitoring systems; and
- ALS Global (ALS) – Structural engineers.

6.2 Consultation

Integra Underground has carried out consultation with technical experts, the regulators and stakeholders. The details of this consultation are provided in the main document of the *Extraction Plan for Longwalls 17 to 20*.

As part of the monitoring and management processes for the Railway and Bridges identified in this Asset Management Plan, ongoing consultation between Integra Underground, technical experts and stakeholders is required. The parties agree to undertake or participate in these consultation processes as required by this Asset Management Plan or as requested by stakeholders or technical experts.

7. Subsidence impacts

The assessments of the potential impacts and the recommended management strategies for the Railway and its associated infrastructure are provided in the following sections.

7.1 Railway

The potential impacts on the railway track comprise changes in track geometry and changes in rail stress.

Changes in track geometry

The changes in track geometry are described using the following parameters:

- Vertical misalignment (top) - vertical deviation of the track from design;
- Horizontal misalignment (line) - horizontal deviation of the track from design;
- Changes in track cant - changes in superelevation across the rails from design; and
- Track Twist - changes in superelevation over a length of track from design.

The Australian Rail Track Corporation's (ARTC) National Code of Practice provide allowable deviations in track geometry. These standards are for high speed trains and, therefore, are conservative when applied to the low speed trains (i.e. 20 km/h) on the Railway.

The predicted incremental changes in track geometry for the Railway due to the extraction of Longwalls 17 to 20 have been determined using the predicted conventional mine subsidence movements provided in **Section 5.3.1**. A summary of the maximum allowable and maximum predicted changes in track geometry are provided in **Table 7-1**.

Table 7-1 - Allowable and predicted maximum changes in track geometry based on conventional subsidence movements due to Longwalls 17 to 20

Track geometry parameter	Description	Maximum allowable (mm)		Maximum predicted due to conventional movements (mm)
		Speed limit is first applied	Trains are stopped	
Top	Vertical mid-ordinate deviation over a 10 m chord	38	46	< 2
Line	Horizontal mid-ordinate deviation over an 8 m chord	35	53	4
Change in cant	Deviation from design superelevation across rails spaced 1.435 m apart	41	75	6
Long twist	Changes in cant over a 14 m chord	43	65	< 2

The predicted changes in track geometry are an order of magnitude less than the maximum allowable deviations specified in the National Code of Practice, if conventional subsidence occurs.

The changes in track geometry could be greater than those predicted in **Table 7-1** if non-conventional movements develop along the Railway. The potential rates of development of non-conventional movements have been assessed using the ground monitoring data from the previously extracted longwalls at Integra Underground.

The maximum measured vertical mid-ordinate deviation at Integra Underground is 62 mm along the L-Line between Marks L036 to L038 during the extraction of Longwall 8. The localised uplift in this location was due to an irregular anomalous movement. The survey mark spacing was 20 m and, therefore, the vertical mid-ordinate deviation has been measured over a 40 m chord. The equivalent vertical mid-ordinate deviation measured over a 10 m chord (i.e. Top), therefore, is less than the maximum measured along the L-Line.

The development of the incremental vertical mid-ordinate deviation between Marks L036 and L038 during the extraction of Longwall 8 is illustrated in **Figure 7-1**. The maximum rate of development of vertical mid-ordinate deviation in this location was 18 mm per week based on the weekly surveys.

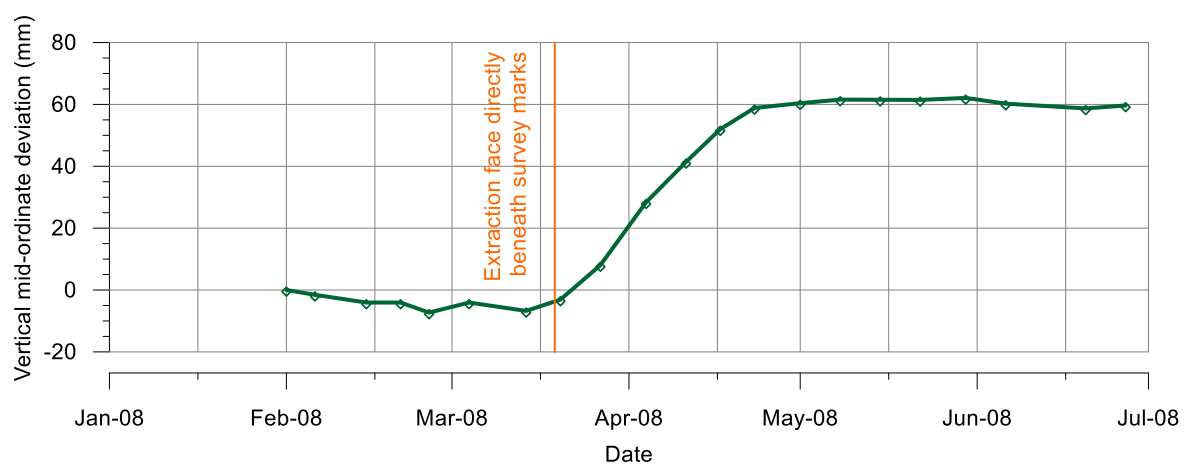


Figure 7-1 Development of vertical mid-ordinate deviation between Marks L036 and L038 along the L-Line during Longwall 8

The maximum measured horizontal mid-ordinate deviation at Integra Underground is 27 mm along the H⁺-Line between Marks H053 and H055 (at approximately 256.010 km) during the extraction of Longwall 9. This localised and elevated movement appeared to be the result of closure movements across a small watercourse. The survey mark spacing was 13 m and, therefore, the vertical mid-ordinate deviation has been measured over a 26 m chord. The equivalent horizontal mid-ordinate deviation measured over an 8 m chord (i.e. Line), therefore, is less than the maximum measured along the H⁺-Line.

The development of the incremental horizontal mid-ordinate deviation between Marks H053 and H055 during the extraction of Longwall 9 is illustrated in **Figure 7-2**. The maximum rate of development of horizontal mid-ordinate deviation in this location was 8 mm per week based on the tri-weekly surveys.

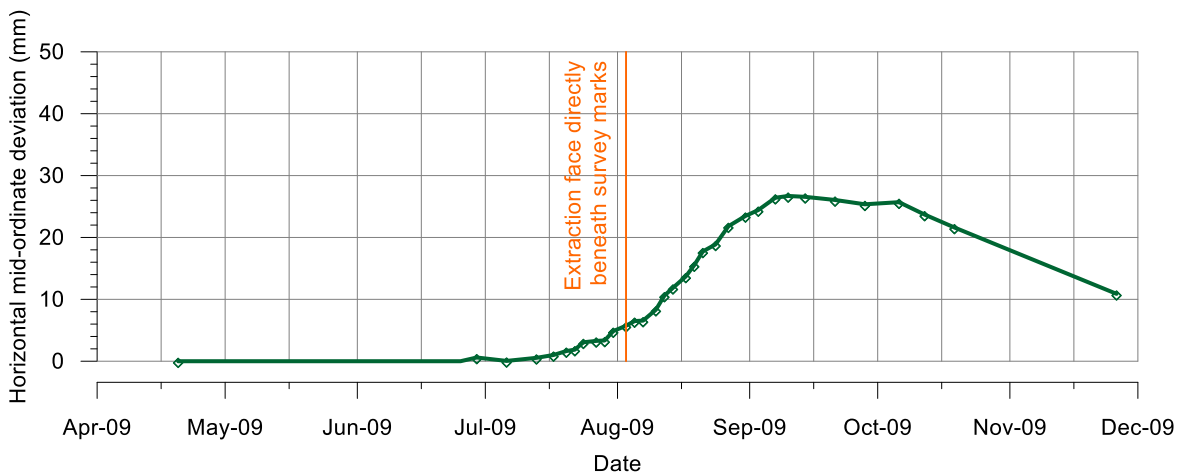


Figure 7-2 Development of horizontal mid-ordinate deviation between Marks H053 and H055 along the H*-Line during Longwall 9

The maximum measured rates of development of vertical mid-ordinate deviation (based on a 40 m chord) and horizontal mid-ordinate deviation (based on a 26 m chord) over a period of one week are less than the allowable limits for Top and Line, respectively, prior to the application of speed restrictions. It is noted that the speed limit for trains on the Railway is 20 km/h.

The changes in track geometry due to non-conventional ground movements, therefore, can be managed using weekly visual inspections, track geometry surveys and ground monitoring surveys (refer to Section 8). If adverse impacts on the track geometry are anticipated, then this can be managed using normal rail maintenance techniques including tamping and provision of additional ballast.

The pre-mining and predicted post-mining grades along the alignment of the Railway are shown in Figure 7-3. The existing grade is shown by the red line and the predicted grade at the completion of Longwall 14 is shown as the cyan line. The predicted grade after the completion of each Longwalls 17 to 20 are shown by the thin and thick blue lines, respectively.

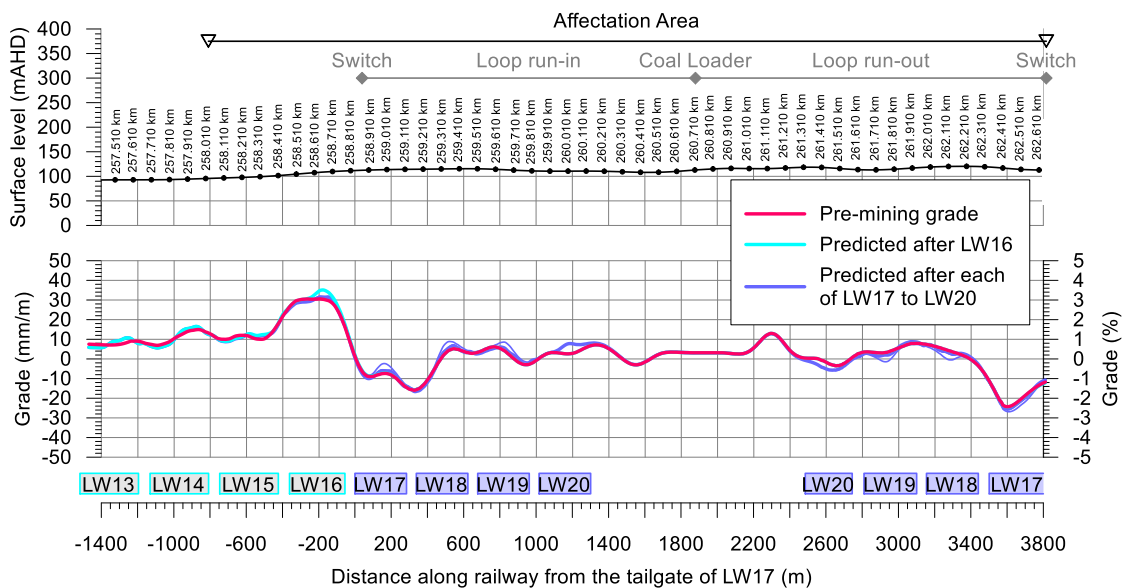


Figure 7-3 Pre-mining and predicted post-mining grades along the Railway

The maximum pre-mining grade along the Railway is approximately 33 mm/m (i.e. 3.3 % or 1 in 30) near Railway Chainage 258.460 km. The extraction of the approved Longwalls 15 and 16 slightly increase the grade in this location and the subsequent extraction of the proposed Longwall 17 reduces it close to the pre-mining value. In this location, the trains are unloaded as they approach the railway loop (i.e. in the uphill direction).

Elsewhere, the predicted changes in grade due to the mining of Longwalls 17 to 20 are up to 5.5 mm/m (i.e. 0.55 %, or 1 in 180). The increases or decreases in grade occur over lengths of approximately 100 m above each of Longwalls 17 to 20. It is unlikely, therefore, that these small predicted changes in grade along the Railway would adversely impact on the operation of the trains.

Changes in rail stress

The Railway comprises continuously welded rail and, therefore, changes in temperature induce stresses in the rail. Higher temperatures result in increased compression and lower temperatures result in increased tension in the rail. The Stress Free Temperature (SFT) is the rail temperature at which it is at zero stress.

The predicted change in SFT for continuously welded rail due to mine subsidence has been determined using the following empirical formula:

Equation 1: Predicted change in SFT (°C):
$$E_t = \frac{85.5C_t}{L}$$

where C_t = change in length due to strain
 L = long bay length

The review of the ground and rail monitoring data for Longwall 9 (MSEC, 2009) found that there is good correlation between the measured and predicted changes in rail SFT when: the change in length due to strain (C_t) is determined over 100 m long bay lengths (i.e. $L = 100$ m); and 100 % transfer of ground strain to rail strain is assumed (i.e. $\epsilon_{\text{track}} = \epsilon_{\text{ground}}$).

The accumulated changes in rail SFT (considering the changes during the track adjustments) due to the extraction of Longwalls 13 and 14 were determined by PCE (2018a and 2020). The profiles of the measured changes in 100 m long bays along the PH-Line and the accumulated changes in rail SFT are shown in **Figure 7-4** for Longwall 13 and in **Figure 7-5** for Longwall 14.

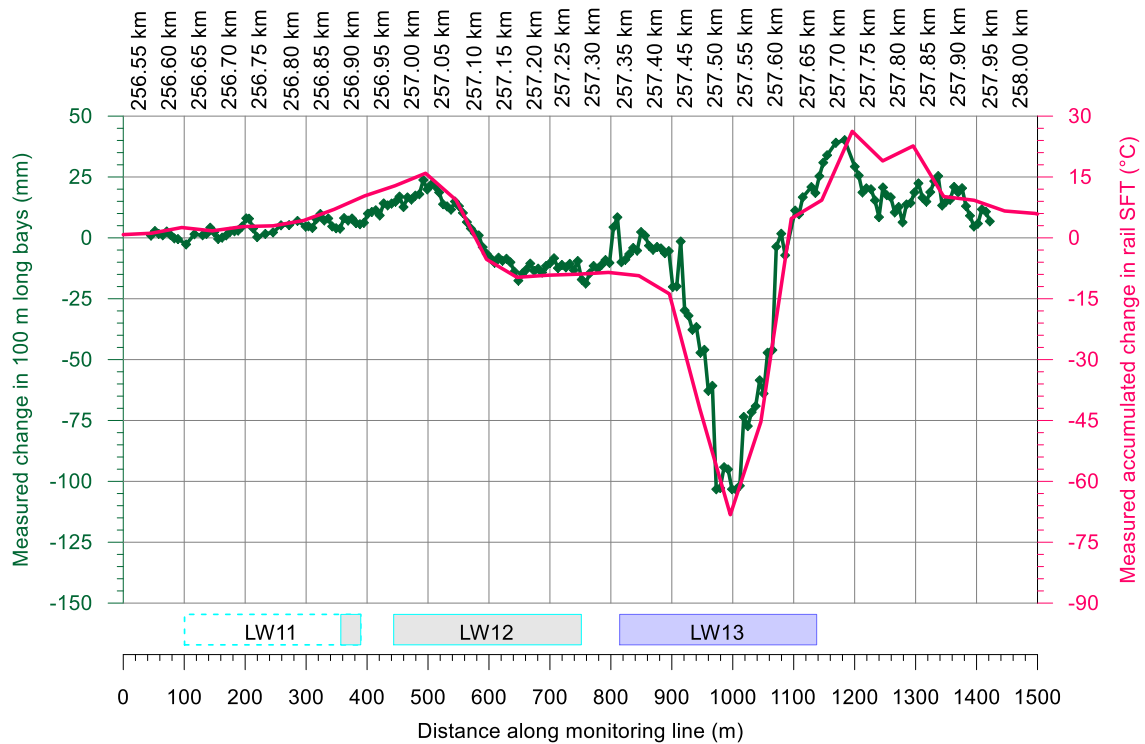


Figure 7-4 Profiles of the changes in 100 m long bays and accumulated rail SFT due to Longwall 13

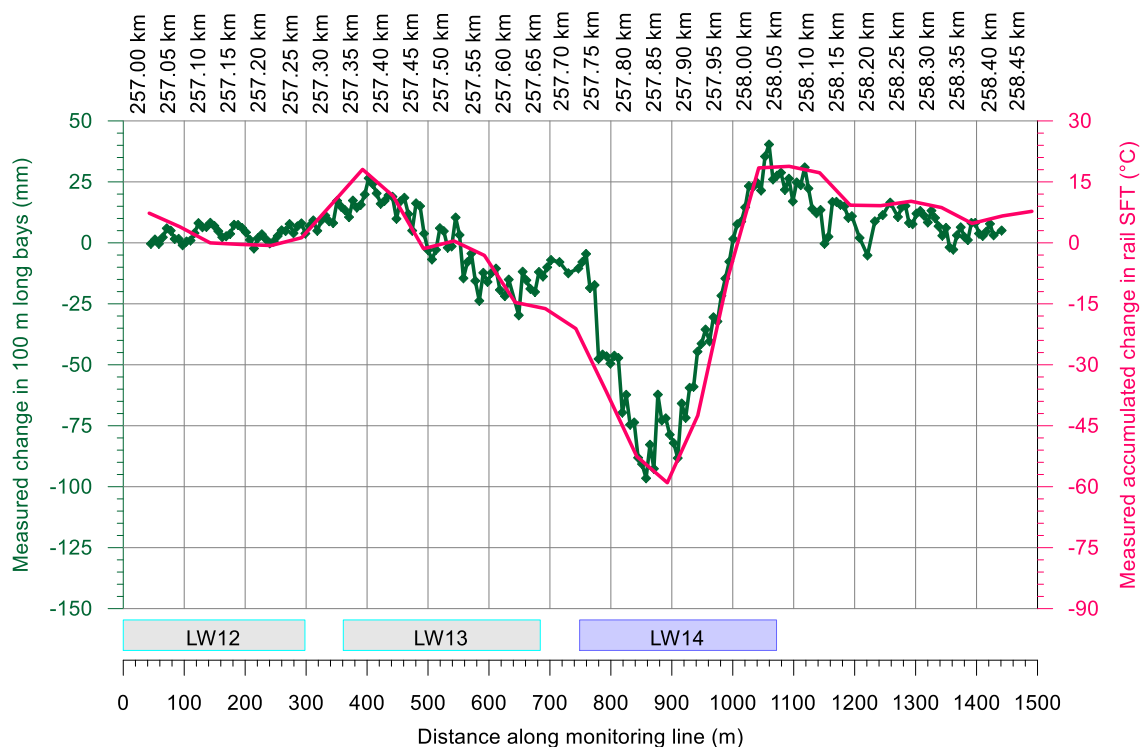


Figure 7-5 Profiles of the changes in 100 m long bays and accumulated rail SFT due to Longwall 14

The profiles of the measured change in 100 m long bays and the accumulated change in rail SFT reasonably match. The ratios of the maximum changes in rail SFT to the maximum changes in 100 m long bays are approximately 0.60 at the completion of both Longwalls 13 and 14.

