UG1 LONGWALLS 101 TO 103 BUILT FEATURES MANAGEMENT PLAN
AUSTRALIAN RAIL TRACK CORPORATION

<table>
<thead>
<tr>
<th>Version</th>
<th>Issue Date</th>
<th>Approval Date</th>
<th>Description</th>
<th>Author(s)</th>
<th>Review Team</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>September 2017</td>
<td>September 2017</td>
<td>Approved</td>
<td>MCO and MSEC</td>
<td>Environmental Department</td>
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</tbody>
</table>

Approved: S. Archinal

Date: 21/9/2017
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<td>MCO_BFMP_ARTC</td>
<td>1</td>
<td>Sept 2017</td>
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<td>Sept 2018</td>
<td>MCO</td>
<td>S. Archinal</td>
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1.0 INTRODUCTION

The Moolarben Coal Complex is an open cut and underground coal mining operation located approximately 40 kilometres north of Mudgee in the Western Coalfield of New South Wales (NSW) (Figure 1).

Moolarben Coal Operations Pty Ltd (MCO) is the operator of the Moolarben Coal Complex on behalf of the Moolarben Joint Venture (Moolarben Coal Mines Pty Ltd [MCM], Sojitz Moolarben Resources Pty Ltd and a consortium of Korean power companies). MCO and MCM are wholly owned subsidiaries of Yancoal Australia Limited.

The UG1 Underground Mine is a component of the approved Moolarben Coal Complex (Figure 2). The UG1 Underground Mine commenced first workings in April 2016 and is scheduled to commence secondary workings (longwall extraction) in October 2017 by longwall mining methods from the Ulan Seam within Mining Lease (ML) 1605, ML 1606, ML 1628, ML 1691 and ML 1715 (Figure 3).

Mining operations at the Moolarben Coal Complex are currently approved until 31 December 2038 and would continue to be carried out in accordance with Project Approval (05_0117) (Moolarben Coal Project Stage 1) as modified and Project Approval (08_0135) (Moolarben Coal Project Stage 2) as modified, granted under the NSW Environmental Planning and Assessment Act, 1979 (EP&A Act).

This UG1 Longwalls 101 to 103 Built Features Management Plan – Australian Rail Track Corporation (LW101-103 BFMP-ARTC) forms a part of the Extraction Plan being developed for Longwalls 101 to 103 (herein referred to as Longwalls 101-103) of the approved UG1 Underground Mine.

1.1 PURPOSE AND SCOPE

Purpose: This LW101-103 BFMP-ARTC outlines the management of potential subsidence impacts of the proposed secondary workings described in the Extraction Plan on the existing Sandy Hollow Gulgong Railway.

Scope: This LW101-103 BFMP-ARTC covers the section of the Sandy Hollow Gulgong Railway in the vicinity of the Study Area¹, which relates to the extent of subsidence effects resulting from the secondary extraction of Longwalls 101-103 (Figure 4). This LW101-103 BFMP-ARTC will be reviewed and updated, prior to the secondary extraction of Longwalls 104 and 105.

¹ Longwalls 101-103 and the area of land within the furthest extent of the 26.5 degree (°) angle of draw and 20 millimetres (mm) predicted subsidence contour. The Australian Rail Track Corporation (ARTC) assets are not located within the Study Area.

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<td>MCO_BFMP_ARTC</td>
<td>1</td>
<td>Sept 2017</td>
<td>Sept 2017</td>
<td>Sept 2018</td>
<td>MCO</td>
<td>S. Archinal</td>
</tr>
</tbody>
</table>
Figure 1

Source: NSW Land & Property Information (2015); NSW Department of Industry (2016); Office of Environment and Heritage NSW (2016)
Source: MSEC (2016)

Figure 4
1.2 SUITABLY QUALIFIED AND EXPERIENCED PERSONS

In accordance with Condition 5(a), Schedule 4 of Project Approval (08_0135), the suitably qualified and experienced persons that have prepared this LW101-103 BFMP-ARTC, namely representatives from Mine Subsidence Engineering Consultants (MSEC) and MCO were endorsed by the Secretary of the Department of Planning and Environment (DP&E).

This LW101-103 BFMP-ARTC has been prepared in consultation with the ARTC (Section 4.4).

A list of the key responsibilities of MCO personnel in relation to this LW101-103 BFMP-ARTC, and a list of key contacts is provided in Section 11.

1.3 STRUCTURE OF THE LONGWALLS 101-103 BFMP-ARTC

The remainder of the LW101-103 BFMP-ARTC is structured as follows:

Section 2: Describes the review and update of the LW101-103 BFMP-ARTC.
Section 3: Outlines the statutory requirements applicable to the LW101-103 BFMP-ARTC.
Section 4: Provides baseline data, extraction schedule, revised assessment of the potential subsidence impacts and environmental consequences for Longwalls 101-103, as well as the outcomes of the risk assessment.
Section 5: Details the performance measures relevant to ARTC assets.
Section 6: Describes the monitoring program.
Section 7: Describes the management measures that will be implemented.
Section 8: Details the performance indicators that will be used to assess against the performance measures.
Section 9: Provides a contingency plan to manage any unpredicted impacts and their consequences.
Section 10: Describes the Trigger Action Response Plan (TARP) management tool.
Section 11: Describes the roles and responsibilities for MCO personnel and key contacts.
Section 12: Describes the program to collect sufficient baseline data for future Extraction Plans.
Section 13: Describes the Annual Review, audits, regular reporting and improvement of environmental performance.
Section 14: Outlines the management and reporting of incidents.
Section 15: Outlines the management and reporting of complaints.
Section 16: Outlines the management and reporting of non-compliances with statutory requirements.
Section 17: Lists the references cited in this LW101-103 BFMP-ARTC.
2.0 LONGWALLS 101 TO 103 BFMP-ARTC REVIEW AND UPDATE

In accordance with Condition 5, Schedule 6 of Project Approval (08_0135), this LW101-103 BFMP-ARTC will be reviewed within three months of the submission of:

- an Annual Review under Condition 4, Schedule 6;
- an incident report under Condition 7, Schedule 6;
- an audit under Condition 9, Schedule 6; or
- any modification to the conditions of Project Approval (08_0135) or Project Approval (05_0117) (unless the conditions require otherwise); and

if necessary, revised to the satisfaction of the Secretary of the DP&E to ensure the plan is updated on a regular basis and to incorporate any recommended measures to improve environmental performance. Where this review leads to revisions to the LW101-103 BFMP-ARTC, then within four weeks of the review, the revised LW101-103 BFMP-ARTC will be submitted to the Secretary of the DP&E for approval.

2.1 ACCESS TO INFORMATION

In accordance with Condition 11, Schedule 6 ‘Access to Information’, MCO will make the approved LW101-103 BFMP-ARTC publicly available on the MCO website.
3.0 STATUTORY REQUIREMENTS

MCO’s statutory obligations are contained in:

- the conditions of the NSW Project Approval (05_0117) (as modified) and NSW Project Approval (08_0135) (as modified);
- the conditions of Commonwealth Approvals (EPBC 2007/3297, EPBC 2013/6926 and EPBC 2008/4444);
- relevant licences and permits, including conditions attached to the Environment Protection Licence (EPL) No. 12932 and MLs (i.e. ML 1605, ML 1606, ML 1628, ML 1691 and ML 1715); and
- other relevant legislation.

Obligations relevant to this LW101-103 BFMP-ARTC are described below.

3.1 EP&A ACT APPROVAL

Condition 5(g), Schedule 4 of Project Approval (08_0135) requires the preparation of a Built Features Management Plan as a component of the Extraction Plan. In addition, Conditions 3, 5(n), 5(p) and 6, Schedule 4 and Condition 3, Schedule 6 of Project Approval (08_0135) outline general management plan requirements that are applicable to the preparation of this LW101-103 BFMP-ARTC.

