MEMBER OF GFG ALLIANCE

SIMEC

EXTRACTION PLAN – MAIN DOCUMENT – TAHMOOR SOUTH DOMAIN – LONGWALLS SOUTH 1A – SOUTH 7A

Tahmoor Coal Pty Ltd

Author: April Hudson

Document Control

Applicant:	Tahmoor Coal Pty Ltd
Mine:	Tahmoor Coal Mine
Development Approval:	SSD 8445
Mining Leases:	CCL716 and CCL747
Document Title:	Tahmoor South Domain Longwalls South 1A – South 7A Extraction Plan (Main Document)
Document Number:	TAH-HSEC-00360
Publication Date:	October 2025
Document Status:	Final (Version 7)
Prepared By:	Nick Le Baut, Environment Project Manager Tahmoor Coal – SIMEC Mining

Approved by:	Zina Ainsworth Environment and Community Manager Tahmoor Coal – SIMEC Mining Signature: Date:
	Malcolm Waterfall Mining Engineering Manager Tahmoor Coal – SIMEC Mining Signature: Date:
	Peter Vale Executive General Manager Coal Operations Tahmoor Coal – SIMEC Mining Signature: Date:

Table of Contents

Table of Contents **3**
List of Figures **7**
List of Tables **8**
1 Introduction **9**
1.1 Background 9
1.2 Purpose 10
1.3 Scope 10
1.4 Extraction Plan Structure 11
2 Extraction Plan Development **15**
2.1 Stakeholder Identification and Engagement 15
2.1.1 Community Consultation 15
2.1.2 Identification of Key Stakeholders 15
2.1.3 Results and Outcomes of Consultation 17
2.2 Subsidence Background 33
2.2.1 History of Mine Plan Changes for the Tahmoor South Domain 33
2.2.2 Revised Subsidence Predictions 34
2.2.3 Current Methods and Models used by MSEC 34
2.2.3.1 Incremental Profile Method 34
2.2.3.2 2002 ACARP Method 35
2.2.3.3 Prediction of Strains 35
2.2.3.4 Ground Stain 35
2.3 Extraction Plan Team 35
3 Extraction Plan Overview **38**
3.1 Extraction Plan Study Area 38
3.1.1 Definition of Study Area 38
3.1.2 Environmental Features in the Study Area 38
3.1.3 Land Use and Built Features in the Study Area 43
3.2 Approvals and Licensing Requirements 46
3.2.1 Project Approval 47
3.2.1.1 Development Consent Conditions for Extraction Plan 47
3.2.1.2 Additional Consent Conditions Relevant to Extraction Plan 53
3.2.1.3 EIS Commitments Relevant to Extraction Plan and Supporting Documents 59
3.2.1.4 EPBC Act Approval Conditions 62
3.2.2 Mining Lease Conditions 64

3.2.3 Environmental Licences 65
*Lease in process of renewal for FY2026 65
3.2.4 Work, Health and Safety Legislations 66
3.2.4.1 WHS Requirements for Persons Conducting a Business or Undertaking....66
3.2.4.2 Subsidence as a Principal Hazard 66
3.2.4.3 Principal Hazard Management Plan 72
3.2.4.4 High Risk Activity 72
3.2.4.5 Managing Risks of Subsidence Guide: WHS (Mines and Petroleum Sites) Legislation73
3.2.5 Extraction Plan Guidelines 73
3.3 Mine Planning and Design 74
3.3.1 Geology 75
3.3.1.1 Sydney Basin....75
3.3.1.2 Local Geology 75
3.3.1.3 Southern Coalfield....79
3.3.1.4 Bulli Coal Seam 79
3.3.2 Existing Workings....79
3.3.3 Proposed Mining Method 80
3.3.4 Mine Geotechnical Overview....81
3.3.4.1 Depth of Cover 81
3.3.4.2 Roof Stata Characteristics 81
3.3.4.3 Floor Strata Characteristics 81
3.3.4.4 Seam Dip....81
3.3.4.5 Seam Thickness and Working Section....81
3.3.4.6 Faulting....82
3.3.4.7 Igneous Intrusions 82
3.3.4.8 Seam Splitting....82
3.3.4.9 Geotechnical Design Parameters 82
3.3.4.10 Stability of Underground Workings....82
3.3.5 Mine Geometry....85
3.3.5.1 Variations to the Original Mine Plan 85
3.3.5.2 Current proposed Mine Plan....85
3.3.5.3 Mining Considerations and Hazards....86
3.3.6 Mine Schedule 87
3.3.7 Resource Recovery....88
3.3.7.1 Coal Quality 88
3.3.7.2 Resource Recovery 88
3.3.7.3 Justification Statement....89

3.4 Subsidence Predictions and Observations 89
3.4.1 Overview 89
3.4.2 First Workings 90
3.4.3 Subsidence Prediction 90
3.4.4 Strain Prediction 91
3.4.4.1 Strain Measured in Survey Bays 92
3.4.4.2 Strain Measured along Whole Monitoring Lines 92
3.4.4.3 Shear Strains 92
3.5 Performance Measures and Indicators 92
3.5.1 Performance Measures 92
3.5.2 Performance Indicators 92
3.6 Subsidence Management Strategies 93
3.6.1 Avoidance 93
3.6.2 Trigger Action Response Plans 93
3.6.2.1 Implementation of Monitoring Program and TARP Requirements 94
3.6.3 Adaptive Management Strategies 95
3.6.3.1 Continuous Improvement 95
3.6.3.2 Effectiveness of Management Measures 95
3.6.3.3 Adaptive Management Strategy - Review of Mine Plan for Built Features 96
3.6.3.4 Adaptive Management Strategy - Review of Mine Plan for Heritage Features 96
3.6.4 Strategy for Continuous Improvement to the Aquatic Monitoring Program 96
3.6.5 Strategy for Continuous Improvement to the Riparian and Amphibian Monitoring Program 97
4 Key Sub-Plans 98
4.1 Overview of Environmental Management 98
4.1.1 Environmental Management Strategy Framework 98
4.1.2 Overview of Key Sub-plans of this Extraction Plan 98
4.2 Water Management Plan 101
4.3 Land Management Plan 103
4.4 Figure 10 Cliffs and Steep Slopes in the LW S1A-S7A Study Area (PSM, 2025)Biodiversity Management Plan 104
4.5 Heritage Management Plan 105
4.6 Built Features Management Plan 109
4.7 Public Safety Management Plan 109
5 Subsidence Monitoring Plan 111
5.1 Monitoring Strategy and Approach 111
5.1.1 Subsidence Monitoring Plan for LW S1A-S7A 111
5.1.2 Summary of Monitoring in this Extraction Plan 111
5.2 Subsidence Effects Monitoring 112
5.3 Subsidence Impacts and Environmental Consequences Monitoring 116
5.3.1 Monitoring of Built Features 116

5.3.2 Monitoring of Environmental Features 116
5.4 Baseline Monitoring to Support Future Extraction Plans....121
6 Graphical Plans 122
7 Implementation 123
7.1 General Reporting 123
7.1.1 Annual Review 123
7.1.2 Annual Return 123
7.2 Incidents 124
7.2.1 Incident Definition 124
7.2.2 Incident Management....124
7.2.3 Incident Reporting 124
7.3 Non-Compliances 125
7.3.1 Non-Compliance Definition....125
7.3.2 Non-Compliance Management....125
7.3.3 Non-Compliance Reporting....125
7.4 Exceedances 127
7.4.1 Exceedance Definition 127
7.4.2 Exceedance Management....127
7.4.3 Exceedance Reporting 127
7.5 Complaints and Disputes....128
7.6 Risk Assessments....129
7.6.1 Site-wide Risk Assessment 129
7.6.2 General Risk Assessment 129
7.6.3 Built Feature Specific Risk Assessments 130
7.7 Audits and Reviews of Environment and Community Performance....130
7.7.1 Internal Audit and Review 130
7.7.2 Independent Environmental Audit 130
7.7.3 Extraction Plan Audit 131
7.8 Review of Documents 131
7.8.1 Review of Extraction Plan 131
7.8.2 Review of Other Management Plans 132
7.8.3 Document Control....132
7.9 Roles and Responsibilities 133
7.9.1 General Roles and Responsibilities 133
7.9.2 Employee & Contractor Training 134
7.9.3 Response Groups 134
7.10 Access to Information 134
7.10.1 Tahmoor Coal Website 134
7.10.2 Tahmoor Colliery Community Consultative Committee....135
8 Document Information....136
8.1 Referenced Documents....136

8.2 Related Documents 136
8.3 Glossary of Terms 137
8.4 Abbreviations 140
8.5 Change Information 143
8.6 Document Distribution 144
APPENDIX A – Subsidence Predictions and Impact Assessment Report (MSEC, 2022) 146
APPENDIX B – Modification 3 – Longwall S7A - Subsidence Predictions and Impact Assessment Report (MSEC, 2024) 147
APPENDIX C – Master Trigger Action Response Plan 148
APPENDIX D – Letter of Endorsement 149

List of Figures

Figure 1 Regional Context 13
Figure 2 Tahmoor Mining Areas and Tenure 14
Figure 3 Extraction Plan Study Area 45
Figure 4 Sydney Basin and the Southern Coalfields 77
Figure 5 Southern Coalfield Stratigraphy 78
Figure 6 Structure of the Bulli Coal Seam in the Tahmoor Mine Lease Areas (Palaris, 2019) 84
Figure 7 Continuous Improvement Model 95
Figure 8 Overview of Environmental Management Structure for Tahmoor Coal 100
Figure 9 Study Area Surface Water Resources (ATC Williams, 2025) 102
Figure 10 Cliffs and Steep Slopes in the LW S1A-S7A Study Area (PSM, 2025) 104
Figure 11 Aboriginal Heritage Sites in the LW S1A-S7A Study Area (EMM, 2025) 107
Figure 12 Historical Heritage Sites in the LW S1A-S7A Study Area (EMM, 2025) 108
Figure 13 Diagrammatic representation of Active Subsidence Zone 114
Figure 14 Monitoring Locations for LW S1A-S7A Extraction Plan Study Area (from Subsidence Monitoring Plan) 115
Figure 15 Aquatic Biodiversity Monitoring Program (from Biodiversity Management Plan) 118
Figure 16 Surface Water Monitoring Program (from Water Management Plan) 119
Figure 17 Existing and Proposed Groundwater Monitoring Sites (from Water Management Plan) 120

List of Tables

Table 1 Extraction Plan Structure 11
Table 2 Stakeholders Consulted during the preparation of the LW S1A-S6A Extraction Plan 16
Table 3 Summary of Key Issues Raised and Outcomes of Consultation Undertaken for LW S1A-S7A Extraction Plan (referred to as per previous Department names) 19
Table 4 Extraction Plan Team 36
Table 5 Environmental and Built Features within the LW S1A-S7A Extraction Plan Area and Management Plans 39
Table 6 SSD 8445 Condition Requirements for Extraction Plans 47
Table 7 Additional Development Consent Requirements for this Extraction Plan 53
Table 8 EIS Commitments 59
Table 9 EPBC Act Approval Conditions 62
Table 10 Mining Lease Conditions Relevant to this Extraction Plan 65
Table 11 Water Access Licences 65
Table 12 Work Health and Safety Legislation Compliance 67
Table 13 Extraction Plan Guideline Requirements 73
Table 14 LW S1A-S6A Design Parameters 85
Table 15 Mine Schedule for LW S1A-S7A (as per original schedule) 88
Table 16 Coal Reserve Estimates 88
Table 17 Estimated Individual Panel Tonnages and Recovery (as per original schedule) 89
Table 18 S7A Maximum Predicted Increment Conventional Subsidence, Tilt and Curvature for the Proposed LW S1A- 91
Table 19 Maximum Predicted Total Conventional Subsidence, Tilt and Curvature for the Proposed LW S1A-S7A . 91
Table 20 Baseline Monitoring Program to Support Future Extraction Plans 121
Table 21 Graphical Plans 122
Table 22 Roles and Responsibilities 133
Table 23 Reference Information 136
Table 24 Related Documents 136
Table 25 Glossary of Terms 137
Table 26 Abbreviations 140
Table 27 Document History 143
Table 28 Distribution List for Extraction Plan 144

1 Introduction

1.1 Background

Tahmoor Coal Pty Ltd (Tahmoor Coal) owns and operates the Tahmoor Mine, an existing underground coal mine located approximately 80 kilometres (km) south-west of Sydney in the Southern Coalfields of New South Wales (NSW). Tahmoor Mine surface facilities are situated between the towns of Tahmoor and Bargo within the Wollondilly Local Government Area (LGA). The mine has previously extracted longwalls to the north and west of the surface facilities and has been operating continuously since 1979 when coal was first mined using bord and pillar mining methods, followed by longwall mining methods since 1987.

The location of Tahmoor Mine in the regional context is shown in **Figure 1.**

Tahmoor Mine produces a primary hard coking coal product and a secondary higher ash coking coal product that are used predominantly for coke manufacture for steel production. Extracted coal is processed on site at the coal handling and preparation plant (CHPP) and coal clearance facilities prior to transportation via rail to Port Kembla and Newcastle for Australian domestic and export customers.

An Environmental Impact Statement (EIS) was exhibited in early 2019 to gain approval for the Tahmoor South Coal Project, which involves use of the existing surface infrastructure and the expansion of underground longwall mining to the south of the existing workings (referred to as the Tahmoor South Domain). Tahmoor Coal subsequently revised the proposed mine design and submitted amended development applications on two occasions (in February and August 2020). In April 2021, Tahmoor Coal received Development Application Approval (SSD 8445) from NSW Department of Planning and Environment (DPE, formerly NSW Department of Planning, Industry and Environment (DPIE), now NSW Department of Planning, Housing and Infrastructure (DPHI)) for the extraction of up to 4 Mtpa of ROM coal, with a total of up to around 35 Mt of ROM coal proposed to be extracted over a 10-year period.

SSD 8445 has been modified on two occasions relating to:

- Modification 1 - Extension of time to commission the Tahmoor Coal Water Treatment Plant, approved on 19 July 2022;
- Modification 2 - Underground brine disposal and transfer of mine water, approved on 13 June 2023; and
- Modification 3 - Inclusion of an additional longwall panel (Longwall South 7A (LW S7A)) to the existing approved mine plan, approved on 26 May 2025.

In addition to the SSD 8445 approval, Tahmoor Coal also received conditions of approval (EPBC 2017/8084) under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) in October 2021.

The Tahmoor South Domain is located south of the Bargo River and east of Remembrance Driveway and the township of Bargo. Longwall mining would be used to extract coal from the Bulli coal seam within the bounds of Consolidated Coal Lease (CCL) 716 and CCL 747. Thirteen longwalls are proposed in this domain which are divided into a series of seven northern (A series) and six southern (B series) longwalls. The A series, Longwalls South 1A to South 7A (LW S1A-S7A), are the focus of the current Extraction Plan.

The location of LW S1A-S7A and associated Study Area are illustrated in **Figure 2.**

It is noted that LW S3A has been shortened by 104 m, as approved by DPHI on 27 March 2024. LW S4A is shortened by 104m as approved by DPHI on 11 November 2024. Modifications to these longwalls are discussed in a separate document and further discussion in this document have been omitted.

1.2 Purpose

This Extraction Plan was prepared and updated to seek approval for secondary extraction of coal from LW S1A-S7A, in accordance with condition C8 of the Development Consent (SSD 8445). This Extraction Plan was prepared to comply with the following relevant approvals, legislation and guidelines:

- CCL 716 and CCL 747 issued under the *Mining Act 1992*;
- Department of Planning, Industry and Environment's *Extraction Plan Guidelines* (DPE, 2022);
- *Work Health and Safety Regulation 2017* (WHS Regulation) and *Work Health and Safety (Mines and Petroleum Sites) Regulation 2022* (WHSMP Regulation); and
- NSW Resources Regulator's *Managing Risks of Subsidence Guide: WHS (Mines and Petroleum Sites) Legislation* (Department of Industry – Resources Regulator, 2017).

A compliance register showing how the Extraction Plan complies with the relevant approvals, legislation and guidelines has been included in **Section 3.2** of this Extraction Plan.

The key purpose of this Extraction Plan is to outline the monitoring and management measures to be implemented to manage potential subsidence related impacts to ensure the protection of all surface / subsurface natural and built features and the protection of public safety within the Extraction Plan Study Area during extraction of LW S1A-S7A. This Study Area is defined in **Section 3.1** of this Extraction Plan.

Full details of the proposed monitoring and management measures are provided in the supporting component management plans for the Extraction Plan and summarised in **Section 4** of this document.

1.3 Scope

The Study Area applicable to this Extraction Plan is defined in **Section 3.1**.

This Extraction Plan Main Document has the following structure:

- Section 1: Introduction - This section provides background to the Extraction Plan, the purpose and scope of this Extraction Plan Main Document, and the document structure of the Extraction Plan;
- Section 2: Development - This section outlines stakeholders consulted as part of the preparation of this Extraction Plan, outlines the process of updating subsidence predictions, and outlines the Extraction Plan team;
- Section 3: Overview - This section provides an introduction to the LW S1A-S7A Extraction Plan:
    - Describes the Study Area covered by the Extraction Plan and the environmental and built features in the Study Area;
    - Addresses specific requirements set by SSD 8445 Condition C8, including detailed performance indicators for subsidence performance measures;
    - Addresses Work Health and Safety legislation specifically in relation to subsidence as a principal mining hazard in relation to the safety of 'other persons';
    - Addresses other regulatory requirements, approvals, leases, licences and guidelines relevant to the preparation of the Extraction Plan;
    - Describes all key proposed and existing mining parameters, and any special features;
    - Outlines potential subsidence effects, subsidence impacts and environmental consequences of LW S1A-S7A;
    - Describes the subsidence management measures that will be implemented to ensure compliance;

- Outlines the adaptive management approach and contingency plans in the event of exceedances of performance measures and predicted environmental consequences;

- Section 4: Key Sub-Plans - This section outlines the individual management plans intended to manage particular environmental or built features within the Extraction Plan Study Area;
- Section 5: Subsidence Monitoring Plan - This section details the Subsidence Monitoring Plan for potential subsidence impacts and environmental consequences;
- Section 6: Graphical Plans – This section lists the graphical plans that have been prepared for the LW S1A-S7A Extraction Plan Study Area, which include detailed mine plans of LW S1A-S7A;
- Section 7: Implementation - This section describes the key elements of implementation, including reporting requirements, reviews and key responsibilities; and
- Section 8: Document Information - This section provides a compiled list of references, related documents, terms, and abbreviations used in this document. In addition, this section provides the change information for this document, and a summary of the distribution of this document to stakeholders.

1.4 Extraction Plan Structure

This Extraction Plan for LW S1A-S7A comprises a main document, supporting management plans, graphical plans, and technical studies, as outlined in **Table 1**.

Table 1 Extraction Plan Structure

Key Sub-Plans	Appendix / Contributing Reports
Extraction Plan Main Document (this document)	Appendix A – LW S1A to S6A Subsidence Predictions and Impact Assessment Report (MSEC, 2022) Appendix B – Modification 3 – Longwall 7A Subsidence Predictions and Impact Assessment (MSEC, 2024) Appendix C – Master Trigger Action Response Plan Appendix D – Letters of Endorsement
Water Management Plan	Appendix A – Trigger Action Response Plan Appendix B – Surface Water level Monitoring Data Plots Appendix C – Surface Water Quality Summary Tables Appendix D – Groundwater Impact Assessment Appendix E –Remediation Progress Review Report
Land Management Plan	Appendix A – Trigger Action Response Plan Appendix B – Geotechnical Assessment (Douglas Partners, 2024a) Appendix C – Geotechnical Assessment for LW S7A (PSM, 2025) Appendix D – Land and Agricultural Resource Assessment (SLR, 2025) Appendix E – Detailed Slope Stability Assessment (Douglas Partners, 2022)
Biodiversity Management Plan	Appendix A – Trigger Action Response Plan Appendix B – Detailed Aquatic Monitoring Maps Appendix C – Detailed Riparian and Amphibian Monitoring Maps
Heritage Management Plan	Appendix A – Trigger Action Response Plan Appendix B – Aboriginal Consultation Appendix C – Teatree Hollow 2013.1: Test Excavation Methodology

Key Sub-Plans	Appendix / Contributing Reports
	Appendix D – Bargo Cemetery: Site overview and plan Appendix E – Archival record of rockshelter Teatree Hollow 2013.1 Appendix F – Archaeological Research Design – Teatree Hollow Rockshelter Appendix G – Teatree Hollow Rockshelter (#52-2-4471) – Archaeological Excavations – Completion of excavations and results
Built Features Management Plan	Appendix A - Drawings
Public Safety Management Plan	Appendix A – LW S1A – S6A Risk Assessment Appendix B – LW S7A Risk Assessment
Subsidence Monitoring Plan	Appendix A – Drawings Appendix B – Survey Specifications by SMEC Appendix C – Survey Specifications by Southern Rail Surveys
Graphical Plans	(None)

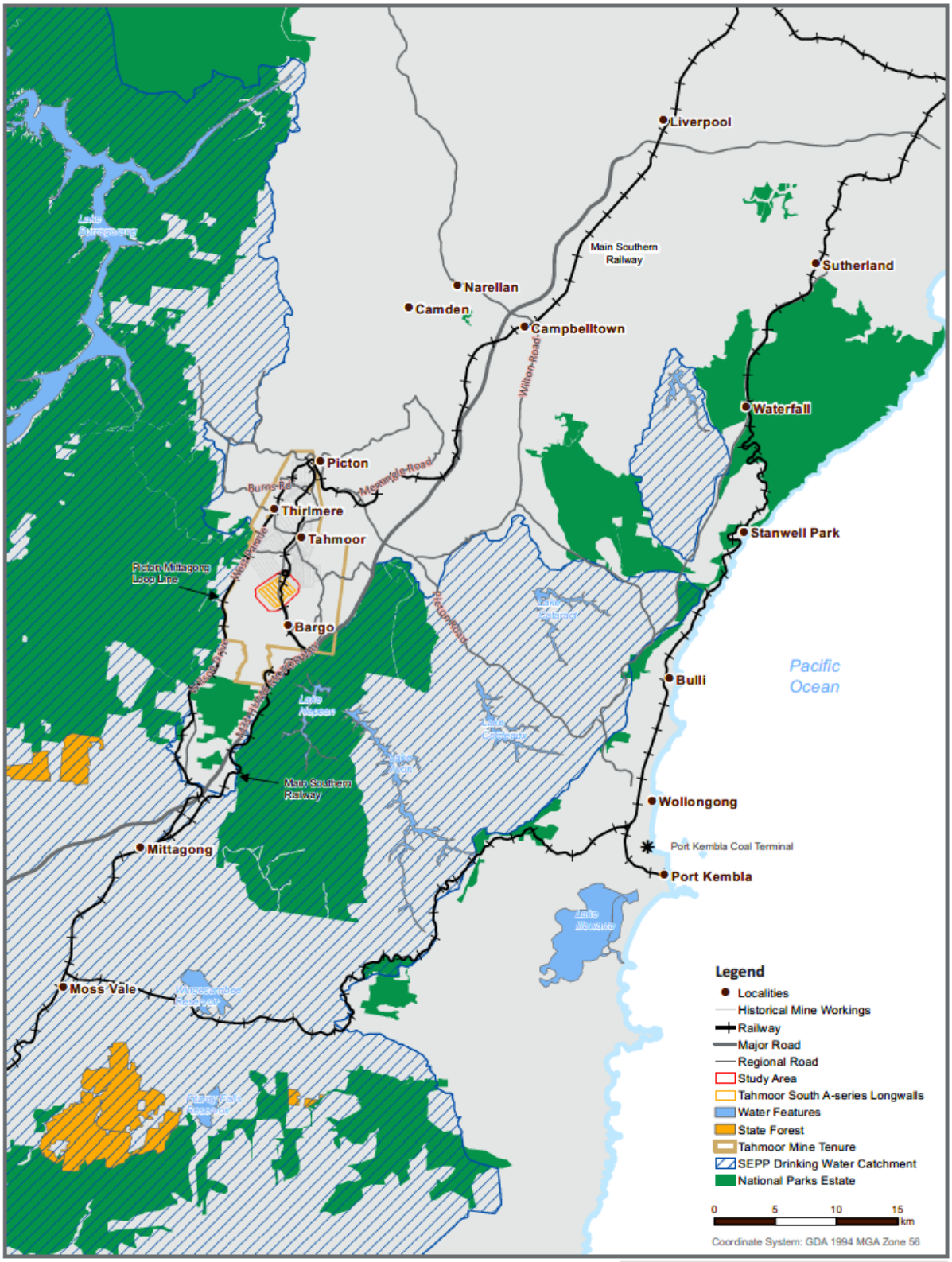


Figure 1 **Regional Context**

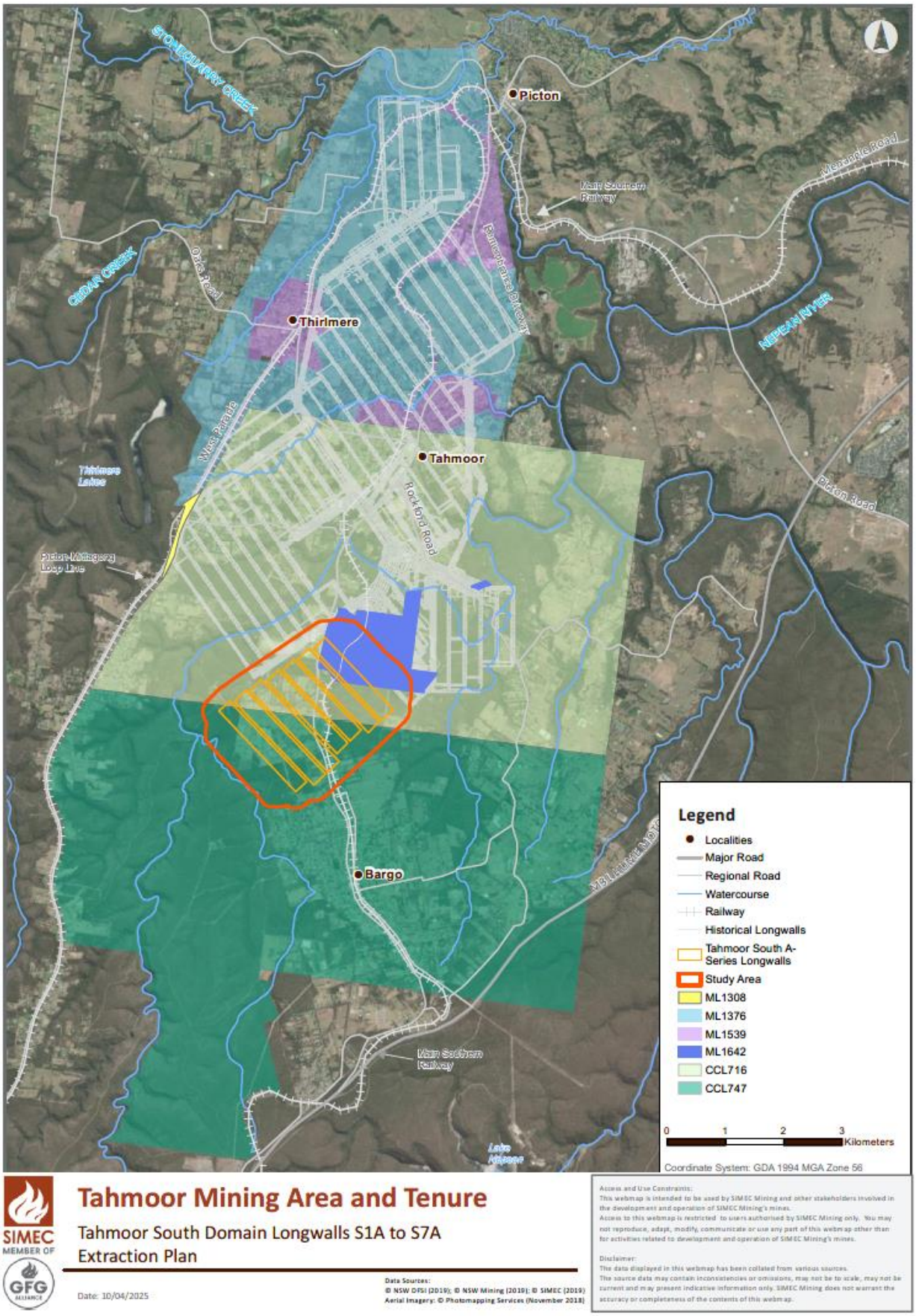


Figure 2 **Tahmoor Mining Areas and Tenure**

2 Extraction Plan Development

2.1 Stakeholder Identification and Engagement

This section provides an overview of the stakeholder engagement process with government agencies and the community, the various engagement activities undertaken, a summary of findings from these activities, and references to where these findings have been incorporated and addressed in this Extraction Plan.

2.1.1 Community Consultation

Tahmoor Coal has a long history of successful engagement with the local community in which it operates, striving to sustain positive relationships through a process of ongoing consultation and interaction. Stakeholder communication is undertaken in accordance with the *TAH-HSEC-00031 - Community Development Plan, TAH-HSEC-00120 – Community Complaints and Enquiry Procedure* and the *TAH-HSEC-00039 – Stakeholder Engagement Plan*.

A number of community consultation mechanisms are utilised throughout each phase of mining for current and future mining (including Tahmoor South Domain LW S1A-S7A, past mining areas, exploration activities, and general enquiries). These consultation mechanisms include:

- Written correspondence (e.g. Resident Information Packs, letters, newsletters, emails);
- Display of newsletters at local shopping centre;
- Meetings (face to face or phone);
- Door knocking;
- Periodic community drop-in sessions;
- 24hr call line for enquiries;
- Provision of contact details for Tahmoor Coal Representatives;
- Publication of information on the Tahmoor Coal Website; and
- Provision of information at the Tahmoor Colliery Community Consultative Committee (TCCCC) (quarterly meetings).

2.1.2 Identification of Key Stakeholders

Consultation has been completed in accordance with Condition C8 of SSD 8445, which outlines relevant stakeholders to be consulted in the development of the Extraction Plan and key sub-plans. The purpose of this consultation was to provide stakeholders with an overview of the proposed development and to seek input during the development of key sub-plans and other documents prepared in support of the LW S1A-S7A Extraction Plan described in **Section 4** of this document.

Table 2 provides an overview of stakeholders that have been consulted with during the preparation of this Extraction Plan primarily in accordance with the consultation requirements of SSD 8445.

Table 2 Stakeholders Consulted during the preparation of the LW S1A-S7A Extraction Plan

SSD 8445 Condition	Component	SSD 8445 Consultation Requirements	Additional Stakeholders Consulted
C8(b)	Preparation of Extraction Plan	• Department of Regional NSW - Resources Regulator (Resources Regulator (Subsidence)) • DPE – Water (DPE Water) (now NSW DCCEEW – Water) • Subsidence Advisory NSW	• DPE (Resource Assessments) (now NSW DPHI) • Department of Regional NSW - Resources Regulator (Resources Regulator) (Mining Act Inspectorate) • Department of Regional NSW – Mining Exploration and Geoscience (MEG)
C8(d)	Consultation for mine planning (in relation to mine roof and floor conditions)	• Resources Regulator (Subsidence)	-
C8(g)(i)	Preparation of Subsidence Monitoring Plan	• Resources Regulator (Subsidence)	-
C8(g)(ii)	Preparation of Built Features Management Plan	• Resources Regulator (Subsidence) • NSW Environment Protection Authority (EPA) • Owners of potentially affected features	• Dams Safety NSW (DSNSW) • Subsidence Advisory NSW • Wollondilly Shire Council (WSC) • Transport for NSW (TfNSW) • Australian Rail Track Corporation (ARTC) • Office of the National Rail Safety Regulator (ONRSR)
C8(g)(iii)	Preparation of Water Management Plan	• DPE Water (now NSW DCCEEW – Water) • DPE - Environment, Energy and Science (EES) Group (part of Biodiversity and Conservation Division (BCD) within the Department) (now NSW DCCEEW – Environment and Heritage)	• NSW Industry – Land & Water – Natural Resources Access Regulator – East (NRAR) • WaterNSW • DSC • EPA
C8(g)(iv)	Preparation of Biodiversity Management Plan	• EES	-
C8(g)(v)	Preparation of Land Management Plan	• Affected public authorities	• NSW Department of Primary Industries – Agriculture (DPI Agriculture) • WSC • DPE - Crown Lands Division (Crown Lands) (now NSW DPHI – Crown Lands)
C8(g)(vi)	Preparation of Heritage Management Plan	• Heritage NSW • WSC • Relevant stakeholders for heritage items (Aboriginal and non-Aboriginal heritage items)	• Registered Aboriginal Parties (RAPs)
C8(g)(vii)	Preparation of Public Safety Management Plan	• Resources Regulator (Subsidence)	-
C9	Approval of Extraction Plan	• DPE (Resource Assessments) (now NSW DPHI)	-

In addition, consultation with the following stakeholders was also undertaken:

- Resource Regulator in accordance with WHS legislation; and
- TCCCC, in accordance with Condition A25 of SSD 8445.

It is noted that the following stakeholders were not consulted with for the preparation of this Extraction Plan:

- Technical Committee required under condition C14: The Bargo Waste Management Centre is not included in the Study Area.
- NSW Department regulating the *Pipelines Act 1976* (now NSW DCCEEW – Climate and Energy Action): The Moomba to Sydney gas pipeline is not in the Study Area. Jemena have been and will continue to be consulted for the management of potential subsidence impacts to local gas pipelines within the Study Area.

A number of requests for information and comments from DPE (now NSW DPHI), the Independent Advisory Panel for Underground Mining (IAPUM), and key Government Agencies were received during the post-submission review stage of the Extraction Plan. This correspondence included:

- DPE letters with comments dated 12 July 2022, 28 July 2022, and 30 August 2022;
- IAPUM final report dated August 2022;
- DPI Agriculture letter with comments dated 3 June 2022;
- Heritage NSW letter with comments dated 6 June 2022;
- DPE Crown Lands letter with comments dated 7 June 2022;
- MEG letter with comments dated 10 June 2022;
- Subsidence Advisory NSW email with comments dated 15 June 2022;
- Resources Regulator letter with comments dated 29 June 2022;
- DPE Water letter with comments dated 1 July 2022;
- WSC letter with comments dated 12 July 2022; and
- DPE BCS (now BCD) letter with comments dated 20 July 2022.

Comments were provided by Tahmoor Coal and reviewed by DPE (now NSW DPHI) as part of the assessment process and have not been included in this Extraction Plan document.

2.1.3 Results and Outcomes of Consultation

Stakeholder engagement has been undertaken with local and State Governments, industry regulators, the local Aboriginal community, affected landowners, and the wider local community during the preparation of this Extraction Plan.

A summary of preliminary consultation with government agencies and stakeholders to date during the preparation of this Extraction Plan is provided in **Table 3**. An additional round of consultation has been completed with government agencies and stakeholders following the submission of the Extraction Plan documents, as facilitated by DPE (now NSW DPHI). This consultation provided an opportunity for detailed comments to be submitted by government agencies and stakeholders regarding the documents, to which Tahmoor Coal has provided a response. This consultation has not been discussed further in the Extraction Plan document.

Following the preparation of draft management plans for the various built features in the Study Area, relevant owners with built features located in or near the Study Area will be consulted to review and endorse the relevant Subsidence Management Plans that outline the management of their built features during LW S1A-S7A extraction. Tahmoor Coal has completed such consultation with built feature owners as part of previous longwalls and has well-established relationships with built feature owners in the local area, who are familiar with the process and structure of the management plans.

The following built feature owners have been / will be consulted regarding the corresponding management plans for built features in or near the Study Area:

- Endeavour Energy for the management of electrical infrastructure;
- Jemena for the management of gas infrastructure;
- Sydney Water for the management of potable water infrastructure and sewer infrastructure;
- Telstra for management of Telstra-managed telecommunications infrastructure;
- NBNCo for management of NBN-managed telecommunications infrastructure;
- TPG for management of TPG-managed telecommunications infrastructure;
- Australian Rail Track Corporation (ARTC) for the management of the Main Southern Railway and associated infrastructure;
- Wollondilly Shire Council (WSC) for management of public roads, culverts and bridges, and the Bargo Cemetery;
- Dams Safety NSW for management of Picton Weir;
- Tahmoor Coal for the management of the Tahmoor Mine Site and associated built structures and infrastructure at 2975 Remembrance Driveway, Bargo;
- Wollondilly Anglican College for the management of the school at 3000 Remembrance Driveway, Bargo;
- Bargo Petroleum and Road Tested Spares for the management of the petrol station and wreckers yard at 3030 Remembrance Driveway, Bargo;
- Inghams for the management of the Inghams Bargo Breeder Farm (chickens) at 3030 Remembrance Driveway, Bargo and the Inghams Turkey Farm at 100-110 Yarran Road, Bargo;
- Tahmoor Garden Centre for the management of the property at 3070 Remembrance Driveway, Bargo;
- National Trust NSW for management of the Australian Wildlife Sanctuary property and structures at 3105 Remembrance Driveway, Bargo;
- MKD Machinery for the management of built structures at 3165 Remembrance Driveway, Bargo;
- Pamak Hobbies for the management of the garden railway at 40 Great Southern Road, Bargo;
- Canine Country Club for the management of built structures at 85 Yarran Road, Bargo; and
- Bargo Valley Product Pty Limited for the management of built structures at 80-90 Yarran Road, Bargo.

In addition, a Built Structures Management Plan has been prepared for the management of privately-owned built structures in the Study Area.

Table 3 Summary of Key Issues Raised and Outcomes of Consultation Undertaken for LW S1A-S7A Extraction Plan (referred to as per previous Department names)

Stakeholder	Description of Consultation	Summary of Comments	Tahmoor Coal Response
NSW Department of Planning and Environment (DPE) – Resource Assessments	A letter seeking approval of suitably qualified and experienced persons to prepare the Extraction Plan was sent on 14 September 2021.	Approval of suitably qualified and experienced persons to prepare the Extraction Plan was received from DPE on 26 November 2021.	Noted.
	A meeting was held between representatives of DPE (Jessie Evans and Gabrielle Allan) and Tahmoor Coal via teleconference on 20 December 2021. This meeting was an opportunity to outline the proposed LW S1A-S6A Extraction Plan, the key features in the Study Area to be monitored and managed, and stakeholder consultation currently in progress.	DPE noted that Jessie Evans is taking over as point of contact for Tahmoor Coal from Stephen O'Donoghue.	Noted.
		DPE asked how the proposed impact to the Aboriginal heritage item (AHIMS Site #52-2-4471, rockshelter) compares to the performance measures.	Tahmoor Coal advised that this would be addressed in the Heritage Management Plan as part of the Extraction Plan. Tahmoor Coal noted that there may be indirect harm and a partial loss of value for the item.
		DPE interested in management of the petrol station during subsidence.	Tahmoor Coal noted that petrol stations have been successfully undermined by previous longwalls at Tahmoor Mine. A subsidence management plan for this property will be prepared to manage impacts from subsidence.
		DPE enquired how many landowners are above the A longwall series.	Tahmoor Coal noted that the number is less than that for the B longwall series and most are situated along Caloola Road and nearby streets. Tahmoor Coal noted that consultation with all residents within the Study Area has started, including the provision of the resident information packs, and offering of Pre-Mining Inspections for those residents within the 20 mm subsidence contour for the first few longwalls. Tahmoor Coal noted that the next round of landholder consultation will be provided early 2022.
		DPIE advised that a meeting with DPE and other government agencies should coincide with lodgement of the Extraction Plan. The meeting should be an overview only to prepare agencies for their review of the Extraction Plan. A site visit should also be included.	Tahmoor Coal will liaise with DPE to set up this meeting and site visit at the time of lodgement of the Extraction Plan.
		DPE advised that there are no set criteria to determine the involvement of the Independent Advisory Panel for Underground Mining (IAPUM), and the decision is made once government agency comments are received and reviewed.	Noted.

Stakeholder	Description of Consultation	Summary of Comments	Tahmoor Coal Response
	A letter introducing the Extraction Plan for LW S1A-S6A was sent on 22 December 2021. Tahmoor Coal provided a figure of the Extraction Plan Study Area, and an overview of the longwalls.	As of 18 May 2022, no response to the letter of consultation has been received from DPE Resource Assessments, however two meetings have been held to discuss the proposal.	Noted.
	A meeting was held between representatives of DPE (Jessie Evans and Gabrielle Allan) and Tahmoor Coal via teleconference on 10 February 2022. This meeting was an opportunity to discuss further the involvement of the Independent Advisory Panel for Underground Mining (IAPUM) for the assessment of the proposed LW S1A-S6A Extraction Plan.	Jessie Evans taking lead on assessment going forward.	Noted.
		Six longwalls of approximately four years for the Extraction Plan assessment has been done previously, and ok to proceed.	Noted.
		Extraction Plans over the last 5 years are getting more complex, as well as underground mining in general, hence the introduction of IAPUM. IAPUM is likely to be involved, however will depend on agency advice and DPE ability / expertise to deal with the matter. IAPUM focus can be broad or narrow, depending on the issues at hand.	Tahmoor Coal asked if it more likely that IAPUM will be involved, can they be involved earlier on? DPE responded that there is no value in having them involved prior to the submission of the Extraction Plan. The Department can brief them earlier. It is an evolving space as to when to involve them. IAPUM receive all the agency advice and DPE briefing.
		Key considerations for the Extraction Plan: • Do the predictions meet the Performance Measures • Details of the TARPs • Sufficient and robust baseline monitoring • Adaptive management planning. Approval will depend on surface features and adaptive management proposed.	Noted.
		How will Wirrimbirra / Australian Wildlife Sanctuary be covered?	Tahmoor Coal responded that an individual subsidence management plan will be prepared, and submitted prior to the start of Longwall South 1A. Tahmoor Coal also noted that there is a good relationship with Wirrimbirra / National Trust NSW and a Land Access Agreement is in place.
		DPE suggested a one hour briefing around the time of lodgement of the Extraction Plan.	Noted.

Stakeholder	Description of Consultation	Summary of Comments	Tahmoor Coal Response
NSW Department of Planning and Environment – Environment, Energy and Science (EES) Group	A letter introducing the Extraction Plan for LW S1A-S6A was sent on 22 December 2021. Tahmoor Coal provided a figure of the Extraction Plan Study Area, and an overview of the longwalls.	A response was received on 3 February 2022.	Noted.
		It is recommended that consideration be given to subsidence impacts to Hornes Creek which currently has good water quality and feeds into the Bargo River near Picton Weir and re-opening of fractures in the Bargo River caused by extraction of longwalls 14 – 19. In both instances, this will require an appropriate water monitoring program and a clear commitment to undertake the necessary remediation actions, should impacts occur.	Section 5 of the Water Management Plan demonstrates that monitoring locations in the Hornes Creek and Bargo River have been included in the monitoring program for this Extraction Plan. The Water Management Plan TARPs include a commitment for remediation should impacts to these systems occur as a result of longwall mining.
		It is suggested that an update is provided on the progress of the remediation of Myrtle and Redbank Creek which outlines the outcomes of an inspection of Redbank Creek remediation works and data that demonstrates 'success' of this work.	A report on the remediation progress of Myrtle and Redbank Creek is provided in Appendix F of the Water Management Plan.
NSW Department of Planning and Environment – Water (DPE Water)	A letter introducing the Extraction Plan for LW S1A-S6A was sent on 22 December 2021. Tahmoor Coal provided a figure of the Extraction Plan Study Area, and an overview of the longwalls.	A response was received on 1 March 2022 stating there are no preliminary comments at this stage.	Noted.
	The over-arching Tahmoor South Surface Water Management Plan was sent to DPE Water for review on 14 December 2021. Comments were received on 19 January 2022, and one comment was relevant to this Extraction Plan.	DPE Water requested that a record of pre- and post-subsidence state of key rock bars and pools be maintained for review of impact predictions reporting.	Pre-mining and post-mining monitoring of rockbars and pools is included in the monitoring program, as discussed in Section 5 of the Water Management Plan. This will include photographic record of these features for future reference.
NSW Department of Planning and Environment – Crown Lands Division (Crown Lands)	A letter introducing the Extraction Plan for LW S1A-S6A was sent on 22 December 2021. Tahmoor Coal provided a figure of the Extraction Plan Study Area, and an overview of the longwalls.	A response was received on 2 February 2022.	Noted.
		It is envisaged that the purpose of the "Study Area" and "600m Study Area for Natural Features" outlined in the Extraction Plan, attached to your letter, will best be further explained in the plan.	The definition and purpose of the Study Area and 600 m Study Area for Natural Features is discussed in **Section 3.1.1** of this document.
		Mitigation of impacts on the Bargo River and other watercourses, as a consequence of the longwall extraction works will need to be addressed in the plan.	The Water Management Plan TARPs include a commitment for remediation of watercourses, should impacts to these systems occur as a result of longwall mining.

Stakeholder	Description of Consultation	Summary of Comments	Tahmoor Coal Response
		Within the Longwall area, there is a substantial amount of Crown Land. This Crown Land includes Dedication 500432 managed by The National Trust of Australia for Conservation of Native Flora, Fauna (45.03 ha) including Lot 33 DP 751250, Lot 18 DP 751250, Lot 19 DP 751250, all on the eastern side of Remembrance Drive.	Land associated with the Australian Wildlife Sanctuary (managed by The National Trust of Australia) will be managed in accordance with the Australian Wildlife Sanctuary Management Plan. This land includes the three land parcels noted in the comment from Crown Land. This management plan will be prepared in consultation with The National Trust, and will be finalised prior to the commencement of Longwall South 1A extraction. Further information on management plans to be prepared for infrastructure and structures is provided in **Section 2.1.2** and **Table 5**.
		This reserve is adjoined by other Crown reserves e.g. R751250 (1784 ha), a Parish reserve for Bargo, Camden with purpose of future public requirements, environmental studies and training purposes.	There are numerous lots for DP751250, however they do not appear to contain any structures. Any waterways or dams contained within these reserve lots will be managed in accordance with the Water Management Plan. The management of flora and fauna within the Study Area will be in accordance with the Biodiversity Management Plan.
		Within the 600 m Study Area for Natural Features, identified in the Extraction plan, the Wingecarribee Shire Council holds Licence No 625498 (a Section 2.20 licence – Short Term Licence Type 1a – Combined) with Crown lands for Environmental Protection, which includes Lot 7311 DP 11410250. The account area for this licence is 9397 ha of Crown Land, so extends well beyond the Study Areas identified.	The land mentioned does not appear to contain any structures. Any waterways or dams contained within these reserve lots will be managed in accordance with the Water Management Plan. The management of flora and fauna within the Study Area will be in accordance with the Biodiversity Management Plan.
		The Crown Land area between Bargo and Tahmoor is understood to support numerous Endangered Ecological Communities and Threatened Species of Flora and Fauna. The Extraction Plan will need to address mitigation of adverse impacts of the extraction operation on flora and fauna within the Study Areas.	The Biodiversity Management Plan confirms the presence of any Endangered Ecological Communities and Threatened Species (flora and fauna) in the Study Area, as well as outlining the proposed management of ecology during mining of LW S1A-S6A.

Stakeholder	Description of Consultation	Summary of Comments	Tahmoor Coal Response
		Further, access arrangements to be made by Tahmoor Coal Pty Ltd are not to adversely impact any Crown Land within the Study Areas.	Access to Crown Land for the purpose of monitoring will be arranged by Tahmoor Coal, and will be rehabilitated following the completion of monitoring. As per condition A39 of SSD 8445, Tahmoor Coal will consult with Crown Land and enter into a compensation agreement prior to undertaking any new development on Crown Land or Crown Roads.
		Surface disposal areas for material from the underground longwall sites will likely be documented in the plan. It is desirable that arrangements for disposal of spoil do not adversely impact on public land (including Crown land) in the environs.	This Extraction Plan discusses the management of potential impact from the extraction of LW S1A-S6A only. Details on the REA and any proposed changes as a result of proposed longwall extraction in the Tahmoor South Domain are documented in the EIS and two Amendment Reports, which were reviewed as part of the approval of SSD 8445. As per condition A39 of SSD 8445, Tahmoor Coal will consult with Crown Land and enter into a compensation agreement prior to undertaking any development on Crown Land or Crown Roads.
Department of Regional NSW - Resources Regulator (Resources Regulator)	A letter introducing the Extraction Plan for LW S1A-S6A was sent on 22 December 2021. Tahmoor Coal provided a figure of the Extraction Plan Study Area, and an overview of the longwalls.	A response was received on 23 December 2021 from Resources Regulator requesting a subsidence monitoring plan for the proposed longwalls.	Tahmoor Coal provided a copy of the Subsidence Monitoring Plan on 14 May 2022 to Resources Regulator for review. Tahmoor Coal recognised that Far Field assets would form part of the monitoring plan.
	As part of operational approvals for first workings in the Tahmoor South Domain, Tahmoor Coal has submitted notification of various High-Risk Activities which refer to the geological conditions including the roof and floor and comparison to existing conditions in Tahmoor North which are well understood by the Resource Regulator.	All of these notifications have been accepted without objection by the Resource Regulator.	Operations have been conducted in Tahmoor South for over thirty years with the knowledge and approval of the Resources Regulator. The area Tahmoor operations is conducting first workings in currently (referred to as Tahmoor South) is bounded on two sides to the north -east and southeast by old workings and as such the geology of this area is well understood on a macro level. This knowledge is compounded by the fact that no significant geological structures have been encountered within these workings or identified in exploration boreholes, the roof and floor geology throughout the longwall blocks laid out throughout Tahmoor South is therefore well understood.
Department of Regional NSW - Resources Regulator (Mining Act Inspectorate)	A letter introducing the Extraction Plan for LW S1A-S6A was sent on 22 December 2021. Tahmoor Coal provided a figure of the Extraction Plan Study Area, and an overview of the longwalls.	A response was received on 25 January 2022 stating there are no specific comments at this stage.	Noted.

Stakeholder	Description of Consultation	Summary of Comments	Tahmoor Coal Response
Department of Regional NSW – Mining Exploration and Geoscience (MEG)	A letter introducing the Extraction Plan for LW S1A-S6A was sent on 22 December 2021. Tahmoor Coal provided a figure of the Extraction Plan Study Area, and an overview of the longwalls.	A response was received on 27 January 2022 stating that comments will be provided on review of the submitted Extraction Plan documents.	Noted.
NSW Infrastructure - Land & Water - Natural Resources Access Regulator (NRAR)	A letter introducing the Extraction Plan for LW S1A-S6A was sent on 22 December 2021. Tahmoor Coal provided a figure of the Extraction Plan Study Area, and an overview of the longwalls.	As of 18 May 2022, no response to the letter of consultation has been received from NRAR.	Noted.
WaterNSW	A letter introducing the Extraction Plan for LW S1A-S6A was sent on 22 December 2021. Tahmoor Coal provided a figure of the Extraction Plan Study Area, and an overview of the longwalls.	A response was received on 10 January 2022.	Noted.
		WaterNSW confirmed that the Study Area is located outside the Sydney Drinking Water Catchment (SDWC) and Special Areas.	Noted.
		WaterNSW recommends that the proposed LW S1A-S6A Extraction Plan, including the Surface Water Management Plan, confirm the WaterNSW's assessment on the SDWC and detail relevant monitoring and management measures. This assessment concluded that the impact on SDWC would be insignificant due to 4 assumptions listed in the consultation letter.	Impacts to the Sydney Drinking Water Catchment and Special Areas are not predicted to occur. Monitoring and management measures for surface water features are detailed in the Water Management Plan.
		WaterNSW recommends that the Extraction Plan considers WaterNSW Mining Principles and Water Monitoring Guidelines for Underground Mining Activities even though the application area is located outside the SDWC and Special Areas. These documents are part of current accepted Best Recommended Practice for managing mining impacts in NSW.	These guidelines are considered in Section 5 of the Water Management Plan.
Heritage NSW	A letter introducing the Extraction Plan for LW S1A-S6A was sent on 22 December 2021. Tahmoor Coal provided a figure of the Extraction Plan Study Area, and an overview of the longwalls.	A response was received on 13 March 2022 stating there are no specific comments on the proposed extraction.	Noted.
Dams Safety NSW (DSNSW)	A letter introducing the Extraction Plan for LW S1A-S6A was sent on 22 December 2021. Tahmoor Coal provided a figure of the Extraction Plan Study Area, and an overview of the longwalls.	A response was received on 11 March 2022 stating, as there are no declared dams or notification areas in the area, DSNSW has no further comments on the proposed extraction.	Noted.

Stakeholder	Description of Consultation	Summary of Comments	Tahmoor Coal Response
NSW Environment Protection Authority (EPA)	A letter introducing the Extraction Plan for LW S1A-S6A was sent on 22 December 2021. Tahmoor Coal provided a figure of the Extraction Plan Study Area, and an overview of the longwalls.	A response was received on 11 January 2022 stating there are no specific comments on the proposed extraction.	Noted.
NSW Department of Primary Industries – Agriculture (DPI Agriculture)	A letter introducing the Extraction Plan for LW S1A-S6A was sent on 22 December 2021. Tahmoor Coal provided a figure of the Extraction Plan Study Area, and an overview of the longwalls.	A response was received on 4 February 2022.	Noted.
		A full assessment of the agricultural land uses in the area that may be potentially impacted so any agricultural developments and associated enterprises in the area are considered in terms of identified risks and economic disruption particularly with subsidence.	An Agricultural Impact Statement was prepared for the first Amendment Report for SSD 8445 approval. For this Extraction Plan, a Land and Agricultural Resource Assessment (SLR, 2022b) has been prepared to complement the information from the Agricultural Impact Statement, and provide any updates on agricultural development impacts from the proposed longwalls.
		Consult with the owners / managers of affected and adjoining neighbours and agricultural operations in a timely and appropriate manner about: the proposal, the likely impacts and suitable mitigation measures or compensation.	Consultation with owners of agricultural businesses in the Study Area has commenced. Tahmoor Coal will continue to consult with the owners during the preparation of a subsidence management plans for each individual agricultural business, and will monitor and manage potential impacts to the properties in accordance with these management plans. Further information on management plans to be prepared for built features is provided in **Section 2.1.2** and **Table 5**. In addition, all landowners in the Study Area have been informed by an information packaged delivered by mail of the proposed development and the subsidence impact claims process in the event that their property is damaged by mining.
		Consider possible cumulative effects to agricultural enterprises and landholders from subsidence/ other impacting events.	Given the described impacts are of a minor nature and readily managed through application of appropriate mitigation measures and management strategies, any resulting cumulative impacts on agricultural resources and enterprises are also expected to be minor and readily mitigated.
		An assessment of the monitoring regime that will identify any changes as a result of the effects of the longwall mining,	Tahmoor Coal will consult with the agricultural business owners during the preparation of subsidence management

Stakeholder	Description of Consultation	Summary of Comments	Tahmoor Coal Response
		especially subsidence. This may include impacts of farm infrastructure i.e. buildings, fences, slope changes, water supply infrastructure.	plans for each individual agricultural business, and will monitor and manage potential impacts to the properties in accordance with these management plans. Further information on management plans to be prepared for built features is provided in **Section 2.1.2** and **Table 5**.
		In relation to the poultry enterprises that exist in the area, that these owner / managers as well as the processors / owners of the birds be consulted to ensure that production plans can be adjusted if required. This should have at least for 12 month period of mining activity.	Tahmoor Coal will consult with the agricultural business owners during the preparation of subsidence management plans for each individual agricultural business, and will monitor and manage potential impacts to the properties in accordance with these management plans. Further information on management plans to be prepared for built features is provided in **Section 2.1.2** and **Table 5**.
		For protected cropping enterprises (glasshouses) located in the impacted area, the slope of the glasshouses is critical for efficient irrigation so subsidence may be a potential issue. This may also be an issue for other open horticultural enterprises e.g. olives if they are irrigated with a dripper system.	Tahmoor Coal will consult with the agricultural business owners during the preparation of management plans for each individual agricultural business, and will monitor and manage potential impacts to the properties (including hothouses and greenhouses) in accordance with these management plans. Further information on management plans to be prepared for built features is provided in **Section 2.1.2** and **Table 5**.
		Dust can also be an issue for greenhouse / glasshouse light transmission so this needs to be addressed if dust levels are an issue above ground.	The extraction of LW S1A-S6A involves the extraction of six underground longwall panels and as such there will be no impact to air quality resulting from this extraction activity. All other activities associated with the Tahmoor South Project that have the potential to create dust will be undertaken in accordance with the approved Air and Greenhouse Gas Management Plan for any onsite construction as well as the ongoing operation of Tahmoor Mine.
		With water quality any increase in the total dissolved salts (TDS) or an increase in sodium level will be a limitation to any horticultural system relying on hydroponics or fertigation.	There is no predicted increase in total dissolved salts or sodium in groundwater bores associated with LW S1A-S6A. This is discussed further in the Land and Agricultural Resource Assessment (SLR, 2022b).
Subsidence Advisory NSW	A letter introducing the Extraction Plan for LW S1A-S6A was sent on 22 December 2021. Tahmoor Coal	A response was received on 2 February 2022 stating that specific feedback on the proposed application will be	Noted.

Stakeholder	Description of Consultation	Summary of Comments	Tahmoor Coal Response
	provided a figure of the Extraction Plan Study Area, and an overview of the longwalls.	provided when supporting documentation has been finalised.	
		It is noted that the proposed layout includes panels that are located further to the south and southwest and of greater length than those shown in the layout submitted as part of SIMEC's project approval. Supporting documentation should include a comparison between extraction and project approval regarding predicted impacts to residential dwellings.	Tahmoor Coal confirms that the longwall layout has been straightened up, resulting in lengthening of the A series longwalls and shortening of the B series longwalls in the Tahmoor South Domain. However, as discussed in the Subsidence Predictions and Impact Assessment Report by MSEC (2022; **Appendix A**), there is no real net effect in subsidence impact to residential dwellings as a result of this change. Refer to Section 1.1 of **Appendix A** for further information.
Transport for NSW (TfNSW)	A letter introducing the Extraction Plan for LW S1A-S6A was sent on 22 December 2021. Tahmoor Coal provided a figure of the Extraction Plan Study Area, and an overview of the longwalls.	A response was received on 8 March 2022 from TfNSW (Southern Region) requesting a map showing the proposed longwalls in relation to Picton Road, Hume Highway and Victoria Bridge.	MSEC provided the requested map on 9 March 2022.
		Following a review of the closest distances from the mining area to TfNSW assets, TfNSW (Southern Region) responded on 11 March 2022 that, as TfNSW assets are more than five times the depth of cover, there are no further comments for the Extraction Plan.	Noted.
		A response was received on 9 March 2022 from TfNSW (Sydney Region) stating that there are no further requirements are recommended.	Noted.
		It was noted by TfNSW (Sydney Region) that consent under Section 138 of the *Roads Act 1993* would be required for any proposed longwall extension adjacent to or under the Hume Highway, or any road/rail within the TfNSW network, as well as any works within the classified reserve. If any such work was to occur, the proponent would also need to enter into a Deed of Agreement.	As confirmed by TfNSW (Southern Region), Tahmoor Coal are more than five times the depth of cover from TfNSW assets. Therefore, these requirements are not applicable to the proposed longwalls.
		TfNSW (Sydney Region) advised that consideration should be given to the impacts of any additional traffic generated by the proposed extension of longwall mining operations.	Tahmoor Coal confirm that there will be a negligible increase in traffic generated as a result of the proposed longwalls.
		Further comments may be provided when the LW S1A-S6A Built Features Management Plan is made available as these works may impact Remembrance Driveway and the nearby school zone associated with Wollondilly Anglican College.	Noted.

Stakeholder	Description of Consultation	Summary of Comments	Tahmoor Coal Response
		TfNSW has previously resumed and dedicated a strip of land as road along the Remembrance Driveway frontage of the subject property.	Noted.
		No objections are raised to the development proposal on property grounds provided all buildings and structures, together with any improvements integral to the future use of the site are wholly within the freehold property (unlimited in height or depth) along the Remembrance Drive boundary.	Noted.
Office of the National Rail Safety Regulator (ONRSR)	A letter introducing the Extraction Plan for LW S1A-S6A was sent on 23 December 2021. Tahmoor Coal provided a figure of the Extraction Plan Study Area, and an overview of the longwalls.	A response was received on 12 January 2022 from Resources Regulator requesting the draft plan for the proposed longwalls.	Tahmoor Coal advised that the Tahmoor South Rail Management Plan is scheduled for delivery by 500 metres of extraction of Longwall South 1A (estimated January 2023), and will be provided to ONRSR at this time. ONRSR have been involved in discussions regarding the Tahmoor South Rail Risk Assessment on 28 August 2021.
Australian Rail Track Corporation (ARTC)	A letter introducing the Extraction Plan for LW S1A-S6A was sent on 23 December 2021. Tahmoor Coal provided a figure of the Extraction Plan Study Area, and an overview of the longwalls.	As of 1 May 2022, no response to the letter of consultation has been received from ARTC.	Noted. ARTC have been involved in discussions regarding the Tahmoor South Rail Risk Assessment completed on 28 August 2021.
Wollondilly Shire Council (WSC)	A letter introducing the Extraction Plan for LW S1A-S6A was sent on 22 December 2021. Tahmoor Coal provided a figure of the Extraction Plan Study Area, and an overview of the longwalls.	A response from Council's Assets and Transport Team was received on 21 January 2022.	Noted.
		Council noted that they can only effect repairs to road pavement in the event of an emergency. All other repairs are required to be carried out by Tahmoor Coal to the satisfaction of Wollondilly Shire Council's Construction Specifications. Suitably qualified civil contractors employed by Tahmoor Coal must be available to complete temporary restoration works as required, and after to complete the final restoration works. All cracks/damage to kerb and gutter, footpaths, drainage structure and property entrances are the responsibility of Tahmoor Coal and must be managed throughout the length of the mining activity, and permanent repairs carried out to the satisfaction of the property owner (either Council or a private party) upon the completion of any subsidence activity.	Noted. The Wollondilly Shire Council Management Plan outlines the requirements for road mitigation works in the event of damage to public roads, kerbs, gutters, footpaths or property entrances as a result of longwall subsidence.

Stakeholder	Description of Consultation	Summary of Comments	Tahmoor Coal Response
		A response from Council's Waste and Environmental Services Team was also received on 14 February 2022.	Noted.
		It is understood that the longwalls covered by the Extraction Plan are at a sufficient distance to not result in any subsidence induced impacts to the operation of the Bargo Waste Management Centre. However, clarification by SIMEC of this understanding would be appreciated.	The Bargo Waste Management Centre is located more than 1 kilometre from the proposed LW S1A-S6A and is situated outside of the 20 mm subsidence impact area (and Study Area). Therefore, it is unlikely that the proposed longwalls will result in any subsidence induced impacts to the operation of this facility.
		Council would expect in this regard that the Extraction Plan involve a detailed consultation program as well as identification to the greatest accuracy possible likely subsidence-related impacts to dwellings over the full duration of a particular longwall.	A Social Impact Management Plan is being prepared which will include a detailed community engagement plan. A Built Features Management Plan will also be prepared covering the predicted subsidence-related impacts and risk management to dwellings located over LW S1A-S6A.
		The Independent Planning Commission is noted to have included a condition in the Determination "for the voluntary acquisition rights for properties affected by certain types of damage that are impacted by more than one longwall". It is requested to be noted Council does not have a formal position over such acquisition. However, the offering of this process as an alternative and detailed explanation of its potential negative and positive implications to landowners would be expected.	Tahmoor Coal offers weekly visual inspections to landowners during the active subsidence periods. Should any damage be assessed that meets the voluntary acquisition requirements, Tahmoor will assess this on a case-by-case basis and liaise with government agency, Subsidence Advisory NSW who administers the *Coal Mine Subsidence Compensation Act 2017* and has guidelines for property acquisition for subsidence damage.
		An assessment of impacts to surface and groundwaters be consistent with all current scientific research that includes the Characterisation and Modelling of Geological Fault Zones Guideline publication available on the Commonwealth Independent Expert Scientific Committee (IESC) website.	An assessment of potential impacts for surface water and groundwater, as presented in Section 4 of the Water Management Plan, has been complete in accordance with current scientific research.
		A detailed geological model that identifies the likely interaction of subsidence induced fractures with the modelled groundwater environment as part of complying with the IESC publication.	The Tahmoor South Geological Model has been updated, as discussed in the Groundwater Technical Report in Appendix E of the Water Management Plan.
		A scientific based investigation over the establishment of Risk Management Zones for third order watercourses for the purposes of identifying and managing impacts associated with subsidence to the ecological health of waterways within a catchment context.	Management of watercourses in the Study Area, including those of third order, is provided in Sections 4, 5 and 6 of the Water Management Plan.

Stakeholder	Description of Consultation	Summary of Comments	Tahmoor Coal Response
		An assessment of potential impacts of mining activities to the operation of private bores and mitigation measures to address any identified potential adverse implications.	Potential impacts to privately owned bores and the monitoring and management measures proposed is provided in Sections 4.3.3, 5 and 6.2.1 of the Water Management Plan.
		Trigger Response Action Plans and related monitoring programs that are developed as part of the Extraction Plan and Water Plan are to be scientifically based, supported by commensurate data. They are requested in this regard to include appropriate ecological focussed indicators to monitor any impacts to the ecological health of waterways at a suitable timeframe that would restrict the need for Creek Management Action Plans.	TARPs for surface water and groundwater that meet these requirements are provided in **Appendix B**, as well as Appendix A of the Water Management Plan.
Tahmoor Colliery Community Consultative Committee (TCCCC)	Quarterly meetings are held with the Tahmoor Colliery Community Consultative Committee (TCCCC) and representatives of Tahmoor Coal at the Tahmoor Mine or via teleconference. These meetings are an opportunity to provide the TCCCC with an update of activities at Tahmoor Mine, as well as details of the proposed LW S1A-S6A Extraction Plan. The LW S1A-S6A Extraction Plan was introduced at the TCCCC meeting on 2 December 2021.	A TCCCC Committee Member asked if Picton Weir was within the LW S1A-S6A Extraction Plan Study Area and if it would be impacted.	Tahmoor Coal responded that the Picton Weir was not within the Study Area, however in accordance with the precautionary approach, a management plan for the structure would be prepared as part of the Extraction Plan.
	The LW S1A-S6A Extraction Plan was introduced at the TCCCC meeting on 3 March 2022.	A TCCCC Committee Member asked if the quality of coal to be extracted from the Tahmoor South longwalls would be similar to that which is currently being extracted.	Tahmoor Coal responded that yes, the coal quality is similar, as is evident from old longwalls near the proposed Tahmoor South Longwalls.
		David Henry (Wollondilly Shire Council Representative) advised that the Thirlmere Lakes Research Program report has been delayed and will be ready in 3-4 weeks pending ministerial approval. Martin Krogh (DPE) will notify Council once the report is approved, and it will be circulated to TCCCC.	Noted.
Registered Aboriginal Parties	EMM Heritage Consultants, on behalf of Tahmoor Coal, sent a letter via email on 17 January 2022 to 29 Registered Aboriginal Parties (RAPs) (refer to the	The Kamilaroi Yankuntjatjara Working Group provided interim feedback stating that the rockshelter Teatree Hollow 2013.1 was of high cultural value, further investigation of the site was needed, and options for protective measures be	EMM and Tahmoor considered options to address this feedback through developing site management measures with a focus on archaeologically investigating the rockshelter. This was done with the aim to provide a positive

Stakeholder	Description of Consultation	Summary of Comments	Tahmoor Coal Response
	Heritage Management Plan for a list of RAPs) to inform them of the upcoming Heritage Management Plan scope.	considered. Cubbitch Barta also responded during this period reiterating the high cultural value of the rockshelter and advocated for the site's protection.	cultural heritage output by contributing to Aboriginal archaeology of the local area.
	On 1 April 2022, EMM provided the draft Heritage Management Plan for RAP review and feedback. This version included options for ochre pigmentation sampling and test excavation in the draft Heritage Management Plan. A further draft of the Heritage Management Plan, along with details of a test excavation methodology for the rockshelter with art and stone artefacts was also provided to RAPs on 19 April 2022. On 14 August 2025, EMM provided the updated draft Heritage Management Plan incorporating LW S7A for RAP review and feedback.	Through further consultation during the draft HMP period, it was determined that archaeological test excavation was the most appropriate method to pursue to wholistically address RAP feedback gathered during the HMP consultation process. Following distribution of the updated draft HMP in August 2025, four groups responded with comments. Guntawang Aboriginal Resources Incorporated and Thomas Dahlstrom agreed with the recommendations of the HMP. Corroboree Aboriginal Corporation recommended that fieldwork be shared equally among the RAPs. Cubbitch Barta provided detailed feedback, supporting the recording of rock shelters and advising that no site should be assigned a low level of significance. They further recommended that all sites in Hornes Creek be considered of high cultural significance, as they "still exist today, the way the ancestors left them". They also included a request for clarification on who will undertake fortnightly monitoring inspections of the shelters.	The Heritage Management Plan provide details about the proposed test excavation, as well as further detail regarding consultation with RAPs during the preparation of this Extraction Plan. The significance of the sites in the HMP adopts those outlined in the existing Aboriginal cultural heritage assessment. It is acknowledged that these rankings primarily apply scientific significance to the classification and may contrast from views of specific Aboriginal individuals or parties. Rockshelter visual inspections will be conducted by a geotechnical engineer (PSM), and following completion of longwall panels a visual inspection will be undertaken by an archaeologist with RAPs, as detailed in HMP TARP – HMP1 Aboriginal Cultural Heritage Sites.
Landowners of private property within the LW S1A-S6A Study Area	Letters of consultation were sent to all landowners of private property within the LW S1A-S6A Study Area on 24 August 2021 informing residents of upcoming first and second workings. These letters included a Resident Information Pack and information about LW S1A-S6A, as well as an offer to landowners for the completion of a Pre-Mining Inspection.	Responses to this correspondence have been received with requests for PMIs.	PMIs have been scheduled where requested. Going forward, Tahmoor Coal will conduct regular consultation with landowners / occupiers in the Study Area as LW S1A commences and during extraction of LW S1A-S6A. This will include consultation via letter box drops and door knocking. A Community Drop-In session was held on 28 July 2022 at the Bargo Community Hall. Tahmoor Coal is currently in the process of consulting with built feature owners in the Study Area for the preparation of management plans for each individual built feature and will monitor and manage potential impacts to built features in accordance with these management plans.
Landowners of private property within the LW S7A Study Area	Letters of consultation were sent to all landowners of private property within the LW S7A Study Area on 30 May 2025 informing residents of the Mod 3 (LW S7A) approval. Resident Information Packs were previously	No landowner responses or enquiries received.	

Stakeholder	Description of Consultation	Summary of Comments	Tahmoor Coal Response
	provided to residents in the LW S7A Study Area on 1 November 2023.		

2.2 Subsidence Background

2.2.1 History of Mine Plan Changes for the Tahmoor South Domain

The Tahmoor South Domain mine plan has undergone a series of amendments since the issue of the first EIS for the Tahmoor South Project in 2014. These mine plan revisions are summarised below:

- EIS Submission (2014): Original EIS submission, which was placed on hold and subsequently withdrawn in late 2015;
- EIS Submission (January 2019): Updated EIS submission based on revised Planning Secretary's Environmental Assessment Requirements (SEARs) issued in June 2018;
- Project Amendment Report (February 2020): The mine design was modified to reduce potential environmental impacts of the Project through the reduction in the extent of longwall mining. This was achieved by the following modifications:
    i. Removal of LW 109, which was located directly beneath Dog Trap Creek. This would result in elimination of direct impacts to Aboriginal heritage items;
    ii. Configuration of the longwall layout to comprise two series of shorter longwall panels;
    iii. Reduction in the proposed longwall width, from approximately 305 m to approximately 285 m;
    iv. Reduction in the height of extraction within the longwall panels from up to 2.85 m to up to 2.6 m;
- Second Amendment Report (August 2020): The mine design was again modified to further reduce potential environmental impacts. This included the removal of two longwalls in the southern part of the mine near the township of Bargo (LW 107B and LW108B), which would result in a reduction in magnitude of subsidence impacts.

The numerous modifications of the Tahmoor South Domain mine plan have resulted in a reduction of the magnitude and extent of subsidence impacts, as well as avoidance of significant impact to sensitive surface features of the environment, including Aboriginal heritage items.

The current mine plan proposes to complete underground mining with access to the Tahmoor South Domain provided from the existing pit top facilities. This mine design consideration minimises surface impacts from mining through the avoidance of establishing new surface facilities.

A number of minor changes have been made to the mine layout since development consent was received. A summary of these minor changes is provided below (MSEC, 2022):

- The layout for LW S1A-S6A has been shifted approximately 35 m to the south-west;
- LW S2A to LW S6A have been widened by 2 m (the width of LW S1A is unchanged);
- Chain pillar widths for the tailgates for LW S3A to LW S6A have been reduced by 2 m (the chain pillar between LW S1A and LW S2A was unchanged);
- The commencing ends of LW S1A-S6A have been aligned, compared to the previous staggered layout. The outcome of the change is that LW S2A to LW S6A have been extended in length. The gap between the A and B series longwalls will be maintained, such that the future B series will be shortened when compared to the mine layout that was submitted for development consent; and

- The planned sequence has been amended, such that the A series longwalls are proposed to be extracted in sequence. During the application for development consent, it was planned that Longwalls 101A to 103A (now renamed Longwalls S1A to S3A) would be extracted first, followed by the B series longwalls, and then the extraction of Longwalls 104A to 106A (now renamed Longwalls S4A to S6A).

Additional changes include:

- LW S3A and LW S4A have been shortened by 104m at the start end;
- The addition of LW S7A (Modification 3) to the west of LW S6A as approved by DPHI on 26 May 2025.

2.2.2 Revised Subsidence Predictions

To support this Extraction Plan, MSEC have revised the subsidence predictions for the proposed longwalls and prepared the following reports:

- MSEC1192 Tahmoor South Project – Extraction Plan for Longwalls S1A to S6A, Subsidence ground movement predictions and subsidence impact assessments for natural features and surface infrastructure (hereafter referred to as the 'Subsidence Predictions and Impact Assessment Report') (MSEC, 2022; refer to **Appendix A**).
- MSEC1348 Tahmoor Coal – Modification 3 – Longwall 7A, The effects of the proposed addition of LW S7A on previous subsidence predictions and impact assessment (MSEC, 2024; refer to **Appendix B**).

Tahmoor Coal considers that these current subsidence predictions are acceptable, and that the current mine plan appropriately balances the requirements of resource recovery, minimisation of environmental impact, and consideration of community and government agency concerns. Maximum predicted subsidence within the study area from the addition of LW S7A (Modification 3) was found to be similar to those based on LW S1A-LW S6A layout. This is because predicted maximum subsidence due to the extraction of the B series longwalls is greater than the A series and the addition of LW S7A does not influence maximum subsidence predictions associated with the B series of longwalls.

If the measured mining induced movements were to be in excess of the predicted values, a review of the model will be undertaken and would include the review of subsidence values and impacts to any surface features within the Extraction Plan Study Area.

2.2.3 Current Methods and Models used by MSEC

The following sections outline the methods and models used by MSEC to provide revised subsidence predictions for the proposed LW S1A-S7A (MSEC, 2022 and MSEC, 2024; refer to **Appendix A** and **Appendix B**). Particular note has been made regarding the process of review of the methods and models used to make predictions of subsidence effects, subsidence impacts and environmental consequences.

2.2.3.1 Incremental Profile Method

The predicted conventional subsidence parameters for the proposed longwalls have been determined using the Incremental Profile Method (IPM), which has been developed by MSEC in 1994. The method is an empirical model based on a large database of observed monitoring data from previous mining within the Southern, Newcastle, Hunter and Western Coalfields of NSW and the Bowen Basin in Queensland. This IPM subsidence prediction model has been continually developed, revised and updated since 1994, as the new additional monitoring data became available, to suite specific local geology and conditions (MSEC, 2022).

For the Tahmoor South Project, the IPM has been based on the Southern Coalfields predictive curves with calibrations for the local conditions, based on the extensive ground monitoring data from Tahmoor Mine.

A discussion on the calibration of the IPM is provided in Section 3.7 of **Appendix A**, while Section 3.8 of **Appendix A** discusses areas where increased subsidence has been observed in comparison with the predictions generated from the IPM**.**

2.2.3.2 2002 ACARP Method

The predicted upsidence and closure movements for the longwalls at Tahmoor Mine have been obtained using the empirical method outlined in Australian Coal Association Research Program (ACARP) Research Project No. C9067 (Waddington and Kay, 2002), referred to as the 2002 ACARP method. A comparison between the measured and predicted valley related effects for previously extracted longwalls at Tahmoor Mine has been provided in Section 3.9 of **Appendix A**.

2.2.3.3 Prediction of Strains

A linear relationship between curvature and strain provides a reasonable prediction for conventional tensile and compressive strains. In the Southern Coalfields, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvature and the predicted maximum conventional strains. This method is effective for predicting typical values when the ground subsides regularly with no localised or elevated strains due to near-surface geological structures or valley closure effects. The maximum strains can be much greater than these typical values and there can be considerable variation from the linear relationship.

The Subsidence Predictions and Impact Assessment Reports (MSEC, 2022 and MSEC, 2024) therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain. The range of potential strains above the proposed LW S1A-S7A has been determined using monitoring data from the previously extracted longwalls at the mine. The range of strains measured during the extraction of these longwalls should, therefore, provide a reasonable indication of the range of potential strains for the proposed LW S1A-S7A. The data used in the analysis of observed strains included those resulting from both conventional and nonconventional anomalous movements, however did not include those resulting from valley related effects.

2.2.3.4 Ground Stain

Ground strain comprises two components, being normal strain and shear strain, which can be interrelated using Mohr's Circle. The magnitudes of the normal strain and shear strain components are, therefore, dependent on the orientation in which they are measured. The maximum normal strains (i.e. principal strains) are those in the direction where the corresponding shear strain is zero.

Normal strains along monitoring lines can be measured using 2D and 3D techniques, by taking the change in horizontal distance between two points on the ground and dividing by the original horizontal distance between them. This provides the magnitude of normal strain along the orientation of the monitoring line and, therefore, this strain may not necessarily be the maximum (i.e. principal) strain.

Shear deformations are more difficult to measure, as they are the relative horizontal movements perpendicular to the direction of measurement. However, 3D monitoring techniques provide data on the direction and the absolute displacement of survey marks and, therefore, the shear deformations perpendicular to the monitoring line can be determined. Shear deformations perpendicular to monitoring lines can be described using various parameters, including horizontal tilt, horizontal curvature, horizontal mid-ordinate deviation, angular distortion and shear index.

Horizontal mid-ordinate deviation has been used as the measure for shear deformation, which is defined as the differential horizontal movement of each survey mark, perpendicular to a line drawn between two adjacent survey marks.

2.3 Extraction Plan Team

In accordance with condition C8(a) of SSD 8445, Tahmoor Coal sought the endorsement of qualified and experienced persons to prepare the Extraction Plan from the Planning Secretary. The appointment of experts was first endorsed in November 2021, and was then reviewed in August 2025. The Director of Resource Assessments (as nominated by the Planning Secretary) endorsed the appointment of the experts listed in **Table 4**.

A copy of the letter of endorsement from DPHI is provided in **Appendix D**.

Table 4 Extraction Plan Team

SSD 8445 Condition	Management Plan and Supporting Documents	Company	Team Member
C8	Extraction Plan Main Document	Tahmoor Coal	Nick Le Baut Natalie Brumby Zina Ainsworth
C8(c)	Graphical Plans	Tahmoor Coal	Justin Smith
C8(e)	Subsidence Predictions and Impact Assessment Report	MSEC	Daryl Kay
C8(g)(i)	Subsidence Monitoring Plan	MSEC	Daryl Kay
C8(g)(ii)	Built Features Management Plan and associated Subsidence Management Plans for individual built features	MSEC	Daryl Kay
C8(g)(iii)	Water Management Plan	HEC / ATC Williams	Anthony Marszalek Camilla West Makaela McGrath
	Supporting surface water documents for the Water Management Plan	HEC / ATC Williams	Anthony Marszalek Camilla West Makaela McGrath
	Supporting groundwater documents for the Water Management Plan	SLR	Sharon Hulbert Raymond Minnaar
C8(g)(v)	Land Management Plan and supporting documents	PSM	Gareth Swarbrick Josselin Ribot
		Douglas Partners	Roderick Haselden Huw Smith Jackson Green
		SLR	Murray Fraser
C8(g)(iv)	Biodiversity Management Plan	Niche Environment and Heritage	Stephen Bloomfield Luke Stone
		Stantec	Dane Fogliada Sean Smith Dan Pygas
C8(g)(vi)	Heritage Management Plan	EMM Consulting	Susan Lampart Anthony Dakhoul Pamela Chauvel Dr Alan Williams

SSD 8445 Condition	Management Plan and Supporting Documents	Company	Team Member
C8(g)(vii)	Public Safety Management Plan	Tahmoor Coal	Nick Le Baut Natalie Brumby Zina Ainsworth

3 Extraction Plan Overview

3.1 Extraction Plan Study Area

3.1.1 Definition of Study Area

The Extraction Plan Study Area is defined as the surface area that is likely to be affected by the extraction of LW S1A-S7A from the Bulli Coal Seam. This Study Area has been calculated by combining the areas bound by the following limits:

- The predicted limit of vertical subsidence, taken as the 20 millimetre (mm) subsidence contour resulting from the extraction of LW S1A-S7A; and
- A 35^{o} angle of draw line from the limit of proposed extraction for LW S1A-S7A.

The Study Area is illustrated in **Figure 3**.

An expansion of the Study Area to 600 m from extraction has also been defined by MSEC (2024) (refer to **Figure 3**). Relevant features within this 600 m buffer could be susceptible to far-field or valley related movements have been included for consideration in the Subsidence Predictions and Impact Assessment Reports (MSEC, 2022 and MSEC, 2024) and within this Extraction Plan and associated documents. The 600 m buffer for natural features has been included based on recommendations in the independent inquiry report titled *Impacts of Underground Coal Mining on Natural Features in the Southern Coalfields – Strategic Review* (NSW Department of Planning (DoP), 2008).

3.1.2 Environmental Features in the Study Area

Topography within the Study Area is generally undulating with a fall from the south-west to the north-east. The major topographical feature in and near the Study Area are Teatree Hollow, Hornes Creek and Bargo River valley, the latter which is located to the north of the Study Area.

Teatree Hollow is located directly above the LW S1A to LW S6A, while the tributary of Teatree Hollow (Wirrimbirra Creek) is located directly above the proposed LW S1A to LW S4A. These are located in the catchment of the Hawkesbury-Nepean River.

The Study Area is located predominantly within the Teatree Hollow catchment which is a sub-catchment of the Bargo River. Small portions of the Study Area and 600 m buffer are also located within the Hornes Creek, Dogtrap Creek and Bargo River catchments. The lower reaches of Teatree Hollow, Dogtrap Creek and the Bargo River have, to varying degrees, experienced subsidence-related effects due to historical mining operations at the Tahmoor Mine.

The surface lithology above the LW S1A-S7A generally comprises the Wianamatta Group, with the Hawkesbury Sandstone exposed in the river gorges and creek alignments within the Study Area (MSEC, 2024). The landscape of the Study Area includes a number of steep slopes.

The Study Area is generally cleared for small scale rural production, while native vegetation is present predominantly in the riparian zones and steep slopes of the Study Area.

The Study Area does not include any Drinking Water Catchment Areas, Declared Special Areas, springs, sea, lake, shoreline, natural dams, escarpments, swamps, wetlands or water related ecosystems, National Parks, State Forests, State Conservation Areas, or areas of significant geological interest (MSEC, 2022).

Table 5 provides a summary of the environmental features within the Extraction Plan Study Area and the Key Sub-Plans and associated documents that discuss and manage these features.

Table 5 Environmental and Built Features within the LW S1A-S7A Extraction Plan Area and Management Plans

Feature	Investigation and Assessment	Management and Monitoring
Natural and Aboriginal Heritage Features		
Waterways	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • Water Management Plan (WMP) • Myrtle Creek and Redbank Creek Remediation Progress Review (ATC Williams, 2022)	• WMP • Subsidence Monitoring Plan
Flood-prone land	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • WMP	• WMP • Subsidence Monitoring Plan
Groundwater	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • WMP • Groundwater Technical Report (SLR, 2024) • Baseline Private Bore Assessment Report (SLR, 2022a)	• WMP • Subsidence Monitoring Plan
Steep slopes and cliffs	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • Land Management Plan (LMP) • Detailed Slope Stability Assessment	• LMP • Subsidence Monitoring Plan • Tahmoor Coal – LW S1A-S7A Management Plan for Potential Impacts to Main Southern Railway, Report No. MSEC1201, 2025 (Revision D) • Tahmoor Coal – LW S1A-S6A Management Plan for Potential Impacts to Tahmoor Mine Site, Report No. MSEC1247, 2023 • Tahmoor Coal – LW S1A-S7A Management Plan for Potential Impacts to Wollondilly Shire Council Infrastructure, Report No. MSEC1193-03, 2025 (Revision D)
Land and soil capability	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • LMP • Geotechnical Assessment (Douglas Partners, 2024) • Geotechnical Assessment (PSM, 2025) • Land and Agricultural Resource Assessment (SLR, 2022b) • Land and Agricultural Resource Assessent (SLR, 2025)	• LMP • Subsidence Monitoring Plan
Aquatic ecology (e.g. threatened or protected species, aquatic habitat)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • Biodiversity Management Plan (BMP)	• BMP • Subsidence Monitoring Plan
Terrestrial ecology (e.g. threatened or protected species, natural vegetation)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • BMP	• BMP • Subsidence Monitoring Plan
Aboriginal heritage	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • Heritage Management Plan (HMP)	• HMP • Subsidence Monitoring Plan • Tahmoor Coal – LW S1A-S6A Management Plan for Potential Impacts to Australian Wildlife Sanctuary, Report No. MSEC1074, 2023 (Revision D)

Feature	Investigation and Assessment	Management and Monitoring
		• Tahmoor Coal – LW S1A-S7A Management Plan for Potential Impacts to Wollondilly Shire Council Infrastructure, Report No. MSEC1193-03, 2025 (Revision D) • Tahmoor Coal – LW S1A-S7A Management Plan for Potential Impacts to Main Southern Railway, Report No. MSEC1201, 2025 (Revision D) Tahmoor Coal – LW S3A-S7A Management Plan for Potential Impacts to Picton Weir, Report No. MSEC1193-12 (Revision C) in April 2025Tahmoor Coal – LW S1A-S6A Management Plan for Potential Impacts to Tahmoor Mine Site, Report No. MSEC1247, 2
Built Features (infrastructure owner in brackets)		
Electrical infrastructure (Endeavour Energy)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • Built Features Management Plan (BFMP)	• BFMP • Subsidence Monitoring Plan • Tahmoor Coal – LW S1A-S7A Management Plan for Potential Impacts to Endeavour Energy Infrastructure, Report No. MSEC1193-07, 2025 (Revision C)
Gas infrastructure (Jemena)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • BFMP	• BFMP • Subsidence Monitoring Plan • Tahmoor Coal – LW S1A-S7A Management Plan for Potential Impacts to Jemena Gas Infrastructure, Report No. MSEC1193-06, 2024 (Revision B), Amendment No. 1 for LW S4A in November 2024
Potable water infrastructure (Sydney Water)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • BFMP	• BFMP • Subsidence Monitoring Plan • Tahmoor Coal – LW S1A-S7A Management Plan for Potential Impacts to Sydney Water Potable Water Infrastructure, Report No. MSEC1193-04, 202 5 (Revision C)
Sewer infrastructure (Sydney Water)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • BFMP	• BFMP • Subsidence Monitoring Plan • Tahmoor Coal – LW S1A-S7A Management Plan for Potential Impacts to Sydney Water Sewer Infrastructure, Report No. MSEC1193-05, 2025 (Revision B)
Telecommunications infrastructure (Telstra, NBNCo and TPG)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • BFMP	• BFMP • Subsidence Monitoring Plan • Telecommunications Management Plan – Tahmoor South Domain – Longwalls South 3A to South 7A - Revision of Telstra, NBN Co and TPG Management Plans for LW S1A-S6A, Tahmoor Coal, June 2024
Main Southern Railway (ARTC)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • HMP • BFMP	• HMP • BFMP • Subsidence Monitoring Plan • Tahmoor Coal – LW S1A-S7A Management Plan for Potential Impacts to Main Southern Railway, Report No. MSEC1201, 2025 (Revision D) •
Public roads, bridges and culverts (Wollondilly Shire Council)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • HMP • BFMP	• HMP • BFMP • Subsidence Monitoring Plan • Tahmoor Coal – LW S1A-S7A Management Plan for Potential Impacts to Wollondilly Shire Council

Feature	Investigation and Assessment	Management and Monitoring
		Infrastructure, Report No. MSEC1193-03, 2025 (Revision D)
Picton Weir (Dams Safety NSW)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • HMP • BFMP	• HMP • BFMP • Subsidence Monitoring Plan • Tahmoor Coal – LW S3A-S7A Management Plan for Potential Impacts to Picton Weir, Report No. MSEC1193-12 (Revision C) in April 2025
Farm dams (privately owned)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • LMP • BFMP	• LMP • BFMP • Subsidence Monitoring Plan • Tahmoor Coal – LW S1A-S7A Management Plan for Potential Impacts to Built Structures, Report No. MSEC1193-09, 2025 (Revision C)
Groundwater bores (privately owned)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • WMP • Groundwater Technical Report (SLR, 2024) • Baseline Private Bore Assessment (SLR, 2022a) • BFMP	• WMP • BFMP • Subsidence Monitoring Plan
Permanent survey control marks (Spatial Services)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • BFMP	• BFMP • Subsidence Monitoring Plan
Wellers Road Overbridge (Transport for NSW)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • HMP • BFMP	• Tahmoor Coal – Management Plan for extraction of Tahmoor South LW S4A-S7A adjacent to Wellers Road Overbridge 2025 (Revision B)
Built Features (property / structure owner in brackets)		
Bargo Cemetery (Wollondilly Shire Council)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • HMP • BFMP	• HMP • BFMP • Subsidence Monitoring Plan • Tahmoor Coal – LW S1A-S7A Management Plan for Potential Impacts to Wollondilly Shire Council Infrastructure, Report No. MSEC1193-03, 2025 (Revision D)
Tahmoor Mine Site (Tahmoor Coal)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • HMP • BFMP	• HMP • BFMP • Subsidence Monitoring Plan • Tahmoor Coal – LW S1A-S6A Management Plan for Potential Impacts to Tahmoor Mine Site, Report No. MSEC1247, 2023
Wollondilly Anglican College (Anglican Diocese)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • BFMP	• BFMP • Subsidence Monitoring Plan • Tahmoor Coal – LW S1A-S6A Management Plan for Potential Impacts to Wollondilly Anglican College, Report No. MSEC1193-11, 2023
Bargo Petroleum and Road Tested Spares (private ownership)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • BFMP	• BFMP • Subsidence Monitoring Plan

Feature	Investigation and Assessment	Management and Monitoring
		• Tahmoor Coal – LW S1A-S6A Management Plan for Potential Impacts to No. 3030 Remembrance Drive, Bargo Report No. MSEC1193-13, 2023 and Amendment No. 1 for LW S3A in May 2024
Inghams Bargo Breeder Farm (Inghams)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • BFMP	• BFMP • Subsidence Monitoring Plan • Tahmoor Coal – LW S1A-S6A Management Plan for Potential Impacts to Inghams Bargo Chicken Breeder Production Complex, 3010 Remembrance Drive, Bargo, Report No. MSEC1193-14, 2023
Inghams Turkey Farm (Inghams)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • BFMP	• BFMP • Subsidence Monitoring Plan • Tahmoor Coal – LW S5A-S7A Management Plan for Potential Impacts to Inghams Bargo Breeder Turkey Farm, (planned to be complete prior to LW S5A)
Tahmoor Garden Centre (private ownership)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • BFMP	• BFMP • Subsidence Monitoring Plan • Tahmoor Coal – LW S1A-S6A Management Plan for Potential Impacts to Tahmoor Garden Centre, Report No. MSEC1193-15, 2023, Amendment No. 1 for LW S3A in May 2024 and Amendment No.2 for LW S4A in November 2024
Australian Wildlife Sanctuary (National Trust)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • HMP • BFMP	• HMP • BFMP • Subsidence Monitoring Plan • Tahmoor Coal – LW S1A-S6A Management Plan for Potential Impacts to Australian Wildlife Sanctuary, Report No. MSEC1074, 2023 (Revision E)
MKD Machinery (private ownership)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • BFMP	• BFMP • Subsidence Monitoring Plan • Tahmoor Coal – LW S1A-S7A Management Plan for Potential Impacts to MKD Machinery, Report No. MSEC1193-16, 2025 (Revision D)
Pamak Hobbies (private ownership)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • BFMP	• BFMP • Subsidence Monitoring Plan • Tahmoor Coal – LW S1A-S7A Management Plan for Potential Impacts to Built Structures, Report No. MSEC1193-09, 2025 (Revision C)
Canine Country Club (private ownership)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • BFMP	• BFMP • Subsidence Monitoring Plan • Tahmoor Coal – LW S6A-S7A Management Plan for Potential Impacts to Canine Country Club, (planned to complete prior to LW S6A)
Bargo Valley Produce (Bargo Valley Product Pty Limited)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • BFMP	• BFMP • Subsidence Monitoring Plan • Tahmoor Coal – LW S5A-S7A Management Plan for Potential Impacts to Bargo Valley Produce, (planned to complete prior to LW S5A)
Public amenities	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • BFMP	• BFMP • Subsidence Monitoring Plan • Tahmoor Coal – LW S1A-S7A Management Plan for Potential Impacts to Built Structures, Report No. MSEC1193-09, 2025 (Revision C)

Feature	Investigation and Assessment	Management and Monitoring
Dwellings, driveways, pools, rural structures (privately owned)	• Subsidence Prediction and Impact Assessment Report (MSEC, 2022) • Modification 3 – Longwall S7A (MSEC, 2024) • BFMP	• BFMP • Subsidence Monitoring Plan • Tahmoor Coal – LW S1A-S7A Management Plan for Potential Impacts to Built Structures, Report No. MSEC1193-09, 2025 (Revision C)

3.1.3 Land Use and Built Features in the Study Area

The Study Area is located within the Wollondilly Shire Council Local Government Area, and the predominant land uses within the Study Area include rural residential, small-scale cattle and horse grazing. The main agricultural enterprise within or adjacent to the Study Area is poultry farming, and numerous horticultural enterprises (managed by irrigation systems, greenhouses, hothouses and hydroponic systems) are also present in the Study Area (SLR, 2025).

A number of infrastructure are located within the vicinity of the proposed longwalls, including:

- Main Southern Railway, including the Wellers Road Overbridge;
- Public roads, drainage culverts, and bridges;
- Potable water infrastructure;
- Sewer infrastructure;
- Gas infrastructure;
- Electrical infrastructure;
- Telecommunications infrastructure;
- Picton Wier;
- Groundwater bores; and
- Survey control marks.

A number of properties with built features have been identified within the vicinity of the proposed longwalls, including:

- 110 private properties, with a total of 65 houses located directly above the proposed longwalls. These properties include built structures, driveways, pools, septic tanks, farm dams, and water tanks;
- Wollondilly Anglican College (including church, sewerage treatment plant, oval, tennis courts);
- Farm land and facilities (farm buildings and sheds, tanks, gas and fuel storages, poultry sheds, hydroponic systems, irrigation systems, fences, farm dams, bores). This included the businesses Inghams Bargo Breeder Farm, Inghams Turkey Farm, and Bargo Valley Produce;
- Bargo Cemetery;
- Australian Wildlife Sanctuary;
- Tahmoor Mine Site;
- Bargo Petroleum and Road Tested Spares;
- Tahmoor Garden Centre;
- MKD Machinery;
- Pamak Hobbies; and

- Canine Country Club.

The Study Area does not include tunnels, liquid fuel pipelines, air strips, hospitals, shopping centres, community centres, office buildings, swimming pools, bowling greens, racecourses, golf courses, glass houses, factories, buildings equipment or operations that are sensitive to surface movements, surface mining voids or rehabilitation areas, items of architectural significance, retirement or age care villages (MSEC, 2022 and MSEC, 2024).

The Study Area encompasses nine Aboriginal heritage sites and four historical heritage sites (refer to **Figure 11**):

- Aboriginal heritage sites:
  - Isolated find: TC14-2-19 (AHIMS 48-2-0275);
  - Artefact scatter: Remembrance Drive 2013.1 (AHIMS 52-2-3968);
  - Rockshelter with art and stone artefacts: Teatree Hollow 2013.1 (AHIMS 52-2-4471);
  - Rockshelter with deposit and stone artefacts: Hornes Creek RS2 (AHIMS 52-2-4975);
  - Rockshelter with deposit: Hornes Creek RS3 (AHIMS 52-2-4976);
  - Rockshelter with deposit and stone artefact: Hornes Creek RS4 (AHIMS 52-2-4977);
  - Rockshelter: Hornes Creek RS5 (AHIMS 52-2-4978);
  - Rockshelter with deposit and stone artefact: Hornes Creek RS6 (AHIMS 52-2-4982);
  - Rockshelter with deposit: Hornes Creek RS7 (AHIMS 52-2-4981);
- Historical heritage sites:
  - Wirrimbirra Sanctuary (known as the Australian Wildlife Sanctuary) [State Heritage Register (SHR) and Wollondilly local environment plan (WLEP)];
  - Bargo Cemetery (WLEP);
  - Part of the Great Southern Road (non-statutory listed); and
  - Tahmoor Colliery (known as the Tahmoor Mine Site) (non-statutory listed).

One locally listed heritage item, Railway Bridge North (also known as Wellers Road Overbridge), is located within the 600 m buffer from extraction that could be susceptible to far-field or valley related movements. In addition, three heritage items, AHIMS #52-2-4980 (Hornes Creek GG1), Picton Weir (WLEP) and Bargo Railway Viaduct (WLEP and SHR), are outside the 600 m buffer but could also be susceptible to far-field or valley related movements.

Table 5 provides a summary of the built features within the Extraction Plan Study Area and the Key Sub-plans and associated documents that discuss and manage these features.

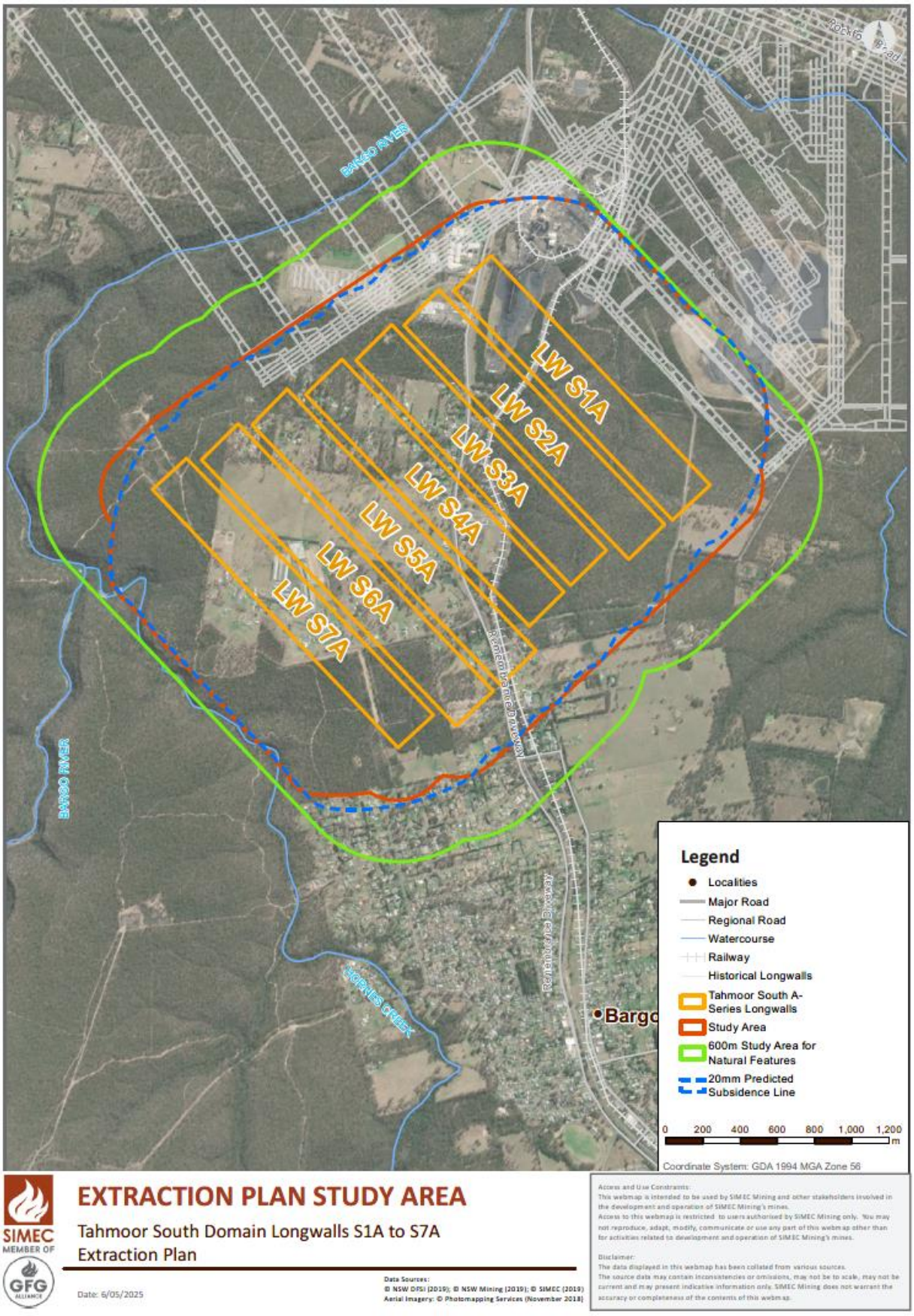


Figure 3 **Extraction Plan Study Area**

3.2 Approvals and Licensing Requirements

Tahmoor Coal's operations are conducted in accordance with applicable Commonwealth and State environmental, planning, mining safety, and natural resource legislation. A register of relevant environmental legislative and regulatory requirements (including development consents, leases, licences, and other relevant approvals) is maintained by Tahmoor Coal in a compliance database.

Tahmoor Mine currently operates under a number of approvals, including:

- Development Consent (7105/47) granted in 1975 by Wollondilly Shire Council for the development of a mine and associated mine infrastructure;
- Development Consent (76/20188) granted in 1979 by NSW Planning and Environment Commission (and subsequent minor modifications approved by NSW Planning and Environment Commission and NSW Department of Planning) for a CHPP and reject emplacement, coal transportation, upgrade of surface facilities for longwall mining, and extension of the CHPP.
- Development Consent (190/85) granted in 1985 by Wollondilly Shire Council for surface civil and mechanical work for gas extraction;
- Development Consent (DA 57/93) (and subsequent minor modification) granted by the Land and Environment Court in 1994 for an expansion of underground coal mining into the Tahmoor North area, continued operation of the existing Tahmoor Mine surface facilities including the coal preparation plant and the reject emplacement area;
- Development Consent (DA 67/98) (and subsequent minor modification) granted by the Minister for Urban Affairs and Planning in 1999 for the expansion of underground mining into those areas of Tahmoor North in which mining was classified as prohibited development;
- Development Consent (SSD 8445) granted in 2021 by DPIE for the Tahmoor South Project, including the extraction of up to 4 Mtpa of ROM coal, with a total of up to around 35 Mt of ROM coal proposed to be extracted over a 10-year period. SSD 8445 has been modified on three occasions relating to:
    i. Modification 1 - Extension of time to commission the Tahmoor Coal Water Treatment Plant, approved on 19 July 2022; and
    ii. Modification 2 - Underground brine disposal and transfer of mine water, approved on 13 June 2023;
    iii. Modification 3 – Inclusion of an additional longwall panel (Longwall South 7A (LW S7A)) to the existing approved mine plan as approved on 26 May 2025.
- Approval (EPBC 2017/8084) granted in 2021 by the then Department of Agriculture, Water and the Environment (DAWE) (now Department of Climate Change, Energy, the Environment and Water (Commonwealth DCCEEW)) for the Tahmoor South Project under sections 130(1) and 133(1) of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act);
- CCL 716, CCL 747, ML 1376, ML 1308, ML 1539, and ML 1642;
- Tahmoor Rehabilitation Management Plan (RMP); and
- Environmental Protection Licence (EPL) 1389 under the *Protection of the Environment Operations Act 1997*.

It is noted that development consents 7105/47, 76/20188, 190/85 and 57/93 will be surrendered in accordance with Consent A21 (SSD 8445) following the completion of current mining activities and mine closure/rehabilitation activities required by these consents.

These approvals constitute Tahmoor Coal's licences to conduct underground mining operations by longwall and bord and pillar mining methods within the Bulli Coal Seam.

Applicable conditions relevant to the extraction of LW S1A-S7A from development consent SSD 8445, EPBC 2017/8084, Leases CCL 716 and CCL 747, EPL 1389 and relevant Work Health and Safety Legislation (WHS Legislation) are outlined in the following sections. Each sub-plan management plan prepared in support of the Extraction Plan also includes these details as well as where each plan addresses the DPE Extraction Plan Guidelines (NSW Department of Planning & Environment, 2022) and WHS Legislation.

Statutory approvals areas and mining tenement boundaries applicable to the LW S1A-S7A Extraction Plan Study Area are detailed on **Figure 2** and Graphical Plan 5.

3.2.1 Project Approval

3.2.1.1 Development Consent Conditions for Extraction Plan

LW S1A-S7A will be extracted in the Tahmoor South mining area in accordance with Development Consent SSD 8445. SSD 8445 provides the conditional planning approval framework for mining activities in the Tahmoor South Domain to be addressed within an Extraction Plan and supporting management plans. Conditions relevant to this management plan from SSD 8445 are detailed in **Table 6**.

Table 6 SSD 8445 Condition Requirements for Extraction Plans

<table>
<tr><th>Condition Reference</th><th>Condition Requirement</th><th>Tahmoor Coal Response / Section Addressed</th></tr>
<tr><td>C1</td><td>SUBSIDENCE
Performance Measures – Natural and Heritage Features etc.
The Applicant must ensure that the development does not cause any exceedances of the performance measures in Table 7.</td><td rowspan="2">Section 3.4.2, Section 3.5, Section 3.6, Section 4, Section 5
Appendix C – Master TARP
Key Sub-plans and Supporting Documents</td></tr>
<tr><td>Excerpt from Table 7</td><td>Table 7: Subsidence impact performance measures - natural and heritage features etc
<table>
<tr><th>Feature</th><th>Performance Measures</th></tr>
<tr><td colspan="2">Water Resources</td></tr>
<tr><td>All watercourses within the Subsidence Area</td><td>- No greater subsidence impact or environmental consequences to water quality, water flows (including baseflow) or stream health (including riparian vegetation), than predicted in the EIS</td></tr>
<tr><td>Other watercourses</td><td>- Negligible environmental consequences including beyond those predicted in the EIS, including:
- negligible diversion of flows or changes in the natural drainage behaviour of pools;
- negligible decline in baseline channel stability;
- negligible gas releases and iron staining; and
- negligible increase in water turbidity</td></tr>
<tr><td>GDEs including Thirlmere Lakes</td><td>- Negligible impacts including:
- negligible change in groundwater levels; and
- negligible change in groundwater quality.</td></tr>
<tr><td colspan="2">Land</td></tr>
<tr><td>Any cliff located directly above longwalls</td><td>- Minor environmental consequences (that is occasional rockwalls, displacement or dislodgement of boulders or slabs, or fracturing, that in total do not impact more than 5% of the total face area of the cliff within any longwall mining domain)</td></tr>
<tr><td>Any cliff within Subsidence Area beyond the extent of longwalls</td><td>- Negligible environmental consequences (that is occasional rockfalls, displacement or dislodgement of boulders or slabs, or fracturing, that in total do not impact more than 0.5% of the total face area of such cliffs within Subsidence Area)</td></tr>
<tr><td>All land within the Subsidence Area</td><td>- No greater subsidence impacts or environmental consequences than predicted in the EIS</td></tr>
<tr><td>All land outside the Subsidence Area</td><td>- Negligible subsidence impacts or environmental consequences</td></tr>
<tr><td colspan="2">Biodiversity</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Condition Reference</th><th>Condition Requirement</th><th>Tahmoor Coal Response / Section Addressed</th></tr>
<tr><td></td><td>
<table>
<tr><td>Threatened species, threatened populations, or endangered ecological communities</td><td>- No greater subsidence impacts or environmental consequences than predicted in the EIS
- Negligible impacts on threatened species, populations or communities due to remediation of subsidence cracking</td></tr>
<tr><td>Aquatic habitat</td><td>- Negligible environmental consequences to aquatic and riparian ecosystems beyond those predicted in the EIS</td></tr>
<tr><td colspan="2">Heritage</td></tr>
<tr><td>Aboriginal cultural heritage sites listed in Appendix 4</td><td>- No greater subsidence impacts or loss of heritage values than predicted in the EIS</td></tr>
<tr><td>Historic heritage sites listed in Appendix 4</td><td>- No greater subsidence impacts or loss of heritage values than predicted in the EIS</td></tr>
<tr><td colspan="2">Mine workings</td></tr>
<tr><td>First workings</td><td>- To remain long term stable and non-subsiding</td></tr>
<tr><td>Second workings</td><td>- To be carried out only within the approved mine plan, in accordance with an approved Extraction Plan</td></tr>
</table>
Notes for Table 7 (C1):
Notes:
• These performance measures apply to all mining taking place after the date of this consent.
• The Applicant is required to define more detailed performance indicators (including impact assessment criteria) for each of these performance measures in the various management plans that are required under this consent (see condition C8).
</td><td></td></tr>
<tr><td>C2</td><td>Performance Measures – Natural and Heritage Features etc.
Measurement and monitoring of compliance with performance measures and performance indicators in this consent 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 and monitoring programs. In the event of a dispute over the appropriateness of proposed methods, the Planning Secretary will be the final arbiter.</td><td>Section 2.2.3, Section 3.6, Section 5
Appendix C – Master TARP
Key Sub-plans and Supporting Documents</td></tr>
</table>

<table>
<tr><th>Condition Reference</th><th>Condition Requirement</th><th>Tahmoor Coal Response / Section Addressed</th></tr>
<tr><td>C5</td><td>Performance Measures - Built Features
The Applicant must ensure that the development meets the performance measures in Table 8.
Table 8: Subsidence impact performance measures – built features
<table>
<tr><th>Feature</th><th>Performance Measures</th></tr>
<tr><td colspan="2">Public Infrastructure</td></tr>
<tr><td>Key public infrastructure:
• Main Southern Railway
• Remembrance Drive
• M31 Motorway
• Moomba to Sydney Gas Pipeline
• Gorodok Ethane Pipeline
• Bargo Waste Management Centre</td><td>- Always safe and serviceable
- Damage that does not affect safety or serviceability must be fully repairable, and must be fully investigated and repaired at the cost of the Applicant</td></tr>
<tr><td>• All other public infrastructure including roads, culverts, bridges, viaducts, water supply pipelines, sewerage mains, gas pipelines, electrical and telecommunication infrastructure and survey control marks</td><td>- Always safe
- Serviceability should be maintained wherever practicable
- Loss of serviceability must be fully compensated
- Damage must be fully repairable, and must be fully investigated and repaired or else replaced or fully compensated at the cost of the Applicant</td></tr>
<tr><td colspan="2">Other Built Features</td></tr>
<tr><td>• Public amenities including schools, churches and community centres
• Industrial, commercial and business premises
• Bargo Cemetery
• Wirrimbirra Sanctuary
• Privately-owned residences
• Other privately-owned built features and improvements, including petrol stations, sheds, garages, farm dams, tanks, swimming pools, tennis courts, roads, tracks and fences</td><td>- Always safe
- Serviceability should be maintained wherever practicable
- Loss of serviceability must be fully compensated
- Damage must be fully repairable, and must be fully investigated and repaired or else replaced or fully compensated at the cost of the Applicant</td></tr>
<tr><td colspan="2">Public Safety</td></tr>
<tr><td>- Public safety</td><td>- Negligible additional risk</td></tr>
</table>
Notes for Table 8 (C5)
Notes:
• These performance measures apply to all mining taking place after the date of this consent.
• The Applicant is required to define more detailed performance measures in the Built Features Management Plans or Public Safety Management Plan (see condition C8).
• Requirements regarding safety or serviceability do not prevent preventative or mitigatory actions being taken prior to or during mining.
• Requirements under this condition may be met by measures undertaken in undertaken in accordance with the Coal Mine Subsidence Compensation Act 2017.</td><td>Section 3.5, Section 3.6, Section 5
Appendix C – Master TARP
Key Sub-plans and Supporting Documents</td></tr>
<tr><td>C6</td><td>Performance Measures - Built Features
Any dispute between the Applicant and the owner of any built feature over the interpretation, application or implementation of the performance measures in Table 8 is to be settled by the Planning Secretary, following consultation with the Resources Regulator. Any decision by the Planning Secretary shall be final.</td><td>Noted.</td></tr>
<tr><td>C8</td><td>Extraction Plan
The Applicant must prepare an Extraction Plan for all second workings on the site of the development to the satisfaction of the Planning Secretary. Each Extraction Plan must:</td><td>This document.</td></tr>
<tr><td>C8(a)</td><td>Be prepared by a suitably qualified and experienced person/s whose appointment has been endorsed by the Planning Secretary;</td><td>Section 2.3
Appendix D – Consultation for evidence of endorsement</td></tr>
<tr><td>C8(b)</td><td>Be prepared in consultation with the Resources Regulator, DPE Water and Subsidence Advisory NSW;</td><td>Section 2.1, Section 2.2
Appendix D – Consultation for evidence of endorsement</td></tr>
<tr><td>C8(c)</td><td>Include detailed plans of existing and proposed first and second workings and overlying surface features, including any applicable adaptive management measures;</td><td>Section 6
Graphical Plans</td></tr>
</table>

Condition Reference	Condition Requirement	Tahmoor Coal Response / Section Addressed
C8(d)	Include adequate consideration of mine roof and floor conditions which has been undertaken in consultation with the Resources Regulator;	**Section 2.1.3, Section 3.3.4, Section 3.4.2**
C8(e)	provide revised predictions of the potential subsidence effects, subsidence impacts and environmental consequences of the proposed mining covered by the Extraction Plan, incorporating any relevant information obtained since this consent;	**Section 3.4** **Appendix A** – Subsidence Prediction and Impact Assessment Report
C8(f)	describe in detail the performance indicators to be implemented to ensure compliance with the performance measures in Table 7 and Table 8, and manage or remediate any impacts and/or environmental consequences to meet the rehabilitation objectives in condition B56;	**Section 3.4.2, Section 3.5, Section 3.6, Section 5** **Appendix C** – Master TARP Key Sub-plans and Supporting Documents
C8(g)	Including a:	See below
C8(g)(i)	Subsidence Monitoring Plan which has been prepared in consultation with the Resources Regulator to:	**Section 5** Subsidence Monitoring Plan
	• describe the ongoing conventional and non-conventional Subsidence Monitoring Plan;	
	• provide data to assist with the management of risks associated with conventional and non-conventional subsidence;	
	• validate the conventional and non-conventional subsidence predictions;	
	• analyse the relationship between the predicted and resulting conventional and non-conventional subsidence effects and predicted and resulting impacts under the plan and any ensuing environmental consequences; and	
	• inform the adaptive management process;	
C8(g)(ii)	Built Features Management Plan which has been prepared in consultation with the Resources Regulator, to manage the potential subsidence impacts of the proposed underground workings on built features, and which:	**Section 4.6** Built Features Management Plan Subsidence Management Plans for built features
	• has also been prepared in consultation with: - the owners of potentially affected features; - the Technical Committee required under condition C14; - the EPA in relation to the Bargo Waste Management Centre; and - the NSW Department regulating the Pipelines Act 1967 in relation to the licensed gas pipelines;	
	• addresses in appropriate detail all items of key public infrastructure (with particular consideration of public roads and rail lines, including any associates bridges and culverts, gas pipelines and waste facilities), other public infrastructure and all classes of other built features;	
	• recommends appropriate pre-mining mitigation measures to reduce subsidence impacts;	
	• recommends appropriate remedial measures and includes commitments to mitigate, repair, replace or compensate predicted impacts on potentially affected built features in a timely manner; and	
	• 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 an alternative standard agreed with the infrastructure owner), and provides for annual auditing of compliance and effectiveness during extraction which may impact the infrastructure;	
C8(g)(iii)	Water Management Plan which has been prepared in consultation with DPE Water and BCD and is consistent with the Water Management Plan required under condition B34, which provides for the management of potential impacts and environmental consequences of the proposed underground workings on watercourses and aquifers, including:	**Section 4.2** Water Management Plan
	• detailed baseline data on: - surface water flows, quality and geomorphic conditions of watercourses and/or water bodies that could be affected by subsidence; and - groundwater levels, yield and quality in the region, including for privately-owned licensed bores;	
	• detailed surface and groundwater impact assessment criteria, including specific trigger levels for: - investigating any potentially adverse impacts on water resources or water quality; - active remediation of geomorphic and erosional impacts (including supporting justification for the selected triggers); and	

Condition Reference	Condition Requirement	Tahmoor Coal Response / Section Addressed
	- providing compensatory water supply to affected water users under condition B26 of this Schedule;	
	• a surface water monitoring program to monitor and report on: - stream flows and quality; - stream and riparian vegetation; - channel and bank stability; and - the effectiveness of remediation measures in controlling geomorphic and erosional impacts;	
	• a groundwater monitoring program to monitor and report on: - groundwater inflows to the underground mining operations; - the height of groundwater depressurisation; - height of fracturing above indicative longwall panels following mining; - background changes in groundwater yield/quality against mine-induced changes, in particular, on privately-owned groundwater bores in the vicinity of the site; - permeability, hydraulic gradient, flow direction and connectivity of the deep and shallow groundwater aquifers; and - impacts of the development on GDEs (including Thirlmere Lakes);	
	• a description of any adaptive management practices implemented to guide future mining activities in the event of greater than predicted impacts on aquatic habitat;	
	• a program to validate the surface water and groundwater models for the development and compare monitoring results with modelled predictions; and	
	• a plan to respond to any exceedances of the surface water and groundwater assessment criteria, including a Watercourse Corrective Action Management Plan as detailed in Condition C12.	
C8(g)(iv)	Biodiversity Management Plan which is consistent with the Biodiversity Management Plan required under condition B38:	**Section 4.4** Biodiversity Management Plan
	• has been prepared in consultation with BCD;	
	• establishes baseline data for existing habitat within the subsidence area, including water table depth, vegetation condition, stream morphology, key fish habitat and threatened species habitat; and	
	• provides for the adaptive management of potential impacts and environmental consequences of the proposed second workings on aquatic and terrestrial flora and fauna, with a specific focus on threatened species, populations and their habitats, EECs/CEECs and water dependent ecosystems;	
C8(g)(v)	Land Management Plan which:	**Section 4.3** Land Management Plan
	• has been prepared in consultation with any affected public authorities;	
	• provides for the management of potential impacts and/or environmental consequences of the proposed underground workings on land in general, with a specific focus on steep slopes; and	
	• is informed by a detailed slope stability assessment prepared by a suitably qualified and experienced person/s;	
C8(g)(vi)	Heritage Management Plan which is consistent with the requirements of conditions B42 to B47:	**Section 4.5** Heritage Management Plan
	• has been prepared in consultation with Heritage NSW, Council and relevant stakeholders for both Aboriginal heritage and non-Aboriginal heritage items;	
	• includes a pre-mining assessment of the condition and structure of local and State significant heritage items within the subsidence area;	
	• describes the measures to be implemented to: - protect, monitor and manage potential environmental consequences of the proposed second workings on identified Aboriginal objects and Aboriginal places and local and State significant heritage items, in accordance with the commitments made in the EIS; - manage the discovery of suspected human remains and any new Aboriginal objects or Aboriginal places, including provisions for burials, over the life of the development; - ensure compliance with the requirements under conditions B41 to B46 inclusive and the subsidence impact performance measures in Table 7; and - facilitate ongoing consultation and involvement of Registered Aboriginal Parties in the conservation and management of Aboriginal cultural heritage sites within the subsidence area;	
C8(g)(vii)	Public Safety Management Plan which has been prepared in consultation with the Resources Regulator, which ensures public safety and manages access on the site;	**Section 4.7** Public Safety Management Plan

Condition Reference	Condition Requirement	Tahmoor Coal Response / Section Addressed
C8(g)(viii)	Trigger Action Response Plans addressing all features in Table 7 and Table 8, which contain:	**Section 3.6.2** Appendix C – Master TARP
	• appropriate triggers to warn of increased risk of exceedance of any performance measure;	**Section 3.6.2** Appendix C – Master TARP
	• specific actions to respond to high risk of exceedance of any performance measure to ensure that the measure is not exceeded;	**Section 3.6.3** Appendix C – Master TARP
	• an assessment of remediation measures that may be required if exceedances occur and the capacity to implement the measures; and	**Section 3.6.3**
	• adaptive management where monitoring indicates that there has been an exceedance of any performance measures in Table 7 and/or Table 8, or where any such exceedance appears likely; and	**Section 3.6.4**
C8(g)(ix)	Contingency Plan that expressly provides for:	**Section 3.6.3** Appendix C – Master TARP
	• adaptive management where monitoring indicates that there has been an exceedance of any performance measure in Table 7 and/or Table 8, or where any such exceedance appears likely;	**Section 3.6.4**
	• an assessment of remediation measures that may be required if exceedances occur and the capacity to implement those measures;	**Section 3.6.3**
C8(h)	Propose appropriate revisions to the Rehabilitation Management Plan required under Condition B60; and	The Rehabilitation Management Plan, as required under Condition B60, was approved after the approval of this Extraction Plan. The plan will be revised every 3 years unless site conditions changes.
C8(i)	include a program to collect sufficient baseline data for future Extraction Plans.	**Section 5.4** Subsidence Monitoring Plan
C9	The Applicant must not undertake second workings until the relevant Extraction Plan is approved by the Planning Secretary.	Noted.
C10	The Applicant must implement the Extraction Plan as approved by the Planning Secretary.	Noted.
C11	**Payment of Reasonable Costs** The Applicant must pay all reasonable costs incurred by the Department to engage a suitably qualified, experienced and independent person/s to review the adequacy of any aspect of an Extraction Plan.	Noted.

3.2.1.2 Additional Consent Conditions Relevant to Extraction Plan

In addition to the requirements in SSD 8445 specific to the preparation of this Extraction Plan, **Table 7** provides a summary of additional requirements listed in SSD 8445 that are applicable to this Extraction Plan.

It is noted that, while DA 1975 (7105/47) is applicable to the first portion of first workings (refer to response to Condition C7 in the table below), there are no conditions from DA 1975 that are relevant to this Extraction Plan. In addition, DA 1975 will be surrendered in accordance with Consent A21 (SSD 8445) following the completion of current mining activities and mine closure/rehabilitation activities required by these consents.

Table 7 Additional Development Consent Requirements for this Extraction Plan

Condition	Condition Requirement	Tahmoor Coal Response / Section Addressed
SSD 8445		
A1	**Obligation to minimise harm to the environment** In addition to meeting the specific performance measures and criteria established under this consent, the Applicant must implement all reasonable and feasible measures to prevent, and if prevention is not reasonable and feasible, minimise, any material harm to the environment that may result from the construction and operation of this development, and any rehabilitation required under this consent.	**Section 3.6** The management measures discussed in this Extraction Plan have been proposed to meet the requirements of this condition.
A2	**Terms of consent** The development may only be carried out: (a) in compliance with conditions of this consent; (b) in accordance with all written directions of the Planning Secretary; (c) generally in accordance with the EIS; and (d) generally in accordance with the Development Layout in Appendix 2.	**Section 3.2.1** This Extraction Plan has been developed in compliance with the listed conditions and commitments as discussed in Condition A2, which is required in Condition E5.
A5	**Mining operations** First workings and second workings may only be carried out within the area covered by the approved mine plan, subject to Condition A7 requiring shortening of Longwall S3B (LW S3B) and Longwall S4B (LW S4B).	**Appendix A** – Subsidence Predictions and Impact Assessment shows the 'Extent of Longwalls' as defined in the Tahmoor South Project EIS, and illustrates that the proposed longwalls are within this area. LW S3B and LW S4B are not relevant to this Extraction plan.
A19	**Mining operations** The proposed downcast ventilation shaft TSC2 must be constructed on the same site as TSC1. Disturbance must not occur at the proposed TSC2 site. Construction of shafts TSC1 and TSC2 must not be commenced until a revised layout and design has been submitted to and approved by the Planning Secretary. This Condition does not remove the need for the Applicant to pursue micro-siting of surface infrastructure to avoid biodiversity impacts as required under condition B38(e)(i).	**Section 7.8** The construction of TSC1 and TSC2 ventilation shafts is no longer planned.
A25	**Community Consultative Committee** Within three months of the commencement of the development, a Community Consultative Committee (CCC) must be established for the development in accordance with the Department's Community Consultative Committee Guidelines: State Significant Projects (2019). The CCC must meet at a minimum frequency of once every six months. The CCC must continue to operate during the life of the development, or other timeframe agreed by the Planning Secretary. The Committee must comprise an independent chair and appropriate representation from the Applicant, Council, affected stakeholder groups and the local community.	**Section 2.1, Section 2.1.3** The TCCCC was established in 2003 in response to the requirement for DA 67/98 Condition 47 to establish and operate a Community Consultative Committee in general accordance with DPE Community Consultative Committee Guidelines: State Significant Projects (2016). DPE (now NSW DPHI) have approved the existing TCCCC as meeting the requirements for this condition. This Extraction Plan has been discussed at recent TCCCC meetings.

Condition	Condition Requirement	Tahmoor Coal Response / Section Addressed
A36	**Compliance** The Applicant must ensure that all of its employees, contractors (and their sub-contractors) are made aware of, and are instructed to comply with, the conditions of this consent relevant to activities they carry out in respect of the development.	**Section 7.9.1** Tahmoor Coal provides Environmental Awareness Training for all on-site employees on an annual basis. This training includes information on all relevant environmental aspects, including relevant information included in this Extraction Plan.
A39	**Crown Land** The Applicant must consult with DPE Crown Lands prior to undertaking any development on Crown Land or Crown Roads. Notes: • Under section 265 of the Mining Act 1992, the Applicant is required to enter into a compensation agreement with DPE Crown Lands prior to undertaking any mining operations or related activities on Crown land or Crown roads within a mining lease. • Under section 141 of the Mining Act 1992, the Applicant is required to enter into an access arrangement with DPE Crown Lands prior to undertaking any prospecting operations on Crown land or Crown roads within an exploration licence.	**Section 2.1.3** Tahmoor Coal is in consultation with Crown Land and is seeking to enter into a compensation agreement.
B25	Prior to the commencement of second workings under this consent, the Applicant must complete a bore census for all licensed privately-owned groundwater bores that are predicted to have a drawdown of greater than 2 metres as a result of the development providing: (a) notification of bore owners, including an indication of the level of risk of impact to their water supply; (b) ongoing engagement and consultation with bore owners in accordance with the Make Good Strategy contained in the EIS; (c) detailed baseline data regarding groundwater levels, yield and quality for privately-owned groundwater bores; and (d) a condition assessment of existing groundwater bores and monitoring equipment; to the satisfaction of the Planning Secretary.	A Baseline Private Bore Assessment Report is included as an appendix to the Water Management Plan, and includes a review of all licensed privately-owned groundwater bores that are predicted to have a drawdown of greater than 2 metres by the proposed development.
B26	**Compensatory Water Supply** The Applicant must provide a compensatory water supply to any landowner of privately-owned land whose rightful water supply is adversely and directly impacted (other than an impact that is minor or negligible) as a result of the development, in consultation with NRAR and DPE Water, and to the satisfaction of the Planning Secretary	Water Management Plan includes the compensation management plan to be implemented if water supply is impacted by the extraction of LW S1A-S7A.
B27	The compensatory water supply measures must provide an alternative long-term supply of water that is equivalent, in quality and volume, to the loss attributable to the development. Equivalent water supply should be provided (at least on an interim basis) as soon as practicable after the loss is identified, unless otherwise agreed with the landowner. The burden of proof that any loss of water supply is not due to mining impacts rests with the Applicant.	Water Management Plan includes the compensation management plan to be implemented if water supply is impacted by the extraction of LW S1A-S7A.
B34	**Water Management Plan** Prior to the commencement of construction activities, the Applicant must prepare a Water Management Plan for the development to the satisfaction of the Planning Secretary. (Refer to the SSD 8445 Consent Conditions for full condition)	A Water Management Plan for the Tahmoor South Project has been approved by DPE (now NSW DPHI). Relevant sections from this management plan have been included in the LW S1A-S7A Water Management Plan.
B38	**Biodiversity Management Plan** The Applicant must prepare a Biodiversity Management Plan for all areas of the development to the satisfaction of the Planning Secretary. (Refer to the SSD 8445 Consent Conditions for full condition)	A Biodiversity Management Plan for the Tahmoor South Project has been approved by DPE (now NSW DPHI). Relevant sections from this management plan have been included in the LW S1A-S7A Biodiversity Management Plan.
B41	**Heritage** The Applicant must ensure that the development does not cause any direct or indirect impact on any identified heritage item, beyond those predicted in the EIS. Note: Identified heritage items are listed in Appendix 4.	The Heritage Management Plan includes management measures to address this condition.

Condition	Condition Requirement	Tahmoor Coal Response / Section Addressed
B42	**Protection of Aboriginal Heritage** If any previously unknown Aboriginal object is discovered on the site, or suspected to be on the site: (a) all work in the immediate vicinity of the object or place must cease immediately; (b) a 10 m buffer area around the object or place must be cordoned off; and (c) Heritage NSW must be contacted immediately.	Managements measures have been included in the Heritage Management Plan if potential or actual archaeological objects or sites are identified.
B43	**Protection of Aboriginal Heritage** Work in the immediate vicinity may only recommence if: (a) the potential Aboriginal object is confirmed by Heritage NSW, in consultation with the Registered Aboriginal Parties, not to be an Aboriginal object or Aboriginal place; or (b) the Planning Secretary is satisfied with the measures to be implemented in respect of the Aboriginal object and makes a written direction in that regard.	Managements measures have been included in the Heritage Management Plan if potential or actual archaeological objects or sites are identified.
B44	**Protection of Aboriginal Heritage** If suspected human remains are discovered on the site, then all work surrounding the area must cease, and the area must be secured. The Applicant must immediately notify NSW Police Force and Heritage NSW, and work must not recommence in the area until authorised by NSW Police Force and Heritage NSW.	Managements measures have been included in the Heritage Management Plan if potential or actual archaeological objects or sites are identified.
B45	**Protection of Aboriginal Heritage** The Applicant must ensure that all known Aboriginal objects or Aboriginal places on the site and within any offset areas are properly recorded, and those records are kept up to date, in the Aboriginal Heritage Information Management System (AHIMS) Register.	The Heritage Management Plan includes management measures to address this condition.
B46	**Protection of Historic Cultural Heritage** The Applicant must not commence second workings until the Historic Heritage Plan required under condition C8 is approved by the Planning Secretary. The Applicant must implement the Historic Heritage Plan as approved by the Planning Secretary.	Noted. The Heritage Management Plan is included as part of this Extraction Plan application, in accordance with condition C8.
B47	**Visual Amenity and Lighting** The Applicant must: • Take all reasonable steps to minimise the visual and off-site lighting impacts of the development; • take all reasonable steps to shield views of mining operations and associated equipment from users of public roads and privately-owned residences; • ensure no fixed outdoor lights shine directly above the horizontal or above the building line or any illuminated structure; • ensure mobile lighting rigs do not shine directly above the horizontal (except where required for emergency safety purposes); • ensure that all external lighting associated with the development complies with relevant Australian Standards including the latest version of Australian Standard AS4282 (INT) 2019 - Control of Obtrusive Effects of Outdoor Lighting; and • ensure that the visual appearance of any new buildings, structures, facilities or works (including paint colours and specifications) is aimed at blending as far as possible with the surrounding landscape.	Considered in each individual Construction Environmental Management Plan for surface construction works. This condition is not relevant to the Heritage Management Plan (as indicated in Condition C8(g)(vi)) as the extraction of LW S1A-S7A does not include any of these surface construction works.
B56	**Rehabilitation Objectives** The Applicant must rehabilitate the site in accordance with the conditions imposed on the mining lease(s) associated with the development under the Mining Act 1992. This rehabilitation must be generally consistent with the proposed rehabilitation activities described in the EIS (and shown conceptually in the Rehabilitation Plan in Appendix 5), and must comply with the objectives in Table 6. Table 6: Rehabilitation Objectives Feature: Community Objective: • Ensure public safety • Minimise adverse socio-economic effects associated with mine closure	The rehabilitation objectives of this condition are required to be met in Condition C8(f). **Section 3.4.2, Section 3.5, Section 3.6, Section 5** **Appendix C** – Master TARP Key Sub-Plans and Supporting Documents
B60	**Rehabilitation Management Plan** The Applicant must prepare a Rehabilitation Management Plan for the development, in accordance with the conditions imposed on the mining lease(s) associated with the development under the Mining Act 1992. (Refer to the SSD 8445 Consent Conditions for full condition)	The Rehabilitation Management Plan as specified in this condition is required to be revised to be met in Condition C8(h).

Condition	Condition Requirement	Tahmoor Coal Response / Section Addressed
		The Rehabilitation Management Plan, as required under Condition B60, was approved after the approval of this Extraction Plan. The plan will be revised every 3 years unless site conditions changes.
C3	**Additional Offsets** If the Applicant exceeds the performance measures in Table 7 and the Planning Secretary determines that: • it is not reasonable or feasible to remediate the subsidence impact or environmental consequences; or • remediation measures implemented by the Applicant have failed to satisfactorily remediate the subsidence impact or environmental consequence, then the Applicant must provide an offset to compensate for the subsidence impact or environmental consequence, that is proportionate to the significance of the subsidence impact or environmental consequence, following consultation with BCD and/or Heritage NSW and to the satisfaction of the Planning Secretary.	Noted. Performance measures in Table 7 of SSD 8445 are not anticipated to be exceeded.
C4	The offset required under condition C3 must give priority to like-for-like physical environmental offsets, but may also consider other offsets under the Biodiversity Offsets Scheme of the BC Act, such as the Biodiversity Conservation Fund established by BCT, or funding or implementing supplementary measures, such as: • actions outlined in threatened species recovery programs; • actions that contribute to threat abatement programs; • biodiversity research and survey programs; and/or • rehabilitating degraded habitat.	Noted. Performance measures in Table 7 of SSD 8445 are not anticipated to be exceeded.
C7	**First Workings** The Applicant may carry out first workings within the area of the approved mine plan, other than in accordance with an approved Extraction Plan, provided that the Resources Regulator is satisfied that the first workings are designed to remain stable and non-subsiding in the long term, and do not generate more than 20 mm of vertical subsidence, except insofar as they may be impacted by approved second workings. Note: The intent of this condition is to ensure that first workings are built to geotechnical and engineering standards sufficient to ensure long term stability, with negligible direct subsidence impacts.	**Section 3.4.2** First workings for LW S1A remain within the Tahmoor North Lease, for which DA 1975 (applies. Under this development consent there are no requirements for first workings notifications. Requirements for first workings notifications under the Tahmoor South development consent commenced when LW S1A extraction starts. A letter was sent to the Resources Regulator prior to this commencement with information on the first workings as required under this condition.
C12	**Watercourse Corrective Action Management Plan(s)** The Applicant must prepare a Watercourse Corrective Action Management Plan(s) for watercourses damaged by subsidence impacts associated by the development, to the satisfaction of the Planning Secretary. (Refer to the SSD 8445 Consent Conditions for full condition)	In accordance with Condition C8(g)(iii), the Water Management Plan will include a plan to respond to any exceedances of the surface water and groundwater assessment criteria, in the event that exceedances occur. This includes references to Watercourse Corrective Action Management Plan(s), if required.
C14	**Technical Committee for the Bargo Waste Management Centre** Prior to commencing second workings, the Applicant must establish a Technical Committee for the Bargo Waste Management Centre, comprising engineering and geotechnical specialists and a representative of Council, whose appointment has been endorsed by the Planning Secretary; the Applicant and Council. The Technical Committee must continue to operate during the life of the development, or other timeframe agreed by the Planning Secretary. The role of the Technical Committee is to: (a) provide input into the preparation and implementation of the Built Features Management Plan;	Consultation with this technical committee is required under Condition C8(g)(ii). However, the Bargo Waste Management Centre is not included in the Study Area. A Technical Committee for the Bargo Waste Management Centre was established prior to

Condition	Condition Requirement	Tahmoor Coal Response / Section Addressed
	(b) consult with relevant statutory agencies, including the EPA and Subsidence Advisory NSW; (c) identify all potential mechanisms for impacts of the development on the Bargo Waste Management Centre, including from non-conventional subsidence; (d) undertake a risk assessment to identify the level of subsidence induced risks; (e) recommend appropriate pre-mining mitigation measures required to reduce subsidence impacts; (f) recommend appropriate remedial measures and measures to investigate, mitigate, repair, replace or compensate predicted impacts and associated cost sharing responsibilities; and (g) recommend monitoring programs, trigger action response plan(s) and communication plans, to ensure the development meets the performance measures in Table 8. Note: • Technical Committees may also be established for other public infrastructure assets listed in Table 8.	the commencement of second workings.
E4	**Adaptive Management** The Applicant must assess and manage development-related risks to ensure that there are no exceedances of the criteria and performance measures in this consent. Any exceedance of these criteria or performance measures constitutes a breach of this consent and may be subject to offset or other provisions as specified in this consent and/or penalty or offence provisions under the EP&A Act or EP&A Regulation. Where any exceedance of these criteria or performance measures has occurred, the Applicant must, at the earliest opportunity: (a) take all reasonable and feasible steps to ensure that the exceedance ceases and does not recur; (b) consider all reasonable and feasible options for remediation (where relevant) and submit a report to the Department describing those options and any preferred remediation measures or other course of action; (c) within 14 days of the exceedance occurring (or other timeframe agreed by the Planning Secretary), submit a report to the Planning Secretary describing these remediation options and any preferred remediation measures or other course of action; and (d) implement reasonable remediation measures as directed by the Planning Secretary.	**Section 3.6, Section 7.4**
E5	**Management Plan Requirements** Management plans required under this consent must be prepared in accordance with relevant guidelines, and include:	This main document and all management plans under this Extraction Plan have been prepared in accordance with this condition.
	(a) a summary of relevant background or baseline data;	**Section 2.2, Section 3.1** Key Sub-Sub-plans and Supporting Documents
	(b) details of:	NA
	(b)(i) the relevant statutory requirements (including any relevant approval, licence or lease conditions);	**Section 3.2** KeySub-Sub-plans and Supporting Documents
	(b)(ii) any relevant limits or performance measures and criteria; and	**Section 3.5.1** Key Sub-Sub-plans and Supporting Documents
	(b)(iii) the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the development or any management measures;	**Section 3.5.2** Key Sub-Sub-plans and Supporting Documents
	(c) any relevant commitments or recommendations identified in the document/s listed in condition A2(c);	**Section 3.2.1.3** Key Sub- Sub-plans and Supporting Documents
	(d) a description of the measures to be implemented to comply with the relevant statutory requirements, limits, or performance measures and criteria;	**Section 3.6** Key Sub- Sub-plans and Supporting Documents
	(e) a program to monitor and report on the:	NA
	(e)(i) impacts and environmental performance of the development; and	**Section 5** Key Sub- Sub-plans and Supporting Documents

Condition	Condition Requirement	Tahmoor Coal Response / Section Addressed
	(e)(ii) effectiveness of the management measures set out pursuant to condition E5(d);	**Section 3.6.5** Key Sub-Plans and Supporting Documents
	(f) a contingency plan to manage any unpredicted impacts and their consequences and to ensure that ongoing impacts reduce to levels below relevant impact assessment criteria as quickly as possible;	**Section 3.6.3** Key Sub-Plans and Supporting Documents
	(g) a program to investigate and implement ways to improve the environmental performance of the development over time;	**Section 3.6.4** Key Sub-Plans and Supporting Documents
	(h) a protocol for managing and reporting any:	NA
	(h)(i) incident, non-compliance or exceedance of any impact assessment criterion or performance criterion;	**Section 7.2, Section 7.3, Section 7.4**
	(h)(ii) complaint; or	**Section 7.5**
	(h)(iii) failure to comply with other statutory requirements;	**Section 7.1**
	(i) public sources of information and data to assist stakeholders in understanding environmental impacts of the development; and	**Section 7.10**
	(j) a protocol for periodic review of the plan.	**Section 7.8**
E6	**Management Plan Requirements** The Applicant must ensure that management plans prepared for the development are consistent with the conditions of this consent and any EPL issued for the site.	**Section 3.2** All known conditions and environmental licensing requirements are dealt with in this Extraction Plan and Key Sub-plans.
E7	**Revision of Strategies, Plans and Programs** Within three months of: (a) the submission of an incident report under condition E9; (b) the submission of an Annual Review under condition E13; (c) the submission of an Independent Environmental Audit under condition E15; (d) the approval of any modification of the conditions of this consent (unless the conditions require otherwise); or (e) notification of a change in development phase under condition A19; The suitability of existing strategies, plans and programs required under this consent must be reviewed by the Applicant.	**Section 7.8**
E9	**Incident Notification** The Planning Secretary must be notified in writing via the Major Projects website immediately after the Applicant becomes aware of an incident. The notification must identify the development (including the development application number and the name of the development if it has one) and set out the location and nature of the incident. Subsequent notification requirements must be given, and reports submitted in accordance with the requirements set out in Appendix 8.	**Section 7.2**
E10	**Non-Compliance Notification** The Planning Secretary must be notified in writing via the Major Projects website within seven days after the Applicant becomes aware of any non-compliance.	**Section 7.3**
E13	**Annual Review** By the end of March in each year after the commencement of the development, or other timeframe agreed by the Planning Secretary, a report must be submitted to the Department reviewing the environmental performance of the development, to the satisfaction of the Planning Secretary. (Refer to the SSD 8445 Consent Conditions for full condition)	**Section 7.1.3**
E15	**Independent Environmental Audit** Independent Audits of the development must be conducted and carried out in accordance with the Independent Audit Post Approval Requirements (2020).	**Section 7.7.2**
E23	**Monitoring and Environmental Audits** Before the commencement of construction until the completion of all rehabilitation required under this consent, the Applicant must: (a) make the following information and documents (as they are obtained, approved or as otherwise stipulated within the conditions of this consent) publicly available on its website: (i) the EIS;	**Section 7.10.1**

Condition	Condition Requirement	Tahmoor Coal Response / Section Addressed
	(ii) all current statutory approvals for the development; (iii) all approved strategies, plans and programs required under the conditions of this consent; (iv) the proposed staging plans for the development if the construction, operation or decommissioning of the development is to be staged; (v) minutes of CCC meetings; (vi) regular reporting on the environmental performance of the development in accordance with the reporting requirements in any plans or programs approved under the conditions of this consent; (vii) a comprehensive summary of the monitoring results of the development, reported in accordance with the specifications in any conditions of this consent, or any approved plans and programs; (viii) a summary of the current phase and progress of the development; (ix) contact details to enquire about the development or to make a complaint; (x) a complaints register, updated monthly; (xi) a register of incident and non-compliance notifications made to the Planning Secretary, updated monthly; (xii) the Annual Reviews of the development; (xiii) audit reports prepared as part of any Independent Environmental Audit of the development and the Applicant's response to the recommendations in any audit report; (xiv) annual returns made under the National Greenhouse and Energy Reporting legislation (xv) any other matter required by the Planning Secretary; and (b) keep such information up to date, to the satisfaction of the Planning Secretary.	

3.2.1.3 EIS Commitments Relevant to Extraction Plan and Supporting Documents

Condition A2(g) of the Consent states that the development may only be carried out generally in accordance with the EIS. The relevant EIS documents include:

- Tahmoor South Project Environmental Impact Statement, Volumes 1 and 7, dated January 2019;
- Tahmoor South Project Amendment Report, including Appendices A to R and response to submissions, dated February 2020;
- Tahmoor South Project Second Amendment Report, Appendices A to O and response to submissions, dated August 2020; and
- Additional information responses dated 14 September 2020 (including Appendices A to L), 23 October 2020 and 4 November 2020.

EIS commitments relevant to this management plan are outlined in **Table 8**. These EIS commitments do not include commitments that are covered by the SSD 8445 Conditions of Consent.

Table 8 EIS Commitments

EIS Reference	Commitment	Tahmoor Coal Response / Section Addressed
GE-1	**Geomorphology** Potential impact: Impacts to geomorphological features in the Project Area from mining-induced subsidence Management and mitigation measures: - Pre-, during- and post-mining photographic surveys and visual inspections of geomorphological features for each longwall. Results would be documented in the Extraction Plan and Annual Review. - Annual catchment survey at 10 headwater photographic sampling locations to monitor mining-induced subsidence impacts of the Project over time. - A geomorphology survey (baseline and post mining) of waterways overlying each longwall to complement monitoring of subsidence at each longwall. - Installation of subsidence monitoring points before mining of secondary workings for all longwalls. The adaptive management plan for the Project would include re-evaluation of the monitoring	Water Management Plan

EIS Reference	Commitment	Tahmoor Coal Response / Section Addressed
	techniques for subsidence and biodiversity after mining of each longwall. This would then inform monitoring for subsequent longwall panels. - Monitoring of knickpoint formation during mining of each longwall, and implementation of appropriate controls to prevent knickpoint formation. - Reporting of monitoring results within the Annual Review.	
SW-1	**Surface water** Potential impact: Impacts to surface water from mining-induced subsidence Management and mitigation measures: Monitoring would be undertaken before mining commences to assess the baseline conditions above each longwall, and would include: - Geomorphological conditions, including creek mapping and high-resolution photography (before, during and after mining beneath each longwall) of rock bars, shallow alluvium (i.e. less than 2 m deep) and permanent or semi-permanent pools within the subsidence impact area. - Water quality - Stream flow Monitoring sites will include: - Ongoing streamflow monitoring at Hornes Creek, Dog Trap Creek, Eliza Creek and Carters Creek in order to expand baseline data of these waterways up to the period of mining within these catchments; - An additional stream flow gauging station would be installed at Tea Tree Hollow, downstream of the edge of the longwall and upstream of Licensed Discharge Point (LDP) 1. - Additional water level monitoring at Hornes Creek, Dog Trap Creek, Tea Tree Hollow and Eliza Creek to establish baseline water level data to enable the assessment of potential impacts to pool water levels; - Streamflow gauging activities would be continued. Enhanced low flow control weirs would be established at the existing gauging station at Dog Trap Creek downstream and the proposed new gauging station at Tea Tree Hollow to support the generation of reliable continuous flow data (including reliable low flow data) at the stations. Routine water level and water quality monitoring at the stations would also be continued. Monitoring results would be reported in the Annual Review.	Water Management Plan
SW-2	**Surface water** Potential impact: Impacts to surface water from mining-induced subsidence Management and mitigation measures: Monitoring of waterways within 200 m of active longwall mining, including weekly photographic recording and monthly water quality sampling upstream and downstream of potentially affected areas. Results would be analysed in relation to action response triggers, as detailed in the surface water management plan. Monitoring to be reported in the Annual Review.	Water Management Plan
SW-5	**Surface water** Potential impact: Impacts to surface water from mining-induced subsidence Management and mitigation measures: Update the monitoring and management plans and the groundwater/ surface water model in relation to impacts to the Thirlmere Lakes as findings from the OEH research project become available to guide ongoing management of impacts.	Water Management Plan
SW-6	**Surface water** Potential impact: Water quality impacts due to discharge of treated water from LDP1. Management and mitigation measures: Monitoring and management of water quality downstream of LDP1 would include: - A new water quality monitoring site would be established on the Bargo River downstream of the confluence with Tea Tree Hollow and upstream of SW14 to increase the spatial representation of water quality sites downstream of LDP1. - Establishment of a TARP for water quality exceedances which incorporate both baseline and control monitoring data. - The pit top water management system performance would be assessed annually against its predicted performance range. - Revision to the water management plan would be undertaken if the performance review indicates the water management system has, or is likely to be, unable to meet its regulatory performance requirements. - The discharge monitoring would include: - A full suite of metals;	Water Management Plan

EIS Reference	Commitment	Tahmoor Coal Response / Section Addressed
	- Sulfate, total dissolved solids and electrical conductivity, major ions; - Total suspended solids and turbidity; - Any residual settling agent risks (flocculants or coagulants); and - Volume and frequency of controlled discharges and frequency of managed overflows.	
SW-7	**Surface water** Potential impact: Surface water entitlement Management and mitigation measures: Obtain the necessary authorised entitlement to account for the maximum take of water from both surface water and groundwater sources in accordance with the Aquifer Interference Policy.	Water Management Plan
PAR #6	**Surface water** - Prior to the commencement of longwall mining, an adaptive monitoring and TARP would be developed. The following surface water elements would be incorporated into the plan: - TARPs for water quality exceedances which incorporate both baseline and control monitoring data. Site specific trigger values have been developed in accordance with ANZECC (2000) and ANZG (2018) for baseline sites which may potentially be affected by the Project – refer HEC (2019). - TARPs for unexpected flow loss based on analysis of baseline (i.e. pre-subsidence) streamflow data, post-subsidence streamflow data and contemporaneous data from control sites. Catchment flow modelling would also be used in the analysis. - TARPs for unexpected loss of pool water holding capacity based on analysis of baseline (i.e. pre-subsidence) pool water level data, post-subsidence pool water level data and contemporaneous data from control pool sites. Pool water balance modelling would also be used in the analysis particularly during unusual climatic/hydrological conditions.	Water Management Plan
PAR #9	**Surface water** - Monitoring of streamflow, pool water levels and water quality would continue for two years following cessation of longwall subsidence related movement in a watercourse or following completion of any stream/pool remediation.	Water Management Plan
GW-3	**Groundwater** Potential impact: Impacts to groundwater as a result of mining induced subsidence Management and mitigation measures: Update and maintain regional groundwater monitoring network, with monitoring results reported annually within the Annual Review. This would include replacement of failed bores around Tahmoor North and Tahmoor South, as well as establishing new bores. Monitoring of groundwater levels would include: - A condition assessment of bores and monitoring equipment (VMPs) of new bores around Tahmoor South, with a specific update of the GWMP. - Geophysical logging of boreholes that allow changes in groundwater storage and fracture apertures to be quantified and depth of rock deformation to be identified (i.e. observations of non-deformed ground which could be at least 10- 30 m below surface). - Re-install at least one bore in the footprint of a Tahmoor North longwall (e.g. at TNC029) to monitor post-mining groundwater level and groundwater quality. - Monitoring in longwall centre-lines of pre- and post-mining conditions Tahmoor South. This would be undertaken for the longwall (101A), and then every two or three after that. Packer testing would also be undertaken, followed by installing VMPs at four elevations in the Hawkesbury Sandstone and then two in the Bulgo Sandstone to assist in defining a profile of fracturing and depressurisation above longwalls. Results from monitoring would be compared to those from groundwater monitoring of reference sites including upstream and outside the predicted subsidence impact zone where relevant	Water Management Plan
GW-5	**Groundwater** Potential impact: Impacts to groundwater as a result of mining induced subsidence Management and mitigation measures: Revision of the groundwater model to: - Take further advantage of unstructured mesh capabilities; - Incorporate conceptual developments from the OEH Thirlmere Lakes Research Program (once complete); and - Incorporate the results of mine inflow monitoring; - Incorporate monitoring data from groundwater bores in the Western Domain of Tahmoor North.	Water Management Plan
AE-2	**Aquatic ecology** Potential impact:	Biodiversity Management Plan

EIS Reference	Commitment	Tahmoor Coal Response / Section Addressed
	Impacts to aquatic ecology as a result of longwall mining and mining induced subsidence Management and mitigation measures: Undertake monitoring of macroinvertebrates for a baseline of two years prior to longwall extraction. The monitoring program may require adding or relocating sites according to the final mine plan and using the same sampling methods as used in the aquatic monitoring conducted to date.	
AE-3	**Aquatic ecology (existing commitment)** Potential impact: Impacts to aquatic ecology as a result of longwall mining and mining induced subsidence Management and mitigation measures: Implement a BACI (Before After Control Impact) designed monitoring program to compliment the baseline information collected and to assess monitoring impacts in an adaptive management framework.	Biodiversity Management Plan
358/SAR	**Terrestrial ecology** Transmission lines - the proposed transmission lines has been revised to maximise the existing cleared land, road and existing easement as much as practical. Clearing is therefore only required where vegetation encroaches on the proposed transmission line easement. The installation of the transmission line has also been designed to avoid direct impact to threatened flora by: Engaging a suitably qualified ecologist to be present during clearing associated with the transmission line easement to: clearly mark the threatened plants to ensure that the contractors avoid impacts during clearing event; and be present during the installation of the power poles to safeguard against direct impacts to the threatened plants. The transmission line will require on-going maintenance, such as slashing of vegetation within the easement to a height of 2 m. Given the plants will not grow above 2 m in height, the long-term maintenance slashing is unlikely to impact the threatened plants."	Biodiversity Management Plan
LUR-3	**Land use and resources** Potential impact: Impacts of the surface aspects of the Project on land use Management and mitigation measures: Develop a Land Management Plan to manage land use and agricultural land within the Project Area	Land Management Plan
HH-3	**Non-Aboriginal Heritage** Potential impact: Impacts to items of non-Aboriginal Cultural Heritage Significance as a result of longwall mining and mining-induced subsidence. Management and mitigation measures: Develop a site-specific Heritage Property Subsidence Management Plan for Wirrimbirra Sanctuary prior to commencement of mining, including a detailed site inspection. The outcomes of the assessment would be provided in an additional Statement of Heritage Impact in consultation with the National Trust and NSW Heritage Council, or its delegate.	Heritage Management Plan Built Features Management Plan

3.2.1.4 EPBC Act Approval Conditions

Conditions relevant to the Extraction Plan from the approval (EPBC 2017/8084) granted by the DAWE (now Commonwealth DCCEEW) for the Tahmoor South Project are outlined in **Table 9**.

Table 9 EPBC Act Approval Conditions

Condition	Condition Requirement	Tahmoor Coal Response / Section Addressed
1	The approval holder must not impact any listed threatened species and ecological communities outside the Development Application Area. Within the Development Application Area, the approval holder must not impact more than: a. 7.3 hectares of the Shale Sandstone Transition Forest in Sydney Basin Bioregion. b.0 individuals of Small-flower Grevillea; c. 0 individuals of Bargo Geebung; d. 0 individuals of Rufous Pomaderris e. 1.3 hectares of Koala habitat	The Biodiversity Management Plan outline the proposed ecology monitoring program and management measures for the management of ecology (including threatened species and ecological communities) during mining of LW S1A-S7A.
2	The approval holder must comply with the State development consent conditions A9, B37, B38, B39, B40, B56, B58, B59, B60, C1, C2, C3, C4, C8, C9 and C10	Relevant conditions applicable to this Extraction Plan are discussed

Condition	Condition Requirement	Tahmoor Coal Response / Section Addressed
		in **Section 3.2.1.1** and **Section 3.2.1.2**. Condition A9 of SSD 8445 is not considered relevant to this Extraction Plan. Conditions B37, B38, B39, B40, B58 and B59 of SSD 8445 are covered by the generic Biodiversity Management Plan for the Tahmoor South Domain, which has been approved by DPE (NSW DPHI).
3	For the protection of water resources, the approval holder must comply with State development consent conditions A7, B23, B24, B30, B31, B32, B33, B34, B35, B36, C1, C2, C8, C9 and C10	Relevant conditions applicable to this Extraction Plan are discussed in **Section 3.2.1.1** and **Section 3.2.1.2**. Condition A7 of SSD 8445 is not considered relevant to this Extraction Plan. Conditions B30, B31, B33, B34, B35 and B36 of SSD 8445 are covered by the generic Water Management Plan for the Tahmoor South Domain, which has been approved by DPE (NSW DPHI). Condition B32 has been deleted as part of Modification 2. Conditions B23 and B24 of SSD 8445 will be reported on in the Annual Review.
4	The approval holder must ensure there is no adverse effect on the function of a water resource as a result of the action.	Water Management Plan
8	The approval holder must submit to Department each approved Extraction Plan for second workings within 2 business days of its approval by the NSW Planning Secretary.	Noted.
9	The approval holder must notify the Department within 5 business days of any proposed changes to any approved Extraction Plan. If the NSW Planning Secretary approves a revised version of an Extraction Plan, the approval holder must provide the Department with the approved revised Extraction Plan within 5 business days of its approval by the NSW Planning Secretary, accompanies by a detailed explanation of what changes have been made and any implications the changes could have for protected matters.	Noted.
10	If the approval holder detects or predicts an exceedance of a performance measure, the approval holder must notify the Department of the exceedance within 2 business days.	Noted.
11	If the approval holder detects an exceedance as described in condition 10, the approval holder must submit to the Department for approval an Impact Response Plan that has been peer reviewed. Each Impact Response Plan must at a minimum: a. be prepared by a suitably qualified person; b. describe all potential and actual impacts to water resources arising from the exceedance; c. include conceptual modelling, as well as a review of all historical monitoring data to determine the stressor-response relationships for any potential GDEs and consideration of potential contributing activities; d. consider and where appropriate include local scale numerical modelling with consideration of potential contributing activities; e. derive a scientifically-robust rectification strategy based on multiple lines of evidence and field data to support the assessment of the environmental values of water resources (including the groundwater-dependence of any potential GDEs) within the Development Application Area. f. identify if any further investigations are required to determine the cause of, and/or corrective actions, for the exceedance; g. include the mitigation and management measures that the approval holder has taken and/or proposes to take to reverse the exceedance, including data demonstrating the effectiveness of the mitigation and management measures;	**Section 7.4.3** Tahmoor Coal will also observe Conditions 12-16 of this approval.

Condition	Condition Requirement	Tahmoor Coal Response / Section Addressed
	h. provide justification for how the proposed mitigation and management measures will achieve and maintain the requirements of condition 4; and i. include a peer review and details of how the approval holder has addressed any inadequacies raised in the peer review. The approved Impact Response Plan must be implemented.	
21	The approval holder must: a. submit plans electronically to the Department; b. unless otherwise agreed to in writing by the Minister, publish each plan on the website within 20 business days of the date: i. of this approval, if the version of the plan to be implemented is specified in these conditions; or ii. that the plan is submitted to the Minister or the Department if the plan does not require the approval of the Minister but was not finalised before the date of this approval; or iii. that the plan was approved in writing by the Minister or by the NSW Planning Secretary, if the plan requires the approval of the Minister or by the NSW Planning Secretary; c. exclude or redact sensitive ecological data from plans that are to be published on the website or provided to a member of the public; and d. keep plans published on the website for the period this approval has effect.	**Section 7.10** Noted.
22	The approval holder must prepare a compliance report for each 12 month period following the date of commencement of the action, or otherwise as agreed in writing by the Minister. The approval holder must: a. publish each compliance report on a website within 60 business days following the relevant 12 month period; b. notify the Department by email that a compliance report has been published on the website and provide the website's link for the compliance report within five business days of the date of publication; c. keep all compliance reports publicly available on the website until this approval expires; d. exclude or redact sensitive ecological data from compliance reports published on the website; and e. where any sensitive ecological data has been excluded from the version published, submit the full compliance report to the Department within 5 business days of publication.	**Section 7.1.3** Tahmoor Coal have obtained DAWE (now Commonwealth DCCEEW) approval to submit this annual compliance report in the form of the Annual Review, which is submitted by 31 March annually.
23	The approval holder must notify the Department in writing of any: incident, or non-compliance with the conditions, or non-compliance with the commitments made in plans. The notification must be given as soon as practicable, and no later than two business days after becoming aware of the incident or non-compliance. The notification must specify: a. any condition which is in breach; b. a short description of the incident and/or non-compliance; and c. the location (including co-ordinates), date, and time of the incident and/or non-compliance. In the event the exact information cannot be provided, provide the best information available.	**Section 7.2.3, Section 7.3.3**
24	The approval holder must provide to the Department the details of any incident or non-compliance with the conditions or commitments made in plans as soon as practicable and no later than 10 business days after becoming aware of the incident or non-compliance, specifying: a. any corrective action or investigation which the approval holder has already taken or intends to take in the immediate future; b. the potential impacts of the incident or non-compliance; and c. the method and timing of any remedial action that will be undertaken by the approval holder.	**Section 7.2.3, Section 7.3.3**
28	The approval holder must comply with condition A6 in Schedule 2 of the State Development Consent.	The extraction of LW S1A-S6A will be completed by 31 December 2033 or within 10 years of commencement of second workings.

3.2.2 Mining Lease Conditions

The LW S1A-S7A Extraction Plan Study Area is associated with two approved CCLs held by Tahmoor Coal - CCL 716 and CCL 747 (refer to **Figure 2**).

CCL 716 is the original Tahmoor Lease and was granted on 15 June 1990 and expired on 13 March 2021. CCL 716 was renewed on 16 August 2023 and expires on 13 March 2042.

CCL 747 is the Bargo Mining Lease and was granted on 23 May 1990 and expires on 6 November 2025. CCL 747 was renewed on 16 May 2025, effective from 7 November 2025 and expires on 6 November 2046.

Table 10 outlines the mining lease conditions relating directly to subsidence management from CCL 716 and CCL 747.

Table 10 Mining Lease Conditions Relevant to this Extraction Plan

Mining Lease	Condition Number	Condition Requirement	Tahmoor Coal Response / Section Addressed
CCL 716	6	The lease holder shall not knowingly destroy, deface or damage any aboriginal place or relic within the subject area, except in accordance with an authority issued under the *National Parks and Wildlife Act 1974,* and shall take every precaution in drilling, excavating or disturbing the land against any such destruction, defacement or damage.	Addressed in the HMP.
CCL 747	5	The lease holder shall observe and perform any instruction given to which may be given by the Minister regarding any aboriginal relics within the subject area.	Such a direction can be given through the Extraction Plan process. Addressed in the HMP.

3.2.3 Environmental Licences

Tahmoor Mine operates under EPL 1389, which authorises carrying out of scheduled activities associated with coal works, mining for coal and sewage treatment processing by small plants.

An Annual Return stating Tahmoor Mine's compliance with the conditions of EPL 1389 and summarising monitoring results and complaints is completed and submitted to the EPA by 28 February of each year. Each Annual Review is lodged via the EPL portal.

Tahmoor Coal holds Water Access Licences as per **Table 11** below. Further details of these licences and Tahmoor Coal's compliance with the licences are discussed in the Water Management Plan.

Table 11 Water Access Licences

Approval Title / Description	Date Granted	Expiry Date
Environmental Protection Licence 1389	01/05/1994, latest variation 28/06/2024	No Expiry
WAL36442	6/12/2013	No Expiry
WAL25777	27/10/2014	No Expiry
SWC871469 (Leased)	11/07/2025	01/07/2026
SWC868868 (Leased)	01/07/2024	30/06/2025*
WAL43631	08/03/2021	No Expiry
WAL43655	09/03/2021	No Expiry
WAL43656	1/8/2022	No Expiry
WAL43657	09/03/2021	No Expiry
WAL43659	09/03/2021	No Expiry
WAL45204	07/08/2024	No Expiry
XSTR200005 Dangerous Goods Licence	02/02/2017	02/02/2027
5061521 Radiation Management Licence	29/10/2025	29/10/2026

*Lease in process of renewal for FY2026

3.2.4 Work, Health and Safety Legislations

Tahmoor Coal has developed a Health and Safety Management Plan (TAH-HSEC-00189) that integrates plans, policies and procedures that enables a systematic approach to establishing and maintaining effective systems to manage health and safety consistent with WHS legislation.

Tahmoor Mine has been planned so that LW S1A-S6A will meet all the requirements of the following Work Health and Safety (WHS) Legislation:

- *Work Health and Safety Act 2011* (WHS Act);
- *Work Health and Safety Regulation 2017* (WHS Regulation);
- *Work Health and Safety (Mines and Petroleum Sites) Act 2013* (WHSMP Act); and
- *Work Health and Safety (Mines and Petroleum Sites) Regulation 2022* (WHSMP Regulation).

The WHS Act and WHS Regulations came into force on 1 January 2012. The WHS Act, is the primary piece of legislation dealing with the health and safety of workers in NSW. The WHSMP Act and WHSMP Regulations apply to all mining workplaces in NSW commenced on 1 February 2015 and updated on 1 September 2022. These laws support the WHS Act and WHS Regulation and provide additional provisions for work health and safety issues unique to mines and petroleum sites.

This Extraction Plan has been prepared to address the relevant requirements of the WHS legislation, principally within the context of subsidence related risks to public safety with regards to private property and public infrastructure.

Details regarding the compliance with the relevant requirements of the WHS Regulations and WHSMP Regulations are provided in **Table 15**, as well as being discussed in the Public Safety Management Plan (PSMP).

3.2.4.1 WHS Requirements for Persons Conducting a Business or Undertaking

In accordance with Section 19 of the WHS Act, 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, so far as is reasonably practicable. PCBUs must also ensure, so far as is reasonably practicable, the health and safety of other persons is not put at risk from work carried out as part of the conduct of the business or undertaking.

Under Clause 14(1) of the WHSMP Regulation, a PCBU at a mine, including the Mine Operator, must manage risks to health and safety associated with the mining operations in accordance with Part 3.1 of the WHS Regulation. Specifically, Clause 70(1) of the WHSMP Regulation requires the operator of an underground coal mine to (in complying with Clause 14) manage risks to health and safety associated with subsidence at the mine. Clause 70(2) of the WHSMP Regulation outlines specific requirements regarding subsidence including monitoring, investigation and reporting.

The Mine Operator's responsibilities include developing and implementing the Health and Safety Management Plan (TAH-HSEC-00189) that is used as the primary means of ensuring, so far as is reasonably practicable that the above discussed PCBU duty of care.

Details regarding the compliance with the relevant requirements of the WHS Regulations and WHSMP Regulations are provided in **Table 12**, as well as being discussed in the PSMP.

3.2.4.2 Subsidence as a Principal Hazard

According to Clause 4 of the WHSMP Regulation provides the definition of a principal hazard as:

"…an activity, process, procedure, plant, structure, substance, situation or other circumstance relating to the carrying out of mining operations or petroleum operations that has a reasonable potential to result in multiple deaths in a single incident or a series of recurring incidents in relation to

(vi) subsidence,"

In accordance with Table 7 in Condition C1 and Condition C7 of SSD 8445, all first workings in the Tahmoor South Domain are required to be designed to remain stable and non-subsiding in the long-term, except insofar as they may be impacted by approved second workings. While it is not considered that there is reasonable potential for a subsidence incident to cause multiple fatalities, Tahmoor Coal has prepared this Extraction Plan generally in accordance with the relevant WHS legislation and guidelines as outlined further below and detailed in **Table 12** and the PSMP.

Under Clauses 27(1) and 27(2) of the WHSMP Regulation, the Mine Operator must identify all principal mining hazards associated with mining operations and conduct a risk assessment in relation to each principal hazard identified that involves a comprehensive and systematic investigation and analysis of all aspects of risk to health and safety associated with each principal hazard. Tahmoor Coal has prepared a risk assessment to identify and assess principal hazards and controls in relation to subsidence as discussed further in **Section 7.6**, **Table 12**, and the PSMP.

Table 12 Work Health and Safety Legislation Compliance

WHS Legislation and Clause	Section Addressed	WHS Legislation and Clause
WHS Regulations		
Clause 34	**Duty to identify hazards** A duty holder, in managing risks to health and safety, must identify reasonably foreseeable hazards that could give rise to risks to health and safety.	**Section 7.6** PSMP
Clause 35	**Managing risks to health and safety** A duty holder, in managing risks to health and safety, must: (a) eliminate risks to health and safety so far as is reasonably practicable, and (b) if it is not reasonably practicable to eliminate risks to health and safety, minimise those risks so far as is reasonably practicable.	**Section 3.6** Section 6 of WMP, LMP, BMP and HMP.
Clause 36	**Hierarchy of control measures** (1) This clause applies if it is not reasonably practicable for a duty holder to eliminate risks to health and safety. (2) A duty holder, in minimising risks to health and safety, must implement risk control measures in accordance with this clause. (3) The duty holder must minimise risks, so far as is reasonably practicable, by doing 1 or more of the following: (a) substituting (wholly or partly) the hazard giving rise to the risk with something that gives rise to a lesser risk, (b) isolating the hazard from any person exposed to it, (c) implementing engineering controls. (4) If a risk then remains, the duty holder must minimise the remaining risk, so far as is reasonably practicable, by implementing administrative controls. (5) If a risk then remains, the duty holder must minimise the remaining risk, so far as is reasonably practicable, by ensuring the provision and use of suitable personal protective equipment.	**Section 3.6, Section 7.6** PSMP Section 6 of WMP, LMP, BMP and HMP.

	Note. A combination of the controls set out in this clause may be used to minimise risks, so far as is reasonably practicable, if a single control is not sufficient for the purpose.	
Clause 37	**Maintenance of control measures** A duty holder who implements a control measure to eliminate or minimise risks to health and safety must ensure that the control measure is, and is maintained so that it remains, effective, including by ensuring that the control measure is and remains: (a) fit for purpose, and (b) suitable for the nature and duration of the work, and (c) installed, set up and used correctly.	**Section 3.6** Section 6 of WMP, LMP, BMP and HMP.
Clause 38	**Review of control measures** (1) A duty holder must review and as necessary revise control measures implemented under this Regulation so as to maintain, so far as is reasonably practicable, a work environment that is without risks to health or safety. (2) Without limiting subclause (1), the duty holder must review and as necessary revise a control measure in the following circumstances: (a) the control measure does not control the risk it was implemented to control so far as is reasonably practicable, (b) before a change at the workplace that is likely to give rise to a new or different risk to health or safety that the measure may not effectively control, (c) a new relevant hazard or risk is identified, (d) the results of consultation by the duty holder under the Act or this Regulation indicate that a review is necessary, (e) a health and safety representative requests a review under subclause (4). (3) Without limiting subclause (2) (b), a change at the workplace includes: (a) a change to the workplace itself or any aspect of the work environment, or (b) a change to a system of work, a process or a procedure. (4) A health and safety representative for workers at a workplace may request a review of a control measure if the representative reasonably believes that: (a) a circumstance referred to in subclause (2) (a), (b), (c) or (d) affects or may affect the health and safety of a member of the work group represented by the health and safety representative, and (b) the duty holder has not adequately reviewed the control measure in response to the circumstance.	**Section 3.6, Section 7.6** PSMP Section 6 of WMP, LMP, BMP and HMP.
WHSMP Regulations		
Clause 14	**Management of risks to health and safety** (1) A person conducting a business or undertaking at a mine or petroleum site must manage risks to health and safety associated with mining operations or petroleum operations at the mine or petroleum site in accordance with the WHS Regulations, Part 3.1. (2) A person conducting a business or undertaking at a mine or petroleum site must ensure a risk assessment is conducted in accordance with this section by a person who is competent to conduct the risk assessment having regard to the nature of the hazard. (3) In conducting a risk assessment, the person must have regard to the following—	**Section 7.6** PSMP

	(a) the nature of the hazard, (b) the likelihood of the hazard affecting the health or safety of a person, (c) the severity of the potential health and safety consequences. (4) Subsection (3) does not limit the operation of another requirement to conduct a risk assessment under this Regulation. (5) A person conducting a business or undertaking at a mine or petroleum site, who is the operator of the mine or petroleum site or who is a contractor, must keep a record of the following— (a) each risk assessment conducted under this section and the name and competency of the person who conducted the risk assessment, (b) the control measures implemented to eliminate or minimise a risk that was identified by the risk assessment. (6) A person conducting a business or undertaking at a mine or petroleum site is not required to keep a record of a risk assessment if— (a) the risk assessment is required to be carried out by an individual before the worker commences a task that forms part of an activity, and (b) the person keeps a record of risk assessments that addresses the overall activity being undertaken, of which the task forms a part. (7) A record kept under subsection (5) by an operator of a mine or petroleum site forms part of— (a) the safety management system of the mine or petroleum site, and (b) the records of the mine or petroleum site. (8) A record, kept under subsection (5) by a contractor who has prepared a contractor health and safety management plan, forms part of the plan.	
Clause 15	**Review of control measures** (1) A person conducting a business or undertaking at a mine or petroleum site must review and as necessary revise control measures implemented under section 14(5)(b) in the following circumstances— (a) an audit of the effectiveness of the safety management system for the mine or petroleum site indicates a deficiency in a control measure, (b) a worker is moved from a hazard or assigned to different work in response to a recommendation contained in a health monitoring report provided under Part 4, (c) an incident referred to in section 124 occurs, (d) another incident occurs that is required to be notified to the regulator under the WHS laws. (2) The operator of a mine or petroleum site must ensure a control measure the subject of a request under the WHS Regulations, clause 38(4) is reviewed and as necessary revised, whether the request is made— (a) to the operator by a health and safety representative, or (b) notified to the operator under subsection (3). (3) A person conducting a business or undertaking at the mine or petroleum site who is not the operator of the mine or petroleum site must immediately notify the operator of a request made to the person under the WHS Regulations, clause 38(4). (4) A health and safety representative for workers at a mine or petroleum site may request a review of a control measure under the WHS Regulations, clause	**Section 7.2, Section 7.6, Section 7.7, Section 7.8** PSMP

	38(4) as if the circumstances referred to in subsection (1) were included as a circumstance in the WHS Regulations, clause 38(4)(a).	
Clause 27	**Identification of Principal Mining Hazard Management Plan** (1) The operator of a mine or petroleum site must identify all principal hazards associated with mining operations or petroleum operations at the mine or petroleum site. (2) The operator must conduct, in relation to each principal hazard identified, a risk assessment that involves a comprehensive and systematic investigation and analysis of all aspects of risk to health and safety associated with the principal hazard. (3) The operator, in conducting a risk assessment under subsection (2), must— (a) use investigation and analysis methods appropriate to the principal hazard being considered, and (b) consider the principal hazard individually and also cumulatively with other hazards at the mine or petroleum site.	**Section 7.6** PSMP
Clause 28	**Preparation of Principal Mining Hazard Management Plan** (1) The operator of a mine or petroleum site must prepare a principal hazard management plan for each principal hazard associated with mining operations or petroleum operations at the mine or petroleum site in accordance with this section and Schedule 1. (2) A principal hazard management plan must— (a) provide for the management of all aspects of risk control in relation to the principal hazard, and (b) as far as reasonably practicable, be set out and expressed in a way that is readily understandable by persons who use it. (3) A principal hazard management plan must— (a) describe the nature of the principal hazard, and (b) describe how the principal hazard relates to other hazards associated with mining operations or petroleum operations at the mine or petroleum site, and (c) describe the analysis methods used in identifying the principal hazard, and (d) include a record of the most recent risk assessment conducted in relation to the principal hazard, and (e) describe the investigation and analysis methods used in determining the control measures to be implemented, and (f) describe all control measures to be implemented to manage risks to health and safety associated with the principal hazard, and (g) describe the arrangements in place for providing the information, training and instruction required by the WHS Regulations, clause 39 in relation to the principal hazard, and (h) refer to the design principles, engineering standards and technical standards relied on for control measures for the principal hazard, and (i) set out the reasons for adopting or rejecting each control measure considered. (4) The operator of a mine or petroleum site must consider the following when preparing a principal hazard management plan for a principal hazard at the mine or petroleum site— (a) the matters set out in Schedule 1 for the principal hazard, (b) other matters relevant to managing the risks associated with the principal hazard.	The Principal Mining Hazard Management Plan for subsidence was revised and updated to include LW S1A-S6A prior to the commencement of extraction.