The developments of the maximum measured contraction over 100 m long bays along the PH-Line and the maximum accumulated decrease in rail SFT during the extraction of Longwalls 13 and 14 are shown in **Figure 7-6**. The line of best fit through the origin is shown by the red dashed line in this figure.

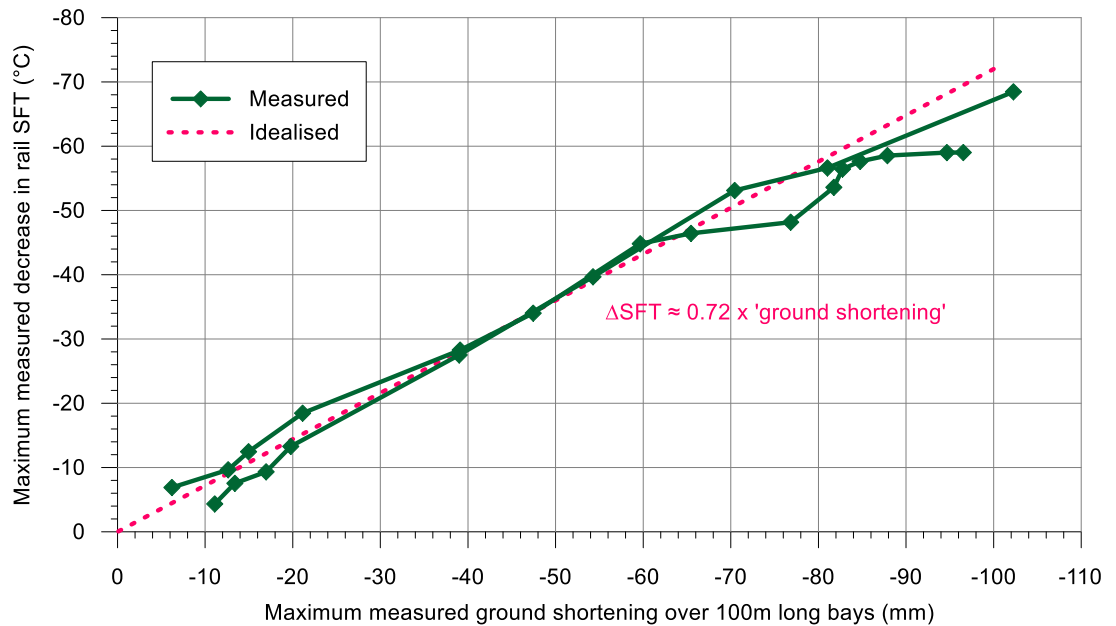


Figure 7-6 Developments of the maximum measured contraction over 100 m long bays and maximum decrease in rail SFT during the extraction of Longwalls 13 and 14

The gradient of the line of best fit shown in **Figure 7-6** is 0.72. That is, the maximum decrease in rail SFT can be idealised as 0.72 times the maximum measured contraction over 100 m long bays. This ratio is slightly less than the value adopted in *Equation 1* of 0.855 (i.e. 85.5 divided by 100 m). The predicted changes in rail SFT for Longwalls 17 to 20, therefore, have been based on *Equation 1*. The use of this equation provides slightly conservative predictions for the changes in rail SFT of approximately +19 % (i.e. 0.855 divided by 0.72).

The predicted profiles of the incremental changes in rail SFT along the alignment of the Railway due to the extraction of Longwalls 17 to 20 are provided in **Figure 7-7** to **Figure 7-10**, respectively.

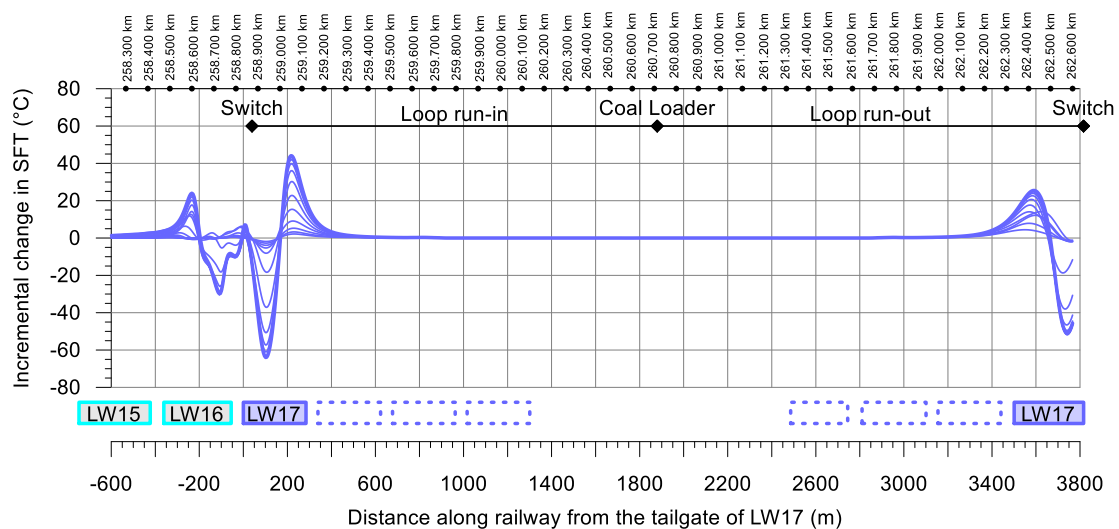


Figure 7-7 Profile of predicted incremental change in rail SFT due to Longwall 17

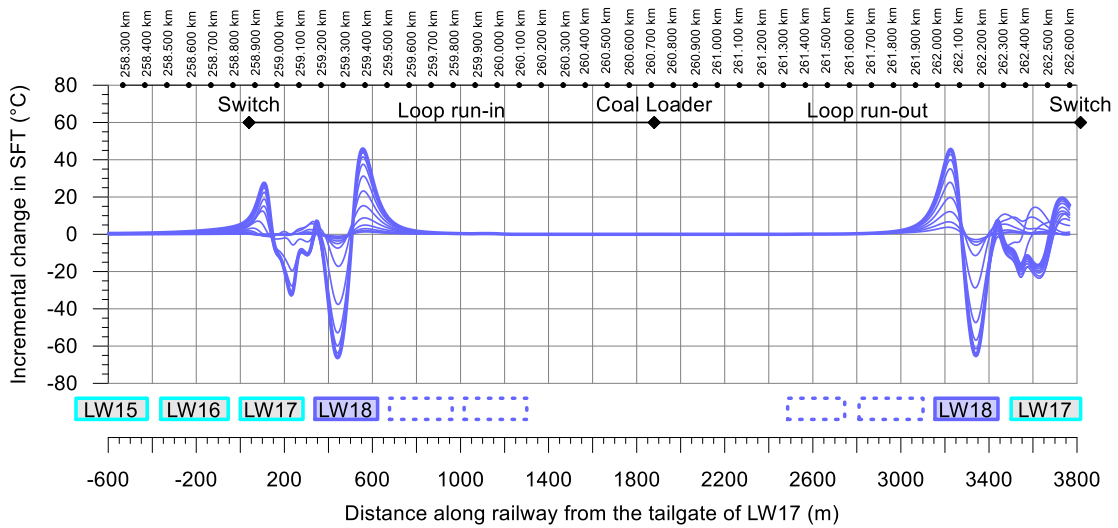


Figure 7-8 Profile of predicted incremental change in rail SFT due to Longwall 18

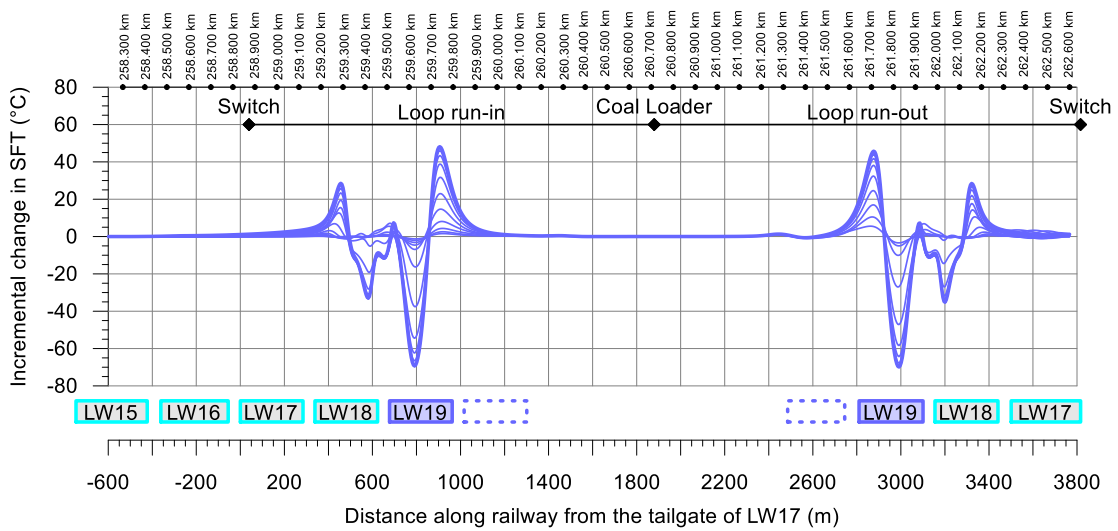


Figure 7-9 Profile of predicted incremental change in rail SFT due to Longwall 19

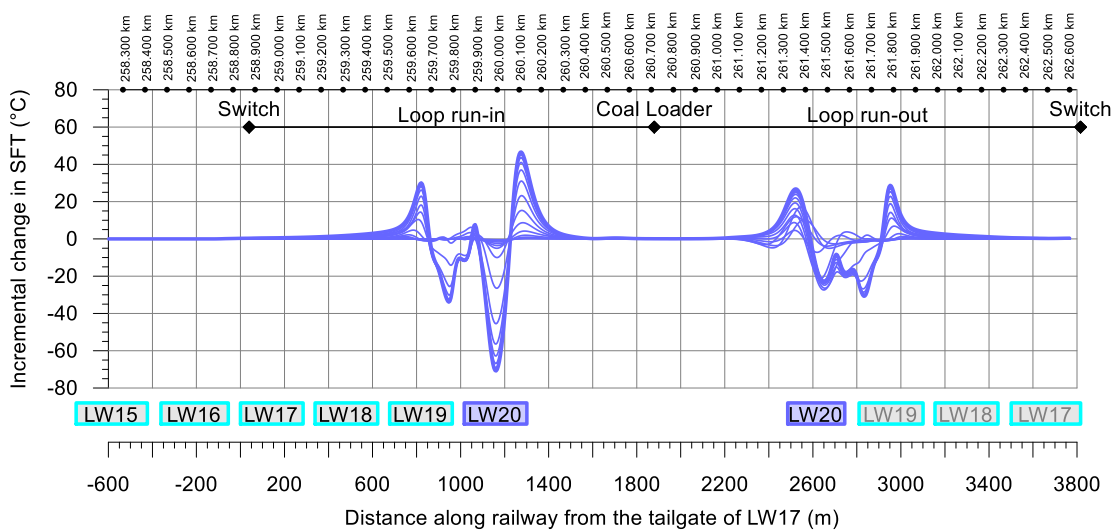


Figure 7-10 Profile of predicted incremental change in rail SFT due to Longwall 20

The maximum predicted incremental changes in rail SFT due to the mining of each of the Longwalls 17 to 20 are +50°C and -70°C. The predicted changes in rail SFT are sufficient to result in rail instability and possibly rail break, if no preventive measures were to be implemented.

The consideration of risk controls for rail stress have included:

Elimination – in this case, no reasonably practical controls could be identified that would eliminate the identified risks associated with rail stress.

Substitution – the use of a track expansion system has been considered comprising switches, zero toe load clips and anchor points. This type of system was adopted for the extraction of Longwall 8 beneath the Railway and for longwall mining beneath the Main Southern Railway at Appin and Tahmoor Collieries. It has been considered that engineering controls (see below) are more appropriate for the Railway at Integra Underground due to:

- Limited number of trains (up to 12 per day);
- The low speed track (20 km/h); and
- The Railway is owned by the MGO and is on land owned by the mine.

Engineering controls – the rail stress has been successfully managed during the extraction of Longwalls 9 to 15 directly beneath the Railway at Integra underground. It has been considered that these strategies are more than appropriate for the management of rail stress for Longwalls 17 to 20 and include:

- Investigation and repair of rail defects prior to active subsidence;
- The installation of strain and temperature gauges along the Railway;
- Restressing the rail to adjust the SFT (within allowable limits) prior to active subsidence;
- Monitoring of the strain and temperature of the rail during active subsidence;
- Undertaking track adjustments (cutting of rail, tensioning to achieve the required SFT and re-welding) prior to the rail stress reaching prescribed triggers; and
- Final restressing to achieve the required SFT after the completion of active subsidence.

The track adjustments will reset the SFT to within the design tolerance so that the rails can accommodate additional subsidence without affecting the normal operations. These adjustments can be planned in advance and undertaken multiple times. The frequency of interventions can be increased if the ground movements along the Railway exceed the predictions.

The rail stress will be continuously monitored and alarmed based on prescribed triggers during the timeframes provided in **Section 10**. The rail stress will develop gradually allowing track adjustments to be undertaken prior to the track becoming unsafe. The management of rail stress required between 5 and 8 interventions during the extraction of each of Longwalls 12 to 15.

Administrative controls – include the preparation of the monitoring and management strategies and the implementation of Trigger Action Response Plans (TARPs). These controls have been based on the successful implementation of similar controls for Longwalls 8 to 15 directly beneath the Railway at Integra Underground.

The monitoring for the Railway is described in **Section 8**. The risk control procedures, the Action Plans and Trigger Action Response Plans are provided in **Sections 9, 10 and 11**, respectively.

7.2 Bridges

The Bridges are not expected to experience measurable movements due to the mining of Longwalls 17 to 20. It is unlikely, therefore, that the Bridges would experience adverse impacts due to the mining of these proposed longwalls.

Engineering controls – mitigation measures were carried out on the Bridges prior to active subsidence from Longwall 13. The preventive works considered the predicted movements due to mining in both the Middle Liddell and Hebden Seams.

The Bridges experience mine subsidence due to the mining of Longwalls 13 to 15 beneath and adjacent to them. The measured differential movements of the Bridges remained well below the design movements that can be accommodated based on the preventive works. A summary of the maximum measured movements due to Longwalls 13 to 15 and the design movements for the preventive works for the Bridges is provided in **Table 7-2**.

Table 7-2 - Maximum measured subsidence effects due to Longwalls 13 to 15 and the design parameters for the preventive works for the Bridges

Parameter	Maximum measured movement	Design movement for bridge preventive works
Differential horizontal movement between abutments in longitudinal direction	13 mm opening (nil closure)	75 mm opening 150 mm closure
Differential horizontal movement between abutments in transverse direction (i.e. shear)	6 mm	50 mm
Differential vertical movement between abutments (i.e. vertical step)	< 3 mm	50 mm
Tilt along alignment (i.e. longitudinal rotation)	2.5 mm/m	8 mm/m
Tilt across alignment (i.e. transverse rotation)	2.5 mm/m	4 mm/m
Differential transverse tilt between abutments (i.e. longitudinal twist)	< 1 mm/m	2 mm/m

Administrative controls – include the preparation of the monitoring and management strategies and the implementation of TARPs. These controls have been established for the mining of Longwalls 13 to 16 directly beneath and near the Bridges.

Regular monitoring of the Bridges for Longwalls 17 to 20 is not required as the predicted movements are not expected to be measurable. However, periodic monitoring of the Bridges may be carried out based on the recommendations by the Technical Committee.

The monitoring for the Bridges is described in **Section 8**. The risk control procedures, the Action Plans and Trigger Action Response Plans are provided in **Sections 9, 10 and 11**, respectively.