Table 1 presents these requirements and indicates where they are addressed within this LW101-103 BFMP-ARTC.
<table>
<thead>
<tr>
<th><strong>Table 1: Management Plan Requirements</strong></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Condition 3, Schedule 4</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Notes:</strong></td>
</tr>
<tr>
<td>...</td>
</tr>
<tr>
<td>- The Proponent will be required to define more detailed performance indicators for each of these performance measures in Built Features Management Plans or Public Safety Management Plan (see condition 5 below).</td>
</tr>
<tr>
<td>- Measurement and/or monitoring of compliance with performance measures and performance indicators is to be undertaken using generally accepted methods that are appropriate to the environment and circumstances in which the feature or characteristic is located. These methods are to be fully described in the relevant management plans. In the event of a dispute over the appropriateness of proposed methods, the Secretary will be the final arbiter.</td>
</tr>
<tr>
<td>...</td>
</tr>
<tr>
<td>- Requirements under this condition may be met by measures undertaken in accordance with the Mine Subsidence Compensation Act 1961.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Condition 5(g), Schedule 4</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>(g) include a Built Features Management Plan, which has been prepared in consultation with DRE and the owners of affected public infrastructure, to manage the potential subsidence impacts and/or environmental consequences of the proposed second workings, and which:</td>
</tr>
<tr>
<td>- addresses in appropriate detail all items of key public infrastructure and other public infrastructure and all classes of other built features;</td>
</tr>
<tr>
<td>- has been prepared following appropriate consultation with the owner/s of potentially affected feature/s;</td>
</tr>
<tr>
<td>- recommends appropriate remedial measures and includes commitments to mitigate, repair, replace or compensate all predicted impacts on potentially affected built features in a timely manner; and</td>
</tr>
<tr>
<td>- in the case of all key public infrastructure, and other public infrastructure except roads, trails and associated structures, reports external auditing for compliance with ISO 31000 (or alternative standard agreed with the infrastructure owner) and provides for annual auditing of compliance and effectiveness during extraction of longwalls which may impact the infrastructure;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Condition 5(n), Schedule 4</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>(n) include a contingency plan that expressly provides for adaptive management where monitoring indicates that there has been an exceedance of any performance measure in Tables 18 and 19, or where any such exceedance appears likely;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Condition 5(p), Schedule 4</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>(p) include a program to collect sufficient baseline data for future Extraction Plans.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Condition 6, Schedule 4</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>6. The Proponent shall ensure that the management plans required under conditions 5(g)-(l) above include:</td>
</tr>
<tr>
<td>(a) an assessment of the potential environmental consequences of the Extraction Plan, incorporating any relevant information that has been obtained since this approval; and</td>
</tr>
<tr>
<td>(b) a detailed description of the measures that would be implemented to remediate predicted impacts.</td>
</tr>
</tbody>
</table>
Table 1 (Continued): Management Plan Requirements

<table>
<thead>
<tr>
<th>Condition 3, Schedule 6</th>
<th>Project Approval (08_0135) Condition</th>
<th>LW101-103 BFMP-ARTC Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:</td>
<td></td>
<td>Sections 3 and 4.4</td>
</tr>
<tr>
<td>(a) detailed baseline data;</td>
<td></td>
<td>Section 4.1</td>
</tr>
<tr>
<td>(b) a description of:</td>
<td></td>
<td>Section 3</td>
</tr>
<tr>
<td>• the relevant statutory requirements (including any relevant approval, licence or lease conditions);</td>
<td></td>
<td>Section 5</td>
</tr>
<tr>
<td>• the relevant limits or performance measures/criteria;</td>
<td></td>
<td>Section 8</td>
</tr>
<tr>
<td>• the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;</td>
<td></td>
<td>Sections 7 &amp; 9</td>
</tr>
<tr>
<td>(c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(d) a program to monitor and report on the:</td>
<td></td>
<td>Sections 6, 8 &amp; 13</td>
</tr>
<tr>
<td>• impacts and environmental performance of the project;</td>
<td></td>
<td>Section 9</td>
</tr>
<tr>
<td>• effectiveness of any management measures (see c above);</td>
<td></td>
<td>Sections 6 &amp; 13</td>
</tr>
<tr>
<td>(e) a contingency plan to manage any unpredicted impacts and their consequences;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(f) a program to investigate and implement ways to improve the environmental performance of the project over time;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(g) a protocol for managing and reporting any:</td>
<td></td>
<td>Section 14</td>
</tr>
<tr>
<td>• incidents;</td>
<td></td>
<td>Section 15</td>
</tr>
<tr>
<td>• complaints;</td>
<td></td>
<td>Section 16</td>
</tr>
<tr>
<td>• non-compliances with statutory requirements; and</td>
<td></td>
<td>Section 9</td>
</tr>
<tr>
<td>• exceedances of the impact assessment criteria and/or performance criteria; and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(h) a protocol for periodic review of the plan.</td>
<td></td>
<td>Section 2</td>
</tr>
</tbody>
</table>

3.2 OTHER LEGISLATION

MCO will operate the Moolarben Coal Complex consistent with Project Approval (08_0135) and any other legislation that is applicable to an approved Part 3A Project under the EP&A Act.

The following Acts may be applicable to, but are not limited to, the conduct of the Moolarben Coal Complex:

- Crown Lands Act, 1989;
- Fisheries Management Act, 1994;
- Heritage Act, 1977;
- Mine Subsidence Compensation Act, 1961;
- Mining Act, 1992;
• National Parks and Wildlife Act, 1974;
• Biodiversity Conservation Act, 2016;
• Protection of the Environment Operations Act, 1997;
• Roads Act, 1993;
• Water Act, 1912;
• Water Management Act, 2000;
• Work Health and Safety Act, 2011; and

Relevant licences or approvals required under these Acts will be obtained as required.
4.0 SANDY HOLLOW GULGONG RAILWAY

4.1 BASELINE DATA

The Sandy Hollow Gulgong Railway owned by ARTC runs adjacent to Ulan-Wollar Road and is shown on Figure 4. The Sandy Hollow Gulgong Railway is located to the north and east of the Study Area and the nearest edge of the Longwalls 101-103 vary from approximately 380 metres (m) (Longwall 103) to 470 m (Longwall 101) from the rail track.

Drainage culverts are located along the Sandy Hollow Gulgong Railway, the largest of which is at Murragamba Creek crossing.

At these locations, the rail track and culverts will not be subjected to measureable systematic mine subsidence ground movement; however they may experience small far-field horizontal movements (Section 4.3).

4.2 LONGWALLS 101-103 EXTRACTION SCHEDULE

The Sandy Hollow Gulgong Railway is located to the north and east of the Study Area for Longwalls 101-103 (Figure 4) and may be subject to subsidence effects (i.e. low level far-field horizontal movements) (MSEC, 2016).

Longwalls 101-103 and the area of land within the furthest extent of the 26.5° angle of draw and 20 mm predicted subsidence contour (i.e. the Longwalls 101-103 Study Area) are shown on Figures 3 and 4. Longwall extraction will occur from the west to the east. The longwall layout includes approximately 311 m panel widths (void) with 20 m pillars (solid).

The provisional extraction schedule for Longwalls 101-103 is provided in Table 2.