	(5) The operator of a mine or petroleum site at which there is a principal hazard must ensure no mining operations or petroleum operations are carried out at the mine or petroleum site that may give rise to the hazard before the principal hazard management plan for the hazard has been prepared in accordance with this section.	
Clause 70	**Subsidence** (1) In complying with section 14, the mine operator of an underground coal mine must manage risks to health and safety associated with subsidence at the mine. (2) Without limiting subsection (1), the mine operator must ensure— (a) as far as reasonably practicable, the rate, method, layout, schedule and sequence of mining operations do not put the health and safety of a 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) an investigation of subsidence and an interpretation of subsidence information is carried out only by a competent person, and (d) all subsidence monitoring data is provided to the regulator— (i) in the approved way and form, and (ii) at the times required by the regulator, and (e) as far as reasonably practicable, procedures are implemented for the effective consultation, co-operation and co-ordination of action in relation to subsidence between the mine operator and relevant persons conducting business or an undertaking that is, or is likely to be, affected by subsidence.	**Section 3.3, Section 5, Section 7.6**, Master TARP (**Appendix C**) PSMP
Clause 124	Duty to notify regulator of certain incidents (1) The operator of a mine or petroleum site must take all reasonable steps to ensure the regulator is notified in accordance with this section after becoming aware of an incident, other than a notifiable incident, arising out of the carrying out of mining operations or petroleum operations at the mine or petroleum site, but only if the incident— (a) results in an illness or injury that requires medical treatment within the meaning of Schedule 9, section 12, or (b) is a high potential incident. (5) In this clause. High potential incident means any indication from monitoring data of the development of subsidence which may result in any incident referred to in clause: • 190 (a) (p) – a failure of ground, or of slope stability control measures, or • 190 (a) (q) – 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, or • 190 (a) (p) and (q) These clauses are relevant only if a person could reasonably be expected to be present.	**Section 7.2,** Master TARP (**Appendix C**) PSMP
Schedule 1 Subsidence Clause 6	**Principal Hazard Management Plans – additional matters to be considered** **Subsidence** The following matters must be considered in developing the control measures to manage the risks of subsidence— (a) the characteristics of all relevant surface and subsurface features,	Subsidence Predictions and Impact Assessment Report (**Appendix A**) Master TARP (**Appendix C**)

	(b) the characteristics of all relevant geological, hydrogeological, hydrological, geotechnical, topographic and climatic conditions, including conditions that may cause elevated or abnormal subsidence or the formation of sinkholes, (c) the characteristics of a previously excavated or abandoned workings that may interact with a proposed or existing mine workings, (d) the existence, distribution, geometry and stability of significant voids, standing pillars or remnants within an old pillar workings that may interact with a proposed or existing mine workings, (e) the predicted and actual nature, magnitude, distribution, timing and duration of subsidence, (f) the rate, method, layout, schedule and sequence of mining operations	
Schedule 3 Clause 17	**High Risk Activities** (1) Secondary extraction is identified as a high risk activity. (2) The waiting period for the activity is 3 months. (3) The information and documents that must be provided in relation to the activity are as follows— (a) details of the authoritative sources used in determining that the proposed method of work can be done safely, (b) engineering plans showing the method and sequence of extraction, endorsed by the individual nominated to exercise the statutory function of mining engineering manager at the mine, (c) information about the land above or near the proposed activity including land use and details of who owns or occupies land that may be affected by subsidence, (d) for a pillar extraction, details of the procedures for the recovery of buried and immobile mining plant in or around a goaf, (e) details of how the risks to the health and safety of workers and other persons from subsidence caused by the activity will be managed.	A High Risk Activity Notification, as required by WHS Regulation, was submitted separately to this Extraction Plan, prior to the commencement of secondary extraction.

3.2.4.3 Principal Hazard Management Plan

Under Clause 28 of the WHSMP Regulation, the Mine Operator must prepare a Principal Hazard Management Plan for each principal hazard associated with mining operations in accordance with Clause 28 and Schedule 1. The Principal Hazard Management Plan for subsidence was revised and updated to include LW S1A-S76A prior to the commencement of secondary extraction of LW S1A. The Plan was further updated to include Longwall South 7A following approval of Modification 3, prior to the commencement of LW S7A.

3.2.4.4 High Risk Activity

A Mine Operator must give notice of a High Risk Activity to the regulator and ensure that the requirements of Clause 35 and Schedule 3 of the WHSMP Regulation are complied with. In Schedule 3 of the WHSMP Regulation, there are three High Risk Activities that relate to subsidence:

- Clause 17 – Secondary extraction;
- Clause 18 – Shallow depth of cover mining; and
- Clause 30 – Highwall mining.

Mining of LW S1A-S7A involves secondary extraction, therefore it is considered a High Risk Activity under Schedule 3, Clause 17 of the WHSMP Regulation. A High Risk Activity Notification, as required by WHS

Regulation, was submitted separately to this Extraction Plan, prior to the commencement of secondary extraction of LW S1A.

It is noted that Clause 18 and Clause 19 do not apply to the extraction of LW S1A-S7A.

3.2.4.5 Managing Risks of Subsidence Guide: WHS (Mines and Petroleum Sites) Legislation

To assist Mine Operators in complying with their obligations under the WHS laws relevant to subsidence, the Resources Regulator released the document *Managing Risks of Subsidence Guide: WHS (Mines and Petroleum Sites) Legislation* (Resources Regulator, 2017). This Extraction Plan has been prepared in accordance with the requirements of the Guideline.

Section 2.2.2 of the *Managing Risks of Subsidence Guideline* lists the surface and subsurface features which could give rise to risks to health and safety, if the features are affected by subsidence. The surface and subsurface features include:

- Public utilities (e.g. highways, railways, tunnels, bridges, air strips, electrical transmission infrastructure or pressurised gas pipelines);
- Public amenities (e.g. shopping centres, hospitals, churches, sport facilities, child care centres or schools);
- Built features other than public utilities and amenities (e.g. dwellings, factories, workshops, privately owned gas storages or surface mining voids or facilities); and
- Natural features (e.g. cliffs, steep slopes, natural caves or dams or surface of land), where subsidence may result in hazardous conditions due to instability of rock or soil masses, rock falls, landslide, fractures, sinkholes, inundation, gas release or pollution of drinking water.

A summary of the relevant natural and built features that may pose a risk to public safety, the WHS risk assessment undertaken, and the management and monitoring of subsidence in relation to public safety is addressed in the PSMP.

3.2.5 Extraction Plan Guidelines

This Extraction Plan has been prepared in accordance with the DPE *Extraction Plan Guidelines* (DPE, 2022), as summarised in **Table 13**.

Table 13 Extraction Plan Guideline Requirements

Extraction Plan Guideline	Section Detail	Section Addressed
1. Title block	A title block should be included at the beginning of the Extraction Plan, which contains the: • name of the applicant company; • name of mine; • development consent and mining lease reference numbers; • Extraction Plan title, date and reference number; and • the signature(s) of person(s) taking responsibility for the accuracy and comprehensiveness of the information contained within the plan, including an authorised representative of the lease holder and the mine manager (for the purposes of relevant safety legislation).	Page 2
2. Development of the Plan	The process of development of the Extraction Plan should be described. Most importantly, this section should address consultation undertaken by the Applicant with affected agencies and other key stakeholders, such as the owners and/or operators of both publicly and privately-owned land and infrastructure and the mine's Community Consultative Committee. This section should also describe the process of reviewing and updating the predictions of subsidence effects, subsidence impacts and environmental consequences used in	**Section 2**

Extraction Plan Guideline	Section Detail	Section Addressed
	previous environmental impact assessment or environmental management plan documentation relied upon by the Applicant (eg the predictions in any previous Environmental Impact Statement and/or the predictions in any previous Extraction Plan or SMP Application).	
3. Overview	The overview section is an essential introduction to the Extraction Plan. It should accurately describe: • Mine planning and design; • Subsidence predictions; • Performance objectives and other regulatory requirements; and • Subsidence management strategies and measures.	**Section 3**
4. Key sub-plans:	The main body of the Extraction Plan primarily comprises a set of six key sub-plans. It is appropriate that these are presented in a particular order, even if some of the later plans deserve a particular priority due to local circumstances (eg the Built Features or Heritage Management Plans). The preferred order for these sub-plans is as follows: • Water Management Plan; • Land Management Plan; • Biodiversity Management Plan; • Heritage Management Plan; • Built Features Management Plan; and • Public Safety Management Plan. All six key sub-plans should give appropriate consideration to risk assessment and risk management.	**Section 4** Key Sub-plans and Supporting Documents
5. Subsidence Monitoring Plan	The key sub-plans should be followed by a Subsidence Monitoring Plan. This program should address two purposes. The first is to set out the program for monitoring the *subsidence effects* associated with the proposed coal extraction. The second is to summarise and consolidate the various environmental monitoring programs presented in each of the key sub-plans. These environmental monitoring programs should be directed towards monitoring the *subsidence impacts* and environmental consequences of mine subsidence.	**Section 5** Subsidence Monitoring Plan
6. Implementation	This section of the Extraction Plan should address all key elements of how the plan is going to be implemented, including reporting, regular review and key responsibilities. This section should follow the structure set out below: • Reporting Framework; • Review of the Extraction Plan; • Review of other Management Plans; and • Key Responsibilities.	**Section 7**
7. Graphical Plans	The following plans are required as part of the application: • Plan 1 • Plan 2 • Plan 3 • Plan 4 (not required) • Plan 5 • Plan 6 • Plan 7 • Plan with aerial photography	**Section 6** Graphical Plans
8. Attachments to the Extraction Plan	All other material necessary to support the Extraction Plan should be included as Attachments or Appendices.	Appendices A-D

3.3 Mine Planning and Design

3.3.1 Geology

3.3.1.1 Sydney Basin

The Sydney Basin is a large sedimentary basin on the east coast of Australia covering almost 50,000 km^2, whereby approximately 44,000 km^2 is located onshore and another 5,000 km^2 located offshore extending to the edge of the continental shelf. The basin forms part of the larger Sydney Gunnedah-Bowen Basin system, as outlined on **Figure 4**, which extends 1,700 km north from coastal southern NSW to Townsville.

The Sydney Basin is sedimentary in origin, with deposition of sediments occurring from the early Permian (290 million years ago) through to the latter part of the Triassic (200 million years ago). The Sydney Basin on-laps the Lachlan Fold Belt to the west and south, with basin depth increasing to the north and east.

The geological strata of the Sydney Basin can be summarised (from youngest to oldest) as following:

- Unconsolidated alluvial deposits along the major rivers and dune/beach deposits along the coast (Tertiary and Quaternary in age);
- Fractured volcanic intrusive and flows (and associate dyke swarms and occasional sills) within the Sydney Basin (Jurassic and Tertiary in age);
- Sedimentary rocks (including substantial coal measures at depth) of the Sydney Basin (Permian and Triassic age); and
- Fractured basement rocks below the Sydney Basin (Palaeozoic age).

3.3.1.2 Local Geology

The stratigraphy of the local geology (from youngest to oldest) can be summarised as below (and illustrated in **Figure 5**):

- Alluvial sediments – sediments consisting of sand, gravel, silt and clay overlie the Wianamatta Shales and Hawkesbury Sandstone along the major rivers and creeks. These sediments are rarely more than 20 m thick;
- Wianamatta Group – the Triassic Wianamatta Group comprises the surficial geology over most of the area. It can be very thin to more than 100m thick in some of the more elevated areas. The Wianamatta Group primarily comprises shales, with occasional calcareous claystone, laminate and coal. The Ashfield Shale is the most widespread rock type, at surface, across the area;
- Hawkesbury Sandstone:
    - Mittagong Formation – separates the Ashfield Shale from the underlying Hawkesbury Sandstone. It is a thin layer (generally less than 10 m thick) comprising dark grey to grey alternating beds of shale laminate, siltstone and quartzose sandstone;
    - Hawkesbury Sandstone – alluvial in origin, with a thickness of approximately 170 m in the region. Sandstone thicknesses increase to the north. The Triassic Hawkesbury Sandstone is generally medium to coarse grained quartz sandstone, with interbedded siltstone, finer grained sandstone and shale lenses. Shale lenses are common within this formation;
- Narrabeen Group – the total thickness of these Triassic rocks is approximately 450 m across the area and consists of the following subgroups:
- Gosford Sub-group:
    - Newport Formation – medium grained, light to dark grey, quartzose sandstone interbedded with siltstone;
    - Garie Formation – a thin, cream kaolinite claystone, which grades upwards to grey;

- Clifton Sub-group:
  - Bald Hill Claystone – grey to red/brown claystones and mudstones, occasional siderite nodules and generally softer than the overlying Garie Formation;
  - Bulgo Sandstone – white to grey coarse grained sandstone, fining upwards to coarse pebbly sandstone, with interbedded siltstone;
  - Stanwell Park Claystone – alternating light grey/green to brown sandstone and claystone intervals, with minor conglomerate;
  - Scarborough Sandstone – fine to very coarse grained, white to grey sandstone, with occasional siltstone and conglomerate laminae;
  - Wombarra Claystone – light grey/green to dark grey claystone, siltstone, mudstone with minor quartz lithic sandstone and conglomerate;
- Illawarra Coal Measures – the sedimentary thickness is approximately 300 m in the central area of the Southern Coalfield. The upper sections of the Permian Illawarra Coal Measures (Sydney Sub-group) contain the major coal seams including the Bulli, Balgownie and Wongawilli Coal seams. The underlying Cumberland Sub-group generally contains thin coal seam development;
- Shoalhaven Group – The Permian Budgong Sandstone is shallow marine to littoral, typically comprising fine and course grained sandstone;
- Talateran Group – basal Permian coal-bearing sequences including the Clyde Coal Measures and the Wasp Head Formation; and
- Basement geology – The Southern Sydney Basin Permian and Triassic rocks have been deposited upon early to middle Palaeozoic basement rocks of the Lachlan Fold Belt. These rocks consist of intensely folded and faulted slates, phyllites, quartzite sandstones and minor limestones of Ordovician to Silurian age.

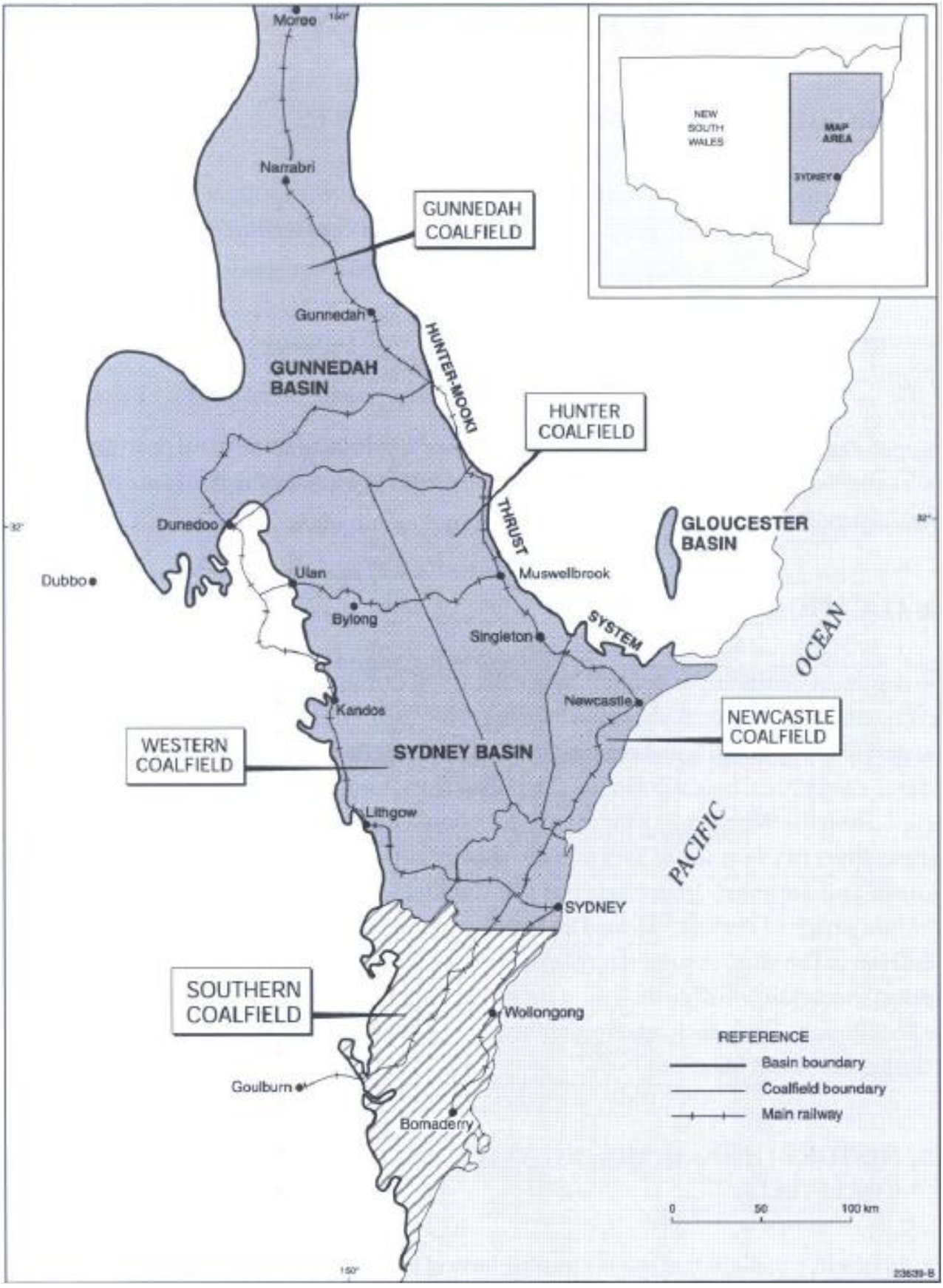


Figure 4 **Sydney Basin and the Southern Coalfields**

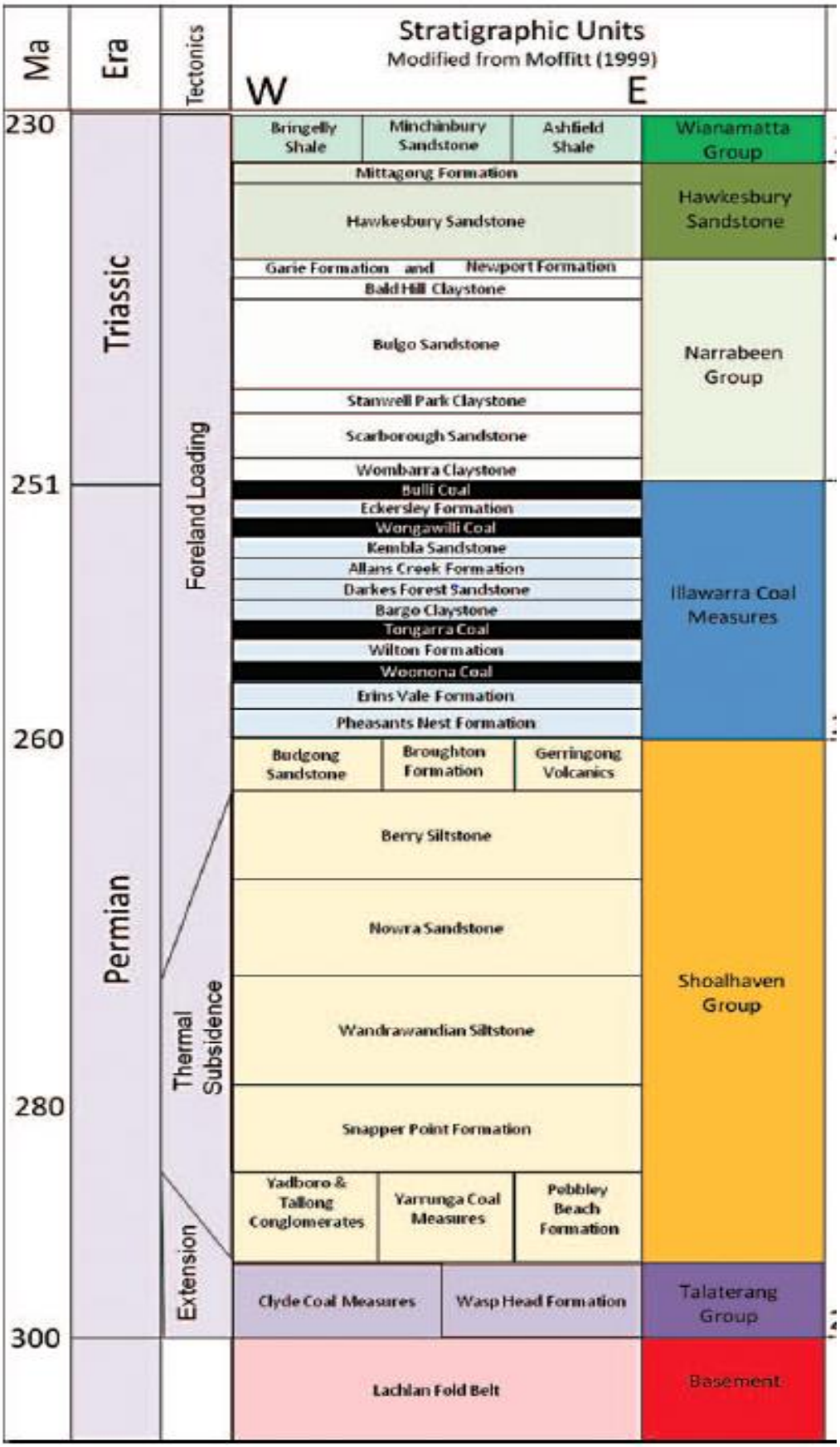


Figure 5 **Southern Coalfield Stratigraphy**

3.3.1.3 Southern Coalfield

The Southern Coalfield comprises the southern portion of the Sydney Basin, as outlined in **Figure 4**, covering an area south of Sydney almost to Batemans Bay, bounded in the west by the towns of Camden and Mittagong, and Helensburgh and Wollongong in the east.

The geological units of major economic significance in the Southern Coalfield are the late Permian Illawarra Coal Measures, a 240 m thick deltaic sequence that occurs above the Shoalhaven Group and beneath the Hawkesbury Sandstone and Narrabeen Group. The Illawarra Coal Measures are divided into two subgroups - the basal Cumberland Subgroup containing both the Pheasants Nest Formation and Erins Vale Formation, and the Sydney Subgroup containing the economic coal seams that are the Bulli, Balgownie, Wongawilli, and Tongarra seams.

The coal measures outcrop above sea level approximately 20 km to the north of Wollongong. The Illawarra Coal Measures dip at approximately four degrees to the north-west in the Illawarra that creates the outcrop pattern that extends from sea level about 20 km north of Wollongong before turning westward to track the northern side of the Shoalhaven River valleys.

The coal in the Southern Coalfield differs in rank from the other coalfields of the Sydney Basin. It is generally low to high volatility bituminous coal, in contrast to the medium to high volatility bituminous coal which predominates in other regions. The coal is buried at depths of greater than 300 m.

3.3.1.4 Bulli Coal Seam

The Bulli Coal Seam is stratigraphically the top seam in the Illawarra Coal Measures and represents the majority of the coal reserves. The seam reaches depths of up to 800 m in the central north of the coalfield and is situated at more than 850 m below the surface in the north-west. To the north of the coalfield, the Bulli Coal Seam is 5 m at its thickest and in other regions varies in thickness between 2 to 3 m. The thicker sections of the Bulli Coal Seam occur in synclines and down-thrown fault blocks.

The Bulli Coal Seam consists of interbanded coal seams composed of dull and bright plies. In addition to the coal, minor claystone and siderite is present in the seam. The Bulli Coal Seam contains 8-9% ash, 21.5-27.5% volatile matter, 30-55% vitrinite, a high inertinite percentage (up to 55%) and a relatively low sulphur content.

The Bulli Coal Seam is a prime quality coking coal with medium to high ash and low to medium volatiles, with an average raw yield ranging from 70-85% and average of approximately 76%. The regional dip of the Bulli Coal Seam towards the north-west is about 2.5 degrees. Where igneous intrusive bodies occur near the Bulli Coal Seam, the economic potential has been decreased due to thermal alteration of the coal.

3.3.2 Existing Workings

Tahmoor Coal has extracted coal from the Bulli Coal Seam through the operation of Tahmoor Mine since 1979. Tahmoor Mine has included the following longwall series:

- Longwalls 1 to 9 – mined from 1987 to 1992, with widths from 170 m to 200 m (void width) and length up to 1640 m;
- Longwalls 10 to 21 – mined from 1992 to 2004, with widths from 230 m to 235 m (void width) and lengths up to 2675 m;
- Longwalls 22 to 32 – mined from 2005 to 2019, with widths from 283 m to 285 m (void width) and lengths up to 3580 m. This longwall series was orientated in a north-west to south-east direction, and progressively mined from west to east; and
- Longwalls West 1 to West 4 – mined from 2019 to 2022, with widths of 283 to 285 m (void width) and lengths up to 1875 m. These longwalls are located in the Western Domain and are orientated in a north to south direction, and progressively mined from west to east.

The workings typically comprise of a five heading mains development configuration and numerous two heading gate road developments to establish the main and tailgates for the corresponding headwalls. Long-term mains development pillars are designed to be long-term stable and not cause subsidence, resulting in serviceable roads for the life of the mine. Gate road pillars are designed to exceed one-tenth of the overburden depth and are serviceable up until extraction.

Workings for both development and secondary extraction are identified in **Figure 2** and the Graphical Plans as part of this Extraction Plan application.

LW S1A-S7A are located in the Tahmoor South Domain. The new series of longwalls exist to the south of the previously mined Longwalls 14-19 and to the west of Longwall 2 at Tahmoor Mine.

Tahmoor Mine shares the Southern coalfield with numerous operating and discontinued coal mines that also target the Bulli Coal Seam, although no workings are immediately adjacent to the Tahmoor leases. These mines include GM3's Bulli Seam Operations, Russell Vale Mine, and Cordeaux Mine. GM3's Dendrobium Mine is situated to the south-east of Tahmoor Mine and targets the deeper Wongawilli Coal Seam.

3.3.3 Proposed Mining Method

First workings (primary extraction or development mining) for LW S1A-S7A utilises continuous miners and shuttle cars to develop roadways that form the longwall panels. The two heading development roadways for LW S1A-S7A are typically extracted at 5.2 m wide and 2.7-2.8 m high by single pass continuous miners.

Development mining equipment required for first workings includes, but is not limited to:

- Continuous miners;
- Shuttle cars;
- Breaker feeders;
- Auxiliary fans;
- Graders;
- Underground personnel transporters; and
- Underground load haul dumps.

Second workings (secondary extraction or longwall mining) for LW S1A-S7A will utilise longwall retreat mining method to extract coal from the Bulli Coal Seam. Longwall mining is supported by continuous miner development operations. Each longwall panel will retreat in a direction away from the Central Mains Headings towards the 500 Mains Headings, nominally extracting from south to north.

Longwall mining equipment required for second workings includes, but is not limited to:

- Longwall shearer – to cut coal from the face of the seam;
- Face conveyor – to collect sheared coal and carry it to a coal sizer and stage loader;
- Panel conveyor – to transfer the coal to a trunk conveyor in one of the main headings; and
- Hydraulic roof supports – to temporarily hold up the roof strata to provide a working space for the shearing machinery and face conveyor. After each slice of coal is removed, the hydraulic roof supports, face conveyor and shearing machinery are moved forward and the roof immediately above the seam is allowed to collapse into the void that is left as the face retreats (the goaf).

ROM coal from Tahmoor Mine is conveyed to the surface via a series of conveyor belts and discharged to the ROM Stockpile area, where the coal is reclaimed and transferred to the Coal Handling Preparation Plant. At the plant, the ROM coal is processed by crushing, washing, sizing and dewatered and then transferred to the product coal stockpile by conveyor. Product Coal is reclaimed and transferred by conveyors to the Rail Load Out Bin, and then loaded into rail coal wagons for transport to either Port Kembla or the Port of Newcastle by rail.

Coal is mined from within the Bulli Coal Seam, producing hard coking coal for steel production. Product coal is marketed to Australian domestic, and export customers.

3.3.4 Mine Geotechnical Overview

3.3.4.1 Depth of Cover

The depth of cover over LW S1A-S7A ranges from between a minimum of approximately 365 m to a maximum of approximately 405 m (**Figure 6** (in masl)).

3.3.4.2 Roof Stata Characteristics

The immediate Bulli Coal Seam roof consists of an interbedded sandstone, siltstone and mudstone sequence of varying thickness, stratigraphically named the Wombarra Claystone. This sequence is overlain by the more thickly bedded Scarborough Sandstone.

Generally, the overburden for the 50 m of roof above the Bulli Coal Seam averages 60-80 Mpa. Roof strengths range typically 40-80 Mpa. The immediate 0.5 m roof strength is typically in the range 40-70 Mpa. The average strength of the 0-2 m horizon is generally stronger, ranging between 50-80 Mpa. The 2-8 m roof horizon ranges in strength from 60-90 Mpa.

Roof conditions vary with both the roof lithology and local stress conditions. Tahmoor Coal undertakes extensive roof monitoring, including roof sampling at specified locations.

3.3.4.3 Floor Strata Characteristics

The Bulli Coal Seam floor typically consists of carbonaceous mudstone grading into the coarser Loddon Sandstone sediments below. Floor strengths range typically 40-70 Mpa. In the current Tahmoor mining area, the immediate floor 0.2-0.5 m below the Bulli Coal Seam averages 50-80 Mpa.

Floor heave is commonly observed during development at Tahmoor Mine. Floor brushing is carried out, usually at least once, to provide adequate clearance within the first two weeks of mining. Typically, 0.5 m of floor is brushed in development roadways.

A laboratory strength range for the coal of the Bulli Coal Seam is about 15-20 Mpa.

3.3.4.4 Seam Dip

The Bulli Coal Seam has a gentle dip to the northeast, averaging 1.7°, although can range with dips up to 4° being recorded. This northeast dip is consistent to being positioned on the western arm of the Camden Syncline and western edge of the Sydney Basin.

The Bulli Coal Seam average gradient is 3-5% (i.e. 1 in 20) or from 8-15 m across the proposed longwall face width within the mining area of LW S1A-S7A.

3.3.4.5 Seam Thickness and Working Section

The main part of the Bulli Coal Seam at Tahmoor Mine is a consistent seam of bright and dull coal. The thickness of the Bulli Coal Seam section ranges from 1.82-2.07 m thick in LW S1A-S7A.

The Bulli seam geology (full) consists of a main Bulli Coal portion, underlain by a stone band (bedding parting) that typically varies in thickness between 0.05-0.2 m, which is further underlain by a poorer quality coal split which ranges in thickness from 0.1-0.3 m. The longwall working section in LW S1A-S7A

plans to extract all three stratigraphic layers. Product yield is primarily driven by the proportionality of the aforementioned layers within the working section.

3.3.4.6 Faulting

Faults and seam continuity have been interpreted from exploration drilling, extensive seismic surveys and underground mapping.

No faults have been identified within the LW S1A-S7A from underground workings by Tahmoor Coal.

Tahmoor south mining area is bounded by the Nepean fault to the east and the Central fault zone to the west (refer to **Figure 6**).

This system is the southern extension of the Lapstone Monocline, and at Tahmoor Mine, it consists of closely spaced sub-vertical en-echelon faults in a zone up to 400 m wide. The net displacement of the faults is approximately 30 m at Picton, diminishing to 10 m at Tahmoor North, and 3m in Tahmoor South. The Nepean Fault Zone is the only hydraulically charged geological structure encountered during mining to date.

3.3.4.7 Igneous Intrusions

Igneous intrusions are present throughout the broader Tahmoor Mine area and are typically identified to be north-west to south-east orientated when intersected in the workings. These bodies have presented as dykes with associated sill material, ranging from very strong fresh material to weak highly altered rock. In the eastern part of the mining leasehold, a plug, which is exposed at the surface, is considered to be present at Bulli Coal Seam level. This feature is external to current mine plans.

Within the southern mining domain, a small-scale igneous intrusion has been mapped and projected within the South 2 Mains Headings, immediately to the East of LW S1A. No further intrusions have been encountered through extensive inseam drilling conducted to date.

Regionally, to the south-east of the Tahmoor Mine leases, the Bulli Coal Seam is extensively intruded and/or cindered to the east of Bargo. The north-western limits of this intrusion partly encroach on the south-eastern part of the Tahmoor South Lease.

3.3.4.8 Seam Splitting

Seam splitting has been observed within underground workings, exploration drilling, gas drainage drilling and roadway development, and is described in **Section 3.3.4.5**.

3.3.4.9 Geotechnical Design Parameters

Chain pillars at Tahmoor Mine typically range between 35-40 m wide (solid), varying slightly with depth of cover. Pillar dimensions are consistent with double abutment chain pillar widths in the local mining district. Narrower chain pillars down to 25 m have been adopted where single sided abutment is planned. Similar dimensions have been adopted in the new mining domain of S1A-S7A.

Specific details of the proposed design parameters are provided in **Table 14.**

3.3.4.10 Stability of Underground Workings

The Coal Mine Roof Rating is routinely measured at Tahmoor Mine to characterise the immediate roof strata, and ranges between 40-55 in the Tahmoor South Domain.

Due to the laminated immediate roof, goafing is typically observed directly behind the shields. Large en-masse roof falls are not a feature of longwalling in the Bulli Coal Seam at Tahmoor Mine.

The Tahmoor Mine Hazard Plan summarises the main features affecting the longwall stability as:

- Roadway stability due to stress notching;
- Cross grades across the face; and

- Minor strike slip faulting.

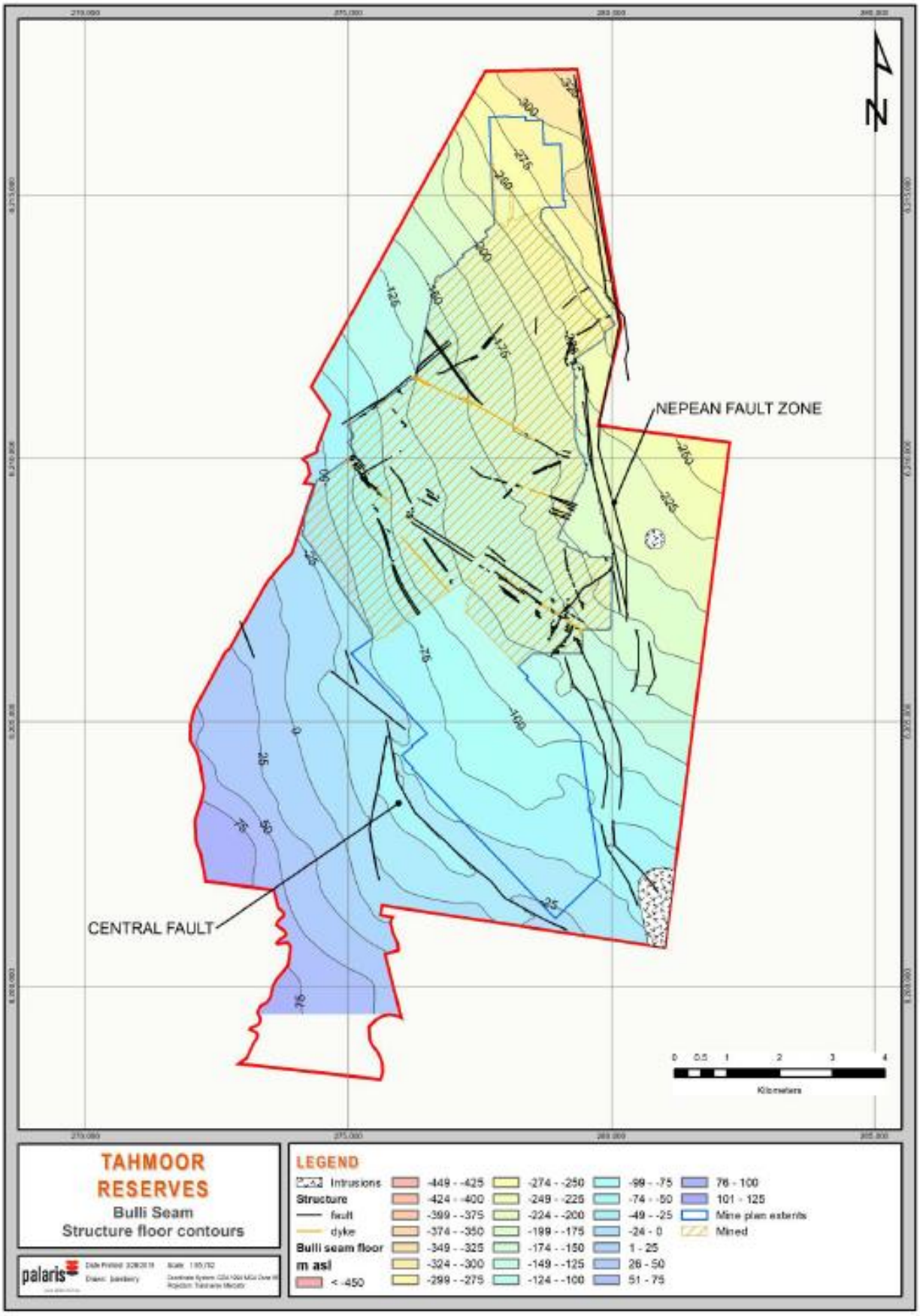


Figure 6 **Structure of the Bulli Coal Seam in the Tahmoor Mine Lease Areas (Palaris, 2019)**

3.3.5 Mine Geometry

3.3.5.1 Variations to the Original Mine Plan

As discussed in **Section 2.2.1,** the Tahmoor South Domain mine plan has been modified over time since the EIS submission in 2019, including modifications for each of the two amendment development applications.

Since development approval in April 2021, modifications to the Tahmoor South Domain mine plan have been applied to optimise development drivage and sequencing, and to maximise resource recovery within the constraints of available longwall equipment, features and boundaries. These minor adjustments include:

- Minor increases of longwall panel widths;
- Minor amendments to chain pillar widths;
- 'Squaring up' the headings to the south of the A series; and
- Minor adjustment to the commencement ends of the A series panels as a result of modification to the headings.

3.3.5.2 Current proposed Mine Plan

The current proposed mine plan for the Tahmoor South Domain is shown on **Figure 3**.

LW S1A-S7A are to be developed south of the 500 Mains Headings in an approximate north-south orientation and will be extracted from south to north. LW S1A was mined first, followed by LW S2A to LW S7A in a western progression. The layout for LW S1A-S7A is within the footprint of the Amended Extent of Longwalls as approved under the 2021 Development Consent (MSEC, 2022 and MSEC, 2024).

The dimensions of LW S1A-S7A are outlined in **Table 14**. Detailed mine layout drawings are provided in the Graphical Plans that form part of this Extraction Plan application.

The LW S1A-S6A panels will be 283 m (LW S1A) and 285 m (LW S2A–S7A) in width. The length of the longwalls will vary between 1,706 m for LW S1A and 1,994 m for LW S6A with LW S7A being 1918 m (excluding first workings). The overall void length is approximately 8 m greater than the longwall extraction length, owing to the installation headings. The mining height of the longwalls is anticipated to be between 2.1 m to 2.6 m.

Table 14 LW S1A-S7A Design Parameters

Longwall Panel Parameters	Units	LW S1A	LW S2A	LW S3A	LW S4A	LW S5A	LW S6A	LW S7A
ROM Coal Extracted	Tonnes	1,555,032	1,601,165	1,652,936	1,749,809	1,844,764	1,901,748	1,357,638
Gate Road Width	m	5.2	5.2	5.2	5.2	5.2	5.2	5.2
Gate Road Height	m	2.75	2.75	2.75	2.75	2.75	2.75	2.75
Maingate (MG) Chain Pillar Width	m	37.8	36	36	36	36	36	36
Tailgate (TG) Chain Pillar Width	m	90.4	37.8	36	36	36	36	36

Longwall Panel Parameters	Units	LW S1A	LW S2A	LW S3A	LW S4A	LW S5A	LW S6A	LW S7A
Pillar Width/Height Ratio		13.7	13.1	13.1	13.1	13.1	13.1	13.1
Tailgate (TG) Chain Pillar Length	m	119.8	119.8	119.8	119.8	119.8	119.8	119.8
Longwall Void Width	m	283	285	285	285	285	285	285
Longwall Extraction Width	m	272.6	274.6	274.6	274.6	274.6	274.6	180
Longwall Void Length	m	1714	1771	1811	1862	1952	2002	1918
Longwall Extraction Length	m	1706	1763	1803	1854	1944	1994	2026
Longwall Extraction Height	m	2.1-2.2	2.1-2.2	2.1	2.1	2.1	2.1-2.2	2.1-2.6
Coal Seam thickness	m	1.98	2.01	1.93	1.82	1.85	1.92	2.07
Minimum Depth of Cover	m	380	380	375	375	365	380	375
Maximum Depth of Cover	m	405	395	395	390	385	390	385

3.3.5.3 Mining Considerations and Hazards

A number of criteria and potential mining hazards have been taken into account during the design of the Tahmoor South mine plan. These items were:

- Seam access;
- Geological information and level of certainty;
- Access to shaft locations;
- Seam dip;
- Alignment with geological structure;
- Major horizontal stress;
- Depth of cover;
- Subsidence limits;
- Ventilation and gas drainage;
- Timing of government approvals;
- Number of development units required to support a highly productive longwall;
- Mains development requirement;

- Scoping accurate productivity levels;
- Frequency of longwall and development relocations; and
- Mine planning effectiveness.

Tahmoor Mine prepares mining and geotechnical hazard plan for each longwall in advance of mining.

3.3.6 Mine Schedule

An indicative mining schedule, as per the mining schedule prior to commencement, for development and secondary extraction of LW S1A-S7A is provided in **Table 15**.

Mining of LW S1A commenced on 18 October 2022, with LW S7A scheduled for completion in June 2028 (subject to operations). It is estimated that each longwall will be extracted in approximately 6 to 8 months.

The rate of longwall retreat is anticipated to range from 50-80 m per week, depending on geological conditions and support regime. Tahmoor Coal operates seven days a week, 24 hours a day on a roster basis.

Table 15 Mine Schedule for LW S1A-S7A (as per original schedule)

Longwall Panel	Start Date	Completion Date	Estimated Duration	Status
Longwalls South 1A (LW S1A)	18/10/2022	04/07/2023	259 days	Extraction completed
Longwalls South 2A (LW S2A)	02/08/2023	06/04/2024	248 days	Extraction completed
Longwalls South 3A (LW S3A)	8/05/2024	17/12/2024	193 days	Extraction completed
Longwall Panel	**Estimated Start Date**	**Estimated Completion Date**	**Estimated Duration**	**Status**
Longwalls South 4A (LW S4A)	01/01/2026	26/08/2026	237 days (7.8 months)	Scheduled
Longwalls South 5A (LW S5A)	25/09/2026	21/04/2027	208 days (6.9 months)	Scheduled
Longwalls South 6A (LW S6A)	21/05/2027	18/12/2027	211 days (6.9 months)	Scheduled
Longwalls South 7A (LW S7A)	17/01/2028	15/06/2028	150 days (4.8 months)	Scheduled

3.3.7 Resource Recovery

3.3.7.1 Coal Quality

Tahmoor Mine is a well-established and consistent metallurgical coal brand in the global marketplace that borders on being a hard coking coal. The Tahmoor Mine sells coking coal products to steel producers in Australian domestic market and export markets to European, Indian and Asian customers.

High quality coking coal is the primary product of the Tahmoor Mine. This product has a target ash of an average 9.3% with 8% product moisture. A higher ash coal is produced as a secondary product, which is washed to a target ash of 25% with a product moisture of 6%.

The geological definition of Tahmoor South coal has primarily been determined by the TBC series of boreholes from 2008-2010. Near term geological data is gained by a longwall block strip sampling regime and selective input of inseam exploration/gas drainage drill holes.

Coal Reserve for the Tahmoor South Domain mining area has been reported in accordance with the JORC Code, 2012. The reserves are estimated as of 31 December 2019 and generally reflect the mine design currently used for the Tahmoor South with the exception of minor alterations as described in **Section 3.3.5** and are outlined in **Table 16**.

Table 16 Coal Reserve Estimates

Reserve	Domain	Proved (Mt)
ROM Reserve	Tahmoor South Domain – LW S1A-S7A Bulli Coal Seam (5% M_{ROM})	10.4
Marketable Reserve	Coking Coal (8.5% M_{Prod}, 10% Ash)	6.3
	Secondary Coking Coal (6% M_{Prod}, 20% Ash)	0.4
	Total Product	6.6

3.3.7.2 Resource Recovery

The full seam ranges in thickness from 1.82 m - 2.07 m for LW S1A-S7A. Longwall equipment is able to cut at height of 2.15 m up to 2.6 m, therefore the full seam thickness will be mined. The total recoverable

reserve from the extraction area is 7,570,054 tonnes for LW S1A-S7A. Expected longwall resource recovery from LW S1A-S7A is presented in **Table 17**.

Table 17 Estimated Individual Panel Tonnages and Recovery (as per original schedule)

Longwall	ROM tonnes (t)	Coking Coal Product tonnes (t)	High Ash Secondary product tonnes (t)	Reject tonnes (t)	Yield (%)
LW S1A	1,572,027	1,008,346	65,319	498,362	68.3
LW S2A	1,618,664	1,004,247	71,720	542,697	66.5
LW S3A	1,671,001	1,021,598	62,130	587,273	64.9
LW S4A	1,768,933	1,033,279	53,152	682,502	61.4
LW S5A	1,864,925	1,096,971	61,103	706,851	62.1
LW S6A	1,922,532	1,127,953	66,707	727,873	62.1
LW S7A	1,357,638	860,630	36,899	460,109	66

3.3.7.3 Justification Statement

There are no significant environmental impacts anticipated, given the mine plan avoidance of sensitive areas and the ability for ongoing adaptive management, which will preclude longwall mining within the Extraction Plan Study Area. In addition, there are no significant subsidence impacts anticipated to surface infrastructure that cannot be mitigated prior to mining that will preclude longwall mining within the Extraction Plan Study Area.

The subsidence monitoring plan forming part of this Extraction Plan summaries the overall monitoring of mining impacts on both the natural environment and built features, with management actions and controls detailed within the relevant key sub-plans and subsidence management plans for built features.

Tahmoor Coal considers that the mine layout of LW S1A-S7A provides the most efficient resource recovery given the environmental and surface features constraints to mining. The extraction of the proposed longwalls has no detrimental impact on the potential to mine economically recoverable coal in the remainder of the lease areas.

3.4 Subsidence Predictions and Observations

3.4.1 Overview

Key parameters used in the description, prediction and assessment of surface movements resulting from underground mining are subsidence, tilt, strain, curvature, valley closure, and upsidence. A glossary of subsidence terms is provided in **Section 8.3** of this Extraction Plan Main Document.

As discussed in **Section 2.2.1**, the Tahmoor South Domain mine plan has undergone a series of changes since the original EIS submission was prepared in 2014.

Subsidence predictions for the extraction of LW S1A-S7A have been presented in the Subsidence Predictions and Impact Assessment Report by MSEC (2022; refer to **Appendix A** and 2024; refer to **Appendix B**). The following sections provide a summary of the information contained in the report (MSEC, 2022 and MSEC, 2024) to provide the maximum predicted conventional subsidence parameters resulting from the extraction of the proposed LW S1A-S7A in the Bulli Coal Seam.

The predicted subsidence, tilt and curvature have been obtained using the Incremental Profile Method, which has been calibrated for local conditions. The predicted strains have been determined by analysing the strains measured at Tahmoor Mine and other mines in the NSW Coalfields where the longwall width-to-depth ratios and extraction heights are similar to those for the proposed longwalls. A summary of subsidence predictions methods used to predict subsidence parameters for the extraction of LW S1A-S7A is provided in **Section 2.2.3** and are discussed in further detail in the Subsidence Predictions and Impact Assessment Report (MSEC, 2022; **Appendix A** and MSEC, 2024; **Appendix B**).

The maximum predicted subsidence parameters and the predicted subsidence contours describe and show the conventional movements. These predicted subsidence parameters do not include non-conventional movements such as valley related upsidence and closure movements, nor the effects of faults and other geological structures. Such effects have been addressed separately in the Subsidence Predictions and Impact Assessment Report for each environmental and built feature provided in Chapters 5 to 11 of **Appendix A** and Section 3 of **Appendix B.**

Subsidence impact predictions have been used in the various Key Sub-plans and associated documents to determine the appropriate management of the relevant environmental and built features. **Table 5** provides a summary of the environmental and built features considered and the relevant Key Sub-plans and associated documents that discuss and manage these features.

3.4.2 First Workings

The underground workings proposed are consistent with the proven success of the pillar geometries previously employed at Tahmoor Mine over a period of 35 years. Roof stratigraphy and floor conditions are well understood and controlled by the established roadway reinforcement systems. Coal strength, from the pillar stability point of view, is expected to be undiminished in the Extraction Plan Study Area and is complemented by rib bolting where necessary.

The parameters used for first workings at Tahmoor Coal Mine are width of 5.2 m and height of 2.7-2.8 m. The design parameters for first workings utilised at Tahmoor Mine are below the criteria for a High Risk Activity notification, as outlined within Schedule 3, Part 2, Clause 14 of the WHSMP Regulations.

The first workings for LW S1A-S7A are expected to be long term stable and non-subsiding in accordance with the requirements of Table 7 in Condition C1 and Condition C7 of SSD 8445. **Section 3.3.3** provides more details regarding first workings methodology.

First workings for LW S1A remain within the Tahmoor North Lease, for which DA 1975 applies. Under this development consent there are no requirements for first workings notifications. First workings for LW S1A commenced in April 2021.

Requirements for first workings notifications under the Tahmoor South development consent commences when LW S1A extraction starts (extraction of Longwall S1A commenced on 18 October 2022). A letter was sent prior to this commencement to the Resources Regulator with information on the first workings as required under Condition C7 of the Development Consent.

3.4.3 Subsidence Prediction

A summary of the maximum predicted values of incremental vertical subsidence, tilt and curvature resulting from the proposed LW S1A-S7A are provided in **Table 18**. The incremental parameters represent the additional movements due to the extraction of each of the proposed longwalls.

Table 18 Maximum Predicted Increment Conventional Subsidence, Tilt and Curvature for the Proposed LW S1A-S7A

Longwall	Maximum Predicted Incremental Vertical Subsidence (mm)	Maximum Predicted Incremental Tilt (mm/m)	Maximum Predicted Incremental Hogging Curvature (km^{-1})	Maximum Predicted Incremental Sagging Curvature (km^{-1})
LW S1A	800	7.0	0.08	0.22
LW S2A	950	7.5	0.08	0.22
LW S3A	950	8.0	0.09	0.22
LW S4A	950	8.0	0.09	0.22
LW S5A	950	8.0	0.10	0.22
LW S6A	975	8.3	0.09	0.23
LW S7A	1050	8.9	0.10	0.24

A summary of the maximum predicted values of total vertical subsidence, tilt and curvature resulting from the extraction of the proposed longwalls is provided in **Table 19**. The predicted total parameters represent the accumulated movements due to the extraction of all proposed longwalls within each of the mining areas. The predicted total vertical subsidence profiles are shown in **Figure A.01** of **Appendix B**.

Table 19 Maximum Predicted Total Conventional Subsidence, Tilt and Curvature for the Proposed LW S1A-S7A

Longwall	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
LW S1A	800	7.0	0.08	0.22
LW S2A	1,000	8.0	0.10	0.22
LW S3A	1,200	8.0	0.10	0.22
LW S4A	1,250	8.5	0.13	0.22
LW S5A	1,350	9.0	0.14	0.22
LW S6A	1,350	9.5	0.14	0.24
LW S7A	1,400	10.0	0.14	0.25

The maximum predicted total vertical subsidence of 1,400 mm represents 63 % of the proposed mining height. The maximum predicted total tilt is 10.0 mm/m. The maximum predicted total curvatures are 0.14 km^{-1} hogging and 0.25 km^{-1} sagging, which represent minimum radii of curvature of 7.1 km and 4.1 km, respectively.

The predicted conventional subsidence parameters vary across the mining area. To illustrate this variation, the predicted profiles of conventional subsidence, tilt and curvature have been prepared along a prediction line, which are located as shown in **Figure A.01** of **Appendix B**.

3.4.4 Strain Prediction

For features that are in discrete locations, such as building structures, farm dams and archaeological sites, it is appropriate to assess the frequency of the maximum strains measured in individual survey bays.

3.4.4.1 Strain Measured in Survey Bays

The survey database has been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of the previous longwalls at Tahmoor, Appin and West Cliff Collieries, for survey bays that were located directly above goaf or the chain pillars that are located between the extracted longwalls, which has been referred to as “above goaf”.

The 95 % confidence levels for the maximum total strains that the individual survey bays above goaf experienced at any time during mining were 0.9 mm/m tensile and 1.6 mm/m compressive. The 99 % confidence levels for the maximum total strains that the individual survey bays above goaf experienced at any time during mining were 1.4 mm/m tensile and 3.1 mm/m compressive.

The survey database has also been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of the previous longwalls at Tahmoor, Appin and West Cliff Collieries, for survey bays that were located outside and within 200 m of the nearest longwall goaf edge, which has been referred to as “above solid coal”.

The 95 % confidence levels for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining were 0.6 mm/m tensile and 0.5 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 0.0 mm/m tensile and 1.5 mm/m compressive.

3.4.4.2 Strain Measured along Whole Monitoring Lines

For linear features such as roads, cables and pipelines, it is more appropriate to assess the frequency of the maximum strains measured along whole monitoring lines, rather than for individual survey bays. That is, an analysis of the maximum strains measured anywhere along the monitoring lines, regardless of where the strain occurs.

A total of 42 of the 52 monitoring lines (i.e. 92 %) at Tahmoor, Appin and West Cliff Collieries had recorded maximum total tensile strains of 2.0 mm/m, or less. A total of 45 of the 52 monitoring lines (i.e. 87 %) at the mines had recorded maximum total compressive strains of 4.0 mm/m, or less.

3.4.4.3 Shear Strains

The 95 % and 99 % confidence levels for the maximum total horizontal mid-ordinate deviation that the individual survey marks located above goaf experienced at any time during mining were 20 mm and 35 mm, respectively.

3.5 Performance Measures and Indicators

3.5.1 Performance Measures

Performance objectives in relation to the subsidence impacts are outlined in SSD 8445. Performance measures relating to natural and heritage features are provided in Table 7 of SSD 8445 Condition C1, and are presented in **Table 6**. Performance measures relating to built features are provided in Table 8 of SSD 8445 Condition C3, and are also presented in **Table 6.** These objectives have been used when developing the management strategies incorporated in this Extraction Plan.

With regards to the subsidence performance measure discussed in **Table 6**, ‘negligible’ is defined as being ‘so small and insignificant as to not be worth considering’.

3.5.2 Performance Indicators

To establish compliance with the performance measures outlined in **Table 6**, Tahmoor Coal has developed subsidence and environmental monitoring programs in consultation with stakeholders as detailed in **Section 5** of this Extraction Plan, and within the key sub-plans.

Trigger Action Response Plans (TARP) have been developed as part of the monitoring of performance indicators for the relevant management plans to establish an appropriate response if a performance measure is triggered. A 'Normal Condition' section is provided in each TARP to indicate that the environment is performing within normal levels or natural variability. Deviation from baseline or expected conditions triggers an increased level of risk to the environment (Level 1 or higher based on escalating corresponding risk). Each TARP provides a number of trigger levels based on the feature under observation, and each trigger is clearly defined with an appropriate action and response assigned for each risk level.

The TARPs are discussed further in **Section 3.6.2** and a Master TARP consolidating all the aspects is provided in **Appendix C**. TARPs associated with individual Subsidence Management Plans for built features will be / have been developed separately as part of their individual management plan, and will be / have been incorporated into the Master TARP.

3.6 Subsidence Management Strategies

Subsidence management at Tahmoor Mine follows the risk hierarchy approach of risk elimination (impact avoidance), substitution and mitigation, engineering controls, management and monitoring.

Subsidence management and mitigation strategies for each relevant environmental and built feature are described within the relevant management plans developed in support of the Extraction Plan outlined in **Section 4**. Further to detailed discussion in mine design (refer **Section 2.2**), the following sections provide addition discussion on impact avoidance measures, adaptive management processes, and contingency management using TARPs.

3.6.1 Avoidance

Impact avoidance (risk elimination) is the highest level of risk management control under the risk hierarchy and is the starting point for mine design wherever practicable.

There are two management strategies for avoiding or minimising the impacts to sensitive surface features as a result of mining. These are:

- Avoid mining under sensitive surface features; and/or
- Mine design under the sensitive surface features with a sub-critical void width.

As discussed in **Section 2.2**, the mine plan for LW S1A-S7A has been modified since the 2014 Original EIS submission. The numerous modifications of the Tahmoor South Domain mine plan have resulted in a reduction of the magnitude and extent of subsidence impacts, as well as avoidance of significant impact to sensitive surface features of the environment, including Aboriginal heritage items. This included the removal of LW 109 in February 2020, which was located directly beneath Dogtrap Creek and would have resulted in direct impacts to Aboriginal heritage items.

The current mine plan proposes to complete underground mining with access to the Tahmoor South Domain provided from the existing pit top facilities. This mine design consideration minimises surface impacts from mining through the avoidance of establishing new surface facilities.

3.6.2 Trigger Action Response Plans

Tahmoor Coal has developed TARPs for each relevant component management plan prepared to support the LW S1A-S7A Extraction Plan (refer to key sub-plans discussed in **Section 4** of this Extraction Plan). A Master TARP consolidating all aspects from the management plans is provided in **Appendix C**, and will be added to with TARPs from individual Subsidence Management Plans for built features once completed.

The TARPs have been developed using the performance indicators for subsidence impacts relevant to each component management plan. The TARPs outline the assigned level of risk for each performance measure. The 'Normal Condition' Level of each TARP indicates that, based on monitoring results, the

environment is performing within normal levels. Where performance indicators indicate that a level of risk has been triggered greater than a normal level (Levels 1 or higher with escalating corresponding risk), a response in the form of management / corrective management actions is required to be implemented as outlined in the TARP.

3.6.2.1 Implementation of Monitoring Program and TARP Requirements

Tahmoor Coal's standard approach for all monitoring, reporting, investigation and remediation is to commence all tasks as soon as practicable. The following sections provide more information on this standard approach to be adopted during the LW S1A-S7A pre-mining, mining and post-mining phases:

- All monitoring commitments will be tracked on a weekly basis so that tasks are completed as required, taking into consideration land access and environmental factors. Post-mining monitoring will typically be completed within one month of the completion of the relevant longwall and prior to the influence from the active subsidence zone on the feature from the next longwall.
- Following the receipt of monitoring data and laboratory results, specialist consultants will review the data against the relevant TARPs as soon as practicable. If any TARP trigger has occurred, specialist consultants will notify Tahmoor Coal as soon as practicable. Monitoring results and TARP triggers will also be discussed during the monthly Environmental Response Group meetings, and any relevant information from other disciplines will be shared within the group. It is noted that discussions amongst specialists from different disciplines will not be restricted to ERG meetings, and relevant specialists will be included at any time to discuss results and assist with the completion of required actions and responses, as required.
- In the event of a TARP trigger occurrence, Tahmoor Coal will initiate all requirements (actions and responses) in accordance with the relevant TARP (i.e. investigation, report, negotiation, CMA determination, or similar) as soon as practicable and endeavour to commence actions and responses within one month of the exceedance being recorded. This timeframe is noted to be subject to issues outside of Tahmoor Coal's control such as land access constraints, inclement weather, extended timeframes where further monitoring is required, and inability to communicate with a third party / landholder.
- Tahmoor Coal will complete the required actions and responses relating to the TARP trigger as soon as practicable and will endeavour to finalise these requirements, subject to issues outside of Tahmoor Coal's control, as follows:
    - Level 1 and Level 2 TARP trigger actions and responses within three months of the exceedance being recorded;
    - Level 3 and Level 4 TARP trigger actions and responses within six months of the exceedance being recorded; and
    - Exceeds Performance Measures actions and responses in accordance with the timeframes provided in the relevant TARPs.

The contingency plan in the event of an exceedance of performance indicators may include:

- Management actions;
- Corrective management actions;
- Preventative actions;
- Further investigations;
- Implementation of a Rehabilitation Management Plan; and/or

- Implementation of a Corrective Action Management Plan (CAMP).

If a CAMP is required in accordance with the TARP, this document will be prepared in consultation with key Government agencies. The CAMP will include the following key elements:

- Investigation of the impact and root cause analysis;
- Review of monitoring data and extent of environmental consequences;
- Technical review into remediation methodology options;
- Establishment of remediation success criteria;
- Development of remediation strategy;
- Development of post-remediation review; and
- Project management administration, controls, scheduling and reporting.

The success of remediation measures that has been implemented for any TARP exceedance would be reviewed as part of any CAMP and the Annual Review (refer to **Section 7.1.2**).

3.6.3 Adaptive Management Strategies

3.6.3.1 Continuous Improvement

Tahmoor Coal have adopted the "Plan-Do-Check-Act" model as shown in **Figure 7**. This model will be applied to all aspects of Tahmoor Coal's environmental management and is utilised to embed the continuous improvement process in all system documents.

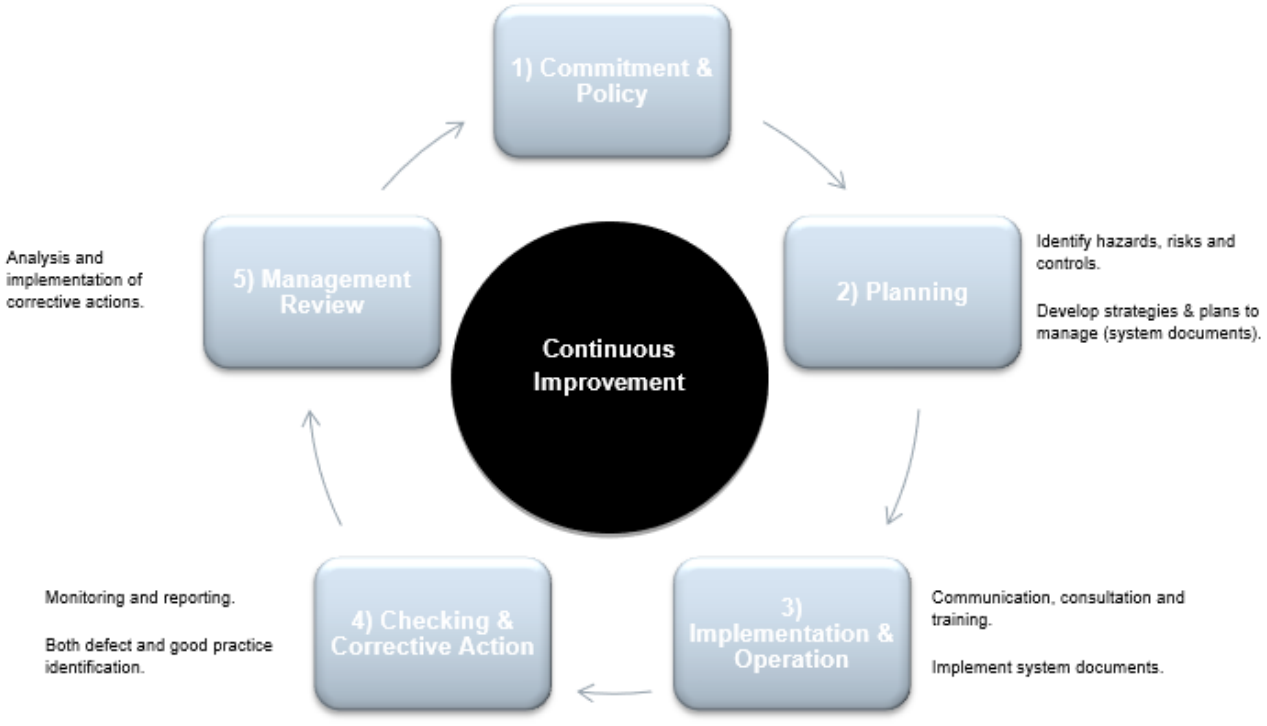


Figure 7 Continuous Improvement Model

3.6.3.2 Effectiveness of Management Measures

The effectiveness of the management measures presented in each of the key sub-plans will be validated periodically via comparison of monitoring results with modelled predictions. Re-calibration will occur as necessary, and an independent review of the model will occur every three years.

3.6.3.3 Adaptive Management Strategy - Review of Mine Plan for Built Features

Adaptive management measures for the reduction of impact to environmental features is not proposed for the extraction of LW S1A-S7A. However, a number of built features may benefit from adaptive management strategies, as discussed below.

An Adaptive Management Strategy is proposed to review mining-induced ground movements, subsidence impacts and environmental consequences to three properties / infrastructure during the mining of the following longwalls:

- Wollondilly Anglican College - In the extremely unlikely event that severe impacts develop, it would be possible to pause longwall extraction as it approaches the school to ensure that the school remains safe, serviceable and operational during and after the proposed mining;
- Picton Weir - As Tahmoor Mine will progressively approach the Picton Weir, it will be possible to review observations during the mining of each longwall and adjust the mine plan, if necessary to reduce the potential for impacts on Picton Weir. Picton Weir is also located beyond the finishing ends of the longwalls and it will be possible to stop the longwall during mining, if necessary based on actual observations during mining; and
- Wellers Road Overbridge - As Tahmoor Mine will progressively approach the Wellers Road Overbridge, it will be possible to review observations during the mining of each longwall and adjust the mine plan, if necessary to reduce the potential for impacts on the Overbridge.

According to the Adaptive Management Strategy, if impacts to built features listed above were greater than anticipated, Tahmoor Coal would review amending the commencing / finishing positions of the longwalls in question to reduce the potential for impacts on these built features.

If it was determined that the current start / finishing positions of these longwalls is likely to result in an exceedance of the subsidence impact performance measure for these built features, detailed analysis would be undertaken to determine if a modification of the longwall(s) is likely to result in an exceedance of the subsidence performance measures. If a setback is likely to reduce the likelihood of an exceedance occurring, modification of the longwall(s) would be determined. This process would be completed by re-generating the subsidence model for the relevant longwall to include observed subsidence measurements, and generating potential subsidence predictions for defined incremental changes to future longwall(s) from the built feature in question.

3.6.3.4 Adaptive Management Strategy - Review of Mine Plan for Heritage Features

If extraction of LW S1A-S7A indicates that an environmental consequence has occurred to the heritage significance of Rockshelter Sites 52-2-4471, 52-2-4975, 52-2-4976, 52-2-4977, 52-2-4978, 52-2-4982, 52-2-4981 (and a Level 2 of TARP HMP1 has been triggered), Tahmoor Coal would review the impacts that occurred to the rockshelter sites and also review the experiences that were observed at other non-heritage rockshelters during the mining of LW S1A-S7A. If the review indicates that impacts on Aboriginal sites above the B Series longwalls are likely to be greater than predicted in the EIS, Tahmoor Coal will review the mine design and determine whether some longwall panels should be setback further to avoid directly mining beneath other rockshelter sites.

3.6.4 Strategy for Continuous Improvement to the Aquatic Monitoring Program

The BACI designed aquatic monitoring program will be evaluated each season and adapted where required to account for prevailing environmental conditions. To date, the baseline aquatic monitoring program has been adapted to account for consistently dry creek beds at sampling locations and to avoid

collecting data where other environmental variables would confound results. Monitoring reports will identify any limitations and improvements that could be made to the program including additional sites and analyses that could be incorporated.

3.6.5 Strategy for Continuous Improvement to the Riparian and Amphibian Monitoring Program

The BACI designed terrestrial monitoring program will be evaluated each season and adapted where required to account for prevailing environmental conditions. To date, the baseline amphibian monitoring program has been adapted to account for the potential decline in amphibian populations within watercourses of the Study Area. The program currently collects watercourse parameters associated with sensitive amphibian habitat areas and accounts for total frog species richness and abundance.

Riparian monitoring focuses on signs of riparian vegetation dieback. To date, the program obtains data on flora species richness, floristic cover, prevalence of exotic species, and other anecdotal information (e.g., visual shifts in vegetation assemblages, evidence of post-fire recovery, stochastic events [flooding], and above surface human disturbance). Monitoring reports will identify any limitations and improvements that could be made to the program including additional sites and analyses that could incorporated.

4 Key Sub-Plans

4.1 Overview of Environmental Management

4.1.1 Environmental Management Strategy Framework

The Tahmoor Environmental Management System (EMS) Framework provides the strategic context for the environmental management of Tahmoor Coal and forms part of the broader Health, Safety, Environment and Community (HSEC) management systems at Tahmoor Coal. The EMS outlines how Tahmoor Coal manages environment and community (E&C) aspects, impacts and performance. It provides a framework for the standards, plans and procedures implemented to ensure operations are managed in accordance with the ISO:14001 principles.

The objectives of the EMS are:

- To provide an overall framework for environmental management at Tahmoor Mine utilising the principles of ISO:14001;
- To ensure compliance with all development consent, licences and approvals at Tahmoor Mine;
- To detail the relationship and interactions between various operational and environmental components at Tahmoor Mine;
- To provide effective mechanisms for external communications, maintaining a relationship with the local community; and
- To assist Tahmoor Coal employees and contractors in administering their responsibilities regarding environmental management.

This Extraction Plan will be implemented in conjunction with the EMS framework. **Figure 8** provides an overview of the EMSF and the documents which are part of the strategic framework for environmental management at Tahmoor Mine.

4.1.2 Overview of Key Sub-plans of this Extraction Plan

The overall framework for subsidence monitoring and management of impacts of this Extraction Plan is provided in the Subsidence Monitoring Plan for this Extraction Plan. This document outlines the monitoring program for the measurement of actual subsidence, and the inspection program for environmental consequences of subsidence to compare against predicted impacts to determine if actions have been triggered.

The Extraction Plan is supported by a set of individual management plans intended to manage particular environmental or built features within the Extraction Plan Study Area. The individual management plans, which have been prepared to specifically address Condition C8 of SSD 8445, include:

- Water Management Plan – to manage potential environmental consequences to surface water and groundwater as a result of secondary extraction;
- Land Management Plan – to manage potential environmental consequences to landscape features and agricultural enterprises as a result of secondary extraction;
- Biodiversity Management Plan – to manage potential environmental consequences to aquatic and terrestrial biodiversity as a result of secondary extraction;
- Heritage Management Plan – to manage potential environmental consequences to Aboriginal and historical heritage as a result of secondary extraction;

- Built Features Management Plan – to manage potential environmental consequences to built feature as a result of secondary extraction. A number of sub-plans are currently in preparation to manage potential environmental consequences to built features as a result of secondary extraction; and
- Public Safety Management Plan – to ensure public safety in the Extraction Plan Study Area.

If a subsidence impact or environmental consequence occurs, the required action(s) are provided in the master TARP in **Appendix C** or the individual management plan to which the trigger refers to.

Figure 8 provides an overview of the environmental management plans and other environmental management documents that have been prepared to manage environmental impact resulting from LW S1A-S7A extraction.

Table 5 provides a summary of environment and built features within the Extraction Plan Study Area and in which key sub-plans they are managed. The location of these features is illustrated in Appendix F of the Subsidence Predictions and Impact Assessment Report (MSEC, 2022;**Appendix A**) and Appendix B of Modification 3 Longwall S7A subsidence predictions and impact assessment (MSEC, 2024; **Appendix B**)**.**

It should be noted that:

- All environmental and built features are discussed in the Subsidence Prediction and Impact Assessment Report (MSEC, 2022; **Appendix A** and MSEC, 2024; **Appendix B**);
- All monitoring measures for these features are summarised in the Subsidence Monitoring Plan; and
- The Built Features Management Plan is an umbrella document for the management of built features, and a number of sub-plans are currently in preparation to manage potential environmental consequences to built features as a result of secondary extraction.

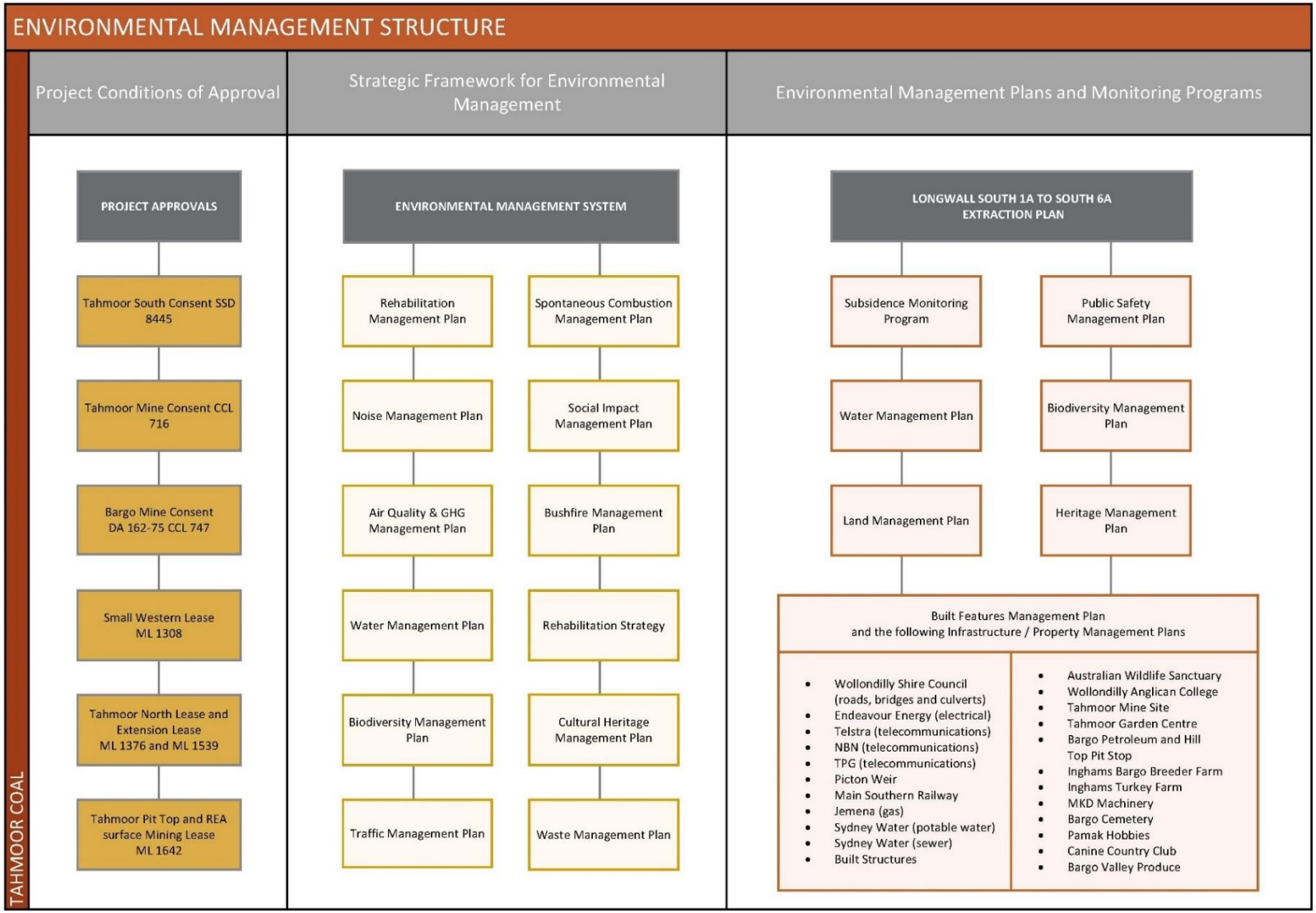


Figure 8 Overview of Environmental Management Structure for Tahmoor Coal

4.2 Water Management Plan

A WMP for LW S1A-S7A has been prepared and updated to identify the monitoring and management measures for surface water and groundwater resources within the Extraction Plan Study Area that are required to be implemented to demonstrate that the relevant performance measures are achieved. The WMP focused on watercourses and groundwater. The Study Area is located predominantly within the Teatree Hollow catchment, which is a sub-catchment of the Bargo River. Small portions of the Study Area and 600 m buffer are also located within the Hornes Creek, Dogtrap Creek and Bargo River catchments.

The WMP was prepared to address the requirements listed in Condition C8(g)(iii) of SSD 8445 (refer to Table 1 of the WMP), the *Extraction Plan Guideline* (DPE, 2022), and regulatory requirements (refer to Section 2.2 of the WMP). The WMP was prepared in consultation with former Departments EES, DPE Water, Crown Lands, WaterNSW, and WSC (refer to **Section 2.1.3**).

The WMP provides information on (but not limited to) the following:

- Baseline data for surface water (water level, streamflow and water quality), and groundwater levels (Section 3 of the WMP);
- Predicted subsidence impacts and environmental consequences to surface water and groundwater resources (Section 4 of the WMP);
- Performance measures and performance criteria for surface water and groundwater (Section 5.1 of the WMP);
- Surface water monitoring measures relating to pool water level, streamflow, stream water quality, and channel and bank stability (Section 5.2 of the WMP);
- Groundwater monitoring measures relating to groundwater level and water quality (Section 5.2 of the WMP);
- Water management measures for surface water and groundwater resources (Section 6.2 of the WMP); and
- TARPs to be implemented to manage and protect surface water and groundwater resources (Appendix A of the WMP).

Watercourses within the LW S1A-S7A Study Area are identified on **Figure 9**. A summary of water monitoring measures is provided in **Section 5.3**, and surface water and groundwater TARP actions are consolidated in **Appendix C**.

The following documents were prepared to support the WMP:

- Groundwater Impact Assessment (SLR, 2024) – provides details of baseline data, monitoring and management measures, and TARPs for groundwater resources in the LW S1A-S7A Study Area; and
- Baseline Private Bore Assessment (SLR, 2022a) – provides a description of existing private groundwater bores in the Study Area, bore yields and serviceability of accessible bores, groundwater quality from accessible bores.

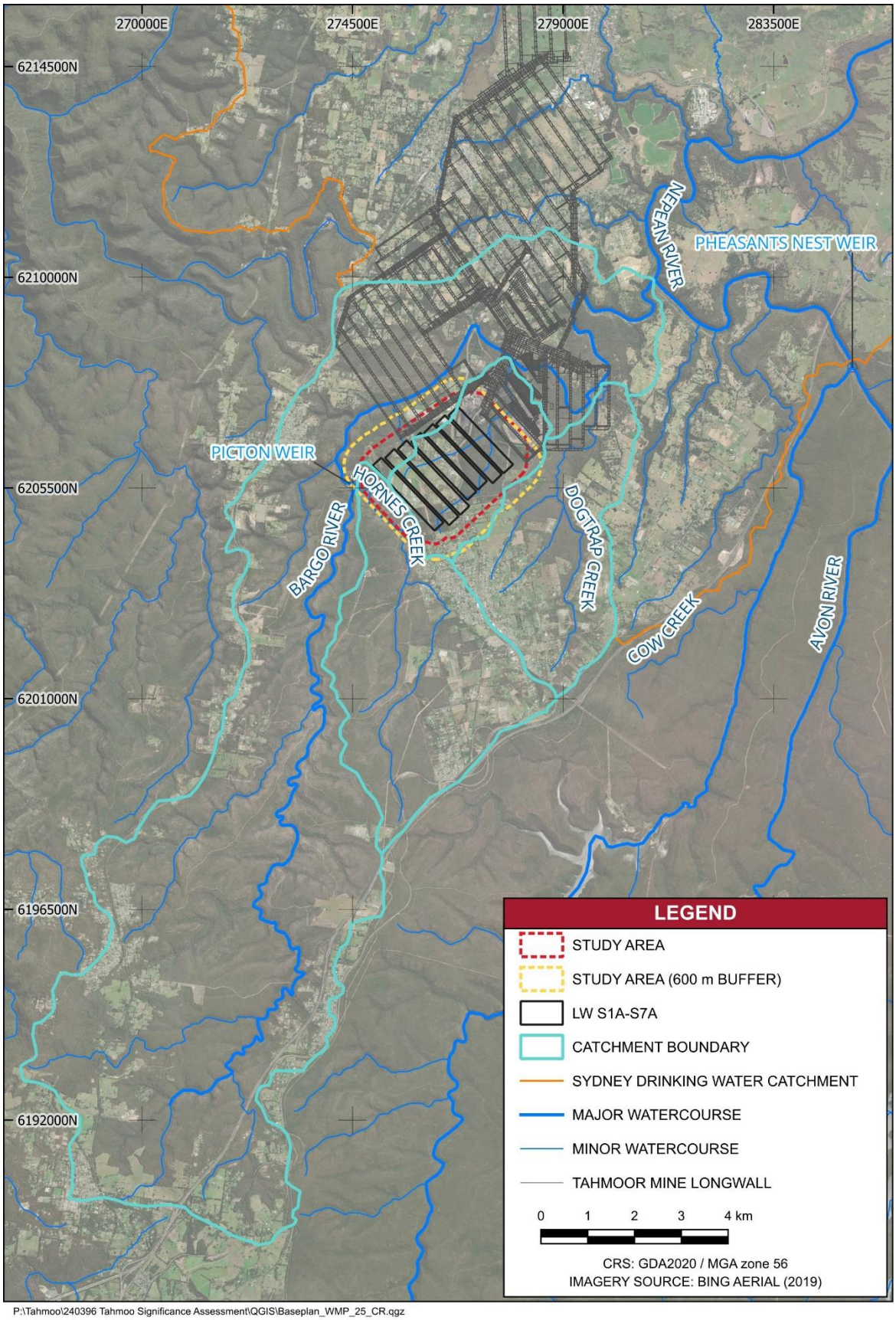


Figure 9 **Study Area Surface Water Resources (ATC Williams, 2025)**

4.3 Land Management Plan

A LMP for LW S1A-S7A has been prepared and updated to identify the monitoring and management measures for landscape features and agricultural resources within the Extraction Plan Study Area that are required to be implemented to demonstrate that the relevant performance measures are achieved. The LMP focused on cliffs, natural steep slopes, farm dams and agricultural enterprises.

The LMP was prepared and updated to address the requirements listed in Condition C8(g)(v) of SSD 8445 (refer to Table 2 of the LMP), the DPE *Extraction Plan Guidelines* (DPE, 2022), and other regulatory requirements (refer to Section 2 of the LMP). The LMP was prepared in consultation with former Departments DPI Agriculture and DPE Crown Lands (refer to **Section 2.1.3**).

The LMP provides information on (but not limited to) the following:

- Baseline data for landscape features and agricultural enterprises (Section 3 of the LMP);
- Predicted subsidence impacts and environmental consequences to landscape features and agricultural enterprises (Section 4 of the LMP);
- Performance measures and performance criteria for landscape features (Section 5.1 of the LMP);
- Monitoring measures for landscape features (Section 5.2 of the LMP);
- Management measures for landscape features (Section 6.2 of the LMP); and
- TARPs to be implemented to manage landscape features (Appendix A of the LMP).

Cliffs and natural steep slopes within the LW S1A-S7A Study Area are identified on **Figure 10**. A summary of landscape and agricultural monitoring measures is provided in **Section 5.3**, and landscape TARP actions are consolidated in **Appendix C**.

The following document was prepared to support the LMP:

- Geotechnical Assessments (Douglas Partners, 2024 and PSM, 2025) – provides an overview of steep slopes and dams in the Study Area, as well as an assessment of likely impacts to these features and impacts to built features as a result of LW S1A-S7A extraction; and
- Land and Agricultural Resource Assessment (SLR, 2022b and SLR, 2025) – provides an overview of the landscape, land and soil capability, and agricultural enterprises in the Study Area, as well as an assessment of likely impacts to these features as a result of LW S1A-S7A extraction.

Potential risks to constructed steep slopes along road embankments and cuttings are managed separately in accordance with the Wollondilly Shire Council Management Plan. Potential risks to constructed steep slopes along railway embankments and cuttings are managed separately in accordance with the Main Southern Railway Management Plan. Potential risks to constructed steep slopes and dams at the Tahmoor Mine site are managed in accordance separately with the Tahmoor Mine Site Management Plan.

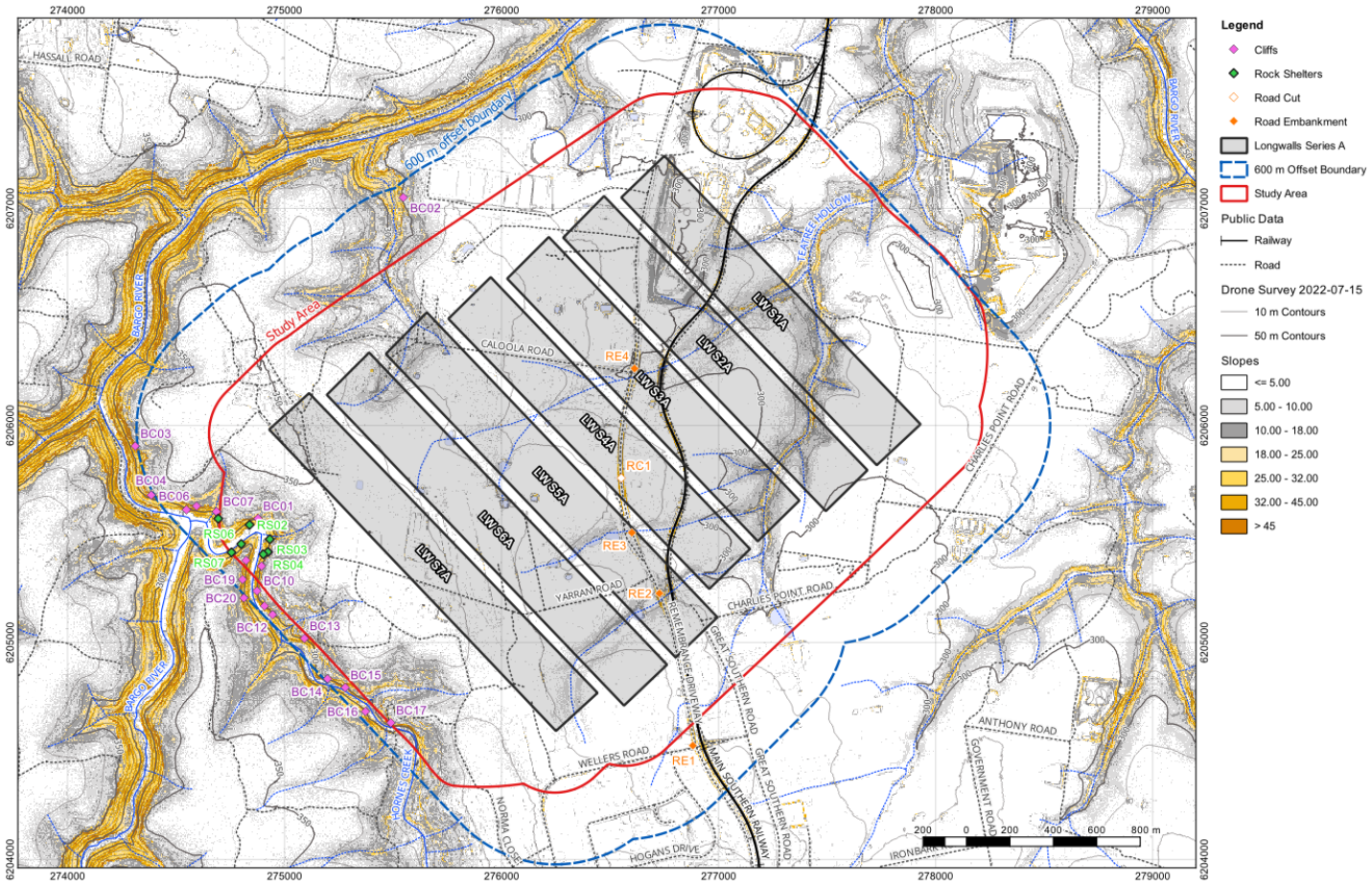


Figure 10 **Cliffs and Steep Slopes in the LW S1A-S7A Study Area (PSM, 2025)**

4.4 Biodiversity Management Plan

A BMP for LW S1A-S7A has been prepared and updated to identify the monitoring and management measures for aquatic and terrestrial biodiversity within the Extraction Plan Study Area that are required to be implemented to demonstrate that the relevant performance measures are achieved. The BMP focused on aquatic and terrestrial biodiversity, with particular focus on threatened species, populations and their habitats, and Endangered Ecological Communities (EECs) and water dependent ecosystems.

The BMP was prepared to address the requirements listed in Condition C8(g)(iv) of SSD 8445 (refer to Table 2 of the BMP), the DPE *Extraction Plan Guidelines* (DPE, 2022), and regulatory requirements (refer to Section 2 of the BMP). The BMP was prepared in consultation with former Departments EES, Crown Lands, and Wollondilly Shire Council (refer to **Section 2.1.3**).

The BMP provides information on (but not limited to) the following:

- Baseline data for terrestrial vegetation communities (including threatened ecological communities, riparian vegetation, and vegetation condition), threatened flora and fauna and communities, watercourses and stream morphology, aquatic biodiversity (Section 3 of the BMP);
- Predicted subsidence impacts and environmental consequences to aquatic and terrestrial biodiversity (Section 4 of the BMP);
- Performance measures and performance criteria for aquatic and terrestrial biodiversity (Section 5.1 and 5.2 of the BMP);
- Biodiversity monitoring measures relating to aquatic biodiversity (water quality, aquatic habitats, macroinvertebrates) and terrestrial biodiversity (amphibian and riparian vegetation) (Section 5.3 of the BMP);

- Biodiversity management measures for aquatic and terrestrial biodiversity (Section 6.2 of the BMP); and
- TARPs to be implemented to manage and protect aquatic and terrestrial biodiversity (Appendix A of the BMP).

A summary of biodiversity monitoring measures is provided in **Section 5.3**, and biodiversity TARP actions are consolidated in **Appendix C**.

A number of threatened species and one TEC were recorded, or potentially recorded, within the Study Area during the monitoring surveys:

- *Pomaderris brunnea (*Brown Pomaderris), *Grevillea parviflora* subsp. *parviflora*, *Persoonia bargoensis, and Persoonia glaucescens* (Mittagong Geebung) – Threatened flora species in the Study Area;
- Twelve threatened fauna species recorded within or near the Study Area, as well as the Giant Burrowing Frog and Red-crowned Toadlet recorded at Cow Creek and Hornes Creek. However, no threatened amphibian species have been detected during the baseline monitoring; and
- Shale Sandstone Transition Forest in the Sydney Basin Bioregion – Threatened Ecological Community confirmed in the Study Area.

4.5 Heritage Management Plan

A HMP for LW S1A-S7A has been prepared and updated to identify the monitoring and management measures for Aboriginal and historical heritage items within the Extraction Plan Study Area that are required to be implemented to demonstrate that the relevant performance measures are achieved. The HMP focused on Aboriginal and historical heritage items listed on heritage databases, and Aboriginal and historical heritage items identified in the Study Area during site investigations.

The HMP was prepared and updated to address the requirements listed in Condition C8(g)(vi) of SSD 8445 (refer to Table 1 of the HMP), the DPE *Extraction Plan Guidelines* (DPE, 2022), and regulatory requirements (refer to Section 2 of the HMP). The HMP was prepared in consultation with former Departments DPE, EES, Heritage NSW, Wollondilly Shire Council, and RAPs (refer to **Section 2.1.3**).

The HMP provides information on (but not limited to) the following:

- Baseline data for Aboriginal and historical heritage items (Section 3 of the HMP);
- Predicted subsidence impacts and environmental consequences to Aboriginal and historical heritage items (Section 4 of the HMP);
- Performance measures and performance criteria for Aboriginal and historical heritage items (Section 5.1 of the HMP);
- Aboriginal and historical heritage monitoring measures (Section 5.2 of the HMP);
- Management measures for Aboriginal and historical heritage items (Section 6.2 of the HMP); and
- TARPs to be implemented to manage and protect Aboriginal and historical heritage (Appendix A of the HMP).

Aboriginal and historical heritage items located within the LW S1A-S7A Study Area are identified on **Figure 11 and Figure 12**. A summary of heritage monitoring measures is provided in **Section 5.3**, and heritage TARP actions are consolidated in **Appendix C**.

The Study Area encompasses nine Aboriginal heritage sites and four historical heritage sites (refer to **Figure 11**):

- Aboriginal heritage sites:

- Isolated find: TC14-2-19 (AHIMS 48-2-0275);
- Artefact scatter: Remembrance Drive 2013.1 (AHIMS 52-2-3968);
- Rockshelter with art and stone artefacts: Teatree Hollow 2013.1 (AHIMS 52-2-4471);
- Rockshelter with deposit and stone artefacts: Hornes Creek RS2 (AHIMS 52-2-4975);
- Rockshelter with deposit: Hornes Creek RS3 (AHIMS 52-2-4976);
- Rockshelter with deposit and stone artefact: Hornes Creek RS4 (AHIMS 52-2-4977);
- Rockshelter: Hornes Creek RS5 (AHIMS 52-2-4978);
- Rockshelter with deposit and stone artefact: Hornes Creek RS6 (AHIMS 52-2-4982);
- Rockshelter with deposit: Hornes Creek RS7 (AHIMS 52-2-4981).

- Historical heritage sites:
  - Wirrimbirra Sanctuary (known as the Australian Wildlife Sanctuary) [SHR and WLEP];
  - Bargo Cemetery (WLEP);
  - Part of the Great Southern Road (non-statutory listed); and
  - Tahmoor Colliery (known as the Tahmoor Mine Site) (non-statutory listed).

One locally listed heritage item, Railway Bridge North (also known as Wellers Road Overbridge), is located within the 600 m buffer from extraction that could be susceptible to far-field or valley related movements. In addition, three heritage items, AHIMS #52-2-4980 (Hornes Creek GG1), Picton Weir (WLEP) and Bargo Railway Viaduct (WLEP and SHR), are located outside the 600 m buffer but could also be susceptible to far-field or valley related movements.

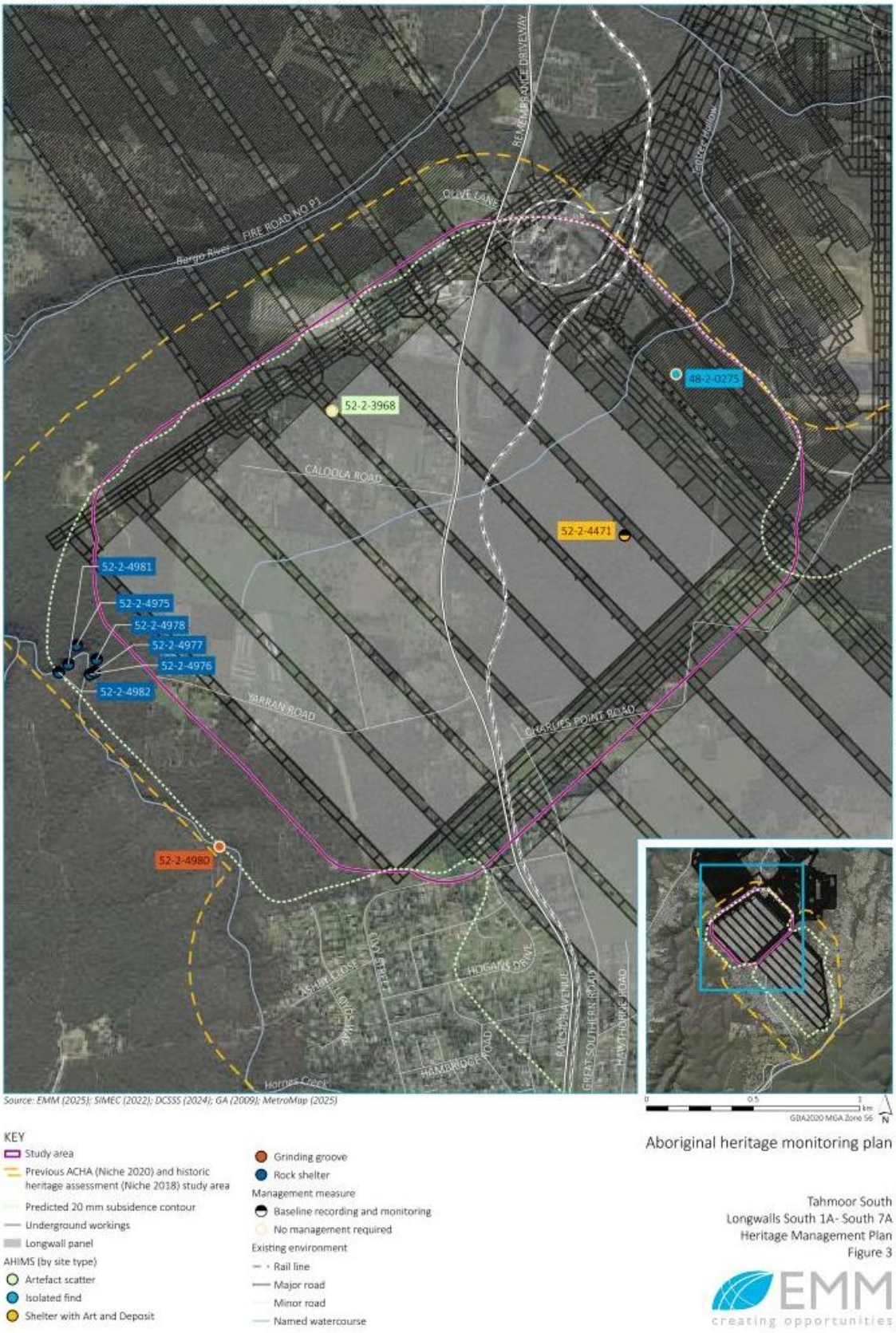


Figure 11 Aboriginal Heritage Sites in the LW S1A-S7A Study Area (EMM, 2025)

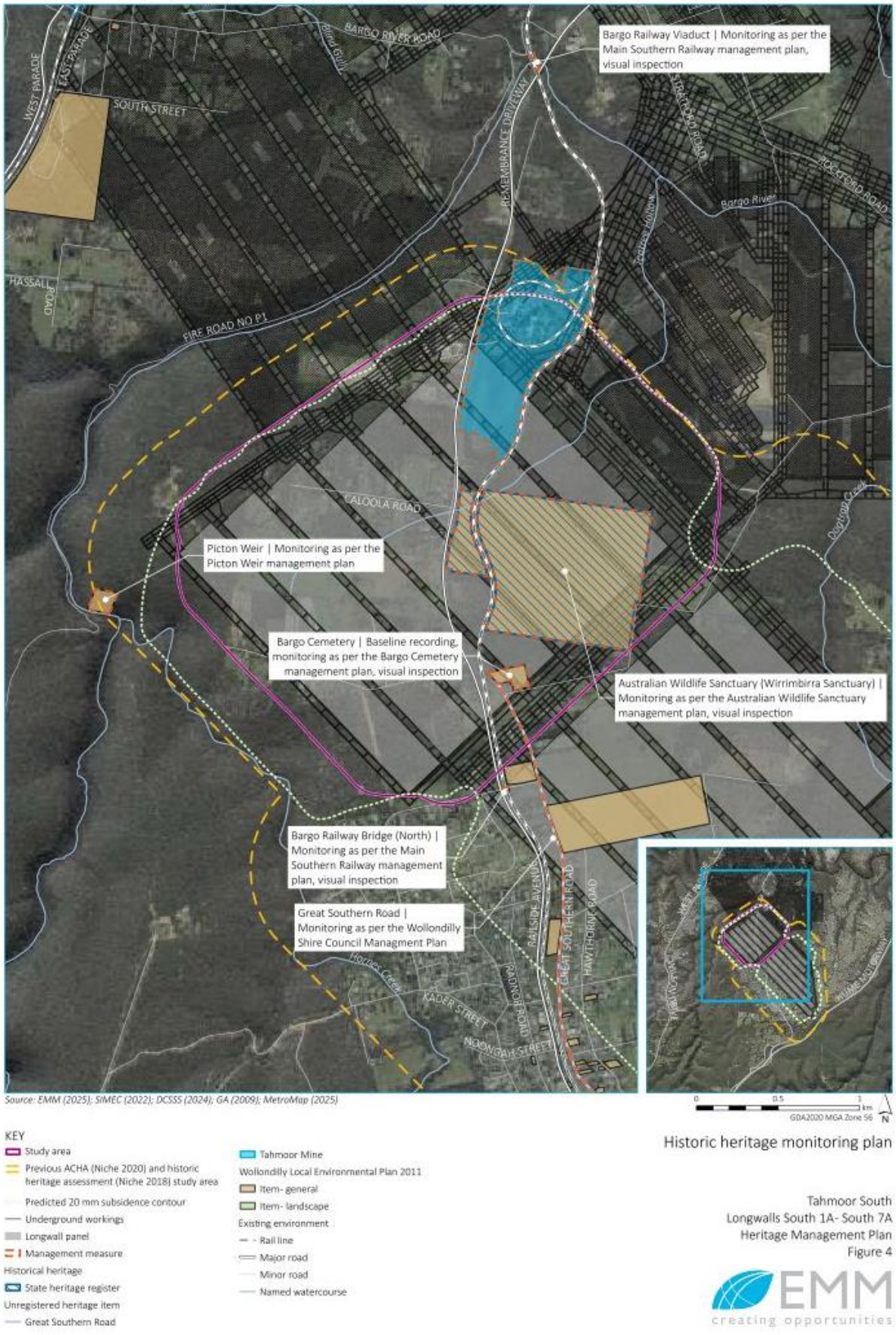


Figure 12 Historical Heritage Sites in the LW S1A-S7A Study Area (EMM, 2025)

4.6 Built Features Management Plan

A Built Features Management Plan (BFMP) for LW S1A-S7A has been prepared and updated to identify the monitoring and management measures for all built features within the Extraction Plan Study Area that are required to be implemented to demonstrate that the relevant performance measures are achieved. The BFMP focused on the management of infrastructure (electrical, potable water, sewer, gas, telecommunications, roads, culverts, bridges, rail, Picton Weir, and survey control marks), structures for industrial, commercial and business, rural properties and structures (built structures, pools, septic tanks, and farm dams), and historical heritage (e.g. Bargo Cemetery, Australian Wildlife Sanctuary, Wellers Road Overbridge).

The BFMP provides information on the key built features within the Study Area and which Subsidence Management Plan to refer to with regards to monitoring and management of potential subsidence-related impacts for each built feature resulting from the extraction of LW S1A-S7A. Built features within the LW S1A-S7A Study Area are also identified in Sections 6-11 of the Subsidence Predictions and Impact Assessment Report (MSEC, 2022; refer to **Appendix A** of this document) and Section 3 of Modification 3 - Longwall S7A - Subsidence Predictions and Impact Assessment Report (MSEC, 2024); refer to **Appendix B** of this document).

The BFMP was prepared to address the requirements listed in Condition C8(g)(ii) of SSD 8445 (refer to Table 1 of the BFMP), the DPE *Extraction Plan Guidelines* (DPE, 2022), the *Managing Risks of Subsidence Guide: WHS (Mines and Petroleum Sites) Legislation* (Resources Regulator, 2017), and other regulatory requirements (refer to Section 2 of the BFMP). The BFMP was prepared in consultation with the Resources Regulator, TfNSW, and WSC (refer to **Section 2.1.3**).

A number of sub-plans for individual built features (Subsidence Management Plans), as summarised in **Table 5,** have been/are being prepared. Each sub-plan includes a summary of potential risks, impact predictions and assessment, appropriate management and monitoring measures, and a detailed TARP for the built feature. The contents of each sub-plan will be prepared in consultation with the built feature owners and other relevant stakeholders. Following approval and signature by the built feature owner, each sub-plan will be submitted to DPE (now NSW DPHI) and Resources Regulator.

4.7 Public Safety Management Plan

A PSMP for LW S1A-S7A has been prepared and updated to address all potential safety hazards to the public through the provision of management strategies, controls and monitoring programs to be implemented to manage potential risks from subsidence related impacts as a result of LW S1A-S7A secondary extraction. Features located within the Extraction Plan Study Area that could pose a hazard to public safety are summarised in **Table 5.**

The PSMP was prepared to address the requirements listed in Condition C8(g)(vii) of SSD 8445 (refer to Table 1 of the PSMP), the DPE *Extraction Plan Guidelines* (DPE, 2022), the *Managing Risks of Subsidence Guide: WHS (Mines and Petroleum Sites) Legislation* (Department of Industry – Resources Regulator, 2017), requirements of the Work Health and Safety (Mines and Petroleum Sites) Regulation 2022 (Clause 27 and Clause 28) and other regulatory requirements (refer to Section 2 of the PSMP). Regulatory requirements applicable to the PSMP to manage subsidence related risks to public safety are outlined further in Section 2.2 of the PSMP.

Risk assessments undertaken in support of the development of the PSMP are detailed in Section 7.6 of this Extraction Plan Main Document. The PSMP was prepared in consultation with the Resources Regulator (refer to **Section 2.1.3**).

The PSMP provides information on (but not limited to) the following:

- Potential subsidence-related public safety hazards (Section 3.2 of the PSMP); and
- Performance measures for public safety (Section 6.1 of the PSMP).

Features identified within the Extraction Plan Study Area relevant to public safety are managed under a number of supporting plans in addition to the PSMP, as noted in **Table 5**.

The following documents were prepared to support the PSMP:

- Built Features Management Plan;
- Land Management Plan;
- Subsidence Prediction and Impact Assessment Report (MSEC, 2022); and
- Modification 3 - Longwall S7A - Subsidence Predictions and Impact Assessment Report (MSEC, 2024).

5 Subsidence Monitoring Plan

5.1 Monitoring Strategy and Approach

5.1.1 Subsidence Monitoring Plan for LW S1A-S7A

An integrated Subsidence Monitoring Plan has been developed and updated for LW S1A-S7A as a component of this Extraction Plan in accordance with Condition C8(g)(i) of SSD 8445. The Subsidence Monitoring Plan sets out the program for the monitoring of subsidence movements and effects associated with second workings of LW S1A-S7A and provides consolidated summaries for the monitoring of subsidence impacts and environmental consequences to environmental and built features.

The purpose of the Subsidence Monitoring Plan is to:

- Demonstrate mine development and extraction are undertaken as per the mine design;
- Provide information to demonstrate that statutory performance measures are met;
- Target monitoring of environmental and built features within the Extraction Plan Study Area;
- Meet stakeholder monitoring requirements for environmental features;
- Meet built feature owners monitoring requirements for built features;
- Provide appropriate information required to assess against triggers within the relevant TARPs, including data for trend analysis to inform adaptive management; and
- Provide a suitable basis for future Extraction Plans and associated monitoring programs required as part of Tahmoor Mine operations.

The Subsidence Monitoring Plan is designed to ensure that a clear and concise monitoring program of all subsidence related effects, impacts and environmental consequences is implemented. The Subsidence Monitoring Plan includes:

- A detailed program for subsidence movement and effects monitoring for LW S1A-S7A using subsidence monitoring lines to measure both conventional and non-conventional vertical subsidence, tile and strain (tensile and compressive);
- A consolidated summary of built features monitoring as detailed within the BFMP and supporting sub-plans; and
- A consolidated summary of environmental monitoring for management of water (surface and groundwater), landscape features, biodiversity, and heritage (Aboriginal and historical) as detailed in the management plans for this Extraction Plan.

The Subsidence Monitoring Plan is scheduled and tracked by Tahmoor Coal according to longwall distance and/or scheduled dates. Tahmoor Coal will carry out surveys, inspections and notifications as scheduled, and the required actions will be assigned to the relevant role to ensure the Subsidence Monitoring Plan is achieved.

5.1.2 Summary of Monitoring in this Extraction Plan

The following sections provide a summary and re-presentation of monitoring details from the Subsidence Monitoring Plan and other relevant management plans and sub-plans for the monitoring of subsidence effects (**Section 5.2**), subsidence impacts and environmental consequences (**Section 5.3**) associated with the extraction of LW S1A-S7A.

Full detail pertaining to subsidence monitoring methodology can be found in the Subsidence Monitoring Plan and the relevant management plans and sub-plans discussed in the sections below.

5.2 Subsidence Effects Monitoring

The Subsidence Monitoring Plan includes a monitoring program to evaluate subsidence effects as a result of LW S1A-S7A extraction has been prepared and updated in accordance with Condition C8(g)(i) of SSD 8445 and the DPE *Extraction Plan Guidelines* (DPE, 2022).

As a longwall progresses, subsidence begins to develop at a point in front of the active longwall face and continues to develop after the longwall passes. This is termed the 'active subsidence zone' for the purposes of this Extraction Plan. The active subsidence zone for each longwall is defined by the area bounded by the predicted 20 mm subsidence contour for the active longwall and a distance of 150 m in front of the active longwall face and 450 m behind the active longwall face. The active subsidence zone is illustrated in **Figure 13**.

Tahmoor Coal has established a monitoring network to monitor subsidence movements as a result of LW S1A-S7A. The layout of monitoring lines and points is illustrated in **Figure 14** as well as on Graphical Plan 7, and is discussed further in the Subsidence Monitoring Plan.

The combined monitoring network consists of the following:

- Global Navigation Satellite System (GNSS) units installed in the following locations:
    - Centrelines of LW S1A to S3A - The GNSS units are located in bushland within the Australian Wildlife Sanctuary. The units are proposed to track the development of subsidence and horizontal movements above the commencing ends of the longwalls. The monitoring data will provide the first subsidence results for each panel to compare against subsidence predictions. Conventional survey lines are not possible in this area due to thick vegetation, preventing lines of sight;
    - Valley closure across Tributary to Teatree Hollow - Pairs of GNSS units are be located across the Tributary to Teatree Hollow to measure valley closure. Conventional survey lines are not possible in this area due to thick vegetation, preventing lines of sight across the sides of the valley. Two pairs of GNSS units are planned to be located across rockbars controlling pools along the creek. A site of archaeological significance is located near one these rockbars. The results will be cross-checked by manual surveys across the rockbars in the base of the valley;
    - Valley closure across Teatree Hollow – A pair of GNSS units have been installed across the Teatree Hollow to measure valley closure above LW S2A. Conventional survey lines are not possible in this area due to thick vegetation, preventing lines of sight across the sides of the valley.
    - Bargo River – Two GNSS units were installed across the Bargo River to monitor for valley closure and whether the existing goaf above previously extracted LWs 14B to 19 subsides during the extraction of LWs S1A to S7A. The locations are shown in Drawing No. MSEC1193-01-01, subject to approval by landowners;
    - Railway Viaduct across Bargo River - Two GNSS units are located within the Main Southern Railway corridor to measure far field movements, if any, between the abutments of the Viaduct. The two GNSS units will also allow valley closure, if any, to be detected. The results will be cross-checked by manual surveys across the Viaduct if they exceed trigger levels;
    - Main Southern Railway above LW S5A – One GNSS unit is located within the Main Southern Railway corridor above the commencing end of LW S5A The GNSS unit will provide early detection of subsidence within the rail corridor and the results may trigger earlier than planned commencement of weekly surveys along the railway. ;

- Picton Weir - Two GNSS units are located at the tops of the valley on either side of the Picton Weir to measure far field movements, if any, across the valley. The two GNSS units will also allow valley closure, if any, to be detected. An additional GNSS unit has been installed between the Picton Weir and LW S7A. The results can be cross-checked by manual surveys across the Weir if they exceed trigger levels;
- Hornes Creek – Three pairs of GNSS units were installed at the tops of the valley on either side of Hornes Creek to measure far field movements, if any, across the valley.
- Wellers Road Overbridge - A GNSS unit has been installed at the Wellers Road Overbridge. to measure far field movements. The results will trigger surveys of the Bridge if they exceed trigger levels; and
- Tahmoor Mine base station site - A GNSS unit has been installed at Tahmoor Mine's survey base station. The surveys will assist Tahmoor Mine's underground survey team to establish survey control, as required.

- Survey lines and survey marks in association with Teatree Hollow and the tributary to Teatree Hollow. This includes survey marks across the base of the creek along Tributary of Teatree Hollow, and where roads, railways and other infrastructure services cross the tributary and associated first order drainage lines. Survey marks were also installed across the base of Teatree Hollow, and a survey line across the road crossing that intersects Teatree Hollow;
- Survey lines across the southern boundary of Tahmoor Mine's property and along the western side of the REA;
- Survey lines installed along Remembrance Drive, Caloola Road, Yarran Road, Charlies Point Road and Great Southern Road;
- Survey line along the Main Southern Railway from 97.7 km to 99.8 km, and monitoring points for key items along the railway;
- Survey points at the Tahmoor Mine site to allow monitoring of the Main Southern Railway, Remembrance Drive, Rail Loop and road bridge, stockpile area and conveyors, the drift, winder house, building structures, dams, and associated services infrastructure;
- Survey points at the Wollondilly Anglican College and Australian Wildlife Sanctuary, as well as other commercial, industrial and business establishments in the Study Area; and
- Survey points at private properties, dwellings, buildings and dams.

The purpose of the survey lines is to measure the general magnitude and shape of surface subsidence. The observed subsidence movements will be used to provide early subsidence information to inform Tahmoor Coal and affected stakeholders. The information would assist Tahmoor Coal and affected stakeholders in considering whether any additional measures are required to manage potential impacts on the built features. In addition, survey lines in the creek systems will measure potential valley closure and upsidence movements at these locations.

The information will also be used by Tahmoor Coal as part of its ongoing review of subsidence effects on natural features.

Survey lines will consist of pegs spaced nominally every 20 m, where possible. Surveys will measure levels and horizontal distances between adjacent pegs. Baseline surveys were completed prior to the commencement of mining of LW S1A.

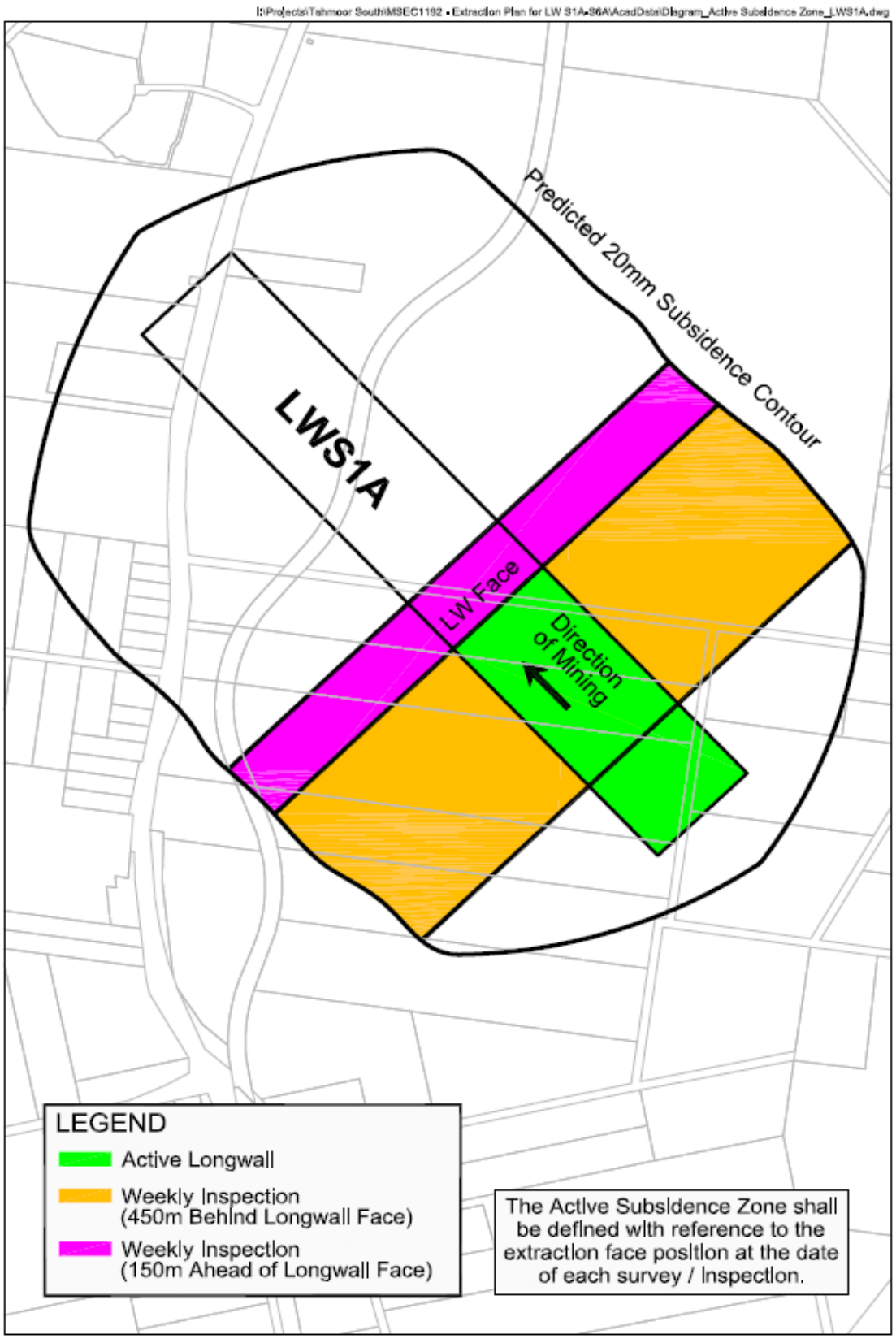


Figure 13 **Diagrammatic representation of Active Subsidence Zone**

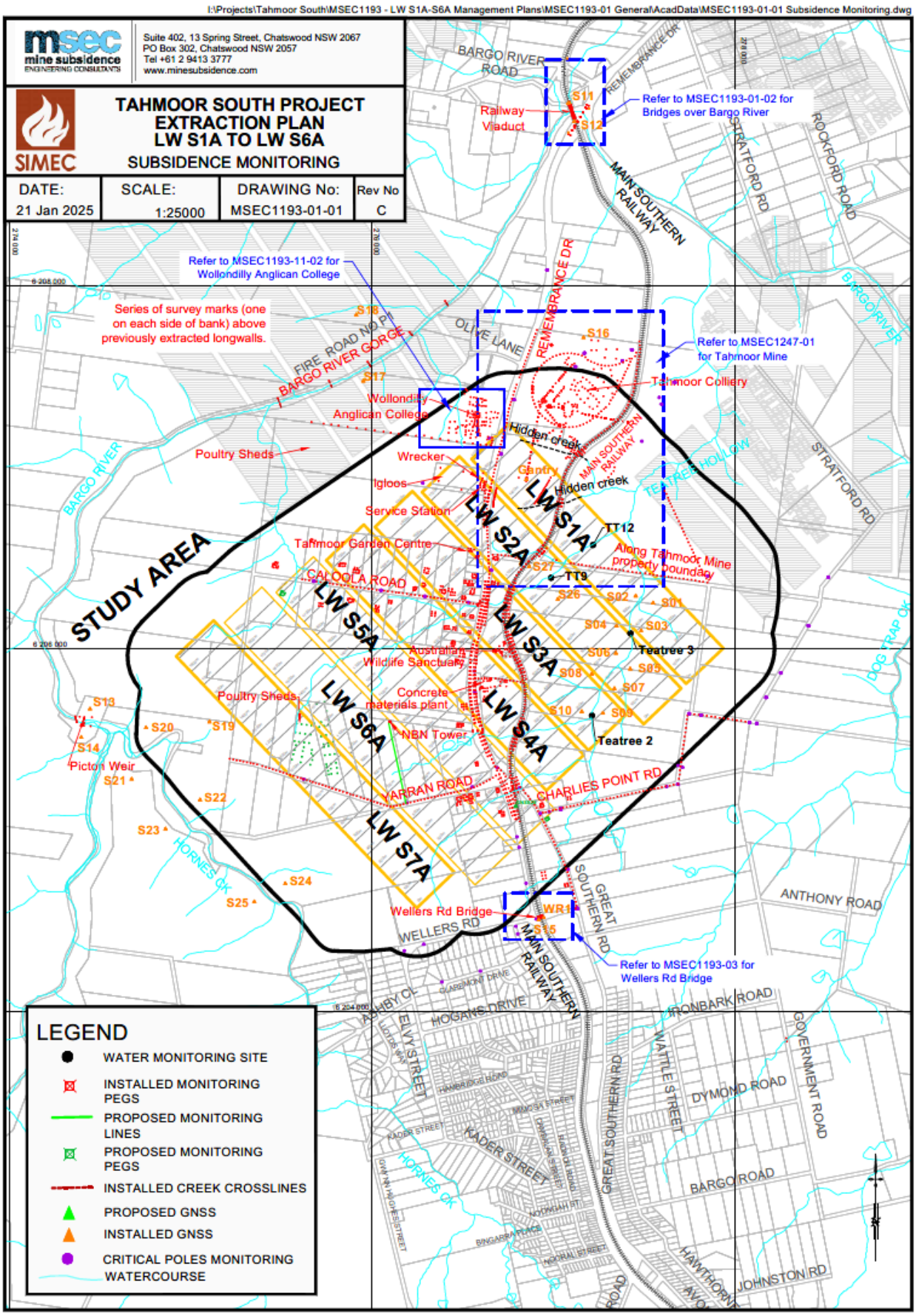


Figure 14 **Monitoring Locations for LW S1A-S7A Extraction Plan Study Area (from Subsidence Monitoring Plan)**

5.3 Subsidence Impacts and Environmental Consequences Monitoring

A monitoring program to evaluate subsidence impacts and environmental consequences as a result of LW S1A-S7A extraction has been prepared and updated in accordance with Condition C8(g)(i) of SSD 8445 and the DPE *Extraction Plan Guidelines* (DPE, 2022).

5.3.1 Monitoring of Built Features

Built features in the Study Area, as described in **Section 4.6** of this Extraction Plan, are monitored and managed in accordance with dedicated supporting Subsidence Management Plans (sub-plans) developed for each type of built feature specifically in consultation with the relevant stakeholders. The sub-plans for built features are managed collectively by the over-arching BFMP.

Monitoring of built features will include (in addition to subsidence effects monitoring discussed in **Section 5.2**):

- Public roads and main infrastructure - Ground surveys along public roads, visual inspection along public roads, gas detection surveys, power pole surveys, Optical Time Domain Reflectometer (OTDR) monitoring for optical fibre cables;
- Picton Weir- Continuous GNSS monitoring, ground survey, visual inspections;
- Wollondilly Anglican College - ground surveys, alignment survey of sensitive classroom equipment, visual inspections;
- Australian Wildlife Sanctuary - ground survey, asbestos air monitoring, visual inspections;
- Structures - ground surveys, visual inspections of specific structures including pools;
- Farm dams - visual inspection;
- Commercial, industrial and business establishments - ground surveys, visual inspections;
- Tahmoor Mine Site Infrastructure - Monitoring at key items of infrastructure, which includes absolute 3D and 2D surveys, continuous GNSS monitoring, and baseline surveys and visual inspections as defined in the Tahmoor Mine Site Management Plan; and
- Main Southern Railway and Tahmoor Mine Rail Loop - Monitoring at key items of railway infrastructure, which will include absolute 3D surveys, continuous GNSS monitoring, and baseline structural surveys and additional monitoring as defined in the Main Southern Railway Management plan.

A consolidated summary of the monitoring of built features is presented in Section 3 of the Subsidence Monitoring Plan, and location of built features monitoring is illustrated in **Figure 14**.

5.3.2 Monitoring of Environmental Features

Monitoring and evaluation of subsidence performance measures and potential mining related impacts on surface water, groundwater, surface water, landscape features, flora and fauna, Aboriginal and European heritage, are described in detail in the Section 5.2 of each of the WMP, LMP, BMP and HMP.

Monitoring of environmental features will include (in addition to subsidence effect monitoring discussed in **Section 5.2**):

- Creeks:
  - Streamflow monitoring, continuous water level monitoring, manual water level monitoring and water quality sampling at locations show in **Figure 17**;
  - Visual inspections of pools and geomorphology survey of stream reaches in Teatree Hollow, Teatree Hollow tributary and the Bargo River tributary;

- Catchment survey of 10 headwater sites;

- Groundwater - Monitoring of groundwater levels and quality in shallow bores, private bores, NSW Government monitoring bores and deep groundwater pressure monitoring bores;
- Cliffs and natural steep slopes - Visual monitoring by a geotechnical engineer;
- Agricultural land - Visual inspection;
- Biodiversity - Bi-annual monitoring of amphibians, riparian vegetation, and aquatic biodiversity;
- Aboriginal heritage sites - Visual inspection; and
- Historical heritage sites - Monitoring as per built features monitoring, and visual inspection by an archaeologist.

The location of the biodiversity monitoring is illustrated in **Figure 15** and the location of surface water monitoring and groundwater monitoring is illustrated in **Figure 16** and **Figure 17**, respectively.

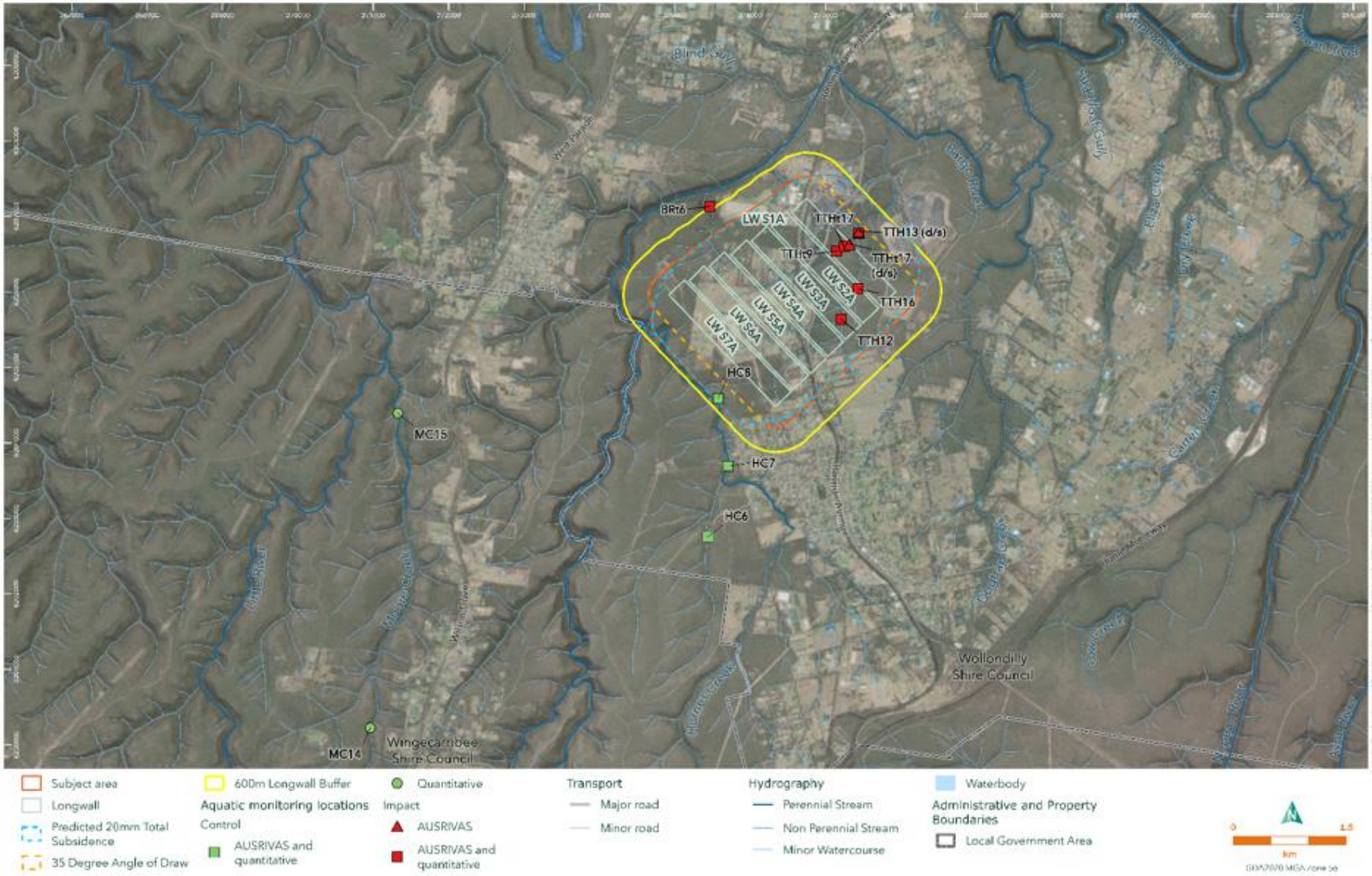


Figure 15 **Aquatic Biodiversity Monitoring Program (from Biodiversity Management Plan**

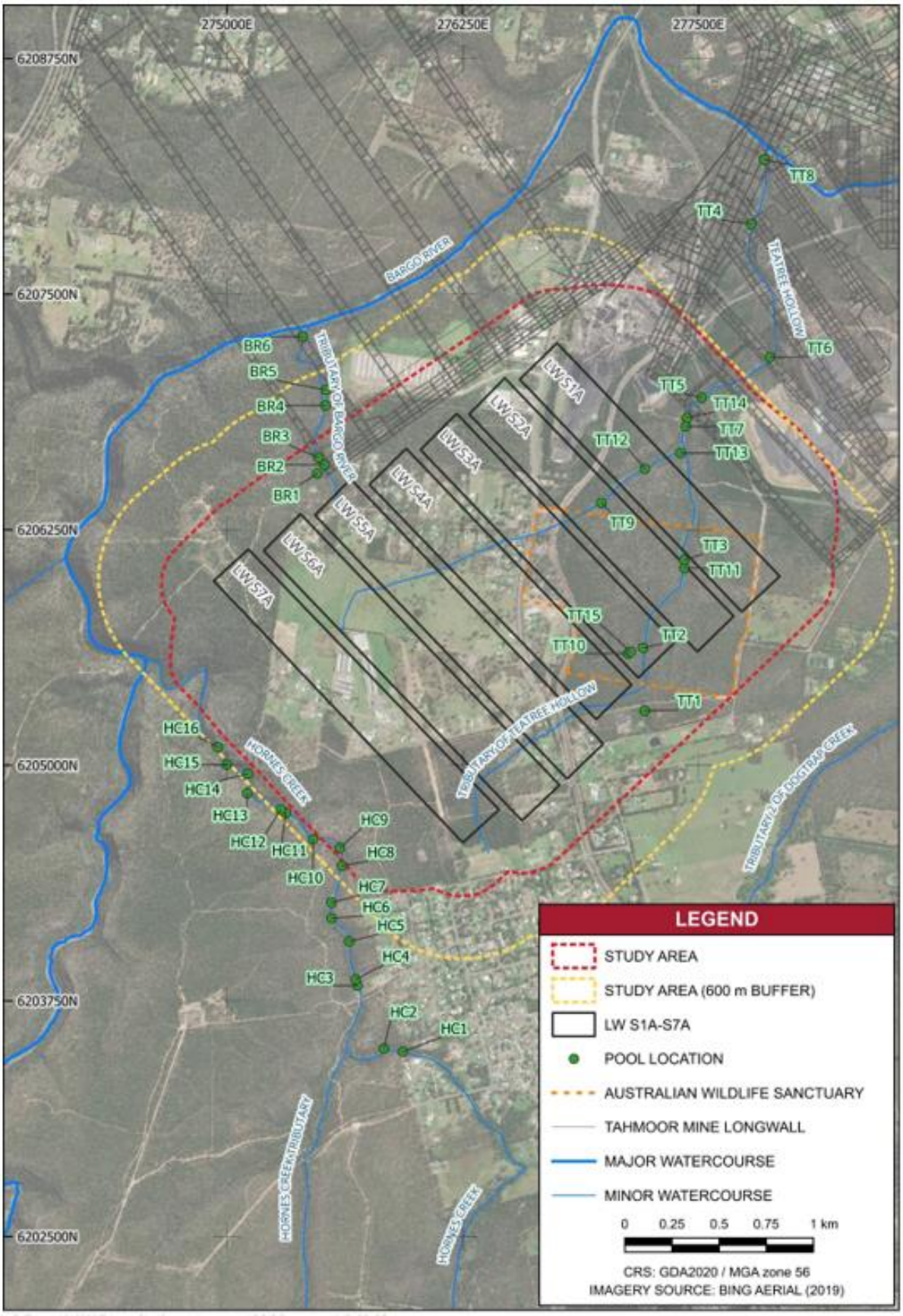


Figure 16 **Surface Water Monitoring Program (from Water Management Plan)**

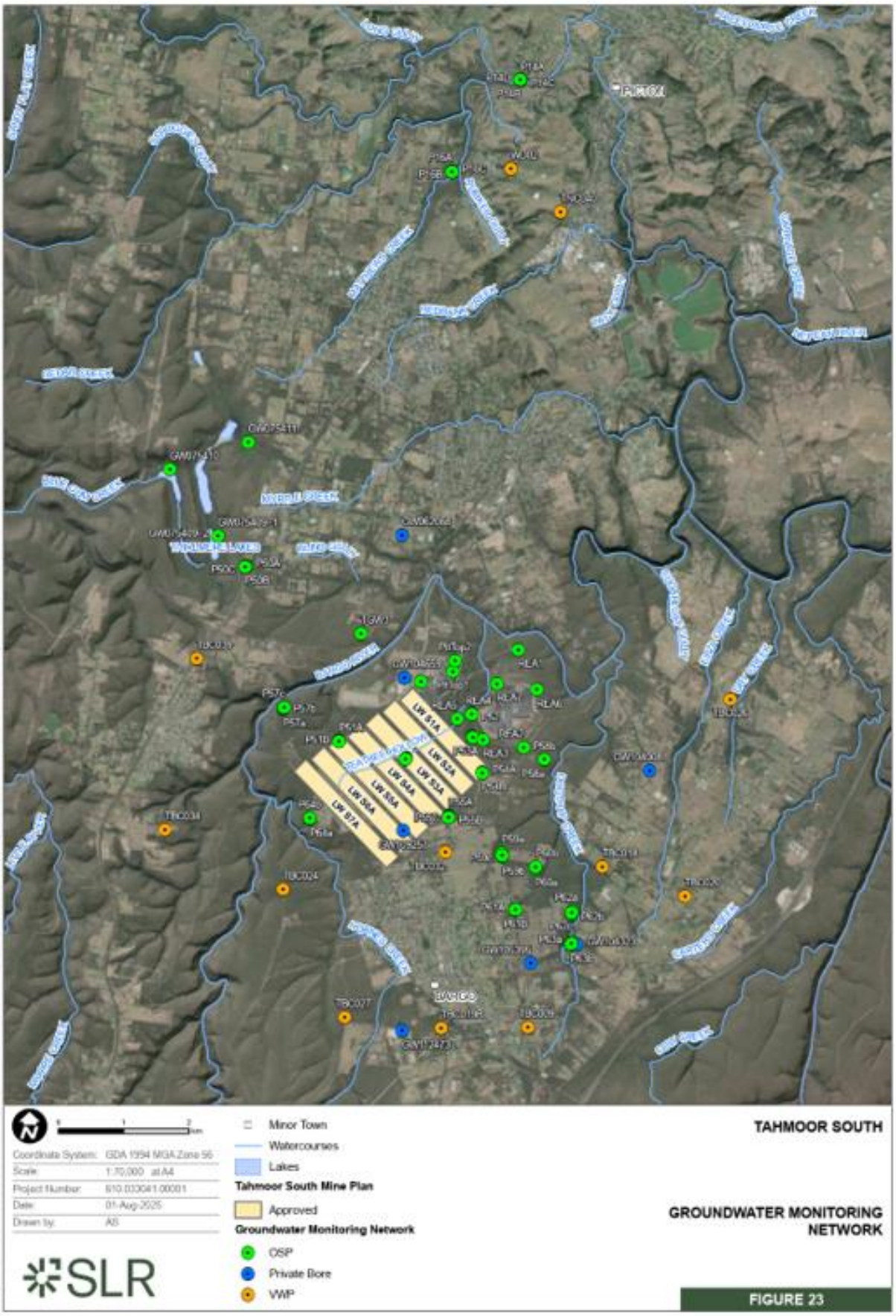


Figure 17 **Existing and Proposed Groundwater Monitoring Sites (from Water Management Plan)**

5.4 Baseline Monitoring to Support Future Extraction Plans

Tahmoor Coal has approval for the extraction of an addition six longwalls (Longwalls South 1B to South 6B, or the Tahmoor South 'B Series') in the Tahmoor South Domain. Monitoring data collected during the extraction of LW S1A-S7A will be used as baseline data to support these future longwalls. An extraction plan for LW S1B-S6B will be lodged in accordance with the relevant conditions of consent.

A monitoring program to collect sufficient baseline data for future extraction plans is summarized in **Table 19**, in accordance with Condition C8(i) of SSD 8445 and the DPE *Extraction Plan Guidelines* (DPE, 2022). This monitoring program has been consolidated from the various key sub-plans and this monitoring program will be used as reference site data for future longwalls. In addition, monitoring data collected during the mining of LW S1A-S6A would be used in the review of observed subsidence impacts and environmental consequences for future extraction plans.

Table 20 Baseline Monitoring Program to Support Future Extraction Plans

Aspect of Future Extraction Plans	Existing and Proposed Monitoring Programs	Tahmoor Coal Document Reference
Subsidence	• Subsidence monitoring undertaken in accordance with the Subsidence Monitoring Plan. • A significant amount of baseline data has been collected during the extraction of the previous longwall panels in the Tahmoor North Domain, which includes the most recently mined Western Domain as well as longwalls mined directly to the north and east of the proposed longwalls.	Subsidence Monitoring Plan
Surface Water	• Surface water monitoring (flow and quality) will be undertaken in accordance with the WMP. • A significant amount of baseline surface water data has been collected during the extraction of the previous longwall panels in the Western Domain and to the south of the Western Domain, as well as baseline data from the Tahmoor South Domain. • A monitoring program for future longwalls would be implemented at least two years in advance of mining.	WMP
Groundwater	• Groundwater monitoring (groundwater level and quality) undertaken in accordance with the WMP. • A significant amount of baseline groundwater data has been collected during the extraction of the previous longwall panels in the Western Domain and to the south of the Western Domain, as well as baseline data from the Tahmoor South Domain. • A monitoring program for future longwalls would be implemented at least two years in advance of mining.	WMP
Landscape	• Monitoring of impacts to steep slopes and agricultural land in accordance with the LMP. • A significant amount of baseline landscape feature data for cliffs, steep slopes and agricultural land has been collected during the extraction of the previous longwall panels in the Western Domain.	LMP
Biodiversity	• Biodiversity monitoring of aquatic habitat, macroinvertebrates, riparian vegetation, and amphibians in accordance with the BMP. • A significant amount of baseline ecology data has been collected during 2019-2022 in the Tahmoor South Domain. • A significant amount of baseline ecology data for aquatic and terrestrial biodiversity has been collected during the extraction of the previous longwall panels in the Western Domain.	BMP
Heritage	• Monitoring of Aboriginal and historical heritage items in accordance with the HMP would be used in the review of observed subsidence impacts to inform future Extraction Plans for the Tahmoor South Domain. • A significant amount of baseline Aboriginal heritage data has also been collected during the extraction of the previous longwall panels in the Tahmoor South and Western Domains, as well as baseline data from the Tahmoor South Domain.	HMP

6 Graphical Plans

Graphical plans have been prepared for the LW S1A-S6A Extraction Plan Study Area in accordance with the *Extraction Plan Guidelines (*DPE, 2022) are listed in **Table 20**.

It is noted that given there are no existing or proposed workings in other seams above or below the proposed working seam, Plan 4 is not required.

Table 21 Graphical Plans

Plan Number	Plan Title	Plan Reference Number
Plan 1	Workings and Dimensions	TAH01144-1
Plan 2	Surface Features	TAH01144-2
Plan 3	Bulli Seam Geological Data	TAH01144-3
Plan 4	Existing and Proposed Workings in Seams Above and/or Below	Not required
Plan 5	Mining Titles and Land Ownership	TAH01144-5
Plan 6	Geological Sections	TAH01144-6
Plan 7	Subsidence Monitoring	TAH01144-7
Plan 8	Aerial Photography	TAH01144-8

7 Implementation

7.1 General Reporting

Reporting for the Extraction Plan is undertaken in accordance with the specific requirements from the Consent, relevant licences, and generally in accordance with the DPE *Extraction Plan Guidelines* (DPE, 2022), and the requirements of the WHSMP Regulation.

Details of the regular reporting requirements are provided in the following sections.

7.1.1 Annual Review

In accordance with Consent Condition E13, an Annual Review is required to be submitted by 31 March each year. The Annual Review will:

- Describe the development (including any rehabilitation) that was carried out in the previous calendar year, and the development that is proposed to be carried out over the current calendar year;
- Include a comprehensive review of the monitoring results and complaints records of the development over the previous calendar year, including a comparison of these results against the:
  - Relevant statutory requirements, limits or performance measures/criteria;
  - Requirements of any plan or program required under this consent;
  - Monitoring results of previous years; and
  - Relevant predictions in the EIS (or updated and contemporary modelling, as required by agencies).
- Identify any non-compliance or incident which occurred in the previous calendar year, and describe what actions were (or are being) taken to rectify the non-compliance and avoid reoccurrence;
- Evaluate and report on:
  - The effectiveness of the noise and air quality management systems; and
  - Compliance with the performance measures, criteria and operating conditions of this consent.
- Identify any trends in the monitoring data over the life of the development and provide any raw monitoring data as requested by the Planning Secretary;
- Identify any discrepancies between the predicted and actual impacts of the development, and analyse the potential cause of any significant discrepancies; and
- Describe what measures will be implemented over the next calendar year to improve the environmental performance of the development.

The Annual Review is completed in accordance with the post-approval requirements for State significant mining developments and incorporates reporting requirements of the Resources Regulator. In addition, the Annual Review will also include a summary of environmental effects.

Annual Reports are lodged on the NSW Planning Portal and a copy is submitted to relevant agencies (e.g. Resources Regulator (Subsidence), Resources Regulator (Mining Act Inspectorate), EPA, Water NSW, Subsidence Advisory NSW, and Wollondilly Shire Council, TCCCC, and any interested person upon request. The reports are also made publicly available on the Tahmoor Coal website.

7.1.2 Annual Return

An Annual Return stating Tahmoor Mine's compliance with the conditions of EPL 1389 is completed and submitted to the EPA via the EPL portal by 28 February of each year. In addition to a statement of compliance with the conditions of EPL 1389, the report also includes a summary of monitoring results and complaints received for the 12-month period.

7.2 Incidents

7.2.1 Incident Definition

The Consent defines an incident as 'an occurrence or set of circumstances that causes or threatens to cause material harm and which may or may not be or cause a non-compliance'.

Material Harm is defined within the Consent as "harm to the environment that:

- Involves actual or potential harm to the health or safety of human beings or to the environment that is not trivial, or results in actual or potential loss or property damage of an amount, or
- Amounts in aggregate, exceeding $10,000, (such loss includes the reasonable costs and expenses that would be incurred in taking all reasonable and practicable measures to prevent, mitigate or make good harm to the environment)".

This definition excludes "harm" that is authorised under either this Consent or any other statutory approval.

As per the WHS Regulations (Mining and Petroleum Sites) 2022, a 'high potential incident' means any indication from monitoring data of the development of subsidence which may result in any incident referred to in:

- Clause 190 (a) (p) – a failure of ground, or of slope stability control measures; or
- Clause 190 (a) (q) – 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; or
- Clause 190 (a) (p) and (q).

7.2.2 Incident Management

Tahmoor Coal manages and responds to incidents in accordance with the following plans:

- Emergency Response Control Plan (TAH-HSEC-416);
- Pollution Incident Response Management Plan (TAH-HSEC-00155); and
- Notification of Environmental Pollution Incidents (TAH-HSEC-00224).

These plans have been developed to manage preparation, incident response and reporting requirements under the NSW *Protection of the Environment Operations Act 1997*.

The management plans provide roles and responsibilities, management strategies, action and response plans and record management protocols for incidents and emergencies.

7.2.3 Incident Reporting

A Written Incident Notification will be submitted to the Planning Secretary via the Major Projects website, and any other relevant agencies, within seven days after Tahmoor Coal becomes aware of an incident.

Written Incident Notifications will include:

- The development and application number;
- Details of the incident (date, time, location, a brief description of what occurred and why it is classified as an incident);
- How the incident was detected;

- When Tahmoor Coal became aware of the incident;
- Any actual or potential non-compliance with conditions of consent;
- Describe what immediate steps were taken in relation to the incident;
- Identify further action(s) that will be taken in relation to the incident; and
- Identify a project contact for further communication regarding the incident.

Within 30 days of the date on which the incident occurred or as otherwise agreed to by the Planning Secretary, Tahmoor Coal will provide the Planning Secretary and any relevant public authorities (as determined by the Planning Secretary) with a Detailed Incident Report.

Detailed Incident Reports will include:

- A summary of the incident;
- Outcomes of an incident investigation, including identification of the cause of the incident;
- Details of the corrective and preventative actions that have been, or will be, implemented to address the incident and prevent recurrence; and
- Details of any communication with other stakeholders regarding the incident.

All incidents will be reported in the Annual Review and a record maintained in Tahmoor Coal's Compliance Management System, Cority.

In addition, in accordance with the DAWE (now Commonwealth DCCEEW) approval conditions 23 and 24 for the Tahmoor South Project, Tahmoor Coal will notify the Department in writing of any incident. Notification of this occurrence will be given as soon as practicable, and no later than two business days after becoming aware of the incident.

The notification will specify:

- Any condition which is in breach;
- A short description of the incident; and
- The location (including co-ordinates), date, and time of the incident. In the event the exact information cannot be provided, provide the best information available.

Tahmoor Coal will also provide details of any incident as soon as practicable and no later than 10 business days after becoming aware of the incident, specifying:

- Any corrective action or investigation which the approval holder has already taken or intends to take in the immediate future;
- The potential impacts of the incident; and
- The method and timing of any remedial action that will be undertaken by the approval holder.

7.3 Non-Compliances

7.3.1 Non-Compliance Definition

The Consent defines a non-compliance as 'an occurrence, set of circumstances or development that is in breach of the consent'.

7.3.2 Non-Compliance Management

Non-compliances or system defects detected during monitoring, inspections and audits will be managed in accordance with the Tahmoor Coal Environmental Management Framework Document (TAH-HSEC-00173), with corrective action plans developed and implemented to rectify any issues.

7.3.3 Non-Compliance Reporting

The Planning Secretary will be notified in writing via the Major Projects website within seven days after Tahmoor Coal becomes aware of any non-compliance.

If a non-compliance is detected, the following steps will be followed:

- Identify and confirm the non-compliance (i.e. review against approval criteria or condition and confirm that a non-compliance has occurred);
- Complete internal environmental incident reporting documentation including an investigation to capture all relevant information;
- In accordance with the relevant approval, determine what action (i.e. external reporting) is required. Specifically, determine if immediate reporting is required and to which stakeholders, or ensure that the event is captured for future reporting;
- Following the incident investigation, develop a corrective action plan aimed at preventing future re-occurrence; and
- Complete all required reporting and consult with relevant agencies on the corrective action plan to be implemented.

A non-compliance notification will identify the following:

- The development and the application number;
- The condition of consent that the development is non-compliant with:
    i. The way in which it does not comply and the reasons for the non-compliance (if known); and
    ii. Any actions which have been, or will be, undertaken to address the non-compliance.

In addition, in accordance with the DAWE (now Commonwealth DCCEEW) approval conditions 23 and 24 for the Tahmoor South Project, Tahmoor Coal will notify the Department in writing of any non-compliance with the conditions or commitments made in the Extraction Plan. Notification of this occurrence will be given as soon as practicable, and no later than two business days after becoming aware of the non-compliance.

The notification will specify:

- Any condition which is in breach;
- A short description of the non-compliance; and
- The location (including co-ordinates), date, and time of the non-compliance. In the event the exact information cannot be provided, provide the best information available.

Tahmoor Coal will also provide details of any non-compliance with the conditions or commitments made in the Extraction Plan as soon as practicable and no later than 10 business days after becoming aware of the non-compliance, specifying:

- Any corrective action or investigation which the approval holder has already taken or intends to take in the immediate future;
- The potential impacts of the non-compliance; and
- The method and timing of any remedial action that will be undertaken by the approval holder.

A non-compliance which has been notified as an incident does not need to also be notified as a non-compliance.

All non-compliances will be reported in the Annual Review and a record maintained in Tahmoor Coal's Compliance Management System, Cority.

7.4 Exceedances

7.4.1 Exceedance Definition

For the purposes of this plan, an exceedance is defined 'any instance where monitoring results show an exceedance of criterion outlined within the Consent or other regulatory instrument'.

7.4.2 Exceedance Management

Exceedances will be managed by Tahmoor Coal through the Contingency Plan and TARP process as outlined in **Section 3.6** and **Appendix C**.

7.4.3 Exceedance Reporting

Exceedance reporting will occur as per the response in the Trigger Actions Response Plans, with reporting to DPHI (and other relevant agencies) within 7 days of investigation completion where the TARP Level 'exceedance of performance measure' has occurred.

In accordance with Condition E4 of the Consent, where any exceedance of the criteria or performance measures outlined within this document has occurred, Tahmoor Coal will:

- Take all reasonable and feasible steps to ensure that the exceedance ceases and does not recur;
- Consider all reasonable and feasible options for remediation (where relevant) and submit a report to the Department describing those options and any preferred remediation measures / corrective management actions or other course of action;
- Within 14 days of the exceedance occurring (or other timeframe agreed by the Planning Secretary), submit a report to the Planning Secretary describing these remediation options and any preferred remediation measures / corrective management actions or other course of action; and
- Implement reasonable remediation measures / corrective management actions as directed by the Planning Secretary.

In addition, notification to Commonwealth DCCEEW is also required of any detection or prediction of an exceedance of a performance measure within 2 business days.

In accordance with Condition 11 of the DAWE (now Commonwealth DCCEEW) Consent for the Tahmoor South Project, if an exceedance of the performance measures is detected, Tahmoor Coal will submit to the Department for approval an Impact Response Plan that has been peer reviewed. Each Impact Response Plan will include, at a minimum:

- Be prepared by a suitably qualified person;
- Describe all potential and actual impacts to water resources arising from the exceedance;
- Include conceptual modelling, as well as a review of all historical monitoring data to determine the stressor-response relationships for any potential GDEs and consideration of potential contributing activities;
- Consider and where appropriate include local scale numerical modelling with consideration of potential contributing activities;
- Derive a scientifically-robust rectification strategy based on multiple lines of evidence and field data to support the assessment of the environmental values of water resources (including the groundwater-dependence of any potential GDEs) within the Development Application Area;
- Identify if any further investigations are required to determine the cause of, and/or corrective actions, for the exceedance;

- Include the mitigation and management measures that the approval holder has taken and/or proposes to take to reverse the exceedance, including data demonstrating the effectiveness of the mitigation and management measures;
- Provide justification for how the proposed mitigation and management measures will achieve and maintain the requirements of condition 4; and
- Include a peer review and details of how the approval holder has addressed any inadequacies raised in the peer review.

The approved Impact Response Plan will be implemented. Conditions 12 to 16 of the DAWE (now Commonwealth DCCEEW) approval of the Tahmoor South Project will also be observed.

All exceedances will be reported in the Annual Review and a record maintained in Tahmoor Coal's Compliance Management System, Cority.

7.5 Complaints and Disputes

Community Complaints at Tahmoor Coal are managed in accordance with Community Complaints and Enquiry Procedure (TAH-HSEC-00120). Tahmoor Coal operates a 24-hour complaints line (1800 154 415) for receiving community complaints and other stakeholder communications. The general process detailed in the procedure for responding to complaints is:

- Acknowledging all complaints and responding to the complainant within 24 hours where practicable;
- Registering all complaint details in Cority;
- Investigating complaints impartially considering the facts and the circumstances prevailing at the time;
- Implementing corrective actions if required; and
- Reporting to relevant stakeholders of investigation outcomes and corrective actions taken.

A record of all community complaints in relation to activities undertaken by the licensee must be kept in a legible form and be in accordance with Tahmoor Coal's Environmental Protection Licence (EPL) 1389.

The following information will also be kept in the event of a community complaint, as required by Section M4 in Tahmoor Coal's EPL 1389:

- The date and time of the complaint;
- The method by which the complaint was made;
- Any personal details of the complainant which were provided by the complainant or a note to that effect;
- The nature of the complaint;
- The action taken by the licensee in relation to the complaint, including any follow-up contact with the complainant; and
- If no action was taken by the licensee, the reasons why no action was taken.

These records must be kept for at least 4 years after the complaint was made and be able to be produced to any authorised officer who asks to see them.

In the event of a dispute or conflict between Tahmoor Coal personnel and a member of the community, the Tahmoor Coal Environment and Community Manager will facilitate communication between both parties to reach a resolution, which may include a meeting with the complainant to discuss the issue.

Where relevant, negotiations will be initiated in accordance with any relevant Consent conditions. This general process is documented in the Community Complaints and Enquiry Procedure (TAH-HSEC-00120). If a dispute cannot be resolved, the matter will be escalated to involve the site Operations Manager or General Manager as required and may involve consultation with the relevant government agency to assist in reaching a determination on the matter.

7.6 Risk Assessments

7.6.1 Site-wide Risk Assessment

Aspects and impacts at Tahmoor Mine are considered in light of legislative requirements and internal and external stakeholder views. Key aspects and impacts are identified during the annual review of the Tahmoor Coal Environment and Community (E&C) Broad Brush Risk Assessment (BBRA) and the operational Life of Mine (LOM) Risk Assessment and Site Wide Broad-Brush Risk Assessment (Mine BBRA).

7.6.2 General Risk Assessment

Tahmoor Coal completed a risk assessment for the extraction of LW S1A-S6A on 3 November 2021 to determine the major risks relating to built features and environmental features associated with secondary extraction of LW S1A-S6A. A risk assessment was also completed on 30 July 2025 to determine the additional risks to environmental features and built infrastructure associated with the extraction of the LW S7A. This risk assessment forms an addendum of the existing LW S1A-LW S6A risk assessment.

The primary objectives of the risk assessments were to:

- Ensure the required approvals for the proposed longwalls are obtained in a timely manner to enable mining to commence;
- Ensure all environmental risks are appropriately eliminated or managed according to environmental legislation requirements;
- Ensure the safe and serviceable operation of all surface built features in the Study Area;
- Ensure that the health and safety of people who may be present in the Study Area are not put at risk due to mine subsidence;
- Assist in the establishment of procedures to measure, monitor, control, mitigate and repair built features in the Study Area; and
- Ensure the required management plans for environmental features and built features are prepared and in place in a timely manner to manage potential impacts to environmental features or built features during mining.

The risk assessment was completed to satisfy Tahmoor Coal's requirements in relation to WHS and in compliance to mining regulations and conditions and is completed in consultation with key stakeholders. The risk assessments for LW S1A-S6A and LW S7A were completed in accordance with:

- Risk Management (TAH-HSEC-00229) standard prepared by Tahmoor Coal, which details the 12 Step Risk Management Process for managing risk and the risk matrix used to categorise risks;
- WRAC Workplace Risk Assessment and Controls (TAH-HSEC-00014) standard prepared by Tahmoor Coal, which details the methodology for use during the risk assessment;
- DPE (now NSW DPHI) requirements and Conditions of Approval (SSD 8445);
- *NSW Work Health and Safety (Mines and Petroleum Sites) Regulations 2014* (it is noted that this was updated in 2022);
- AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines; and
- Risk Management Handbook for the Mining Industry (MDG1010).

Risks were identified and assessed through the review of known surface and sub-surface features within the Extraction Plan Study Area. The risk assessments also drew upon the experience and results of previous risk assessments completed for previous longwalls at Tahmoor Mine.

The risk assessments were completed by members of the Tahmoor Coal E&C Department and relevant technical specialists, and was facilitated by a Tahmoor Coal internal facilitator.

The outcomes of the risk assessments are outlined in the PSMP.. Treatment plans / tasks identified during the risk assessment have been recorded in in Cority and assigned to responsible personnel for completion within appropriate timeframes.

7.6.3 Built Feature Specific Risk Assessments

Further risk assessments for specific built features in the LW S1A-S7A Study Area will be completed if potential impacts to these features are deemed to be more detailed than the risks assessed in the general LW S1A-S7A Risk Assessment. The results from these risk assessments will be included in the individual management plans for the features, as listed in **Section 2.1.2** and **Table 5**.

7.7 Audits and Reviews of Environment and Community Performance

7.7.1 Internal Audit and Review

In accordance with internal company requirements, Tahmoor Coal has implemented a system for the monitoring and review of E&C performance at the site. Tahmoor Coal is to provide ongoing monitoring and regular management review of E&C performance to:

- Confirm the adequacy and effectiveness of management plans, procedures and standards;
- Address any identified weaknesses;
- Share good performance and lessons learnt with other sites; and
- Ensure ongoing compliance with all leases, licences and approvals.

Process or area specific internal audits are also conducted periodically, generally administered by the E&C Manager, focussing on the following areas:

- Air quality;
- Water management;
- Erosion and sediment control; and
- Statutory approvals.

These audits may be conducted by consultants on behalf of Tahmoor Coal, by Liberty GFG employees or may be self-assessments conducted by Tahmoor Coal personnel. Audit results and corrective actions are recorded in Cority and assigned to responsible personnel for completion within appropriate timeframes.

7.7.2 Independent Environmental Audit

In accordance with Conditions E15 – E20 of the Consent, Tahmoor Coal will complete Independent Environmental Audits of the development at the frequencies determined within DPE's Independent Audit Post Approval Requirements (2020). For extraction, the 'Operational Phase' requirements are relevant, requiring an initial independent audit within 26 weeks of the commencement of operation and ongoing independent audits at intervals no greater than 3 years or as otherwise agreed by the Planning Secretary.

The audits will assess:

- Environmental performance of the Mine;
- Compliance with the requirements of all relevant development consents, mining leases, Exploration Authorisations, and site environmental protection licence.

The audit will also assess:

- Environmental assessments; and
- Plans and programs required by above approvals.

The audit will review the adequacy of the following requirements under the abovementioned approvals:

- Strategies;
- Plans; and
- Programs.

The audit will recommend appropriate measures and corrective actions to improve environmental performance at Tahmoor Coal. Audit results and corrective actions are recorded in Cority and assigned to responsible personnel for completion within appropriate timeframes.

7.7.3 Extraction Plan Audit

Audits of the Extraction Plan are to be conducted in consultation with the Plan owner and nominated individuals and shall focus on the content and implementation.

Audits on the content shall consist of a determination of understanding of the Extraction Plan by the individual's allocated responsibility under this plan.

Audits on the implementation shall consist of reviews of the safe working procedures and risk assessments developed to ensure safe operation of this Extraction Plan, they may also involve discussions with personnel involved in the management plan to determine understanding and compliance.

Should an audit of this Extraction Plan determine that a deficiency is evident in the content or implementation, the results are to be brought to the attention of the E&C Manager that corrective actions can be developed and implemented. Corrective actions are recorded in Cority and assigned to responsible personnel for completion within appropriate timeframes.

Tahmoor Coal is responsible to verify that the nominated corrective action has been implemented by way of a follow up audit.

Any changes to the Extraction Plan are to be managed and communicated to all personnel in accordance with Tahmoor Coal's Document and Record Control (TAH-HSEC-00124) and Change Management Standard (TAH-HSEC-00171) documents.

Additionally, auditing will be undertaken in accordance with:

- Health and Safety Management Plan (TAH-HSEC-00189); and
- Environmental Management System Framework (EMSF) (TAH-HSEC-00173).

7.8 Review of Documents

7.8.1 Review of Extraction Plan

This Extraction Plan Main Document will be reviewed on a time or event basis, as is required:

Time based:

- In accordance with Condition E7 (a) of the Consent, a review will be required within 3 months of:
  - Any incident, event or finding that identifies an inadequacy in the risk assessment or associated documents to continue to effectively manage the identified hazard;
  - A change to the workplace itself or any aspect of the work environment, a change to a system of work, a process or a procedure;

- In accordance with Condition E7 (b-e) of the Consent, this plan will be reviewed within three months of:
  - the submission of an Annual Review under Condition E13;
  - the submission of an Independent Environmental Audit under Condition E15;
  - the approval of any modification of the conditions of this consent (unless the conditions require otherwise); or
  - notification of a change in development phase under Condition A19.

Event based:

- Stakeholders raise issues that necessitate a review;
- Significant change in mine design or layout;
- Unpredicted subsidence impacts or environmental consequences have required implementation of contingency actions;
- Development Consent requirements trigger a review;
- Circumstances in either Clause 15 and/or Clause 124 of the WHSMP Regulation and/or Clause 38 of the WHS Regulation (refer to Section 3.2.4 of this Extraction Plan for further detail); and/or
- Monitoring, incident or audit processes demonstrate that a review is warranted.

If deemed appropriate, relevant stakeholders may be included in the review process. All reviews are to be documented. The process for review of this document will be in according to Tahmoor Coal's Document and Record Control (TAH-HSEC-00124) document.

Following changes (or as otherwise required above) a copy of the amended management plan will be forwarded to the Planning Secretary for approval.

7.8.2 Review of Other Management Plans

The Key Sub-plans prepared in support of this Extraction Plan (refer to **Section 4**) are also subject to individual review requirements as detailed within each plan. Amendments to the Key Sub-plans will be undertaken in consultation with relevant stakeholders, where deemed necessary. Following changes (or as otherwise required above) a copy of the amended Key Sub-plans will be forwarded to the Planning Secretary for approval.

The review of other management plans that apply more broadly to the whole mine site, such as the Rehabilitation Management Plan (TAH-HSEC-00402) and the Environmental Management Strategy (TAH-HSEC-00375), may be required following the completion of this Extraction Plan. The process for review of these documents will be in according to Tahmoor Coal's Document and Record Control (TAH-HSEC-00124) document.

7.8.3 Document Control

This Extraction Plan includes Document Control details as part of the document quality assurance and control (QA/QC). This includes the following Document Control information:

- Document details including author(s), revision numbers, dates and status (refer to Document Control table at the start of this Extraction Plan main document, and **Section 8.5**);
- Revision, approval and authorisation details (refer to Document Control table at the start of this Extraction Plan main document, and **Section 8.5**); and
- Distribution details including the provision to external stakeholders (refer to **Section 8.6**).

All revisions of this Extraction Plan are stored on Tahmoor Coal's Document Control Software, Intelex, and are updated in accordance with Tahmoor Coal's Document and Record Control (TAH-HSEC-00124) and Change Management Standard (TAH-HSEC-00171) documents.

7.9 Roles and Responsibilities

7.9.1 General Roles and Responsibilities

E&C management is regarded as part of the responsibilities of all employees and contractors at Tahmoor Coal. Specific information pertaining to the role, responsibility, authority and accountability of key personnel involved in environmental management at Tahmoor Coal is provided in **Table 21** below.

Table 22 Roles and Responsibilities

Position	Responsibilities
Operations Manager	• Approve this management plan and any revised versions as required. • Provide adequate environmental personnel/resources for implementation of this management plan and associated plans. • Ensure underground mining activities are conducted in accordance with this management plan.
Environment & Community Manager	• Approve this management plan and any revised versions as required. • Determine adequate resources and funds are available to ensure the effectiveness of this procedure. • Ensure this management plan is implemented and maintained. • Certify compliance and adherence to this management plan. • Ensure any potential or actual issues, triggers and non-conformances are reported in accordance with this management plan, regulatory requirements and corporate standards. • Liaise with relevant government agencies and built feature owners in relation to regulatory conditions and compliance issues. • Coordinate external audits, corporate reporting and management.
Approvals Specialist	• Develop, implement, review and maintain this management plan and system documents. • Review and assess subsidence monitoring results against predictions. • Coordinate environmental reporting for timely completion in accordance with internal and external requirements. • Investigate and report any exceedances of performance indicators in accordance with the TARPs. • Implement subsidence management actions as required by the TARPs.
Environmental Specialist	• Coordinate environmental compliance on-site including timely completion of monitoring and reporting in accordance with internal and external requirements. • Assist in the development, implementation, review and maintain of this management plan and system documents. • Implement and ensure the completion of audit actions.
Community Liaison Specialist	• Liaise with the community as required and as per the Stakeholder Engagement Plan, including facilitation of Community Consultative Committee meetings. • Consult with relevant stakeholders during the development of management plans relating to their built features. • Liaise with land owners, landholders and land managers to gain access for subsidence monitoring and any remediation works. • Ensure all community complaints are addressed, investigated and appropriately managed as per site procedures, and reported internally as per internal requirements.
Surveyor	• Coordinate with the Community Liaison Specialist to gain access for subsidence monitoring. • Establish and undertake subsidence monitoring in accordance with this management plan to the required survey standard and within the specified timeframes.
Mine Subsidence Engineer	• Ensure monitoring data are adequately checked, processed and recorded. • Review and assess subsidence monitoring results against predictions. • Provide monitoring results to the E&C Team, relevant agencies and built feature owners. • Notify the Environment and Community Manager of any identified public safety issues.
All Other Employees and Contractors	• Complete activities under their control in accordance with this management plan and associated plans and site procedures.

Position	Responsibilities
	• Ensure environmental controls within their jurisdiction are operated and maintained in a proper and efficient manner. • Report all environmental incidents and complaints in a timely manner.

7.9.2 Employee & Contractor Training

Environmental training for Tahmoor Coal employees and contractors is conducted in accordance with the Environment & Community Training Needs Analysis, which Tahmoor Coal manages through the Scenario Training Database. General environmental awareness training is provided to all employees and contractors annually through a generic visitor induction and the safety training session scheduled by the Tahmoor Coal Health, Safety & Training Department.

7.9.3 Response Groups

Tahmoor Coal operates three response groups made up of Tahmoor Coal Staff and relevant technical specialists:

- Environmental Response Group (ERG);
- Structural Response Group (SRG); and
- Rail Response Group (RRG).

The response groups are responsible for taking the necessary actions required to manage the risks that are identified from monitoring of natural and built features to ensure that the health and safety of people and the environment are not put at risk due to mine subsidence. Each response group assists in the development and review management plans, collects and analyses monitoring results, determines potential impacts, and provides advice regarding appropriate actions relevant to the area of interest.

Each response group is made up of a group of key members, and the response group may invite other specialist consultants and stakeholders depending on the topic of conversation. Each group meets regularly and outcomes of the meetings are documented.

7.10 Access to Information

7.10.1 Tahmoor Coal Website

In accordance with Condition E23 of the Consent, Tahmoor Coal is required to make publicly available information pertaining to Tahmoor Coal's general environmental performance against internal targets and external approvals criteria.

The following information is available on Tahmoor Coal's Website:

- Tahmoor South Project EIS;
- All current statutory approvals for Tahmoor Mine;
- All approved strategies, plans and programs;
- Any proposed staging plans for the Tahmoor South Project;
- Minutes of TCCCC meetings;
- Regular reporting on the environmental performance;
- A comprehensive summary of the monitoring results of Tahmoor Mine;
- A summary of the current phase and progress of development at Tahmoor Mine;
- Contact details to enquire about Tahmoor Mine or to make a complaint;
- A complaints register updated on a monthly basis;

- A record of incidents and non-compliance notifications made to the Planning Secretary updated monthly;
- Annual Review documents;
- Independent Environmental Audits of the Tahmoor Mine, and Tahmoor Coal's response to the recommendations in the audits;
- Annual returns made under the National Greenhouse and Energy Reporting legislation;
- Environmental Protection Licence Annual Return; and
- Any other matter required by the Planning Secretary.

These reports are prepared in accordance with relevant guidelines and are published on Tahmoor Coal's website in accordance with the Tahmoor Website Procedure (TAH-HSEC-00221).

This Extraction Plan will be uploaded to the Tahmoor Coal Website following approval.

7.10.2 Tahmoor Colliery Community Consultative Committee

Information pertaining to Tahmoor Coal's general environmental performance against internal targets and external approvals criteria is reported to the community via the TCCCC.

The TCCCC was established in 2003 in response to the requirement for DA 67/98 Condition 47 to establish and operate a Community Consultative Committee in general accordance with DPE *Community Consultative Committee Guidelines: State Significant Projects (2016)*. The requirement for the TCCCC was renewed for the Tahmoor South Project in Condition A25 of the Consent.

The TCCCC currently meets on a quarterly basis and provides a forum of two-way communication between community representatives and Tahmoor Coal. Some of the information reported at the TCCCC includes:

- Progress at the mine and operational issues;
- Activities, projects and community initiatives;
- Subsidence monitoring and environmental performance; and
- Community complaints and the response to complaints.

As discussed in **Section 7.10.1,** the minutes from the TCCCC meetings is provided on the Tahmoor Coal Website.

8 Document Information

8.1 Referenced Documents

Reference information that is directly related to the development of this document or referenced from within this document is listed in **Table 22** below.

Table 23 Reference Information

Title
ATC Williams (2022), Tahmoor South LW S1A-S6A Water Management Plan – Myrtle Creek and Redbank Creek Remediation Program Review, May 2022, document 121171.17.
Department of Industry – Resources Regulator (2017), Managing Risks of Subsidence Guide: WHS (Mines and Petroleum Sites) Legislation.
Department of Planning (2008), Impacts of Underground Coal Mining on Natural Features in the Southern Coalfields: Strategic Review. NSW Department of Planning, July 2008.
Department of Planning and Environment (DPE) (2022), Extraction Plan Guidelines.
Douglas Partners (2024), Report on Geotechnical Assessment, Longwalls S1A to S6A, Bargo, prepared for Tahmoor Coal, June 2024.
Douglas Partners (2022), Detailed Slope Stability Assessment, Longwalls S1A to S6A, Bargo, prepared for Tahmoor Coal, September 2022.
Mine Subsidence Engineering Consultants (2022), Tahmoor South Project – Extraction Plan for Longwalls S1A to S6A: Subsidence ground movement predictions and subsidence impact assessments for natural features and surface infrastructure. Prepared for Tahmoor Coal, May 2022, document MSEC1192.
Mine Subsidence Engineering Consultants (2024), Tahmoor Coal – Modification 3 – Longwall S7A: The effect of the proposed addition of LW S7A on previous subsidence predictions and impact assessments. Prepared for Tahmoor Coal, March 2024, document MSEC1348, Rev B.
PSM (2025), Geotechnical Assessment – Longwall S7A. Prepared for Tahmoor Coal, Ocotber 2025, document PSM5522-013R.
SLR (2024). Tahmoor South Mod 3 – LW S7A Groundwater Impact Assessment. Prepared for Tahmoor Coal, May 2024.SLR (2022a), Tahmoor South - Baseline Private Bore Assessment Report, prepared for Tahmoor Coal, May 2022, document 310.30637.00000.
SLR (2022b), Tahmoor Extraction Plan LW S1A-S6A Land and Agricultural Resource Assessment, prepared for Tahmoor Coal, April 2022, document 630.12732.002.
SIMEC (2019), Tahmoor South Project Environmental Impact Statement, Volumes 1 and 7, dated January 2019.
SIMEC (2020a), Tahmoor South Project Amendment Report, including Appendices A to R and response to submissions, dated February 2020.
SIMEC (2020b), Tahmoor South Project Second Amendment Report, Appendices A to O and response to submissions, dated August 2020.
SIMEC (2020c), Additional information responses dated 14 September 2020 (including Appendices A to L), 23 October 2020 and 4 November 2020.
Tahmoor Coal (2022), Tahmoor South Domain, Longwalls South 1A to South 6A, Risk Assessment Report.
Waddington, A.A. and Kay, D.R., (2002). ACARP Management Information Handbook on the Undermining of Cliffs, Gorges and River Systems-Version 1. Developed from ACARP Research Projects C8005 and C9067, September 2002.

8.2 Related Documents

Related documents (internal documents) directly related to or referenced from this document are listed in **Table 24** below.

Table 24 Related Documents

Document Number	Document Title
TAH-HSEC-00375	Environmental Management Strategy
TAH-HSEC-00402	Rehabilitation Management Plan
TAH-HSEC-00124	Document and Record Control
TAH-HSEC-00171	Change Management Standard
TAH-HSEC-00229	Risk Management
TAH-HSEC-00014	WRAC Workplace Risk Assessment and Controls
TAH-HSEC-00189	Health and Safety Management Plan
TAH-HSEC-00416	Emergency Response Control Plan

Document Number	Document Title
TAH-HSEC-00155	Pollution Incident Response Management Plan
TAH-HSEC-00224	Notification of Environmental Pollution Incidents
TAH-HSEC-00120	Community Complaints and Enquiry Procedure
TAH-HSEC-00221	Tahmoor Website Procedure
TAH-HSEC-00360	LW S1A-S7A Extraction Plan Main Document
TAH-HSEC-00361	LW S1A-S7A Water Management Plan
TAH-HSEC-00362	LW S1A-S7A Land Management Plan
TAH-HSEC-00363	LW S1A-S7A Biodiversity Management Plan
TAH-HSEC-00364	LW S1A-S7A Heritage Management Plan
TAH-HSEC-00366	LW S1A-S7A Built Features Management Plan
TAH-HSEC-00365	LW S1A-S7A Public Safety Management Plan
TAH-HSEC-00367	LW S1A-S7A Subsidence Monitoring Plan

8.3 Glossary of Terms

Terms references to this document are provided below in **Table 24**.

Table 25 Glossary of Terms

Term	Definition
Adaptive management	Monitoring subsidence impacts and subsidence effects and, based on the results, modifying the mine plan as mining proceeds to ensure that the effects, impacts and/or associated environmental consequences remain within the predicted and designated ranges and in compliance with the conditions of the Project Approval.
Angle of draw	The angle of inclination from the vertical of the line connecting the goaf edge of the workings and the limit of subsidence (which is usually taken as 20 mm of subsidence).
Aquifer	A sub-surface rock formation containing water in recoverable quantities.
Block	A dimensional delineation of the mineral deposit; as in “a block of coal” or a “coal blocked out for extraction”.
Built features	Includes any building or work erected or constructed on land, including dwellings and infrastructure such as a formed road, street, path, walk, or driveway; any pipeline, water sewer, telephone, gas or other infrastructure service main.
Chain pillar	A block of coal left unmined between the longwall extraction panels.
Cliff	A continuous rock faces, including overhangs, having a minimum length of 20 m, a minimum height of 10 m and a minimum slope of 2 to 1, i.e. having minimum angles to the horizontal of 63°.
Closure	The reduction in the horizontal distance between the valley sides. The magnitude of closure, which is typically expressed in the units of mm, is the greatest reduction in distance between any two points on the opposing valley sides. It should be noted that the observed closure movement across a valley is the total movement resulting from various mechanisms, including conventional mining induced movements, valley closure movements, far-field effects, downhill movements and other possible strata mechanisms.
Coal face	The current working place for coal extraction.
Coal Preparation Plan (CPP)	Processing plant where coal is sized, washed and prepared for the market.
Coal seam	Naturally formed underground layer of coal.
Continuous miner	The electric powered cutting machine used to remove coal from the active mining face and load it into the shuttle car.
Conveyor	The means of transporting coal from the coal face to the underground bin or surface. It consists of a belt being driven by a motor over a roller assembly.
Cover depth (H)	The depth of coal seam from the ground surface in m. Cover depth is normally provided as an average over the area of the panel.

Term	Definition
Critical area	The area of extraction at which the maximum possible subsidence of one point on the surface occurs.
Curvature	Second derivative of subsidence, or the rate of change of tilt, and is calculated as the change in tilt between two adjacent sections of the tilt profile divided by the average length of those sections. Curvature is usually expressed as the inverse of the Radius of Curvature with the units of 1/km (km^{-1}), but the value of curvature can be inverted, if required, to obtain the radius of curvature, which is usually in km. Curvature can be either hogging (i.e. convex) or sagging (e.g. concave).
Development	The operations involved in preparing the coal seam for extraction.
Downcast	A shaft or other mine opening down to the underground workings in which fresh air from the surface passes.
Drift	An inclined access opening from the surface to the coal seam.
Exploration	The search for mineral deposits and the work done to prove or establish the extent of a mineral deposit.
Extracted seam	The thickness of coal that is extracted. The extracted seam thickness is thickness normally given as an average over the area of the panel.
Effective extracted seam thickness (T)	The extracted seam thickness modified to account for the percentage of coal left as pillars within the panel.
Face length	The width of the coalface measured across the longwall panel.
Far-field movements	The measured horizontal movements at pegs that are located beyond the longwall panel edges and over solid unmined coal areas. Far-field horizontal movements tend to be bodily movements towards the extracted goaf area and are accompanied by very low levels of strain.
First workings	The driving of headings (underground roadways) into the solid coal seam prior to the commencement of extraction. First workings do not result in surface subsidence.
Gate road	An underground roadway leading to a working place in longwall mining.
Goaf	The void created by the extraction of the coal into which the immediate roof layers collapse.
Goaf end factor	A factor applied to reduce the predicted incremental subsidence at points lying close to the commencing or finishing ribs of a panel.
Headings	An underground roadway formed in the direction of a development panel.
Horizontal displacement	The horizontal movement of a point on the surface of the ground as it settles above an extracted panel. Displacement is described by various parameters including horizontal tilt, horizontal curvature, mid-ordinate deviation, angular distortion and shear index.
Incremental subsidence	The difference between the subsidence at a point before and after a panel is mined. It is therefore the additional subsidence at a point resulting from the excavation of a panel.
Inflection point	The point on the subsidence profile where the profile changes from a convex curvature to a concave curvature. At this point the strain changes sign and subsidence is approximately one half of S max.
Longwall	A system of mining coal in which the seam is extracted on a broad front or long face using a coal shearer and the roof is supported by hydraulic roof supports.
Minor cliff	A continuous rock face, including overhangs, having a: • Minimum length of 20 metres and a height between 5 metres and 10 metres or maximum length of 20 metres and a minimum height of 20 metres; and • A minimum slope of 2 in 1 (>63.4°)
Mitigation measures	Subsidence management measures which aim to reduce subsidence impacts, usually implemented prior to or during mining.
Overlap adjustment factor	A factor that defines the ratio between the maximum incremental subsidence of a panel and the maximum incremental subsidence of the panel if it were the first panel in a series.