7.3 Railway switch

The switch is located at railway chainage 258.840 km just north of the tailgate of Longwall 17. The switch could be adversely affected by ground extension or contraction due to Longwall 17 and, to lesser extents Longwall 18 to 20, if no preventive measures were to be implemented.

Engineering controls – the potential impacts on the railway switch were reviewed as part of the Railway Management Plan for Longwalls 15 and 16. It was identified that the risk to the rail switch could be minimised by installing a rail expansion switch to accommodate the predicted mining-induced extension and contraction (PCE, 2018b).

A Type 5 rail expansion switch has been installed on the southern side of the railway switch. A photograph of the expansion switch is provided in **Figure 7-11**.



Figure 7-11 Rail expansion switch

Administrative controls – include the preparation of the monitoring and management strategies and the implementation of TARPs.

The monitoring for the expansion switch is described in **Section 8**. The risk control procedures, the Action Plans and Trigger Action Response Plans are provided in **Sections 9, 10 and 11**, respectively.

7.4 Embankment, cuttings and culverts

Emb 1 is located directly above Longwalls 14 to 15. No adverse impacts occurred to this embankment due to the mining of these longwalls. The additional vertical subsidence due to the mining of Longwalls 17 to 20 is 150 mm. Emb 3 is located outside of the mining area and the predicted vertical subsidence due to the mining of Longwalls 17 to 20 is 80 mm. Adverse impacts on Emb 1 and Emb 3 are therefore not anticipated due to the low levels of predicted subsidence.

Emb 2 is located directly above Longwalls 19 and 20. The extraction of these proposed longwalls could result in a small amount of vertical settlement and lateral spread (SCT, 2006, 2017b and 2020). The settlement and spread of the embankment is expected to be small due to the: relatively low height (up to 3 m); the low slopes of the batters (approximately 2 horizontal to 1 vertical); and the relatively low predicted mine subsidence movements.

It was identified in the risk assessment that tensile cracking in the embankment could also result in the increased potential for erosion and/or water ingress. This could result in the deterioration of the embankment in the longer term if the larger tensile cracks are not remediated.

The potential for low level settlement, spreading of the embankment and tensile cracking can be identified using ground monitoring, visual inspections and track geometry monitoring. If adverse impacts on the track geometry occur, then this can be managed using normal rail maintenance techniques including tamping and additional ballast. Tensile cracking in the embankment can be repaired by infilling with engineered fill and recompacting.

Cut 1 to Cut 6 are located directly above or adjacent to Longwalls 17 to 20. The batters of the cuttings are highly weathered and it is possible that loose rocks could be dislodged due to mine subsidence. Debris from dislodged rocks can be identified from the visual inspections during active subsidence. Experience of mining beneath cuttings in the NSW coalfields has found that ground strain can be concentrated within the cuttings and, therefore, result in increased rail stress. The management of rail stress is discussed in **Section 7.1**.

The drainage culverts are predicted to experience tilts up to 1.5 mm/m (i.e. 0.15 %) along their alignments. The predicted changes in grade are very small (i.e. less than 1 %) and, therefore, are unlikely to affect their serviceability. The culverts are also unlikely to be adversely impacted by the predicted curvatures and strains based on the experience of mining beneath concrete culverts at similar depths of cover in the NSW coalfields.

Culvert C3 is located near the low point along the Railway loop. The mining of Longwall 18 could result in increased ponding in this location, as it is located near the centreline of this longwall. If adverse impacts on ponding were to develop adjacent to the Railway, then mitigation measures would be required to improve the surface drainage to C3. These mitigation measures are described in the *Land Management Plan* within the *Extraction Plan for Longwalls 17 to 20*.

7.5 Coal loading infrastructure

The coal loading infrastructure is predicted to experience less than 20 mm vertical subsidence. While the infrastructure could experience very low levels of vertical subsidence, it is not expected to experience tilts, curvatures or strains that are measurable using traditional ground monitoring.

The coal loading infrastructure is not expected to be adversely impacted by vertical subsidence or its associated effects. However, the load cell used to weight the trains could be sensitive to the very low levels of tilt. The low level tilt will be monitored using a tilt-metre as described in **Section 8.5**.

The coal loading infrastructure is predicted to experience far-field horizontal movements towards the mining area. The conveyor could be sensitive to the predicted low level differential horizontal movements, as summarised in **Section 5.3.5**.

Engineering controls – ALS has carried out an initial review of the predicted differential horizontal movements for the conveyor and loading bin. No preventive measures have been recommended at this stage based on this initial review. A more detailed engineering assessment of the conveyor and loading bin will be carried out before the commencement of Longwall 19.

Administrative controls – include the preparation of the monitoring and management strategies and the implementation of TARPs.

The monitoring for the coal loading infrastructure is described in **Section 8**. The risk control procedures, the Action Plans and Trigger Action Response Plans are provided in **Sections 9, 10 and 11**, respectively.

7.6 Signal line

The signal line is not expected to be adversely impacted based on the conventional ground movements. However, the signal line could be impacted if localised and irregular movements develop

along its alignment. Elevated tensile strains could result in damage of the insulating sheaves and exposure of the cables, then, subsequent compression could allow them to cross over. The potential risks from irregular ground movements include loss of service or possible wrong side failure.

Longwalls 8 to 15 have been mined directly beneath or near the signal line. Localised compressive strains up to 3.5 mm/m were measured along the Railway and minor surface cracking was observed. However, these were no adverse impacts on the serviceability of the signal line.

There is extensive experience of mining beneath buried copper telecommunications cables in the NSW coalfields, where the ground strains have been similar to or greater than those predicted along the Railway. This extensive experience indicates that the potential for impact on buried copper telecommunications cables is extremely rare. However, the risk must still be managed due to the consequence of signal line failure.

No reasonably practical elimination, substitution and engineering controls could be identified as the signal line is buried in the ground. An administrative control of implementing a monitoring and TARP has been selected.

The potential for impacts on the signal line will be managed using the ground monitoring line along the Railway and visual inspections of the surface. An impedance test can be carried out to assess the mining-induced impacts on the cable. Alternatively, the signal line could be locally unburied, exposed and inspected if an irregular ground movement is measured. In the case of loss of signal, the control room will be notified and the trains can be escorted along the affected section of the Railway.

The monitoring for the signal line is described in **Section 8**. The risk control procedures, the Action Plans and Trigger Action Response Plans are provided in **Sections 9, 10** and **11**, respectively.

7.7 Service road

It is unlikely that adverse impacts would occur to the service road due to the mining of Longwalls 17 to 20. The service road will be visually monitored as part of the regular subsidence inspections to identify tensile cracking or compressive heaving. Surface deformations will be remediated, as required, so as to maintain the road in a safe and serviceable condition.

8. Monitoring and management strategies

The Railway and its associated infrastructure will be monitored using ground monitoring, strain and temperature gauges, track geometry trolley and visual inspections. These monitoring methods are described in the following sections.

8.1 Ground monitoring

8.1.1 The Railway

The ground movements along the alignment of the Railway will be monitored using the PH-Line. This monitoring line was originally established for Longwall 12 and it was progressively extended for each of the Longwalls 13 to 16. The monitoring line will be extended further to the north to monitor Longwalls 17 to 20.

The monitoring line will be measured during active subsidence to the predicted limits of vertical subsidence, for each of the longwalls, taken as the further of the:

- 20 mm of predicted incremental vertical subsidence due to the active longwall; and
- 26.5° angle of draw line from the active longwall.

The extents of monitoring on the maingate sides of Longwalls 17 to 20 have been increased by an additional 80 m due to the difference between the measured and predicted limits of vertical subsidence (refer to **Section 5.2**). A summary of the extents of monitoring along the PH-Line is provided in **Table 8-1** and is illustrated in **Figure 8-1**.

Table 8-1 - Extents of monitoring for the PH-Line

Longwall	Location	Approximate position	Kilometrage (km)
LW17	Loop-in	E321165, N6410680 to E320780, N6412065	258.030 to 259.470
	Loop-out	E320875, N6412160 to E320995, N6411505	261.970 to 262.650
LW18	Loop-in	E321110, N6411025 to E320665, N6412380	258.380 to 259.810
	Loop-out	E320765, N6412485 to E320995, N6411505	261.630 to 262.650
LW19	Loop-in	E321035, N6411390 to E320545, N6412695	258.760 to 260.150
	Loop-out	E320840, N6412810 to E320995, N6411505	261.200 to 262.650
LW20	Loop-in	E320920, N6411705 to E320995, N6411765	259.090 to 262.390
	Loop-out		

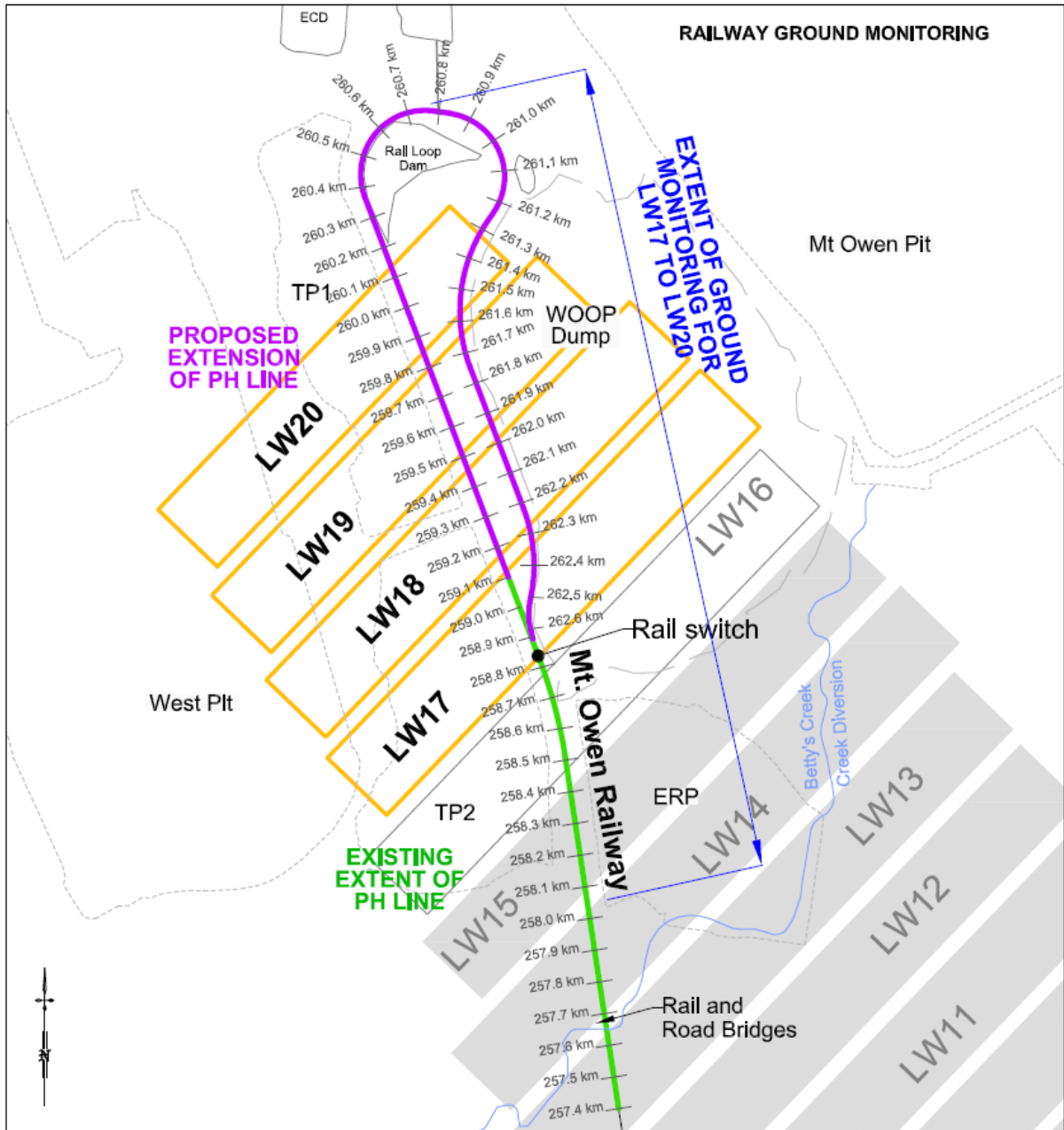


Figure 8-1 Extent of ground monitoring

The monitoring line comprises prisms fixed to posts at approximately 15 m centres located on the eastern side of the Railway. The monitoring line will be extended using a similar prism and post arrangement and spacings. A photograph of a typical monitoring point is provided in **Figure 8-2**.



Figure 8-2 Prism arrangement for the PH-Line

The PH-Line will be measured using 3D monitoring techniques providing the position (MGA Easting and Northing) and reduced level (mAHD). The required target accuracies for monitoring by total station are:

- 2.0 second angular resolution; and
- ± 2 mm and 2 ppm distance.

The horizontal positions and reduced levels will be measured to accuracies of: ± 10 mm or better for absolute position and level; and ± 3 mm or better for relative position and level. The strain distances will be measured to an accuracy of ± 3 mm (i.e. ± 0.2 mm/m over a 15 m bay).

The PH-Line will be extended and the base line survey undertaken prior to the longwall reaching a distance of 500 m from the first rail contact. The monitoring frequencies of the PH-Line for Longwalls 17 to 20 are provided in **Table 10-1** to **Table 10-4**, respectively.

The monitoring frequency can be modified by the TC based on the review of the ground monitoring data and the longwall extraction rate. The monitoring frequency may be increased if irregular ground movements develop along the Railway. The monitoring frequency may be reduced if the longwall extraction rate is slower than anticipated.

8.1.2 The Bridges

Monitoring points and tell-tales were instated on the Bridges as part of the Longwalls 13 to 16 Management Plans. The Bridges are predicted to experience less than 20 mm vertical subsidence due to the mining of Longwalls 17 to 20. While the Bridges could experience very low levels of vertical subsidence, they are not expected to experience measurable tilts, curvatures or strains.

There is no specific monitoring recommended of the Bridges for Longwalls 17 to 20. However, the Technical Committee can recommend that the existing survey marks and tell-tales to be measured, during the mining of these longwalls, if required.

The locations of the existing 3D monitoring points are illustrated in **Figure 8-3**. There are three marks fixed to the southern abutment (B01, B10 and B13), five marks fixed to the northern abutment (B03, B12, B14, B15 and B16), four marks fixed to the rail bridge (B02, B04, B05 and B07) and four marks fixed to the road bridge (B06, B08, B09 and B11).



Figure 8-3 Locations of the 3D monitoring points for the Bridges

The horizontal positions and reduced levels for the 3D marks should be measured to accuracies of: ± 10 mm or better for absolute position and level; and ± 3 mm or better for relative position and level. The 2D distances between marks on opposing abutments will be measured to accuracies of ± 3 mm or better.

There are eight existing tell tales fixed across the expansion joints of the Bridges, with one at each corner of the Railway Bridge (Refs. NWRL, NERL, SWRL and SERL) and one at each corner of the Road Bridge (Refs. NWRD, NERD, SWRD and SERD).

Photographs of the existing monitoring on the Bridges are provided in **Figure 8-4**.



Figure

8-4

Existing 3D monitoring points and tell-tales on the Bridges

The 3D marks and tell tales will be inspected and the base line survey undertaken, prior to Longwall 17 reaching 100 m before first rail contact, in accordance with the Action Plan provided in **Table 10-1**. Subsequent surveys are only required if recommended by the Technical Committee.

8.2 Track gauges

The track will be monitored using strain and temperature gauges. These gauges were previously installed for the monitoring of Longwall 12 and were progressively extended for each of the Longwalls 13 to 16. The strain and temperature gauges will be extended further to the north to monitor Longwalls 17 to 20.

The track monitoring will extend to the predicted limits of vertical subsidence (as defined in **Table 8-1**) plus an additional 350 m on the tailgate side and plus an additional 500 m on the maingate side. A summary of the extents of the strain and temperature monitoring is provided in **Table 8-2** and is illustrated in **Figure 8-5**.