<table>
<thead>
<tr>
<th>Longwall</th>
<th>Estimated Start Date</th>
<th>Estimated Duration</th>
<th>Estimated Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
<td>October 2017</td>
<td>10 months</td>
<td>August 2018</td>
</tr>
<tr>
<td>102 (A+B)</td>
<td>October 2018</td>
<td>12 months</td>
<td>October 2019</td>
</tr>
<tr>
<td>103</td>
<td>November 2019</td>
<td>10 months</td>
<td>September 2020</td>
</tr>
</tbody>
</table>
Following approval of the UG1 Optimisation Modification in April 2016, MCO has delineated a geological feature in Longwall 102 that prevents economic mining of this section, and has subsequently revised the longwall layout to incorporate a barrier pillar around this feature. The barrier pillar separating Longwalls 102A and 102B is approximately 140 m in length. In addition, following further detailed design, Longwalls 101-103 have been shortened by approximately 70 m to provide safe operational conveyor distance between the end of the longwalls and main headings. With the exception of these changes, the longwall geometry is the same as that for the approved UG1 Optimisation Modification, and MSEC (2017) concludes that the overall impact assessments for the natural and built features are unchanged or reduced.

4.3 REVISED SUBSIDENCE AND IMPACT PREDICTIONS

Subsidence and impact predictions for Longwalls 101-105 in relation to the ARTC assets was conducted by MSEC (2015) as part of the Moolarben Coal Complex UG1 Optimisation Modification Environmental Assessment (EA) and was summarised as follows:

The longwalls at the MCC are not passing under the railway line.

... 
At these distances between the panels and the railway track and based on these depths of cover, the rail track will not be subjected to measurable systematic mine subsidence ground movements; however, ... , the ground near the railway line may experience far field horizontal movements and possibly small valley upsidence and closure movements.

... 
These far-field horizontal movements generally do not result in impact at structures, except where they occur at large structures, such as railway lines, since these large structures can be very sensitive to differential horizontal movements. The predicted far-field horizontal movements of less than 70 mm at the railway track are expected to be bodily movements that are directed across the track towards the extracted goaf area and should be accompanied by very low levels of strain.

... 
The effects of this subsidence and the differential far field movements due to the proposed extraction of the UG1 longwalls on the Gulgong to Sandy Hollow Railway are very small and are unlikely to adversely impact on the railway line.

Revised subsidence and impact predictions specifically for the extraction of Longwalls 101-103 on ARTC assets were conducted by MSEC and reported in MSEC (2016) (Attachment 1). Subsequent to the preparation of MSEC (2016), the longwall layout was revised to incorporate a reduced longwall length and shorter barrier pillar (Section 4.2). MSEC (2017) includes updated subsidence predictions for the revised layout. As the asset is located further from Longwalls 101-103, a reduced impact is predicted by MSEC (2017) compared to MSEC (2016).
In relation to subsidence predictions, MSEC (2016; 2017) makes the following conclusions:

- Longwall extraction will not occur directly below the Sandy Hollow Gulgong Railway.
- At its nearest point, the Sandy Hollow Gulgong Railway is located approximately 380 to 470 m away from the end of the longwall panels.
- The railway line will not be subjected to measurable conventional vertical mine subsidence ground movements (i.e. less than survey accuracy limits).
- The railway line may be subject to low level far-field horizontal movements that are likely to be less than 60 mm.
- The existing open cut (OC1) will significantly reduce the potential for far-field movements.
- The presence of unconsolidated Tertiary sediments (in the north-east) should result in further reducing the potential for far-field movements to develop at the railway line.
- It is possible that a slight increase in compression could develop in the rail due to the curve near Longwall 101.
- It is recommended that a program of ground monitoring near the Sandy Hollow Gulgong Railway be implemented and monitoring and management strategies be developed.

4.4 RISK ASSESSMENT MEETING

In accordance with the Guidelines for the Preparation of Extraction Plans (DP&E and DRE, 2015), potential risks and potential risk control measures and procedures have been considered at a risk assessment for the ARTC infrastructure in the vicinity of Longwalls 101-103, held on 23 March 2017. Attendees at the risk assessment meeting included representatives from MCO, ARTC, MSEC, Resource Strategies and a risk assessment facilitator (AXYS Consulting Pty Ltd [AXYS]).

The investigation and analysis methods used during the risk assessment included (AXYS, 2017):

- Confirmation of relevant ARTC assets.
- Review of the revised subsidence predictions and potential impacts on ARTC assets (including consideration of past experience in the Western Coalfield).
- Consideration and discussion of the proposed monitoring program, management measures and contingency measures.
The following potential risks were identified during the risk assessment (AXYS, 2017):

- Longwall mining causes impacts to Sandy Hollow Gulgong Railway Infrastructure and MCO are required to compensate ARTC to make repairs.
- Longwall mining causes impacts to Sandy Hollow Gulgong Railway Infrastructure causes impacts to other rail users’ operations.

A number of risk control measures and procedures were identified prior to and during the risk assessment and are summarised as follows:

**Baseline Data / Validation**

1. Conduct a baseline survey and dilapidation audit of Sandy Hollow Gulgong Railway Infrastructure in the area that may be affected by the mining of Longwalls 101-103.
2. Installation of the subsidence monitoring program.

**Management / Monitoring / Response Measures**

3. Establish a key contacts list between MCO and ARTC to provide a regular update of status of mining activities, and for ongoing liaison.
4. Include in the LW101-103 BFMP-ARTC a schedule of times/frequency of communication with ARTC for the status of mining of Longwalls 101-103.
5. Develop a TARP and include triggers for conditions that may need to be actioned by MCO and/or ARTC.

MCO considers all risk control measures and procedures to be feasible to manage all identified risks.

The proposed risk control measures and procedures have been incorporated where relevant in this LW101-103 BFMP-ARTC and the program for implementation is summarised in Table 3.
Table 3: Program for Implementation of Proposed Risk Control Measures and Procedures

<table>
<thead>
<tr>
<th>Risk Control Measure / Procedure</th>
<th>LW101-103 BFMP-ARTC Section</th>
<th>Proposed Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline Data / Validation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Conduct a baseline survey and dilapidation audit of Sandy Hollow Gulgong Railway Infrastructure in the area that may be affected by the mining of Longwalls 101-103.</td>
<td>Section 6.2</td>
<td>Prior to Longwall 101</td>
</tr>
<tr>
<td>2 Installation of the subsidence monitoring program.</td>
<td>Section 6.2</td>
<td>Prior to Longwall 101</td>
</tr>
<tr>
<td><strong>Management / Monitoring / Response Measures</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Establish key contacts list in the LW101-103 BFMP-ARTC.</td>
<td>Section 11.1</td>
<td>Complete</td>
</tr>
<tr>
<td>4 Include in the LW101-103 BFMP-ARTC a schedule of times/frequency of communication with ARTC for the status of mining of Longwalls 101-103.</td>
<td>Section 7 and Table 6</td>
<td>Complete</td>
</tr>
<tr>
<td>5 Develop a TARP and include triggers for conditions that may need to be actioned by MCO and/or ARTC.</td>
<td>Section 10 and Attachment 2</td>
<td>Complete</td>
</tr>
</tbody>
</table>
5.0 PERFORMANCE MEASURES

The performance measures specified in Table 19, Schedule 4 of Project Approval (08_0135) relevant to the Sandy Hollow Gulgong Railway, as a built feature, are listed in Table 4.

Table 4: Built Features Subsidence Impact Performance Measures

<table>
<thead>
<tr>
<th>Feature</th>
<th>Subsidence Impact Performance Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key public infrastructure:</td>
<td></td>
</tr>
<tr>
<td>Gulgong-Sandy Hollow Railway Line</td>
<td>Always safe and serviceable. Damage that does not affect safety or serviceability must be fully repairable, and must be fully repaired.</td>
</tr>
</tbody>
</table>

Source: Table 19 in Schedule 4 of Project Approval (08_0135).

In accordance with Condition 3, Schedule 4 of Project Approval (08_0135), MCO must ensure that there is no exceedance of the performance measures listed in Table 19, to the satisfaction of the Secretary of the DP&E.