Term	Definition
Panel or longwall panel	The plan area of coal extraction, or a block of coal to be mined by longwalls defined by gate roads and coal seam thickness.
Panel length (L)	The longitudinal distance along a panel measured in the direction of mining from the commencing rib to the finishing rib.
Panel width (Wv)	The transverse distance across a panel, usually equal to the face length plus the widths of the roadways on each side.
Panel centre line	An imaginary line drawn down the middle of the panel.
Pillar	A block of coal left unmined.
Pillar width (Wpl)	The shortest dimension of a pillar measured from the vertical edges of the coal pillar, i.e. from rib to rib.
Remediation measures	Subsidence management measures which aim to repair any adverse effects of subsidence, usually implemented after mining.
Risk	The chance of something happening that will have an impact on objectives. It is measures in terms of consequence and likelihood.
Rock face feature	A rock face having a: • Minimum length of 20 metres and heights between 3 metres and 5 metres, or maximum length of 20 metres and a minimum height of 5 metres; and • A minimum slope of 2 in 1 (>63.4°).
Run of mine (ROM)	Raw coal production, or the unprocessed mined coal that is conveyed to the CPP. ROM may consist of coal and rock.
Safe, serviceable and Repairable	Safe means no danger to users who are present; serviceable means available for its intended use; repairable means damaged components can be repaired economically.
Second workings	Extraction of coal by longwall mining that may result in surface subsidence.
Shaft	A vertical opening connecting the surface with the underground workings.
Shear deformations	The horizontal displacements that are measured across monitoring lines and these can be described by various parameters including; horizontal tilt, horizontal curvature, mid-ordinate deviation, angular distortion and shear index.
Steep slopes	An area of land having a gradient between 1 in 3 (33% or 18.3°) and 2 in 1 (200% or 63.4°).
Strain	The change in the horizontal distance between two points divided by the original horizontal distance between the points, i.e. strain is the relative differential displacement of the ground along or across a subsidence monitoring line. Strain is dimensionless and can be expressed as a decimal, a percentage or in parts per notation. Tensile Strains are measured where the distance between two points or survey pegs increases and Compressive Strains where the distance between two points decreases. Whilst mining induced strains are measured along monitoring lines, ground shearing can occur both vertically, and horizontally across the directions of the monitoring lines.
Sub-critical area	An area of panel smaller than the critical area.
Subsidence	The vertical movement of a point on the surface of the ground as it settles above an extracted panel, but, 'subsidence of the ground' in some references can include both a vertical and horizontal movement component. The vertical component of subsidence is measured by determining the change in surface level of a peg that is fixed in the ground before mining commenced and this vertical subsidence is usually expressed in units of mm. Sometimes the horizontal component of a peg's movement is not measured, but in these cases, the horizontal distances between a particular peg and the adjacent pegs are measured.
Subsidence effects	The deformations of the ground mass surrounding a mine, sometimes referred to as 'components' or 'parameters' of mine subsidence induced ground movements, including vertical and horizontal displacements, tilts, curvatures, strains, upsidence and closure.

Term	Definition
Subsidence impacts	The physical changes or damage to the fabric or structure of the ground, its surface and environmental features, or built structures that are caused by the subsidence effects. These impacts considerations can include tensile and shear cracking of the rock mass, localised buckling of strata, bed separation, rock falls, collapse of overhangs, failure of pillars, failure of pillar floors, dilation, slumping and also include subsidence depressions or troughs.
Subsidence consequences	The knock-on results of subsidence impacts, i.e. any change in the amenity or function of a natural feature or built structure that arises from subsidence impacts. Consequence considerations include public safety, loss of flows, reduction in water quality, damage to artwork, flooding, draining of aquifers, the environment, community, land use, loss of profits, surface improvements and infrastructure. Consequences related to environmental features are referred to as environmental consequences.
Super-critical area	An area of panel greater than the critical area.
Tilt	The change in the slope of the ground as a result of differential subsidence, and is calculated as the change in subsidence between two points divided by the horizontal distance between those points. Tilt is, therefore, the first derivative of the subsidence profile. Tilt is usually expressed in units of mm/m. A tilt of 1 mm/m is equivalent to a change in grade of 0.1 %, or 1 in 1000.
Total subsidence, tilts, curvatures and strains	Accumulated parameters after the completion of each longwall.
Travelling subsidence, tilts, curvatures and strains	Transient movements as the longwall extraction face mines directly beneath a given point.
Upcast	A shaft or other mine opening through which air returns to the surface after ventilating the underground workings.
Uplift	An increase in the level of a point relative to its original position.
Upsidence	Upsidence results from the dilation or buckling of near-surface strata at or near the base of the valley. The term uplift is used for the cases where the ground level is raised above the pre-mining level, i.e. when the upsidence is greater than the subsidence. The magnitude of upsidence, which is typically expressed in the units of mm, is the difference between the observed subsidence profile within the valley and the conventional subsidence profile which would have otherwise been expected in flat terrain.
Vertical displacement	Vertical downward movements of the ground surface caused by underground coal mining.
Valley related movements	Valley bulging movements are a natural phenomenon, resulting from the formation and ongoing development of the valley. The potential for these natural movements are influenced by the geomorphology of the valley. Valley related movements can be caused by or accelerated by mine subsidence as the result of a number of factors, including the redistribution of horizontal in situ stresses and down slope movements. Valley related movements are normally described by the parameters upsidence, closure, compressive strains and tensile strains.

8.4 Abbreviations

Abbreviations used in this document are provided below in **Table 26.**

Table 26 Abbreviations

Abbreviation	Definition
ACARP	Australian Coal Association Research Program
AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management System
ARTC	Australian Rail Track Corporation
BCD	Department of Planning and Environment – Biodiversity and Conservation Division (formerly Biodiversity, Conservation and Science)

Abbreviation	Definition
	Now known as NSW DPHI Environment and Heritage
BCS	Department of Planning and Environment - Biodiversity, Conservation and Science (now Biodiversity and Conservation Division) Now known as NSW DPHI Environment and Heritage
BFMP	LW S1A-S7A Built Features Management Plan
BMP	LW S1A-S7A Biodiversity Management Plan
CAMP	Corrective Action Management Plan
CCL	Consolidated coal lease
CHPP	Coal handling and preparation plant
Crown Lands	NSW Department of Planning and Environment – Crown Lands Division Now known as DPHI Crown Lands
Commonwealth DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment and Water Formerly known as Commonwealth Department of Agriculture, Water and the Environment (DAWE)
DA	Development Application
DAWE	Commonwealth Department of Agriculture, Water and the Environment Now known as Commonwealth Department of Climate Change, Energy, the Environment and Water (Commonwealth DCCEEW)
DPE	NSW Department of Planning and Environment Formerly known as NSW Department of Planning, Industry and Environment (DPIE) Now known as NSW Department of Planning, Housing and Infrastructure (DPHI)
DPIE	NSW Department of Planning, Industry and Environment (former) Now known as NSW Department of Planning, Housing and Infrastructure (DPHI)
DPE Crown Lands	NSW Department of Planning and Environment – Crown Lands Now known as NSW Department of Planning, Housing and Infrastructure (DPHI) – Crown Lands
DPE Water	NSW Department of Planning and Environment – Water Now known as NSW Department of Climate Change, Energy, the Environment and Water - Water
DPHI	NSW Department of Planning, Housing and Infrastructure Formerly part of NSW Department of Planning and Environment
DPI	NSW Department of Primary Industries
DPI Agriculture	NSW Department of Primary Industries – Agriculture
DSNSW	Dams Safety NSW
E&C	Environment and community
EEC	Endangered Ecological Community
EES	NSW Department of Planning and Environment – Environment, Energy and Science Group Now known as NSW DPHI Environment and Heritage
EIS	Environmental Impact Statement
EMS	Environmental Management System
EMSF	Environmental Management System Framework
EPA	NSW Environment Protection Authority
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999*
EPL	Environment Protection Licence

Abbreviation	Definition
ERG	Tahmoor Coal Environmental Response Group
Ha	Hectares
HMP	LW S1A-S7A Heritage Management Plan
HSEC	Health, Safety, Environment and Community
IAPUM	Independent Advisory Panel for Underground Mining
IESC	Commonwealth Independent Expert Scientific Committee
IPM	Incremental Profile Method
km	Kilometre/s
LGA	Local Government Area
LMP	LW S1A-S7A Land Management Plan
LW	Longwall
LW S1A-S6A	Longwalls South 1A to South 6A
LW S1A-S7A	Longwalls South 1A to South 7A
m	Metre/s
MEG	Department of Regional NSW – Mining Exploration and Geoscience
Masl	Metres above sea level
MG	Main Gate
mm	Millimetre
ML	Mining Lease
MSEC	Mine Subsidence Engineering Consultants
NRAR	NSW Industry – Land & Water – Natural Resources Access Regulator – East
NSW	New South Wales
NSW DCCEEW	NSW Department of Climate Change, Energy, the Environment and Water Formerly part of NSW Department of Planning and Environment
OEH	NSW Office of Environment and Heritage Now known as NSW DPHI Environment and Heritage
PCBCs	Persons conducting a business or undertaking
PSMP	LW S1A-S7A Public Safety Management Plan
ONRSR	NSW Office of the National Rail Safety Regulator
QA/QC	Quality assurance and control
RAPs	Registered Aboriginal Parties
Resources Regulator	Department of Regional NSW – Resources Regulator
ROM	Run of Mine
RRG	Rail Response Group
SHR	State Heritage Register
SIMEC	SIMEC Mining Division
Spatial Services	NSW Department of Finance, Services and Innovation – Spatial Services
SRG	Structural Response Group
SSD 8445	Tahmoor South Project Development Consent

Abbreviation	Definition
SDWC	Sydney Drinking Water Catchment
T	Tonnes
Tahmoor Mine	Tahmoor Coal Mine
Tahmoor Coal	Tahmoor Coal Pty Ltd
TARP	Trigger Action Response Plan
TCCCC	Tahmoor Colliery Community Consultative Committee
TDS	Total dissolved salts
TfNSW	Transport for NSW
TG	Tailgate
Western Domain	The area to the north-west of the Main Southern Rail within ML 1376 and ML 1539
WHS	Work Health and Safety
WHS Act	*Work Health and Safety Act 2011*
WHS Regulation	*Work Health and Safety Regulation 2017*
WHSMP Act	*Work Health and Safety (Mines and Petroleum Sites) Act 2013*
WHSMP Regulation	*Work Health and Safety (Mines and Petroleum Sites) Regulation 2022*
WLEP	*Wollondilly Local Environment Plan 2011*
WMP	LW S1A-S7A Water Management Plan
WSC	Wollondilly Shire Council

8.5 Change Information

Full details of the document history are recorded below in **Table 27**.

Table 27 Document History

Version	Date Reviewed	Reviewed By	Change Summary
1.0	May 2022	Zina Ainsworth, Charlie Wheatley Malcolm Waterfall, Peter Vale	New Document
1.1	May 2022	Zina Ainsworth, Charlie Wheatley Malcolm Waterfall, Peter Vale	Minor formatting changes made to document and TARP.
2.0	September 2022	Charlie Wheatley, Zina Ainsworth	Updated document following consultation with DPE, government agencies and the Independent Advisory Panel for Underground Mining.
3.0	January 2023	April Hudson, Zina Ainsworth	Review in accordance with Condition E7(e) following the commencement of first and second workings (18 October 2022) of the Consent SSD 8445.
4.0	June 2023	April Hudson, Zina Ainsworth	Review in accordance with Condition E7(b) following the submission of an Annual Review (31 March 2023), Condition E7(c) following the submission of an Independent Environmental Audit (2 June 2023) and Condition E7 (d) following the approval of any modification (Modification - 13 June 2023) of the Consent SSD 8445.
5.0	June 2024	April Hudson, Zina Ainsworth	Review in accordance with Condition E7(b) following the submission of an Annual Review (28 March 2024).
6.0	February 2025	Nick Le Baut, Zina Ainsworth	Review following the approval of Amendment 2 (shortening of LWS4A) to the Tahmoor South LWS1A-S6A Extraction plan (11 November 2024).
7.0	October 2025	Nick Le Baut, Zina Ainsworth	Review in accordance with Condition E7(d) following the approval of Modification 3 (26 May 2025) and Condition E7(b) following the submission of an annual review (30 September 2025).

8.6 Document Distribution

This Extraction Plan and associated document have been distributed according to **Table 27**.

Table 28 Distribution List for Extraction Plan

Agency	Contact Person	Position	Email Address / Portal
DPHI	(Planning Portal)	(Planning Portal)	(https://www.planningportal.nsw.gov.au/major-projects)
	Jessie Evans	Director – Resource Assessments	Jessie.Evans@dpie.nsw.gov.au
	Gabriel Wardenburg	Principal Planning Officer	Gabriel.wardenburg@dpie.nsw.gov.au
–NSW DCCEEW – Environment and Heritage	Liza Schaeper	Senior Team Leader	liza.schaeper@environment.nsw.gov.au
	Meagan Hinds	Senior Threatened Species Officer, Ecosystems and Threatened Species	meagan.hinds@envirnment.nsw.gov.au
NSW DCCEEW - Water	(General email)	(General email)	water.assessments@dpie.nsw.gov.au
	Fabienne Boudoux d'Hautefeuille	Manager of Water Assessments	fabienne.d'hautefeuille@dpie.nsw.gov.au
	Liz Rogers	Manager Assessments	Liz.rogers@dpie.nsw.gov.au
DPHI - Crown Lands	(General email)	(General email)	cl.enquiries@crownland.nsw.gov.au
Resources Regulator (Subsidence)	(General email)	(General email)	subsidence.monitoring@planning.nsw.gov.au nswresourcesregulator@service-now.com
	Dr. Gang Li	Principal Subsidence Engineer	gang.li@planning.nsw.gov.au
	Ray Ramage	Senior Mine Safety Officer - Subsidence	ray.ramage@planning.nsw.gov.au
Resources Regulator (Mining Act Inspectorate)	(General email)	(General email)	nswresourcesregulator@service-now.com
	Greg Kininmonth	Manager Environmental Operations (Southern)	greg.kininmonth@planning.nsw.gov.au
Department of Regional NSW - MEG	(General email)	(General email)	Resource.operations@planning.nsw.gov.au assessment.coordination@planning.nsw.gov.au
NRAR	(General email)	(General email)	nrar.servicedesk@dpie.nsw.gov.au
WaterNSW	(General email)	(General email)	environmental.assessments@waternsw.com.au
Heritage NSW	(General email)	(General email)	heritagemailbox@environment.nsw.gov.au
DSNSW	(General email)	(General email)	mining@damsafety.nsw.gov.au
	Heather Middleton	Manager Mining Impacts	heather.middleton@damsafety.nsw.gov.au
EPA	(General email)	(General email)	epa.illawarra@epa.nsw.gov.au
	Andrew Couldridge	Senior Operations Officer - Metropolitan Illawarra	andrew.couldridge@epa.nsw.gov.au
DPI Agriculture	(General email)	(General email)	landuse.ag@dpi.nsw.gov.au
Subsidence Advisory NSW	(General email)	(General email)	subsidencetechnical@customerservice.nsw.gov.au
TfNSW	(General email)	(General email)	Development.Sydney@transport.nsw.gov.au
ONRSR	Ian Cochran	Technical Specialist – Bridges & Structures	ian.Cockran@onrsr.com.au
ARTC	Michael Irons	Prooperty Manager Wagga Wagga	mirons@ARTC.com.au
	(General email)	(General email)	council@wollondilly.nsw.gov.au

Agency	Contact Person	Position	Email Address / Portal
Wollondilly Shire Council	David Henry	Acting Team Leader Environmental Services	david.henry@wollondilly.nsw.gov.au

APPENDIX A – Subsidence Predictions and Impact Assessment Report (MSEC, 2022)

msec mine subsidence ENGINEERING CONSULTANTS

SIMEC

SIMEC Mining:

Tahmoor South Project – Extraction Plan for Longwalls S1A to S6A

Subsidence ground movement predictions and subsidence impact assessments for natural features and surface infrastructure

DOCUMENT REGISTER

Revision	Description	Author	Checker	Date
A	Final	DJK	TC	May-22

Report produced to:- Support the Tahmoor South Project Extraction Plan, prepared by Tahmoor Coal for submission to the NSW Department of Planning, Industry and Environment (DPIE).

Background reports available at *www.minesubsidence.com*:-

Introduction to Longwall Mining and Subsidence (Revision A)

General Discussion of Mine Subsidence Ground Movements (Revision A)

Mine Subsidence Damage to Building Structures (Revision A)

EXECUTIVE SUMMARY

Tahmoor Coal Pty Ltd, (Tahmoor Coal), owns and operates Tahmoor Mine, an existing underground coal mine that is located approximately 80 km south-west of Sydney in the Southern Coalfield of New South Wales (NSW). Tahmoor Coal is a wholly owned entity within the SIMEC Mining division of the GFG Alliance group.

Tahmoor Coal received development consent in April 2021 for the Tahmoor South Project, which is an extension of the current Tahmoor Mine underground coal mining within the Bulli seam towards the south of the existing Tahmoor Mine.

Tahmoor Coal is submitting an Extraction Plan for Longwalls S1A to S6A (LWs S1A to S6A), which will be the first longwall panels to be extracted in the Tahmoor South domain. The proposed longwalls are located between Tahmoor's surface facilities to the north and the township of Bargo to the south.

The proposed mine layout for LWs S1A to S6A lies within the approved Extent of Longwalls. Minor changes have been made to the mine layout since development consent was received (approved EIS Layout), as foreshadowed by Tahmoor Coal when it applied for development consent.

MSEC has been commissioned to prepare a subsidence prediction and impact assessment report to provide subsidence predictions and assessments based on the proposed mine layout.

This report should be read in conjunction with the Extraction Plan being prepared by Tahmoor Coal and in conjunction with the reports from the other specialist consultants engaged by the Tahmoor South Project.

MSEC has been commissioned by Tahmoor Coal to:-

- Identify the natural features and items of surface infrastructure that are in the vicinity of the proposed longwalls,
- Provide subsidence predictions at each of these natural features and items of surface infrastructure,
- Provide impact assessments, in conjunction with other specialist consultants, for each of these natural features and items of surface infrastructure, and to
- Provide information on the measures that can be implemented to manage potential impacts.

The proposed mining will affect a broad range of natural features and built infrastructure.

Chapter 1 provides an introduction, outlines the Project, presents the purpose of the report, and provides the base information on the mine layout, surface topography, seam and geological information.

Chapter 2 defines the *Subsidence Study Area* and provides a list of the natural features and items of surface infrastructure that have been identified within the *Subsidence Study Area*.

Chapter 3 includes an overview of conventional and non-conventional subsidence movements and the methods that have been used to predict these movements resulting from the extraction of the proposed longwalls.

Chapter 4 provides the maximum predicted subsidence parameters resulting from the extraction of the proposed longwalls.

Chapters 5 to 11 provide descriptions, predictions and impact assessments for each of the natural features and items of surface infrastructure that have been identified within the *Subsidence Study Area*. Recommendations for each of these features are also provided, which have been based on the predictions and impact assessments.

The overall findings of the assessments undertaken by MSEC are that the levels of impact and damage to all identified natural features and built infrastructure are manageable and can be controlled by the preparation and implementation of Subsidence Management Plans (or Extraction Plans), many of which have been successfully implemented during previous mining at Tahmoor Mine.

These management plans are developed in consultation with the owners of infrastructure and are approved by relevant government agencies. The findings in this report should be read in conjunction with all other associated consultant reports.

Recommended management measures generally include monitoring of ground movements and the condition of surface features. Some mitigation measures are recommended to mitigate or avoid the risk of serious consequences should impacts occur to some critical surface features.

It is recommended that Tahmoor Coal continues to develop management plans to manage the potential impacts for the surface features due to the extraction of the proposed longwalls.

CONTENTS

1.0 INTRODUCTION **1**

1.1. Background 1

1.2. Purpose of the report 3

1.2.1. Scope of Work and Report structure 3

1.3. Mining Geometry 3

1.4. Surface topography 4

1.5. Seam information 4

1.6. Geological details 5

1.7. Geological structures 6

2.0 IDENTIFICATION OF SURFACE FEATURES **8**

2.1. Definition of the Subsidence Study Area 8

2.2. Natural Features and items of surface infrastructure within the Subsidence Study Area 9

2.3. Bargo Mine Subsidence District and the role of Subsidence Advisory NSW 11

3.0 OVERVIEW OF CONVENTIONAL AND NON-CONVENTIONAL SUBSIDENCE MOVEMENTS AND THE METHODS USED TO PREDICT THESE MOVEMENTS FOR THE PROPOSED LONGWALLS **12**

3.1. Introduction 12

3.2. Overview of longwall mining 12

3.3. Overview of conventional subsidence parameters 13

3.4. Overview of conventional and non-conventional subsidence movements 14

3.4.1. Non-conventional subsidence movements due to changes in geological conditions 14

3.4.2. Non-conventional subsidence movements due to valley related Movements 15

3.4.3. Non-conventional subsidence movements due to steep topography 16

3.5. Far-field movements 16

3.6. The Incremental Profile Method (IPM) 17

3.7. Calibration of Incremental Profile Method, outside the increased subsidence area 18

3.7.1. Comparisons between the observed and predicted tilt and curvature for previously extracted longwalls in the Southern Coalfield 23

3.8. Areas where increased subsidence, compared to predictions, have been observed 25

3.9. Review of the measured and predicted valley-related effects at Tahmoor 27

3.9.1. Myrtle Creek and the Skew Culvert 27

3.9.2. Redbank Creek 30

3.9.3. Creek crossings directly above LW W1-W2 31

3.9.4. Reliability of the predicted valley-related movements 31

3.10. Rate of subsidence development and timing required for remedial actions 33

4.0 MAXIMUM PREDICTED SUBSIDENCE PARAMETERS FOR THE PROPOSED LONGWALLS **34**

4.1. Introduction 34

4.2. Maximum predicted conventional subsidence, tilt and curvature 34

4.2.1. Comparison between predictions based on proposed LWs S1A to S6A with predictions based on the approved EIS layout 35

4.3. Predicted strains 39

4.3.1. Analysis of strains measured in survey bays 42

4.3.2. Analysis of strains measured along whole monitoring lines 44

4.3.3. Analysis of shear strains 45

4.4. Potential additional settlement above coal barriers between proposed and previous mine workings 46
4.5. Predicted conventional horizontal movements 47
4.6. Predicted far-field horizontal movements 47
4.7. Non-conventional ground movements 48
4.8. General discussion on mining induced ground deformations 51
5.0 DESCRIPTIONS, PREDICTIONS AND IMPACT ASSESSMENTS FOR NATURAL FEATURES WITHIN THE SUBSIDENCE STUDY AREA 53
5.1. Catchment Areas or Declared Special Areas 53
5.2. The Bargo River 53
5.2.1. Description of the Bargo River 53
5.2.2. Management of potential impacts on the Bargo River 54
5.3. Streams 54
5.3.1. Descriptions of the streams 54
5.3.2. Predictions for the streams 57
5.3.3. Predicted changes in stream gradients 58
5.3.4. Impact assessments for the streams 59
5.3.5. Impact assessments for the streams based on increased predictions 65
5.3.6. Comparison of predictions and assessments provided based on the proposed LWs S1A to S6A and the EIS Layout 65
5.3.7. Management of potential impacts on the streams 66
5.4. Cliffs 66
5.4.1. Descriptions of the cliffs 66
5.4.2. Predictions for the cliffs 67
5.4.3. Impact assessments for cliffs located above solid coal 67
5.4.4. Impact assessments for the cliffs based on increased predictions 68
5.5. Steep slopes 68
5.5.1. Management of potential impacts on steep slopes 69
5.6. Escarpments 69
5.7. Land prone to flooding and inundation 69
5.8. Swamps, wetlands and water related ecosystems 69
5.9. Threatened, protected species or critical habitats 69
5.10. National Parks or Wilderness Areas 69
5.11. State Recreational or Conservation Areas 69
5.12. Natural vegetation 70
5.13. Areas of significant geological interest 70
5.14. Any other natural feature considered significant 70
6.0 DESCRIPTIONS, PREDICTIONS AND IMPACT ASSESSMENTS FOR THE PUBLIC UTILITIES 71
6.1. The Main Southern Railway 71
6.1.1. Description of the Main Southern Railway 71
6.1.2. Predictions for the Main Southern Railway 72
6.1.3. Impact assessments for the Main Southern Railway 73
6.1.4. Changes in track geometry 73
6.1.5. Changes in track grades 75

6.1.6. Changes in rail stress 75
6.1.7. Potential impacts on Railway Viaduct over Bargo River and Remembrance Drive Bridge over Bargo River and Main Southern Railway 76
6.1.8. Potential impacts on Tahmoor Mine overhead coal conveyor 3R 77
6.1.9. Potential impacts on Wellers Road Overbridge 78
6.1.10. Railway Culverts 79
6.1.11. Potential impacts on railway culverts at creek crossings 82
6.1.12. Potential impacts on railway cuttings 83
6.1.13. Potential impacts on embankments 84
6.1.14. Potential impacts on signalling and communications systems 84
6.2. Tahmoor Mine Rail Loop 85
6.2.1. Description of the Rail Loop 85
6.2.2. Predictions for the Rail Loop 86
6.2.3. Impact assessments for the Rail Loop 86
6.2.4. Potential impacts on Tahmoor Mine overhead coal conveyors 3R, 4S, 4C and 7C 87
6.2.5. Potential impacts on Tahmoor Mine road bridge over Rail Loop 88
6.3. Local roads 89
6.3.1. Descriptions of local roads 89
6.3.2. Predictions for local roads 91
6.3.3. Impact assessments for local roads 93
6.3.4. Impact assessments for local road culverts 94
6.3.5. Management of potential impacts on local roads 94
6.4. Road bridges 94
6.5. Tunnels 94
6.6. Potable water infrastructure 95
6.6.1. Descriptions of potable water infrastructure 95
6.6.2. Predictions for potable water infrastructure 96
6.6.3. Impact assessments for potable water pipelines 96
6.6.4. Management of potential impacts on water infrastructure 96
6.7. Sewerage pipelines 97
6.7.1. Descriptions of sewerage pipelines 97
6.7.2. Predictions for sewer infrastructure 97
6.7.3. Impact assessments for sewer infrastructure 97
6.7.4. Management of potential impacts on proposed sewerage infrastructure 98
6.8. Gas infrastructure 98
6.8.1. Moomba-Sydney Gas Pipeline and Gorodok Ethane Pipeline 98
6.8.2. Local Jemena infrastructure 98
6.8.3. Predictions for gas infrastructure 98
6.8.4. Impact assessments for gas infrastructure 98
6.8.5. Management of potential impacts on gas infrastructure 99
6.9. Electrical Infrastructure 99
6.9.1. Descriptions of electrical infrastructure 99
6.9.2. Predictions for electrical infrastructure 99

6.9.3. Impact assessments for electrical infrastructure 100
6.9.4. Impact assessments for electrical infrastructure based on increased predictions 100
6.9.5. Management of potential impacts on electrical infrastructure 101
6.10. Telecommunications Infrastructure 101
6.10.1. Description of telecommunications infrastructure 101
6.10.2. Predictions for telecommunications infrastructure 102
6.10.3. Impact assessments for optical fibre cables 104
6.10.4. Impact assessments for copper telecommunications cables 105
6.10.5. Impact assessments for NBN telecommunications tower 106
6.10.6. Management of potential impacts on telecommunications infrastructure 106
6.11. Dams, reservoirs or associated works 107
6.12. Survey control marks 107
6.12.1. Recommendations for the survey control marks 107
7.0 DESCRIPTIONS, PREDICTIONS AND IMPACT ASSESSMENTS FOR THE PUBLIC AMENITIES 108
7.1. Predictions and impact assessments for each public amenity 108
7.2. Methods of impact assessment 108
7.3. Hospitals 108
7.4. Places of worship 108
7.5. Schools 109
7.5.1. Predictions for school infrastructure 114
7.5.2. Impact assessments for school infrastructure 115
7.5.3. Management of potential impacts on Wollondilly Anglican School 116
7.6. Shopping centres 116
7.7. Community centres 116
7.8. Office buildings 116
7.9. Swimming Pools 116
7.10. Bowling greens 116
7.11. Ovals or cricket grounds 116
7.12. Racecourses 117
7.13. Golf courses 117
7.14. Tennis courts 117
7.15. Any other public amenities 117
8.0 DESCRIPTIONS, PREDICTIONS AND IMPACT ASSESSMENTS FOR THE FARM LAND AND FARM FACILITIES 120
8.1. Agricultural utilisation 120
8.2. Rural structures 121
8.2.1. Descriptions of the rural structures 121
8.2.2. Predictions for rural structures 121
8.2.3. Impact assessments for rural structures 122
8.2.4. Impact assessments for rural structures based on increased predictions 123
8.2.5. Management of potential impacts on rural structures 123
8.3. Tanks 123
8.3.1. Descriptions of the tanks 123

8.3.2. Predictions for the tanks 123
8.3.3. Impact assessments for the tanks 125
8.3.4. Impact assessments for the tanks based on increased predictions 125
8.3.5. Management of potential impacts on the tanks 125
8.4. Gas and fuel storages 125
8.5. Poultry sheds 126
8.5.1. Predictions for the poultry sheds 126
8.5.2. Impact assessments for the poultry sheds 126
8.5.3. Management of potential impacts on the poultry sheds 126
8.6. Glass houses 127
8.7. Hydroponic systems 127
8.8. Irrigation systems 127
8.9. Farm fences 127
8.10. Farm dams 128
8.10.1. Descriptions of the farm dams 128
8.10.2. Predictions for the farm dams 128
8.10.3. Impact Assessments for the farm dams 130
8.10.4. Impact assessments for the farm dams based on increased predictions 131
8.10.5. Management of potential impacts on the farm dams 131
8.11. Groundwater bores 131
9.0 DESCRIPTIONS, PREDICTIONS AND IMPACT ASSESSMENTS FOR THE INDUSTRIAL, COMMERICAL AND BUSINESS ESTABLISHMENTS 132
9.1. Industrial, commercial and business establishments in general 132
9.2. Gas or fuel storages and associated plant 133
9.3. Mine infrastructure including tailings dams or emplacement areas 134
9.3.1. Predictions for the mine infrastructure 136
9.3.2. Impact assessments for Mine Infrastructure 138
10.0 DESCRIPTIONS, PREDICTIONS AND IMPACT ASSESSMENTS FOR AREAS OF ARCHAEOLOGICAL AND HERITAGE SIGNIFICANCE 142
10.1. Archaeological sites 142
10.1.1. Predictions for the archaeological sites 142
10.1.2. Impact assessments for the Open Camp Site 143
10.1.3. Impact assessments for the rock shelter 143
10.1.4. Impact assessments for the Isolated Find site 144
10.1.5. Impact assessments for the archaeological sites based on increased predictions 144
10.1.6. Management of potential impacts on the archaeological sites 144
10.2. Heritage sites 145
10.2.1. Descriptions of the heritage sites 145
10.2.2. Predictions and impact assessments for heritage sites previously discussed 145
10.2.3. Wirrimbirra Sanctuary 145
10.2.4. Great Southern Road 147
10.2.5. Management of potential impacts on heritage sites 147
10.3. Items of architectural significance 147

11.0 DESCRIPTIONS, PREDICTIONS AND IMPACT ASSESSMENTS FOR RESIDENTIAL BUILDING STRUCTURES **148**
11.1. Houses 148
11.1.1. Descriptions of the houses 148
11.1.2. Predictions for the houses 155
11.1.3. Impact assessments for the houses 156
11.1.4. Future development of houses within the *Subsidence Study Area* 161
11.1.5. Management of potential impacts on the houses 162
11.2. Flats or units 163
11.3. Caravan parks 163
11.4. Retirement or aged care villages 163
11.5. Swimming pools 163
11.5.1. Descriptions of the swimming pools 163
11.5.2. Predictions for the swimming pools 164
11.5.3. Impact assessments for the swimming pools 165
11.5.4. Impact assessments for the swimming pools based on increased predictions 165
11.5.5. Management of potential impacts on the swimming pools 166
11.5.6. Tennis courts 166
11.5.7. On-site waste water systems 166
11.5.8. Rigid external pavements 166
11.6. Fences 166
11.7. Any other residential feature 166
12.0 ANY KNOWN FUTURE DEVELOPMENTS **167**
13.0 CONCLUSIONS **167**
APPENDIX A. GLOSSARY OF TERMS AND DEFINITIONS **168**
APPENDIX B. REFERENCES **171**
APPENDIX C. METHOD OF IMPACT ASSESSMENTS FOR HOUSES **175**
C.1. Introduction 176
C.2. Review of the Performance of the Previous Method 176
C.3. Method of Impact Classification 178
C.3.1. Previous Method 178
C.3.2. Need for Improvement to the Previous Method of Impact Classification 179
C.3.3. Broad Recommendations for Improvement of Previous Method of Impact Classification 181
C.3.4. Revised Method of Impact Classification 182
C.4. Method of Impact Assessment 184
C.4.1. Need for Improvement of the Previous Method 184
C.4.2. Factors that Could be Used to Develop a Probabilistic Method of Prediction 184
C.4.3. Revised Method of Impact Assessment 185
C.4.4. Review of Observed Probabilities as mining continues 187
APPENDIX D. TABLES **189**
APPENDIX E. FIGURES SHOWING PREDICTED SUBSIDENCE PARAMETERS OVER THE TAHMOOR SOUTH PROJECT **190**
APPENDIX F. DRAWINGS **191**

APPENDIX G. FIGURES COMPARING OBSERVED AND PREDICTED SUBSIDENCE PARAMETERS OVER PREVIOUSLY EXTRACTED LONGWALLS AT TAHMOOR MINE 192

Tables

Tables are prefixed by the number of the chapter or the letter of the appendix in which they are presented.

Table No.	*Description*	*Page*
Table 1.1	Geometry of the proposed Longwalls S1A to S6A compared to EIS Layout	3
Table 2.1	Natural features and surface infrastructure	10
Table 3.1	Predicted and measured incremental closure at the monitoring lines across Myrtle Creek and the Skew Culvert	29
Table 4.1	Maximum predicted incremental conventional subsidence, tilt and curvature resulting from the extraction of each of the proposed longwalls	34
Table 4.2	Maximum predicted total conventional subsidence, tilt and curvature after the extraction of each of the proposed longwalls	35
Table 4.3	Maximum predicted incremental conventional subsidence, tilt and curvature resulting from the extraction of the Extraction Plan Layout and the EIS Layout	38
Table 4.4	Maximum predicted total conventional subsidence, tilt and curvature resulting from the extraction of the Extraction Plan Layout and the EIS Layout	38
Table 4.5	Monitoring lines used in the strain analysis	41
Table 4.6	Mining geometry for the proposed LWs S1A to S6A	41
Table 5.1	Minimum distances of the proposed longwalls from the Bargo River	53
Table 5.2	Streams within the Subsidence Study Area	54
Table 5.3	Maximum predicted total subsidence, upsidence and closure for the streams	57
Table 5.4	Maximum predicted changes in grade along the streams	59
Table 5.5	Predicted Total Subsidence, Upsidence and Closure along Streams resulting from the extraction of the Extraction Plan Layout and the approved EIS Layout	65
Table 6.1	Major railway structures within the Subsidence Study Area	72
Table 6.2	Maximum predicted total conventional subsidence parameters along the alignment of the Main Southern Railway after the extraction of the proposed LWs S1A to S6A	72
Table 6.3	Allowable and predicted maximum changes in track geometry due to conventional subsidence movements	74
Table 6.4	Railway Culverts within Study Area	79
Table 6.5	Predicted Conventional Subsidence and Valley Related Movements for the Main Southern Railway Culverts within the Study Area	82
Table 6.6	Maximum predicted total conventional subsidence parameters along the alignment of the Rail Loop after the extraction of the proposed LWs S1A to S6A	86
Table 6.7	Maximum predicted total conventional subsidence parameters for Remembrance Drive due to the extraction of LWs S1A to S6A	92
Table 6.8	Predicted Conventional Subsidence and Valley Related Movements for the Culverts along Remembrance Drive within the Study Area	92
Table 6.9	Potable water pipelines within the Study Area	95
Table 6.10	Distribution of water mains by pipe diameter	95
Table 6.11	Distribution of water mains by pipe type	95
Table 6.12	Examples of previous experience of mining beneath water pipelines in the Southern Coalfield	96
Table 6.13	Sewerage pipelines within the Subsidence Study Area	97
Table 6.14	Summary of the local gas infrastructure within the Subsidence Study Area	98
Table 6.15	Summary of the electrical infrastructure within the Subsidence Study Area	99
Table 6.16	Previous experience of mining beneath powerlines in the Southern Coalfield	100
Table 6.17	Summary of telecommunications infrastructure within the Subsidence Study Area	101
Table 6.18	Maximum predicted total conventional subsidence parameters for the Telstra optical fibre cable along Remembrance Drive and Main Southern Railway	102
Table 6.19	Maximum predicted upsidence and closure movements for optical fibre cables along Remembrance Drive and Main Southern Railway at the stream crossings	103
Table 6.20	Maximum predicted total conventional subsidence parameters for the NBN telecommunications tower at No. 3166 Remembrance Drive	104
Table 6.21	Examples of mining beneath optical fibre cables	105

Table 6.22	Examples of mining beneath copper telecommunications cables	106
Table 9.1	Maximum predicted total conventional subsidence parameters along the alignment of Conveyors 5C, 6C and 7C after the extraction of the proposed LWs S1A to S6A	138
Table 10.1	Maximum Predicted Total Conventional Subsidence Parameters for the Archaeological Sites	142
Table 10.2	Maximum predicted total upsidence and closure for the archaeological sites	142
Table 10.3	Heritage sites within the Subsidence Study Area	145
Table 11.1	Number of houses located directly above each of the proposed longwalls	148
Table 11.2	House type categories	149
Table 11.3	Distribution of houses by construction type	150
Table 11.4	Assessed impacts for houses within the *Subsidence Study Area*	160
Table 11.5	Observed frequency of impacts for building structures resulting from the extraction of Tahmoor Mine longwalls 22 to 29	161

Table C.1	Summary of Comparison between Observed and Predicted Impacts for each Structure	176
Table C.2	Classification of Damage with Reference to Strain	178
Table C.3	Classification of Damage with Reference to Tilt	178
Table C.4	Revised Classification based on the Extent of Repairs	182
Table C.5	Probabilities of Impact based on Curvature and Construction Type based on the Revised Method of Impact Classification	186
Table C.6	Observed Frequency of Impacts observed for all buildings at Tahmoor Mine	186

Table D.01	Maximum Predicted Subsidence, Upsidence and Closure for the Stream Pools	App. D
Table D.02	Details of the Houses within the Study Area	App. D
Table D.03	Maximum Predicted Conventional Subsidence Parameters and Impact Assessments for the Houses	App. D
Table D.04	Maximum Predicted Conventional Subsidence Parameters for the Rural Structures	App. D
Table D.05	Maximum Predicted Conventional Subsidence Parameters for the Tanks	App. D
Table D.06	Maximum Predicted Conventional Subsidence Parameters for the Pools	App. D
Table D.07	Maximum Predicted Conventional Subsidence Parameters for the Farm Dams	App. D
Table D.08	Maximum Predicted Conventional Subsidence Parameters and Impact Assessments for the Public Amenities	App. D
Table D.09	Maximum Predicted Conventional Subsidence Parameters and Impact Assessments for the Public Utilities	App. D
Table D.10	Maximum Predicted Conventional Subsidence Parameters and Impact Assessments for the Business and Commercial Establishments	App. D
Table D.11	Maximum Predicted Conventional Subsidence Parameters for the Archaeological Sites	App. D
Table D.12	Maximum Predicted Conventional Subsidence Parameters for the Heritage Structures	App. D

Figures

All figures are prefixed by the number of the chapter or the letter of the appendix in which they are presented.

Fig. No.	*Description*	*Page*
Fig. 1.1	Proposed longwalls and the Study Area	1
Fig. 1.2	Comparison between mine layouts for LWs S1A to S6A (2022 Extraction Plan) and LWs 101A to 106A (2021 approved EIS Layout)	2
Fig. 1.3	Cross-section 1 through LWs S1A to S6A	4
Fig. 1.4	Typical stratigraphic section – Southern Coalfield (MBGS, 2013)	5
Fig. 1.5	West to east geological cross-section through western, central and eastern domains	6
Fig. 1.6	Surface geology within the Study Area (DTIRIS, Geological Series Sheet 9029-9129)	7
Fig. 2.1	The proposed longwalls and the Subsidence Study Area overlaid on CMA Map No. Bargo 9029-3-N	9
Fig. 3.1	Cross-section along the length of a typical longwall at the coal face	12
Fig. 3.2	Valley formation in flat-lying sedimentary rocks (after Patton and Hendren 1972)	15
Fig. 3.3	Tahmoor North monitoring lines used in testing calibration of the IPM model	19
Fig. 3.4	Comparison between observed and predicted total subsidence at individual survey marks for the Tahmoor Longwalls 1 to 19	21
Fig. 3.5	Comparison between observed and predicted total subsidence at individual survey marks for the Tahmoor North longwalls 22 to 26	22
Fig. 3.6	Comparison between observed and predicted maximum total subsidence along whole monitoring lines for the Tahmoor North longwalls 22 to 26	22
Fig. 3.7	Distribution of the ratio of the maximum observed to maximum predicted total subsidence for monitoring lines at Tahmoor Mine	23
Fig. 3.8	Comparisons of raw observed curvature with curvature derived from smoothed subsidence along the Moreton Park Road line due to Appin Colliery Longwall 702	24
Fig. 3.9	Zones of increased subsidence over Longwalls 22 to 32	26
Fig. 3.10	Monitoring lines across Myrtle Creek and the Skew Culvert	27
Fig. 3.11	Development of closure across Myrtle Creek during LW24B to LW27	27
Fig. 3.12	Development of closure across the Skew Culvert during LW26 and LW27	28
Fig. 3.13	Location of survey marks across Redbank Creek	30
Fig. 3.14	Comparison between observed and predicted valley closure along Redbank Creek	31
Fig. 3.15	Observed Development of subsidence along Longwall 27 centreline versus distance to longwall face	33
Fig. 4.1	Comparison of predictions between proposed Extraction Layout and approved EIS Layout	37
Fig. 4.2	Distributions of the measured maximum tensile and compressive strains for surveys bays located *above goaf* at Tahmoor, Appin and West Cliff Collieries	43
Fig. 4.3	Distributions of the measured maximum tensile and compressive strains for survey bays located *above solid Coal* at Tahmoor, Appin and West Cliff Collieries	44
Fig. 4.4	Distributions of measured maximum tensile and compressive strains anywhere along the monitoring lines at Tahmoor, Appin and West Cliff Collieries	45
Fig. 4.5	Distribution of measured maximum mid-ordinate deviation during the extraction of previous longwalls in the Southern Coalfield for marks located above goaf	46
Fig. 4.6	Observed incremental far-field horizontal movements above goaf or solid coal	48
Fig. 4.7	Observed incremental far-field horizontal movements above solid coal only	48
Fig. 4.8	Changes in vertical alignment across a geological fault within a railway cutting during the mining of Longwalls 29 to 31 at Tahmoor Coal	49
Fig. 4.9	Map showing locations of observed non-conventional movement above Tahmoor Mine Longwalls 22 to 32	50
Fig. 4.10	Surface compression buckling observed in a pavement	51
Fig. 4.11	Surface tension cracking along the top of a steep slope	52
Fig. 4.12	Surface tension cracking along the top of a steep slope	52
Fig. 4.13	Fracturing and bedding plane slippage in sandstone bedrock in the base of a stream	52
Fig. 5.1	Pool TT9 in Teatree Hollow directly above proposed LW S2A	55
Fig. 5.2	Pool TT12 in Teatree Hollow directly above proposed LW S1A	55

Fig. 5.3 Pool TT11 and TT3 (Ockenden Pools) in Tributary to Teatree Hollow directly above proposed LW S2A 56
Fig. 5.4 Pool TT2 (Big Pool) in Tributary to Teatree Hollow directly above proposed LW S3A 57
Fig. 5.5 Natural and predicted post mining surface levels along Teatree Hollow 58
Fig. 5.6 Natural and predicted post mining surface levels along Tributary of Teatree Hollow 58
Fig. 5.7 Large pool in the Bargo River, located upstream of Rockford Road Bridge, directly above previously extracted Longwall 12 61
Fig. 5.8 Ponded water in Dog Trap Creek near bridge over Arina Road above previously extracted Longwall 13 62
Fig. 5.9 Immediately upstream of Picton Weir – January 2002 62
Fig. 5.10 Picton Weir 1st February 2003 63
Fig. 5.11 Picton Weir 24th February 2003 63
Fig. 6.1 Main Southern Railway at 99.400 km 71
Fig. 6.2 Rail expansion switch 76
Fig. 6.3 Tahmoor Mine overhead coal conveyor 3R over the Main Southern Railway near 98.160 km 77
Fig. 6.4 Wellers Road Overbridge at 101.162 km 78
Fig. 6.5 Culvert with concrete extension on Up side at 98.739 km 79
Fig. 6.6 Culvert at 99.388 km on Up and Down sides 80
Fig. 6.7 Internal view of Culvert at 99.035 km 80
Fig. 6.8 Culvert with concrete extension on Up side at 100.121 km 81
Fig. 6.9 Culvert with concrete extension on Up side at 100.425 km 81
Fig. 6.10 Railway cutting at 98.900 km 83
Fig. 6.11 Railway embankment at 100.200 km 84
Fig. 6.12 Rail Loop under road bridge 85
Fig. 6.13 Aerial view of Rail Loop 86
Fig. 6.14 Conveyors 4S and 4C over Rail Loop and Rail Loader Bin 87
Fig. 6.15 Tahmoor Mine road bridge over Rail Loop 88
Fig. 6.16 Remembrance Drive near Caloola Road 89
Fig. 6.17 Culvert beneath approach to Caloola Road and continuing under Remembrance Drive along Teatree Hollow 90
Fig. 6.18 Remembrance Drive embankment at intersection with Caloola Road 90
Fig. 6.19 RCP culvert beneath Remembrance Drive and brick arch culvert beneath Main Southern Railway at 100.425 km with private land in between them 91
Fig. 6.20 Previously observed impacts on local roads above Tahmoor Mine 93
Fig. 6.21 NBN telecommunications tower with access from Yarran Road 102
Fig. 7.1 Wollondilly Anglican College – Clifford Warne Auditorium 109
Fig. 7.2 Wollondilly Anglican College – Clifford Warne Auditorium with articulation joints in brick wall 109
Fig. 7.3 Wollondilly Anglican College – Banks Cottage and Sturt Cottage (single storey) 110
Fig. 7.4 Wollondilly Anglican College – Elizabeth Cottage (two-storey) 110
Fig. 7.5 Wollondilly Anglican College – Example of brickwork details 110
Fig. 7.6 Wollondilly Anglican College – Example of equipment inside Bradfield Cottage 111
Fig. 7.7 Wollondilly Anglican College – Hospitality training facilities inside TTC 111
Fig. 7.8 Wollondilly Anglican College – Lift in Cuthbert Cottage 112
Fig. 7.9 Wollondilly Anglican College – Shoulder to Shoulder Shelter 112
Fig. 7.10 Wollondilly Anglican College – Footbridge 113
Fig. 7.11 Wollondilly Anglican College – Sewage treatment tanks 113
Fig. 7.12 Predicted subsidence contours overlaid on aerial photograph of Wollondilly Anglican College 114
Fig. 7.13 Australian Wildlife Sanctuary visitor centre 118
Fig. 8.1 Agricultural Land Classification within the Subsidence Study Area (Source DTIRIS, November 2008) 120
Fig. 8.2 Maximum predicted conventional subsidence and tilt for rural structures within the Subsidence Study Area 121

Fig. 8.3 Maximum predicted conventional hogging curvature (left) and sagging curvature (right) for rural structures within the Subsidence Study Area 122
Fig. 8.4 Maximum predicted conventional subsidence and tilt for tanks within the Subsidence Study Area 124
Fig. 8.5 Maximum predicted conventional hogging curvature (left) and sagging curvature (right) for tanks within the Subsidence Study Area 124
Fig. 8.6 Distributions of longest lengths and surface areas of the farm dams 128
Fig. 8.7 Maximum predicted conventional subsidence and tilt for the farm dams within the Subsidence Study Area 129
Fig. 8.8 Maximum predicted conventional hogging curvature (left) and sagging curvature (right) for the farm dams within the Subsidence Study Area 129
Fig. 8.9 Predicted changes in freeboards for the farm dams within the Subsidence Study Area 130
Fig. 9.1 Tahmoor Garden Centre 132
Fig. 9.2 Bargo Petroleum and Mechanic's Workshop 133
Fig. 9.3 Aerial view of Tahmoor Mine site 135
Fig. 9.4 Aerial view of Stockpile area and Overhead Conveyor 5C 135
Fig. 9.5 Reclaim tunnel with Underground Conveyor 6C 136
Fig. 9.6 Tahmoor Mine Site overlaid with predicted total subsidence contours due to LWs S1A to S6A 137
Fig. 9.7 Aerial photograph showing Bins, Raw Stockpile, Drift Portal and Winder 140
Fig. 9.8 Drift Portal 140
Fig. 11.1 Distribution of houses by maximum plan dimension and plan area 149
Fig. 11.2 Distributions of wall and footing construction for houses within the Subsidence Study Area 150
Fig. 11.3 Location of houses by construction type 151
Fig. 11.4 Aerial photograph of Study Area in 1975 when Mine Subsidence District was declared 152
Fig. 11.5 Aerial photograph of Study Area in 2021 153
Fig. 11.6 Distribution of Houses by Age as at 2021 153
Fig. 11.7 Location of houses by age 154
Fig. 11.8 Maximum predicted conventional subsidence for the houses within the Subsidence Study Area 155
Fig. 11.9 Maximum predicted conventional tilts after the extraction of all longwalls (left) and maximum predicted conventional tilts after the extraction of any longwall (right) 155
Fig. 11.10 Maximum predicted conventional hogging curvature (left) and sagging curvature (right) for the houses within the Subsidence Study Area 156
Fig. 11.11 Distribution of predicted final tilts for the houses at the completion of mining 157
Fig. 11.12 Distribution of measured tilts for survey bays located in the areas of increased subsidence above Tahmoor Mine longwalls 24A, 25 and 26 158
Fig. 11.13 Distribution of predicted hogging curvatures (left) and sagging curvatures (right) for houses at the completion of mining 159
Fig. 11.14 Distributions of measured curvatures for survey bays located in the areas of increased subsidence above Tahmoor Mine LWs 24A, 25 and 26 159
Fig. 11.15 Maximum predicted conventional subsidence and tilt for pools within the Subsidence Study Area 164
Fig. 11.16 Maximum predicted conventional hogging curvature (left) and sagging curvature (right) for the pools within the Subsidence Study Area 164

Fig. C.1 Example of slippage on damp proof course 179
Fig. C.2 Example of crack in mortar only 180
Fig. C.3 Comparison between Previous and Revised Methods of Impact Classification 183
Fig. C.4 Probability Curves for Impacts to Buildings (based on observations up to Longwall 29) 188

Fig. E.01 Predicted Profiles of Conventional Subsidence, Tilt and Curvature along Prediction Line 1 App. E
Fig. E.02 Predicted Profiles of Subsidence, Upsidence and Closure along Teatree Hollow App. E

Fig. E.03	Predicted Profiles of Subsidence, Upsidence and Closure along Tributary of Teatree Hollow	App. E
Fig. E.04	Predicted Profiles of Conventional Subsidence, Tilt and Change in Grade Along the Alignment of the Main Southern Railway	App. E
Fig. E.05	Predicted Profiles of Conventional Horizontal Movement, Change in Track Cant and Long Twist Across the Alignment of the Main Southern Railway	App. E
Fig. E.06	Predicted Profiles of Conventional Horizontal Movement Along the Track, Change in Long Bay Length and Change in SFT for the Main Southern Railway	App. E
Fig. E.07	Predicted Profiles of Conventional Subsidence, Tilt and Curvature along 150mm Gas Main	App. E
Fig. E.08	Predicted Profiles of Conventional Subsidence, Tilt and Curvature along Optical Fibre Cable	App. E
Fig. E.09	Predicted Profiles of Conventional Subsidence, Tilt and Curvature along the Tahmoor Mine Rail Loop	App. E
Fig. E.10	Predicted Profiles of Conventional Subsidence, Tilt and Curvature along 5C-6C-7C conveyors	App. E
Fig. G.01	Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the 100-Line	App. G
Fig. G.02	Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the 200-Line	App. G
Fig. G.03	Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the 300-Line	App. G
Fig. G.04	Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the 800-Line	App. G
Fig. G.05	Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the 900-Line	App. G
Fig. G.06	Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the 1000-Line	App. G
Fig. G.07	Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the Brundah Road Line	App. G
Fig. G.08	Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the Castlereagh Street Line	App. G
Fig. G.09	Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the Remembrance Drive Line	App. G
Fig. G.10	Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the Thirlmere Way Line	App. G
Fig. G.11	Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the York Street Line	App. G
Fig. G.12	Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the High-Rise Freezer Line	App. G
Fig. G.13	Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the LW25 XS1 Line	App. G
Fig. G.14	Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the LW24A Draw Line	App. G
Fig. G.15	Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the LW25 Centreline	App. G

Drawings

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

Drawing No.	*Description*	*Revision*
MSEC1192-01	General layout	A
MSEC1192-02	Surface level contours	A
MSEC1192-03	Seam roof contours	A
MSEC1192-04	Extraction height	A
MSEC1192-05	Depth of cover contours	A
MSEC1192-06	Geological structures at seam level	A
MSEC1192-07	Streams – general layout	A
MSEC1192-08	Cliffs and steep slopes – general layout	A
MSEC1192-09	Natural features detail map	A
MSEC1192-10	Railway and associated infrastructure	A
MSEC1192-11	Roads and associated infrastructure	A
MSEC1192-12	Water infrastructure	A
MSEC1192-13	Sewer infrastructure	A
MSEC1192-14	Gas infrastructure	A
MSEC1192-15	Electrical infrastructure	A
MSEC1192-16	Telecommunications infrastructure	A
MSEC1192-17	Archaeological and heritage sites	A
MSEC1192-18	Building structures and dams	A
MSEC1192-19	Public amenities and commercial establishments	A
MSEC1192-20	Tahmoor Mine infrastructure	A
MSEC1192-21	Groundwater bores and survey control marks	A
MSEC1192-22	Predicted total subsidence contours	A
MSEC1192-23	Proposed monitoring plan	A

1.1. Background

Tahmoor Coal Pty Ltd, (Tahmoor Coal), owns and operates Tahmoor Mine, an existing underground coal mine that is located approximately 80 km south-west of Sydney in the Southern Coalfield of New South Wales (NSW). Tahmoor Coal is a wholly owned entity within the SIMEC Mining division of the GFG Alliance group.

Tahmoor Coal received development consent in April 2021 for the Tahmoor South Project, which is an extension of the current Tahmoor Mine underground coal mining within the Bulli seam towards the south of the existing Tahmoor Mine.

Tahmoor Coal is submitting an Extraction Plan for Longwalls S1A to S6A (LWs S1A to S6A), which will be the first longwall panels to be extracted in the Tahmoor South domain. The proposed longwalls are located between Tahmoor's surface facilities to the north and the township of Bargo to the south. The locations of LWs S1A to S6A are shown in Fig. 1.1 and Drawing No. MSEC1192-01, which, together with all other drawings, are included in Appendix F.

The proposed mine layout for LWs S1A to S6A lies within the approved Extent of Longwalls. Minor changes have been made to the mine layout since development consent was received (approved EIS Layout), as foreshadowed by Tahmoor Coal when it applied for development consent. A comparison between mine layouts is shown in Fig. 1.2.

- The layout for LWs S1A to S6A has been shifted approximately 35 metres to the south-west;
- LWs S2A to S6A have been widened by 2 metres (the width of LW S1A is unchanged);
- Chain pillar widths for the tailgates of LWs S3A to S6A have been reduced by 2 metres (the chain pillar between LWs S1A and S2A is unchanged);
- The commencing ends of LWs S1A to S6A have been aligned compared to the previous staggered layout. The outcome of the change is that LWs S2A to S6A have been extended in length. The gap between the A and B series longwalls will be maintained, such that the future B series will be shortened when compared to the mine layout that was submitted for development consent; and
- The planned sequence has been amended, such that the A series longwalls are proposed to be extracted in sequence. When Tahmoor Coal applied for development consent, it had been planned to extract LWs 101A to 103A first, then the B series longwalls and return to extract LWs 104A to 106A. The longwalls have renamed S1A to S6A since the EIS was approved.

Photograph courtesy Nearmap

Fig. 1.1 Proposed longwalls and the Study Area

The Study Area comprises an area adjacent to, and to the south of, the existing Tahmoor Approved Mining Area. The *Subsidence Study Area* for the purposes of this report is defined in Section 2.1 and is shown in Drawing No. 1192-01.

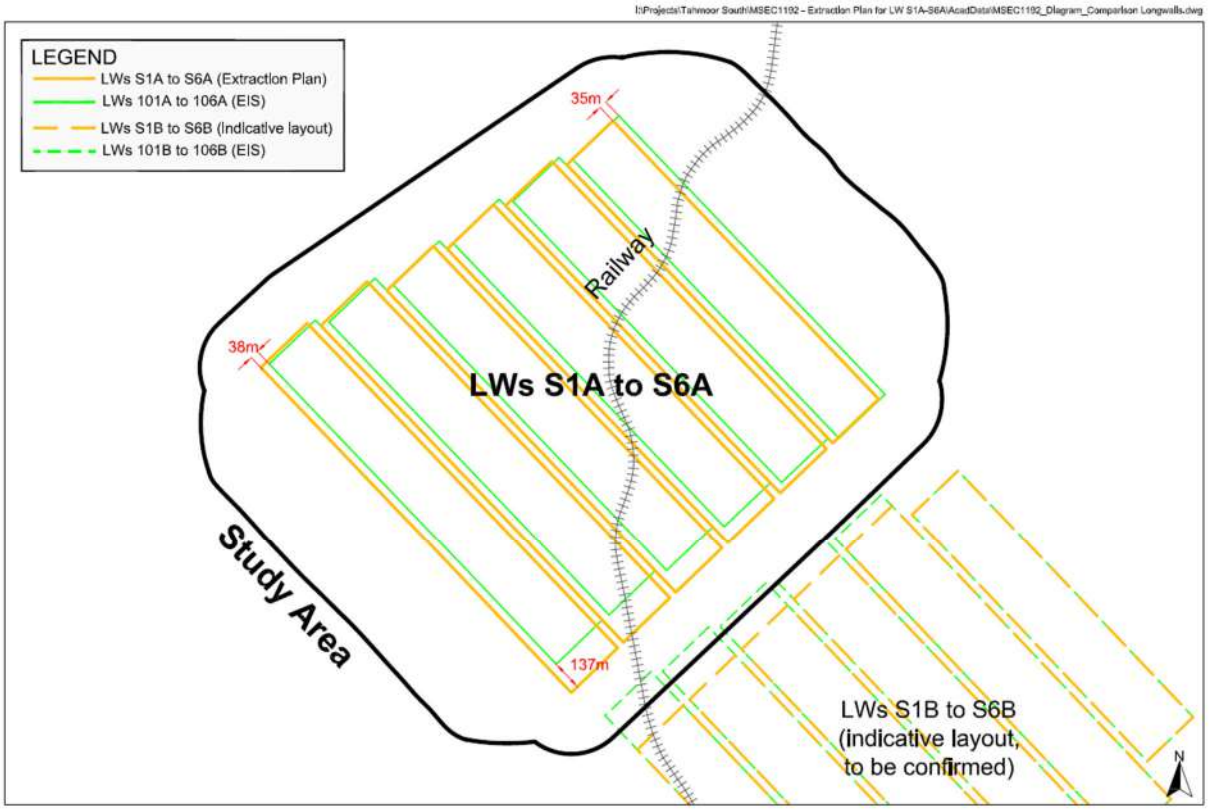


Fig. 1.2 Comparison between mine layouts for LWs S1A to S6A (2022 Extraction Plan) and LWs 101A to 106A (2021 approved EIS Layout)

1.2. Purpose of the report

1.2.1. Scope of Work and Report structure

MSEC has been commissioned by Tahmoor Coal to:-

- Identify the natural features and items of surface infrastructure that are in the vicinity of the proposed longwalls;
- Provide subsidence predictions at each of these natural features and items of surface infrastructure;
- Provide impact assessments, in conjunction with other specialist consultants, for each of these natural features and items of surface infrastructure; and to
- Provide information on the measures that can be implemented to manage potential impacts.

This report is structured as follows:

Chapter 1 provides an introduction, outlines the Project, presents the purpose of the report, and provides the base information on the mine layout, surface topography, seam and geological information.

Chapter 2 defines the *Subsidence Study Area* and provides a list of the natural features and items of surface infrastructure that have been identified within the *Subsidence Study Area*.

Chapter 3 includes an overview of conventional and non-conventional subsidence movements and the methods that have been used to predict these movements resulting from the extraction of the proposed longwalls.

Chapter 4 provides the maximum predicted subsidence parameters resulting from the extraction of the proposed longwalls.

Chapters 5 to 11 provide descriptions, predictions and impact assessments for each of the natural features and items of surface infrastructure that have been identified within the *Subsidence Study Area*. Recommendations for each of these features are also provided, which have been based on the predictions and impact assessments.

1.3. Mining Geometry

The proposed LWs S1A to S6A are shown in Drawing No. MSEC1192-01. A summary of the proposed longwall dimensions is provided in Table 1.1.

Table 1.1 Geometry of the proposed Longwalls S1A to S6A compared to EIS Layout

Layout	Longwall	Overall void length including installation heading (m)	Overall void width including first workings (m)	Overall tailgate chain pillar width (m)
Extraction Plan LWs S1A to S6A	LW S1A	1,711	283	-
	LW S2A	1,768	285	38
	LW S3A	1,808	285	36
	LW S4A	1,860	285	36
	LW S5A	1,949	285	36
	LW S6A	1,999	285	36
EIS Layout (MSEC1123)	LW101A	1,715	283	-
	LW102A	1,730	283	38
	LW103A	1,745	283	38
	LW104A	1,760	283	38
	LW105A	1,800	283	38
	LW106A	1,845	283	38

Table 1.1 also compares the proposed mining geometries with the geometries provided in the EIS. The minor changes in panel and pillar widths result in minor changes in predicted subsidence movements, which are discussed in Section 4.2 of this report.

The commencing ends of LWs S1A to S6A have been aligned compared to the previous staggered layout. The outcome of the change is that LWs S2A to S6A have been extended in length by up to 154 metres. The gap between the A and B series longwalls will be maintained, such that the future B series will be shortened when compared to the mine layout that was submitted in the EIS layout.

1.4. Surface topography

The surface level contours in the vicinity of the proposed longwalls are shown in Drawing No. MSEC1192-02. They were generated from 2012 and 2013 airborne laser scans of the area.

The ground surface within the *Subsidence Study Area*, as is defined in Section 2.1, is generally undulating with a fall from the south-west to the north-east. The major topographical feature within the *Subsidence Study Area* is Teatree Hollow. The major topographical feature near the *Subsidence Study Area* is the Bargo River valley, which is located to the north of the *Subsidence Study Area*.

The surface levels near the Subsidence Study Area vary from a low point of approximately 265 metres AHD, in the base of Teatree Hollow, downstream from of the proposed Longwall S1A, to a high point of approximately 345 metres AHD, at the south-western end of the *Subsidence Study Area* to the south-west of the proposed LW S6A.

1.5. Seam information

The seam roof contours, seam thickness contours and depth of cover contours, for the Bulli seam, have been provided by Tahmoor Coal and are shown in Drawing Nos. MSEC1192-03, MSEC1192-04 and MSEC1192-05, respectively.

Fig. 1.3 shows the surface, Bulli seam levels and proposed extraction heights across the proposed mining area along Cross-Section 1. The location of this section is shown in Drawings Nos. MSEC1192-02 and MSEC1192-03.

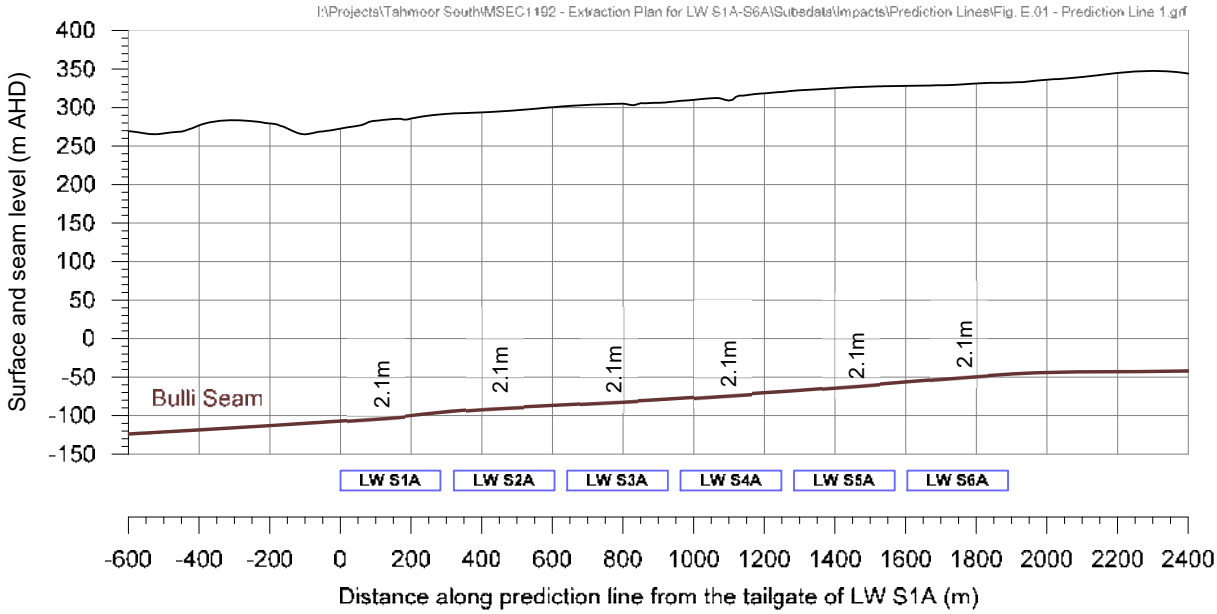


Fig. 1.3 Cross-section 1 through LWs S1A to S6A

The Bulli seam within the Subsidence Study Area generally dips from the south-west to the north-east, as shown by the seam roof contours in Drawing No. MSEC1192-03. The seam roof contours show the presence of several major faults which are discussed further in the next section of this report.

The planned Bulli seam extraction heights, i.e. the height of the Bulli seam that is to be mined, vary from a minimum extraction height of 2.1 metres to a maximum extraction height of 2.2 metres, as is shown in Drawing No. MSEC1192-04. Depending on the strength of floor under the longwall chocks, these extraction heights are planned to include parts of the stone roof, a stone band, a shaly coal layer and some stone floor and, as a result, the subsidence calculations in this report have assumed that these stone partings in both the floor and the roof will be extracted. This planned working section, including the stone partings in the floor and roof, is also shown in Fig. 1.4.

The depth of cover contours to the Bulli seam vary from a minimum of approximately 365 metres beneath a tributary to the Bargo River directly above the proposed LW S5A to a maximum of approximately 410 metres above proposed LW S1A as shown in Drawing No. MSEC1192-05.

1.6. Geological details

Tahmoor Mine lies in the southern part of the Permo-Triassic Sydney Basin, within which the main coal bearing sequence is the Illawarra Coal Measures, of Late Permian age. The Illawarra Coal Measures contain four workable seams, the uppermost of which is the Bulli seam, and it is this seam from which coal is proposed to be extracted as part of the proposed development.

The sediments that form the overburden to the Bulli seam belong to the Hawkesbury Tectonic Stage, which comprises three stratigraphic divisions. The lowest division is the Narrabeen Group, which is subdivided into a series of interbedded sandstone and claystone units. It ranges in age from Lower to Middle Triassic and varies in thickness up to 310 metres. Overlying the Narrabeen Group is the Hawkesbury Sandstone Group, which is a series of bedded sandstone units which dates from the Middle Triassic and has a thickness of up to 185 metres. Above the Hawkesbury is the Wianamatta Group, which consists of shales and siltstones and is poorly represented in this region, having a thickness of only a few tens of metres.

A typical stratigraphic section for the Southern Coalfield area is shown in Fig. 1.4, courtesy of McElroy Bryan Geological Services, (MBGS, 2013) and a west to east stratigraphic geological section is shown in Fig. 1.5 below, which is also available courtesy of MBGS.

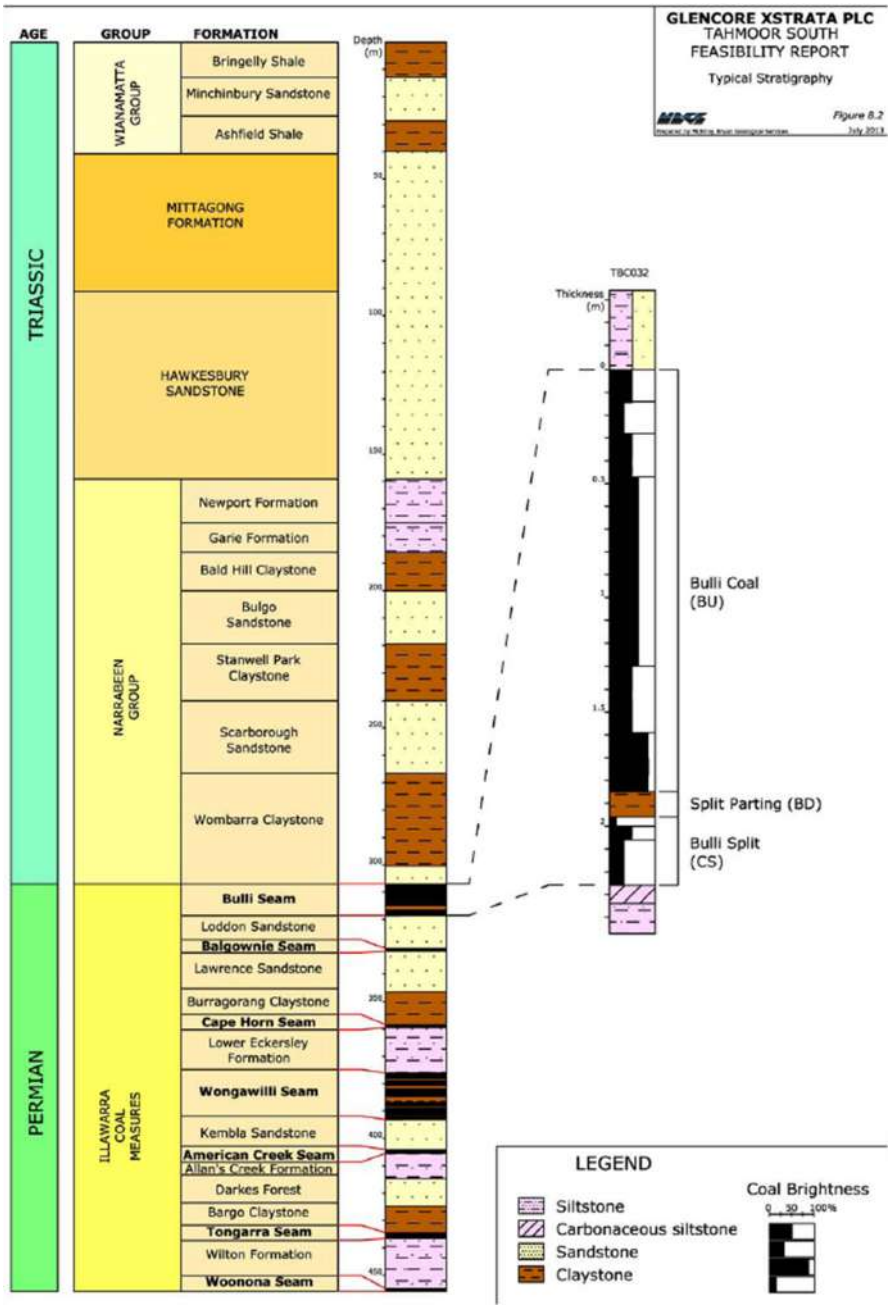


Fig. 1.4 Typical stratigraphic section – Southern Coalfield (MBGS, 2013)

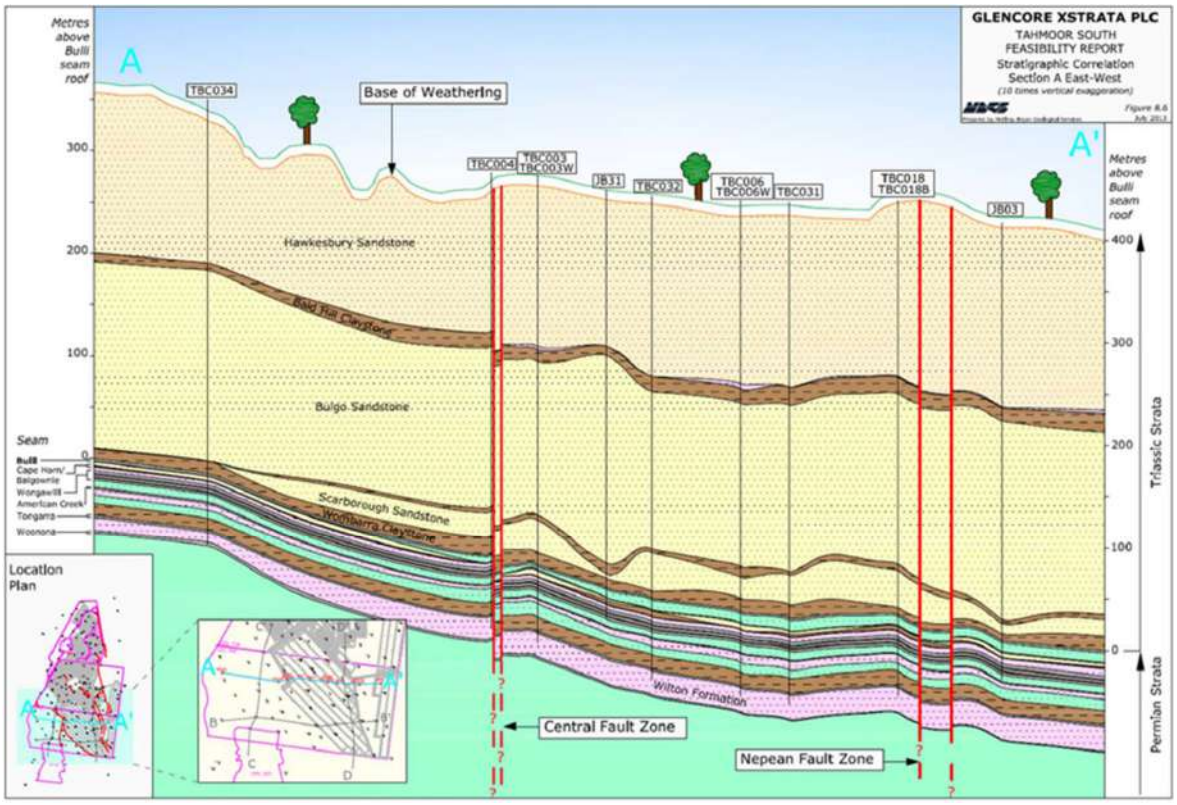


Fig. 1.5 West to east geological cross-section through western, central and eastern domains

The major sandstone units are interbedded with other rocks and, though shales and claystones are quite extensive in places, the sandstone predominates. The major sandstone units are the Scarborough (Narrabeen Group), the Bulgo (Narrabeen Group) and the Hawkesbury Sandstones (Hawkesbury Sandstone Group) and these units vary in thickness from a few metres to as much as 200 metres. The rocks exposed in the river gorges and creek alignments within the *Subsidence Study Area* belong to the Hawkesbury Sandstone Group. The other rocks generally exist in discrete but thinner beds of less than 15 metres thickness or are interbedded as thin bands within the sandstone.

The major claystone unit is the Bald Hill Claystone, which lies above the Bulgo Sandstone and at the base of the Hawkesbury Sandstone. As shown in Fig. 1.5 above, the base of the Bald Hill Claystone is between 180 metres to 220 metres above the Bulli Seam. This claystone unit varies in thickness and is, in some places, more than 25 metres thick. The Bald Hill Claystone has been described in the literature as an aquitard (e.g. the Independent Inquiry report entitled "*Strategic Review of Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield*", (Southern Coalfield Inquiry Report), which was published in July 2008, (NSW DPIE, 2008), and detailed information on this claystone and other claystone and siltstone units within the overburden are provided in the reports by SCT (2013a) and SLR (2022a).

1.7. Geological structures

Tahmoor Mine has undertaken comprehensive geological exploration of the overburden and the Illawarra Coal Measures within the *Subsidence Study Area* using several geological and geotechnical consultants (MBGS, 2013; Gordon Geotechniques, 2013; SCT, 2013a) and a number of geological structures have been identified.

Several fault structures were identified and the two main structures that separate the mining domains are the Nepean Fault zone and the Central Fault zone. These and other identified faults and igneous intrusions are shown in Drawing No. MSEC1192-06. MBGS (2013) reviewed 205 drill holes in the Tahmoor area for Tahmoor Coal of which 72 drill holes were in Tahmoor South. Additionally, an extensive array of seismic survey lines (140 km) were completed over recent years and combined this data provides sufficient data to have a sound understanding of overall deposit geometry, structural features likely to impact on mining, seam gas and raw coal quality characteristics within the Bulli Seam.

The Nepean Fault zone is the major structural feature in the Tahmoor complex and it marks the eastern boundary to the existing mining operations at Tahmoor Mine. The MBGS (2013) advises that the Nepean Fault zone runs in an approximate North-South direction and is a normal fault system which appears to exhibit en echelon style. Seismic surveys indicate the fault zone within the Tahmoor South area comprises many near vertical faults with overall displacement in the order of 10 metres to 15 metres and has a varying width of approximately 350 metres wide. A report by Gordon Geotechniques (2013), quoted two other reports, Lohe, et al., (1992), advising that the Nepean Fault was a high angle westerly dipping reverse fault and SEA, (2002), advising that the Nepean Fault was a series of reverse and normal faults. Gordon Geotechniques noted that the Nepean Fault zone was up to 200 metres wide with the western side of the fault being more disturbed than the eastern side. The proposed LWs S1A to S6A are not located near the Nepean Fault complex.

The Central Fault zone, which lies to the west and south of the proposed longwalls, was described by MBGS as a normal fault trending northwest with vertical displacement up to 20 metres, east side up. This fault was identified in the 2D seismic lines and was also intercepted in one drill hole (JB06) where the Wongawilli Seam has been displaced. The Gordon Geotechniques report advised that this Central Fault zone was associated with a number of features including a change in Bulli Seam fluidity and thinning of the Balgownie to Bulli Seam interburden. The Central Fault has a surface expression which affects Hornes Creek as it flows into the Bargo River.

It is noted that while comprehensive drilling and seismic exploration has been carried out, further in-seam drilling is planned to be undertaken and additional smaller geological structures may be discovered at that time. Further discussion on the influence of faulting on mining induced subsidence movements is presented in Chapters 3, 4 and 6.

The surface geology within the Study Area, as is defined in Section 2.1, is shown in Fig. 1.6, which presents the proposed longwalls overlaid on Geological Series Sheet 9029, (Geological Survey of NSW, NSW Government, 1999).

It can be seen from Fig. 1.6 that the majority of surface geology within the Study Area comprises the Hawkesbury Sandstone Group (Rh), with the Wianamatta Group, (Rw) located near the finishing ends of LWs S1A and S2A.

Hawkesbury Sandstone Group (Rh) is exposed along the majority of streams within the *Subsidence Study Area*.

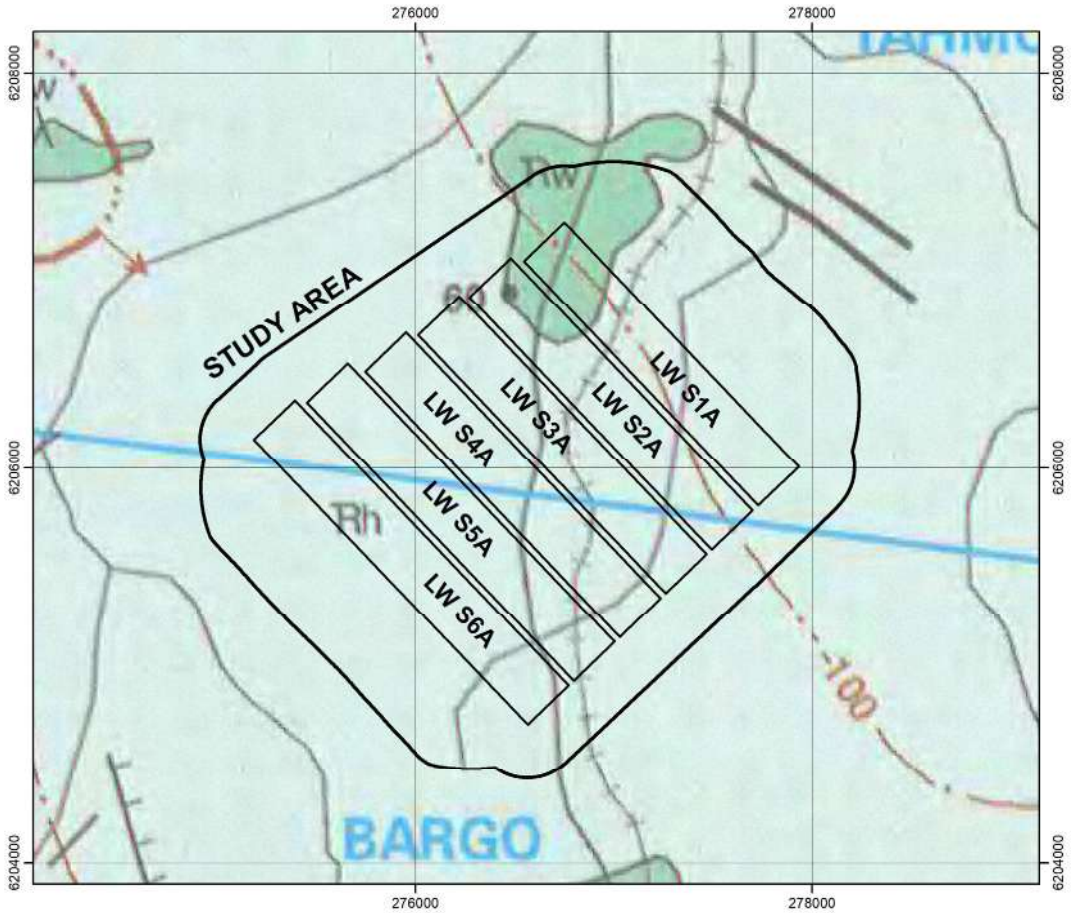


Fig. 1.6 Surface geology within the Study Area (DTIRIS, Geological Series Sheet 9029-9129)

2.1. Definition of the Subsidence Study Area

The *Subsidence Study Area* is the surface area within which natural surface features and items of infrastructure have been identified and assessed for their potential to experience mine subsidence impacts as a result of the proposed extraction of LWs S1A to S6A.

The extent of the *Subsidence Study Area* has been conservatively defined by combining the areas bounded by the following limits:-

- A 35° angle of draw from the extents of LWs S1A to S6A;
- The predicted limit of vertical subsidence, taken as the 20 mm subsidence contour, resulting from the extraction of LWs S1A to S6A; and
- Features that could experience far-field or valley-related movements and could be sensitive to such movements.
- For natural features, the *Subsidence Study Area* has been extended to a minimum of 600 metres from the extents of LWs S1A to S6A, as recommended in the independent inquiry report titled "Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield – Strategic Review" (NSW Department of Planning(DoP), 2008).

The depths of cover contours for the Bulli Seam are shown in Drawing No. MSEC1192-05. The depths of cover directly above LWs S1A to S6A vary between 375 m and 410 m. The 35° angle of draw, therefore, has been determined by drawing a line that is a horizontal distance varying between 260 m and 290 m around the extent of the longwall mining area.

The predicted limit of vertical subsidence, taken as the predicted total 20 mm subsidence contour, has been determined using the Incremental Profile Method, which is described in Chapter 3. The predicted 20 mm subsidence contour has been calibrated to account for measured subsidence in the northern areas of the existing Tahmoor Mine and the measured values were based on detailed ground surveys that were carried out using remote stable datum points. In some cases, the predicted 20 mm subsidence contour extends to 600 metres from the nearest edge of longwalls.

The extent of the *Subsidence Study Area* has therefore been drawn with a line around the longwalls based on whichever of the above limits extended the furthest from the proposed mining area. The extent of the *Subsidence Study Area* is shown in Drawings MSEC1192-01.

Additionally, it was found that there may be areas that are outside this line showing the extent of the *Subsidence Study Area* that could experience either far-field movements, or valley-related upsidence and closure movements. Some surface features have been identified that may be sensitive to such movements and, hence, impact assessments have been provided in this report for all the surface features or items of infrastructure that are outside the *Subsidence Study Area* and could be impacted by these far-field movements, or valley-related upsidence and closure movements.

The features that are located beyond the *Subsidence Study Area* for LWs S1A to S6A that could be sensitive to impacts from such movements are shown in Drawing MSEC1192-01 and are listed below. The descriptions and impact assessments for each of these natural features or items of infrastructure are provided in later sections of the report:-

- The Main Southern Railway viaduct over the Bargo River, located 1,755 metres from LW S1A;
- The Remembrance Drive Bridge over the Bargo River and Main Southern Railway, located 1,690 metres from LW S1A;
- The Picton Weir, (or Bargo Weir), on Bargo River, located 940 metres from LW S6A;
- Streams, within the predicted limits of 20 mm total upsidence and 20 mm total closure;
- Groundwater bores; and
- Survey control marks.

2.2. Natural Features and items of surface infrastructure within the Subsidence Study Area

The major natural features and items of surface infrastructure within the *Subsidence Study Area* can be seen in the 1:25,000 Topographic Maps of the area, published by the Central Mapping Authority (CMA), numbered PICTON 9029-4-S and BARGO 9029-3-N. The proposed longwalls and the *Subsidence Study Area* have been overlaid on an extract of this CMA map in Fig. 2.1.

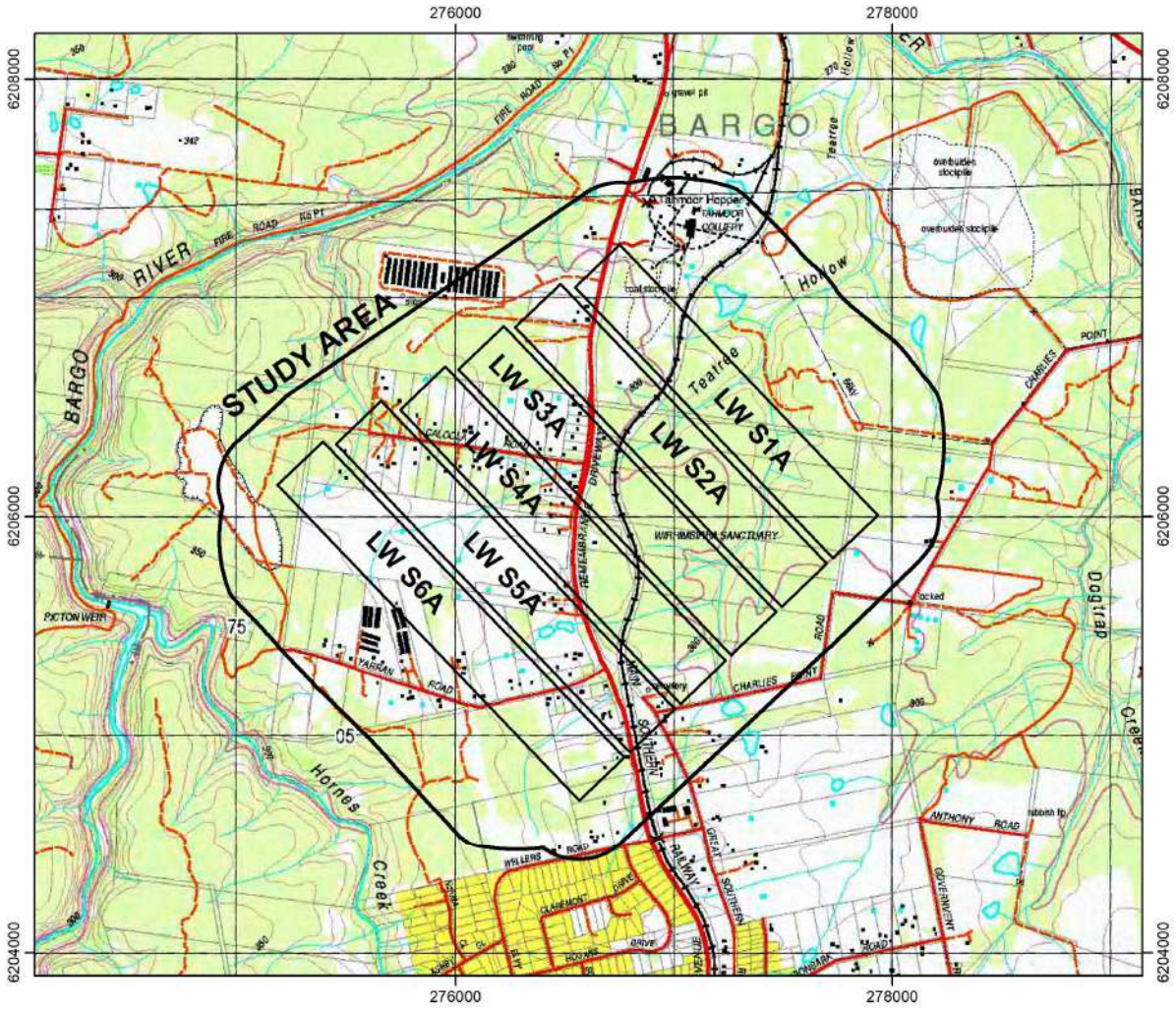


Fig. 2.1 The proposed longwalls and the Subsidence Study Area overlaid on CMA Map No. Bargo 9029-3-N

A summary of the natural features and items of surface infrastructure within the *Subsidence Study Area* is provided in Table 2.1. The locations of these features are shown in Drawing Nos. MSEC1192-07 to MSEC1192-21, in Appendix F.

Descriptions, predictions and impact assessments for the natural features and items of surface infrastructure are provided in Chapters 5 though to 11. The relevant chapter and section number references in this report that address these features and items are provided in Table 2.1.

Table 2.1 Natural features and surface infrastructure

Item	Within *Study Area*	Section Number Reference
NATURAL FEATURES		
Catchment Areas or Declared Special Areas	×	
Rivers or Creeks	✓	5.2 & 5.3
Aquifers or Known Groundwater Resources	✓	8.11
Springs	×	
Sea or Lake	×	
Shorelines	×	
Natural Dams	×	
Cliffs or Pagodas	✓	5.4
Steep Slopes	✓	5.5
Escarpments	×	
Land Prone to Flooding or Inundation	✓	5.7
Swamps, Wetlands or Water Related Ecosystems	×	
Threatened or Protected Species	✓	5.9
National Parks	×	
State Forests	×	
State Conservation Areas	×	
Natural Vegetation	✓	5.12
Areas of Significant Geological Interest	×	
Any Other Natural Features Considered Significant	✓	5.14
PUBLIC UTILITIES		
Railways	✓	6.1
Roads (All Types)	✓	0
Bridges	✓	6.4
Tunnels	×	
Culverts	✓	6.1 & 0
Water, Gas or Sewerage Infrastructure	✓	0, 6.7 & 6.8
Liquid Fuel Pipelines	×	
Electricity Transmission Lines or Associated Plants	✓	6.9
Telecommunication Lines or Associated Plants	✓	6.10
Water Tanks, Water or Sewage Treatment Works	✓	0
Dams, Reservoirs or Associated Works	✓	6.11
Air Strips	×	
Any Other Public Utilities	×	
PUBLIC AMENITIES		
Hospitals	×	
Places of Worship	✓	7.4
Schools	✓	0
Shopping Centres	×	
Community Centres	×	
Office Buildings	×	
Swimming Pools	×	
Bowling Greens	×	
Ovals or Cricket Grounds	✓	7.11
Race Courses	×	
Golf Courses	×	
Tennis Courts	✓	7.14
Any Other Public Amenities	✓	7.15

Item	Within *Study Area*	Section Number Reference
FARM LAND AND FACILITIES		
Agricultural Utilisation or Agricultural Suitability of Farm Land	✓	8.1
Farm Buildings or Sheds	✓	8.2
Tanks	✓	8.3
Gas or Fuel Storages	✓	8.4
Poultry Sheds	✓	0
Glass Houses	×	
Hydroponic Systems	✓	8.7
Irrigation Systems	✓	8.8
Fences	✓	8.9
Farm Dams	✓	8.10
Wells or Bores	✓	8.11
Any Other Farm Features	×	
INDUSTRIAL, COMMERCIAL AND BUSINESS ESTABLISHMENTS	×	
Factories	×	
Workshops	✓	9.1
Business or Commercial Establishments or Improvements	✓	9.1
Gas or Fuel Storages or Associated Plants	✓	9.2
Waste Storages or Associated Plants	×	
Buildings, Equipment or Operations that are Sensitive to Surface Movements	×	
Surface Mining (Open Cut) Voids or Rehabilitated Areas	×	
Mine Infrastructure Including Tailings Dams or Emplacement Areas	✓	9.3
Any Other Industrial, Commercial or Business Features	×	
AREAS OF ARCHAEOLOGICAL OR HERITAGE SIGNIFICANCE	✓	10.1 & 0
ITEMS OF ARCHITECTURAL SIGNIFICANCE	×	
PERMANENT SURVEY CONTROL MARKS	✓	6.12
RESIDENTIAL ESTABLISHMENTS		
Houses	✓	11.1
Flats or Units	✓	11.2
Caravan Parks	✓	0
Retirement or Aged Care Villages	×	
Associated Structures such as Workshops, Garages, On-Site Waste Water Systems, Water or Gas Tanks, Swimming Pools or Tennis Courts	✓	11.5 11.5.6 9.3 11.5.8
Any Other Residential Features	×	
ANY OTHER ITEM OF SIGNIFICANCE	×	
ANY KNOWN FUTURE DEVELOPMENTS	×	

2.3. Bargo Mine Subsidence District and the role of Subsidence Advisory NSW

The *Subsidence Study Area* is located within the Bargo Mine Subsidence District as proclaimed in 1975 and 1994.

Subsidence Advisory NSW (SA NSW) is the NSW Government agency responsible for administering the *Coal Mine Subsidence Compensation Act 2017.* SA NSW has two core functions:

1. To provide compensation or manage the provision of compensation where surface developments are damaged by mine subsidence following extraction of coal or shale in NSW; and
2. To regulate surface development within mine subsidence districts to reduce the risk of mine subsidence damage.

SA NSW provides expert advice to property owners, government departments, councils, community organisations and industries within coal mining areas of NSW. This advice aims to provide compatibility between surface development and underground mining.

The owners of buildings or other surface improvements damaged by mine subsidence can lodge claims for compensation through SA NSW. Currently, under the Coal Mine Subsidence Compensation Act 2017, any claim for mine subsidence damage needs to be lodged with SA NSW. SA NSW staff will arrange for the damage to be assessed by an independent specialist assessor. If the damage is attributable to mine subsidence, a scope of repairs will be prepared and compensation will be determined.

Proposed development in mine subsidence districts requires SA NSW approval. SA NSW sets building and construction requirements to protect buildings and other surface improvements from subsidence damage. These requirements cover the nature and class of improvements, including height, type of building materials used and the construction method.

SA NSW has the power to issue stop work notices to prevent illegal construction in mine subsidence districts, and any improvements erected without SA NSW's approval, or contrary to an approval are not eligible for compensation.

Further information about SA NSW's services is available at www.subsidenceadvisory.nsw.gov.au.

3.1. Introduction

This chapter provides a brief overview of; longwall mining; the development of mine subsidence and the methods that have been used to predict the mine subsidence movements resulting from the extraction of the longwalls. Further details on longwall mining, the development of subsidence and the methods used to predict mine subsidence movements can be obtained in the background reports entitled *Introduction to Longwall Mining and Subsidence* and *General Discussion on Mine Subsidence Ground Movements* which can be obtained from *www.minesubsidence.com*.

3.2. Overview of longwall mining

The proposed development at Tahmoor Mine is to continue mining coal using the longwall mining method. A typical cross-section at a coal face showing a typical longwall shearer and roof supports and showing typical immediate floor and roof strata, is sketched in Fig. 3.1.

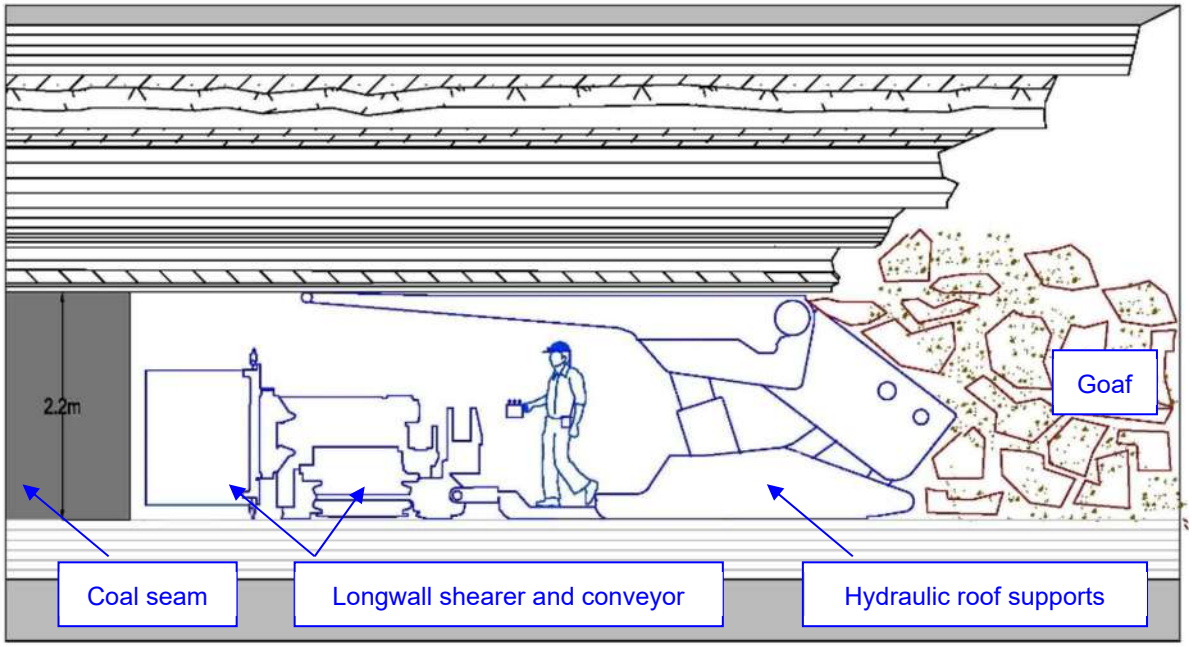


Fig. 3.1 Cross-section along the length of a typical longwall at the coal face

The coal is removed by a shearer, which cuts the coal from the coal face on each pass as it traverses the width of the longwall. The roof at the coal face is supported by a series of hydraulic roof supports, which temporarily hold up the roof strata, and provide a secure working space at the coal face. The coal is then transported by a face conveyor belt which is located behind and beneath the shearer. As the coal is removed from each section of the coal face, the hydraulic supports are stepped forward, and the coal face progresses (retreats) along the length of the longwall.

The strata directly behind the hydraulic supports, immediately above the coal seam, collapses into the void that is left as the coal face retreats. The collapsed zone, often called the goaf, comprises loose blocks and can contain large voids. Immediately above this collapsed zone, the strata remain relatively intact and bends into the goaf, resulting in new vertical factures and the opening up of existing vertical fractures and creation of bed openings or separations. The amount of fracturing, strata sagging and bedding plan separation reduces for the overlying strata that are higher up again that is up towards the surface.

At the surface, the ground subsides vertically and moves horizontally towards the centre of the mined goaf area. The maximum subsidence at the surface varies, depending on a number of factors including longwall geometry, depth of cover, extracted seam thickness, extent and proximity of previously extracted panels and seams and the overburden geology. The maximum subsidence in the Southern Coalfield, within a single seam and for a single panel of supercritical critical width of extraction, that is the panel width is much wider than the depth of cover, is generally about 65 % of the extracted seam thickness.

3.3. Overview of conventional subsidence parameters

The normal ground movements resulting from the extraction of longwalls are referred to as conventional or systematic subsidence movements. These movements are described by the following parameters:-

- **Subsidence** usually refers to vertical displacement of a point, but subsidence of the ground includes both vertical and horizontal displacements. These horizontal displacements in some cases, where the subsidence is small beyond the longwall goaf edges, can be greater than the vertical subsidence.
- Unlike mining induced vertical subsidence, which has a magnitude only, **Horizontal Displacements** have both a magnitude and a direction, i.e. they can be referred to as a vector. Early researchers generally only measured and predicted vertical subsidence and ground strains and rarely measured or predicted the horizontal displacements of points. Subsidence and horizontal movements are usually expressed in units of *millimetres (mm)*.
- **Tilt** is the change in the slope of the ground as a result of differential subsidence and is calculated as the change in subsidence between two points divided by the distance between those points. Tilt is, therefore, the first derivative of the subsidence profile. Tilt is usually expressed in units of *millimetres per metre (mm/m)*. A tilt of 1 mm/m is equivalent to a change in grade of 0.1 %, or 1 in 1000.
- **Curvature** is the bending of the ground as a result of differential subsidence and is calculated as the change in tilt between two adjacent sections of the tilt profile divided by the average length of those sections. Curvature is usually expressed as the inverse of the **Radius of Curvature** with the units of *1/kilometres (km^{-1})*, but the values of curvature can be inverted, if required, to obtain the radius of curvature, which is usually expressed in *kilometres (km)*.
- **Strain** is the relative differential horizontal movements of the ground. **Normal strain** is calculated as the change in horizontal distance between two points on the ground, divided by the original horizontal distance between them. Strain is typically expressed in units of *millimetres per metre (mm/m)*. **Tensile strains** occur where the distance between two points increases and **Compressive strains** occur when the distance between two points decreases. So that ground strains can be compared between different locations, they are typically measured over bay lengths that are equal to the depth of cover between the surface and seam divided by 20. When strains are measured over longer bay lengths lower averaged values are generally observed.

  Whilst mining induced normal strains are measured along monitoring lines, **ground shearing** can also occur both vertically and horizontally across the directions of monitoring lines. Most of the published mine subsidence literature discusses the differential ground movements that are measured along subsidence monitoring lines, however, differential ground movements can also be measured across monitoring lines using 3D survey monitoring techniques.
- **Horizontal shear deformation** across monitoring lines can be described by various parameters including horizontal tilt, horizontal curvature, mid-ordinate deviation, angular distortion and shear index. However, is not possible to determine the horizontal shear strain across a monitoring line using standard 2D or 3D monitoring techniques. High deformations along monitoring lines (i.e. normal strains) are generally measured where high deformations have been measured across the monitoring line (i.e. shear deformations) and vice versa.

High resolution surveying techniques using GPS technology and satellite based differential interferometry are providing far more data and a much better basis for understanding the extent and the mechanics of the mining induced vertical and horizontal ground movements. Modern surveyors now provide the current easting, northing and reduced level of each installed peg from which three-dimensional subsidence and mining induced horizontal movements and directions can be derived for each epoch. Because of these improvements in subsidence surveying our understanding of both the magnitude and direction of mining induced vertical and horizontal ground movements and the lateral extent of these mining induced ground movements has improved substantially.

The **total** subsidence, tilts, curvatures and strains are the accumulated parameters which result from the extraction of a series of longwalls. **Incremental** subsidence, tilts, curvatures and strains are the additional movements due to the extraction of each longwall and are determined from monitored data by subtracting the movements monitored before a longwall was mined from the movements monitored after that longwall was mined. The **travelling** tilts, curvatures and strains are the transient movements as the longwall extraction face mines directly beneath a given point.

Residual subsidence is defined as the additional, time-dependent subsidence that develops after active mining has been completed or has moved sufficiently far enough away from the affected area to no longer have an immediate influence. As the amount of subsidence being measured reduces asymptotically to smaller and smaller levels, the shrinking and swelling of the soil due to changes in moisture content and the survey accuracy can form a large proportion of the measured subsidence.

3.4. Overview of conventional and non-conventional subsidence movements

Some subsidence terms and definitions were first published in an Independent Inquiry report entitled "*Strategic Review of Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield*", (Southern Coalfield Inquiry Report), which was published in July 2008, (NSW DP, 2008). The terms and definitions draw a distinction between subsidence effects, subsidence impacts, environmental consequences, consequences, secondary consequences, conventional effects and non-conventional effects.

Conventional subsidence profiles are typically smooth in shape and can be explained by the expected caving mechanisms associated with overlying strata spanning the extracted void. Normal conventional subsidence movements due to longwall extraction are easy to identify where longwalls are regular in shape, the extracted coal seams are relatively uniform in thickness, the geological conditions are consistent and surface topography is relatively flat.

As a general rule, the smoothness of the profile is governed by the depth of cover and lithology of the overburden, particularly the near surface strata layers. Where the depth of cover is greater than 400 metres, such as the case within the Study Area, the observed subsidence profiles along monitoring survey lines are generally smooth. Where the depth of cover is less than 100 metres, the observed subsidence profiles along monitoring lines are generally irregular. Very irregular subsidence movements are observed with much higher tilts, curvatures and strains at very shallow depths of cover where the collapsed zone above the extracted longwalls extends up to or near to the surface.

Irregular subsidence movements are occasionally observed at the deeper depths of cover along an otherwise smooth subsidence profile. The cause of these irregular subsidence movements can be associated with:-

- sudden or abrupt changes in geological conditions;
- steep topography; and
- valley related mechanisms.

Non-conventional movements due to geological conditions, steep topography and valley related movements are discussed in the following sections.

3.4.1. Non-conventional subsidence movements due to changes in geological conditions

For those sites where the depth of cover is less than 100 metres, the observed subsidence profiles along monitoring lines are generally irregular with much higher tilts, curvatures and strains principally because the collapsed zone has extended up to or near to the surface. Where the depth of cover is around 400 metres, as is the case over most of the *Subsidence Study Area*, the observed subsidence profiles along monitoring survey lines will generally be smooth as is typical in the Southern Coalfields. However, irregular subsidence movements can occasionally be observed at these deeper depths of cover along an otherwise smooth subsidence profile and these localised irregular subsidence movements, that are called non-conventional subsidence movements, are often associated with sudden or abrupt changes in geological conditions, steep topography, and valley related mechanisms.

Accordingly, non-conventional subsidence movements may occur or could be expected within the river and creek valleys, near the major fault zones, near the outcrop of the interface between sandstone and shale strata layers. It is believed that most the unexpected irregular subsidence movements, i.e. the non-conventional ground movements, are a 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 bumps in an otherwise smooth subsidence profile which are usually accompanied by locally increased tilts, curvatures and strains.

Even though it may be possible to attribute a reason behind many of the 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. It is expected that these methods will improve as further knowledge is gained through ongoing research and investigation.

In this report, the analyses of non-conventional ground movements have been carried out statistically in the predictions and impact assessments, by basing these on the frequency of past occurrence of both the

conventional and non-conventional ground movements and impacts. The analysis of strains provided in Section 4.3 includes those resulting from both conventional and non-conventional anomalous movements.

An analysis of observations during the mining of Tahmoor Longwalls 22 to 31 provides an indication of the spatial frequency of non-conventional movements, which is discussed in Section 4.7. The impact assessments for the natural features and items of surface infrastructure, which are provided in Chapters 5 through to 11, include a discussion of historical impacts resulting from previous longwall mining which have occurred as the result of both conventional and non-conventional subsidence movements.

3.4.2. Non-conventional subsidence movements due to valley related Movements

Valley bulging movements are a natural phenomenon, resulting from the formation and ongoing weathering, erosion and development of valleys, as illustrated in Fig. 3.2. These naturally occurring valley bulging movements include inward movement of the valley sides and the bulging or upwards movement of the valley floor. The potential for these natural movements are influenced by the geomorphology of valleys.

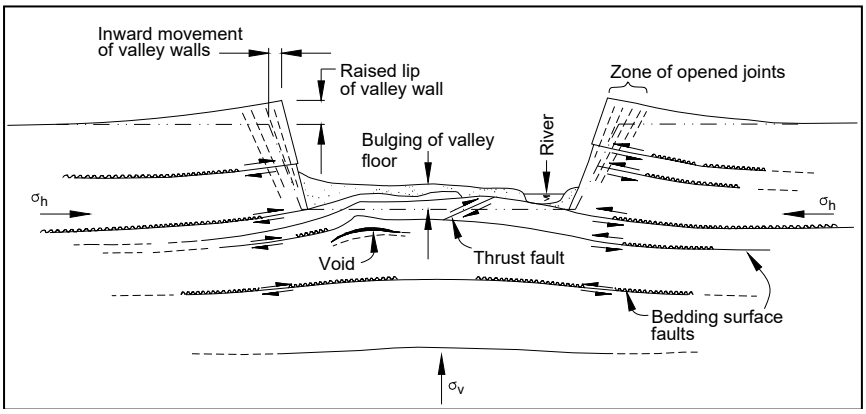


Fig. 3.2 Valley formation in flat-lying sedimentary rocks (after Patton and Hendren 1972)

The streams within the *Subsidence Study Area* may also be subjected to mining induced valley related movements, which result in similar consequences to the naturally occurring valley bulging movements that are discussed above. These mining induced valley closure result in closure movements across the valley and upsidence in the floor of the valley. The potential for these mining induced movements are influenced by the geomorphology of the valleys and the proximity and magnitude of the mining induced subsidence movements. As discussed in Section 3.4 and in the Southern Coalfield Inquiry Report (DPIE 2008), mining induced valley related movements are commonly observed across river and creek alignments in the Southern Coalfield and extensive studies have been carried out to predict the extent of these valley related movements.

As stated in the peer review by SCT (2014), a number of explanations of the mechanics of valley closure have been provided in the literature. Valley related movements are believed to be caused by the mining process through a number of different complex mechanisms and the relative contribution from each mechanism is expected to vary from case to case.

Valley related movements are normally described by the following parameters:-

- **Upsidence** is the reduced subsidence, or the relative uplift within a valley which results from the dilation or buckling of near surface strata at or near the base of the valley. The magnitude of upsidence, which is typically expressed in the units of *millimetres (mm)*, is the difference between the observed subsidence profile within the valley and the conventional subsidence profile which would have otherwise been expected in flat terrain.
- **Closure** is the reduction in the horizontal distances across the valley sides. The magnitude of maximum valley closure, which is typically expressed in the units of *millimetres (mm)* and is defined as the greatest reduction in distance between any two points on the opposing valley sides, is generally measured from pegs located at the top of the sides of the valley, however, sometimes the greatest closure is observed between pegs located in the base of the valley.
- **Compressive valley closure strains** occur within the bases of valleys as a result of valley closure and upsidence movements. **Tensile strains** tend occur in the sides and near the tops of the valleys as a result of valley closure movements. The magnitudes of these strains, which are typically expressed in the units of *millimetres per metre (mm/m)*, are calculated as the changes in horizontal distance over a standard bay length, divided by the original bay length.

The predicted valley related movements resulting from the extraction of the proposed longwalls were made using the empirical method outlined in Australian Coal Association Research Programme (ACARP) Research Project No. C9067 (Waddington and Kay, 2002). Further details can be obtained from the background report entitled *General Discussion on Mine Subsidence Ground Movements* which can be found at *www.minesubsidence.com*.

3.4.3. Non-conventional subsidence movements due to steep topography

Non-conventional movements can also result from slope instability movements where longwalls are extracted beneath steep slopes. In these cases, elevated tensile strains develop near the tops of the steep slopes and elevated compressive strains develop near the bases of the steep slopes. The potential impacts resulting from slope instability movements include the development of tension cracks at the tops and the sides of the steep slopes and compression ridges at the bottoms of the steep slopes. The term 'slope instability movements' is not intended to be confused with horizontal movements in a downslope direction, as correctly raised in the peer review by SCT (2014).

Further discussions on the potential for slope instability movements for the steep slopes within the *Subsidence Study Area* are provided in Section 5.5.

3.5. 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 much greater than the observed vertical movements at those marks. These movements are often referred to as *far-field 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 features or surface infrastructure, except where they are experienced by large structures which are very sensitive to differential horizontal movements.

These observed far field horizontal movements appear to occur as a result of a number of mechanisms or components, however, the main mechanism thought to be responsible for the observed far-field movements in flat terrain is the partial relief or relaxation of the in situ horizontal stresses of the immediate strata around the goaf towards the goaf areas. For the strata around the goaf to expand towards the collapsed zone there has to be slippage along some bedding planes. It is agreed with the statements in the peer review by SCT (2014) that the shear horizon or horizons on which movement occurs is not necessarily at the level of the coal seam and may occur at one or many horizons within the overburden.

The extent to which a particular stratum can expand into the goaf is dependent on the height of the void formation, the dilation in the neighbouring strata and the elastic properties of each stratum, and hence, the horizontal expansion varies from stratum to stratum with the greatest expansion occurring near, or just above, seam level. The measured far-field horizontal movements on the surface would, therefore, be expected to increase wherever the in situ compressive stresses are higher and where the height and extent of the goaf is more extensive, i.e. where the mining activity is more extensive.

Where narrow sub-critical panels are being mined and the height of collapse may only extend part of the way up to the surface, the strata that is overlying the collapsed zone may be able accommodate increased horizontal stresses. However, around wide supercritical panels where the cracking and goafing can extend up to the surface, there would be greater disturbance to the strata over the goaf and less stiffness within the collapsed strata to accommodate increased horizontal stresses. It is likely therefore that greater redistribution of in situ horizontal stresses would occur under and around these supercritical panels, greater stress relief and far field movements can occur towards these supercritical panels and these far field movements would extend well beyond a mined area before equilibrium is regained in the rock mass.

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

Far-field horizontal movements can be predicted with reasonable accuracy and the method used to predict such movements are described further in Section 4.6.

3.6. The Incremental Profile Method (IPM)

The predicted conventional subsidence parameters due to the extraction of the proposed longwalls were determined using the Incremental Profile Method (IPM), which was developed by MSEC in 1994, when formally known as Waddington Kay and Associates. This method is an empirical model based on a large database of observed subsidence monitoring data from previous mining within the Southern, Newcastle, Hunter and Western Coalfields of New South Wales and the Bowen Basin in Queensland.

The database of detailed subsidence monitoring data from various coalfields includes data from the following Collieries or Mines: Abel, Angus Place, Appin, Ashton, Awaba, Austar, Baal Bone, Bellambi, Beltana, Blakefield South, Bulga, Bulli, Burwood, Carborough Downs, Chain Valley, Clarence, Coalcliff, Cook, Cooranbong, Cordeaux, Corrimal, Crinum, Cumnock, Dartbrook, Delta, Dendrobium, Donaldson, Eastern Main, Ellalong, Elouera, Fernbrook, Glennies Creek, Grasstree, Gretley, Grosvenor, Invincible, John Darling, Kenmare, Kemira, Kestrel, Lambton, Liddell, Mandalong, Metropolitan, Moranbah North, Mt. Kembla, Munmorah, Narrabri, Nardell, Newpac, Newstan, Newvale, Newvale 2, NRE Wongawilli, Oaky Creek, Ravensworth, South Bulga, South Bulli, Southern, Springvale, Stockton Borehole, Tasman, Teralba, Tahmoor, Tower, Wambo, Wallarah, Western Main, Ulan, United, West Cliff, West Wallsend, and Wyee.

Observed incremental subsidence profiles show the additional subsidence that resulted from the extraction of an individual longwall panel and these can be derived by subtracting the observed subsidence profiles of points along monitoring lines before mining from the observed subsidence profiles after mining. Reviews of the available incremental and total subsidence profiles showed that, whilst the final observed total subsidence profiles measured over a series of longwalls were irregular, the observed incremental subsidence profiles due to the extraction of individual longwalls were more consistent in both shape and magnitude.

The observed incremental subsidence at a point has been shown to vary according to local geology, depth of cover, panel width, the pillar widths, the extracted seam thickness, the extent and proximity of adjacent previously mined panels in the currently mined seam and/or in the overlying or underlying seams, the stability of the chain pillars, the strength of the coal seams and the overburden strata and a time-related subsidence component.

The regularity in shape between observed incremental subsidence profiles was first noticed whilst carrying out an empirical study in the Southern Coalfields of NSW using monitoring data from more than 72 longwall panels. A prediction model was then developed to predict the incremental subsidence at points for each of the longwalls in a series of longwalls and then adding together the appropriate subsidence values to derive the total subsidence at each point. MSEC then developed standard subsidence prediction curves and shapes of predicted incremental subsidence profiles using observed profiles from monitoring lines with similar mining geometry and overburden geology. This IPM subsidence prediction model has been continually developed, revised and updated since 1994, as the new additional monitoring data became available, to suite specific local geology and conditions.

The prediction of subsidence using the IPM is now fully automated and subsidence predictions can be made anywhere above or outside the extracted longwalls, based on the local surface and seam information. Details as to how this model was developed have been outlined in various published papers, which include information that would allow others to use this method to predict mine subsidence ground movements resulting from underground coal mining operations, based on local observed data. MSEC can use the current IPM model to predict subsidence contours over complex underground mine layouts within days of receiving the necessary data.

MSEC has used this IPM for almost 1,000 studies for proposed mines and numerous comparisons have been provided between the predicted subsidence movements and the subsequently monitored ground movements. The results of these comparisons have been included in many prediction reports, government inquiry reports and end of panel monitoring reports, and these comparisons and reviews confirm the use of this IPM subsidence prediction model provides reasonable, if not, slightly conservative predictions for both single seam and multi-seam conditions in NSW and QLD for those cases where the mining geometry and overburden geology are similar to and within the range of the empirical data from which the IPM model was developed. When the mining geometry and overburden geology are outside the ranges of the empirical data from which the IPM model was developed then additional advice is sought from relevant mathematical models.

For this Tahmoor South Project, the IPM has been based on the Southern Coalfield predictive curves with calibrations for the local conditions, based on the extensive ground monitoring data from Tahmoor Mine as discussed in Section 3.7.

Further details on the IPM are provided in the background report entitled General Discussion on Mine Subsidence Ground Movements which can be obtained from *www.minesubsidence.com*. The following section describes the calibration of the IPM for local single-seam conditions.

3.7. Calibration of Incremental Profile Method, outside the increased subsidence area

The extraction of longwalls at Tahmoor Mine has generally resulted in observed mine subsidence movements that are typical of those observed above other collieries in the Southern Coalfield of NSW at comparable depths of cover. However, during the mining of Longwall 24A at Tahmoor Mine substantially increased subsidence was observed over the predicted subsidence levels and then similar increased subsidence movements were also observed above the southern ends of Longwalls 25 to 27 and Longwall 32. This was a very unusual event for the Southern Coalfield and is discussed further in Section 3.8.

This section of the report describes the calibration and testing of the IPM above the majority of the previously extracted longwalls at Tahmoor Mine and does not include observations in the areas of increased subsidence, which is addressed separately in Section 3.8.

The IPM was previously refined or calibrated using the extensive monitoring data that had been collected during the extraction of Longwalls 22 to 25 at Tahmoor to predict the subsidence parameters for Longwalls 27 to 30 at Tahmoor Mine, and the details of this calibration were provided in Section 3.6 of Report No. MSEC355 (Revision B, July 2009).

The IPM prediction curves from that report are the latest calibration of the IPM and this model was tested against the latest available subsidence data in the Tahmoor North area, plus, the available subsidence data from monitoring lines above the previously extracted Tahmoor Longwalls 1 to 19 since these later longwalls were located closer to the proposed Tahmoor South longwalls.

The reliability of the IPM prediction curves is illustrated by comparing the observed movements with those predicted for the following monitoring lines, which are shown in Appendix G of this report. The results have been extended to include measured subsidence after the mining of Longwall 30, where they have been measured. The locations of the monitoring lines are shown in Fig. 3.3 :-

- Fig. G.01 – 100-Line for Tahmoor Longwalls 1 and 2;
- Fig. G.02 – 200-Line for Tahmoor Longwall 2;
- Fig. G.03 – 300-Line for Tahmoor Longwalls 3 to 7;
- Fig. G.04 – 800-Line for Tahmoor Longwalls 8 to12;
- Fig. G.05 – 900-Line for Tahmoor Longwalls 10A to 13;
- Fig. G.06 – 1000-Line for Tahmoor Longwalls 14B to 19;
- Fig. G.07 – Brundah Road Line for Tahmoor North Longwalls 23B to 28;
- Fig. G.08 – Castlereagh Street Line for Tahmoor North Longwalls 22 to 28;
- Fig. G.09 – Remembrance Drive Line for Tahmoor North Longwalls 23A to 30;
- Fig. G.10 – Thirlmere Way Line for Tahmoor North Longwalls 23A to 27;
- Fig. G.11 – York Street Line for Tahmoor North Longwalls 24A to 28;
- Fig. G.12 – HRF Line for Tahmoor North Longwalls 23 to 26;
- Fig. G.13 – LW25 XS1 Line for Tahmoor North Longwalls 25 to 26;
- Fig. G.14 – LW24A Draw Line for Tahmoor North Longwalls 24A to 26; and
- Fig. G.15 – LW25 Centreline for Tahmoor North Longwalls 25 to 26.

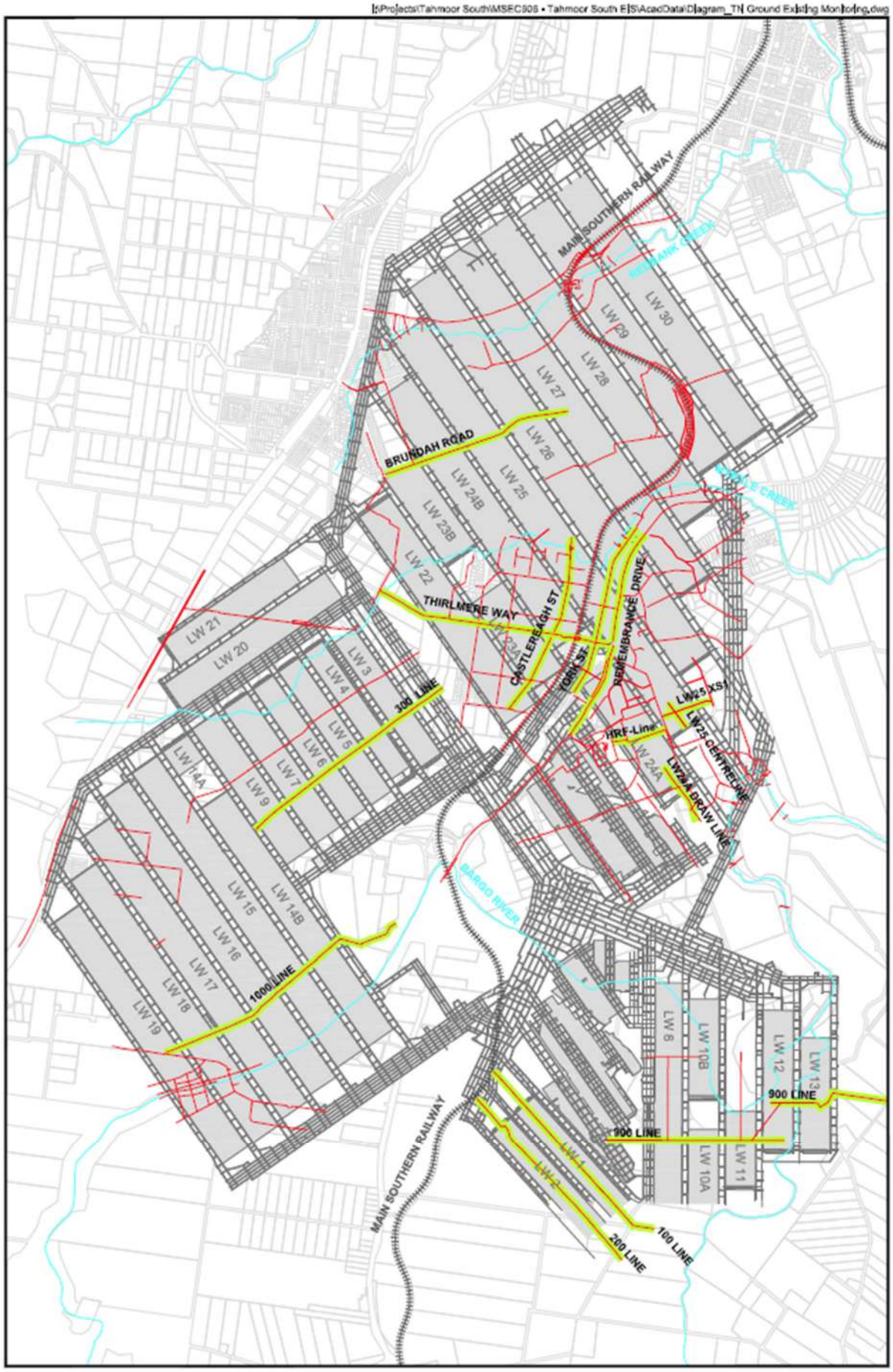


Fig. 3.3 Tahmoor North monitoring lines used in testing calibration of the IPM model

The following observations can be seen from the above figures:

- Predicted maximum subsidence has been greater, for all the monitoring lines over Longwalls 1 to 7, over Longwalls 14 to 23 and over the northern western ends of Longwalls 24B to 26, than the observed maximum subsidence.
- The observed subsidence profiles, for all the monitoring lines over Longwalls 1 to 7, Longwalls 14 to 19, Longwalls 20 to 21 and over Longwalls 21 to 24B, reasonably match those predicted using the calibrated prediction curves with the observed subsidence generally being greater than the observed subsidence. While there is reasonable correlation, it is highlighted that, in some locations away from the points of maxima and, in particular, beyond the longwall goaf edges, the observed subsidence has exceeded that predicted. In these locations beyond the longwall goaf edges, however, the magnitude of subsidence is low and there were very low associated tilts, curvatures and strains.
- Greater maximum subsidence of up to 670 mm has been observed, along some of the lines over Longwalls 24A and above the south eastern ends of Longwalls 25 to 27, than the predicted maximum subsidence as discussed in detail in Section 3.8.
- Greater subsidence was observed compared to predictions along the 800-Line above the centre of Longwall 8 where several small faults and dykes were located. The observed incremental subsidence of 420 mm was 50% greater at that location than the predicted value of 280 mm. The centre of this panel is within 500 metres of the Bargo River, where the valley depth, measured using a one half a depth of cover basis, is 40 metres and this location was within 1,400 m of the Nepean Fault.
- Greater subsidence was observed compared to predictions along the 900-Line above Longwall 13. At this location where the 900-Line crosses Longwall 13 and the Nepean Fault zone, the Nepean Fault zone runs almost parallel to Longwall 13 and the maingate edge of Longwall 13 is within 170 metres of the fault zone. The observed incremental subsidence of 820 mm was approximately 30% greater at that location than the predicted value of 550 mm. The centre of this panel is also within 300 metres of the Bargo River, where the valley depth, measured using a one half a depth of cover basis, is 25 metres and this location was within 300 m of the Nepean Fault.
- Slightly greater subsidence was observed along Castlereagh Street compared to predictions above Longwalls 22 and 23A. This street runs across the south eastern ends of these longwall panels and near the railway corridor.
- Slightly greater subsidence was observed compared to predictions along Remembrance Drive above Longwalls 24A and the southern parts of Longwall 25 and Longwall 26. This area is located on the edge of the zone of increased subsidence.
- Slightly greater subsidence was observed compared to predictions along Thirlmere Way above the southern end of Longwall 24B and the south eastern parts of Longwall 25. This area is located near the zone of increased subsidence.
- Slightly greater subsidence was observed compared to predictions along York Street above Longwalls 24A and the south eastern parts of Longwall 25. This area is located along the edge of the zone of increased subsidence.
- Greater subsidence of up to 600 mm was also observed compared to predictions along the HRF-Line and LW25 XS1 Line, which are within the zone of increased subsidence, as is discussed in more detail in Section 3.8.
- The observed tilt and curvature profiles over all these monitoring lines also reasonably matched the predicted profiles using the calibrated prediction curves. The observed curvatures were derived from the smoothed subsidence profiles, to obtain overall levels of curvature, rather than the localised curvatures at each survey mark. Please see Section 3.7.1 for further discussion on curvature.
- The maximum observed tilts and curvatures were, in most cases, similar to the maximums predicted using the standard Bulli seam prediction curves. The observed tilts and curvatures exceeded those predicted at the tributary crossings, at the locations of the upsidence movements, as the predicted profiles did not include non-conventional valley related movements. There was also some scatter in the observed tilt and curvature profiles.

A comparison between the observed and predicted total subsidence at the individual survey marks from the 100-Line, 200-Line, 300-Line, 800-Line, 900-Line and the 1000-Line after the extraction of Longwalls 1 to 19 at Tahmoor Mine is provided in Fig. 3.4. That is, this analysis includes the occasions when the observed total subsidence exceeded the predicted total subsidence over Longwalls 1 to 19, which were along the 800-Line and 900-Line as shown in Fig. G.04 and Fig. G.05.

The observed subsidence at individual survey pegs, i.e. at a point, for pegs located over Tahmoor Longwalls 1 to 19 exceeded the predicted subsidence by more than +15 % by a small margin at some of the survey marks along the 100-Line, 300-Line, and by much higher margins at surveys marks along the 800-Line and 900-Line. It can be seen from Fig. 3.4 that the observed total subsidence at the other individual survey marks were generally less than the predicted total subsidence plus 15 %, or less than the predicted total subsidence plus 50 mm, which is generally considered acceptable for subsidence prediction methods.

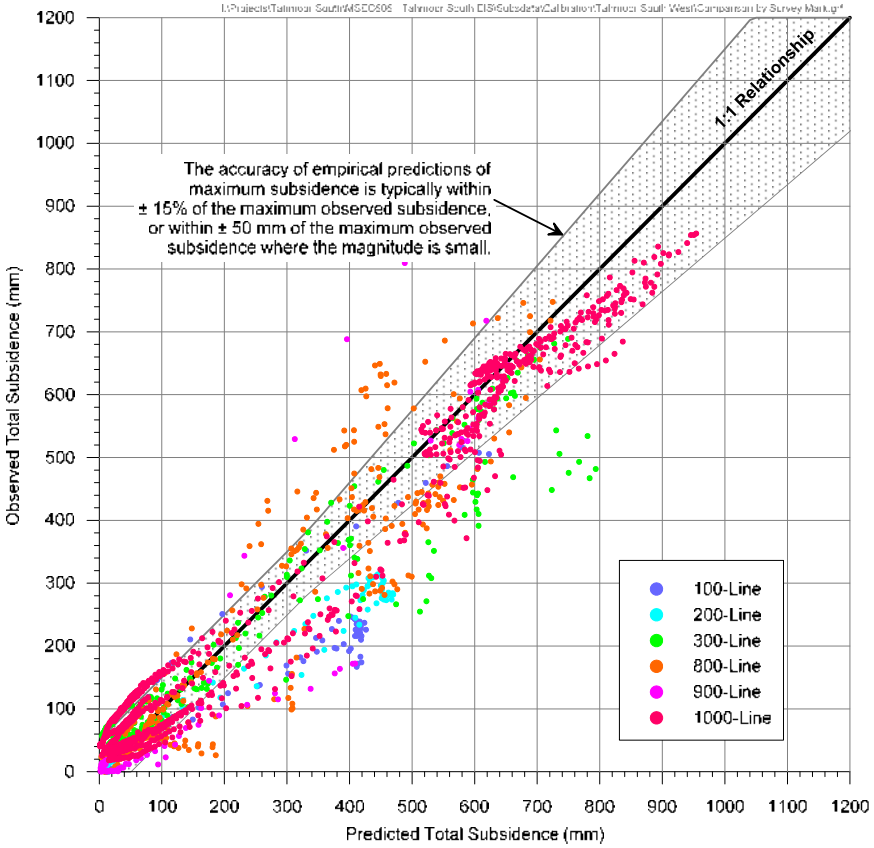


Fig. 3.4 Comparison between observed and predicted total subsidence at individual survey marks for the Tahmoor Longwalls 1 to 19

The further comparison between the observed and predicted total subsidence at all of the individual survey marks over the northern areas of the Tahmoor Mine, at the completion of each of the Longwalls 22 to 26, is provided in Fig. 3.5. These results in Fig. 3.5 have only been provided for the monitoring lines that are located outside the zone of increased subsidence, as is discussed separately in Section 3.8, i.e. these plots do not including pegs located above Longwall 24A and above the south eastern ends of Longwalls 25 and 26. However this analysis does include the monitored data from those parts of Remembrance Drive and Castlereagh Street that are close to or near the zone of increased subsidence, i.e. within a transition zone.

It can be seen from Fig. 3.5, that the observed total subsidence at the individual survey marks at Tahmoor North, due to the extraction of Tahmoor Longwalls 22 to 26, for these monitoring lines that are generally located outside the zone of increased subsidence and outside the transition zone, were generally less than the predicted total subsidence plus 15 %, or less than the predicted total subsidence plus 50 mm, which is generally considered acceptable for subsidence prediction methods. There are several exceedances, however, and these generally occurred along the monitoring lines in those parts of Remembrance Drive and Castlereagh Street that are located close to or near the zone of increased subsidence and from those with lower levels of subsidence.

Instead of plotting the results for all survey marks along a line, a further comparison is provided in Fig. 3.6 between the observed and predicted maximum total subsidence along monitoring lines at the northern parts of the Tahmoor Mine for these monitoring lines that are located outside the zone of increased subsidence, due to the extraction of Tahmoor Longwalls 22 to 26.

It can be seen by comparing Fig. 3.4 and Fig. 3.5 that the maximum observed subsidence values anywhere along the whole monitoring lines are generally less than the predicted total subsidence plus 15 %, or less than the predicted total subsidence plus 50 mm, except where the magnitudes are small. There are some exceedances at the Railway Line (2D) and Larkin St, however, these lines are also located close to or near the zone of increased subsidence and are generally occurred along the monitoring lines with lower levels of subsidence.

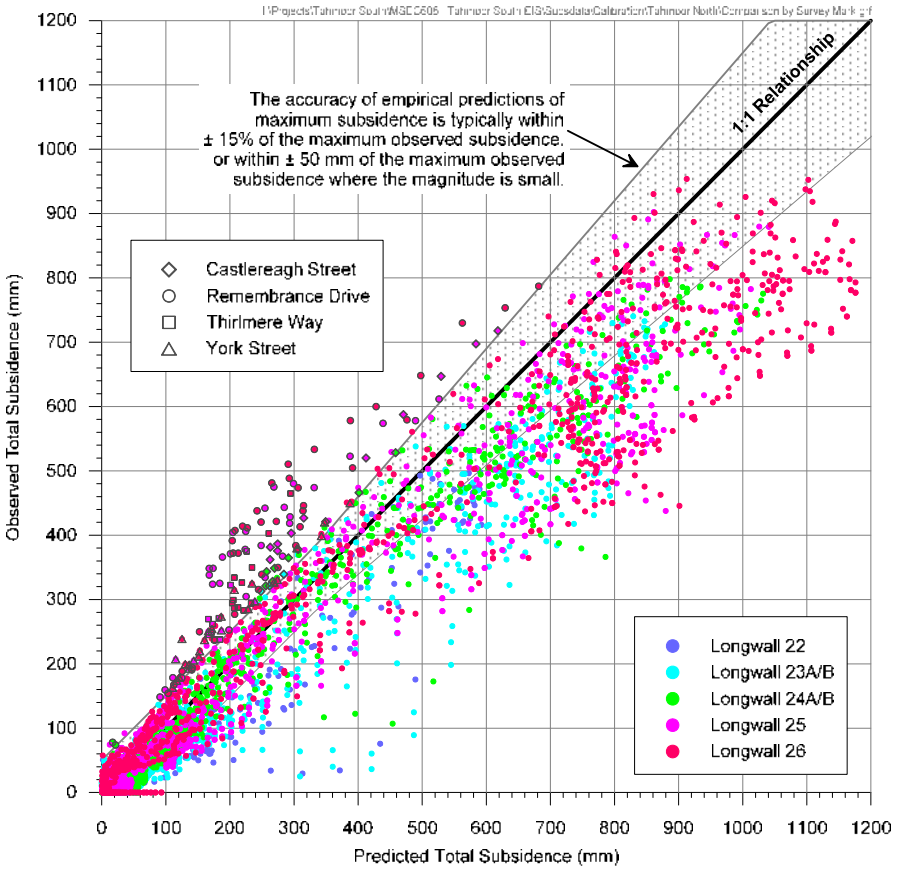


Fig. 3.5 **Comparison between observed and predicted total subsidence at individual survey marks for the Tahmoor North longwalls 22 to 26**

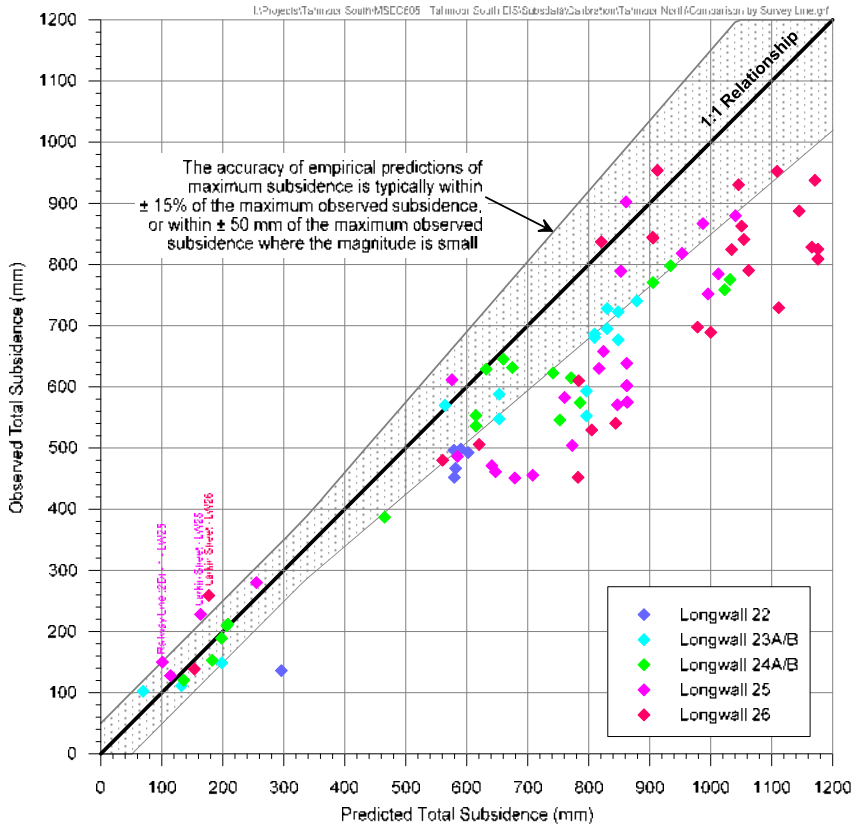


Fig. 3.6 **Comparison between observed and predicted maximum total subsidence along whole monitoring lines for the Tahmoor North longwalls 22 to 26**

A further statistical review of these maximum subsidence values along monitoring lines has been undertaken. The distribution of the ratio of the maximum observed to maximum predicted total subsidence, for the monitoring lines near Longwalls 22 to 26 located outside the zone of increased subsidence at Tahmoor Mine with maximum values greater than 200 mm, is illustrated in Fig. 3.7 (left). A gamma distribution has been fitted to the results and this is also shown in this figure. The resulting probabilities of exceedance have been determined, based on this gamma distribution, which is shown on the right of Fig. 3.7.

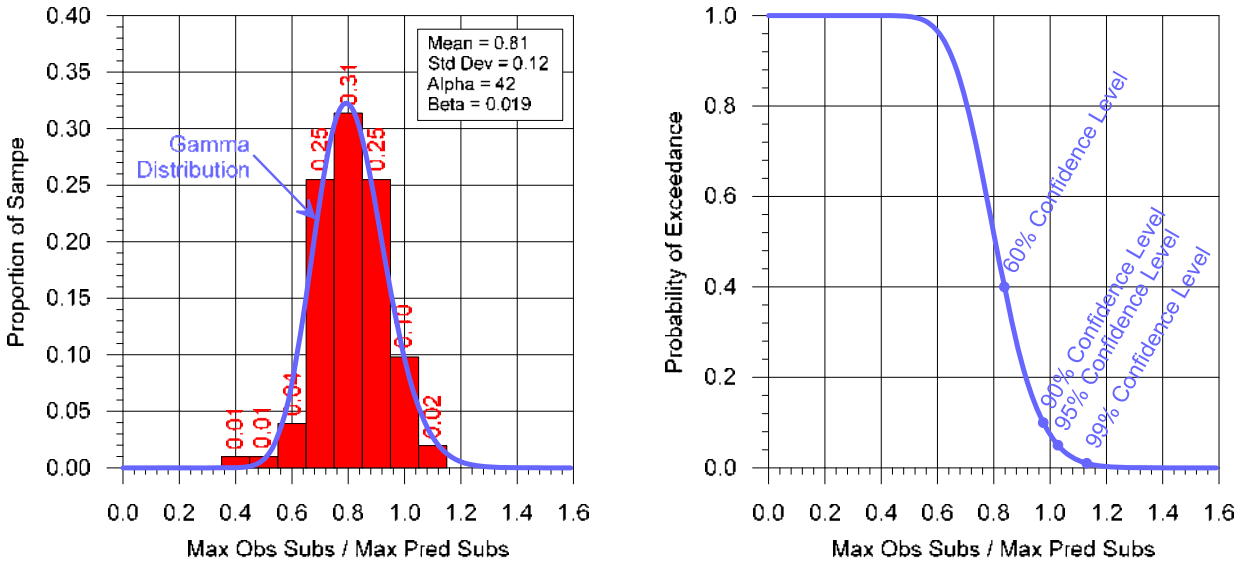


Fig. 3.7 Distribution of the ratio of the maximum observed to maximum predicted total subsidence for monitoring lines at Tahmoor Mine

It can be seen on the left side of the above figure that the maximum observed total subsidence along the monitoring lines at Tahmoor Mine was, on average, 81 % of the maximum predicted total subsidence. The maximum observed total subsidence along the monitoring lines was, at most, 10 % greater than the maximum predicted total subsidence.

It can be seen on the right side of the above figure that, based on the monitoring data, there is approximately a 93 % confidence level that the maximum observed total subsidence would be less than the maximum predicted total subsidence. That is, there is an approximate 7 % probability that the maximum observed total subsidence would exceed the maximum predicted subsidence anywhere along a monitoring line.

The subsidence predictions for the proposed Tahmoor South longwalls using this calibrated IPM model are provided in Section 4.2. Based on the statistical review of the accuracy of this calibrated IPM model, it is expected, therefore, that the calibrated IPM should generally provide reasonable, if not, slightly conservative predictions for conventional subsidence resulting from the extraction of the proposed Tahmoor South longwalls.

However, because of the increased subsidence that has been observed in parts of Tahmoor Mine, consideration should, however, be made for the observed movements exceeding those predicted as the result of anomalous or non-conventional movements, or for increased subsidence which is discussed in Section 3.8.

3.7.1. Comparisons between the observed and predicted tilt and curvature for previously extracted longwalls in the Southern Coalfield

It can be seen from Fig. G.01 to G.11 that there has generally been a reasonable correlation between predicted and observed tilt profiles at Tahmoor Mine. A reasonable correlation has also been found at surrounding collieries in the Southern Coalfield where the depths of cover are similar to those at Tahmoor Mine. Where increased subsidence has been observed at Tahmoor Mine, however, higher than predicted tilts have been observed, and this is discussed further in Section 3.8.

It is difficult to make meaningful comparisons between the profiles of raw observed curvature and predicted conventional curvature. The reason for this is that survey tolerance can be a large proportion of the measured curvatures and hence this can result in very irregular profiles. The survey tolerance for relative vertical movements is typically around ±3 mm, which equates to a survey tolerance for curvature of approximately 0.05 km^{-1} over a 20 metre bay length. This is important when compared to typical magnitudes of curvatures measured in the Southern Coalfield, which are in the order of 0.05 km^{-1} to 0.15 km^{-1}.

To make meaningful curvature comparisons, the observed curvatures have been derived from smoothed observed subsidence profiles, which removes the small deviations resulting from, amongst other things, survey tolerance. The subsidence profile has been smoothed using either the Savitzky-Golay or Loess algorithm, which removes the localised deviations, but does not reduce the overall maxima. This is illustrated in Fig. 3.8 along the Moreton Park Road Line in Area 7, which shows the raw observed subsidence profile, the smoothed subsidence profile, the raw observed curvature profile and the curvature profile derived from the smoothed subsidence.

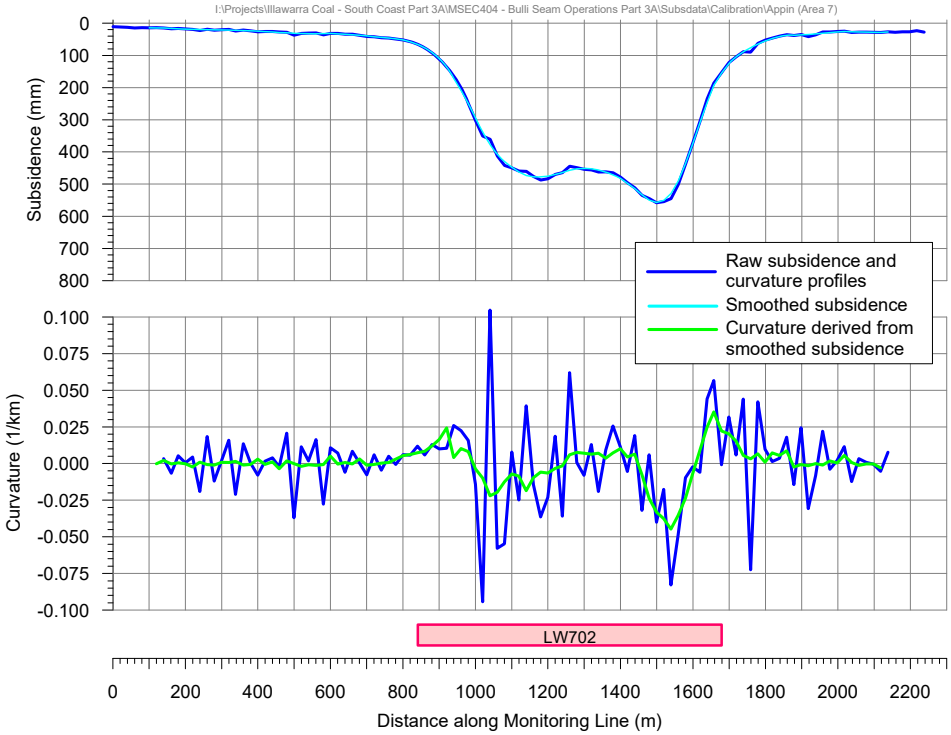


Fig. 3.8 Comparisons of raw observed curvature with curvature derived from smoothed subsidence along the Moreton Park Road line due to Appin Colliery Longwall 702

It can be seen from the above figure, that the smoothed subsidence profile reasonably matches the raw subsidence profile, but the small deviations have been removed. It can also be seen that the raw observed curvatures are very irregular, due to the small deviations in the raw observed subsidence profile. The curvature derived from the smoothed subsidence profile, however, more clearly shows the locations of overall hogging curvature and overall sagging curvature, rather than the localised curvatures at each mark.

Comparisons between the profiles of observed subsidence, tilt and curvature derived from smoothed subsidence profiles with predicted subsidence, tilt and curvature have been provided along the following monitoring lines at Tahmoor Mine:-

- Fig. G.07 – Brundah Road;
- Fig. G.09 – Remembrance Drive; and
- Fig. G.11 – York Street

The comparisons show that when observed curvature has been derived from smoothed subsidence profiles, a reasonable correlation between predicted and observed profiles can be found. A reasonable correlation has also been found at surrounding collieries in the Southern Coalfield where the depths of cover are similar to those at Tahmoor Mine. Where increased subsidence has been observed at Tahmoor Mine, however, higher than predicted curvatures have been observed, and this is discussed further in Section 3.8.

3.8. Areas where increased subsidence, compared to predictions, have been observed

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

However, the locations where greater subsidence was observed compared to the predicted values were identified, in Section 3.7, were:

- over Longwalls 24A and the southern parts of Longwalls 25 to 27;
- over the commencing end of Longwall 32; and
- over Longwall 8 and along the 800-Line, and over Longwall 13 and along the 900-Line.

It is not a coincidence that there are many faults and dykes at these locations, that these locations are near the Nepean Fault and these locations are near major river valleys or gorges. The extents of these zones of increased subsidence are discussed in detail in Report No. MSEC1123, which was submitted by Tahmoor Coal in support of the EIS application for the Tahmoor South Project.

While the proposed LWs S1A to S6A are not located near the Nepean Fault, the experiences are a reminder that increased subsidence movements can occur. Tahmoor Coal has extensive experience in successfully managing potential subsidence impacts on surface features, even when actual subsidence is substantially greater than the magnitudes that have been predicted above LWs S1A to S6A. It is recommended that subsidence management plans be developed to manage potential impacts that could occur if greater than predicted subsidence occurs.

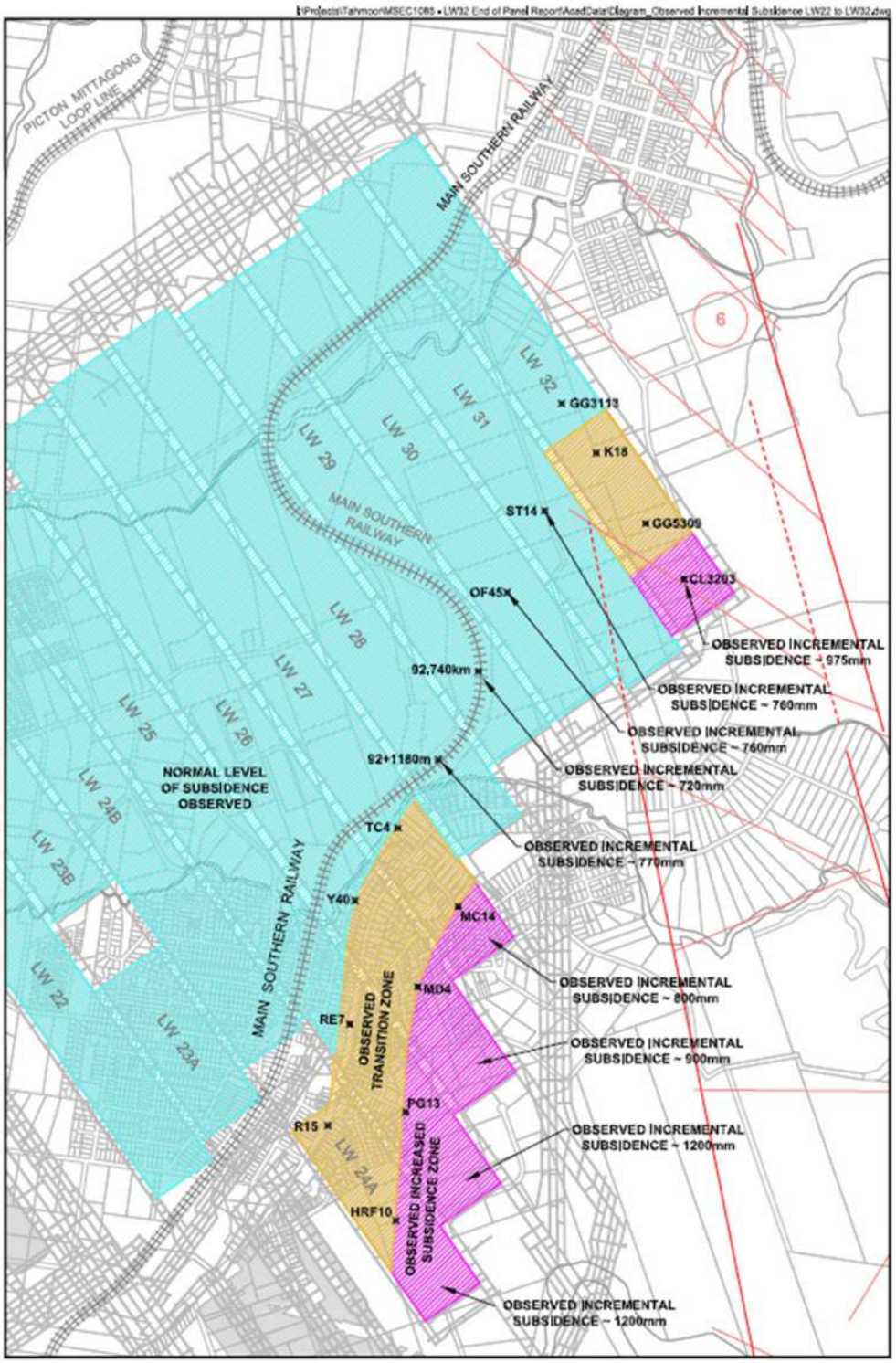


Fig. 3.9 Zones of increased subsidence over Longwalls 22 to 32

3.9. Review of the measured and predicted valley-related effects at Tahmoor

The predicted upsidence and closure movements for the longwalls at Tahmoor Mine have been obtained using the empirical method outlined in Australian Coal Association Research Program (ACARP) Research Project No. C9067 (Waddington and Kay, 2002), referred to as the 2002 ACARP method. Comparisons between the measured and predicted valley-related effects for the previously extracted longwalls at Tahmoor Mine have been provided in the following sections.

3.9.1. Myrtle Creek and the Skew Culvert

Detailed ground monitoring was undertaken where Myrtle Creek and a tributary to this creek (referred to as the Skew Culvert) crosses beneath the Main Southern Railway above Longwalls 26 and 27. A map showing the monitoring lines in these locations is shown in Fig. 3.10.

Fig. 3.10 Monitoring lines across Myrtle Creek and the Skew Culvert

The development of valley closure at each of the monitoring lines across the Myrtle Creek, during the extraction of Longwalls 24B to 27, are illustrated in Fig. 3.11.

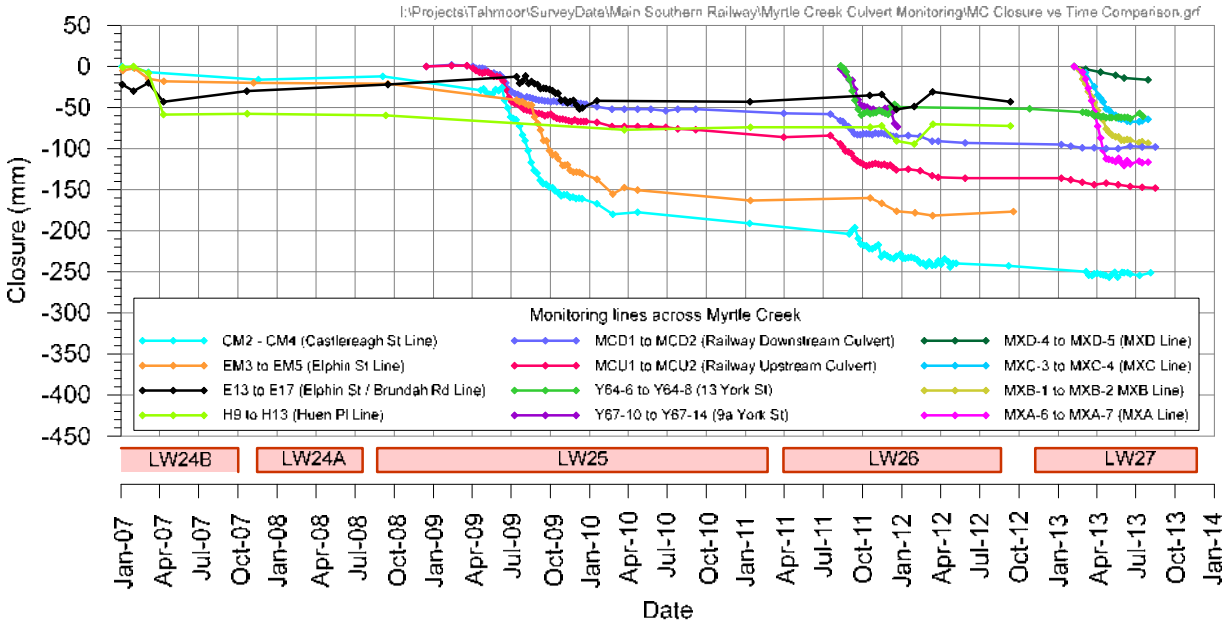


Fig. 3.11 Development of closure across Myrtle Creek during LW24B to LW27

The development of valley closure at each of the monitoring lines across the creek at the Skew Culvert, during the extraction of LW26 and LW27, are shown in Fig. 3.12.

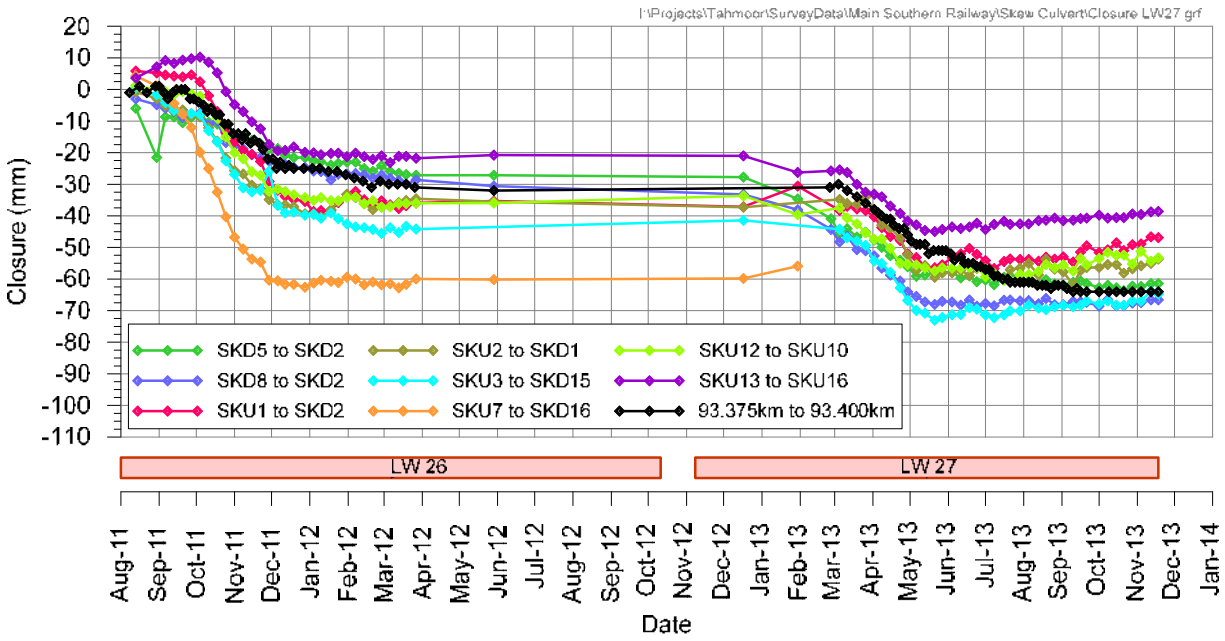


Fig. 3.12 Development of closure across the Skew Culvert during LW26 and LW27

A summary of the predicted and measured incremental closure across Myrtle Creek and the Skew Culvert is provided in Table 3.1. The predictions are consistent with those provided in Report No. MSEC355, which supported the SMP Application for Tahmoor LW27 to LW30.

Table 3.1 Predicted and measured incremental closure at the monitoring lines across Myrtle Creek and the Skew Culvert

Location	Category	Predicted and measured valley closure due to the mining of each longwall (mm)			
		Due to LW24	Due to LW25	Due to LW26	Due to LW27
Castlereagh Street (Pegs CM2 to CM4)	Predicted	30	55	45	25
	Measured	12	179	52	8
Elphin-Myrtle (Pegs EM3 to EM5)	Predicted	60	70	40	-
	Measured	21	142	22	-
Elphin St / Brundah Rd (Pegs E13 to E17)	Predicted	75	75	30	-
	Measured	0	21	6	-
Huen Place (Pegs H9 to H13)	Predicted	60	35	15	-
	Measured	58	15	20	-
Main Southern Railway Upstream (MCU1 to MCU4) Downstream (MCD1 to MCD4)	Predicted	15	30	30	15
	Measured	-	57 (d/s) to 86 (u/s)	36 (d/s) to 50 (u/s)	5 (d/s) to 12 (u/s)
Skew Culvert (8 cross-sections)	Predicted	< 5	10	25	25
	Measured	-	-	21 to 60 (average 36)	8 to 36 (average 21)
13 York Street (Pegs Y64-6 to Y64-8)	Predicted	-	-	65	50
	Measured	-	-	51	9
9a York Street (Pegs Y67-10 to Y67-14)	Predicted	-	-	85	85
	Measured	-	-	73	No access
MXA Line (Pegs MXA-6 to MXA-7)	Predicted	-	-	-	150
	Measured	-	-	-	116
MXB Line (Pegs MXB-1 to MXB-2)	Predicted	-	-	-	170
	Measured	-	-	-	93
MXC Line (Pegs MXC-3 to MXC-4)	Predicted	-	-	-	150
	Measured	-	-	-	64
MXD Line (Pegs MXD-4 to MXD-5)	Predicted	-	-	-	50
	Measured	-	-	-	16

It can be seen from the above table, that the measured valley closure has substantially exceeded predictions at the Castlereagh Street crossing, at the crossing of the Elphin-Myrtle monitoring line and, to a lesser extent, the crossing of the Main Southern Railway during the mining of LW25. It is considered that the reason for the differences in observations may be linked to the change in orientation of Myrtle Creek as the three above-mentioned monitoring lines are located along the same stretch of Myrtle Creek. It is noted, however, that substantially less closure has developed at Castlereagh Street than predicted during the mining of LW27.

The measured valley closure across the creek at the Skew Culvert has also slightly exceeded predictions, where the differences between predicted and measured closure are relatively small for most cross sections.

The measured valley closure across Myrtle Creek where it flows directly above LW27 (MXA to MXC lines) has been less than predicted, but greater in magnitude than that measured across monitoring lines upstream of LW27. This was expected because the valley is deeper compared to sections further upstream.

3.9.2. Redbank Creek

Detailed ground monitoring has been undertaken along Redbank Creek during the extraction of LWs 26 to 31. The ability to survey valley closure across the creek was constrained as access was not provided by some landowners located adjacent to the creek. There was no access to the creek from the northern bank and limited access on the southern bank of the Redbank Creek.

Ground surveys were undertaken in relative 3D from Bridge Street to a monitoring line that is located in cleared pasture land along the top of the valley, as shown in Fig. 3.13. This has provided measurements of total valley closure. Some survey pegs have been installed along a fenceline on the southern side to a point where surveyors can sight a survey peg on Bridge Street. Despite the best efforts of the survey team, the accuracy of the survey is challenged by the lack of cross lines across Redbank Creek. Baseline monitoring indicates that the valley closure measurements were accurate to approximately 20 mm to 30 mm.

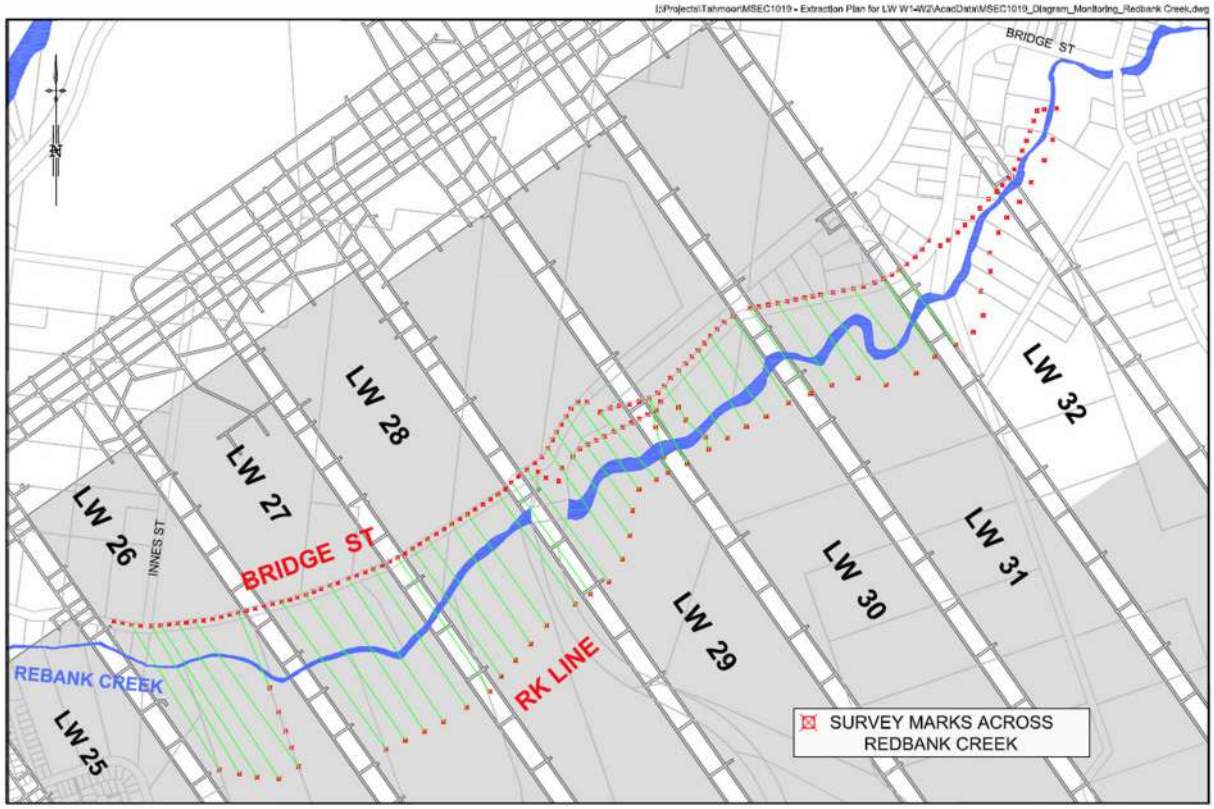


Fig. 3.13 Location of survey marks across Redbank Creek

A comparison between observed and predicted total valley closure along Redbank Creek after the mining of Longwall 31 is shown in Fig. 3.14. A comparison between observed and predicted incremental closure along Redbank Creek is also provided.

The closures are based on calculating changes in horizontal distance between pegs located across the valley in an orientation that is approximately parallel to the longwall panel. This orientation was chosen as Redbank Creek flows approximately at right angles across the panel.

Different results can be derived if the calculations were based on different pairs of pegs, though it is considered that if different pairs were chosen, such calculations would include an additional component of conventional and non-conventional ground shortening that occurs across the panel in both plateau areas or valleys. This is particularly the case if the pegs are located across the width of the longwall panel from each other. When comparing the results against predictions of valley closure, it was considered simpler to choose pegs that are approximately aligned with longwall direction so as not to make allowances for the additional effects of conventional lateral ground closure movements.

A number of observations are made from the monitoring data:

- There has been a reasonable correlation between predicted and observed incremental closure at the completion of Longwall 31. Valley closure was slightly greater for a temporary period of time, when the transient effects of the subsidence travelling wave passed through the valley; and
- Observed total closure from the mining of Longwalls 26 to 31 is less than predicted.

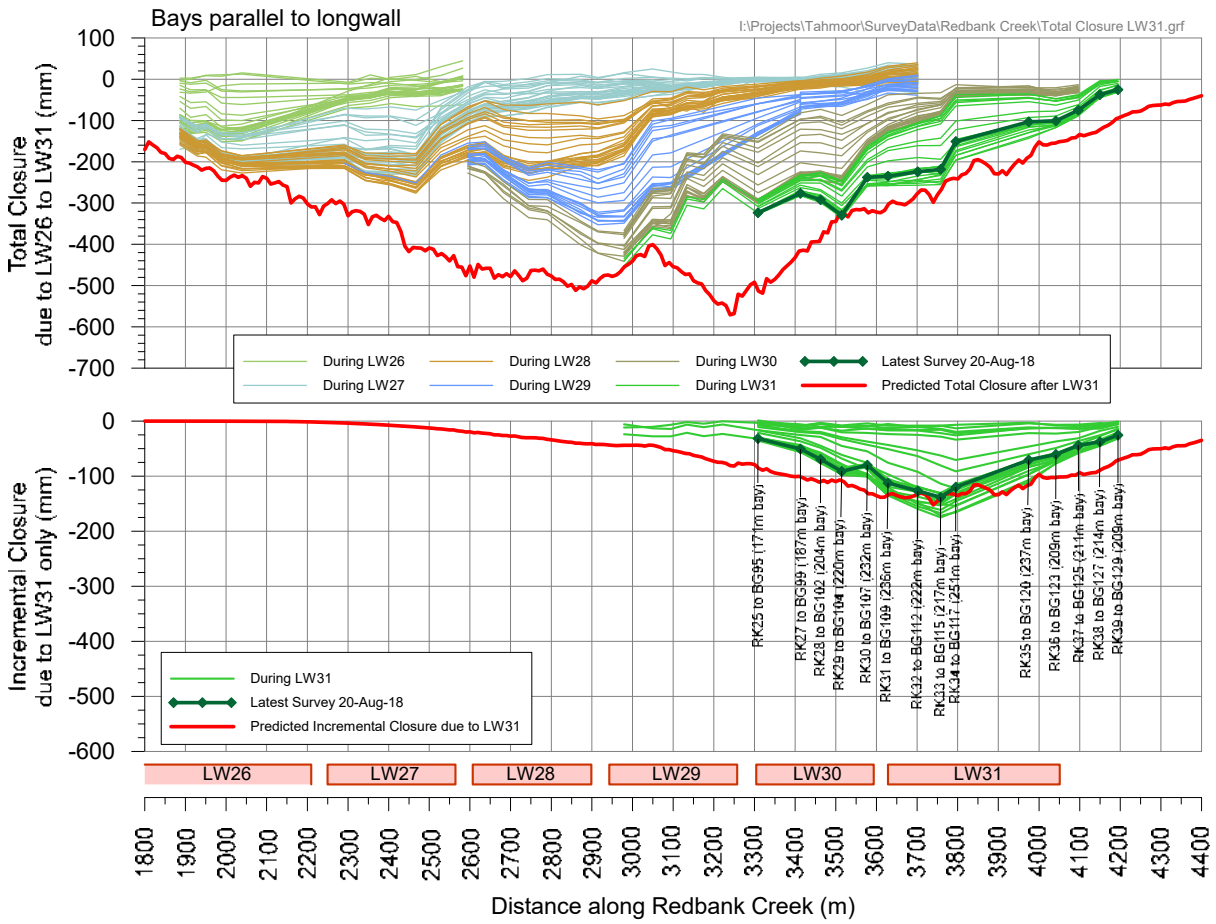


Fig. 3.14 Comparison between observed and predicted valley closure along Redbank Creek

3.9.3. Creek crossings directly above LW W1-W2

Very minor closure of approximately 20 mm was measured across the creek crossing at 88.400 km on the Picton to Mittagong Loop Line during the mining of LW W1, which is less than predicted. Closure is, however, currently developing during the mining of LW W2, with total closure likely to be a similar order of magnitude to the prediction of 125 mm.

Surveys across other creeks above LW W1 have measured very little to no measurable valley closure. As at March 2021, LW W2 has not yet mined directly beneath or adjacent to other creek crossings.

The results show that while the prediction of valley closure is not an exact science, there is a reasonable correlation between measured and predicted subsidence when measured across the width of the valley.

3.9.4. Reliability of the predicted valley-related movements

The review of the observed movements at Myrtle and Redbank Creeks and the observed movements directly above and adjacent to LW W1 indicate that the ACARP Method provides reasonable predictions for valley closure at Tahmoor Mine. It is noted, however, the measured closures substantially exceeded those predicted in three locations along Myrtle Creek, due to the extraction of LW25, but these all occurred along the same section of creek. Elsewhere, the measured closures were typically similar to or less than those predicted.

Whilst the major factors that determine the levels of movement have been identified, there are some factors that are difficult to isolate. One factor that is thought to influence the upsidence and closure movements is the level of in-situ horizontal stress that exists within the strata. In-situ stresses are difficult to obtain and not regularly measured and the limited availability of data makes it impossible to be definitive about the influence of the in-situ stress on the upsidence and closure values. The methods are, however, based predominantly upon the measured data from Tower Colliery in the Southern Coalfield, where the in-situ stresses are high. The methods should, therefore, tend to over-predict the movements in areas of lower stress.

Variations in local geology can affect the way in which the near surface rocks are displaced as subsidence occurs. In the compression zone, the surface strata can buckle upwards or can fail by shearing and sliding over their neighbours. If localised cross bedding exists, this shearing can occur at relatively low values of stress. This can result in fluctuations in the local strains, which can range from tensile to compressive. In

the tensile zone, existing joints can be opened up and new fractures can be formed at random, leading to localised concentrations of tensile strain.

Another factor that is thought to influence the movements is the characteristics of near surface geology, particularly in stream beds. Upsidence in particular is considered to be sensitive to the way in which the bedrock responds, since thin strata layers may respond differently to thicker ones. The location of the point of maximum upsidence is also considered to be strongly influenced by the characteristics of near surface geology.

Another factor that is thought to influence upsidence and closure movements is the presence of geomorphological features. Recent monitoring along a deeper and more incised valley has shown variable measurements around bends. There tended to be less movement at the apex of the bend than in the straight sections.

Notwithstanding the abovementioned limitations, the 2002 ACARP method is the most thoroughly used and tested prediction method for upsidence and closure movements in the Southern Coalfield. It is expected in most cases to provide reasonable, if not, slightly conservative predictions of the valley-related movements for the proposed longwalls.

More recently, the empirical prediction method has been refined based on further research undertaken as part of ACARP Research Project No. 18015 (Kay and Waddington, 2014). The 2014 ACARP method only provides predictions for valley closure and not for upsidence.

The predictions based on the 2002 ACARP method can be directly compared with the predictions provided in previous MSEC subsidence reports for Tahmoor Mine and with other case studies. This method has also been more widely used and tested than the more recent 2014 ACARP method. The assessments provided in this report, therefore, have been based on the predictions obtained using the 2002 ACARP method.

3.10. Rate of subsidence development and timing required for remedial actions

Monitoring of subsidence movements during the mining of previously extracted longwalls at Tahmoor Mine and other surrounding mines in the Southern Coalfield at similar depths of cover have shown that subsidence movements develop gradually over time, with no obvious indication of large and sudden step changes.

The subsidence effect at a point on the surface can be likened to a form of a wave. This wave moves across the ground at approximately the same speed as the longwall face retreats within the longwall panel but the impact of the surface subsidence wave is modified by the depth of cover and the overburden geology.

When the extraction of coal from a panel first commences, there is no immediate surface subsidence, but as the coal within the panel is extracted and the resulting void increases in size, subsidence develops gradually above the goaf area. As mining approaches and before a point is undermined, subsidence movements start to develop and then, after the longwall face passes beyond the point, the maximum value of subsidence is reached and despite further mining occurring within the panel, this level of subsidence is not exceeded except for some small time based residual movements.

An example of the gradual development of subsidence is shown in Fig. 3.15, which shows the development of subsidence of survey pegs that are located along the centreline of Tahmoor Mine's Longwall 27. The development of subsidence is plotted against the distance of each survey peg to the longwall face at the time of each survey. It shows that subsidence at a point above Longwall 27 typically did not commence until the longwall face had approached to within 200 metres of the point and that the majority of the subsidence movements had developed after the longwall face had passed each point by a distance of approximately 400 to 600 metres. The average extraction rate of Longwall 27 was approximately 40 metres per week, so it can be seen that subsidence typically developed over a period of approximately 15 to 20 weeks.

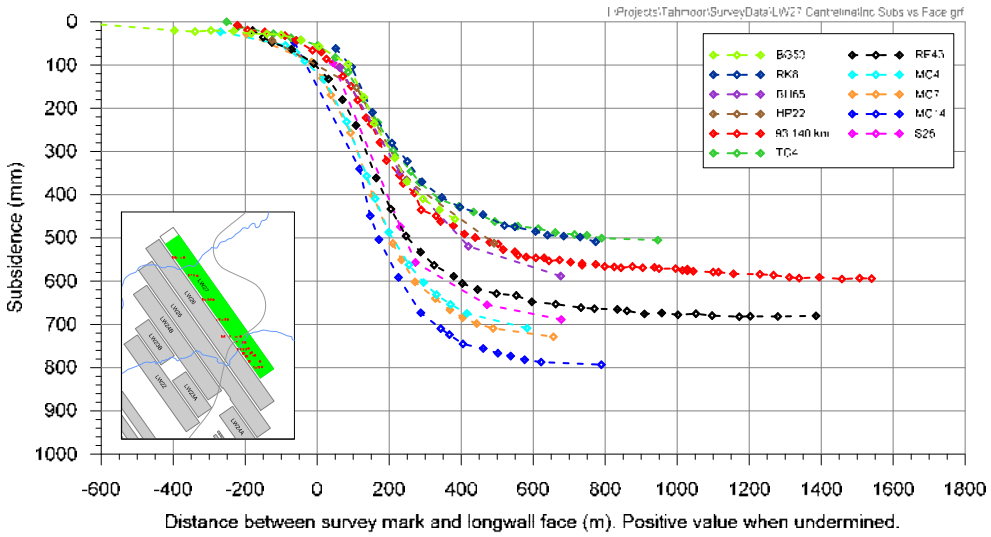


Fig. 3.15 Observed Development of subsidence along Longwall 27 centreline versus distance to longwall face

As further adjacent panels are extracted, additional subsidence can be experienced above the previously mined panel or panels. However, a point is reached where a maximum value of subsidence occurs over the series of panels irrespective of whether more panels are later extracted.