Table 8-2 - Extents of the track strain and temperature monitoring

Longwall	Location	Approximate position	Kilometrage (km)
LW17	Loop-in	E321215, N6410335 to E320605, N6412535	257.680 to 259.970
	Loop-out	E320770, N6412640 to E320995, N6411505	261.400 to 262.650
LW18	Loop-in	E321165, N6410680 to E320485, N6412850	258.030 to 260.310
	Loop-out	E320900, N6412955 to E320995, N6411505	261.130 to 262.650

Longwall	Location	Approximate position	Kilometrage (km)
LW19	Loop-in	E321110, N6411050 to E320995, N6411505	258.410 to 262.650
	Loop-out		
LW20	Loop-in	E321040, N6411375 to E320995, N6411505	258.740 to 262.650
	Loop-out		

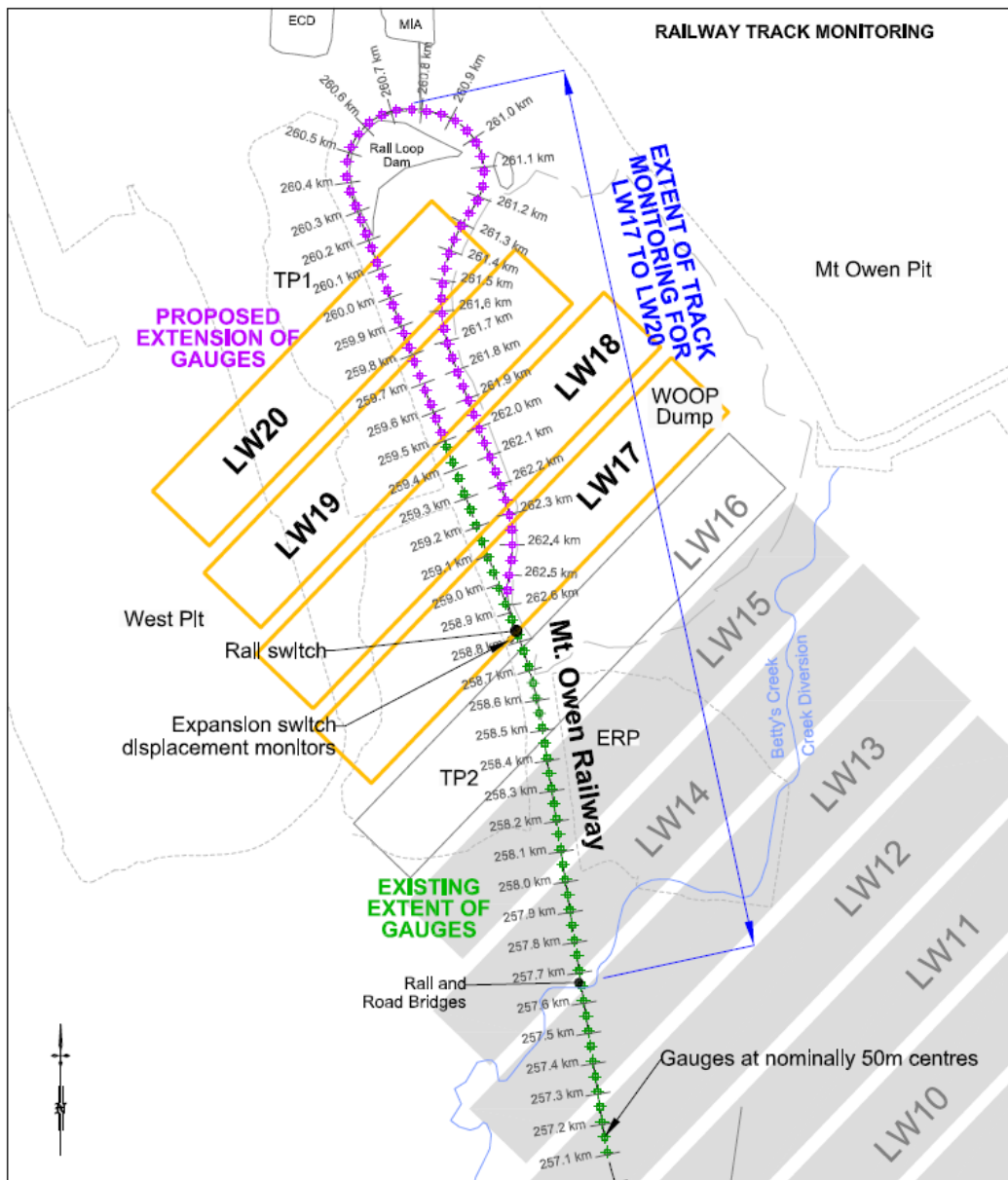


Figure 8-5 Extents of strain and temperature gauge monitoring

Existing gauges located outside the Affection Area will be relocated as required. All existing and relocated gauges will be checked and verified prior to their re-use.

The new and relocated strain and temperature gauges will be spaced at nominally 50 m centres on both rails. Two temperature gauges will be provided for each stress gauge for redundancy. The positions of the gauges near the new expansion switch will be determined on site.

A photograph of the typical strain and temperature gauges is provided in **Figure 8-6**.



Figure 8-6 Track strain and temperature gauges

The strain and temperature gauges will be installed and the base line survey undertaken prior to the longwall reaching a distance of 500 m from the first rail contact. The track will be continuously monitored for the period of active subsidence (refer to **Section 10**).

The track monitoring will be alarmed based on prescribed triggers (refer to **Section 11**). The stakeholders and expert consultants will be notified of an alarm in accordance with the communications protocol (refer to **Section 9.4**). The monitoring data will be uploaded to the project website, for which access is available to the stakeholders and expert consultants.

A rail expansion switch has been installed on the southern side of the existing rail switch at the end of the railway loop (refer to **Section 7.1**) as part of the Longwall 15 and 16 Management Plan. Switch displacement sensors have been installed on both rails to monitor the movements in real-time using the existing track monitoring system. Adjustments of the expansion switch will be carried out during active subsidence if the prescribed triggers are reached.

8.3 Track geometry

The experience from the previously extracted longwalls at Integra Underground has found that localised changes in track geometry can be more readily identified from the regular visual inspections, combined with the nearby ground monitoring, than with that measured using a track geometry trolley.

The track geometry can be measured using a trolley to supplement the visual and ground surveys, when it is available, but it is not considered essential. A Geismar, Krab or equivalent trolley can be used to measure the change in cant, short twist and long twist. The monitoring should extend to the predicted limits of vertical subsidence, as summarised in **Table 8-1**, when track geometry surveys are carried out.

8.4 Visual inspections

Visual inspections will be undertaken by a suitably qualified representative of the Railway Maintainer. The purposes of the inspections are to identify noticeable changes in the track geometry, soft spots beneath the track, noticeable movement or cracking in the embankment and surface deformations in the natural ground adjacent to the Railway. The inspection frequency is provided in **Table 10-1** to **Table 10-4** for Longwalls 17 to 20, respectively.

8.5 Coal loading infrastructure

A Global Navigation Satellite System (GNSS) monitor, or similar, will be installed prior to the commencement of Longwall 17 to provide baseline and far-field measurements. Monitoring prisms will be installed on the conveyor structure before the commencement of Longwall 19. The monitoring program may be expanded to include a ground monitoring line and tilt-meters, subject to the outcomes of the detailed structural assessment of the conveyor and loading bin, which will be completed before the commencement of Longwall 19.

The indicative layout of the monitoring for the coal loading infrastructure is illustrated in **Figure 8-7**. The final monitoring requirements for this infrastructure are subject to the outcomes of the detailed structural assessment of the conveyor and loading bin.

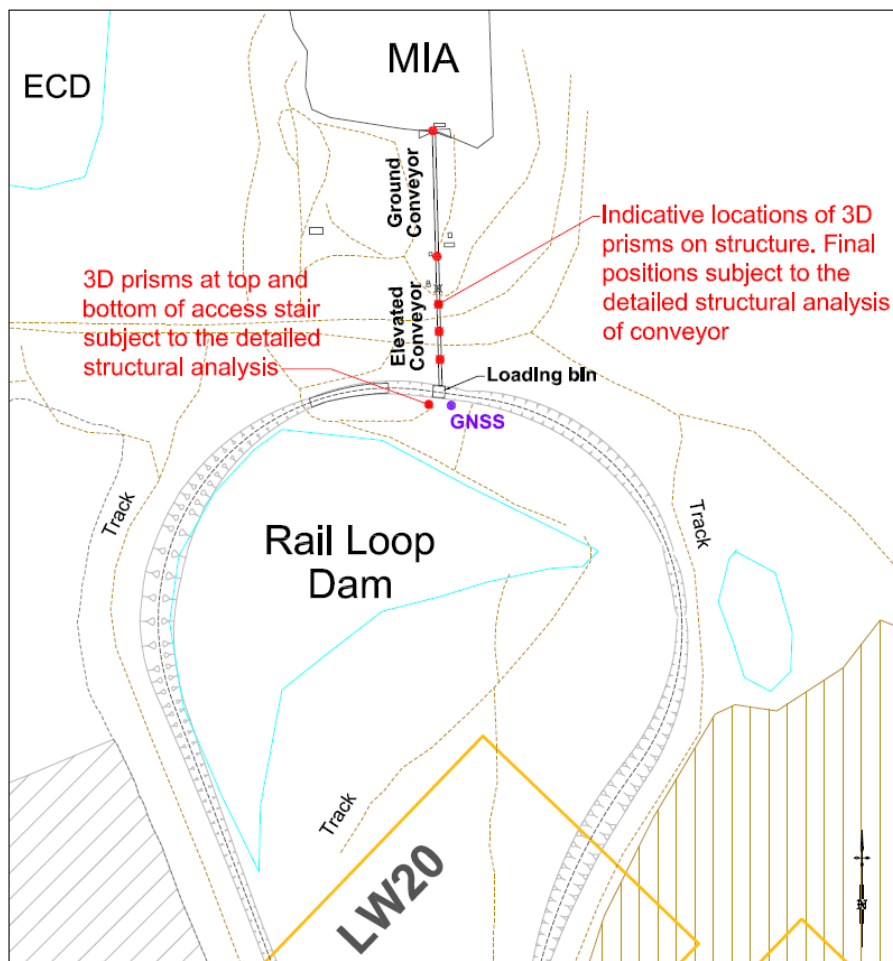


Figure 8-7 Indicative monitoring for the coal loading infrastructure

Survey prisms will be fixed to the coal loading bin and conveyor support structure. These prisms will measure the differential horizontal movements of the loading bin and along the conveyor. The final positions of these survey marks are subject to the outcomes of the detailed structural analysis of the conveyor and loading bin, which will be completed before the commencement of Longwall 19. The measurement accuracy will be the same as the PH-Line, as described in **Section 8.1.1**.

A GNSS unit will be established near the southern extent of the conveyor, i.e. adjacent to the loading bin. This unit will measure the absolute horizontal movements over time to compliment the traditional survey lines and survey marks.

The GNSS unit installation generally includes a solar panel, rechargeable battery, data logger and telemetry hardware. A photograph of a typical GNSS installation is provided in **Figure 8-8**.



Source: Michael Nicholson Consulting

Figure 8-8 Nominal GNSS unit installation set-up

The GNSS unit will measure the absolute vertical and horizontal movements in real time. The nominal accuracy is ± 5 mm for absolute position and ± 10 mm for absolute level. The movements will be recorded at regular intervals and reported daily, as a daily average and a seven day running average. The results will be recorded in a database that can be accessed using an online website.

9. Risk control procedures

9.1 Roles and responsibilities

The Integra Underground is responsible for:

- Participating in the Technical Committee (refer to **Section 9.2**), meetings and risk assessments;
- Developing and revising (as required) the Asset Management Plan for the Railway and its associated infrastructure;
- Providing the longwall face positions to the stakeholders and expert consultants during mining;
- Notifying railway owner (MGO) of any significant delays in mining when the longwall extraction is within the zone of influence of the Railway; and
- Completing the actions specified within the Longwall Action Plans (refer to **Section 10**).

The Mount Owen Glendell Operations (MGO) is responsible for:

- Convening and participating in the Technical Committee (refer to **Section 9.2**), meetings and risk assessments;
- Monitoring the ground movements along the Railway (refer to **Section 8.1**);
- Receiving alarms (control room) and notifying the Railway Maintainer and Railway Operator; and
- Completing the actions specified within the Longwall Action Plans (refer to **Section 10**).

The Railway Maintainer, Laing O'Rourke (LO), is responsible for:

- Participating in the Technical Committee (refer to **Section 9.2**), meetings and risk assessments;
- Undertaking the track geometry and visual inspections of the track;
- Assessing, maintaining and certifying the track;
- Undertaking the track adjustments based on the recommendations of the Technical Committee (refer to **Section 9.2**);
- Providing a direct point of contact with ARTC; and
- Completing the actions specified within the Longwall Action Plans (refer to **Section 10**).

The Railway Operators, Pacific National (PN) and Freightliner (FL), are responsible for:

- Operating the trains (i.e. speed restrictions or stoppages) in accordance with the recommendations of the Technical Committee (refer to **Section 9.2**); and
- Completing the actions specified within the Longwall Action Plans (refer to **Section 10**).

9.2 Technical committee

The role of the Technical Committee (TC) is to:

- Review the potential risks to the Railway and its associated infrastructure;
- Review the potential risks to the coal loading infrastructure;
- Develop the appropriate monitoring and management strategies;
- Review and interpret the monitoring data;
- Assess the current status (i.e. trigger levels) based on the monitoring data;
- Forecast the potential status for exceedance of trigger levels prior to the next status report;
- Provide status reports; and
- Provide recommendations on monitoring and management.

The representatives of the TC include:

- MGO – Shane Holmes / Josh Kowalczyk;
- Integra Underground – Chloe Piggford / Evert Smit;
- Laing O’Rourke – Mark Hill / Antoine Aubin;
- PCE – Allan Pidgeon (when required by the TC for assessment of the railway);
- MSEC – James Barbato;
- Lynton Surveys – Craig Banks / Robert Pinkerton;
- GHD - Tim Furney (when required by TC for assessment of the bridges); and
- ALS – Patrick Torok (when required by TC for assessment of TLO and reclaim conveyor).

The TC will meet in person or via teleconference at regular intervals during mining. The committee members will provide a status report and recommendations, where relevant, during active subsidence in accordance with the Longwall Action Plans (refer to **Section 10**).

The regular status report will include:

- The longwall extraction face position;
- Summary of the monitoring (ground, rail strain and temperature, track geometry and visual);
- Discussions on any identified irregular ground movements or unexpected behaviour; and
- The current status (i.e. trigger levels) and forecast of potential exceedance of trigger levels.

The recommendations from the TC may include:

- Changes to monitoring frequency based on the rate of development of subsidence and/or longwall extraction rate;
- Additional monitoring and/or investigations that a required when irregular or unexpected ground movements develop; and
- Track adjustments to maintain the rail stress within the prescribed triggers.

9.3 Trigger levels

The trigger levels have been divided into four categories, which relate to the safe operation of the Railway, as shown in **Table 9-1**.

Table 9-1 - Trigger levels and actions

Trigger	Action
Green	Observations within operating tolerance. Operate as normal.
Blue	Observations within operating tolerance but nearing limits. Investigate cause. Some action may be required to prevent operating restrictions. Immediately inspect site unless it is obvious that the cause of the trigger cannot be due to physical damage to rail infrastructure. Otherwise inspect within 24 hours. Return status to Green level.
Yellow	Restrictions on operations. Immediate inspection required. Appropriate speed restriction may apply until altered to Green or Blue Level.
Red	Stop trains, inspect prior to next train, repair to lower category, pilot trains if safe.

The Yellow and Red triggers are directly related to the safe operation of the Railway and are linked to ARTC rail safety standards. The triggers are consistent with those adopted for the extraction of longwalls beneath the Main Southern Railway at Appin and Tahmoor Collieries. The actions have been slightly amended to suit the Railway which comprises low frequency and low speed trains operating on a privately owned and managed track.

The Blue trigger level is designed to provide an early warning to provide adequate time to assess and respond and is not linked to NSW rail safety standards. The TC can review the adequacy of the Blue trigger level during mining and adjust as agreed, without updating this management plan.

A Grey trigger has also been introduced to notify loss of communications from the continuous monitoring system for the rail stress and temperature.

Trigger levels are included in the Trigger Action Response Plans (TARPs) provided in **Section 11**.

9.4 Communications and response

A diagrammatic flowchart for communication and response following the exceedance of automated triggers is shown in **Figure 9-1**. More detailed flowcharts for the red, yellow, blue and grey triggers are provided in **Figure 9-2** to **Figure 9-5**.