Section 6 outlines the monitoring that will be undertaken to assess the impact of Longwalls 101-103 against the performance measures in relation to the Sandy Hollow Gulgong Railway. Management measures for the Sandy Hollow Gulgong Railway are outlined in Section 7 and performance indicators for the performance measures are summarised in Section 8.
6.0 MONITORING

A monitoring program will be developed in order to monitor the impacts of the extraction of Longwalls 101-103 on the Sandy Hollow Gulgong Railway to identify unsafe conditions or loss of serviceability during or after mining. Key components of the monitoring program are summarised in Table 5.

Table 5: Sandy Hollow Gulgong Railway Monitoring Program Overview

<table>
<thead>
<tr>
<th>Monitoring Component</th>
<th>Parameter</th>
<th>Timing/Frequency</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-mining</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UG1 subsidence</td>
<td>Installation of survey monitoring program and initial ground survey (including ‘FF Line’). Monitoring parameters include: • subsidence; • tilt; • tensile strain; • compressive strain; and • absolute horizontal translation.</td>
<td>Prior to commencement of Longwall 101 extraction.</td>
<td>Underground Technical Manager / Registered Mine Surveyor</td>
</tr>
<tr>
<td>UG1 subsidence</td>
<td>Maintenance inspections.</td>
<td>Alignment and condition of rail infrastructure.</td>
<td>Routinely as per ARTC inspections.</td>
</tr>
<tr>
<td>Longwalls 101 to 103 Subsidence Monitoring Program (LW101-103 SMP).</td>
<td><strong>During Mining</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sandy Hollow Gulgong Railway – Baseline survey and visual inspection (i.e. dilapidation audit).</td>
<td>Alignment and condition of rail infrastructure.</td>
<td>Prior to secondary extraction within 400 m of the Longwall 101 take-off position.</td>
<td>Underground Technical Manager / Registered Mine Surveyor</td>
</tr>
<tr>
<td>UG1 subsidence</td>
<td>Ground survey (including ‘FF Line’) and comparison against baseline. Monitoring parameters include: • subsidence; • tilt; • tensile strain; • compressive strain; and • absolute horizontal translation.</td>
<td>Prior to secondary extraction within 400 m of the longwall take-off position (i.e. the existing longwall mining limits). At 100 m intervals (determined by the longwall chainage marks) while the active mining face is within 400 m of the longwall take-off position. [Inspection sheets to be provided to ARTC if/when movement detected] Opportunistic visual observations during routine works by MCO and its contractors.</td>
<td>Underground Technical Manager / Registered Mine Surveyor</td>
</tr>
</tbody>
</table>
Table 5 (Continued): Sandy Hollow Gulgong Railway Monitoring Program Overview

<table>
<thead>
<tr>
<th>Monitoring Component</th>
<th>Parameter</th>
<th>Timing/Frequency</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>During Mining (continued)</strong></td>
<td>Sandy Hollow Gulgong Railway – Subsidence impact inspection.</td>
<td>Subsidence impact inspections will target the identification of: • any defects or deformation of the rail line and associated infrastructure; and • changes to the visible surfaces of the culverts including cracking, buckling, shearing, and collapse.</td>
<td>If/when ground movement (in excess of survey accuracy) is detected during monitoring of the FF Line. At any time in case of fault or emergency and where requested by ARTC.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Routinely as per ARTC inspections.</td>
</tr>
<tr>
<td><strong>Post-mining</strong></td>
<td>UG1 subsidence monitoring lines, as described in the LW101-103 SMP.</td>
<td>Ground survey (including ‘FF Line’). Monitoring parameters include: • subsidence; • tilt; • tensile strain; • compressive strain; and • absolute horizontal translation.</td>
<td>Within three months of longwall completion (e.g. longwall has been relocated from the final end of block mining position). Provide a copy of the results of this final survey to ARTC.</td>
</tr>
</tbody>
</table>

The frequency of monitoring will be reviewed either:

- in accordance with the Annual Review; or
- if triggered as a component of the Contingency Plan as outlined in Section 9 of this LW101-103 BFMP-ARTC.

6.1 SUBSIDENCE PARAMETERS

Subsidence parameters (i.e. subsidence, tilt, tensile strain, compressive strain and absolute horizontal translation) associated with mining will be measured in accordance with the LW101-103 SMP.

In summary, surveys will be conducted to measure subsidence movements in three dimensions using a total station survey instrument. Subsidence movements (i.e. subsidence, tilt, tensile strain and compressive strain) will be measured along subsidence lines that have been positioned across the general landscape.
Monitoring of subsidence parameters specific to the Sandy Hollow Gulgong Railway will be measured by a survey line (‘FF Line’) along Ulan-Wollar Road. As agreed with ARTC, in the event the subsidence monitoring program identifies ground movements (in excess of survey accuracy), inspection sheets detailing the results of the subsidence monitoring program will be provided to ARTC, following confirmation of the results.

6.2 SUBSIDENCE IMPACTS

A baseline inspection (including visual inspection and dilapidation audit) of the Sandy Hollow Gulgong Railway in the vicinity of Longwalls 101-103 will be conducted prior to mining within 400 m of the Longwall 101 take-off position.

A survey along the FF Line will be undertaken prior to secondary extraction within 400 m of the Longwall 101 take-off point. Additional surveys along the FF Line will be undertaken by MCO while mining is within 400 m of the longwall take-off position (i.e. at 100 m intervals as determined by the longwall chainage marks).

In the event monitoring identifies ground movement (in excess of survey accuracy) MCO will undertake an inspection of the rail line for any impacts caused by subsidence movements. Opportunistic observations of subsidence impacts will be conducted during routine works by MCO and its contractors.

It is understood that ARTC also conducts routine inspections (including fault and emergency patrols) which would be used for monitoring of the impacts of subsidence if conducted during the course of mining Longwalls 101-103.

Information will be recorded in the LW101-103 BFMP-ARTC Subsidence Impact Register (Attachment 3) and reported in accordance with Project Approval (08_0135) (Section 13).

6.3 ENVIRONMENTAL CONSEQUENCES

MCO and ARTC will compare the results of the subsidence impact monitoring against the built features performance measure and indicators (Sections 5 and 8). In the event the observed subsidence impacts from the Moolarben Coal Complex exceed the performance measure or indicators, MCO and ARTC will assess the consequences of the exceedance in accordance with the Contingency Plan described in Section 9.
7.0 MANAGEMENT MEASURES

A number of potential management measures in relation to the rail line are considered to be applicable, if required. These may include:

- speed restriction of trains; and
- minor repair of track.

A number of potential management measures in relation to culverts are also considered to be applicable, if required. These include:

- point repairs;
- lining;
- grouting; and
- culvert replacement.

Follow-up inspections will be conducted to assess the effectiveness of the management measures implemented and the requirement for any additional management measures.

A summary of management measures will be reported in the Annual Review.