Differential vertical and horizontal subsidence movements, such as tilt, curvature, strain and valley closure and upsidence are also observed to develop gradually as mining progresses.

The gradual development of subsidence movements allows potential impacts on surface features to be managed effectively. This is because with the implementation of an effective monitoring program, unexpected or anomalous subsidence ground movements can be detected early and actions taken in response well before potentially severe impacts occur.

4.1. Introduction

The following sections provide details on the maximum predicted conventional subsidence parameters resulting from the extraction of the proposed mine layout for LWs S1A to S6A using the calibrated IPM model.

The predicted subsidence parameters and the impact assessments for the natural features and surface infrastructure are provided in Chapters 5 through to 11.

The predicted subsidence, tilt and curvature have been obtained using the Incremental Profile Method, which was calibrated for local conditions as described in Section 3.7. The predicted strains have been determined by analysing the strains measured during the previous extraction of longwalls at Tahmoor Mine, as well as at other nearby collieries.

The maximum predicted subsidence parameters and the predicted subsidence contours provided in this Chapter describe and show the conventional movements and do not include the valley-related upsidence and closure movements, nor the effects of faults and other geological structures. Such effects have been addressed separately in the impact assessments for each feature provided in Chapter 5 through to 11.

4.2. Maximum predicted conventional subsidence, tilt and curvature

The maximum predicted conventional subsidence parameters resulting from the extraction of the proposed longwalls were determined using the calibrated Incremental Profile Method, which was described in Chapter 3.

A summary of the maximum predicted values of incremental conventional subsidence, tilt and curvature, due to the extraction of each of the proposed amended longwalls, is provided in Table 4.1. The predicted ground strains are discussed in Section 4.3. The predicted tilts provided in this table are the maxima after the completion of each of the proposed longwalls. The predicted curvatures are the maxima at any time during or after the extraction of each of the proposed longwalls.

Table 4.1 Maximum predicted incremental conventional subsidence, tilt and curvature resulting from the extraction of each of the proposed longwalls

Longwall	Maximum predicted incremental conventional subsidence (mm)	Maximum predicted incremental conventional tilt (mm/m)	Maximum predicted incremental conventional hogging curvature (km^{-1})	Maximum predicted incremental conventional sagging curvature (km^{-1})
LW S1A	800	7.0	0.08	0.22
LW S2A	950	7.5	0.08	0.22
LW S3A	950	8.0	0.09	0.22
LW S4A	950	8.0	0.09	0.22
LW S5A	950	8.0	0.10	0.22
LW S6A	975	8.3	0.09	0.23

The predicted total conventional subsidence contours, using the calibrated IPM model for Tahmoor Mine, resulting from the extraction of the proposed LWs S1A to S6A are shown in Drawing No MSEC1192-22.

A summary of the maximum predicted values of total conventional subsidence, tilt and curvature, after the extraction of each of the proposed amended longwall series, is provided in Table 4.2.

Table 4.2 Maximum predicted total conventional subsidence, tilt and curvature after the extraction of each of the proposed longwalls

Longwalls	Maximum predicted total conventional subsidence (mm)	Maximum predicted total conventional tilt (mm/m)	Maximum predicted total conventional hogging curvature (km^{-1})	Maximum predicted total conventional sagging curvature (km^{-1})
LW S1A	800	7.0	0.08	0.22
LW S2A	1,000	8.0	0.10	0.22
LW S3A	1,200	8.0	0.10	0.22
LW S4A	1,250	8.5	0.13	0.22
LW S5A	1,350	9.0	0.14	0.22
LW S6A	1,350	9.5	0.14	0.24

The maximum predicted total subsidence, after the completion of the proposed longwalls, is 1,350 mm which represents around 61 % of the extraction height. The maximum predicted total conventional tilt is 9.5 mm/m (i.e. 0.95 %), which represents a change in grade of 1 in 95. The maximum predicted total conventional curvatures are 0.14 km^{-1} hogging and 0.24 km^{-1} sagging, which represent minimum radii of curvature of 7.1 kilometres and 4.2 kilometres, respectively.

The predicted conventional subsidence parameters vary across the *Subsidence Study Area* as the result of, amongst other factors, variations in the depths of cover, longwall geometry and extraction heights. To illustrate this variation, the predicted profiles of conventional subsidence, tilt and curvature have been prepared along a prediction line, the locations of which is shown in Drawing No. MSEC1192-22.

The predicted profiles of conventional subsidence, tilt and curvature along Prediction Line 1, resulting from the extraction of the proposed LWs S1A to S6A, are shown in Fig. E.01 in Appendix E. The predicted incremental profiles, due to the extraction of each of the proposed longwalls, are shown as dashed black lines. The predicted total profile, after the extraction of each of the proposed amended longwalls, are shown as solid blue lines with the final predicted total profiles being shown in a thicker solid blue line. The range of predicted curvatures in any direction to the prediction lines, at any time during or after the extraction of the proposed longwalls, is shown by the grey shading.

The reliability of the predictions of subsidence, tilt and curvature, obtained using the Incremental Profile Method, is discussed in Section 3.4 to Section 3.8 and Section 4.4 to Section 4.6.

4.2.1. Comparison between predictions based on proposed LWs S1A to S6A with predictions based on the approved EIS layout

Minor changes have been made to the mine layout for proposed LWs S1A to S6A since development consent was received (EIS Layout). The potential for changes was foreshadowed by Tahmoor Coal when it applied for development consent. A comparison between mine layouts was previously shown in Fig. 1.2 and further details are provided.

- The layout for LWs S1A to S6A has been shifted approximately 35 metres to the south-west;
- LWs S2A to S6A have been widened by 2 metres (the width of LW S1A is unchanged);
- Chain pillar widths for the tailgates of LWs S3A to S6A have been reduced by 2 metres (the chain pillar between LWs S1A and S2A is unchanged);
- The commencing ends of LWs S1A to S6A have been aligned compared to the previous staggered layout. The outcome of the change is that LWs S2A to S6A have been extended in length. The gap between the A and B series longwalls will be maintained, such that the future B series will be shortened when compared to the mine layout that was submitted for development consent; and
- The planned sequence has been amended, such that the A series longwalls are proposed to be extracted in sequence. When Tahmoor Coal applied for development consent, it had been planned to extract LWs 101A to 103A first, then the B series longwalls and return to extract LWs 104A to 106A.

A comparison between predictions based on proposed LWs S1A to S6A with predictions based on the approved EIS layout is shown in Fig. 4.1. A comparison between maximum predicted incremental and total conventional subsidence, tilt and curvature between the EIS Layout and the First Amended Layout is shown in Table 4.3 and Table 4.4.

The proposed increases in panel width by 2 metres are very small compared to the overall depth of cover (0.5%) and panel width (0.7%). The chain pillar widths have been reduced by 5%, the 2 metre reduction from 38 metres to 36 metres represents a 0.5% reduction as a proportion of the depth of cover. Both proposed changes are predicted to result in very small increases in predicted maximum subsidence, tilt and curvature, as shown in Fig. 4.1. The predicted changes are within the accuracy of the subsidence prediction model.

The proposed offset in the layout by 35 metres has resulted in a shift of the predicted subsidence profiles across the panels. As shown in Fig. 4.1, some points on the surface are predicted to experience greater subsidence, tilt and curvature as a result of the change, while other points on the surface are predicted to experience greater subsidence, tilt and curvature.

For linear features such as streams, railways, roads and pipelines, the overall predicted maximum subsidence, tilts and curvatures are similar but shifted slightly. For discrete surface features such as building structures, the proposed changes will result in higher predicted values for some features and lower predicted values for other features but the overall spread across the Subsidence Study Area is expected to be similar. It is further noted that subsidence predictions for discrete surface features have been provided in this Extraction Plan report and the previous EIS report as the maximum predicted values within 20 metres of each feature, in recognition of the accuracy of the prediction method. This conservative approach is expected to buffer the effects of the 35 metre shift in mine layout.

The proposed change to the alignment of the central mains between the A and B series longwalls has been proposed to improve efficiencies in resource recovery and mining operations. The gap between the A and B series longwalls will be maintained, such that the future B series will be shortened when compared to the mine layout that was submitted for development consent. Some points on the surface are predicted to experience greater subsidence, tilt and curvature as a result of the change, while other points on the surface are predicted to experience greater subsidence, tilt and curvature as a result of the change.

The proposed changes to the sequencing of longwall extraction is expected to be beneficial to the community in the sense that the effects of extraction of the A series will occur over a shorter duration. Under the previously proposed sequencing in the EIS, the ground surface above LWs S3A and S4A in particular would have experienced a delay in the order of 5 years between active subsidence events while the B series was extracted.

It is also worthwhile noting that the points on the surface where maximum subsidence, tilt and curvatures were predicted for the approved EIS layout are located above the longwall panels in the B series. While the proposed changes to the mine layout in the A series are predicted to result in very small increases in predicted maximum subsidence, tilt and curvature over the A series, the predicted maxima remain less than the maximum subsidence, tilt and curvatures that were predicted for the approved EIS layout.

Specific subsidence predictions have been provided for identified surface and sub-surface features in this report. Comparisons to previously provided predictions for the EIS Layout have generally not been provided for reasons of brevity. Detailed comparisons can be made for each feature by comparing the findings in Report No. MSEC1123 for the EIS Layout.

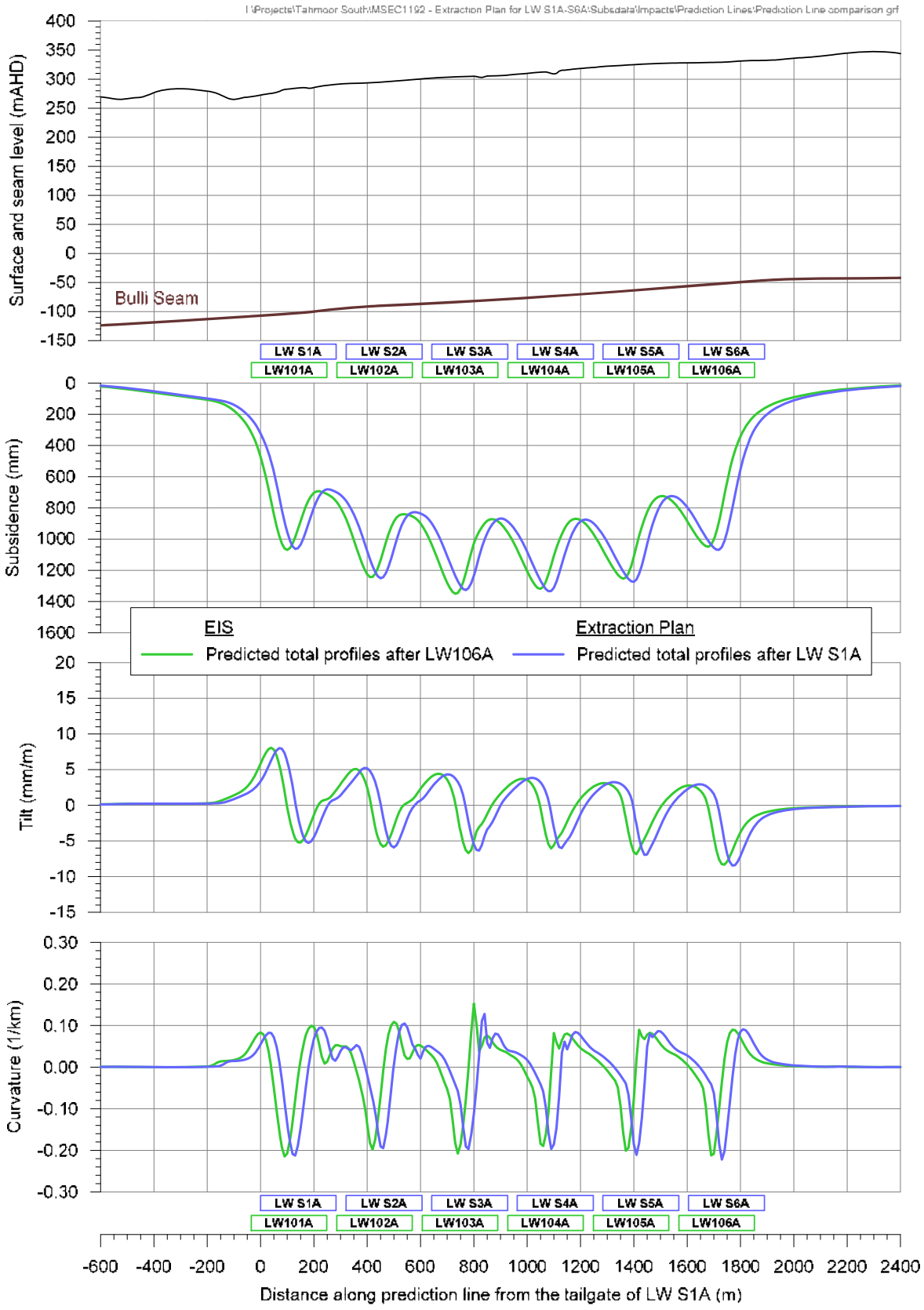


Fig. 4.1 Comparison of predictions between proposed Extraction Layout and approved EIS Layout

Table 4.3 Maximum predicted incremental conventional subsidence, tilt and curvature resulting from the extraction of the Extraction Plan Layout and the EIS Layout

Layout	Longwall	Maximum predicted incremental conventional subsidence (mm)	Maximum predicted incremental conventional tilt (mm/m)	Maximum predicted incremental conventional hogging curvature (km^{-1})	Maximum predicted incremental conventional sagging curvature (km^{-1})
Proposed Extraction Plan LWs S1A to S6A	LW S1A	800	7.0	0.08	0.22
	LW S2A	950	7.5	0.08	0.22
	LW S3A	950	8.0	0.09	0.22
	LW S4A	950	8.0	0.09	0.22
	LW S5A	950	8.0	0.10	0.22
	LW S6A	975	8.3	0.09	0.23
EIS Layout (MSEC1123)	LW101A	800	7.0	0.08	0.22
	LW102A	950	7.5	0.08	0.21
	LW103A	950	7.5	0.08	0.21
	LW104A	950	8.0	0.09	0.21
	LW105A	950	8.0	0.09	0.21
	LW106A	950	8.0	0.09	0.22

Table 4.4 Maximum predicted total conventional subsidence, tilt and curvature resulting from the extraction of the Extraction Plan Layout and the EIS Layout

Layout	Longwall	Maximum predicted total conventional subsidence (mm)	Maximum predicted total conventional tilt (mm/m)	Maximum predicted total conventional hogging curvature (km^{-1})	Maximum predicted total conventional sagging curvature (km^{-1})
Proposed Extraction Plan LWs S1A to S6A	LW S1A	800	7.0	0.08	0.22
	LW S2A	1,000	8.0	0.10	0.22
	LW S3A	1,200	8.0	0.10	0.22
	LW S4A	1,250	8.5	0.13	0.22
	LW S5A	1,350	9.0	0.14	0.22
	LW S6A	1,350	9.5	0.14	0.24
EIS Layout (MSEC1123)	LW101A	800	7.0	0.08	0.22
	LW102A	1000	8.0	0.10	0.22
	LW103A	1200	8.5	0.11	0.22
	LW104A	1300	8.5	0.16	0.22
	LW105A	1350	8.5	0.16	0.22
	LW106A	1350	8.7	0.16	0.23

4.3. Predicted strains

It is important to appreciate that the extraction of coal not only results in subsidence, but, it also induces horizontal ground movements and ground strains, and, unlike subsidence, which is measured vertically, it is important to appreciate that these parameters have both a magnitude and a direction. The magnitude of the measured ground strains can be sensitive to the ground distances over which they were measured, and, both the measured ground strains and horizontal movements are very sensitive to the direction in which they were measured. Hence, strain and horizontal movements are more complex, and they are more difficult to predict than subsidence, tilt and curvature.

The profiles of observed strain along monitoring lines, therefore, were often irregular in shape even when the profiles of observed subsidence, tilt and curvature were relatively smooth.

Early researchers noticed the similarity between the observed curvature and strain profiles and the similarity between the observed tilt and horizontal movement profiles. Hence, it was logical that the early strain prediction methods were based on linear relationships with predicted conventional curvature and the early horizontal ground movement prediction methods were based on linear relationships with predicted conventional tilt.

The locations that are predicted to experience hogging or convex curvature are expected to be net tensile strain zones and the locations that are predicted to experience sagging or concave curvature are expected to be net compressive strain zones and adopting a linear relationship between curvature and strain provided a reasonable prediction for the maximum conventional tensile and compressive strains.

In the Southern Coalfield, it was found that a curvature to conventional strain conversion factor of 15 provided a reasonable relationship between the maximum predicted curvatures and the maximum predicted conventional strains. Similarly, a tilt to conventional horizontal movement conversion factor of 15 was found to provide a reasonable relationship between the maximum predicted tilt and the maximum predicted conventional horizontal movement.

However, it was noticed that, whilst these correlations were reasonable for the maximum values of these parameters over some areas of the mined panels, they were not as reliable in many other areas, particularly in those locations that were beyond the edges of the mined panels that were near changes in geological conditions. It was also noted that survey tolerance and valley related movements can represent a high proportion of measured ground strains and horizontal displacements.

The limited accuracy of strain and horizontal movement predictions at locations away from the point of maximum strain and horizontal movement was discussed in later subsidence prediction reports where it was stated that the measured strains and horizontal ground movements at a point can vary considerably from the predicted conventional values. It was noted that the locations that were predicted to experience hogging or convex curvature experienced net tensile strain zones and the locations that were predicted to experience sagging or concave curvature experienced net compressive strain zones, but, it was highlighted that the observed strain and horizontal movement profiles along monitoring lines were irregular in shape, with an occasional spike, compared to the observed subsidence, tilt and curvature profiles which were relatively smooth. Hence, it was concluded that, whilst the prediction of vertical subsidence and tilt at a point could be carried out with reasonable accuracy and reliability, the prediction of mining-induced ground strains and horizontal movements at a point was far less accurate, especially when those predictions used linear conversion factors that were based on predicted conventional curvature and tilt.

Furthermore, the horizontal movement predictions at a point were rarely provided and the predictions of ground strains are usually provided based on statistical basis, as is detailed in Section 4.3.1.

However, strain is one of the most important parameters for assessing the likelihood of mine subsidence damage to natural features and built features on the surface. Recent research has resulted in some improved understanding and methods for predicting ground strains and relative horizontal movements in zones across mined panels at the surface, (Barbato, 2016, 2017). These new methods for predicting strain have been developed dependent on the mining geometry, surface topography, surface geology and the likelihood of irregular anomalous movements.

The predicted distribution of strains using this new method also provides guidance on the magnitudes of localised spikes and the likelihoods of exceeding strain thresholds based on previously measured ground monitoring data (Barbato et al., 2016 and 2017).

The reasons why ground strains and horizontal movements are more complex and difficult to predict than subsidence, tilt and curvature are partly associated with the observation that, while the strata has only one direction to move,(i.e. vertically downwards), it can be moved in two directions horizontally and it has been observed that the ground will move wherever it is easiest to go. Additionally, studies have noted that ground strains and horizontal movements are influenced/affected by many multiple factors and a complex interaction of many mechanisms, including the:

- magnitude of the vertical subsidence, tilt and the depth of cover;
- steepness and direction of the surface topography;
- steepness and direction of the seam dip;
- direction of mining in relation to both the surface and seam slope;
- geology, geomechanical properties and thicknesses of the near surface strata, as well as, all the overburden strata layers, the seam and the strata layers immediately under the seam;
- presence of geological faults, pre-existing natural joints and igneous intrusions;
- magnitude and principal direction of the in situ horizontal compressive stresses in the strata layers around the mined goaf and the surface strata layers;
- presence and proximity of previously extracted panels in the currently mined seam and previously extracted panels in other seams;
- behaviour of blocky sandstone environments where initial ground movements occur predominantly along pre-existing natural joints, the location of which would not be known;
- limited ability of opened joints to close fully during the following compression phases after the initial shearing and tensile movements;
- reversing component that seems to initially move surveyed surface pegs towards the longwall face as the face approaches and, then, after the face extracts under and away from this peg, the surface is moved back towards its initial position and often it is moved further past that position as it follows the mining face; and
- other contributing factors such as the degree of surface roughness and frictional resistance along the bedding planes, survey accuracy or survey tolerance (especially where the strains are of a low order of magnitude), the presence of groundwater flows along the bedding planes and its influence on the slippage along bedding planes, etc.

Nevertheless, it has been concluded that the curvature to conventional strain conversion factor and the tilt to horizontal movement conversion factor can be used to provide a reasonable indication of the maximum conventional strains and horizontal movements over extracted panels.

Using the maximum predicted conventional curvatures of 0.14 km^{-1} hogging and 0.24 km^{-1} sagging curvature and the conventional strain conversion factor of 15, the maximum predicted conventional strains for the proposed LWs S1A to S6A, are approximately 2.1 mm/m tensile and 3.4 mm/m compressive.

At specific points around the mined panels, however, there can be considerable variation from this linear curvature to conventional strain relationship, resulting from non-conventional movements and a wide range of scatter is observed between the predicted and observed strain profiles. When expressed as a percentage, observed strains can be many times greater than the predicted conventional strain for low magnitudes of curvature. In this report, therefore, MSEC has provided a statistical approach to predict observed strain and hence account for this variability, instead of just providing a single predicted conventional strain.

The range of potential strains above the proposed longwalls has been determined using monitoring data from the previously extracted longwalls at Tahmoor Mine, as well as from other nearby collieries, including Appin and West Cliff, where the regional geology and mining geometries are reasonably similar to that for the proposed longwalls. A summary of the monitoring lines that were used in the strain analysis is provided in Table 4.5 and Table 4.6 shows the mining geometry for the proposed longwalls.

Table 4.5 Monitoring lines used in the strain analysis

Location	Monitoring Lines	Longwall Widths (m)	Depths of Cover (m)	Width-to-Depth Ratios	Extraction Heights (m)
Early longwall areas at Tahmoor Mine	100-Line	190	410	0.47	2.0
	200-Line	190	410	0.46	1.9
	300-Line	190 ~ 240	430	0.47	2.2
	800-Line	235	420	0.56	2.1
	900-Line	235	420	0.56	2.0
	1000-Line	190 ~ 240	400	0.57	1.8
Northern areas over Tahmoor	40 monitoring lines located outside the area of '*increased subsidence*'	285	425 ~ 470 *(440 average)*	0.60 ~ 0.67 *(0.64 average)*	1.7 ~ 2.3 *(2.1 average)*
Appin Area 3	M-Line	260	480 ~ 520 *(500 average)*	0.50 ~ 0.54 *(0.52 average)*	2.6 ~ 3.0 *(2.8 average)*
Appin Area 7	HW2 East, HW2 West, ARTC and Moreton Park Road	305	500 ~ 560 *(530 average)*	0.54 ~ 0.61 *(0.58 average)*	2.8 ~ 3.2 *(3.0 average)*
West Cliff Area 5	B-Line	305	490 ~ 530 *(510 average)*	0.58 ~ 0.62 *(0.60 average)*	2.4 ~ 3.0 *(2.6 average)*

Table 4.6 Mining geometry for the proposed LWs S1A to S6A

Location	Longwall Widths (m)	Depths of Cover (m)	Width-to-Depth Ratios	Extraction Heights (m)
LW S1A to LW S6A	283-285	375 ~ 410 *(390 average)*	0.69 ~ 0.76 *(0.73 average)*	2.1 ~ 2.2 *(2.1 average)*

It can be seen from the above tables, that the extraction heights for the proposed longwalls vary between 2.1 metres and 2.2 metres, which similar to those for the previously extracted longwalls at Tahmoor Mine, which varied between 1.7 metres and 2.3 metres, but is less on average than those for the previously extracted longwalls at Appin and West Cliff Collieries, which varied between 2.4 metres and 3.2 metres. That is, the extraction heights for the proposed longwalls are within the ranges of those for the previously extracted longwalls at Tahmoor, Appin and West Cliff Collieries.

The width-to-depth ratios for the proposed longwalls varies between 0.69 and 0.76, which are slightly greater than those for the previously extracted longwalls at Tahmoor, Appin and West Cliff Collieries, which varied between 0.46 and 0.67. Unfortunately, there is limited available ground monitoring data from previously extracted longwalls in the Southern Coalfield where the width-to-depth ratios are exactly similar to the proposed longwalls.

There is, however, extensive ground monitoring data available from previously extracted longwalls in the Newcastle, Hunter and Western Coalfields where the width-to-depth ratios were similar and much greater than those for the proposed longwalls. This data was not included in the strain analyses, since the overburden geology is different to that in the Southern Coalfield and since the width-to-depth ratios for the proposed longwalls are only slightly higher than the available Southern Coalfields data that has similar overburden geology.

A review of the available data from the Newcastle, Hunter and Western Coalfields indicates that the observed strains for previously extracted longwalls having width-to-depth ratios between 0.70 and 0.85, i.e. slightly greater when compared to the proposed amended longwalls, were on average, around 20 % to 40 % greater than the observed strains for previously extracted longwalls in the Newcastle, Hunter and Western Coalfields having width-to-depth ratios between 0.50 and 0.70, i.e. similar to Tahmoor North, Appin and West Cliff Collieries.

It could be expected, therefore, that the observed strains resulting from the extraction of the proposed longwalls would be, on average, around 20 % to 40 % greater than those previously experienced at Tahmoor, Appin and West Cliff Collieries and, hence, the predicted strains for the proposed longwalls have been determined from the analyses of strain from the previously extracted longwalls at Tahmoor, Appin and West Cliff Collieries, with the magnitudes increased by 20 % to 40 % to account for the higher width-to-depth ratios based on the observations from the Newcastle, Hunter and Western Coalfields.

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, which are addressed separately in this report. The strains resulting from damaged or disturbed survey marks have also been excluded.

A number of probability distribution functions were fitted to the empirical monitored strain data. It was found that a *Generalised Pareto Distribution (GPD)* provided a good fit to the raw strain data. 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).

4.3.1. Analysis of strains measured in survey bays

For features that are in discrete locations, such as building structures, farm dams and archaeological sites, it is appropriate to assess the frequency of the observed maximum strains for individual survey bays.

Predictions of strain above goaf

The survey database has been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of the previous longwalls at Tahmoor, Appin and West Cliff Collieries, for survey bays that were located directly above goaf or the chain pillars that are located between the extracted longwalls, which has been referred to as "*above goaf*".

The histogram of the maximum observed total tensile and compressive strains measured in survey bays above goaf, for monitoring lines at Tahmoor, Appin Area and West Cliff Collieries, is provided in Fig. 4.2. The probability distribution functions, based on the fitted GPDs, have also been shown in this figure.

The 95 % confidence levels for the maximum total strains that the individual survey bays *above goaf* experienced at any time during mining at Tahmoor, Appin and West Cliff Collieries were 0.9 mm/m tensile and 1.6 mm/m compressive. The strains for the proposed longwalls are predicted to be 20 % to 40 % greater than those previously observed at these collieries and, therefore, it is expected that 95 % of the strains measured *above goaf* would be less than 1.3 mm/m tensile and 2.2 mm/m compressive.

The 99 % confidence levels for the maximum total strains that the individual survey bays *above goaf* experienced at any time during mining at Tahmoor, Appin and West Cliff Collieries were 1.4 mm/m tensile and 3.1 mm/m compressive. Similarly, it is expected that 99 % of the strains measured *above goaf* for the proposed longwalls would be less than 2.0 mm/m tensile and 4.3 mm/m compressive.

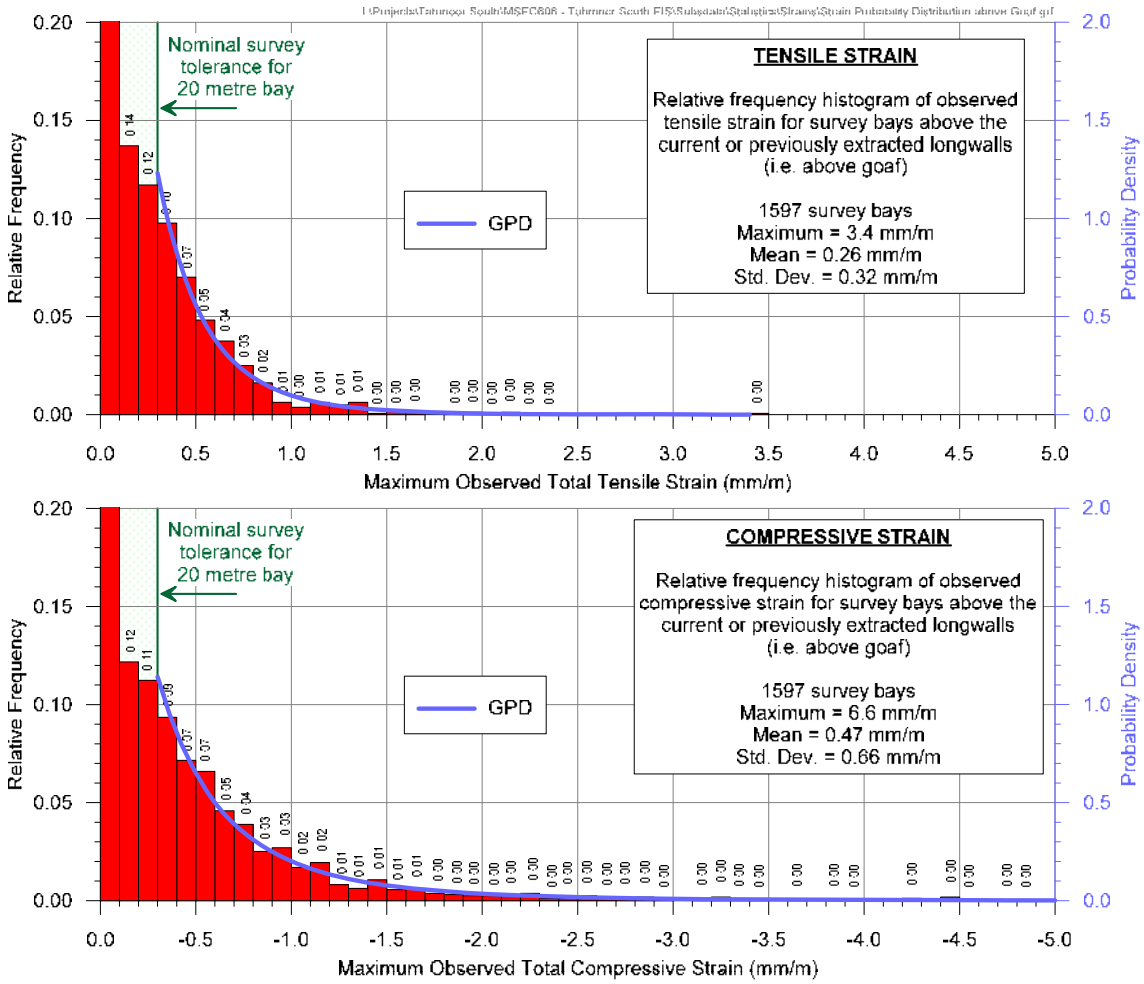


Fig. 4.2 Distributions of the measured maximum tensile and compressive strains for surveys bays located *above goaf* at Tahmoor, Appin and West Cliff Collieries

Predictions of strain above solid coal

The survey database has also been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of the previous longwalls at Tahmoor, Appin and West Cliff Collieries, for survey bays that were located beyond the goaf edges of the mined panels and positioned on unmined areas of coal, i.e. outside panels but within 200 metres of the nearest longwall goaf edge, which has been referred to as "*above solid coal*".

The histogram of the maximum observed tensile and compressive strains measured in survey bays above solid coal, for monitoring lines at Tahmoor, Appin and West Cliff Collieries, is provided in Fig. 4.3. The probability distribution functions, based on the fitted GPDs, have also been shown in this figure.

The 95 % confidence levels for the maximum total strains that the individual survey bays *above solid coal* experienced at any time during mining at Tahmoor, Appin and West Cliff Collieries were 0.6 mm/m tensile and 0.5 mm/m compressive. The strains for the proposed longwalls are predicted to be 20 % to 40 % greater than those previously observed at these collieries and, therefore, it is expected that 95 % of the strains measured *above solid coal* would be less than 1.0 mm/m tensile and compressive.

The 99 % confidence levels for the maximum total strains that the individual survey bays *above solid coal* experienced at any time during mining at Tahmoor, Appin and West Cliff Collieries were 0.9 mm/m tensile and compressive. Similarly, it is expected that 99 % of the strains measured *above solid coal* adjacent to the proposed longwalls would be less than 1.5 mm/m tensile and compressive.

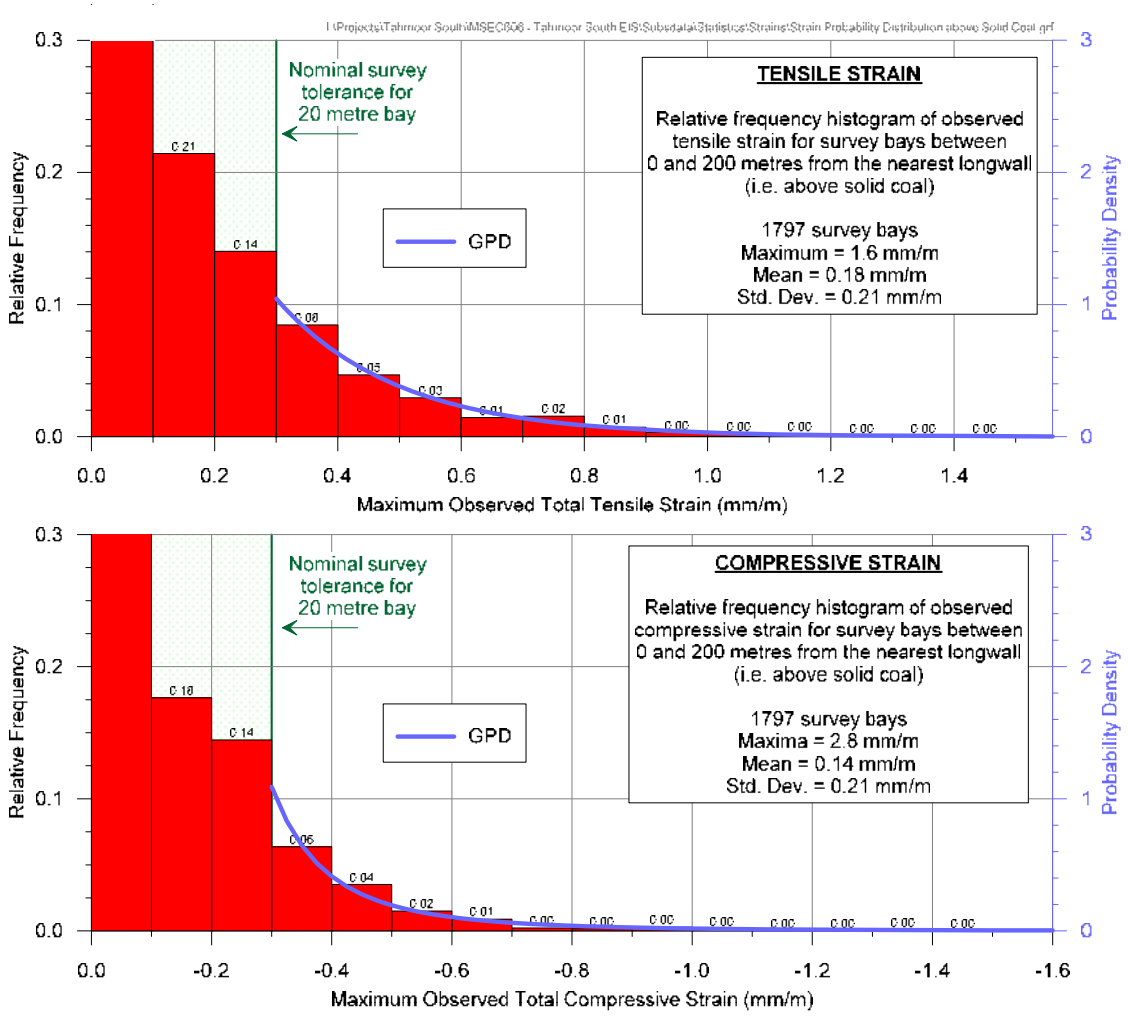


Fig. 4.3 Distributions of the measured maximum tensile and compressive strains for survey bays located *above solid Coal* at Tahmoor, Appin and West Cliff Collieries

4.3.2. Analysis of strains measured along whole monitoring lines

For linear features such as roads, cables and pipelines, it is more appropriate to assess the frequency of the maximum observed strains along whole monitoring lines, rather than for individual survey bays. That is, an analysis of the maximum strains measured anywhere along the monitoring lines, regardless of where the strain actually occurs.

The histogram of maximum observed total tensile and compressive strains measured anywhere along the monitoring lines, at any time during or after the extraction of the previous longwalls at Tahmoor, Appin and West Cliff Collieries, is provided in Fig. 4.4.

It can be seen from Fig. 4.4, that 42 of the 52 monitoring lines (i.e. 92 % of the total) at Tahmoor, Appin and West Cliff Collieries had recorded maximum total tensile strains of 2.0 mm/m, or less. The strains for the proposed longwalls are predicted to be 20 % to 40 % greater than those previously observed at these collieries and, therefore, it is expected that 92 % of the monitoring lines above the proposed longwalls would experience maximum tensile strains of 3.0 mm/m, or less.

It can also be seen, that 45 of the 52 monitoring lines (i.e. 87 % of the total) at Tahmoor, Appin and West Cliff Collieries had recorded maximum total compressive strains of 4.0 mm/m, or less. The strains for the proposed longwalls are predicted to be 20 % to 40 % greater than those previously observed at these collieries and, therefore, it is expected that 87 % of the monitoring lines above the proposed longwalls would experience maximum compressive strains of 5.5 mm/m, or less.

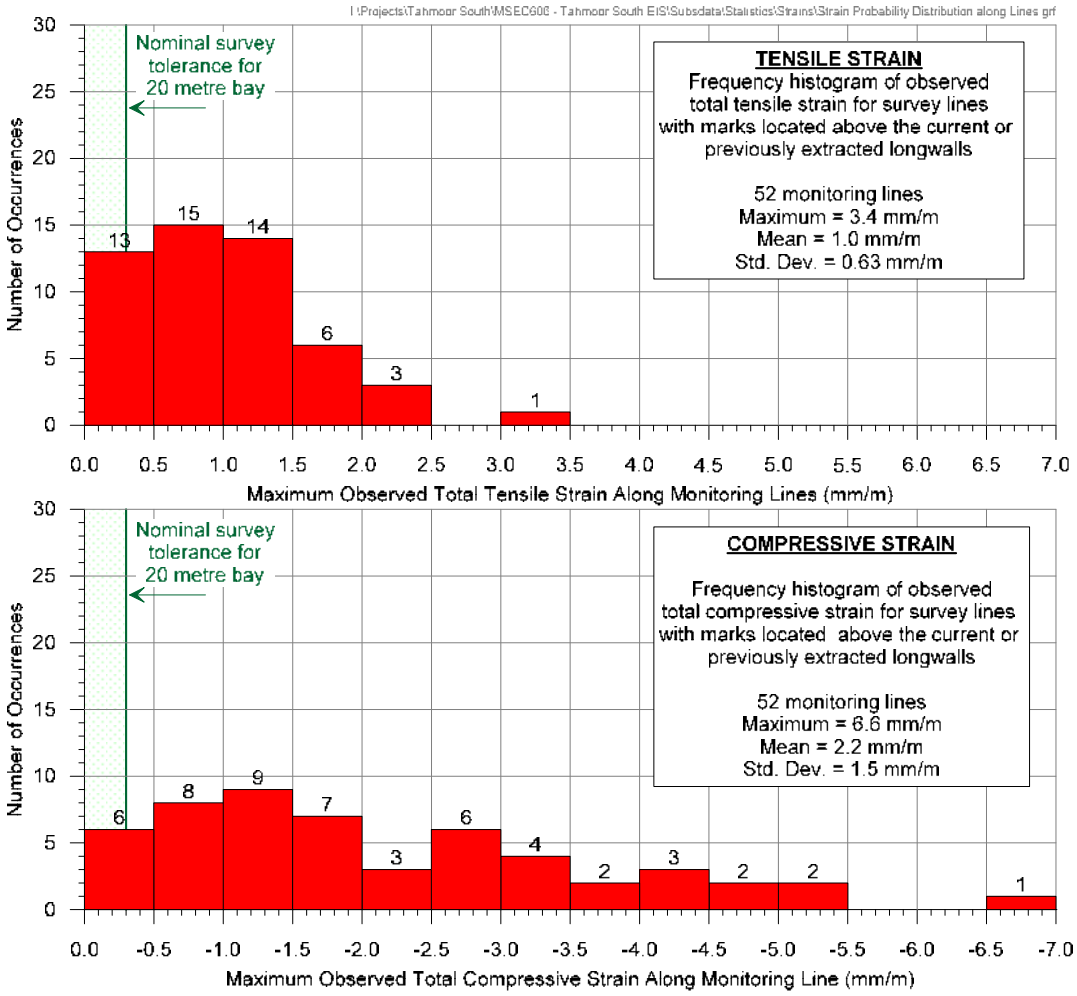


Fig. 4.4 Distributions of measured maximum tensile and compressive strains anywhere along the monitoring lines at Tahmoor, Appin and West Cliff Collieries

4.3.3. Analysis of shear strains

As described in Section 3.3, ground strain comprises two components, being normal strain and shear strain, which can be interrelated using a Mohr's Circle analysis. The magnitudes of the normal strain and shear strain components are, therefore, dependent on the orientation in which they are measured. The maximum normal strains (i.e. principal strains) are those in the direction where the corresponding shear strain is zero.

Normal strains along monitoring lines can be measured using 2D and 3D techniques, by taking the change in horizontal distance between two points on the ground and dividing by the original horizontal distance between them. This provides the magnitude of normal strain along the orientation of the monitoring line but, this strain may not necessarily be the maximum (i.e. principal) strain.

Shear deformations are more difficult to measure, as they are the relative horizontal movements perpendicular to the direction of measurement. However, 3D monitoring techniques provide data on the direction and the absolute displacement of survey marks and, therefore, the shear deformations perpendicular to the monitoring line can be determined. It is possible to gain an understanding of the shear strain along a monitoring line with repeat measurements, but, in accordance with rigorous definitions and the principles of continuum mechanics, (e.g. Jaeger, 1969), it is not possible to accurately determine horizontal shear strains in any direction relative to the monitoring line using 3D monitoring data from a straight line of survey marks.

As described in Section 3.3, shear deformations perpendicular to monitoring lines can be described using various parameters, including horizontal tilt, horizontal curvature, horizontal mid-ordinate deviation, angular distortion and shear index. In this report, horizontal mid-ordinate deviation has been used as the measure for shear deformation, which is defined as the differential horizontal movement of each survey mark, perpendicular to a line drawn between two adjacent survey marks.

The frequency distribution of the maximum total horizontal mid-ordinate deviations measured at survey marks above goaf, for previously extracted longwalls in the Southern Coalfield, is provided in Fig. 4.5. As the typical survey bay length was 20 metres, the calculated mid-ordinate deviations were over a chord length of 40 metres. The probability distribution function, based on the fitted GPD, has also been shown in this figure.

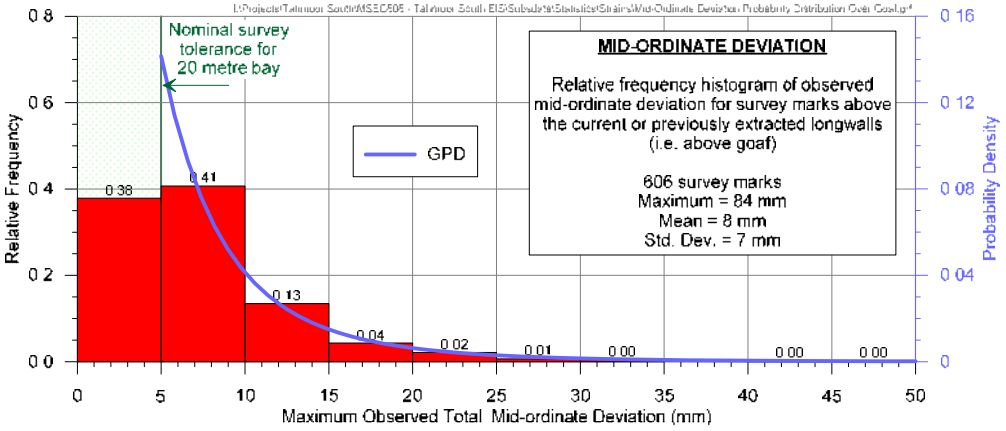


Fig. 4.5 Distribution of measured maximum mid-ordinate deviation during the extraction of previous longwalls in the Southern Coalfield for marks located above goaf

The 95 % and 99 % confidence levels for the maximum total horizontal mid-ordinate deviation that the individual survey marks located above goaf experienced at any time during mining were 20 mm and 35 mm, respectively. The shear deformations for the proposed longwalls are estimated to be 20 % to 40 % greater than those previously observed at Tahmoor, Appin and West Cliff Collieries and, therefore, it is expected that 95 % and 99 % of the horizontal mid-ordinate deviations measured above the proposed longwalls would be less than 30 mm and 50 mm, respectively.

4.4. Potential additional settlement above coal barriers between proposed and previous mine workings

Parts of the proposed longwalls are located close or adjacent to the previously extracted Longwall 2, Longwall 14B and Longwalls 15 to 19 with a proposed barrier of unmined coal being left between the previously extracted panels and the proposed workings, (except for development headings).

Slightly increased levels of subsidence over the predicted levels of subsidence were observed within the following areas at Tahmoor, Appin or Tower Collieries that were also located above similar unmined barriers of coal (with some development headings) between previously extracted areas, such as:

- Between Longwall 3 and Longwall 22 at Tahmoor Mine;
- Between Longwall 23A and 23B at Tahmoor Mine;
- Between Longwall 24A and the 200 Panels at Tahmoor Mine;
- Between Longwalls 22 to 24B and Longwall 24A and the 200 Panels and Longwall 25 (i.e. mining on three sides of a corridor of intact coal) at Tahmoor Mine;
- Between Longwalls 8-12, Longwall 18 and Longwall 408 at Appin Colliery; and
- Between Longwalls 14-18, 301-302 and 401 at Appin Colliery.

The amount of increased subsidence in these areas has generally been between 50 and 150 mm of subsidence above what was predicted using the IPM and generally low levels of tilt and strain were measured within these areas.

These areas of increased subsidence have not always been observed in these situations. For example, it was not observed between Longwalls 3-9 and Longwall 20, nor between Longwalls West 1-2 and Longwalls 30-32 at Tahmoor Mine.

While observed subsidence may exceed predictions above the coal barrier between proposed LW S1A and previously extracted Longwall 2, between proposed LWs S1A to S6A and previously extracted LWs 14B to 19, subsidence monitoring has shown that it is usually accompanied by relatively low systematic tilts, curvature and strains (less than 0.5 mm/m and usually within survey tolerance).

It is noted that the *Subsidence Study Area* encompasses the surface areas located directly above the coal barriers.

4.5. Predicted conventional horizontal movements

Tahmoor Coal commenced surveys of absolute horizontal movement during the mining of Longwall 25. The great majority of the surveys at Tahmoor Mine are now undertaken using 3D surveying techniques, including most of the pegs along the Main Southern Railway and within the monitoring network around the ends of Longwalls 25 to 32.

The maximum measured incremental horizontal movement to date has been 255 mm at Peg RE14 on Remembrance Drive during the mining of Longwall 26. The maximum measured incremental horizontal movement after the completion of Longwall 25 was 175 mm at Peg 25-21 along the Longwall 25 Centreline.

These horizontal movements are within the normal range in the Southern Coalfield at similar depths of cover.

Absolute horizontal movements by themselves do not directly impact on natural and built features, rather impacts occur as the result of differential horizontal movements. Strain is a measure of change of horizontal movement as was discussed in Sections 3.3 and 0. The impacts of strain movements on the natural and built features are addressed in the impact assessments for each feature, which have been provided in Chapters 5 through to 11.

4.6. Predicted far-field horizontal movements

As discussed in Section 3.5, in addition to the conventional subsidence movements that have been predicted above and adjacent to the proposed longwalls, far-field horizontal movements will also be experienced during the extraction of the proposed longwalls.

The observed incremental far-field horizontal movements resulting from the extraction of incremental longwall panels, in any location above goaf, i.e. above the currently mined or previously mined panels, or above solid coal, i.e. unmined areas of coal, are provided in Fig. 4.6. The observed incremental far-field horizontal movements above solid coal only, i.e. outside the extents of extracted longwalls, are provided Fig. 4.7. The confidence levels, based on fitted *Generalised Pareto Distributions* (GPDs), have also been shown in these figures to illustrate the spread of the data. It can be seen from Fig. 4.6 and Fig. 4.7 that the magnitude of the observed far-field horizontal movements over solid unmined areas of coal are lower and more consistent than the observed far-field horizontal movements over previously extracted panels.

A far field monitoring program was conducted by Tahmoor Coal during the extraction of Longwall 32 at key civil structures. The observed horizontal movements were within the normal range. Similar experiences have been observed during the extraction of the Tahmoor West longwalls.

As successive longwalls within a series of longwalls 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 within the strata have been redistributed around the collapsed zones above the first few extracted longwalls, the potential for further movement is reduced. The total far-field horizontal movement may be less, therefore, than the sum of the incremental far-field horizontal movements for the individual longwalls.

The predicted far-field horizontal movements resulting from the extraction of the proposed longwalls are very small and could only be detected by precise surveys. Such movements tend to be bodily movements towards the extracted goaf area, and are accompanied by very low levels of strain, which are generally less than the order of survey tolerance (i.e. less than 0.3 mm/m). The potential impacts of differential far-field horizontal movements on the natural and built features within the vicinity of the proposed longwalls are not expected to be measurable, with possibly the exception of the road and railway bridges, which are discussed in the impact assessments for these features in Chapter 5 through to 11.

No measurable differential movements were observed during the far field monitoring program conducted by Tahmoor Coal during the extraction of Longwall 32 at key civil structures. Some of these structures were located near or across mapped first order faults, including structures within the Picton Water Recycling Plant, the Picton Viaduct, the Victoria Bridge and the Argyle Street Railway Underbridge.

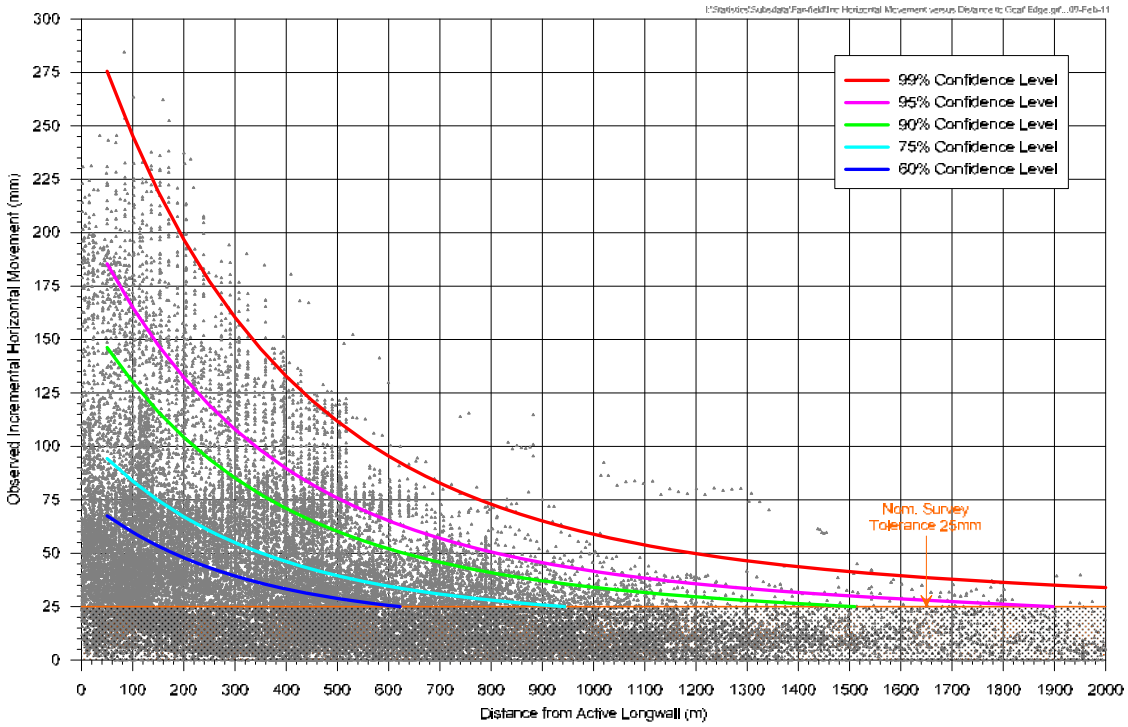


Fig. 4.6 Observed incremental far-field horizontal movements above goaf or solid coal

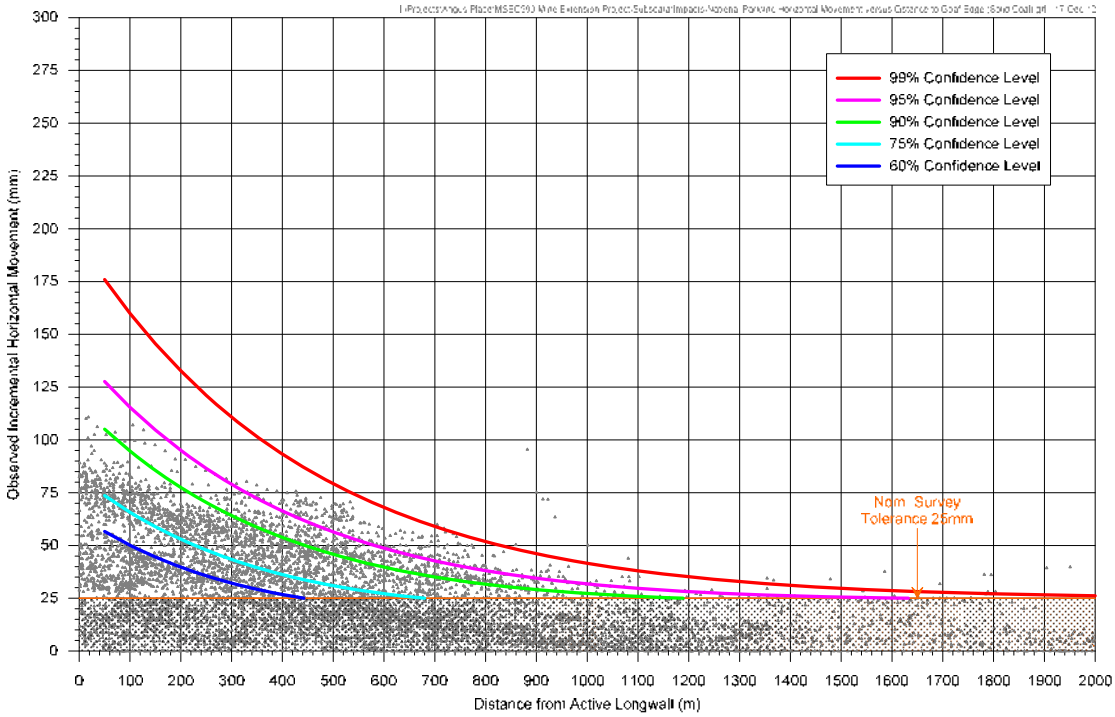


Fig. 4.7 Observed incremental far-field horizontal movements above solid coal only

4.7. Non-conventional ground movements

It is likely non-conventional ground movements will occur within and around the *Subsidence Study Area*, due to near surface geological conditions, steep topography and valley related movements, which were discussed in Section 3.4. These non-conventional movements are often accompanied by elevated tilts, curvatures and strains, which are likely to exceed the conventional predictions.

Specific predictions of upsidence, closure and compressive strain due to the valley related movements are provided for the streams in Section 5.3. The impact assessments for the streams are based on both the conventional and valley related movements. The potential for non-conventional movements associated with steep topography is discussed in the impact assessments for the steep slopes provided in Section 5.5.

In most cases, it is not possible to accurately predict the exact locations or magnitudes of the non-conventional anomalous movements due to near surface geological conditions. For this reason, the strain predictions provided in this report are based on a statistical analysis of measured strains in the Southern Coalfield, including both conventional and non-conventional anomalous strains, which is discussed in Section 4.3. In addition to this, the impact assessments for the natural features and surface infrastructure, which are provided in Chapters 5 through to 11, include historical impacts resulting from previous longwall mining which have occurred as the result of both conventional and non-conventional subsidence movements.

Mining beneath urban and semi-rural areas at Tahmoor and Thirlmere by Tahmoor Mine Longwalls 22 to 32 provides valuable "whole of panel" information. A plot of locations of potential non-conventional movement is shown in Fig. 4.9. The locations were selected based on ground monitoring results or observed impacts that appear to have been caused by non-conventional movement. A total of approximately 59 locations (not including valleys) have been identified over the extracted Longwalls 22 to 32. The surface area directly above the longwalls is approximately 9.1 km^2. This equates to a frequency of 6 sites per square kilometre or one site for every 16 hectares. The non-conventional movements were mainly characterised by elevated compressive ground strains that varied up to a maximum of approximately 5 mm/m.

The largest known case of non-conventional movement in the Southern Coalfield occurred above Appin Colliery Longwall 408 (Swarbrick, *et al.*, 2007). In this case, a low angle thrust fault was re-activated in response to mine subsidence movements, resulting in differential vertical and horizontal movements across the fault. Observations at the site showed that the non-conventional movements developed gradually over a period of time. Regular ground monitoring across the fault indicated that the rate of differential movement was less than 0.5 mm/day at the time non-conventional movements could first be detected. Subsequently as mining progressed, the rate of differential movement increased to a maximum of 28 mm/week.

A recent example occurred at a low angle fault that intersected the Main Southern Railway in the Deviation Cutting at Tahmoor, which was located directly above Longwall 29. The site was monitored extensively during the mining of Longwalls 28 to 31. This included three monitoring lines along the railway cutting, and survey prisms along the railway track.

The results of observed changes in vertical alignment of the pegs along the railway cutting are shown in Fig. 4.8. It can be seen that the most significant changes occurred during the mining of Longwall 29. The changes, however, developed gradually over time, allowing the railway track to be adjusted such that trains could continue to travel through the site.

The observations of the gradual development of differential movements have been consistently observed during the mining of previous longwalls at Tahmoor Mine. While some sites have experienced severe impacts, the subsidence movements developed gradually, allowing time for repair before they became unsafe.

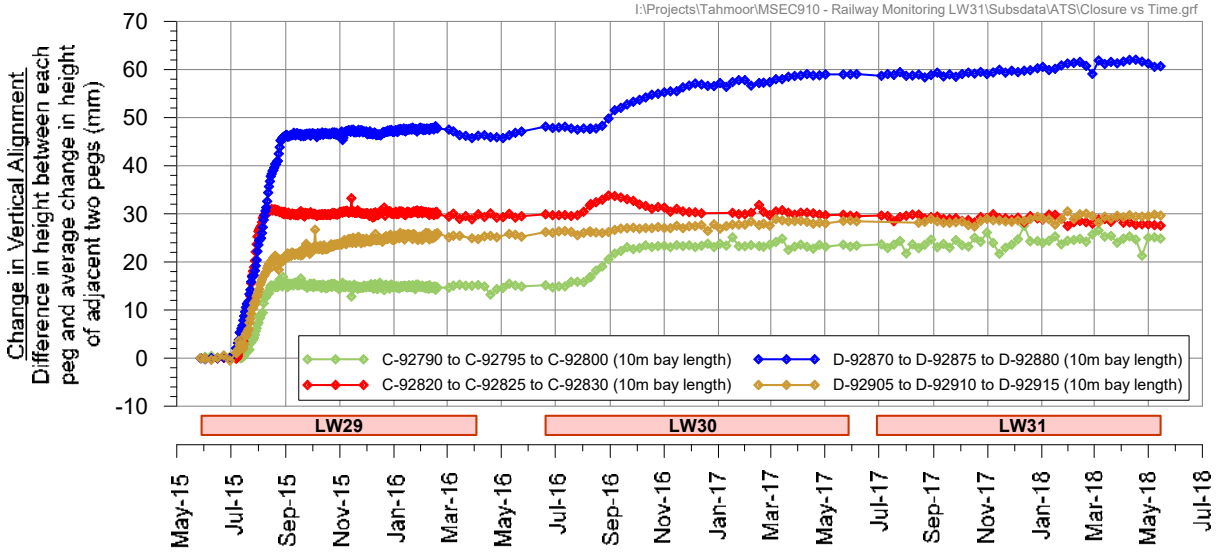


Fig. 4.8 Changes in vertical alignment across a geological fault within a railway cutting during the mining of Longwalls 29 to 31 at Tahmoor Coal

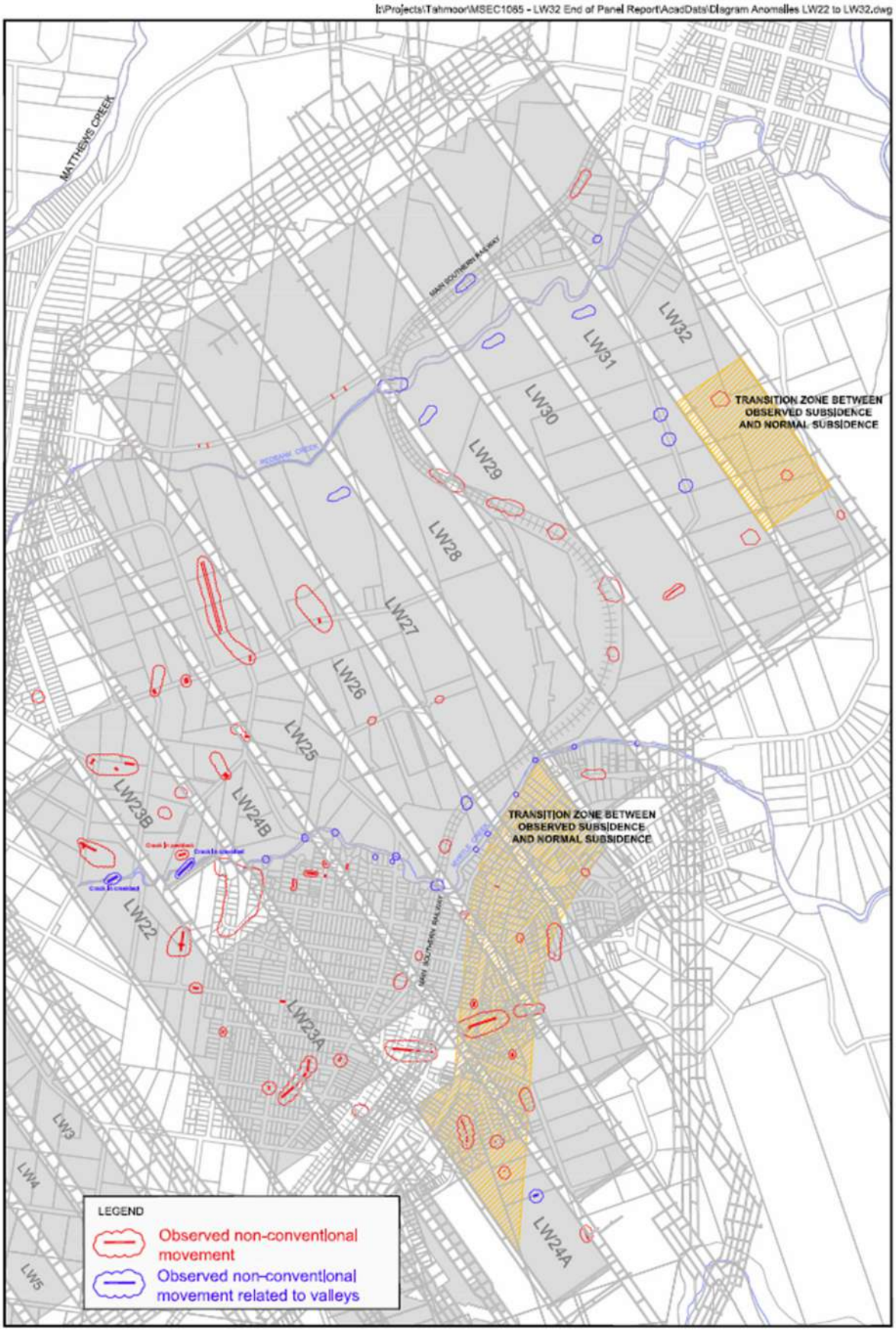


Fig. 4.9 Map showing locations of observed non-conventional movement above Tahmoor Mine Longwalls 22 to 32

4.8. General discussion on mining induced ground deformations

Longwall mining can result in surface cracking, heaving, buckling, humping and stepping at the surface. The extent and severity of these mining induced ground deformations are dependent on a number of factors, including the mine geometry, depth of cover, overburden geology, locations of natural jointing in the bedrock and the presence of near surface geological structures.

Faults and joints in bedrock develop during the formation of the strata and from subsequent distressing associated with movement of the strata. Longwall mining can result in additional fracturing in the bedrock, which tends to occur in the tensile zones, but fractures can also occur due to buckling of the surface beds in the compressive zones. The incidence of visible cracking at the surface is dependent on the pre-existing jointing patterns in the bedrock as well as the thickness and inherent plasticity of the soils that overlie the bedrock.

Surface cracking in soils as the result of conventional subsidence movements, i.e. away from valleys and steep slopes, is not commonly observed where the depths of cover are, for example, around 400 metres, such as the case within the *Subsidence Study Area*. Surface cracking that has been observed as the result of conventional subsidence movements has generally been relatively isolated and of a minor nature.

Cracking is found more often in the bases of valleys due to the compressive strains associated with upsidence and closure movements, which is discussed in Section 5.3. Cracking can also occur at the tops of steep slopes as the result of downslope movements, which is discussed in Section 5.5.

Surface cracks are more readily observed in built infrastructure such as compacted road pavements. In many cases, no visible ground deformations can be seen in the natural ground adjacent to the cracks in the road pavements. In rare instances, more noticeable ground deformations, such as humping or stepping of the ground can be observed at thrust faults. Examples of ground deformations previously observed in the Southern Coalfield, where the depths of cover are 400 metres, or greater, are provided in the photographs in Fig. 4.10 to Fig. 4.13 below.

Localised ground buckling and shearing can occur wherever faults, dykes and abrupt changes in geology occur near the ground surface. The identified geological structures within the *Subsidence Study Area* are discussed in Section 3.8 and it is possible that ground deformations could develop where the Nepean Fault daylights on the surface. Discussions on irregular ground movements were provided in Section 4.7.

Fig. 4.10 Surface compression buckling observed in a pavement

Fig. 4.11 Surface tension cracking along the top of a steep slope

Fig. 4.12 Surface tension cracking along the top of a steep slope

Fig. 4.13 Fracturing and bedding plane slippage in sandstone bedrock in the base of a stream

The following sections provide descriptions, predictions and impact assessments for natural features that have been identified within the *Subsidence Study Area*. The natural features located outside the *Subsidence Study Area*, which may be subjected to far-field movements or valley related movements and may be sensitive to these movements, have also been included as part of these assessments.

5.1. Catchment Areas or Declared Special Areas

There are no catchment areas or declared special areas within the Study Area. The nearest catchment area is the Metropolitan Special Area, which is located approximately 4.5 km southeast of the proposed longwalls.

5.2. The Bargo River

The location of the Bargo River is shown in Drawing No. MSEC1192-07. Descriptions, predictions and impact assessments for the river are provided in the following sections.

5.2.1. Description of the Bargo River

The Bargo River commences north of Colo Vale and near the townships of Hill Top and Yerrinbool and flows generally towards the north and to the west of the Bargo township. The Bargo River then flows to the west and north of the proposed Tahmoor South longwalls. The Bargo River then drains into the Nepean River approximately 4.9 kilometres north-east of the proposed Longwall S1A.

The Bargo River is not located within the 600m Subsidence Study Area for Natural Features. The closest distance between the Bargo River and the proposed longwalls is 690 metres, i.e. to the nearest corner of LW S2A. This section of the river was directly mined beneath by Longwalls 14B to 19.

A summary of the minimum distances between the river and the proposed longwalls is provided below in Table 5.1.

Table 5.1 Minimum distances of the proposed longwalls from the Bargo River

Longwall	Minimum distance from the centreline of Bargo River (m)
LW S1A	720
LW S2A	690
LW S3A	730
LW S4A	780
LW S5A	830
LW S6A	850

The length of the river that is nearest to the *Subsidence Study Area* is a 5th order perennial stream as defined by the Strahler Stream Order Method. This section of the river was directly mined beneath by Longwalls 14B to 19.

The surface water flows in this section of the river are controlled by the Picton Weir (also called the Bargo Weir) with discharge regulated by a fixed discharge valve. The reservoir is emptied following extended dry periods, but it is quickly filled with the spillway overtopping following large storm events. The following article from the Picton Post, dated 1945, provides some background;

> *"The existing dam was built to T.W.L.912 in 1899, the lowest foundation being at R.L.887, which was a few feet below river bed level. In 1910 the wall was raised to T.W.L.920, giving a storage of 37 m.g."*
>
> *"During the recent drought the water level dropped considerably, and it was ascertained that the dam had silted up. It is understood that the silt level is approximately at R.L.904, which would leave an available storage, if this level were uniform, of 33 m.g. It is quite probable that the silt level in the upper reaches of storage is higher."*

The water stored by the Picton Weir was initially used to supply the nearby communities. After pipes were laid from the much larger Nepean Dam, however, Bargo, Thirlmere, Picton and The Oaks were supplied water from the Nepean Dam (now through the Nepean Water Filtration Plant), and the water from the Picton Weir is no longer used for town water supply.

The reports by Fluvial Systems (2013) and the Water Management Plan (Tahmoor Coal, 2022a) provide a detailed description of the river.

As shown in Drawings No. MSEC1192-01 and MSEC1192-07, Tahmoor Mine extracted longwalls LW14B to LW19 under parts of this section of the Bargo River valley. The overall depth of the Bargo River valley varies from 90 metres down to 50 metres with the steeper sections of the valley comprising cliffs, rock outcrops and talus slopes in a number of locations.

There has been a long history of mining directly beneath or near the Bargo River at Tahmoor Mine. While impacts have occurred when various previously extracted longwalls were mined directly beneath the river (refer Section 5.3.4), impacts have been not observed when mining has been undertaken more than 500 metres away from the river.

Previously extracted Longwall 24A was approximately 340 metres from the river at its closest point and Longwall 25 was approximately 510 metres from the river. Ground surveys measured very little vertical subsidence (less than 20 mm) and closure (less than 10 mm) occurred even though at this section of the river the gorge was 80 metres deep. Impacts to the river were not observed during the extraction of these longwalls.

Based on the previous experience at Tahmoor Mine, it is unlikely that the extraction of the proposed longwalls would result in any adverse impacts on the river. Even if the predictions and impact assessments were exceeded, the likelihood of pool drainage is considered extremely low given the water flows in the river.

Further detailed discussions on the impacts and consequences of changes in the surface water flows are provided in the Water Management Plan (Tahmoor Coal, 2022a).

5.2.2. Management of potential impacts on the Bargo River

Tahmoor Coal has previously developed Environmental Management Plans to manage potential impacts on streams during the mining of longwalls, including the Bargo River. The management plans include monitoring and triggered response plans. They include monitoring of the required pre-mining conditions and data collection during mining. Monitoring typically continues for a period following mining.

While the proposed longwalls do not mine directly beneath the Bargo River, it is recommended that Tahmoor Coal monitor changes in the Bargo River during the extraction of proposed Tahmoor South longwalls. Tahmoor Coal is required to development and implement a Water Management Plan as part of the Extraction Plan.

5.3. Streams

5.3.1. Descriptions of the streams

The locations of the streams within the *Subsidence Study Area* are shown in Drawing No. MSEC1192-07. A summary of the major streams within the *Subsidence Study Area* is provided below in Table 5.2.

The reports by Fluvial Systems (2013) and the Water Management Plan (Tahmoor Coal, 2022a) provide a description of the streams.

Table 5.2 Streams within the Subsidence Study Area

Location	Strahler Stream Order	Description
Teatree Hollow	3rd Order	Located directly above the proposed LW S1A to LW S6A, with a total length of 2.1 kilometres directly mined beneath. LW1 and LW2 have been previously mined beneath a 0.5 kilometre section downstream of LW S1A
Tributary to Teatree Hollow (Wirrimbirra Creek)	3rd Order	Located directly above the proposed LW S1A to LW S4A, with a total length of 1.3 kilometres directly mined beneath

The streams have flow controlling features along their alignments that include; rockbars, riffles, knick points and debris accumulations. The locations of pools along the streams were determined by the specialist geomorphology consultant, (Fluvial Systems, 2013), and the locations of the pools are shown in Drawing No. MSEC1192-09. Descriptions of the streams are provided in the Water Management Plan (Tahmoor Coal, 2022a).

Example photographs of the streams within the *Subsidence Study Area* are shown in Fig. 5.1 to Fig. 5.4.

Fig. 5.1 Pool TT9 in Teatree Hollow directly above proposed LW S2A

Fig. 5.2 Pool TT12 in Teatree Hollow directly above proposed LW S1A

Fig. 5.3 Pool TT11 and TT3 (Ockenden Pools) in Tributary to Teatree Hollow directly above proposed LW S2A

The Tributary of Teatree Hollow is named Wirrimbirra Creek and Pools TT3 and TT11 are named Ockenden Pools at the Australian Wildlife Sanctuary (formerly called Wirrimbirra Sanctuary). Water levels at Ockenden Pools are partly controlled by a small weir, which was damaged during the 2019 bush fire. The pools were dry at this time. A surface water level sensor is located at this site.

Fig. 5.4 Pool TT2 (Big Pool) in Tributary to Teatree Hollow directly above proposed LW S3A

Pool TT2 is named the Big Pool at Wirrimbirra Sanctuary. The pool was observed to contain water after the 2019 bush fire. A surface water level sensor is located at this site.

Hidden creeks are defined as natural watercourses that appear to have been covered during development of a property or road. Hidden creeks have been identified from surface contours and historical aerial photographs. Two hidden creeks have been identified within the *Subsidence Study Area*. The creeks were infilled as part of the development of Tahmoor Mine and their locations are shown in Drawing No. MSEC1192-09.

5.3.2. Predictions for the streams

The predicted profiles of subsidence, upsidence and closure, using the IPM subsidence model and the 2002 ACARP valley closure prediction model, along the streams within the *Subsidence Study Area* are shown in Figs. E.02 to E.03, in Appendix E. The predictions are based on the extraction of the proposed longwalls, as shown in Drawing No. MSEC1192-07. The predicted total profiles along the alignments of the streams, after the completion of each of the proposed amended longwalls, are shown as solid blue lines.

A summary of the maximum predicted values of total subsidence, upsidence and closure for the streams is provided in Table 5.3.

Table 5.3 Maximum predicted total subsidence, upsidence and closure for the streams

Location	Figure no. (Appendix E)	Maximum predicted subsidence (mm)	Maximum predicted upsidence (mm)	Maximum predicted closure (mm)
Teatree Hollow	E.02	1,350*	400*	275*
Tributary to Teatree Hollow	E.03	1,300	450	375

** Note: downstream sections of Teatree Hollow have been previously mined beneath by LW1 and LW2 at Tahmoor Mine. The maximum predicted parameters provided in the above table include those resulting from the extraction of these earlier longwalls.*

The streams, which are located directly above the proposed longwalls, could experience the full range of predicted subsidence movements. A summary of the maximum predicted conventional subsidence movements within the *Subsidence Study Area* is provided in Chapter 4.

5.3.3. Predicted changes in stream gradients

The natural and the predicted post mining surface levels and grades along Teatree Hollow are illustrated in Fig. 5.5 and indicated in Fig. E.02. The natural grades along the stream vary between 20 mm/m and 50 mm/m above the proposed longwalls. The predicted maximum tilts, therefore, are substantially less than the natural grades along the stream.

The predicted maximum decreasing tilts are 8 mm/m (i.e. 0.8 %, or 1 in 125) along Teatree Hollow, directly above LW S1A.

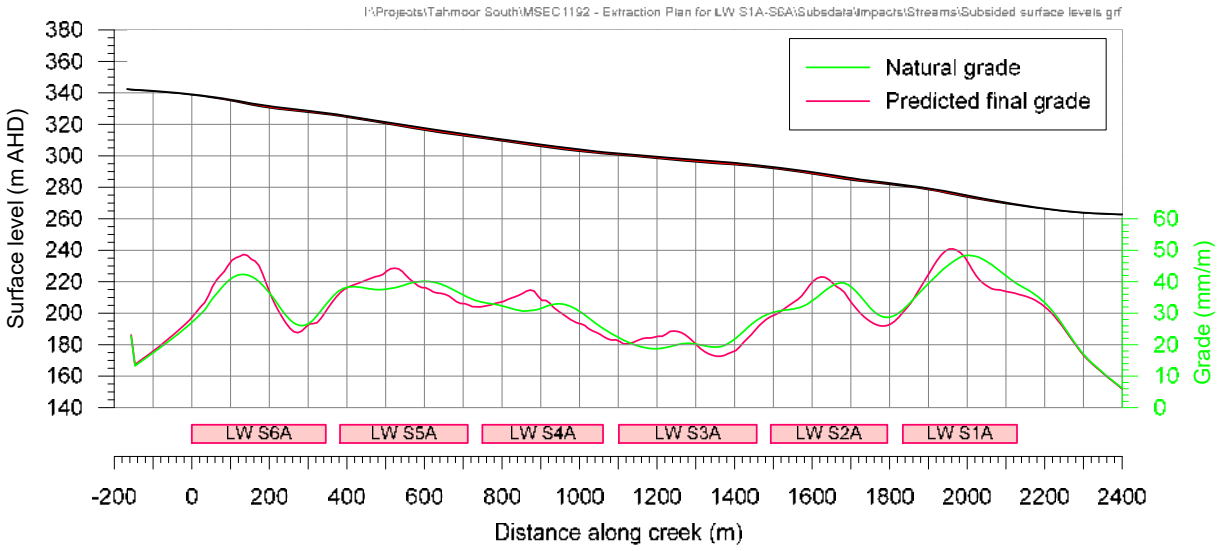


Fig. 5.5 Natural and predicted post mining surface levels along Teatree Hollow

The natural and the predicted post mining surface levels and grades along the Tributary of Teatree Hollow are illustrated in Fig. 5.6 and indicated in Fig. E.03. The natural grades along the stream vary between 9 mm/m and 40 mm/m above the proposed longwalls. The predicted maximum tilts, therefore, are substantially less than the natural grades along the stream.

The predicted maximum decreasing tilts are 6 mm/m (i.e. 0.6 %, or 1 in 167) along the Tributary of Teatree Hollow, directly above LW S1A.

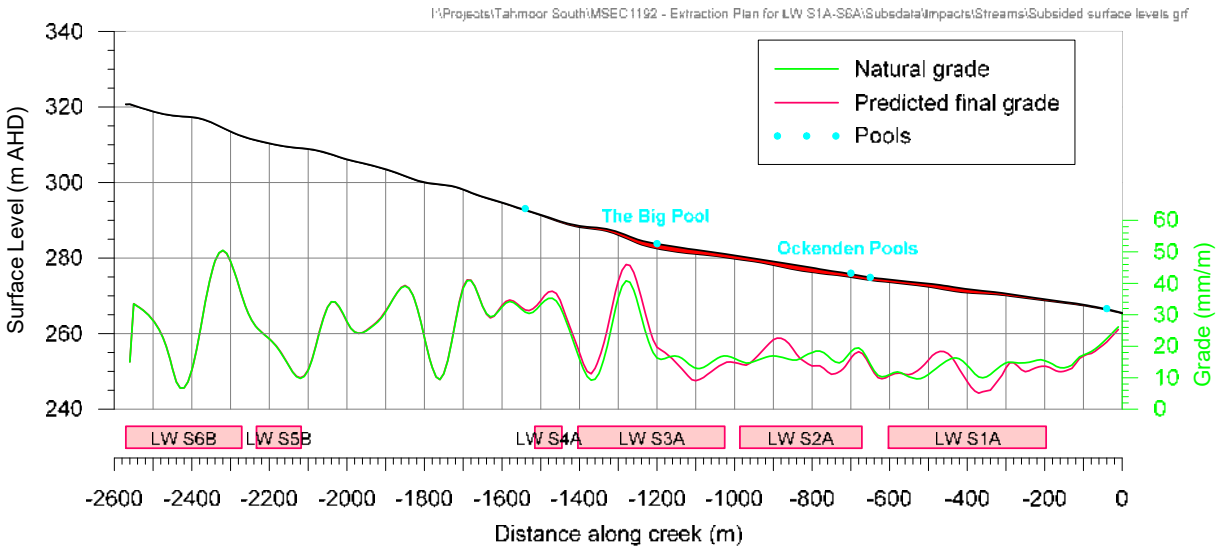


Fig. 5.6 Natural and predicted post mining surface levels along Tributary of Teatree Hollow

A summary of the maximum predicted changes in grade and the predicted curvatures, due to the conventional subsidence resulting from the extraction of the proposed longwalls, is provided in Table 5.4. The maximum predicted increases in grades occur downstream of the longwall goaf edges, whilst the maximum predicted decreases in grade occur upstream of the longwall goaf edges.

The predicted changes in grade provided in Table 5.4 are the maxima along the alignments of the streams after the extraction of any or all of the proposed longwalls. The predicted curvatures are the maxima in any direction at any time during or after the extraction of the proposed longwalls.

The streams will also experience strains resulting from far field movements and valley related movements and discussions are provided in Section 5.3.4 on the impact assessments from these movements.

The locations of the pools along the streams are shown in Drawing No. MSEC1123-09. A summary of the maximum predicted subsidence, upsidence and closure at the pools along Teatree Hollow and the Tributary to Teatree Hollow is provided in Table D.01, in Appendix D.

Table 5.4 Maximum predicted changes in grade along the streams

Location	Maximum change in grade (mm/m)		Maximum conventional curvature (km^{-1})	
	Increase in grade	Decrease in grade	Hogging curvature	Sagging curvature
Teatree Hollow	7.0	8.0	0.11	0.22
Tributary to Teatree Hollow	6.0	6.0	0.10	0.21

5.3.4. Impact assessments for the streams

The impact assessments for the streams within the *Subsidence Study Area* are provided in the following sections. The assessments provided in this report should be read in conjunction with the Water Management Plan (Tahmoor Coal, 2022a) and the Biodiversity Management Plan (Tahmoor Coal, 2022c), which assess the consequences of the impacts on surface water flows and ecology.

Potential for increased levels of ponding, scouring or desiccation due to mining tilt

Mining can potentially result in increased levels of ponding in locations where the mining induced tilts oppose and are greater than the natural stream gradients that exist before mining. Mining can also potentially result in an increased likelihood of scouring of the stream beds in the locations where the mining induced tilts considerably increase the natural stream gradients that exist before mining.

There are no other predicted reversals of grade due to the proposed extraction of LWs S1A to S6A.

It is possible that there could be localised areas along the streams which could experience small increases in the levels of ponding, where the predicted maximum tilts occur in the locations where the natural gradients are low. As the predicted changes in grade are typically less than 1 %, however, any localised changes in ponding are expected to be minor and not result in adverse impacts on these streams.

It can also be seen from the above figures that the stream gradients increase where they flow into the predicted subsidence trough near the edges of the proposed longwalls. The streams flow predominantly over Hawkesbury Sandstone, which has a high resilience to scouring. As discussed in the report by Fluvial Systems (2013), mud was commonly found in the channel bed with soft knickpoints in small streams on the plateau. The predicted maximum increases in grade are up to 1.0 %, which are relatively small compared to the natural gradients and, therefore, the potential for increased scouring is not expected to be substantial.

Further discussions on the potential changes in ponding and flooding along the streams and the impacts, consequences and implications of the changes are provided by the specialist surface water consultant in the Water Management Plan (Tahmoor Coal, 2022a).

Potential for fracturing and surface water flow diversion in the streams

Where the longwalls mine directly beneath the streams it is considered likely that fracturing could result in surface water flow diversions. Upsidence and compressive strains due to valley closure are expected to be of sufficient magnitude to cause the underlying strata to buckle and induce cracking at the surface at some locations. This can lead to the diversion of water from the stream beds into the dilated strata beneath it.

It is unlikely, however, that there would be any net loss of water from the catchment since any redirected flow would not intercept any flow path that would allow the water to be diverted into deeper strata or the mine.

Geotechnical and groundwater reports by Strata Control Technology (2013) and SLR (2022a) present further discussions on the impacts, consequences and implications of the changes and potential for hydraulic connectivity from surface to seam.

The maximum predicted conventional curvatures for the streams located directly above the proposed longwalls are 0.11 km^{-1} hogging and 0.22 km^{-1} sagging, which equate to minimum radii of curvature of 9.1 kilometres and 4.5 kilometres, respectively.

The range of non-valley related movement strains above the proposed longwalls is expected to be similar to the range of strains measured during the previously extracted longwalls in the Southern Coalfield, which is described in Section 4.3 and the results illustrated in Fig. 4.4. It is also likely that the streams would experience elevated compressive strains as a result of valley closure movements.

The compressive strains resulting from valley related movements are more difficult to predict than conventional strains. It has been observed in the past, however, that compressive strains due to valley related movements between 10 mm/m and 20 mm/m (over a standard 20 metre bay length) have occurred above previously extracted longwalls at similar depths of cover, where the magnitudes of closure were similar to those predicted for the streams in the *Subsidence Study Area*.

It has been observed in the past that the depth of buckling and dilation of the uppermost bedrock, resulting from longwall mining, is generally less than 10 metres to 15 metres (Mills 2003, Mills 2007, and Mills and Huuskes 2004).

If substantial fracturing were to occur, partial or complete diversion of surface water and drainage of pools could occur at locations and times where the rate of flow diversion is greater than the rate of incoming surface water. The majority of the streams are ephemeral and so water typically flows during and for a period of time after each rain event. In times of heavy rainfall, most of the runoff would flow over the beds of the streams and would not be diverted into the dilated strata below the stream beds. In times of low flow, however, some or all of the water could be diverted into the strata below the stream beds for those sections of the streams that are located over the mined panels.

While much of the channel beds are exposed bedrock, Fluvial Systems (2013) report that sand, gravel, cobble and mud were also commonly found in the channel beds throughout the Project Area. Where such loose materials occur, it is possible that fracturing in the bedrock would not be seen at the surface. In the event that fracturing of the bedrock occurs in these locations within the alignments of the streams, the fractures may be filled with soil during subsequent flow events reducing the flow through the fractures.

Tahmoor Mine has previously extracted longwalls beneath streams and their ability to naturally fill mining-induced fractures has varied, mainly depending on the availability of sediment.

- Longwalls 1 and 2 were mined in 1987 directly beneath a 500 metre section of Teatree Hollow immediately downstream of the proposed longwalls. Bord and pillar workings with secondary extraction also took place prior to longwall mining directly beneath this stream.

  Substantial fracturing was observed by Fluvial Systems (2013) at one location in a small tributary to Teatree Hollow (Site TT1-18) directly above the bord and pillar workings with secondary extraction. It is likely that this fracturing was mining-induced.

  No flow diversions were reported at this location, nor in other sections of Teatree Hollow located directly above Longwalls 1 and 2. Water flows in the section of Teatree Hollow, which is located above the previously extracted longwalls and secondary extraction workings, were greatly controlled by Tahmoor Mine's licensed discharge LDP4 and this has likely aided in filling the mining-induced fractures.

- Longwalls 8, 10 to 13 were mined between 1991 and 1994 directly beneath a 2.0 kilometre section of the Bargo River and directly beneath a 1.0 kilometre section of Dog Trap Creek.

  These were the first series of longwalls to be mined directly beneath the Bargo River at Tahmoor Mine. Very little monitoring of the river occurred during this time, although extensive protective works were undertaken at the Rockford Road Bridge that was located over Longwall 12.

Surface fracturing of exposed bedrock was observed near to the supporting piers of the Bridge following the extraction of Longwalls 12 and 13. Fractures were also observed in flute holes downstream of the bridge over the goaf edge of Longwall 13, which were first observed during the extraction of Longwall 12 (Holla and Barclay, 2000). The fractures were localised and did not consistently run along the length of the river valley. They appeared to be the result of localised shearing and compressive buckling and some fractures were located where there was noticeable cross bedding within the river bed. There were no reports of impact to water flows along this section of river.

While surface fracturing is still visible in the flute holes that are located on a large, exposed rockbar, surface water diversion is not evident and large pools exist directly above the previously extracted longwalls, as Tahmoor Mine's licensed discharge has contributed a base flow to this section of the Bargo River.

Fig. 5.7 Large pool in the Bargo River, located upstream of Rockford Road Bridge, directly above previously extracted Longwall 12

Very little monitoring of the Dog Trap Creek occurred when Longwalls 12 and 13 mined directly beneath it, although extensive monitoring and works were undertaken at the small Road Bridge over Dog Trap Creek on Arina Road. No surface fractures are visible in the stream at the location, however, and pools are observed to exist. It is noted that this section of Dog Trap Creek contains plenty of sediment that could assist in the filling of fractures.

Fig. 5.8 Ponded water in Dog Trap Creek near bridge over Arina Road above previously extracted Longwall 13

- Longwalls 14 to 19 were mined between 1995 and 2002 directly beneath a 1.7 kilometre section of the Bargo River. As shown in Table 5.1, this section of river is located between 720 metres and 850 metres north-west of the proposed LWs S1A to S6A.

  Limited monitoring indicated little impact on the River during the extraction of Longwalls 14 to 17. Fracturing was not observed on the surface, although many sections were concealed by alluvial and talus deposits.

  The first adverse impacts on the river were reported in January 2002, after the extraction of Longwall 18, when residents alerted Tahmoor Mine to reduced pool levels downstream of the mining area. At that time there was very little water in the Picton Weir due to low rainfalls and surface flows from the weir had reduced to a mere trickle. Inspections along the river indicated minor fracturing of rock shelves in the river bed and drainage of some shallow pools.

Fig. 5.9 Immediately upstream of Picton Weir – January 2002

Detailed subsidence monitoring of survey pegs within the Bargo River over the centre of LW18 after LW18 was extracted, i.e. in October 2001 had indicated that total upsidence in the base of LW18 was 250 mm, the total valley closure was approximately 400 mm and the maximum measured valley closure strain was 15 mm/m.

The inspections in January 2002 found that the river had been drained directly above Longwall 18 and the length of drainage extended downstream for some distance beyond Longwall 14.

Shortly after this time a large rainfall event occurred, which filled the Weir and restored surface water flows along the River. A dry period followed and by July 2002 the Picton Weir was empty again and the extraction of Longwall 19 was completed. Inspections showed that surface flows ceased again, with the furthest drained pool from the longwalls being located 125 metres upstream of LW19. This coincided with the completion of this longwall.

Detailed subsidence monitoring of survey pegs within the Bargo River over the centre of LW18 after LW19 was extracted indicated that total upsidence in the base of LW18 was 450 mm, the total valley closure was approximately 700 mm and the maximum measured valley closure strain was 18 mm/m.

A further period of heavy rainfall occurred in February 2003 which then refilled the upstream sections of Picton Weir which then overtopped (see Fig. 5.10 and Fig. 5.11).

Fig. 5.10 Picton Weir 1st February 2003

Fig. 5.11 Picton Weir 24th February 2003

After this large storm, it was then observed that the water flows along the surface above the longwalls were progressively restored even during the following drier periods. It is believed that the high sediment load in the river, that was retained by the Picton Weir except when it is overtopped, had been washed down the river and filled in the mining induced fractures in the bedrock reducing the loss of surface water flows.

The extraction of Longwalls 14 to 19 also mined directly beneath small tributaries to the Bargo River. Fluvial Systems (2013) reports fracturing and surface flow diversions in two unnamed tributaries, which are located above previously extracted Longwalls 15 and 19. The stream channel bed in this was exposed bedrock.

- Longwalls 22 to 28 were mined between 2004 and 2014 beneath a 3 kilometre section of Myrtle Creek.

  The impacts observed along this creek were localised bed cracking in exposed sandstone areas, surface flow diversions in four locations over Longwalls 22, 23B and 25 as well as cracking in soil within the upper banks and flanks over Longwall 23B. Three areas of isolated cracking of exposed sandstone were also observed in the base or sides of generally dry pools above Longwall 25.

  The extraction of Longwalls 26 to 28 has resulted in further mining-induced fractures on exposed bedrock. At times of low flow, pools have been observed to drain.

- Longwalls 25 to 32 have mined, since 2008, beneath a 2.8 kilometre section of Redbank Creek.

  The impacts observed along the creek were cracks along most pools located directly above Longwalls 25 to 32. At times of low flow, pools have been observed to drain. Stream flow re-emerges in a section of the creek downstream from Longwall 32.

Based on the previous experience of mining beneath streams at Tahmoor Mine, it is likely that fracturing and surface flow diversions will occur in the sandstone bedrock along the streams over Tahmoor South, particularly for streams that are located directly above the proposed longwalls. In some of these locations, the fracturing could impact the holding capacity of the standing pools, particularly those located directly above the proposed longwalls. It is unlikely, however, that there would be any net loss of water from the catchment.

Where there are substantial sediment accumulations upstream of these areas, it is expected that some of the fractures would be naturally filled over time with sediment during subsequent flow events, as was observed in the Bargo River. Where little sediment is present, the impacts are likely to remain for longer periods of time and remediation may be required after the completion of mining, which could include sealing these fractures and voids with grout.

With respect to streams or sections of streams located away from the proposed longwalls, the likelihood of fracturing and surface flow diversions reduces substantially compared to stream sections located directly above the proposed longwalls. The furthest known rockbar impact site where fracturing resulted in the diversion of surface water was at Pool F in the Waratah Rivulet that was being affected by a previously extracted longwall on one side and by the end of another longwall, i.e. the rockbar was located over solid unmined coal, but it was located in the corner between two longwalls. This site was located 160 metres to the side of one longwall and 230 metres from the approaching face of the active longwall. Surface water diversions have also been observed at three sites from the sides of longwalls at distances between 125 metres and 100 metres at the Bargo River, Waratah Rivulet and Native Dog Creek. Surface water diversion has only been observed at one site at Pool G1 in the Waratah Rivulet beyond the ends of the longwalls and in this case the closest distance was approximately 75 metres.

Minor and isolated fracturing could also occur outside the extents of the proposed longwalls. The furthest distance of an observed fracture from longwall mining was at the base of Broughtons Pass Weir, which was located approximately 415 metres from Appin Colliery Longwall 401. Another minor fracture was also recorded in the upper Cataract River, approximately 375 metres from Appin Colliery Longwall 301. This fracture occurred in a large rockbar, which was formed in thinly bedded sandstone, which had experienced movements from nearby previously extracted longwalls. These are the furthest most recorded fractures from longwall mining in the NSW Coalfields.

Further discussions on the potential impacts of surface cracking and on changes in surface water flows are provided in the Water Management Plan (Tahmoor Coal, 2022a) and the Biodiversity Management Plan (Tahmoor Coal, 2022c).

Potential for Gas Emissions and Changes to Water Quality

Gas emissions from the sandstone strata have been previously observed above and adjacent to mining areas in the Southern Coalfield, and some gas emissions have also been observed in water bores. Analyses of gas compositions indicate that the Bulli seam is not the direct and major source of the gas and that the most likely source is the Hawkesbury Sandstone (APCRC, 1997).

It is likely that gas emissions will occur as a result of the mining of the longwalls. Gas is often released into rivers and streams as these areas form topographical low points in the landscape. Where these gas releases occur into the water column there is insufficient time for any substantial amount of gas to dissolve into the water. The majority of the gas is released into the atmosphere and is unlikely to have an adverse impact on water quality.

It is possible for substantial gas emissions at the surface to cause localised vegetation die-back. This is a rare event and has only been observed to occur previously on one occasion at Tower Colliery, over small areas in the base of the Cataract Gorge that had been directly mined beneath by Longwalls 10 and 14. These impacts were limited to small areas of vegetation, local to the points of emission, and when the gas emissions declined, the affected areas were successfully restored.

A description of potential water quality impacts, including iron stains, and environmental consequences is presented in the Water Management Plan (Tahmoor Coal, 2022a) and the Biodiversity Management Plan (Tahmoor Coal, 2022c).

5.3.5. Impact assessments for the streams based on increased predictions

If the actual conventional subsidence movements exceeded those predicted by a factor of 2 times, the maximum tilts along the streams would be 16 mm/m (i.e. 1.6 %, or 1 in 63) along Teatree Hollow. The existing stream grades are greater than the predicted tilts multiplied by a factor of 2 times and no reversals of grade due to the proposed extraction of LWs S1A to S6A.

If the actual conventional subsidence movements exceeded those predicted by a factor of 2 times, the maximum tilts along the streams would be 12 mm/m (i.e. 1.2 %, or 1 in 83) along the Tributary of Teatree Hollow. This would result in a short section of stream of approximately 10 to 20 metres experiencing grades that are close to level or slightly reverse.

If the actual strains or valley related movements exceeded those predicted by a factor of 2 times, the extent of fracturing in the uppermost bedrock would increase along the streams which are located directly above the proposed longwalls.

While the predicted ground movements are important parameters when assessing the potential impacts on the streams, it is noted that the impact assessments for fracturing and loss of surface water were primarily based on historical observations from previous longwall mining at Tahmoor Mine and other mines operating at similar depths of cover in the Southern Coalfield. The overall levels of impact on the streams, resulting from the extraction of the proposed longwalls, are expected to be similar to those observed where longwalls have previously mined directly beneath streams at the mine.

Further discussions on the potential impacts, consequences and implications of changes along these streams are provided in the surface water and ecology reports by Water Management Plan (Tahmoor Coal, 2022a) and the Biodiversity Management Plan (Tahmoor Coal, 2022c).

5.3.6. Comparison of predictions and assessments provided based on the proposed LWs S1A to S6A and the EIS Layout

A summary comparison between maximum predicted subsidence, upsidence and closure along the streams between the approved EIS Layout and the proposed LWs S1A to S6A is shown in Table 5.5.

Table 5.5 Predicted Total Subsidence, Upsidence and Closure along Streams resulting from the extraction of the Extraction Plan Layout and the approved EIS Layout

Layout	Location	Maximum predicted total subsidence (mm)	Maximum predicted total upsidence (mm)	Maximum predicted total closure (mm)
Proposed Extraction Plan LWs S1A to S6A	Teatree Hollow	1,350*	400*	275*
	Tributary to Teatree Hollow	1,300	450	375
EIS Layout (MSEC1123)	Teatree Hollow	1,350*	375*	275*
	Tributary to Teatree Hollow	1,250	400	350

It can be seen that the predicted maximum total conventional subsidence, upsidence and closure movements due to the extraction of proposed LWs S1A to S6A are slightly greater than the predicted maxima from the EIS Layout. The differences for Teatree Hollow are very slight and reflect the very minor changes in panel and chain pillar widths. The differences for the Tributary to Teatree Hollow are also very slight and in addition to the panel and chain pillar widths, the increase in predictions is also due to the extensions of the commencing ends of LWs S3A and S4A.

It should be noted though that, whilst the overall predicted total subsidence, upsidence and closure along the streams have been increased slightly, predictions at points on the surface directly above the longwalls will be greater or less than predictions previously provided for the EIS Layout due to the lateral shift in the mine layout.

Specific subsidence predictions have been provided for streams in this report. Detailed comparisons can be made for each stream by comparing this report with detailed predictions that were provided in our previous Report No. MSEC1123.

The potential for physical impacts (i.e. surface cracking and rock fracturing) is not, however, dependent on absolute vertical subsidence. Physical impacts develop due to differential movements, which are described by curvature and strain.

Whilst the predicted strains and valley closure and, hence, the potential for physical impacts increase with wider longwall panel widths and narrower pillar widths, the strains and valley closure due to the extraction of the proposed Extraction Plan and the EIS layout are both predicted to be of sufficient magnitude to result in the fracturing of bedrock.

Based on the above, the potential for impacts on the sections of streams that are proposed to be directly mined beneath due to the extraction of proposed Extraction Plan do not materially change as a result of the changes in mine layout, even though the overall mining-induced movements and associated frequency and severity of impacts are expected to slightly increase.

This assessment is supported by the observations of adverse impacts along streams that have been directly mined beneath at nearby collieries at similar depths of cover in the Southern Coalfield, including where longwall void widths are less than those that are proposed in the Extraction Plan.

In the case of streams that are not directly mined beneath, the offset distances between the proposed longwalls in the proposed LWs S1A to S6A and the streams remain sufficiently large such that the impact assessments do not change significantly compared to the assessments that were provided for the approved EIS Layout. This includes the fourth and fifth order sections of Hornes Creek and the Bargo River, which are located more than 670 metres and 690 metres, respectively, from the proposed longwalls.

5.3.7. Management of potential impacts on the streams

Tahmoor Coal has previously developed Environmental Management Plans to manage the potential impacts on streams during the mining of longwalls. The management plans include ground monitoring, water quality and pool level monitoring and visual inspections. The plans also commit to remediation of waterways if impacts occur.

Tahmoor Coal is required to develop and implement a Water Management Plan as part of the Extraction Plan for LWs S1A to S6A.

5.4. Cliffs

5.4.1. Descriptions of the cliffs

A total of 2 cliffs are located within the *600 metre Study Area for Natural Features* but outside the general *Subsidence Study Area*. The locations of the cliffs are shown in Drawing No. MSEC1192-08, and in greater detail in Drawing No. MSEC1192-09.

One cliff is located within a tributary to the Bargo River and is more than 500 metres from the proposed LW S4A. A small portion of another cliff is located along Hornes Creek and is located approximately 600 metres from the proposed LW S6A.

For the purposes of this report, a cliff has been defined as a continuous rockface having a maximum height greater than 10 metres, a minimum length of 20 metres and a minimum slope of 2 in 1, i.e. having a minimum angle to the horizontal of 63°. The definition is consistent with the definition provided in the Project Approval of the EIS layout. The locations and heights of cliffs within the *Subsidence Study Area* were determined by Fluvial Systems based on the results of an airborne laser scan, refer to Fluvial Systems (2013).

5.4.2. Predictions for the cliffs

The cliffs are located outside the predicted limit of subsidence due to the extraction of LWs S1A to S6A. They are not expected to experience any substantial conventional tilts, curvatures and strains.

5.4.3. Impact assessments for cliffs located above solid coal

The two cliffs are located more than 500 metres from the proposed longwalls and will not be directly mined beneath.

It is extremely difficult to assess the likelihood of cliff instabilities based upon predicted ground movements. The likelihood of a cliff becoming unstable is dependent on a number of factors which are difficult to fully quantify. These factors include jointing, inclusions, weaknesses within the rock mass, groundwater pressure and seepage flow behind the rockface. Even if these factors could be determined, it would still be difficult to quantify the extent to which these factors influence the stability of a cliff naturally or when it is exposed to mine subsidence movements. It is possible, therefore, that cliff instabilities may occur during mining that may be attributable to either natural causes, mine subsidence, or both.

The likelihood of cliff instabilities can be assessed using case studies where previous longwall mining has occurred close to but not directly beneath cliffs. Although very minor rock falls have been observed over solid coal outside the extracted goaf areas of longwall mining in the Southern Coalfield, there have been no recorded large cliff instabilities outside the extracted goaf areas of longwall mining in the Southern Coalfield. This statement is based on the following observations:-

- ***Tahmoor Longwalls 24A to 26***

  Tahmoor Longwalls 24A to 26 were mined near and adjacent to the cliff lines along the Bargo River valley between November 2007 and July 2011. The cliff lines are continuous on both sides of the valley along this section of the river. The cliffs are located at a minimum distance of 300 metres east of Longwall 24A, at their closest point to these longwalls. The whilst the overall valley depths, within one depth of cover of this gorge was over 100 metres, the heights of the cliffs are around 60 metres and are formed within the Hawkesbury Sandstone.

  Tahmoor Longwalls 24A to 26 have void widths of 285 metres, solid chain pillar widths of 35 metres to 40 metres and were extracted from the Bulli seam at a depth of cover of 350 metres at the base of the gorge and 450 metres around the plateau areas. There were no impacts observed on the cliffs along the Bargo River Valley as a result of the extraction of Tahmoor Longwalls 24A to 26.

- ***Appin Longwalls 301 and 302 near the Cataract River***

  Appin Longwalls 301 and 302 were mined adjacent to a number of cliff lines located along the Cataract River valley between October 2006 and September 2007. A total of 68 cliffs were identified within a 35 degree angle of draw from these longwalls. These cliffs had continuous lengths ranging between 5 metres and 230 metres, overall cliff heights ranging between 10 metres and 37 metres, overall valley depths, within one depth of cover of the river, ranging from 50 to 75 metres, and had been formed within the Hawkesbury Sandstone.

  Appin Longwalls 301 and 302 have void widths of 260 metres, solid chain pillar widths of 40 metres and were extracted from the Bulli seam at a depth of cover of 420 metres at the base of the gorge and 490 metres around the plateau areas. These longwalls mined to within 50 metres of the identified locations of the cliffs along the Cataract River valley.

  There were no large cliff instabilities observed as a result of the extraction of Appin Longwalls 301 and 302. There were, however, five minor rock falls or disturbances which occurred during the mining period, of which, three were considered likely to have occurred due to a substantial rainfall event and one was probably a natural instability of the cliff overhang. Nevertheless, the length of cliff line disturbed as a result of the extraction of Appin Longwalls 301 and 302 was, therefore, estimated to be less than 0.5 % of the total face area of the cliff lines within the mining domain.

- ***Tower Longwalls 18 to 20 and Appin Longwalls 701 to 704 near the Nepean River***

  Tower Longwalls 18 to 20 and Appin Longwalls 701 to 704 mined adjacent to a number of cliff lines located along the Nepean River valley. A total of approximately 50 cliffs were identified within a 35 degree angle of draw from these longwalls. The cliffs had continuous lengths ranging between 5 metres and 225 metres, overall heights ranging between 10 metres and 40 metres, overall valley depths, within one depth of cover of the river, ranging from 60 to 80 metres and had been formed within the Hawkesbury Sandstone.

  Tower Longwalls 18 to 20 have void widths of 235 metres, solid chain pillar widths of 40 metres and were extracted from the Bulli seam at a depth of cover of 460 metres at the base of the gorge and 510 metres around the plateau areas. Appin Longwalls 701 to 704 have void widths of 320 metres, solid

chain pillar widths of 40 metres and were extracted from the Bulli seam at a depth of cover of 460 metres at the base of the gorge and 510 metres around the plateau areas.

Tower Longwall 20 was mined directly beneath some cliffs located at the confluence of Elladale Creek and the Nepean River. Appin Longwalls 701 to 704 mined to within 75 metres of the identified locations of the cliffs along the Nepean River valley.

There were no cliff instabilities observed as a result of the extraction of Tower Longwalls 18 to 20 and Appin Longwalls 701 to 704.

Based on this previous experience of mining at Tahmoor, Appin and Tower Collieries, it is unlikely that cliffs beyond the extent of the longwall panels will experience large instabilities. It is possible that isolated rock falls could occur during the mining period due to natural weathering processes. Any impacts are expected to represent less than 0.5 % of the total face area of the cliffs.

5.4.4. Impact assessments for the cliffs based on increased predictions

If the actual mine subsidence exceeded those predicted values by a factor of 2 times, the likelihood of impacts for the cliffs that are located well outside the proposed longwalls would still be expected to be very low.

While the predicted ground movements are important parameters when assessing the potential impacts on the cliffs, it is noted that the impact assessments for cliff instabilities have primarily been based on historical observations from previous longwall mining in the Southern Coalfield.

5.5. Steep slopes

The purpose of identifying steep slopes for this assessment is to highlight areas in which existing ground slopes may be marginally stable. As a conservative first pass, a steep slope has been defined as an area of land having a gradient greater than 1 in 3 (33 % or 18.3°). The definition is consistent with the definition provided in the Project Approval of the EIS layout. The minimum slope of 1 to 3 represents a slope that would generally be considered stable for slopes consisting of rocky soils or loose rock fragments. Clearly the stability of natural slopes varies depending on their soil or rock types, and in many cases, natural slopes are stable at much higher gradients than 1 to 3 (for example, talus slopes in Hawkesbury Sandstone).

The locations of the steep slopes within the *Subsidence Study Area* are shown in Drawing No. MSEC1192-08, with greater detail in Drawing No. MSEC1192-09. The steep slopes were identified by Fluvial Systems from an airborne laser scan supplied by Tahmoor Coal. The steep slopes shown on the drawings can be broadly categorised as:

a) Steep slopes on the sides of valleys;
b) Batters of road and railway embankments and cuttings;
c) Slopes on Farm dams; and
d) Slopes around Tahmoor Mine infrastructure, including spoil heaps, coal piles and dams.

Types (b) to (d) are addressed in Chapter 6 of this report.

The steep slopes on the sides of valleys are predominantly found in Hawkesbury Sandstone and consist of a mixture of cliffs and rock outcrops, which are stable at vertical to overhanging, and screed slopes with rocky soils and loose rock fragments. The majority of slopes are stabilised, to some extent, by natural vegetation.

The ranges of predicted subsidence parameters for the steep slopes are similar to those predicted along the streams, which are provided in Section 5.3.2.

There has been extensive experience of mining beneath steep slopes in the Southern Coalfield. These include steep slopes along the Cataract, Nepean, Bargo and Georges Rivers and streams such as Myrtle Creek and Redbank Creek above Tahmoor Mine Longwalls 22 to 32, slopes on Redback Range above Tahmoor Mine Longwalls 26 and 27 and slopes along ridges and valleys above Tahmoor LWs W1-W3. No large-scale slope failures have been observed along these slopes, even where longwalls have been mined directly beneath them. Surface cracking and minor rock falls along clifflines or rock outcrops have been observed, for example, during the mining of Appin Longwalls 301 and 302 adjacent to the Cataract River, however, no large-scale slope failures have been observed.

Potential impacts on steep slopes would generally result from the movement of soils, causing tension cracks to appear at the tops of the slopes and compression ridges to form at the bottoms of the slopes. These movements are consistent with observations of upsidence and closure of creek valleys where compression is developed at the bottoms of the valleys and tension is developed at the tops of the valleys. If tension cracks were left untreated it is possible that soil erosion could occur.

It is possible, therefore, that some remediation might be required to ensure that mining-induced surface cracking does not result in the formation of soil erosion channels. In some cases, erosion protection

measures may be needed, such as the planting of additional vegetation in order to stabilise the slopes in the longer term.

While in most cases impacts to slopes are likely to consist of surface cracking, there remains a low probability of large-scale slope slippage. The probability is assessed to be very low for slopes that will not be directly mined beneath by the longwalls. Experience indicates that the probability of mining induced large-scale slippages is extremely low due to the substantial depths of cover within the *Subsidence Study Area*. While the risk is extremely low, some risk remains and attention must therefore be paid to any structures or roads that may be located in the vicinity of steep slopes.

There are no structures or roads located along natural steep slopes within the *Subsidence Study Area*.

5.5.1. Management of potential impacts on steep slopes

Tahmoor Coal has developed subsidence management plans for managing potential impacts on steep slopes during the mining of Longwalls 22 to 32 and LWs W1-W4. These management plans include:

- Identification of all structures, dams and roads that are in close proximity to steep slopes;
- Site investigation and landslide risk assessment of structures near slopes by a qualified geotechnical engineer;
- Site investigation and structural assessment of structures where recommended by the geotechnical engineer. This may include recommendations to mitigate against potential impacts;
- Monitoring, including ground survey and visual inspections; and
- Remediation if cracking or slippage occurs.

It is recommended that Tahmoor Coal continue to develop management plans to manage potential impacts on slopes during the mining of the proposed longwalls. Tahmoor Coal is required to develop and implement a Land Management Plan as part of the Extraction Plan for LWs S1A to S6A.

5.6. Escarpments

There are no major escarpments within the *Subsidence Study Area*. Discussions on the cliffs are provided in Section 5.4.

5.7. Land prone to flooding and inundation

There are areas prone to flooding or inundation within the *Subsidence Study Area*. The subsidence ground movement predictions determined for the Tahmoor South project have been provided to hydrologist ATC Williams, who have undertaken a detailed flood study for the project and provided detailed discussions of the impacts and consequences of the subsidence ground movements on future floods within the *Subsidence Study Area* in the Water Management Plan (Tahmoor Coal, 2022a).

5.8. Swamps, wetlands and water related ecosystems

As discussed in detail in the Biodiversity Management Plan (Tahmoor Coal, 2022c), there are some water related ecosystems and wet areas in the headwaters of some streams but there are no upland swamps or wetlands within the *Subsidence Study Area*.

Please refer to the Biodiversity Management Plan (Tahmoor Coal, 2022c).

5.9. Threatened, protected species or critical habitats

Please refer to the Biodiversity Management Plan (Tahmoor Coal, 2022c).

5.10. National Parks or Wilderness Areas

There are no National Parks, nor any land identified as wilderness under the Wilderness Act 1987 within the *Subsidence Study Area*.

5.11. State Recreational or Conservation Areas

There are no State Recreational or Conservation Areas within the *Subsidence Study Area*.

5.12. Natural vegetation

Please refer to the terrestrial and aquatic ecology assessments in the Biodiversity Management Plan (Tahmoor Coal, 2022c).

5.13. Areas of significant geological interest

There are no areas of significant geological interest within the *Subsidence Study Area*.

5.14. Any other natural feature considered significant

The Australian Wildlife Sanctuary is located on Remembrance Driveway. The site is also known as Wirrimbirra Sanctuary, which is the name that is listed as an item of heritage on the State Heritage Register (01508). The Australian Wildlife Sanctuary covers an area of approximately 95 ha.

Wirrimbirra preserves a part of the original 'Bargo Brush' which was of considerable historical importance in the problems which faced the settlement of the Argyle or Southern Tablelands during the early half of the 1800s. The Sanctuary contains rich and diverse plantings of native plants in formalised gardens, which were developed to provide areas of representative native plants for education and research purposes. Within the 43 established gardens, there are over 1800 native plants representing a resource base for the study of native flora.

The Australian Wildlife Sanctuary is located above LWs S1A to S4A near Teatree Hollow and the Main Southern Railway Line and will be directly mined beneath by the proposed longwalls.

The Australian Wildlife Sanctuary has named the creeks that flow through its property. Wirrimbirra Creek has been identified as Tributary of Teatree Hollow in this report. The Big Pool (Ref. TT2) and Ockenden Pools (TT3 and TT11) are located on Tributary of Teatree Hollow (Wirrimbirra Creek) and their locations are shown in Drawing No. MSEC1123-09. Predictions for these pools are provided in Table D.01. The descriptions and impact assessments for streams are provided in Section 5.3 of this report.

Predictions and impact assessments for the structures within the Australian Wildlife Sanctuary are provided separately in Section 10.2.3 of this report. A site of archaeological significance has been identified on the property and predictions and impact assessments for the site are provided separately in Section 10.1 of this report.

The following sections provide the descriptions, predictions and impact assessments for the Public Utilities within the *Subsidence Study Area*. The public utilities located outside the *Subsidence Study Area*, which may be subjected to far-field movements or valley-related movements and may be sensitive to these movements, have also been included as part of these assessments.

6.1. The Main Southern Railway

The location of the Main Southern Railway is shown in Drawing No. MSEC1192-11. Descriptions, predictions and impact assessments for the railway are provided in the following sections.

6.1.1. Description of the Main Southern Railway

The Main Southern Railway is a key national transport route that carries substantial freight and passenger services between Sydney and Melbourne. The Main Southern Railway is leased by Australian Rail Track Corporation (ARTC), who is responsible for maintaining the track.

Approximately 3 km of track is located within the *Subsidence Study Area* between kilometrages 98 km and 101 km. Approximately 2.1 km of track is located directly above proposed Longwalls S1A to S5A, between 98.6 km and 100.7 km.

The railway line is a dual track consisting of 60 kg rail on concrete sleepers with a mix of straight and curved track sections within the *Subsidence Study Area*. The maximum speed limits on both tracks are 95 km/h for normal services and 105 km/h for XPT services. A photograph of a section of the railway at 99.400 km directly above proposed LW S4A is provided in Fig. 6.1.

Photograph courtesy Newcastle Geotech

Fig. 6.1 Main Southern Railway at 99.400 km

The railway consists of a number of items of infrastructure within the *Subsidence Study Area* and these are listed below in Table 6.1. Further details on each feature are provided later in this report.

Table 6.1 Major railway structures within the Subsidence Study Area

Approximate Kilometrage	Major structure	Closest distance to extent of amended longwall layout
96.300	Railway Viaduct over Bargo River	1.75 kilometres north of LW S1A
96.400	Remembrance Drive Bridge over Bargo River and Main Southern Railway	1.69 kilometres north of LW S1A
98.160	Tahmoor Mine overhead coal conveyor	450 metres to the north western side of LW S1A
101.162	Wellers Road Overbridge	370 metres south of LW S6A

In addition to the major structures listed in Table 6.1, there are a number of smaller railway structures within the *Subsidence Study Area*. These include:-

- Culverts;
- Cuttings;
- Embankments; and
- Signalling, electrical and telecommunications equipment.

6.1.2. Predictions for the Main Southern Railway

The predicted profiles of conventional subsidence and tilt along the alignment of Main Southern Railway, resulting from the extraction of the proposed longwalls, are shown in Fig. E.04, in Appendix E. The initial and the predicted post mining grade of the track are also shown in this figure.

A summary of the maximum predicted total conventional subsidence parameters along the alignment of the railway, after the extraction of each of the proposed longwalls, is provided in Table 6.2. The predicted subsidence effects are predominately due to Longwalls S1A to S5A, which directly mine beneath the railway.

Table 6.2 Maximum predicted total conventional subsidence parameters along the alignment of the Main Southern Railway after the extraction of the proposed LWs S1A to S6A

Longwall	Maximum predicted total subsidence (mm)	Maximum predicted change in Grade (%)	Maximum predicted total hogging curvature along alignment (km^{-1})	Maximum predicted total sagging curvature along alignment (km^{-1})
After LW S1A	775	0.55	0.06	0.12
After LW S2A	1000	0.75	0.08	0.20
After LW S3A	1150	0.65	0.09	0.20
After LW S4A	1250	0.70	0.10	0.20
After LW S5A	1300	0.70	0.10	0.20
After LW S6A	1350	0.85	0.10	0.20

The maximum predicted conventional strains for the railway, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1.5 mm/m tensile and 3.0 mm/m compressive. Non-conventional movements can also occur as a result of, among other things, anomalous movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The railway is a linear feature and, therefore, the most relevant distribution of strain is the maximum strains measured along whole monitoring lines above previous longwall mining. An analysis of strains along whole monitoring lines during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.3.2 and the results are provided in Fig. 4.4.

6.1.3. Impact assessments for the Main Southern Railway

Tahmoor Coal and the Australian Rail Track Corporation (ARTC) have developed detailed risk management plans for managing potential mine subsidence impacts on the Main Southern Railway due to the extraction of LWs 25 to 32 and LWs W1-W4 at Tahmoor Mine. South32 Illawarra Coal has also developed similar strategies to manage potential impacts on the railway due to the extraction of Longwalls 702 to 708, and Longwalls 901 to 904 at Appin Colliery.

The management measures described in this plan are similar to those that have been developed in consultation with ARTC and successfully implemented at Tahmoor Mine and Appin Colliery, as described in a paper by Pidgeon, et al. (2011).

A Rail Management Group have been coordinated to develop the risk management strategies. The Rail Management Group includes representatives from ARTC, Tahmoor Coal and specialist consultants in the fields of railway track engineering, geotechnical engineering, structural engineering, track signalling, mine subsidence, risk assessment and project management. The Technical Committee consults with the Resources Regulator and the Office of the National Rail Safety Regulator.

Works by the Rail Management Group include:-

- Identification of potential impacts on the railway;
- Undertaking a risk management approach, where identified risks are assessed and risk control measures are implemented; and
- Development of management measures that include mitigation and preventive works, monitoring plans, triggered response plans and communication plans; and
- Supervision and oversight of railway track and infrastructure mitigation, monitoring and maintenance of affected rail track and infrastructure.

Tahmoor Coal and ARTC continue to develop plans to manage potential impacts during the mining of the proposed LWs S1A to S6A. The following sub-sections provide details of the potential impacts to the Main Southern Railway and management measures that have been developed by the Rail Management Group to ensure that the railway remains safe and serviceable during mining.

The following sections provide the impact assessments and discuss the proposed strategies to manage the potential impacts on the Main Southern Railway for the proposed Tahmoor South longwalls.

6.1.4. Changes in track geometry

The extraction of the proposed LWs S1A to S6A will result in changes to track geometry along the Main Southern Railway. Changes to track geometry are described using a number of 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 of each track from design; and
- Track Twist – changes in superelevation over a length of track from design.

The Australian Rail Track Corporation's National Code of Practice for Track Geometry provides allowable deviations in track geometry. Predictions of conventional subsidence, tilt and horizontal movement have been made at 5 metre intervals along the railway to calculate each track geometry parameters at any stage of mining. The predicted changes in cant and long twist for the railway are shown in Fig. E.05.

A summary of the maximum allowable and maximum predicted changes in geometry are provided in Table 6.3.

Table 6.3 Allowable and predicted maximum changes in track geometry due to conventional subsidence movements

Track Geometry parameter	Description	Value at which speed limit is first applied*	Value at which trains are stopped*	Predicted maximum due to conventional subsidence
Top	Mid-ordinate vertical deviation Design Offset	14 mm over 4m chord 56 mm over 20m chord	16 mm over 4m chord 66 mm over 20m chord	< 5
Line	Mid-ordinate horizontal deviation over a 10 m chord	34 mm	44 mm	< 5
Change in Cant	Deviation from design superelevation across rails spaced 1.435 m apart	20 to 50 mm (depends on whether track is on a straight or curve)	40 to 75 mm (depends on whether track is on a straight or curve)	8
Long Twist	Changes in Cant over a 14 m chord	46 mm	52 mm	< 3

Note: Values have been taken from the trigger levels in the Tahmoor Mine LW32 Railway Management Plan, which were based on the ARTC National Code of Practice.

Table 6.4 shows that 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. For example, the maximum allowable change in cant is 75 mm over a length of 1.435 metres before the trains are stopped. In mining terminology, this represents a tilt of approximately 50 mm/m, which is substantially greater than the maximum predicted tilt anywhere above the proposed longwalls of 8.3 mm/m.

It is recognised that subsidence predictions in the Southern Coalfield are generally based on the results of surveys marks that are spaced nominally 20 metres apart. The bay lengths used to measure the track geometry parameters, described in Table 6.3, are less than these mark spacings, particularly for changes in track cant and twist. However, confidence in the predictions is gained from the following observations:-

- Monitoring of track geometry at 125 mm intervals along both tracks during the mining of Longwalls 25 to 32 at Tahmoor Mine and Longwalls 703 to 708, and Longwalls 901 to 904 at Appin Colliery have shown that the observed changes compared reasonably well with predictions. The observed changes were very small and an order of magnitude less than the National Code of Practice;
- Monitoring of track geometry during the mining of other longwalls beneath railways has shown that the observed changes to track geometry have been well below ARTC standards; and
- Literature studies of mining beneath railways in NSW (Lea, 1991) and the UK (Grainger, 1993) indicate that mine subsidence results in minimal impacts to track geometry.

It is, however, possible that mine subsidence could result in changes in track geometry that exceed ARTC Standards in the following ways:-

- Track becomes unstable as the result of rail stress, which is discussed in the following section; or
- Track loses support as the result of failure or collapse of culverts or embankment slopes; or
- Development of substantial non-conventional ground movements.

Non-conventional movements can occur and have occurred in the Southern Coalfield as a result of, among other things, valley upsidence and closure movements and anomalous movements. The impact assessments for the valley related movements at the stream crossings are provided in Section 6.1.11. Discussion on the likelihood and nature of anomalous movements is provided in Sections 3.4 and 4.7.

One example occurred at a low angle fault that intersected the Main Southern Railway in a railway cutting, which was located directly above Tahmoor Longwall 29. The site was monitored extensively during the mining of Longwalls 28 to 31. This included three monitoring lines along the railway cutting, and survey prisms along the railway track. The results of observed changes in vertical alignment of the pegs along the railway cutting are shown in Fig. 4.8. It can be seen that the most significant changes occurred during the mining of Longwall 29. The changes, however, developed gradually over time, allowing sufficient time for the railway track to be adjusted such that trains could continue to travel through the site.

It is therefore considered that while non-conventional movements may potentially result in changes to track geometry that exceed National Code of Practice, the potential risk to track safety can be managed through early detection via monitoring and early response through the implementation of triggered response plans. It is likely that the following management measures will be used to manage changes in track geometry:-

- Assess pre-mining track condition and adjust track (if necessary) so that pre-mining track geometry is at or close to design prior to the development of subsidence;
- Identify potential sites of non-conventional movement, such as creeks and geological structures;
- Install a monitoring system, which includes, among other things, the monitoring of ground movements, rail stress, rail temperature, switch displacement and track geometry;
- Regularly review and assess the monitoring data;
- Conduct regular visual inspections of the track; and
- Adjust the track in response to monitoring results during mining if required to keep the track well within safety limits.

With an appropriate management plan in place, it is considered that potential impacts on track geometry can be managed during the mining of the proposed longwalls, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur.

6.1.5. Changes in track grades

The Main Southern Railway climbs steadily in a southbound direction through the *Subsidence Study Area* from Tahmoor to Bargo and Yanderra.

Existing track gradients have been estimated from Curve and Gradient Diagrams provided by ARTC. The maximum gradient along the Main Southern Railway within the *Subsidence Study Area* is 1.4 % (1 in 73), which is located between 101 km and 102 km, above the proposed longwalls. Steeper grades exist regionally along the track, such as 1 in 63 (1.59 % or 15.9 mm/m) between Moss Vale and Exeter.

The predicted changes in track gradient along the Main Southern Railway and the predicted gradients along the track after the completion of mining are shown in Fig. E.04.

It can be seen that the predicted maximum grade after mining is 1.9 % or 1 in 52, which is higher than the regional maximum grades.

It should be noted, however, that the locations of high grades exist over short lengths (a couple of hundred metres), which is of less concern as freight trains are many hundreds of metres long. It is expected, however, that track resurfacing will be required to reduce the magnitude of the mining-induced undulations in the track. This work can be undertaken during planned ARTC maintenance weekends.

6.1.6. Changes in rail stress

Mine subsidence will result in changes to rail stress unless preventive measures are implemented. If no action is taken, it is likely that the rails will become unstable as a result of the mining of the proposed longwalls. The maximum predicted change in stress free temperature is approximately 140 degrees if 100 % of predicted ground strains are transferred into the rails. By comparison a change in stress free temperature of approximately 14 degrees is sufficient to warrant immediate preventative action on a track with concrete sleepers.

Management of rail stress during active mine subsidence has been a primary focus of the Rail Management Group. Traditionally, rail stress has been managed in Australia and overseas by rail strain or stress monitoring. Once measured changes in rail stress reach defined triggers, the stress is dissipated by unclipping the rails from the sleepers, cutting the rails and adding steel to, or removing steel from the rails as required, followed by re-stressing the rails to their desired stress. This process is effective, but it is labour intensive and very difficult to undertake on busy tracks such as the Main Southern Railway, particularly if the frequency of required rail re-stressing is likely to be more often than weekly, as would be expected during the mining of the proposed longwalls at Tahmoor Mine.

For this reason, the Rail Management Group has introduced a combination of rail expansion switches and zero toe load clips to dissipate mining and temperature related rail stress during mining. Rail expansion switches consist of a tapered joint in the track, which allow the rails on each side of the joints to slide independently. Maximum allowable displacements of expansion switches vary between different types of switches and those that have been employed above Tahmoor Mine Longwalls 25 to 32 have a capacity of approximately 310 mm. Expansion switches are standard rail equipment and operate in non-subsidence applications in Australia and overseas to accommodate, for example, differential thermal movements between bridges and natural ground. A rail expansion switch is shown in Fig. 6.2.

Fig. 6.2 Rail expansion switch

Zero toe load clips allow the rails to slide longitudinally along the track while maintaining lateral stability. In combination, the rails are able to expand or contract in response to mine subsidence and thermal loads into and out of the expansion switches. It is estimated that the switches will be spaced between 200 metres and 400 metres apart along the track within the subsidence area.

The combination of expansion switches and zero toe load clips has been successfully employed during the mining of Longwalls 25 to 32 at Tahmoor Mine and Longwalls 703 to 708, and Longwalls 901 and 902 at Appin Colliery.

A substantial advantage of using rail expansion switches and zero toe load clips is that the system is flexible and can be adjusted during mining should the tolerance of the switches reach their design limits. The rails can be cut and steel can be either added or removed as necessary to restore capacity in the switches. The process is substantially faster than conventional re-stressing work as the clips do not have to be removed and reinstated and no stressing work is required. The process can be safely achieved in between the passage of trains without delaying the operation of trains.

It is likely that the following management measures will be used to manage changes in rail stress:

- Assess pre-mining track condition and adjust track if required so that pre-mining track geometry and sleeper arrangements are at or close to design prior to the development of subsidence. This will include non-destructive measurement of rail stresses in the track;
- Identify potential sites of non-conventional movement, such as creeks and geological structures;
- Assess the required spacing of expansion switches based on the predicted ground movements;
- Install the expansion switches and zero toe load clips;
- Install a monitoring system, which includes, among other things, the monitoring of ground movements, rail stress, rail temperature, switch displacement and track geometry;
- Regularly review and assess the monitoring data;
- Conduct regular visual inspections of the track, switches and clips; and
- Adjust the track in response to monitoring results during mining if required.

With an appropriate management plan in place, it is considered that potential impacts on rail stress can be managed during the mining of the proposed longwalls, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur.

6.1.7. Potential impacts on Railway Viaduct over Bargo River and Remembrance Drive Bridge over Bargo River and Main Southern Railway

The Railway Viaduct and Remembrance Drive Road Bridge are located approximately 1.7 km to the north of LW S1A. While the Viaduct and Bridges may experience small far field horizontal movements during the extraction of the proposed longwalls, they are not expected to experience impacts.

The Viaduct consists of a series of masonry arches and is an item of Heritage Significance. The Remembrance Drive Bridge is a reinforced concrete deck supported by a series of reinforced concrete piers.

Previous mining at Tahmoor Mine has virtually surrounded the Viaduct and Bridge. The closest distance between the Viaduct and Bridge and the previously extracted Longwalls 4 and 5 is 640 metres. No impacts have been reported at the Viaduct or Bridge during mining at Tahmoor Mine.

It is planned to monitor horizontal movements on both side of the Viaduct as part of Tahmoor Coal's monitoring program.

6.1.8. Potential impacts on Tahmoor Mine overhead coal conveyor 3R

Tahmoor Mine's overhead coal conveyor 3R crosses over the Main Southern Railway near 98.160 km. It is located approximately 450 metres to the side of LW S1A.

The conveyor is supported by a series of steel supports, and is shown in Fig. 6.3.

Fig. 6.3 Tahmoor Mine overhead coal conveyor 3R over the Main Southern Railway near 98.160 km

The conveyor is predicted to experience approximately 50 mm of vertical subsidence at the railway crossing, with negligible tilts, curvature and strain.

The supports to the conveyor can be adjusted in the unlikely event that increased differential horizontal movements are observed.

Tahmoor Coal, in consultation with ARTC, will study the potential for impacts to the coal conveyor and develop management measures to ensure that the conveyor and the Main Southern Railway remains safe and serviceable throughout the mining period. The study would require input from structural engineers and subsidence engineers. The management measures will include a combination of:-

- Installation of a monitoring system, which includes, among other things, the monitoring of ground movements and structure movements and visual inspections;
- Implementation of a response plan, where actions are triggered by monitoring results. This will include an adjustment of the conveyor supports if triggered by monitoring results; and
- Implementation of a reporting and communication plan.

With an appropriate management plan in place, it is considered that potential impacts on the conveyor crossing can be managed during the mining of the proposed longwalls, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur.

6.1.9. Potential impacts on Wellers Road Overbridge

The Wellers Road Overbridge is located at Bargo at 101.162 km. A photograph of the Overbridge is shown in Fig. 6.4. Wellers Road Overbridge is located just outside the *Subsidence Study Area*, 370 metres from the commencing end of LW S6A.

Fig. 6.4 Wellers Road Overbridge at 101.162 km

The bridge structure consists of a single span supported by a concrete arch on masonry abutments with masonry vehicle barrier walls. The concrete arch appears to have been reinforced with old steel rails. The bridge was constructed between 1917 and 1920 and is listed as an item of heritage significance.

The bridge is predicted to experience less than 20 mm of conventional subsidence, with negligible tilt, curvature and strain due to the extraction of LWs S1A to S6A.

Mining-induced ground movements will develop gradually at the bridge. With the implementation of an effective subsidence management plan, the development of ground movements and impacts can be detected early with time to implement intervention measures before the bridge becomes unserviceable.

Tahmoor Coal, in consultation with ARTC, will study the potential for impacts to the bridge and develop management measures to ensure that the Wellers Road Overbridge remains safe and serviceable throughout the mining period. The study would require input from structural and geotechnical engineers and subsidence engineers. The management measures may include a combination of:

- Re-assessment of the pre-mining condition of the bridge prior to mining;
- Consideration of mitigation measures prior to mining and implementation if required;
- Installation of a monitoring system, which includes, among other things, the monitoring of ground movements and bridge movements. It is planned to monitor horizontal movements at the Bridge as part of Tahmoor Coal's monitoring program;
- Regular review and assess the monitoring data,
- Regular visual inspections of the bridge; and
- Implementation of planned responses if triggered by monitoring and inspections.

With an appropriate management plan in place, it is considered that potential impacts on the Wellers Road Overbridge can be managed during the mining of the proposed longwalls, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur.

6.1.10. Railway Culverts

There are 7 railway culverts located within the *Subsidence Study Area* and their locations are shown in Drawing No. MSEC1192-10. A summary is provided in Table 6.4.

Table 6.4 Railway Culverts within Study Area

Kilometrage (km)	Diameter (mm)	Description	Location relative to Proposed Longwalls
98.445 km	900 dia	Brick arch culvert with concrete extension on both sides	Approx. 170 m to the side of LW S1A
98.739 km	900 dia	Brick arch culvert with concrete extension on both sides	Above LW S1A
99.035 km	1200 dia	Brick arch culvert with concrete extension on both sides	Above LW S2A
99.388 km	1200 dia	Brick arch culvert with concrete extension on UP side	Above LW S3A
100.121 km	1500 dia	Brick arch culvert	Above LW S4A
100.425 km	2000 dia	Brick arch culvert	Above LW S5A
101.000 km	1200 dia	Brick arch culvert	Approx. 230 m beyond the end of LW S6A

Photographs of culverts are shown in Fig. 6.5 to Fig. 6.9.

Photograph courtesy Robinson Rail

Fig. 6.5 Culvert with concrete extension on Up side at 98.739 km

Photographs courtesy Robinson Rail / MSEC

Fig. 6.6 Culvert at 99.388 km on Up and Down sides

Photograph courtesy Newcastle Geotech

Fig. 6.7 Internal view of Culvert at 99.035 km

Photograph courtesy Robinson Rail

Fig. 6.8 Culvert with concrete extension on Up side at 100.121 km

Photograph courtesy Robinson Rail

Fig. 6.9 Culvert with concrete extension on Up side at 100.425 km

The railway crosses a number of streams within the *Subsidence Study Area* and valley-related movements could be experienced in these locations. A summary of the maximum predicted conventional subsidence and valley related movements for the railway culverts is provided in Table 6.5.

Table 6.5 Predicted Conventional Subsidence and Valley Related Movements for the Main Southern Railway Culverts within the Study Area

Location	Maximum predicted total subsidence (mm)	Maximum predicted total tilt (mm/m)	Maximum predicted total hogging curvature (1/km)	Maximum predicted total sagging curvature (1/km)	Maximum predicted total upsidence (mm)	Maximum predicted total closure (mm)
98.445 km	125	< 0.5	< 0.01	< 0.01	20	20
98.739 km	1050	8.0	0.05	0.17	100	50
99.035 km	1000	5.0	0.05	0.04	100	75
99.388 km	1225	5.0	0.06	0.04	200	150
100.121 km	1225	7.0	0.08	0.09	200	100
100.425 km	1275	3.5	0.05	0.12	150	75
101.000 km	20	< 0.5	< 0.01	< 0.01	50	20

The values provided in Table 6.5 are the maximum predicted parameters within a 20 metre radius of each culvert.

6.1.11. Potential impacts on railway culverts at creek crossings

There are a number of railway culverts within the *Subsidence Study Area*. The majority of the culverts are relatively small in size, being 2 metres in diameter or less.

The culverts above proposed LWs S1A to S6A are situated in defined drainage lines that form part of the Teatree Hollow catchment. The culverts are buried beneath small railway embankments. These culverts are expected to experience non-conventional valley related subsidence movements in addition to conventional subsidence movements.

Given that the maximum predicted tilt is 8.0 mm/m, which equates to a 0.8% change in grade, it is expected that mining-induced conventional tilts will not substantially impact the drainage flows in the culverts. It is, however, recommended that the culverts be cleared of ballast which has accumulated in the culvert prior to mining.

The main impact identified with the brick arch culverts is the potential for physical impacts to occur. It is possible that these culverts will experience some cracking and spalling of the masonry as a result of mining the longwalls. Cracking may occur in the masonry arch or in the wingwalls and headwalls. The predicted movements are not considered likely to result in collapse of the culvert.

However, given the potentially severe consequences of culvert collapse, the Rail Management Group will consider mitigation measures prior to each culvert experiencing subsidence movements. Mitigation works could include, for example, sleeving the masonry arch with new pipes. Alternatively, in the case of small shallow buried culverts, steel baulk structures could be placed above the culvert to prevent impacts on the track in the event of culvert collapse.

More substantial mitigation measures may be required for the larger culverts, which may include substantial strengthening of the culvert, wingwalls and headwalls. Substantial strengthening work has successfully been undertaken at culverts above Longwalls 25 and 29 at Tahmoor Mine (Leventhal, *et al.*, 2011; Leventhal, *et al.*, 2017).

A structural steel liner was successfully installed by Tahmoor Mine in a small culvert above Longwall 26. In this case a small air gap was left between the structural steel liner and the original masonry culvert. It was found that while the masonry culvert has experienced cracking during mining, it has remained safe and serviceable during mining. While providing effective insurance against failure, the structural steel liner was not required to support the track and maintain the waterway.

It is likely that the following management measures will be used to manage potential impacts on culverts:-

- Assess pre-mining condition of culverts;
- Consider and implement mitigation measures to reduce or avoid the potential for culvert collapse;
- Install a monitoring system, which includes, among other things, the monitoring of ground movements around the culverts and changes in track geometry and rail stress;

- Regularly review and assess the monitoring data;
- Conduct regular visual inspections of the culverts, and
- Provide additional track and/or culvert support in response to actual measurements and observations during mining.

With an appropriate management plan in place, it is considered that potential impacts on the culverts can be managed during the mining of the proposed longwalls, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur.

The predicted valley upsidence and closure movements are also expected to result in changes in track geometry and rail stress. Methods for managing of changes in track geometry and rail stress are provided in Section 6.1.4 and Section 6.1.6.

6.1.12. Potential impacts on railway cuttings

The Main Southern Railway follows a ridgeline within the *Subsidence Study Area* and only small cuttings less than 4 metres in depth are present.

The cutting batters consist of competent sandstone rock, as shown in Fig. 6.10.

Photograph courtesy Newcastle Geotech

Fig. 6.10 Railway cutting at 98.900 km

In the unlikely event that the faces of these cuttings are impacted by mine subsidence, the failure is likely to be very minor, in the form of small fragments of rock, and likely to fall into the clear area at the base of the cutting (the *cess*).

Tahmoor Mine has successfully mined directly beneath railway cuttings during the extraction of Longwalls 25 to 32, with only minor impacts observed on cuttings.

The Rail Management Plan will consider mitigation measures before the cuttings experience subsidence movements. Mitigation works could include, for example, scaling the cutting faces and removing debris from *the cess*. *The cess* will then be maintained during the mining period.

With an appropriate management plan in place, it is considered that potential impacts on the cuttings can be managed during the mining of the proposed longwalls, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur.

6.1.13. Potential impacts on embankments

The Main Southern Railway crosses relatively small valleys in the *Subsidence Study Area* and the railway embankments are less than 5 metres in height. The embankments are typically constructed with local fill material and contain relatively steep batters.

Photographs of embankments are shown previously in Fig. 6.1 and below in Fig. 6.11.

Photograph courtesy Newcastle Geotech

Fig. 6.11 Railway embankment at 100.200 km

The likelihood of impacts on the embankments is considered to be relatively low provided that the culverts remain serviceable and do not become blocked.

The embankments may experience tensile surface cracking during mining, however, these can be readily treated before they develop into a safety hazard. Compressive impacts are less likely as the voids within the embankment can accommodate some compressive movement.

The Rail Management Group will consider mitigation measures before each embankment experiences subsidence movements. Mitigation works could include, for example, cleaning out of the culverts and drainage lines beneath the embankments, or the stabilisation of the batters.

With an appropriate management plan in place, it is considered that potential impacts on the embankments can be managed during the mining of the proposed longwalls, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occurred.

6.1.14. Potential impacts on signalling and communications systems

There are a number of signalling, communications and electrical services along the Main Southern Railway. These include signal boxes and an optical fibre cable.

The potential for impacts on cabling and wiring along the track is considered to be very low. Mine subsidence impacts on electrical and telecommunications cabling is historically very low in the Southern Coalfield, as discussed in Section 6.10. It is noted that there are failsafe signalling procedures designed within the track management system that substantially reduce the potential for train collisions.

With an appropriate management plan in place, it is considered that the potential impacts on signalling, communications and electrical services can be managed during the mining of the proposed longwalls, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occurred.

6.2. Tahmoor Mine Rail Loop

The location of Tahmoor Mine's Rail Loop is shown in Drawing No. MSEC1192-10. Descriptions, predictions and impact assessments for the railway are provided in the following sections.

6.2.1. Description of the Rail Loop

Trains enter Tahmoor Mine's Rail Loop at 95.000 km on the Main Southern Railway and travel through the mine site in a clockwise direction. The Rail Loop passes beneath four overhead coal conveyors, the rail loader bin and a road crossing.

The Rail Loop consists of 53 kg rail on concrete sleepers. The track speed limit in the Rail Loop 15 km/hour and 5 km/hour when coal loading. Rail operations vary depending on volumes of coal available at the stockpile and the arrival of ships at port. The maximum rail activity at the mine is 4 train movements per day.

Fig. 6.12 Rail Loop under road bridge

Fig. 6.13 Aerial view of Rail Loop

The Rail Loop is located within the *Subsidence Study Area.* The closest distance between the Rail Loop and LW S1A is approximately 160 metres.

6.2.2. Predictions for the Rail Loop

The predicted profiles of conventional subsidence, tilt and curvature along the alignment of Rail Loop, resulting from the extraction of the proposed longwalls, are shown in Fig. E.09, in Appendix E.

A summary of the maximum predicted total conventional subsidence parameters along the alignment of the Rail Loop, after the extraction of each of the proposed longwalls, is provided in Table 6.6.

Table 6.6 Maximum predicted total conventional subsidence parameters along the alignment of the Rail Loop after the extraction of the proposed LWs S1A to S6A

Longwall	Maximum predicted total subsidence (mm)	Maximum predicted change in Grade (%)	Maximum predicted total hogging curvature along alignment (km^{-1})	Maximum predicted total sagging curvature along alignment (km^{-1})
After LW S6A	90	< 0.05	< 0.01	< 0.01

The majority of the subsidence movements are predicted to occur during the extraction of proposed LW S1A.

The maximum predicted conventional strains for the railway, based on applying a factor of 15 to the maximum predicted conventional curvatures, are less than 0.5 mm/m. Non-conventional movements can also occur as a result of, among other things, anomalous movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

6.2.3. Impact assessments for the Rail Loop

The Rail Loop is predicted to experience minor subsidence movements due to the extraction of proposed LWs S1A to S6A.

The changes in track geometry and rail stress are expected to be very minor and unlikely to adversely impact on rail operations. Non-conventional movements can, however, occur and impact the track. In the unlikely event that impacts occur, they can be readily repaired in between rail operations.

A Rail Management Group has been coordinated to develop the risk management strategies. The Rail Management Group includes representatives from ARTC, Tahmoor Coal and specialist consultants in the fields of railway track engineering, geotechnical engineering, structural engineering, track signalling, mine subsidence, risk assessment and project management. The Technical Committee consults with the Resources Regulator and the Office of the National Rail Safety Regulator.

Works by the Rail Management Group include:-

- Identification of potential impacts on the railway;
- Undertaking a risk management approach, where identified risks are assessed and risk control measures are implemented;
- Development of management measures that include mitigation and preventive works, monitoring plans, triggered response plans and communication plans; and
- Supervision and oversight of railway track and infrastructure mitigation, monitoring and maintenance of affected rail track and infrastructure.

With an appropriate management plan in place, it is considered that potential impacts on the Rail Loop can be managed during the mining of the proposed longwalls, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur.

6.2.4. Potential impacts on Tahmoor Mine overhead coal conveyors 3R, 4S, 4C and 7C

Tahmoor Mine's overhead coal conveyors 3R, 4S, 4C and 7C cross over the Rail Loop. The conveyors are supported by a series of steel supports. Conveyors 4S and 4C and the Rail Loader Bin are shown in Fig. 6.14

Fig. 6.14 Conveyors 4S and 4C over Rail Loop and Rail Loader Bin

The conveyor is predicted to experience approximately 90 mm of vertical subsidence at the railway crossing, with negligible tilts, curvature and strain.

The supports to the conveyor can be adjusted in the unlikely event that increased differential horizontal movements are observed.

Tahmoor Coal will study the potential for impacts to the coal conveyor and develop management measures to ensure that the conveyor and the Rail Loop remains safe and serviceable throughout the mining period. The study would require input from structural engineers and subsidence engineers. The management measures will include a combination of:-

- Installation of a monitoring system, which includes, among other things, the monitoring of ground movements and structure movements and visual inspections;
- Implementation of a response plan, where actions are triggered by monitoring results. This will include an adjustment of the conveyor supports if triggered by monitoring results; and
- Implementation of a reporting and communication plan.

With an appropriate management plan in place, it is considered that potential impacts on the conveyor crossings over the Rail Loop can be managed during the mining of the proposed longwalls, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur.

6.2.5. Potential impacts on Tahmoor Mine road bridge over Rail Loop

The road bridge over the Rail Loop is supported by an Armco Culvert with a compacted earth embankment fill. A close up view is shown in Fig. 6.15.

Photograph courtesy JMA Solutions

Fig. 6.15 Tahmoor Mine road bridge over Rail Loop

The road bridge is predicted to experience approximately 40 mm of vertical subsidence with negligible tilts, curvatures and strains. Non-conventional movements can, however, occur and impact the road bridge.

The Armco structure is generally ductile in nature and can tolerate differential movement.

Tahmoor Coal will study the potential for impacts to the road bridge over the Rail Loop and develop management measures to ensure that the track and road remains safe and serviceable throughout the mining period. The study would require input from structural engineers and subsidence engineers. The management measures will include a combination of:-

- Installation of a monitoring system, which includes, among other things, the monitoring of ground movements and structure movements and visual inspections;
- Implementation of a response plan, where actions are triggered by monitoring results. This will include an adjustment of the Armco culvert if triggered by monitoring results; and
- Implementation of a reporting and communication plan.

With an appropriate management plan in place, it is considered that potential impacts on the road bridge and the Rail Loop can be managed during the mining of the proposed longwalls, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur.

6.3. Local roads

6.3.1. Descriptions of local roads

The locations of local roads within the Study Area are shown in Drawing No. MSEC1192-11.

The main local road within the *Subsidence Study Area* is Remembrance Drive which runs along the western side of the Main Southern Railway and crosses directly above the proposed Longwalls S1A to S5A. The road provides a connection between the M31 Hume Motorway and the township of Bargo with the township of Tahmoor to the north of the Study Area.

Caloola Road and Yarran Road are one-way sealed roads that connect to Remembrance Drive from the west. The two road are located within the *Subsidence Study Area.*

Great Southern Road runs alongside the eastern side of the Main Southern Railway and becomes Avon Dam Road, which connects to the M31 Hume Motorway. Only the northern end of Great Southern Road is located within the *Subsidence Study Area.* Charlies Point Road is a sealed local road that connects Great Southern Road and Arina Road.

The local roads are maintained by Wollondilly Shire Council. A photograph of Remembrance Drive near the intersection with Caloola Road is provided in Fig. 6.16.

Photograph courtesy Building Inspection Services

Fig. 6.16 Remembrance Drive near Caloola Road

There are no bridges along local roads within the *Subsidence Study Area.* A number of culverts are located within the *Subsidence Study Area*, as shown in Drawing No. MSEC1192-11. Almost every culvert is a reinforced concrete pipe (RCP), with the exception of one earthenware pipe on Charlies Point Road. The pipe diameters vary between 500 mm and 1.8 metres.

A photograph of twin, 1.35 metre diameter reinforced concrete culverts beneath bus stop at the end of Caloola Road is shown in Fig. 6.17. The culvert carries the pavement over Teatree Hollow and continues beneath Remembrance Drive. A photograph of the road embankment to Remembrance Drive at Teatree Hollow is shown in Fig. 6.18.

Two culverts are located in close proximity at the intersection between Remembrance Drive, Yarran Road and the Main Southern Railway. The 1800 mm RCP culvert beneath Remembrance Drive drains into a small parcel of privately owned land and a 2000 mm diameter brick arch culvert beneath the Main Southern Railway.

Photograph courtesy Building Inspection Services

Fig. 6.17 Culvert beneath approach to Caloola Road and continuing under Remembrance Drive along Teatree Hollow

Photograph courtesy Building Inspection Services

Fig. 6.18 Remembrance Drive embankment at intersection with Caloola Road

Photographs courtesy Building Inspection Services

Fig. 6.19 RCP culvert beneath Remembrance Drive and brick arch culvert beneath Main Southern Railway at 100.425 km with private land in between them

6.3.2. Predictions for local roads

The predicted profiles of conventional subsidence and tilt along the alignment of Remembrance Drive, resulting from the extraction of the proposed longwalls, are shown in Fig. E.07, in Appendix E.

A summary of the maximum predicted total conventional subsidence parameters for Remembrance Drive, after the extraction of each of the proposed longwalls, is provided in Table 6.7.

The predicted tilts are the maxima along the alignment of the road after the completion of each of the proposed longwalls. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each of the proposed longwalls.

Table 6.7 Maximum predicted total conventional subsidence parameters for Remembrance Drive due to the extraction of LWs S1A to S6A

Longwall	Maximum predicted subsidence (mm)	Maximum predicted tilt along alignment (mm/m)	Maximum predicted tilt across alignment (mm/m)	Maximum predicted hogging curvature in any direction (km^{-1})	Maximum predicted sagging curvature in any direction (km^{-1})
LW S1A	325	2.5	5.0	0.06	0.06
LW S2A	1000	5.0	5.5	0.08	0.20
LW S3A	1200	6.5	5.5	0.10	0.21
LW S4A	1250	6.0	6.0	0.12	0.21
LW S5A	1300	6.5	5.5	0.12	0.21
LW S6A	1350	7.5	5.5	0.12	0.21

The maximum predicted conventional strains for Remembrance Drive, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1.8 mm/m tensile and 3.2 mm/m compressive. Non-conventional movements can also occur as a result of, among other things, anomalous movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The road is a linear feature and, therefore, the most relevant distribution of strain is the maximum strains measured along whole monitoring lines above previous longwall mining. The analysis of strains along whole monitoring lines during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.3.2 and the results are provided in Fig. 4.4.

Caloola Road and Yarran Road are located directly above the proposed longwalls and, therefore, could experience the full range of predicted subsidence movements. A summary of the maximum predicted conventional subsidence movements within the Study Area is provided in Chapter 4.

Remembrance Drive crosses Teatree Hollow and a number of its tributaries within the *Subsidence Study Area* and valley-related movements could be experienced in these locations. A summary of the maximum predicted conventional subsidence and valley related movements for the crossing at Teatree Hollow is provided in Table 6.8.

Table 6.8 Predicted Conventional Subsidence and Valley Related Movements for the Culverts along Remembrance Drive within the Study Area

Location	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Total Tilt along Culvert (mm/m)	Maximum Predicted Total Hogging Curvature (1/km)	Maximum Predicted Total Sagging Curvature (1/km)	Maximum Predicted Total Upsidence (mm)	Maximum Predicted Total Closure (mm)
Teatree Hollow (Caloola Road)	1300	6.9	0.06	-0.18	250	150
Tributary to Teatree Hollow	1100	3.6	0.05	-0.04	125	100
Tributary to Teatree Hollow (Yarran Road)	1300	6.7	0.05	-0.22	150	75
Tributary to Teatree Hollow (Wellers Road)	25	< 0.5	< 0.01	< 0.01	40	25

6.3.3. Impact assessments for local roads

There is extensive experience of mining directly beneath local roads in the Southern Coalfield which demonstrates that impacts can be managed with the implementation of suitable management strategies. In all cases the local roads have remained in safe and serviceable condition and have been remediated using normal road maintenance techniques.

Longwalls 22 to 32 and LW W1-W3 at Tahmoor Mine have mined directly beneath 28 kilometres of local roads and a total of 54 impact sites have been observed. The observed rate of impact on the local roads equates to an average of one impact for every 520 metres of pavement. In most cases, the impacts were relatively minor and were remediated by locally resurfacing the pavements.

The most severe impacts were located where substantial non-conventional movements had developed. These impact sites were identified using visual and ground monitoring and remediation was undertaken during active subsidence to maintain these roads in safe and serviceable conditions.

Photographs of typical impacts observed on local roads at Tahmoor are provided in Fig. 6.20.

Fig. 6.20 Previously observed impacts on local roads above Tahmoor Mine

As the predicted subsidence parameters for the proposed longwalls are greater than those at Tahmoor North, it is expected that the rates of impact on the local roads within the *Subsidence Study Area* will be greater than experienced at Tahmoor. The impacts, however, can be managed with the implementation of

suitable management strategies. Impacts on local roads have been successfully managed elsewhere in the NSW Coalfields, where the predicted subsidence parameters were similar to or greater than those predicted for the proposed longwalls.

6.3.4. Impact assessments for local road culverts

The maximum predicted tilt across Remembrance Drive within the *Subsidence Study Area* is 6.9 mm/m (i.e. 0.69 %), which represents a change in grade of 1 in 145.

The predicted changes in grade are small, in the order of 1 % and, therefore, are unlikely to result in any adverse impacts on the serviceability of the drainage culverts. If the flow of water through any drainage culverts were to be adversely affected, as a result of the proposed mining, this could be remediated by re-levelling the affected culverts.

The predicted curvatures and strains could be of sufficient magnitudes to result in cracking in the culverts or the headwalls. It is unlikely, however, that these movements would adversely impact on the stabilities or structural integrities of the culverts. The potential impacts on the drainage culverts could be managed by visual inspection and, where required, any affected culverts can be repaired or replaced.

The drainage culverts are located along drainage lines and could, therefore, experience valley related upsidence and closure movements. The drainage culverts are orientated along the alignments of the drainage lines and, therefore, the upsidence and closure movements are orientated perpendicular the main axes of the culverts and unlikely to result in adverse impacts to the culvert pipes.

Previous experience of mining beneath culverts in the NSW Coalfields, at similar depths of cover, indicates that the incidence of impacts is low. Impacts have generally been limited to cracking in the concrete headwalls which can be readily remediated. In some cases, however, cracking in the culvert pipes occurred which required the culverts to be replaced.

6.3.5. Management of potential impacts on local roads

Tahmoor Coal has developed a Subsidence Management Plan in consultation with Wollondilly Shire Council for the extraction of existing longwalls at Tahmoor Mine to manage the impacts on the public roads, bridges and culverts.

It is recommended that a similar Subsidence Management Plan be developed in consultation with Wollondilly Shire Council to manage potential impacts on the local roads, bridges and culverts within the *Subsidence Study Area*. With the implementation of these management strategies, it would be expected that the local roads could be maintained in safe and serviceable conditions during and after the extraction of the proposed longwalls.

With an appropriate management plan in place, it is considered that potential impacts on the roads, bridges and culverts can be managed during the extraction of the proposed longwalls, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur.

6.4. Road bridges

Descriptions, predictions and impact assessments for Wellers Road Bridge over the Main Southern Railway is provided in Section 6.1.9. There are no other bridges within the *Subsidence Study Area.*

6.5. Tunnels

There are no tunnels within the *Subsidence Study Area*.

6.6. Potable water infrastructure

6.6.1. Descriptions of potable water infrastructure

The locations of the potable water infrastructure within the *Subsidence Study Area* are shown in Drawing No. MSEC1192-12. The water pipelines are owned and operated by Sydney Water.

The potable water infrastructure includes a Cast Iron Cement Lined (CICL) 450 mm diameter watermain which follows the alignment of Remembrance Drive, before crossing beneath the Main Southern Railway and following Great Southern Road. 200 mm and 250 mm diameter Ductile Iron Cement Lined (DICL) water pipelines are located along Caloola Road, Yarran Road and along a short section Remembrance Drive to the south the railway crossing.

A summary of the potable water pipelines within the Study Area is provided in Table 6.9.

Table 6.9 Potable water pipelines within the Study Area

Type	Size (diameter) (mm)	Total length of pipeline within Study Area (km)	Total length of pipeline located directly above proposed LWs S1A to S6A (km)
450 mm dia. watermain along Remembrance Drive	450	3.0	2.4
Distribution Network	100 to 200	3.4	2.1

The distribution of water mains by pipe diameter within the Study Area is shown in Table 6.10.

Table 6.10 Distribution of water mains by pipe diameter

Pipe diameter (mm)	Total length within Study Area (km)	%
100	2.9	44.5
150	< 0.1	0.1
200	0.6	8.7
375	< 0.1	< 0.1
450	3.0	46.7
Total	**6.4**	**100.0**

The types of pipeline within the *Subsidence Study Area* are mainly DICL and CICL, with short sections of Steel Cement Lined (SCL) beneath road crossings. The distribution of water mains by type of pipe is shown in Table 6.11.

Table 6.11 Distribution of water mains by pipe type

Pipe diameter (mm)	Total length within Study Area (km)	%
CICL	4.6	71.9
DICL	1.8	27.6
SCL IBL	< 0.1	0.4
Unknown	< 0.1	< 0.1
Total	**6.4**	**100.0**

6.6.2. Predictions for potable water infrastructure

The 450 mm diameter CICL watermain generally follows the alignment of Remembrance Drive. Predictions of subsidence effects along the pipeline, including predictions of valley closure at creek crossing are provided in Section 6.3.2.

6.6.3. Impact assessments for potable water pipelines

Longwalls 22 to 32 at Tahmoor Mine have directly mined beneath approximately 5.5 kilometres of DICL pipe and 19.5 kilometres of CICL pipe, with only minor impacts recorded to the older CICL pipes. Water leaks were repaired by Sydney Water using normal response procedures.

The predicted systematic curvatures and strains for the water pipelines within the *Subsidence Study Area* are of a similar order of magnitude to those observed and predicted along the pipelines that have been mined directly beneath by previously extracted longwalls in the Southern Coalfield. The overall levels of impacts on the water pipelines in the *Subsidence Study Area*, therefore, are expected to be similar to those observed during the previously extracted longwalls in the Southern Coalfield. Longwalls in the Southern Coalfield have been mined directly beneath water pipelines in the past, and some of these cases are provided in Table 6.12.

Table 6.12 Examples of previous experience of mining beneath water pipelines in the Southern Coalfield

Colliery and Longwalls	Pipelines	Observed movements	Observed impacts
Appin LW301 and LW302	0.6 km of 150 dia. DICL 0.6 km of 300 dia. CICL 0.6 km of 1200 dia. SCL	650 mm Subsidence 4.5 mm/m Tilt 1 mm/m Tensile Strain 3 mm/m Comp. Strain (Measured M & N-Lines)	Leakage of the 150 mm and 300 mm CICL pipelines at a creek crossing, elsewhere no other reported impacts
Tahmoor Mine LW22 to LW32	5.5 km DICL pipes 19.5 km CICL pipes	1200 mm Subsidence 6 to 10 mm/m Tilt 1.5 mm Tensile Strain 2 mm (typ.) and up to 5 mm/m Comp. Strain (Extensive street monitoring)	Impacts occurred to the distribution network at 8 locations and a very small number of minor leaks in the consumer connection pipes
West Cliff LW5A3, LW5A4 & LW29 to LW34	2.8 km of 100 dia. CICL pipe directly mined beneath	1100 mm Subsidence 10 mm/m Tilt 1 mm/m Tensile Strain 5.5 mm/m Comp. Strain (Measured B-Line)	No reported impacts

Based on this experience, it is expected that some minor leakages of the water pipelines could occur at isolated locations, as the result of the extraction of the longwalls, however, the incidence of impacts is expected to be low. Impacts are more likely to occur in the locations of non-systematic movements, and at creek crossings, due to valley related movements.

Any impacts are expected to be of a minor nature which could be easily remediated. It is recommended that Tahmoor Coal develop management strategies, in consultation with Sydney Water, to manage these potential impacts.

6.6.4. Management of potential impacts on water infrastructure

Tahmoor Coal has developed a Subsidence Management Plan in consultation with Sydney Water for the extraction of existing longwalls at Tahmoor Mine to manage potential impacts on potable water infrastructure.

With an appropriate management plan in place, it is considered that the potential impacts on the Sydney Water potable water pipelines can be managed during the extraction of the proposed longwalls, even if actual subsidence movements are greater than the predictions.

6.7. Sewerage pipelines

6.7.1. Descriptions of sewerage pipelines

A *Priority Sewer Program* has been constructed in the township of Bargo by Sydney Water. The sewer infrastructure includes a pressure main along Remembrance Drive and a consumer reticulation network along the local roads. The locations of the sewerage infrastructure are shown in Drawing No. MSEC1192-13.

The sewerage system was designed to accommodate mine subsidence movements and consists of polyethylene (PE) pipelines with diameters up to 630 mm.

A summary of the sewerage pipelines within the *Subsidence Study Area* is provided in Table 6.13.

Table 6.13 Sewerage pipelines within the Subsidence Study Area

Type	Size (diameter) (mm)	Total length of pipeline within Subsidence Study Area (km)	Total length of pipeline located directly above proposed LWs S1A to S6A (km)
PE Pressure Main along Remembrance Drive	180	3.0	2.3

6.7.2. Predictions for sewer infrastructure

The 180 mm diameter PE pressure main generally follows the alignment of Remembrance Drive. Predictions of subsidence effects along the pipeline, including predictions of valley closure at creek crossing are provided in Section 6.3.2.

6.7.3. Impact assessments for sewer infrastructure

The sewer reticulation network within the *Subsidence Study Area* consists of a 180 mm diameter welded PE pipe.

Tahmoor Coal, in consultation with Sydney Water, has successfully mined beneath a sewerage system at Tahmoor and Thirlmere during the mining of Longwalls 22 to 32. The sewerage infrastructure at Tahmoor and Thirlmere are gravity sewers and consist mainly of PVC pipes. While impacts on the sewerage system at Tahmoor have been successfully managed, the pressurised sewerage system at Bargo will be able to accommodate substantially greater differential subsidence movements.

The sewer main transports sewage by hydraulic pressure and does not rely on gravity. While the sewer main will experience changes in grade due to subsidence, the changes will not adversely affect it.

The PE pipes can accommodate substantial deformations without losing their integrity. Only extreme deformations, such as the development of a step in the ground may adversely impact on the pipes.

If the PE pipe experiences severe deformation, the pipe may become blocked. The sewerage system has been designed to store sewage for approximately 8 hours after which time sewage may leak or overflow from the sewerage system. This can be readily repaired by local excavation and repair.

There do not appear to be any house connections to the pressure main within the *Subsidence Study Area.* Houses can connect to the system via a Sydney Water designed pot that is approximately 2 metres deep and 1 metre in diameter. The pot stores sewage, which is pumped into the reticulation network. The connection between each house and the pot consists of a gravity flow PVC pipe. It is possible that the pot and the house will act as anchors to the ground during subsidence, and that differential horizontal movements between the two structures may result in leakage at the connections. This is similar to the current connections between houses and septic tanks. Experience from mining beneath septic tanks has been that while impacts have previously occurred during, the rate of impact is low. Impacts to the connections can be readily repaired.

A number of valves and chambers are located above the proposed longwalls. These chambers, valves and pipe fittings are small in size and are connected via flange adapters. It is expected that the chambers, valves and fittings will act as anchors to the ground during subsidence, allowing the PE pipe to stretch or compress in response to mining-induced differential horizontal movements. While there is potential for impacts to occur at these locations, many similar structures are located within the Tahmoor sewerage system and no impacts have occurred to chambers, valves and other pipe fittings during mining. There is, however, a remote chance that anomalous ground deformation could occur during extraction of the proposed longwalls.

Any impacts are expected to be of a minor nature which could be easily remediated. It is recommended that Tahmoor Coal develop management strategies, in consultation with Sydney Water, to manage these potential impacts.

6.7.4. Management of potential impacts on proposed sewerage infrastructure

Tahmoor Coal has developed a Subsidence Management Plan in consultation with Sydney Water for the extraction of existing longwalls at Tahmoor Mine to manage potential impacts on sewerage infrastructure.

With an appropriate management plan in place, it is considered that the potential impacts on the Sydney Water sewerage pipelines can be managed during the extraction of the proposed longwalls, even if actual subsidence movements are greater than the predictions.

6.8. Gas infrastructure

6.8.1. Moomba-Sydney Gas Pipeline and Gorodok Ethane Pipeline

The *Moomba-Sydney Gas Pipeline and Gorodok Ethane Pipeline* is located south of Bargo township and is outside the *Subsidence Study Area* for LWs S1A to S6A.

6.8.2. Local Jemena infrastructure

The locations of local gas infrastructure within and adjacent to the *Subsidence Study Area* are shown in Drawing No. MSEC1192-14. There is a 150 mm diameter steel main, which runs along Remembrance Drive and distributes gas to the townships north of Bargo, including Tahmoor, Thirlmere and Picton.

The take-off point for the 150 mm steel main from the Moomba-Sydney Gas Pipeline is located on Hawthorne Road outside the *Subsidence Study Area*. The local Jemena gas infrastructure servicing the Bargo township has a take-off point at the same location. The take-off point consists of a number of buried pits, a pillar box and guard rail.

A summary of the local gas infrastructure within the *Subsidence Study Area* is provided in Table 6.14.

Table 6.14 Summary of the local gas infrastructure within the Subsidence Study Area

Type	Total length of local gas infrastructure within Subsidence Study Area (km)	Total length of local gas infrastructure directly above proposed LWs S1A to S6A (km)
32 mm nylon	0.2	0
50 mm nylon	< 0.05	0
150 mm steel	3.0	2.4

6.8.3. Predictions for gas infrastructure

The 150 mm diameter PE pressure main generally follows the alignment of Remembrance Drive. Predictions of subsidence effects along the pipeline, including predictions of valley closure at creek crossing are provided in Section 6.3.2.

6.8.4. Impact assessments for gas infrastructure

Longwalls 22 to 32 have directly mined beneath approximately 19 kilometres of gas pipes and no impacts have been recorded so far. The local nylon and 160 mm polyethylene main along Remembrance Drive are very flexible and have demonstrated that they are able to withstand the full range of subsidence experienced during longwall extraction at Tahmoor Mine to date. While no impacts have been experienced to date, it is acknowledged that the most vulnerable element of the system is the rigid copper pipe connections between the gas mains and houses, which can be readily repaired.

A difference between the gas infrastructure at Bargo compared to the gas infrastructure at Tahmoor is the existence of the 150 mm steel gas main at Bargo. This pipe passes through the Bargo township, mainly along Remembrance Drive. As the steel pipe was constructed in 1994, it was designed and constructed in accordance with the requirements of SA NSW. Steel gas pipelines of similar and larger diameter have been successfully mined directly beneath in the past in the Southern Coalfield (McGill, 2007) and Newcastle Coalfield (Robinson, 2007). Being of relatively small diameter, the pipe is expected to withstand considerable deformation.

Tahmoor Coal has consulted with Jemena and has engaged specialist pipeline engineers who are experienced in mine subsidence to conduct analyses to assess the potential for impacts on the pipeline. The analyses includes an assessment of changes in pipe stresses due to the predicted subsidence, tilt, curvature and strain movements and a sensitivity analysis to assess the magnitudes at which differential movements may exceed acceptable limits. The results indicate that the pipeline can tolerate the predicted conventional subsidence movements due to the extraction of LWs S1A and S2A.

Investigations are currently underway to assess the risks and select feasible risk controls that can be implemented either prior to mining and/or during mining, taking into account the specific site conditions along Remembrance Drive. This may include, for example, exposing sections of pipeline at creek crossings prior to the influence of subsidence.

If observed ground strains or severe ground deformations are observed to develop during mining, the pipe can be exposed and adjusted to decouple the pipe from the differential ground movements. Pre-planned traffic control and security measures would be required to be implemented if these works are required. In the event of a minor gas leak, the pipeline can also be repaired without interruption to services.

6.8.5. Management of potential impacts on gas infrastructure

Tahmoor Coal has developed Subsidence Management Plans in consultation with Jemena for the existing longwalls at Tahmoor Mine to manage potential impacts on local gas infrastructure at Tahmoor.

It is recommended that a similar Subsidence Management Plan be developed in consultation with Jemena to manage potential impacts on the local gas infrastructure within the *Subsidence Study Area*. With the implementation of these management strategies, it would be expected that the local gas infrastructure could be maintained in safe and serviceable conditions during and after the extraction of the proposed longwalls.

With an appropriate management plan in place, it is considered that potential impacts on the local gas infrastructure can be managed during the extraction of the proposed longwalls, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur.

6.9. Electrical Infrastructure

6.9.1. Descriptions of electrical infrastructure

The locations of the electrical infrastructure within the *Subsidence Study Area* are shown in Drawing No. MSEC1192-15.

The electrical infrastructure comprises 66 kV, 11 kV and low voltage powerlines which are located across the *Subsidence Study Area*. There are no transmission lines located within the *Subsidence Study Area*.

A summary of the power lines within the *Subsidence Study Area* is provided in Table 6.15.

Table 6.15 Summary of the electrical infrastructure within the Subsidence Study Area

Type	Total length of powerline within Subsidence Study Area (km)	Total length of powerline directly above proposed LWs S1A to S6A (km)
66 kV Powerlines	1.5	Nil
11 kV Powerlines	11.4	5.4
Low Voltage Powerlines	11.1	6.9

The power lines generally comprise aerial copper cables supported on timber poles, but there are also some sections of direct buried cables. The power lines are owned and operated by Endeavour Energy.

6.9.2. Predictions for electrical infrastructure

The power lines are located across the *Subsidence Study Area* and, therefore, could experience the full range of predicted subsidence movements. A summary of the maximum predicted conventional subsidence movements within the *Subsidence Study Area* is provided in Chapter 4.

6.9.3. Impact assessments for electrical infrastructure

The aerial power lines will not be directly affected by the ground strains, as the cables are supported by poles above ground level. The cables may, however, be affected by changes in the bay lengths, i.e. the distances between the poles at the levels of the cables, resulting from differential subsidence, horizontal movements, and tilt at the pole locations. The stabilities of the poles may also be affected by conventional tilt, and by changes in the catenary profiles of the cables.

There is extensive experience of mining directly beneath power lines in the Southern Coalfield which indicates that the incidence of impacts is very low and that any impacts are readily repairable. A summary of previous experiences is provided in Table 6.16.

Table 6.16 Previous experience of mining beneath powerlines in the Southern Coalfield

Colliery and LWs	Length of powerlines directly mined beneath (km)	Observed maximum movements at powerlines	Observed impacts
Appin LW1 to LW12	5.2 km of 11 kV 104 power poles	850 mm Subsidence 6 mm/m Tilt (Measured WX-Line)	No significant impacts
Appin LW14 to LW29	1.0 km of 66 kV 4.6 km of 11 kV 76 power poles	1200 mm Subsidence 7 mm/m Tilt (Measured A-Line)	No significant impacts
Appin LW301 and LW302	0.6 km of 66 kV 0.2 km of 11 kV 14 power poles	650 mm Subsidence 4.5 mm/m Tilt (Measured M & N-Lines)	No significant impacts
Appin LW401 to LW408	3.4 km of 66 kV 0.6 km of 33 kV 2.9 km of 11 kV 96 power poles	700 mm Subsidence 5 mm/m Tilt (Measured A-Line)	No significant impacts
Appin LW702	1.5 km of 11 kV 19 power poles	550 mm Subsidence 3.5 mm/m Tilt (Measured MPR-Line)	No significant impacts
Dendrobium LW3 and LW4	0.8 km of 33 kV	1100 mm Subsidence 40 mm/m Tilt (Measured 2000-Line)	No significant impacts
Tahmoor LW22 to LW32	Approx. 44 km of electrical cables and 1100 power poles	1200 mm Subsidence 12 mm/m Tilt (Extensive street monitoring, surveys of critical power poles)	Some minor adjustments to cable catenaries, pole tilts and consumer cables required.
Tower LW1 to LW10	6.0 km of 66 kV 4.3 km of 11 kV 112 power poles	400 mm Subsidence 3 mm/m Tilt (Measured T & TE-Lines)	No significant impacts
West Cliff LW5A3 to LW5A4 & LW29 to LW33	0.8 km of a 66 kV 3.7 km of 11 kV 113 power poles	950 mm Subsidence 5 mm/m Tilt (Measured B-Line)	No significant impacts

Some remedial measures have been required, in the past, which included adjustments to cable catenaries, pole tilts and to consumer cables which connect between the power lines and building structures. It is expected that the mining during the proposed development will result in similar experiences.

6.9.4. Impact assessments for electrical infrastructure based on increased predictions

If the actual subsidence movements exceeded those predicted by a factor of 2 times, the maximum tilt at the power lines would be 16.6 mm/m (i.e. 1.6 %), or a change in grade of 1 in 60. In this case, the tilts would still be less than the tolerable tilt, which is in the order of 33 mm/m. The incidence of impacts would increase in the locations of greatest tilt, such as adjacent to the active longwall maingate and adjacent to the ends of the proposed longwalls. It would still be expected that any impacts could remediated, including some adjustments of the cable catenaries, pole tilts and the consumer cables, as has been undertaken in the past.

While the predicted ground movements are important parameters when assessing the potential impacts on the power lines, it is noted that the impact assessments were primarily based on historical observations from previous longwall mining in the Southern Coalfield. The overall levels of impact on the power lines, resulting from the extraction of the proposed longwalls, are expected to be similar to those observed where longwalls have previously mined directly beneath power lines in the Southern Coalfield.

6.9.5. Management of potential impacts on electrical infrastructure

Tahmoor Coal has developed Subsidence Management Plans in consultation with Endeavour Energy for the existing longwalls at Tahmoor Mine to manage potential impacts on electrical infrastructure.

It is recommended that a similar Subsidence Management Plan be developed in consultation with Endeavour Energy to manage potential impacts on the electrical infrastructure within the *Subsidence Study Area*.

With an appropriate management plan in place, it is considered that potential impacts on the electrical infrastructure can be managed during the extraction of the proposed longwalls, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur.

6.10. Telecommunications Infrastructure

6.10.1. Description of telecommunications infrastructure

The locations of the telecommunications infrastructure are shown in Drawing No. MSEC1192-16.

The telecommunications infrastructure within the *Subsidence Study Area* comprises optical fibre cables and copper cables. A summary of the telecommunications cables within the *Subsidence Study Area* is provided in Table 6.17.

Table 6.17 Summary of telecommunications infrastructure within the Subsidence Study Area

Type	Total length of cable within Subsidence Study Area (km)	Total length of cable located directly above proposed LWs S1A to S6A (km)
Copper Cables		
Telstra	15.9	10.5
National Broadband Network (NBN)	16.7	11.1
Optical Fibre Cables		
Telstra	3.6	2.6
TPG	2.8	2.3

Telstra telecommunications infrastructure

A Telstra optical fibre cable follows the alignment of Remembrance Drive and the Main Southern Railway and crosses directly above the proposed LWs S1A to S5A.