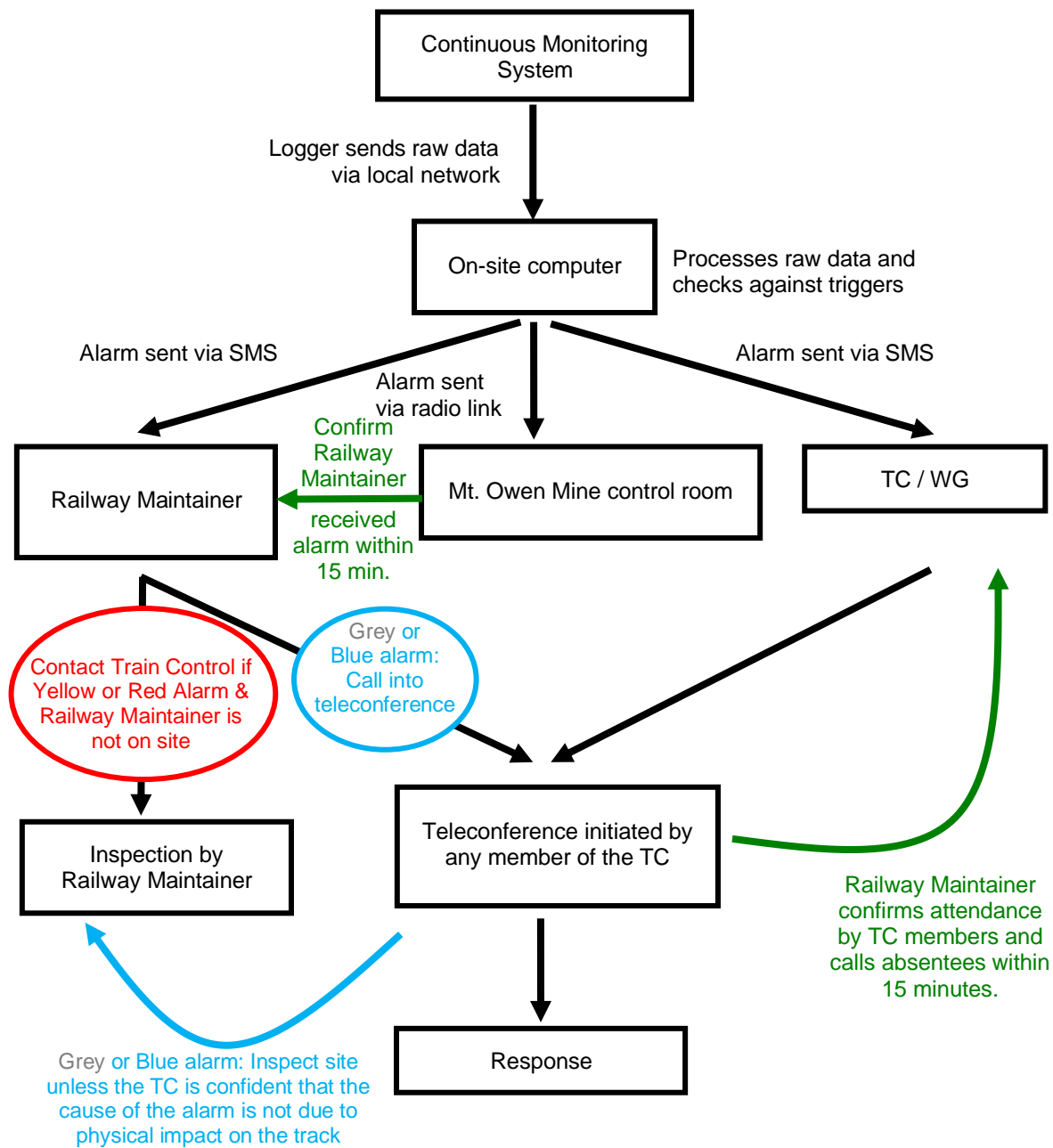


Figure 9-1 Communication and response flowchart following an exceedance of an automated trigger

It is appreciated that the Railway Maintainer may not have reached site before the TC meets via a teleconference if the status of the monitoring system was at GREEN level before the trigger. While the Railway Maintainer is travelling to the site, it is likely that the TC will have assessed the monitoring data and undertaken action, which may include a resolution to reconvene the teleconference after the Railway Maintainer reaches site. Upon inspection, the Railway Maintainer may initiate action if impacts are observed and report the findings of the inspection and any action undertaken to the TC.

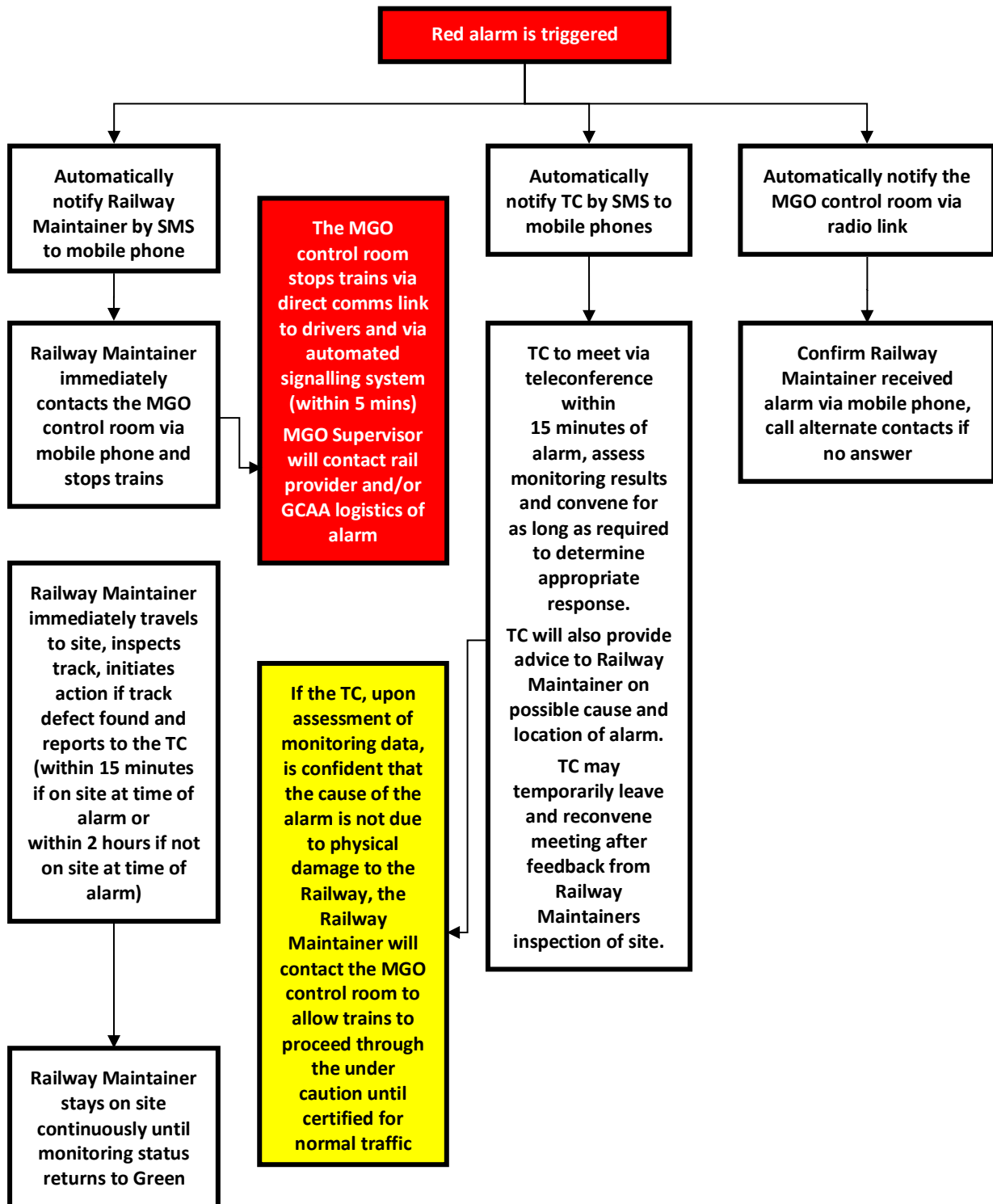


Figure 9-2 Flowchart showing response to a Red Alarm



Figure 9-3 Communication and response flowchart following an exceedance of an automated trigger

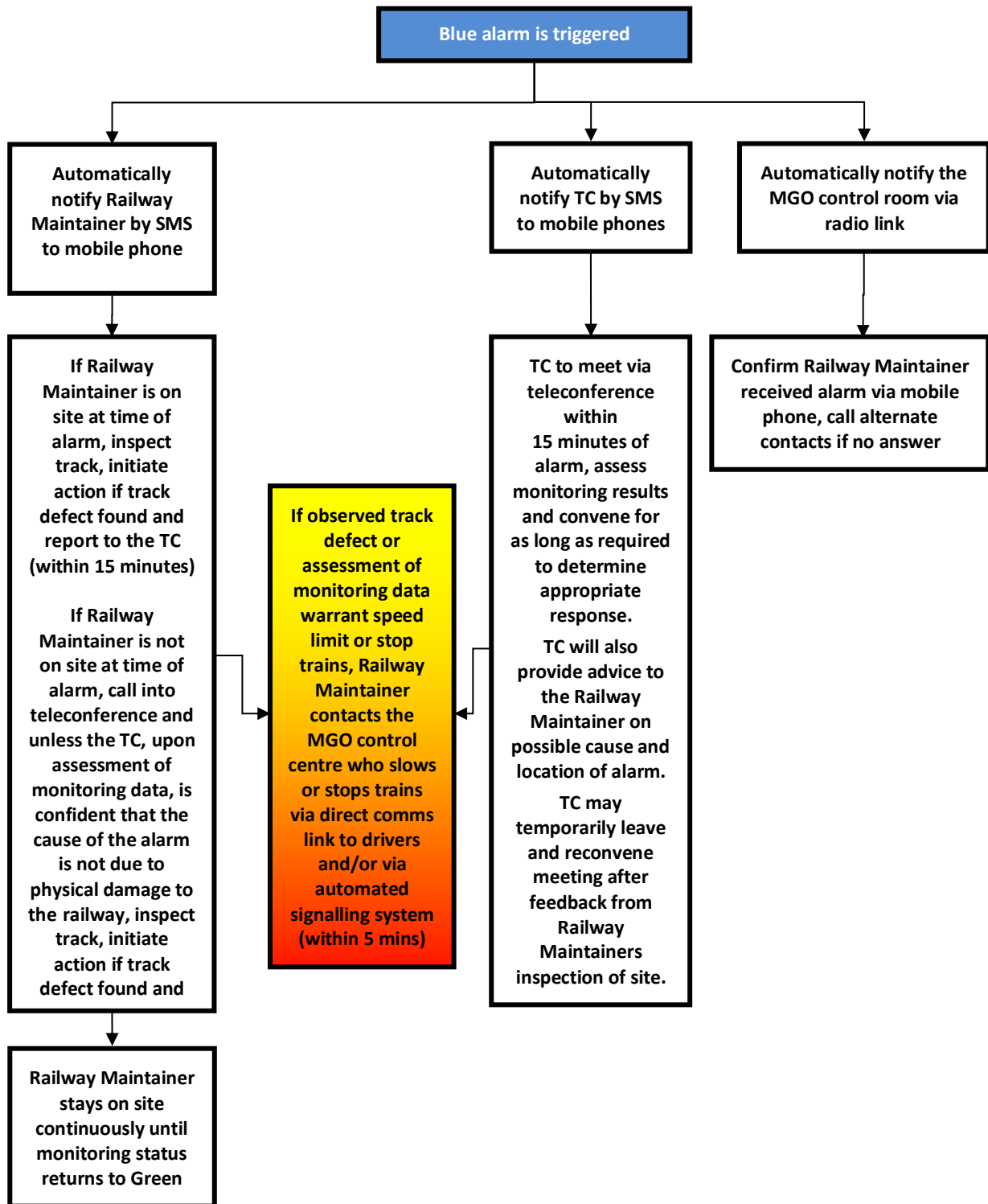


Figure 9-4 Flowchart showing response to a Blue Alarm

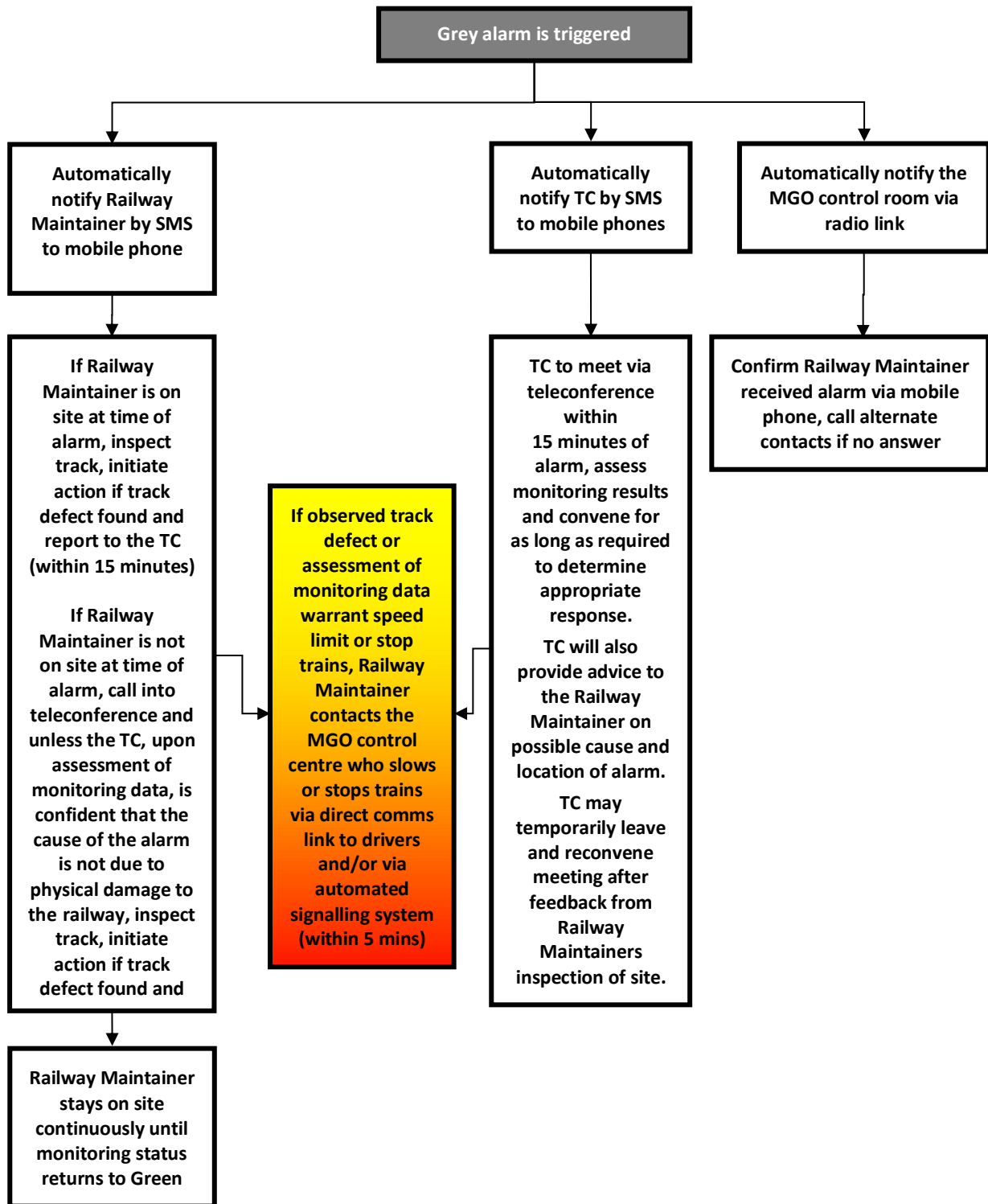


Figure 9-5 Flowchart showing response to a Grey Alarm

A summary of the notifications for the trigger alarms is provided in **Table 9-2**.

Table 9-2 - Notifications for the trigger alarms

Member	Notification			
	Grey	Blue	Yellow	Red
Integra Underground Mine	✓	✓	✓	✓
Mt. Owen Glendell Operations (MGO)	✓	✓	✓	✓
Laing O'Rourke (LO)	✓	✓	✓	✓
Pacific National (PN) and Freightliner (FL)	x	x	x	✓
Pidgeon Civil Engineering (PCE)	✓	✓	✓	✓
Lynton Surveys (LS)	✓	✓	✓	✓

A summary of the details for the primary and alternative contacts for each stakeholder and expert consultant is provided in **Table 9-3**.

Table 9-3 – Contact list

Stakeholder	Primary contact	Alternate contact
Integra Underground (Proponent)	Chloe Piggford Ph: (02) 6577 4200 Mob: 0427 928 906 Chloe.Piggford@glencore.com.au	Evert Smit Ph: (02) 6577 4200 Mob: 0419 766 819 Evert.Smit@glencore.com.au
MGO (Railway owner)	Shane Holmes Ph: (02) 6570 0880 Mob: 0414 608 040 Shane.Holmes@glencore.com.au	Josh Kowalczuk Ph: (02) 6570 0864 Mob: 0427 580 979 Josh.Kowalczuk@glencore.com.au
MGO (Coal loading infrastructure)	Ian Buffier Ph: (02) 6520 2659 Mob: 0418 405 765 Ian.Buffier@glencore.com.au	Josh Kowalczuk Ph: (02) 6570 0864 Mob: 0427 580 979 Josh.Kowalczuk@glencore.com.au
Laing O'Rourke (Railway maintainer)	Mark Hill Mob: 0409 678 765 markhill@laingorourke.com.au	Antoine Aubin Ph: (02) 4913 7655 Mob: 0411 724 036 aaubin@laingorourke.com.au
Pacific National (Railway operator)	Renee Sharpe Ph: (07) 3002 3759 Mob: 0499 466 251 renee_sharpe@pacificnational.com.au	Brad Griffin Mob: 0427 748 792 brad_griffin@pacificnational.com.au
Freightliner (Railway operator)	Geoff Harragon Mob: 0409 881 323 geoff.harragon@gwrr.com	Ben Cribb Mob: 0418 841 460 ben.cribb@gwrr.com
PCE (Railway engineer)	Allan Pidgeon Ph: (02) 9566 4826 Mob: 0418 761 351 pce@bigpond.com	Contact Mark Hill if Allan Pidgeon is not available.

Stakeholder	Primary contact	Alternate contact
MSEC (Subsidence engineer)	James Barbato Ph: (02) 9413 3777 Mob: 0403 685 530 james@minesubsidence.com	Daryl Kay Ph: (02) 9413 3777 Mob: 0416 191 304 daryl@minesubsidence.com
Lynton Surveys (Ground and rail stress monitoring)	Craig Banks Mob: 0475 378 319 cbanks@lyntonsurveys.com.au	Robert Pinkerton Mob: 0401 291 637 rpinkerton@lyntonsurveys.com.au Liam Harkin Mob: 0487 400 604 lharkin@lyntonsurveys.com.au
ALS Global (Conveyor engineer)	Patrick Torok Mob: 0488 123 304 Patrick.Torok@alsglobal.com	To be provided to Technical Committee prior to LW19
GHD (Bridge engineer)	Tim Furney Mob: 0422 811 032 tim.furney@ghd.com	Jorge Pautasso Mob: 0403 038 504 jorge.pautasso@ghd.com
ARTC (Operator Main Northern Railway)	Sean Cumpson Mob: 0429 927 925 scumpson@artc.com.au	Upper Hunter Network Control (Emergency Contact only) Ph: (02) 4902 7970
ONRSR (National railway regulator)	Colin Holmes Ph: (02) 8263 7153 Mob: 0418 440 356 cholmes@transportregulator.nsw.gov.au	David James Ph: (08) 8406 1522 David.James@onrsr.com.au

10. Longwall Action Plans

The longwall actions plans are provided in:

- Table 10-1 – Longwall 17;
- Table 10-2 – Longwall 18;
- Table 10-3 – Longwall 19; and
- Table 10-4 – Longwall 20.