Key management actions and timing is summarised in Table 6.
## Table 6: Sandy Hollow Gulgong Railway Key Management Actions

<table>
<thead>
<tr>
<th>Management Measure</th>
<th>Timing/Frequency</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-mining</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notification to ARTC prior to commencement of secondary extraction.</td>
<td>Prior to secondary extraction of Longwall 101.</td>
<td>Underground Technical Manager</td>
</tr>
<tr>
<td>Baseline survey and visual inspection (e.g. dilapidation audit) of Sandy Hollow Gulgong Railway Infrastructure.</td>
<td>Prior to secondary extraction of Longwall 101.</td>
<td>Underground Technical Manager</td>
</tr>
<tr>
<td><strong>During Mining</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notification to ARTC prior to subsidence effects on the Sandy Hollow Gulgong Railway.</td>
<td>Prior to secondary extraction within 400 m of the longwall take-off positions.</td>
<td>Underground Technical Manager</td>
</tr>
<tr>
<td>Provision of inspection sheets detailing the outcome of the subsidence impact monitoring program to ARTC (unless otherwise agreed by ARTC).</td>
<td>If/when ground survey identifies movement (in excess of survey accuracy).</td>
<td>Underground Technical Manager</td>
</tr>
<tr>
<td>Ensure safe access to Sandy Hollow Gulgong Railway is available such that routine inspections and maintenance and remediation works are able to be undertaken.</td>
<td>During Longwalls 101-103 extraction.</td>
<td>Underground Technical Manager</td>
</tr>
<tr>
<td>Implement TARP (Attachment 2).</td>
<td>During Longwall 101-103 extraction.</td>
<td>Underground Technical Manager</td>
</tr>
<tr>
<td><strong>Post-mining</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual inspection of Sandy Hollow Gulgong Railway to identify any post-mining remediation works required.</td>
<td>Following completion of active mining at UG1.</td>
<td>Underground Technical Manager</td>
</tr>
</tbody>
</table>
8.0 ASSESSMENT OF PERFORMANCE INDICATORS AND MEASURES

In accordance with Condition 5(d), Schedule 4 of Project Approval (08_0135), performance indicators have been developed for the performance measures listed in Table 4 (Section 5).

The performance indicators proposed to ensure that the performance measures for the Sandy Hollow Gulgong Railway are achieved include:

- no defects or deformation of the rail track and associated infrastructure due to mining; and
- no visual displacement at joints or cracks in culverts.

Monitoring conducted to inform the assessment of secondary extraction of Longwalls 101-103 against the performance indicators for the performance measures relevant to the Sandy Hollow Gulgong Railway as a built feature is outlined in Section 6.

If a performance measure is considered to have been exceeded, the Contingency Plan outlined in Section 9 of this LW101-103 BFMP-ARTC will be implemented.
9.0 CONTINGENCY PLAN

In the event the performance measures relevant to the Sandy Hollow Gulgong Railway as a built feature, summarised in Table 4, are considered to have been exceeded or are likely to be exceeded, MCO will implement the following Contingency Plan:

- The observation will be reported to the Underground Technical Manager or the Environmental and Community Manager within 24 hours.
- The observation will be recorded in the Subsidence Impact Register (Attachment 3).
- The likely exceedance will be reported in an Incident Report (refer to the Extraction Plan).
- MCO will provide the Incident Report to relevant stakeholders (i.e. DP&E, DRE and ARTC).
- MCO will conduct an investigation to identify and evaluate contributing factors to the exceedance, including re-survey of the relevant subsidence monitoring lines, analysis of predicted versus observed subsidence parameters and a review of the subsidence monitoring program with updates to the program where appropriate.
- An appropriate course of action will be developed in consultation with relevant stakeholders and government agencies including proposed contingency measures (Section 9.1), and a program to review the effectiveness of the contingency measures.
- The course of action will be approved by, and implemented to the satisfaction of, ARTC and DRE.
- This LW101-103 BFMP-ARTC and the performance indicators will be reviewed to adequately manage future potential impacts within the limits of Project Approval (08_0135).

MCO will comply with the NSW Mine Subsidence Compensation Act, 1961 in the event that property damages occur as a result of mining Longwalls 101-103.

9.1 CONTINGENCY MEASURES

Contingency measures will be developed in consideration of the specific circumstances of the feature (e.g. the location, nature and extent of the impact, and the assessment of environmental consequences).

Potential contingency measures that could be considered in the event the performance measure for the Sandy Hollow Gulgong Railway is exceeded are summarised in Table 7.
### Table 7: Potential Contingency Measures

<table>
<thead>
<tr>
<th>Environmental Consequence</th>
<th>Potential Contingency Measures</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Impact on:</strong></td>
<td><strong>Rail Track</strong></td>
<td>Replace length of track</td>
</tr>
</tbody>
</table>
10.0 TRIGGER ACTION RESPONSE PLAN – MANAGEMENT TOOL

The framework for the various components of this LW101-103 BFMP-ARTC are summarised in the TARP shown in Attachment 2. The TARP illustrates how the various predicted subsidence impacts, monitoring components, performance measures, and responsibilities are structured to achieve compliance with the relevant statutory requirements, and the framework for management and contingency actions.

The TARP comprises:

- baseline conditions;
- predicted subsidence impacts;
- trigger levels from monitoring to assess performance; and
- triggers that flag implementation of contingency measures.

The TARP system provides a simple and transparent snapshot of the monitoring of environmental performance and the implementation of management and/or contingency measures.
11.0 ROLES AND RESPONSIBILITIES

Key responsibilities of MCO personnel in relation to this LW101-103 BFMP-ARTC are summarised in Table 8. Responsibilities may be delegated as required.

Table 8: Longwalls 101 to 103 Built Features Management Plan – Australian Rail Track Corporation Responsibility Summary

<table>
<thead>
<tr>
<th>Responsibility</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Manager</td>
<td>• Ensure resources are available to MCO personnel to facilitate the completion of responsibilities under this LW101-103 BFMP-ARTC.</td>
</tr>
<tr>
<td>Underground Technical Manager</td>
<td>• Ensure the LW101-103 SMP is implemented.</td>
</tr>
<tr>
<td></td>
<td>• Ensure monitoring required under this LW101-103 BFMP-ARTC is carried out within specified timeframes, adequately checked and processed and prepared to the required standard.</td>
</tr>
<tr>
<td></td>
<td>• Undertake relevant monitoring and implementation of management measures summarised in Tables 5 and 6 respectively.</td>
</tr>
<tr>
<td>Environmental and Community Manager</td>
<td>• Ensure the LW101-103 BFMP-ARTC is implemented.</td>
</tr>
<tr>
<td></td>
<td>• Liaise with relevant stakeholders regarding subsidence impact management and related environmental consequences.</td>
</tr>
<tr>
<td>Registered Mine Surveyor</td>
<td>• Undertake all subsidence monitoring to the required standard within the specified timeframes and ensure data are adequately checked, processed and recorded.</td>
</tr>
</tbody>
</table>

11.1 KEY CONTACTS

The details of key contacts and phone numbers in relation to this LW101-103 BFMP-ARTC are summarised in Table 9.

Table 9: Longwalls 101 to 103 Built Features Management Plan – Australian Rail Track Corporation Key Personnel Contact Details

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Position</th>
<th>Contact Name</th>
<th>Phone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCO</td>
<td>Underground Technical Manager</td>
<td>Mr Shane Pegg</td>
<td>02 6376 1656</td>
</tr>
<tr>
<td></td>
<td>Environmental and Community Manager</td>
<td>Mr Graham Chase</td>
<td>02 6376 1407</td>
</tr>
<tr>
<td></td>
<td>Moolarben Coal Hotline</td>
<td></td>
<td>1800 556 484</td>
</tr>
<tr>
<td>ARTC</td>
<td>Third Party Works Officer</td>
<td>Mr John Brown</td>
<td>02 4978 9880</td>
</tr>
<tr>
<td></td>
<td>Area Manager Muswellbrook</td>
<td>Mr Nick Brown</td>
<td>0459 824 332</td>
</tr>
<tr>
<td></td>
<td>Upper Hunter (3) Network Control (24 hour contact)</td>
<td></td>
<td>02 4902 7905</td>
</tr>
</tbody>
</table>
12.0 FUTURE EXTRACTION PLANS

In accordance with Condition 5(p), Schedule 4 of Project Approval (08_0135), MCO will collect baseline data for the future Extraction Plan (e.g. Longwalls 104-105). However, for the Sandy Hollow Gulgong Railway, the baseline (and post-mining) data collected for Longwalls 101-103 will be used as baseline for Longwalls 104-105 as longwall mining progressively moves further south of the ARTC assets.