The copper telecommunications cables are generally direct buried and follow the alignments of local roads across the *Subsidence Study Area*.

National Broadband Network (NBN) infrastructure

The National Broadband Network (NBN) cables comprise both Optical fibre and copper service cables. NBN optical fibre cable follows the alignment of Remembrance Drive. Copper service cables follow the alignments of local roads across the *Subsidence Study Area*.

An NBN telecommunications tower is located at No. 3166 Remembrance Drive, with access from Yarran Road. The tower is located directly above LW S6A, as shown in Drawing No. MSEC1192-16. An aerial photograph is shown in Fig. 6.21.

TPG infrastructure

TPG have installed an optical fibre cable along Remembrance Drive from the Wollondilly Anglican College to the Bargo Exchange, following the same route as the NBN optical fibre cable, as shown in Drawing No. MSEC1192-16.

Fig. 6.21 NBN telecommunications tower with access from Yarran Road

6.10.2. Predictions for telecommunications infrastructure

Predictions of subsidence effects along Remembrance Drive, including predictions of valley closure at creek crossings are provided in Section 6.3.2.

The predicted profiles of conventional subsidence, tilt and curvature along the Telstra optical fibre cable along Remembrance Drive and the Main Southern Railway are shown in Fig. E.08, in Appendix E. The predicted profiles of conventional subsidence, tilt and curvature along the NBN and TPG optical fibre cables along Remembrance Drive are shown in Fig. E.07, in Appendix E. The predicted incremental profiles along the alignments of the cables, due to the extraction of each of the proposed longwalls, are shown as dashed black lines. The predicted total profiles along the alignments of the cables, after the completion of each of the proposed longwalls, are shown as solid blue lines. The range of predicted curvatures in any direction to the cables, at any time during or after the extraction of the proposed longwalls, is shown by the grey shading.

A summary of the maximum predicted total conventional subsidence parameters for the optical fibre cable, after the completion of each of the proposed longwalls, is provided in Table 6.18. The predicted tilts are the maxima along the alignments of the cables after the completion of each of the proposed longwalls. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each of the proposed longwalls.

Table 6.18 Maximum predicted total conventional subsidence parameters for the Telstra optical fibre cable along Remembrance Drive and Main Southern Railway

Longwall	Maximum predicted subsidence (mm)	Maximum predicted tilt along alignment (mm/m)	Maximum predicted hogging curvature in any direction (km^{-1})	Maximum predicted sagging curvature in any direction (km^{-1})
LW S1A	325	2.5	0.06	0.06
LW S2A	1000	7.5	0.08	0.20
LW S3A	1200	6.5	0.10	0.20
LW S4A	1250	7.0	0.14	0.20
LW S5A	1300	7.0	0.14	0.20
LW S6A	1350	8.5	0.14	0.20

The optical fibre cables along the Main Southern Railway and Remembrance Drive cross a number of streams within the *Subsidence Study Area* and could experience valley related movements in these locations. A summary of the maximum predicted upsidence and closure movements at the stream crossings is provided in Table 6.19.

Table 6.19 Maximum predicted upsidence and closure movements for optical fibre cables along Remembrance Drive and Main Southern Railway at the stream crossings

Location	Maximum predicted total subsidence (mm)	Maximum predicted total tilt (mm/m)	Maximum predicted total hogging curvature (1/km)	Maximum predicted total sagging curvature (1/km)	Maximum predicted total upsidence (mm)	Maximum predicted total closure (mm)
Main Southern Railway						
99.388 km	1225	5.0	0.06	0.04	200	150
100.121 km	1225	7.0	0.08	0.09	200	100
100.425 km	1275	3.5	0.05	0.12	150	75
101.000 km	20	< 0.5	< 0.01	< 0.01	50	20
Remembrance Drive						
Teatree Hollow (Caloola Road)	1300	6.9	0.06	-0.18	250	150
Tributary to Teatree Hollow	1100	3.6	0.05	-0.04	125	100
Tributary to Teatree Hollow (Yarran Road)	1300	6.7	0.05	-0.22	150	75
Tributary to Teatree Hollow (Wellers Road)	25	< 0.5	< 0.01	< 0.01	40	25

The predicted total closure at each stream crossing is the sum of the valley related movement calculated using the 2002 ACARP prediction method (Waddington and Kay, 2002) plus the conventional movement within the valley. It is noted that this provides some additional conservatism, as the 2002 ACARP prediction method also includes some component of the conventional movement.

The maximum predicted conventional strains for the optical fibre cables, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 2.1 mm/m tensile and 3.0 mm/m compressive. Non-conventional movements can also occur as a result of, among other things, anomalous movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The optical fibre cables are linear features and, therefore, the most relevant distribution of strain is the maximum strains measured along whole monitoring lines above previous longwall mining. An analysis of strains along whole monitoring lines during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.3.2 and the results are provided in Fig. 4.4.

The Telstra, NBN and TPG copper telecommunications cables are located across the *Subsidence Study Area* and, therefore, could experience the full range of predicted subsidence movements. A summary of the maximum predicted conventional subsidence movements within the *Subsidence Study Area* is provided in Chapter 4.

The NBN telecommunications tower is located off at No. 3166 Remembrance Drive, with access from Yarran Road. Predictions of conventional subsidence, tilt and curvature have been made at the centroid and at points located around the perimeter of the tower and the shed, as well as at points located at a distance of 20 metres from the perimeter of each structure. A summary of the maximum predicted values of conventional subsidence, tilt and curvature for each structure is provided in Table 6.20.

Table 6.20 Maximum predicted total conventional subsidence parameters for the NBN telecommunications tower at No. 3166 Remembrance Drive

Structure	Maximum predicted subsidence (mm)	Maximum predicted tilt along alignment (mm/m)	Maximum predicted hogging curvature in any direction (km^{-1})	Maximum predicted sagging curvature in any direction (km^{-1})
Shed	900	3.0	0.05	0.04
Tower	850	2.5	0.04	0.04

6.10.3. Impact assessments for optical fibre cables

The optical fibre cables are direct buried or buried in conduit and could, therefore, potentially be impacted by ground strains. The greatest potential for impacts will occur as the result of localised ground strains due to non-conventional movements or valley related movements.

Tensile strains in the optical fibre cables could be higher than predicted, where the cables connect to the support structures, which may act as anchor points, preventing any differential movements that may have been allowed to occur with the ground. Tree roots have also been known to anchor cables to the ground. The extent to which the anchor points affect the ability of the cables to tolerate the mine subsidence movements depends on the cable size, type, age, installation method and ground conditions.

In addition to this, optical fibre cables contain additional fibre lengths over the sheath lengths, where the individual fibres are loosely contained within tubes. Compression of the sheaths can transfer to the loose tubes and fibres and result in “micro-bending” of the fibres constrained within the tubes, leading to higher attenuation of the transmitted signal. If the maximum predicted compressive strains were to be fully transferred into the optical fibre cables, the strains could be of sufficient magnitude to result in the reduction in capacities of the cables or transmission loss.

Strains transferred into the optical fibre cables can be monitored using Optical Time Domain Reflectometry (OTDR), which can be used to notify the infrastructure owners of strain concentrations due to non-conventional ground movements or valley related movements.

Longwalls in the Southern Coalfield have been successfully mined directly beneath optical fibre cables in the past, with little to no adverse impacts on these cables. A summary of some of these cases is provided in Table 6.21.

Table 6.21 Examples of mining beneath optical fibre cables

Colliery and Longwalls	Length of optical fibre cables directly mined beneath (km)	Observed maximum movements at optical fibre cables	Pre-mining mitigation, monitoring and observed impacts
Appin LW301 and LW302	0.8	650 mm Subsidence 1 mm/m Tensile Strain 3 mm/m Comp. Strain (Measured M & N-Lines)	600 metre aerial cable on standby. Ground survey, visual, OTDR. No reported impacts.
Appin LW703 to LW705	10.0 total for five cables	1200 mm Subsidence 2.1 mm/m Tensile Strain 4.5 mm/m Comp. Strain (Measured HW2, ARTC and MPR Lines)	New cable redirection to avoid potential impacts to old optical fibre cable. Ground survey, visual, OTDR. Strain concentrations detected in three cables, attenuation losses were relieved by locally exposing the cables or by building a bypass cable.
Tahmoor LW22 to LW32	4.5	775 mm Subsidence 0.8 mm/m Tensile Strain 1.9 mm/m Comp. Strain	Ground survey, visual, OTDR, SBS. No reported impacts.
Tower LW1 to LW10	1.7	400 mm Subsidence 3 mm/m Tilt 0.5 mm/m Tensile Strain 1 mm/m Comp. Strain	No reported impacts
West Cliff LW5A3, LW5A4 and LW29 to LW36	3.4	1300 mm Subsidence 1.3 mm/m Tensile Strain 5.5 mm/m Comp. Strain (Measured B-Line)	Survey, visual, OTDR, SBS. No reported impacts.

Note: SBS is a method of monitoring optical fibres and means Stimulated Brillouin Scattering

6.10.4. Impact assessments for copper telecommunications cables

The copper telecommunications cables are direct buried and could, therefore, potentially be impacted by ground strains. The greatest potential for impacts will occur as the result of localised ground strains due to non-conventional movements or valley related movements.

The copper cables are more likely to be impacted by tensile strains rather than compressive strains. It is possible, that the direct buried cables could experience higher tensile strains where they are anchored to the ground by associated infrastructure, or by tree roots. The cables could also experience higher compressive strains at the creek crossings as the result of valley related movements.

Aerial copper telecommunications cables are generally not affected by ground strains, as they are supported by the poles above ground level. The aerial cables, however, could be affected by the changes in bay lengths, i.e. the distances between the poles at the levels of the cables, which result from mining induced differential subsidence, horizontal ground movements and lateral movements at the tops of the poles due to tilting of the poles. The stabilities of the poles can also be affected by mining induced tilts and by changes in the catenary profiles of the cables.

Longwalls in the Southern Coalfield have been successfully mined directly beneath copper telecommunications cables, where the magnitudes of the predicted mine subsidence movements were similar to those predicted within the *Subsidence Study Area*. Some of these cases have been summarised in Table 6.22.

Table 6.22 Examples of mining beneath copper telecommunications cables

Colliery and Longwalls	Length of copper cables directly mined beneath (km)	Observed maximum movements at the copper cables	Observed impacts
Appin LW301 and LW302	0.8	650 mm Subsidence 1 mm/m Tensile Strain 3 mm/m Comp. Strain (Measured M & N-Lines)	No adverse impacts
Appin LW401 to LW409	4 km of underground cables and 0.8 km of aerial cables	700 mm Subsidence 5 mm/m Tilt 1 mm/m Tensile Strain 2 mm/m Comp. Strain (Measured A6000-Line)	No adverse impacts
Appin LW702 to LW705	8.3	1200 mm Subsidence 2.1 mm/m Tensile Strain 4.5 mm/m Comp. Strain (Measured HW2, ARTC and MPR Lines)	No adverse impacts
Tahmoor Mine LW22 to LW30	43.1 km of underground cables and 4.9 km of aerial cables	1300 mm Subsidence 12 mm/m Tilt 3.2 mm Tensile Strain 2 mm (typ.) and up to 7 mm/m Comp. Strain (Extensive street monitoring)	No adverse impacts to underground cables. Some pole tilts and cable catenaries adjusted. Some consumer cables were re-tensioned as a precautionary measure
West Cliff LW29 to LW36	13.9 km of underground cables	1300 mm Subsidence 1.3 mm/m Tensile Strain 5.5 mm/m Comp. Strain (Measured B-Line)	No adverse impacts

It can be seen from the above table, that there were no reported impacts on the direct buried copper telecommunications cables in the above examples. It is expected that the mining during the proposed development will result in similar experiences.

6.10.5. Impact assessments for NBN telecommunications tower

The NBN telecommunications tower is expected to experience subsidence during the extraction of proposed LWs S4A and S6A. The tower is a single pole structure and its structural integrity is unlikely to be adversely affected by the extraction of the proposed longwalls. The predicted tilts of 2.5 mm/m, while small, may affect the operation of the antennae on the structure.

The tilts can be readily adjusted by either relevelling the pole or the individual antennae, if required.

It is recommended that Tahmoor Coal consult with NBN regarding the tower to manage potential impacts on the tower and its operations.

6.10.6. Management of potential impacts on telecommunications infrastructure

Tahmoor Coal has developed Subsidence Management Plans in consultation with Telstra for the existing longwalls at Tahmoor Mine to manage potential impacts on telecommunications infrastructure.

It is recommended that similar Subsidence Management Plans be developed in consultation with Telstra, NBN and TPG to manage potential impacts on the telecommunications infrastructure within the *Subsidence Study Area*.

With appropriate management plans in place, it is considered that potential impacts on the telecommunications infrastructure can be managed during the extraction of the proposed longwalls, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur.

6.11. Dams, reservoirs or associated works

The Picton Weir is located on the Bargo River just downstream of the confluence with Hornes Creek. The weir was constructed in the late 19th century and it provided water to the surrounding townships. It is now heavily silted and is no longer used for water supply. Water retained by the weir is released at its base through a seized open valve and outlet pipe. No impacts were reported on the Picton Weir during the mining of previously extracted Longwalls 14 to 19, the closest of which was approximately 1.5 kilometres from the Weir (Longwall 19).

The Picton Weir is located approximately 940 metres from LW S6A. At this distance the Weir could experience very small far-field horizontal movements. While the Weir may experience very small differential horizontal movements as a result of the extraction of the proposed longwalls, it is extremely unlikely that the Picton Weir would be adversely impacted by the proposed mining.

It is recommended that Tahmoor Coal, in consultation with relevant government agencies, study the potential for impacts to the Picton Weir and develop management measures to ensure that it remains safe throughout the mining period and that impacts on the Picton Weir do not result in environmental consequences on the Bargo River. The study would require input from structural, geotechnical and subsidence engineers. The management measures may include a combination of:

- Mitigation or strengthening measures prior to mining;
- Installation of a monitoring system, which includes, among other things, the monitoring of ground movements;
- Conduct regular visual inspections of the Picton Weir; and
- Implement planned responses if triggered by monitoring and inspections.

As Tahmoor Mine will progressively approach the Picton Weir, it will be possible to review observations during the mining of each longwall and adjust the mine plan, if necessary to reduce the potential for impacts on Picton Weir. Picton Weir is also located beyond the finishing ends of the longwalls and it will be possible to stop the longwall during mining, if necessary based on actual observations during mining.

With an appropriate management plan in place, it is considered that the Picton Weir will remain safe and serviceable at all times during the extraction of the proposed longwalls, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

6.12. Survey control marks

The locations of the survey control marks in the vicinity of the proposed longwalls are shown in Drawing No. MSEC1192-21. The locations and details of the survey control marks were obtained from Spatial Services using the *SCIMS Online* website (SCIMS, 2013).

The survey control marks are located across the *Subsidence Study Area* and, therefore, are expected to experience the full range of predicted subsidence movements. A summary of the maximum predicted conventional subsidence movements within the *Subsidence Study Area* is provided in Chapter 4.

The survey control marks located outside and in the vicinity of the *Subsidence Study Area* are also expected to experience small amounts of subsidence and small far-field horizontal movements. It is possible that other survey control marks outside the immediate area could also be affected by far-field horizontal movements, up to 3 kilometres outside the *Subsidence Study Area*. Far-field horizontal movements and the methods used to predict such movements are described further in Sections 3.5 and 4.6.

6.12.1. Recommendations for the survey control marks

In accordance with the Surveying and Spatial Information Act (2002) and the Surveyor-General's Direction No. 11 (2017), Tahmoor Coal is required to make a POSI application to disturb the survey control marks.

It will be necessary on the completion of the longwalls, when the ground has stabilised, to re-establish any state survey control marks that are required for future use. Consultation between Tahmoor Coal and Spatial Services NSW will be required throughout the mining period to ensure that these survey marks are reinstated at an appropriate time, as required.

A number of public amenities have been identified within the Study Area and their locations are shown in Drawing No. MSEC1192-19.

7.1. Predictions and impact assessments for each public amenity

The public amenities within the *Subsidence Study Area* are spread over the proposed longwall mining area. The structures will collectively experience a range of subsidence movements varying from very small movements, where longwalls do not extract directly beneath them, to the maximum movements directly above the proposed longwalls. In a small proportion of cases, non-conventional subsidence movements will develop on the surface and these may coincide with the structures.

The maximum predicted values of conventional subsidence, tilt and curvature, based on the proposed LWs S1A to S6A, are provided in Table D.08, in Appendix D.

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and at points located around the perimeter of each structure, as well as at points located at a distance of 20 metres from the perimeter of each public amenity.

The predicted tilts provided in this table are the maxima in any direction after the completion of each of the proposed longwalls. The predicted curvatures provided in this table are the maxima in any direction at any time during or after the extraction of each of the proposed longwalls.

7.2. Methods of impact assessment

Some public amenities are of similar size and construction to houses and the method of assessment adopted for houses has been applied to these public amenities, the results of which are summarised in Appendix C.

Other public amenities are substantial in size and the method of assessment for houses is not applicable. The potential for impacts to these structures has been assessed on a case by case basis.

7.3. Hospitals

There are no hospitals within the *Subsidence Study Area*.

7.4. Places of worship

There are no places of worship within the *Subsidence Study Area*.

7.5. Schools

The Wollondilly Anglican College is located within the *Subsidence Study Area* and its location is shown in Drawing No. MSEC1192-19.

The Wollondilly Anglican College is located on Remembrance Drive opposite Tahmoor Mine, directly above and beyond the finishing end of proposed LW S1A. The structures have been constructed in stages from 2003 to 2020. Photographs of some of the buildings are provided in Fig. 7.1 to Fig. 7.11.

Fig. 7.1 Wollondilly Anglican College – Clifford Warne Auditorium

Fig. 7.2 Wollondilly Anglican College – Clifford Warne Auditorium with articulation joints in brick wall

Fig. 7.3 Wollondilly Anglican College – Banks Cottage and Sturt Cottage (single storey)

Fig. 7.4 Wollondilly Anglican College – Elizabeth Cottage (two-storey)

Fig. 7.5 Wollondilly Anglican College – Example of brickwork details

Fig. 7.6 Wollondilly Anglican College – Example of equipment inside Bradfield Cottage

Fig. 7.7 Wollondilly Anglican College – Hospitality training facilities inside TTC

Fig. 7.8 Wollondilly Anglican College – Lift in Cuthbert Cottage

Fig. 7.9 Wollondilly Anglican College – Shoulder to Shoulder Shelter

Fig. 7.10 Wollondilly Anglican College – Footbridge

Fig. 7.11 Wollondilly Anglican College – Sewage treatment tanks

The buildings are a mixture of single and double storey structures. The majority of the structures are steel framed with brick veneer walls. Newer double storey structures have been constructed as reinforced concrete frames with brick veneer walls. The oldest building, Sturt Cottage, is a single storey, double brick structure.

As demonstrated by the photographs, the building structures are in good condition and have been designed to accommodate future subsidence movements. The brickwork is consistent across the buildings, with recessed yellow coloured brickwork beneath the window sills. Most of the windows have light-weight panelling above the window and door openings, which will reduce the potential for impacts (Fig. 7.5).

While the majority of the building consist of standard classrooms, there are some specialised rooms that contain manufacturing and hospitality training equipment. A passenger lift is located within Cuthbert Cottage, as shown in Fig. 7.8. The open air Shoulder to Shoulder Shelter has been constructed with structural steel portal frames, as shown in Fig. 7.9.

Small creeks drainage surface water at the rear of the campus. A steel footbridge crosses a creek to provide access to the Rev. John Flynn Collegiate. A photograph of the footbridge is shown in Fig. 7.10. The steel deck connects to the concrete pavements at each end of the bridge, where a small air gap is present to accommodate expansion and contraction of the deck in response to changes in temperature.

Wollondilly Anglican College has provided details of services infrastructure within the property. Reinforced concrete sewage treatment tanks are located at the rear of the campus, as shown in Fig. 7.11.

7.5.1. Predictions for school infrastructure

The maximum predicted values of conventional subsidence, tilt and curvature, based on the proposed LWs S1A to S6A, are provided in Table D.08, in Appendix D. A summary image overlaying the predicted subsidence contours over Wollondilly Anglican College is shown in Fig. 7.12.

Fig. 7.12 Predicted subsidence contours overlaid on aerial photograph of Wollondilly Anglican College

It can be seen from Fig. 7.12 that the majority of the school structures are predicted to experience less than 100 mm of vertical subsidence, with very small tilts and curvatures. One structure, the Auditorium, is partly located directly above the finishing end of proposed LW S1A. The Auditorium is predicted to experience 300 mm of vertical subsidence, with maximum tilt of 4 mm/m and hogging curvature of 0.05 km^{-1}.

As the Wollondilly Anglican College is adjacent to previously extracted Longwalls 14B to 19, the property may also experience additional subsidence as has been previously observed above similar unmined coal barriers, as discussed in Section 4.4.

Where longwalls have previously been extracted on either side of main headings, the amount of increased subsidence in these areas has been generally been between 50 and 150 mm of subsidence above what was predicted using the prediction model. Subsidence monitoring from previous situations has shown that the additional subsidence is usually accompanied by relatively low conventional tilts, curvatures and strains (less than 0.5 mm/m and usually within survey tolerance).

7.5.2. Impact assessments for school infrastructure

Whilst many of the school buildings are larger in size, the form of construction of the structures within the Wollondilly Anglican School are similar to other rural and residential structures in the area. There is extensive experience of mining directly beneath similar structures in the Southern Coalfield which indicates that the incidence of impacts on these structures is very low and the structures have remained in safe and serviceable conditions. This is not surprising as these structures are generally small in size and of light-weight construction, such that they are relatively flexible and ductile compared to masonry buildings.

Tahmoor Mine has mined directly beneath more than 2000 structures of similar construction during the mining of LWs 22 to 32 and LW W1-W3. It has managed the mining induced impacts with the implementation of suitable management strategies. The structures have remained safe and serviceable during mining.

The primary risk associated with mining beneath the school structures is public safety. Occupants of building structures have not been exposed to immediate and sudden safety hazards as a result of impacts that occur due to mining at the depths of cover similar to those found within the *Subsidence Study Area*. This includes the recent experience at Tahmoor Mine, where longwall mining has occurred beneath more than 2000 houses and civil structures. Tahmoor Mine has successfully mined directly beneath public amenity structures during the extraction of Longwalls 22 to 32.

Emphasis is placed on the words “immediate and sudden” as in rare cases, some structures have experienced severe impacts, but the impacts did not present an immediate risk to public safety as they developed gradually with ample time (over a period of months or weeks rather than hours) to relocate occupants.

Given that the proposed longwalls do not mine directly beneath the majority of the school campus, the potential for impacts is considered to be relatively low. The building structures have been designed to accommodate mine subsidence parameters. The structures consist of steel or reinforced concrete frames and the external walls are generally well articulated, with flexible panelling above window and door openings.

While the potential for impacts on the health and safety of students and staff at the school is considered to be very low, there is a chance that some cracking may develop at the school in isolated locations. The most likely areas to experience cracking are long brick walls, including the rendered feature walls that are located on the campus. Trip hazards may also develop along footpaths.

Tahmoor Coal has commenced consultation with Wollondilly Anglican School and has engaged an experienced structural engineer to conduct a pre-mining hazard identification inspection to assess the potential for impacts on school infrastructure, taking into account the predicted subsidence movements. The inspection has been completed and the findings from the structural assessments will inform a risk assessment.

In the event that impacts occur, repairs can be undertaken outside school hours, on weekends or during school holidays, to minimise inconvenience to students and staff. Any impacts would be expected to be minor and develop gradually, allowing them to be repaired at a suitable time. In the extremely unlikely event that severe impacts develop, it would be possible to pause longwall extraction as it approaches the school to ensure that the school remains safe, serviceable and operational during and after the proposed mining.

Based on the above information, it is assessed that with the implementation of a robust subsidence management plan, the proposed longwalls can be extracted without impacting on the safety of students and staff, or affect the use of the buildings at any time for educational or other purposes.

7.5.3. Management of potential impacts on Wollondilly Anglican School

Tahmoor Coal has extensive experience in successfully managing potential impacts on critical public amenities, including Picton High School during the extraction of LW 32.

Tahmoor Coal will develop a Property Subsidence Management Plan in consultation with Wollondilly Anglican School to manage potential impacts on during the extraction of the proposed longwalls. The management measures will include a combination of:

- Pre-mining hazard identification inspection of each structure by structural engineer (complete);
- Consider the implementation of possible mitigation measures prior to mining to reduce the likelihood of severe impacts;
- Installation of a monitoring system, which includes, among other things, the monitoring of ground movements around the school buildings, footbridge and sewage treatment tanks, and baseline measurements of sensitive classroom equipment;
- Conduct regular visual inspections of the building structures, and
- Implement planned responses if triggered by monitoring and inspections. Repairs would be completed outside school hours.

With an appropriate management plan in place, it is considered that potential impacts on the Wollondilly Anglican School can be managed during the extraction of the proposed longwalls, even if actual subsidence movements are greater than the predictions or substantial non-conventional movements occur.

7.6. Shopping centres

There are no shopping centres within the *Subsidence Study Area*. There are, however, a number of shops are located along Remembrance Drive within the *Subsidence Study Area* and the predictions and impact assessments for these establishments are provided in Section 9.1.

7.7. Community centres

With there are no community centres within the *Subsidence Study Area*.

7.8. Office buildings

There are no large commercial office buildings within the *Subsidence Study Area*. Small office buildings are located within the *Subsidence Study Area* and the predictions and impact assessments for these establishments are provided in Section 9.1.

7.9. Swimming Pools

There are no public swimming pools within the *Subsidence Study Area*.

7.10. Bowling greens

There are no bowling greens within the *Subsidence Study Area*.

7.11. Ovals or cricket grounds

A sportsground is located at the Wollondilly Anglican College. The oval, which is called the WACA, is located 260 metres from the end of proposed LW S2A. Given the offset distance from the proposed longwalls, it is not expected to experience impacts as a result of the proposed extraction.

Part of the oval is located above previously extracted LW 16 but was constructed well after mining had occurred. As the oval is located between previously extracted Longwalls 14B to 19 and the proposed LW S1A to S6A, the oval may also experience additional subsidence as has been previously observed above similar unmined coal barriers, as discussed in Section 4.4.

Where longwalls have previously been extracted on either side of main headings, the amount of increased subsidence in these areas has generally been between 50 and 150 mm of subsidence above what was predicted using the prediction model. Subsidence monitoring from previous situations has shown that the additional subsidence is usually accompanied by relatively low systematic tilts, curvature and strains (less than 0.5 mm/m and usually within survey tolerance).

With an appropriate management plan in place, it is considered that the oval will remain safe and serviceable at all times during the extraction of the proposed longwalls, even if actual subsidence movements were greater than the predictions or substantial non- conventional movements occurred.

7.12. Racecourses

There are no racecourses within the *Subsidence Study Area*.

7.13. Golf courses

There are no golf courses within the *Subsidence Study Area*.

7.14. Tennis courts

There are two tennis courts within the *Subsidence Study Area* at the Wollondilly Anglican College. The courts are located 150 and 180 metres from the end of proposed LW S1A. Given the offset distance from the proposed longwalls, it is not expected to experience impacts as a result of the proposed extraction.

With an appropriate management plan in place, it is considered that the tennis courts will remain safe and serviceable at all times during the extraction of the proposed longwalls, even if actual subsidence movements were greater than the predictions or substantial non- conventional movements occurred.

7.15. Any other public amenities

Australian Wildlife Sanctuary

The Australian Wildlife Sanctuary (formerly the Wirrimbirra Sanctuary) is located on Remembrance Drive and covers an area of approximately 95 ha. The Sanctuary contains rich and diverse plantings of native plants in formalised gardens, which were developed to provide areas of representative native plants for education and research purposes.

Australian Wildlife Sanctuary includes a visitor centre, a glass house and other shade structures, along with established gardens and walks. A dingo sanctuary is located on the property. Two cottages are located next to the visitor centre. Some structures were destroyed by bushfires in late 2019 but the main structures within the sanctuary, and the dingo sanctuary were successfully protected. It is planned to replace the lost buildings in the future.

The Australian Wildlife Sanctuary structures are located above LWs S3A and S4A near Teatree Hollow and the Main Southern Railway Line and will be directly mined beneath by the proposed longwalls. Predictions of subsidence, tilt and curvature have been provided for the identified structures within the Australian Wildlife Sanctuary in Table D.08, in Appendix D.

The visitor centre and surrounding structures are located directly above a chain pillar between LWs S3A and S4A. These structures will, therefore, experience slightly reduced subsidence, tilt and curvature compared to locations that are closer to the centre of LW S4A where greater subsidence movements typically occur.

The structures were inspected by John Matheson of JMA Solutions in January 2020. The structures generally comprise timber-framed structures with metal-clad timber-framed rooves on reinforced concrete ground slabs. The structures were found to be in serviceable condition. A photograph of the visitor centre is shown in Fig. 7.13.

Fig. 7.13 Australian Wildlife Sanctuary visitor centre

The nature and footprint size of structures within the Australian Wildlife Sanctuary are similar to other rural and residential structures in the area. There is extensive experience of mining directly beneath similar structures in the Southern Coalfield which indicates that the incidence of impacts on these structures is very low and the structures have remained in safe and serviceable conditions. This is not surprising as these structures are generally small in size and of light-weight construction, such that they are relatively flexible and ductile compared to masonry buildings.

Tahmoor Mine has mined directly beneath more than 2000 structures of similar construction during the mining of Longwalls 22 to 32. It has managed the mining induced impacts with the implementation of suitable management strategies. The structures have remained safe and serviceable during mining.

If impacts occur, they will most likely consist of non-structural cracking of walls, concrete floors or ceilings. There remains a small probability (less than 2 %), however, that a structure may experience severe impacts as result of substantial non-conventional movements. If impacts occur to heritage listed properties, the damage can be repaired in consultation with a heritage consultant to ensure that the heritage value of the structure is restored.

The primary risk associated with mining beneath the public amenity structures is public safety. Occupants of building structures have not been exposed to immediate and sudden safety hazards as a result of impacts that occur due to mining at the depths of cover similar to those found within the *Subsidence Study Area*. This includes the recent experience at Tahmoor Mine, where longwall mining has occurred beneath more than 2000 houses and civil structures. Tahmoor Mine has successfully mined directly beneath public amenity structures during the extraction of Longwalls 22 to 32.

Emphasis is placed on the words “immediate and sudden” as in rare cases, some structures have experienced severe impacts, but the impacts did not present an immediate risk to public safety as they developed gradually with ample time (over a period of months or weeks rather than hours) to relocate occupants.

The Dingo Sanctuary Bargo is located on the same property as the Australian Wildlife Sanctuary but is managed separately. The dingos reside in a fenced enclosure with small structures. It is unlikely that dingo enclosure and associated structures will experience adverse impacts due to the extraction of the proposed longwalls. It is important, however, that integrity of the fences be monitored during periods of active subsidence, so that potential impacts can be readily repaired.

Tahmoor Coal has developed a draft Property Subsidence Management Plan to manage potential impacts on the Australian Wildlife Sanctuary. The management plan is currently being considered by Australian Wildlife Sanctuary as part of the consultation process. The management measures include a combination of:-

- Pre-mining hazard identification inspection of each structure by structural engineer (complete);
- Consider the implementation of possible mitigation measures prior to mining to reduce the likelihood of severe impacts (complete);
- Installation of a monitoring system, which includes, among other things, the monitoring of ground movements around the visitor centre;
- Conduct regular visual inspections of the building structures and the adjacent Dingo Sanctuary; and
- Implement planned responses if triggered by monitoring and inspections. Repairs to heritage structures would be planned in consultation with a heritage consultant.

With an appropriate management plan in place, it is considered that the Australian Wildlife Sanctuary will remain safe and serviceable at all times during the extraction of the proposed longwalls, even if actual subsidence movements were greater than the predictions or substantial non- conventional movements occurred.

Bargo Cemetery

The Bargo Cemetery is managed by Wollondilly Shire Council. It is located at the northern end of Great Southern Road directly above the south-eastern end of the proposed LW 5SA, as shown in Drawing No. MSEC1192-19. The Cemetery is expected to experience less than the maximum predicted movements as provided in Table 4.1. Non-conventional subsidence movements may also develop at the cemetery.

The small cemetery is surrounded by a plantation of mature trees (Tahmoor Coal, 2022d). The grave sites and tombstones are in various condition and some graves do not have tombstones. The tombstones are generally of low height. The grounds are grassed and well kept. The cemetery is listed as an item of Heritage Significance.

The grave sites consist of isolated concrete and stone structures that are typically placed on the natural ground surface with minimal foundations. Due to their small sizes, the sites are expected to accommodate normal conventional subsidence movements. Impacts may occur, however, if substantial non-conventional movements developed at the cemetery. This may result in cracking of the surrounds or displacement of tombstones relative to the graves. Non-conventional movements are localised in nature and should substantial non- conventional movements develop at the cemetery, it is extremely unlikely that they will affect every grave site.

It is recommended that Tahmoor Coal consult with Wollondilly Shire Council to develop a subsidence management plan.

With an appropriate management plan in place, it is considered that the grave sites can be maintained at all times during the extraction of the proposed longwalls, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

The following sections provide the descriptions, predictions and impact assessments for the farm land and farm facilities within the *Subsidence Study Area*.

8.1. Agricultural utilisation

The agricultural land classification types within the *Subsidence Study Area* are illustrated in Fig. 8.1.

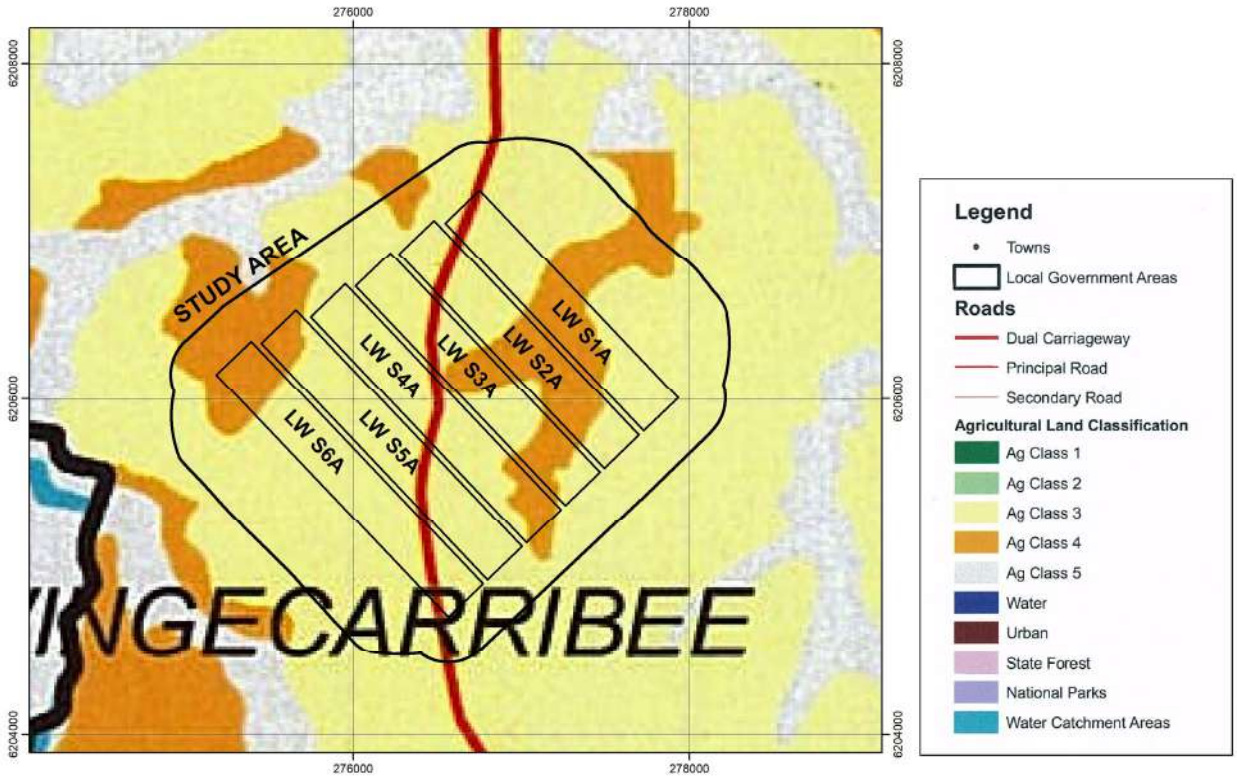


Fig. 8.1 Agricultural Land Classification within the Subsidence Study Area (Source DTIRIS, November 2008)

The above figure shows that there are two main agricultural land classification types within the *Subsidence Study Area*, which are:-

- Class 3 – Grazing land or land well suited to pasture improvement; and
- Class 4 – Land suitable for grazing but not for cultivation.

The flatter areas of land within the *Subsidence Study Area* have been predominately cleared and are used for light agricultural and residential purposes. The deeper valleys within the *Subsidence Study Area* have generally not been cleared of the natural vegetation.

Further information is included in the Land Management Plan (Tahmoor Coal, 2022b).

8.2. Rural structures

8.2.1. Descriptions of the rural structures

The locations of the rural structures (Structure Type R) within the *Subsidence Study Area* are shown in Drawing No. MSEC1192-18.

There are 441 rural structures which have been identified within the *Subsidence Study Area*, of which 62 % will be mined directly beneath by the proposed longwalls. The rural structures include sheds, garages, carports, gazebos, pergolas, greenhouses, shade structures and other non-residential structures. The locations and sizes of the rural structures were determined from aerial photographs of the area.

8.2.2. Predictions for rural structures

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and at the vertices of each rural structure, as well as at eight equally spaced points placed radially around the centroid and vertices at a distance of 20 metres. In the case of a rectangular shaped structure, predictions have been made at a minimum of 45 points within and around the structure.

A summary of the maximum predicted values of conventional subsidence, tilt and curvature for each rural structure within the *Subsidence Study Area* is provided in Table D.04, in Appendix D. The predicted tilts provided in this table are the maxima in any direction after the completion of each of the proposed longwalls. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each of the proposed longwalls.

Distributions of the maximum predicted conventional subsidence, tilt and curvature for the rural structures within the *Subsidence Study Area* are illustrated in Fig. 8.2 and Fig. 8.3.

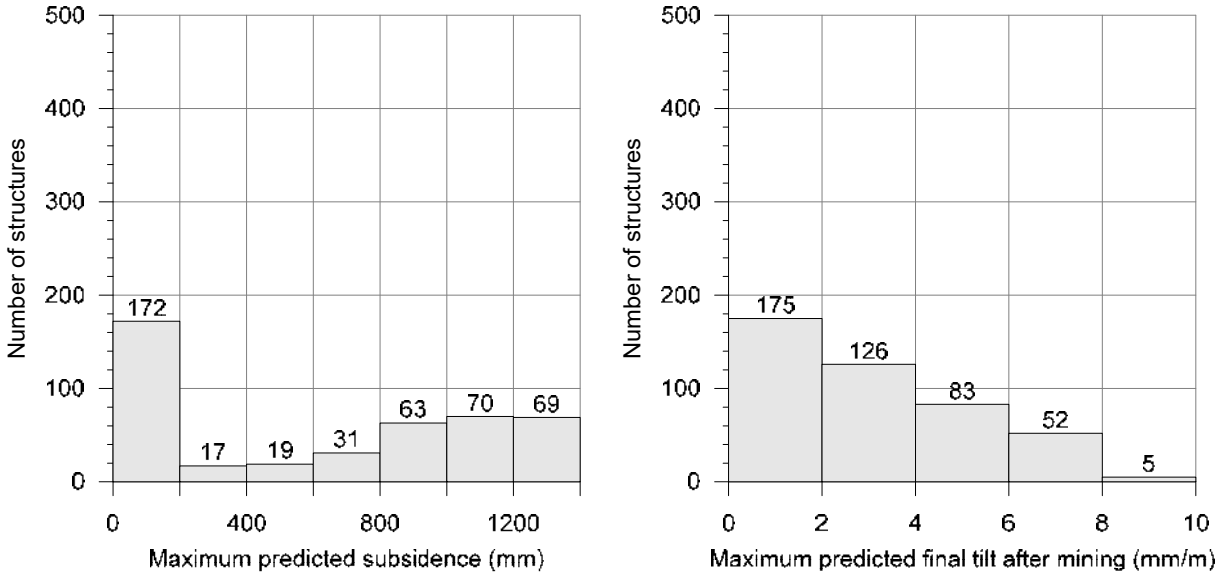


Fig. 8.2 Maximum predicted conventional subsidence and tilt for rural structures within the Subsidence Study Area

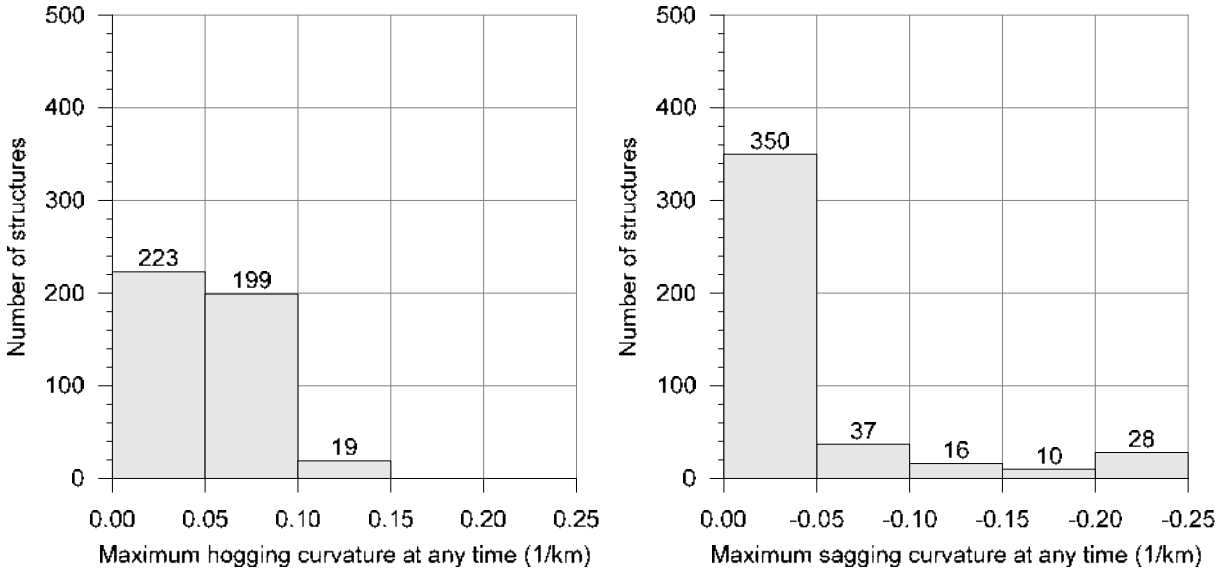


Fig. 8.3 Maximum predicted conventional hogging curvature (left) and sagging curvature (right) for rural structures within the Subsidence Study Area

The maximum predicted conventional curvatures for the rural structures are 0.11 km^{-1} hogging and 0.23 km^{-1} sagging, which equate to minimum radii of curvature of 9.1 kilometres and 4.3 kilometres, respectively. The maximum predicted conventional strains for the rural structures, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1.7 mm/m tensile and 3.5 mm/m compressive. Non-conventional movements can also occur as a result of, among other things, anomalous movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The rural structures are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.3.1. The results for survey bays located above goaf are provided in Fig. 4.2 and the results for survey bays located above solid coal are provided in Fig. 4.3.

8.2.3. Impact assessments for rural structures

The maximum predicted tilt for the rural structures is 9 mm/m (i.e. 0.9 %), which represents a change in grade of 1 in 111. The majority of the rural structures within the *Subsidence Study Area* are of lightweight construction and able to tolerate mining-induced tilt. It has been found from past longwall mining experience that tilts of the magnitudes predicted within the *Subsidence Study Area* generally do not result in adverse impacts on rural structures. Some minor serviceability impacts could occur at the higher levels of predicted tilt, including door swings and issues with roof and pavement drainage, all of which can be remediated using normal building maintenance techniques.

There is extensive experience of mining directly beneath rural structures in the Southern Coalfield which indicates that the incidence of impacts on these structures is very low and the structures have remained in safe and serviceable conditions. This is not surprising as rural structures are generally small in size and of light-weight construction, which makes them less susceptible to impact than houses which are typically more rigid.

Tahmoor Mine has mined directly beneath more than 2000 rural structures of similar construction during the mining of LWs 22 to 32 and LW W1-W3. It has managed the mining induced impacts with the implementation of suitable management strategies. The structures have remained safe and serviceable during mining.

Whilst the predicted subsidence parameters for the proposed longwalls are greater than those at Tahmoor North, it would still be expected that the rates of impact would be low and could be managed with the implementation of suitable management strategies. Impacts on rural structures have been successfully managed elsewhere in the NSW Coalfields, where the predicted subsidence parameters were similar to or greater than those predicted for the proposed longwalls.

Based on previous experiences, it is expected that the rural structures within the *Subsidence Study Area* would remain safe and serviceable during the mining period, provided that they are in sound existing condition. The risk of impact is clearly greater if the structures are in poor existing condition, though the chances of there being a public safety risk remains very low. A number of rural structures which were in

poor existing condition have been directly mined beneath and these structures have not experienced impacts during mining.

Impacts on the rural structures that occur as the result of the extraction of the proposed longwalls are expected to be remediated using well established building techniques. With these remediation measures available, it is unlikely that there would be long term impacts on rural structures resulting from the extraction of the proposed longwalls.

8.2.4. Impact assessments for rural structures based on increased predictions

If the actual tilts exceeded those predicted by a factor of 2 times, the maximum tilt at the rural structures would be 18 mm/m (i.e. 1.8 %), or a change in grade of 1 in 56. In this case, the incidence of serviceability impacts, such as door swings and issues with gutter and pavement drainage, would increase in the locations of greatest tilt, such as adjacent to the active longwall maingate and adjacent to the ends of the proposed longwalls. It would still be unlikely that stabilities of these rural structures would be affected by tilts of these magnitudes.

If the actual curvatures exceeded those predicted by a factor of 2 times, the incidence of impacts would increase for the rural structures located directly above the proposed longwalls. Since rural structures are generally small in size and of light-weight construction, they would still be expected to remain safe, serviceable and repairable using normal building maintenance techniques. With the implementation of any necessary remediation measures, it is unlikely that there would be any substantial long-term impacts on the rural structures.

While the predicted ground movements are important parameters when assessing the potential impacts on the rural structures, it is noted that the impact assessments were primarily based on historical observations from previous longwall mining in the Southern Coalfield. The overall levels of impact on the rural structures, resulting from the extraction of the proposed longwalls, are expected to be similar to those observed where longwalls have previously mined directly beneath rural structures in the Southern Coalfield.

8.2.5. Management of potential impacts on rural structures

Tahmoor Coal has developed and acted in accordance with a risk management plan to manage potential impacts to farm buildings during the mining of LWs 22 to 32 and LWs W1-W3. The management plan provides for identification of buildings in poor pre-mining condition that are hazardous or may become hazardous due to mining, and monitoring of structures during active subsidence. If impacts occur, the structure will be repaired in accordance with the *Coal Mine Subsidence Compensation Act 2017*.

It is recommended that Tahmoor Coal continue to develop management plans to manage potential impacts on rural structures during the mining of the proposed longwalls.

With an appropriate management plan in place, it is considered that rural structures can be maintained at all times during the extraction of the proposed longwalls, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

8.3. Tanks

8.3.1. Descriptions of the tanks

The locations of the tanks (Structure Type T) within the *Subsidence Study Area* are shown in Drawing No. MSEC1192-18.

There are 74 tanks which have been identified within the *Subsidence Study Area*, just less than half of which will not be mined directly beneath by the proposed longwalls. The locations and sizes of the tanks were determined from aerial photographs of the area and kerb side inspections. There are also a number of smaller rainwater tanks associated with the houses which are not shown in these drawings.

8.3.2. Predictions for the tanks

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and at points located around the perimeter of each tank, as well as at points located at a distance of 20 metres from the perimeter of each tank.

A summary of the maximum predicted values of conventional subsidence, tilt and curvature for each tank within the *Subsidence Study Area* is provided in Table D.05, in Appendix D. The predicted tilts provided in this table are the maxima in any direction after the completion of each of the proposed longwalls. The predicted curvatures provided in this table are the maxima in any direction at any time during or after the extraction of each of the proposed longwalls.

Distributions of the maximum predicted conventional subsidence, tilt and curvature for the tanks within the *Subsidence Study Area* are illustrated in Fig. 8.4 and Fig. 8.5.

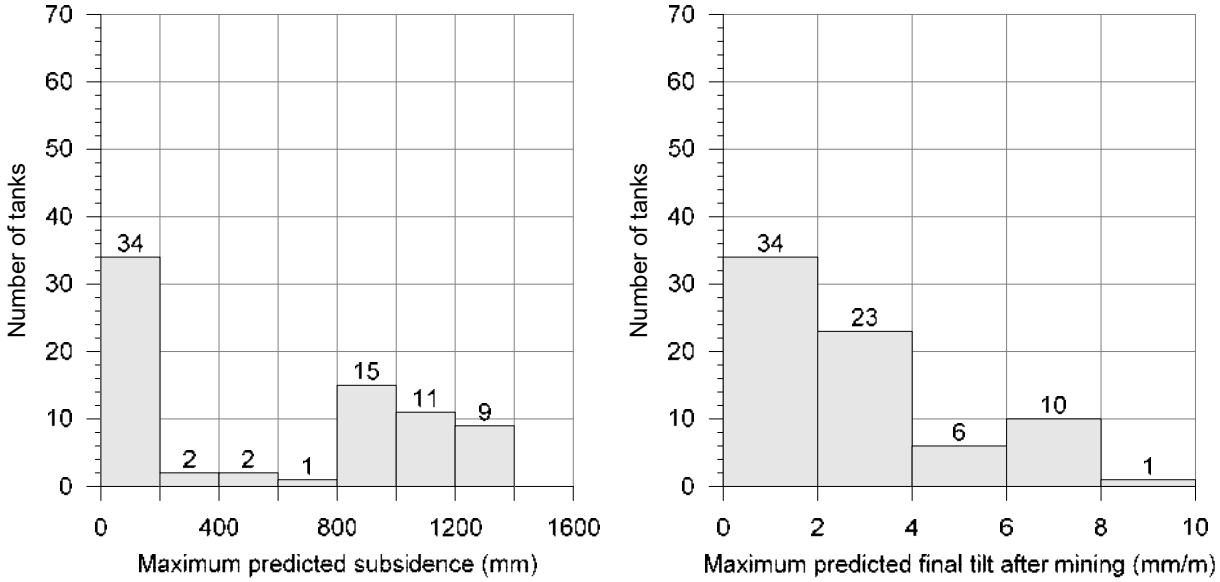


Fig. 8.4 Maximum predicted conventional subsidence and tilt for tanks within the Subsidence Study Area

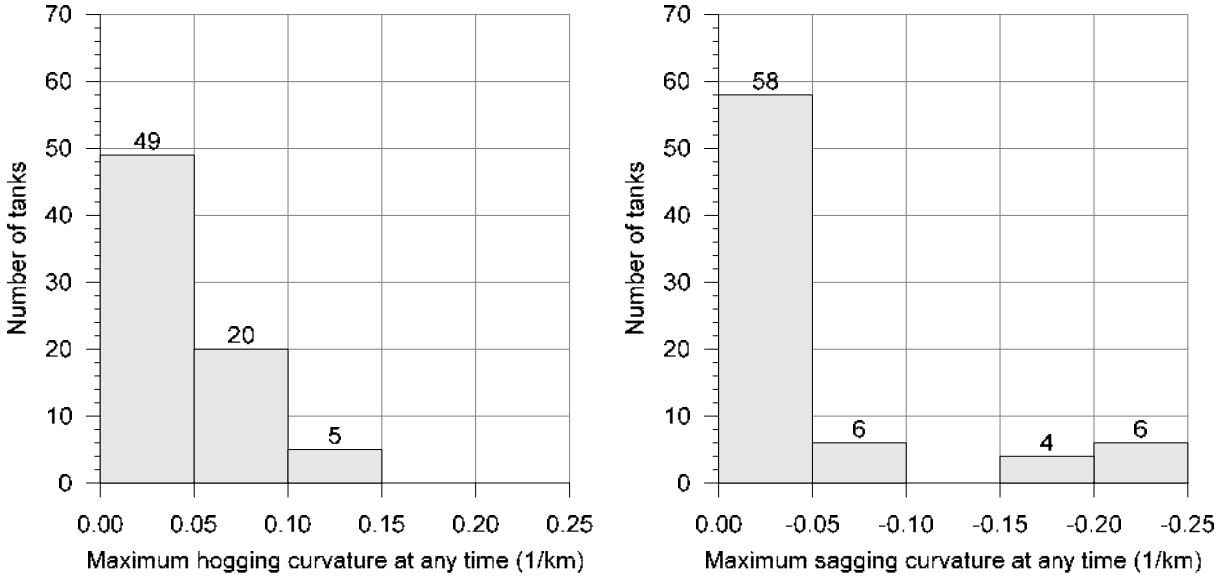


Fig. 8.5 Maximum predicted conventional hogging curvature (left) and sagging curvature (right) for tanks within the Subsidence Study Area

The maximum predicted conventional strains for the tanks, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1.7 mm/m tensile and 3.3 mm/m compressive. Non-conventional movements can also occur as a result of, among other things, anomalous movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The tanks are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.3.1. The results for survey bays located above goaf are provided in Fig. 4.2 and the results for survey bays located above solid coal are provided in Fig. 4.3.

8.3.3. Impact assessments for the tanks

Tilt can potentially affect the serviceability of tanks by altering the water levels in the tanks, which can in turn affect the minimum level of water which can be released from the outlets. The maximum predicted conventional tilt for the tanks within the *Subsidence Study Area* is 9 mm/m (i.e. 0.9 %), which represents a change in grade of 1 in 111. The predicted changes in grade are small and unlikely, therefore, to result in any adverse impacts on the serviceability of the tanks.

The tanks are typically constructed above ground level and, therefore, are unlikely to experience the curvatures and ground strains resulting from the extraction of the proposed longwalls. It is possible that any buried water pipelines associated with the tanks within the *Subsidence Study Area* could be impacted by the ground strains, if they are anchored by the tanks, or by other structures in the ground.

Any impacts are expected to be of a minor nature, including leaking pipe joints, and could be easily repaired. With these remedial measures in place, it would be unlikely that there would be any adverse impacts on the pipelines associated with the tanks.

8.3.4. Impact assessments for the tanks based on increased predictions

If the actual tilts exceeded those predicted by a factor of 2 times, the maximum tilt at the tanks would be 18 mm/m (i.e. 1.8 %), or a change in grade of 1 in 56. In this case, the incidence of serviceability impacts, such as changes in the minimum water levels which can be released from the outlets, could increase in the locations of greatest tilt, such as adjacent to the active longwall maingate and adjacent to the ends of the proposed longwalls. Impacts would be expected to be remediated by relevelling the tanks.

If the actual curvatures exceeded those predicted by a factor of 2 times, the incidence of impacts on the tank structures would not be expected to change substantially, as they are not expected to experience these ground movements. The incidence of impacts on the buried pipelines would, however, be expected to increase in the locations directly above the proposed longwalls. Impacts would still be expected to be of a minor nature which could be easily repaired. With these remediation measures in place, it would be unlikely that there would be long term impacts on the pipelines associated with the tanks.

8.3.5. Management of potential impacts on the tanks

Tahmoor Coal has developed and acted in accordance with a risk management plan to manage potential impacts to tanks during the mining of LWs 22 to 32 and LWs W1-W3. The management plan provides for identification of tanks in poor pre-mining condition that are hazardous or may become hazardous due to mining, and monitoring of structures during active subsidence. If impacts occur, the structure will be repaired in accordance with the *Coal Mine Subsidence Compensation Act 2017*.

It is recommended that Tahmoor Coal continue to develop management plans to manage potential impacts on tanks during the mining of the proposed longwalls.

With an appropriate management plan in place, it is considered that tanks can be maintained at all times during the extraction of the proposed longwalls, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

8.4. Gas and fuel storages

A number of the residences within the *Subsidence Study Area* have gas or fuel storages.

The domestic gas and fuel storages are located across the *Subsidence Study Area* and, therefore, are expected to experience the full range of predicted subsidence movements. A summary of the maximum predicted conventional subsidence movements within the *Subsidence Study Area* is provided in Chapter 4.

The storage tanks are generally elevated above ground level and, therefore, are not susceptible to mine subsidence movements. It is possible, however, that any buried gas pipelines associated with the storage tanks within the *Subsidence Study Area* could be impacted by the curvatures and ground strains, if they are anchored by the storage tanks, or by other structures in the ground.

Impacts are expected to be of a minor nature, including minor gas leaks, which could be easily repaired. It is unlikely that there would be any adverse impacts on the pipelines associated with the gas and fuel storage tanks, even if the actual movements exceeded the predictions by a factor of 2 times.

8.5. Poultry sheds

There are 21 poultry sheds within the *Subsidence Study Area*. The poultry sheds are lightweight structures up to 113 metres in length.

The Inghams Bargo Chicken Breeder Complex Production Complex is located on Remembrance Drive, beyond the finishing ends of LWs S2A and S3A (MSEC Ref. BRE_030). The Inghams Turkey Farm (MSEC Ref. BYR_065) and Bargo Valley Produce poultry sheds, which are leased to Inghams (MSEC Ref. BYR_055) are located on Yarran Road, to the side of LW S6A. Part of one shed at Bargo Valley Produce is located directly above LW S6A.

8.5.1. Predictions for the poultry sheds

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and at points located around the perimeter of each poultry shed, as well as at points located at a distance of 20 metres from the perimeter of each poultry shed.

A summary of the maximum predicted values of conventional subsidence, tilt and curvature for each poultry shed within the *Subsidence Study Area* is provided in Table D.10, in Appendix D. The predicted tilts provided in this table are the maxima in any direction after the completion of each of the proposed longwalls. The predicted curvatures provided in this table are the maxima in any direction at any time during or after the extraction of each of the proposed longwalls.

The poultry sheds are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.3.1. The results for survey bays located above goaf are provided in Fig. 4.2 and the results for survey bays located above solid coal are provided in Fig. 4.3.

8.5.2. Impact assessments for the poultry sheds

The poultry sheds are predicted to experience relatively mild conventional subsidence, tilt, curvatures and strains as the proposed LWs S1A to S6A do not mine directly beneath all but one of them. The maximum predicted conventional subsidence for the poultry sheds within the *Subsidence Study Area* is 325 mm.

Tilt can potentially affect the serviceability of poultry sheds by altering the watering and drainage systems in the sheds. The maximum predicted conventional tilt for the poultry sheds within the *Subsidence Study Area* is 3.5 mm/m (i.e. 0.35 %), which represents a change in grade of 1 in 285. The predicted changes in grade are small and unlikely, therefore, to result in any adverse impacts on the serviceability of the poultry sheds.

Mining-induced curvature and ground strain can result in the opening of gaps or cracks in the wall linings of the poultry sheds. This may adversely affect their hygiene integrity, depending on the birds that are housed in them. The potential for impacts are, however, considered low as the proposed LWs S1A to S6A do not mine directly beneath all but one of the sheds.

A number of large poultry sheds have been previously mined beneath in the Southern Coalfield. West Cliff Longwalls 30 to 33, for example, mined directly beneath 40 poultry sheds and in all cases the structures remained in safe and serviceable condition. This included four sheds which experienced large non-conventional ground movements, due to near surface geological structures, which resulted in impacts to the walls and roofs of the sheds but did not result in the structures becoming unsafe.

It is expected that the predicted mine subsidence movements on the sheds and ancillary building structures can be managed by the implementation of suitable management strategies, which may include visual monitoring during active subsidence. The level of monitoring and management may vary depending on the type and age of bird in the sheds and the level of isolation that is required from the external environment.

8.5.3. Management of potential impacts on the poultry sheds

Tahmoor Coal has developed and acted in accordance with a risk management plan to manage potential impacts to commercial operations during the mining of LWs 22 to 32 and LWs W1-W3.

It is recommended that Tahmoor Coal continues its current practice of ensuring that the structures remain safe and serviceable at all times during mining and that impacts on business operations are minimised. It is recommended that Tahmoor Coal, in consultation with the owners of the poultry farms, study the potential for impacts on the poultry sheds and other infrastructure and develop management measures. The management measures may include a combination of:-

- Pre-mining hazard identification inspection of each structure by structural engineer;
- Consider the implementation of possible mitigation measures prior to mining to reduce the likelihood of severe impacts;

- Installation of a monitoring system, which includes, among other things, the monitoring of ground movements;
- Conduct regular visual inspections of the poultry farms; and
- Implement planned responses if triggered by monitoring and inspections.

With an appropriate management plan in place, it is considered that poultry farms will remain safe and serviceable at all times during the extraction of the proposed longwalls, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occur.

8.6. Glass houses

No glass houses have been identified within the *Subsidence Study Area*, though there are a number of greenhouses and hothouses. These structures are expected to experience the full range of predicted subsidence movements. As these structures are relatively lightweight in construction, they are usually able to tolerate differential subsidence movements. Impacts can occur, for example, if the roof materials are designed to be slid open or closed to ventilation the greenhouse or hothouse, as substantial differential horizontal movements can cause the frames to rack and prevent sliding of the materials.

It is expected that the predicted mine subsidence movements on the greenhouses and hothouses can be managed in consultation with the landowner by the implementation of suitable management strategies, which may include visual monitoring during active subsidence.

8.7. Hydroponic systems

There are no known hydroponic systems within the *Subsidence Study Area*. However, there are a number of greenhouses and hothouses. These buildings may have hydroponic systems. While the water pipes are usually flexible and able to tolerate differential subsidence movements, the drainage of the systems may require monitoring and adjustment, if necessary.

It is expected that the predicted mine subsidence movements on the hydroponic systems can be managed in consultation with the landowner by the implementation of suitable management strategies, which may include visual monitoring during active subsidence.

8.8. Irrigation systems

Irrigation systems are used on commercial and private properties with agricultural utilisation. Elevated troughs are located on Bargo Valley Produce on Yarran Road, to the side of LW S6A. Irrigation systems are usually constructed from polyethylene pipes which can tolerate ground movements much larger than the predicted mine subsidence movements within the *Subsidence Study Area*.

Elevated strains can occur in the pipelines where they are anchored to the ground, or where they are subjected to non-systematic ground movements. Impacts are expected to be minor, including leaking joints, which could be readily remediated.

8.9. Farm fences

Fences are located across the *Subsidence Study Area* and, therefore, are expected to experience the full range of predicted subsidence movements. A summary of the maximum predicted conventional subsidence movements within the *Subsidence Study Area* is provided in Chapter 4.

The fences are linear features and, therefore, the most relevant distribution of strain is the maximum strains measured along whole monitoring lines above previous longwall mining. The analysis of strains along whole monitoring lines during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.3.2 and the results are provided in Fig. 4.4.

Non-conventional movements can also occur and have occurred in the NSW Coalfields as a result of, among other things, anomalous movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The fences within the *Subsidence Study Area* are constructed in a variety of ways, generally using either timber, brick or metal materials.

Wire fences can be affected by tilting of the fence posts and by changes of tension in the fence wires due to strain as mining occurs. These types of fences are generally flexible in construction and can usually tolerate tilts of up to 10 mm/m and strains of up to 5 mm/m without adverse impacts. It is possible, that some of the wire fences within the *Subsidence Study Area* could be impacted as the result of the extraction of the proposed longwalls. Any impacts on the wire fences are likely to be of a minor nature and relatively easy to remediate by re-tensioning the fencing wire, straightening the fence posts, and if necessary, replacing some sections of fencing.

Colorbond, brick and timber paling fences are more rigid than wire fences and, therefore, are more susceptible to impacts resulting from mine subsidence movements. It is possible that these types of fences could be impacted as the result of the extraction of the proposed longwalls. Any impacts on Colorbond, brick or timber paling fences can be remediated or, where necessary, affected sections of the fences replaced.

It is recommended that Tahmoor Coal continue to develop management plans to manage potential impacts on fences during the mining of the proposed longwalls.

8.10. Farm dams

8.10.1. Descriptions of the farm dams

The locations of the farm dams within the *Subsidence Study Area* are shown in Drawing No. MSEC1192-18. The maximum plan dimensions and plan areas for these dams are provided in Table D.07, in Appendix D.

There are 45 farm dams (Structure Type D) which have been identified within the *Subsidence Study Area*. The locations and sizes of the farm dams were determined from aerial photographs of the area. The distributions of the longest lengths and surface areas of the farm dams within the *Subsidence Study Area* are shown in Fig. 8.6.

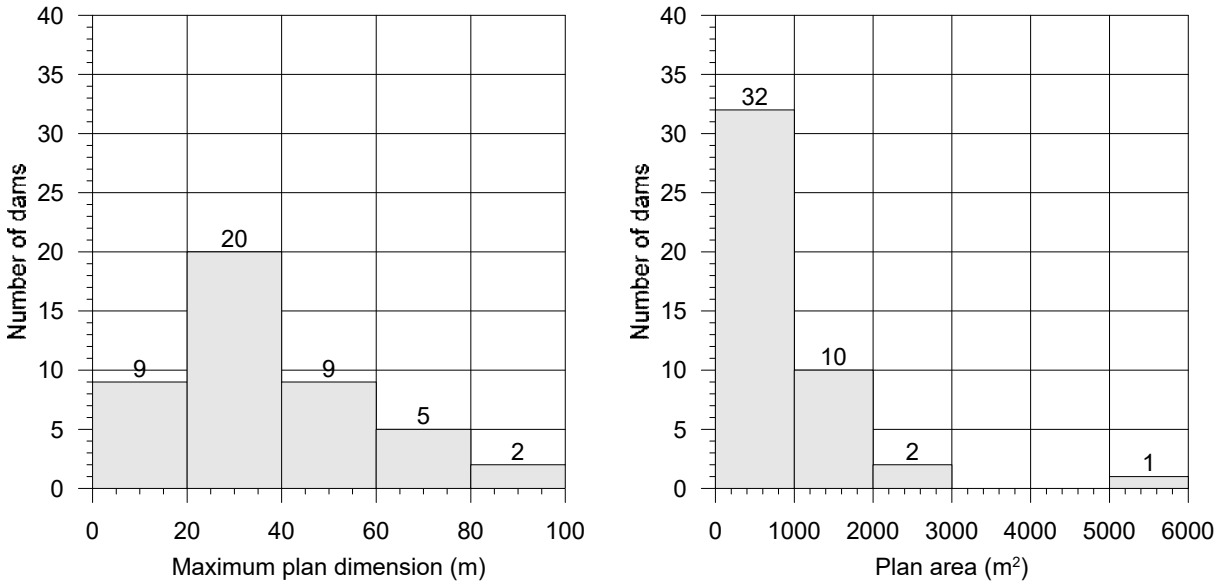


Fig. 8.6 Distributions of longest lengths and surface areas of the farm dams

The longest lengths of the farm dams within the *Subsidence Study Area* vary between 8 metres and 99 metres and the plan areas vary between 26 m^2 and 5,047 m^2.

The dams are typically of earthen construction and have been established by localised cut and fill operations within the natural streams. The farm dams are generally shallow, with the dam wall heights generally being less than 3 metres.

8.10.2. Predictions for the farm dams

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and around the perimeters of each farm dam, as well as at points located at a distance of 20 metres from the perimeter of each dam.

A summary of the maximum predicted values of conventional subsidence, tilt and curvature for each farm dam within the *Subsidence Study Area* is provided in Table D.07, in Appendix D. The predicted tilts provided in this table are the maxima in any direction after the completion of each of the proposed longwalls. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each of the proposed longwalls.

Distributions of the maximum predicted conventional subsidence, tilt and curvature for the farm dams within the *Subsidence Study Area* are illustrated in Fig. 8.7 and Fig. 8.8.

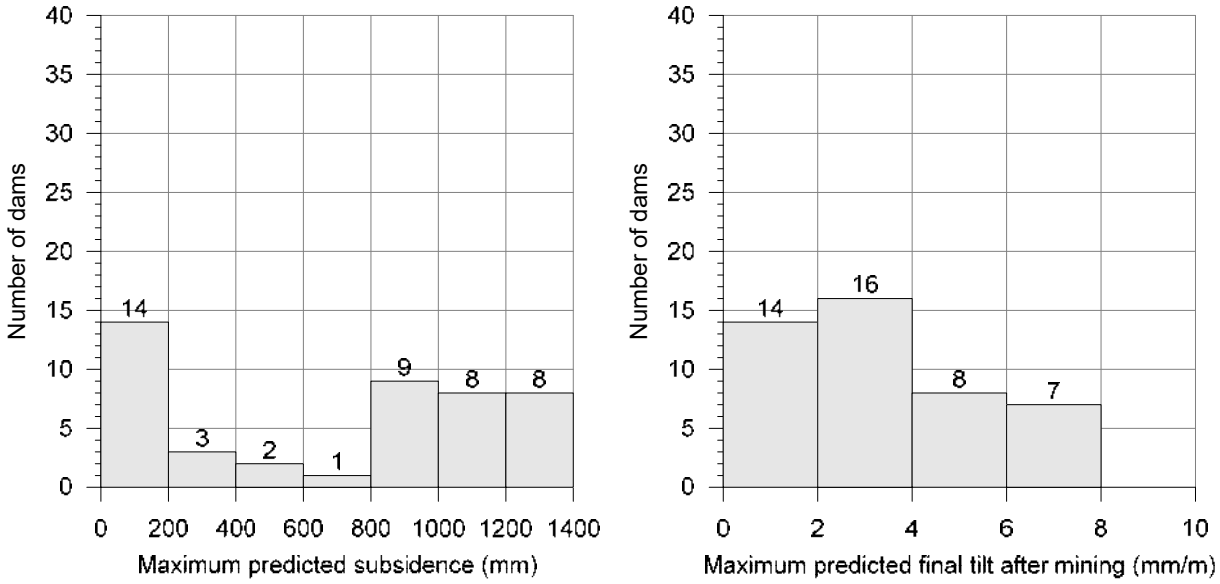


Fig. 8.7 Maximum predicted conventional subsidence and tilt for the farm dams within the Subsidence Study Area

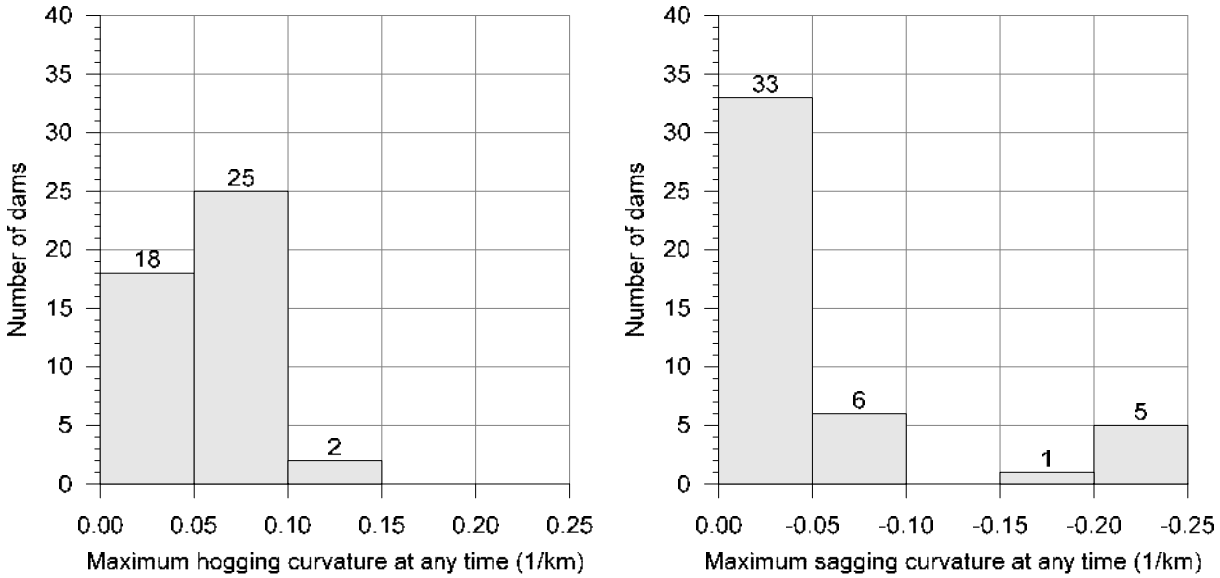


Fig. 8.8 Maximum predicted conventional hogging curvature (left) and sagging curvature (right) for the farm dams within the Subsidence Study Area

The maximum predicted conventional strains for the farm dams, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 2.0 mm/m tensile and 3.3 mm/m compressive. Non-conventional movements can also occur as a result of, among other things, anomalous movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The farm dams are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.3.1. The results for survey bays located above goaf are provided in Fig. 4.2 and the results for survey bays located above solid coal are provided in Fig. 4.3.

The farm dams have typically been constructed within the streams and, therefore, may be subjected to valley related movements resulting from the extraction of the proposed longwalls. The equivalent valley heights at the dams are very small and it is expected, therefore, that the predicted valley related upsidence and closure movements at the dam walls would be much less than the predicted conventional subsidence movements and would not be substantial.

8.10.3. Impact Assessments for the farm dams

The maximum predicted final tilt for the farm dams is 7.5 mm/m (i.e. 0.75 %), which represents a change in grade of 1 in 133. Mining induced tilts can affect the water levels around the perimeters of farm dams, with the freeboard increasing on one side, and decreasing on the other. Tilt can potentially reduce the storage capacity of farm dams, by causing them to overflow, or can affect the stability of the dam walls.

The predicted changes in freeboard at the farm dams within the *Subsidence Study Area* were determined by taking the difference between the maximum predicted subsidence and the minimum predicted subsidence anywhere around the perimeter of each farm dam. The predicted maximum changes in freeboard at the farm dams within the *Subsidence Study Area*, after the completion of the proposed longwalls, are provided in Table D.07, in Appendix D, and are illustrated in Fig. 8.9.

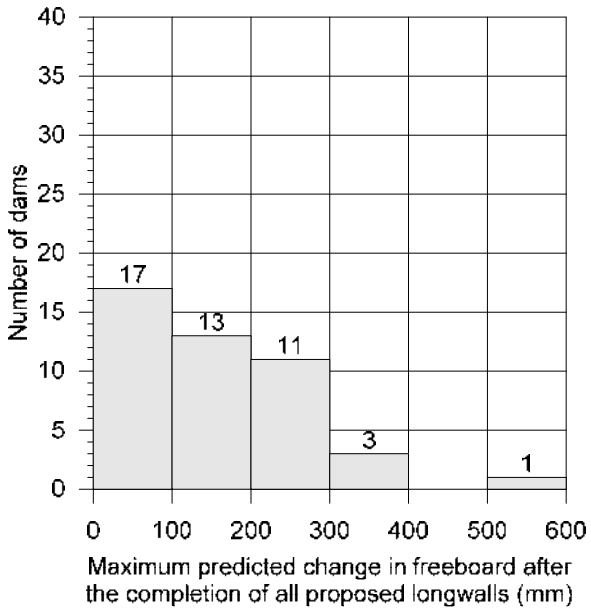


Fig. 8.9 Predicted changes in freeboards for the farm dams within the Subsidence Study Area

It can be seen from the above figure, that the predicted changes in freeboard are less than 300 mm at 41 dams within the *Subsidence Study Area* (i.e. 91 % of the total) and less than 400 mm at 44 dams (i.e. 98 % of the total). It is unlikely that the majority of the farm dams within the *Subsidence Study Area* would experience adverse impacts on the storage capacities due to these small changes in freeboard.

The predicted changes in freeboard are greater than 500 mm at 1 dam within the *Subsidence Study Area* (i.e. < 2 % of the total), with the maximum predicted change in freeboard being 500 mm. It is possible that this dam could experience a reduced storage level, however, this could be remediated by increasing the height of the affected dam wall.

The maximum predicted conventional curvatures for farm dams are 0.14 km^{-1} hogging and 0.22 km^{-1} sagging, which represent minimum radii of curvature of 7.1 kilometres and 4.5 kilometres, respectively. The predicted curvatures and strains could be sufficient to result in cracking in the bases and walls of some farm dams within the *Subsidence Study Area*.

There is extensive experience of mining directly beneath farm dams in the Southern Coalfield, which indicates that the incidence of impacts on these features is very low. Farm dams are commonly constructed with cohesive materials in the bases and walls which can absorb the conventional subsidence movements typically experienced in the Southern Coalfield without the development of substantial cracking. Non-conventional movements can result in localised cracking and deformations at the surface and, where coincident with farm dams, could result in adverse impacts.

Tahmoor Coal has mined LW22 to LW32 and LW W1-W3 beneath approximately 110 dams. While a small number of landowners have advised of impacts, there has been one claim to SA NSW for impacts on farm dams at the time of the report.

Similarly, South32 Illawarra Coal has mined directly beneath more than 200 farm dams in Appin Area 3, Appin Area 4, Appin Area 7, Appin Area 9 and West Cliff Area 5. Loss of water was reported for one dam in Appin Area 7, however, it was noted that this dam was of poor, shallow construction and seepage was observed at the base of the dam wall prior to mining.

Whilst the predicted subsidence parameters for the proposed longwalls are greater than those at Tahmoor North and at Appin and West Cliff Collieries, it would still be expected that the rates of impact on the farm dams would be very low and could be managed with the implementation of suitable management strategies.

Any substantial cracking in the dam bases or walls could be repaired by reinstating with cohesive materials. If any farm dams were to lose water as a result of mining, the mine would provide an alternative water source until the completion of repairs in accordance with the *Coal Mine Subsidence Compensation Act 2017*.

8.10.4. Impact assessments for the farm dams based on increased predictions

If the actual tilts exceeded those predicted by a factor of 2 times, the maximum tilt at the farm dams, at the completion of mining, would be 15 mm/m (i.e. 1.5 %), or a change in grade of 1 in 67. In this case, there would be 7 dams within the *Subsidence Study Area* (i.e. 16 % of the total) where the predicted change in freeboard was greater than 500 mm. In some cases, the tilts could be sufficient to reduce the capacities of the farm dams below acceptable levels, however, these could be remediated by increasing the heights of the affected dam walls.

If the actual curvatures or strains exceeded those predicted by a factor of 2 times, the likelihood and extent of cracking would increase for the farm dams located directly above the proposed longwalls. Any surface cracking would still be expected to be of a minor nature and could be readily repaired by reinstating with cohesive materials. If any farm dams were to lose water as a result of mining, the mine would provide an alternative water source until the completion of repairs in accordance with the *Coal Mine Subsidence Compensation Act 2017*.

8.10.5. Management of potential impacts on the farm dams

Tahmoor Coal has developed and acted in accordance with a risk management plan to manage potential impacts to dams during the mining of LWs 22 to 32 and LWs W1-W3. This includes an assessment of potential environmental or safety consequences as a result of dam breach. The management plan provides for visual monitoring of dams immediately prior to and after active subsidence at each dam.

If impacts occur to the dams, Tahmoor Coal will supply water to the landowner on a temporary basis until the dam is repaired in accordance with the *Coal Mine Subsidence Compensation Act 2017*.

It is recommended that Tahmoor Coal continue to develop management plans to manage potential impacts on dams during the mining of the proposed longwalls, as part of the Land Management Plan.

With an appropriate management plan in place, it is considered that dams can be maintained at all times during the extraction of the proposed longwalls, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

8.11. Groundwater bores

The Groundwater Impact Assessment (SLR, 2022a) provides an assessment on groundwater bores.

9.1. Industrial, commercial and business establishments in general

A total of 143 structures are located within the *Subsidence Study Area* that are used for industrial, commercial or business purposes. The establishments include the Bargo Petroleum and Hill Top Pit Stop (petrol station, automotive repair workshop), Wreck1 (an auto wreckers yard), MKD Machinery (a concrete plant), Inghams poultry farms, Bargo Valley Produce facilities, the Canine Country Club and Cattery, Pamak Hobbies and garden railway and the Tahmoor Garden Centre. They also include mine infrastructure owned and operated by Tahmoor Mine.

The Bargo Waste Management Centre is located more than 1 kilometre from the proposed LWs S1A to S6A and will not experience mine subsidence as a result of the extraction of the proposed longwalls.

As shown in Drawing No. MSEC1192-19, most of the structures are located along either Remembrance Drive or Yarran Road.

Photograph courtesy JMA Solutions

Fig. 9.1 Tahmoor Garden Centre

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and around the perimeters of each structure, as well as at points located at a distance of 20 metres from the perimeter of each structure.

A summary of the maximum predicted values of conventional subsidence, tilt and curvature and impact assessments for each structure within the *Subsidence Study Area* is provided in Table D.10, in Appendix D. The predicted tilts provided in this table are the maxima in any direction after the completion of each of the proposed longwalls. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each of the proposed longwalls.

Tahmoor Coal has previously developed and acted in accordance with risk management plans to successfully manage potential impacts to industrial, commercial and business establishments during the mining of LWs 22 to 32, including a turkey processing plant, a large shopping centre and a variety of shops.

Each business is unique in terms of the structures on the property and the activities that are conducted on each property.

Due to the unique nature of each business, it is recommended that individual subsidence management plans be developed in consultation with the owners of each business that are predicted to experience more than 20 mm of subsidence due to the extraction of the proposed longwalls. The management strategy for each business would include:

- Consultation with the owner of each business
- Pre-mining hazard identification inspection of each structure by structural engineer
- Identification and assessment of potential impacts to the operation of each business and safety of workers and the general public
- Consideration of mitigation measures to reduce risk prior to the commencement of subsidence movements
- Consideration of appropriate monitoring measures
- Consideration of appropriate triggered responses during mining
- Development of an agreed detailed subsidence management plan between Tahmoor Coal and the owners of each business

Each management plan would be reviewed periodically by Tahmoor Coal and the owners of each business.

9.2. Gas or fuel storages and associated plant

The Bargo Petroleum service station (MSEC Structure Ref. BRE_040) is located on Remembrance Drive near the Wollondilly Anglican College. It is located directly above LW S2A. A vehicle mechanic workshop and a wreckers yard is located adjacent to the service station.

Photographs of the site were taken during the pre-mining hazard identification inspection by structural engineer JMA Solutions and a selection is provided in Fig. 9.2.

Photographs courtesy JMA Solutions

Fig. 9.2 Bargo Petroleum and Mechanic's Workshop

There is limited history of longwall mining beneath petrol stations in the Southern Coalfield. Appin Longwall 1 mined directly beneath a petrol station in the 1970's and no information on impacts on this operation is known.

West Cliff Longwall 5A3 mined directly beneath a petrol station at Appin. A flexible coupling was installed prior to mining to ensure that ground movement between pumps, tanks and the connecting pipes could be accommodated. A monitoring line (B-Line) was installed directly outside the petrol station. Substantial non-conventional movements were observed in the vicinity of the petrol station, including a bulge in the road directly outside it. The monitoring line indicated that total subsidence of 140 mm to 290 mm developed during the mining of Longwalls 5A1 to 5A4, with observed compressive ground strain of 3.7 mm/m, which is substantial.

The MSB (now SA NSW) reported that no impacts were observed to the petrol tank, though some impacts were observed to the anti-flood valve and some lines connecting the petrol tank to the bowsers and fill points. There were also some impacts to the shop and concrete pavement. The impacts did not present an immediate public safety hazard.

Tahmoor Mine Longwall 25 mined adjacent to but not directly beneath a petrol station located at Thirlmere Way at Tahmoor. The petrol station experienced approximately 250 mm of subsidence during the mining of Longwalls 22 to 25. While no impacts were observed to the petrol tanks, some impacts were observed to the concrete slabs and kerbs. The structural steel columns to the awning were also observed to bend as a result of differential subsidence movements.

Predictions for the petrol station structures are provided in Table D.10, in Appendix D, where it can be seen that the Bargo Petroleum service station is predicted to experience subsidence of approximately 1000 mm at the workshop.

It is possible the Bargo Petroleum station could experience impacts to the petrol tanks and fuel lines, the hardstand areas or the building and awning structures as a result of the extraction of the proposed longwalls.

Tahmoor Coal has commenced consultation with the owner of the petrol station, for the purposes of developing management measures to ensure that the petrol station remains safe and serviceable throughout the mining period. The management measures may include a combination of:

- Engineering inspections of existing condition of the petrol stations, including the buried tanks;
- Pre-mining hazard identification inspection of each structure by structural engineer;
- Mitigation or strengthening measures prior to mining, particularly to the petrol tanks and fuel lines;
- Installation of a monitoring system, which includes, among other things, the monitoring of ground movements and integrity of the petrol tanks and fuel lines;
- Conduct regular visual inspections of the petrol station; and
- Implement planned responses if triggered by monitoring and inspections.

With appropriate management plans in place, it is considered that the petrol station will remain safe and serviceable at all times during the extraction of the proposed longwalls, even if actual subsidence movements were greater than the predictions or substantial non- conventional movements occurred.

9.3. Mine infrastructure including tailings dams or emplacement areas

Surface facilities at Tahmoor Mine, including a total of 142 building structures, tanks and dams are located within the *Subsidence Study Area*, as shown in Drawing No. MSEC1192-20. The majority of the facilities will not be directly mined beneath but a number of structures and other infrastructure will experience mine subsidence movements due to the extraction of the proposed LWs S1A to S6A. These include:

- Rail loop line;
- The coal stockpile area;
- Overhead coal conveyors;
- Underground coal conveyors and associated tunnels;
- Plant associated with the coal conveyors,
- The drift portal;
- The winder;
- Building structures, including the coal bins, mine office, bath houses, the washery, workshops and the administration building;
- Overhead gantry crane and monorail within the washery;
- The road bridge over the Rail Loop;

- Associated services infrastructure;
- Dams; and
- Unsealed access roads.

There are also surface facilities just outside the *Subsidence Study Area*, including the No. 3 Shaft that is the second entry and egress from the mine, the gas plant and the power generation plant.

The stockpile area will be directly mined beneath by LW S1A and this consists of an Overhead Conveyor 5C with the reclaim tunnel and Conveyor 6C underneath. Photographs are provided in Fig. 9.3 to Fig. 9.5.

Fig. 9.3 Aerial view of Tahmoor Mine site

Fig. 9.4 Aerial view of Stockpile area and Overhead Conveyor 5C

Fig. 9.5 Reclaim tunnel with Underground Conveyor 6C

9.3.1. Predictions for the mine infrastructure

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and around the perimeters of each structure, tank and dam, as well as at points located at a distance of 20 metres from the perimeter of each feature.

A summary of the maximum predicted values of conventional subsidence, tilt and curvature and impact assessments for each mine structure, tank and dam within the *Subsidence Study Area* is provided in Table D.10, in Appendix D. The predicted tilts provided in this table are the maxima in any direction after the completion of each of the proposed longwalls. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each of the proposed longwalls.

The predictions in Table D.10 do not include linear infrastructure features, including the rail loop and the conveyors. A map of the surface facilities at Tahmoor Mine has been overlaid with the predicted subsidence contours, which is shown in Fig. 9.6

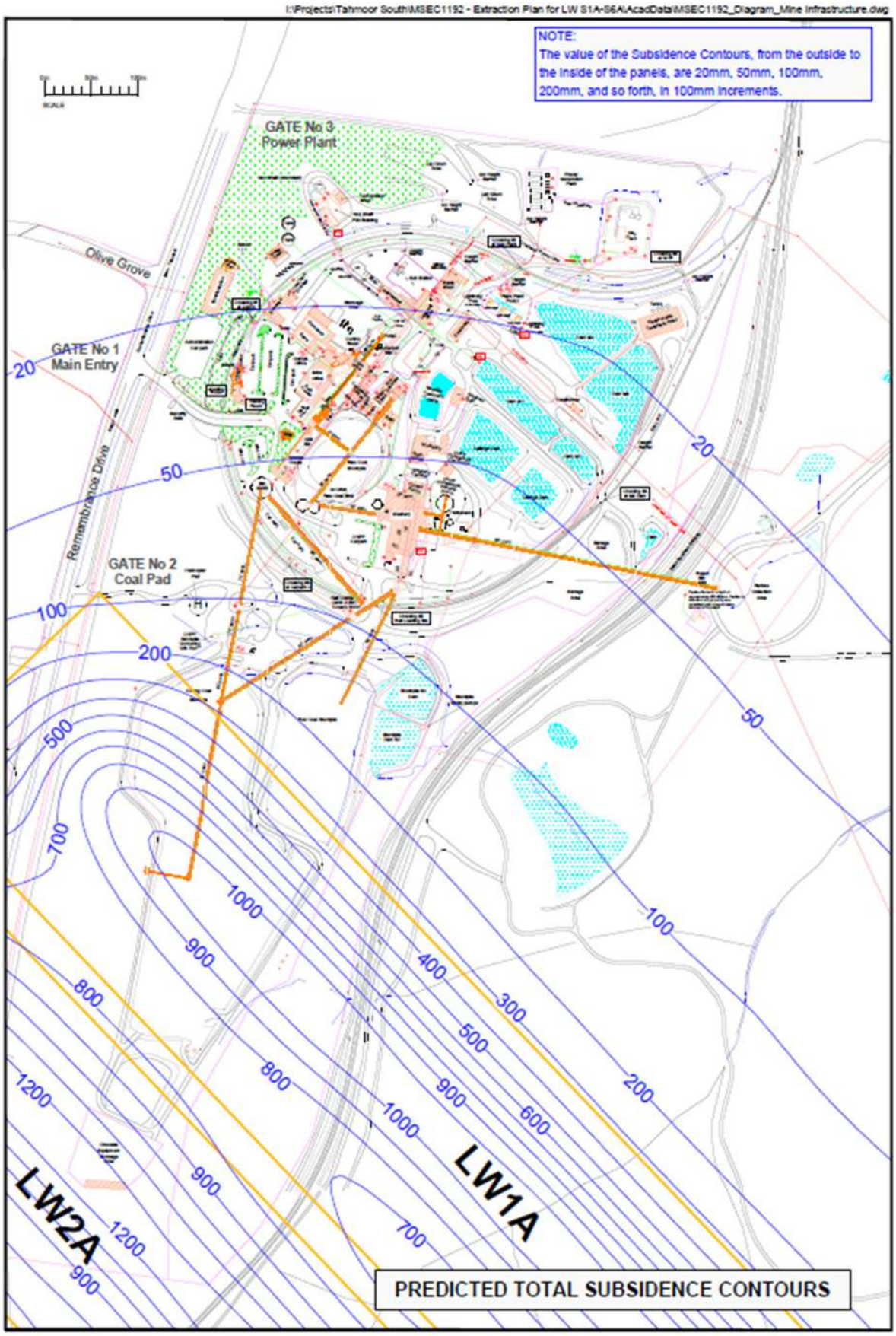


Fig. 9.6 Tahmoor Mine Site overlaid with predicted total subsidence contours due to LWs S1A to S6A

The predicted profiles of conventional subsidence, tilt and curvature along the alignment of Rail Loop, resulting from the extraction of the proposed longwalls, are shown in Fig. E.09, in Appendix E.

The predicted profiles of conventional subsidence, tilt and curvature along the alignment of Conveyors 5C, 6C and 7C, resulting from the extraction of the proposed longwalls, are shown in Fig. E.10, in Appendix E.

A summary of the maximum predicted total conventional subsidence parameters along the alignment of the Conveyors 5C, 6C and 7C, after the extraction of each of the proposed longwalls, is provided in Table 9.1. The predicted subsidence effects are predominately due to Longwalls S1A to S3A.

Table 9.1 Maximum predicted total conventional subsidence parameters along the alignment of Conveyors 5C, 6C and 7C after the extraction of the proposed LWs S1A to S6A

Longwall	Maximum predicted total subsidence (mm)	Maximum predicted tilt along conveyors (mm/m)	Maximum predicted tilt across conveyors (mm/m)	Maximum predicted total hogging curvature along alignment (km^{-1})	Maximum predicted total sagging curvature along alignment (km^{-1})
After LW S1A	750	5.0	4.0	0.06	0.17
After LW S2A	975	6.0	3.5	0.07	0.17
After LW S3A	1000	6.0	3.5	0.07	0.17
After LW S4A	1050	6.0	3.5	0.07	0.17
After LW S5A	1050	6.0	3.5	0.07	0.17
After LW S6A	1050	6.0	3.5	0.07	0.17

The majority of the subsidence movements are predicted to occur during the extraction of proposed LW S1A.

The maximum predicted conventional strains for the conveyors and associated structures, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1.1 mm/m tensile and 2.6 mm/m compressive. Non-conventional movements can also occur as a result of, among other things, anomalous movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The reclaim tunnel is a linear feature and, therefore, the most relevant distribution of strain is the maximum strains measured along whole monitoring lines above previous longwall mining. An analysis of strains along whole monitoring lines during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.3.2 and the results are provided in Fig. 4.4.

A minor creek was infilled during the construction of the surface facilities. Using historical aerial photographs, the “hidden creek” passed through conveyor 7C. Minor valley closure and upsidence movements of less than 20 mm may develop across the conveyors, potentially resulting in closure between the bases of the conveyor trestles.

9.3.2. Impact assessments for Mine Infrastructure

Rail Loop

Predictions and impact assessments for the Rail Loop are provided in Section 6.2.

Conveyors

Conveyor 5C and 6C and the associated supporting structures in the Stockpile area are located directly above proposed LW S1A. The infrastructure is predicted to experience up to 1,050 mm of vertical subsidence.

The conveyors are predicted to experience a reversal in grade of up to 6 mm/m. The conveyors were constructed with a grade of 20 mm/m (2%) and the predicted changes in grade will not affect the operation of the conveyors and the tripper that runs along the conveyor.

Tahmoor Coal conduct regular structural engineering inspections of the conditions of its building structures and the support structure for Conveyor 5C is currently in reasonable condition. Inspections and structural assessments are currently being conducted by JMA Solutions to assess the ability of the structure to accommodate the predicted conventional subsidence movements and potential non-conventional subsidence movements.

The support structure consists of reinforced concrete piers with 6 structural steel trestles in between them. The legs of the steel trestles are mounted on and cast into the reinforced concrete reclaim tunnel structure underneath. Whilst each pair of trestle legs are effectively held together by reinforced concrete, it is possible that mining-induced ground strains could result in differential movements between each trestle.

The primary concern is the potential for impacts resulting in workplace safety hazards. Tahmoor Coal is currently considering options to control the risks. This may include managing the gap in the structural frame superstructure to accommodate potential differential movements. Monitoring measures are currently being developed, which include the monitoring the gap in the superstructure and surveying the tops of the trestles and along the reclaim tunnel underneath. It is also possible, for example, to restrict stockpiling operations in areas of concern.

The other conveyors on site will not be directly mined beneath. The support trestles for the overhead conveyors are founded on concrete footings at the surface. While the potential for adverse impacts on these conveyors is low, the primary concern remains the potential for impacts resulting in workplace safety hazards. Tahmoor Coal is currently considering options to control the risks associated with mining adjacent to these overhead conveyors, including where they cross railways, access roads, carparking spaces and pedestrian walkways.

Tahmoor Coal is currently considering options to control the risks associated with mining adjacent to the conveyors themselves. The conveyors can be readily managed for potential changes due to subsidence. The conveyor linestands can be adjusted, if required, to maintain vertical and lateral alignment to with operating tolerances. The alignment can be monitored by a combination of surveys and visual inspections.

Building structures

The building structures generally consist of structural steel frames with metal sheet cladding on concrete slabs. These structures can accommodate substantial differential movements. They will be inspected and assessed prior to mining by a structural engineer to identify potential hazards and consider risk controls.

The Washery building includes an overhead gantry crane and a monorail, which are regularly serviced. Tahmoor Coal has extensive experience in managing potential impacts on overhead gantry cranes. An inspection and assessment will be conducted by a mechanical engineer that is experienced with overhead gantry cranes and mine subsidence. The advice will be used to develop monitoring and management measures.

Three circular reinforced concrete bin structures are located on site. The bins temporarily hold either raw or washed coal material. The structures are found on reinforced concrete slabs. The structures will not be mined directly beneath and will likely withstand the predicted mining-induced tilts, even if they are greater than predicted. They will be inspected and assessed prior to mining by a structural engineer to identify potential hazards and consider controls.

While the potential for adverse impacts to occur on the building structures is considered to be low, Tahmoor Coal will implement measures to ensure that the buildings remain safe and serviceable during the mining of the proposed longwalls. The measures will include monitoring for changes in addition to visual inspections.

Fig. 9.7 Aerial photograph showing Bins, Raw Stockpile, Drift Portal and Winder

Drift Portal

The Drift is the primary entry and exit to the underground mine. The drift conveyor is mounted on the roof of the drift and trolley cars transport workers, materials and equipment on rails via a rope and pulley system that is powered by a winder at the surface. The drift portal is located approximately 380 metres from proposed LW S1A. The drift then proceeds underground away from the proposed longwalls. A photograph of the drift portal is shown in Fig. 9.8.

Fig. 9.8 Drift Portal

The portal structure is predicted to experience approximately 20 mm of vertical subsidence with negligible tilt, curvature and strain. While the potential for adverse impacts to occur on the drift portal is considered to be very low, Tahmoor Coal will implement measures to ensure that the drift remains safe and serviceable during the mining of the proposed longwalls. The measures will include monitoring for changes across the drift, in addition to visual inspections that are routinely conducted as part of the mine's safety management system.

Reject Emplacement Area (REA)

The section of the REA within the *Subsidence Study Area* is predominantly bush with unsealed access roads. The western portion of emplacement activities is located within the *Subsidence Study Area*. The REA will experience low level subsidence movements (less than 50 mm) as a result of the proposed longwall extraction. Tahmoor Coal will implement measures to ensure that the emplacement area remains safe and serviceable during the mining of the proposed longwalls. The measures will include visual inspections that are routinely conducted as part of the mine's safety management system.

Dams

A number of dams are located within the *Subsidence Study Area* a, as shown in Drawing No. MSEC1192-20. As discussed in Section 8.10, the likelihood of impacts on dams is very low. Despite the low likelihood, it is recognised that the dams are located in close proximity to a tributary to Teatree Hollow. The consequences of leakage from the pond can be minimised by dewatering the pond prior to active subsidence and the likelihood of impacts could be reduced by installing a flexible waterproof liner in the pond.

The dams will be inspected by geotechnical engineer Douglas Partners prior to the influence of mining to identify potential hazards and consider risk controls. While the potential for adverse impacts to occur on the dams is considered to be very low, Tahmoor Coal will implement measures to ensure that the dams remain safe and serviceable during the mining of the proposed longwalls. The measures will include monitoring for changes across dam walls, in addition to visual inspections that are routinely conducted as part of the mine's safety management system.

Services infrastructure

Tahmoor Coal has an extensive network of services infrastructure, including water pipework, sewer pipework, gas pipework, electrical and telecommunications cabling. Tahmoor Coal has extensive experience in managing services infrastructure. While the potential for impacts is considered to be low, Tahmoor Coal will implement measures to ensure that the infrastructure remains safe and serviceable during the mining of the proposed longwalls. The measures will include monitoring of subsidence and visual inspections.

Summary

Tahmoor Coal is currently developing management measures to ensure that the mine remains safe and serviceable throughout the mining period and that impacts on the facilities do not result in environmental consequences on the adjacent Teatree Hollow catchment. The study would require input from structural, geotechnical and subsidence engineers. The management measures may include a combination of:

- Mitigation or strengthening measures prior to mining, particularly in relation to the coal conveyor support structures and dams,
- Installation of a monitoring system, which includes, among other things, the monitoring of ground movements,
- Conduct regular visual inspections of the surface facilities, and
- Implement planned responses if triggered by monitoring and inspections.

With appropriate management plans in place, it is considered that the surface facilities at Tahmoor Mine will remain safe and serviceable at all times during the extraction of the proposed longwalls, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

Descriptions, predictions and impact assessments for the archaeological and heritage sites within the *Subsidence Study Area* are provided in the following sections. The sites located outside the *Subsidence Study Area*, which may be subjected to far-field movements or valley related movements and may be sensitive to these movements, have also been included as part of these assessments.

10.1. Archaeological sites

There are no lands within the *Subsidence Study Area* declared as an Aboriginal Place under the *National Parks and Wildlife Act 1974*.

There are 3 archaeological sites which have been identified within the *Subsidence Study Area* and their locations are shown in Drawing No. MSEC1192-17. There is one rock shelter site on the Tributary to Teatree Hollow, one open camp site and one isolated find. Detailed descriptions of the archaeological sites within the *Subsidence Study Area* are provided in the Heritage Management Plan (Tahmoor Coal, 2022d).

10.1.1. Predictions for the archaeological sites

The predicted conventional subsidence, tilts and curvatures for the archaeological sites within the *Subsidence Study Area* are provided in Table D.11, in Appendix D. A summary of the maximum predicted conventional subsidence parameters for the archaeological sites is provided in Table 10.1. The predicted tilts are the maxima after the completion of any or all of the proposed longwalls. The predicted curvatures are the maxima at any time during or after the extraction of the proposed longwalls.

Table 10.1 Maximum Predicted Total Conventional Subsidence Parameters for the Archaeological Sites

Site Type	Maximum predicted total conventional subsidence (mm)	Maximum predicted total conventional tilt (mm/m)	Maximum predicted total conventional hogging curvature (km^{-1})	Maximum predicted total conventional sagging curvature (km^{-1})
Open Camp Site (52-2-3968)	550	5.0	0.05	0.02
Rock Shelter Site (52-2-4471)	900	4.5	0.06	0.03
Isolated Find (48-2-0275)	70	< 0.5	< 0.01	< 0.01

The maximum predicted conventional strains for the archaeological sites, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 0.9 mm/m tensile and 0.5 mm/m compressive. Non-conventional movements can also occur as a result of, among other things, anomalous movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The archaeological sites are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.3.1. The results for survey bays above goaf are provided in Fig. 4.2. The results for survey bays above solid coal are provided in Fig. 4.3.

The rock shelter is located along the side of a valley and, therefore, could experience valley-related movements. A summary of the maximum predicted upsidence and closure movements for the stream in the location of this sites is provided in Table 10.2.

Table 10.2 Maximum predicted total upsidence and closure for the archaeological sites

Site Type	Stream	Maximum predicted total upsidence (mm)	Maximum predicted total closure (mm)
Rock Shelter Site (52-2-4471)	Tributary of Teatree Hollow (Wirrimbirra Creek)	300	350

10.1.2. Impact assessments for the Open Camp Site

There is one open camp site located within the *Subsidence Study Area*. The site is located directly above the chain pillars between proposed LWs S3A and S4A.

The maximum predicted final tilt for the open camp site is 5.0 mm/m (i.e. 0.5 %), which represents a change in grade of 1 in 200. It is unlikely that the sites would experience any adverse impacts resulting from the mining induced tilts.

The maximum predicted curvatures for the open camp site are 0.05 km^{-1} hogging and 0.02 km^{-1} sagging, which represent minimum radii of curvature of 20 kilometres and 50 kilometres, respectively. The maximum predicted conventional strains for this site, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 0.8 mm/m tensile and 0.3 mm/m compressive.

The open camp site can potentially be affected by cracking of the surface soils as a result of mine subsidence movements. It is unlikely, however, that artefacts within the camp site would be impacted by surface cracking.

Further assessments of the potential impacts on the open camp site are provided in the Heritage Management Plan (Tahmoor Coal, 2022d).

10.1.3. Impact assessments for the rock shelter

There is one rock shelter identified within the *Subsidence Study Area*, directly above LW S2A on the Tributary to Teatree Hollow.

The maximum predicted tilt for the rock shelters is 4.5 mm/m (i.e. 0.45 %), which represents a change in grade of 1 in 222. It is unlikely that the site would experience any adverse impacts resulting from the mining induced tilt.

The maximum predicted curvatures for the rock shelters are 0.06 km^{-1} hogging and 0.03 km^{-1} sagging, which represent minimum radii of curvature of 17 kilometres and 33 kilometres, respectively. The maximum predicted conventional strains for these sites, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 0.9 mm/m tensile and 0.5 mm/m compressive. The predicted closure across the valley at the rock shelter site is 350 mm.

It is extremely difficult to assess the likelihood of instabilities for the rock shelters based upon predicted ground movements. The likelihood of the shelters becoming unstable is dependent on a number of factors which are difficult to fully quantify. These factors include jointing, inclusions, weaknesses within the rockmass, groundwater pressure and seepage flow behind the rockface. Even if these factors could be determined, it would still be difficult to quantify the extent to which these factors may influence the stability of the shelter naturally or when it is exposed to mine subsidence movements.

The predicted conventional and valley related movements at the rock shelters are similar to the typical movements in the Southern Coalfield, where there is extensive experience of mining beneath rock shelters. It has been reported that, where longwall mining has previously been carried out in the Southern Coalfield, beneath 52 shelters, that approximately 10 % of the shelters have been affected by fracturing of the strata or shear movements along bedding planes and that none of the shelters have collapsed (Sefton, 2000). Regal Heritage (2022) advises that 221 rock shelter sites have been monitored since 1990, of which 22 sites have observed changes due to mine subsidence, which is consistent with Sefton's advice in 2000. Two of the affected sites have experienced adverse consequences to the physical fabric that supports the heritage value of the site.

The experience from the Southern Coalfield indicates that the likelihood of substantial physical impacts on rock shelters within the *Subsidence Study Area* is relatively low.

10.1.4. Impact assessments for the Isolated Find site

There is one isolated find site located within the *Subsidence Study Area*. The site is located to the north of LW S1A directly above the previously extracted Tahmoor LW 2.

The maximum predicted final tilt for the isolated find site is less than 0.5 mm/m (i.e. 0.05 %), which represents a change in grade of 1 in 2000. It is unlikely that the site would experience any adverse impacts resulting from the mining induced tilts.

The maximum predicted curvatures for the isolated find site are less than 0.01 km^{-1} hogging and sagging, which represent minimum radii of curvature of 100 kilometres. The maximum predicted conventional strains for these sites, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 0.2 mm/m tensile and compressive.

The isolated find site can potentially be affected by cracking of the surface soils as a result of mine subsidence movements. It is unlikely, however, that the isolated finds themselves would be impacted by surface cracking.

Further assessments of the potential impacts on the isolated find site are provided in the Heritage Management Plan (Tahmoor Coal, 2022d).

10.1.5. Impact assessments for the archaeological sites based on increased predictions

If the actual tilts exceeded those predicted by a factor of 2 times, the maximum tilts would be 10 mm/m (i.e. 1.0 %, or 1 in 100) for the open camp site, 9 mm/m (i.e. 0.9 %, or 1 in 111) for the rock shelter and less than 1 mm/m (i.e. 0.1 %, or 1 in 1000) for the isolated find. These types of archaeological sites are not adversely affected by tilt and, therefore, the likelihoods of impact would not be expected to increase.

If the actual curvatures or strains at the open camp site exceeded those predicted by a factor of 2 times, the likelihoods and extents of cracking in the surface soils would also increase. It would still be unlikely that the artefacts themselves would be impacted by the surface cracking and the methods of subsidence management would not be expected to change.

If the actual curvatures or strains at the rock shelter site exceeded those predicted by a factor of 2 times, the likelihoods and extents of fracturing in the bedrock would also increase. Whilst the observed curvatures could exceed those predicted, the experience from the Southern Coalfield indicates that the likelihood of substantial impacts on shelters is relatively low, particularly when they are not directly mined beneath.

10.1.6. Management of potential impacts on the archaeological sites

Tahmoor Coal has developed a Heritage Management Plan to manage potential impacts to Aboriginal heritage sites for previously extracted longwalls at the mine. The management plan included consultation with the community, monitoring and reporting. Tahmoor Coal is required to develop a Heritage Management Plan as part of the Extraction Plan for LWs S1A to S6A, in consultation with the community, to manage the Aboriginal heritage sites during the extraction of the proposed longwalls.

10.2. Heritage sites

10.2.1. Descriptions of the heritage sites

There are 5 heritage sites which have been identified within the *Subsidence Study Area* and their locations are shown in Drawing Nos. MSEC1192-17. Brief descriptions of the heritage sites are provided below in Table 10.3, and more detailed descriptions are provided in the Heritage Management Plan (Tahmoor Coal, 2022d).

Table 10.3 Heritage sites within the Subsidence Study Area

Name	Description	Closest distance to extent of longwall mining area
Bargo Cemetery	Grave sites	Directly above longwall mining area
Wirrimbirra Sanctuary (now called Australian Wildlife Sanctuary)	Native gardens	Directly above longwall mining area
Great Southern Road	Local road	Directly above LW S5A
Tahmoor Mine	Coal mine and coal handling preparation plant	Centre of surface facilities ~500 m from extent of LW mining area
Picton Weir	Concrete arch dam	850 m west of LW S6A

Wellers Road Railway Overbridge over the Main Southern Railway is located just outside the *Subsidence Study Area*. Descriptions and impact assessments for this site are provided in Section 6.1.9.

10.2.2. Predictions and impact assessments for heritage sites previously discussed

Predictions and impact assessments have been provided previously in this report for some of the heritage sites:

- Bargo cemetery (Section 7.15);
- Tahmoor Mine (Section 9.3); and
- Picton Weir (Section 6.11).

The predictions and impact assessments for heritage aspects of Wirrimbirra Sanctuary and Great Southern Road are provided below.

10.2.3. Wirrimbirra Sanctuary

The Wirrimbirra Sanctuary is located on Remembrance Driveway and is listed as an item of heritage on the State Heritage Register (01508). Wirrimbirra Sanctuary is now called the Australian Wildlife Sanctuary and covers an area of approximately 95 ha.

Wirrimbirra preserves a part of the original 'Bargo Brush' which was of considerable historical importance in the problems which faced the settlement of the Argyle or Southern Tablelands during the early half of the 1800s. The Sanctuary contains rich and diverse plantings of native plants in formalised gardens, which were developed to provide areas of representative native plants for education and research purposes. Within the 43 established gardens, there are over 1800 native plants representing a resource base for the study of native flora.

The Australian Wildlife Sanctuary includes a visitor centre, a glass house and other shade structures, along with established gardens and walks. Two cottages are located next to the visitor centre. Dingo Sanctuary Bargo is also located on the property. Some structures were destroyed by bushfires in late 2019 but the main structures within the sanctuary, and the dingo sanctuary were successfully protected. It is planned to replace the lost buildings in the future.

The Australian Wildlife Sanctuary structures are located directly above proposed LWs S3A and S4A. The Australian Wildlife Sanctuary was inspected by heritage consultant EMM in January 2020. The Heritage Management Plan (Tahmoor Coal, 2022d) has identified the following items of heritage significance.

- Complex of building structures at and around the visitor centre;
- Animal pens (dingo sanctuary)
- Allen Strom pond
- Landscaping
- Shale and sandstone relics at multiple locations
- Artefact deposits
- Wells

Structures including within the Dingo Sanctuary

Predictions of subsidence, tilt and curvature have been provided for the identified heritage structures within the Australian Wildlife Sanctuary in Table D.10, in Appendix D.

The Australian Wildlife Sanctuary property will experience the full range of subsidence movements due to the extraction of the proposed longwalls. The visitor centre and surrounding structures are located near the chain pillar between LWs S3A and S4A. These structures will, therefore, experience slightly reduced subsidence, tilt and curvature compared to locations that are closer to the centre of the longwall panels where greater subsidence movements typically occur.

The structures were inspected by John Matheson of JMA Solutions in January 2020. The structures generally comprise timber-framed structures with metal-clad timber-framed rooves on reinforced concrete ground slabs. The structures were found to be in serviceable condition. Impact assessments for the building structures and the dingo sanctuary are provided in Section 7.15.

A farm dam is located to the north of the complex. The dam has been constructed with compacted earth. The inlet to the dam appears to have been cut through surface rock.

There is extensive experience of mining directly beneath farm dams in the Southern Coalfield, which indicates that the incidence of impacts on these features is very low. Farm dams are commonly constructed with cohesive materials in the bases and walls which can absorb the conventional subsidence movements typically experienced in the Southern Coalfield without the development of substantial cracking. Non-conventional movements can result in localised cracking and deformations at the surface and, where coincident with farm dams, could result in adverse impacts.

Tahmoor Coal has mined LW22 to LW32 and LW W1-W3 beneath approximately 110 dams. While a small number of landowners have advised of impacts, there has been one claim to SA NSW for impacts on farm dams at the time of the report.

Any substantial cracking in the dam bases or walls could be repaired by reinstating with cohesive materials. If any farm dams were to lose water as a result of mining, the mine would provide an alternative water source until the completion of repairs in accordance with the *Coal Mine Subsidence Compensation Act 2017*.

Further assessments of the potential impacts on the structures are provided in the Heritage Management Plan (Tahmoor Coal, 2022d).

Allen Strom Pond

The Allen Strom Pond is a shallow pond, which is located within the formalised garden area of the Australian Wildlife Sanctuary. The pond was damaged during the bushfires of late 2019. EMM inspected the pond after the bushfires. A random-split sandstone edging surrounds the pond and does not appear to have been mortared together. The floor of the pond has been lined with cement or concrete.

The pond may experience adverse impacts from ground strains and curvature due to the extraction of the proposed longwalls. The cement or concrete floor may experience cracking, resulting in leakage. The damage can be readily repaired.

Further assessments of the potential impacts on the Pond are provided in the Heritage Management Plan (Tahmoor Coal, 2022d).

Landscape

The Australian Wildlife Sanctuary preserves a part of the original 'Bargo Brush' landscape, which was of considerable historical importance in the problems which faced the settlement of the Argyle or Southern Tablelands during the early half of the 1800s.

While the landform will experience mine subsidence movements, the mining-induced changes in slope will be orders of magnitude less than natural gradients and not visually perceptible. It is very unlikely, therefore, that the vertical subsidence would reduce the visual aesthetics or the heritage value of the landscape.

Historical relics and artefact deposits

A number of historical relic sites were identified by EMM during the site inspection in January 2020. Some of the sites were discovered following the loss of vegetation by the bushfires.

The relics include remnant sandstone structures including an old fireplace, old fireplaces consisting of mixtures of clay and small stones, and collections of rocks and pebbles.

The relic sites can potentially be affected by cracking of the surface soils as a result of mine subsidence movements. It is unlikely, however, that the sandstone features or isolated artefact deposits would be impacted by surface cracking. The cracks would fill in over time and not be visible.

Further assessments of the potential impacts on the relic sites are provided in the Heritage Management Plan (Tahmoor Coal, 2022d).

Wells

Two small, shallow excavations were identified on the property. The excavations have previously been identified as wells but have been reinterpreted as non-specific waterholes/soaks. The wells are relatively shallow, being less than 2 metres deep. The sides and base of these features are unlined.

The wells are very unlikely to experience adverse impacts due to the extraction of the proposed longwalls.

Heritage Management Plan

Tahmoor Coal has previously developed historical heritage management plans to manage potential impacts on items of heritage significance above previously extracted LWs 22 to 32 and LWs W1-W3.

Tahmoor Coal has developed a draft Property Subsidence Management Plan to manage potential impacts on the Australian Wildlife Sanctuary. The management plan is currently being considered by Australian Wildlife Sanctuary as part of the consultation process. The management measures include a combination of:-

- Pre-mining hazard identification inspection of each structure by structural engineer (complete);
- Consider the implementation of possible mitigation measures prior to mining to reduce the likelihood of severe impacts (complete);
- Installation of a monitoring system, which includes, among other things, the monitoring of ground movements around the visitor centre;
- Conduct regular visual inspections of the building structures and dingo sanctuary; and
- Implement planned responses if triggered by monitoring and inspections. Repairs to heritage structures would be planned in consultation with a heritage consultant.

With an appropriate management plan in place, it is considered that the Australian Wildlife Sanctuary will remain safe and serviceable at all times during the extraction of the proposed longwalls, even if actual subsidence movements were greater than the predictions or substantial non- conventional movements occurred.

10.2.4. Great Southern Road

The northern section of Great Southern Road is located directly above the southern end of proposed LW S5A. There are sealed and unsealed sections of pavement within the *Subsidence Study Area*.

The sealed and unsealed sections of pavement are predicted to experience minor subsidence movements and impacts as a results of the extraction of the proposed longwalls. Further information is provided in Section 6.3.3.

As the road has been upgraded many times, there is little evidence of the original heritage fabric. While impacts may occur to the road, repairs will not impact on the heritage value of the road, which is generally related to its alignment and this will not be affected by the proposed mining.

10.2.5. Management of potential impacts on heritage sites

Tahmoor Coal has previously developed a Heritage Management Plan to manage the potential impacts on heritage sites. The management plans include pre-mining assessments by structural engineers and heritage consultants, monitoring and triggered response plans. Monitoring typically continues for a period following mining.

Tahmoor Coal has developed a Heritage Management Plan as part of the Extraction Plan for LWs S1A to S6A to manage potential impacts on heritage sites in consultation with each landowner during the mining of the proposed longwalls.

10.3. Items of architectural significance

There are no items of architectural significance within the *Subsidence Study Area*.

11.1. Houses

11.1.1. Descriptions of the houses

There are 105 houses that have been identified within the *Subsidence Study Area.* A total of 65 houses are located directly above the proposed longwalls. The locations of the houses are shown in Drawing No. MSEC1192-18 and details are provided in Table D.02, in Appendix D.

The locations, sizes, and construction details of the houses were determined from orthophotographs of the area in 2017 and 2021, kerbside inspections in 2013 and *Google Street View*® in February 2021. In some cases, the houses were inspected at the request or consent of the landowners.

Given the medium-term nature of the proposed mining activity, it is likely that there will be a growth and renewal of houses over time. It is likely the total number of houses affected by the extraction of the proposed longwalls will be greater than currently identified.

The following provides further discussions on the details of the houses within the *Subsidence Study Area*.

Locations

There are 65 houses located directly above the proposed longwalls (i.e. 62 % of the total number of houses within the *Subsidence Study Area*). A summary of the number of houses located directly above each of the proposed longwalls is provided in Table 11.1.

Table 11.1 Number of houses located directly above each of the proposed longwalls

Layout	Longwall	Number of houses directly above each proposed longwall
Extraction Plan LWs S1A to S6A	LW S1A	0
	LW S2A	1
	LW S3A	13
	LW S4A	20
	LW S5A	20
	LW S6A	11
	Total	**65**
EIS Layout (MSEC1123) LWs S1A to S6A	LW101A	0
	LW102A	1
	LW103A	8
	LW104A	22
	LW105A	16
	LW106A	8
	Total	**55**

When compared to the count provided in Report No. MSEC1123 for the EIS, the numbers of houses directly above the proposed LWs S1A to S6A have increased for the following reasons:

- The commencing ends of LWs S1A to S6A have been aligned compared to the previous staggered layout. The outcome of the change is that LWs S2A to S6A have been extended in length. The gap between the A and B series longwalls will be maintained, such that the future B series will be shortened when compared to the mine layout that was submitted for development consent. This means that fewer houses will experience mine subsidence movements due to future extraction in the B Series than were previously counted under the previous EIS layout.
- Six new houses have been constructed and identified from recent aerial images that were not present since the area was previously mapped for the EIS report from a 2017 aerial photograph.
- Two structures that were previously mapped as sheds have been identified to be houses or granny flats.

Maximum plan dimension, plan area and height

Distributions of the maximum plan dimensions and plan areas of the houses within the *Subsidence Study Area* are provided in Fig. 11.1. The majority of the houses are between 10 metres and 30 metres in length, with an average of 20 metres. The majority of the houses have plan areas between 100 m^2 and 300 m^2, with an average of 220 m^2.

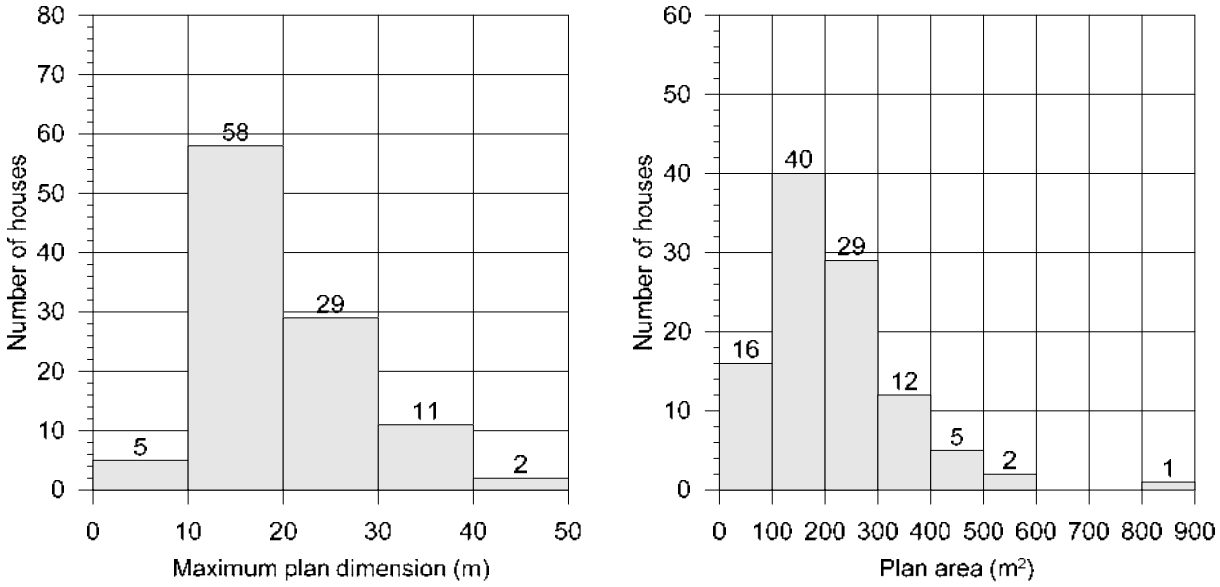


Fig. 11.1 Distribution of houses by maximum plan dimension and plan area

The houses have been categorised into four groups, on the basis of their maximum plan dimension and the number of stories. A summary of these house type categories is provided in Table 11.2 below. It is noted that two-storey houses include split-level houses.

Table 11.2 House type categories

House type	Description	Number	Percentage
H1	Single-storey with maximum plan dimension less than 30 metres	86	81 %
H2	Single-storey with maximum plan dimension of 30 metres or greater	13	12 %
H3	Two-storey with maximum plan dimension less than 30 metres	6	6 %
H4	Two-storey with maximum plan dimension of 30 metres or greater	0	0 %

It can be seen from the above table that the majority of houses within the *Subsidence Study Area* are single-storey with a maximum plan dimension less than 30 metres (i.e. Type H1), and there are no two-storey houses with a maximum plan dimension greater than 30 metres (i.e. Type H4) identified within the *Subsidence Study Area*.

The distribution of house heights within the *Subsidence Study Area* at this point in time has been compared to the distribution of house types in the township of Tahmoor, which have previously experienced mine subsidence movements. Of the 105 houses within the *Subsidence Study Area*, 86 houses (81 %) are single-storey houses with maximum plan dimension less than 30 metres.

Type of construction

Distributions of the wall and footing construction of the houses within the *Subsidence Study Area* are provided in Fig. 11.2. The majority of the houses within the *Subsidence Study Area* are of brick or brick-veneer construction. There are similar numbers of houses with slab on ground and piered footings, with a small number of houses on strip footings.

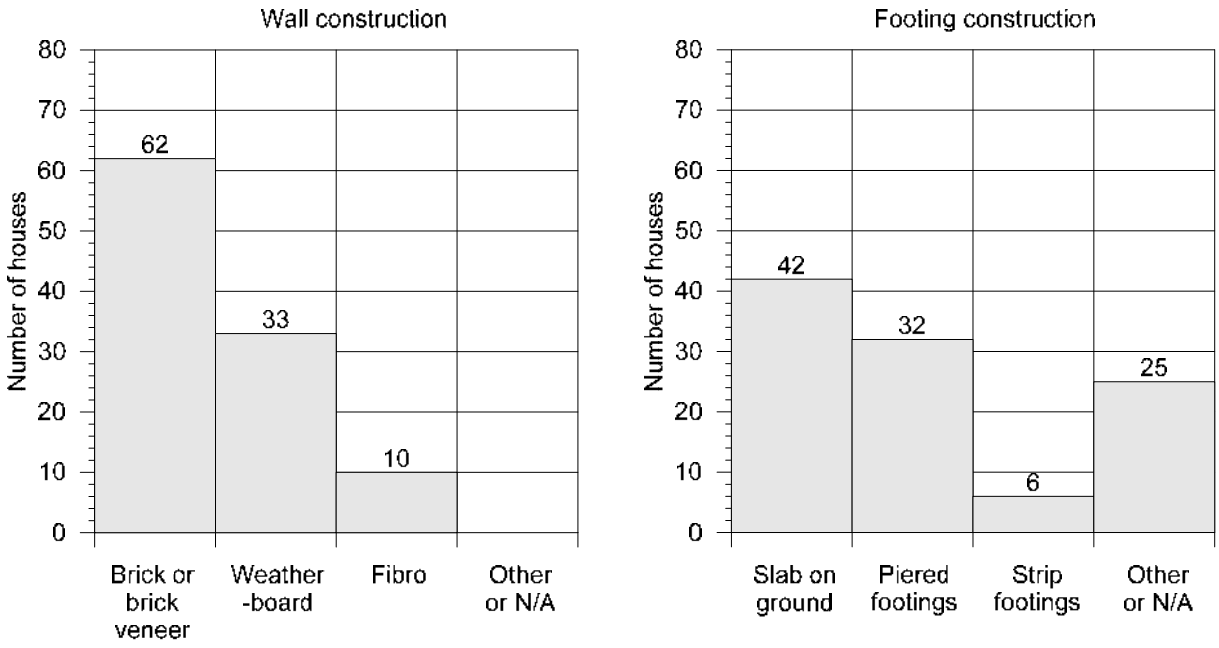


Fig. 11.2 Distributions of wall and footing construction for houses within the Subsidence Study Area

Following a review of impacts to houses during the mining of Tahmoor Mine Longwalls 22 to 25, it was found that there was a noticeable difference in structural performance in response to mine subsidence movements between the following construction types:-

- Brick or brick-veneer houses constructed on a ground slab;
- Brick or brick-veneer houses constructed on strip footings; and
- Weatherboard or fibro houses constructed on either ground slabs or strip footings.

The distribution of houses by construction type is provided in Table 11.3.

Table 11.3 Distribution of houses by construction type

Description	Number of houses	Percentage of houses
Brick or brick-veneer houses constructed on a ground slab	37	35 %
Brick or brick-veneer houses constructed on strip footings	25	24 %
Weatherboard or fibro houses constructed on either ground slabs or strip footings or other	43	41 %

Of the 105 houses within the *Subsidence Study Area*, 62 houses (58 %) are brick or brick-veneer houses.

A map showing the spatial distribution of structures by construction type is provided in Fig. 11.3.

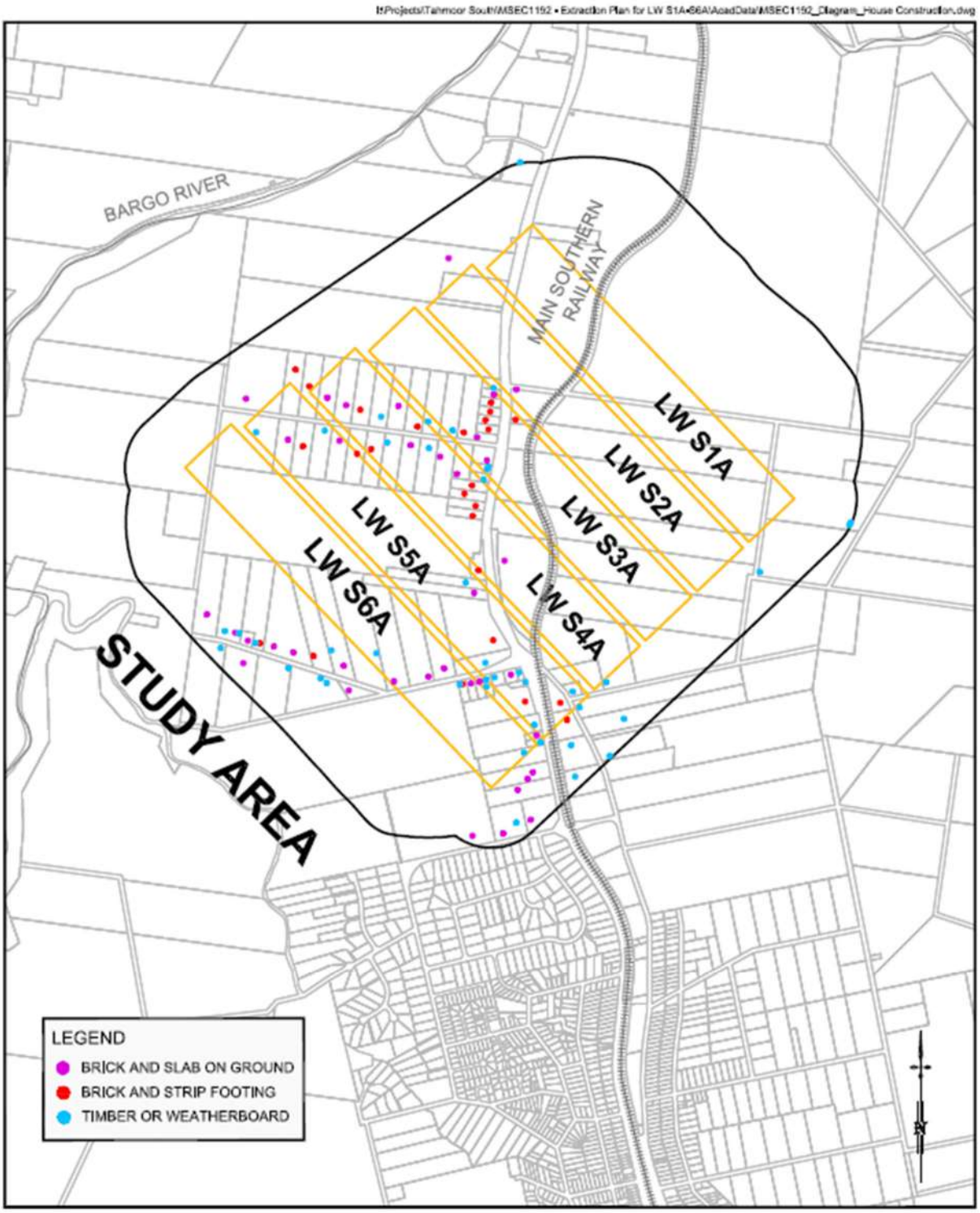


Fig. 11.3 Location of houses by construction type

The information on construction types has been undertaken using *Google Street View*® images and front of house inspections. It is possible that some houses will be renovated or rebuilt before the proposed longwalls are extracted.

As discussed in Section 11.1.3 and in Appendix C, construction type is an input parameter to the probabilistic method of assessment of impacts.

Age of houses

The Bargo area has expanded from a rural township to an urban village, as demonstrated by the following two images. An aerial photograph taken in 1975 is shown in Fig. 11.4. The most recent available aerial photograph in 2021 is shown in Fig. 11.5 for comparison. 51% of houses in the *Subsidence Study Area* have been built since the Bargo Mine Subsidence District was declared in 1975.

House age has been determined by examination of a series of historical aerial photographs provided by Land and Property Information. The photographs that were available over the Subsidence Study Area were taken in 1963, 1975, 1984, 1994, 2002 and Tahmoor Mine commissioned orthophotographs over the *Subsidence Study Area* in 2013. A Nearmap image taken in 2017 was used to identify houses with the *Subsidence Study Area* at the time MSEC's report in support of the original EIS was submitted. A Nearmap image taken in 2021 was used to identify new houses with the *Subsidence Study Area* at the time of preparing the Extraction Plan.

Photograph courtesy Department of Lands (now Spatial Services NSW)

Fig. 11.4 Aerial photograph of Study Area in 1975 when Mine Subsidence District was declared

Photograph courtesy Nearmap

Fig. 11.5 Aerial photograph of Study Area in 2021

A map showing the spatial distribution of structures by house age is provided in Fig. 11.7. The older houses are located throughout the *Subsidence Study Area*. A histogram showing the distribution of houses by age is shown in Fig. 11.6.

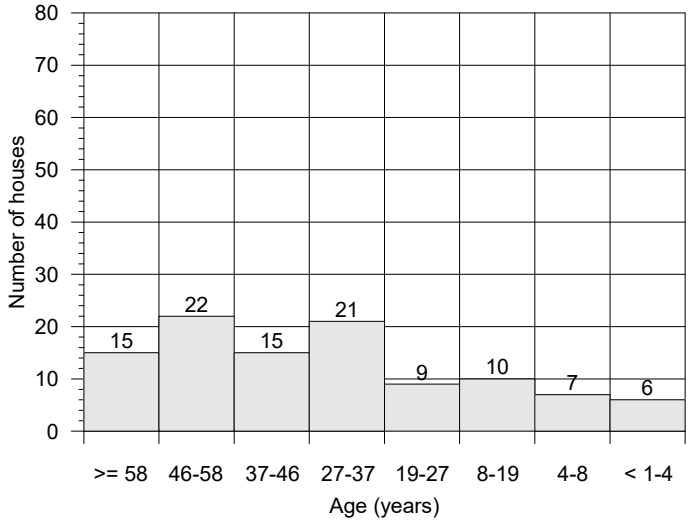


Fig. 11.6 Distribution of Houses by Age as at 2021

It can be seen from Fig. 11.6 that, as at 2021, the greatest proportion of houses were constructed 27 to 58 years prior between 1975 and 1994.

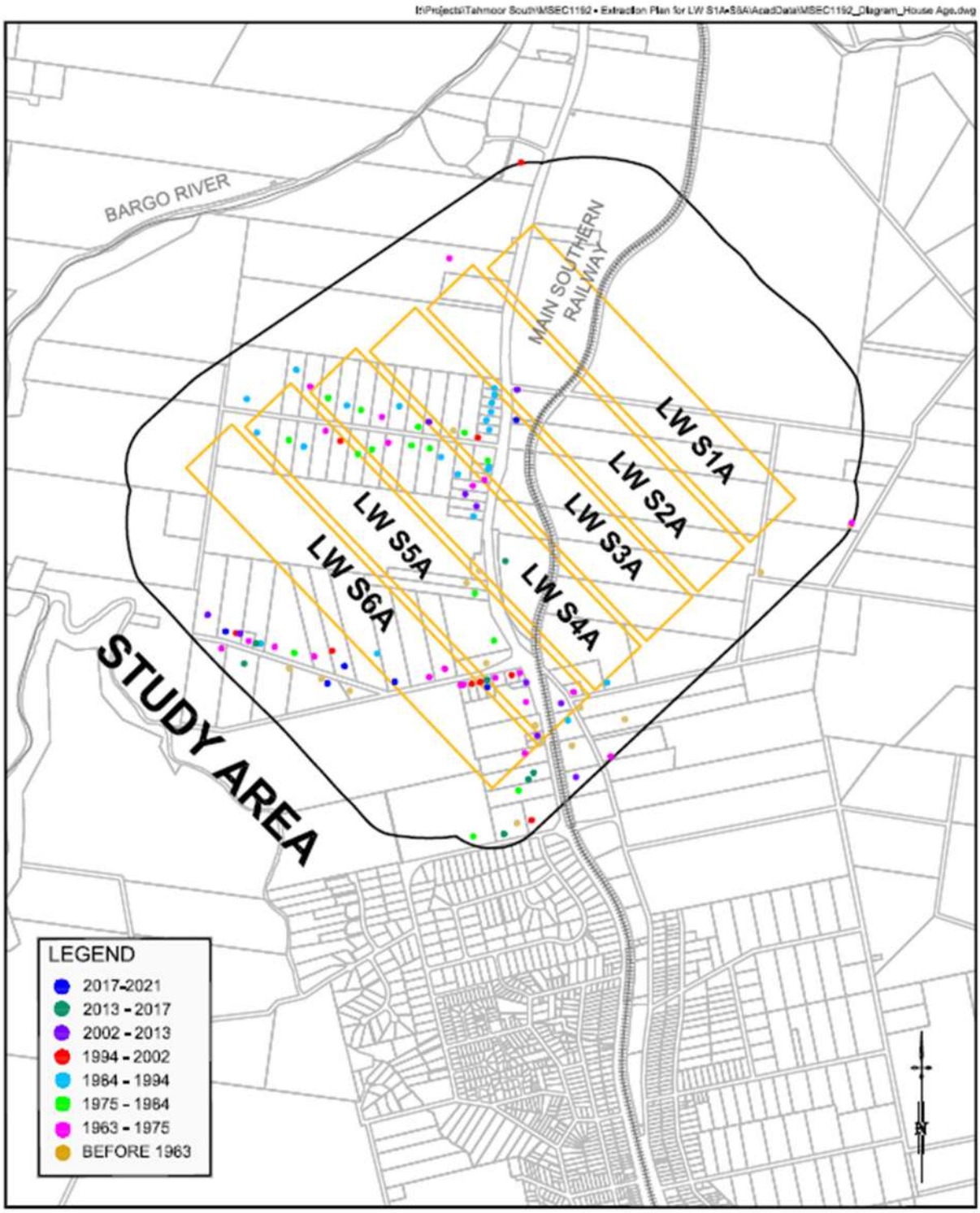


Fig. 11.7 Location of houses by age

11.1.2. Predictions for the houses

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and at the vertices of each house, as well as eight equally spaced points placed radially around the centroid and vertices at a distance of 20 metres. In the case of a rectangular shaped structure, predictions have been made at a minimum of 45 points within and around the structure.

A summary of the maximum predicted values of conventional subsidence, tilt and curvature for each house within the *Subsidence Study Area*, resulting from the extraction of the proposed longwalls, is provided in Table D.03, in Appendix D. The predicted tilts provided in this table are the maxima in any direction after the completion of each of the proposed longwalls. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each of the proposed longwalls.

Distributions of the predicted conventional subsidence parameters for the houses within the *Subsidence Study Area* are illustrated in Fig. 11.8, Fig. 11.9 and Fig. 11.10 below.

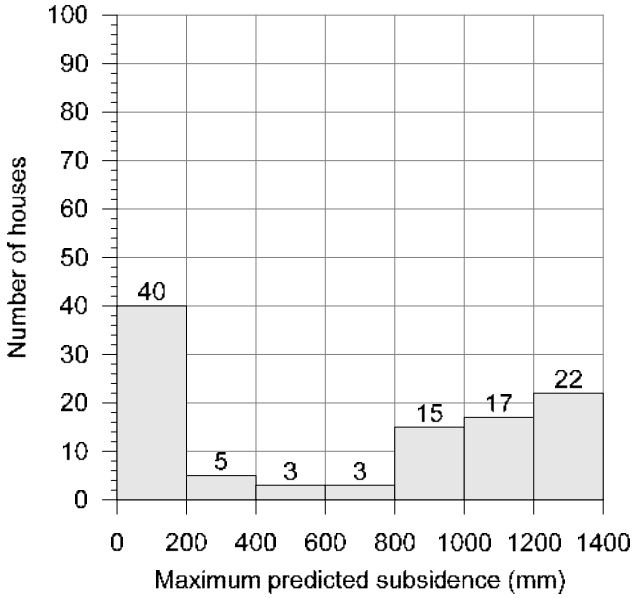


Fig. 11.8 Maximum predicted conventional subsidence for the houses within the Subsidence Study Area

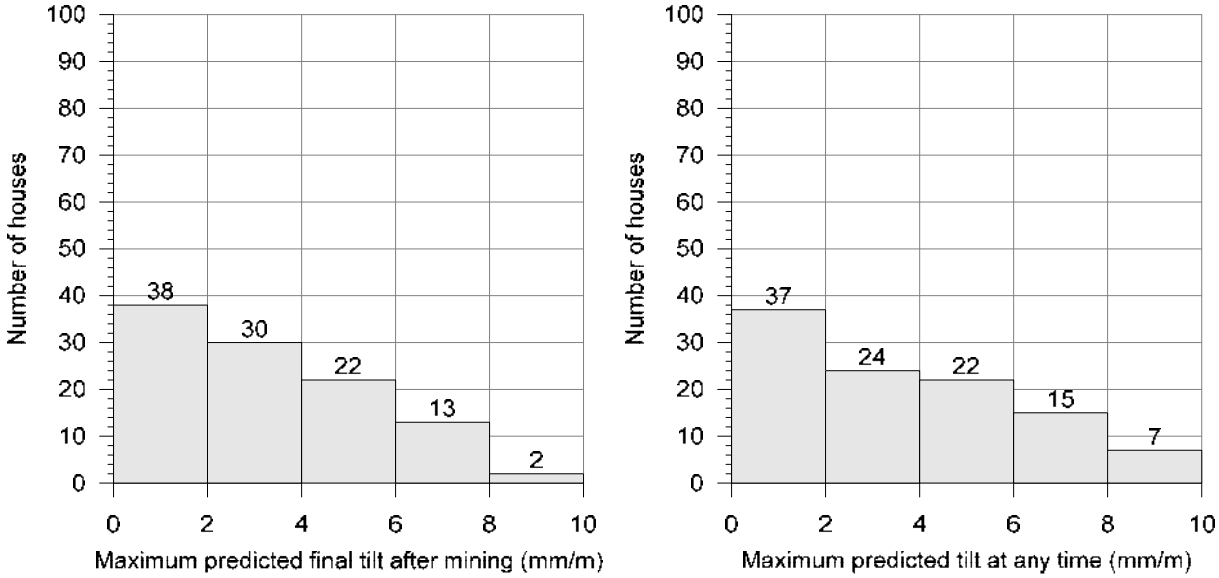


Fig. 11.9 Maximum predicted conventional tilts after the extraction of all longwalls (left) and maximum predicted conventional tilts after the extraction of any longwall (right)

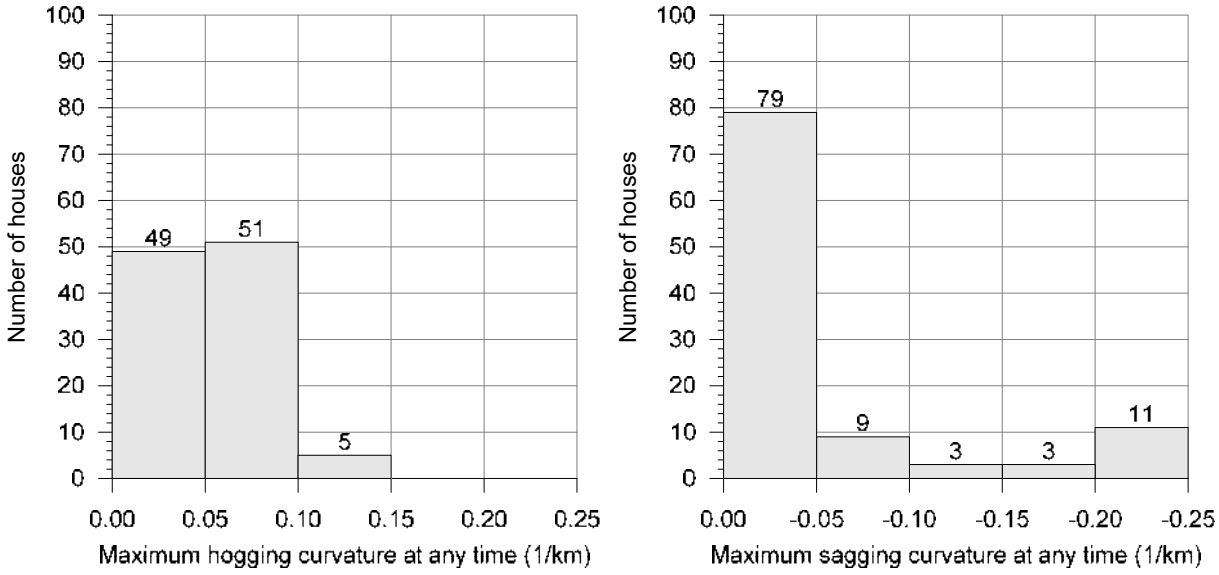


Fig. 11.10 Maximum predicted conventional hogging curvature (left) and sagging curvature (right) for the houses within the Subsidence Study Area

The maximum predicted conventional strains for the houses, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1.7 mm/m tensile and 3.5 mm/m compressive. Non-conventional movements can also occur as a result of, among other things, anomalous movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The houses are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. An analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.3.1. The results for survey bays located above goaf are provided in Fig. 4.2 and the results for survey bays located above solid coal are provided in Fig. 4.3.

11.1.3. Impact assessments for the houses

The following sections provide the impact assessments for the houses within the *Subsidence Study Area*.

Potential impacts resulting from vertical subsidence

Vertical subsidence does not directly affect the stability or serviceability of houses. The potential for impacts on houses is affected by differential subsidence, which includes tilt, curvature and strain, and the impact assessments based on these parameters are described in the following sections.

Vertical subsidence may affect the heights of some the houses above the flood level. The potential impacts on the houses resulting from the changes in flood level from the proposed mining has been assessed as part of the flood model, which is described in the Water Management Plan (Tahmoor Coal, 2022a).

Potential impacts resulting from tilt

It has been found from past longwall mining experience that tilts of less than 7 mm/m generally do not result in any substantial impacts on houses. Some minor serviceability impacts can occur at these levels of tilt, including door swings and issues with roof gutter and wet area drainage, all of which can be remediated using normal building maintenance techniques. Tilts greater than 7 mm/m can result in greater serviceability impacts which may require more substantial remediation measures, including the relevelling of wet areas or, in some cases, the relevelling of the building structure.

The predicted maximum tilts are less than 7 mm/m at 97 of the houses within the *Subsidence Study Area* (i.e. 92 % of the total) at the completion of mining. It is expected that only minor serviceability impacts would occur at these houses, as the result of tilt, which could be remediated using normal building techniques.

The maximum predicted tilt for the houses is 9 mm/m (i.e. 0.9 %, or 1 in 111). A total of 8 houses (i.e. 8 % of the total) are predicted to experience tilts greater than 7 mm/m. The potential for serviceability impacts is greater for these houses. In some cases, more substantial remediation measures may be required, such as relevelling of the building structure.

The distribution of predicted final tilts for the houses within the *Subsidence Study Area* is provided in Fig. 11.11.

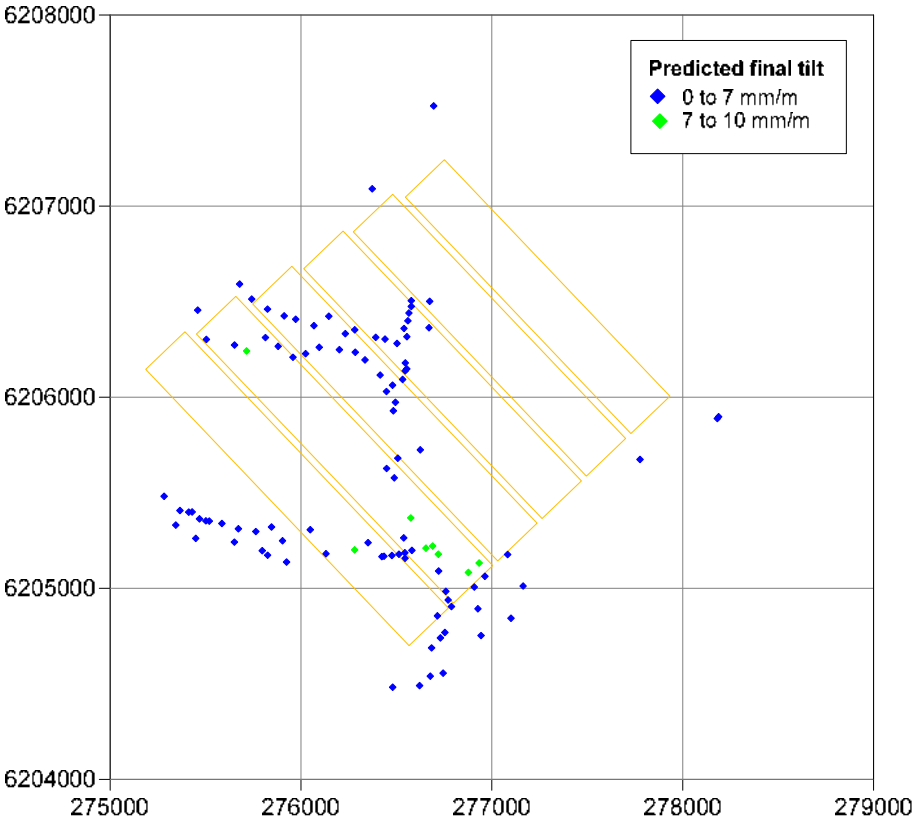


Fig. 11.11 Distribution of predicted final tilts for the houses at the completion of mining

It can be seen from the above figure, that the houses with predicted final tilts greater than 7 mm/m are located above proposed LWs S5A and S6A.

Houses located above previously extracted longwalls at Tahmoor have experienced mining-induced tilts within the predicted range for the Amended Layout. This includes tilts at magnitudes of 10 mm/m and greater, which were observed above Tahmoor Mine LW 24A and above the south-eastern ends of LWs 25 and 26, in the areas of increased subsidence. To date, there have been very few claims to SA NSW for impacts on houses as a result of mining induced tilt. Claims in these areas have mainly been based on impacts resulting from mining induced curvatures or strains.

The distribution of measured tilts for the survey bays located in the area of increased subsidence above LWs 24B, 25 and 26, is provided in Fig. 11.12. A gamma function has also been fitted to the observed data which is shown by the blue curve.

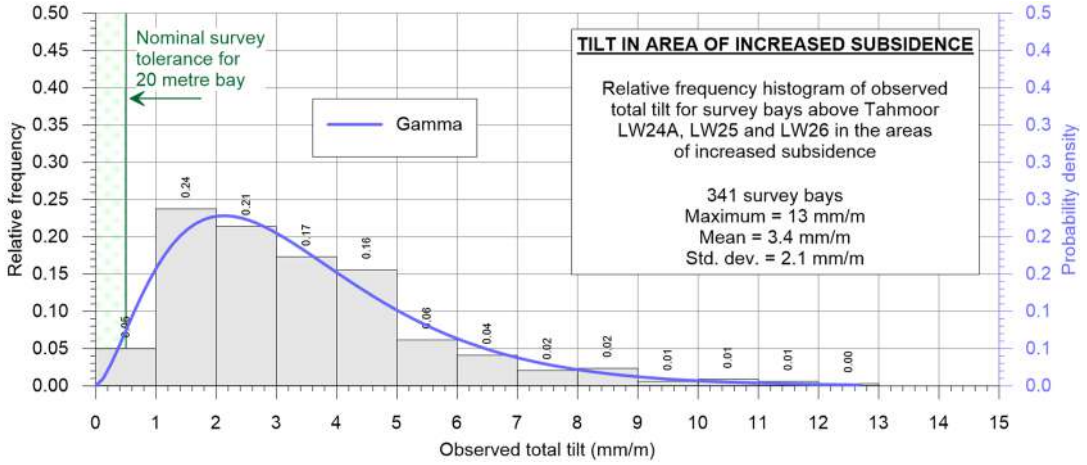


Fig. 11.12 Distribution of measured tilts for survey bays located in the areas of increased subsidence above Tahmoor Mine longwalls 24A, 25 and 26

It can be seen from the above figure, that the maximum observed total tilt for the survey bays in the areas of increased subsidence was 13 mm/m, which is greater than the maximum predicted tilt at the houses directly above the proposed longwalls, which is 9 mm/m.

The range of predicted tilts for the houses within the *Subsidence Study Area*, therefore, is less than that observed above previously extracted longwalls at Tahmoor Mine, including LW 24A and above the south-eastern ends of LWs 25 and 26, in the areas of increased subsidence. It is expected that the incidence of claims for impacts resulting from the mining induced tilt would be low, due to the extraction of the proposed longwalls, as was previously experienced in the areas of increased subsidence.

It is expected that, in all cases, the houses within the *Subsidence Study Area* will remain in safe and serviceable conditions as the result of the mining induced tilts as tilts by themselves rarely impact on the stability of building structures at the levels that are predicted to occur.

Potential impacts resulting from curvature and strain

It has been found from past longwall mining experience that the majority of mining-induced impacts on houses are a result of curvature and strain.

There are 100 houses within the *Subsidence Study Area* (i.e. 95 % of the total) that are predicted to experience hogging curvatures less than 0.10 km^{-1} and 88 houses (i.e. 84 % of the total) that are predicted to experience sagging curvatures less than 0.10 km^{-1}, which represent minimum radii of curvature of 10 kilometres.

The maximum predicted curvatures for the houses within the *Subsidence Study Area* are 0.11 km^{-1} hogging and 0.23 km^{-1} sagging, which represent minimum radii of curvature of 9.1 kilometres and 4.3 kilometres, respectively.

The distribution of predicted curvatures for the houses within the *Subsidence Study Area* is provided in Fig. 11.13.

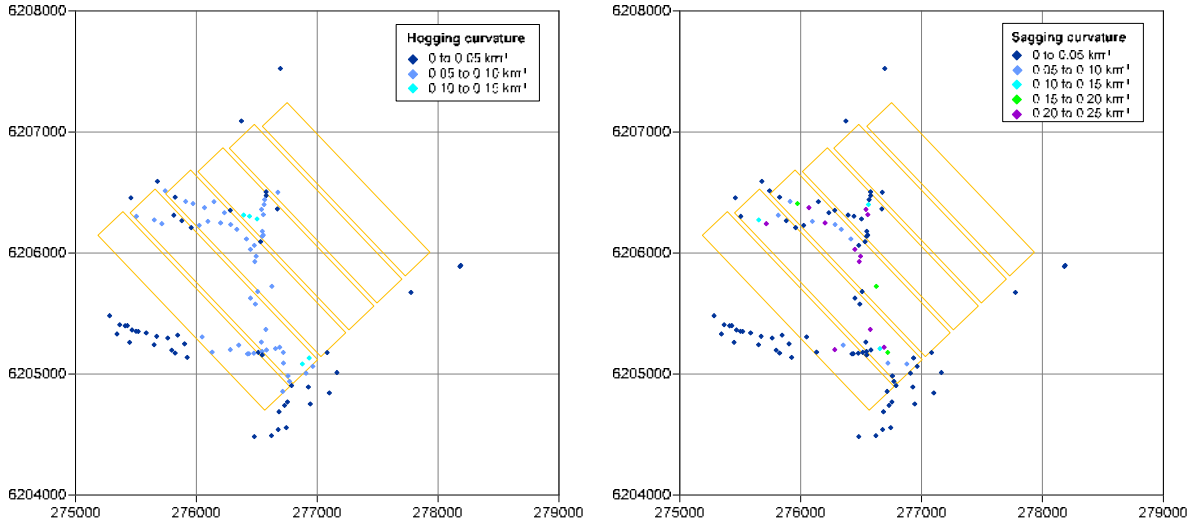


Fig. 11.13 Distribution of predicted hogging curvatures (left) and sagging curvatures (right) for houses at the completion of mining

The above figure shows that the greatest predicted curvatures occur directly above the proposed longwalls.

Houses located above previously extracted longwalls at Tahmoor have experienced mining-induced curvatures within the predicted range for the Amended Layout. This includes curvatures greater than 0.10 km^{-1}, which were observed above Tahmoor Mine LW 24A and above the south-eastern ends of LWs 25 and 26, in the areas of increased subsidence. The distributions of measured hogging and sagging curvatures for the survey bays located in the area of increased subsidence above LW 24A, LWs 25 and 26, is provided in Fig. 11.14. Generalised Pareto Distributions (GDPs) have also been fitted to the observed data which are shown by the blue curves.

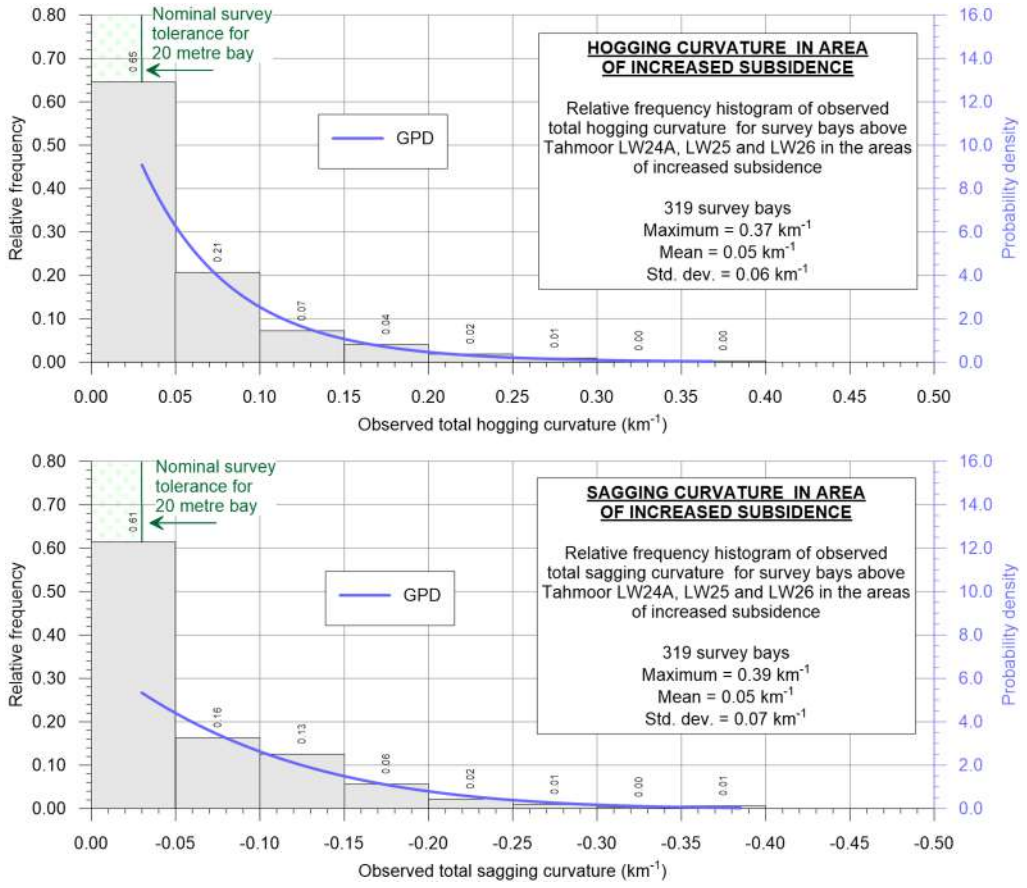


Fig. 11.14 Distributions of measured curvatures for survey bays located in the areas of increased subsidence above Tahmoor Mine LWs 24A, 25 and 26

It can be seen from the above figure, that the maximum observed total curvatures for the survey marks in the areas of increased subsidence were 0.37 km^{-1} hogging and 0.39 km^{-1} sagging, which are greater than the maximum predicted curvatures at the houses within the *Subsidence Study Area* of 0.11 km^{-1} hogging and 0.23 km^{-1} sagging.

The range of predicted curvatures for the houses within the *Subsidence Study Area*, therefore, less than those observed above previously extracted longwalls at Tahmoor Mine, including LW 24A and above the eastern ends of LWs 25 and 26 in the areas of increased subsidence. It is expected, therefore, that the incidence of claims for impacts resulting from the mining induced curvature and strain for the proposed longwalls would be similar to those previously experienced in the areas of increased subsidence. The methods for predicting and assessing impacts on building structures have developed over time as knowledge and experience has grown. MSEC has provided predictions and impact assessments for the houses within the *Subsidence Study Area* using the latest methods available at the time of writing.

Building structures have been directly mined beneath at a number of collieries throughout the NSW Coalfields. The experience gained has provided substantial information that has been used to continually develop the methods of impact assessment for houses. The assessments provided in this report are based on the latest research, which is summarised in Appendix C.

Trend analyses were conducted following the mining of Tahmoor Mine LWs 22 to 29. The analyses indicated that the chance of impact is higher for the following houses:-

- Houses predicted to experience higher strains and curvatures,
- Houses with masonry walls,
- Masonry walled houses that are constructed on strip footings,
- Larger houses, and
- Houses with variable foundations, such as those with extensions added.

The probabilities of impacts for each house within the *Subsidence Study Area* have been assessed using the method developed as part of ACARP Research Project C12015 (Waddington, 2009) and it has been updated based on observations of impacts at Tahmoor up to 2016 when the extraction of Longwall 29 was completed. This method uses the primary parameters of ground curvature and type of construction and is described in Appendix C. The parameter of strain is indirectly used in this method due to its relationship with curvature. A summary of the predicted movements and the assessed impacts for each house within the *Subsidence Study Area* is provided in Table D.03, in Appendix D.

The overall distribution of the assessed impacts for the houses within the *Subsidence Study Area* is provided in Table 11.4. The assessed impacts have been determined based on the existing construction type of each house, as described in Section 11.1.1.

Table 11.4 Assessed impacts for houses within the *Subsidence Study Area*

Group	Repair category			
	No Claim or R0	R1 or R2	R3 or R4	R5
All houses (total of 105)	74 (71 %)	21 (20 %)	8 (8 %)	2 (1 %)
Directly above proposed longwalls (total of 65)	38 (59 %)	18 (28 %)	7 (11 %)	1 (2 %)
Directly above solid coal (total of 40)	36 (90 %)	3 (8 %)	1 (2 %)	< 1 (< 0.5 %)

In comparison, extensive data has come from the extraction of Tahmoor Mine Longwalls 22 to 29, where approximately 1,900 houses have experienced mine subsidence movements. A summary of the observed distribution of impacts for all houses within a 35° angle of draw of previously extracted Longwalls 22 to 29 as at 2016 is provided in Table 11.5.

Table 11.5 Observed frequency of impacts for building structures resulting from the extraction of Tahmoor Mine longwalls 22 to 29

Group	Repair category			
	No Claim or R0	R1 or R2	R3 or R4	R5
All houses within 35 degree angle of draw of LWs 22 to 29 (total of 1890)	1430 (76 %)	329 (17 %)	111 (6 %)	20 (1 %)
All houses, located directly above LWs 24A to 27 in Zone of Increased Subsidence (total of 432)	235 (54 %)	128 (30 %)	55 (13 %)	14 (3 %)

As discussed previously, the range of predicted curvatures for the houses within the *Subsidence Study Area* are less than but similar to those observed above Tahmoor Mine Longwalls 24A to 27 within the observed zone of increased subsidence.

When the assessed distribution of impacts for the houses located directly above the proposed longwalls (second row of Table 11.4) are compared with the observed distribution of impacts of houses and major civil structures located directly above Longwalls 24A to 27 within the zone of increased subsidence (bottom row of Table 11.5), it can be seen that these are reasonably similar.

As mentioned earlier, the assessed impacts have been undertaken based on the existing construction type of each house. It is recognised that houses may be rebuilt in the future before the proposed mining occurs. The proportion of houses impacted by mining would, for example, increase if a greater proportion of houses are constructed directly above the proposed longwalls, or if a greater proportion of houses are constructed with brick walls rather than timber-framed weatherboard style structures. The most vulnerable style of house affected by mine subsidence movements above Tahmoor Mine Longwalls 22 to 29 were constructed as brick or brick-veneer houses on strip footings.

Severe impacts have previously occurred as a result of substantial non-conventional movements and in plateau areas away from incised valleys, such as where the houses are located within the *Subsidence Study Area.* The precise location of non-conventional movements cannot be predicted prior to mining. The impacts, however, develop gradually such that they can be detected early and repairs can be undertaken incrementally to ensure that the houses remain safe and serviceable during mining.

As noted in Appendix C, at the time of writing ACARP Research Project C12015 (Waddington, 2009), the observed proportion of houses where the Mine Subsidence Board (MSB, now SA NSW) and affected landowners had agreed to rebuild rather than repair, i.e. Category R5 impacts was less than 0.5 %. Since the publication of the research report, the proportion of houses where a decision has been made to rebuild has increased to approximately 1.1 % overall and 3.2 % above Longwalls 24A to 27 within the observed zone of increased subsidence.

The observed proportion of houses with Category R1 to R4 impacts have also increased since the original ACARP study. This is partly due to the time lag effect between the mining impact, when damage is claimed by residents and when the nature and level of the damage requiring repairs is assessed in detail by SA NSW. The latest review includes observations up to the end of Longwall 29 in 2016, which was approximately two years after the completion of Longwall 27 and one year after the completion of Longwall 28, which was the last panel to directly mine beneath the urban areas of Tahmoor.

The primary risk associated with mining beneath houses is public safety. Residents have not been exposed to immediate and sudden safety hazards as a result of impacts that occur due to mine subsidence movements in the NSW Coalfields, where the depths of cover were greater than 350 metres, such as the case above the proposed longwalls. This includes the recent experience at Tahmoor Mine, which has affected more than 1,950 houses, and the experiences at Appin, Teralba, West Cliff and West Wallsend Collieries, which have affected around 500 houses.

Emphasis is placed on the words “immediate and sudden” as in rare cases, some structures have experienced severe impacts, but the impacts did not present an immediate risk to public safety as they developed gradually with ample time to temporarily relocate residents.

All houses within the *Subsidence Study Area* are expected to remain safe and repairable throughout the mining period, provided that effective management measures are adopted during mining and these are described in Section 11.1.5.

11.1.4. Future development of houses within the *Subsidence Study Area*

There are no known future developments within the *Subsidence Study Area*.

11.1.5. Management of potential impacts on the houses

Tahmoor Mine has extensive experience of mining beneath urban areas. It has developed and acted in accordance with a risk management process to manage potential impacts to residential structures during the mining of LWs 22 to 32 and LWs W1-W3.

The Subsidence Management Process has been developed in consideration of the following facts and observations:

1. Australian standards have been available for use in the design of structures since 1948. The great majority of structures at Tahmoor and Thirlmere (approximately 80 %) have been constructed after the declaration of the Bargo Mine Subsidence District in November 1975.
2. There is sufficient redundancy in structural design such that ductile deformation will develop and be noticeable to residents before structural failure occurs.
3. Subsidence movements develop gradually over time at Tahmoor Mine as they have above other previously extracted longwalls at similar depths of cover.
4. Experiences during the mining of LWs 22 to 32 and LWs W1-W3 have found that the most effective method of managing potential impacts on the safety and serviceability of structures are by way of community consultation. Residents living within the active subsidence zone have often provided early feedback to Tahmoor Mine and/or SA NSW about impacts developing at their houses or along their local roads. Contact is made well before impacts develop to a level of severity sufficient to become a safety hazard.
5. On the basis of the above, there is sufficient time for residents to notify Tahmoor Mine or SA NSW of significant displacement or deflection well before structural failure will occur.
6. The conclusions are supported by the observation that residents have not been exposed to immediate and sudden safety hazards as a result of impacts that occur due to mine subsidence movements at Tahmoor Mine and above other previously extracted longwalls at similar depths of cover. This includes the recent experience at Tahmoor Mine during the mining of LWs 22 to 32 and LWs W1-W3, which have affected more than 2000 houses and civil structures.

While severe impacts have developed during the mining of LWs 22 to 32, there is sufficient redundancy in structural design such that when structures have experienced severe impacts, they have developed gradually with ample time for residents to notify Tahmoor Mine or SA NSW to repair the structure and/or relocate residents before structural failure occurs.

While the three most important factors in managing risks to public safety are redundancy in structural design, gradual development of subsidence movements and an effective community consultation program, a number of additional management measures have been undertaken, including site specific investigations, regular surveys and inspections during mining and triggered response measures. The method of management would not change if additional houses are constructed in the future as described in Section 11.1.4.

It is recommended that Tahmoor Coal continues its current practice of ensuring that built structures remain safe and serviceable at all times during mining. It is recommended that Tahmoor Coal, in consultation with landowners, study the potential for impacts on the structures and other infrastructure and develop management measures. The study would require input from structural and subsidence engineers. The risk management process includes the following processes:-

1. Regular consultation, cooperation and coordination with the community before, during and after mining. This includes letters and door knocking to all residents of structures that will soon be affected by subsidence. The letters offer a free pre-mining inspection and hazard identification inspection by a structural engineer;
2. Site-specific investigations, where they are necessary and appropriate, into the conditions of buildings and associated structures and their surrounding environment (where access is allowed). The site-specific investigations have been and will continue to be undertaken early so that there is adequate time, if required, to arrange additional inspections and/or surveys and implement any mitigation measures before mining-induced impacts are experienced;

   For properties located directly above the first 300 metres of the commencing end of a longwall, the investigations are targeted to be undertaken prior to extraction or at the latest, they will be undertaken prior to the first 200 metres of extraction of the longwall.

   The site-specific investigations include the following:

   a) Identification of structures from aerial photographs and kerbside inspections;
   b) Front of house risk and visual screening inspections by Tahmoor Coal in company with a structural engineer for all properties that are predicted to experience more than 20 mm of incremental vertical subsidence due to the extraction of each upcoming longwall. The purpose of the inspections is to identify hazards where access has not been granted by the landowner.

In some cases, particularly in semi-rural and rural areas, it is difficult to inspect a structure that is remote from the street front. Where these cases involve properties that are located directly above a longwall, Tahmoor Coal will request access to conduct a pre-mining inspection and hazard identification inspection by a structural engineer;

c) Tahmoor Coal will request access to conduct pre-mining geotechnical inspections of structures located on or immediately adjacent to steep slopes that are predicted to experience more than 20 mm of incremental vertical subsidence due to the extraction of each longwall;

d) Tahmoor Coal will request access to conduct pre-mining hazard identification inspections by a structural engineer (where access is allowed by the landowner) to properties with structures that have been specifically targeted on the basis that may be more sensitive to mine subsidence movements. These include:

   i) Commercial and business establishments, public amenities and public utilities;

   ii) Structures of heritage significance;

   iii) Structures that are located above hidden creeks (none identified within the *Subsidence Study Area*);

   iv) Structures that are located above mapped geological structures (none identified within the *Subsidence Study Area*);

   v) Structures that are located on or adjacent to steep slopes or that have been recommended for structural inspection by the geotechnical engineer;

   vi) Structures that have been identified as being potentially unstable or unsafe by landowners (Item 1), or from the front of house inspections (Item 2b);

   vii) Houses and units located outside the declared Mine Subsidence Districts; and

   viii) Houses and units estimated to have been constructed prior to the declaration of the Bargo Mine Subsidence District (in November 1975).

3. Implementation of pre-mining mitigation measures following inspections by the geotechnical engineer and the structural engineer, in consultation and agreement with the landowner.

4. Surveys and inspections during mining within the active subsidence area:

   a) detailed visual inspections and vehicle-based inspections along the streets;

   b) ground surveys along the streets;

   c) specific ground surveys for selected properties, where recommended by the geotechnical engineer or structural engineer due to their proximity to steep slopes or pre-existing condition;

   d) visual inspections of residential structures that are either: located on or adjacent to steep slopes, are in poor existing condition (based on the hazard identification inspections), have previously reported impacts, or where recommended by the Structures Response Group;

   e) visual inspections of pool fences and gates; and

   f) visual inspections of commercial, industrial and business establishments, public amenities and public utilities.

With appropriate management plans in place, it is considered that the houses will remain safe and serviceable at all times during the extraction of the proposed longwalls, even if actual subsidence movements were greater than the predictions or substantial non- conventional movements occurred.

11.2. Flats or units

There are no flats or units within the *Subsidence Study Area*.

11.3. Caravan parks

There are no caravan parks within the *Subsidence Study Area*.

11.4. Retirement or aged care villages

There is no retirement village within the *Subsidence Study Area*.

11.5. Swimming pools

11.5.1. Descriptions of the swimming pools

The locations of the private swimming pools within the *Subsidence Study Area* are shown in Drawing No. MSEC1192-18.

There are 22 privately owned swimming pools which have been identified within the *Subsidence Study Area*. The majority of these pools (68 %) will be directly mined beneath by the proposed longwalls. The locations and sizes of the pools were determined from orthophotographs of the area.

11.5.2. Predictions for the swimming pools

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and at points located around the perimeter of each pool, as well as at points located at a distance of 20 metres from the perimeter of each pool.

A summary of the maximum predicted values of conventional subsidence, tilt and curvature for each pool within the *Subsidence Study Area* is provided in Table D.06, in Appendix D. The predictions are based on the proposed longwall layout, as shown in Drawing No. MSEC1192-18. The predicted tilts provided in this table are the maxima in any direction after the completion of each of the proposed longwalls. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each of the proposed longwalls.

Distributions of the maximum predicted conventional subsidence, tilt and curvature for the pools within the *Subsidence Study Area* are illustrated in Fig. 11.15 and Fig. 11.16.

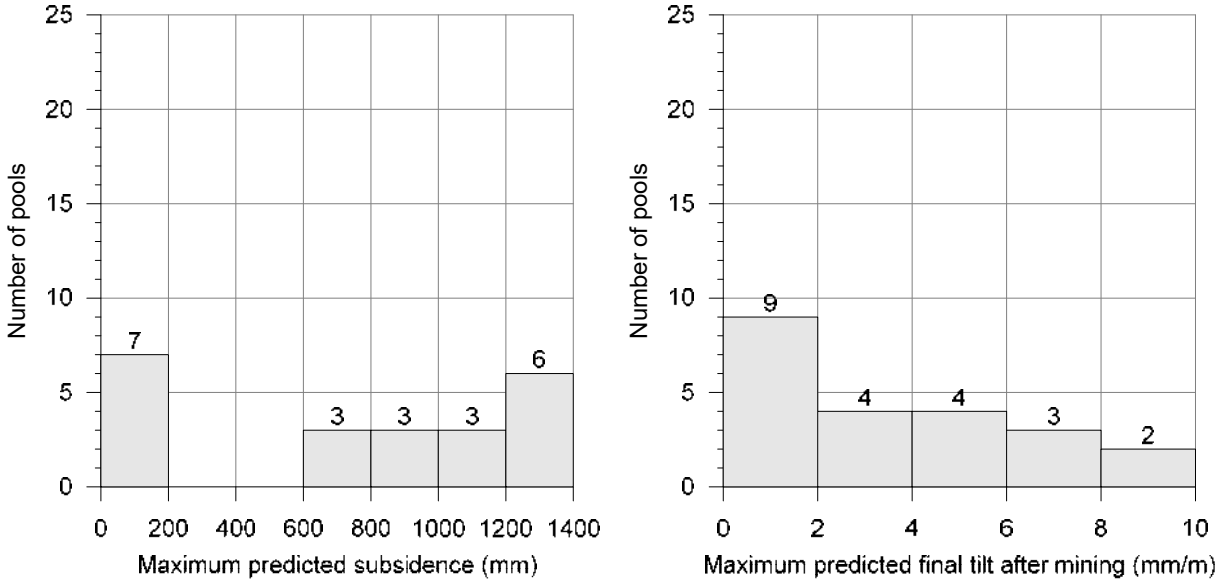


Fig. 11.15 Maximum predicted conventional subsidence and tilt for pools within the Subsidence Study Area

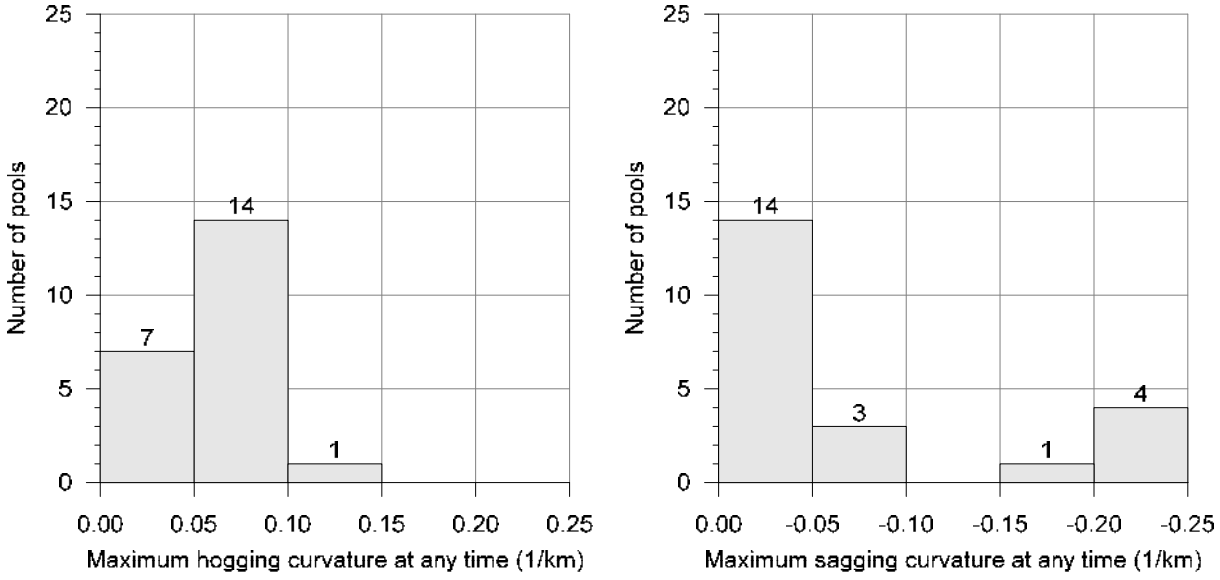


Fig. 11.16 Maximum predicted conventional hogging curvature (left) and sagging curvature (right) for the pools within the Subsidence Study Area

The maximum predicted conventional strains for the pools, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1.7 mm/m tensile and 3.4 mm/m compressive. Non-conventional movements can also occur as a result of, among other things, anomalous movements. The analysis of strains provided in Chapter 4 includes those resulting from both conventional and non-conventional anomalous movements.