Table 10-1 Longwall 17 action plan – notification, governance, monitoring and reporting actions

			Indicative longwall chainage marks (not to scale)								
			1680 m	1425 m	1175 m	1025 m	925 m	685 m	435 m	0 m	
			Triggers								
			Commencement of longwall mining Longwall chainage 1680 m	500 m before first rail contact Longwall chainage 1425 m	250 m before first rail contact Longwall chainage 1175 m	100 m before first rail contact Longwall chainage 1025 m	First rail contact Longwall chainage 925 m	Last rail contact Longwall chainage 685 m	250 m past last rail contact Longwall chainage 435 m	End of longwall mining Longwall chainage 0 m	3 months after end of longwall mining
Requirements	Responsibility	Notes	Actions								
Governance											
Notify longwall progress	IUG		Monthly	Monthly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	
Technical Group Meeting	MGO (TC)		As required	Monthly	Monthly	Weekly	Weekly	Weekly	Weekly	As required	
Mitigation measures											
Initial track SFT adjustment	MGO (RM)		Track adjustment and baseline								
Initial rail expansion switch inspection	MGO (RM)		Adjust rail expansion switch (if required)								
Initial bridge inspection	MGO (RM)		Bridge inspection and adjustment (if required)								
Ground monitoring											
PH-Line	MGO (RM)	MGO (TC) to review monitoring frequency based on monitoring results and longwall extraction rate	Extend line			Weekly	Weekly	Weekly	As required	Final survey	
Bridge 3D marks	MGO (RM)		Inspect marks			As required	As required	As required	As required	As required	
Coal loading infrastructure monitoring (GNSS)	MGO (RM)	MGO (TC) to review data based on monitoring results and longwall extraction rate	Install GNSS & Monthly			Monthly	Monthly	Monthly	Monthly	As required	Final survey
Trolley monitoring											
	MGO (RM)		Base survey			As required	As required	As required	As required	As required	
Rail stress monitoring											
Stress and temperature	MGO (RM)		Install gauges			Real time	Real time	Real time	Real time	Real time	Real time
Alarms for rail stress	MGO (RM)		Verify system			On	On	On	On	As required	As required
Visual inspections											
Track	MGO (RM)	MGO (TC) to review monitoring frequency based on monitoring results and longwall extraction rate	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	As required
Bridges	MGO (RM)		As required	As required	As required	As required	As required	As required	As required	As required	As required
Service road	MGO (MO)	Embankments, cuttings and culverts	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	As required
Structures	MGO (RM)		As required	As required	As required	As required	As required	As required	As required	As required	As required
Coal loading infrastructure	MGO (RM)	MGO (TC) to review inspection frequency based on monitoring results and longwall extraction rate	As required	As required	As required	As required	As required	As required	As required	As required	As required
Reporting											
	MGO (TC)	Monitoring, track, visual and summary reports	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	As required	EoP report	

Key:
 IUG - Integra Underground Mine RM - Rail Maintainer MO - Mine Operator
 MGO - Mt. Owen Glendell Operations RO - Rail Operator TC - Technical Committee

Table 10-2 Longwall 18 action plan – notification, governance, monitoring and reporting actions

Indicative longwall chainage marks (not to scale)				1465 m	1465 m	1375 m	1225 m	1125 m	860 m	610 m	0 m									
				Triggers																
				Commencement of longwall mining	Longwall chainage 1465 m	500 m before first rail contact	Longwall chainage 1465 m	250 m before first rail contact	Longwall chainage 1375 m	100 m before first rail contact	Longwall chainage 1225 m	First rail contact	Longwall chainage 1125 m	Last rail contact	Longwall chainage 860 m	250 m past last rail contact	Longwall chainage 610 m	End of longwall mining	Longwall chainage 0 m	3 months after end of longwall mining
Requirements	Responsibility	Notes	Actions																	
Governance																				
Notify longwall progress	IUG			Monthly		Weekly	Weekly	Weekly	Weekly	Weekly	Weekly									
Technical Group Meeting	MGO (TC)			Monthly		Monthly	Weekly	Weekly	Weekly	Weekly	Weekly									
Mitigation measures																				
Initial track SFT adjustment	MGO (RM)		Track adjustment and baseline																	
Initial rail expansion switch inspection	MGO (RM)		Adjust rail expansion switch (if required)																	
Initial bridge inspection	MGO (RM)	Not required for LW19																		
Ground monitoring																				
PH-Line	MGO (RM)	MGO (TC) to review monitoring frequency based on monitoring results and longwall extraction rate	Extend line and base survey				Weekly	Weekly	Weekly											Final survey
Bridge 3D marks	MGO (RM)	Not required for LW19																		
Coal loading infrastructure monitoring (GNSS and survey marks)	MGO (RM)	MGO (TC) to review monitoring frequency based on monitoring results and longwall extraction rate	Install survey marks, base survey & monthly	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly										Final survey
Trolley monitoring	MGO (RM)		Base survey		As required	As required	As required	As required	As required	As required	As required	As required	As required	As required	As required	As required	As required	As required	As required	As required
Rail stress monitoring																				
Stress and temperature	MGO (RM)		Install gauges and verify system		Real time	Real time	Real time	Real time	Real time	Real time	Real time	Real time	Real time	Real time	Real time	Real time	Real time	Real time	Real time	Real time
Alarms for rail stress	MGO (RM)				On	On	On	On	On	On	On	On	On	On	On	On	On	On	On	On
Visual inspections																				
Track	MGO (RM)	MGO (TC) to review monitoring frequency based on monitoring results and longwall extraction rate		Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly
Bridges	MGO (RM)	Not required for LW19																		
Service road	MGO (MO)	MGO (TC) to review monitoring frequency based on monitoring results and longwall extraction rate				Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly
Structures	MGO (RM)	Embankments, cuttings and culverts				Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly
Coal loading infrastructure	MGO (RM)	MGO (TC) to review inspection frequency based on monitoring results and longwall extraction rate		As required	As required	As required	As required	As required	As required	As required	As required	As required	As required	As required	As required	As required	As required	As required	As required	As required
Reporting	MGO (TC)	Monitoring, track, visual and summary reports					Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly

Key:
IUG - Integra Underground Mine RM - Rail Maintainer MO - Mine Operator
MGO - Mt. Owen Glendell Operations RO - Rail Operator TC - Technical Committee

Table 10-4 Longwall 20 action plan – notification, governance, monitoring and reporting actions

**Integra Underground
Asset Management Plan**

Mt. Owen Railway Infrastructure Longwalls 17 to 20

Indicative longwall chainage marks (not to scale)				1315 m	1315 m	1315 m	1315 m	1315 m	930 m	680 m	0 m	
			Triggers	Commencement of longwall mining Longwall chainage 1315 m	500 m before first rail contact Longwall chainage 1315 m	250 m before first rail contact Longwall chainage 1315 m	100 m before first rail contact Longwall chainage 1315 m	First rail contact Longwall chainage 1315 m	Last rail contact Longwall chainage 930 m	250 m past last rail contact Longwall chainage 680 m	End of longwall mining Longwall chainage 0 m	3 months after end of longwall mining
Requirements	Responsibility	Notes	Actions									
Governance												
Notify longwall progress	IUG											
Technical Group Meeting	MGO (TC)											
Mitigation measures												
Initial track SFT adjustment	MGO (RM)		▲ Track adjustment and baseline									
Initial rail expansion switch inspection	MGO (RM)		▲ Adjust rail expansion switch (if required)									
Initial bridge inspection	MGO (RM)	Not required for LW20										
Ground monitoring												
PH-Line	MGO (RM)	MGO (TC) to review monitoring frequency based on monitoring results and longwall extraction rate	▲ Extend line, base survey & weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	As required		Final survey ▲
Bridge 3D marks	MGO (RM)	Not required for LW20										
Coal loading infrastructure monitoring (GNSS and survey marks)	MGO (RM)	MGO (TC) to review monitoring frequency based on monitoring results and longwall extraction rate	▲ Base survey & weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Monthly	As required		Final survey ▲
Trolley monitoring	MGO (RM)		▲ Base survey	As required	As required	As required	As required	As required	As required	As required		
Rail stress monitoring												
Stress and temperature	MGO (RM)		Install Gauges and Verify system	Real time	Real time	Real time	Real time	Real time	Real time	Real time	Real time	Real time
Alarms for rail stress	MGO (RM)			On	On	On	On	On	On	On	As required	As required
Visual inspections												
Track	MGO (RM)	MGO (TC) to review monitoring frequency based on monitoring results and longwall extraction rate		Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	As required
Bridges	MGO (RM)	Not required for LW20										
Service road	MGO (MO)	MGO (TC) to review monitoring frequency based on monitoring results and longwall extraction rate		Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	As required
Structures	MGO (RM)	Embankments, cuttings and culverts		Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	As required
Coal loading infrastructure	MGO (RM)	MGO (TC) to review inspection frequency based on monitoring results and longwall extraction rate		As required	As required	As required	As required	As required	As required	As required	As required	As required
Reporting	MGO (TC)	Monitoring, track, visual and summary reports		Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	As required	EoP report ▲

Key:
 IUG - Integra Underground Mine RM - Rail Maintainer MO - Mine Operator
 MGO - Mt. Owen Giendell Operations RO - Rail Operator TC - Technical Committee

Number: INTUG-793190785-3021

Status: Submitted for Approval

Effective: TBA

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Owner: Environment and Community Manager

Version: 1.0

Review: TBA

Uncontrolled unless viewed on the intranet

11. Trigger Action Response Plans

The Trigger Action Response Plans (TARPs) are provided in:

- Table 11-1 – track geometry;
- Table 11-2 – rail stress;
- Table 11-3 – expansion switch displacement;
- Table 11-4 – signal line;
- Table 11-5 – bridges; and
- Table 11-6 – coal loading infrastructure.

Table 11-1 TARP for track geometry

<p>Risk issue</p>	<p>Track geometry exceeds ARTC National Code of Practice resulting in:</p> <ul style="list-style-type: none"> • unplanned maintenance response; • temporary speed restrictions; • track closure; or • derailment. <p>The track geometry triggers are based on a maximum operating speed of 20 km/h along the Railway.</p>		
<p>Trigger Action Response Plan</p>	<p>Green</p>	<p>Blue</p>	<p>Yellow</p>
	<p>Difference from design cant: 0 mm to < 40 mm (tangents and radius > 2000 m) 0 mm to < 14 mm (radius < 2000 m)</p> <p>Twist: 0 mm to < 18 mm (2 m chord) 0 to < 46 mm (14 m chord)</p> <p>Top, mid-ordinate vertical deviation from design offset: 0 mm to < 14 mm (4 m chord) 0 mm to < 56 mm (20 m chord)</p> <p>Mid-ordinate horizontal deviation from design offset: 0 mm to < 34 mm (10 m chord)</p>	<p>Difference from design cant: ≥ 40 mm to < 50 mm (tangents and radius > 2000 m) ≥ 14 mm to < 20 mm (radius < 2000 m, insufficient cant) ≥ 14 mm to < 50 mm (radius < 2000 m, excess cant)</p> <p>Twist: ≥ 18 mm to < 20 mm (2 m chord) ≥ 46 mm to < 52 mm (14 m chord)</p> <p>Top, mid-ordinate vertical deviation from design offset: ≥ 14 mm to < 16 mm (4 m chord) ≥ 56 mm to < 66 mm (20 m chord)</p> <p>Mid-ordinate horizontal deviation from design offset: ≥ 34 mm to < 45 mm (10 m chord)</p>	<p>Difference from design cant: ≥ 50 mm to < 75 mm (tangents and radius > 2000 m) ≥ 20 mm to < 40 mm (radius < 2000 m, insufficient cant) ≥ 50 mm to < 75 mm (radius < 2000 m, excess cant)</p> <p>Twist: ≥ 20 mm to < 22 mm (2 m chord) ≥ 52 mm to < 60 mm (14 m chord)</p> <p>Top, mid-ordinate vertical deviation from design offset: ≥ 16 mm to < 19 mm (4 m chord) ≥ 66 mm to < 71 mm (20 m chord)</p> <p>Mid-ordinate horizontal deviation from design offset: ≥ 45 mm (10 m chord)</p>
<p>Persons affected</p>	<p>Action / Response</p>	<p>Action / Response</p>	<p>Action / Response</p>
<p>-</p>	<p>Follow general procedures and action plan.</p>	<p>-</p>	<p>-</p>
<p>RM</p>	<p>-</p>	<p><u>Within 3 days</u> inspect track in location of exceedance.</p>	<p><u>Within 24 hours</u> contact control room and inspect track at trigger point. Trains to proceed with caution.</p>
<p>Integra Underground</p>	<p>-</p>	<p><u>Within 3 days</u> contact TC and arrange teleconference.</p>	<p><u>Within 24 hours</u> contact TC and arrange teleconference.</p>
<p>TC</p>	<p>-</p>	<p><u>Within 1 week</u> TC to undertake the following actions:</p> <ul style="list-style-type: none"> • investigate the cause; • assess monitoring data for trends and forecast if and/or when the YELLOW trigger level might be exceeded; • consider whether to increase survey and/or inspection frequencies; • consider whether to resurface the track; and • consider whether any other additional management measures are required. 	<p><u>Within 24 hours</u>, TC to undertake the following actions:</p> <ul style="list-style-type: none"> • investigate the cause; • assess monitoring data for trends and forecast the expected total movement; • consider whether to increase survey and/or inspection frequencies; • consider whether to resurface the track; and • consider whether any other additional management measures are required.

Table 11-2 TARP for rail stress

Risk issue	<p>Rail stress exceeds SFT triggers resulting in:</p> <ul style="list-style-type: none"> unplanned maintenance response; temporary speed restrictions; track closure; or derailment. <p>(<i>Note:</i> triggers based on all concrete sleepers)</p>			
Trigger Action Response Plan	Green	Blue	Yellow	Red
	Normal state	<p>Rail SFT triggers: Lower SFT: 28°C Upper SFT: 46°C</p> <p>Rail stress triggers: Lower stress: -83.3 MPa Upper stress: +114.2 MPa</p>	<p>Rail SFT triggers: Lower SFT: 24°C Upper SFT: 48°C</p> <p>Rail stress triggers: Lower stress: -92.8 MPa Upper stress: +123.8 MPa</p>	<p>Tail SFT triggers: Lower SFT: 22°C Upper SFT: 50°C</p> <p>Rail stress triggers: Lower stress: -97.6 MPa Upper stress: +128.5 MPa</p>
Persons affected	Action / Response	Action / Response	Action / Response	Action / Response
-	Follow general procedures and action plan.	-	-	-
RM	-	<u>Within 3 days</u> inspect track in location of exceedance.	<u>Within 24 hours</u> contact control room and inspect track at trigger point. Trains to proceed with caution.	<u>As soon as practical</u> stop trains and implement mandatory responses as required. Inspect track at trigger location.
Integra Underground	-	<u>Within 24 hours</u> contact TC and arrange teleconference.	<u>Within 15 minutes</u> contact TC and arrange teleconference.	<u>Within 15 minutes</u> contact TC and arrange teleconference <u>Within 24 hours</u> report trigger exceedance and TC recommendations to RR, ARTC and ONSRS.
TC	-	<u>Within 24 hours</u> TC to undertake the following actions: <ul style="list-style-type: none"> investigate the cause; assess monitoring data for trends and forecast if and/or when the YELLOW and RED trigger levels might be exceeded; consider whether to increase survey and/or inspection frequencies; consider whether to undertake a track adjustment; and consider whether any other additional management measures are required. 	<u>Within 15 minutes</u> TC to undertake the following actions: <ul style="list-style-type: none"> investigate the cause; assess monitoring data for trends and forecast if and/or when the RED trigger level might be exceeded; consider whether to undertake a track adjustment; consider whether to resurface the track; and consider whether any other additional management measures are required. 	<u>Within 15 minutes</u> TC to undertake the following actions: <ul style="list-style-type: none"> investigate the cause; consider whether trains can proceed under supervision; consider whether to undertake a track adjustment; consider whether any additional management measures are required; and consider whether to introduce speed restrictions until track adjustment has been completed.
PCE	-	-	-	<u>Within 1 week</u> report details of trigger exceedance and actions undertaken.