In addition to the baseline data collection, consideration of the environmental performance and management measures, in accordance with the review(s) conducted as part of this LW101-103 BFMP-ARTC, will inform the appropriate type and frequency of monitoring of the assets relevant to the next Extraction Plan.
13.0 ANNUAL REVIEW, REGULAR REPORTING AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE

In accordance with Condition 4, Schedule 6 of Project Approval (08_0135), MCO will conduct an Annual Review of the environmental performance of the Project by the end of March each year, or as otherwise agreed by the Secretary of the DP&E.

The Annual Review will:

- describe the works carried out in the previous calendar year, and the development proposed to be carried out over the current calendar year;
- include a comprehensive review of the monitoring results and complaints records of the Project over the previous calendar year, including a comparison of these results against the:
  - relevant statutory requirements, limits or performance measures/criteria;
  - monitoring results of previous years; and
  - relevant predictions in the EA;
- identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- identify any trends in the monitoring data over the life of the Project;
- identify any discrepancies between the predicted and actual impacts of the Project, and analyse the potential cause of any significant discrepancies; and
- describe what measures will be implemented over the next year to improve the environmental performance of the Project.

In accordance with Condition 11, Schedule 6 of Project Approval (08_0135), the Annual Review will be made available on the MCO website.

As described in Section 2, this LW101-103 BFMP-ARTC will be reviewed within three months of the submission of an Annual Review, and revised where appropriate.

In accordance with Condition 8, Schedule 6 of Project Approval (08_0135), MCO will also provide regular reporting on the environmental performance of the Project on the MCO website.
13.1 AUDITS

In accordance with Condition 9, Schedule 6 of Project Approval (08_0135), an independent environmental audit was conducted by the end of December 2015, and will be undertaken every three years thereafter. A copy of the independent environmental audit will be provided to the Secretary of the DP&E and made available on the MCO website.

The independent environmental audit will be conducted by suitably qualified, experienced and independent team of experts whose appointment has been endorsed by the Secretary of the DP&E.

The independent environmental audit will assess the environmental performance of the Project and assess whether it is complying with the requirements of Project Approval (08_0135), and any other relevant approvals, and recommend measures or actions to improve the environmental performance of the Project.

Further to the above, external auditing for compliance with ISO 31000 – Risk Management (or alternative standard agreed with ARTC) will be undertaken annually to report compliance and effectiveness of risk management practices during the extraction of Longwalls 101-103.
14.0 INCIDENTS

An incident is defined in Project Approval (08_0135) as a set of circumstances that:

- causes or threatens to cause material harm to the environment; and/or
- breaches or exceeds the limits or performance measures/criteria in Project Approval (08_0135).

In the event that an incident which causes, or threatens to cause, material harm to the environment occurs, the incident will be managed in accordance with the Pollution Incident Response Management Plan.

The reporting of incidents will be conducted in accordance with Condition 7, Schedule 6 of Project Approval (08_0135).

MCO will notify the Secretary of DP&E and any other relevant agencies of any incident associated with the UG1 Underground Mine immediately after MCO confirms that an incident has occurred. Within seven days of the date of the incident, MCO will provide the Secretary of DP&E and any relevant agencies with a detailed report on the incident. The report will:

- describe the date, time and nature of the exceedance/incident;
- identify the cause (or likely cause) of the exceedance/incident;
- describe what action has been taken to date; and
- describe the proposed measures to address the exceedance/incident.
15.0 COMPLAINTS

MCO maintains a Community Complaints Line (Phone Number: 1800 556 484) that is dedicated to the receipt of community complaints. The Community Complaints Line is publicly advertised and operates 24 hours per day, seven days a week, to receive any complaints from neighbouring residents or other stakeholders.

MCO has developed a Community Complaints Procedure which details the process to be followed when receiving, responding to and recording community complaints. The Community Complaints Procedure is supported by a Complaints Database.

The Community Complaints Procedure is a component of the MCO Environmental Management Strategy which requires the recording of relevant information including:

- the nature of complaint;
- method of the complaint;
- relevant monitoring results and meteorological data at the time of the complaint;
- site investigation outcomes;
- any necessary site activity and activity changes;
- any necessary actions assigned; and
- communication of the investigation outcome(s) to the complainant.

In accordance with Condition 11, Schedule 6 of Project Approval (08_0135), the complaints register will be updated monthly and made available on the MCO website.
16.0 NON-COMPLIANCES WITH STATUTORY REQUIREMENTS

A protocol for the managing and reporting of non-compliances with statutory requirements has been developed as a component of MCO’s Environmental Management Strategy and is described below.

Compliance with all approvals, plans and procedures will be the responsibility of all personnel (staff and contractors) employed on or in association with the Moolarben Coal Complex.

The Environmental and Community Manager (or delegate) will undertake regular inspections, internal audits and initiate directions identifying any remediation/rectification work required, and areas of actual or potential non-compliance.

As described in Section 14, MCO will notify the Secretary of the DP&E, and any other relevant agencies, of any incident associated with MCO immediately after MCO becomes aware of the incident. Within seven days of the date of the incident, MCO will provide the Secretary of the DP&E, and any relevant agencies, with a detailed report on the incident.

A review of MCO’s compliance with all conditions of Project Approval (08_0135), mining leases and all other approvals and licenses will be undertaken prior to (and included within) each Annual Review. The Annual Review will be made publicly available on the MCO website.

As described in Section 13.1, an independent environmental audit was conducted by the end of December 2015, and will be undertaken every three years thereafter. A copy of the audit report will be submitted to the Secretary of the DP&E and made publicly available on the MCO website.
17.0 REFERENCES


ATTACHMENT 1

MSEC (2016) MOOLARBEN COAL OPERATIONS – LONGWALLS 101 TO 103
- SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS
FOR THE ARTC INFRASTRUCTURE
20th December 2016

Shane Pegg
Underground Technical Manager
Moolarben Coal Operations Pty Ltd
Locked Bag 2003
Mudgee NSW 2850

Ref: MSEC877-01

Dear Shane,

RE: Moolarben Coal Operations – Longwalls 101 to 103 - Subsidence Predictions and Impact Assessments for the ARTC Infrastructure

Moolarben Coal Operations is preparing an Extraction Plan to support the commencement of longwall mining operations in the 4th quarter of 2017, and this letter has been prepared to detail potential subsidence impacts on infrastructure owned and operated by the Australian Rail Track Corporation Ltd (ARTC).

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the ARTC infrastructure resulting from the extraction of Longwalls 101 to 103 at the Moolarben Coal Complex. In doing so this letter considers potential subsidence induced mechanisms of impact and concludes with a summary of the impact assessment. The potential subsidence impacts are consistent with those previously assessed and approved for the Moolarben Coal Complex UG1 Optimisation Modification Environmental Assessment.

The locations of the ARTC infrastructure and Longwalls 101 to 103 are shown in the attached Drawing No. MSEC877-01. The ARTC infrastructure comprises the Sandy Hollow – Gulgong Railway Line which is located to the north and east of Longwalls 101 to 103. Two rail loops associated with Ulan and Moolarben coal mines connect to the Sandy Hollow – Gulgong Railway Line as shown in Drawing No. MSEC877-01.

The nearest ends of Longwalls 101 to 103 to the Sandy Hollow – Gulgong Railway Line vary from approximately 310 m (LW103) to 400 m (LW101). At these locations the depths of cover range from 110 m to 130 m and, hence, these distances between the edges of the mined panels and the railway are equivalent to 2.8 to 3 times the depths of cover.