The pools are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 4.3.1. The results for survey bays located above goaf are provided in Fig. 4.2 and the results for survey bays located above solid coal are provided in Fig. 4.3.

11.5.3. Impact assessments for the swimming pools

Mining-induced tilts are more noticeable in pools than other structures due to the presence of the water line and the small gap to the edge coping, particularly when the pool lining has been tiled. Skimmer boxes are also susceptible of being lifted above the water line due to mining tilt.

The Australian Standard AS2783-1992 (Use of reinforced concrete for small swimming pools) requires that pools be constructed level ± 15 mm from one end to the other. This represents a tilt of approximately 3 mm/m for pools that are 10 metres in length. Australian Standard AS/NZS 1839:1994 (Swimming pools – Pre-moulded fibre-reinforced plastics – Installation) also requires that pools be constructed with a tilt of 3 mm/m or less.

There are 11 pools within the *Subsidence Study Area* (i.e. 50 % of the total) which are predicted to experience final tilts of 3 mm/m or less, at the completion of the proposed longwalls, which is similar to or less than the Australian Standard.

There are 9 pools (i.e. 41 % of the total) predicted to experience final tilts between 3 mm/m and 7 mm/m and 2 pools (i.e. 9 % of the total) predicted to experience final tilts greater than 7 mm/m. The maximum predicted final tilt for the pools is 9 mm/m (i.e. 0.9 %), which represents a change in grade of 1 in 111. It is likely that a number of these pools would require some remediation of the pool copings.

The maximum predicted conventional curvatures for the pools are 0.11 km^{-1} hogging and 0.23 km^{-1} sagging, which equate to minimum radii of curvature of 9.1 kilometres and 4.3 kilometres, respectively. Whilst the predicted subsidence parameters for the proposed longwalls are greater than those at Tahmoor North, it would still be expected that the rates of impact on pools at Tahmoor North would provide a reasonable guide to the likely levels of impact.

Observations during the mining of Tahmoor Mine LWs 22 to 32 have shown that pools, particularly in-ground pools, are more susceptible to severe impacts than houses and other structures. Pools cannot be easily repaired and most of the impacted pools need to be replaced.

As of June 2017, a total of 157 pools have experienced mine subsidence movements during the mining of Tahmoor Mine Longwalls 22 to 30, of which 141 were located directly above the extracted longwalls. A total of 36 pools have reported impacts, all of which were located directly above the extracted longwalls. This represents an impact rate of approximately 23 %. A higher proportion of impacts have been observed for in-ground pools, particularly fibreglass pools. The majority of the impacts related to tilt or cracking, though in a small number of cases the impacts were limited to damage to skimmer boxes or the edge coping.

It is expected that the rate of impact on the pools within the *Subsidence Study Area* would be similar, but, slightly greater than those previously experienced at Tahmoor North. Impacts to the pools would be repaired or, if required the pool would be replaced in accordance with the *Coal Mine Subsidence Compensation Act 2017*.

11.5.4. Impact assessments for the swimming pools based on increased predictions

If the actual tilts exceeded those predicted by a factor of 2 times, the final tilts would still be 3 mm/m or less at 7 pools within the *Subsidence Study Area* (i.e. 32 % of the total) at the completion of mining. In this case, there would be 5 pools (i.e. 23 % of the total) predicted to experience final tilts between 3 mm/m and 7 mm/m and 10 pools (i.e. 45 % of the total) predicted to experience final tilts greater than 7 mm/m. It is possible that approximately half the pools within the *Subsidence Study Area* would require some remediation of the coping due to the mining induced tilt, if the actual tilts exceeded those predicted by a factor of 2 times.

If the actual curvatures exceeded those predicted by a factor of 2 times, the incidence of impacts would increase for the pools located directly above the proposed longwalls. While the predicted ground movements are important parameters when assessing the potential impacts on the pools, it is noted that the impact assessments were primarily based on observed rate of impact from Tahmoor North. The overall

levels of impact on the pools, resulting from the extraction of the proposed longwalls, are expected to be similar to, but, slightly greater than those observed at Tahmoor North.

11.5.5. Management of potential impacts on the swimming pools

Tahmoor Coal has developed and acted in accordance with a risk management plan to manage potential impacts to pools during the mining of LWs 22 to 32 and LWs W1-W3. The management plan is reviewed periodically by Tahmoor Coal. It is recommended that Tahmoor Coal continue to develop management plans to manage potential impacts during the mining of the proposed longwalls.

While not strictly related to the pool structure, a number of pool gates have been impacted as the result of the previous extraction of longwalls beneath pools. While the gates can be easily repaired, the worst-case consequence of breaching pool fence integrity could be severe. As a result, Tahmoor Coal inspects the integrity of pool fences once a week for pools that are experiencing active subsidence during mining.

With an appropriate management plan in place, it is considered that pools and pool fences can be maintained at all times during the extraction of the proposed longwalls, even if actual subsidence movements were greater than the predictions or substantial non- conventional movements occurred.

11.5.6. Tennis courts

There are no privately owned tennis courts within the *Subsidence Study Area*.

11.5.7. On-site waste water systems

The majority of the residences within the *Subsidence Study Area* operate on-site waste water systems.

The on-site waste water system tanks are generally small, typically less than 3 metres in diameter, are constructed from reinforced concrete, and are usually bedded in sand and backfilled. It is unlikely, therefore, that the maximum predicted curvatures and strains would be fully transferred into the tank structures.

It is possible, however, that the buried pipelines associated with the on-site waste water tanks could be impacted by the strains if they are anchored by the tanks or other structures in the ground. Any impacts are expected to be of a minor nature, including leaking pipe joints, and could be readily repaired. With the implementation of these remedial measures, it would be unlikely that there would be any adverse impacts on the pipelines associated with the on-site wastewater systems.

11.5.8. Rigid external pavements

Adverse impacts on rigid external pavements are often reported to SA NSW in the NSW Coalfields. This is because pavements are typically thin relative to their length and width. The design of external pavements is also not regulated by Council or SA NSW.

A study by MSEC of 120 properties at Tahmoor and Thirlmere indicated that 98 % of the properties with external concrete pavements demonstrated some form of cracking prior to mining. These cracks are sometimes difficult to distinguish from cracks caused by mine subsidence. It is therefore uncertain how many claims for damage can be genuinely attributed to mine subsidence impacts.

Residential concrete pavements are typically constructed with tooled joints which do not have the capacity to absorb compressive movements. It is possible that some of the smaller concrete footpaths or pavements within the *Subsidence Study Area*, in the locations of the larger compressive strains, could buckle upwards if there are insufficient movement joints in the pavements. It is expected, however, that the buckling of footpaths and pavements would not be common, given the magnitudes of the predicted ground strains, and could be easily repaired.

11.6. Fences

Predictions and impact assessments for fences are provided in Section 8.9.

11.7. Any other residential feature

There are no other substantial residential features within the *Subsidence Study Area*.

12.0 ANY KNOWN FUTURE DEVELOPMENTS

There are currently no known future developments *Subsidence Study Area*.

13.0 CONCLUSIONS

Mine Subsidence Engineering Consultants (MSEC) has studied the Extraction Plan Layout and identified the natural features and items of surface infrastructure that are in the *Subsidence Study Area*.

Predictions of subsidence movements have been provided for each of these natural features and items of surface infrastructure. The predictions have been produced using a model that has been calibrated from observations of previous movements during the extraction of previous longwalls at Tahmoor Mine and more broadly from observations of previous movements during the extraction of previous longwalls at similar depths of cover at nearby mines in the Southern Coalfield.

The maximum predicted total subsidence, after the completion of the proposed longwalls, is 1,350 mm which represents around 61 % of the extraction height.

The potential for impacts has been assessed based on the predicted subsidence movements, consultation with infrastructure owners and experiences gained during the extraction of previous longwalls at Tahmoor Mine and more broadly from experiences during the extraction of previous longwalls at similar depths of cover at nearby mines in the Southern Coalfield.

The overall findings of the assessments undertaken by MSEC are that the levels of impact and damage to all identified natural features and built infrastructure are manageable and can be controlled by the preparation and implementation of Subsidence Management Plans (or Extraction Plans), many of which have been successfully implemented during previous mining at Tahmoor Mine. These management plans are developed in consultation with the owners of infrastructure and are approved by relevant government agencies. The findings in this report should be read in conjunction with all other associated consultant reports.

Recommended management measures generally include monitoring of ground movements and the condition of surface features. Some mitigation measures are recommended to mitigate or avoid the risk of serious consequences should impacts occur to some critical surface features.

It is recommended that Tahmoor Coal continues to develop management plans to manage the potential impacts for the surface features due to the extraction of the proposed longwalls.

APPENDIX A. GLOSSARY OF TERMS AND DEFINITIONS

Glossary of Terms and Definitions

Some of the more common mining terms used in the report are defined below:-

Angle of draw	The angle of inclination from the vertical of the line connecting the goaf edge of the workings and the limit of subsidence (which is usually taken as 20 mm of subsidence).
Chain pillar	A block of coal left unmined between the longwall extraction panels.
Cover depth (H)	The depth from the surface to the top of the seam. Cover depth is normally provided as an average over the area of the panel.
Closure	**T**he reduction in the horizontal distance between the valley sides. The magnitude of closure, which is typically expressed in the units of *millimetres (mm)*, is the greatest reduction in distance between any two points on the opposing valley sides. It should be noted that the observed closure movement across a valley is the total movement resulting from various mechanisms, including conventional mining induced movements, valley closure movements, far-field effects, downhill movements and other possible strata mechanisms.
Critical area	The area of extraction at which the maximum possible subsidence of one point on the surface occurs.
Curvature	The change in tilt between two adjacent sections of the tilt profile divided by the average horizontal length of those sections, i.e. curvature is the second derivative of subsidence. Curvature is usually expressed as the inverse of the **Radius of Curvature** with the units of *1/kilometres (km-1)*, but the value of curvature can be inverted, if required, to obtain the radius of curvature, which is usually expressed in *kilometres (km)*. Curvature can be either **hogging** (i.e. convex) or **sagging** (i.e. concave).
Extracted seam	The thickness of coal that is extracted. The extracted seam thickness is thickness normally given as an average over the area of the panel.
Effective extracted seam thickness (T)	The extracted seam thickness modified to account for the percentage of coal left as pillars within the panel.
Face length	The width of the coalface measured across the longwall panel.
Far-field movements	The measured horizontal movements at pegs that are located beyond the longwall panel edges and over solid unmined coal areas. Far-field horizontal movements tend to be bodily movements towards the extracted goaf area and are accompanied by very low levels of strain.
Goaf	The void created by the extraction of the coal into which the immediate roof layers collapse.
Goaf end factor	A factor applied to reduce the predicted incremental subsidence at points lying close to the commencing or finishing ribs of a panel.
Horizontal displacement	The horizontal movement of a point on the surface of the ground as it settles above an extracted panel.
Inflection point	The point on the subsidence profile where the profile changes from a convex curvature to a concave curvature. At this point the strain changes sign and subsidence is approximately one half of S max.
Incremental subsidence	The difference between the subsidence at a point before and after a panel is mined. It is therefore the additional subsidence at a point resulting from the excavation of a panel.
Panel	The plan area of coal extraction.
Panel length (L)	The longitudinal distance along a panel measured in the direction of mining from the commencing rib to the finishing rib.
Panel width (Wv)	The transverse distance across a panel, usually equal to the face length plus the widths of the roadways on each side.
Panel centre line	An imaginary line drawn down the middle of the panel.
Pillar	A block of coal left unmined.
Pillar width (Wpi)	The shortest dimension of a pillar measured from the vertical edges of the coal pillar, i.e. from rib to rib.

Shear deformations	The horizontal displacements that are measured across monitoring lines and these can be described by various parameters including; horizontal tilt, horizontal curvature, mid-ordinate deviation, angular distortion and shear index.
Strain	The change in the horizontal distance between two points divided by the original horizontal distance between the points, i.e. strain is the relative differential displacement of the ground along or across a subsidence monitoring line. Strain is dimensionless and can be expressed as a decimal, a percentage or in parts per notation. **Tensile Strains** are measured where the distance between two points or survey pegs increases and **Compressive Strains** where the distance between two points decreases. Whilst mining induced **strains** are measured **along** monitoring lines, ground **shearing** can occur both vertically, and horizontally **across** the directions of the monitoring lines.
Sub-critical area	An area of panel smaller than the critical area.
Subsidence	The vertical movement of a point on the surface of the ground as it settles above an extracted panel, but, 'subsidence of the ground' in some references can include both a vertical and horizontal movement component. The vertical component of subsidence is measured by determining the change in surface level of a peg that is fixed in the ground before mining commenced and this vertical subsidence is usually expressed in units of *millimetres (mm)*. Sometimes the horizontal component of a peg's movement is not measured, but in these cases, the horizontal distances between a particular peg and the adjacent pegs are measured.
Super-critical area	An area of panel greater than the critical area.
Tilt	The change in the slope of the ground as a result of differential subsidence, and is calculated as the change in subsidence between two points divided by the horizontal distance between those points. Tilt is, therefore, the first derivative of the subsidence profile. Tilt is usually expressed in units of *millimetres per metre (mm/m)*. A tilt of 1 mm/m is equivalent to a change in grade of 0.1 %, or 1 in 1000.
Uplift	An increase in the level of a point relative to its original position.
Upsidence	Upsidence results from the dilation or buckling of near surface strata at or near the base of the valley. The magnitude of upsidence, which is typically expressed in the units of *millimetres (mm)*, is the difference between the observed subsidence profile within the valley and the conventional subsidence profile which would have otherwise been expected in flat terrain.

APPENDIX B. REFERENCES

References

AECOM (2020). Tahmoor South Project – Environmental Impact Statement. AECOM, 2020.

APCRC (1997). *Geochemical and isotopic analysis of soil, water and gas samples from Cataract Gorge*. George, S. C., Pallasser, R. and Quezada, R. A., APCRC Confidential Report No. 282, June 1997.

ATC Williams (2022). *Tahmoor South LW S1A-S6A Water management Plan – Myrtle Creek and Redbank Creek Remediation program Review*, May 2022, document 121171.17-R02d.

Australian Standards Association, AS 2870 - 1996, *Residential Slabs and Footings – Construction.*

Barbato, J., et al. (2016). "*Prediction of horizontal movement and strain at the surface due to longwall coal mining*". International Journal of Rock Mechanics & Mining Sciences. Vol 84, April 2016, pp 105-118.

Barbato, J., et al. (2017). *Development of Predictive Methods for Horizontal Movement and Strain at the Surface due to Longwall Mining.* Mining Technology, October 2017

DPIE (2008a). *Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield – Strategic Review.* Department of Planning, Industry and Environment, 2008.

DPIE (2008b). *Strategic Review of Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield.* Department of Planning, Industry and Environment, 2008.

DPIE (2011). *Major Project Assessment: Bulli Seam Operations Project*, Director-General's Environmental Assessment Report Section 75I of the Environmental Planning and Assessment Act 1979. Department of Planning, Industry and Environment, December 2011.

Douglas Partners (2022). *Report on Geotechnical Assessment, Longwalls S1A to S6A, Bargo*, prepared for Tahmoor Coal, May 2022, document R.001

EMM (2020a), *Tahmoor South Project, Second Amendment Report and Response to Submissions.* EMM Consulting Pty Limited, 2020.

EMM (2020b), *Tahmoor South Project: Wirrimbirra Sanctuary, Statement of Heritage Impact.* EMM Consulting Pty Limited, 2020.

Fluvial Systems (2013). *Tahmoor South Project – Geomorphology*. Fluvial Systems Pty Ltd, 2013.

Gale, W., Sheppard, I. (2011). *Investigation into Abnormal Increased Subsidence above Longwall Panels at Tahmoor Colliery NSW*.

Gale, W., Page,J. (2004). *Mining and the Bargo River, Presentation to MSTS*.

Gilbert & Associates, 2014, *Tahmoor South Project Surface Water Baseline Study*

Gilbert & Associates, 2014, *Tahmoor South Project Water Management System and Site Water Balance, J1210-1*

Gordon Geotechniques (2013). *Feasibility Geotechnical Assessment – Tahmoor South Project. Gordon Geotechniques*. Report No. TahmoorSth13 – R1, July 2013.

Grainger, M.A. (1993). *Effects of mining on railway infrastructure and developments in their control*. Proceedings of the Institution of Civil Engineers, Transport, 100, May, pp. 83-93.

Holla, L. and Armstrong, M., (1986). *Measurement of Sub-Surface Strata Movement by Multi-wire Borehole Instrumentation*. Proc. Australian Institute of Mining and Metallurgy, 291, pp. 65-72.

Holla, L. (1991). *Reliability of Subsidence Prediction Methods for Use in Mining Decisions in New South Wales.* Conference on Reliability, Production and Control in Coal Mines, Wollongong.

Holla, L. and Barclay, E. (2000). *Mine Subsidence in the Southern Coalfield, NSW, Australia.* Published by the Department of Mineral Resources, NSW.

Hydro Engineering and Consulting (2020a). *Tahmoor South Project Surface Water Baseline Study*. Hydro Engineering and Consulting, 2020.

Hydro Engineering and Consulting (2020b). *Tahmoor South Project Flood Study*. Hydro Engineering and Consulting, 2020.

HydroSimulations (2020). *Tahmoor South Second Amended Project: Groundwater Assessment for Tahmoor Coal Pty Ltd*. HydroSimulations, 2020.

JMA (2014). *Bridges over Main Southern Rail, Bargo*. John Matheson & Associates Pty Ltd, Report No. R0237, May 2014.

Kapp (1982). *Subsidence from Deep Longwall Mining of Coal Overlain by Massive Sandstones*. Kapp, W.A. Proc. Australasian Ins. Min. Met., 7/1 – 7/9.

Kay, D.J., et al. (2017). *Experiences from Longwall Mining beneath Railway Cuttings.* Kay, D.J.; Pidgeon, A.; Bloor, C.; Christie, D.; Leventhal, A.; Matheson, J.; Robinson, G.; Rolles, J.; Pinkerton, R.; Barber, R.; Sheppard, I.; Talbert, D.; Brunero, C.; Patterson, D., Proceedings of the 10th Triennial Mine Subsidence Technological Society Conference, Pokolbin, Hunter Valley, NSW, 5-7 November 2017 (pp. 95-110).

Kratzsch, H. (1983). *Mining Subsidence Engineering*, Published by Springer - Verlag Berlin Heidelberg New York.

Lea, K.R. (1991). *Technical Considerations with respect to Longwall Mining beneath Railways in particular panels 9 & 10 from Teralba Colliery*. Report to State Rail Authority of New South Wales, Cityrail.

Leventhal, et al. (2011). *Management of Mine Subsidence Impact upon Mainline Railway Infrastructure - The Flirtation of Tahmoor Longwall 25 with Myrtle Creek Culvert*. Leventhal, A., Matheson, J., Kay, D., Christie, D., Hull, T., Steindler, A., Robinson, G., Sheppard, I. Mine Subsidence Technological Society Eighth Triennial Conference, May 2011.

Leventhal, et al. (2017). *Valley Closure - How Much Can a Culvert Bear?* Leventhal, A.; Matheson, J.; Hull, A.; Steindler, A.; Sheppard, I. Mine Subsidence Technological Society Tenth Triennial Conference, November 2017.

Lohe, E.M. et al. (1992). *Sydney Basin – Geological Structure and Mining Conditions, Assessment for Mine Planning*. NERDDC Project No. 1239.

McElroy Bryan Geological Services, (2013). *Tahmoor South Project Feasibility Study Section 8: Geology and Coal Resources*. McElroy Bryan Geological Services Pty Ltd. August 2013.

Minister for Planning (2011). *Project Approval for Bulli Seam Operations Project*, Application Number 08_0150, Minister for Planning and Infrastructure, 22 December 2011.

McGill (2007). *Mitigating the Effects of Mine Subsidence Due to Coal Mining on Major Infrastructure Assets Critical to Sydney*. Proceedings of the MSTS Mine Subsidence Technological Society 7th Triennial Conference on Mine Subsidence, 26th to 27th November 2007.

Mills, K. (2003). *WRS1 monitoring results* – End of Longwall 9. SCT Operations Report: MET2659.

Mills, K. (2007). *Subsidence Impacts on River Channels and Opportunities for Control*. SCT Operations Report: MET2659.

Mills, K. and Huuskes, W. (2004). *The Effects of Mining Subsidence on Rockbars in the Waratah Rivulet at Metropolitan Colliery*. Proc. 6th Triennial Conference, Subsidence Management Issues, Mine Subsidence Technological Society, Maitland.

MSEC (2002). "WKA - *Handbook on the Undermining of Cliffs, gorges and River*. ACARP Project No. C8005 & C9067

MSEC (2006). *Tahmoor Colliery Longwalls 24 to 26 - The Prediction of Subsidence Parameters and the Assessment of Mine Subsidence Impacts on Surface and Sub-Surface Features due to mining Longwalls 24 to 26 at Tahmoor Colliery in support of an SMP Application.* Mine Subsidence Engineering Consultants, Report MSEC157, Revision C, March 2006.

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

MSEC (2017). *Tahmoor Mine – Tahmoor South Project Longwalls 101 to 206 – 2017 Mine Plan*. Mine Subsidence Engineering Consultants, 14 December 2017.

Niche (2020a). *Tahmoor South Project – Terrestrial Ecology Assessment.* Niche Environment and Heritage, 2020.

Niche (2020b). *Tahmoor South Project – Aquatic Ecology Assessment.* Niche Environment and Heritage, 2020.

Niche (2020c). *Tahmoor South Project – Aboriginal Cultural Heritage Assessment*. Niche Environment and Heritage, 2020.

Niche (2020d). *Tahmoor South Project – Historical Heritage Assessment*. Niche Environment and Heritage, 2020.

Niche (2020e). *Tahmoor South Project – Biodiversity Assessment Update.* Niche Environment and Heritage, 2020.

NRAtlas (2010). *Natural Resource Atlas* website, viewed 23rd April 2010. The Department of Natural Resources. http://nratlas.nsw.gov.au/

Patton and Hendren (1972). *General Report on Mass Movements*. Patton F.D. & Hendren A.J. Proc. 2nd Intl. Congress of International Association of Engineering Geology, V-GR1-V-GR57.

Reid, P. (1991). *Coal Mining Beneath Dams in NSW Australia.* 1991 ASDSO Annual Conference, September 1991, San Diego, USA pp 240-245.

Regal Heritage (2022). *Southern Coalfields Shelter Monitoring Statistical Analysis*, March 2022.

Robinson, M. (2007). *West Wallsend Colliery - A Coordinated Approach to Managing Subsidence Impacts on Multiple High Risk Sensitive Surface Features: LW27 Case Study*. Robinson, M. Proceedings of the MSTS Mine Subsidence Technological Society 7th Triennial Conference on Mine Subsidence, Nov 2007 (pp. 11-22).

SEA (2002). *A Review of the Likely Ground Conditions and the Appropriate Controls which need to be Considered as Part of the Mine Design Process in Tahmoor North*. Report No. 97083 (TAH)-23a.

Sefton (2000). *Overview of the Monitoring of Sandstone Overhangs for the Effects of Mining Subsidence Illawarra Coal Measures, for Illawarra Coal.* C.E. Sefton Pty Ltd, 2000.

SCIMS (2010). *SCIMS Online* website, viewed 23rd April 2010. The Land and Property Management Authority. http://www.lands.nsw.gov.au/survey_maps/scims_online

SCI (2008). *Inquiry into the Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield Strategic Review*, Southern Coalfield Inquiry, July 2008.

SCT (2013a). *Review of the Hydraulic Conductivity and Geotechnical Characteristics of the Overburden at Tahmoor South*. Strata Control Technologies. Report No. TAH4083, Revision 1, December 2013.

SCT (2013b). *Subsidence Impact Assessment for Selected Archaeological Heritage Sites at Tahmoor South Project*. Strata Control Technologies. Report No. TAH4090, December 2013.

SCT (2014). *Peer Review of Tahmoor South Subsidence Assessment*. Strata Control Technologies. Letter dated 24 March 2014.

SCT (2017). *Peer Review of Tahmoor South Preferred Project Layout Subsidence Assessment*. Strata Control Technologies. Letter dated 11 December 2017.

SCT (2018a). *Investigation into the Potential Impact of the Nepean Fault on Subsidence Adjacent to LW32*. Strata Control Technologies. TAH4851, 2 May 2018.

SCT (2018b). *Structural Determinations of the Nepean Fault Adjacent to Tahmoor Mine*. Strata Control Technologies. TAH4817, 2 May 2018.

SLR (2022a). *LW S1A-S6A Extraction Plan - Groundwater Technical Report*, prepared for Tahmoor Coal, May 2022, document 610.30637.00000-R01-v3.0.

SLR (2022b). *Tahmoor South - Baseline Private Bore Assessment Report*, prepared for Tahmoor Coal, May 2022, document 310.30637.00000-R01-v3.0.

SLR (2022c). *Tahmoor Extraction Plan LW S1A-S6A Land and Agricultural Resource Assessment*, prepared for Tahmoor Coal, April 2022, document 630.12732.002-R01-v1.0.

Swarbrick, et al., (2007). *Subsidence Monitoring at Cataract Tunnel Portal: Lessons Learnt*. Swarbrick, G., Vergara, M., Pinkster, H., and Landon-Jones, I. Proceedings of the MSTS Mine Subsidence Technological Society 7th Triennial Conference on Mine Subsidence, Wollongong, 2007, pp 43-51.

Tahmoor Coal (2022a). *Water Management Plan for LW S1A-S6A*, 2022.

Tahmoor Coal (2022b). *Land Management Plan for LW S1A-S6A*, 2022.

Tahmoor Coal (2022c). *Biodiversity Management Plan for LW S1A-S6A*, 2022.

Tahmoor Coal (2022d). *Heritage Management Plan for LW S1A-S6A*, 2022.

Tahmoor Coal (2022e). *Built Features Management Plan for LW S1A-S6A*, 2022.

Tahmoor Coal (2022f). *Public Safety Management Plan for LW S1A-S6A*, 2022.

Waddington, A.A (2009). *MSEC276 - The Prediction of Mining Induced Movements in Building Structures and the Development of Improved Methods of Subsidence Impact Assessment (ACARP C12015)*. ACARP Project C12015 (Australian Coal Association Research Program). pp 1-207.

Waddington, A.A. and Kay, D.R. (2002). *Management Information Handbook on the Undermining of Cliffs, Gorges and River Systems*. ACARP Research Projects Nos. C8005 and C9067, September 2002.

Whittaker and Reddish (1989). *Subsidence – Occurrence, Prediction and Control.* Whittaker, B.N. and Reddish, D.J. Elsevier.

WSC (2011). *Growth Management Strategy*. Wollondilly Shire Council, 2011.

APPENDIX C. METHOD OF IMPACT ASSESSMENTS FOR HOUSES

APPENDIX C METHOD OF IMPACT ASSESSMENT FOR HOUSES

C.1. Introduction

The methods for predicting and assessing impacts on building structures have developed over time as knowledge and experience has grown. MSEC has provided predictions and impact assessments for the building structures within the *Subsidence Study Area* using the latest methods available at this time.

Longwall mining has occurred directly beneath building structures at a number of collieries in the Southern Coalfield, including Appin, West Cliff, Tower and Tahmoor Mines. The most extensive data has come from extraction of Tahmoor Mine Longwalls 22 to 29, where approximately 2000 houses have experienced subsidence movements. The experiences gained during the mining of these longwalls, as well as longwalls at other collieries in the Southern and Newcastle Coalfields, have provided substantial additional information that has been used to further develop the methods.

The information was initially collected during the mining of Tahmoor Mine Longwalls 22 to 24A and reviewed in two parallel studies, one as part of a funded ACARP Research Project C12015 (Waddington, 2009), and the other at the request of Industry and Investment NSW (now the Department of Planning, Industry and Environment – Resources Regulator).

The outcomes of these studies include:-

- Review of the performance of the previous method,
- Recommendations for improving the method of Impact Classification, and
- Recommendations for improving the method of Impact Assessment.

Additional information was collected in 2016 after the completion of Longwall 29 and impact assessments for the houses in this report have been based on the updated information provided. A summary is provided in the following sections.

C.2. Review of the Performance of the Previous Method

The previous method of impact assessment applied predictions of curvature on the overall length of each house to predict a crack width in the external walls that was classified based primarily in accordance with Table C1 of Australian Standard 2870-1996. This method did not include impacts to other elements, finishes or services.

Extensive data on house impacts has come from extraction of Tahmoor Mine Longwalls 22 to 25 and a comparison between predicted and observed impacts is provided in Table C.1. The comparison is based on pre-mining predictions that were provided in SMP Applications for these longwalls and the observations of impacts using the previous method of impact classification. The comparison is based on information up to 30 November 2008. At that point in time, the length of extraction of Longwall 25 was 611 metres.

A total of 1037 houses and civil structures were affected by subsidence due to the mining of Tahmoor Mine Longwalls 22 to 25 at that time. A total of 175 claims had been received by the MSB, now SA NSW (not including claims that were refused) of which 14 claims did not relate to the main residence or civil structure.

Table C.1 Summary of Comparison between Observed and Predicted Impacts for each Structure

Strain Impact Category	Total No. of Observed Impacts for Structures predicted to be Strain Impact Category 0	Total No. of Observed Impacts for Structures predicted to be Strain Impact Category 1	Total No. of Observed Impacts for Structures predicted to be Strain Impact Category 2	Total
No impact	483	373	20	876
Cat 0	31	70	6	107
Cat 1	8	9	1	18
Cat 2	7	11	2	20
Cat 3	2	2	0	4
Cat 4	3	5	0	8
Cat 5	3	1	0	4
Total	537	471	29	1037
% claim	**10 %**	**21 %**	**31 %**	16 %
% Obs > Pred	**4 %**	**4 %**	**0 %**	-
% Obs <= Pred	**96 %**	**96 %**	**100 %**	-

Note: Predicted impacts due to conventional subsidence only, as described in the SMP Application.

Given that observed impacts are less than or equal to predicted impacts in 96 % of cases, it is considered that the previous methods are generally conservative even though non-conventional movements were not taken into account in the predictions and assessments. However, when compared on a house by house basis, the predictions have been substantially exceeded in a small proportion of cases.

The majority, if not all, of the houses that have experienced Category 3, 4 or 5 impacts are considered to have experienced substantial non-conventional subsidence movements. The consideration is based on nearby ground survey results, where localised bumps are observed in subsidence profiles and high localised strain is observed. The potential for impact from non-conventional movements were discussed generally and not included in the specific impact assessments for each structure.

The inability to specify the number or probability of impacts due to the potential for non-conventional movements is a shortcoming of the previous method. It was considered that there was substantial room for improvement in this area and recommendations are provided to improve the previous method.

The comparison shows a favourable observation that the overall proportion of claims increased for increasing observed ground movements. This suggests that the main parameters currently used to make impact assessments (namely predicted conventional curvature and maximum plan dimension of each structure) are credible. Please note that we have stated predicted conventional curvature rather than strain, as predictions of strain were directly based on predictions of conventional curvature.

A substantial over-prediction is observed at the low end of the spectrum of impacts (Category 0 and 1). A number of causes and/or possible causes for the deviations have been identified:

- Construction methods and standards may mitigate against small differential ground movements.
- The impacts may have occurred but the residents have not made a claim for the following reasons:-
  - All structures contain some existing, pre-mining defects. A pre-mining field investigation of 119 structures showed that it is very rare for all elements of a building to be free of cracks. Cracks up to 3 mm in width are commonly found in buildings. Cracks up to 1 mm in width are very common. There is a higher incidence of cracking in brittle forms of construction such as masonry walls and tiled surfaces.
  - In light of the above, additional very slight Category 0 and 1 impacts may not have been noticed by residents. A forensic investigation of all structures before or after mining may reveal that the number of actual impacts is greater than currently known.
  - Similarly, impacts have been noticed but some residents may consider them to be too trivial to make a claim. While difficult to prove statistically, it is considered that the frequency of claims from tenanted properties is less than the frequency of claims from owner-occupied properties.
- The impacts have been noticed but some residents are yet to make a claim at this stage. It has been observed that there is a noticeable time lag between the moment of impact and the moment of making a claim. At the time of the original study in 2008, more claims were therefore expected to be received in the future within areas that have already been directly mined beneath. This has been confirmed by the findings of the most recent study based on information received in 2016. It has also been found that as assessments and repairs were progressively determined at each house, the level of impacts at each house has generally been greater than was originally reported.
- The predictive method is deliberately conservative in a number of ways.
  - Predicted subsidence movements for each structure are based on the maximum predicted subsidence movements within 20 metres of the structure.
  - An additional 0.2 mm/m of strain was added
  - Maximum strains were applied to the maximum plan dimension, regardless of the maximum predicted strain orientation.
  - The method of impact assessment does not provide for “nil impacts”. The minimum assessed level of impact is Category 0.
  - The impact data was based on double-storey full masonry structures in the UK.

Finally, it is considered that the previous method impact classification has masked the true nature and extent of impacts. It is recommended that an improved method of classification be adopted before embarking on any further analysis. This is discussed in the next chapter of this report.

C.3. Method of Impact Classification

C.3.1. Previous Method

The impacts to structures were previously classified in accordance with Table C1 of Australian Standard 2870-1996, but the table has been extended by the addition of Category 5 and is reproduced below.

Table C.2 Classification of Damage with Reference to Strain

Impact Category	Description of typical damage to walls and required repair	Approximate crack width limit
0	Hairline cracks.	< 0.1 mm
1	Fine cracks which do not need repair.	0.1 mm to 1.0 mm
2	Cracks noticeable but easily filled. Doors and windows stick slightly	1 mm to 5 mm
3	Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weather-tightness often impaired	5 mm to 15 mm, or a number of cracks 3 mm to 5 mm in one group
4	Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window or door frames distort. Walls lean or bulge noticeably. Some loss of bearing in beams. Service pipes disrupted.	15 mm to 25 mm but also depends on number of cracks
5	As above but worse, and requiring partial or complete rebuilding. Roof and floor beams lose bearing and need shoring up. Windows broken with distortion. If compressive damage, severe buckling and bulging of the roof and walls.	> 25 mm

Note 1 of Table C1 states that *"Crack width is the main factor by which damage to walls is categorized. The width may be supplemented by other factors, including serviceability, in assessing category of damage.*

Impacts relating to tilt were classified according to matching impacts with the description in Table C.3, not the observed actual tilt. This is because many houses that had experience tilts greater than 5 mm had not made a claim to the MSB (now SA NSW).

Table C.3 Classification of Damage with Reference to Tilt

Impact Category	Tilt (mm/m)	Description
A	< 5	Unlikely that remedial work will be required.
B	5 to 7	Adjustment to roof drainage and wet area floors might be required.
C	7 to 10	Minor structural work might be required to rectify tilt. Adjustments to roof drainage and wet area floors will probably be required and remedial work to surface water drainage and sewerage systems might be necessary.
D	> 10	Considerable structural work might be required to rectify tilt. Jacking to level or rebuilding could be necessary in the worst cases. Remedial work to surface water drainage and sewerage systems might be necessary.

C.3.2. Need for Improvement to the Previous Method of Impact Classification

It is very difficult to design a method of impact classification that covers all possible scenarios and permutations. The application of any method is likely to find some instances that do not quite fit within the classification criteria.

Exposure to a large number of affected structures has allowed the mining industry to appreciate where improvements can be made to all aspects including the identification of areas for improvement in the previous method of impact classification.

A number of difficulties have been experienced with the previous method during the mining period. The difficulty centres on the use of crack width as the main classifying factor, as specified in Table C1 of Australian Standard 2870-1996.

A benefit of using crack width as the main factor is that it provides a clear objective measure by which to classify impact. However, experience has shown that crack width is a poor measure of the overall impact and extent of repair to a structure. The previous method of impact classification may be useful for assessing impact to newly built structures in a non-subsidence environment but further improvement and clarification is recommended before it can be effectively applied to houses impacted by mine subsidence.

The following aspects highlight areas where the previous classification system could be improved.-

- *Slippage on Damp Proof Course*

  Many houses have experienced slippage along the damp proof course in Tahmoor. Slippage on some houses is relatively small (less than 10 mm) though substantial slippage has been observed in a number of cases, such as shown in Fig. C.1 below.

Fig. C.1 Example of slippage on damp proof course

Under the previous classification method, the “crack” width of the slippage may be very small (Category 1) but the distortion in the brickwork is substantial. Moreover, the extent of work required to repair the impact is substantial as it usually involves re-lining the whole external skin of the structure. Such impacts would be considered Category 4 based on extent of repair but only Category 1 or 2 based on maximum crack width.

There is no reference to slippage of damp proof course in the previous method of impact classification. However, if the extent of repair was used instead of using crack width as the main factor, the impact category would be properly classified as either Category 4 or Category 5.

It was recommended that slippage of damp proof courses be added to the previous impact classification table.

- *Cracks to brickwork*

  In some cases, cracks are observed in mortar only. For example, movement joints in some structures have been improperly filled with mortar instead of a flexible sealant, as shown in Fig. C.2. In these situations, the measured crack width may be substantial but the impact is relatively simple to repair regardless of the crack width.

Fig. C.2 Example of crack in mortar only

In other cases, a small number of isolated bricks have been observed to crack or become loose. This is usually straightforward to repair. Under the previous impact classification method, a completely loose brick could be strictly classified as Category 5 as the crack width is infinitely large. This is clearly not the intention of the previous method but clarification is recommended to avoid confusion.

If a panel of brickwork is cracked, the method of repair is the same regardless of the width. While it is considered reasonable to classify large and severe cracks by its width, it is recommended that cracks less than 5 mm in width be treated the same rather than spread across Categories 0, 1 and 2.

If a brick lined structure contains many cracks of width less than 3 mm, the impact would be classified as no more than Category 2 under the previous method of impact classification. The extent of repair may be substantially more than a house that has experienced only one single 5 mm crack. However, it is recognised that it is very difficult to develop a simple method of classifying impacts based on multiple cracks in wall panels. How many cracks are needed to justify an increase in impact category?

- *Structures without masonry walls*

  Timber framed structures with lightweight external linings such weatherboard panels and fibro sheeting are not referenced in the previous classification table. If crack widths were strictly adopted to classify impacts, it may be possible to classify movement in external wall linings beyond Category 3 when in reality the repairs are usually minor.

  It was recommended that the impact classification table be extended to include structures with other types of external linings.

- *Minor impacts such as door swings*

  Experience has shown that one of the earliest signs of impact is the report of a sticking door. In some instances, the only observed impact is one or two sticking doors. It takes less than half an hour to repair a sticking door and impact is considered negligible.

  Such an impact would be rightly classified as Category 0 based on the previous method of impact classification as there is no observed crack. However, the previous classification table suggests that sticking doors and windows occur when Category 2 crack widths develop. It was recommended that the impact classification table be amended in this respect.

C.3.3. Broad Recommendations for Improvement of Previous Method of Impact Classification

It was recommended that crack width no longer be used as the main factor for classifying impacts. This does not mean that the use of crack width should be abandoned altogether. Crack width remains a good indicator of the severity of impacts and should be used to assist classification, particularly for impacts that are moderate or greater.

By focussing on crack width, the previous impact classification table appears to be classifying impacts from a structural stability perspective. It was recommended that a revised impact classification table be more closely aligned with all aspects of a building, including its finishes and services. Residents who are affected by impacts are concerned as much about impacts to internal linings, finishes and services as they are about cracks to their external walls and a revised impact classification method should reflect this.

With crack width no longer used as the main factor, it was recommended that the wording of the descriptions of impact in the classification table be extended to cover impacts to more elements of buildings. In keeping with the previous method of assessment, the level of impact should distinguish between cosmetic, serviceability and stability related impacts:-

- Low impact levels should relate to cosmetic impacts that do affect the structural integrity of the building and are relatively straight-forward to repair,
- Mid-level impact categories should relate to impacts to serviceability and minor structural issues, and
- High level impacts should be reserved for structural stability issues and impacts requiring extensive repairs.

C.3.4. Revised Method of Impact Classification

The following revised method of impact classification has been developed.

Table C.4 Revised Classification based on the Extent of Repairs

Repair Category	Extent of Repairs
Nil	No repairs required
R0 **Adjustment**	One or more of the following, where the damage does not require the removal or replacement of any external or internal claddings or linings:- - **Door** or **window** jams or swings, or - Movement of **cornices**, or - Movement at external or internal **expansion joints**.
R1 **Very Minor Repair**	One or more of the following, where the damage can be repaired by filling, patching or painting without the removal or replacement of any external or internal brickwork, claddings or linings:- - Cracks in **brick mortar** only, or isolated cracked, broken, or loose **bricks** in the external façade, or - Cracks or movement < 5 mm in width in any external or internal wall **claddings**, **linings**, or **finish**, or - Isolated cracked, loose, or drummy floor or wall **tiles**, or - Minor repairs to any **services** or **gutters**.
R2 **Minor Repair**	One or more of the following, where the damage affects a small proportion of external or internal claddings or linings, but does not affect the integrity of external brickwork or structural elements:- - Continuous cracking in **bricks** < 5 mm in width in one or more locations in the total external façade, or - Slippage along the **damp proof course** of 2 to 5 mm anywhere in the total external façade, or - Cracks or movement ≥ 5 mm in width in any external or internal wall **claddings**, **linings**, **finish**, or - Several cracked, loose or drummy floor or wall **tiles**, or - Replacement of any **services**.
R3 **Substantial Repair**	One or more of the following, where the damage requires the removal or replacement of a large proportion of external brickwork, or affects the stability of isolated structural elements:- - Continuous cracking in **bricks** of 5 to 15 mm in width in one or more locations in the total external façade, or - Slippage along the **damp proof course** of 5 to 15 mm anywhere in the total external façade, or - Loss of bearing to isolated walls, piers, columns, or other load-bearing elements, or - Loss of stability of isolated structural elements.
R4 **Extensive Repair**	One or more of the following, where the damage requires the removal or replacement of a large proportion of external brickwork, or the replacement or repair of several structural elements:- - Continuous cracking in **bricks** > 15 mm in width in one or more locations in the total external façade, or - Slippage along the damp proof course of 15 mm or greater anywhere in the total external façade, or - Relevelling of building, or - Loss of stability of several structural elements.
R5 **Re-build**	Extensive damage to house where the MSB (now SA NSW) and the owner have agreed to rebuild as the cost of repair is greater than the cost of replacement.

As discussed at the start of this chapter, it is very difficult to design a method of impact classification that covers all possible scenarios and permutations. While the method has been floated among some members of the mining industry, it is recommended that this table be reviewed broadly.

The recommended method has attempted to follow the current Australian Standard in terms of the number of impact categories and crack widths for Categories 3 and 4. The method is based on the extent of repairs required to repair the physical damage that has occurred, and does not include additional work that is occasionally required because replacement finishes cannot match existing damaged ones. It is therefore likely that the actual cost of repairs will vary greatly between houses depending on the nature of the existing level and type of finishes used.

The impacts experienced at Tahmoor have been classified in accordance with the revised method of classification with good results. The method allowed clearer trends to be found when undertaking statistical analyses.

A comparison between the previous and revised methods is shown in Fig. C.3.

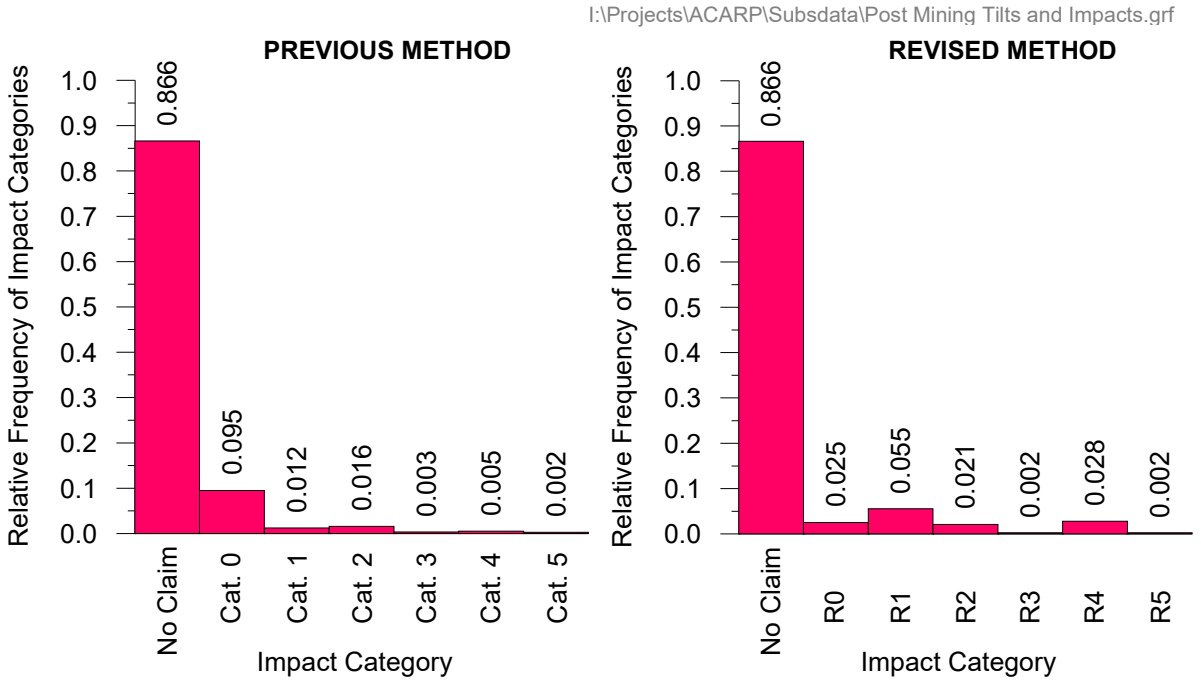


Fig. C.3 Comparison between Previous and Revised Methods of Impact Classification

It can be seen that there was an increased proportion in the higher impact categories using the revised method. This is brought about mainly by the recorded slippage on damp proof courses, which are classified as either Category 3 or Category 4 when they were previously classified as Category 1 or 2.

There was also a noticeable reduction in proportion of Category 0 impacts and noticeable increase in proportion of Category 1 impacts using the revised method. This is because the revised method reserves Category 0 impacts for impacts that did not result in cracking any linings, while the previous method allows hairline cracking to occur.

The consistent low proportion of Category 3 impacts under both the previous and current methods raises questions as to whether this category should be merged with Category 4.

C.4. Method of Impact Assessment

C.4.1. Need for Improvement of the Previous Method

The previous method of impact assessment provided specific quantitative predictions based on predicted conventional subsidence movements and general qualitative statements concerning the potential for impacts due to non-conventional movements. These non-conventional movements are additional to the predicted conventional movements.

This message was quite complex and created the potential for confusion and misunderstanding among members of the community who may easily focus on numbers and letters in a table that deal specifically with their house and misunderstand the message contained in the accompanying words of caution about the low level of reliability concerning predictions of conventional strain and potential for non-conventional movements.

This was unfortunately a necessary shortcoming of the previous method at the time as there was very little statistical information available to quantify the potential for impacts due to non-conventional movement. However, a great deal of statistical information was available following the mining of Tahmoor Mine Longwalls 22 to 24A at the time of the 2009 ACARP study and the method and message to the community could be improved. Additional statistical information was collected in 2016, which was approximately two years after the completion of Longwall 27 and one year after the completion of Longwall 28, which was the last panel to directly mine beneath the urban areas of Tahmoor. The timing of the data is such that it accounts for much of the time lag effect that occurs between the time of impact, when damage is claimed by residents and when the nature and level of the damage requiring repairs is assessed in detail by SA NSW.

While additional statistical information is now available, there remains limited knowledge at this point in time to accurately predict the locations of non-conventional movement. Substantial gains are still to be made in this area.

In the meantime, therefore, a probabilistic method of impact assessment has been developed. The method combines the potential for impacts from both conventional and non-conventional subsidence movement.

C.4.2. Factors that Could be Used to Develop a Probabilistic Method of Prediction

Trend analyses have highlighted a number of factors that could be used to develop a probabilistic method. The trends examined were:-

- *Ground tilt*

  This was found to be an ineffective parameter at Tahmoor Mine as ground tilts have been relatively benign and a low number of claims have been made solely in relation to tilt.

- *Ground strain*

  There appears to be a clear link between ground strain and impacts, particularly compressive strain. The difficulty with adopting ground strain as a predictive factor lies in the ability to accurately predict ground strain at a point.

  Another challenge with using strain to develop a probabilistic method is that there is limited information that links maximum observed strains with observed impacts at a structure. Horizontal strain is a two-dimensional parameter and it has been measured along survey lines that are oriented in one direction only.

  The above issues are less problematic for curvature and the statistical analysis on the relationship between strain and curvature shows that the observed frequency of high strains increased with increasing observed curvature.

- *Ground curvature*

  Curvature appears to be the most effective subsidence parameter to develop a probabilistic method. The trend analysis showed that the frequency of impacts increased with increasing observed curvature.

  It should be noted that we are referring to conventional curvature and not curvatures that have developed as a result of non-conventional subsidence behaviour. This is because conventional curvature can be readily predicted with reasonable correlation with observations. It is also a relatively straight-forward exercise to estimate the observed smoothed or “conventional” mining-induced curvature that has previously been experienced at houses provided some ground monitoring is undertaken across and along extracted longwalls.

  Non-conventional curvature cannot be predicted prior to mining and is accounted for by using a probabilistic method of impact assessment.

  It has also been shown that the observed frequency of high strains increased with increasing observed curvature.

- *Position of structure relative to longwall*

  A clear trend was understandably found that structures located directly above goaf were substantially more likely to experience impact. The calculated probabilities may be applicable for mining conditions that are similar to those experienced at Tahmoor Mine but will be less applicable for other mining conditions. An effective probabilistic method should create a link between the magnitude of differential subsidence movements and impact.

- *Construction type*

  Two trends have been observed. Not surprisingly, structures constructed with lightweight flexible external linings are able to accommodate a far greater range of subsidence movements than brittle inflexible linings such as masonry. The analyses merely quantified what was already well known. The second observation was that houses constructed with strip footings were noticeably more likely to experience impacts than houses constructed with a ground slab, particularly in relation to higher levels of impact. This is because houses with strip footings are more susceptible to slippage along the damp proof course.

- *Structure size*

  Trend analysis showed that larger structures attract a higher likelihood of impact. This is understandable as the chance of impacts increases with increasing footprint area. However, it is noted that the probability of severe impacts was not substantially greater for larger structures even though this would be expected if considering probabilities theoretically rather than empirically. It may be worthwhile including structure size as a factor in the development of a probabilistic method, though it is considered that it is a third order effect behind subsidence movements and construction type.

- *Structure age*

  The trend analysis for structure age did not reveal any noticeable trends.

- *Extensions, variable foundations and building joints*

  There is a clear trend of a higher frequency of impacts for structures that include extensions, variable foundations and building joints. The increased frequency appears to be related mainly to lower impact categories.

- *Urban or rural setting*

  While trends were observed, it is considered that they can be explained by other factors. However, consideration can be made to provide a more conservative estimate of probabilities in rural areas if structure size has not been taken into account.

C.4.3. Revised Method of Impact Assessment

A revised method of impact assessment has been developed, based on information received in 2016 at a time when the extraction of Longwall 29 had been completed. The method is probabilistic and currently includes conventional ground curvature and construction type as input factors.

At the time of the original 2009 ACARP study, the trends in the data were difficult to determine within small ranges of curvature because of the relatively low number of buildings that reported damage at this time. A decision was therefore taken to analyse the data in a limited number of curvature ranges, so that where possible a reasonable sample size would be available in each range. The ranges of curvature originally chosen were 5 to 15 kilometres, 15 to 50 kilometres and greater than 50 kilometres.

Additional information provided in 2016 has demonstrated that the proportion of houses reporting impacts has increased. This has allowed statistical analyses to be conducted using narrower bands of observed curvatures though some inconsistencies remain in some bands due to the sample sizes. The ranges of curvature provided in this report are 2.5 to 15 kilometres, 15 to 50 kilometres and greater than 50 kilometres.

Because the incidence of damage for different construction types showed strong trends and because the sample size was reasonable for each type of structure, the data were analysed to determine the effect of radius of curvature on the incidence of damage for each of the three structure types and for each of the three curvature ranges.

The following probabilities are proposed in Table C.5.

Table C.5 Probabilities of Impact based on Curvature and Construction Type based on the Revised Method of Impact Classification

R (km)	Repair Category			
	No Repair or R0	R1 or R2	R3 or R4	R5
Brick or brick-veneer houses with Slab on Ground				
> 50	90 ~ 95 %	3 ~ 10 %	1 %	< 0.5 %
15 to 50	70 ~ 75 %	20 ~ 25 %	5 ~ 10 %	< 0.5 %
2.5 to 15	45 ~ 65 %	25 ~ 35 %	10 ~ 15 %	1 ~ 3 %
Brick or brick-veneer houses with Strip Footing				
> 50	85 ~ 90 %	5 ~ 15 %	1 ~ 3 %	< 2 %
15 to 50	60 ~ 75 %	20 ~ 30 %	5 ~ 15 %	1 ~ 3 %
2.5 to 15	45 ~ 65 %	25 ~ 30 %	5 ~ 15 %	5 ~ 10 %
Timber-framed houses with flexible external linings of any foundation type				
> 50	90 ~ 95 %	3 ~ 10 %	1 %	< 0.5 %
15 to 50	75 ~ 85 %	10 ~ 20 %	5 ~ 10 %	< 0.5 %
2.5 to 15	70 ~ 80 %	20 ~ 25 %	7 ~ 12 %	< 0.5 %

The results have been expressed as a range of values rather than a single number, recognising that the data had considerable scatter within each curvature range. While structure size and building extensions have not been included in the predictive tables, it is recommended to adopt percentages at the higher end of the range for larger structures or those with building extensions.

The percentages stated in each table are the percentages of building structures of that type that would be likely to be damaged to the level indicated within each curvature range. The levels of damage in the tables are indicated with reference to the repair categories described in the damage classification given in Table C.4.

To place these values in context, Table C.6 shows the actual percentages recorded at Tahmoor Mine for all buildings within the sample.

Table C.6 Observed Frequency of Impacts observed for all buildings at Tahmoor Mine

R (km)	Repair Category			
	No Claim or R0	R1 or R2	R3 or R4	R5
> 50	91 %	7 %	2 %	0 %
15 to 50	72 %	20 %	7 %	1 %
5 to 15	59 %	27 %	14 %	3 %

It can be seen that the proposed probabilities for the higher impact categories have been increased compared to those observed to date. These have been deliberately increased, because it has been noticed that some of the claims for damage have been submitted well after the event and it is possible that the numbers damaged in this category could be increased as further claims are received and investigated. These numbers are sensitive to change. In light of the above, it is recommended that the probabilities be revisited in the future as mining progresses.

The ranges provided in Table C.5 have been converted into a set of probability curves to remove artificial discontinuities that are formed by dividing curvatures into three categories. These are shown in Fig. C.4. The probability curves are applicable for all houses and civil structures.

At the time of writing ACARP Research Project C12015 (Waddington, 2009), the observed proportion of houses where the MSB (now SA NSW) and affected landowners had agreed to rebuild rather than repair (Category R5) impacts was less than 0.5 %. Since the publication of the research report, the proportion of houses where a decision has been made to rebuild has increased to approximately 1.1 % overall and 3.2 % above Longwalls 24A to 27 within the observed zone of increased subsidence. The decision to rebuild rather than repair a house is based on a variety of factors.

Whilst acknowledging the significance of a decision to rebuild compared to repair a house, all houses previously impacted at Tahmoor could have been repaired rather than replaced, including those where a decision has been made to rebuild them. This does not diminish the significance of this category from a social and economic impact point of view and it is important to continue recording the number of instances where a decision has been made to rebuild a house.

C.4.4. Review of Observed Probabilities as mining continues

Reviews of observed probabilities are continually undertaken as Tahmoor Mine and other mines continue to extract beneath houses. The provision of additional information on impact on houses in 2016 has improved the level of understanding on the nature and frequency of impacts during the mining of Longwalls 22 to 29 compared to the information that was collected for the previous 2009 ACARP study, which was conducted after the mining of Longwalls 22 to 24A.

Additional statistical information was collected in 2016, which was approximately two years after the completion of Longwall 27 and one year after the completion of Longwall 28, which was the last panel to directly mine beneath the urban areas of Tahmoor.

A finding from the additional information is that the proportion of houses that have experienced impacts has increased over time. The reasons for the increase are due to the time lag effect that occurs between the mining impact, when damage is claimed by residents and when the nature and level of the damage requiring repairs is assessed in detail by SA NSW.

In light of the above, it is recommended that the probabilities be revisited in the future.

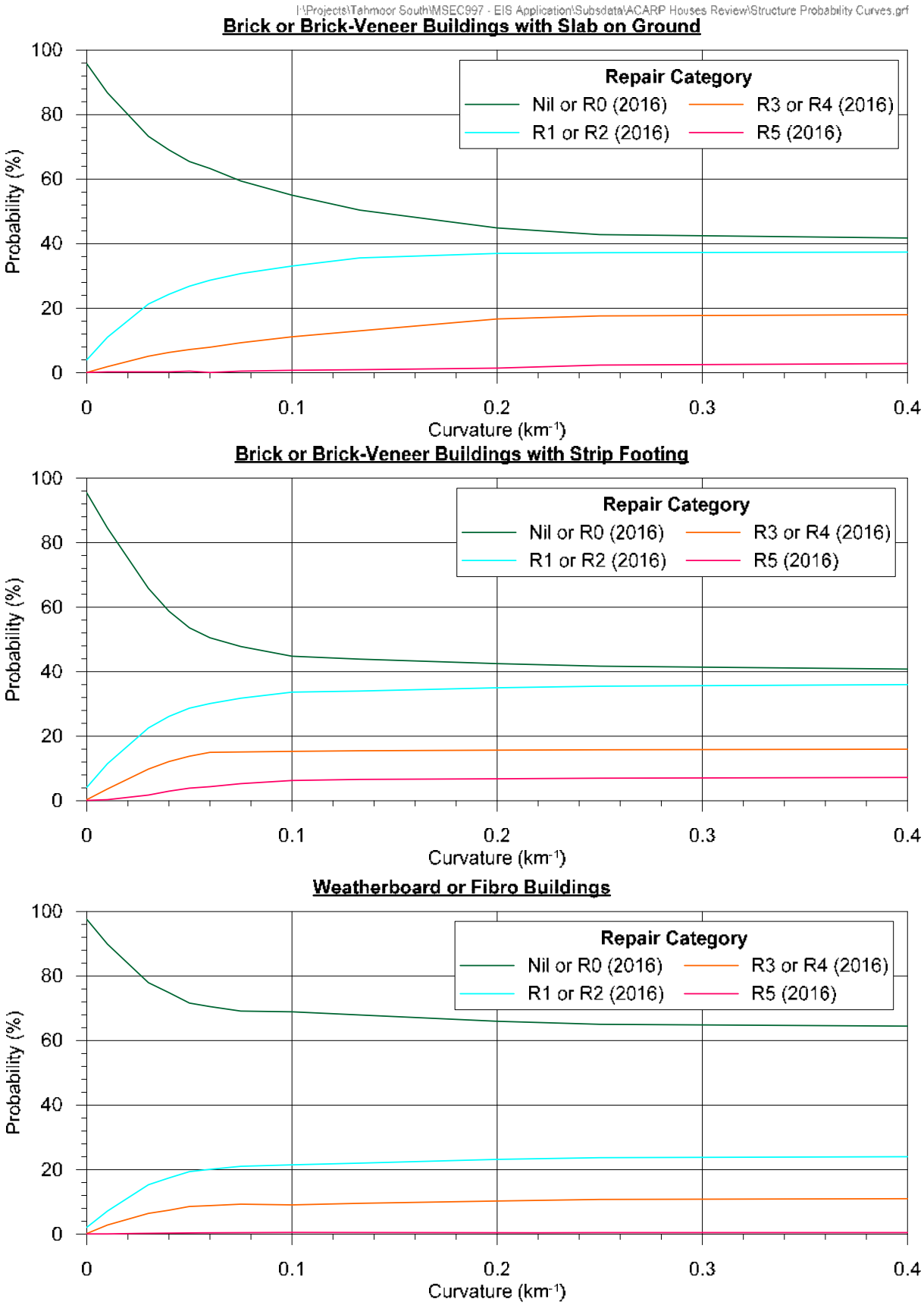


Fig. C.4 Probability Curves for Impacts to Buildings (based on observations up to Longwall 29)

APPENDIX D. TABLES

Table D.01 - Tahmoor South - Predictions for Stream Pools

Stream	Pool	Predicted Total Subsidence after all Longwalls (mm)	Predicted Total Upsidence after all Longwalls (mm)	Predicted Total Closure after all Longwalls (mm)
Teatree Hollow	TT9	1250	275	225
	TT12	1050	375	250
	TT7	100	90	175
	TT14	100	80	150
	TT5	70	50	100
	TT6	< 20	< 20	< 20
	TT4	< 20	< 20	< 20
	TT8	< 20	< 20	< 20
Tributary of Teatree Hollow	TT1	125	125	70
	TT2	1300	375	225
	TT11	850	275	325
	TT3	750	300	350
	TT13	200	125	250

Table D.02 - Tahmoor South - Details of the Houses

House Ref.	Maximum Plan Dimension (m)	Plan Area (m2)	Number of Stories	Wall Construction	Footing Construction	Wall and Footing Construction	Roof Construcftion	House Located Above Goaf	House Located Above Solid Coal
BCA_001_h01	21	234	1	Fibro	Slab on Ground	Timber Framed	Metal	1	
BCA_010_h01	24	252	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Metal	1	
BCA_015_h01	18	227	1	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Metal	1	
BCA_020_h01	17	217	1	Weatherboard	N/A	Timber Framed	Metal	1	
BCA_025_h01	30	298	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Metal	1	
BCA_030_h01	32	291	1	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Tiled	1	
BCA_035_h01	17	181	1	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Tiled	1	
BCA_040_h01	14	159	1	Weatherboard	Suspended on Piers	Timber Framed	Metal	1	
BCA_045_h01	18	138	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BCA_050_h01	10	71	2	Fibro	Suspended on Piers	Timber Framed	Metal	1	
BCA_055_h01	21	239	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BCA_060_h01	28	350	2	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Metal	1	
BCA_065_h01	23	337	1	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Tiled	1	
BCA_070_h01	19	194	1	Weatherboard	Suspended on Piers	Timber Framed	Metal	1	
BCA_075_h01	15	106	1	Weatherboard	Suspended on Piers	Timber Framed	Metal	1	
BCA_080_h01	17	176	1	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Tiled	1	
BCA_085_h01	22	241	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BCA_090_h01	13	138	1	Fibro	Suspended on Piers	Timber Framed	Tiled	1	
BCA_095_h01	22	279	1	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Tiled	1	
BCA_100_h01	31	370	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Metal	1	
BCA_105_h01	22	196	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BCA_110_h01	23	189	1	Brick or Brick-Veneer	Strip Footing	Brick with Strip Footings	Metal		1
BCA_115_h01	34	377	1	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Metal		1
BCA_120_h01	19	230	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Metal		1
BCP_010_h01	13	124	1	Weatherboard	Suspended on Piers	Timber Framed	Tiled		1
BCP_040_h01	14	98	1	Fibro	Suspended on Piers	Timber Framed	Metal		1
BCP_050_h01	6	32	1	Fibro	Suspended on Piers	Timber Framed	Metal		1
BCP_050_h02	11	98	1	Fibro	Suspended on Piers	Timber Framed	Metal		1
BGR_180_h01	19	207	1	Weatherboard	Suspended on Piers	Timber Framed	Tiled		1
BGR_193_h01	16	244	1	Weatherboard	Suspended on Piers	Timber Framed	Metal		1
BGR_203_h01	16	185	1	Weatherboard	Suspended on Piers	Timber Framed	Metal		1
BGR_213_h01	18	145	1	Weatherboard	Suspended on Piers	Timber Framed	Metal	1	
BGR_218_h01	27	245	1	Brick or Brick-Veneer	Strip Footing	Brick with Strip Footings	Metal	1	
BGR_221_h01	26	304	1	Brick or Brick-Veneer	Strip Footing	Brick with Strip Footings	Tiled		1
BGR_225_h01	19	180	1	Fibro	Suspended on Piers	Timber Framed	Metal		1
BGR_230_h01	32	432	1	Weatherboard	Suspended on Piers	Timber Framed	Metal		1
BRE_016_h01	15	106	1	Weatherboard	Slab on Ground	Timber Framed	Metal		1
BRE_030_h01	17	140	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled		1
BRE_055_h01	13	91	1	Weatherboard	Slab on Ground	Timber Framed	Metal	1	
BRE_057_h01	13	127	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BRE_059_h01	19	189	1	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Tiled	1	
BRE_061_h01	18	197	1	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Tiled	1	
BRE_063_h01	28	349	1	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Tiled	1	
BRE_065_h01	22	256	1	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Tiled	1	
BRE_067_h01	15	172	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BRE_070_h01	18	175	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	

Table D.02 - Tahmoor South - Details of the Houses

House Ref.	Maximum Plan Dimension (m)	Plan Area (m2)	Number of Stories	Wall Construction	Footing Construction	Wall and Footing Construction	Roof Construcftion	House Located Above Goaf	House Located Above Solid Coal
BRE_075_h01	18	172	1	Weatherboard	Suspended on Piers	Timber Framed	Metal	1	
BRE_075_h02	11	95	1	Weatherboard	Suspended on Piers	Timber Framed	Metal	1	
BRE_077_h01	16	126	1	Fibro	Suspended on Piers	Timber Framed	Metal	1	
BRE_080_h01	29	260	1	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Tiled	1	
BRE_083_h01	19	236	2	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Metal	1	
BRE_086_h01	29	409	1	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Metal	1	
BRE_089_h01	18	285	1	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Tiled	1	
BRE_140_h01	28	361	1	Brick or Brick-Veneer	Strip Footing	Brick with Strip Footings	Metal	1	
BRE_143_h01	17	176	1	Weatherboard	Suspended on Piers	Timber Framed	Metal	1	
BRE_148_h01	20	303	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BRE_154_h01	19	174	1	Brick or Brick-Veneer	Strip Footing	Brick with Strip Footings	Tiled	1	
BRE_165_h01	9	63	1	Weatherboard	N/A	Timber Framed	Metal	1	
BRE_167_h01	19	160	2	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Tiled	1	
BRE_177_h01	14	158	1	Weatherboard	Suspended on Piers	Timber Framed	Metal	1	
BRE_187_h01	29	396	2	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BRE_189_h01	11	94	1	Fibro	Suspended on Piers	Timber Framed	Metal	1	
BRE_191_h01	15	134	1	Weatherboard	N/A	Timber Framed	Metal	1	
BRE_195_h01	30	372	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Metal		1
BRE_195_h02	14	146	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Metal		1
BRE_201_h01	22	272	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Metal		1
BRE_515_h02	26	401	2	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BRE_644_h01	31	317	1	Brick or Brick-Veneer	Strip Footing	Brick with Strip Footings	Metal	1	
BRE_665_h01	23	261	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Metal	1	
BWE_031_h01	16	143	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled		1
BWE_041_h01	11	96	1	Weatherboard	Suspended on Piers	Timber Framed	Metal		1
BWE_041_h02	31	412	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled		1
BWE_051_h01	22	201	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled		1
BYR_001_h01	10	95	1	Weatherboard	Suspended on Piers	Timber Framed	Tiled	1	
BYR_005_h01	22	165	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BYR_015_h01	17	232	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BYR_025_h01	35	538	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Metal	1	
BYR_035_h01	17	119	1	Weatherboard	N/A	Timber Framed	Metal	1	
BYR_045_h01	18	152	1	Weatherboard	Suspended on Piers	Timber Framed	Metal		1
BYR_045_h02	50	819	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Metal		1
BYR_055_h01	19	275	1	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Tiled		1
BYR_065_h01	18	245	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled		1
BYR_065_h02	15	131	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Metal		1
BYR_075_h01	21	264	1	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Tiled		1
BYR_075_h02	10	80	1	Weatherboard	Suspended on Piers	Timber Framed	Metal		1
BYR_084_h01	17	171	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled		1
BYR_085_h01	19	200	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled		1
BYR_085_h02	8	45	1	Weatherboard	Suspended on Piers	Timber Framed	Metal		1
BYR_085_h03	18	147	1	Weatherboard	Slab on Ground	Timber Framed	Metal		1
BYR_095_h01	37	591	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Metal		1
BYR_105_h01	11	87	1	Fibro	Suspended on Piers	Timber Framed	Metal		1
BYR_115_h02	24	281	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Metal		1

Table D.02 - Tahmoor South - Details of the Houses

House Ref.	Maximum Plan Dimension (m)	Plan Area (m2)	Number of Stories	Wall Construction	Footing Construction	Wall and Footing Construction	Roof Construcftion	House Located Above Goaf	House Located Above Solid Coal
BYR_125_h01	18	156	1	Weatherboard	Suspended on Piers	Timber Framed	Metal		1
BYR_135_h01	16	141	1	Weatherboard	Suspended on Piers	Timber Framed	Tiled		1
BYR_135_h02	41	484	1	Weatherboard	Slab on Ground	Timber Framed	Metal		1
BYR_145_h01	21	215	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled		1
BYR_150_h01	12	102	1	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Tiled	1	
BYR_150_h02	7	39	1	Weatherboard	N/A	Timber Framed	Tiled	1	
BYR_152_h01	20	257	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BYR_154_h01	27	327	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BYR_156_h01	22	268	1	Weatherboard	Suspended on Piers	Timber Framed	Metal	1	
BYR_156_h02	12	95	1	Weatherboard	Suspended on Piers	Timber Framed	Metal	1	
BYR_158_h01	13	89	1	Weatherboard	Suspended on Piers	Timber Framed	Metal	1	
BYR_160_h01	30	285	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BYR_162_h01	18	156	1	Weatherboard	N/A	Timber Framed	Metal	1	

Table D.03 - Tahmoor South - Predictions for Houses

House Ref.	Predicted Total Subsidence (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature (1/km)	Predicted Total Sagging Curvature (1/km)	Predicted Probability of Nil or Category R0 Impact (%)	Predicted Probability of Category R1 or R2 Impact (%)	Predicted Probability of Category R3, R4 or R5 Impact (%)	Predicted Probability of Category R3 or R4 Impact (%)	Predicted Probability of Category R5 Impact (%)
BCA_001_h01	450	4.5	4.5	0.05	0.02	71.5	19.4	9.0	8.6	0.4
BCA_010_h01	1100	7.0	7.5	0.09	0.14	49.9	35.7	14.4	13.4	1.0
BCA_015_h01	1250	7.0	8.0	0.09	0.22	42.3	35.2	22.6	15.7	6.9
BCA_020_h01	1150	4.0	4.0	0.04	0.05	71.5	19.5	9.0	8.6	0.4
BCA_025_h01	1100	3.5	3.5	0.05	0.04	66.7	26.0	7.3	6.9	0.4
BCA_030_h01	1050	3.5	3.5	0.05	0.04	55.2	27.9	16.9	13.3	3.6
BCA_035_h01	900	2.0	4.5	0.08	0.03	46.7	32.5	20.8	15.2	5.6
BCA_040_h01	1200	6.5	8.0	0.09	0.09	69.0	21.4	9.6	9.1	0.5
BCA_045_h01	1350	5.0	6.0	0.06	0.21	44.3	37.1	18.6	16.9	1.7
BCA_050_h01	1300	4.5	4.5	0.06	0.07	70.0	20.5	9.5	9.0	0.5
BCA_055_h01	1300	4.5	4.5	0.06	0.06	62.7	29.0	8.3	8.1	0.2
BCA_060_h01	1300	4.5	4.5	0.06	0.06	63.4	28.6	8.0	7.9	0.1
BCA_065_h01	1000	5.5	7.0	0.10	0.03	44.7	33.7	21.6	15.3	6.3
BCA_070_h01	850	2.5	4.5	0.10	0.02	68.9	21.5	9.6	9.1	0.5
BCA_075_h01	1000	3.5	3.5	0.04	0.03	74.3	17.8	7.9	7.6	0.3
BCA_080_h01	1200	4.0	4.0	0.05	0.04	52.3	29.3	18.4	14.3	4.1
BCA_085_h01	1200	4.0	4.0	0.05	0.04	65.4	26.9	7.7	7.2	0.5
BCA_090_h01	1350	6.0	7.0	0.06	0.21	65.9	23.3	10.9	10.4	0.5
BCA_095_h01	1250	6.0	7.5	0.08	0.17	43.1	34.6	22.3	15.6	6.7
BCA_100_h01	1000	5.5	7.0	0.08	0.06	58.7	31.1	10.2	9.6	0.6
BCA_105_h01	650	4.0	4.0	0.05	0.03	65.9	26.5	7.6	7.1	0.5
BCA_110_h01	375	5.0	5.0	0.05	< 0.01	52.2	29.3	18.4	14.3	4.1
BCA_115_h01	100	1.5	1.5	0.03	< 0.01	64.7	23.1	12.2	10.2	2.0
BCA_120_h01	80	1.0	1.0	0.01	< 0.01	84.2	13.0	2.8	2.5	0.3
BCP_010_h01	150	2.0	2.0	0.05	< 0.01	73.2	18.4	8.4	8.0	0.4
BCP_040_h01	50	< 0.5	< 0.5	< 0.01	< 0.01	95.2	3.7	1.1	1.0	0.1
BCP_050_h01	< 20	< 0.5	< 0.5	< 0.01	< 0.01	97.4	2.2	0.4	0.3	0.1
BCP_050_h02	< 20	< 0.5	< 0.5	< 0.01	< 0.01	97.4	2.3	0.4	0.3	0.1
BGR_180_h01	20	< 0.5	< 0.5	< 0.01	< 0.01	96.0	3.2	0.9	0.8	0.1
BGR_193_h01	30	< 0.5	< 0.5	< 0.01	< 0.01	96.1	3.1	0.8	0.7	0.1
BGR_203_h01	175	2.5	2.5	0.05	< 0.01	71.2	19.6	9.1	8.7	0.4
BGR_213_h01	475	7.5	7.5	0.11	< 0.01	68.7	21.6	9.7	9.2	0.5
BGR_218_h01	650	9.0	9.0	0.11	0.09	44.4	33.8	21.8	15.4	6.4
BGR_221_h01	175	2.5	2.5	0.06	0.02	51.2	29.8	19.0	14.7	4.3
BGR_225_h01	50	< 0.5	< 0.5	< 0.01	< 0.01	94.3	4.2	1.4	1.3	0.1
BGR_230_h01	20	< 0.5	< 0.5	< 0.01	< 0.01	96.6	2.7	0.6	0.5	0.1
BRE_016_h01	< 20	< 0.5	< 0.5	< 0.01	< 0.01	97.1	2.4	0.5	0.4	0.1
BRE_030_h01	90	1.0	1.0	< 0.01	< 0.01	87.2	10.7	2.1	1.8	0.3
BRE_055_h01	950	3.5	3.5	0.05	0.03	72.3	19.0	8.7	8.4	0.4

Table D.03 - Tahmoor South - Predictions for Houses

House Ref.	Predicted Total Subsidence (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature (1/km)	Predicted Total Sagging Curvature (1/km)	Predicted Probability of Nil or Category R0 Impact (%)	Predicted Probability of Category R1 or R2 Impact (%)	Predicted Probability of Category R3, R4 or R5 Impact (%)	Predicted Probability of Category R3 or R4 Impact (%)	Predicted Probability of Category R5 Impact (%)
BRE_057_h01	1050	4.0	4.0	0.05	0.03	66.2	26.3	7.5	7.0	0.5
BRE_059_h01	1200	4.5	4.5	0.05	0.04	52.6	29.2	18.2	14.2	4.0
BRE_061_h01	1300	4.5	4.5	0.06	0.11	44.6	33.7	21.7	15.3	6.3
BRE_063_h01	1300	5.5	7.0	0.06	0.21	42.3	35.1	22.6	15.7	6.8
BRE_065_h01	1350	6.5	8.0	0.06	0.21	42.3	35.1	22.6	15.7	6.8
BRE_067_h01	1150	6.5	8.0	0.11	0.04	54.1	33.6	12.3	11.5	0.8
BRE_070_h01	950	3.5	6.0	0.10	0.02	55.8	32.7	11.5	10.8	0.7
BRE_075_h01	900	2.5	4.5	0.09	0.02	69.0	21.4	9.6	9.1	0.5
BRE_075_h02	900	2.0	3.5	0.09	0.03	69.0	21.3	9.6	9.1	0.5
BRE_077_h01	1000	3.5	3.5	0.04	0.03	74.5	17.7	7.9	7.6	0.3
BRE_080_h01	1250	4.0	4.0	0.06	0.04	51.9	29.5	18.6	14.4	4.1
BRE_083_h01	1350	4.0	4.0	0.06	0.20	42.4	35.0	22.5	15.7	6.8
BRE_086_h01	1350	4.0	4.0	0.06	0.20	42.4	35.0	22.5	15.7	6.8
BRE_089_h01	1350	6.0	8.0	0.06	0.20	42.4	35.0	22.5	15.7	6.8
BRE_140_h01	950	3.0	3.0	0.07	0.03	49.6	30.7	19.7	15.0	4.7
BRE_143_h01	1200	3.5	3.5	0.05	0.04	71.1	19.7	9.2	8.7	0.4
BRE_148_h01	1250	3.5	3.5	0.06	0.05	63.8	28.2	7.9	7.7	0.2
BRE_154_h01	1300	7.0	8.0	0.06	0.22	42.2	35.2	22.6	15.7	6.9
BRE_165_h01	1250	7.0	8.0	0.08	0.19	66.4	22.9	10.6	10.1	0.5
BRE_167_h01	800	5.0	6.0	0.08	0.05	46.8	32.4	20.8	15.2	5.6
BRE_177_h01	400	5.5	5.5	0.07	< 0.01	69.3	20.9	9.8	9.3	0.5
BRE_187_h01	250	4.5	4.5	0.08	< 0.01	59.3	30.8	9.9	9.4	0.5
BRE_189_h01	125	2.0	2.0	0.04	< 0.01	73.7	18.1	8.2	7.8	0.3
BRE_191_h01	200	3.5	3.5	0.08	< 0.01	69.1	21.1	9.8	9.3	0.5
BRE_195_h01	80	0.5	0.5	< 0.01	< 0.01	87.2	10.7	2.1	1.8	0.3
BRE_195_h02	70	0.5	0.5	< 0.01	< 0.01	88.2	9.9	1.9	1.6	0.3
BRE_201_h01	40	0.5	0.5	< 0.01	< 0.01	92.3	6.7	1.0	0.8	0.2
BRE_515_h02	1300	6.0	8.0	0.09	0.17	47.5	36.3	16.2	14.9	1.2
BRE_644_h01	1100	4.5	4.5	0.05	0.04	54.4	28.3	17.3	13.6	3.8
BRE_665_h01	850	3.0	5.0	0.10	0.02	55.1	33.0	11.9	11.1	0.8
BWE_031_h01	< 20	< 0.5	< 0.5	< 0.01	< 0.01	94.8	4.8	0.4	0.3	0.1
BWE_041_h01	< 20	< 0.5	< 0.5	< 0.01	< 0.01	97.1	2.5	0.5	0.4	0.1
BWE_041_h02	< 20	< 0.5	< 0.5	< 0.01	< 0.01	95.5	4.2	0.3	0.2	0.1
BWE_051_h01	< 20	< 0.5	< 0.5	< 0.01	< 0.01	95.3	4.4	0.3	0.2	0.1
BYR_001_h01	850	4.0	5.5	0.09	0.02	69.0	21.3	9.7	9.2	0.5
BYR_005_h01	1100	3.0	3.0	0.06	0.08	59.4	30.8	9.8	9.3	0.5
BYR_015_h01	1100	8.5	8.5	0.06	0.23	43.7	37.1	19.2	17.2	2.0
BYR_025_h01	350	4.0	4.0	0.07	0.01	60.6	30.1	9.3	8.9	0.4
BYR_035_h01	450	5.5	5.5	0.09	0.02	69.0	21.3	9.7	9.2	0.5

Table D.03 - Tahmoor South - Predictions for Houses

House Ref.	Predicted Total Subsidence (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature (1/km)	Predicted Total Sagging Curvature (1/km)	Predicted Probability of Nil or Category R0 Impact (%)	Predicted Probability of Category R1 or R2 Impact (%)	Predicted Probability of Category R3, R4 or R5 Impact (%)	Predicted Probability of Category R3 or R4 Impact (%)	Predicted Probability of Category R5 Impact (%)
BYR_045_h01	150	1.0	1.0	< 0.01	< 0.01	91.7	6.0	2.3	2.2	0.1
BYR_045_h02	150	1.0	1.0	< 0.01	< 0.01	88.1	10.0	1.9	1.7	0.3
BYR_055_h01	100	< 0.5	< 0.5	< 0.01	< 0.01	90.4	7.5	2.1	1.9	0.2
BYR_065_h01	80	< 0.5	< 0.5	< 0.01	< 0.01	92.5	6.6	0.9	0.8	0.2
BYR_065_h02	60	< 0.5	< 0.5	< 0.01	< 0.01	93.1	6.1	0.8	0.6	0.2
BYR_075_h01	60	< 0.5	< 0.5	< 0.01	< 0.01	92.5	6.1	1.4	1.2	0.2
BYR_075_h02	50	< 0.5	< 0.5	< 0.01	< 0.01	95.7	3.4	1.0	0.9	0.1
BYR_084_h01	50	< 0.5	< 0.5	< 0.01	< 0.01	93.7	5.6	0.7	0.5	0.1
BYR_085_h01	40	< 0.5	< 0.5	< 0.01	< 0.01	93.8	5.5	0.6	0.5	0.1
BYR_085_h02	50	< 0.5	< 0.5	< 0.01	< 0.01	95.9	3.2	0.9	0.8	0.1
BYR_085_h03	40	< 0.5	< 0.5	< 0.01	< 0.01	96.1	3.1	0.8	0.7	0.1
BYR_095_h01	40	< 0.5	< 0.5	< 0.01	< 0.01	94.0	5.4	0.6	0.5	0.1
BYR_105_h01	30	< 0.5	< 0.5	< 0.01	< 0.01	96.4	2.9	0.7	0.6	0.1
BYR_115_h02	30	< 0.5	< 0.5	< 0.01	< 0.01	94.2	5.2	0.5	0.4	0.1
BYR_125_h01	60	< 0.5	< 0.5	< 0.01	< 0.01	95.4	3.5	1.0	0.9	0.1
BYR_135_h01	80	< 0.5	< 0.5	< 0.01	< 0.01	94.7	4.0	1.3	1.2	0.1
BYR_135_h02	80	< 0.5	< 0.5	< 0.01	< 0.01	94.6	4.1	1.3	1.2	0.1
BYR_145_h01	100	< 0.5	< 0.5	< 0.01	< 0.01	91.4	7.4	1.2	1.0	0.2
BYR_150_h01	1050	3.0	3.0	0.06	0.05	50.5	30.1	19.3	15.0	4.4
BYR_150_h02	1100	3.0	3.0	0.06	0.05	70.5	20.2	9.4	8.9	0.5
BYR_152_h01	1000	3.0	3.0	0.06	0.04	64.4	27.8	7.9	7.6	0.3
BYR_154_h01	900	3.0	3.0	0.05	0.04	66.2	26.3	7.5	7.0	0.5
BYR_156_h01	850	2.5	2.5	0.06	0.03	70.6	20.1	9.3	8.8	0.5
BYR_156_h02	850	3.0	3.0	0.04	0.04	73.4	18.3	8.3	7.9	0.3
BYR_158_h01	800	2.5	4.5	0.09	0.03	69.1	21.2	9.7	9.2	0.5
BYR_160_h01	1150	7.0	8.0	0.09	0.10	54.8	33.2	12.0	11.2	0.8
BYR_162_h01	1300	7.0	8.0	0.08	0.22	65.6	23.4	11.0	10.5	0.5
Maxima:	**1350**	**9.0**	**9.0**	**0.11**	**0.23**					

Table D.04 - Tahmoor South - Predictions for Rural Structures

Structure Ref.	Predicted Total Subsidence (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature (1/km)	Predicted Total Sagging Curvature (1/km)
BCA_001_r01	375	4.5	4.5	0.05	< 0.01
BCA_001_r02	800	5.5	5.5	0.02	0.06
BCA_001_r03	850	4.0	4.0	0.03	0.05
BCA_001_r04	950	4.5	4.5	0.04	0.06
BCA_001_r05	800	7.0	7.0	0.03	0.12
BCA_001_r07	475	5.5	5.5	0.04	0.03
BCA_001_r09	950	4.0	4.0	0.04	0.06
BCA_001_r10	950	4.0	4.0	0.04	0.06
BCA_010_r01	1000	7.0	7.5	0.09	0.05
BCA_010_r02	800	4.5	6.0	0.08	0.04
BCA_010_r03	850	5.0	7.0	0.08	0.03
BCA_010_r04	1000	6.5	8.0	0.09	0.04
BCA_010_r05	1050	7.0	8.0	0.09	0.06
BCA_010_r06	1050	7.0	8.0	0.09	0.04
BCA_010_r07	1000	7.0	8.0	0.09	0.04
BCA_010_r08	800	2.5	2.5	0.05	0.04
BCA_010_r09	800	5.0	6.5	0.08	0.04
BCA_015_r01	1150	7.0	8.0	0.09	0.12
BCA_015_r02	1200	7.0	8.0	0.09	0.12
BCA_015_r03	1050	7.0	8.0	0.09	0.04
BCA_020_r02	1150	4.0	4.0	0.04	0.05
BCA_020_r03	1150	4.0	4.0	0.05	0.05
BCA_020_r07	1100	3.5	3.5	0.04	0.05
BCA_020_r08	1150	3.5	3.5	0.05	0.05
BCA_020_r09	1200	3.5	3.5	0.05	0.05
BCA_020_r10	1200	3.5	3.5	0.05	0.05
BCA_020_r11	1200	4.0	4.0	0.05	0.06
BCA_020_r12	1250	4.0	4.0	0.05	0.06
BCA_020_r13	1250	4.0	4.0	0.05	0.08
BCA_020_r14	1250	3.5	3.5	0.05	0.10
BCA_020_r15	1250	3.5	3.5	0.05	0.14
BCA_020_r16	1250	3.5	3.5	0.05	0.17
BCA_020_r17	1250	3.0	3.0	0.05	0.20
BCA_020_r18	1300	3.0	3.0	0.05	0.21
BCA_025_r01	1100	3.5	3.5	0.05	0.04
BCA_025_r03	1150	3.5	3.5	0.05	0.04
BCA_025_r04	1200	3.5	3.5	0.05	0.05
BCA_025_r05	1250	3.5	3.5	0.06	0.05
BCA_025_r06	1200	3.5	3.5	0.06	0.05
BCA_025_r07	1250	3.5	3.5	0.06	0.05
BCA_025_r08	1250	3.5	3.5	0.06	0.05
BCA_025_r09	1150	3.5	3.5	0.05	0.04
BCA_030_r01	1000	3.0	3.0	0.04	0.03
BCA_030_r02	1200	3.5	3.5	0.06	0.04
BCA_030_r03	1050	3.5	3.5	0.05	0.04
BCA_030_r04	1100	3.5	3.5	0.05	0.04
BCA_035_r01	900	1.5	4.0	0.08	0.03
BCA_035_r02	1050	3.5	3.5	0.05	0.04
BCA_035_r03	1100	3.5	3.5	0.05	0.04
BCA_040_r02	1100	6.0	8.0	0.09	0.03
BCA_040_r03	1050	5.5	7.5	0.09	0.03
BCA_040_r04	1000	5.0	7.5	0.09	0.03
BCA_040_r05	1000	5.0	7.0	0.09	0.03
BCA_040_r06	950	4.0	6.0	0.09	0.02
BCA_045_r01	1350	5.0	6.0	0.06	0.21
BCA_045_r07	1300	6.5	8.0	0.07	0.18
BCA_045_r08	1350	6.0	6.5	0.06	0.21

Table D.04 - Tahmoor South - Predictions for Rural Structures

Structure Ref.	Predicted Total Subsidence (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature (1/km)	Predicted Total Sagging Curvature (1/km)
BCA_050_r01	1350	4.0	4.0	0.06	0.22
BCA_050_r03	1350	3.5	4.5	0.06	0.22
BCA_055_r01	1300	4.5	4.5	0.06	0.05
BCA_055_r07	1200	4.5	4.5	0.06	0.04
BCA_055_r08	1200	4.5	4.5	0.06	0.04
BCA_060_r01	1150	4.0	4.0	0.05	0.04
BCA_060_r02	1150	4.0	4.0	0.05	0.04
BCA_060_r03	1200	4.0	4.0	0.05	0.04
BCA_060_r04	1200	4.0	4.0	0.05	0.04
BCA_060_r05	1200	4.0	4.0	0.05	0.04
BCA_060_r06	1250	4.0	4.0	0.06	0.04
BCA_060_r07	1300	4.5	4.5	0.06	0.06
BCA_065_r01	950	5.0	7.0	0.10	0.02
BCA_065_r02	1000	5.5	7.5	0.10	0.03
BCA_065_r03	950	4.5	7.0	0.10	0.02
BCA_065_r04	950	5.0	7.0	0.10	0.03
BCA_065_r05	1200	6.5	8.0	0.10	0.11
BCA_065_r06	1250	6.5	8.0	0.10	0.12
BCA_070_r01	900	3.0	5.5	0.10	0.02
BCA_070_r02	850	3.0	5.0	0.10	0.02
BCA_075_r01	900	3.5	5.5	0.09	0.02
BCA_075_r02	850	2.5	4.5	0.09	0.02
BCA_075_r03	850	1.5	4.0	0.09	0.02
BCA_075_r04	1300	6.5	8.0	0.10	0.20
BCA_075_r05	1000	3.0	3.0	0.04	0.03
BCA_075_r06	850	2.0	4.5	0.10	0.02
BCA_080_r01	1150	4.0	4.0	0.05	0.04
BCA_080_r02	1050	3.5	3.5	0.04	0.04
BCA_080_r03	950	3.0	3.0	0.04	0.03
BCA_080_r06	900	2.5	3.0	0.08	0.03
BCA_080_r07	900	2.0	3.5	0.09	0.03
BCA_080_r08	1150	4.0	4.0	0.05	0.04
BCA_080_r09	950	3.0	3.0	0.04	0.03
BCA_085_r03	1200	4.0	4.0	0.05	0.05
BCA_085_r04	1050	4.0	4.0	0.04	0.04
BCA_085_r05	950	3.0	3.0	0.04	0.04
BCA_090_r07	1050	4.5	4.5	0.03	0.05
BCA_095_r01	1100	7.0	7.0	0.01	0.16
BCA_095_r02	1150	6.0	7.5	0.07	0.14
BCA_095_r03	1200	6.0	7.5	0.07	0.15
BCA_100_r01	800	5.5	6.0	0.07	0.05
BCA_100_r02	800	5.5	6.5	0.06	0.05
BCA_100_r03	750	5.5	6.0	0.06	0.05
BCA_100_r04	750	4.5	5.5	0.07	0.05
BCA_100_r05	750	4.5	5.5	0.07	0.05
BCA_105_r01	800	4.5	4.5	0.03	0.04
BCA_105_r02	475	4.0	4.0	0.04	0.02
BCA_105_r03	700	4.5	4.5	0.03	0.04
BCA_110_r01	375	5.0	5.0	0.05	< 0.01
BCA_110_r02	375	4.0	4.0	0.04	0.01
BCA_110_r04	350	4.0	4.0	0.04	< 0.01
BCA_110_r05	125	2.0	2.0	0.03	< 0.01
BCA_110_r07	800	5.0	5.0	0.03	0.04
BCA_110_r08	200	3.0	3.0	0.04	< 0.01
BCA_115_r01	60	0.5	0.5	0.01	< 0.01
BCA_115_r02	60	0.5	0.5	< 0.01	< 0.01
BCA_115_r03	90	1.0	1.0	0.02	< 0.01

Table D.04 - Tahmoor South - Predictions for Rural Structures

Structure Ref.	Predicted Total Subsidence (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature (1/km)	Predicted Total Sagging Curvature (1/km)
BCA_115_r04	80	1.0	1.0	0.02	< 0.01
BCA_115_r05	60	0.5	0.5	< 0.01	< 0.01
BCA_120_r01	90	1.0	1.0	0.02	< 0.01
BCA_120_r02	90	1.0	1.0	0.02	< 0.01
BCA_120_r03	90	1.0	1.0	0.02	< 0.01
BCA_120_r04	50	< 0.5	< 0.5	< 0.01	< 0.01
BCA_120_r05	80	1.0	1.0	0.01	< 0.01
BCA_120_r06	70	0.5	0.5	< 0.01	< 0.01
BCA_120_r07	50	< 0.5	< 0.5	< 0.01	< 0.01
BCP_010_r01	200	3.0	3.0	0.07	0.02
BCP_010_r02	150	2.0	2.0	0.04	< 0.01
BCP_040_r01	40	< 0.5	< 0.5	< 0.01	< 0.01
BCP_040_r02	50	< 0.5	< 0.5	< 0.01	< 0.01
BCP_040_r04	40	< 0.5	< 0.5	< 0.01	< 0.01
BCP_040_r05	40	< 0.5	< 0.5	< 0.01	< 0.01
BCP_040_r06	30	< 0.5	< 0.5	< 0.01	< 0.01
BCP_040_r07	50	< 0.5	< 0.5	< 0.01	< 0.01
BCP_050_r05	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BCP_050_r06	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BCP_050_r09	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BGR_180_r01	20	< 0.5	< 0.5	< 0.01	< 0.01
BGR_180_r02	20	< 0.5	< 0.5	< 0.01	< 0.01
BGR_180_r03	20	< 0.5	< 0.5	< 0.01	< 0.01
BGR_193_r01	30	< 0.5	< 0.5	< 0.01	< 0.01
BGR_193_r02	30	< 0.5	< 0.5	< 0.01	< 0.01
BGR_193_r03	30	< 0.5	< 0.5	< 0.01	< 0.01
BGR_193_r04	20	< 0.5	< 0.5	< 0.01	< 0.01
BGR_193_r05	20	< 0.5	< 0.5	< 0.01	< 0.01
BGR_193_r06	20	< 0.5	< 0.5	< 0.01	< 0.01
BGR_193_r07	20	< 0.5	< 0.5	< 0.01	< 0.01
BGR_193_r08	40	< 0.5	< 0.5	< 0.01	< 0.01
BGR_203_r01	200	3.0	3.0	0.07	< 0.01
BGR_203_r02	175	2.5	2.5	0.06	< 0.01
BGR_203_r03	125	1.5	1.5	0.03	< 0.01
BGR_203_r04	100	1.0	1.0	0.02	< 0.01
BGR_203_r05	90	1.0	1.0	0.01	< 0.01
BGR_203_r06	80	0.5	0.5	< 0.01	< 0.01
BGR_203_r09	150	2.0	2.0	0.04	< 0.01
BGR_213_r01	500	8.0	8.0	0.10	< 0.01
BGR_213_r02	475	7.5	7.5	0.10	< 0.01
BGR_213_r03	450	7.0	7.0	0.10	< 0.01
BGR_213_r04	375	6.5	6.5	0.10	< 0.01
BGR_213_r05	500	7.5	7.5	0.10	< 0.01
BGR_218_r01	450	7.5	7.5	0.11	0.06
BGR_218_r02	600	9.0	9.0	0.11	0.09
BGR_218_r03	450	7.5	7.5	0.11	0.05
BGR_218_r04	800	9.0	9.0	0.08	0.13
BGR_221_r01	300	5.5	5.5	0.10	0.03
BGR_221_r02	175	2.5	2.5	0.06	0.01
BGR_221_r03	100	1.5	1.5	0.02	< 0.01
BGR_221_r04	175	3.0	3.0	0.06	0.02
BGR_221_r05	175	2.5	2.5	0.06	0.02
BGR_221_r06	300	5.5	5.5	0.10	0.02
BGR_221_r07	300	5.5	5.5	0.10	0.02
BGR_225_r01	60	0.5	0.5	< 0.01	< 0.01
BGR_225_r02	50	< 0.5	< 0.5	< 0.01	< 0.01
BGR_225_r03	50	< 0.5	< 0.5	< 0.01	< 0.01

Table D.04 - Tahmoor South - Predictions for Rural Structures

Structure Ref.	Predicted Total Subsidence (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature (1/km)	Predicted Total Sagging Curvature (1/km)
BGR_225_r04	40	< 0.5	< 0.5	< 0.01	< 0.01
BGR_225_r05	40	< 0.5	< 0.5	< 0.01	< 0.01
BGR_225_r06	40	< 0.5	< 0.5	< 0.01	< 0.01
BGR_225_r07	40	< 0.5	< 0.5	< 0.01	< 0.01
BGR_225_r08	30	< 0.5	< 0.5	< 0.01	< 0.01
BGR_225_r09	40	< 0.5	< 0.5	< 0.01	< 0.01
BGR_225_r10	40	< 0.5	< 0.5	< 0.01	< 0.01
BGR_225_r11	50	< 0.5	< 0.5	< 0.01	< 0.01
BGR_225_r12	40	< 0.5	< 0.5	< 0.01	< 0.01
BGR_225_r13	40	< 0.5	< 0.5	< 0.01	< 0.01
BGR_225_r14	40	< 0.5	< 0.5	< 0.01	< 0.01
BGR_225_r15	40	< 0.5	< 0.5	< 0.01	< 0.01
BGR_225_r16	30	< 0.5	< 0.5	< 0.01	< 0.01
BGR_225_r17	30	< 0.5	< 0.5	< 0.01	< 0.01
BGR_230_r01	30	< 0.5	< 0.5	< 0.01	< 0.01
BRE_016_r02	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BRE_016_r03	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BRE_016_r04	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BRE_016_r05	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BRE_016_r06	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BRE_030_r30	80	1.0	1.0	< 0.01	< 0.01
BRE_030_r31	90	1.0	1.0	< 0.01	< 0.01
BRE_055_r01	900	3.0	3.0	0.05	0.03
BRE_057_r01	950	3.5	3.5	0.05	0.03
BRE_057_r02	900	3.0	3.0	0.05	0.03
BRE_057_r03	950	3.5	3.5	0.05	0.03
BRE_057_r04	950	3.5	3.5	0.05	0.03
BRE_057_r06	1000	4.0	4.0	0.05	0.03
BRE_057_r07	1000	4.0	4.0	0.05	0.03
BRE_057_r08	1200	4.5	4.5	0.05	0.04
BRE_059_r01	1300	4.5	4.5	0.06	0.09
BRE_059_r02	1300	4.5	4.5	0.06	0.10
BRE_059_r03	1300	4.5	4.5	0.06	0.10
BRE_061_r02	1300	4.5	4.5	0.06	0.08
BRE_061_r03	1300	4.5	4.5	0.06	0.12
BRE_061_r04	1300	4.0	4.0	0.06	0.21
BRE_061_r05	1200	4.5	4.5	0.05	0.04
BRE_063_r01	1300	6.5	8.0	0.06	0.21
BRE_063_r02	1300	4.0	5.5	0.06	0.21
BRE_063_r03	1300	4.5	6.0	0.06	0.21
BRE_063_r04	1300	5.0	6.5	0.06	0.21
BRE_065_r01	1350	6.5	8.0	0.06	0.21
BRE_065_r02	1250	6.5	8.0	0.10	0.13
BRE_065_r03	1350	6.5	8.0	0.06	0.21
BRE_065_r04	1300	6.5	8.0	0.07	0.19
BRE_070_r01	950	4.0	6.5	0.10	0.02
BRE_070_r02	900	3.5	5.5	0.10	0.02
BRE_070_r03	900	2.0	3.5	0.09	0.03
BRE_070_r04	900	2.0	3.5	0.10	0.03
BRE_070_r05	850	1.5	4.0	0.10	0.02
BRE_070_r06	900	1.5	3.5	0.09	0.03
BRE_070_r07	850	2.0	4.0	0.10	0.02
BRE_070_r08	950	3.5	6.0	0.10	0.02
BRE_070_r09	900	3.5	6.0	0.10	0.02
BRE_070_r10	900	3.5	6.0	0.10	0.02
BRE_075_r01	1000	3.0	3.0	0.04	0.03
BRE_075_r02	900	2.0	3.5	0.09	0.03

Table D.04 - Tahmoor South - Predictions for Rural Structures

Structure Ref.	Predicted Total Subsidence (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature (1/km)	Predicted Total Sagging Curvature (1/km)
BRE_075_r03	900	2.5	2.5	0.07	0.03
BRE_075_r04	900	2.0	3.5	0.09	0.03
BRE_077_r02	1050	3.5	3.5	0.04	0.03
BRE_077_r05	1050	4.0	4.0	0.04	0.04
BRE_077_r06	1000	3.0	3.0	0.04	0.03
BRE_080_r01	1300	4.0	4.0	0.06	0.09
BRE_080_r02	1150	4.0	4.0	0.05	0.04
BRE_080_r03	1300	4.0	4.0	0.06	0.05
BRE_080_r04	1150	4.0	4.0	0.05	0.04
BRE_080_r05	1200	4.0	4.0	0.05	0.04
BRE_080_r06	1350	4.0	4.0	0.06	0.10
BRE_080_r07	1200	4.0	4.0	0.05	0.04
BRE_080_r08	1200	4.0	4.0	0.05	0.04
BRE_080_r09	1200	4.0	4.0	0.05	0.04
BRE_083_r01	1350	4.5	5.5	0.06	0.21
BRE_083_r02	1350	5.0	6.0	0.06	0.21
BRE_083_r03	1350	6.0	7.0	0.06	0.21
BRE_083_r04	1350	4.0	4.0	0.06	0.21
BRE_086_r01	1350	6.5	8.0	0.06	0.21
BRE_086_r02	1350	6.5	8.0	0.06	0.21
BRE_089_r01	1350	6.0	8.0	0.06	0.20
BRE_089_r02	1300	6.0	8.0	0.06	0.19
BRE_089_r03	1250	6.5	8.0	0.08	0.14
BRE_089_r04	1300	6.5	8.0	0.08	0.16
BRE_090_r01	1200	3.5	3.5	0.05	0.04
BRE_140_r01	950	2.5	2.5	0.05	0.03
BRE_140_r02	1000	3.0	3.0	0.04	0.03
BRE_143_r01	1200	3.5	3.5	0.06	0.04
BRE_143_r02	1250	3.5	3.5	0.06	0.05
BRE_143_r03	1250	3.5	3.5	0.06	0.04
BRE_148_r01	1250	3.5	3.5	0.06	0.05
BRE_148_r02	1250	3.5	3.5	0.06	0.08
BRE_148_r03	1300	3.0	3.0	0.06	0.21
BRE_148_r04	1250	3.5	3.5	0.06	0.06
BRE_154_r01	1300	7.0	8.0	0.07	0.22
BRE_154_r02	1250	7.0	8.0	0.08	0.20
BRE_154_r03	1300	7.0	8.0	0.08	0.22
BRE_154_r04	1200	7.0	8.0	0.08	0.15
BRE_154_r05	1100	7.0	8.0	0.09	0.05
BRE_154_r06	1100	7.0	8.0	0.09	0.04
BRE_154_r07	1100	7.0	8.0	0.09	0.06
BRE_167_r01	850	5.0	6.5	0.09	0.05
BRE_167_r02	800	3.5	5.0	0.09	0.04
BRE_167_r03	750	3.0	4.5	0.08	0.04
BRE_167_r04	750	2.5	4.0	0.08	0.04
BRE_167_r05	750	3.0	3.0	0.05	0.05
BRE_167_r06	750	2.0	3.5	0.07	0.04
BRE_167_r07	700	2.5	3.0	0.07	0.04
BRE_167_r08	750	3.0	4.0	0.08	0.05
BRE_167_r09	700	3.0	3.5	0.07	0.05
BRE_167_r10	750	3.5	4.5	0.08	0.05
BRE_167_r12	700	3.0	3.0	0.06	0.05
BRE_167_r13	700	3.0	3.0	0.06	0.05
BRE_167_r14	700	3.0	3.0	0.06	0.05
BRE_167_r15	750	4.5	4.5	0.05	0.06
BRE_167_r16	750	3.5	3.5	0.05	0.05
BRE_167_r17	850	3.5	3.5	0.04	0.05

Table D.04 - Tahmoor South - Predictions for Rural Structures

Structure Ref.	Predicted Total Subsidence (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature (1/km)	Predicted Total Sagging Curvature (1/km)
BRE_167_r18	750	3.0	4.0	0.08	0.04
BRE_177_r01	400	5.5	5.5	0.07	0.01
BRE_187_r01	300	5.5	5.5	0.08	< 0.01
BRE_187_r02	200	3.5	3.5	0.07	< 0.01
BRE_187_r03	225	4.0	4.0	0.08	< 0.01
BRE_189_r01	200	3.0	3.0	0.07	< 0.01
BRE_189_r02	125	2.0	2.0	0.04	< 0.01
BRE_189_r03	175	3.0	3.0	0.06	< 0.01
BRE_191_r01	200	3.5	3.5	0.08	0.01
BRE_191_r02	250	4.5	4.5	0.09	0.02
BRE_191_r03	400	7.0	7.0	0.09	0.07
BRE_195_r01	100	1.0	1.0	0.02	0.01
BRE_195_r02	100	1.0	1.0	0.02	0.01
BRE_195_r03	125	1.5	1.5	0.03	0.02
BRE_195_r04	60	0.5	0.5	< 0.01	< 0.01
BRE_195_r05	100	1.0	1.0	0.02	0.01
BRE_195_r06	125	1.5	1.5	0.03	0.02
BRE_195_r07	60	0.5	0.5	< 0.01	< 0.01
BRE_195_r08	60	0.5	0.5	< 0.01	< 0.01
BRE_195_r09	90	1.0	1.0	0.01	< 0.01
BRE_195_r10	80	0.5	0.5	< 0.01	< 0.01
BRE_195_r11	125	2.5	2.5	0.05	< 0.01
BRE_195_r12	100	1.5	1.5	0.03	0.01
BRE_195_r13	80	1.0	1.0	0.01	0.01
BRE_201_r01	30	< 0.5	< 0.5	< 0.01	< 0.01
BRE_201_r02	30	< 0.5	< 0.5	< 0.01	< 0.01
BRE_201_r03	40	0.5	0.5	< 0.01	< 0.01
BRE_201_r04	40	0.5	0.5	< 0.01	< 0.01
BRE_515_r01	1300	4.0	5.0	0.06	0.20
BRE_515_r02	1300	4.0	5.0	0.06	0.20
BRE_644_r03	900	3.5	3.5	0.05	0.03
BRE_644_r04	1000	4.0	4.0	0.05	0.03
BRE_665_r01	850	2.5	5.0	0.10	0.02
BRE_665_r02	800	1.5	4.0	0.09	0.02
BWE_031_r01	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_031_r02	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_031_r03	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_031_r04	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_031_r05	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_041_r01	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_041_r02	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_041_r03	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_041_r04	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_051_r01	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_051_r02	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_051_r03	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_051_r04	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_051_r05	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_051_r07	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BYR_001_r02	850	4.0	6.0	0.09	0.03
BYR_001_r03	900	5.0	7.0	0.09	0.02
BYR_001_r05	950	5.5	7.5	0.09	0.03
BYR_005_r01	1100	3.0	3.0	0.06	0.09
BYR_005_r02	1100	3.0	3.0	0.06	0.07
BYR_005_r03	1050	3.0	3.0	0.06	0.06
BYR_005_r04	1100	3.0	3.0	0.06	0.10
BYR_005_r05	1000	3.0	3.0	0.06	0.04

Table D.04 - Tahmoor South - Predictions for Rural Structures

Structure Ref.	Predicted Total Subsidence (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature (1/km)	Predicted Total Sagging Curvature (1/km)
BYR_015_r01	1100	6.5	6.5	0.06	0.23
BYR_015_r02	1100	8.5	8.5	0.06	0.23
BYR_015_r06	1100	3.0	3.0	0.06	0.15
BYR_015_r07	1050	8.5	8.5	0.07	0.23
BYR_025_r05	325	3.5	3.5	0.07	0.01
BYR_025_r08	275	2.5	2.5	0.04	0.01
BYR_035_r02	400	5.0	5.0	0.08	0.02
BYR_035_r03	425	5.0	5.0	0.09	0.02
BYR_035_r04	450	6.0	6.0	0.09	0.02
BYR_035_r05	550	7.0	7.0	0.09	0.02
BYR_035_r06	600	7.5	7.5	0.09	0.03
BYR_035_r07	750	8.5	8.5	0.09	0.03
BYR_035_r08	550	7.0	7.0	0.09	0.02
BYR_035_r09	550	7.0	7.0	0.09	0.02
BYR_035_r10	550	7.0	7.0	0.09	0.02
BYR_035_r12	450	5.5	5.5	0.09	0.02
BYR_045_r10	125	0.5	0.5	< 0.01	< 0.01
BYR_045_r11	125	0.5	0.5	< 0.01	< 0.01
BYR_065_r01	70	< 0.5	< 0.5	< 0.01	< 0.01
BYR_065_r02	80	< 0.5	< 0.5	< 0.01	< 0.01
BYR_065_r03	60	< 0.5	< 0.5	< 0.01	< 0.01
BYR_065_r04	60	< 0.5	< 0.5	< 0.01	< 0.01
BYR_065_r05	80	< 0.5	< 0.5	< 0.01	< 0.01
BYR_065_r06	80	< 0.5	< 0.5	< 0.01	< 0.01
BYR_065_r07	70	< 0.5	< 0.5	< 0.01	< 0.01
BYR_065_r08	60	< 0.5	< 0.5	< 0.01	< 0.01
BYR_065_r09	60	< 0.5	< 0.5	< 0.01	< 0.01
BYR_065_r10	70	< 0.5	< 0.5	< 0.01	< 0.01
BYR_065_r11	70	< 0.5	< 0.5	< 0.01	< 0.01
BYR_075_r01	60	< 0.5	< 0.5	< 0.01	< 0.01
BYR_075_r02	60	< 0.5	< 0.5	< 0.01	< 0.01
BYR_075_r03	60	< 0.5	< 0.5	< 0.01	< 0.01
BYR_075_r04	70	< 0.5	< 0.5	< 0.01	< 0.01
BYR_075_r05	50	< 0.5	< 0.5	< 0.01	< 0.01
BYR_075_r06	50	< 0.5	< 0.5	< 0.01	< 0.01
BYR_075_r07	60	< 0.5	< 0.5	< 0.01	< 0.01
BYR_075_r08	50	< 0.5	< 0.5	< 0.01	< 0.01
BYR_075_r09	50	< 0.5	< 0.5	< 0.01	< 0.01
BYR_075_r10	50	< 0.5	< 0.5	< 0.01	< 0.01
BYR_075_r11	50	< 0.5	< 0.5	< 0.01	< 0.01
BYR_084_r01	50	< 0.5	< 0.5	< 0.01	< 0.01
BYR_084_r02	50	< 0.5	< 0.5	< 0.01	< 0.01
BYR_084_r03	50	< 0.5	< 0.5	< 0.01	< 0.01
BYR_085_r01	40	< 0.5	< 0.5	< 0.01	< 0.01
BYR_085_r03	40	< 0.5	< 0.5	< 0.01	< 0.01
BYR_085_r04	50	< 0.5	< 0.5	< 0.01	< 0.01
BYR_085_r05	50	< 0.5	< 0.5	< 0.01	< 0.01
BYR_085_r06	60	< 0.5	< 0.5	< 0.01	< 0.01
BYR_085_r08	50	< 0.5	< 0.5	< 0.01	< 0.01
BYR_085_r09	40	< 0.5	< 0.5	< 0.01	< 0.01
BYR_085_r10	40	< 0.5	< 0.5	< 0.01	< 0.01
BYR_085_r11	50	< 0.5	< 0.5	< 0.01	< 0.01
BYR_085_r12	60	< 0.5	< 0.5	< 0.01	< 0.01
BYR_085_r13	60	< 0.5	< 0.5	< 0.01	< 0.01
BYR_085_r14	70	< 0.5	< 0.5	< 0.01	< 0.01
BYR_085_r15	50	< 0.5	< 0.5	< 0.01	< 0.01
BYR_095_r02	50	< 0.5	< 0.5	< 0.01	< 0.01

Table D.04 - Tahmoor South - Predictions for Rural Structures

Structure Ref.	Predicted Total Subsidence (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature (1/km)	Predicted Total Sagging Curvature (1/km)
BYR_095_r03	50	< 0.5	< 0.5	< 0.01	< 0.01
BYR_095_r04	50	< 0.5	< 0.5	< 0.01	< 0.01
BYR_095_r05	50	< 0.5	< 0.5	< 0.01	< 0.01
BYR_095_r06	30	< 0.5	< 0.5	< 0.01	< 0.01
BYR_105_r01	30	< 0.5	< 0.5	< 0.01	< 0.01
BYR_105_r02	30	< 0.5	< 0.5	< 0.01	< 0.01
BYR_105_r03	20	< 0.5	< 0.5	< 0.01	< 0.01
BYR_105_r07	30	< 0.5	< 0.5	< 0.01	< 0.01
BYR_105_r08	30	< 0.5	< 0.5	< 0.01	< 0.01
BYR_105_r09	30	< 0.5	< 0.5	< 0.01	< 0.01
BYR_105_r10	30	< 0.5	< 0.5	< 0.01	< 0.01
BYR_115_r01	40	< 0.5	< 0.5	< 0.01	< 0.01
BYR_115_r02	40	< 0.5	< 0.5	< 0.01	< 0.01
BYR_115_r04	30	< 0.5	< 0.5	< 0.01	< 0.01
BYR_115_r08	30	< 0.5	< 0.5	< 0.01	< 0.01
BYR_125_r04	50	< 0.5	< 0.5	< 0.01	< 0.01
BYR_135_r01	70	< 0.5	< 0.5	< 0.01	< 0.01
BYR_135_r02	80	< 0.5	< 0.5	< 0.01	< 0.01
BYR_135_r03	70	< 0.5	< 0.5	< 0.01	< 0.01
BYR_135_r04	60	< 0.5	< 0.5	< 0.01	< 0.01
BYR_145_r01	100	0.5	0.5	< 0.01	< 0.01
BYR_145_r02	100	< 0.5	< 0.5	< 0.01	< 0.01
BYR_145_r03	125	0.5	0.5	< 0.01	< 0.01
BYR_145_r04	90	< 0.5	< 0.5	< 0.01	< 0.01
BYR_145_r05	100	< 0.5	< 0.5	< 0.01	< 0.01
BYR_145_r06	90	< 0.5	< 0.5	< 0.01	< 0.01
BYR_150_r01	1100	3.0	3.0	0.06	0.05
BYR_150_r02	1100	3.0	3.0	0.06	0.05
BYR_150_r03	1100	3.0	3.0	0.06	0.05
BYR_150_r04	1100	3.0	3.0	0.06	0.09
BYR_152_r01	950	3.0	3.0	0.05	0.04
BYR_152_r02	950	3.0	3.0	0.05	0.04
BYR_152_r03	1000	3.0	3.0	0.06	0.04
BYR_152_r04	1050	3.0	3.0	0.06	0.05
BYR_152_r05	1050	3.0	3.0	0.06	0.05
BYR_152_r06	1100	3.0	3.0	0.06	0.05
BYR_152_r07	1050	3.0	3.0	0.06	0.04
BYR_154_r01	950	3.0	3.0	0.05	0.04
BYR_156_r01	850	2.5	2.5	0.05	0.03
BYR_158_r01	750	1.5	3.5	0.08	0.03
BYR_160_r01	1150	7.0	8.0	0.09	0.07
BYR_160_r02	1100	7.0	8.0	0.09	0.04
Maxima:	**1350**	**9.0**	**9.0**	**0.11**	**0.23**

Table D.05 - Tahmoor South - Predictions for Tanks

Structure Ref.	Maximum Plan Dimension (m)	Predicted Total Subsidence (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature (1/km)	Predicted Total Sagging Curvature (1/km)
BCA_001_t01	7	200	3.5	3.5	0.06	< 0.01
BCA_001_t02	2	450	4.5	4.5	0.03	0.02
BCA_015_t01	4	1250	7.0	7.5	0.05	0.22
BCA_015_t02	3	1050	7.0	8.0	0.09	0.04
BCA_015_t03	3	1050	7.0	8.0	0.09	0.05
BCA_025_t01	1	1000	3.5	3.5	0.04	0.04
BCA_045_t01	3	1350	3.5	3.5	0.06	0.21
BCA_060_t01	2	1100	4.0	4.0	0.05	0.04
BCA_075_t01	4	900	3.0	5.5	0.09	0.02
BCA_080_t01	4	950	3.0	3.0	0.04	0.03
BCA_080_t02	3	950	3.0	3.0	0.04	0.03
BCA_085_t01	3	1100	4.0	4.0	0.04	0.04
BCA_115_t01	2	60	0.5	0.5	< 0.01	< 0.01
BCA_120_t01	3	950	3.0	3.0	0.04	0.03
BCP_040_t01	2	40	< 0.5	< 0.5	< 0.01	< 0.01
BCP_050_t01	3	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BGR_180_t01	2	20	< 0.5	< 0.5	< 0.01	< 0.01
BGR_180_t02	2	20	< 0.5	< 0.5	< 0.01	< 0.01
BGR_213_t01	1	350	6.0	6.0	0.10	< 0.01
BGR_218_t01	2	450	8.0	8.0	0.11	0.04
BGR_218_t02	2	650	9.0	9.0	0.11	0.09
BGR_225_t01	2	40	< 0.5	< 0.5	< 0.01	< 0.01
BGR_225_t02	2	40	< 0.5	< 0.5	< 0.01	< 0.01
BGR_225_t03	3	40	< 0.5	< 0.5	< 0.01	< 0.01
BGR_225_t04	2	40	< 0.5	< 0.5	< 0.01	< 0.01
BRE_057_t01	2	1050	4.0	4.0	0.04	0.04
BRE_083_t02	2	1350	6.5	7.5	0.06	0.21
BRE_086_t01	2	1350	6.5	8.0	0.06	0.20
BRE_089_t01	2	1300	6.0	8.0	0.06	0.17
BRE_148_t01	2	1300	2.5	2.5	0.06	0.21
BRE_154_t01	4	1300	6.5	7.5	0.06	0.22
BRE_195_t01	4	60	< 0.5	< 0.5	< 0.01	< 0.01
BRE_515_t01	8	1300	6.0	7.5	0.06	0.20
BRE_515_t02	6	1350	6.0	7.0	0.06	0.20
BRE_644_t01	3	900	3.0	3.0	0.05	0.03
BRE_644_t02	3	900	3.0	3.0	0.05	0.03
BRE_644_t03	3	900	3.0	3.0	0.05	0.03
BRE_665_t01	2	900	4.5	6.5	0.10	0.02
BRE_665_t02	2	900	4.0	6.0	0.10	0.02
BWE_031_t01	2	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_031_t02	3	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_041_t01	3	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BYR_001_t01	1	850	3.5	5.0	0.09	0.02
BYR_001_t02	3	850	3.5	5.5	0.09	0.02
BYR_005_t01	3	1100	3.0	3.0	0.06	0.08
BYR_015_t02	3	1100	3.0	3.0	0.06	0.17
BYR_065_t01	9	70	< 0.5	< 0.5	< 0.01	< 0.01
BYR_065_t02	3	70	< 0.5	< 0.5	< 0.01	< 0.01
BYR_075_t01	3	50	< 0.5	< 0.5	< 0.01	< 0.01
BYR_075_t02	2	50	< 0.5	< 0.5	< 0.01	< 0.01
BYR_075_t03	2	70	< 0.5	< 0.5	< 0.01	< 0.01
BYR_075_t04	2	70	< 0.5	< 0.5	< 0.01	< 0.01
BYR_085_t01	3	70	< 0.5	< 0.5	< 0.01	< 0.01
BYR_085_t02	3	70	< 0.5	< 0.5	< 0.01	< 0.01
BYR_085_t03	3	40	< 0.5	< 0.5	< 0.01	< 0.01
BYR_085_t04	3	40	< 0.5	< 0.5	< 0.01	< 0.01
BYR_095_t01	3	50	< 0.5	< 0.5	< 0.01	< 0.01
BYR_095_t02	3	50	< 0.5	< 0.5	< 0.01	< 0.01

Table D.05 - Tahmoor South - Predictions for Tanks

Structure Ref.	Maximum Plan Dimension (m)	Predicted Total Subsidence (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature (1/km)	Predicted Total Sagging Curvature (1/km)
BYR_105_t01	2	30	< 0.5	< 0.5	< 0.01	< 0.01
BYR_115_t01	4	40	< 0.5	< 0.5	< 0.01	< 0.01
BYR_115_t02	4	40	< 0.5	< 0.5	< 0.01	< 0.01
BYR_115_t03	2	30	< 0.5	< 0.5	< 0.01	< 0.01
BYR_115_t04	2	30	< 0.5	< 0.5	< 0.01	< 0.01
BYR_115_t05	2	30	< 0.5	< 0.5	< 0.01	< 0.01
BYR_145_t01	2	90	< 0.5	< 0.5	< 0.01	< 0.01
BYR_145_t02	2	100	< 0.5	< 0.5	< 0.01	< 0.01
BYR_145_t03	2	100	0.5	0.5	< 0.01	< 0.01
BYR_150_t01	2	1100	3.0	3.0	0.06	0.09
BYR_152_t01	2	1100	3.0	3.0	0.06	0.05
BYR_152_t02	2	1100	3.0	3.0	0.06	0.05
BYR_154_t01	2	950	3.0	3.0	0.05	0.04
BYR_156_t01	2	850	2.5	2.5	0.04	0.03
BYR_156_t02	2	850	2.5	2.5	0.04	0.03
BYR_156_t03	2	850	2.5	2.5	0.04	0.03
	Maxima:	**1350**	**9.0**	**9.0**	**0.11**	**0.22**

Table D.06 - Tahmoor South - Predictions for Pools

Structure Ref.	Maximum Plan Dimension (m)	Predicted Total Subsidence (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature (1/km)	Predicted Total Sagging Curvature (1/km)
BCA_035_p01	7	900	2.0	3.0	0.07	0.03
BCA_095_p01	10	1250	6.0	7.5	0.07	0.18
BCA_100_p01	10	950	5.5	7.0	0.07	0.06
BCA_105_p01	9	650	4.0	4.0	0.05	0.03
BCA_115_p01	7	80	1.0	1.0	0.02	< 0.01
BCA_120_p01	9	80	1.0	1.0	0.01	< 0.01
BGR_218_p01	3	650	9.0	9.0	0.11	0.10
BRE_063_p01	7	1300	5.5	7.0	0.06	0.21
BRE_075_p01	9	900	2.0	3.5	0.09	0.03
BRE_080_p01	10	1300	4.0	4.0	0.06	0.07
BRE_089_p01	8	1350	6.0	8.0	0.06	0.20
BRE_148_p01	9	1250	3.5	3.5	0.06	0.05
BRE_167_p01	8	800	4.0	5.5	0.09	0.04
BRE_515_p01	10	1350	6.0	7.5	0.06	0.20
BYR_005_p01	10	1050	3.0	3.0	0.06	0.05
BYR_015_p01	9	1050	8.5	8.5	0.06	0.23
BYR_045_p01	11	125	0.5	0.5	< 0.01	< 0.01
BYR_055_p01	8	90	< 0.5	< 0.5	< 0.01	< 0.01
BYR_065_p01	6	80	< 0.5	< 0.5	< 0.01	< 0.01
BYR_095_p01	9	40	< 0.5	< 0.5	< 0.01	< 0.01
BYR_135_p01	10	70	< 0.5	< 0.5	< 0.01	< 0.01
BYR_152_p01	12	1050	3.0	3.0	0.06	0.05
	Maxima:	**1350**	**9.0**	**9.0**	**0.11**	**0.23**

Table D.07 - Tahmoor South - Predictions for Farm Dams

Dam Ref.	Maximum Length (m)	Plan Area (m2)	Predicted Total Subsidence (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature (1/km)	Predicted Total Sagging Curvature (1/km)	Predicted Change in Freeboard (mm)
BCA_001_d01	25	345	950	5.0	5.0	0.03	0.06	250
BCA_010_d01	21	251	775	4.0	5.5	0.08	0.04	100
BCA_015_d01	26	342	1200	5.0	5.0	0.04	0.07	250
BCA_055_d01	15	135	1250	4.5	4.5	0.06	0.05	250
BCA_060_d01	46	703	1350	6.5	8.0	0.08	0.22	400
BCA_065_d01	55	1424	1200	4.5	4.5	0.05	0.04	350
BCA_070_d01	20	231	1250	4.5	4.5	0.06	0.06	250
BCA_075_d01	14	124	1300	4.0	4.5	0.06	0.20	100
BCA_080_d01	32	627	1100	6.5	8.0	0.12	0.04	250
BCA_085_d01	13	96	850	3.0	5.5	0.08	0.04	100
BCA_105_d01	12	86	525	5.5	5.5	0.08	0.05	250
BCA_105_d02	30	392	325	4.0	4.0	0.04	0.03	200
BCA_110_d01	24	414	575	6.5	6.5	0.06	0.05	300
BCP_010_d01	37	866	125	1.0	1.0	0.02	0.01	50
BCP_020_d01	31	460	90	1.0	1.0	0.01	< 0.01	< 50
BCP_040_d01	35	628	90	1.0	1.0	0.01	< 0.01	< 50
BGR_193_d01	53	1738	30	< 0.5	< 0.5	< 0.01	< 0.01	< 50
BGR_203_d01	95	5047	50	< 0.5	< 0.5	< 0.01	< 0.01	< 50
BGR_203_d02	35	363	70	0.5	0.5	< 0.01	< 0.01	< 50
BGR_230_d01	27	369	20	< 0.5	< 0.5	< 0.01	< 0.01	< 50
BGR_230_d02	16	127	20	< 0.5	< 0.5	< 0.01	< 0.01	< 50
BGR_230_d03	8	26	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 50
BRE_016_d01	33	601	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 50
BRE_020_d01	43	1115	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 50
BRE_040_d01	50	369	225	3.5	3.5	0.06	0.01	150
BRE_045_d01	61	1253	50	< 0.5	< 0.5	< 0.01	< 0.01	< 50
BRE_061_d01	9	55	1150	4.5	4.5	0.05	0.04	200
BRE_090_d01	52	1889	875	4.5	6.5	0.09	0.03	150
BRE_090_d02	24	310	925	2.5	3.0	0.07	0.03	100
BRE_090_d03	69	1849	975	3.0	3.0	0.05	0.04	250
BRE_090_d04	36	508	1000	7.5	7.5	0.04	0.21	250
BRE_143_d01	29	534	825	3.5	5.5	0.09	0.03	100
BRE_148_d01	35	693	1000	3.0	3.0	0.05	0.04	200
BRE_148_d02	22	170	1000	3.0	3.0	0.06	0.04	150
BRE_154_d01	76	2658	1300	6.5	7.0	0.06	0.22	200
BRE_154_d02	64	1554	1250	7.5	8.0	0.09	0.20	500
BRE_167_d01	99	2924	925	3.0	5.0	0.09	0.05	200
BRE_167_d02	16	180	1100	3.0	3.0	0.06	0.08	150
BRE_600_d01	18	205	1200	6.5	8.0	0.14	0.09	300
BWE_031_d01	39	955	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 50
BYR_005_d01	28	404	1050	3.0	3.0	0.06	0.05	200
BYR_005_d02	73	1662	875	3.0	3.5	0.07	0.04	150
BYR_015_d01	50	1415	1100	3.0	3.0	0.06	0.16	200
BYR_065_d01	44	790	325	3.5	3.5	0.07	0.01	150
BYR_095_d01	43	1003	100	< 0.5	< 0.5	< 0.01	< 0.01	< 50
		Maxima:	**1350**	**7.5**	**8.0**	**0.14**	**0.22**	**500**

Table D.08 - Tahmoor South - Predictions for Public Amenities

Structure Ref.	Maximum Plan Dimension (m)	Description	Structure Type	Predicted Total Subsidence (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature (1/km)	Predicted Total Sagging Curvature (1/km)
BRE_020_pa01	43	Wollondilly Anglican College - Clifford Warne Auditorium	Building	300	4.0	4.0	0.05	0.02
BRE_020_pa02	24	Wollondilly Anglican College - White Cottage	Building	100	1.5	1.5	0.02	< 0.01
BRE_020_pa03	19	Wollondilly Anglican College - Canteen	Building	90	1.0	1.0	0.01	< 0.01
BRE_020_pa04	29	Wollondilly Anglican College - Sturt Cottage	Building	100	1.0	1.0	0.02	< 0.01
BRE_020_pa05	41	Wollondilly Anglican College - Bradfield Cottage	Building	100	1.0	1.0	0.02	< 0.01
BRE_020_pa06	32	Wollondilly Anglican College - Melba Cottage	Building	80	0.5	0.5	0.01	< 0.01
BRE_020_pa07	59	Wollondilly Anglican College - Rev John Flynn Collegiate	Building	50	< 0.5	< 0.5	< 0.01	< 0.01
BRE_020_pa08	29	Wollondilly Anglican College - Cook Cottage	Building	60	0.5	0.5	< 0.01	< 0.01
BRE_020_pa09	61	Wollondilly Anglican College - Alfred Deakin Admin Centre	Building	70	1.0	1.0	0.01	< 0.01
BRE_020_pa10	22	Wollondilly Anglican College - Amenities	Building	30	< 0.5	< 0.5	< 0.01	< 0.01
BRE_020_pa11	15	Wollondilly Anglican College - Fred's Shed	Shed	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BRE_020_pa12	33	Wollondilly Anglican College - Hardcourt 1	Tennis Court	30	< 0.5	< 0.5	< 0.01	< 0.01
BRE_020_pa13	33	Wollondilly Anglican College - Hardcourt 2	Tennis Court	50	< 0.5	< 0.5	< 0.01	< 0.01
BRE_020_pa14	29	Wollondilly Anglican College - Elizabeth Cottage	Building	50	< 0.5	< 0.5	< 0.01	< 0.01
BRE_020_pa15	164	Wollondilly Anglican College - WACA	Sports Oval	30	< 0.5	< 0.5	< 0.01	< 0.01
BRE_020_pa16	43	Wollondilly Anglican College - Shoulder to Shoulder Shelter	Building	80	0.5	0.5	0.01	< 0.01
BRE_020_pa17	30	Wollondilly Anglican College - Johnston Cottage	Building	60	0.5	0.5	< 0.01	< 0.01
BRE_020_pa18	40	Wollondilly Anglican College - Cuthbert Cottage	Building	30	< 0.5	< 0.5	< 0.01	< 0.01
BRE_020_pa19	48	Wollondilly Anglican College - Banks Cottage	Building	125	1.5	1.5	0.02	< 0.01
BRE_020_pa20	40	Wollondilly Anglican College - Quarmby Cottage	Building	40	< 0.5	< 0.5	< 0.01	< 0.01
BRE_020_pa21	2	Wollondilly Anglican College	Shed	50	< 0.5	< 0.5	< 0.01	< 0.01
BRE_020_t01	2	Wollondilly Anglican College	Tank	50	< 0.5	< 0.5	< 0.01	< 0.01
BRE_020_t02	2	Wollondilly Anglican College	Tank	50	< 0.5	< 0.5	< 0.01	< 0.01
BRE_020_t04	8	Wollondilly Anglican College	Tank	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BRE_020_t05	8	Wollondilly Anglican College	Tank	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BRE_020_t06	3	Wollondilly Anglican College	Tank	50	< 0.5	< 0.5	< 0.01	< 0.01
BRE_580_pa05	7	Australian Wildlife Sanctuary - Nursery	Building	900	1.5	3.5	0.08	0.02
BRE_580_pa16	6	Australian Wildlife Sanctuary - Shed	Building	900	1.5	3.5	0.08	0.02
BRE_600_pa01	25	Australian Wildlife Sanctuary - Visitor Centre	Building	900	2.0	4.5	0.08	0.03
BRE_600_pa02	14	Australian Wildlife Sanctuary - Cottage 1	Building	950	3.0	5.5	0.08	0.02
BRE_600_pa03	7	Australian Wildlife Sanctuary - Shade house	Building	900	2.5	4.5	0.08	0.02
BRE_600_pa04	12	Australian Wildlife Sanctuary - Workshop	Building	950	3.0	5.5	0.08	0.02
BRE_600_pa06	6	Australian Wildlife Sanctuary - Glass house	Glass house	900	1.5	4.0	0.08	0.02
BRE_600_pa07	14	Australian Wildlife Sanctuary - Enclosure 1	Enclosure	1000	3.0	3.0	0.05	0.03
BRE_600_pa08	7	Australian Wildlife Sanctuary - Enclosure 2	Enclosure	1000	3.0	3.0	0.04	0.03
BRE_600_pa09	10	Australian Wildlife Sanctuary - Cottage 2	Building	950	3.5	6.5	0.08	0.02
BRE_600_pa10	6	Australian Wildlife Sanctuary - Awning	Awning	950	3.0	5.5	0.08	0.02
			Maxima:	**1000**	**4.0**	**6.5**	**0.08**	**0.03**

Table D.09 - Tahmoor South - Predictions for Public Utilities

Structure Ref.	Location	Description	Predicted Total Subsidence (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature (1/km)	Predicted Total Sagging Curvature (1/km)
BYR_200_pu01	NBN Infrastructure Yarran Rd	Shed	900	3.0	3.0	0.05	0.04
BYR_200_pu02	NBN Infrastructure Yarran Rd	Tower	850	2.5	2.5	0.04	0.04
		Maxima:	**900**	**3.0**	**3.0**	**0.05**	**0.04**

Table D.10 - Tahmoor South - Predictions for Commercial and Business Establishments

Structure Ref.	Maximum Plan Dimension (m)	Description	Structure Type	Predicted Total Subsidence (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature (1/km)	Predicted Total Sagging Curvature (1/km)
BRE_030_c01	113	Inghams Bargo Chicken Breeder Production Complex	Poultry Shed	50	0.5	0.5	< 0.01	< 0.01
BRE_030_c02	113	Inghams Bargo Chicken Breeder Production Complex	Poultry Shed	50	< 0.5	< 0.5	< 0.01	< 0.01
BRE_030_c03	113	Inghams Bargo Chicken Breeder Production Complex	Poultry Shed	40	< 0.5	< 0.5	< 0.01	< 0.01
BRE_030_c04	113	Inghams Bargo Chicken Breeder Production Complex	Poultry Shed	40	< 0.5	< 0.5	< 0.01	< 0.01
BRE_030_c05	113	Inghams Bargo Chicken Breeder Production Complex	Poultry Shed	30	< 0.5	< 0.5	< 0.01	< 0.01
BRE_030_c06	113	Inghams Bargo Chicken Breeder Production Complex	Poultry Shed	30	< 0.5	< 0.5	< 0.01	< 0.01
BRE_030_c07	113	Inghams Bargo Chicken Breeder Production Complex	Poultry Shed	30	< 0.5	< 0.5	< 0.01	< 0.01
BRE_030_c08	113	Inghams Bargo Chicken Breeder Production Complex	Poultry Shed	20	< 0.5	< 0.5	< 0.01	< 0.01
BRE_030_c25	13	Inghams Bargo Chicken Breeder Production Complex	Shed	20	< 0.5	< 0.5	< 0.01	< 0.01
BRE_030_c26	6	Inghams Bargo Chicken Breeder Production Complex	Shed	20	< 0.5	< 0.5	< 0.01	< 0.01
BRE_030_c27	8	Inghams Bargo Chicken Breeder Production Complex	Shed	30	< 0.5	< 0.5	< 0.01	< 0.01
BRE_030_c28	11	Inghams Bargo Chicken Breeder Production Complex	Shed	20	< 0.5	< 0.5	< 0.01	< 0.01
BRE_030_t08	6	Inghams Bargo Chicken Breeder Production Complex	Tank - gas	50	< 0.5	< 0.5	< 0.01	< 0.01
BRE_030_t09	6	Inghams Bargo Chicken Breeder Production Complex	Tank - gas	50	< 0.5	< 0.5	< 0.01	< 0.01
BRE_040_c01	14	Auto Wreckers	Shed	700	4.0	4.0	0.05	0.04
BRE_040_c02	28	Auto Wreckers	Shed	800	6.0	6.0	0.05	0.06
BRE_040_c03	17	Bargo Petroleum and Hill Top Pit Stop	Awning	900	4.5	4.5	0.06	0.04
BRE_040_c04	26	Bargo Petroleum and Hill Top Pit Stop	Petrol Station	900	4.5	4.5	0.06	0.04
BRE_040_c05	13	Bargo Petroleum and Hill Top Pit Stop	Workshop	1000	4.5	4.5	0.05	0.05
BRE_040_c06	9		Shed	1050	5.0	5.0	0.03	0.05
BRE_040_c07	17		Shed	1050	5.5	5.5	0.02	0.08
BRE_040_c08	14		Shed	1050	6.5	6.5	0.02	0.12
BRE_040_c09	128		Greenhouse	700	7.0	7.0	0.08	0.10
BRE_040_c10	51		Greenhouse	950	7.5	7.5	0.08	0.15
BRE_040_c11	12		Shed	700	7.0	7.0	0.08	0.10
BRE_040_c12	12		Shed	600	7.0	7.0	0.08	0.06
BRE_040_c13	11		Shed	375	5.0	5.0	0.07	0.01
BRE_055_c01	27	Tahmoor Garden Centre	Cafe	950	3.5	3.5	0.05	0.03
BRE_055_c02	9	Tahmoor Garden Centre	Shop	950	3.5	3.5	0.05	0.03
BRE_055_c03	7	Tahmoor Garden Centre	Shed	1000	4.0	4.0	0.05	0.03
BRE_055_c04	17	Tahmoor Garden Centre	Shade structure	1000	4.0	4.0	0.05	0.03
BRE_515_c01	7	MKD Machinery	Shed	1300	6.0	8.0	0.07	0.20
BRE_515_c02	3	MKD Machinery	Hopper	1300	6.0	7.5	0.06	0.20
BRE_515_c03	6	MKD Machinery	Shed	1300	6.0	7.5	0.07	0.18
BRE_515_c04	3	MKD Machinery	Shed	1350	6.0	7.5	0.06	0.20
BRE_515_c05	3	MKD Machinery	Shed	1350	6.0	7.5	0.06	0.20
BRE_515_c06	14	MKD Machinery	Shed	1300	6.0	7.5	0.07	0.20
BYR_055_c01	29	Bargo Valley Produce	Shed	125	0.5	0.5	< 0.01	< 0.01
BYR_055_c02	41	Bargo Valley Produce	Shed	100	0.5	0.5	< 0.01	< 0.01
BYR_055_c03	89	Bargo Valley Produce	Poultry Shed	175	1.0	1.0	0.01	< 0.01
BYR_055_c04	89	Bargo Valley Produce	Poultry Shed	200	1.5	1.5	0.02	< 0.01
BYR_055_c05	89	Bargo Valley Produce	Poultry Shed	250	2.0	2.0	0.03	< 0.01
BYR_055_c06	89	Bargo Valley Produce	Poultry Shed	325	3.5	3.5	0.06	0.01
BYR_055_c07	86	Bargo Valley Produce	Greenhouse	700	8.5	8.5	0.09	0.03
BYR_055_t01	8	Bargo Valley Produce	Tank	100	0.5	0.5	< 0.01	< 0.01

Table D.10 - Tahmoor South - Predictions for Commercial and Business Establishments

Structure Ref.	Maximum Plan Dimension (m)	Description	Structure Type	Predicted Total Subsidence (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature (1/km)	Predicted Total Sagging Curvature (1/km)
BYR_055_t02	3	Bargo Valley Produce	Tank	175	1.0	1.0	0.01	< 0.01
BYR_065_c06	91	Ingham Turkey Farm	Poultry Shed	90	< 0.5	< 0.5	< 0.01	< 0.01
BYR_065_c07	96	Ingham Turkey Farm	Poultry Shed	100	< 0.5	< 0.5	< 0.01	< 0.01
BYR_065_c08	83	Ingham Turkey Farm	Poultry Shed	100	0.5	0.5	< 0.01	< 0.01
BYR_065_c09	11	Ingham Turkey Farm	Poultry Shed	100	0.5	0.5	< 0.01	< 0.01
BYR_065_c10	15	Ingham Turkey Farm	Poultry Shed	125	0.5	0.5	< 0.01	< 0.01
BYR_065_c11	26	Ingham Turkey Farm	Poultry Shed	100	< 0.5	< 0.5	< 0.01	< 0.01
BYR_065_c12	91	Ingham Turkey Farm	Poultry Shed	150	1.0	1.0	< 0.01	< 0.01
BYR_065_c13	90	Ingham Turkey Farm	Poultry Shed	150	1.0	1.0	< 0.01	< 0.01
BYR_065_c14	91	Ingham Turkey Farm	Poultry Shed	175	1.0	1.0	0.01	< 0.01
BYR_065_t02	5	Ingham Turkey Farm	Tank	100	< 0.5	< 0.5	< 0.01	< 0.01
BYR_065_t03	4	Ingham Turkey Farm	Tank	80	< 0.5	< 0.5	< 0.01	< 0.01
BYR_135_c01	14	Canine Country Club and Cattery	Shed	70	< 0.5	< 0.5	< 0.01	< 0.01
BYR_135_c02	20	Canine Country Club and Cattery	Shed	60	< 0.5	< 0.5	< 0.01	< 0.01
BYR_135_c03	9	Canine Country Club and Cattery	Shed	70	< 0.5	< 0.5	< 0.01	< 0.01
BYR_135_c04	17	Canine Country Club and Cattery	Shed	60	< 0.5	< 0.5	< 0.01	< 0.01
BYR_135_c05	26	Canine Country Club and Cattery	Shed	60	< 0.5	< 0.5	< 0.01	< 0.01
BYR_135_c06	3	Canine Country Club and Cattery	Shed	60	< 0.5	< 0.5	< 0.01	< 0.01
BYR_135_c07	14	Canine Country Club and Cattery	Shed	60	< 0.5	< 0.5	< 0.01	< 0.01
BYR_135_c08	25	Canine Country Club and Cattery	Awning	60	< 0.5	< 0.5	< 0.01	< 0.01
TM_c01	49	Tahmoor Mine - Administration	Building	< 20	< 0.5	< 0.5	< 0.01	< 0.01
TM_c04	25	Tahmoor Mine - Storage	Building	< 20	< 0.5	< 0.5	< 0.01	< 0.01
TM_c05	37	Tahmoor Mine - Workshop	Building	< 20	< 0.5	< 0.5	< 0.01	< 0.01
TM_c06	24	Tahmoor Mine	Building	< 20	< 0.5	< 0.5	< 0.01	< 0.01
TM_c07	32	Tahmoor Mine - Store	Building	< 20	< 0.5	< 0.5	< 0.01	< 0.01
TM_c08	20	Tahmoor Mine - Meeting Room	Building	< 20	< 0.5	< 0.5	< 0.01	< 0.01
TM_c09	14	Tahmoor Mine - OH&S	Building	< 20	< 0.5	< 0.5	< 0.01	< 0.01
TM_c10	12	Tahmoor Mine	Building	< 20	< 0.5	< 0.5	< 0.01	< 0.01
TM_c11	12	Tahmoor Mine	Building	< 20	< 0.5	< 0.5	< 0.01	< 0.01
TM_c12	21	Tahmoor Mine - Training Room	Building	< 20	< 0.5	< 0.5	< 0.01	< 0.01
TM_c13	25	Tahmoor Mine - Winder House	Building	40	< 0.5	< 0.5	< 0.01	< 0.01
TM_c14	5	Tahmoor Mine	Building	30	< 0.5	< 0.5	< 0.01	< 0.01
TM_c15	12	Tahmoor Mine - Bath	Building	30	< 0.5	< 0.5	< 0.01	< 0.01
TM_c16	66	Tahmoor Mine - Bath House and Mine Office	Building	20	< 0.5	< 0.5	< 0.01	< 0.01
TM_c17	12	Tahmoor Mine	Building	< 20	< 0.5	< 0.5	< 0.01	< 0.01
TM_c18	9	Tahmoor Mine	Building	< 20	< 0.5	< 0.5	< 0.01	< 0.01
TM_c19	10	Tahmoor Mine	Building	< 20	< 0.5	< 0.5	< 0.01	< 0.01
TM_c20	8	Tahmoor Mine	Building	< 20	< 0.5	< 0.5	< 0.01	< 0.01
TM_c21	24	Tahmoor Mine - Conveyor Drive	Building	20	< 0.5	< 0.5	< 0.01	< 0.01
TM_c22	8	Tahmoor Mine - Gas	Building	20	< 0.5	< 0.5	< 0.01	< 0.01
TM_c23	18	Tahmoor Mine	Building	20	< 0.5	< 0.5	< 0.01	< 0.01
TM_c24	12	Tahmoor Mine - Contractors Offices	Building	30	< 0.5	< 0.5	< 0.01	< 0.01
TM_c25	12	Tahmoor Mine - Contractors Offices	Building	30	< 0.5	< 0.5	< 0.01	< 0.01
TM_c26	12	Tahmoor Mine - DOM Room	Building	30	< 0.5	< 0.5	< 0.01	< 0.01
TM_c27	12	Tahmoor Mine - Bath	Building	30	< 0.5	< 0.5	< 0.01	< 0.01

Table D.10 - Tahmoor South - Predictions for Commercial and Business Establishments

Structure Ref.	Maximum Plan Dimension (m)	Description	Structure Type	Predicted Total Subsidence (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature (1/km)	Predicted Total Sagging Curvature (1/km)
TM_c28	12	Tahmoor Mine - Bath	Building	30	< 0.5	< 0.5	< 0.01	< 0.01
TM_c29	15	Tahmoor Mine - Critical Equipment	Building	30	< 0.5	< 0.5	< 0.01	< 0.01
TM_c30	15	Tahmoor Mine - Fire Services	Building	30	< 0.5	< 0.5	< 0.01	< 0.01
TM_c31	9	Tahmoor Mine	Building	30	< 0.5	< 0.5	< 0.01	< 0.01
TM_c32	6	Tahmoor Mine	Building	30	< 0.5	< 0.5	< 0.01	< 0.01
TM_c33	15	Tahmoor Mine - Bath	Building	40	< 0.5	< 0.5	< 0.01	< 0.01
TM_c34	7	Tahmoor Mine	Building	30	< 0.5	< 0.5	< 0.01	< 0.01
TM_c35	3	Tahmoor Mine	Building	30	< 0.5	< 0.5	< 0.01	< 0.01
TM_c36	3	Tahmoor Mine	Building	30	< 0.5	< 0.5	< 0.01	< 0.01
TM_c37	19	Tahmoor Mine - Washery Equipment	Building	40	< 0.5	< 0.5	< 0.01	< 0.01
TM_c38	35	Tahmoor Mine - Bath House and Workshop	Building	60	< 0.5	< 0.5	< 0.01	< 0.01
TM_c39	3	Tahmoor Mine	Building	60	< 0.5	< 0.5	< 0.01	< 0.01
TM_c40	12	Tahmoor Mine - CHPP Contractors Crib Room	Building	60	< 0.5	< 0.5	< 0.01	< 0.01
TM_c41	12	Tahmoor Mine - CHPP Contractors Training Room	Building	60	< 0.5	< 0.5	< 0.01	< 0.01
TM_c42	78	Tahmoor Mine - Washery and Control Room	Building	80	< 0.5	< 0.5	< 0.01	< 0.01
TM_c43	8	Tahmoor Mine	Building	80	< 0.5	< 0.5	< 0.01	< 0.01
TM_c44	6	Tahmoor Mine	Building	70	< 0.5	< 0.5	< 0.01	< 0.01
TM_c45	8	Tahmoor Mine	Building	70	< 0.5	< 0.5	< 0.01	< 0.01
TM_c46	7	Tahmoor Mine	Building	125	1.5	1.5	0.01	< 0.01
TM_c47	8	Tahmoor Mine	Building	125	1.5	1.5	0.01	< 0.01
TM_c48	6	Tahmoor Mine - CHPP Stockpile Contractor Crib Room	Building	175	2.0	2.0	0.02	0.01
TM_c49	2	Tahmoor Mine	Building	200	2.0	2.0	0.02	0.01
TM_c50	4	Tahmoor Mine	Building	200	2.0	2.0	0.02	0.01
TM_c54	10	Tahmoor Mine	Building	< 20	< 0.5	< 0.5	< 0.01	< 0.01
TM_c57	24	Tahmoor Mine - Longwall Shed	Building	< 20	< 0.5	< 0.5	< 0.01	< 0.01
TM_c60	30	Tahmoor Mine - Equipment	Building	20	< 0.5	< 0.5	< 0.01	< 0.01
TM_c70	8	Tahmoor Mine	Shed	50	< 0.5	< 0.5	< 0.01	< 0.01
TM_c71	5	Tahmoor Mine	Shed	40	< 0.5	< 0.5	< 0.01	< 0.01
TM_c72	6	Tahmoor Mine	Shed	50	< 0.5	< 0.5	< 0.01	< 0.01
TM_c73	5	Tahmoor Mine	Shed	50	< 0.5	< 0.5	< 0.01	< 0.01
TM_c74	22	Tahmoor Mine - 6000t Bin	Bin	50	0.5	0.5	< 0.01	< 0.01
TM_c75	12	Tahmoor Mine - 1250t Raw Coal Bin	Bin	60	0.5	0.5	< 0.01	< 0.01
TM_c76	12	Tahmoor Mine - 1250t Raw Coal Bin	Bin	60	0.5	0.5	< 0.01	< 0.01
TM_c77	18	Tahmoor Mine	Thickeners	70	< 0.5	< 0.5	< 0.01	< 0.01
TM_c78	4	Tahmoor Mine	Thickeners	70	< 0.5	< 0.5	< 0.01	< 0.01
TM_c79	6	Tahmoor Mine	Thickeners	70	< 0.5	< 0.5	< 0.01	< 0.01
TM_c80	12	Tahmoor Mine	Thickeners	70	< 0.5	< 0.5	< 0.01	< 0.01
TM_c81	2	Tahmoor Mine	Thickeners	70	< 0.5	< 0.5	< 0.01	< 0.01
TM_c82	1	Tahmoor Mine	Thickeners	70	< 0.5	< 0.5	< 0.01	< 0.01
TM_d01	109	Tahmoor Mine - Dam M1	Dam	40	< 0.5	< 0.5	< 0.01	< 0.01
TM_d02	51	Tahmoor Mine - Dam M2	Dam	40	< 0.5	< 0.5	< 0.01	< 0.01
TM_d03	114	Tahmoor Mine - Dam M3	Dam	30	< 0.5	< 0.5	< 0.01	< 0.01
TM_d04	106	Tahmoor Mine - Dam M4	Dam	30	< 0.5	< 0.5	< 0.01	< 0.01
TM_d05	74	Tahmoor Mine - Tailings Dam	Dam	60	< 0.5	< 0.5	< 0.01	< 0.01
TM_d06	51	Tahmoor Mine - Tailings Dam	Dam	60	< 0.5	< 0.5	< 0.01	< 0.01

Table D.10 - Tahmoor South - Predictions for Commercial and Business Establishments

Structure Ref.	Maximum Plan Dimension (m)	Description	Structure Type	Predicted Total Subsidence (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature (1/km)	Predicted Total Sagging Curvature (1/km)
TM_d07	24	Tahmoor Mine - Dam	Dam	40	< 0.5	< 0.5	< 0.01	< 0.01
TM_d08	24	Tahmoor Mine - Dam	Dam	40	< 0.5	< 0.5	< 0.01	< 0.01
TM_d09	35	Tahmoor Mine - Dam	Dam	50	< 0.5	< 0.5	< 0.01	< 0.01
TM_d10	35	Tahmoor Mine - Dam	Dam	90	< 0.5	< 0.5	< 0.01	< 0.01
TM_d11	144	Tahmoor Mine - Dam	Dam	125	1.0	1.0	0.01	< 0.01
TM_d12	109	Tahmoor Mine	Building	200	1.5	1.5	0.02	< 0.01
TM_d13	11	Tahmoor Mine - Dam	Dam	30	< 0.5	< 0.5	< 0.01	< 0.01
TM_t03	10	Tahmoor Mine - Tank	Tank	70	< 0.5	< 0.5	< 0.01	< 0.01
			Maxima:	**1350**	**8.5**	**8.5**	**0.09**	**0.20**

Table D.11 - Tahmoor South - Predictions for Archaeological Sites

Site ID	Type	Significance	Predicted Total Subsidence after all Longwalls (mm)	Predicted Total Tilt after all Longwalls (mm/m)	Predicted Total Hogging Curvature after all Longwalls (1/km)	Predicted Total Sagging Curvature after all Longwalls (1/km)
52-2-3968	Open camp site	Low	550	5.0	0.05	0.02
52-2-4471	Rockshelter with art and deposit	Low	900	4.5	0.06	0.03
48-2-0275	Isolated find	Low	70	< 0.5	< 0.01	< 0.01
		Maxima:	**900**	**5.0**	**0.06**	**0.03**

APPENDIX E. FIGURES SHOWING PREDICTED SUBSIDENCE PARAMETERS OVER THE TAHMOOR SOUTH PROJECT

Predicted profiles of conventional subsidence, tilt and curvature along Prediction Line 1 resulting from the extraction of Longwalls S1A to S6A

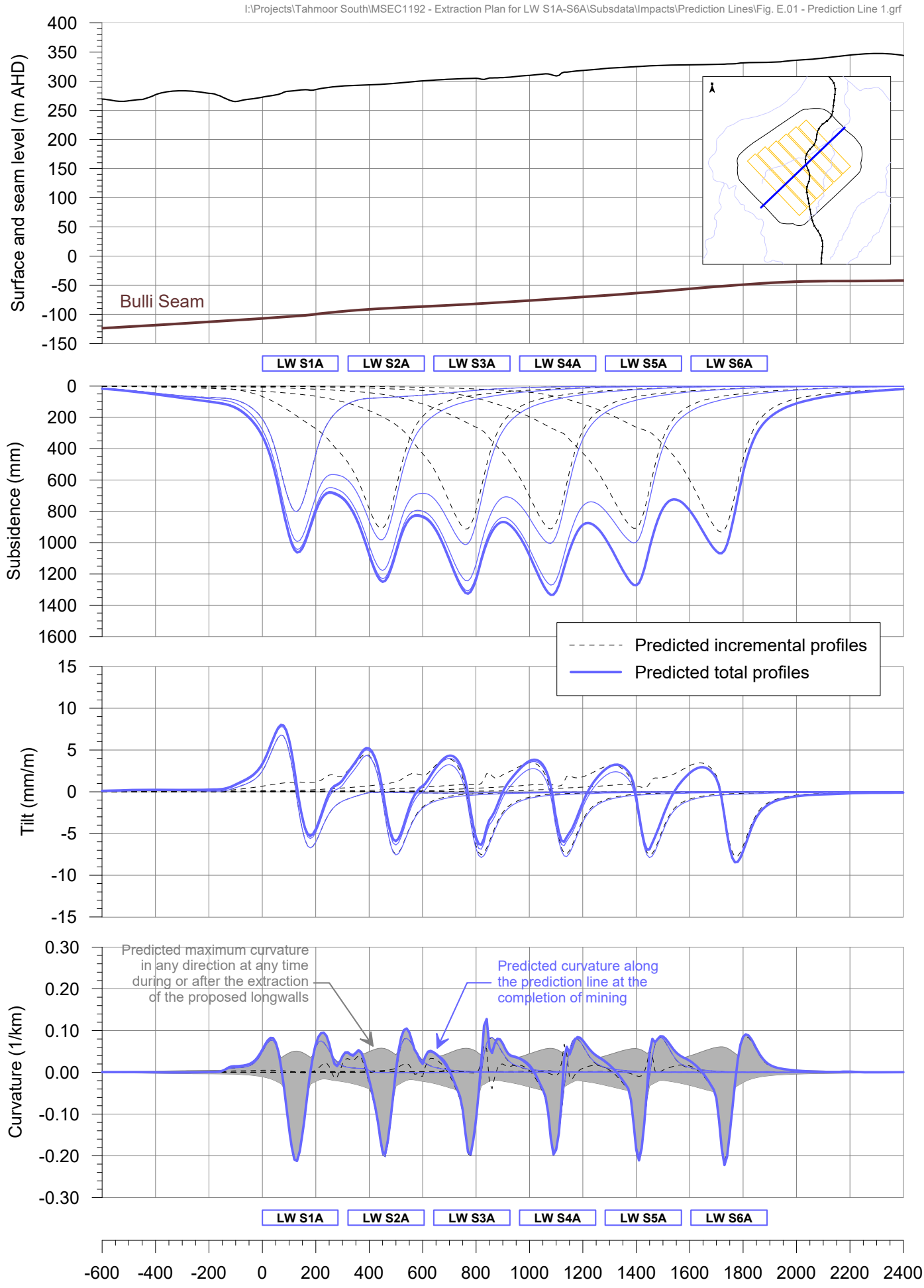
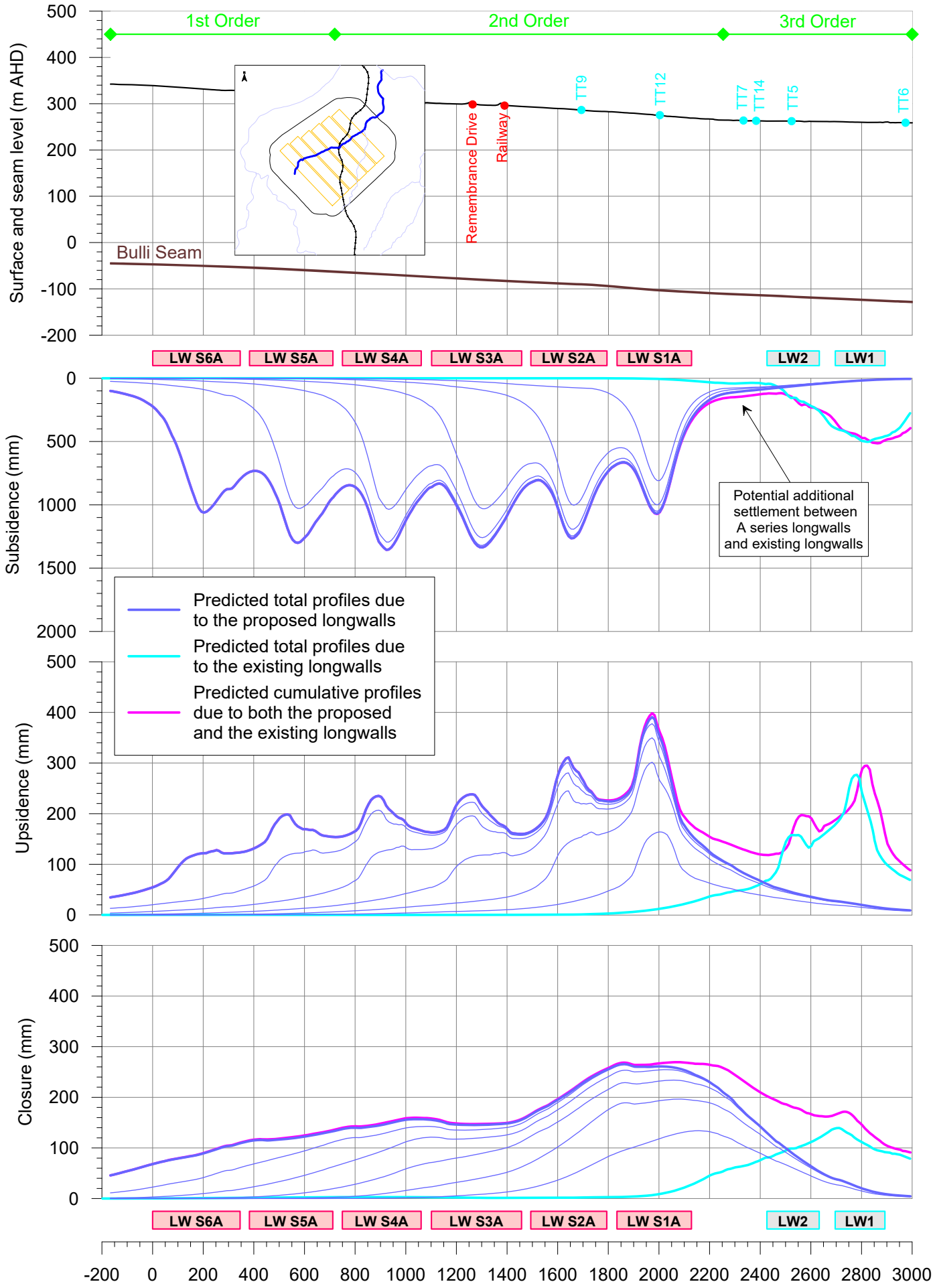


Fig. E.01

Predicted profiles of subsidence, upsidence and closure along Teatree Hollow resulting from the extraction of Longwalls S1A to S6A

I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\Subsdata\Impacts\Streams\Fig. E.02 - Teatree Hollow.grf

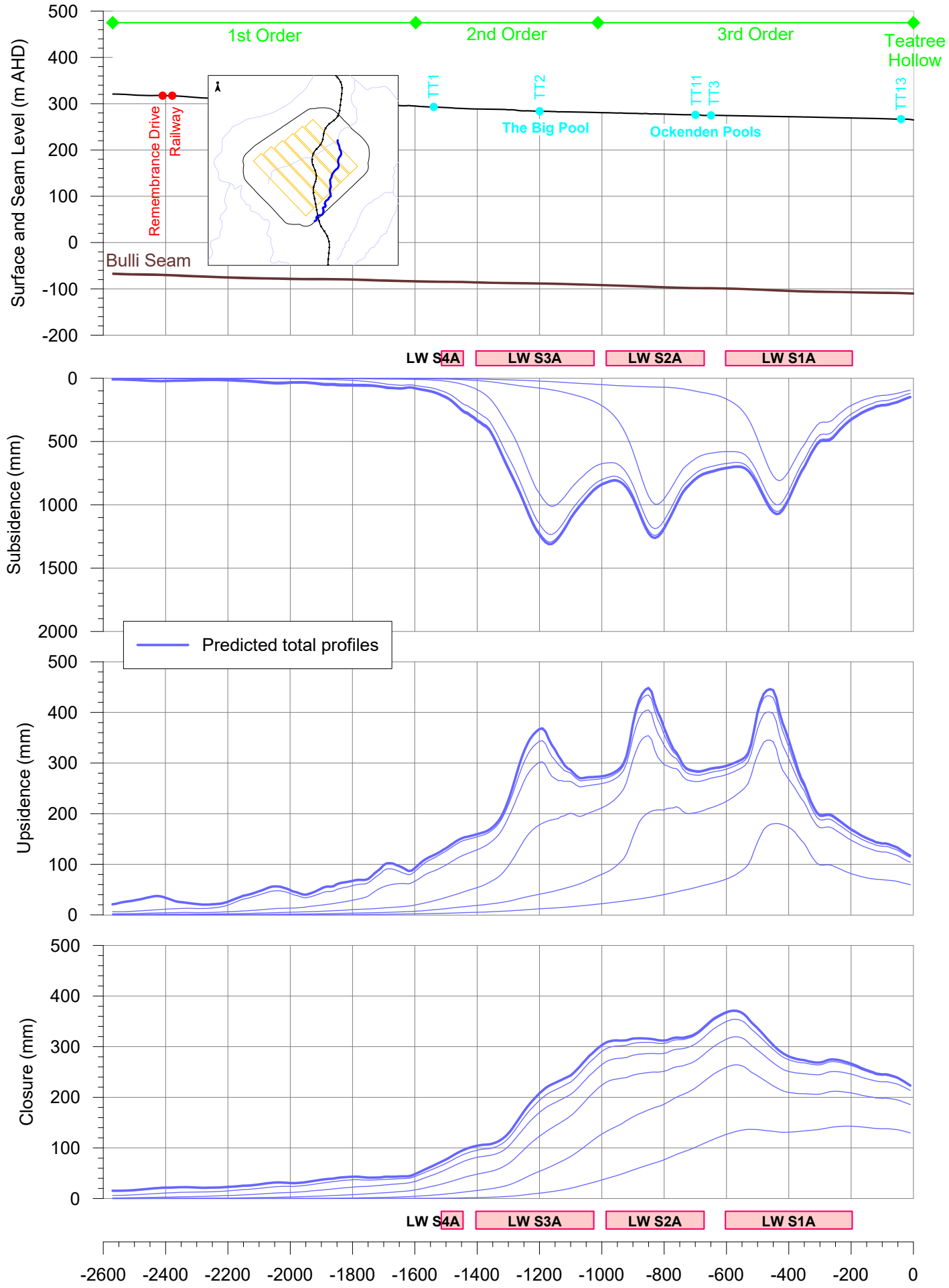


msec

Fig. E.02

Predicted profiles of subsidence, upsidence and closure along Tributary of Teatree Hollow resulting from the extraction of Longwalls S1A to S6A

I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\Subsdata\Impacts\Streams\Fig. E.03 - Tributary of Teatree Hollow.grf



msec

Fig. E.03

Predicted profiles of conventional subsidence, tilt and change in grade along the Main Southern Railway due to the extraction of Longwalls S1A to S6A

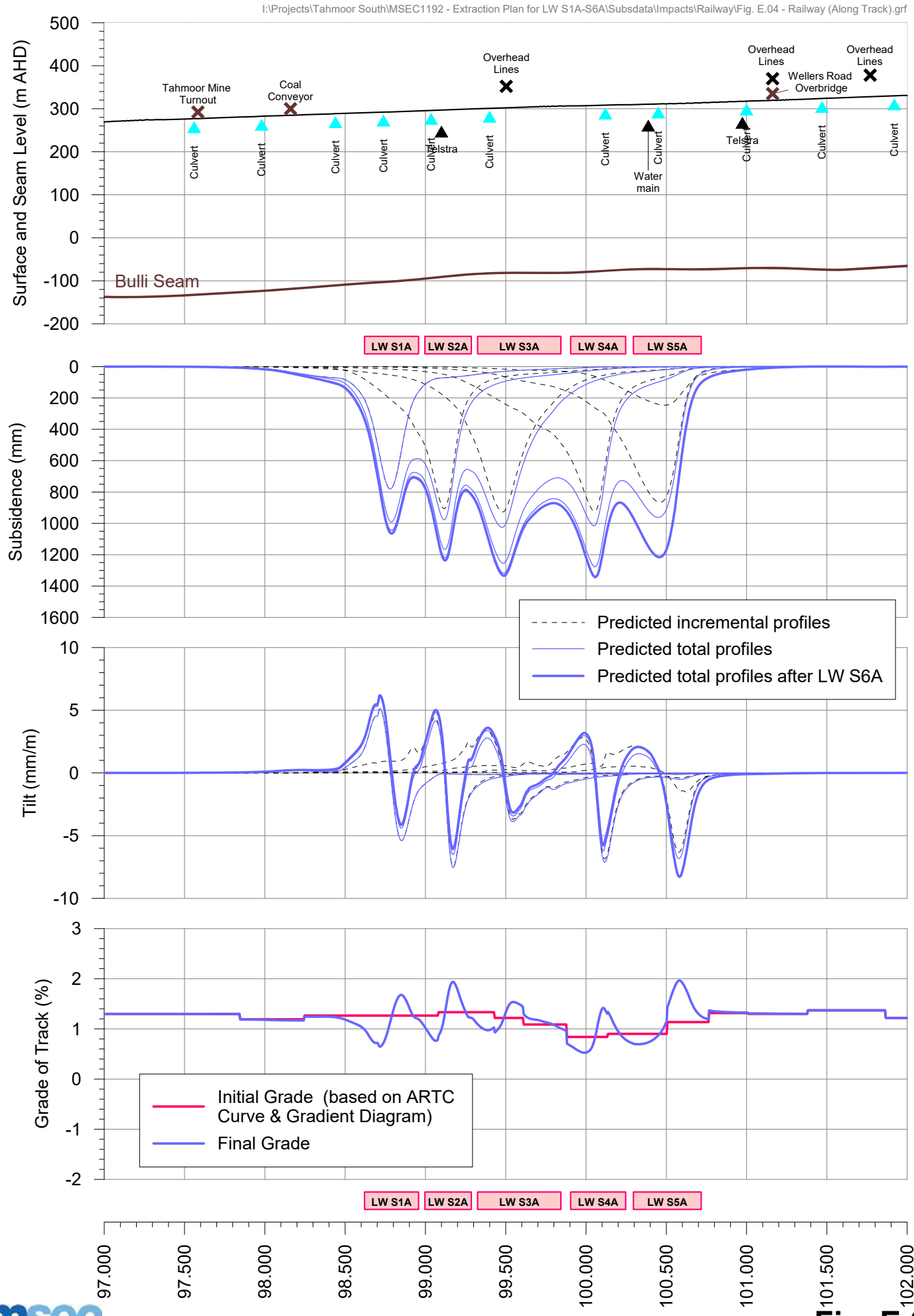
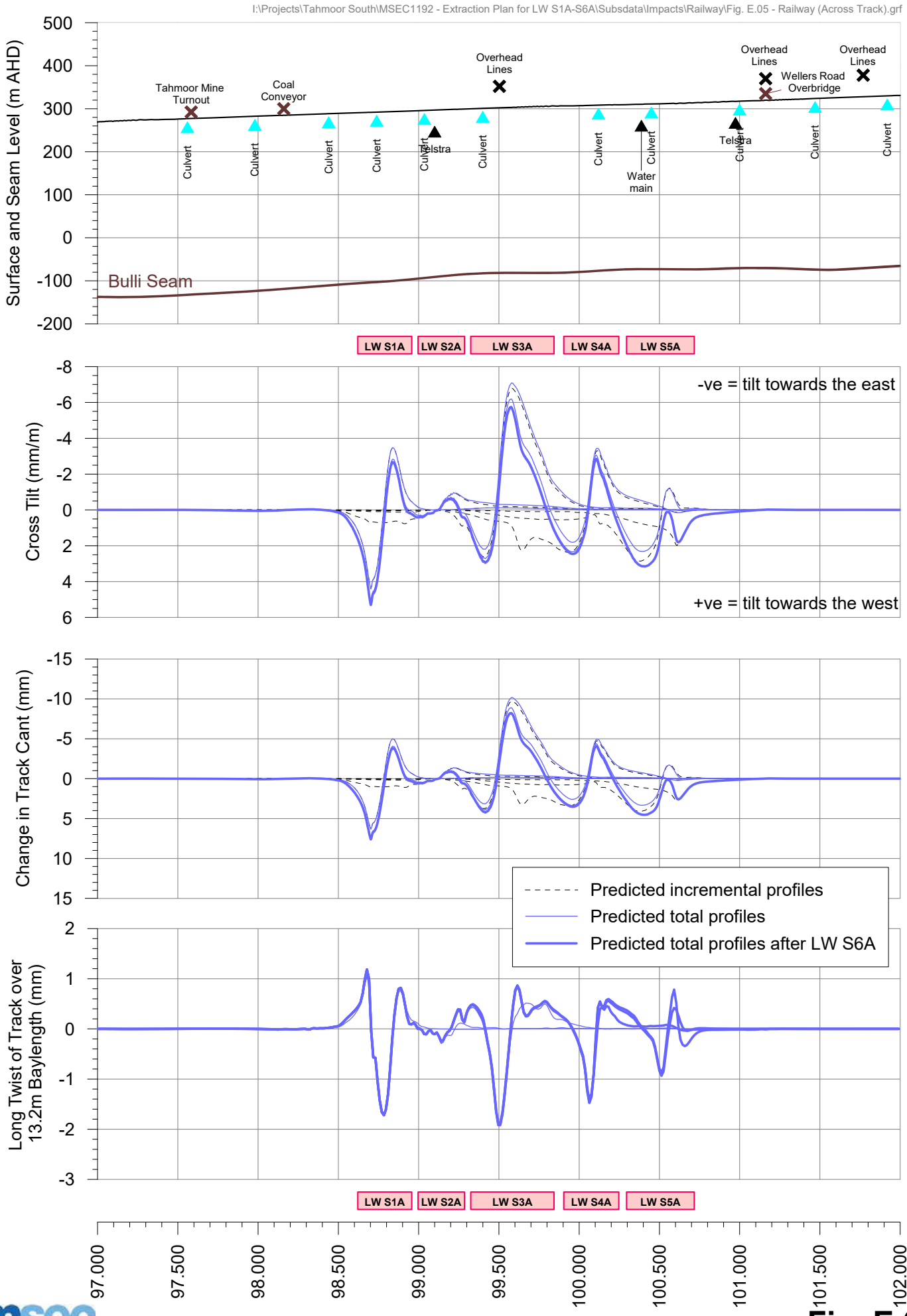


Fig. E.04

Predicted profiles of conventional cross tilt, change in track cant and long twist along the Main Southern Railway due to the extraction of Longwalls S1A to S6A



msec

Fig. E.05

Predicted profiles of conventional horizontal movement along track, change in 100 metre long bay length and change in SFT for the Main Southern Railway due to the extraction of Longwalls S1A to S6A

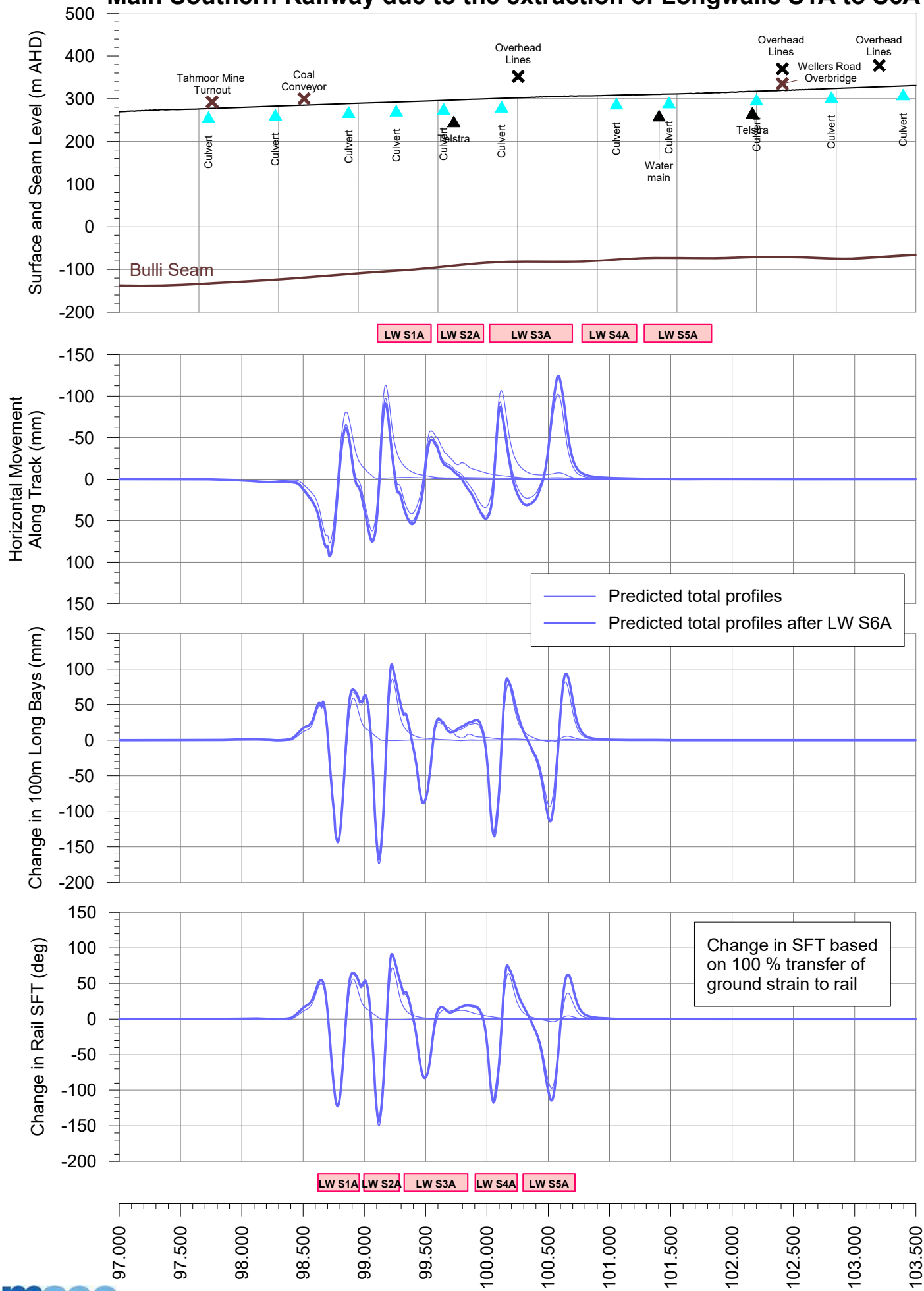
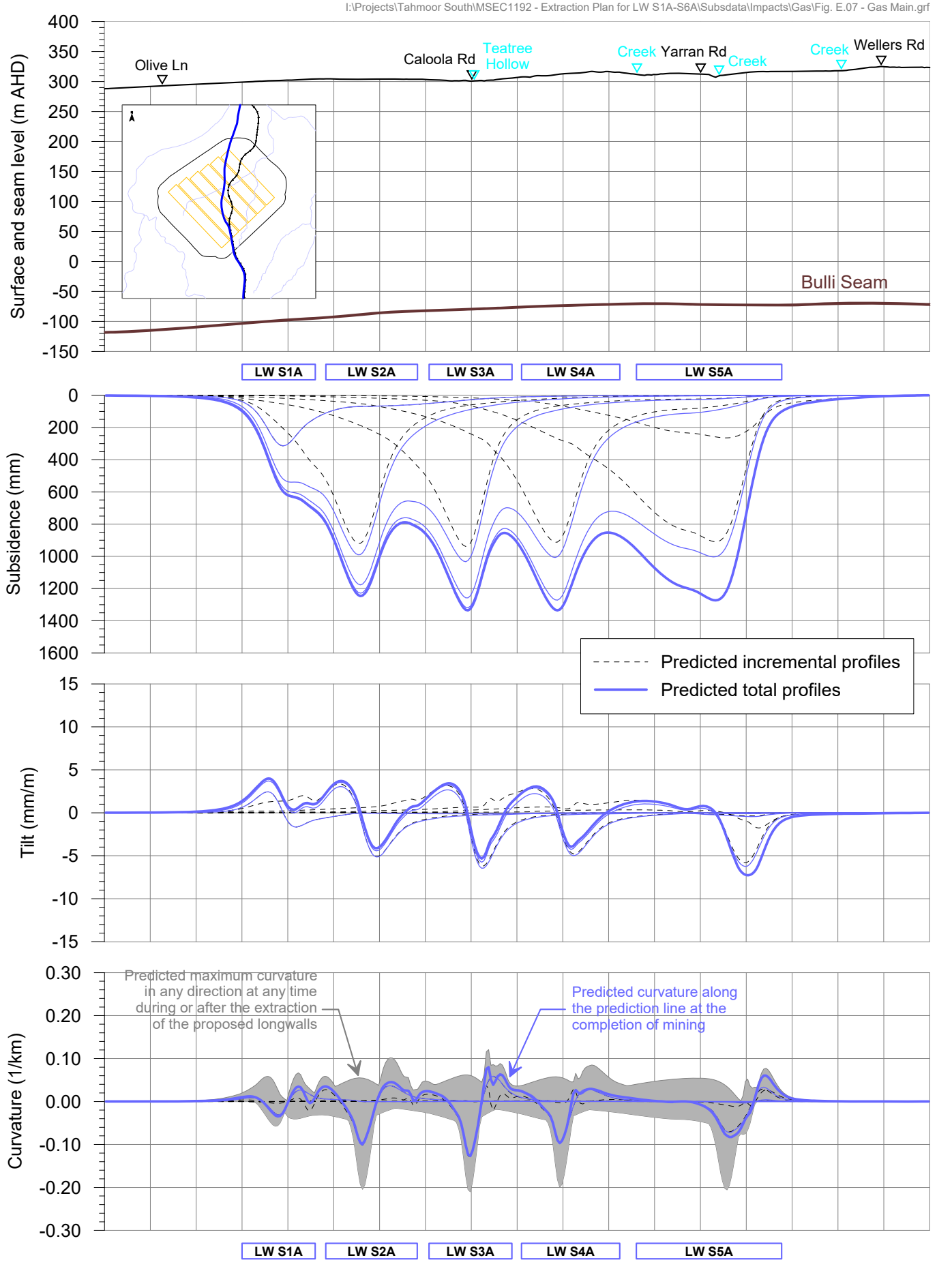


Fig. E.06

Predicted profiles of conventional subsidence, tilt and curvature along Remembrance Drive and the 150mm steel gas main resulting from the extraction of Longwalls S1A to S6A

I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\Subsdata\Impacts\Gas\Fig. E.07 - Gas Main.grf

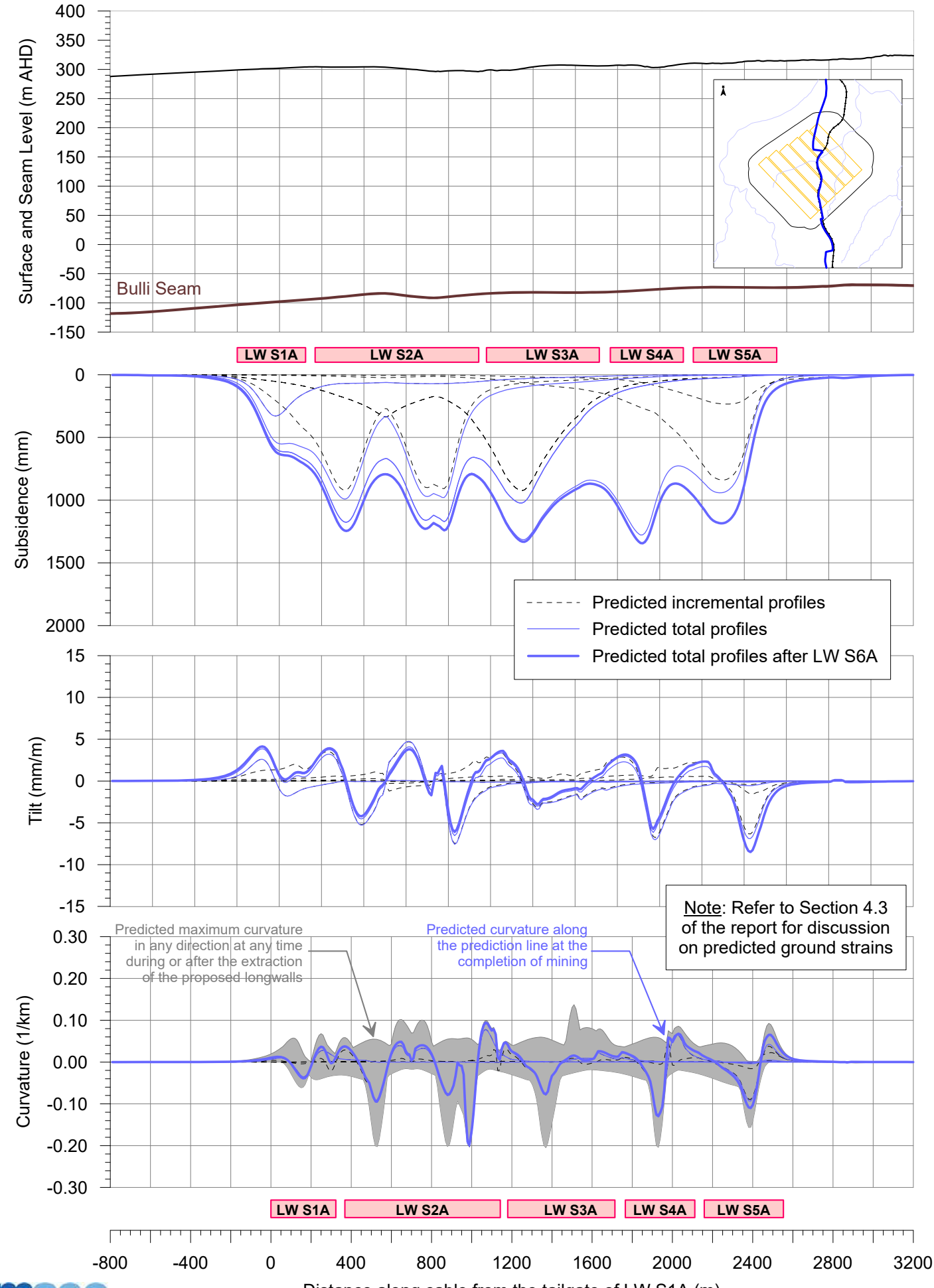


msec

Fig. E.07

Predicted profiles of conventional subsidence, tilt and curvature along Optical Fibre Cable resulting from the extraction of Longwalls S1A to S6A

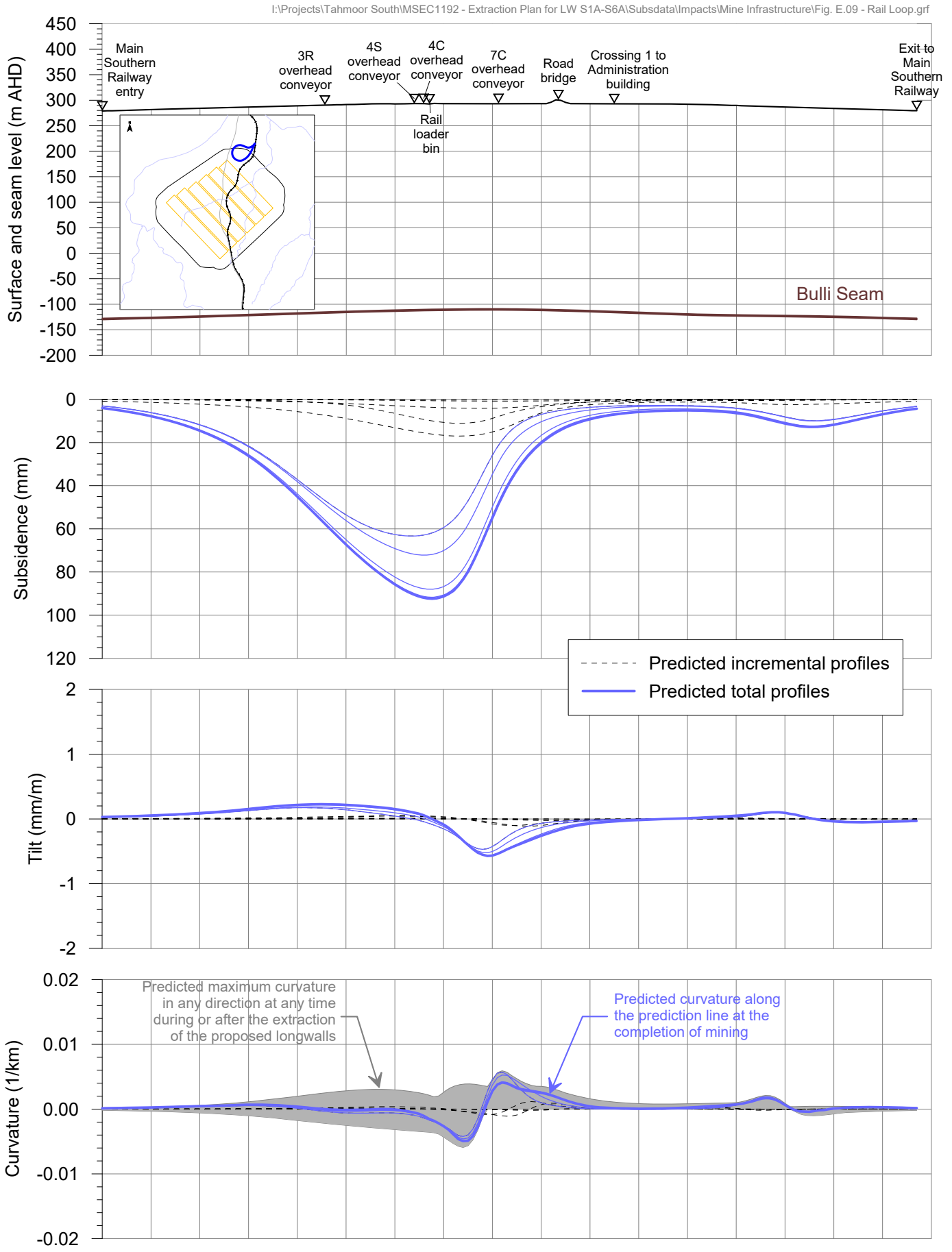
I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\Subsdata\Impacts\Telecommunications\Fig. E.08 - Optical Fibre Cable.grf



msec

Fig. E.08

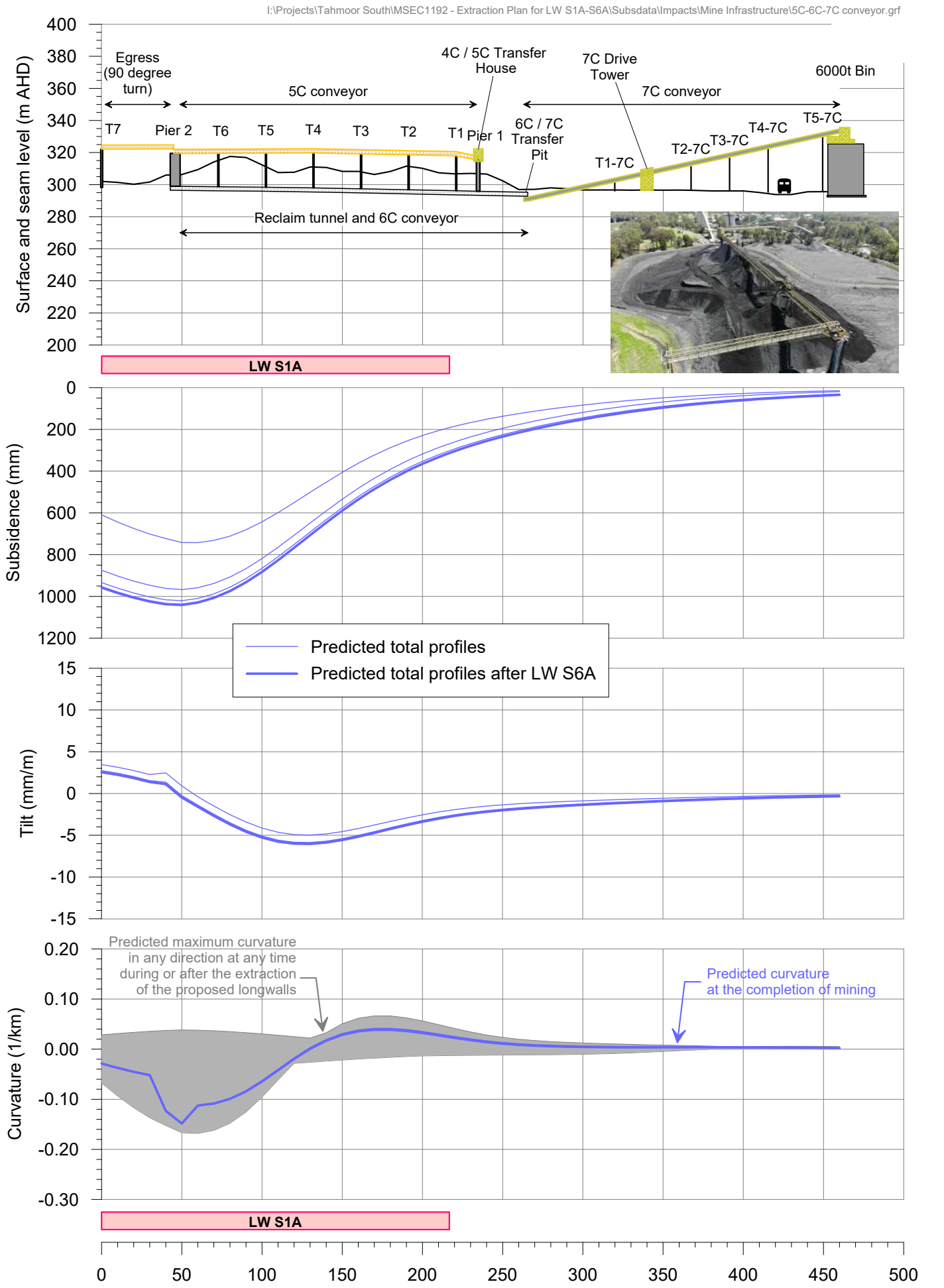
Predicted profiles of conventional subsidence, tilt and curvature along Tahmoor Mine rail loop resulting from the extraction of Longwalls S1A to S6A



msec

Fig. E.09

Predicted profiles of conventional subsidence, tilt and curvature along 5C-6C-7C conveyors resulting from the extraction of Longwalls S1A to S6A



msec

Fig. E.10

APPENDIX F. DRAWINGS

I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\AcadData\MSEC1192-01 General Layout (LWS1A to LWS6A).dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH PROJECT
EXTRACTION PLAN
LW S1A TO LW S6A
GENERAL LAYOUT

DATE:	SCALE:	DRAWING No:	Rev No
12 May 2022	as shown	MSEC1192-01	B

TAHMOOR
COURIDJAH
BARGO
YANDERRA

Railway Viaduct
Remembrance Drive Bridge over Bargo River & Main Southern Railway
1755 m
1690 m
940 m
PICTON WEIR

LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A

Predicted 20mm Contour after LW S1A to LW S6A
EXTENT OF LONGWALLS
600m Study Area for Natural Features
Study Area

BARGO RIVER
BARGO RIVER ROAD
REMEMBRANCE DR
REMEMBRANCE DRIVE
FIRE ROAD NO P1
FIRE ROAD NO 5B
OLIVE GROVE
CALOOLA ROAD
YARRAN ROAD
MAIN SOUTHERN RAILWAY
CHARLIES POINT ROAD
WELLERS ROAD
CLAREMONT DRIVE
ASHBY CLOSE
HOGANS DRIVE
ELVY STREET
HAMBRIDGE ROAD
MIMOSA STREET
KADER STREET
GWYNN HUGHES STREET
GAMBALAN STREET
BANKSIA ROAD
MOOWANI PL
BINGARRA PLACE
NGORAL STREET
GREAT SOUTHERN ROAD
WATTLE STREET
IRONBARK ROAD
GOVERNMENT ROAD
REDMOND ROAD
BARGO ROAD
ANTHONY ROAD
GLENGARRY ROAD
WARROBYN RD
DWYERS RD
ARINA ROAD
TWINLER AVE
JOHNSTON RD
HAWTHORNE ROAD
AVON DAM RD
AVON DAM ROAD
TYLERS ROAD
MARSHALL AVENUE
RESERVOIR ROAD
LUPTON ROAD
CARLISLE STREET
SILICA ROAD
M31 HUME MOTORWAY
COMBA-SYDNEY GAS PIPELINE
STRATFORD RD
PHEASANTS NEST RD
LW 1
LW 2
LW 8
LW 10B
LW 10A
LW 11
LW 12
LW 13
LW 14A
LW 14B
LW 15
LW 16
LW 17
LW 18
LW 19

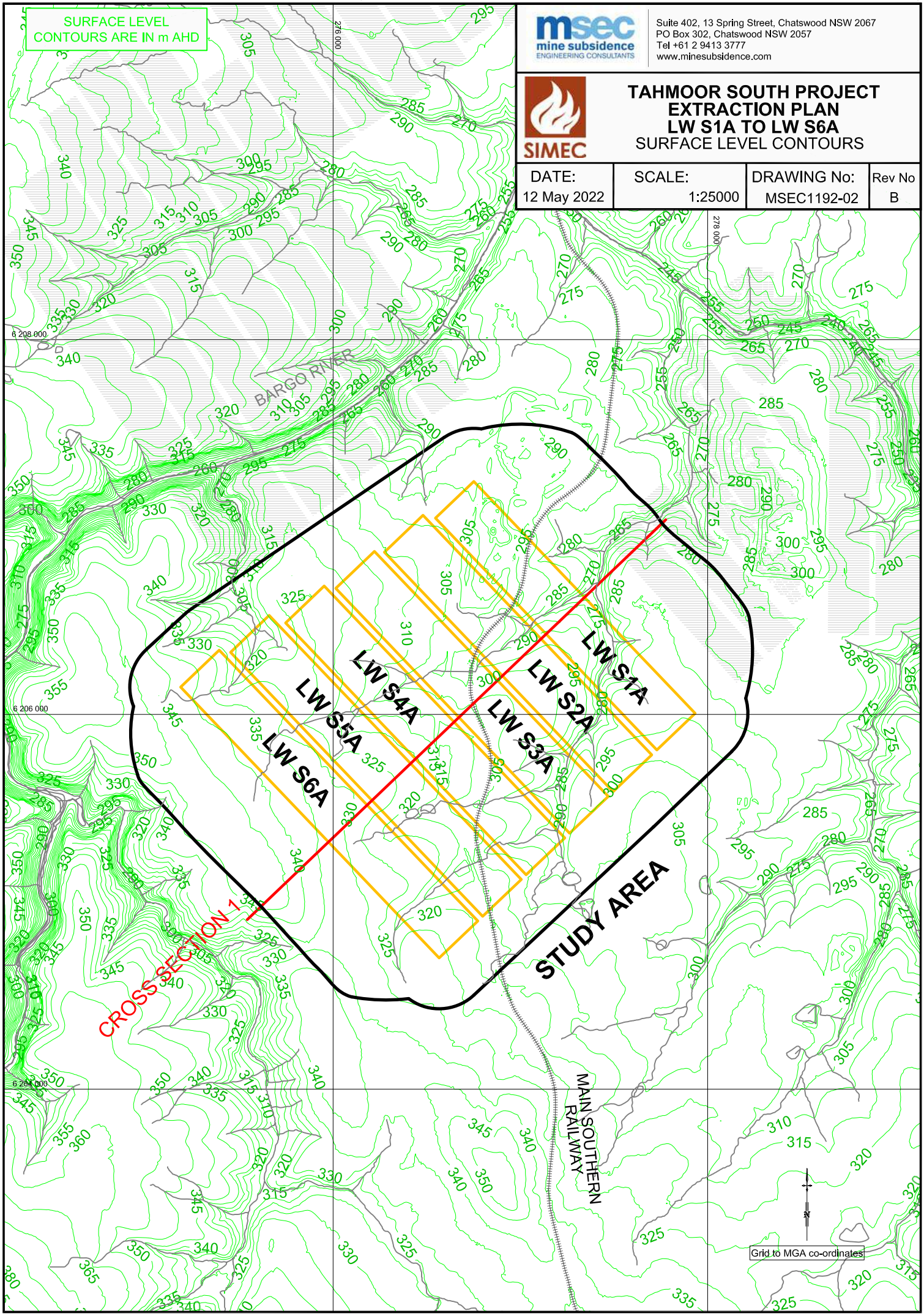
276 000
278 000
280 000
6 208 000
6 206 000
6 204 000
6 202 000

N
Grid to MGA co-ordinates

LEGEND
- Structures potentially sensitive to differential far field movements
- Historical Mine Workings

Note: The 'Extent of Longwalls' boundary encompasses the proposed extent of underground workings, being the proposed longwall panels & mains headings (first workings).