Table 11-3 TARP for the expansion switch displacement

Risk issue	<p>Expansion switch fails resulting in:</p> <ul style="list-style-type: none"> • unplanned maintenance response; • speed restrictions; • track closure; or • derailment. <p>or</p> <p>Expansion switch operational limits reached due to excessive differential subsidence movements resulting in:</p> <ul style="list-style-type: none"> • intervention on track; or • speed restrictions. <p><i>(Note: triggers are based on a Type 5 expansion switch)</i></p>			
Trigger Action Response Plan	Green	Blue	Yellow	Red
	Normal state	<p>Switch displacement: Centre ≤ -135 mm (opening) Centre ≥ 135 mm (closure)</p>	<p>Switch displacement: N/A due to stop blocks</p>	<p>Switch displacement: N/A due to stop blocks</p>
Persons affected	Action / Response	Action / Response	Action / Response	Action / Response
-	Follow general procedures and action plan.	-	-	-
RM	-	Within 3 days inspect ground in location of switch.	-	-
Integra Underground	-	Within 24 hours contact TC and arrange teleconference.	-	-
TC	-	<p>Within 24 hours TC to undertake the following actions:</p> <ul style="list-style-type: none"> • investigate the cause; • assess monitoring data for trends and forecast if and/or when the YELLOW and RED trigger levels might be exceeded; • consider whether to increase survey and/or inspection frequencies; • consider whether to undertake a switch adjustment; and • consider whether any other additional management measures are required. 	-	-

Table 11-4 TARP for the signal line

Risk issue	Irregular ground movement along signal line resulting in: <ul style="list-style-type: none"> • damage of cables; or • wrong side failure. (Note: triggers are based on strain measured along PH-Line)			
	Trigger Action Response Plan	Green	Blue	Yellow
Persons affected	Action / Response	Action / Response	Action / Response	Action / Response
-	Follow general procedures and action plan.	-	-	-
RM	-	Within 1 week inspect ground in location of exceedance.	Within 24 hours contact control room and inspect track at trigger point. Trains to proceed with caution.	As soon as practical stop trains and implement mandatory responses as required. Inspect track at trigger location
Integra Underground	-	Within 1 week contact TC and arrange teleconference.	Within 24 hours contact TC and arrange teleconference.	Within 15 minutes contact TC and arrange teleconference Within 3 days report trigger exceedance and TC recommendations to RR, ARTC and ONSRS.
TC	-	Within 1 week TC to undertake the following actions: <ul style="list-style-type: none"> • investigate the cause; • assess monitoring data for trends and forecast if and/or when the YELLOW and RED trigger levels might be exceeded; • consider whether to increase survey and/or inspection frequencies; • consider whether to unbury and expose the signal line; and • consider whether any other additional management measures are required. 	Within 24 hours TC to undertake the following actions: <ul style="list-style-type: none"> • investigate the cause; • assess monitoring data for trends and forecast if and/or when the RED trigger level might be exceeded; • consider whether to undertake a track adjustment; • consider whether to unbury and expose the signal line; and • consider whether any other additional management measures are required. 	Within 15 minutes TC to undertake the following actions: <ul style="list-style-type: none"> • investigate the cause; • consider whether trains can proceed under supervision; • consider whether to unbury and expose the signal line; and • consider whether any additional management measures are required; and • consider whether to introduce speed restrictions until signal line is unburied and inspected.
PCE	-	-	-	Within 1 week report details of trigger exceedance and actions undertaken

Table 11-5 TARP for the Bridges

Risk issue	Differential movements exceed capacity of expansion joints resulting in: <ul style="list-style-type: none"> • loss of bearing; or • increase in stress in the decks and abutments. 		
Trigger Action Response Plan	Green	Monitoring review point trigger	
	Normal state	Bridge triggers (3D survey marks and PH-Line)	
		Parameter	Movement
		Differential horizontal movement between abutments in longitudinal direction	40 mm opening 75 mm closure
		Differential horizontal movement between abutments in transverse direction (i.e. shear)	25 mm
Differential vertical movement between abutments (i.e. vertical step)	25 mm		
Differential transverse tilt between abutments (i.e. longitudinal twist)	1 mm/m		
Persons affected	Action / Response	Action / Response	
-	Follow general procedures and action plan.	-	
RM	-	<u>Within 3 days</u> structural engineer to inspect Bridges and provide recommendations for required preventive works such as: <ul style="list-style-type: none"> • packing between the decks and abutments; • tying the decks to the abutments using steel dowels; and • repair of cracks. <u>Within 1 week</u> undertake the necessary preventive works as recommended by the structural engineer and TC	
Integra Underground	-	<u>Within 24 hours</u> contact TC and arrange teleconference <u>Within 1 week</u> report trigger exceedance and TC recommendations to RR, ARTC and ONSRS.	
TC	-	<u>Within 3 days</u> TC to undertake the following actions: <ul style="list-style-type: none"> • review the monitoring data and assess for trends; • consider whether to increase survey and/or inspection frequencies; • review of the recommendations from the structural engineer; and • consider whether any other additional management measures are required. 	

Table 11-6 TARP for the coal loading infrastructure

<p>Risk issue</p>	<p>Differential movements exceed capacity of conveyor resulting in:</p> <ul style="list-style-type: none"> increase in stress in the conveyor or support structure. <p>or</p> <p>Tilt of the load cell results in:</p> <ul style="list-style-type: none"> incorrect measurement of train load. 		
<p>Trigger Action Response Plan</p>	<p>Green</p>	<p>Monitoring review point trigger</p>	
	<p>Normal state</p>	<p>Conveyor triggers</p>	
		<p style="text-align: center;">Parameter</p>	<p style="text-align: center;">Movement</p>
		<p>Absolute horizontal movement of coal loading infrastructure (GNSS)</p>	<p>100 mm</p>
		<p>Differential horizontal movement between conveyor supports (3D survey marks)</p>	<p>5 mm</p>
<p>Vertical subsidence at coal loading infrastructure (PH-Line or 3D survey marks)</p>	<p>20 mm</p>		
<p>Tilt of load cell (tilt-meter)</p>	<p>0.2 mm/m</p>		
<p>Persons affected</p>	<p>Action / Response</p>	<p>Action / Response</p>	
<p>-</p>	<p>Follow general procedures and action plan.</p>	<p>-</p>	
<p>Integra Underground</p>	<p>-</p>	<p><u>Within 24 hours</u> contact TC and arrange teleconference.</p> <p><u>Within 3 days</u> structural engineer / conveyor maintainer to inspect coal loading infrastructure and provide recommendations for required preventive works such as:</p> <ul style="list-style-type: none"> adjustment of conveyor at supports to increase tolerance; other preventive works (and advise whether the conveyor should be temporarily stopped until completion of any such works); and recalibration of the load cell. <p><u>Within 1 week</u> undertake the necessary preventive works as recommended by the structural engineer, conveyor maintainer and TC</p>	
<p>TC</p>	<p>-</p>	<p><u>Within 3 days</u> TC to undertake the following actions:</p> <ul style="list-style-type: none"> review the monitoring data and assess for trends; consider whether to increase survey and/or inspection frequencies; review of the recommendations from the structural engineer / conveyor maintainer; and consider whether any other additional management measures are required. 	

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Appendix C - Mount Owen Glendell Operations Key Features Asset Management Plan

INTEGRA UNDERGROUND

GLENCORE



Mt Owen Glendell Operations Key Features Longwalls 17 to 20 Asset Management Plan

Number: INTUG-793190785-3020
Owner: Environment and Community Manager

Status: Submitted for Approval
Version: 3.0

Effective: TBA
Review: TBA

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1. Purpose

This Asset Management Plan (AMP) has been prepared to manage the forecast subsidence impacts to select surface infrastructure and built features of the Mt Owen Glendell Operations (MGO) mines from the planned mining of Longwalls 17 to 20 at the Integra Underground mine. All surface land and infrastructure in the vicinity of Longwalls 17 to 20 is owned by Glencore and not readily accessible to the general public.

The objective of this AMP is to comply with or assist in:

- The requirements of the *Work Health and Safety (Mines and Petroleum Sites) Regulation 2014*, to manage risks to health and safety of workers and other persons from subsidence by developing specific control measures.
- The requirements of subsidence performances measures in Project Approval 08_0101 for the Integra Underground Project, to manage potential impacts and consequences from subsidence on any built features to maintain them in a safe, serviceable and repairable condition, unless the owner agrees otherwise in writing.
- The Extraction Plan requirements of PA 08_0101 for *Built Features Management Plans* and to be consistent with Department of Planning, Industry and Environment (DPIE) draft guideline for the preparation of Extraction Plans – Version 5 (DPIE Guideline) including consideration of the reporting framework requirements.
- The implementation of risk control measures developed during a risk assessment for the Longwalls 17 to 20 Extraction Plan.

2. Scope

This AMP applies to personnel employed by or on behalf of both MGO and Integra Underground. This document is structured to provide details of:

- Surface infrastructure or built features;
- Risk Assessment;
- Predicted subsidence effects, impacts and environmental consequences;
- Relevant subsidence performances measures;
- Performance indicators;
- Remediation measures;
- Responsibilities;
- Monitoring of subsidence impacts and environmental consequences;
- Monitoring of remediation measures;
- Trigger action response plans;
- Adaptive management; and
- Contingency plans.

The MGO infrastructure items or built features within the scope of this AMP include:

- Water Pipelines (raw water, mine water and surface run-off water management);
- Powerlines;
- Mt Owen – North Pit (highwall and haul road);
- Ravensworth East – West Pit tailings pit (highwall);
- Glendell Haul Road;
- Eastern Rail Pit (ERP);
- Mt Owen Rail Loop Tailings Dam (TP1);
- Mt Owen Stage 5/Ravensworth East Tailings Dam (TP2) (Note: Nil tailings);
- Overburden emplacement areas (West Dump; Ravensworth East/Glendell);
- Sediment control dams; and
- Access roads and four-wheel drive tracks.

Figure 1-1 shows these surface features relative to the planned mining of Longwalls 17 to 20.

The more subsidence sensitive infrastructure within the Mt Owen Railway Line corridor will be managed under the *Mt Owen Railway Infrastructure Asset Management Plan* for Longwalls 17 to 20. This includes the train loading infrastructure at the Mine Infrastructure Area.

3. Planning

A subsidence assessment (SCT 2020), that includes forecasting subsidence effects and impacts, has been prepared as part of the process of the Extraction Plan for Longwalls 17 to 20. SCT (2020) provides a description of the infrastructure items or built features listed in **Section 2**. Prior to the preparation of the subsidence assessment, a surface inspection and risk assessment (RA) were conducted on site.

3.1 Risk Assessment

The risk assessment process is based on a preliminary forecast of subsidence effects, the identification of all surface features likely to be affected by subsidence and a preliminary assessment of impacts to these features. The assessment team consisted of subsidence specialists (with site experience) as well as management and engineering personnel from both MGO and Integra Underground. The risk assessment can be found in **Appendix A** of the *Extraction Plan for Longwalls 17 to 20*.

The select infrastructure items or built features owned and operated by MGO within the scope of this AMP are a subset of the complete list considered in the RA. That is, some items covered in the RA that are owned and operated by Integra Underground are not included in the scope of this AMP. Further, the *Mt Owen Railway Infrastructure Asset Management Plan* includes infrastructure related to the Mt Owen Railway Line corridor.

For the infrastructure items or built features within the scope of this AMP, the highest risk rating determined was for the Mt Owen - North Pit highwall. This risk rating was assessed as medium. This feature is included in the *Mt Owen Geotechnical Principal Hazard Management Plan*.

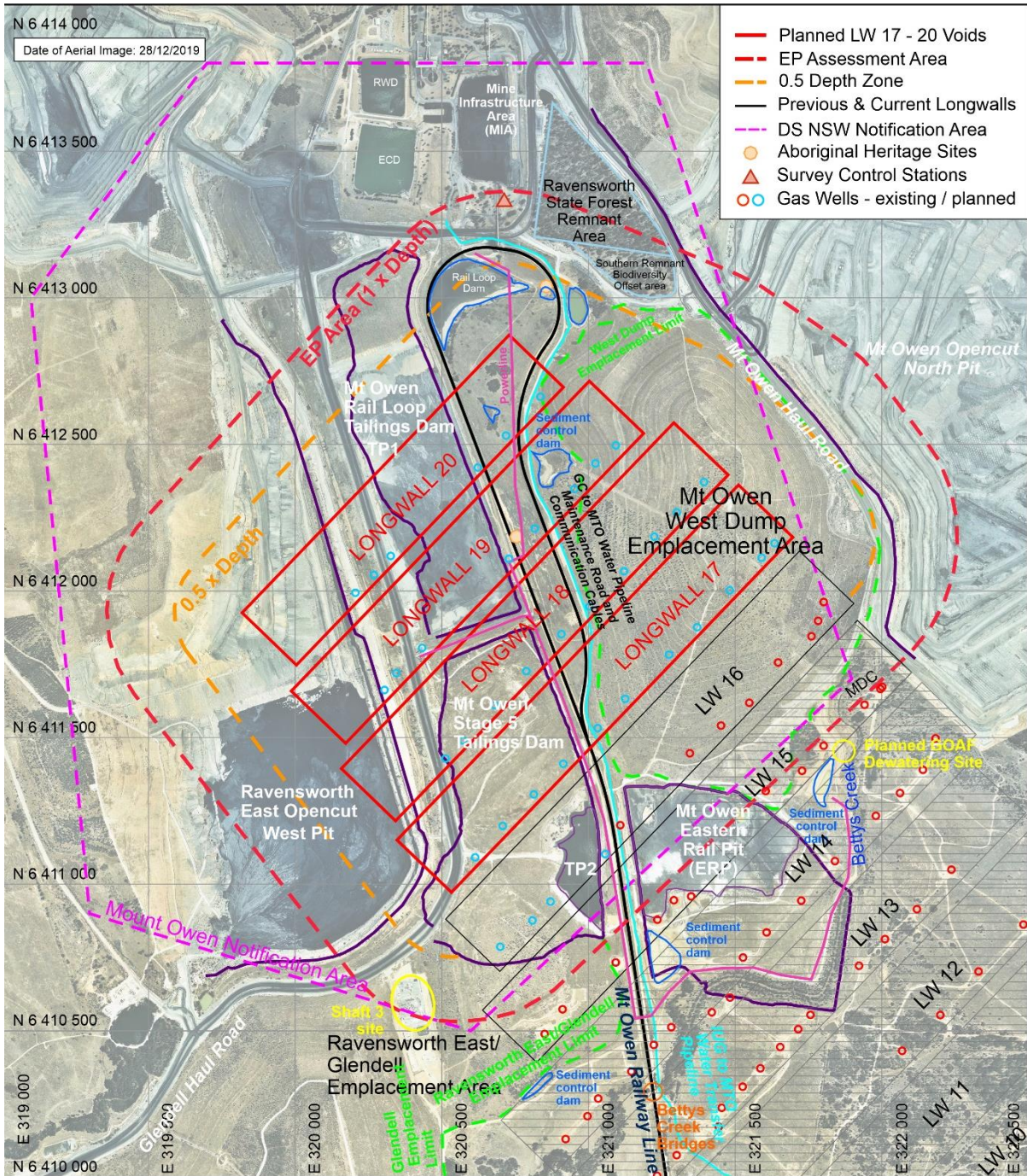


Figure 1-1: Subsidence, EP Area and Major surface Features

Other items rated as medium risk are overburden emplacement areas (West Dump) and built surface water features (e.g. drainage channels).

A summary of the risk control measures developed in consultation with the asset owner (i.e. MGO) to address these risk ratings, are included in **Table 5-1**. These control measures are based on site experience and practical operational requirements.

The program for implementation of risk control measures and responsibilities is detailed in **Sections 4 and 5**.

3.2 Subsidence Assessment

The following sections detail the forecast of subsidence effects and the expected subsidence impacts from the planned mining of Longwalls 17 to 20 are presented in the subsidence assessment (SCT 2020).

3.2.1 Forecast Subsidence Effects

Table 3-1 shows the estimate of primary subsidence parameters for conventional subsidence from the mining of Longwalls 17 to 20 (SCT, 2020).

Table 3-1 - Primary Conventional Subsidence Parameters for Longwalls 17 to 20

Panel	Maximum Subsidence (m)	Maximum Tilt (mm/m)	Maximum Tensile Strain (mm/m)	Maximum Compressive Strain (mm/m)
Natural/Undisturbed Ground (e.g. Rail Loop Corridor)				
LW17	2.0	14	7	10
LW18	2.0	14	7	10
LW19	2.0	14	7	10
LW20	2.0	14	7	10
Areas of Waste Rock Emplacement (e.g. TP1, TP2, ERP, West Pit, West Dump)				
LW17	2.5	14	14	20
LW18	2.5	14	14	20
LW19	2.5	14	14	20
LW20	2.5	14	14	20

Greater vertical subsidence is expected in areas where overburden has been modified by previous surface mining activities. Subsidence above areas filled with waste rock is expected to increase with increasing thickness of waste rockfill. The estimates of maximum vertical subsidence over waste rock emplacements with the EP Area of Longwalls 17 to 20 are less than forecast in SCT (2017) for Modification 8 (Mod 8) to PA 08_0101. None of the subsidence impacts anticipated for the listed surface features are particularly sensitive to specific values of maximum vertical subsidence, tilt or strain (SCT, 2020).

3.2.2 Expected Subsidence Impacts

Subsidence impacts to the listed surface infrastructure or built features are expected to be effectively managed with appropriate management plans in place (SCT, 2020). The control measures for the listed surface infrastructure or built features are provided in **Section 4**.