Conventional Subsidence Parameters

At distances of 310 m to 400 m between the longwalls and the railway track and based on depths of cover of 110 m to 130 m, the rail track will not be subjected to measurable conventional mine subsidence ground movements (i.e. less than limits of survey accuracy); however, the railway line may experience far-field horizontal movements which are discussed below.

Far-Field Movements

The measured horizontal movements at survey marks which are located beyond the longwall goaf edges and over solid unmined coal areas are often greater than the observed vertical movements at those marks. These movements are often referred to as far-field horizontal movements.

Far-field horizontal movements tend to be bodily movements towards the extracted goaf area and are accompanied by very low levels of strain. These movements generally do not result in impacts on natural or built features, except where they are experienced by large structures which are very sensitive to differential horizontal movements.
In some cases, higher levels of far-field horizontal movements have been observed where steep slopes or surface incisions exist nearby, as these features influence both the magnitude and the direction of ground movement patterns. Similarly, increased horizontal movements are often observed around sudden changes in geology or where blocks of coal are left between longwalls or near other previously extracted series of longwalls. In these cases, the levels of observed vertical subsidence and horizontal movement can be slightly higher than normally predicted, but these increased movements are generally accompanied by very low levels of tilt and strain.

An empirical database of observed incremental far-field horizontal movements has been compiled using available monitoring data from the NSW and Queensland Coalfields, but this database predominately comprises measurements from the Southern Coalfield. The far-field horizontal movements are generally observed to be orientated towards the extracted longwall. At very low levels of far-field horizontal movements, however, there is a higher scatter in the orientation of the observed movements.

The observed incremental far-field horizontal movements, resulting from the extraction of each longwall within a series, are shown in Figure 1. The observed directions of these far-field horizontal movements were generally observed to be orientated towards the extracted longwall.

This plot of far-field horizontal movements includes some multi-seam mining cases and some sites where it is known that the plotted movements include components from valley closure effects. The confidence levels, based on fitted Generalised Pareto Distributions (GPDs), have also been shown in this figure to illustrate the spread of the data. The magnitude of these movements decrease with distance from the mined edges however, there have been cases where the observed far-field horizontal movements beyond the edges of the mined panels have approached 400 mm. The highest observed far-field horizontal movements are multi seam cases that are located close to large valleys.

This data includes some of the available observed far-field horizontal movements that have been measured at Ulan Coal Mine and other observed data from other regions where the depths of cover are also relatively shallow compared to the Southern Coalfield of NSW. The available far-field incremental horizontal movement data has therefore been replotted, as shown in Figure 2, against the distances from the nearest edge of the incremental panel divided by the depth of cover.

![Observed Incremental Horizontal Movement versus Distance to Active Longwall](image)

**Figure 1** Observed Incremental Far-field Horizontal Movements (mm) from Many Regions in NSW Plotted Against the Distance to the Nearest Edge of the Mined Panel (m)
Figure 2 replots the available far-field horizontal movement data that is shown in Figure 1 to allow for varying depths of cover and this plot is more appropriate for use at the Moolarben Coal Complex. This plot still includes those many cases where higher movements occurred because of multi-seam mining and valley closure effects.

As successive longwalls within a series of longwall panels are mined, the magnitudes of the incremental far-field horizontal movements decrease. This is possibly due to the fact that once the in situ stresses in the strata within the collapsed zones above the first few extracted longwalls has been redistributed, the potential for further movement is reduced. The total far-field horizontal movement is not, therefore, the sum of the incremental far-field horizontal movements for the individual longwalls.

Figure 2 shows the upper limit of previously observed absolute far-field horizontal movements at Ulan Coal Mine for the sites located 2.8 to 3 times the depths of cover from longwalls, was less than 100 mm, (however this data includes the H-Line case and the F-Line case where high valley closure movements were observed). Ignoring sites with high valley closure movements and the multi seam cases, Figure 2 shows the upper limit of previously observed absolute far-field horizontal movements for sites located 2.8 to 3 times the depths of cover from longwalls, is less than 70 mm.

The Sandy Hollow – Gulgong Railway Line, therefore, is predicted to experience incremental far-field horizontal movements in the order of 70 mm due to the extraction of each of Longwalls 101 to 103. These low level horizontal movements are not expected to be associated with measurable tilts, curvatures or strains.

Influence of Unconsolidated Tertiary Sediments on Horizontal Far-field Movements

There are unconsolidated Tertiary sediments, with a maximum thickness of 40-50 m, to the north and east of the Longwalls 101 to 103 as shown in Drawing No. MSEC877-01. These unconsolidated sediments are remnants of inactive river or stream channels that have been later filled in or buried by younger sediment that can be stronger or weaker than the original strata.
At Moolarben Coal Complex the unconsolidated sediments to the north and east of Longwalls 101 to 103 were formed when Permian strata layers were replaced with infill sediments consisting of poorly-sorted semi-consolidated quartzose sands and gravels in a clayey matrix, i.e. including unsaturated alluvium and low permeability clays. The presence of these materials can modify the subsidence ground movements beyond the end of the longwalls, (depending on the depth of the channels, and its location with respect to the panel edges).

Since these unconsolidated sediments are located away from the edges of the longwalls, then, their presence should result in less subsidence within these areas and reduced far-field movements beyond these channels at the railway line.

**Influence of the Existing Open Cut (OC1) on Horizontal Far-field Movements**

An open cut mining area (OC1) currently in operation is located to the north west of the longwalls as shown in Drawing No. MSEC877-01. Access to the longwalls will be via the OC1 pit. An open cut mining area is also located to the south east (OC4) and will be extracted as part of future operations.

The open cut pits extract the overburden material and the target coal seam, i.e. down to the seam floor level of the longwalls. The effect of the removal of this material is to relieve or redistribute much of the in situ stress in the overburden strata adjacent to the pit. With the removal of the overburden material, the potential for far-field effects to develop in the vicinity of the pit are significantly reduced.

With rehabilitated open cut mine areas, the overburden material has been replaced, typically with other stripped material which is compacted by vehicle tracking during the emplacement process. Potential for far-field movements where the open cut pit has been fully rehabilitated between the longwalls and the outer natural overburden is expected to be significantly reduced, similar to the open cut pit, as the emplaced material is unlikely to support any significant stress redistribution.

**Potential for Non-Conventional Movements**

It is believed that most non-conventional ground movements are the result of the reaction of near surface strata to increased horizontal compressive stresses due to mining operations. Some of the geological conditions that are believed to influence these irregular subsidence movements are the blocky nature of near surface sedimentary strata layers and the possible presence of unknown faults, dykes or other geological structures, cross bedded strata, thin and brittle near surface strata layers and pre-existing natural joints. The presence of these geological features near the surface can result in a localised bump in an otherwise smooth subsidence profile and these bumps are usually accompanied by locally increased tilts and strains.

Even though it may be possible to attribute a reason behind most observed non-conventional ground movements, there remain some observed irregular ground movements that still cannot be explained with the available geological information. The term “anomaly” is therefore reserved for those non-conventional ground movement cases that were not expected to occur and cannot be explained by any of the above possible causes.

It is not possible to predict the locations and magnitudes of non-conventional anomalous movements. In some cases, approximate predictions for the non-conventional ground movements can be made where the underlying geological or topographic conditions are known in advance.

The likelihood of non-conventional anomalous movements reduces with increasing distance away from the longwall panels.

The range of potential strains associated with non-conventional movements has been assessed using monitoring data from previously extracted panels in the NSW Coalfields, for single-seam conditions, where the width-to-depth ratios and extraction heights were similar to those of Longwalls 101 to 103. The data used in the analysis of observed strains included those resulting from both conventional and non-conventional anomalous movements, but did not include those resulting from valley related movements. The strains resulting from damaged or disturbed survey marks have also been excluded. The survey database has been analysed to extract the maximum tensile and compressive strains that have been measured at any time during mining for survey bays that were located beyond the goaf edges of the mined panels and positioned on unmined areas of coal between 200 m and 600 m of the nearest longwall goaf edge.