I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\AcadData\MSEC1192-02 Surface Level Contours.dwg



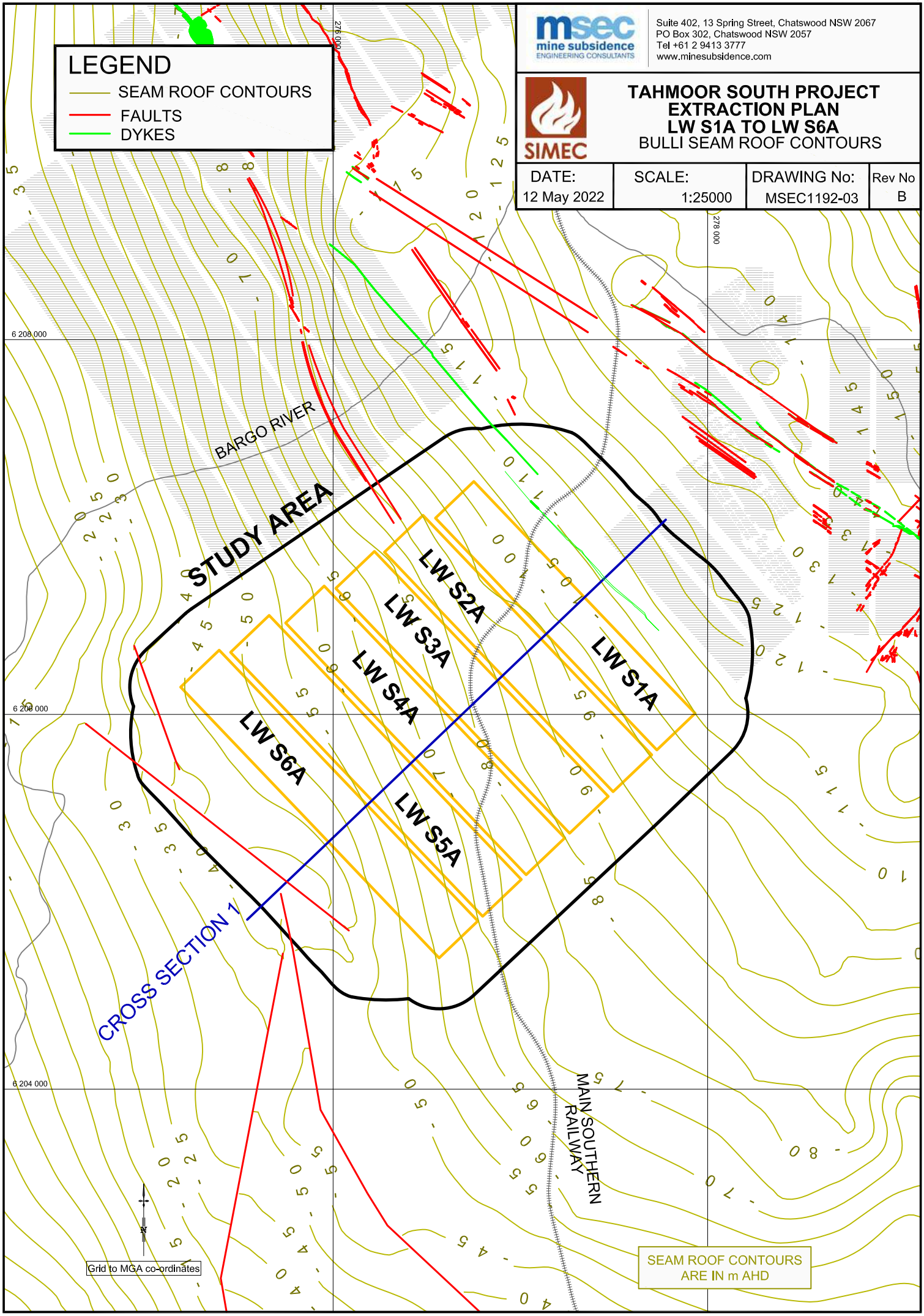
msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH PROJECT
EXTRACTION PLAN
LW S1A TO LW S6A
SURFACE LEVEL CONTOURS

DATE:	SCALE:	DRAWING No:	Rev No
12 May 2022	1:25000	MSEC1192-02	B

I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\AcadData\MSEC1192-03 Seam Roof Contours.dwg



msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH PROJECT
EXTRACTION PLAN
LW S1A TO LW S6A
BULLI SEAM ROOF CONTOURS

DATE:	SCALE:	DRAWING No:	Rev No
12 May 2022	1:25000	MSEC1192-03	B

I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\AcadData\MSEC1192-04 Extraction Height.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH PROJECT
EXTRACTION PLAN
LW S1A TO LW S6A
EXTRACTION HEIGHT

DATE:	SCALE:	DRAWING No:	Rev No
12 May 2022	1:25000	MSEC1192-04	B

Grid to MGA co-ordinates

276 000

278 000

6 208 000

6 206 000

6 204 000

BARGO RIVER

LW S1A

LW S2A

LW S3A

LW S4A

LW S5A

LW S6A

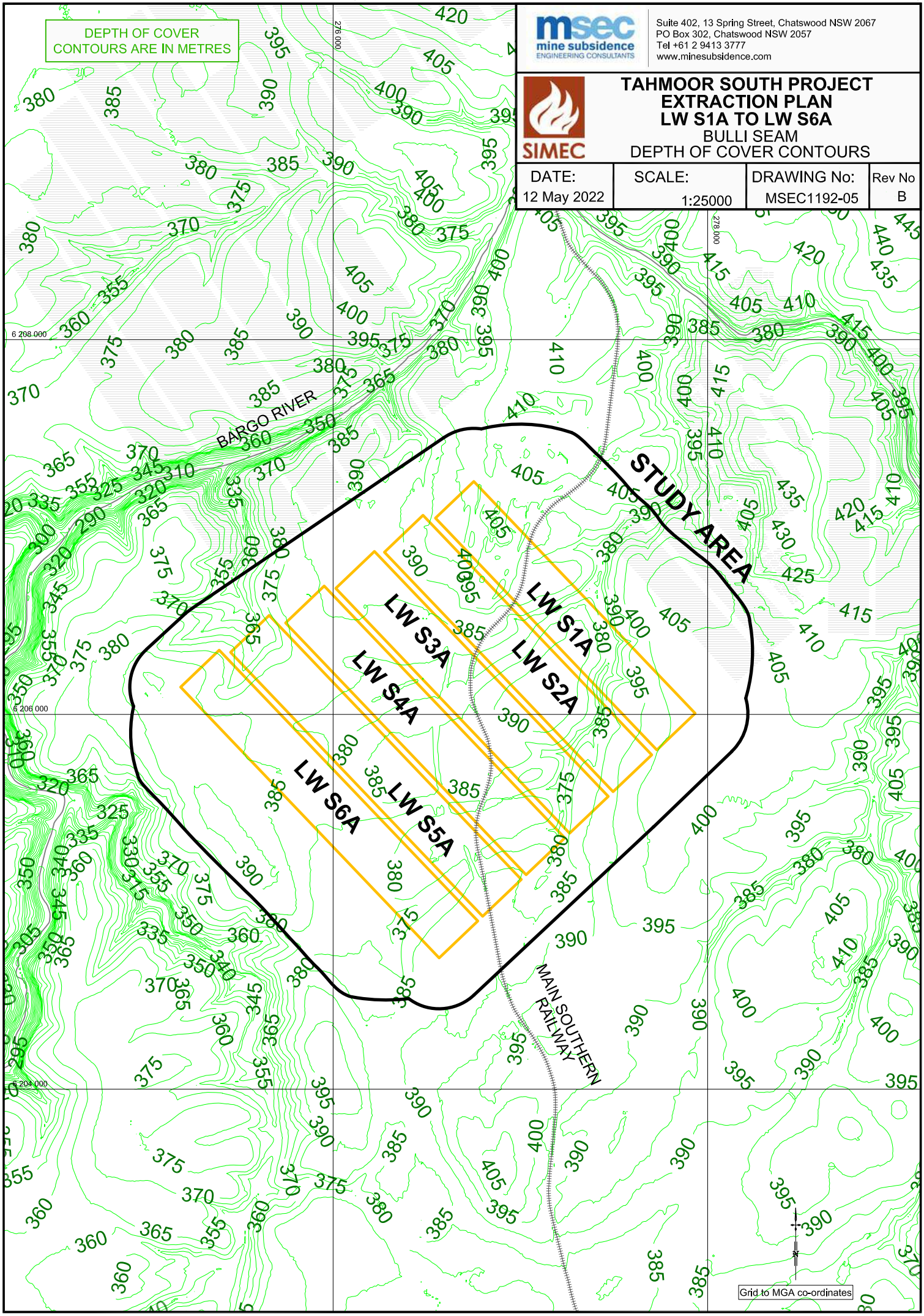
STUDY AREA

MAIN SOUTHERN RAILWAY

LEGEND

- 2.1m
- 2.2m

I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\AcadData\MSEC1192-05 Depth of Cover Contours.dwg



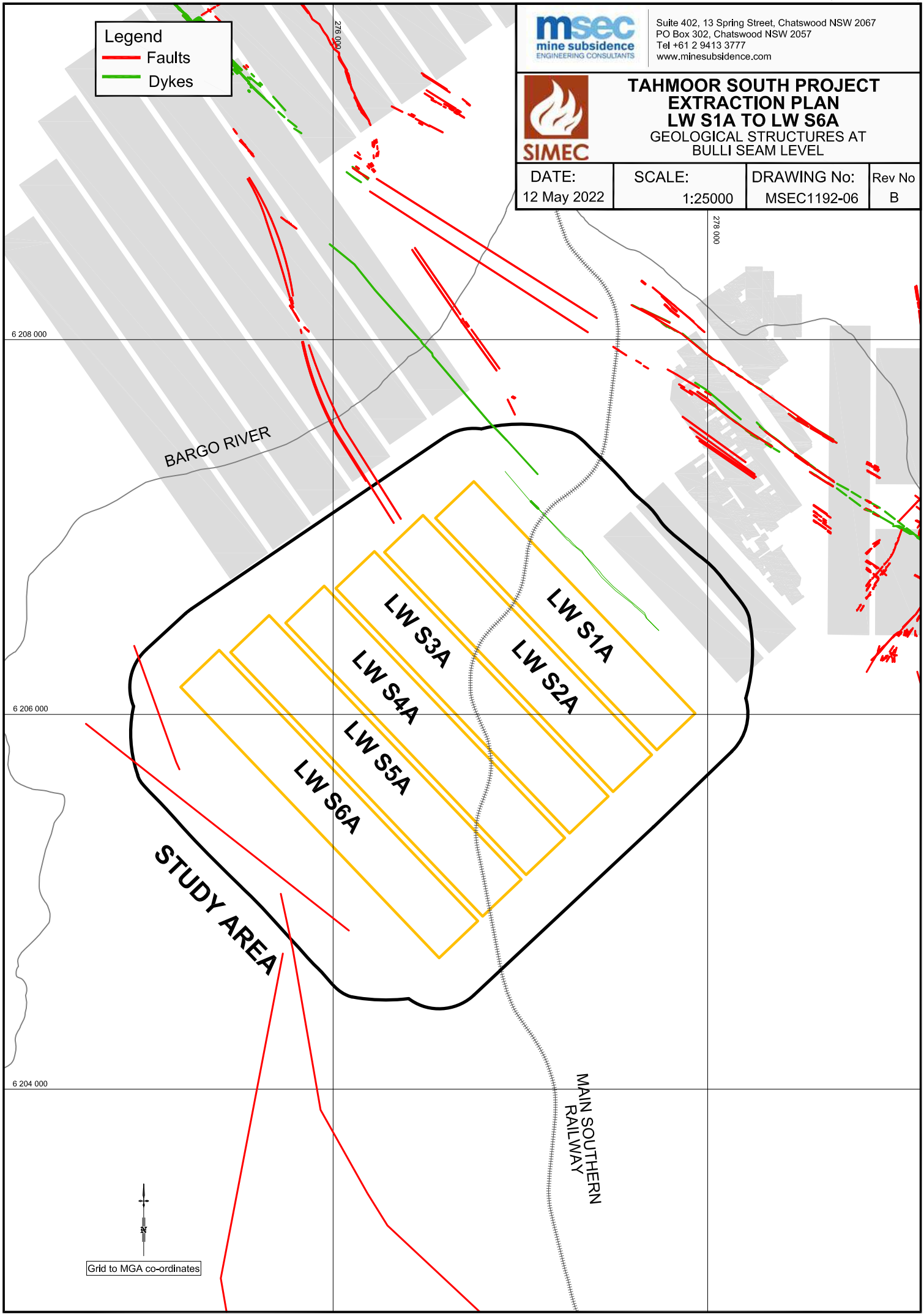
msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH PROJECT
EXTRACTION PLAN
LW S1A TO LW S6A
BULLI SEAM
DEPTH OF COVER CONTOURS

DATE:	SCALE:	DRAWING No:	Rev No
12 May 2022	1:25000	MSEC1192-05	B

I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\AcadData\MSEC1192-06 Geological Structures.dwg



msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH PROJECT EXTRACTION PLAN LW S1A TO LW S6A

GEOLOGICAL STRUCTURES AT BULLI SEAM LEVEL

DATE:	SCALE:	DRAWING No:	Rev No
12 May 2022	1:25000	MSEC1192-06	B

I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\AcadData\MSEC1192-07 Streams - General Layout.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH PROJECT
EXTRACTION PLAN LWS1A TO LWS6A

STREAMS - GENERAL LAYOUT

DATE:	SCALE:	DRAWING No:	Rev No
12 May 2022	1:25000	MSEC1192-07	B

278 000

276 000

6 208 000

6 206 000

6 204 000

BARGO RIVER

BARGO RIVER

MAIN SOUTHERN RAILWAY

Hidden Creek

Hidden Creek

LW S2A

LW S3A

TEATREE HOLLOW

LW S1A

TRIBUTARY OF TEATREE HOLLOW

LW S4A

LW S5A

LW S6A

PICTON WEIR

STUDY AREA

600m Study Area for Natural Features

DOGTRAP CK

TRIBUTARY 2 OF DOG TRAP CREEK

TRIBUTARY 1 OF DOG TRAP CREEK

HORNES CK

MAIN SOUTHERN RAILWAY

DOGTRAP CK

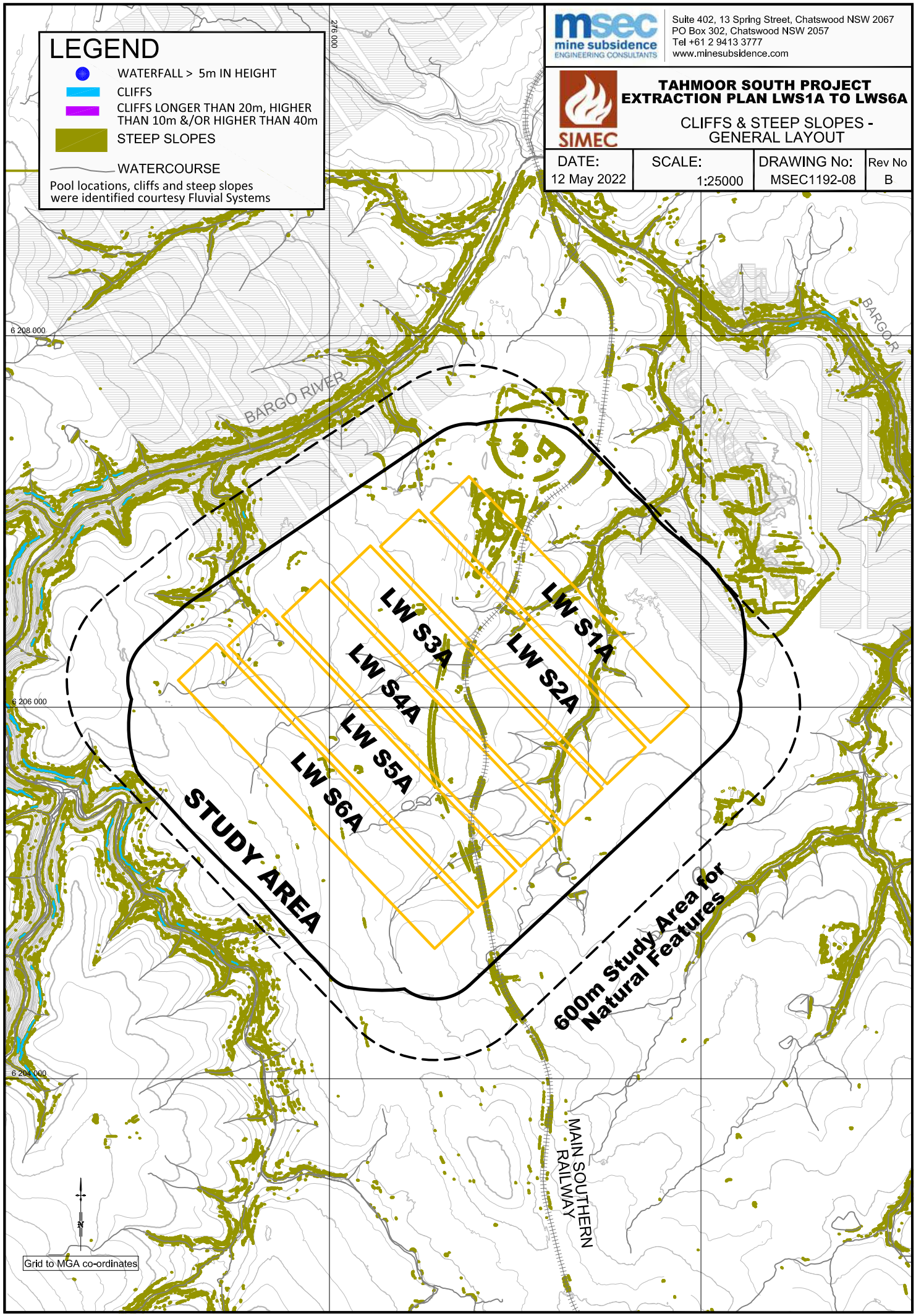
Grid to MGA co-ordinates

LEGEND

Stream order information courtesy Fluvial Systems

- 1st ORDER STREAMS
- 2nd ORDER STREAMS
- 3rd ORDER STREAMS
- 4th ORDER STREAMS
- 5th ORDER STREAMS
- 7th ORDER STREAMS
- SURFACE CONTOURS

I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\AcadData\MSEC1192-08 Cliffs & Steep Slopes - General Layout.dwg



msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

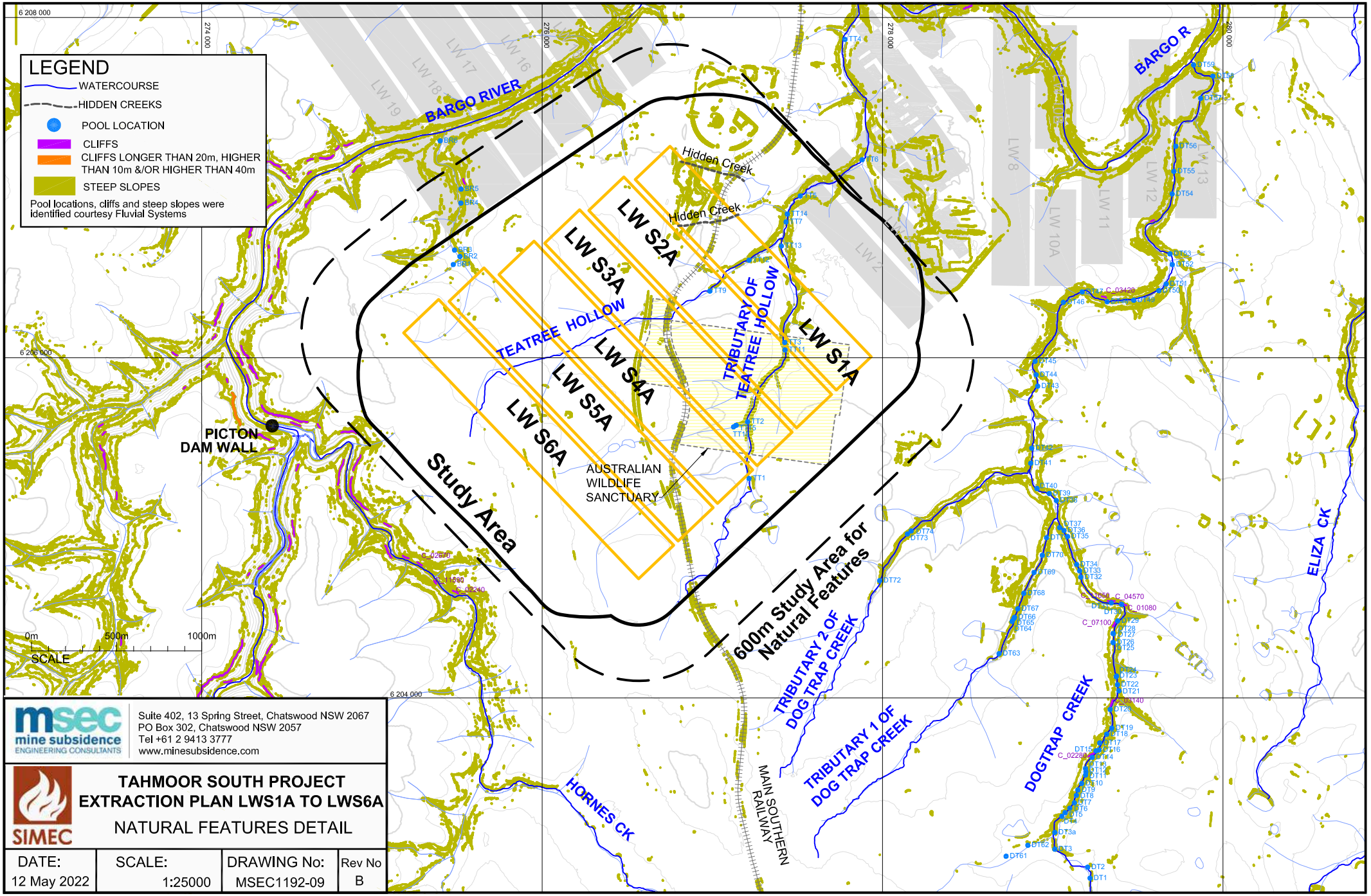
SIMEC

TAHMOOR SOUTH PROJECT
EXTRACTION PLAN LWS1A TO LWS6A

CLIFFS & STEEP SLOPES - GENERAL LAYOUT

DATE:	SCALE:	DRAWING No:	Rev No
12 May 2022	1:25000	MSEC1192-08	B

I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\AcadData\MSEC1192-09 Natural Features Detail Map.dwg



msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH PROJECT
EXTRACTION PLAN LWS1A TO LWS6A
NATURAL FEATURES DETAIL

DATE:	SCALE:	DRAWING No:	Rev No
12 May 2022	1:25000	MSEC1192-09	B

I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\AcadData\MSEC1192-10 Rail.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH PROJECT
EXTRACTION PLAN LWS1A TO LWS6A
RAILWAYS & ASSOCIATED INFRASTRUCTURE

DATE:	SCALE:	DRAWING No:	Rev No
12 May 2022	25000	MSEC1192-10	B

278 000
276 000
6 208 000
6 206 000
6 204 000

Bargo River Road Bridge
Railway Viaduct (over Bargo R)
96.300
Remembrance Drive bridge (over Rail)
96.400
96.860
Railway culvert
See inset diagram below for Railway loop features
97.560
Railway culvert (over tributary of Bargo River)
97.980
98.160
Tahmoor Mine coal conveyor
BARGO RIVER
Hidden creek
98.445
98.739
Hidden creek
Rail culverts (over tributary of Teatree Hollow)
99.035
99.388
STUDY AREA
LWS1A
LWS2A
LWS3A
LWS4A
LWS5A
LWS6A
TEATREE HOLLOW
Rail culverts (over tributary of Teatree Hollow)
100.121
100.425
TRIBUTARY OF TEATREE HOLLOW
DOGTRAP CK
Rail culvert (over tributary of Teatree Hollow)
101.000
101.192
Wellers Road bridge
101.470
MAIN SOUTHERN RAILWAY
101.920
102.244
102.279
102.440
Bargo Railway Station & Pedestrian footbridge
102.873

LEGEND
RAILWAYS
BRIDGE
CULVERT

Railways Loop
Level Crossing
cutting
Pedestrian Crossing
Tunnel opening
Road Bridge
Tunnel opening
embankment
Level Crossing
Level Crossing
Level Crossing
Road culvert
cutting
STUDY AREA

Grid to MGA co-ordinates

I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\AcadData\MSEC1192-11 Roads.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring ST, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH PROJECT EXTRACTION PLAN LW S1A TO LW S6A

ROADS & ASSOCIATED INFRASTRUCTURE

DATE:	SCALE:	DRAWING No:	Rev No
12 May 2022	1:25000	MSEC1192-11	B

Bargo River RD bridge (over Main Southern Railway)

Bargo River RD bridge (over tributary of Bargo R)

Railway Viaduct (over Bargo R)

Remembrance DR Bridge over Bargo River & Main Southern Railway

Wellers RD bridge WR-BR1

KS-BR1 Kader ST bridge

BR-BR1

STUDY AREA

LW S1A

LW S2A

LW S3A

LW S4A

LW S5A

LW S6A

REMEMBRANCE DR

BARGO RIVER RD

BARGO RIVER

MAIN SOUTHERN RAILWAY

STRATFORD RD

ROCKFORD RD

OLIVE GROVE

FIRE RD NO P1

Hidden Creek

CALOOLA RD

TEATREE HOLLOW

TRIBUTARY OF TEATREE HOLLOW

YARRAN RD

CHARLIES POINT RD

DOGTRAP CK

ANTHONY RD

WELLERS RD

CLAREMONT DR

ASHBY CLOSE

HOGANS DR

ELVY ST

LLOYDS WAY

HAMBRIDGE RD

IRONBARK RD

GREAT SOUTHERN RD

HAWTHORNE RD

WATTLE ST

DYMOND RD

GOVERNMENT RD

KADER ST

MIMOSA ST

CAMBALAN ST

RADNOR RD

GWYNN HUGHES ST

NOONGAH ST

BARGO RD

278 000

6 208 000

6 206 000

6 204 000

Grid to MGA co-ordinates

LEGEND

- RAILWAY
- PRINCIPAL RDS
- LOCAL RDS
- FIRE RDS
- BRIDGE
- CULVERT

I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\AcadData\MSEC1192-12 Water Infrastructure.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH PROJECT
EXTRACTION PLAN
LW S1A TO LW S6A
POTABLE WATER INFRASTRUCTURE

DATE:	SCALE:	DRAWING No:	Rev No
12 May 2022	1:25000	MSEC1192-12	B

PIPE SIZE
- 100 mm Ø
- 150 mm Ø
- 200 mm Ø
- 250 mm Ø
- 300 mm Ø
- 375 mm Ø
- 450 mm Ø
- 500 mm Ø
- 600 mm Ø

276 000
278 000
6 208 000
6 206 000
6 204 000
BARGO RIVER
MAIN SOUTHERN RAILWAY
Hidden creek
Hidden creek
LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
TEATREE HOLLOW
TRIBUTARY OF TEATREE HOLLOW
DOGTRAP CK
STUDY AREA
TANK
N
Grid to MGA co-ordinates

I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\AcadData\MSEC1192-13 Sewer Infrastructure.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH PROJECT
EXTRACTION PLAN
LW S1A TO LW S6A
SEWER INFRASTRUCTURE

DATE:	SCALE:	DRAWING No:	Rev No
12 May 2022	1:25000	MSEC1192-13	B

PIPE SIZE
- 40 mm Ø
- 50 mm Ø
- 63 mm Ø
- 75 mm Ø
- 90 mm Ø
- 100 mm Ø
- 110 mm Ø
- 125 mm Ø
- 140 mm Ø
- 150 mm Ø
- 160 mm Ø
- 180 mm Ø
- 225 mm Ø
- 630 mm Ø

276 000
278 000
6 208 000
6 206 000
6 204 000
BARGO RIVER
MAIN SOUTHERN RAILWAY
Hidden Creek
Hidden Creek
LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
STUDY AREA
TEATREE HOLLOW
TRIBUTARY OF TEATREE HOLLOW
DOGTRAP CK
Grid to MGA co-ordinates

I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\AcadData\MSEC1192-14 Gas.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH PROJECT
EXTRACTION PLAN
LW S1A TO LW S6A
GAS INFRASTRUCTURE

DATE:	SCALE:	DRAWING No:	Rev No
12 May 2022	1:25000	MSEC1192-14	B

LEGEND:
Jemena Pipeline
- Ø 32mm NY
- Ø 50mm NY
- Ø 63mm PE
- Ø 150mm Steel Main
- Ø 160mm PE

276 000
278 000
6 208 000
6 206 000
6 204 000

BARGO RIVER
MAIN SOUTHERN RAILWAY
Hidden Creek
Hidden Creek
STUDY AREA
LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
TEATREE HOLLOW
TRIBUTARY OF TEATREE HOLLOW
DOGTRAP CK

N
Grid to MGA co-ordinates

I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\AcadData\MSEC1192-15 Electrical.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH PROJECT
EXTRACTION PLAN
LW S1A TO LW S6A
ELECTRICAL INFRASTRUCTURE

DATE:	SCALE:	DRAWING No:	Rev No
12 May 2022	1:25000	MSEC1192-15	B

276 000

278 000

6 208 000

6 206 000

BARGO RIVER

MAIN SOUTHERN RAILWAY

Hidden Creek

Hidden Creek

STUDY AREA

LW S1A

LW S2A

LW S3A

LW S4A

LW S5A

LW S6A

TEATREE HOLLOW

TRIBUTARY OF TEATREE HOLLOW

DOGTRAP CK

LEGEND:

- Transmission Lines
- Low Voltage
- 11 kV
- 66 kV
- Substation
- Power Poles

N

Grid to MGA co-ordinates

I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\AcadData\MSEC1192-16 Telecommunications.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH PROJECT
EXTRACTION PLAN
LW S1A TO LW S6A

TELECOMMUNICATIONS INFRASTRUCTURE

DATE:	SCALE:	DRAWING No:	Rev No
12 May 2022	1:25000	MSEC1192-16	B

TELSTRA
- OPTICAL FIBRE
- COPPER CABLES

NBN
- OPTICAL FIBRE
- COPPER CABLES

TPG
- OPTICAL FIBRE

276 000
278 000
6 208 000
6 206 000
6 204 000

BARGO RIVER
MAIN SOUTHERN RAILWAY
Hidden creek
Hidden creek
STUDY AREA
LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
TEATREE HOLLOW
TRIBUTARY OF TEATREE HOLLOW
DOGTRAP CK
NBN Tower
Bargo Exchange
Grid to MGA co-ordinates

I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\AcadData\MSEC1192-17 Archaeological & Heritage Sites.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH PROJECT EXTRACTION PLAN LW S1A TO LW S6A

ARCHAEOLOGICAL & HERITAGE SITES

DATE:	SCALE:	DRAWING No:	Rev No
12 May 2022	1:25000	MSEC1192-17	B

LEGEND
ARCHAEOLOGICAL SITES -
- GRINDING GROOVE
- OPEN CAMP SITE
- ISOLATED FIND
- ABORIGINAL DREAMING STORY
- SCARRED TREE
- SHELTER WITH ART
- HERITAGE
- WATERCOURSE

Locations courtesy of Niche

276 000
278 000
6 208 000
6 206 000
6 204 000

BARGO RIVER
MAIN SOUTHERN RAILWAY
STUDY AREA
Tahmoor Mine
Hidden creek
Hidden creek
48-2-0275
52-2-3968
LW S3A
LW S4A
LW S5A
LW S6A
LW S1A
LW S2A
52-2-4471
TEATREE HOLLOW
Picton Weir
Wirrimbirra Sanctuary (Australian Wildlife Sanctuary)
52-2-1532
DOGTRAP CK
TRIBUTARY OF TEATREE HOLLOW
Bargo Cemetery
52-2-3921
52-2-1540
Kalinya Gardens
52-2-4194
52-2-4195
52-2-1538
52-2-1539
Wellers Road bridge (Bargo Railway Bridge North)
Old Coomeroo Homestead
52-2-4395
Great Southern Road
Homestead
Cottage
Post Office
Bargo Surgery
Hotel Bargo
Bargo Rural Trading Centre
Bargo Railway Station and WC
House
House
Railway cottages
Commercial
Cottage
Bargo Public School
Hawthorne
Bargo Public School Residence
Avon Dam Road bridge (over Railway)
52-2-4034
52-2-3872

N
Grid to MGA co-ordinates

I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\AcadData\MSEC1192-18 Buildings & Dams.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH PROJECT
EXTRACTION PLAN
LW S1A TO LW S6A
BUILDINGS & DAMS

DATE:	SCALE:	DRAWING No:	Rev No
12 May 2022	1:25000	MSEC1192-18	B

276 000

278 000

6 208 000

6 206 000

6 204 000

BARGO RIVER RD

OLIVE GROVE

BARGO RIVER

MAIN SOUTHERN RAILWAY

Hidden Creek

Hidden creek

REMEMBRANCE DR

STRATFORD RD

STUDY AREA

LW S1A

LW S2A

LW S3A

LW S4A

LW S5A

LW S6A

CALOOLA RD

TEATREE HOLLOW

TRIBUTARY OF TEATREE HOLLOW

DOGTRAP CK

YARRAN RD

CHARLIES POINT RD

ANTHONY RD

WELLERS RD

CLAREMONT DR

ASHLEY CLOSE

HOGANS DR

ELVY LO

FLORENCE WAY

KINDER ST

GWENN HUGHES CR

MIMOSA ST

CAMBRIDGE RD

ROONGA PL

GREAT SOUTHERN RD

HAWTHORNE RD

IRONBANK RD

DYMOND RD

GOVERNMENT RD

BARGO RD

N

Grid is MGA co-ordinates

LEGEND

- HOUSES
- RURAL STRUCTURES
- HERITAGE STRUCTURES
- COMMERCIAL STRUCTURES
- PUBLIC AMENITIES & UTILITIES
- POOLS
- TANKS
- DAMS

I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\AcadData\MSEC1192-19 Public Amenities & Commercial.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH PROJECT EXTRACTION PLAN LW S1A TO LW S6A

PUBLIC AMENITIES & COMMERCIAL PREMISES

DATE:	SCALE:	DRAWING No:	Rev No
12 May 2022	1:25000	MSEC1192-19	B

LEGEND
- COMMUNITY BUILDINGS & SPACES
- PUBLIC UTILITIES
- COMMERCIAL OR INDUSTRIAL BUILDINGS

Grid to MGA co-ordinates

278 000

6 208 000

6 206 000

6 204 000

Tahmoor Mine

MAIN SOUTHERN RAILWAY

BARGO RIVER

Wollondilly Anglican College

Hidden creek

Auto Wreckers

Tahmoor Mine Reject Emplacement Area (REA)

Inghams Bargo Chicken Breeder Production Complex

Bargo Petroleum and Hill Top Pit Stop

Tahmoor Garden Centre

LW S3A

LW S4A

LW S2A

LW S1A

NBN Tower

TEATREE HOLLOW

Australian Wildlife Sanctuary

Bargo Valley Produce

MKD Machinery

Ingham Turkey Farm

LW S5A

LW S6A

TRIBUTARY OF TEATREE HOLLOW

DOGTRAP CK

Bargo Cemetery

STUDY AREA

Canine Country Club and Cattery

Bargo Waste Management Centre

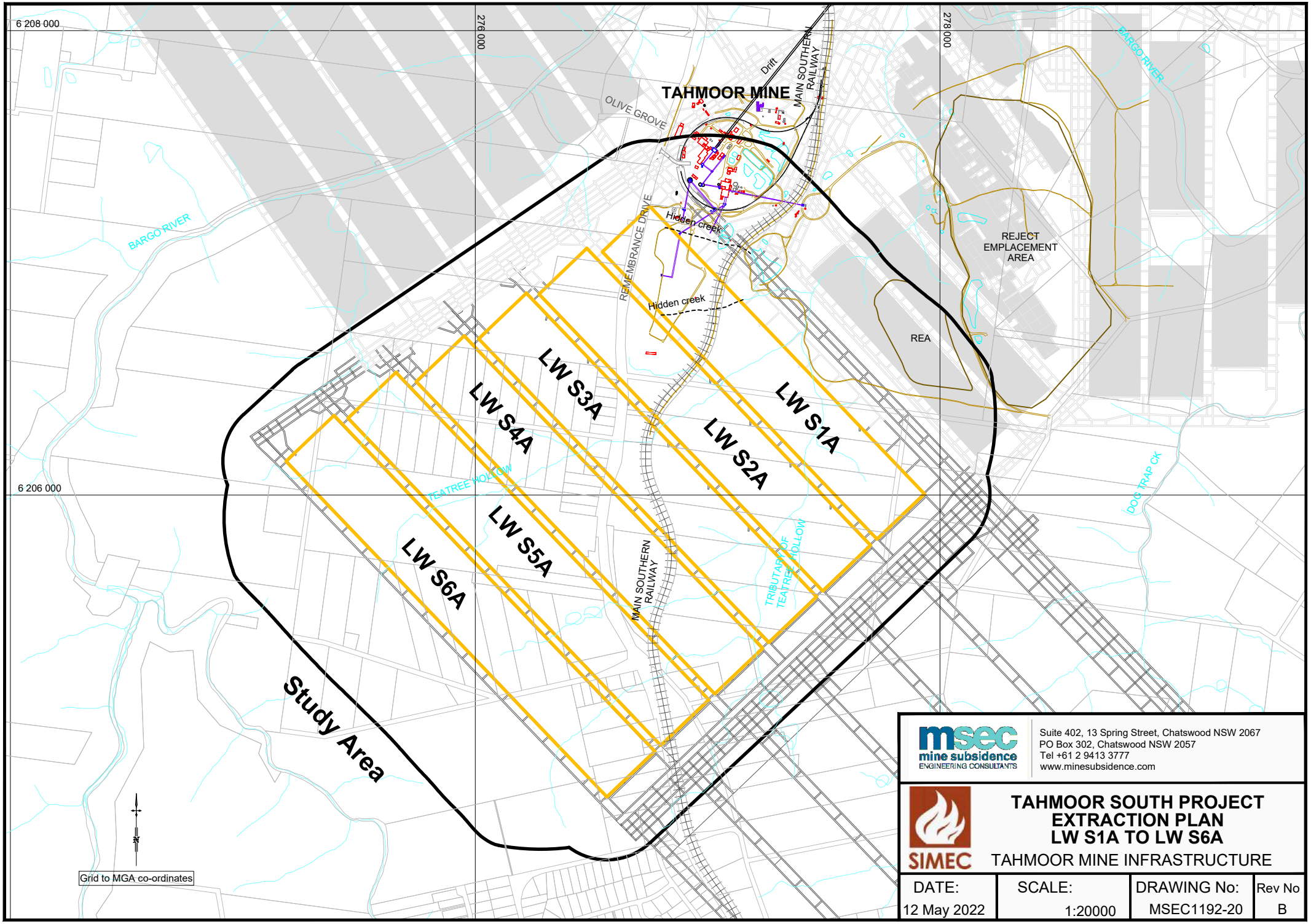
Sydney Water Reservoir

BARGO EXCHANGE

Existing Mine shaft of Historical workings

Bargo Railway Station

I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\AcadData\MSEC1192-20 Tahmoor Mine Infrastructure.dwg



msec mine subsidence ENGINEERING CONSULTANTS

Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH PROJECT EXTRACTION PLAN LW S1A TO LW S6A

TAHMOOR MINE INFRASTRUCTURE

DATE:	SCALE:	DRAWING No:	Rev No
12 May 2022	1:20000	MSEC1192-20	B

I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\AcadData\MSEC1192-21 Groundwater Bores & Survey Control Marks.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH PROJECT EXTRACTION PLAN LW S1A TO LW S6A

GROUNDWATER BORES & SURVEY CONTROL MARKS

DATE:	SCALE:	DRAWING No:	Rev No
12 May 2022	1:25000	MSEC1192-21	B

LEGEND
- SURVEY CONTROL MARKS

GROUNDWATER BORES
- PRIVATELY OWNED BORES
- SHALLOW MONITORING BORES
- DEEP MONITORING BORES
- PIT-TOP & REA MONITORING BORES

STUDY AREA
LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
BARGO RIVER
Hidden creek
TEATREE HOLLOW
TRIBUTARY OF TEATREE HOLLOW
MAIN SOUTHERN RAILWAY
DOGTRAP CK
276 000
278 000
6 208 000
6 206 000
6 204 000
Grid to MGA co-ordinates

I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\AcadData\MSEC1192-22 Predicted Subs Colour Contours.dwg

NOTE:
The value of the Subsidence Contours, from the outside to the inside of the panels, are 20mm, 50mm, 100mm, 200mm and so forth, in 100mm increments.

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH PROJECT
EXTRACTION PLAN
LW S1A TO LW S6A
PREDICTED TOTAL SUBSIDENCE CONTOURS AFTER LW S6A

DATE:	SCALE:	DRAWING No:	Rev No
12 May 2022	1:25000	MSEC1192-22	B

276 000
278 000
6 208 000
6 206 000
6 204 000

BARGO RIVER
MAIN SOUTHERN RAILWAY
Hidden creek
Hidden creek
1350
LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
PREDICTION LINE

LEGEND
SUBSIDENCE CONTOUR COLOUR SCALE (mm)
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
50
20

Grid to MGA co-ordinates

I:\Projects\Tahmoor South\MSEC1192 - Extraction Plan for LW S1A-S6A\AcadData\MSEC1192-23 Proposed Monitoring.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH PROJECT EXTRACTION PLAN LW S1A TO LW S6A

PROPOSED MONITORING

DATE:	SCALE:	DRAWING No:	Rev No
12 May 2022	1:25000	MSEC1192-23	B

STUDY AREA
LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
Tahmoor Colliery
Wollondilly Anglican College
Poultry Sheds
Wrecker
Igloos
Service Station
Tahmoor Garden Centre
Australian Wildlife Sanctuary
Concrete materials plant
NBN Tower
Poultry Sheds
Wellers Rd Bridge
Railway Viaduct
Hidden creek
Hidden creek
Along Tahmoor Mine property boundary
TT12
TT9
Teatree 3
Teatree 2
GNSS
Picton Weir
BARGO RIVER ROAD
REMEMBRANCE DR
MAIN SOUTHERN RAILWAY
STRATFORD RD
ROCKFORD ROAD
BARGO RIVER
FIRE ROAD NO P1
OLIVE GROVE
CALOOLA ROAD
TEATREE HOLLOW
YARRAN ROAD
CHARLIES POINT RD
GREAT SOUTHERN RD
ANTHONY ROAD
WELLERS RD
CLAREMONT DRIVE
ASHBY CL
LLOYDS WAY
ELVY STREET
HOGANS DRIVE
HAMBRIDGE ROAD
KADER STREET
MIMOSA STREET
CAMBALAN STREET
RADNOR ROAD
NOONGAH ST
GWYNN HUGHES
IRONBARK ROAD
WATTLE STREET
DYMOND ROAD
GOVERNMENT ROAD
BARGO ROAD
DOG TRAP CK
278 000
276 000
6 208 000
6 206 000

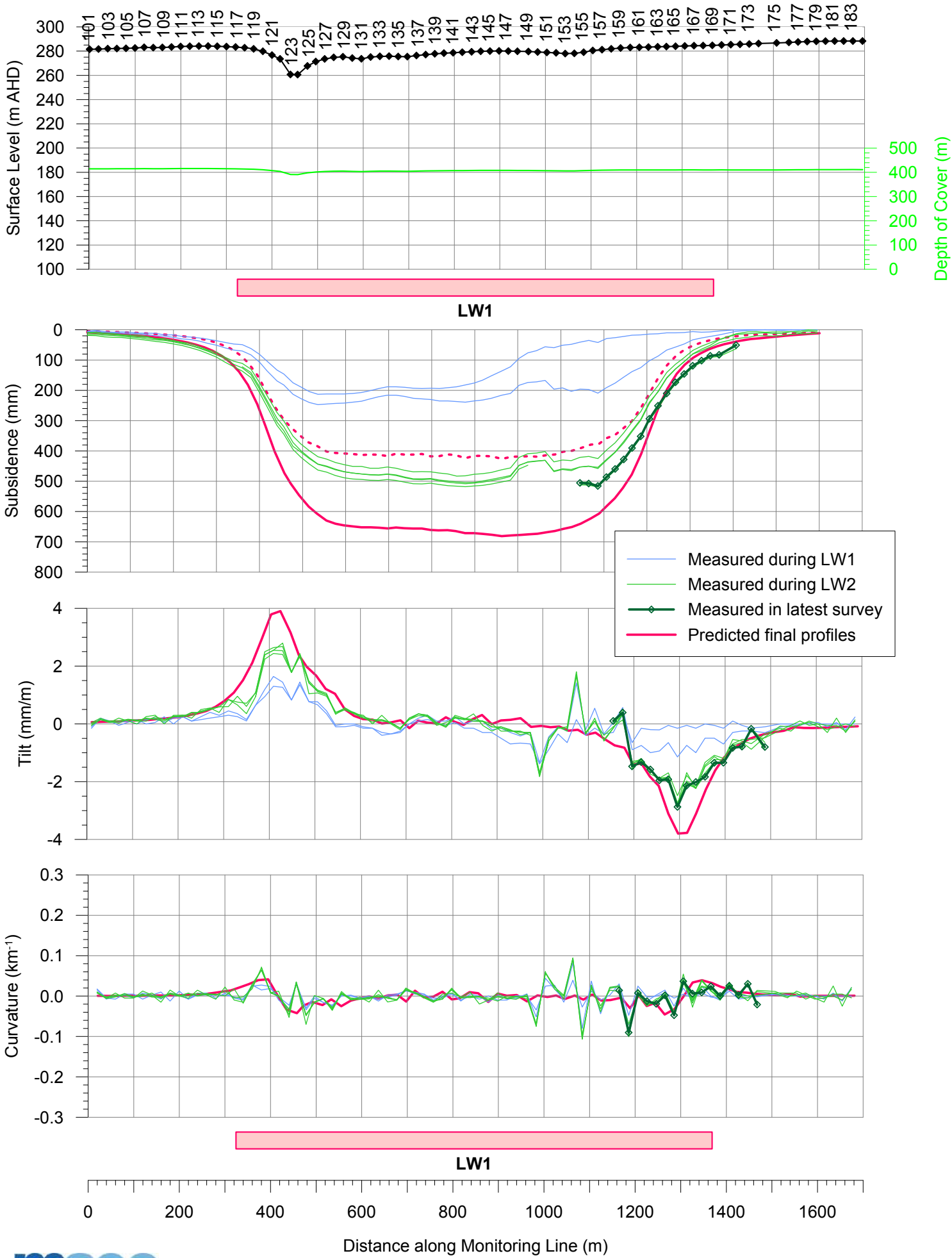
LEGEND

- WATER MONITORING SITE
- PROPOSED MONITORING LINES
- PROPOSED MONITORING PEGS
- PROPOSED CREEK CROSSLINES
- PROPOSED GNSS
- WATERCOURSE

Grid to MGA co-ordinates

APPENDIX G. FIGURES COMPARING OBSERVED AND PREDICTED SUBSIDENCE PARAMETERS OVER PREVIOUSLY EXTRACTED LONGWALLS AT TAHMOOR MINE

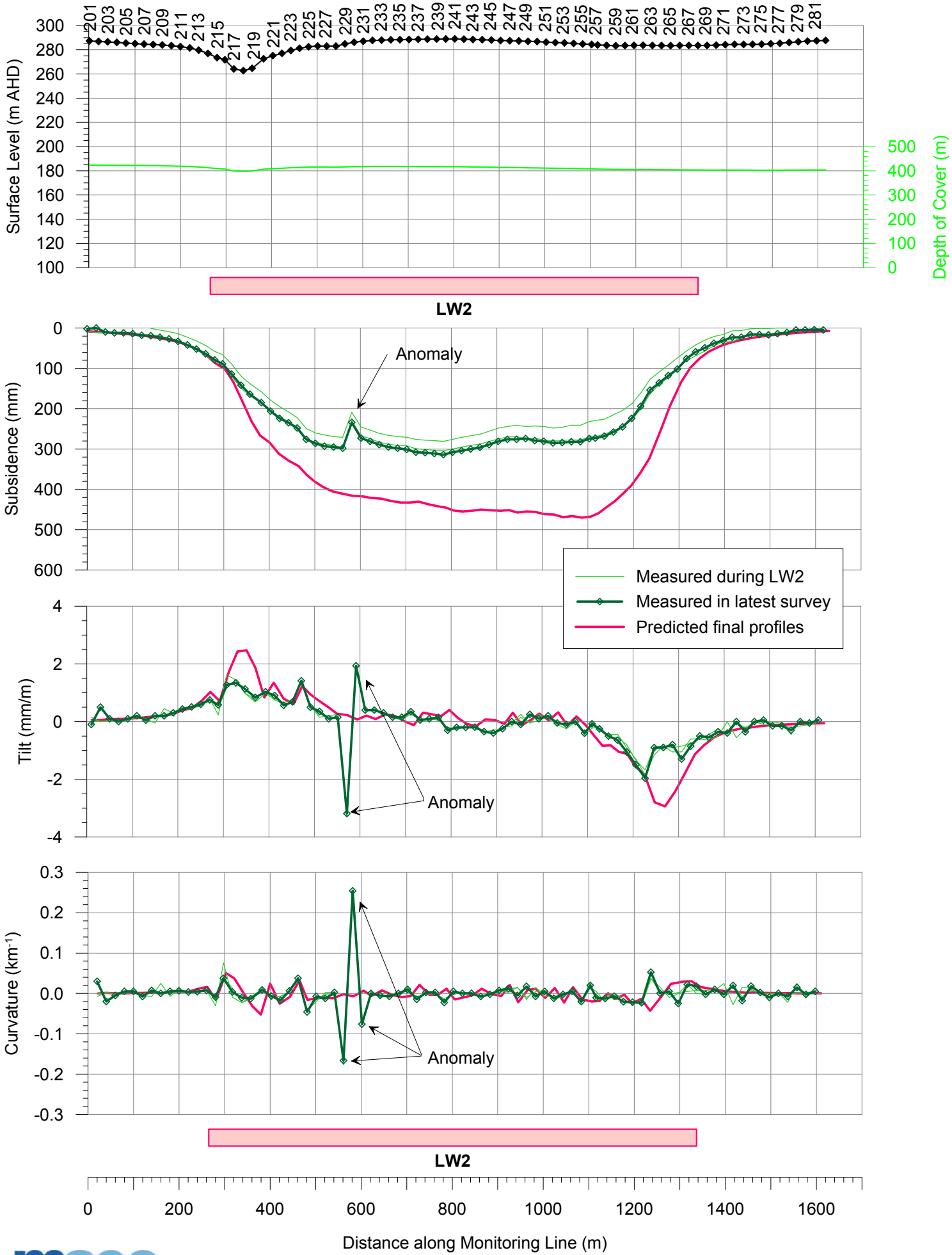
Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the 100-Line due to Tahmoor LW1 and LW2



msec

Fig. G.01

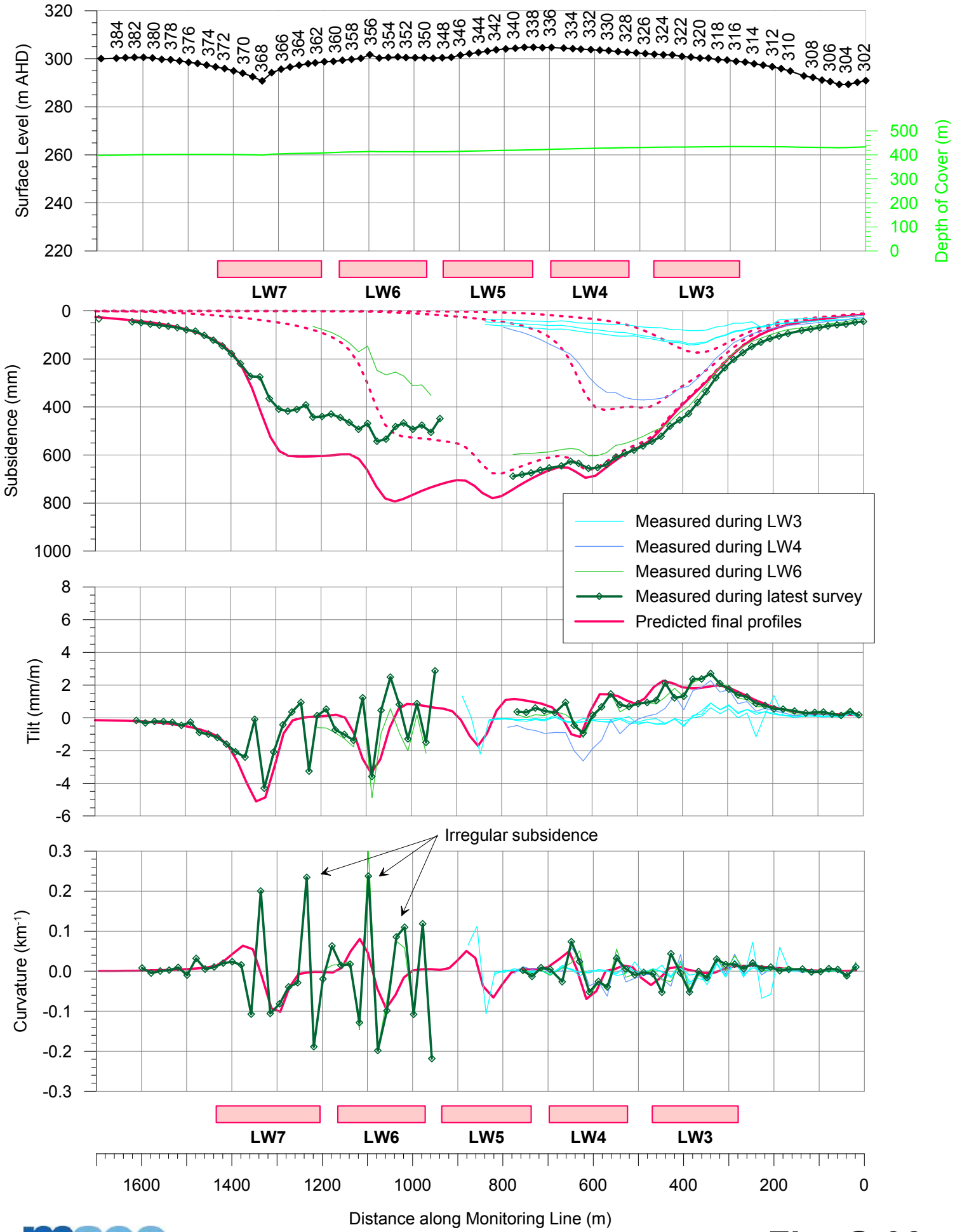
Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the 200-Line due to Tahmoor LW2



msec

Fig. G.02

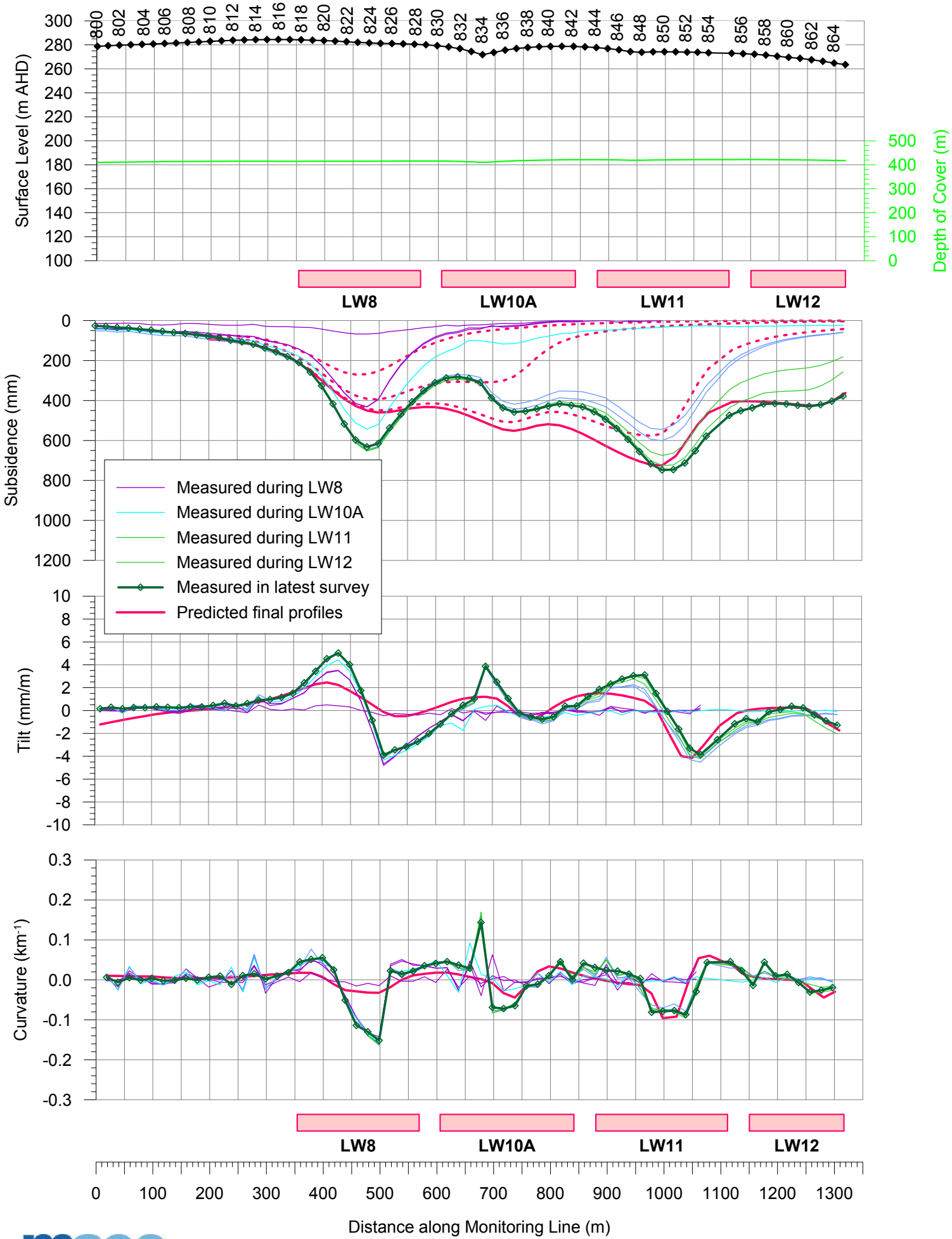
Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the 300-Line due to Tahmoor LW3 to LW7



msec

Fig. G.03

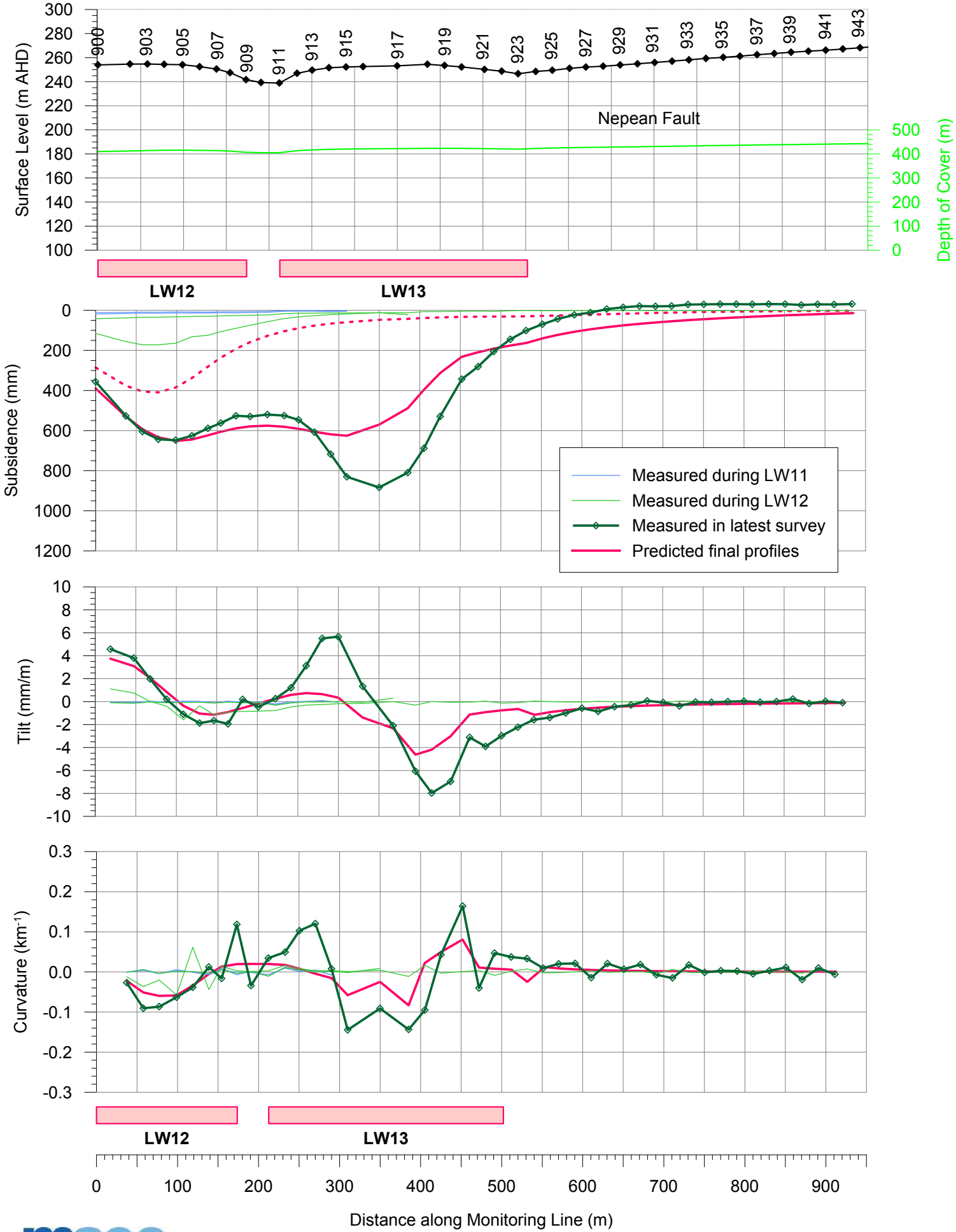
Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the 800-Line due to Tahmoor LW8 to LW12



msec

Fig. G.04

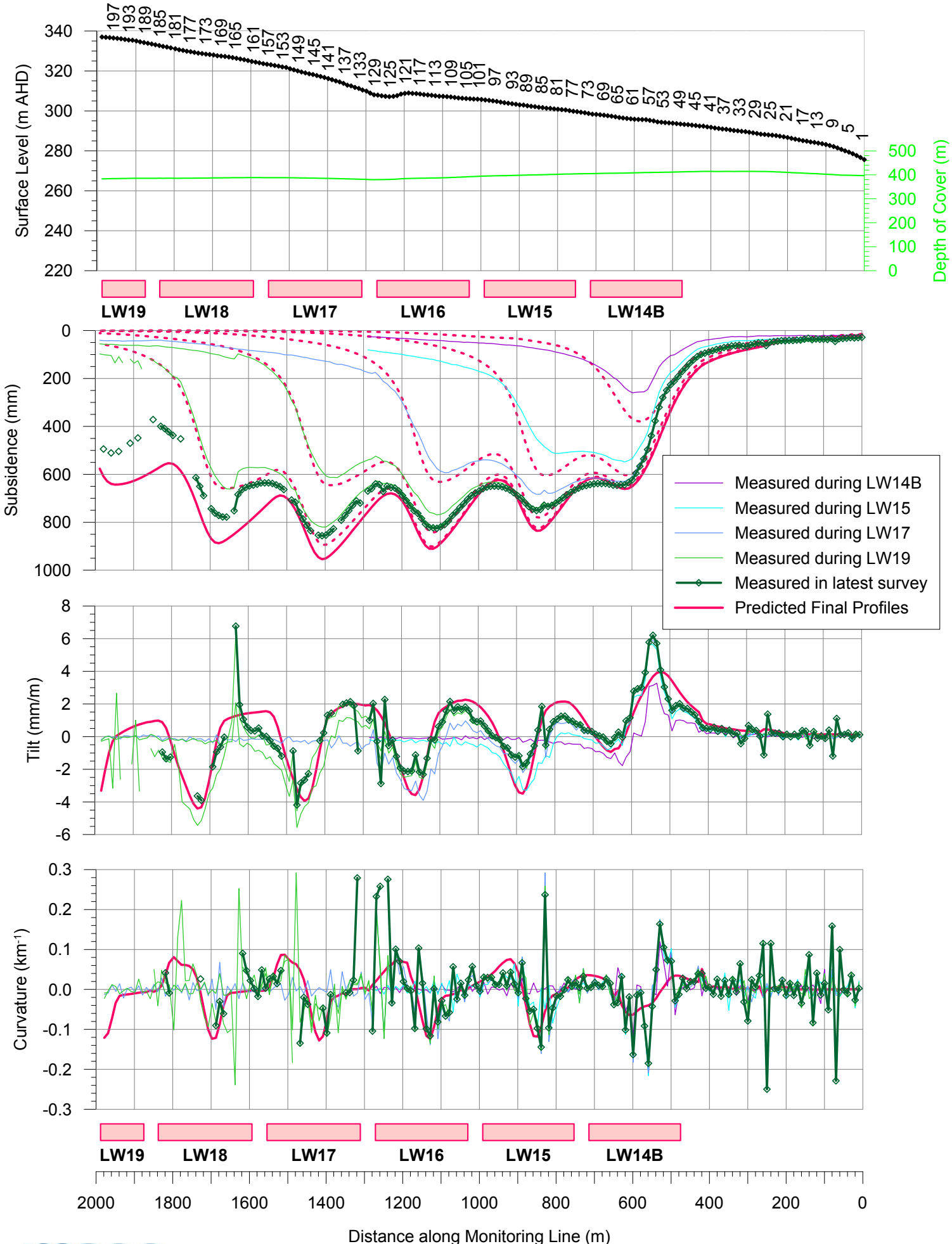
Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the 900-Line due to Tahmoor LW10A to LW13



msec

Fig. G.05

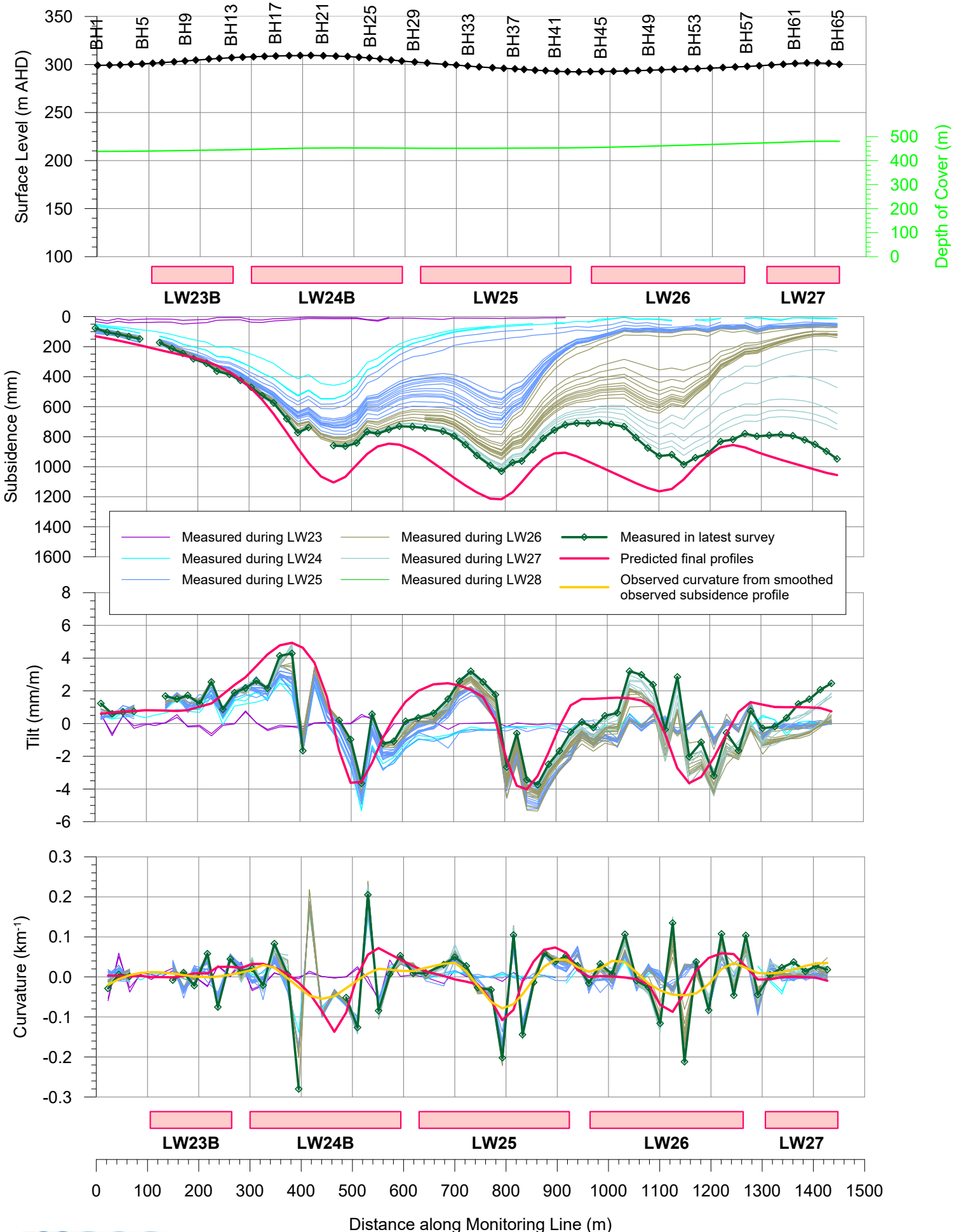
Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the 1000-Line due to Tahmoor LW14B to LW19



msec

Fig. G.06

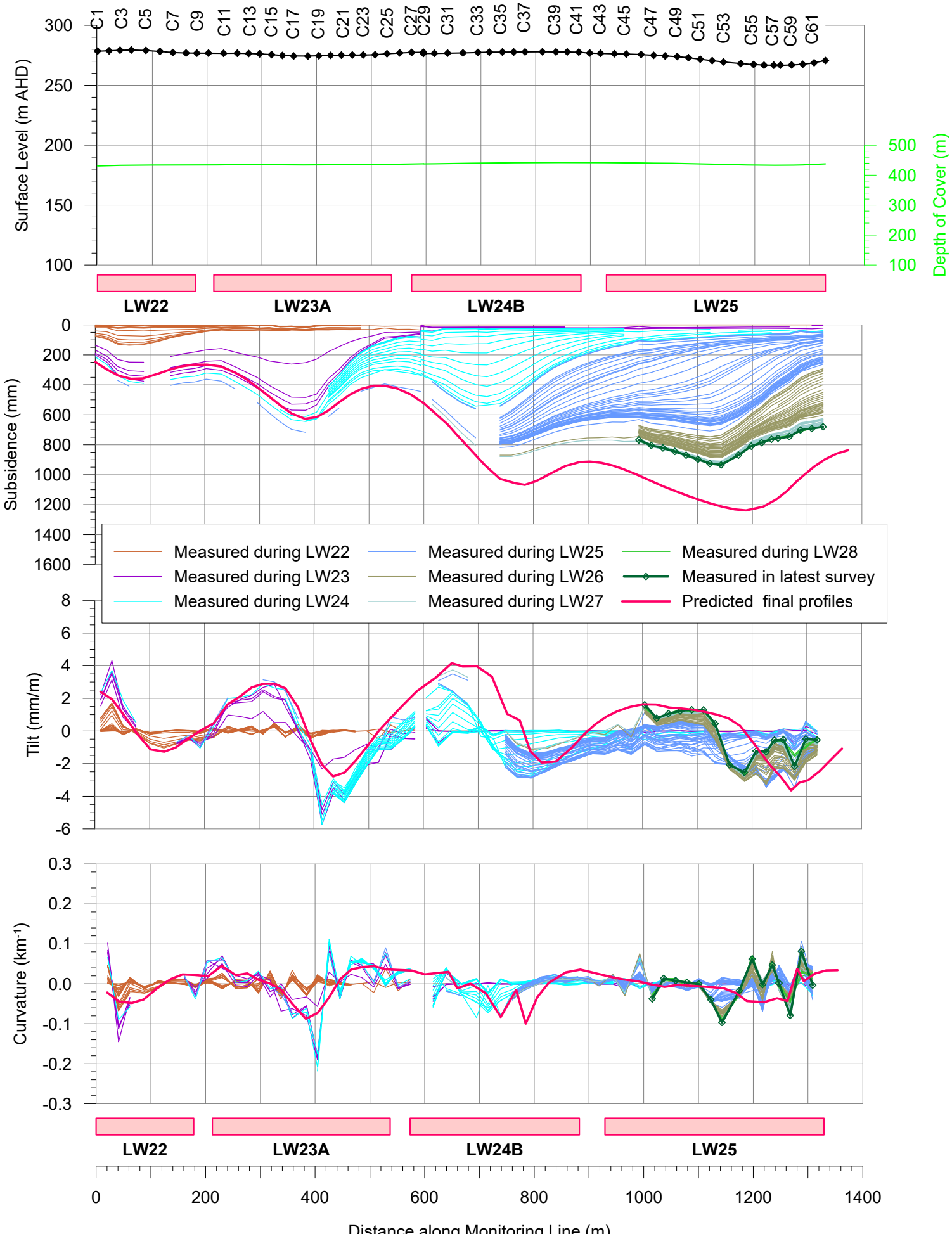
Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the Brundah Road Line due to Tahmoor North LW23B to LW28



msec

Fig. G.07

Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the Castlereagh Street Line due to Tahmoor North LW22 to LW28



msec

Fig. G.08

Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the Remembrance Drive Line due to Tahmoor North LW23A to LW30

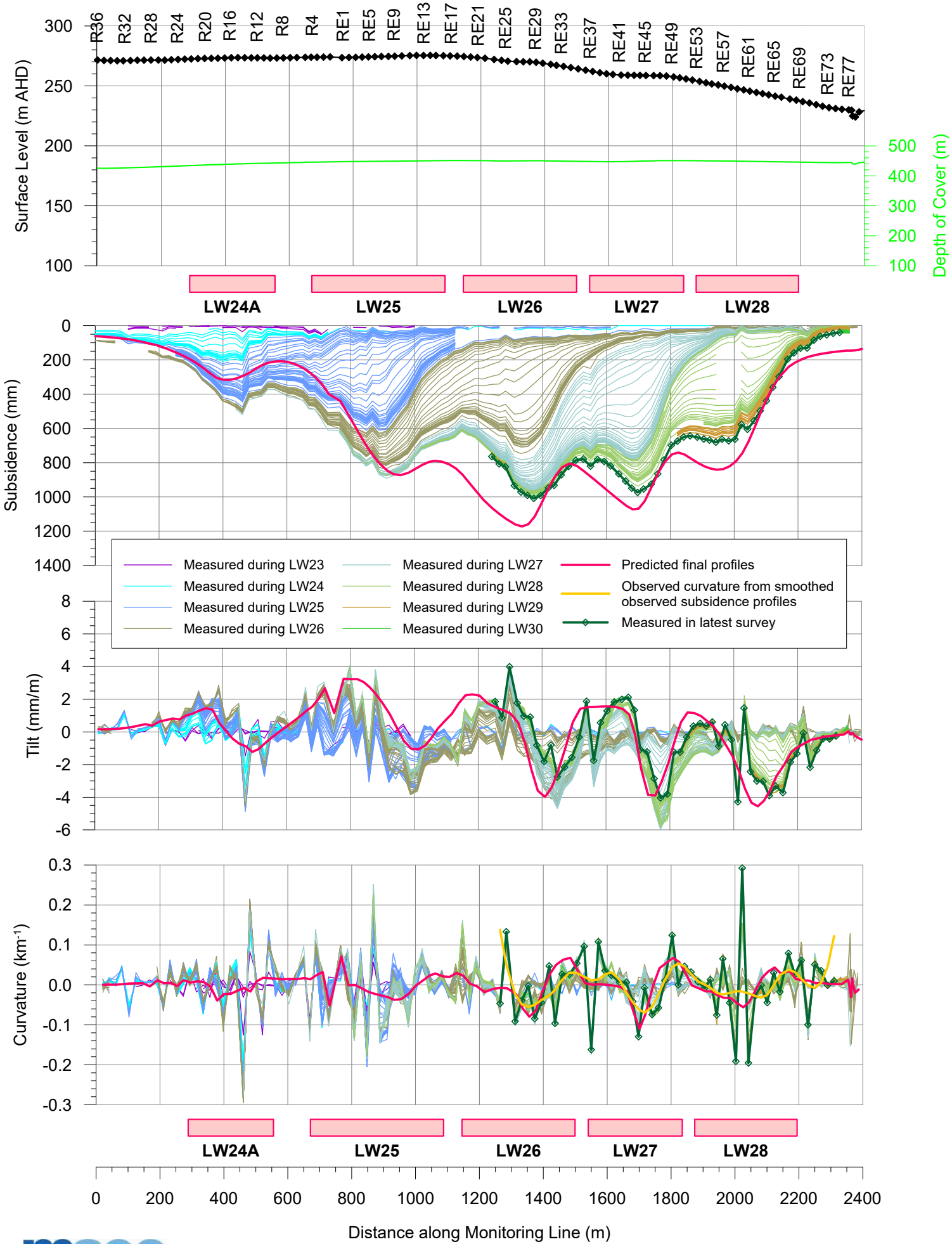
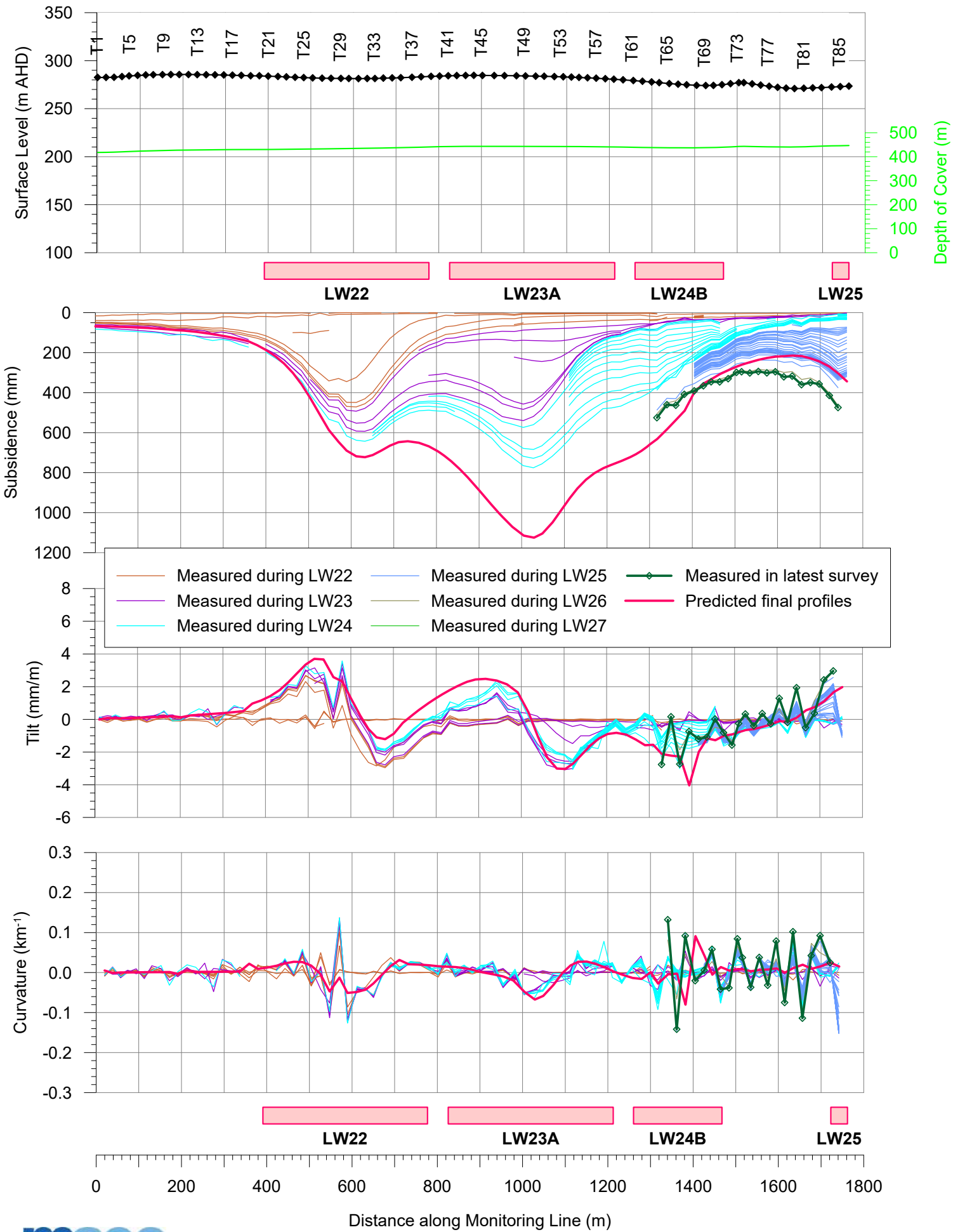


Fig. G.09

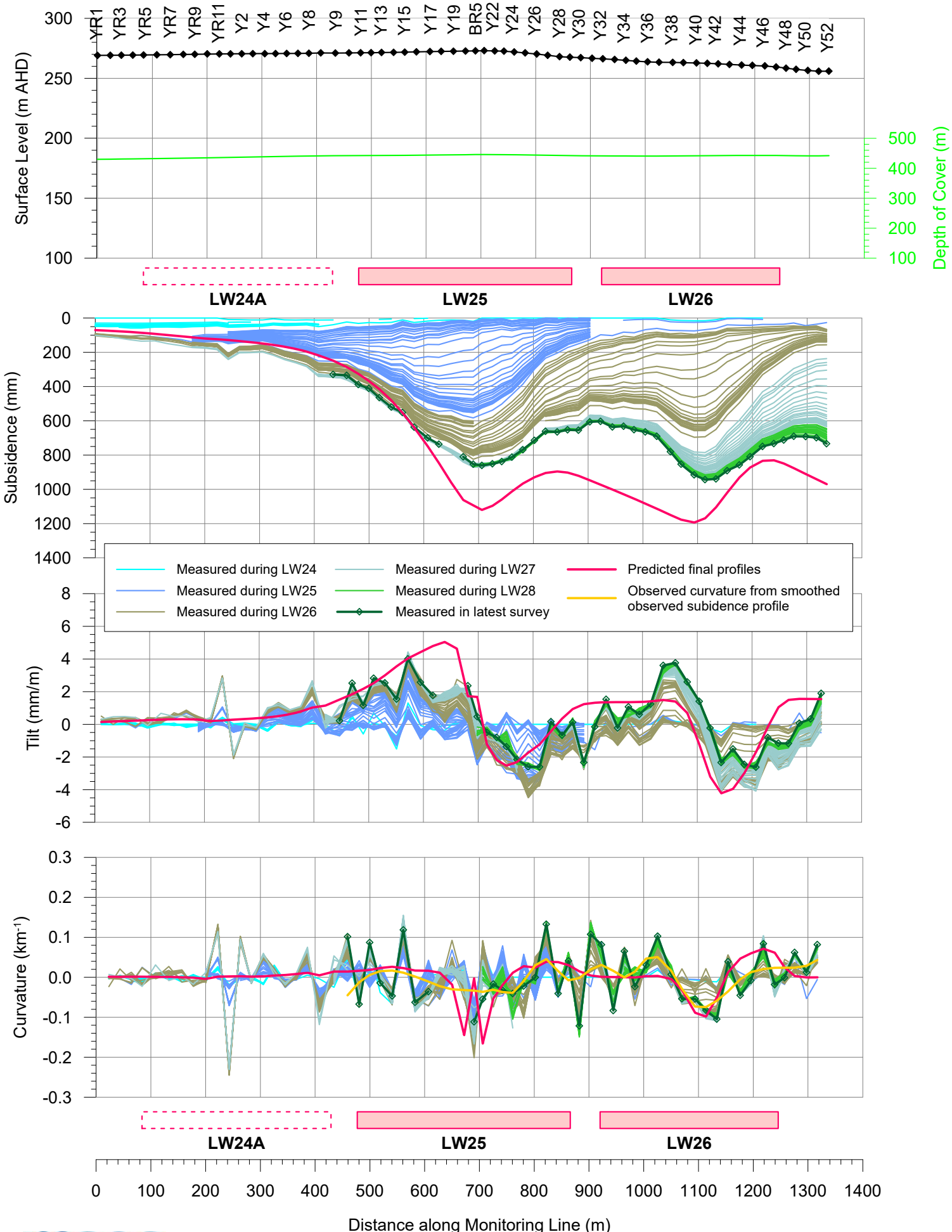
Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the Thirlmere Way Line due to Tahmoor North LW22 to LW27



msec

Fig. G.10

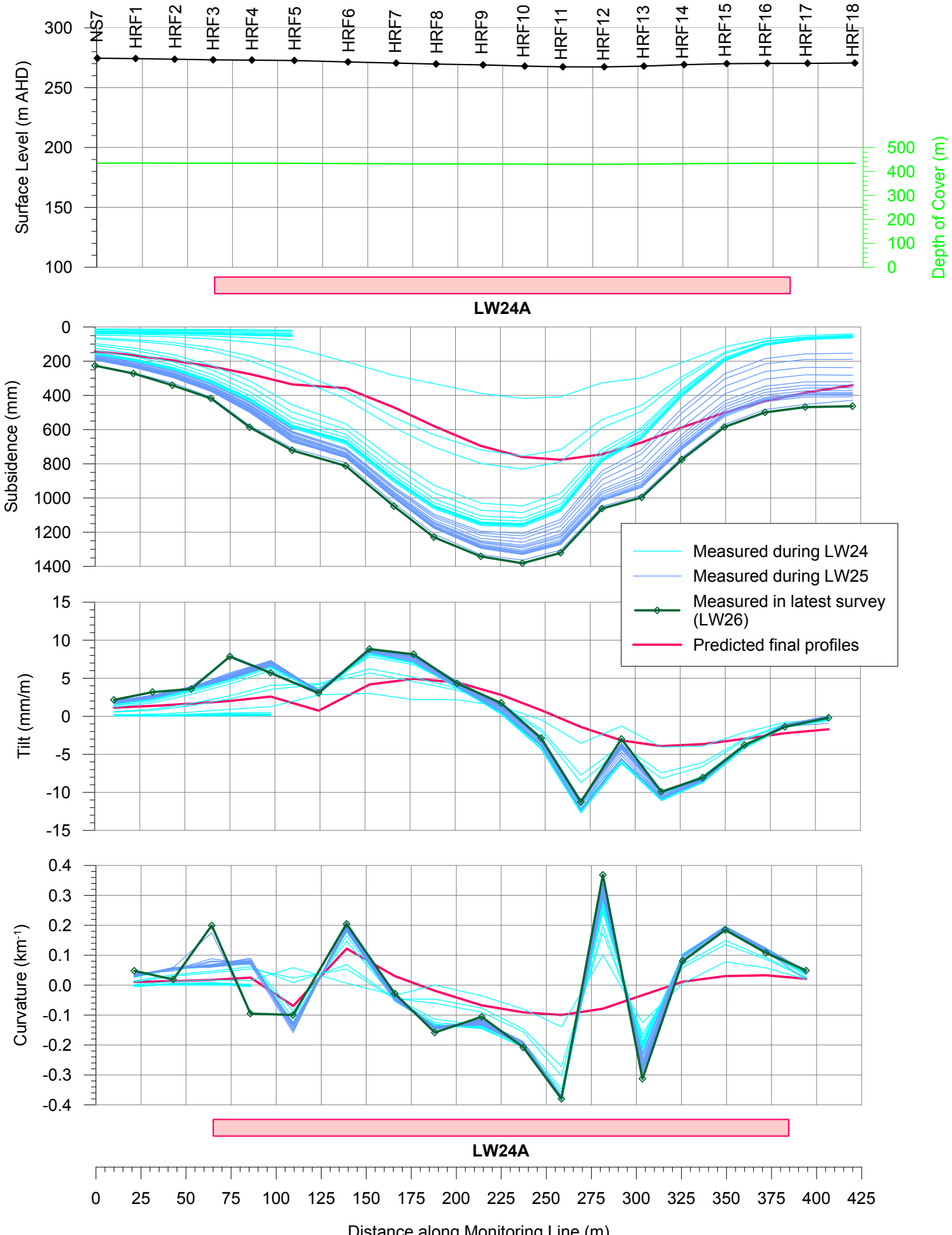
Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the York Street Line due to Tahmoor North LW24A to LW28



msec

Fig. G.11

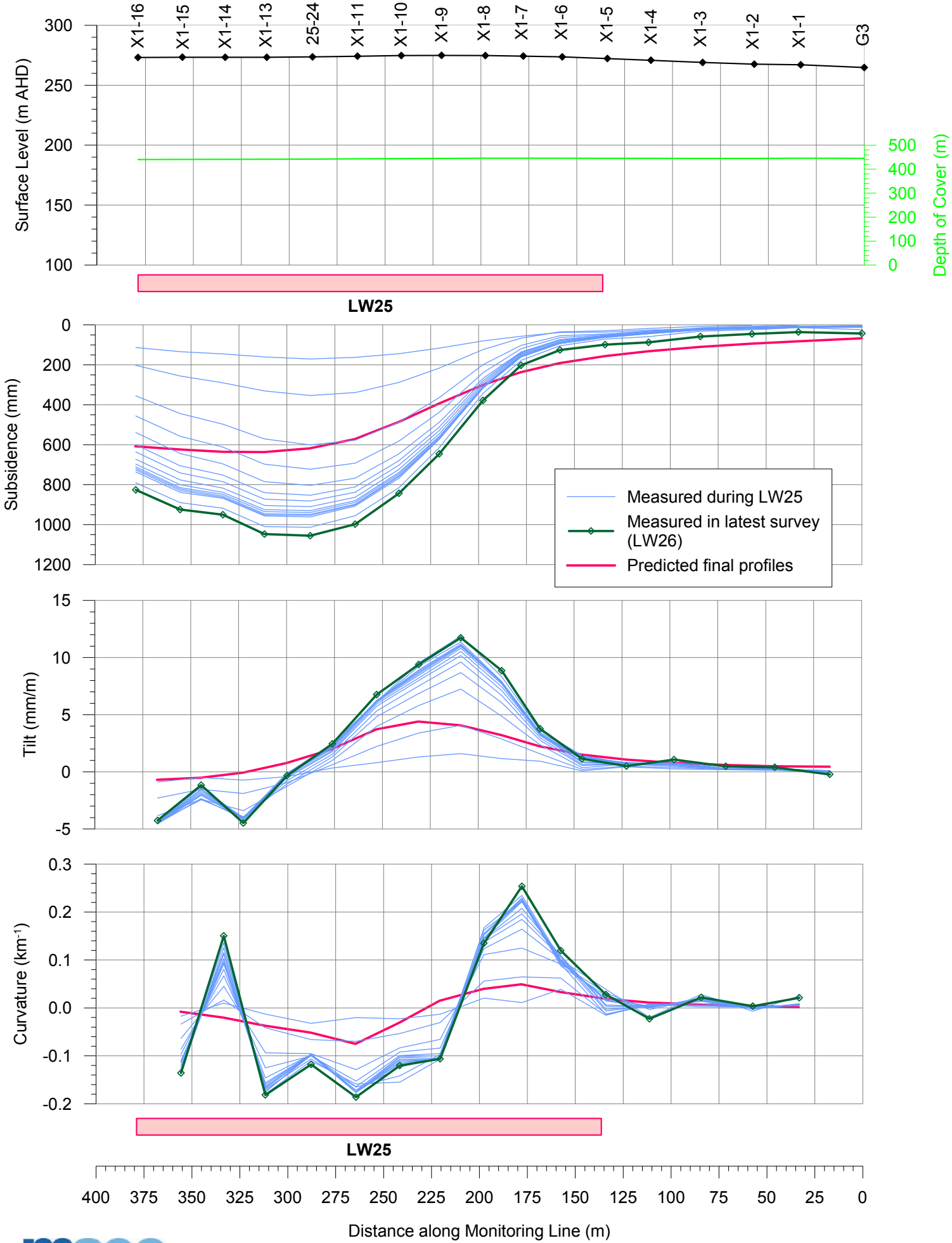
Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the HRF Line due to Tahmoor North LW24A and LW25



msec

Fig. G.12

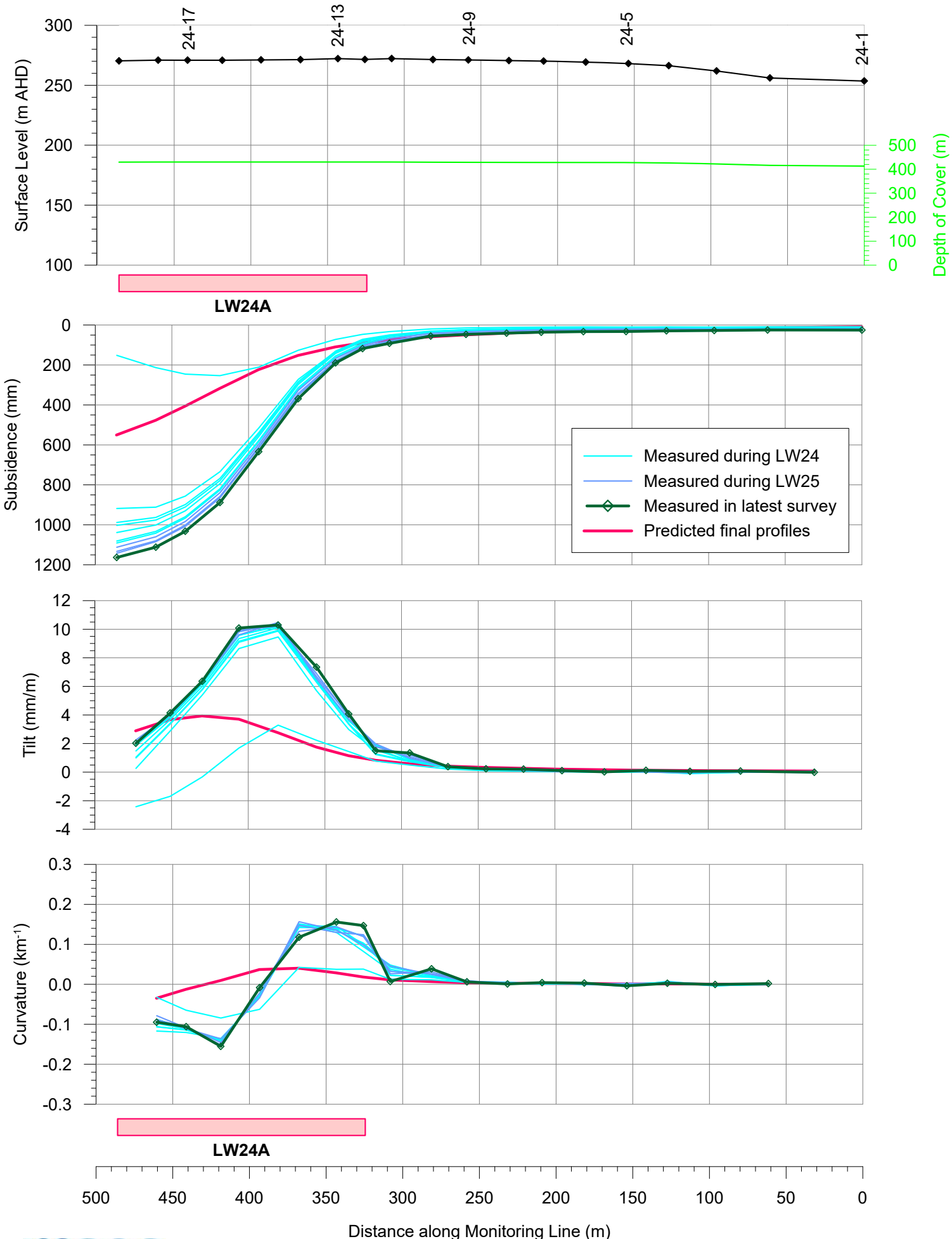
Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the LW25 XS1 Line due to Tahmoor North LW25



msec

Fig. G.13

Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the LW24A Draw Line due to Tahmoor North LW24A and LW25



msec

Fig. G.14

Observed and Predicted Profiles of Total Subsidence, Tilt and Curvature along the LW25 Centreline due to Tahmoor North LW25

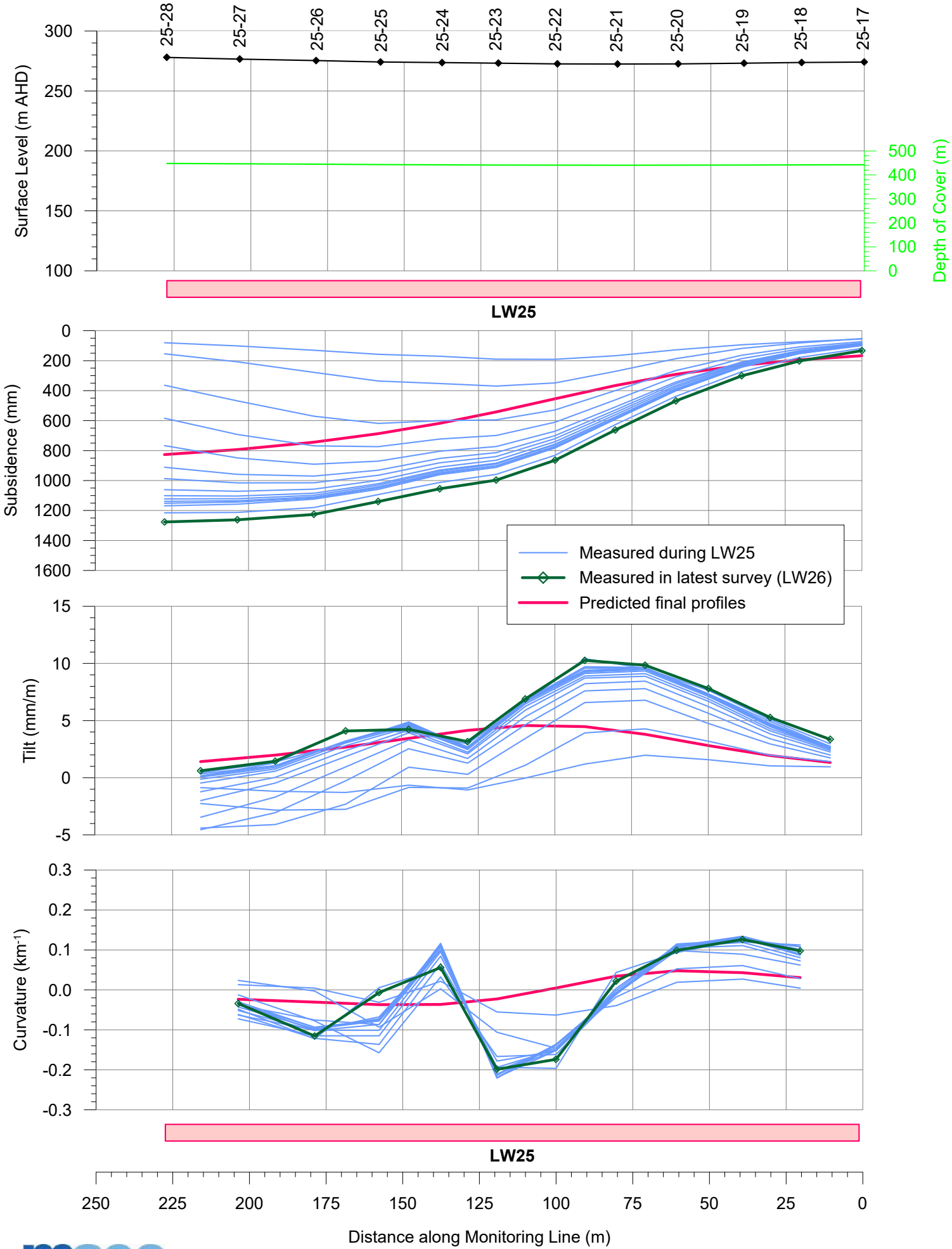


Fig. G.15

APPENDIX B – Modification 3 – Longwall S7A - Subsidence Predictions and Impact Assessment Report (MSEC, 2024)

mine subsidence ENGINEERING CONSULTANTS

SIMEC

SIMEC Mining:

Tahmoor Coal – Modification 3 - Longwall S7A

The effects of the proposed addition of LW S7A
on previous subsidence predictions and impact assessments

DOCUMENT REGISTER

Revision	Description	Author	Checker	Date
A	Draft	DJK		Nov-23
B	Final	DJK	AH/CW	Mar-24

Report produced to:- Support an application to extract Tahmoor LW S7A to be submitted to the Department of Planning and Environment.

Previous reports:- MSEC1192 (Revision A) – Tahmoor South Project – Extraction Plan for Longwalls S1A to S6A - Subsidence ground movement predictions and subsidence impact assessments for natural features and surface infrastructure (May 2022)

Background reports available at *www.minesubsidence.com*:

Introduction to Longwall Mining and Subsidence (Revision A)

General Discussion of Mine Subsidence Ground Movements (Revision A)

Mine Subsidence Damage to Building Structures (Revision A)

CONTENTS

1.0 INTRODUCTION **10**

1.1. Background 10

1.2. Mining geometry 10

1.3. Surface and seam 10

2.0 MAXIMUM PREDICTED SUBSIDENCE EFFECTS FOR LW S7A **12**

2.1. Maximum predicted conventional subsidence effects 12

2.2. Effect of revision of planned extraction heights 13

2.3. Comparison between Observed and Predicted Subsidence during the mining of LWs S1A and S2A 15

2.4. Potential for increased subsidence 18

2.5. Predicted Strain 19

2.5.1. Analysis of strains measured in survey bays 22

2.5.2. Analysis of strains measured along whole monitoring lines 26

2.5.3. Analysis of shear strains 27

2.6. Predicted far-field horizontal movements 28

3.0 PREDICTIONS AND IMPACT ASSESSMENTS FOR NATURAL AND BUILT FEATURES **30**

3.1. The Study Area 30

3.2. Bargo River 30

3.2.1. Description of the Bargo River 30

3.2.2. Predictions for the Bargo River 33

3.2.3. Potential impacts on the Bargo River 33

3.2.4. Management of potential impacts on the Bargo River 37

3.3. Hornes Creek 38

3.3.1. Description of Hornes Creek 38

3.3.2. Predictions for Hornes Creek 40

3.3.3. Statistical analyses of valley closure movements 41

3.3.4. Potential impacts on Hornes Creek 44

3.3.5. Management of potential impacts on Hornes Creek 44

3.4. Teatree Hollow and tributaries 45

3.4.1. Predictions for Teatree Hollow and tributaries 45

3.4.2. Observed subsidence movements during the mining of LWs S1A and S2A directly beneath Teatree Hollow and tributaries 46

3.4.3. Potential impacts on Teatree Hollow and tributaries 51

3.4.4. Management of potential impacts on Teatree Hollow and tributaries 51

3.5. Cliffs 52

3.5.1. Descriptions of the cliffs 52

3.5.2. Predictions for the cliffs 54

3.5.3. Impact assessments for cliffs located above solid coal 54

3.5.4. Impact assessments for the cliffs based on increased predictions 56

3.5.5. Management of potential impacts on cliffs 56

3.6. Steep Slopes 56

3.6.1. Management of potential impacts on steep slopes 57

3.7. Main Southern Railway 58
3.7.1. Description of the Main Southern Railway 58
3.7.2. Predictions for the Main Southern Railway 60
3.7.3. Impact assessments for the Main Southern Railway 60
3.7.4. Management of potential impacts on the Main Southern Railway 61
3.8. Roads 62
3.8.1. Predictions for the roads 62
3.8.2. Impact assessments for the roads 65
3.8.3. Management of potential impacts on the roads 65
3.9. Services Infrastructure 66
3.9.1. Electrical services infrastructure 66
3.9.2. Telecommunications infrastructure 66
3.9.3. Gas infrastructure 68
3.9.4. Potable Water infrastructure 69
3.9.5. Sewer infrastructure 70
3.10. Picton Weir 71
3.10.1. Description and location 71
3.10.2. Geotechnical assessment 73
3.10.3. Subsidence predictions 75
3.10.4. Statistical analyses of valley closure movements at Picton Weir 75
3.10.5. Case study of observed valley closure movements during the mining of LW W1-W4 77
3.10.6. Managing potential far field impacts on the Picton Weir 83
3.11. Rural structures 84
3.11.1. Descriptions of the rural structures 84
3.11.2. Predictions for rural structures 84
3.11.3. Impact assessments for rural structures 86
3.11.4. Impact assessments for rural structures based on increased predictions 87
3.11.5. Management of potential impacts on rural structures 87
3.12. Tanks 87
3.12.1. Descriptions of the tanks 87
3.12.2. Predictions for the tanks 88
3.12.3. Impact assessments for the tanks 90
3.12.4. Impact assessments for the tanks based on increased predictions 90
3.12.5. Management of potential impacts on the tanks 90
3.13. Farm dams 90
3.13.1. Predictions for the farm dams 91
3.13.2. Impact Assessments for the farm dams 94
3.13.3. Impact assessments for the farm dams based on increased predictions 95
3.13.4. Management of potential impacts on the farm dams 95
3.14. Commercial and business establishments 96
3.14.1. Predictions for the commercial and business establishments 96
3.15. Swimming pools 99
3.15.1. Predictions for the swimming pools 99

3.15.2. Impact assessments for the swimming pools 101
3.15.3. Impact assessments for the swimming pools based on increased predictions 102
3.15.4. Management of potential impacts on the swimming pools 102
3.16. Houses 103
3.16.1. Descriptions of the houses 103
3.16.2. Predictions for the houses 109
3.16.3. Impact assessments for the houses 113
3.16.4. Management of potential impacts on the houses 119
3.17. Archaeological Sites 121
3.17.1. Predictions for the archaeological sites 121
3.17.2. Impact assessments for the rock shelter 122
3.17.3. Impact assessments for the Grinding Groove site 122
3.17.4. Impact assessments for the Isolated Find site 122
3.17.5. Impact assessments for the archaeological sites based on increased predictions 122
3.17.6. Management of potential impacts on the archaeological sites 123
3.18. Heritage Sites 123
3.19. Summary 123
4.0 REFERENCES **124**
APPENDIX A. FIGURES **128**
APPENDIX B. DRAWINGS **129**
APPENDIX C. TABLES **130**

Tables

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

Table No.	*Description*	*Page*
Table 1.1	Dimensions of LW S7A based on the Modified Layout	10
Table 2.1	Maximum predicted incremental conventional subsidence, tilt and curvature resulting from the extraction of LWs S1A to S7A	12
Table 2.2	Maximum Predicted Total Conventional Subsidence, Tilt and Curvature resulting from the extraction of LWs S1A to S7A	13
Table 2.3	Comparison of Maximum Predicted Total Conventional Subsidence, Tilt and Curvature resulting from the extraction of LWs S1A to S6A due to revision of extraction heights	13
Table 2.4	Monitoring lines used in the strain analysis	21
Table 2.5	Mining geometry for the proposed LWs S1A to S7A	21
Table 3.1	Minimum distances of the proposed longwalls from the Bargo River	31
Table 3.2	Maximum predicted incremental vertical subsidence, upsidence and closure for Bargo River	33
Table 3.3	Maximum predicted total vertical subsidence, upsidence and closure for Bargo River	33
Table 3.4	Maximum predicted incremental vertical subsidence, upsidence and closure for Hornes Creek	40
Table 3.5	Maximum predicted total vertical subsidence, upsidence and closure for Hornes Creek	41
Table 3.6	Maximum predicted incremental vertical subsidence, upsidence and closure for Teatree Hollow and the Tributary to Teatree Hollow	45
Table 3.7	Maximum predicted total vertical subsidence, upsidence and closure for Teatree Hollow and the Tributary to Teatree Hollow	45
Table 3.8	Maximum predicted total vertical subsidence, tilt and curvature for cliffs due to the extraction of LWs S1A to S7A	54
Table 3.9	Rail culverts potentially affected by LW S1A-S6A	58
Table 3.10	Maximum predicted incremental subsidence parameters along the alignment of the Main Southern Railway due to the extraction of LW S7A	60
Table 3.11	Maximum predicted total conventional subsidence parameters along the alignment of the Main Southern Railway due to the extraction of LWs S1A to S7A	60
Table 3.12	Maximum predicted incremental conventional subsidence parameters for Yarran Road due to the extraction of LW S7A	62
Table 3.13	Maximum predicted total conventional subsidence parameters for Yarran Road due to the extraction of LWs S1A to S7A	63
Table 3.14	Maximum predicted incremental conventional subsidence parameters for Caloola Road due to the extraction of LW S7A	63
Table 3.15	Maximum predicted total conventional subsidence parameters for Caloola Road due to the extraction of LWs S1A to S7A	64
Table 3.16	Maximum predicted incremental conventional subsidence parameters for Remembrance Drive due to the extraction of LW S7A	64
Table 3.17	Maximum predicted total conventional subsidence parameters for Remembrance Drive due to the extraction of LWs S1A to S7A	65
Table 3.18	Maximum predicted incremental conventional subsidence parameters for the NBN telecommunications tower at No. 3166 Remembrance Drive due to the extraction of LW S7A	67
Table 3.19	Maximum predicted total conventional subsidence parameters for the NBN telecommunications tower at No. 3166 Remembrance Drive	67
Table 3.20	Maximum predicted incremental conventional subsidence parameters for Jemena Gas Main along Remembrance Drive due to the extraction of LW S7A	68
Table 3.21	Maximum predicted total conventional subsidence parameters for Jemena Gas Main along Remembrance Drive due to the extraction of LWs S1A to S7A	69
Table 3.22	Predicted incremental vertical subsidence, upsidence and closure at Picton Weir	75
Table 3.23	Predicted total vertical subsidence, upsidence and closure at Picton Weir	75
Table 3.24	Probabilities of exceedance for valley closure for survey bays located at distance of 600 m from the nearest goaf edge in the Southern Coalfield	76

Table 3.25 Probabilities of exceedance for valley closure for survey bays located at normalised distance of 1.875 from the nearest goaf edge in the Southern Coalfield 77
Table 3.26 Number of houses located directly above each longwall 103
Table 3.27 House type categories 104
Table 3.28 Distribution of houses by construction type 105
Table 3.29 Assessed impacts for houses within the Study Area 117
Table 3.30 Observed frequency of impacts for building structures resulting from the extraction of Tahmoor Mine longwalls 22 to 29 118
Table 3.31 Maximum Predicted Total Conventional Subsidence Parameters for the Archaeological Sites 121
Table 3.32 Maximum predicted total upsidence and closure for the archaeological sites 121

Figures

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

Figure No. ***Description*** ***Page***
Fig. 1.1 Location of LW S7A overlaid on aerial photograph 11
Fig. 1.2 Surface and seam levels along the Prediction Line across LWs S1A to S7A 11
Fig. 2.1 Predicted subsidence, tilt and curvature across LWs S1A to S7A 14
Fig. 2.2 Comparison between predicted and observed subsidence above centreline of LW S1A 15
Fig. 2.3 Comparison between predicted and observed subsidence above centreline of LW S2A 15
Fig. 2.4 Observed subsidence along V Line during the mining of LW S1A 16
Fig. 2.5 Observed subsidence along Main Southern Railway during the mining of LW S1A 17
Fig. 2.6 Distributions of the measured maximum tensile and compressive strains for surveys bays located *above goaf* at Tahmoor, Appin and West Cliff Collieries 23
Fig. 2.7 Distributions of the measured maximum tensile and compressive strains for surveys bays located *above goaf* at Tahmoor LW S1A 24
Fig. 2.8 Distributions of the measured maximum tensile and compressive strains for survey bays located *above solid Coal* at Tahmoor, Appin and West Cliff Collieries 25
Fig. 2.9 Distributions of the measured maximum tensile and compressive strains for surveys bays located *above solid coal* at Tahmoor LW S1A 26
Fig. 2.10 Distributions of measured maximum tensile and compressive strains anywhere along the monitoring lines at Tahmoor, Appin and West Cliff Collieries 27
Fig. 2.11 Distribution of measured maximum mid-ordinate deviation during the extraction of previous longwalls in the Southern Coalfield for marks located above goaf 28
Fig. 2.12 Observed incremental far-field horizontal movements above goaf or solid coal 29
Fig. 2.13 Observed incremental far-field horizontal movements above solid coal only 29
Fig. 3.1 View of Bargo River and Picton Weir downstream of confluence with Hornes Creek 31
Fig. 3.2 Aerial photo of section of Bargo River within 600m Study Area on 13 November 2019 32
Fig. 3.3 Aerial photo of section of Bargo River within 600m Study Area on 18 February 2022 32
Fig. 3.4 Large pool in the Bargo River, located upstream of Rockford Road Bridge, directly above previously extracted Longwall 12 34
Fig. 3.5 Ponded water in Dog Trap Creek near bridge over Arina Road above previously extracted Longwall 13 34
Fig. 3.6 Immediately upstream of Picton Weir during period of prolonged dry weather – January 2002 35
Fig. 3.7 Picton Weir 1st February 2003 36
Fig. 3.8 Picton Weir 24th February 2003 36
Fig. 3.9 View of Hornes Creek at bend located closest to LW S7A 38
Fig. 3.10 Aerial of photo of Hornes Creek near Pools HC-P14 to HC-P16 on 13 November 2019 39
Fig. 3.11 Aerial of photo of Hornes Creek near Pools HC-P14 to HC-P16 on 18 February 2022 39
Fig. 3.12 Hornes Creek Pool HC-P09 on 23 September 2023 40
Fig. 3.13 Observed incremental valley closure against distance from the maingate edge of the active longwall over solid, unmined coal 41

Fig. 3.14 Observed incremental valley closure against normalised transverse distance from maingate edge of longwalls and ACARP prediction model 42
Fig. 3.15 Observed incremental valley closure against normalised distance from the maingate edge of longwalls / (longwall width + pillar width) 43
Fig. 3.16 Observed changes in horizontal distances between GNSS units across the Tributary to Teatree Hollow and Teatree Hollow 46
Fig. 3.17 Observed development of closure across Tributary to Teatree Hollow from ground surveys 47
Fig. 3.18 Observed total changes in height, tilt and strain along survey line TT2 across the Tributary to Teatree Hollow during the mining of LWs S1A and S2A 48
Fig. 3.19 Observed total changes in height, tilt and strain along survey line TT3 across the Tributary to Teatree Hollow during the mining of LWs S1A and S2A 49
Fig. 3.20 Observed total changes in height, tilt and strain along survey line TT5 across the Tributary to Teatree Hollow during the mining of LWs S1A and S2A 50
Fig. 3.21 Cliff C_00800 above the Picton Weir 52
Fig. 3.22 Digital reconstruction of aerial photogrammetry survey of Cliff C_00130 52
Fig. 3.23 Digital reconstruction of aerial photogrammetry survey of Cliff C_02060 53
Fig. 3.24 Main Southern Railway at 100.121 km 58
Fig. 3.25 Culvert with concrete extension on Up side at 100.121 km 59
Fig. 3.26 Culvert with concrete extension on Up side at 100.425 km 59
Fig. 3.27 Close up view of Picton Weir 71
Fig. 3.28 Wide angle view of Picton Weir 71
Fig. 3.29 Location of Picton Weir relative to LW S7A 72
Fig. 3.30 Construction drawings of Picton Weir 73
Fig. 3.31 PSM Lineament Assessment (PSM, 2023) 74
Fig. 3.32 PSM Conceptual Geological Model – Cross Section through Picton Weir (PSM, 2023) 74
Fig. 3.33 Frequency distribution of observed valley closure for survey bays between 450m and 750m from maingate side of previously extraction LWs in Southern Coalfield 76
Fig. 3.34 Observed incremental horizontal movements during the mining of LW W4 78
Fig. 3.35 Observed total horizontal movements during the mining of LW W1-W4 79
Fig. 3.36 Observed development of closure across Stonequarry Creek at Victoria Bridge during the mining of LWs 31, 32 and LW W1-W4 81
Fig. 3.37 Observed development of closure across Stonequarry Creek at Retaining Wall at 84.687 km on the Main Southern Railway during the mining of LW W1-W4 82
Fig. 3.38 Observed changes in horizontal distance across Stonequarry Creek at Picton Viaduct on the Main Southern Railway during the mining of LWs 31, 32 and LW W1-W4 82
Fig. 3.39 Maximum predicted incremental conventional subsidence and tilt for the rural structures within the Study Area due to extraction of LW S7A 84
Fig. 3.40 Maximum predicted total conventional subsidence and tilt for the rural structures within the Study Area after extraction of LWs S1A to S7A 85
Fig. 3.41 Maximum predicted incremental conventional hogging curvature (left) and sagging curvature (right) for the farm dams within the Study Area due to extraction of LW S7A 85
Fig. 3.42 Maximum predicted conventional hogging curvature (left) and sagging curvature (right) for tanks within the Study Area due to extraction of LW S7A 86
Fig. 3.43 Maximum predicted incremental conventional subsidence and tilt for the tanks within the Study Area due to extraction of LW S7A 88
Fig. 3.44 Maximum predicted total conventional subsidence and tilt for the tanks within the Study Area after extraction of LWs S1A to S7A 88
Fig. 3.45 Maximum predicted incremental conventional hogging curvature (left) and sagging curvature (right) for the farm dams within the Study Area due to extraction of LW S7A 89
Fig. 3.46 Maximum predicted conventional hogging curvature (left) and sagging curvature (right) for tanks within the Study Area due to extraction of LW S7A 89
Fig. 3.47 Distributions of longest lengths and surface areas of the farm dams 91
Fig. 3.48 Maximum predicted incremental conventional subsidence and tilt for the farm dams within the Study Area due to extraction of LW S7A 92

Fig. 3.49 Maximum predicted total conventional subsidence and tilt for the farm dams within the Study Area after extraction of LWs S1A to S7A 92
Fig. 3.50 Maximum predicted incremental conventional hogging curvature (left) and sagging curvature (right) for the farm dams within the Study Area due to extraction of LW S7A 93
Fig. 3.51 Maximum predicted total conventional hogging curvature (left) and sagging curvature (right) for the farm dams after extraction of LWs S1A to S7A 93
Fig. 3.52 Predicted changes in freeboards for the farm dams within the Study Area 94
Fig. 3.53 Maximum predicted incremental conventional subsidence and tilt for the commercial structures within the Study Area due to extraction of LW S7A 96
Fig. 3.54 Maximum predicted total conventional subsidence and tilt for the commercial structures within the Study Area after extraction of LWs S1A to S7A 97
Fig. 3.55 Maximum predicted incremental conventional hogging (left) and sagging (right) curvatures for commercial structures within the Study Area due to extraction of LW S7A 97
Fig. 3.56 Maximum predicted total conventional hogging curvature (left) and sagging curvature (right) for the commercial structures after extraction of LWs S1A to S7A 98
Fig. 3.57 Maximum predicted incremental conventional subsidence and tilt for the swimming pools within the Study Area due to extraction of LW S7A 99
Fig. 3.58 Maximum predicted total conventional subsidence and tilt for the swimming pools within the Study Area after extraction of LWs S1A to S7A 100
Fig. 3.59 Maximum predicted incremental conventional hogging curvature (left) and sagging curvature (right) for the swimming pools within the Study Area due to extraction of LW S7A 100
Fig. 3.60 Maximum predicted total conventional hogging curvature (left) and sagging curvature (right) for the swimming pools after extraction of LWs S1A to S7A 101
Fig. 3.61 Distribution of houses by maximum plan dimension and plan area 104
Fig. 3.62 Distributions of wall and footing construction for houses within the Study Area 105
Fig. 3.63 Location of houses by construction type 106
Fig. 3.64 Aerial photograph of Study Area in 1975 when Mine Subsidence District was declared 107
Fig. 3.65 Aerial photograph of Study Area in 2023 108
Fig. 3.66 Distribution of Houses by Age as at 2023 108
Fig. 3.67 Location of houses by age 109
Fig. 3.68 Maximum predicted incremental conventional subsidence for the houses within the Study Area due to extraction of LW S7A 110
Fig. 3.69 Maximum predicted total conventional subsidence for the houses within the Study Area after extraction of LWs S1A to S7A 110
Fig. 3.70 Maximum predicted incremental conventional tilts for the houses within the Study Area due to extraction of LW S7A 111
Fig. 3.71 Maximum predicted conventional tilts after the extraction of longwalls S1A to S7A (left) and maximum predicted conventional tilts after extraction of any longwall (right) 111
Fig. 3.72 Maximum predicted incremental conventional hogging curvature (left) and sagging curvature (right) for the houses within the Study Area due to extraction of LW S7A 112
Fig. 3.73 Maximum predicted conventional hogging curvature (left) and sagging curvature (right) for the houses within the Study Area after extraction of LWs S1A to S7A 112
Fig. 3.74 Distribution of predicted final tilts for the houses at the completion of LW S6A 114
Fig. 3.75 Distribution of predicted final tilts for the houses at the completion of LW S7A 114
Fig. 3.76 Distribution of measured tilts for survey bays located in the areas of increased subsidence above Tahmoor Mine longwalls 24A, 25 and 26 115
Fig. 3.77 Distribution of predicted hogging curvatures (left) and sagging curvatures (right) for houses at the completion of mining 116
Fig. 3.78 Distributions of measured curvatures for survey bays located in the areas of increased subsidence above Tahmoor Mine LWs 24A, 25 and 26 116

Fig. A.01 Predicted profiles of vertical subsidence, tilt and curvature along the Prediction Line 1 resulting from the extraction of LWs S1A to S7A App. A
Fig. A.02 Predicted profiles of subsidence, upsidence and closure along Bargo River and Hornes Creek resulting from the extraction of LWs S1A to S7A App. A

Fig. A.03 Predicted profiles of subsidence, upsidence and closure along Teatree Hollow resulting from the extraction of LWs S1A to S7A App. A
Fig. A.04 Predicted profiles of subsidence, upsidence and closure along Tributary to Teatree Hollow resulting from the extraction of LWs S1A to S7A App. A
Fig. A.05 Predicted profiles of conventional subsidence, tilt and change in grade along the Main Southern Railway due to the extraction of LWs S1A to S7A App. A
Fig. A.06 Predicted profiles of conventional cross tilt, change in track cant and long twist along the Main Southern Railway due to the extraction of LWs S1A to S7A App. A
Fig. A.07 Predicted profiles of conventional horizontal movement along track, change in 100 metre long bay length and change in SFT along the Main Southern Railway due to the extraction of LWs S1A to S7A App. A
Fig. A.08 Predicted profiles of conventional subsidence, tilt and curvature along Yarran Road resulting from the extraction of LWs S1A to S7A App. A
Fig. A.09 Predicted profiles of conventional subsidence, tilt and curvature along Caloola Road resulting from the extraction of LWs S1A to S7A App. A
Fig. A.10 Predicted profiles of conventional subsidence, tilt and curvature along Remembrance Drive resulting from the extraction of LWs S1A to S7A App. A
Fig. A.11 Predicted profiles of vertical subsidence, tilt and curvature along Remembrance Drive and the 150mm steel gas main resulting from the extraction of LWs S1A to S7A App. A

Drawings

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

Drawing No.	***Description***	***Revision***
MSEC1348-01	General layout	A
MSEC1348-02	Surface level contours	A
MSEC1348-03	Bulli Seam roof contours	A
MSEC1348-04	Bulli Seam depth of cover contours	A
MSEC1348-05	Extraction height	A
MSEC1348-06	Geological structures at Bulli Seam level	A
MSEC1348-07	Natural features	A
MSEC1348-08	Main Southern Railway	A
MSEC1348-09	Surface infrastructure	A
MSEC1348-10	Archaeological and Heritage sites	A
MSEC1348-11	Built features	A
MSEC1348-12	Predicted incremental subsidence due to LW S7A	A
MSEC1348-13	Predicted total subsidence due to LW S1A to LW S7A	A
MSEC1348-14	Predicted total subsidence due to LW S1A to LW S6B	A
MSEC1348-15	Proposed Subsidence Monitoring Plan	A

1.1. Background

Tahmoor Coal owns and operates Tahmoor Mine, an existing underground coal mine that is located approximately 80 km south-west of Sydney in the Southern Coalfield of NSW. Tahmoor Coal is a wholly owned entity within the SIMEC Mining Division of the GFG Alliance group.

Mine Subsidence Engineering Consultants (MSEC) was previously commissioned by Tahmoor Coal to undertake subsidence predictions and impact assessments for the proposed Longwalls 101A to 106B in the Tahmoor South Domain area at Tahmoor Mine (Tahmoor South Project). Report No. MSEC1123 was issued in support of the EIS for these longwalls. The Department of Planning, Industry and Environment, granted Tahmoor Coal development consent for the Tahmoor South Project on 23 April 2021. This consent has subsequently been modified twice (Mod 1 and Mod 2).

On 20 May 2022, Tahmoor Coal lodged an Extraction Plan Application for the extraction of LWs S1A to S6A. Mine Subsidence Engineering Consultants (MSEC) was previously commissioned by Tahmoor Coal to undertake subsidence predictions and impact assessments for the proposed Longwalls S1A to S6A in the Tahmoor South Domain area at Tahmoor Mine. Report No. MSEC1192 (Revision A) was issued during May 2022 in support of the Extraction Plan Application for these longwalls. The Department of Planning, Industry and Environment, granted Tahmoor Coal approval for extraction of LW S1A to S6A on 20 September 2022.

The longwall layout adopted in Report No. MSEC1192 is referred to as the *Approved Layout* in this report.

Tahmoor Coal is currently extracting LW S2A and proposes to extract an additional longwall panel, Longwall S7A (LW S7A) to the A series compared to *Approved Layout* adopted in Report No. MSEC1192. The proposed LW S7A represents the third modification to the development consent (Modification 3) and the proposed longwall layout including LW S7A is referred to as the *Modified Layout* in this report.

LW S7A has been included following a revision of the geological interpretation of the location of the Central Fault, which is located to the south west of the Tahmoor South Project. The commencing end of LW S7A has been shortened compared to LW S6A for the purposes of reducing the potential for subsidence effects on the urban area of Bargo township.

This subsidence report will support the Modification 3 application for the addition of LW S7A, which will be submitted to the Department of Planning and Environment. The location of LW S7A has been overlaid on an aerial photograph, as shown in Fig. 1.1.

1.2. Mining geometry

The locations of the longwalls in the Tahmoor South Domain are shown in Drawing No. MSEC1348-01, in Appendix B. The location of LW S7A based on the Modified Layout is shown in orange in this drawing.

A summary of the dimensions of LW S7A is provided in Table 1.1.

Table 1.1 Dimensions of LW S7A based on the Modified Layout

Layout (Report No.)	Longwall	Overall void length including installation heading (m)	Overall void width including first workings (m)	Overall tailgate chain pillar width (m)
Modified Layout (MSEC1348)	LW S7A	1,918	285	36

1.3. Surface and seam

The Tahmoor South Domain area at Tahmoor Mine is located between Tahmoor's surface facilities to the north and the township of Bargo to the south. The terrain directly above LW S7A is relatively flat such that the surface level above LW S7A varies between approximately 320 metres above Australian Height Datum (m AHD) and 350 m AHD. The surface level contours are shown in Drawing No. MSEC1348-02.

The seam roof contours are shown in Drawing No. MSEC1348-03. The Bulli Seam generally dips from the south-west towards the north-east with an average gradient of 5 % (i.e. 1 in 20) across the mining area.

The depth of cover contours are shown in Drawing No. MSEC1348-04. The depth of cover directly above LW S7A varies between approximately 375 m and 385 m.

The A series longwalls are approved to extract coal from the Bulli Seam. Tahmoor Coal has revised its forecast extraction heights since the previous predictions were provided in Report No. MSEC1192. The changes are generally minor for the A series longwall panels, in the range of 50 to 100 mm greater than previously forecast. Tahmoor Coal proposes to extract a minimum height of 2.1 metres and maximum extraction height of 2.6 metres within LW S7A, as shown in Drawing No. MSEC1348-05. The surface and seam levels across LW S1A to LW S7A are shown in Fig. 1.2.

Fig. 1.1 Location of LW S7A overlaid on aerial photograph

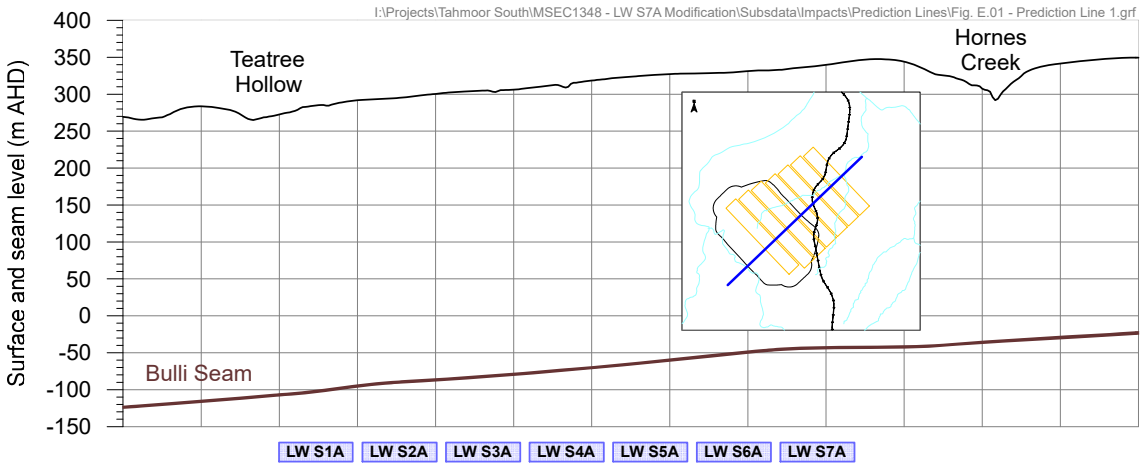


Fig. 1.2 Surface and seam levels along the Prediction Line across LWs S1A to S7A

2.1. Maximum predicted conventional subsidence effects

The Incremental Profile Method (IPM) was previously used to predict the conventional subsidence parameters resulting from the extraction of the approved LW S1A to S6A at Tahmoor, which were provided in Report No. MSEC1192.

The Incremental Profile Method has also been used to predict the conventional subsidence parameters resulting from the extraction of LW S7A, based on the *Modified Layout.*

The predicted incremental subsidence contours due to the extraction of LW S7A, based on the *Modified Layout*, are shown in Drawing No. MSEC1348-12. The predicted total subsidence contours after the extraction of LW S7A, based on the *Modified Layout*, are shown in Drawing No. MSEC1348-13.

The predicted 20 mm incremental and total subsidence contour lines are shown in Drawing No. MSEC1348-01. The predicted total 20 mm subsidence contour line, based on the *Approved Layout*, is also shown in the drawing for comparison. Predicted profiles across LWs S1A to S7A are shown in Fig. A.01, which is included in Appendix A at the back of this report.

The predicted total subsidence contours for the Tahmoor South Project after the extraction of LW S6B, based on the *Modified Layout* is shown in Drawing No. MSEC1348-14. It is noted, however, that Tahmoor Coal has not finalised its mine design for the B series longwall panels. The layout for the B series longwall panels differ from the layout presented in the EIS (Report N. MSEC1123) because some panels have been shortened due to the realignment of the central mains.

The predictions for LWs S1A to S6B have been provided to illustrate the effect of Modification 3 on the whole Tahmoor South Project but the mine layout may change in future when the design for the B series panels is finalised.

A summary of the maximum predicted values of incremental conventional subsidence, tilt and curvature, due to the extraction of LWs S1A to S6A under the *Approved Layout* and LW S7A, based on the *Modified Layout*, is provided in Table 2.1. The predicted tilts provided in this table are the maxima after the completion of each longwall. The predicted curvatures are the maxima at any time during or after the extraction of each longwall.

Table 2.1 Maximum predicted incremental conventional subsidence, tilt and curvature resulting from the extraction of LWs S1A to S7A

Longwall	Maximum predicted incremental conventional subsidence (mm)	Maximum predicted incremental conventional tilt (mm/m)	Maximum predicted incremental conventional hogging curvature (km^{-1})	Maximum predicted incremental conventional sagging curvature (km^{-1})
Approved Layout				
LW S1A	800	7.0	0.08	0.22
LW S2A	950	7.5	0.08	0.22
LW S3A	950	8.0	0.09	0.22
LW S4A	950	8.0	0.09	0.22
LW S5A	950	8.0	0.10	0.22
LW S6A	975	8.3	0.09	0.23
Modified Layout				
LW S7A	1,050	8.9	0.10	0.24

It can be seen from the above table, that the predicted maxima, based on the *Modified Layout*, are similar to those based on the *Approved Layout*. The differences in the predicted maximum parameters due to the proposed modification are not considered to be significant.

As shown in Drawing No. MSEC1348-12, the maximum predicted incremental subsidence due to the proposed extraction of LW S7A is located above the commencing end of the panel. This is because planned extraction heights are greatest in this location. As shown in Fig. 1.1, the commencing end of LW S7A is located directly beneath open farmland.

A summary of the maximum predicted total conventional subsidence, tilt and curvature, based on the *Approved and Modified* Layout are provided in Table 2.2. The values in this table are the maxima anywhere above the longwalls, and at any time during or after extraction of the longwalls.

Table 2.2 Maximum Predicted Total Conventional Subsidence, Tilt and Curvature resulting from the extraction of LWs S1A to S7A

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Hogging Curvature (km^{-1})	Maximum Predicted Total Sagging Curvature (km^{-1})
Approved Layout				
After LW S6A	1,350	9.5	0.14	0.24
After LW S6B	1,600	10.5	0.18	0.28
Modified Layout				
After LW S7A	1,400	10.0	0.14	0.25
After LW S6B	1,600	10.5	0.18	0.28

When comparing maximum predicted total subsidence parameters for the A series longwalls, it can be seen that the addition of LW S7A is predicted to result in a small increase in maximum total subsidence but negligible change in predicted maximum tilt and curvature.

When comparing maximum predicted total subsidence parameters for the A and B series longwalls, it can be seen that there is negligible change to the predictions. This is because predicted maximum subsidence due to the extraction of the B series longwalls is greater than the A series.

2.2. Effect of revision of planned extraction heights

Tahmoor Coal has revised its forecast extraction heights since the previous predictions were provided in Report No. MSEC1192. The changes are generally minor for the A series longwall panels, in the range of 50 to 100 mm greater than previously forecast.

It is noted, however, that forecast extraction heights at the commencing end of LW S7A are greater than previously planned for LWs S1A to S6A, such that predicted maximum incremental subsidence due to the extraction of LW S7A is greater in this area. The planned extraction heights for the rest of the longwall panel are similar in magnitude compared to the rest of the A series longwalls and predicted incremental subsidence due to the mining of LW S7A is similar to the predictions for the rest of the A series longwalls, as demonstrated in Fig. A.01.

A comparison of predicted conventional subsidence due to the extraction of LWs S1A to S6A between the predictions that were previously provided in Report No. MSEC1192 and predictions based on revised extraction heights is shown in Fig. 2.1 and Table 2.3.

Table 2.3 Comparison of Maximum Predicted Total Conventional Subsidence, Tilt and Curvature resulting from the extraction of LWs S1A to S6A due to revision of extraction heights

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Hogging Curvature (km^{-1})	Maximum Predicted Total Sagging Curvature (km^{-1})
Approved Layout (MSEC1192)				
After LW S6A	1,350	9.5	0.14	0.24
Modified Layout with revised extraction heights				
After LW S6A	1,400	10.0	0.14	0.25

As shown in Fig. 2.1 and Table 2.3, the predicted increases in subsidence, tilt and curvature due to the revision in extraction height is relatively minor. The predictions do not materially change the assessment of potential impacts on natural and built features, nor our recommendations for managing potential impacts to natural and built features as previously provided in Report Nos. MSEC1123 (EIS) and MSEC1192 (Extraction Plan for LWs S1A to S6A).

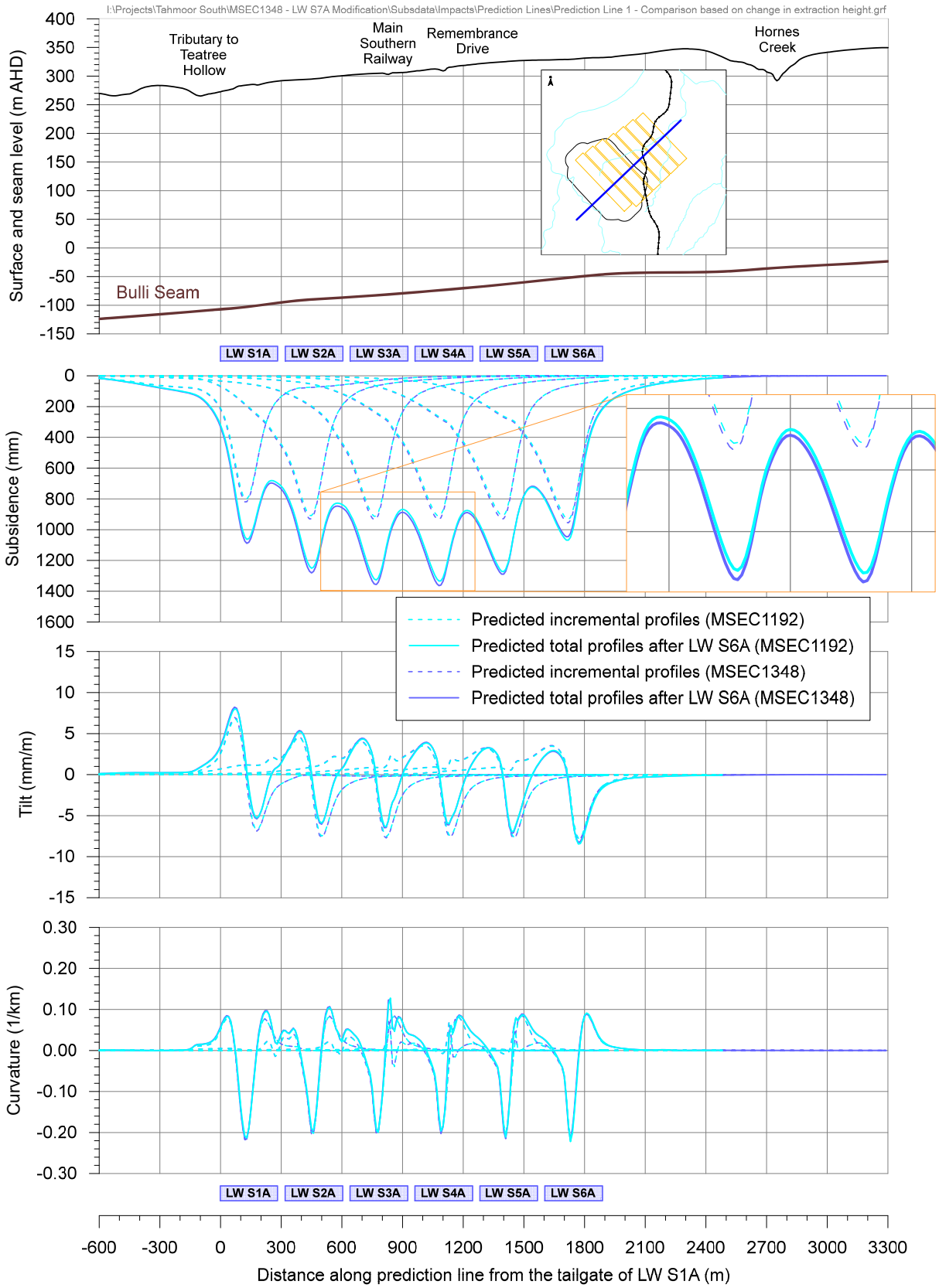


Fig. 2.1 Predicted subsidence, tilt and curvature across LWs S1A to S7A

For the purposes of providing clarity, this report will focus on predicted subsidence movements and potential impacts on natural and built features due to the addition of LW S7A only, rather than comment on the very minor changes in predicted movements due to the revised forecast of extraction heights within the broader mining domain of LW S1A to S6A.

2.3. Comparison between Observed and Predicted Subsidence during the mining of LWs S1A and S2A

Extensive monitoring has been undertaken by Tahmoor Coal during the mining of LWs S1A and S2A. Observed incremental subsidence due to the extraction of LWs S1A and LW S2A has correlated reasonably well with predictions, as shown in Fig. 2.2, Fig. 2.4 and Fig. 2.5.

Subsidence was observed to vary in magnitude along the centreline of LW S1A. Maximum subsidence was measured at Peg V51 on the V-Line, which is located between Teatree Hollow and the Tributary to Teatree Hollow. Observed subsidence was reduced in magnitude on the northern half of the longwall panel at the Main Southern Railway and Tahmoor Mine Site (Pier 2).

As shown in Fig. 2.2, observed subsidence at Peg V51 was slightly greater than predicted but within the accuracy of the prediction model of ± 15% (Reports Nos. MSEC1123 and MSEC1192). Observed subsidence at other locations above LW S1A was less than predicted.

As at January 2024, monitoring during the mining of LW S2A has measured subsidence movements developing within predictions, as shown in Fig. 2.3.

As recommended in Report No. MSEC1192, monitoring will be conducted during mining to compare observations with predictions. TC has extensive experience in successfully managing potential subsidence impacts on surface features, even when actual subsidence is substantially greater than the magnitudes that have been predicted above LW S7A. It is recommended that subsidence management plans be developed to manage potential impacts that could occur if greater than predicted subsidence occurs.

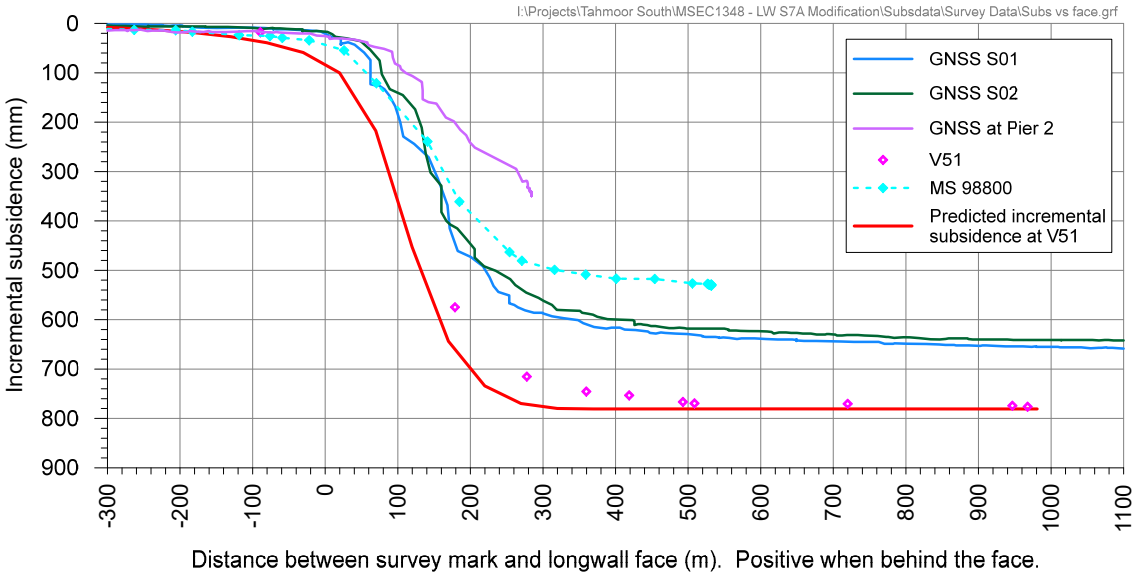


Fig. 2.2 Comparison between predicted and observed subsidence above centreline of LW S1A

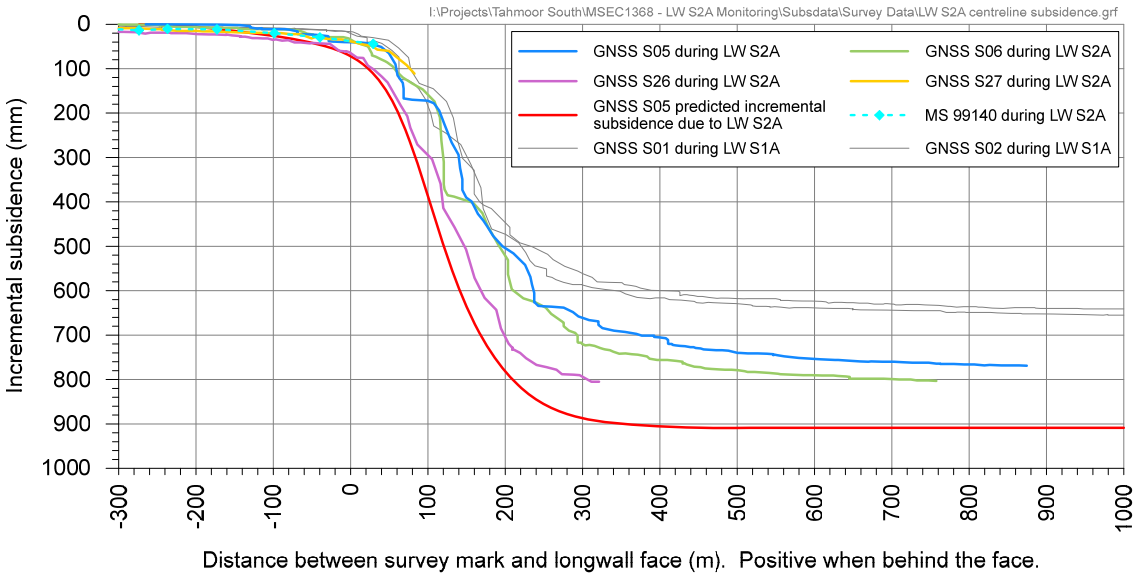


Fig. 2.3 Comparison between predicted and observed subsidence above centreline of LW S2A

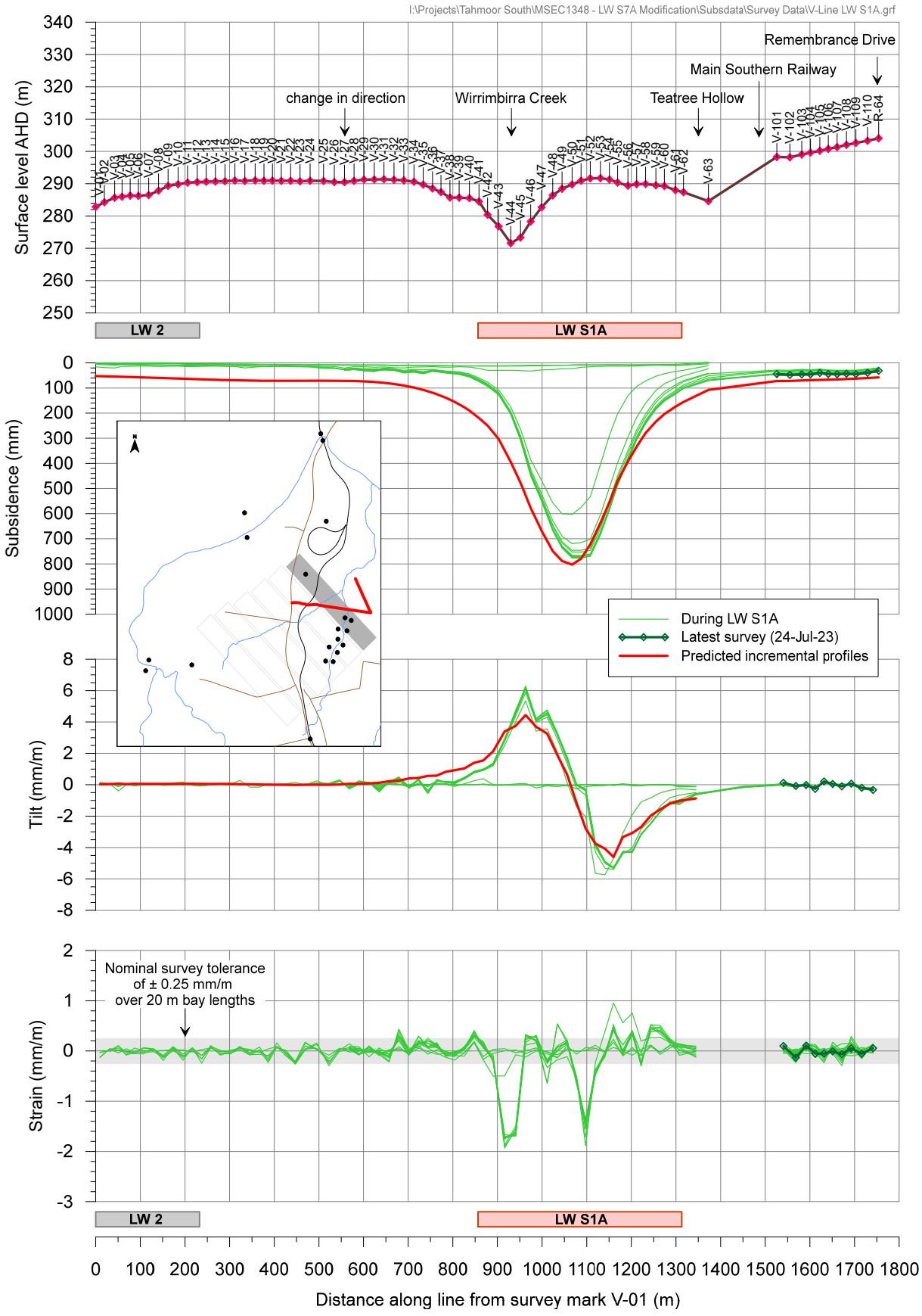


Fig. 2.4 Observed subsidence along V Line during the mining of LW S1A

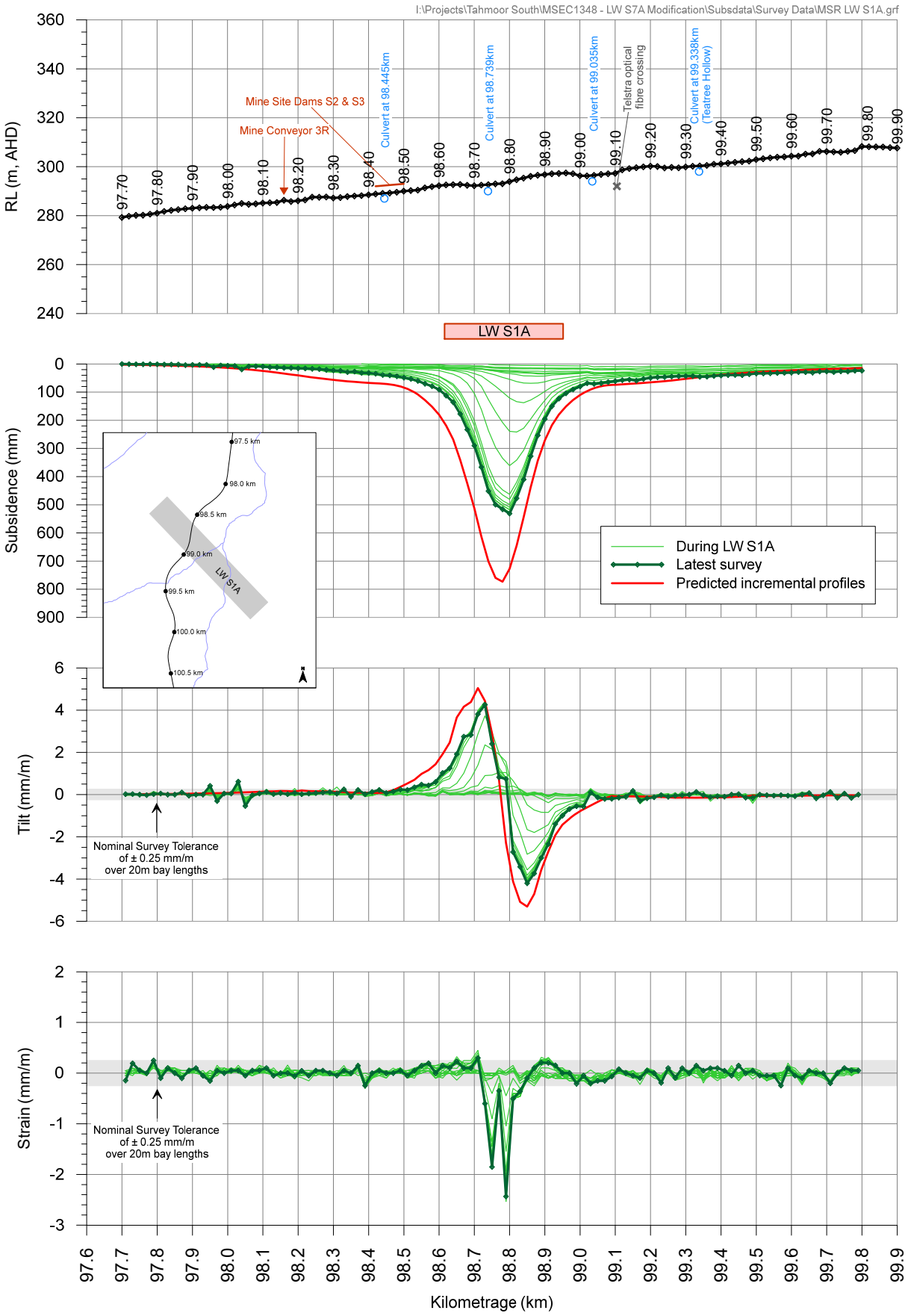


Fig. 2.5 Observed subsidence along Main Southern Railway during the mining of LW S1A

2.4. Potential for increased subsidence

As discussed in Report No. MSEC1123 (EIS), increased subsidence was observed above several previously extracted Longwalls, i.e. Longwall 8, Longwall 13, Longwall 24A and above the commencing ends of Longwalls 24A to 27 and above the commencing end of Longwall 32. Increased subsidence was also observed above the commencing end of LW W4.

The cause for the increased subsidence over Longwall 24A and above the commencing end of Longwall 25 was investigated by Strata Control Technology on behalf of Tahmoor Coal, (Gale and Sheppard, 2011). The investigations concluded that the increased subsidence is consistent with localised weathering of joint and bedding planes above a depressed water table adjacent to an incised gorge. The continued monitoring of the increased subsidence over Longwalls 26 and 27 confirmed that the extent of the increased subsidence reduced with increasing distance from the Bargo River Gorge and the northern end of a mapped fault echelon structure.