In general, the consequences of subsidence impacts to features within the substantially modified surface landform in the vicinity of Longwalls 17 to 20 are expected to be minor and insignificant for all practical purposes (SCT, 2020). Any impacts are not expected to be out of context with general hazards associated with normal operation. These hazards are routinely managed.

3.3 Subsidence

Table 3-2 provides a summary of the subsidence performance measures for built features from PA 08_0101 and assessment of expected compliance for the planned mining of Longwalls 17 to 20 from SCT (2020).

Table 3-2 - Subsidence performance measure for built features and assessment of expected compliance

Subsidence Performance Measures			Status of compliance expected for Longwalls 17 to 20
Built Features	All built features (except those fully covered by an operative contractual arrangement with another mine owner or other owner of the relevant built feature)	Safe, serviceable, and repairable unless the owner agrees otherwise in writing, including: <ul style="list-style-type: none"> • Serviceability should be maintained wherever practicable; • Loss of serviceability must be fully compensated; and • Damage must be fully repaired or replaced, or else compensated 	Compliance expected (with management plans and controls in place) because no greater subsidence effects for natural ground compared to Integra Underground Project EA. Common ownership (Glencore) of assets.

3.4 Performance Indicators

Maximum vertical subsidence for single seam extraction is recognised to be naturally variable by about $\pm 15\%$ for any given panel geometry and overburden depth. To prevent triggering mandatory reporting and incident investigation processes for events that are of no practical consequence, performance indicators for conventional subsidence behaviour are recommended to exceed the expected natural variability by a small margin. Performance indicators for quantitative items such as primary subsidence parameters (vertical subsidence, tilt and strains) should be based on a 20% increase of the maximum values forecast to account for the expected natural variability of 15% (SCT, 2020).

For qualitative measures such as condition of the feature after subsidence impacts two subsidence trigger levels have been established to guide responses within the TARP (see **Section 5.3**):

- 1 – When impacts exceed predictions by less than 20% (low risk); and
- 2 – When impacts exceed predictions by more than 20% (medium/ high risk).

The setting of performance indicators is based on the reporting framework of the DPIE Guideline. The guideline requires reporting of impacts to be clearly distinguished between those which are within predictions, those which exceed predictions but remain within performance measures and/or performance indicators, and those which exceed performance measures and/or performance indicators.

4. Implementation

Implementation of this AMP is dependent on consultation and agreement between Integra Underground and MGO management representatives regarding the monitoring actions and acceptance of the expected subsidence impacts and consequences.

4.1 Roles and Responsibilities

Technical Services Managers for both Integra Underground and MGO are responsible for the implementation of this plan. Personnel for both Integra Underground and MGO are involved in the inspection and reporting protocols outlined in this plan. Regular and timely communications between Integra Underground and MGO are critical for the effective management of subsidence impacts (including personal safety and equipment damage) and environmental consequences.

The MGO Technical Services Manager is responsible for mitigation measures prior to the active subsidence zone affecting the surface feature. Similarly, the MGO Technical Services Manager is responsible for remediation measures or other actions deemed appropriate after impacts requiring actions are identified.

Daily surface inspections are the responsibility of the MGO personnel including open cut examiner (OCE) and operator inspections in operational areas. These inspections are only required when there are surface activities within the active subsidence zone.

Weekly inspections are the responsibility of Integra Underground Environment and Community Department within the Integra Underground access areas (in consultation with the Integra Underground Technical Services Manager).

4.2 Overview of Risk Control Measures

Consistent with the risk assessment outcomes, control measures to be implemented to manage risks to health and safety include:

- Awareness of potential subsidence impacts through:
 - Communication of mining progress and inspection findings between Integra Underground and MGO.
 - The use of subsidence warning signs.
- Mitigation and remediation measures such as:
 - Installation of roller sheaves for conductors on powerlines.
 - Timely response to any impacts.
- Operation controls during period of active subsidence such as:
 - Consideration of suspension or reduction of operations.
 - Limiting access to potential hazards e.g. TP1 and areas near ERP, TP2 and West Pit highwalls.
- Monitoring against baseline:
 - Regular visual inspections.
 - Survey measurements.

Active zone of subsidence is generally defined as an area within half depth of the active longwall face (for Longwalls 17 to 20 this is 170-300m) recognising that around 90% of total subsidence is likely to have occurred within this distance and the rate of subsidence movements subsequently reduced. For practical purposes, subsidence from each longwall is expected to be complete within 500m of the longwall face.

Inspections to identify subsidence impacts and the results of remediation measures in the active zone of subsidence also include consideration of previously remediated areas to maintain these in a safe and acceptable condition.

5. Management, Monitoring, Evaluation and Response

The primary monitoring planned are visual inspections and survey measurements. These will be evaluated against the expected subsidence effects and impacts with appropriate management responses. Responses are detailed in the trigger action response plans (TARPs) in **Section 5.2**.

The weekly visual inspections of subsidence monitoring are to be recorded on a standard form to assist in the reporting required by the DPIE Guideline. The standard form shall include:

- Date and time of inspection.
- Longwall number and face position (chainage or reference mark).
- Observations (plan/sketch and photographic evidence if applicable) of the status and change to:
 - Subsidence and surface deformations including:
 - any surface cracking or steps.
 - any surface humps.
 - any tilting and changes in grade.
 - any slope instability.
 - any highwall instability.
 - any ponding.
 - Any other general comments for each of the items covered by this AMP and within the Extraction Plan Assessment Area.
- Provision for checking on the status of previous remediation measures.

5.1 Management and Monitoring

Table 5-1 details the infrastructure or built features, expected subsidence impacts, existing risk control measures or planned mitigation measures, monitoring frequencies with responsibilities and remediation actions.

Table 5-1 - Subsidence management measures for Longwalls 17 to 20

Infrastructure item or Built Feature	Expected Subsidence Impact	Existing Risk Control Measures or planned Mitigation Measure	Monitoring frequency (and Responsibility)	Remediation or other Actions
Water Pipelines (raw water, mine water and surface run off water)	Impacts unlikely to above ground pipelines No significant impacts to buried pipelines, consistent with previous site experience	Double sleeved (for high risk pipelines in environmentally sensitive areas) (MGO; INT) Differential flow monitoring (for high risk pipelines in environmentally sensitive areas) (MGO; INT)	Inspections when pipelines in use during active subsidence (MGO) Weekly Inspections during active subsidence (Integra Underground)	Program repairs will be undertaken if required based on condition, size and location. All repairs will be undertaken in line with Integra remediation procedures.
Powerlines	No significant impacts	Installation of roller sheaves for conductors and managing guy wire and stay tensions at change of direction during active subsidence (MGO) Review of conductor ground clearances prior to active subsidence (MGO)	Weekly inspections during active subsidence (Integra Underground)	Program repairs will be undertaken if required based on condition, size and location. All repairs will be undertaken in line with Integra remediation procedures.
Mt Owen – North Pit (highwall and haul road)	No significant impacts No practical consequences	Warning signs (MGO)	OCE inspections during active subsidence (MGO) Geotechnical observations and reporting during active subsidence (MGO)	Program repairs will be undertaken if required based on condition, size and location. All repairs will be undertaken in line with Integra remediation procedures.
Ravensworth East – West Pit (highwall)	Cracking No significant consequences	Warning signs (MGO) Restrict access to top and bottom edge of highwall during the periods of active subsidence (MGO)	Survey measurements of the subsidence movements around the top edge of highwall pre and post mining of each Longwall panel (LW17-19) (Integra Underground)	Program repairs will be undertaken if required based on condition, size and location. All repairs will be undertaken in line with Integra remediation procedures. Restrict access to areas affected if required

Infrastructure item or Built Feature	Expected Subsidence Impact	Existing Risk Control Measures or planned Mitigation Measure	Monitoring frequency (and Responsibility)	Remediation or other Actions
Glendell Haul Road	Cracking and changes in grade Potential ponding Compression humps	Warning signs (MGO)	OCE inspections during active subsidence (MGO)	Program repairs will be undertaken if required based on condition, size and location. All repairs will be undertaken in line with Integra remediation procedures. Other actions will be undertaken if required (e.g. speed restrictions)
ERP	No significant impacts	Warning signs (MGO) Restrict access to bottom and top edge of highwalls during the periods of active subsidence (MGO) Reduce water level in pit during period of active subsidence (MGO) Suspend any operations in pit during period of active subsidence (MGO)	Weekly inspections during active subsidence from Longwall 17 and 18 (Integra Underground)	Program repairs will be undertaken if required based on condition, size and location. All repairs will be undertaken in line with Integra remediation procedures. Restrict access to areas affected if required
TP1	No practical impacts Cracking of surface of the tailings and capping material present at time of mining Potential ponding	Draw down of any ponded water to a low level during active subsidence (MGO) Review of potential overflow points following completion of each longwall panel (MGO) Review of final landform design to allow for predicted subsidence profile (MGO)	Weekly inspections during active subsidence (Integra Underground) Lidar survey at end of each longwall (MGO) Ground monitoring on quarterly basis (MGO)	Program repairs will be undertaken if required based on condition, size and location. All repairs will be undertaken in line with Integra remediation procedures. Restrict access to areas affected if required

Infrastructure item or Built Feature	Expected Subsidence Impact	Existing Risk Control Measures or planned Mitigation Measure	Monitoring frequency (and Responsibility)	Remediation or other Actions
TP2	No significant impacts	Warning signs (MGO) Restrict access to top edge of highwall during the periods of active subsidence (MGO)	Weekly inspections during active subsidence from Longwalls 17 and 18 (Integra Underground)	Program repairs will be undertaken if required based on condition, size and location. All repairs will be undertaken in line with Integra remediation procedures. Permanently restrict access to areas affected if required
Overburden emplacement areas	Cracking Minor instability of slopes or steeper ground (if water ingress) Potential changes to contour drains grades	Warning signs (MGO) Baseline review of contour drain grades and post active subsidence (MGO)	Weekly inspections during active subsidence (Integra Underground)	Program repairs will be undertaken if required based on condition, size and location. All repairs will be undertaken in line with Integra remediation procedures.
Sediment control dams	Minor surface cracking and changes in level (temporary)	Warning signs (MGO)	Weekly inspections during active subsidence (Integra Underground)	Program repairs will be undertaken if required based on condition, size and location. All repairs will be undertaken in line with Integra remediation procedures.
Access roads and four-wheel drive tracks	Minor cracking, compression humps and changes in grade Potential ponding	Warning signs (MGO)	Weekly inspections during active subsidence (Integra Underground)	Program repairs will be undertaken if required based on condition, size and location. All repairs will be undertaken in line with Integra remediation procedures.

5.2 Evaluation and Response

Any impacts observed will be assessed according to the likely consequences and the results communicated to those affected.

The results of the monitoring will be communicated at the monthly Integra Underground and MGO interaction meetings or, in the event of unexpected outcomes, as soon as practical after these outcomes have been identified. The TARP shown in **Table 5-2** is to be used as a guide to the level of response required.

5.3 Reporting Requirements

The DPIE Guideline for Extraction Plans requires bi-monthly subsidence impact reporting of new impacts with reference to performance measures and/or indicators, six-monthly reporting of all impacts and environmental monitoring results including reference to TARPs and assessment of compliance with performance measures and indicators.

An annual review based on six-monthly reports and a summary of subsidence effects is also required by the reporting framework of the DPIE guidelines. This will be included in the Annual Review prepared to meet the requirements of PA 08_0101 Schedule 5 Condition 11.

Incident reporting will be carried out in accordance with PA 08_0101 Schedule 5 Condition 9.

Table 5-2 – TARP for Mt Owen Glendell Mines Key Features

Conditions	<ul style="list-style-type: none"> • Subsidence • Cracking • Steps • Humps 	<ul style="list-style-type: none"> • Tilting • Slope stability • Highwall stability 	<ul style="list-style-type: none"> • Ponding • Impact to water supply or environmental risk • Impact to power supply
Normal State	<p><i>Normal – Generally in accordance with or less than expected subsidence effects and impacts. Continued implementation of Extraction Plan for LW 17 to 20.</i></p>		
Trigger Action Response Plan	Level 1 Trigger – Alert / Investigate	Level 3 Triggers – Stop – Withdrawal / Removal	
	Subsidence effects or impacts are greater than expected, and less than performance indicators.	Major exceedance of expected subsidence effects or impacts (i.e. greater than performance indicators)	
Persons affected	Action / Response	Action / Response	
Integra Underground Technical Services Manager	<ul style="list-style-type: none"> • Liaison with stakeholder (i.e. MGO). • Consideration and implementation of additional mitigation and remediation measures (Note: Only required if personal safety, equipment damage, environmental or operational issue). • Include in subsidence reporting. • Determine if an incident has occurred. 	<ul style="list-style-type: none"> • Liaison with stakeholder (i.e. MGO) • Review of subsidence effects and impacts. • Consideration and implementation of additional mitigation and remediation measures as required. • Report incident in accordance with PA 08_0101 Schedule 5 Condition 9. • Continued implementation of Subsidence Monitoring Program. • Include in subsidence reporting. 	
Mt Owen Technical Services Manager	<ul style="list-style-type: none"> • Implementation of additional mitigation and remediation measures (Note: Only required if personal safety, equipment damage, environmental or operational issue). 	<ul style="list-style-type: none"> • Implementation of remedial measures as required. • Continued implementation of Subsidence Monitoring Program. 	

6. Review and Improvement

This AMP should be reviewed at the completion of each longwall panel, after subsidence monitoring results are reviewed and analysed, to confirm the management strategies and procedures are suitable to meet expectations.

The regular inspections and reporting communications essential to this AMP provide the opportunity for an adaptive management process from the learnings of the monitoring. This adaptive management could involve a review of the mitigation and remediation measures required to achieve the expected subsidence management outcomes.

In the event of subsidence impacts regularly exceeding subsidence predictions and performance measures by a significant margin, a contingency plan may be required. It is envisaged any such contingency plan would be based a revised risk assessment incorporating the improved understandings of the magnitude of subsidence effects and impacts gained from the previous monitoring undertaken as part of this AMP.

7. Document Information

Relevant legislation, standards and other reference information must be regularly reviewed and monitored for updates and should be included in the site management system. Related documents and reference information in this section provides the linkage and source to develop and maintain site compliance information.

7.1 Related Documents

Related documents, listed in **Table 7-1 below**, are *documents* directly related to or referenced from within this document.

Table 7-1 – Related documents

Number	Title
INTUG-793190785-3013	Extraction Plan Longwalls 17 to 20

7.2 Reference Information

Reference information, listed in **Table 7-2 below**, is *information* that is directly referred to for the development of this document.

Table 7-2 – Reference information

Reference	Title
SCT (2020)	Subsidence Assessment for LW 17-20 Extraction Plan
SCT (2017)	Subsidence Assessment for Mod 8
DPIE	Extraction Plan Guidelines

7.3 Change Information

Full details of the document history are recorded in the document control register, by version. A summary of the current change is provided in **Table 7-3** below.

Table 7-3 – Change information

Version	Date	Change Details
1.0	August 2020	New document for Extraction Plan LW 17 to 20
2.0	January 2021	Updated Extraction Plan LW 17 to 20 based on DPIE feedback
3.0	February 2021	Updated Extraction Plan LW 17 to 20 based on further DPIE feedback

Appendix D - Subsidence Management Protocol

Integra Underground and Mt Owen Glendell Operations Responsibilities for Subsidence Management

Item	Details	Responsibility
Weekly visual inspection on longwall surface	As per Subsidence Inspection Form	Integra Underground Environment & Community Department
Survey of subsidence monitoring pegs	Within Integra Underground Project Approval Area	Integra Underground Surveyors
	Outside of Integra Project Approval Boundary	Mt Owen Glendell Operations Surveyor (Coordination by Integra Underground Surveyors)
LiDAR	As per Extraction Plan	Mt Owen Glendell Operations Surveyors (Analysis by Integra Underground Environment & Community Department)
Monitoring and maintenance required under Mount Owen Rail Infrastructure Asset Management Plan	Coordination of railway monitoring and maintenance, and Technical Review Committee	Mt Owen Glendell Operations Technical Services Manager (Participation by other MGO Departments and Integra Underground as required)
Mt Owen active mining area / overburden emplacement / high wall	As per Extraction Plan	Mt Owen Glendell Operations Technical Services Manager (In liaison with Thiess)
Monitoring of Bettys Creek	As per Extraction Plan	Integra Underground Environment & Community Department
Mount Owen Glendell and Integra Underground Interaction Meeting	Discussion including longwall progression, subsidence observed and mitigation methods, including responsibilities for actions	Mount Owen Glendell Operations Technical Services Manager (Participation by relevant representatives from Integra Underground, MGO and Thiess)
Remediation of surface subsidence impacts	Railway	Mount Owen Glendell Operations CHPP Manager
	Access tracks	Integra Underground Technical Services Manager
	Gas drainage infrastructure	Integra Underground Technical Services Manager
	Power lines and other Mt Owen Glendell infrastructure	Mount Owen Glendell Operations Technical Services Manager
	Mount Owen Glendell overburden emplacements, including contour drains, drop structures and dams	Mount Owen Glendell Operations Technical Services Manager
	General surface impacts observed	Integra Underground Environment and Community Manager
Subsidence reporting	As per Extraction Plan	Integra Underground

Note: To be implemented in accordance with Extraction Plan, including monitoring programs and TARPs.