The 95 % confidence levels for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining were 1.6 mm/m tensile and 1.5 mm/m compressive. The 99 % confidence
levels for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining were 2.9 mm/m tensile and 3.0 mm/m compressive. It is noted that these results comprise a component of survey tolerance and have also been affected by disturbed survey marks and survey errors.

**Impact Assessments for the Sandy Hollow – Gulgong Railway Line**

The Sandy Hollow – Gulgong Railway Line is located more than 310 m from Longwalls 101 to 103. The railway line is not expected to be subject to measurable conventional vertical subsidence, tilt, curvature or strain. However, the railway may experience low level far-field horizontal movements. The upper limit of previously observed absolute far-field horizontal movements for sites located 2.8 to 3 times the depths of cover from longwalls, is in the order of 70 mm. The presence of unconsolidated sediments should result in reduced far-field movements at the railway line.

The existing open cut (OC1) would significantly reduce the potential for far-field movements to develop at features located beyond the open cut extent. The location of the railway line outside OC1 is greater than nine times the depth of cover from the longwalls and far-field horizontal movements would not be expected, even without the presence of OC1.

The predicted far-field horizontal movements of less than 70 mm at the railway track are expected to be bodily movements that are directed across the track towards the extracted goaf area and should be accompanied by very low levels of strain that are in the order of survey tolerance. If horizontal movement towards the longwalls develops along the alignment of the railway line, it is possible however, that a slight increase in compression could develop in the rail due to the curve around the Northern corner of Longwall 101. The horizontal movement along the straight sections of the railway line or with increasing distance from the extracted longwalls are unlikely to adversely impact on the railway line.

**Recommendations**

In order to manage the predicted impacts on ARTC infrastructure, the following is recommended:

a) Implement a program of ground monitoring near the railway line for each longwall to check for the development of compression along the alignment of the rail and for possible anomalous movements.

b) Develop and implement monitoring and management strategies for dealing with the potential impacts on the ARTC infrastructure.

**Summary**

The Gulgong - Sandy Hollow Railway Line is not expected to experience measurable conventional vertical subsidence movements resulting from the extraction of Longwalls 101 to 103, and the predicted far-field horizontal movements are likely to be less than 70 mm.

If far-field horizontal movement towards the longwalls develops along the railway line, it is possible that an increase in compression could develop in the rail due to the curve around the Northern corner of Longwall 101. The horizontal movement along the straight sections of the railway line or with increasing distance from the extracted longwalls are unlikely to adversely impact on the railway line.

Ground monitoring is recommended near the railway line for each longwall to check for the development of compression along the alignment of the rail and for possible anomalous movements.

It is expected that the potential impacts on the ARTC infrastructure can be managed with the implementation of the necessary monitoring and management strategies.

Yours sincerely

Peter DeBono

Attachments:
Drawing No. MSEC877-01 – Longwalls 101 to 103 – ARTC Infrastructure
ATTACHMENT 2

UG1 LONGWALLS 101 TO 103
BUILT FEATURES MANAGEMENT PLAN – AUSTRALIAN RAIL TRACK CORPORATION
TRIGGER ACTION RESPONSE PLAN

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<td>Predicted Impacts</td>
<td>Management Measures</td>
<td>Restoration/Contingency Phase</td>
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<td>Rail track and associated infrastructure is safe, serviceable and repairable or as otherwise identified by pre-mining inspection.</td>
<td>Subsidence effects on the Sandy Hollow Gulgong Railway (i.e. small field horizontal movements). Impacts are considered to be within acceptable limits if monitoring identifies (limits as advised by ARTC): - Less than 10 mm of horizontal movement at the railway line.</td>
<td>Monitoring identifies impacts that are greater than predicted, but the performance measure has not been exceeded and is not likely to be exceeded. Management measures are considered to be required if monitoring identifies (limits as advised by ARTC): - Between 10 and 15 mm of horizontal movement at the railway line.</td>
<td>If the Performance Measure relevant to the Sandy Hollow Gulgong Railway has been exceeded, or is likely to be exceeded (i.e. unsafe or loss of serviceability). Contingency measures are considered to be required if monitoring identifies (limits as advised by ARTC): - Greater than 15 mm of horizontal movement at the railway line.</td>
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<td>Establish baseline data, including: - Maintenance inspections (as per ARTC inspections). - Pre-extraction subsidence survey as per the UG1 Longwalls 101 to 103 Subsidence Monitoring Program.</td>
<td>Conduct monitoring as described in Section 6, including: - Ground survey. - Rail survey and visual inspection of the alignment and condition of rail infrastructure. - Subsidence impact inspections, targeting the identification of: - any defects or deformation of the rail line and associated infrastructure; and - changes to the visible surfaces of the culverts including cracking, buckling, shearing and collapse.</td>
<td>Management measures implemented as described in Section 7 (with regard to the specific circumstances of the subsidence impact [e.g. the nature and extent of the impact]). Follow-up inspections will be conducted to assess the effectiveness of the management measures implemented and the requirement for any additional management measures.</td>
<td>Contingency Plan implemented (with regard to the specific circumstances of the subsidence impact). In summary: - The observation will be reported to the Underground Technical Manager or the Environmental and Community Manager within 24 hours. - The observation will be recorded in the Subsidence Impact Register. - The exceedance or likely exceedance will be reported in an incident report. - An investigation will be conducted to identify and evaluate contributing factors to the exceedance. - An appropriate course of action will be developed in consultation with relevant stakeholders and government agencies. - The course of action will be approved by, and implemented to the satisfaction of, relevant stakeholders and government agencies. - The Built Features Management Plan – Australian Rail Track Corporation and the performance indicators will be reviewed to adequately manage future potential impacts.</td>
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<td>Prior to commencement of extraction of Longwall 101.</td>
<td>Ground survey: - Prior to secondary extraction within 400 m of the Longwall 101 take-off position. - At 100 m intervals (determined by the longwall chainage marks) while the active mining face is within 400 m of the longwall take-off position. - Within three months of longwall completion (e.g. longwall has been relocated from the final end of block mining position). - Rail survey and visual inspection: - Prior to secondary extraction within 400 m of the Longwall 101 take-off position. - Subsidence impact inspection: - If/when ground movement (in excess of survey accuracy) is detected during monitoring of the FF Line. - At any time in case of fault or emergency and where requested by ARTC.</td>
<td>To be implemented as required (i.e. if monitoring identifies impacts that are greater than predicted, but the performance measure has not been exceeded and is not likely to be exceeded).</td>
<td>To be implemented following identification of an exceedance of the performance measure, or if the performance measure is likely to be exceeded (i.e. unsafe or loss of serviceability).</td>
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**Position of Decision Making**
- Underground Technical Manager.
- Australian Rail Track Corporation – Third Party Works Officer.
- Underground Technical Manager.
- Australian Rail Track Corporation – Third Party Works Officer.
- Underground Technical Manager.
- Australian Rail Track Corporation – Third Party Works Officer, Area Manager and Network Control.

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## ATTACHMENT 3

**UG1 LONGWALLS 101 TO 103**

**BUILT FEATURES MANAGEMENT PLAN – AUSTRALIAN RAIL TRACK CORPORATION**

**SUBSIDENCE IMPACT REGISTER**

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## UG1 Longwalls 101 to 103 Built Features Management Plan – Australian Rail Track Corporation

### Subsidence Impact Register

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<th>Impact Description</th>
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<th>Management Measures Implemented</th>
<th>Were Management Measures Effective? (Yes/No)</th>
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