The observation above the commencing end of Longwall 32 and the commencing end of LW W4 has shown that increased subsidence has developed where mining has occurred close to other mapped first order fault echelon structures associated with the Nepean Fault.

It is worthwhile noting that Longwalls 10A, 10B, and 12 are also located near the Nepean Fault and the Bargo River and there was a reasonable correlation between observed and predicted subsidence along the available monitoring lines. Similarly, many longwalls have been extracted close to major river valleys and gorges and there were reasonable correlations between observed and predicted subsidence along all the available monitoring lines. Accordingly, it appears that the location of the zones of increased subsidence is linked to both the;

- close proximity to and the alignment of the Nepean Fault, and
- close proximity to the Bargo River Gorge, which is approximately 100 metres deep, which permitted groundwater flows to weather the joint and bedding plane properties of the surrounding strata.

The proposed LW S7A runs adjacent and approximately parallel to the Central Fault complex, which is located on the western side of the mining area. The Central Fault zone lies to the west and south of the proposed LW S7A, was described by MBGS (2013) as a normal fault trending northwest with vertical displacement up to 20 metres, east side up. This fault was identified in the 2D seismic lines and was also intercepted in one drill hole (JB06) where the Wongawilli Seam has been displaced. The Gordon Geotechniques (2013) report advised that this Central Fault zone was associated with a number of features including a change in Bulli Seam fluidity and thinning of the Balgownie to Bulli Seam interburden. The downstream part of Hornes Creek follows the surface expression of the Central Fault. Further analyses of exploration data has improved confidence in defining the location of the Central Fault, which has allowed Tahmoor Coal to propose extraction of LW S7A. Since the Extraction Plan of LW S1A to S6A was approved, Tahmoor Coal has also drilled boreholes on both ends of the Picton Weir. The fault was not observed by PSM (2023) during the geological field mapping and the boreholes did not intercept it.

It is possible that increased subsidence may develop above LW S7A but this is not certain for the following reasons:

- The Central Fault is less defined in the Tahmoor South area compared to the Nepean Fault in the Tahmoor North area, and
- The measured groundwater gradients in the Tahmoor South area are less than those measured near Longwalls 24A to 26.

If greater than predicted subsidence was to occur above the proposed longwalls, it is unlikely that the magnitude of this increased subsidence will be much greater than the predictions for the following reasons:

- Predicted maximum incremental subsidence is 1,150 mm, which represents approximately 45 % to 52 % of the proposed extraction height. Maximum observed incremental subsidence above Longwalls 24A to 27 was approximately 55 % of the extraction height.
- Predicted maximum total subsidence is 1,650 mm, which represents approximately 63 % of the proposed extraction height. Maximum observed total subsidence above Longwalls 24A to 27 was approximately 62 % of the extraction height.
- The higher levels of predicted subsidence at Tahmoor South are due to a combination of greater extraction heights and slightly shallower depths of cover. They are comparable to or just less than the observed increased subsidence above Longwalls 24A to 27 when expressed as a proportion of extraction height.
- In the cases of Longwalls 24A and 25, the observed maximum subsidence was greater than predictions by between 2 to 2.3 times. This was partly because the panels were the first and second in a series of longwalls where reduced subsidence would normally have been expected to develop. Increasing the predicted levels of subsidence by factors of 2 to 2.3 would result in subsidence much greater than the proposed extraction height, which is extremely unlikely to occur.

While the potential exists for increased subsidence to occur above LW S7A adjacent to the Central Fault, it is important to note that the potential impacts on surface infrastructure from this extra subsidence can be managed, as it was managed over Longwalls 24A to 27, Longwall 32 and Longwall W4, so that they remain safe and serviceable during and after the mining period with the implementation of effective management measures. When required, these measures would include;

- A detailed pre-mining assessment of the potential impacts on surface infrastructure in the event that increased subsidence occurs.
- Monitoring of subsidence movements above and beyond the proposed mining footprint, including across the projected location of the Central Fault on the surface.
- Monitoring of the condition of surface infrastructure during and after the mining period.
- Implementation of planned early intervention measures to further protect the safety and serviceability of surface infrastructure based on pre-determined trigger levels based on monitoring data.
- If increased subsidence were to occur during the mining of a proposed longwall, consideration of whether to continue mining future longwalls at the same commencing and/or finishing ends as proposed or make amendments to avoid future increased subsidence.

2.5. Predicted Strain

It is important to appreciate that the extraction of coal not only results in subsidence, but, it also induces horizontal ground movements and ground strains, and, unlike subsidence, which is measured vertically, it is important to appreciate that these parameters have both a magnitude and a direction. The magnitude of the measured ground strains can be sensitive to the ground distances over which they were measured, and, both the measured ground strains and horizontal movements are very sensitive to the direction in which they were measured. Hence, strain and horizontal movements are more complex, and they are more difficult to predict than subsidence, tilt and curvature.

The profiles of observed strain along monitoring lines, therefore, were often irregular in shape even when the profiles of observed subsidence, tilt and curvature were relatively smooth.

Early researchers noticed the similarity between the observed curvature and strain profiles and the similarity between the observed tilt and horizontal movement profiles. Hence, it was logical that the early strain prediction methods were based on linear relationships with predicted conventional curvature and the early horizontal ground movement prediction methods were based on linear relationships with predicted conventional tilt.

The locations that are predicted to experience hogging or convex curvature are expected to be net tensile strain zones and the locations that are predicted to experience sagging or concave curvature are expected to be net compressive strain zones and adopting a linear relationship between curvature and strain provided a reasonable prediction for the maximum conventional tensile and compressive strains.

In the Southern Coalfield, it was found that a curvature to conventional strain conversion factor of 15 provided a reasonable relationship between the maximum predicted curvatures and the maximum predicted conventional strains. Similarly, a tilt to conventional horizontal movement conversion factor of 15 was found to provide a reasonable relationship between the maximum predicted tilt and the maximum predicted conventional horizontal movement.

However, it was noticed that, whilst these correlations were reasonable for the maximum values of these parameters over some areas of the mined panels, they were not as reliable in many other areas, particularly in those locations that were beyond the edges of the mined panels that were near changes in geological conditions. It was also noted that survey tolerance and valley related movements can represent a high proportion of measured ground strains and horizontal displacements.

The limited accuracy of strain and horizontal movement predictions at locations away from the point of maximum strain and horizontal movement was discussed in later subsidence prediction reports where it was stated that the measured strains and horizontal ground movements at a point can vary considerably from the predicted conventional values. It was noted that the locations that were predicted to experience hogging or convex curvature experienced net tensile strain zones and the locations that were predicted to experience sagging or concave curvature experienced net compressive strain zones, but, it was highlighted that the observed strain and horizontal movement profiles along monitoring lines were irregular in shape, with an occasional spike, compared to the observed subsidence, tilt and curvature profiles which were relatively smooth. Hence, it was concluded that, whilst the prediction of vertical subsidence and tilt at a point could be carried out with reasonable accuracy and reliability, the prediction of mining-induced ground strains and horizontal movements at a point was far less accurate, especially when those predictions used linear conversion factors that were based on predicted conventional curvature and tilt.

Furthermore, the horizontal movement predictions at a point were rarely provided and the predictions of ground strains are usually provided based on statistical basis, as is detailed in Section 2.5.1.

However, strain is one of the most important parameters for assessing the likelihood of mine subsidence damage to natural features and built features on the surface. Recent research has resulted in some improved understanding and methods for predicting ground strains and relative horizontal movements in zones across mined panels at the surface, (Barbato, 2016, 2017). These new methods for predicting strain have been developed dependent on the mining geometry, surface topography, surface geology and the likelihood of irregular anomalous movements.

The predicted distribution of strains using this new method also provides guidance on the magnitudes of localised spikes and the likelihoods of exceeding strain thresholds based on previously measured ground monitoring data (Barbato et al., 2016 and 2017).

The reasons why ground strains and horizontal movements are more complex and difficult to predict than subsidence, tilt and curvature are partly associated with the observation that, while the strata has only one direction to move,(i.e. vertically downwards), it can be moved in two directions horizontally and it has been observed that the ground will move wherever it is easiest to go. Additionally, studies have noted that ground strains and horizontal movements are influenced/affected by many multiple factors and a complex interaction of many mechanisms, including the:

- magnitude of the vertical subsidence, tilt and the depth of cover;
- steepness and direction of the surface topography;
- steepness and direction of the seam dip;
- direction of mining in relation to both the surface and seam slope;
- geology, geomechanical properties and thicknesses of the near surface strata, as well as, all the overburden strata layers, the seam and the strata layers immediately under the seam;
- presence of geological faults, pre-existing natural joints and igneous intrusions;
- magnitude and principal direction of the in situ horizontal compressive stresses in the strata layers around the mined goaf and the surface strata layers;
- presence and proximity of previously extracted panels in the currently mined seam and previously extracted panels in other seams;
- behaviour of blocky sandstone environments where initial ground movements occur predominantly along pre-existing natural joints, the location of which would not be known;
- limited ability of opened joints to close fully during the following compression phases after the initial shearing and tensile movements;
- reversing component that seems to initially move surveyed surface pegs towards the longwall face as the face approaches and, then, after the face extracts under and away from this peg, the surface is moved back towards its initial position and often it is moved further past that position as it follows the mining face; and
- other contributing factors such as the degree of surface roughness and frictional resistance along the bedding planes, survey accuracy or survey tolerance (especially where the strains are of a low order of magnitude), the presence of groundwater flows along the bedding planes and its influence on the slippage along bedding planes, etc.

Nevertheless, it has been concluded that the curvature to conventional strain conversion factor and the tilt to horizontal movement conversion factor can be used to provide a reasonable indication of the maximum conventional strains and horizontal movements over extracted panels.

Using the maximum predicted conventional curvatures of 0.14 km^{-1} hogging and 0.25 km^{-1} sagging curvature and the conventional strain conversion factor of 15, the maximum predicted conventional strains for the proposed LWs S1A to S6A, are approximately 2.1 mm/m tensile and 3.8 mm/m compressive.

At specific points around the mined panels, however, there can be considerable variation from this linear curvature to conventional strain relationship, resulting from non-conventional movements and a wide range of scatter is observed between the predicted and observed strain profiles. When expressed as a percentage, observed strains can be many times greater than the predicted conventional strain for low magnitudes of curvature. In this report, therefore, MSEC has provided a statistical approach to predict observed strain and hence account for this variability, instead of just providing a single predicted conventional strain.

The range of potential strains above the proposed longwalls has been determined using monitoring data from the previously extracted longwalls at Tahmoor Mine, as well as from other nearby collieries, including Appin and West Cliff, where the regional geology and mining geometries are reasonably similar to that for the proposed longwalls. A summary of the monitoring lines that were used in the strain analysis is provided in Table 2.4 and Table 2.5 shows the mining geometry for the proposed longwalls.

Table 2.4 Monitoring lines used in the strain analysis

Location	Monitoring Lines	Longwall Widths (m)	Depths of Cover (m)	Width-to-Depth Ratios	Extraction Heights (m)
Early longwall areas at Tahmoor Mine	100-Line	190	410	0.47	2.0
	200-Line	190	410	0.46	1.9
	300-Line	190 ~ 240	430	0.47	2.2
	800-Line	235	420	0.56	2.1
	900-Line	235	420	0.56	2.0
	1000-Line	190 ~ 240	400	0.57	1.8
Northern areas over Tahmoor	40 monitoring lines located outside the area of '*increased subsidence*'	285	425 ~ 470 *(440 average)*	0.60 ~ 0.67 *(0.64 average)*	1.7 ~ 2.3 *(2.1 average)*
Appin Area 3	M-Line	260	480 ~ 520 *(500 average)*	0.50 ~ 0.54 *(0.52 average)*	2.6 ~ 3.0 *(2.8 average)*
Appin Area 7	HW2 East, HW2 West, ARTC and Moreton Park Road	305	500 ~ 560 *(530 average)*	0.54 ~ 0.61 *(0.58 average)*	2.8 ~ 3.2 *(3.0 average)*
West Cliff Area 5	B-Line	305	490 ~ 530 *(510 average)*	0.58 ~ 0.62 *(0.60 average)*	2.4 ~ 3.0 *(2.6 average)*

Table 2.5 Mining geometry for the proposed LWs S1A to S7A

Location	Longwall Widths (m)	Depths of Cover (m)	Width-to-Depth Ratios	Extraction Heights (m)
LW S1A to LW S7A	283-285	375 ~ 410 *(390 average)*	0.69 ~ 0.76 *(0.73 average)*	2.1 ~ 2.6 *(2.2 average)*

It can be seen from the above tables, that the extraction heights for the LWs S1A and S6A and the proposed LW S7A vary between 2.1 metres and 2.6 metres, which are similar to those for the previously extracted longwalls at Tahmoor Mine, which varied between 1.7 metres and 2.3 metres, but is less on average than those for the previously extracted longwalls at Appin and West Cliff Collieries, which varied between 2.4 metres and 3.2 metres. That is, the extraction heights for the proposed longwalls are within the ranges of those for the previously extracted longwalls at Tahmoor, Appin and West Cliff Collieries.

The width-to-depth ratios for the proposed longwalls varies between 0.69 and 0.76, which are slightly greater than those for the previously extracted longwalls at Tahmoor, Appin and West Cliff Collieries, which varied between 0.46 and 0.67. Unfortunately, there is limited available ground monitoring data from previously extracted longwalls in the Southern Coalfield where the width-to-depth ratios are exactly similar to the proposed longwalls.

There is, however, extensive ground monitoring data available from previously extracted longwalls in the Newcastle, Hunter and Western Coalfields where the width-to-depth ratios were similar and much greater than those for the proposed longwalls. This data was not included in the strain analyses, since the overburden geology is different to that in the Southern Coalfield and since the width-to-depth ratios for the proposed longwalls are only slightly higher than the available Southern Coalfields data that has similar overburden geology.

A review of the available data from the Newcastle, Hunter and Western Coalfields indicates that the observed strains for previously extracted longwalls having width-to-depth ratios between 0.70 and 0.85, i.e. slightly greater when compared to the proposed amended longwalls, were on average, around 20 % to 40 % greater than the observed strains for previously extracted longwalls in the Newcastle, Hunter and Western Coalfields having width-to-depth ratios between 0.50 and 0.70, i.e. similar to Tahmoor North, Appin and West Cliff Collieries.

It could be expected, therefore, that the observed strains resulting from the extraction of the proposed longwalls would be, on average, around 20 % to 40 % greater than those previously experienced at Tahmoor, Appin and West Cliff Collieries and, hence, the predicted strains for the proposed longwalls have been determined from the analyses of strain from the previously extracted longwalls at Tahmoor, Appin and West Cliff Collieries, with the magnitudes increased by 20 % to 40 % to account for the higher width-to-depth ratios based on the observations from the Newcastle, Hunter and Western Coalfields.

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, which are addressed separately in this report. The strains resulting from damaged or disturbed survey marks have also been excluded.

A number of probability distribution functions were fitted to the empirical monitored strain data. It was found that a *Generalised Pareto Distribution (GPD)* provided a good fit to the raw strain data. 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).

2.5.1. Analysis of strains measured in survey bays

For features that are in discrete locations, such as building structures, farm dams and archaeological sites, it is appropriate to assess the frequency of the observed maximum strains for individual survey bays.

Predictions of strain above goaf

The survey database has been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of the previous longwalls at Tahmoor, Appin and West Cliff Collieries, for survey bays that were located directly above goaf or the chain pillars that are located between the extracted longwalls, which has been referred to as "*above goaf*".

The histogram of the maximum observed total tensile and compressive strains measured in survey bays above goaf, for monitoring lines at Tahmoor, Appin Area and West Cliff Collieries, is provided in Fig. 2.6. The probability distribution functions, based on the fitted GPDs, have also been shown in this figure.

The 95 % confidence levels for the maximum total strains that the individual survey bays *above goaf* experienced at any time during mining at Tahmoor, Appin and West Cliff Collieries were 0.9 mm/m tensile and 1.6 mm/m compressive. The strains for the proposed longwalls are predicted to be 20 % to 40 % greater than those previously observed at these collieries and, therefore, it is expected that 95 % of the strains measured *above goaf* would be less than 1.3 mm/m tensile and 2.2 mm/m compressive.

The 99 % confidence levels for the maximum total strains that the individual survey bays *above goaf* experienced at any time during mining at Tahmoor, Appin and West Cliff Collieries were 1.4 mm/m tensile and 3.1 mm/m compressive. Similarly, it is expected that 99 % of the strains measured *above goaf* for the proposed longwalls would be less than 2.0 mm/m tensile and 4.3 mm/m compressive.

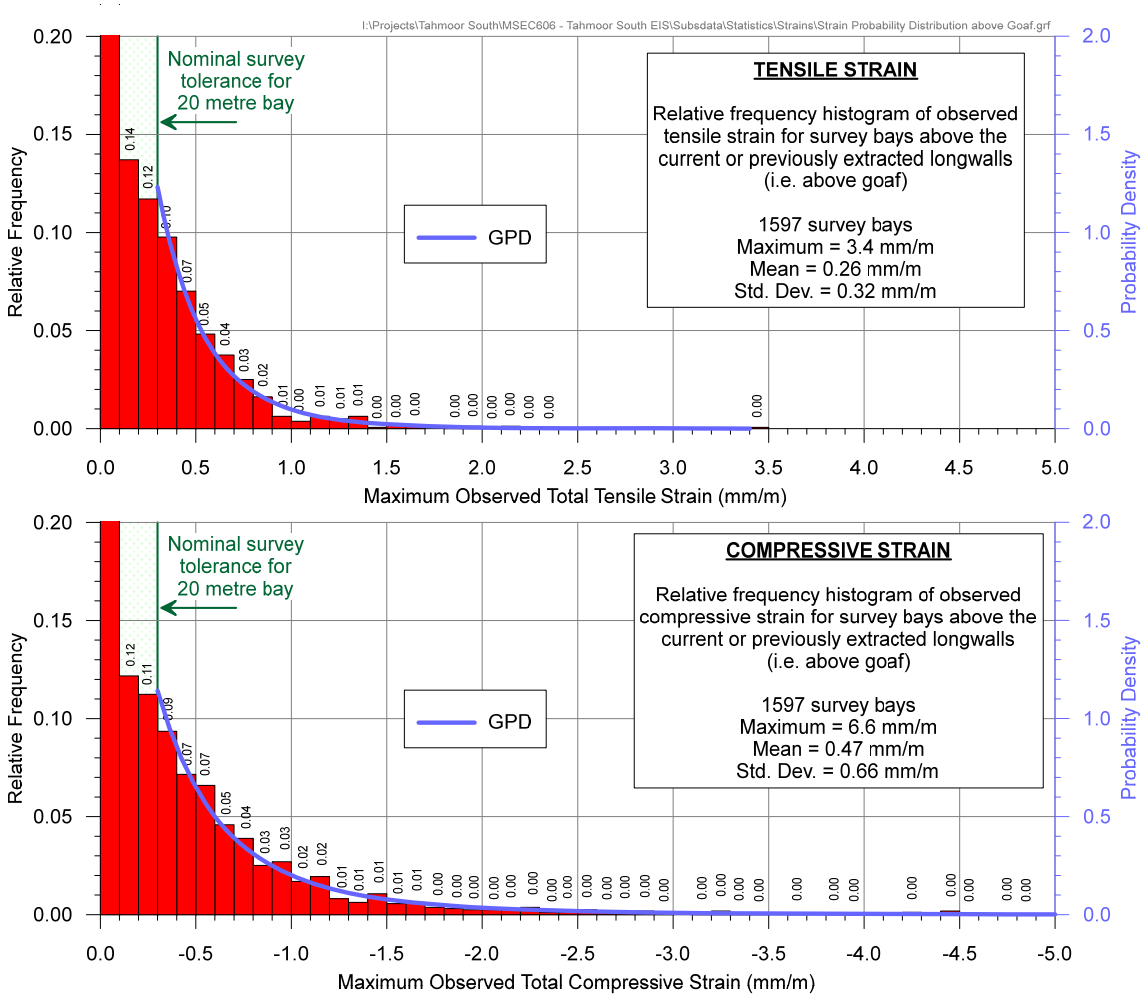


Fig. 2.6 Distributions of the measured maximum tensile and compressive strains for surveys bays located *above goaf* at Tahmoor, Appin and West Cliff Collieries

The histogram of the maximum observed total tensile and compressive strains measured in survey bays above goaf, for monitoring lines at Tahmoor, Appin Area and West Cliff Collieries, is provided in Fig. 2.7. The probability distribution functions, based on the fitted GPDs, have also been shown in this figure, along with the probability distribution function shown in Fig. 2.6 for comparison.

It can be seen that the observed strains above LW S1A have generally been less than previously observed at Tahmoor, Appin and West Cliff Collieries. LW S1A is, however, the first panel in the series and ground strains were predicted to be smaller above LW S1A than above future longwalls.

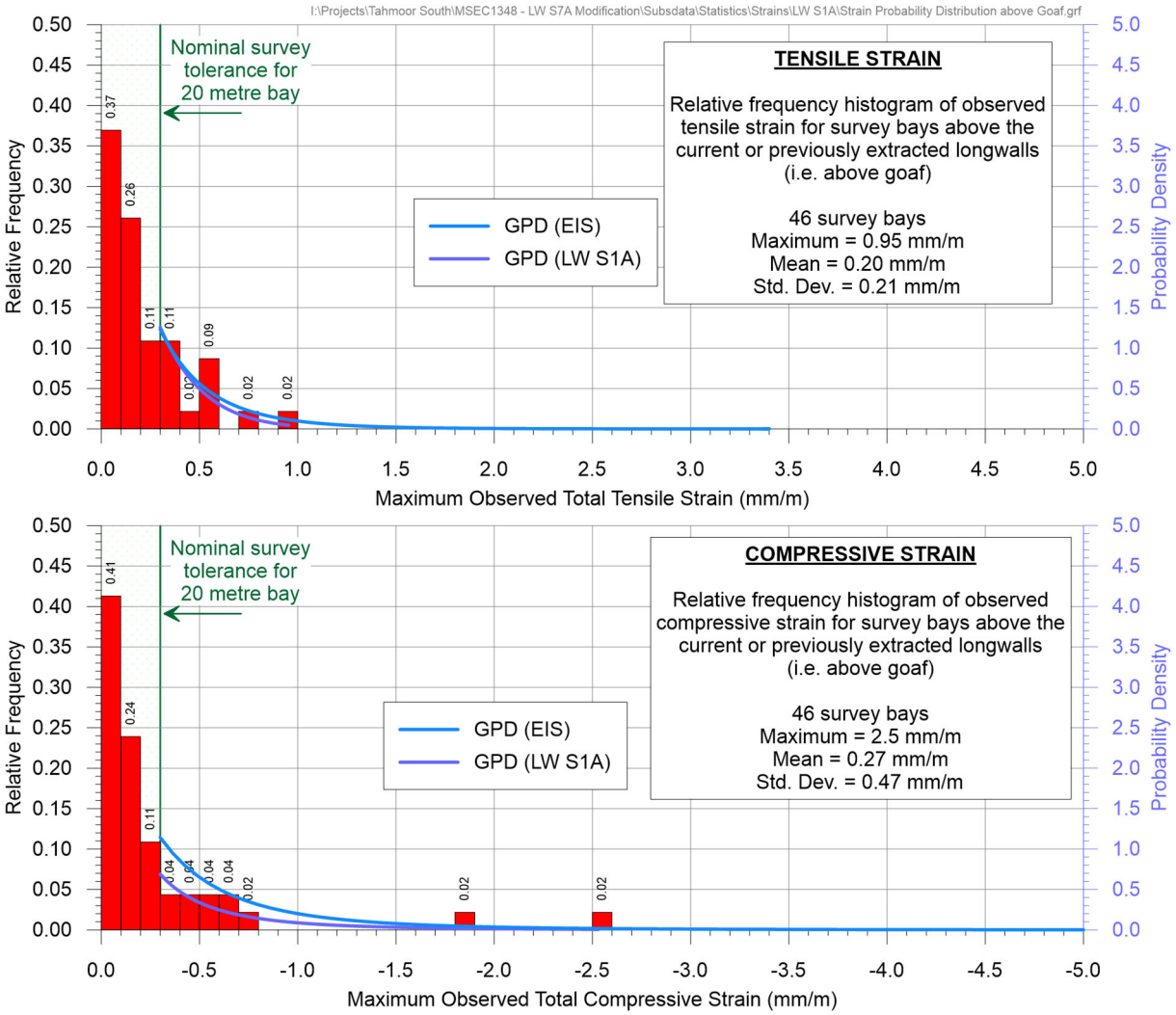


Fig. 2.7 Distributions of the measured maximum tensile and compressive strains for surveys bays located *above goaf* at Tahmoor LW S1A

Predictions of strain above solid coal

The survey database has also been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of the previous longwalls at Tahmoor, Appin and West Cliff Collieries, for survey bays that were located beyond the goaf edges of the mined panels and positioned on unmined areas of coal, i.e. outside panels but within 200 metres of the nearest longwall goaf edge, which has been referred to as "*above solid coal*".

The histogram of the maximum observed tensile and compressive strains measured in survey bays above solid coal, for monitoring lines at Tahmoor, Appin and West Cliff Collieries, is provided in Fig. 2.8. The probability distribution functions, based on the fitted GPDs, have also been shown in this figure.

The 95 % confidence levels for the maximum total strains that the individual survey bays *above solid coal* experienced at any time during mining at Tahmoor, Appin and West Cliff Collieries were 0.6 mm/m tensile and 0.5 mm/m compressive. The strains for the proposed longwalls are predicted to be 20 % to 40 % greater than those previously observed at these collieries and, therefore, it is expected that 95 % of the strains measured *above solid coal* would be less than 1.0 mm/m tensile and compressive.

The 99 % confidence levels for the maximum total strains that the individual survey bays *above solid coal* experienced at any time during mining at Tahmoor, Appin and West Cliff Collieries were 0.9 mm/m tensile and compressive. Similarly, it is expected that 99 % of the strains measured *above solid coal* adjacent to the proposed longwalls would be less than 1.5 mm/m tensile and compressive.

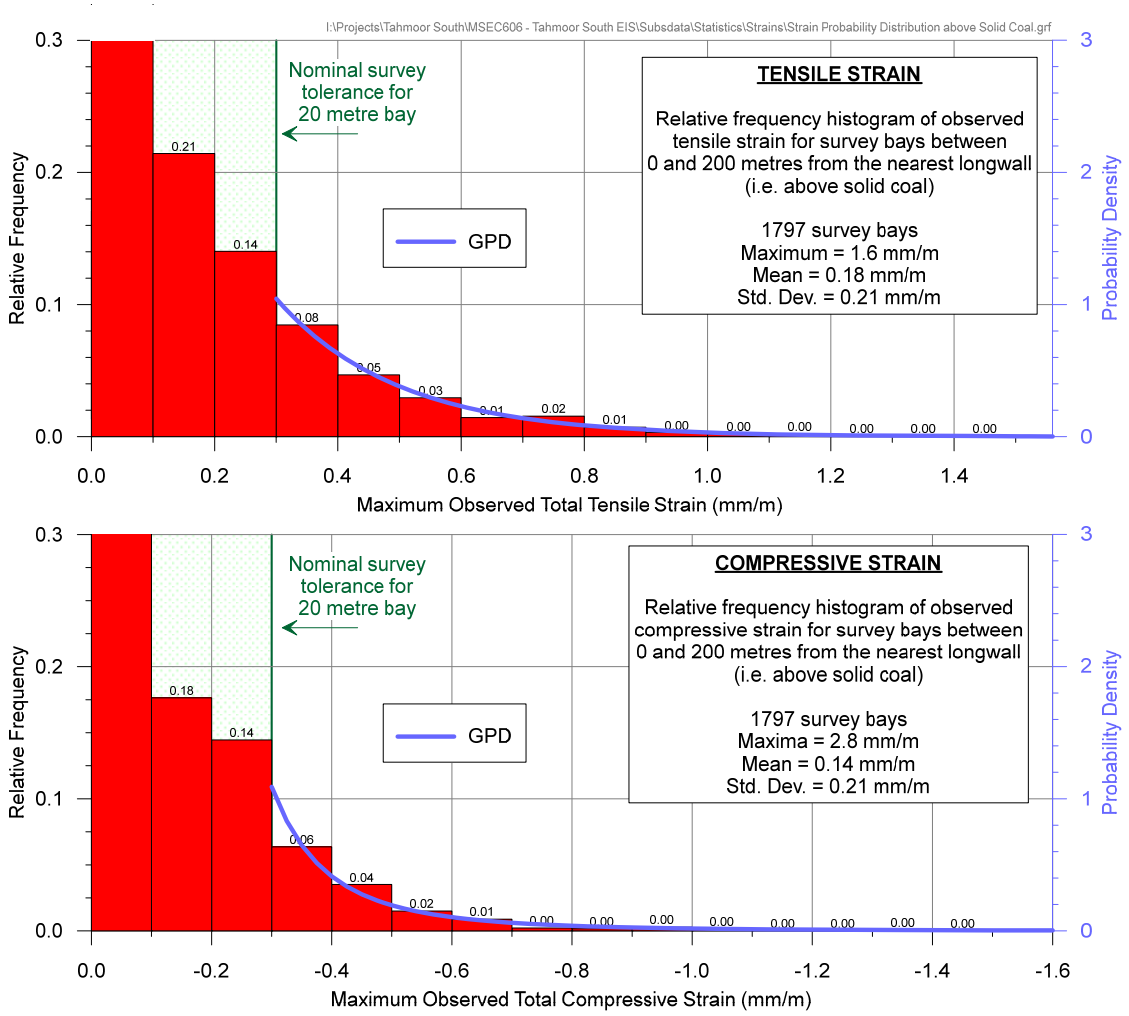


Fig. 2.8 Distributions of the measured maximum tensile and compressive strains for survey bays located *above solid Coal* at Tahmoor, Appin and West Cliff Collieries

The histogram of the maximum observed total tensile and compressive strains measured in survey bays above goaf, for monitoring lines at Tahmoor, Appin Area and West Cliff Collieries, is provided in Fig. 2.9. The probability distribution functions, based on the fitted GPDs, have also been shown in this figure, along with the probability distribution function shown in Fig. 2.8 for comparison.

The results include the observed non-conventional compressive ground strain of 2.0 mm/m that was observed between Pegs R47 and R48 to the side of LW S1A.

It can be seen that the observed strains adjacent to LW S1A have generally been less than previously observed at Tahmoor, Appin and West Cliff Collieries. The distribution in LW S1A is, however, the first panel in the series and ground strains were predicted to be smaller above LW S1A than above future longwalls.

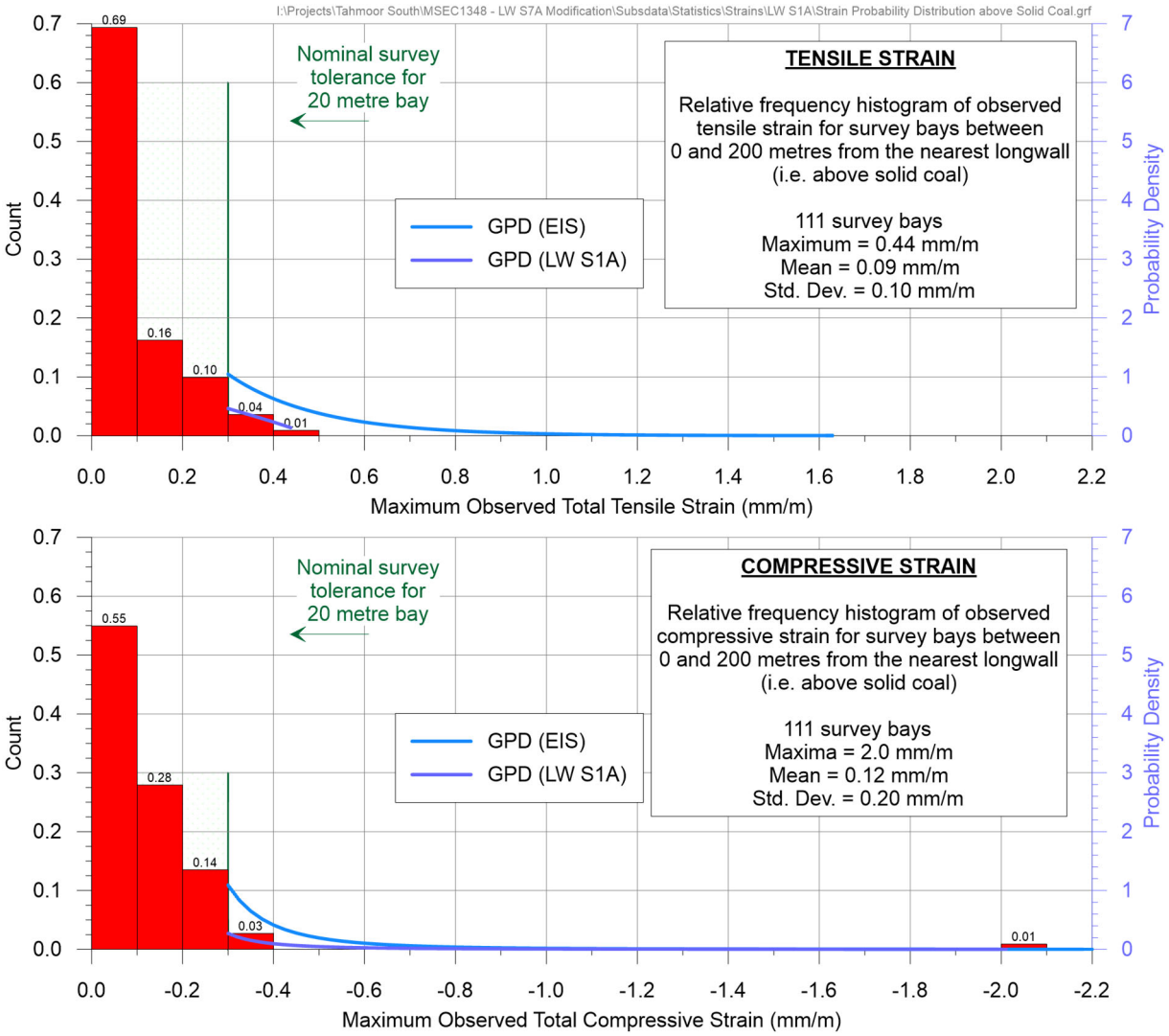


Fig. 2.9 Distributions of the measured maximum tensile and compressive strains for surveys bays located *above solid coal* at Tahmoor LW S1A

2.5.2. Analysis of strains measured along whole monitoring lines

For linear features such as roads, cables and pipelines, it is more appropriate to assess the frequency of the maximum observed strains along whole monitoring lines, rather than for individual survey bays. That is, an analysis of the maximum strains measured anywhere along the monitoring lines, regardless of where the strain actually occurs.

The histogram of maximum observed total tensile and compressive strains measured anywhere along the monitoring lines, at any time during or after the extraction of the previous longwalls at Tahmoor, Appin and West Cliff Collieries, is provided in Fig. 2.10.

It can be seen from Fig. 2.10, that 42 of the 52 monitoring lines (i.e. 92 % of the total) at Tahmoor, Appin and West Cliff Collieries had recorded maximum total tensile strains of 2.0 mm/m, or less. The strains for the proposed longwalls are predicted to be 20 % to 40 % greater than those previously observed at these collieries and, therefore, it is expected that 92 % of the monitoring lines above the proposed longwalls would experience maximum tensile strains of 3.0 mm/m, or less.

It can also be seen, that 45 of the 52 monitoring lines (i.e. 87 % of the total) at Tahmoor, Appin and West Cliff Collieries had recorded maximum total compressive strains of 4.0 mm/m, or less. The strains for the proposed longwalls are predicted to be 20 % to 40 % greater than those previously observed at these collieries and, therefore, it is expected that 87 % of the monitoring lines above the proposed longwalls would experience maximum compressive strains of 5.5 mm/m, or less.

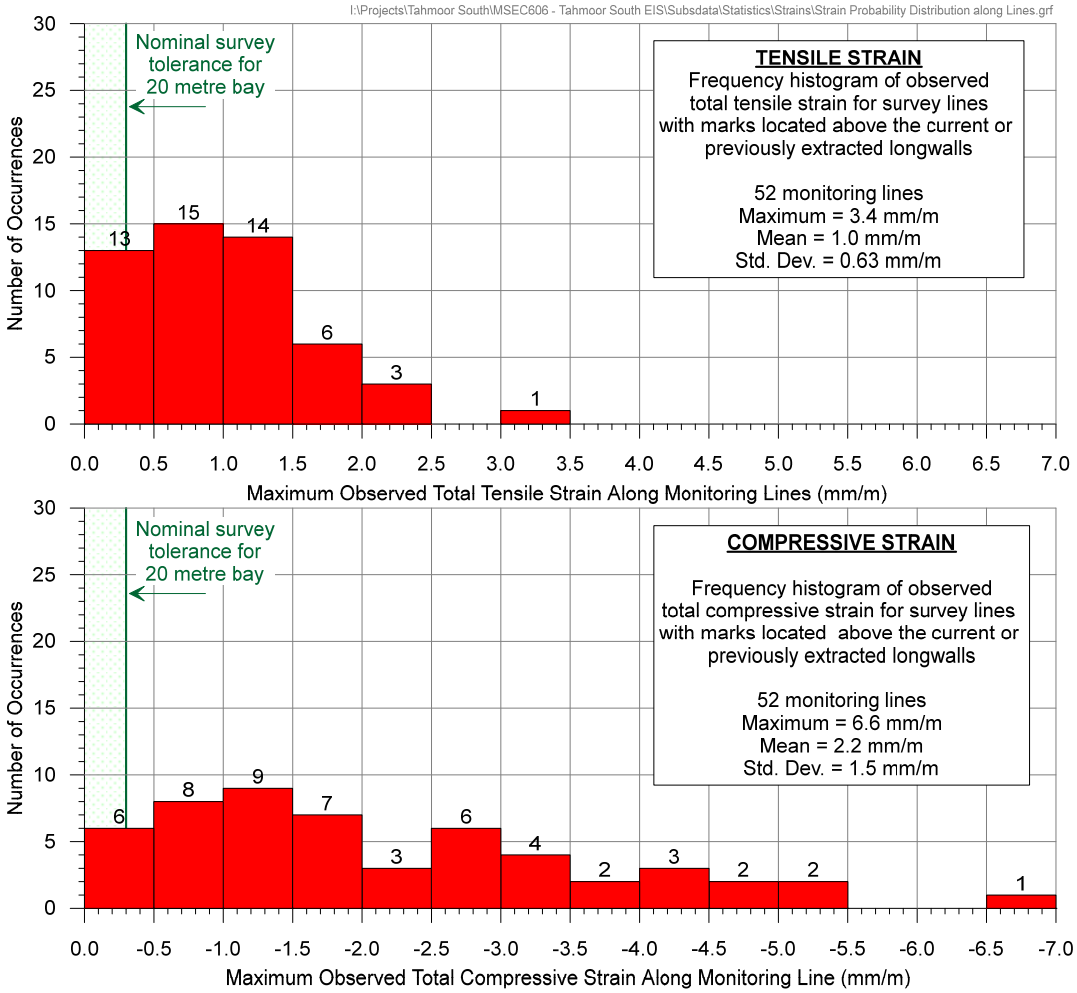


Fig. 2.10 Distributions of measured maximum tensile and compressive strains anywhere along the monitoring lines at Tahmoor, Appin and West Cliff Collieries

A statistical comparison of observed maximum strains along monitoring lines above LW S1A has not been conducted due to limited data. Two monitoring lines, the Main Southern Railway and Remembrance Drive recorded a maximum compressive strain of 2.5 mm/m and 2 mm/m, respectively.

2.5.3. Analysis of shear strains

Ground strain comprises two components, being normal strain and shear strain, which can be interrelated using a Mohr's Circle analysis. The magnitudes of the normal strain and shear strain components are, therefore, dependent on the orientation in which they are measured. The maximum normal strains (i.e. principal strains) are those in the direction where the corresponding shear strain is zero.

Normal strains along monitoring lines can be measured using 2D and 3D techniques, by taking the change in horizontal distance between two points on the ground and dividing by the original horizontal distance between them. This provides the magnitude of normal strain along the orientation of the monitoring line but, this strain may not necessarily be the maximum (i.e. principal) strain.

Shear deformations are more difficult to measure, as they are the relative horizontal movements perpendicular to the direction of measurement. However, 3D monitoring techniques provide data on the direction and the absolute displacement of survey marks and, therefore, the shear deformations perpendicular to the monitoring line can be determined. It is possible to gain an understanding of the shear strain along a monitoring line with repeat measurements, but, in accordance with rigorous definitions and the principles of continuum mechanics, (e.g. Jaeger, 1969), it is not possible to accurately determine

horizontal shear strains in any direction relative to the monitoring line using 3D monitoring data from a straight line of survey marks.

Shear deformations perpendicular to monitoring lines can be described using various parameters, including horizontal tilt, horizontal curvature, horizontal mid-ordinate deviation, angular distortion and shear index. In this report, horizontal mid-ordinate deviation has been used as the measure for shear deformation, which is defined as the differential horizontal movement of each survey mark, perpendicular to a line drawn between two adjacent survey marks.

The frequency distribution of the maximum total horizontal mid-ordinate deviations measured at survey marks above goaf, for previously extracted longwalls in the Southern Coalfield, is provided in Fig. 2.11. As the typical survey bay length was 20 metres, the calculated mid-ordinate deviations were over a chord length of 40 metres. The probability distribution function, based on the fitted GPD, has also been shown in this figure.

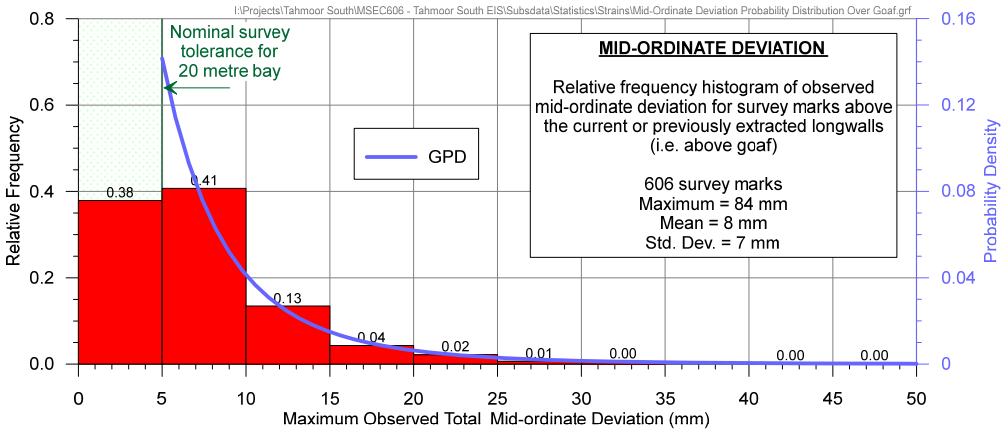


Fig. 2.11 Distribution of measured maximum mid-ordinate deviation during the extraction of previous longwalls in the Southern Coalfield for marks located above goaf

The 95 % and 99 % confidence levels for the maximum total horizontal mid-ordinate deviation that the individual survey marks located above goaf experienced at any time during mining were 20 mm and 35 mm, respectively. The shear deformations for the proposed longwalls are estimated to be 20 % to 40 % greater than those previously observed at Tahmoor, Appin and West Cliff Collieries and, therefore, it is expected that 95 % and 99 % of the horizontal mid-ordinate deviations measured above the proposed longwalls would be less than 30 mm and 50 mm, respectively.

A statistical comparison of observed maximum strains along monitoring lines above LW S1A has not been conducted due to limited data.

2.6. Predicted far-field horizontal movements

In addition to the conventional subsidence movements that have been predicted above and adjacent to the proposed LW S7A, far-field horizontal movements will also be experienced during the extraction of the proposed longwall.

The observed incremental far-field horizontal movements resulting from the extraction of incremental longwall panels, in any location above goaf, i.e. above the currently mined or previously mined panels, or above solid coal, i.e. unmined areas of coal, are provided in Fig. 2.12. The observed incremental far-field horizontal movements above solid coal only, i.e. outside the extents of extracted longwalls, are provided Fig. 2.13. The confidence levels, based on fitted *Generalised Pareto Distributions* (GPDs), have also been shown in these figures to illustrate the spread of the data. It can be seen from Fig. 2.12 and Fig. 2.13 that the magnitude of the observed far-field horizontal movements over solid unmined areas of coal are lower and more consistent than the observed far-field horizontal movements over previously extracted panels.

As successive longwalls within a series of longwalls 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 within the strata have been redistributed around the collapsed zones above the first few extracted longwalls, the potential for further movement is reduced. The total far-field horizontal movement may be less, therefore, than the sum of the incremental far-field horizontal movements for the individual longwalls.

The predicted far-field horizontal movements resulting from the extraction of the proposed LW S7A are very small and could only be detected by precise surveys. Such movements tend to be bodily movements towards the extracted goaf area, and are accompanied by very low levels of strain, which are generally less than the order of survey tolerance (i.e. less than 0.3 mm/m). The potential impacts of differential far-field horizontal movements on the natural and built features within the vicinity of the proposed longwalls are not

expected to be measurable, with possibly the exception of the road and railway bridges and the Picton Weir, which are discussed in the impact assessments for these features in the following chapter.

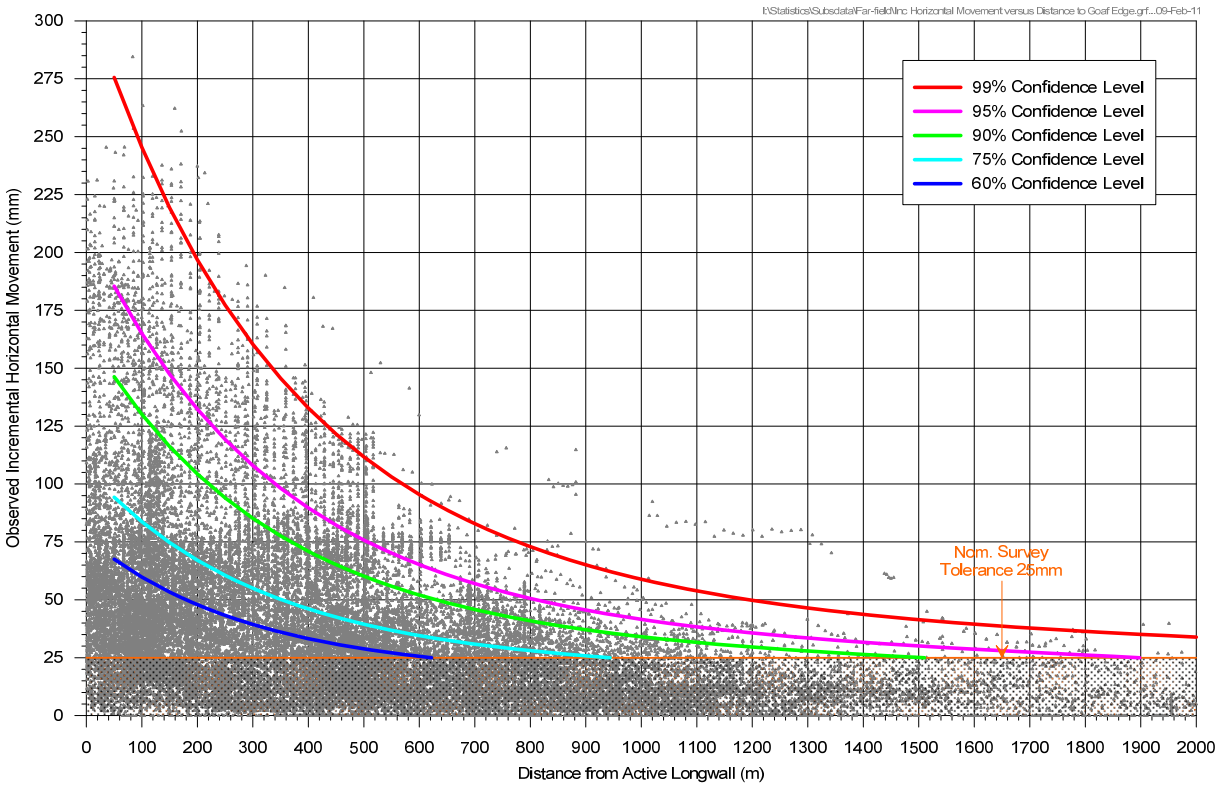


Fig. 2.12 Observed incremental far-field horizontal movements above goaf or solid coal

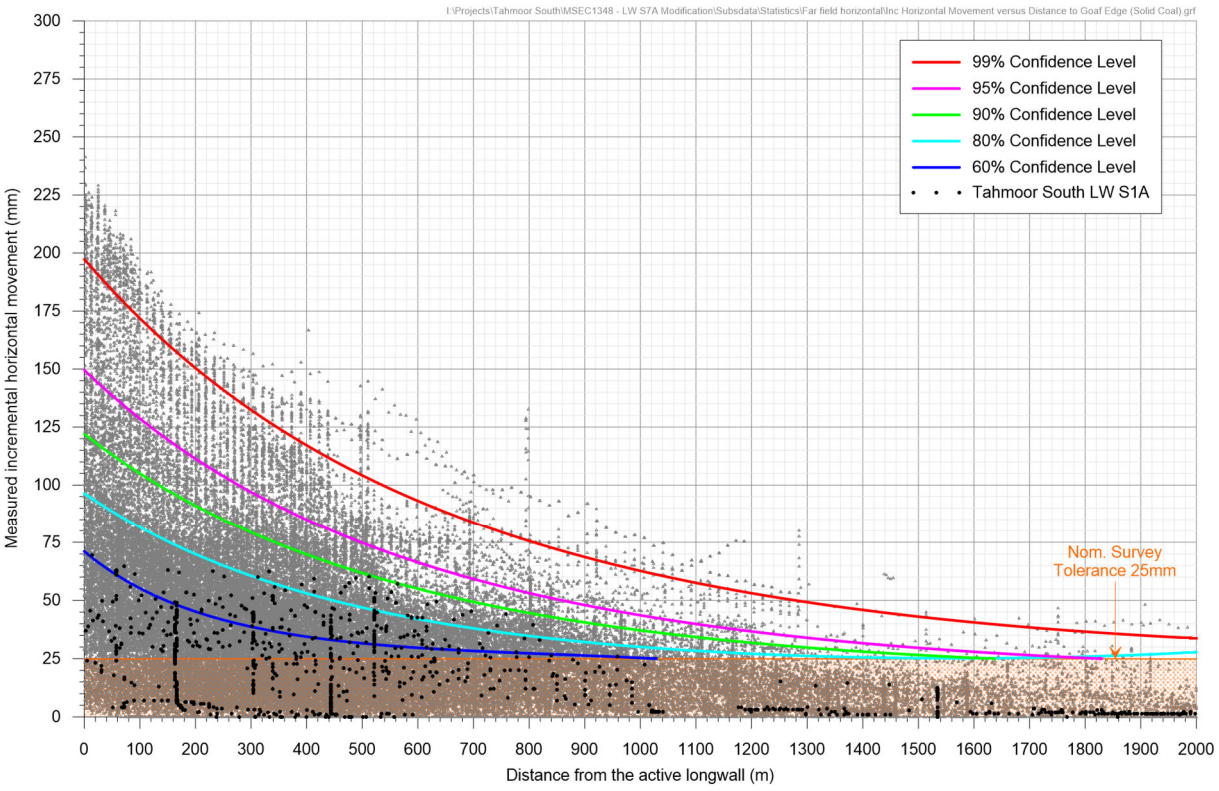


Fig. 2.13 Observed incremental far-field horizontal movements above solid coal only

A far field monitoring program was conducted by Tahmoor Coal during the extraction of LW S1A at key civil structures and along the Bargo River and Hornes Creek. The observed horizontal movements during the mining of LW S1A were within the normal range, as shown in Fig. 2.13.

3.1. The Study Area

The Study Area has been defined as the zone where the predicted subsidence effects, based on the *Modified Layout*, are different to those predicted based on the *Approved Layout*. The Study Area has been based on the following:

- 35° angle of draw line around LW S7A, based on the Modified Layout;
- The limit where the predicted incremental vertical subsidence due to the extraction of LW S7A on the tailgate (eastern side) of the panel is greater than 20 mm; and
- The limit where the predicted incremental total subsidence due to the extraction of LWs S1A to S7A on the maingate (western side) of the panel is greater than 20 mm.

The extent of the Study Area is shown in Drawing No. MSEC1348-01. Surface features that are located within 600 m of LW S7A, which will experience valley-related effects and could be sensitive to these effects, have also been included in the assessments provided in this report.

The natural and built features that are located within the Study Area are shown in Drawings Nos. MSEC1348-07 to MSEC1348-10. The surface features that have been included in the assessments provided in this report are:

- Bargo River at the confluence with Hornes Creek;
- Hornes Creek;
- Teatree Hollow and tributaries;
- Cliffs and steep slopes;
- Main Southern Railway;
- Local roads, specifically the whole of Yarran Road and parts of Caloola Road, Remembrance Drive and Wellers Road at Elvy Street;
- Powerlines, telecommunication infrastructure, gas pipelines, potable water pipelines and sewer pipelines;
- Picton Weir;
- Items of Heritage Significance;
- Farm dams;
- Commercial establishments; and
- Houses and other building structures.

The effects of the proposed LW S7A on the subsidence predictions and impact assessments for these features are provided in the following sections.

3.2. Bargo River

The location of the Bargo River is shown in Drawing No. MSEC1348-07. Descriptions, predictions and impact assessments for the river are provided in the following sections.

3.2.1. Description of the Bargo River

The Bargo River commences north of Colo Vale and near the townships of Hill Top and Yerrinbool and flows generally towards the north and to the west of the Bargo township. The Bargo River then flows to the west and north of the proposed Tahmoor South longwalls. The Bargo River ultimately drains into the Nepean River approximately 4.9 kilometres north-east of Longwall S1A.

While the Bargo River is located outside the Study Area, a short 200 metre long section of the Bargo River at the confluence with Hornes Creek is located within the 600m Study Area for Natural Features. The 200 metre long section commences from the Picton Weir and continues up to the confluence of Hornes Creek and slightly around the bend in the Bargo River. A photograph is shown in Fig. 3.1.

The 200 metre long section is located completely within the stored waters behind the Picton Weir. With exception of periods of prolonged drought, the bedrock is usually under water. The bedrock is covered with sediments that have been washed down the Bargo River and Hornes Creek.

The remainder of the Bargo River is outside the 600m Study Area for Natural Features. The closest distance between the Bargo River and LW S7A is approximately 520 metres.

A summary of the minimum distances between the river and the proposed longwalls is provided below in Table 3.1.

Table 3.1 Minimum distances of the proposed longwalls from the Bargo River

Longwall	Minimum distance from the centreline of Bargo River (m)
LW S1A	720
LW S2A	690
LW S3A	730
LW S4A	780
LW S5A	830
LW S6A	850
LW S7A	520

The section of Bargo River that is within the Study Area is a 5th order perennial stream as defined by the Strahler Stream Order Method.

The surface water flows in this section of the river are controlled by the Picton Weir (also called the Bargo Weir) with discharge regulated by a fixed discharge valve. The reservoir is emptied following extended dry periods, but it is quickly filled with the spillway overtopping following large storm events. The following article from the Picton Post, dated 1945, provides some background:

> *"The existing dam was built to T.W.L.912 in 1899, the lowest foundation being at R.L.887, which was a few feet below river bed level. In 1910 the wall was raised to T.W.L.920, giving a storage of 37 m.g."*
>
> *"During the recent drought the water level dropped considerably, and it was ascertained that the dam had silted up. It is understood that the silt level is approximately at R.L.904, which would leave an available storage, if this level were uniform, of 33 m.g. It is quite probable that the silt level in the upper reaches of storage is higher."*

The Weir was raised again in 1947 to its final height of RL1927 (Haigh, 1954). The water stored by the Picton Weir was initially used to supply the nearby communities. After pipes were laid from the much larger Nepean Dam, however, Bargo, Thirlmere, Picton and The Oaks were supplied water from the Nepean Dam (now through the Nepean Water Filtration Plant), and stored water from the Picton Weir was no longer used for town water supply.

Examples of fluctuations in water levels in the Bargo River are provided below:

- 13 November 2019 (Fig. 3.2) – Picton Weir was dry after an extended drought period, just prior to bushfires through the area in December 2019. It can be seen that water storage had receded such that very little surface water was visible upstream of the confluence with Hornes Creek. Alluvial sediments were visible in the aerial photograph, covering the bedrock.
- 18 February 2022 (Fig. 3.3) – Picton Weir was full and overtopping after substantial rain events. It can be seen that the whole section of Bargo River within the 600m Study Area for Natural Features was inundated with stored water.

The reports by Fluvial Systems (2013) and the Water Management Plan (Tahmoor Coal, 2023a) provide a detailed description of the river.

Image courtesy EMM on 24 May 2022

Fig. 3.1 View of Bargo River and Picton Weir downstream of confluence with Hornes Creek

Image courtesy Nearmap

Fig. 3.2 Aerial photo of section of Bargo River within 600m Study Area on 13 November 2019

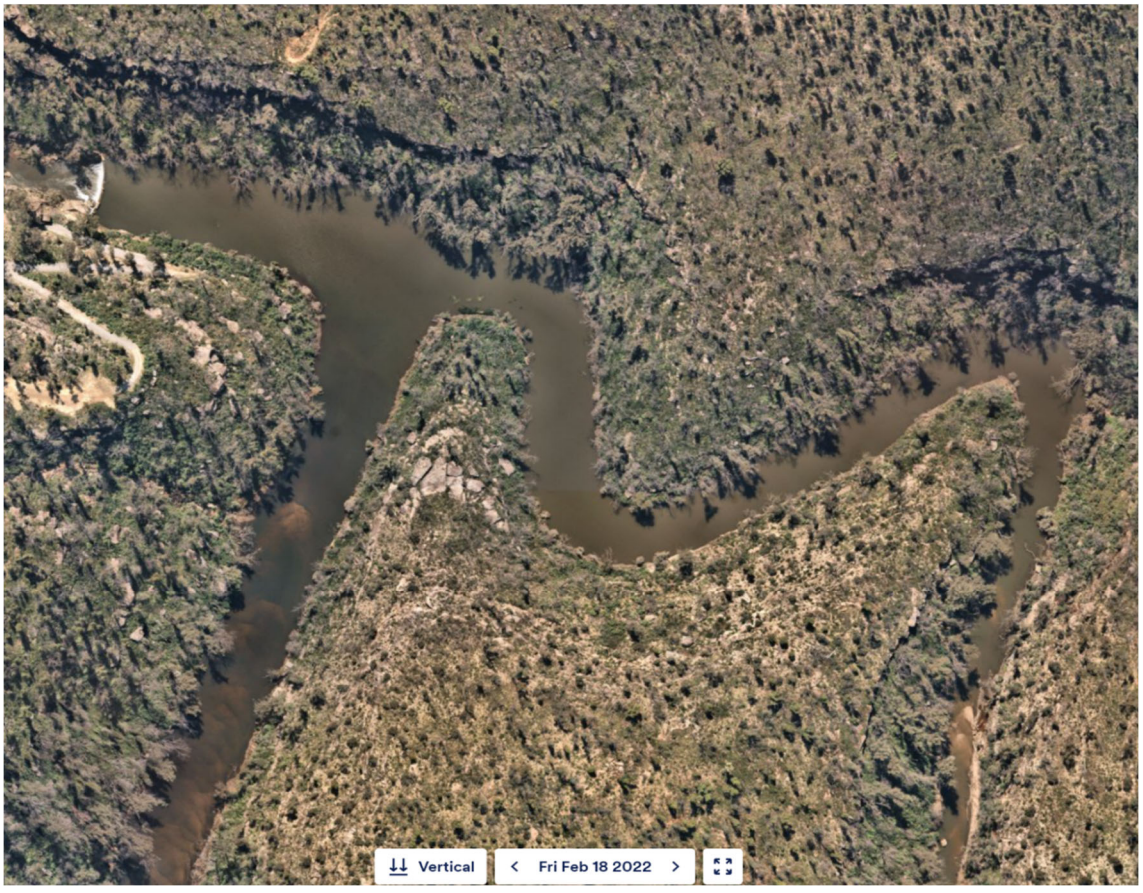


Image courtesy Nearmap

Fig. 3.3 Aerial photo of section of Bargo River within 600m Study Area on 18 February 2022

3.2.2. Predictions for the Bargo River

The predicted profiles of subsidence, upsidence and closure, using the IPM subsidence model and the 2002 ACARP valley closure prediction model, along the Bargo River and Hornes Creek are shown in Fig. A.02.

A summary of the maximum predicted values of incremental vertical subsidence, upsidence and closure for the Bargo River is provided Table 3.2 and the maximum predicted total values of vertical subsidence, upsidence and closure is provided in Table 3.3.

Table 3.2 Maximum predicted incremental vertical subsidence, upsidence and closure for Bargo River

Layout	Longwall	Maximum predicted incremental vertical subsidence (mm)	Maximum predicted incremental upsidence (mm)	Maximum predicted incremental closure (mm)
Modified Layout	LW S7A	< 20	20	20

Table 3.3 Maximum predicted total vertical subsidence, upsidence and closure for Bargo River

Layout	Longwall	Maximum predicted total vertical subsidence (mm)	Maximum predicted total upsidence (mm)	Maximum predicted total closure (mm)
Approved Layout	After LW S6A	< 20	< 20	< 20
Modified Layout	After LW S7A	< 20	30	20

It can be seen that the predictions for the *Modified Layout* are slightly increased when compared to the predictions based on the *Approved Layout*, which is expected given that LW S7A is closer to the River. Further statistical analysis and discussion on predicted closure movements are provided in the following Section 3.3 of this report for Hornes Creek.

3.2.3. Potential impacts on the Bargo River

The impact assessments for the Bargo River within the 600m Study Area are provided in the following sections. The assessments provided in this report should be read in conjunction with the Water Management Plan (Tahmoor Coal, 2023a) and the Biodiversity Management Plan (Tahmoor Coal, 2023c), which assess the consequences of the impacts on surface water flows and ecology.

Potential for increased levels of ponding, scouring or desiccation due to mining-induced tilt

Mining can potentially result in increased levels of ponding in locations where the mining-induced tilts oppose and are greater than the natural stream gradients that exist before mining. Mining can also potentially result in an increased likelihood of scouring of the stream beds in the locations where the mining-induced tilts considerably increase the natural stream gradients that exist before mining.

In this case, the predicted changes in grade along the Bargo River due to the proposed extraction of LW S7A are negligible. The potential for impacts due to mining-induced changes in stream gradients is also irrelevant given that the section of Bargo River within the 600m Study Area is usually inundated with stored water.

Potential for fracturing and surface water flow diversion in the stream

There has been a long history of mining directly beneath or near the Bargo River at Tahmoor Mine. While impacts have occurred when various previously extracted longwalls were mined directly beneath the river, impacts have not been observed when mining has been undertaken more than 500 metres away from the river.

- Longwalls 8, 10 to 13 were mined between 1991 and 1994 directly beneath a 2.0 kilometre section of the Bargo River and directly beneath a 1.0 kilometre section of Dog Trap Creek.

  These were the first series of longwalls to be mined directly beneath the Bargo River at Tahmoor Mine. Very little monitoring of the river occurred during this time, although extensive protective works were undertaken at the Rockford Road Bridge, which was located over Longwall 12.

  Surface fracturing of exposed bedrock was observed near to the supporting piers of the Bridge following the extraction of Longwalls 12 and 13. Fractures were also observed in flute holes downstream of the bridge over the goaf edge of Longwall 13, which were first observed during the extraction of Longwall 12 (Holla and Barclay, 2000). The fractures were localised and did not

consistently run along the length of the river valley. They appeared to be the result of localised shearing and compressive buckling and some fractures were located where there was noticeable cross bedding within the river bed. There were no reports of impact to water flows along this section of river.

While surface fracturing is still visible in the flute holes that are located on a large, exposed rockbar, surface water diversion is not evident and large pools exist directly above the previously extracted longwalls, as Tahmoor Mine's licensed discharge has contributed a base flow to this section of the Bargo River.

Fig. 3.4 Large pool in the Bargo River, located upstream of Rockford Road Bridge, directly above previously extracted Longwall 12

Very little monitoring of the Dog Trap Creek occurred when Longwalls 12 and 13 mined directly beneath it, although extensive monitoring and works were undertaken at the small Road Bridge over Dog Trap Creek on Arina Road. No surface fractures are visible in the stream at the location, however, and pools are observed to exist. It is noted that this section of Dog Trap Creek contains plenty of sediment that could assist in the filling of fractures.

Fig. 3.5 Ponded water in Dog Trap Creek near bridge over Arina Road above previously extracted Longwall 13

- Longwalls 14 to 19 were mined between 1995 and 2002 directly beneath a 1.7 kilometre section of the Bargo River, downstream of Picton Weir. This section of river is located between 720 metres and 850 metres north-west of the proposed LWs S1A to S6A, as shown in Drawings No. MSEC1348-01 and MSEC1192-07.

  Limited monitoring indicated little impact on the River during the extraction of Longwalls 14 to 17. Fracturing was not observed on the surface, although many sections were concealed by alluvial and talus deposits.

  The first adverse impacts on the river were reported in January 2002, after the extraction of Longwall 18, when residents alerted Tahmoor Mine to reduced pool levels downstream of the mining area. At that time there was very little stored water in the Picton Weir due to low rainfalls and surface flows from the weir had reduced to a mere trickle. Inspections along the river indicated fracturing of rock shelves in the river bed and drainage of some shallow pools.

Fig. 3.6 Immediately upstream of Picton Weir during period of prolonged dry weather – January 2002

Detailed subsidence monitoring of survey pegs within the Bargo River over the centre of LW18 after LW18 was extracted, i.e. in October 2001 had indicated that total upsidence in the base of LW18 was 250 mm, the total valley closure was approximately 400 mm and the maximum measured valley closure strain was 15 mm/m.

The inspections in January 2002 found that the river had been drained directly above Longwall 18 and the length of drainage extended downstream for some distance beyond Longwall 14.

Shortly after this time a large rainfall event occurred, which filled the Weir and restored surface water flows along the River. A dry period followed and by July 2002 the Picton Weir was empty again and the extraction of Longwall 19 was completed. Inspections showed that surface flows ceased again, with the furthest drained pool from the longwalls being located 125 metres upstream of LW19. This coincided with the completion of this longwall.

Detailed subsidence monitoring of survey pegs within the Bargo River over the centre of LW18 after LW19 was extracted indicated that total upsidence in the base of LW18 was 450 mm, the total valley closure was approximately 700 mm and the maximum measured valley closure strain was 18 mm/m.

A further period of heavy rainfall occurred in February 2003 which then refilled the upstream sections of Picton Weir which then overtopped (see Fig. 3.7 and Fig. 3.8).

After this large storm, it was then observed that the water flows along the surface above the longwalls were progressively restored even during the following drier periods. It is believed that the high sediment load in the river, that was retained by the Picton Weir except when it is overtopped, had been washed down the river and filled in the mining induced fractures in the bedrock reducing the loss of surface water flows.

The extraction of Longwalls 14 to 19 also mined directly beneath small tributaries to the Bargo River. Fluvial Systems (2013) reports fracturing and surface flow diversions in two unnamed tributaries, which are located above previously extracted Longwalls 15 and 19. The stream channel beds in these tributaries were exposed bedrock.

Fig. 3.7 Picton Weir 1st February 2003

Fig. 3.8 Picton Weir 24th February 2003

- Previously extracted Longwall 24A was approximately 340 metres from the river at its closest point and Longwall 25 was approximately 510 metres from the river. Ground surveys measured very little vertical subsidence (less than 20 mm) and closure (less than 10 mm) occurred even though at this section of the river the gorge was 80 metres deep. Impacts to the river were not observed during the extraction of these longwalls.

With respect to streams or sections of streams located away from the proposed longwalls, the likelihood of fracturing and surface flow diversions reduces substantially compared to stream sections located directly above the proposed longwalls. The furthest known rockbar impact site where fracturing resulted in the diversion of surface water was at Pool F in the Waratah Rivulet that was being affected by a previously extracted longwall on one side and by the end of another longwall, i.e. the rockbar was located over solid unmined coal, but it was located in the corner between two longwalls. This site was located 160 metres to the side of one longwall and 230 metres from the approaching face of the active longwall. Surface water diversions have also been observed at three sites from the sides of longwalls at distances between 125 metres and 100 metres at the Bargo River, Waratah Rivulet and Native Dog Creek. Surface water diversion has only been observed at one site at Pool G1 in the Waratah Rivulet beyond the ends of the longwalls and in this case the closest distance was approximately 75 metres.

Minor and isolated fracturing could also occur outside the extents of the proposed longwalls. The furthest distance of an observed fracture from longwall mining at Appin Colliery was at the base of Broughtons Pass Weir, which was located approximately 415 metres from Appin Colliery Longwall 401. Another minor fracture was also recorded in the upper Cataract River, approximately 375 metres from Appin Colliery Longwall 301. This fracture occurred in a large rockbar, which was formed in thinly bedded sandstone, which had experienced movements from nearby previously extracted longwalls.

More recently, visual inspections along the Tributary to Teatree Hollow have identified a minor fracture that is located approximately 500 metres from LW S1A. The fracture was identified within a surface boulder upstream of Pool TT2. The boulder is wedged between two larger rocks on either side of the creek.

The above observations represent the furthest-most recorded fractures from longwall mining in the NSW Coalfields.

In the present case, the proposed LW S7A is located approximately 520 metres from the Bargo River at its closest point. The section of Bargo River within the 600 m Study Area is located within the stored waters behind the Picton Weir. Based on the previous experiences at Tahmoor Mine, it is very unlikely that the extraction of the proposed longwalls would result in adverse impacts on surface water flows in the river.

In the very unlikely event that surface fractures develop in the Bargo River due to the extraction of LW S7A, the fractures would likely not be detected as the bedrock is covered by alluvial sediment and frequently by stored water. Even if the predictions and impact assessments were exceeded, the likelihood of impacts on surface flow is considered extremely low given that water levels are controlled by the Picton Weir. Previously observed experiences have found that mining-induced sub-surface fracturing in this section of the Bargo River has been filled by sediment that is stored behind the Picton Weir, reducing the potential for impacts on surface water flows.

Further detailed discussions on the impacts and consequences of changes in the surface water flows are provided in the Water Management Plan (Tahmoor Coal, 2023a).

Potential for Gas Emissions and Changes to Water Quality

Gas emissions from the sandstone strata have been previously observed above and adjacent to mining areas in the Southern Coalfield, and some gas emissions have also been observed in water bores. Analyses of gas compositions indicate that the Bulli seam is not the direct and major source of the gas and that the most likely source is the Hawkesbury Sandstone (APCRC, 1997).

Gas emissions may occur and become visible in the stored water behind the Picton Weir as a result of the proposed extraction of the longwalls. Where these gas releases occur into the water column there is insufficient time for any substantial amount of gas to dissolve into the water. The majority of the gas is released into the atmosphere and is unlikely to have an adverse impact on water quality.

A description of potential water quality impacts and environmental consequences is presented in the Water Management Plan (Tahmoor Coal, 2023a) and the Biodiversity Management Plan (Tahmoor Coal, 2023c).

3.2.4. Management of potential impacts on the Bargo River

Tahmoor Coal has developed a Water Management Plan for LWs S1A to S6A to manage potential impacts on streams during the mining of longwalls, including the Bargo River. The management plan includes monitoring and triggered response plans. It includes monitoring of the required pre-mining conditions and data collection during mining. Monitoring typically continues for a period following mining.

The Water Management Plan will be updated to include LW S7A (Tahmoor Coal, 2023a).

Tahmoor Coal is currently monitoring ground movements at the Bargo River during the mining of LW S2A according to the Subsidence Monitoring Plan.

- Two GNSS have been installed near the tops of the Bargo River valley across the Picton Weir. The GNSS units have continuously monitored changes during mining since the commencement of LW S1A. While the GNSS units have measured minor horizontal movements, changes in horizontal distances between the units are less than 5 mm and within survey tolerance.
- Prior to the commencement of LW S2A, additional GNSS units have been installed along Hornes Creek, which will also provide relevant monitoring information for monitoring changes and potential impacts along the Bargo River.
- Two GNSS units have been installed across the Bargo River valley, directly above previously extracted LW 16. The GNSS units have continuously monitored changes during mining since the commencement of LW S1A. While the GNSS units have measured minor horizontal movements, changes in horizontal distances between the units are less than 5 mm and within survey tolerance.
- Tahmoor Coal installed ground surveys pegs across the Bargo River above previously extracted LWs 14B to 19. A re-survey after the completion of LW S1A on 6 November 2023 measured changes of ± 7 mm, which is considered to be within survey tolerance given the environment within which the pegs have been installed.

Tahmoor Coal will continue to monitor changes in the Bargo River during the extraction of proposed Tahmoor South longwalls, in accordance with the Subsidence Monitoring Plan and Water Management Plan.

3.3. Hornes Creek

The location of Hornes Creek is shown in Drawing No. MSEC1348-07. Descriptions, predictions and impact assessments for the creek are provided in the following sections.

3.3.1. Description of Hornes Creek

Hornes Creek commences west of the township of Bargo and flows generally towards the north-west before draining into the Bargo River. Hornes Creek catchment is located to the south-southwest of LW S1A-S6A. The catchment area of Hornes Creek is approximately 19.3 km^2 which comprises predominantly bushland, rural-residential area and residential area associated with the Bargo township (Tahmoor Coal, 2023a). Hornes Creek is a fourth order stream within the Study Area (Fluvial Systems, 2013).

The downstream section of Hornes Creek meanders inside and outside the Study Area and the majority of the downstream section is located inside the 600m Study Area for Natural Features, as shown in Drawing No. MSEC1348-07.

The closest distance between Hornes Creek and LW S7A is approximately 330 metres at a sharp bend and a photograph of the bend is shown in Fig. 3.9. Upstream of the bend, the distance between Hornes Creek and LW S7A is between 470 metres and 620 metres.

Image courtesy EMM

Fig. 3.9 View of Hornes Creek at bend located closest to LW S7A

Water levels in the downstream section of Hornes Creek are controlled by the Picton Weir. As discussed for the Bargo River in Section 3.2.1, Hornes Creek is generally inundated with stored water but the extent of stored water recedes during periods of prolonged dry weather.

Examples of fluctuations in water levels in Hornes Creek are provided below:

- 13 November 2019 (Fig. 3.2 and Fig. 3.10) – Picton Weir was dry after an extended drought period, just prior bushfires through the area in December 2019. It can be seen that water storage had receded such that very little surface water was visible upstream of the confluence with the Bargo River. Alluvial sediments were visible in the aerial photograph, covering the bedrock up to the upstream end of the storage area at Pool HC-16. Isolated pools were visible along the stream.
- 18 February 2022 (Fig. 3.3 and Fig. 3.11) – Picton Weir was full and overtopping after substantial rain events. It can be seen that the whole section of Bargo River within the 600m Study Area for Natural Features was inundated with stored water up to Pool HC-16.

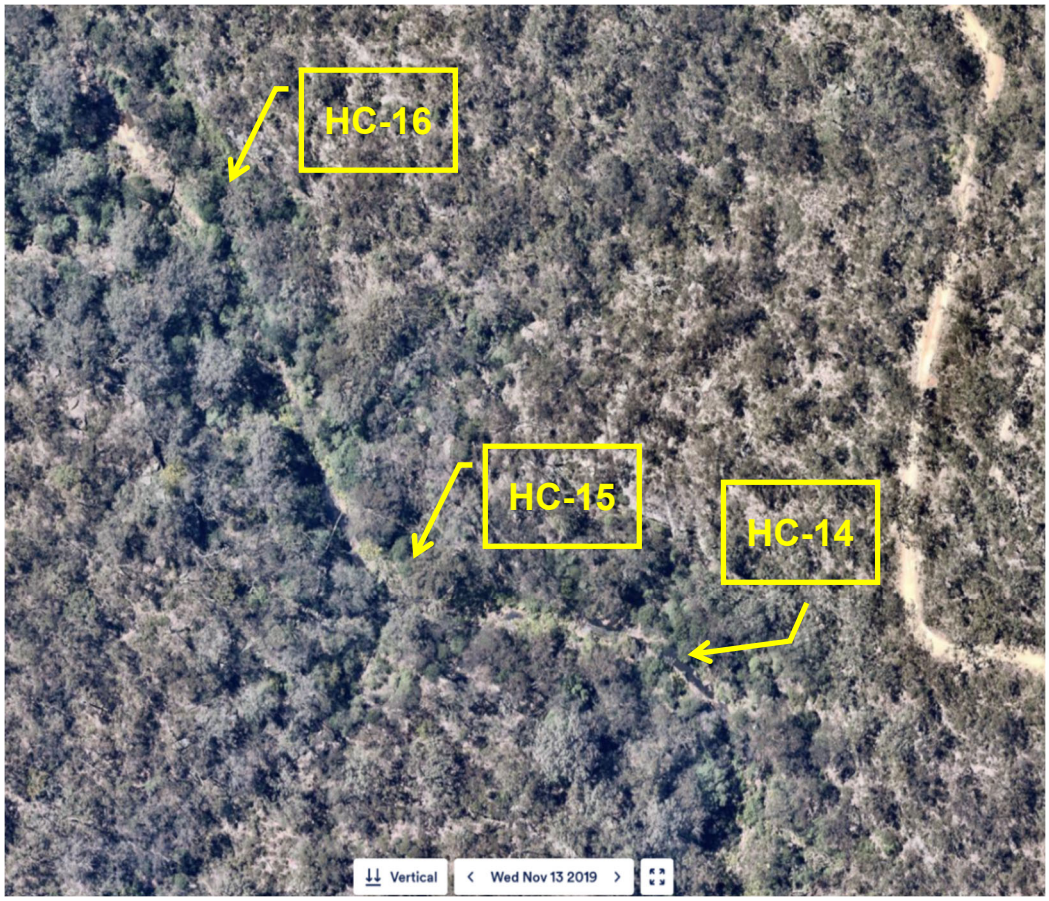


Image courtesy Nearmap

Fig. 3.10 Aerial of photo of Hornes Creek near Pools HC-P14 to HC-P16 on 13 November 2019

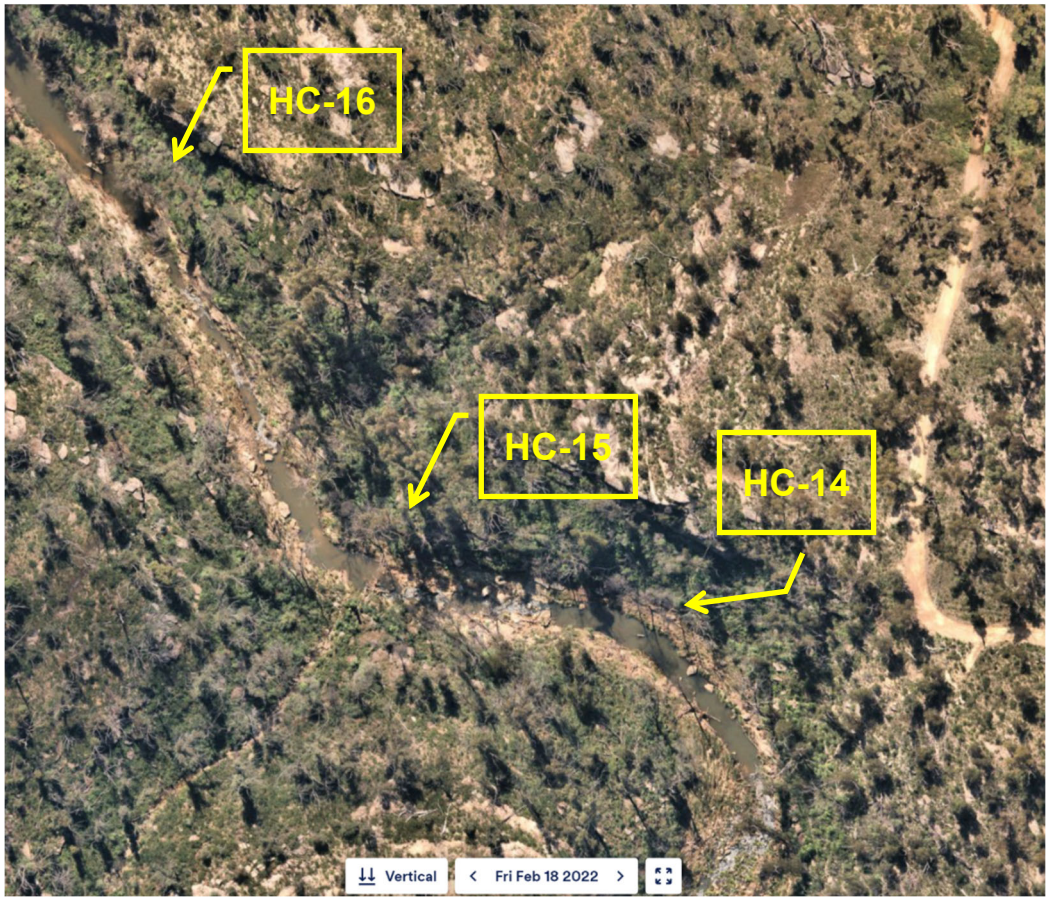


Image courtesy Nearmap

Fig. 3.11 Aerial of photo of Hornes Creek near Pools HC-P14 to HC-P16 on 18 February 2022

Upstream of Pool HC-16, Hornes Creek is comprised of a series of pools that are controlled by rockbars and boulders. Water flows are intermittent, with flowing water recorded on at least 81% of sampling occasions at all monitoring sites in Hornes Creek (Tahmoor Coal, 2023a). During periods of prolonged dry weather, however, the creek is dry with localised pools. A total of 9 pools (HC-08 to HC-16) are located within the 600m Study Area.

A photograph of Pool HC-09, which is closest to LW S7A is shown in Fig. 3.12.

Image courtesy MNC consulting

Fig. 3.12 Hornes Creek Pool HC-P09 on 23 September 2023

The reports by Fluvial Systems (2013) and the Water Management Plan (Tahmoor Coal, 2023a) provide a detailed description of Hornes Creek.

3.3.2. Predictions for Hornes Creek

The predicted profiles of subsidence, upsidence and closure, using the IPM subsidence model and the 2002 ACARP valley closure prediction model, along the Bargo River and Hornes Creek are shown in Fig. A.02.

A summary of the maximum predicted values of incremental vertical subsidence, upsidence and closure for Hornes Creek is provided in Table 3.4 and a summary of the maximum predicted values of total vertical subsidence, upsidence and closure for Hornes Creek is provided in Table 3.5.

Table 3.4 Maximum predicted incremental vertical subsidence, upsidence and closure for Hornes Creek

Layout	Longwall	Maximum predicted incremental vertical subsidence (mm)	Maximum predicted incremental upsidence (mm)	Maximum predicted incremental closure (mm)
Modified Layout	LW S7A			
Section with water levels controlled by Picton Weir downstream from Pool HC-16 to confluence with Bargo River		30	50	130
Section with water levels controlled by rockbars and boulders upstream from Pool HC-16		20	30	60

Table 3.5 Maximum predicted total vertical subsidence, upsidence and closure for Hornes Creek

Layout	Longwall	Maximum predicted total vertical subsidence (mm)	Maximum predicted total upsidence (mm)	Maximum predicted total closure (mm)
Approved Layout	After LW S6A	< 20	30	< 20
Modified Layout	After LW S7A			
Section with water levels controlled by Picton Weir downstream from Pool HC-16 to confluence with Bargo River		40	80	150
Section with water levels controlled by rockbars and boulders upstream from Pool HC-16		25	45	70

It can be seen that the predictions based on the *Modified Layout* are increased when compared to the predictions based on the *Approved Layout*, which is expected given that LW S7A is closer to Hornes Creek.

Maximum subsidence, closure and upsidence is located at the sharp bend in Hornes Creek, which is located closest to LW S7A. As shown in Fig. A.02, predicted movements reduce further upstream and downstream of the bend.

3.3.3. Statistical analyses of valley closure movements

Statistical analyses of previously measured valley closure in the Southern Coalfield have been conducted based on monitoring data from Tahmoor Colliery and nearby Appin and West Cliff Collieries, where depths of cover and extraction heights are similar to those proposed for LW S7A. The results are relevant for the proposed extraction of LW S7A adjacent to Hornes Creek and the Bargo River.

Observed incremental valley closure at sites located above solid, unmined coal, are shown relative to their distances from the maingate edges of previously extracted longwalls in Fig. 3.13. A total of 2390 measurements have been plotted, sorted into groups based on valley depths that are greater than or less than 40 metres. Where surveys were conducted on multiple occasions at a site during the extraction of a longwall, only the maximum measured incremental closure for each longwall has been plotted.

The confidence levels, based on fitted *Generalised Pareto Distributions* (GPDs), have also been shown in Fig. 3.13 to illustrate the spread of the data. The GPD and confidence levels have been calculated without filtering the data based on valley depths, nor the locations of the sites relative to the sides or ends of the longwalls.

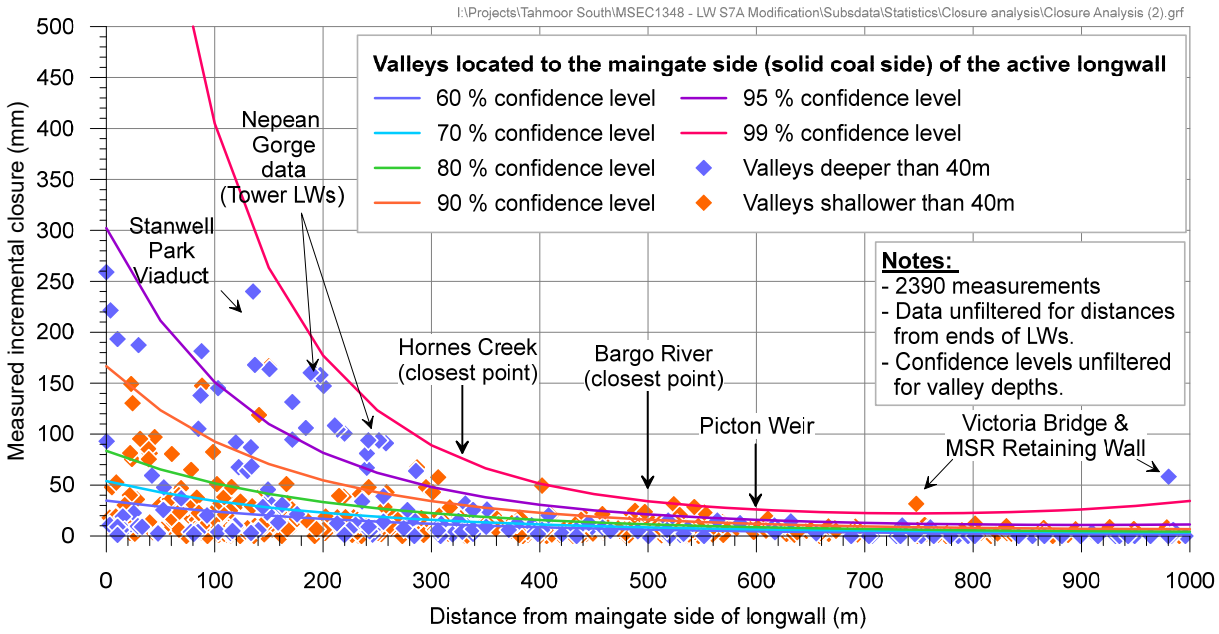


Fig. 3.13 Observed incremental valley closure against distance from the maingate edge of the active longwall over solid, unmined coal

It can be seen from Fig. 3.13 that observed valley closure increases as the distance of the sites to the extracted longwalls reduce, as expected. Given that predicted maximum incremental valley closure along Hornes Creek is 130 mm at a distance of 330 metres from the maingate edge of LW S7A, the statistical analyses also demonstrates that observed closure, when plotted against distance from the maingate edge, is generally less than predicted by the ACARP method.

The reason for the more conservative prediction by the ACARP method can be explained by the way in which the ACARP normalises the offset distances by dividing them by the sum of the longwall panel width and chain pillar width. The ACARP method of predicting valley closure relative to the transverse distance to the active longwall is shown in Fig. 3.14, with the latest available empirical data overlaid on the graph. It can be seen that upper bound prediction curves are conservative, though some outliers can be seen.

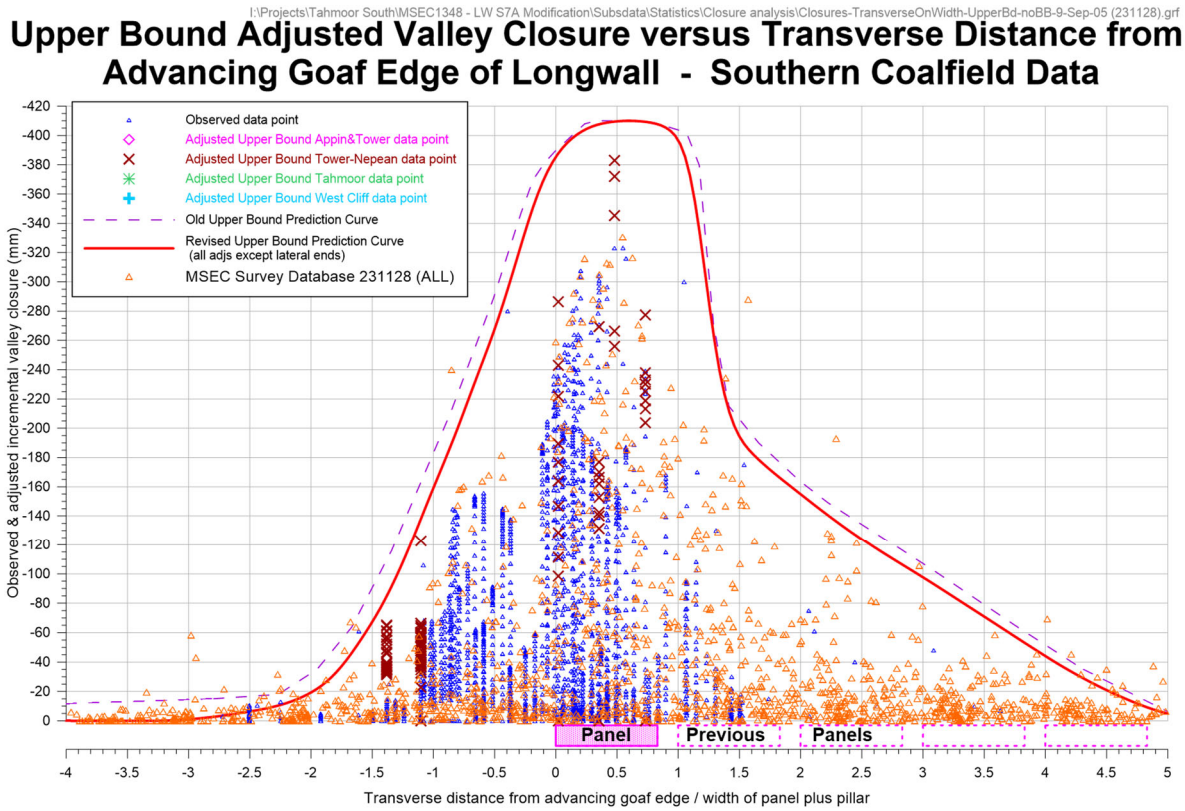


Fig. 3.14 Observed incremental valley closure against normalised transverse distance from maingate edge of longwalls and ACARP prediction model

The closest distance between Hornes Creek and LW S7A is approximately 330 metres at a sharp bend. The distance equates to an normalised distance of -1.03 in Fig. 3.14. The empirical data that influenced the shape of the prediction curve in the ACARP model was primarily based on surveys conducted across the Nepean Gorge during the extraction of longwalls at Tower Colliery, where the longwall panels were approximately 210 metres wide. When the data is plotted against distance only, as shown in Fig. 3.13, the Nepean Gorge data is located around 200 to 250 metres from the maingate edge. When the data is plotted against normalised distance, as shown in Fig. 3.14 and also in Fig. 3.15 below, the Nepean Gorge data is more applicable to the predictions at the closest point of Hornes Creek to LW S7A.

Similarly, measured incremental valley closure across the Stanwell Park Viaduct during mining at CoalCliff Colliery fits within the confidence level curves when plotted against distance in Fig. 3.13, but becomes an outlier when the distance is normalised due to the narrowness of the extracted panel.

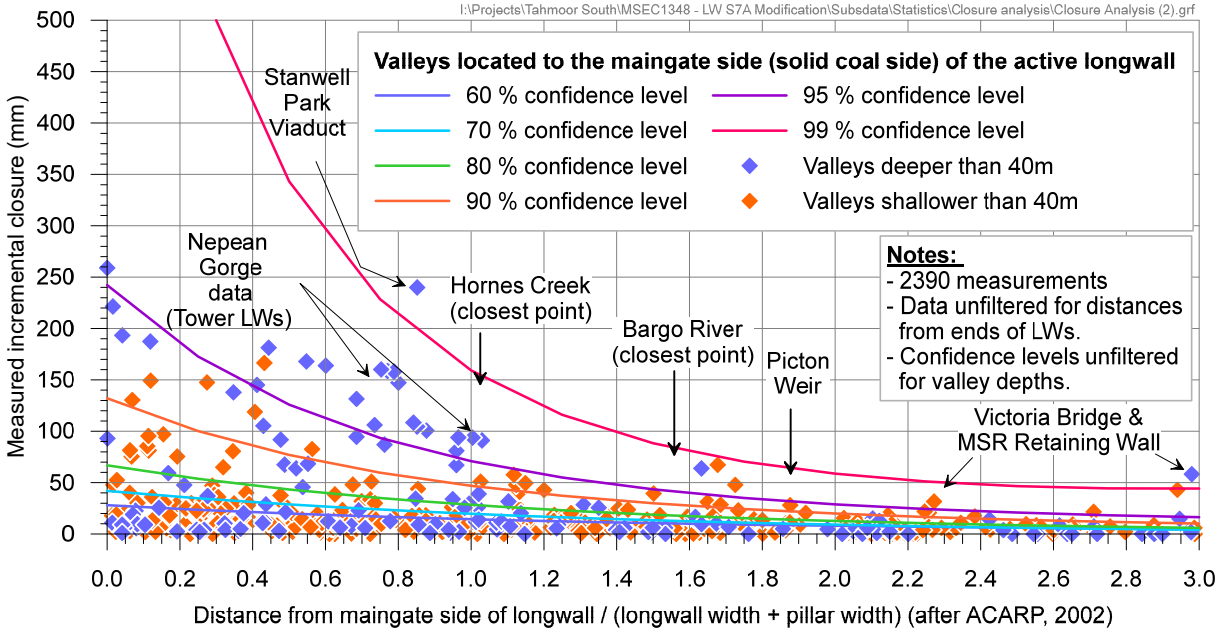


Fig. 3.15 Observed incremental valley closure against normalised distance from the maingate edge of longwalls / (longwall width + pillar width)

The closest distance between Hornes Creek and LW S7A is approximately 330 metres at a sharp bend. The statistical analyses indicates that the ACARP prediction of maximum incremental closure of 130 mm at the closest point to Hornes Creek is reasonably conservative:

- When compared against the empirical database based on the offset distance of 330 metres, it can be seen from Fig. 3.13 that the likelihood of exceedance is less than 1 in 100 (i.e. above the 99% confidence level curve).
- When compared against the empirical dataset based on a normalised offset distance of 1.03, it can be seen from Fig. 3.15 that the likelihood of exceedance is between 1 in 20 and 1 in 100 (i.e. between the 95% and 99% confidence level curves).

Upstream of the bend, the distance between Hornes Creek and LW S7A is between 470 metres and 620 metres. The statistical analyses indicates that the ACARP prediction of maximum incremental closure of 60 mm at the closest point to Hornes Creek is reasonably conservative:

- When compared against the empirical database based on the offset distance of 470 to 600 metres, it can be seen from Fig. 3.13 that the likelihood of exceedance is considerably less than 1 in 100 (i.e. above the 99% confidence level curve).
- When compared against the empirical dataset based on a normalised offset distance of 1.5 to 1.9, it can be seen from Fig. 3.15 that the likelihood of exceedance is between 1 in 20 and 1 in 100 (i.e. between the 95% and 99% confidence level curves).

While the statistical analyses show that the valley closure prediction is likely to be conservative, the empirical data presented in Fig. 3.13 and Fig. 3.15 shows there are two outliers at distances greater than 600 metres from previously extracted longwalls. These relate to recently observed closure during the mining of Tahmoor LW W3 and LW W4 across Stonequarry Creek at the Victoria Bridge and a Retaining Wall at 84.687 km on the Main Southern Railway. LW W4 was relatively short in length and incremental valley closure would likely have been greater if LW W4 was longer. LW W4 was also the last longwall to be extracted in this mining domain. Valley closure would likely have continued to develop at a greater magnitude if additional longwalls had been extracted closer to the monitoring sites. The observed closure, however, only developed along one arm of Stonequarry Creek, where less than 10 mm of valley closure was observed where the Picton Viaduct crosses Stonequarry Creek, 300 metres upstream of Victoria Bridge. The observations are discussed in Section 3.10.5.

The case study is relevant to the extraction of LW S7A to the side of Hornes Creek and the Bargo River as both sites involve a regionally significant valley (Stonequarry Creek compared to Bargo River) and both are located near a major geological fault system (Nepean Fault compared to the Central Fault). The case study is a reminder that greater valley closure movements can sometimes occur. The potential for greater than predicted movements has been considered when conducting impact assessments for Hornes Creek and the Bargo River.

3.3.4. Potential impacts on Hornes Creek

The impact assessments for Hornes Creek within the 600m Study Area are provided in the following sections. The assessments provided in this report should be read in conjunction with the Water Management Plan (Tahmoor Coal, 2023a) and the Biodiversity Management Plan (Tahmoor Coal, 2023c), which assess the consequences of the impacts on surface water flows and ecology.

Potential for increased levels of ponding, scouring or desiccation due to mining-induced tilt

Mining can potentially result in increased levels of ponding in locations where the mining-induced tilts oppose and are greater than the natural stream gradients that exist before mining. Mining can also potentially result in an increased likelihood of scouring of the stream beds in the locations where the mining-induced tilts considerably increase the natural stream gradients that exist before mining.

In this case, the predicted changes in grade along Hornes Creek due to the proposed extraction of LW S7A are negligible. The potential for impacts due to mining-induced changes in stream gradients is also irrelevant for the section downstream of Pool HC-16, given that this section is usually inundated with stored water.

Potential for fracturing and surface water flow diversion in the stream

A summary of observed experiences of impacts due to previous longwall mining adjacent but not directly beneath streams was discussed in Section 3.2.3.

The section of Hornes Creek downstream of Pool HC-16 is located approximately 330 metres from the proposed LW S7A at its closest point at the sharp bend in the stream. This section of Hornes Creek is located within the stored waters behind the Picton Weir. Based on the previous experiences at Tahmoor Mine, it is unlikely that the extraction of the proposed longwalls would result in adverse impacts on this section of the stream.

Minor fractures in bedrock have previously been observed in isolated locations at offset distances between 330 metres and 500 metres in the Southern Coalfield. In the event that minor, isolated surface fractures develop within the stored water areas of Hornes Creek due to the extraction of LW S7A, the fractures would likely not be detected as the bedrock is covered by alluvial sediment and frequently by stored water.

Even if the predictions and impact assessments were exceeded, the likelihood of impacts on surface flow is considered extremely low given that water levels are controlled by the Picton Weir. Previously observed experiences have found that mining-induced sub-surface fracturing in this section of the Bargo River have been filled by sediment that is stored behind the Picton Weir reducing the potential for impacts on surface water flows.

The section of Hornes Creek upstream of Pool HC-16 is located between 470 metres and 620 metres from the proposed LW S7A. The likelihood of fracturing occurring in this section of the creek is considered to be low. In the unlikely event that fracturing occurs, the fractures are expected to be minor and isolated.

The likelihood of fracturing resulting in surface flow diversion is considered to be very low given the offset distance of LW S7A to this section of stream.

Further detailed discussions on the impacts and consequences of changes in the surface water flows are provided in the Water Management Plan (Tahmoor Coal, 2023a).

Potential for Gas Emissions and Changes to Water Quality

Gas emissions from the sandstone strata have been previously observed above and adjacent to mining areas in the Southern Coalfield, and some gas emissions have also been observed in water bores. Analyses of gas compositions indicate that the Bulli seam is not the direct and major source of the gas and that the most likely source is the Hawkesbury Sandstone (APCRC, 1997).

Gas emissions may occur and become visible in the stored water behind the Picton Weir as a result of the proposed extraction of the longwalls. Where these gas releases occur into the water column there is insufficient time for any substantial amount of gas to dissolve into the water. The majority of the gas is released into the atmosphere and is unlikely to have an adverse impact on water quality.

A description of potential water quality impacts and environmental consequences is presented in the Water Management Plan (Tahmoor Coal, 2023a) and the Biodiversity Management Plan (Tahmoor Coal, 2023c).

3.3.5. Management of potential impacts on Hornes Creek

Tahmoor Coal has developed a Water Management Plan for LWs S1A to S6A to manage potential impacts on streams during the mining of longwalls, including Hornes Creek. The management plan includes monitoring and triggered response plans. It includes monitoring of the required pre-mining conditions and data collection during mining. Monitoring typically continues for a period following mining.

The Water Management Plan will be updated to include LW S7A (Tahmoor Coal, 2023a).

Tahmoor Coal is currently monitoring ground movements at Hornes Creek during the mining of LW S2A according to the Subsidence Monitoring Plan.

- Six GNSS units have been installed along the tops of Hornes Creek in pairs across the valley. The GNSS units have continuously monitored changes during mining since the commencement of LW S2A. While the GNSS units have measured minor horizontal movements, changes in horizontal distances between the units are less than 5 mm and within survey tolerance.

Tahmoor Coal will continue to monitor changes along Hornes Creek during the extraction of proposed Tahmoor South longwalls, in accordance with the Subsidence Monitoring Plan and Water Management Plan.

3.4. Teatree Hollow and tributaries

The locations of Teatree Hollow and its tributaries are shown in Drawing No. MSEC1348-07. The sections of Teatree Hollow and its tributaries within the Study Area are ephemeral first or second order drainage lines having shallow incisions into the natural surface soils.

The catchment area is located above LW S7A in predominantly grazing land, with stream flow captured by a number of farm dams.

3.4.1. Predictions for Teatree Hollow and tributaries

The predicted profiles of subsidence, upsidence and closure, using the IPM subsidence model and the 2002 ACARP valley closure prediction model, along the Teatree Hollow and the Tributary to Teatree Hollow are shown in Fig. A.03 and Fig. A.04, respectively.

A summary of the maximum predicted values of incremental vertical subsidence, upsidence and closure for Teatree Hollow and the Tributary to Teatree Hollow is provided in Table 3.6. A summary of the maximum predicted values of total vertical subsidence, upsidence and closure for Teatree Hollow and the Tributary to Teatree Hollow is provided in Table 3.7.

Table 3.6 Maximum predicted incremental vertical subsidence, upsidence and closure for Teatree Hollow and the Tributary to Teatree Hollow

Modified Layout	Longwall	Maximum predicted incremental vertical subsidence (mm)	Maximum predicted incremental upsidence (mm)	Maximum predicted incremental closure (mm)
Teatree Hollow	LW S7A	925	90	50
Tributary to Teatree Hollow	LW S7A	< 20	< 20	< 20

Table 3.7 Maximum predicted total vertical subsidence, upsidence and closure for Teatree Hollow and the Tributary to Teatree Hollow

Layout	Longwall	Maximum predicted total vertical subsidence (mm)	Maximum predicted total upsidence (mm)	Maximum predicted total closure (mm)
Teatree Hollow				
Approved Layout	After LW S6A	1400*	400*	275*
Modified Layout	After LW S7A	1400*	400*	275*
Tributary to Teatree Hollow				
Approved Layout	After LW S6A	1350	450	375
Modified Layout	After LW S7A	1350	450	375

* *Note: downstream sections of Teatree Hollow have been previously mined beneath by LW1 and LW2 at Tahmoor Mine. The maximum predicted parameters provided in the above table include those resulting from the extraction of these earlier longwalls.*

The proposed LW S7A is located directly beneath the upstream end of Teatree Hollow and it can be seen from Fig. A.03 that the predictions are increased at the upstream end of Teatree Hollow under the *Modified Layout* when compared to the predictions based on the *Approved Layout*.

The Tributary to Teatree Hollow is located to the east of the proposed LW S7A. It can be seen from Fig. A.04 that there is very little change between the predictions under the *Modified Layout* when compared to the predictions based on the *Approved Layout*.

It can be seen from Drawing No. MSEC1348-07 that another first order tributary to Teatree Hollow will be directly mined beneath by LW S7A. This tributary would experience increased subsidence movements under the *Modified Layout* when compared to the predictions based on the *Approved Layout.*

3.4.2. Observed subsidence movements during the mining of LWs S1A and S2A directly beneath Teatree Hollow and tributaries

LWs S1A and S2A have mined directly beneath Teatree Hollow and the Tributary to Teatree Hollow.

Tributary to Teatree Hollow

Ten GNSS units have been installed along the tops of the Tributary to Teatree Hollow in pairs across the valley, as shown in Drawing No. MSEC1348-15. The GNSS units have measured the development of subsidence and valley closure during the extraction of LWs S1A and S2A.

Observed subsidence during the extraction of LWs S1A and S2A are discussed in Section 2.3, where it can be seen that observed subsidence has been less than predicted.

Changes in horizontal distances can be calculated between GNSS units that are stationed close together and results are shown in Fig. 3.16.

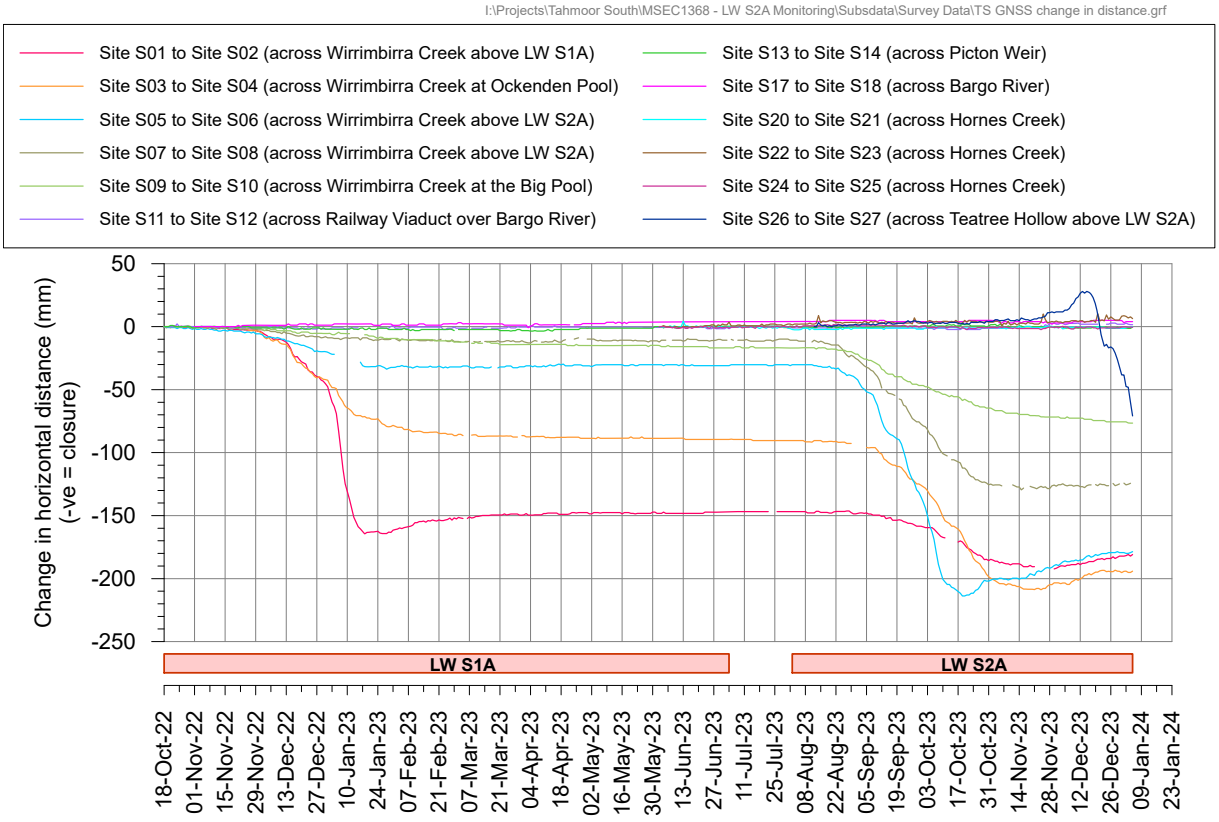


Fig. 3.16 Observed changes in horizontal distances between GNSS units across the Tributary to Teatree Hollow and Teatree Hollow

It can be seen from Fig. 3.16 that observed valley closure is less than the predicted maximum closure of 275 mm due to the extraction of LWs S1A and S2A.

In addition to the GNSS units, survey marks have been installed at four locations across valley floor of the Tributary to Teatree Hollow (Wirrimbirra Creek), as shown in Drawing No. MSEC1348-15. The observed development of valley closure at the ground survey lines across the Tributary to Teatree Hollow is shown in Fig. 3.17. The results correlate reasonably well with the observations from GNSS units, taking into account the shorter lengths of the survey lines, which are based within the floor of the creek valley, compared to the distances between the GNSS units, which are mounted at the tops of the valleys.

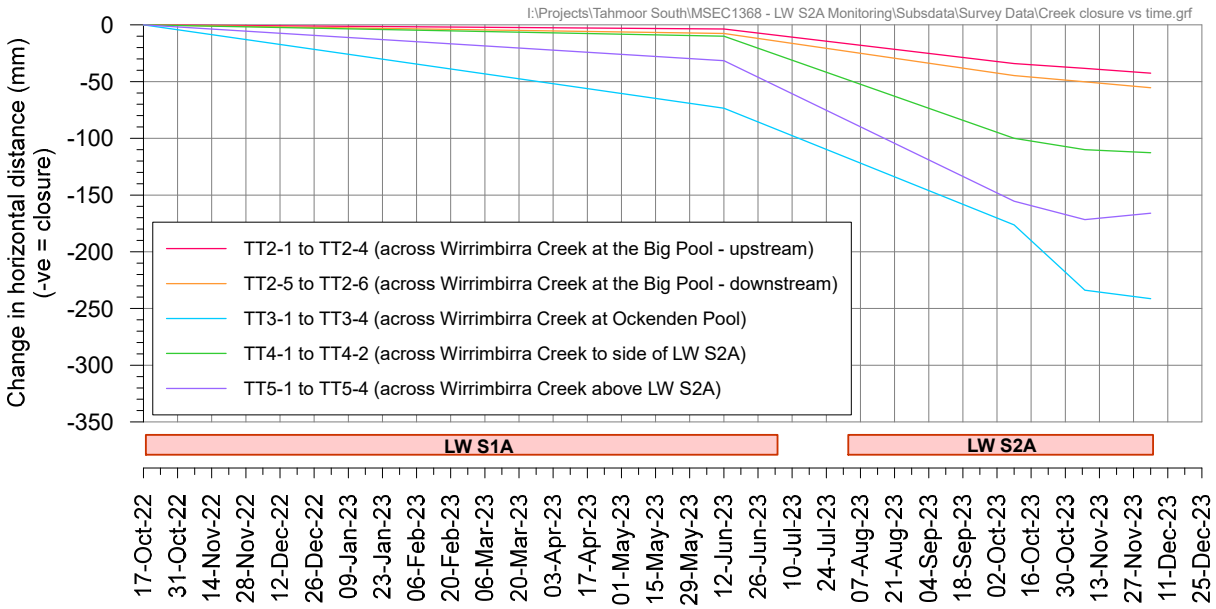


Fig. 3.17 Observed development of closure across Tributary to Teatree Hollow from ground surveys

The results from the ground surveys across lines TT2, TT3 and TT5 are shown in Fig. 3.18, Fig. 3.19 and Fig. 3.20, respectively. The survey lines are restricted to the base of the valley floor due to the remoteness of the sites and presence of thick vegetation and do not measure absolute vertical subsidence (this is measured by the GNSS units along the tops of the valley). The ground surveys measure changes in height relative to the first survey peg in the survey lines.

The results show that upsidence and closure has developed within the valley floor, concentrating either in the centre of the valley floor or to one side of the valley floor.

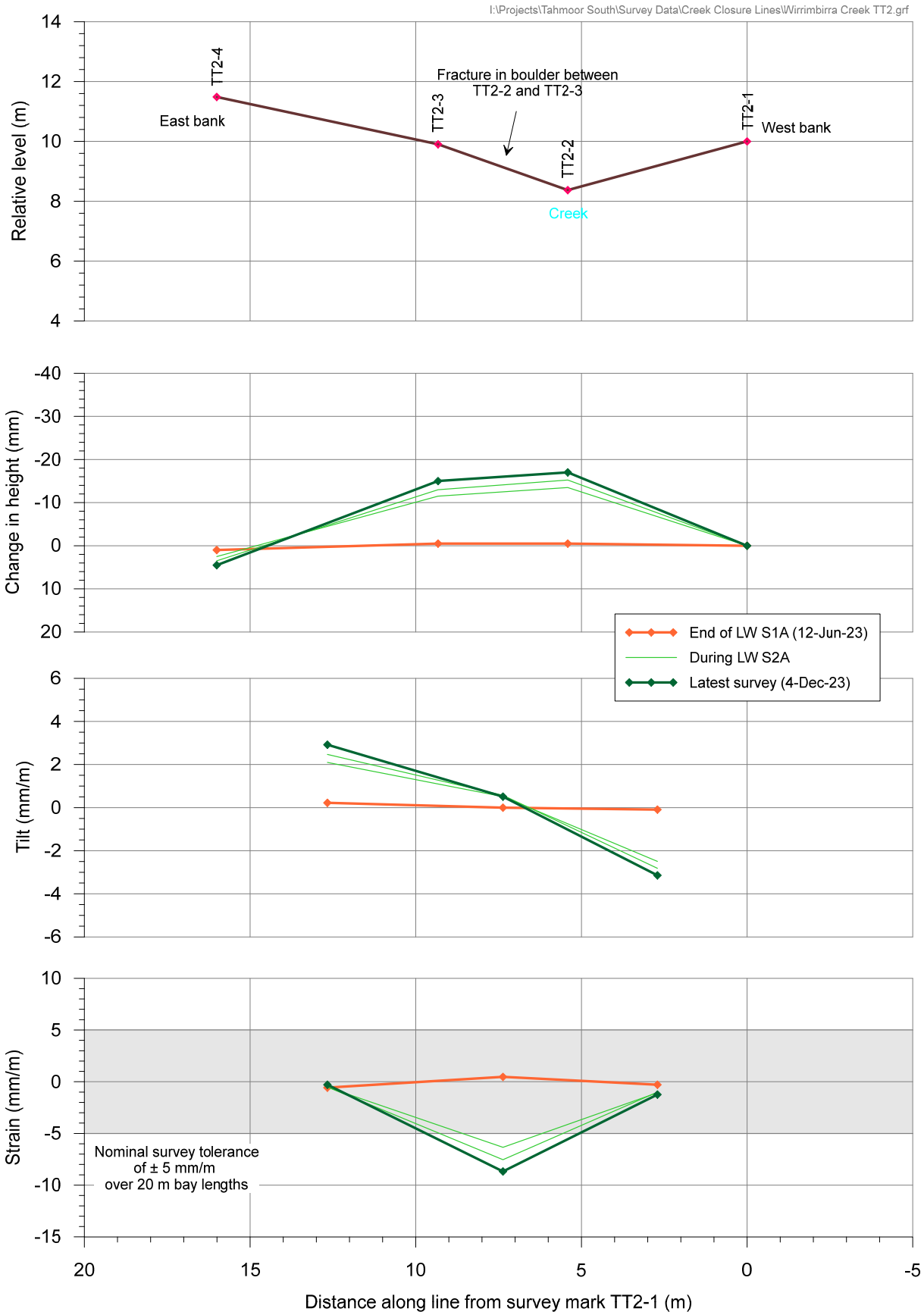


Fig. 3.18 Observed total changes in height, tilt and strain along survey line TT2 across the Tributary to Teatree Hollow during the mining of LWs S1A and S2A

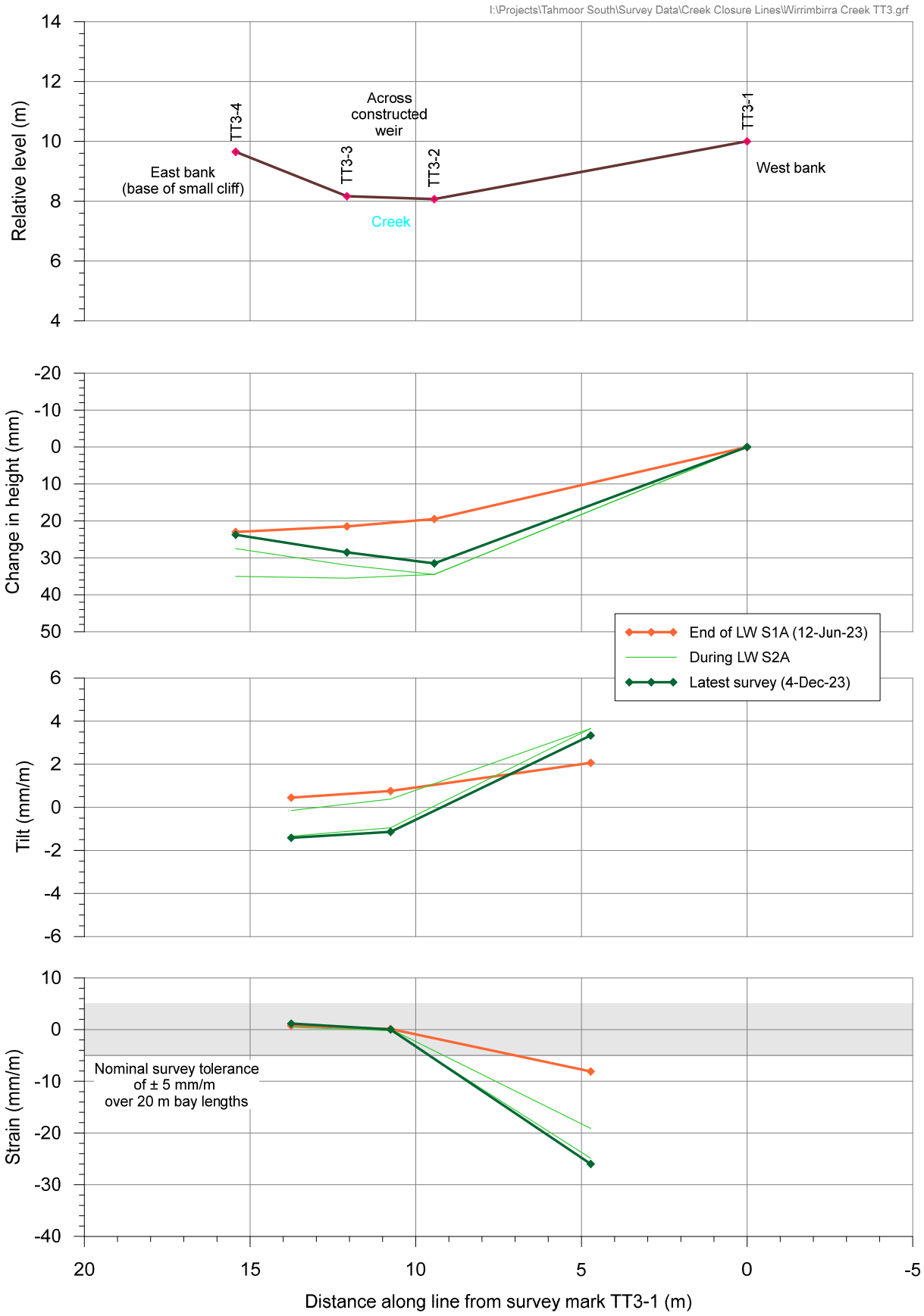


Fig. 3.19 Observed total changes in height, tilt and strain along survey line TT3 across the Tributary to Teatree Hollow during the mining of LWs S1A and S2A

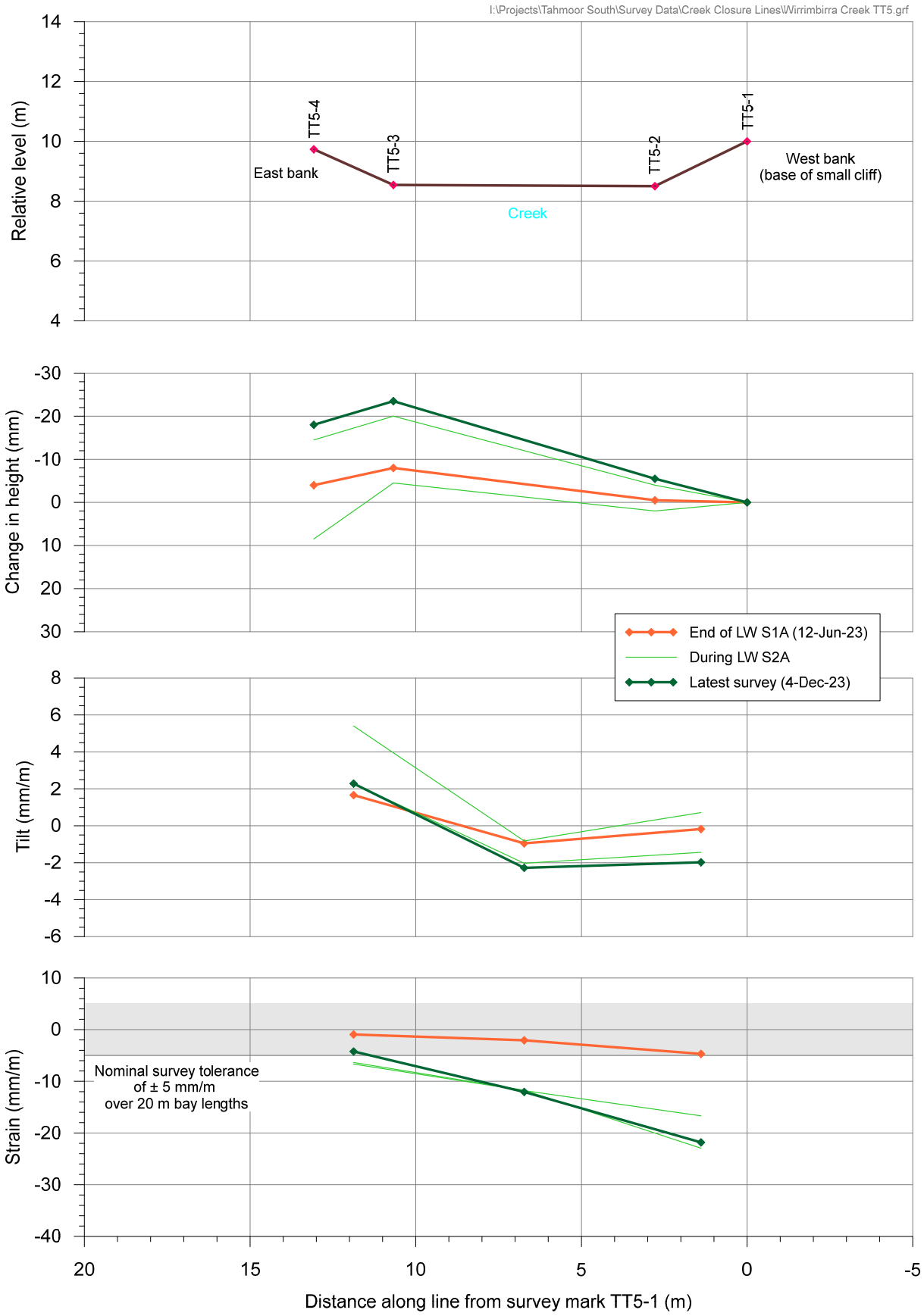


Fig. 3.20 Observed total changes in height, tilt and strain along survey line TT5 across the Tributary to Teatree Hollow during the mining of LWs S1A and S2A

3.4.3. Potential impacts on Teatree Hollow and tributaries

The impact assessments for Teatree Hollow and its tributaries within the Study Area are provided in the following sections. The assessments provided in this report should be read in conjunction with the Water Management Plan (Tahmoor Coal, 2023a) and the Biodiversity Management Plan (Tahmoor Coal, 2023c), which assess the consequences of the impacts on surface water flows and ecology.

Potential for increased levels of ponding, scouring or desiccation due to mining-induced tilt

Mining can potentially result in increased levels of ponding in locations where the mining-induced tilts oppose and are greater than the natural stream gradients that exist before mining. Mining can also potentially result in an increased likelihood of scouring of the stream beds in the locations where the mining-induced tilts considerably increase the natural stream gradients that exist before mining.

A flood study has been completed by ATC Williams on the potential changes to flood levels due to the extraction of LWs S1A to S7A (ATC, 2024). Minor increases to flood levels are predicted in areas subject to flooding under existing conditions above LW S3A at Caloola Road and LW S5A at Yaran Road. The addition of LW S7A does not materially change the results of the flood study and the results are generally consistent with the findings of the EIS.

It is further noted that the predicted 1% AEP flood levels do not extend to surface areas located directly above LW S7A prior to mining or after the extraction of LW S7A.

Potential for fracturing and surface water flow diversion in the stream

Teatree Hollow and its tributaries will be directly mined beneath by the *Approved Layout*. It was assessed that fracturing and surface flow diversions will occur in the sandstone bedrock along both streams due to the extraction of the longwalls in the *Approved Layout*. In some of these locations, the fracturing could impact the holding capacity of the standing pools, particularly those located directly above the proposed longwalls. It is unlikely, however, that there would be any net loss of water from the catchment. Mining-induced fractures and impacts on surface water flow and pool water levels have been observed during the extraction of LW S1A and LW S2A.

The addition of LW S7A does not materially change this assessment, though the extent of impacts increases further upstream to the include the headwaters of two first order sections in the catchment.

While the extent of impacts is increased, Tahmoor Coal will continue to develop and implement measures to manage the potential for impacts on Teatree Hollow and its tributaries during the extraction of LWs S1A to S7A.

Potential for Gas Emissions and Changes to Water Quality

Gas emissions from the sandstone strata have been previously observed above and adjacent to mining areas in the Southern Coalfield, and some gas emissions have also been observed in water bores. Analyses of gas compositions indicate that the Bulli seam is not the direct and major source of the gas and that the most likely source is the Hawkesbury Sandstone (APCRC, 1997).

As LW S7A is proposed to extract directly beneath the headwaters of first order tributaries, any gas emissions that occur will release into the atmosphere and is unlikely to have an adverse impact on water quality.

A description of potential water quality impacts and environmental consequences is presented in the Water Management Plan (Tahmoor Coal, 2023a) and the Biodiversity Management Plan (Tahmoor Coal, 2023c).

3.4.4. Management of potential impacts on Teatree Hollow and tributaries

Tahmoor Coal has developed a Water Management Plan for LWs S1A to S6A to manage potential impacts on streams during the mining of longwalls, including Teatree Hollow and its tributaries. The management plan includes monitoring and triggered response plans. It includes monitoring of the required pre-mining conditions and data collection during mining. Monitoring typically continues for a period following mining.

The Water Management Plan will be updated to include LW S7A (Tahmoor Coal, 2023a).

3.5. Cliffs

3.5.1. Descriptions of the cliffs

The locations of cliffs within the Study Area are shown in Drawing No. MSEC1348-07. A total of 19 cliffs are located within the 600m Study Area for Natural Features, of which 5 cliffs are located within the Study Area.

The cliffs are located within the Hawkesbury Sandstone along the Bargo River and Hornes Creek, at distances of between 275 metres and 600 metres from LW S7A. Photographs of the cliff lines are shown in Fig. 3.1, Fig. 3.9 and Fig. 3.28. There is no direct vehicle access to the cliffs within the Study Area though some cliffs can be reached on foot via walking trails. The Picton Weir is located beneath Cliff C_0800, which is located approximately 575 metres from LW S7A and setback approximately 50 metres from the dam wall (refer Fig. 3.32). A photograph of the cliff above Picton Weir is provided in Fig. 3.21.

Fig. 3.21 Cliff C_00800 above the Picton Weir

For the purposes of this report, a cliff has been defined as a continuous rockface having a maximum height greater than 10 metres, a minimum length of 20 metres and a minimum slope of 2 in 1, i.e. having a minimum angle to the horizontal of 63°. The definition is consistent with the definition provided in the Project Approval of the EIS. The locations and heights of cliffs within the Study Area were determined by Fluvial Systems based on the results of an airborne laser scan, refer to Fluvial Systems (2013).

The closest cliff (MSEC ID C_00130, DP ID BC1) is located approximately 275 metres from LW S7A. The cliff has been surveyed by aerial photogrammetry by MNC Consulting. The result of the survey is shown in Fig. 3.22.

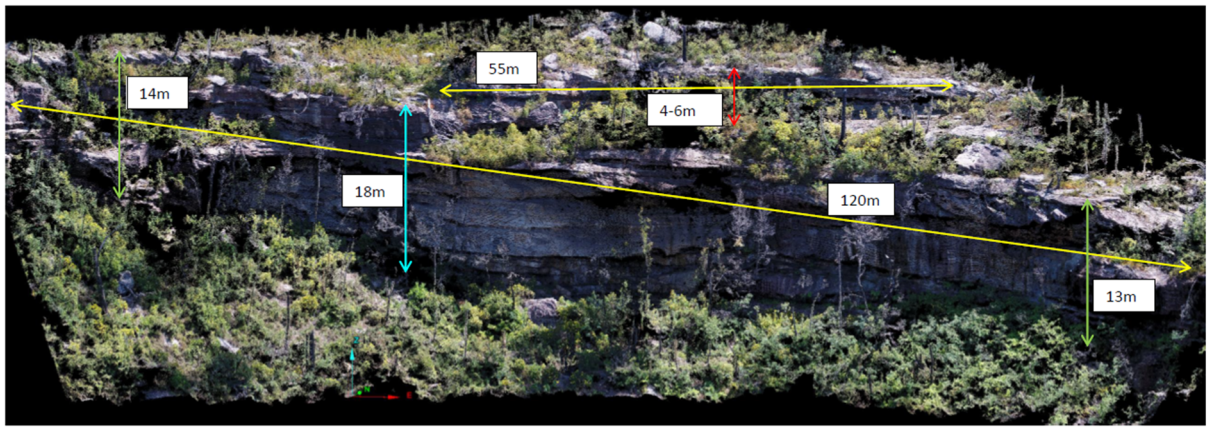


Image courtesy MNC Consulting

Fig. 3.22 Digital reconstruction of aerial photogrammetry survey of Cliff C_00130

The cliff is measured to be approximately 120 metres long with a maximum height of 18 metres, when the smaller upper section of the cliff is included in the height calculation with the main cliff. The cliff includes an overhang of approximately 4 to 5 metres in depth which is 50 metres long. The total face area has been calculated to be 2,685 m^2.

The second closest cliff (MSEC ID C_02060) is located approximately 360 metres from LW S7A. The cliff has been surveyed using aerial photogrammetry by MNC Consulting. The result of the survey is shown in Fig. 3.23.

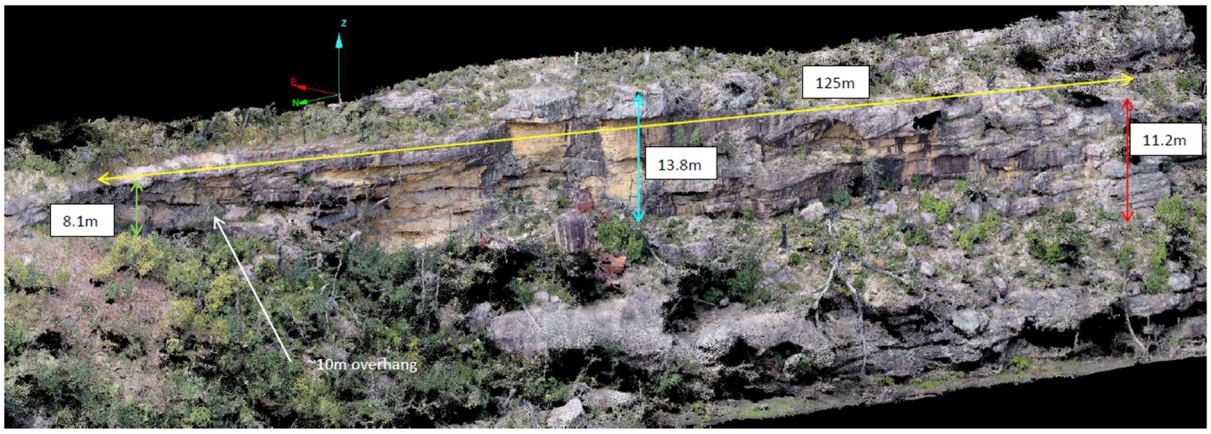


Image courtesy MNC Consulting

Fig. 3.23 Digital reconstruction of aerial photogrammetry survey of Cliff C_02060

The cliff is measured to be approximately 125 metres long with a maximum height of 14 metres. The cliff includes an overhang of approximately 10 metres at the northern end. The total face area has been calculated to be 1,583 m^2.

3.5.2. Predictions for the cliffs

A summary of the maximum predicted values of total vertical subsidence, tilt and the maximum predicted total hogging curvature and sagging curvature at the 19 identified cliffs is provided in Table 3.8. Because of the distance between the cliffs and the *Approved Layout* LWs S1A to S6A, the predicted subsidence movements due to the extraction of these longwalls are negligible, and hence the predicted total subsidence movements shown in Table 3.8 are essentially the incremental subsidence movements due to LW S7A.

Table 3.8 Maximum predicted total vertical subsidence, tilt and curvature for cliffs due to the extraction of LWs S1A to S7A

Modified Layout After LW S7A	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Hogging Curvature (km^{-1})	Maximum Predicted Total Sagging Curvature (km^{-1})
C_00130	60	< 0.5	< 0.01	< 0.01
C_00710	25	< 0.5	< 0.01	< 0.01
C_00800	< 20	< 0.5	< 0.01	< 0.01
C_00830	< 20	< 0.5	< 0.01	< 0.01
C_00920	< 20	< 0.5	< 0.01	< 0.01
C_01160	< 20	< 0.5	< 0.01	< 0.01
C_01280	< 20	< 0.5	< 0.01	< 0.01
C_01610	30	< 0.5	< 0.01	< 0.01
C_02020	< 20	< 0.5	< 0.01	< 0.01
C_02060	40	< 0.5	< 0.01	< 0.01
C_02170	< 20	< 0.5	< 0.01	< 0.01
C_02240	25	< 0.5	< 0.01	< 0.01
C_02670	< 20	< 0.5	< 0.01	< 0.01
C_02920	< 20	< 0.5	< 0.01	< 0.01
C_03370	< 20	< 0.5	< 0.01	< 0.01
C_05140	20	< 0.5	< 0.01	< 0.01
C_07220	30	< 0.5	< 0.01	< 0.01
C_11150	20	< 0.5	< 0.01	< 0.01
C_11590	< 20	< 0.5	< 0.01	< 0.01

3.5.3. Impact assessments for cliffs located above solid coal

The cliffs are located more than 275 metres from the proposed LW S7A and will not be directly mined beneath.

It is extremely difficult to assess the likelihood of cliff instabilities based upon predicted ground movements. The likelihood of a cliff becoming unstable is dependent on a number of factors which are difficult to fully quantify. These factors include jointing, inclusions, weaknesses within the rock mass, groundwater pressure and seepage flow behind the rockface. Even if these factors could be determined, it would still be difficult to quantify the extent to which these factors influence the stability of a cliff naturally or when it is exposed to mine subsidence movements. It is possible, therefore, that cliff instabilities may occur during mining that may be attributable to either natural causes, mine subsidence, or both.

The likelihood of cliff instabilities can be assessed using case studies where previous longwall mining has occurred close to but not directly beneath cliffs. Although very minor rock falls have been observed over solid coal outside the extracted goaf areas of longwall mining in the Southern Coalfield, there have been no recorded large cliff instabilities outside the extracted goaf areas of longwall mining in the Southern Coalfield. This statement is based on the following observations:-

- ***Tahmoor Longwalls 24A to 26***

  Tahmoor Longwalls 24A to 26 were mined near and adjacent to the cliff lines along the Bargo River valley between November 2007 and July 2011. The cliff lines are continuous on both sides of the valley along this section of the river. The cliffs are located at a minimum distance of 300 metres east of Longwall 24A, at their closest point to these longwalls. Whilst the overall valley depths, within one depth of cover of this gorge, were over 100 metres, the heights of the cliffs are around 60 metres and are formed within the Hawkesbury Sandstone.

  Tahmoor Longwalls 24A to 26 have void widths of 285 metres, solid chain pillar widths of 35 metres to 40 metres and were extracted from the Bulli seam at a depth of cover of 350 metres at the base of the gorge and 450 metres around the plateau areas. There were no impacts observed on the cliffs along the Bargo River Valley as a result of the extraction of Tahmoor Longwalls 24A to 26.

- ***Appin Longwalls 301 and 302 near the Cataract River***

  Appin Longwalls 301 and 302 were mined adjacent to a number of cliff lines located along the Cataract River valley between October 2006 and September 2007. A total of 68 cliffs were identified within a 35 degree angle of draw from these longwalls. These cliffs had continuous lengths ranging between 5 metres and 230 metres, overall cliff heights ranging between 10 metres and 37 metres, overall valley depths, within one depth of cover of the river, ranging from 50 to 75 metres, and had been formed within the Hawkesbury Sandstone.

  Appin Longwalls 301 and 302 have void widths of 260 metres, solid chain pillar widths of 40 metres and were extracted from the Bulli seam at a depth of cover of 420 metres at the base of the gorge and 490 metres around the plateau areas. These longwalls mined to within 50 metres of the identified locations of the cliffs along the Cataract River valley.

  There were no large cliff instabilities observed as a result of the extraction of Appin Longwalls 301 and 302. There were, however, five minor rock falls or disturbances which occurred during the mining period, of which, three were considered likely to have occurred due to a substantial rainfall event and one was probably a natural instability of the cliff overhang. Nevertheless, the length of cliff line disturbed as a result of the extraction of Appin Longwalls 301 and 302 was, therefore, estimated to be less than 0.5 % of the total face area of the cliff lines within the mining domain.

- ***Tower Longwalls 18 to 20 and Appin Longwalls 701 to 704 near the Nepean River***

  Tower Longwalls 18 to 20 and Appin Longwalls 701 to 704 mined adjacent to a number of cliff lines located along the Nepean River valley. A total of approximately 50 cliffs were identified within a 35 degree angle of draw from these longwalls. The cliffs had continuous lengths ranging between 5 metres and 225 metres, overall heights ranging between 10 metres and 40 metres, overall valley depths, within one depth of cover of the river, ranging from 60 to 80 metres and had been formed within the Hawkesbury Sandstone.

  Tower Longwalls 18 to 20 have void widths of 235 metres, solid chain pillar widths of 40 metres and were extracted from the Bulli seam at a depth of cover of 460 metres at the base of the gorge and 510 metres around the plateau areas. Appin Longwalls 701 to 704 have void widths of 320 metres, solid chain pillar widths of 40 metres and were extracted from the Bulli seam at a depth of cover of 460 metres at the base of the gorge and 510 metres around the plateau areas.

  Tower Longwall 20 was mined directly beneath some cliffs located at the confluence of Elladale Creek and the Nepean River. Appin Longwalls 701 to 704 mined to within 75 metres of the identified locations of the cliffs along the Nepean River valley.

  There were no cliff instabilities observed as a result of the extraction of Tower Longwalls 18 to 20 and Appin Longwalls 701 to 704.

Based on this previous experience of mining at Tahmoor, Appin and Tower Collieries, it is unlikely that cliffs beyond the extent of the longwall panels will experience large instabilities. It is possible that isolated rock falls could occur during the mining period due to natural weathering processes. Any impacts are expected to represent less than 0.5 % of the total face area of the cliffs.

The cliffs are located in area that is very difficult to access publicly. In the very unlikely event that an isolated rock fall occurs, the likelihood of a rock fall affecting public safety is assessed to be extremely low.

3.5.4. Impact assessments for the cliffs based on increased predictions

If the actual mine subsidence movements exceeded those predicted values by a factor of 2 times, the likelihood of impacts for the cliffs that are located well outside the proposed LW S7A would still be expected to be very low.

While the predicted ground movements are important parameters when assessing the potential impacts on the cliffs, it is noted that the impact assessments for cliff instabilities have primarily been based on historical observations from previous longwall mining in the Southern Coalfield.

3.5.5. Management of potential impacts on cliffs

Tahmoor Coal has developed a Land Management Plan for managing potential impacts on cliffs during the mining of LWs S1A to S6A. The management plan includes:

- Identification of all structures, dams and roads that are in close proximity to cliffs;
- Site investigation of cliffs by a qualified geotechnical engineer;
- Baseline mapping of cliffs to measure face area;
- Monitoring, including ground survey and visual inspections; and
- Erection of warning signs and consultation with landowners if impacts are observed.

It is recommended that Tahmoor Coal continue to develop management plans to manage potential impacts on cliffs during the mining of the proposed LW S7A. The Land Management Plan will be extended to include management of potential impacts due to the extraction of LW S7A.

3.6. Steep Slopes

The locations of the steep slopes are shown in Drawing No. MSEC1348-07.

The purpose of identifying steep slopes for this assessment is to highlight areas in which existing ground slopes may be marginally stable. As a conservative first pass, a steep slope has been defined as an area of land having a gradient greater than 1 in 3 (33 % or 18.3°). The definition is consistent with the definition provided in the Project Approval of the EIS layout. The minimum slope of 1 to 3 represents a slope that would generally be considered stable for slopes consisting of rocky soils or loose rock fragments. Clearly the stability of natural slopes varies depending on their soil or rock types, and in many cases, natural slopes are stable at much higher gradients than 1 to 3 (for example, talus slopes in Hawkesbury Sandstone).

The steep slopes were identified by Fluvial Systems from an airborne laser scan supplied by Tahmoor Coal. The steep slopes within the Study Area can be broadly categorised as:

a) Steep slopes on the sides of valleys;
b) Batters of road and railway embankments and cuttings;
c) Slopes on farm dams.

Types (b) and (c) are addressed later in this report.

The steep slopes on the sides of valleys are predominantly found in Hawkesbury Sandstone and consist of a mixture of cliffs and rock outcrops, which are stable at vertical to overhanging, and screed slopes with rocky soils and loose rock fragments. The majority of slopes are stabilised, to some extent, by natural vegetation.

The ranges of predicted subsidence parameters for the steep slopes are similar to those predicted along the streams, which are provided in Section 3.2.2.

There has been extensive experience of mining beneath steep slopes in the Southern Coalfield. These include steep slopes along the Cataract, Nepean, Bargo and Georges Rivers and streams such as Myrtle Creek and Redbank Creek above Tahmoor Mine Longwalls 22 to 32, slopes on Redback Range above Tahmoor Mine Longwalls 26 and 27 and slopes along ridges and valleys above Tahmoor LWs W1-W4. No large-scale slope failures have been observed along these slopes, even where longwalls have been mined directly beneath them. Surface cracking and minor rock falls along clifflines or rock outcrops have been observed, for example, during the mining of Appin Longwalls 301 and 302 adjacent to the Cataract River, however, no large-scale slope failures have been observed.

Potential impacts on steep slopes would generally result from the movement of soils, causing tension cracks to appear at the tops of the slopes and compression ridges to form at the bottoms of the slopes. These movements are consistent with observations of upsidence and closure of creek valleys where compression is developed at the bottoms of the valleys and tension is developed at the tops of the valleys. If tension cracks were left untreated it is possible that soil erosion could occur.

It is possible, therefore, that some remediation might be required to ensure that mining-induced surface cracking does not result in the formation of soil erosion channels. In some cases, erosion protection measures may be needed, such as the planting of additional vegetation in order to stabilise the slopes in the longer term.

While in most cases impacts to slopes are likely to consist of surface cracking, there remains a low probability of large-scale slope slippage. The probability is assessed to be very low for slopes that will not be directly mined beneath by the longwalls. Experience indicates that the probability of mining induced large-scale slippages is extremely low due to the substantial depths of cover within the Study Area. While the risk is extremely low, some risk remains and attention must therefore be paid to any structures or roads that may be located in the vicinity of steep slopes.

There are no structures or roads located along natural steep slopes within the Study Area.

3.6.1. Management of potential impacts on steep slopes

Tahmoor Coal has developed a Land Management Plan for managing potential impacts on steep slopes during the mining of LWs S1A to S6A. The management plan includes:

- Identification of all structures, dams and roads that are in close proximity to steep slopes;
- Site investigation and landslide risk assessment of structures near slopes by a qualified geotechnical engineer;
- Site investigation and structural assessment of structures where recommended by the geotechnical engineer. This may include recommendations to mitigate against potential impacts;
- Monitoring, including ground survey and visual inspections; and
- Remediation if cracking or slippage occurs.

It is recommended that Tahmoor Coal continue to develop management plans to manage potential impacts on slopes during the mining of the proposed LW S7A. The Land Management Plan will be extended to include management of potential impacts due to the extraction of LW S7A.

3.7. Main Southern Railway

The location of the Main Southern Railway is shown in Drawing No. MSEC1348-08. It can be seen that a section of the Main Southern Railway and associated infrastructure are located within the Study Area, however the proposed LW S7A is not located directly beneath the Main Southern Railway. The closest distance between the Railway and the proposed LW S7A is approximately 400 metres.

3.7.1. Description of the Main Southern Railway

The Main Southern Railway is a key national transport route that carries substantial freight and passenger services between Sydney and Melbourne. The Main Southern Railway is leased by Australian Rail Track Corporation (ARTC), who is responsible for maintaining the track.

Approximately 500 metres of track is located within the Study Area between kilometrages 100.1 km and 100.6 km.

The railway line is a dual track consisting of 60 kg rail on concrete sleepers with a mix of straight and curved track sections within the Study Area. The maximum speed limits on both tracks are 95 km/h for normal services and 105 km/h for XPT services. A photograph of a section of the railway at 99.400 km directly above proposed LW S4A is provided in Fig. 3.24.

Photograph courtesy Newcastle Geotech

Fig. 3.24 Main Southern Railway at 100.121 km

Two railway culverts are located within the Study Area at 100.121 km and 100.425 km, as shown in Drawing No. MSEC1348-08. A summary is provided in Table 3.9.

Table 3.9 Rail culverts potentially affected by LW S1A-S6A

Kilometrage (km)	Diameter (mm)	Description	Location relative to Proposed Longwalls
100.121 km	1500 dia	Skewed brick arch culvert with 1500 mm dia concrete extension on both sides. Separation observed between brick arch culvert and concrete extension on Down side.	Above LW S4A
100.425 km	1500 dia	Skewed brick arch culvert with brick wingwalls on both sides (no concrete extensions)	Above LW S5A

Based on boreholes drilled by Newcastle Geotech, the culverts appear to be either founded on natural soils or on the rock surface with no evidence of the culverts being constructed against rock. The culverts are located within rail embankments that are up to 6 metres in height.

A small cutting is located at 100.310 km, which up to 2 metres high in competent sandstone rock. Wellers Road Overbridge is located approximately 540 metres from LW S7A.

Photograph courtesy Robinson Rail

Fig. 3.25 Culvert with concrete extension on Up side at 100.121 km

Photograph courtesy Robinson Rail

Fig. 3.26 Culvert with concrete extension on Up side at 100.425 km

3.7.2. Predictions for the Main Southern Railway

The predicted profiles of total subsidence, tilt and change in track grade along the alignment of the Main Southern Railway are shown in Fig. A.05, which is included in Appendix A. Predicted profiles of cross tilt, change in track cant and long twist along the railway are shown in Fig. A.06 while predicted profiles of horizontal movement along the track, changes in 100 m long bays and change in Rail SFT are shown in Fig. A.07.

A summary of the maximum predicted incremental subsidence parameters due to the extraction of LW S7A is provided in Table 3.10.

Table 3.10 Maximum predicted incremental subsidence parameters along the alignment of the Main Southern Railway due to the extraction of LW S7A

Modified Layout	Maximum predicted incremental subsidence (mm)	Maximum predicted change in Grade (%)	Maximum predicted incremental hogging curvature along alignment (km^{-1})	Maximum predicted incremental sagging curvature along alignment (km^{-1})
LW S7A	40	< 0.05	< 0.01	< 0.01

A summary of the maximum predicted total subsidence parameters after the extraction of LW S7A is provided in Table 3.11.

Table 3.11 Maximum predicted total conventional subsidence parameters along the alignment of the Main Southern Railway due to the extraction of LWs S1A to S7A

Layout	Maximum predicted total subsidence (mm)	Maximum predicted change in Grade (%)	Maximum predicted total hogging curvature along alignment (km^{-1})	Maximum predicted total sagging curvature along alignment (km^{-1})
Approved Layout				
After LW S6A	1350	0.85	0.10	0.20
Modified Layout				
After LW S7A	1400	0.85	0.10	0.20

It can be seen from Fig. A.05, A.06 and A.07 and the preceding two tables that predicted subsidence movements along the Railway for the *Modified Layout* are similar or only slightly higher than the corresponding predicted conventional subsidence movements for the *Approved Layout*. The locations of the predicted maxima for subsidence, tilt along the Railway and curvature remain the same.

3.7.3. Impact assessments for the Main Southern Railway

The Railway will be directly mined beneath by the *Approved Layout*. There is extensive experience of mining directly beneath railways in the Southern Coalfield which demonstrates that impacts can be managed with the implementation of suitable management strategies.

The Railway is located approximately 400 metres from the proposed LW S7A at its closest point. The Railway is predicted to experience minor additional subsidence movements due to the proposed extraction of LW S7A.

The addition of LW S7A under the *Modified Layout* does not materially change the impact assessment, though the potential for impacts increases slightly within the Study Area.

Track geometry

The predicted differential subsidence movements are expected to result in negligible changes to track geometry, as they are an order of magnitude less than the maximum allowable deviations specified in Australian Rail Track Corporation's National Code of Practice. Non-conventional subsidence movements could result in impacts on track geometry, however, and potential impacts can be managed with the implementation of an effective subsidence management plan, which is discussed later in this report.

Track grades

The predicted changes in track gradient along the Main Southern Railway due to the extraction of LW S7A are an order of magnitude less than the existing gradients, as shown in Fig. A.05.

While non-conventional movements could result in localised changes in track grades, it should be noted, however, that they occur over short lengths, which is of less concern as freight trains are many hundreds of metres long. It is expected, however, that track resurfacing would be required to reduce the magnitude of the mining-induced undulations in the track.

Rail stress

The predicted mining-induced ground strains are predicted to result in changes in rail stress less than 10 degrees, which is not expected to be sufficient to warrant immediate preventative action on a track with concrete sleepers.

Non-conventional subsidence movements could result in impacts on rail stress, however, and potential impacts can be managed with the implementation of an effective subsidence management plan, which is discussed later in this report.

Wellers Road Overbridge

The Wellers Road Overbridge is located at Bargo at 101.162 km outside the Study Area. The Overbridge is 370 metres from the commencing end of LW S6A and 540 metres from LW S7A.

The bridge is predicted to experience less than 20 mm of conventional subsidence, with negligible tilt, curvature and strain due to the extraction of LWs S1A to S7A.

The bridge is expected to experience far field horizontal movements, as discussed in Report No. MSEC1192 for LWs S1A to S6A. With the implementation of an effective subsidence management plan, the development of ground movements and impacts can be detected early with time to implement intervention measures before the bridge becomes unserviceable.

Railway Culverts and Embankments

The culverts at 100.121 km and 100.425 km are predicted to experience less than 40 mm additional subsidence and 20 mm additional valley closure due to the extraction of proposed LW S7A.

Potential impacts from the additional subsidence and valley closure on the culverts and embankments can be managed with the implementation of an effective subsidence management plan, which is discussed later in this report.

Railway Cuttings

The cutting at 100.310 km is predicted to experience 40 mm of additional subsidence due to the extraction of proposed LW S7A.

Tahmoor Mine has successfully mined directly beneath railway cuttings during the extraction of Longwalls 25 to 32, with only minor impacts observed on cuttings. It is extremely unlikely that the cutting will experience adverse impacts due to the extraction of LW S7A.

Signalling and communications systems

The potential for impacts on cabling and wiring along the track is considered to be very low. Mine subsidence impacts on electrical and telecommunications cabling is historically very low in the Southern Coalfield. It is extremely unlikely that the signalling and communications will experience adverse impacts due to the extraction of LW S7A.

3.7.4. Management of potential impacts on the Main Southern Railway

Tahmoor Coal and the Australian Rail Track Corporation (ARTC) have developed a detailed risk management plan for managing potential mine subsidence impacts on the Main Southern Railway due to the extraction of LWs S1A to S6A. The Railway Management Plan will be updated to include LW S7A (Tahmoor Coal, 2023a).

The management measures described in this plan are similar to those that have been developed in consultation with ARTC and successfully implemented at Tahmoor Mine and Appin Colliery, as described in a paper by Pidgeon, et al. (2011).

A Rail Management Group has been coordinated to develop the risk management strategies. The Rail Management Group includes representatives from ARTC, Tahmoor Coal and specialist consultants in the fields of railway track engineering, geotechnical engineering, structural engineering, track signalling, mine subsidence, risk assessment and project management. The Technical Committee consults with the Resources Regulator and the Office of the National Rail Safety Regulator.

Works by the Rail Management Group include:-

- Identification of potential impacts on the railway;
- Undertaking a risk management approach, where identified risks are assessed and risk control measures are implemented; and
- Development of management measures that include mitigation and preventive works, monitoring plans, triggered response plans and communication plans; and
- Supervision and oversight of railway track and infrastructure mitigation, monitoring and maintenance of affected rail track and infrastructure.

With an appropriate management plan in place, it is considered that the Main Southern Railway will remain safe and serviceable at all times during and after the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

3.8. Roads

The locations of the local roads are shown in Drawing No. MSEC1348-09 in Appendix B, where there are sections of four roads located within the Study Area. The entire length of Yarran Road and sections of Caloola Road, Remembrance Drive, and Wellers Road at Elvy Street are all located within the Study Area. These local roads are maintained by Wollondilly Shire Council.

There are three road drainage culverts located within the Study Area, one under Caloola Road and two under Remembrance Drive in the vicinity of Yarran Road, although none of these are located directly over LW S7A. The culverts are reinforced concrete pipes (RCP).

Remembrance Drive is supported by two road embankments located within the Study Area, one north of Yarran Road (identified as RE3) and one south of Yarran Road (RE2). Both of these are located directly over LW S5A and will not be mined beneath during extraction of LW S7A.

Remembrance Drive passes through a rock cutting between Caloola Road and Yarran Road, which is located within the Study Area directly above LW S4A and not directly over LW S7A.

3.8.1. Predictions for the roads

Yarran Road

Yarran Road is a sealed no-through road that connects to Remembrance Drive from the west. It is located directly above LW S7A and also crosses LWs S5A and S6A, and therefore could experience the full range of predicted subsidence movements due to the extraction of LW S7A. The predicted profiles of conventional subsidence, tilt and curvature along the alignment of Yarran Road, resulting from the extraction of the proposed longwalls, is shown in Fig. A.08, which is included in Appendix A.

A summary of the maximum predicted incremental conventional subsidence parameters for Yarran Road, due to the extraction of S7A, is provided in Table 3.12.

Table 3.12 Maximum predicted incremental conventional subsidence parameters for Yarran Road due to the extraction of LW S7A

Longwall	Maximum predicted incremental subsidence (mm)	Maximum predicted incremental tilt along alignment (mm/m)	Maximum predicted incremental tilt across alignment (mm/m)	Maximum predicted incremental hogging curvature in any direction (km^{-1})	Maximum predicted incremental sagging curvature in any direction (km^{-1})
Modified Layout					
LW S7A	950	3.5	7.0	0.04	0.05

A summary of the maximum predicted total conventional subsidence parameters for Yarran Road, after the extraction of each longwall, is provided in Table 3.13.

The predicted tilts are the maxima along and across the alignment of the road after the completion of each longwall. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each longwall.

Table 3.13 Maximum predicted total conventional subsidence parameters for Yarran Road due to the extraction of LWs S1A to S7A

Longwall	Maximum predicted total 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})
Approved Layout					
LW S1A	< 20	< 0.5	< 0.5	< 0.01	< 0.01
LW S2A	< 20	< 0.5	< 0.5	< 0.01	< 0.01
LW S3A	20	< 0.5	< 0.5	< 0.01	< 0.01
LW S4A	100	< 0.5	< 0.5	< 0.01	< 0.01
LW S5A	1050	8.0	2.0	0.09	0.20
LW S6A	1300	7.0	4.0	0.09	0.20
Modified Layout					
After LW S7A	1350	6.5	7.5	0.10	0.20

It can be seen from Fig. A.08 and the preceding two tables that predicted subsidence, tilt along Yarran Road and curvatures for the *Modified Layout* are similar or only slightly higher than the corresponding predicted conventional subsidence movements for the *Approved Layout*. The locations of the predicted maxima for subsidence, tilt and curvature along Yarran Road remain the same.

Caloola Road

Caloola Road is a sealed no-through road that connects to Remembrance Drive from the west, via entry and exit ramps along the base of an embankment at Remembrance Drive.

Caloola Road is not located directly above LW S7A but crosses LWs S3A to S5A at the northern end of the Study Area. Caloola Road therefore would be expected to experience only small additional subsidence movements due to extraction of LW S7A. The predicted profiles of conventional subsidence, tilt and curvature along the alignment of Caloola Road, resulting from the extraction of the proposed longwalls, is shown in Fig. A.09, which is included in Appendix A.

A summary of the maximum predicted incremental conventional subsidence parameters for Caloola Road, due to the extraction of S7A, is provided in Table 3.14.

Table 3.14 Maximum predicted incremental conventional subsidence parameters for Caloola Road due to the extraction of LW S7A

Longwall	Maximum predicted incremental subsidence (mm)	Maximum predicted incremental tilt along alignment (mm/m)	Maximum predicted incremental tilt across alignment (mm/m)	Maximum predicted incremental hogging curvature in any direction (km^{-1})	Maximum predicted incremental sagging curvature in any direction (km^{-1})
Modified Layout					
LW S7A	60	< 0.5	< 0.5	< 0.01	< 0.01

A summary of the maximum predicted total conventional subsidence parameters for Caloola Road, after the extraction of each longwall, is provided in Table 3.15.

The predicted tilts are the maxima along and across the alignment of the road after the completion of each longwall. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each longwall.

Table 3.15 Maximum predicted total conventional subsidence parameters for Caloola Road due to the extraction of LWs S1A to S7A

Longwall	Maximum predicted total 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})
Approved Layout					
LW S1A	20	< 0.5	< 0.5	< 0.01	< 0.01
LW S2A	80	< 0.5	< 0.5	< 0.01	< 0.01
LW S3A	875	5.5	6.0	0.09	0.09
LW S4A	1150	5.0	6.5	0.11	0.20
LW S5A	1300	6.0	5.5	0.11	0.20
LW S6A	1350	6.5	6.0	0.12	0.20
Modified Layout					
After LW S7A	1400	6.5	6.5	0.12	0.20

The predicted conventional subsidence movements along Caloola Road for the *Modified Layout* are similar or only slightly higher than the corresponding predicted conventional subsidence movements for the *Approved Layout*. The locations of the predicted maxima for the conventional subsidence movements, tilt and curvature remain the same.

Remembrance Drive

Remembrance Drive is the main road linking the M31 Hume Motorway with the townships of Bargo and Tahmoor and traverses generally flat terrain along the western side of the Main Southern Railway. It crosses LWs S1A to S5A but does not cross directly above LW S7A. Remembrance Drive therefore would be expected to experience only small additional subsidence movements due to LW S7A following extraction of LWs S1A to S6A. The predicted profiles of conventional subsidence and tilt along the alignment of Remembrance Drive, resulting from the extraction of the proposed longwalls, are shown in Fig. A.10, which is included in Appendix A.

A summary of the maximum predicted incremental conventional subsidence parameters for Remembrance Drive, due to the extraction of S7A, is provided in Table 3.16.

Table 3.16 Maximum predicted incremental conventional subsidence parameters for Remembrance Drive due to the extraction of LW S7A

Longwall	Maximum predicted incremental subsidence (mm)	Maximum predicted incremental tilt along alignment (mm/m)	Maximum predicted incremental tilt across alignment (mm/m)	Maximum predicted incremental hogging curvature in any direction (km^{-1})	Maximum predicted incremental sagging curvature in any direction (km^{-1})
Modified Layout					
LW S7A	60	< 0.5	< 0.5	< 0.01	< 0.01

A summary of the maximum predicted total conventional subsidence parameters for Remembrance Drive, after the extraction of each longwall, is provided in Table 3.17.

The predicted tilts are the maxima along the alignment of the road after the completion of each longwall. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each longwall.

Table 3.17 Maximum predicted total conventional subsidence parameters for Remembrance Drive due to the extraction of LWs S1A to S7A

Longwall	Maximum predicted total 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})
Approved Layout					
LW S1A	200	1.5	4.0	0.06	0.03
LW S2A	975	5.0	5.5	0.08	0.20
LW S3A	1150	7.0	4.5	0.10	0.20
LW S4A	1300	6.0	5.5	0.12	0.20
LW S5A	1350	5.5	6.0	0.13	0.20
LW S6A	1350	6.5	5.5	0.13	0.25
Modified Layout					
After LW S7A	1400	7.0	5.0	0.13	0.25

It can be seen that the predicted conventional subsidence movements for Remembrance Drive for the *Modified Layout* are similar or only slightly higher than the corresponding predicted conventional subsidence movements for the *Approved Layout*. The locations of the predicted maxima for subsidence, tilt and curvature along Remembrance Drive remain the same.

Wellers Road

Wellers Road is predicted to experience maximum total vertical subsidence of 20 mm of due to the extraction of LWs S1A to S7A, with tilts less than 0.5 mm/m and hogging and sagging curvature less than 0.01 km^{-1}.

3.8.2. Impact assessments for the roads

The local roads will be directly mined beneath by the *Approved Layout*. There is extensive experience of mining directly beneath local roads in the Southern Coalfield which demonstrates that impacts can be managed with the implementation of suitable management strategies. In all cases the local roads have remained in safe and serviceable condition and have been remediated using normal road maintenance techniques.

Longwalls 22 to 32 and LW W1-W3 at Tahmoor Mine have mined directly beneath 28 kilometres of local roads and a total of 54 impact sites have been observed. The observed rate of impact on the local roads equates to an average of one impact for every 520 metres of pavement. In most cases, the impacts were relatively minor and were remediated by locally resurfacing the pavements.

The most severe impacts were located where substantial non-conventional movements had developed. These impact sites were identified using visual and ground monitoring and remediation was undertaken during active subsidence to maintain these roads in safe and serviceable conditions.

The addition of LW S7A under the *Modified Layout* does not materially change this assessment, though the extent of impacts increases further west along Yarran Road.

While the extent of impacts is increased, Tahmoor Coal will continue to develop and implement measures to manage the potential for impacts on local roads during the extraction of LWs S1A to S7A.

3.8.3. Management of potential impacts on the roads

Tahmoor Coal and Wollondilly Shire Council have implemented extensive measures to manage potential impacts on local roads and the associated structures due to the extraction of LWs S1A to S6A, in accordance with a Subsidence Management Plan. This plan will be updated to include potential impacts due to the extraction of LW S7A under the *Modified Layout*.

With an appropriate management plan in place, it is considered that the local roads will remain safe and serviceable at all times during and after the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

3.9. Services Infrastructure

The locations of electrical services and telecommunications infrastructure, gas, potable water and sewer pipelines is shown in Drawing No. MSEC1348-09. It can be seen that there are elements of each of these all located within the Study Area, as described in the following sections.

3.9.1. Electrical services infrastructure

Electrical infrastructure located within the Study Area comprises 11 kV and low voltage powerlines which are located across the area, generally following the alignment of Yarran Road, Caloola Road and Remembrance Drive, or the Main Southern Railway. There are no transmission lines or higher voltage powerlines located within the Study Area.

The power lines generally comprise aerial copper cables supported on timber poles, but there are also some sections of direct buried cables. The power lines are owned and operated by Endeavour Energy.

Because there are powerlines located directly above LW S7A, these therefore could experience the full range of predicted subsidence movements due to extraction of the longwalls under the *Modified Layout*.

The predicted profiles of conventional subsidence, tilt and curvature along the powerlines following the alignment of local roads are as predicted for these roads themselves (see Section 3.8). The profiles are shown in Figs. A.08 to A.10 in Appendix A, while maximum predicted incremental subsidence movements due to LW S7A are summarised in Table 3.12 for Yarran Road, Table 3.14 for Caloola Road and Table 3.16 for Remembrance Drive. Maximum predicted total conventional subsidence movements after extraction of LW S7A are summarised in Table 3.13 for Yarran Road, Table 3.15 for Caloola Road and Table 3.17 for Remembrance Drive.

As discussed in relation to the local roads, any additional subsidence movements due to extraction of LW S7A under the *Modified Layout* are slight when compared to the *Approved Layout*, and the locations of the predicted maxima do not change along these powerline alignments.

The electrical infrastructure will be directly mined beneath by the *Approved Layout*. There is extensive experience of mining directly beneath electrical infrastructure in the Southern Coalfield which demonstrates that impacts can be managed with the implementation of suitable management strategies. In all cases the electrical infrastructure have remained in safe and serviceable condition and have been remediated using normal maintenance techniques.

The addition of LW S7A under the *Modified Layout* does not materially change this assessment, though the extent of impacts increases further west along Yarran Road.

Tahmoor Coal and Endeavour Energy have implemented extensive measures to manage potential impacts on electrical infrastructure due to the extraction of LWs S1A to S6A under the *Approved Layout*, in accordance with a Subsidence Management Plan. This plan will be updated to include potential impacts due to the extraction of LW S7A under the *Modified Layout*.

With an appropriate management plan in place, it is considered that the electrical infrastructure will remain safe and serviceable at all times during and after the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

3.9.2. Telecommunications infrastructure

Telecommunications infrastructure within the Study Area comprises optical fibre cables and copper cables which are owned by Telstra, the National Broadband Network (NBN) and TPG. The optical fibre cables are direct buried or buried in conduit. There is an NBN telecommunications tower and adjacent shed located at No. 3166 Remembrance Drive, with access from Yarran Road. The tower and shed are located directly above LW S6A, as shown in Drawing No. MSEC1348-09.

- The **Telstra** optical fibre cable follows the alignment of the Main Southern Railway and crosses directly above the proposed LWs S1A to S5A but does not cross directly above LW S7A. Telstra copper cables are generally direct buried and follow the alignments of local roads across the Study Area.
- The **NBN** optical fibre cable follows the alignment of Remembrance Drive but does not cross directly above LW S7A. NBN copper service cables follow the alignments of local roads across the Study Area.
- The **TPG** optical fibre cable follows the alignment of Remembrance Drive from the Wollondilly Anglican College to the Bargo Exchange, following the same route as the NBN optical fibre cable.

The predicted profiles of conventional subsidence, tilt and curvature along the optical fibre cables and copper cables following the alignment of the Main Southern Railway and the local roads are as predicted for the railway and these roads themselves (see Section 3.7 and Section 3.8). The profiles are shown in Fig. A.05 for the Telstra optical fibre cable alongside the Main Southern Railway, and Figs. A.08 to A.10 for the optical fibre and copper cables along the local roads.

The corresponding maximum predicted incremental subsidence movements due to LW S7A are summarised in Table 3.12 for Yarran Road, Table 3.14 for Caloola Road and Table 3.16 for Remembrance Drive. Maximum predicted total conventional subsidence movements after extraction of LW S7A are summarised in Table 3.13 for Yarran Road, Table 3.15 for Caloola Road and Table 3.17 for Remembrance Drive.

As discussed in relation to the local roads, any additional subsidence movements due to extraction of LW S7A under the *Modified Layout* are slight when compared to the *Approved Layout*, and the locations of the predicted maxima do not change along the alignments of these telecommunications cables.

The NBN telecommunications tower and shed located at No. 3166 Remembrance Drive (access from Yarran Road) will not be directly mined beneath during extraction of LW S7A, however they will experience some additional subsidence movements under the *Modified Layout* when compared to the *Approved Layout*. The maximum predicted incremental subsidence movements due to LW S7A are summarised in Table 3.18

Table 3.18 Maximum predicted incremental conventional subsidence parameters for the NBN telecommunications tower at No. 3166 Remembrance Drive due to the extraction of LW S7A

Longwall	Maximum predicted incremental subsidence (mm)	Maximum predicted incremental tilt (mm/m)	Maximum predicted incremental hogging curvature in any direction (km^{-1})	Maximum predicted incremental sagging curvature in any direction (km^{-1})
Modified Layout				
LW S7A				
Shed	175	1.0	0.01	< 0.01
Tower	175	1.0	0.01	< 0.01

A summary of the maximum predicted total conventional subsidence parameters for the NBN tower and shed for the *Approved Layout* and for the *Modified Layout*, is provided in Table 3.19. Predictions of conventional subsidence, tilt and curvature have been made at the centroid and at points located around the perimeter of the tower and the shed, as well as at points located at a distance of 20 metres from the perimeter of each structure. The predicted tilts are the maxima along and across the structures after the completion of the proposed longwalls. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each longwall.

Table 3.19 Maximum predicted total conventional subsidence parameters for the NBN telecommunications tower at No. 3166 Remembrance Drive

Structure	Maximum predicted total subsidence (mm)	Maximum predicted total tilt (mm/m)	Maximum predicted hogging curvature in any direction (km^{-1})	Maximum predicted sagging curvature in any direction (km^{-1})
Approved Layout				
(after LW S6A)				
Shed	900	3.0	0.05	0.04
Tower	850	2.5	0.04	0.04
Modified Layout				
(after LW S7A)				
Shed	1050	3.5	0.05	0.21
Tower	1050	3.5	0.05	0.22

The NBN telecommunications tower is expected to experience some additional subsidence movements during the extraction of proposed LWs S7A. These are not likely to affect the structural integrity of the tower, although predicted tilts of 3.5 mm/m, while small, may affect the operation of the antennae on top of the structure. The tilts can be readily adjusted by either re-levelling the pole or the individual antennae, if required.

Tahmoor Coal has developed Subsidence Management Plans in consultation with Telstra, NBN and TPG to manage potential impacts on the telecommunications infrastructure due to the extraction of LWs S1A to S6A under the *Approved Layout*. This plan will be updated to include potential impacts due to the extraction of LW S7A under the *Modified Layout*.

With appropriate management plans in place, it is considered that the telecommunications infrastructure will remain safe and serviceable at all times during and after the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

3.9.3. Gas infrastructure

Gas infrastructure located within the Study Area is owned by Jemena and comprises a 150 mm diameter steel main which generally follows the alignment of Remembrance Drive, and a short section of 50 mm nylon pipeline alongside Wellers Road, on the southern boundary of the Study Area. The gas main along Remembrance Drive crosses LWs S1A to S5A but does not cross directly above LW S7A. The nylon gas pipeline alongside Wellers Road also does not cross directly above LW S7A.

The steel gas main along Remembrance Drive therefore would be expected to experience only small additional subsidence movements due to LW S7A following extraction of LWs S1A to S6A. The predicted profiles of conventional subsidence and tilt along the steel gas main beside Remembrance Drive, resulting from the extraction of the proposed longwalls, are shown in Fig. A.11, which is included in Appendix A.

A summary of the maximum predicted incremental conventional subsidence parameters for the Jemena gas main along Remembrance Drive, due to the extraction of S7A, is provided in Table 3.20.

Table 3.20 Maximum predicted incremental conventional subsidence parameters for Jemena Gas Main along Remembrance Drive due to the extraction of LW S7A

Longwall	Maximum predicted incremental subsidence (mm)	Maximum predicted incremental tilt along alignment (mm/m)	Maximum predicted incremental hogging curvature in any direction (km^{-1})	Maximum predicted incremental sagging curvature in any direction (km^{-1})
Modified Layout				
LW S7A	50	< 0.5	< 0.01	< 0.01

A summary of the maximum predicted total conventional subsidence parameters for the Jemena gas main along Remembrance Drive, after the extraction of each longwall, is provided in Table 3.21. The predicted additional subsidence movements due to the extraction of LW S7A are very slight and these are not expected to result in any additional impacts on the gas infrastructure under the *Modified Layout*.

The predicted tilts are the maxima along the alignment of the road after the completion of each longwall. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each longwall.

Table 3.21 Maximum predicted total conventional subsidence parameters for Jemena Gas Main along Remembrance Drive due to the extraction of LWs S1A to S7A

Longwall	Maximum predicted total subsidence (mm)	Maximum predicted total tilt along alignment (mm/m)	Maximum predicted total hogging curvature in any direction (km^{-1})	Maximum predicted total sagging curvature in any direction (km^{-1})
Approved Layout				
LW S1A	325	2.5	0.06	0.06
LW S2A	1000	5.0	0.08	0.20
LW S3A	1200	6.5	0.10	0.21
LW S4A	1300	6.0	0.12	0.21
LW S5A	1350	6.5	0.12	0.21
LW S6A	1375	7.5	0.12	0.21
Modified Layout				
After LW S7A	1400	7.5	0.12	0.21

The nylon gas pipeline alongside Wellers Road also does not cross directly above LW S7A and is predicted to experience less than 20 mm of subsidence. There is extensive experience of mining directly beneath nylon gas pipelines above Tahmoor LWs 22 to 32 where no impacts were experienced. Based on the subsidence predictions and past experiences observed, it is extremely unlikely that the nylon gas pipeline along Wellers Road will experience adverse impacts due to the extraction of the proposed LW S7A.

Tahmoor Coal has developed a Subsidence Management Plan in consultation with Jemena to manage potential impacts on local gas infrastructure due to the extraction of LWs S1A to S2A under the *Approved Layout*. Tahmoor Coal and Jemena are currently developing an updated Subsidence Management Plan to manage potential impacts on local gas infrastructure due to the extraction of LWs S3A to S6A under the *Approved Layout*. This plan will be updated to include potential impacts due to the extraction of LW S7A under the *Modified Layout*.

With an appropriate management plan in place, it is considered that the gas infrastructure will remain safe and serviceable at all times during and after the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

3.9.4. Potable Water infrastructure

The water pipelines within the Study Area are owned and operated by Sydney Water. The potable water infrastructure includes a Cast Iron Cement Lined (CICL) 450 mm diameter watermain which follows the alignment of Remembrance Drive, before crossing beneath the Main Southern Railway just north of Yarran Road and following Great Southern Road. 100 mm and 200 mm diameter Ductile Iron Cement Lined (DICL) water pipelines are located along Caloola Road, Yarran Road and along a short section Remembrance Drive to the south of the railway crossing. The types of pipeline within the Study Area are mainly DICL and CICL, with short sections of Steel Cement Lined (SCL) beneath road crossings.

The predicted profiles of conventional subsidence, tilt and curvature along the water pipelines following the alignment of local roads are as predicted for these roads themselves (see Section 3.8). The profiles are shown in Figs. A.08 to A.10 in Appendix A, while maximum predicted incremental subsidence movements due to LW S7A are summarised in Table 3.12 for Yarran Road, Table 3.14 for Caloola Road and Table 3.16 for Remembrance Drive. Maximum predicted total conventional subsidence movements after extraction of LW S7A are summarised in Table 3.13 for Yarran Road, Table 3.15 for Caloola Road and Table 3.17 for Remembrance Drive.

As discussed in relation to the local roads, any additional subsidence movements due to extraction of LW S7A under the *Modified Layout* are slight when compared to the *Approved Layout*, and the locations of the predicted maxima do not change along the pipelines.

Tahmoor Coal and Sydney Water have implemented extensive measures to manage potential impacts on potable water infrastructure due to the extraction of LWs S1A to S6A under the *Approved Layout*, in accordance with a Subsidence Management Plan. This plan will be updated to include potential impacts due to the extraction of LW S7A under the *Modified Layout*.

With an appropriate management plan in place, it is considered that the potable water infrastructure will remain safe and serviceable at all times during and after the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

3.9.5. Sewer infrastructure

The sewer infrastructure within the Study Area is owned and operated by Sydney Water, and comprises a 180 mm diameter pressure main along Remembrance Drive. The sewer pressure main crosses LWs S1A to S5A but does not cross directly above LW S7A. There is no further sewer reticulation network along the local roads within the Study Area for the *Modified Layout*. The sewerage system was designed to accommodate mine subsidence movements and consists of polyethylene (PE) pipelines.

The predicted profiles of conventional subsidence, tilt and curvature along the sewer pressure main following the alignment of Remembrance Drive are as predicted for Remembrance Drive (see Section 3.8). The profiles are shown in Fig. A.10 in Appendix A. The maximum predicted incremental subsidence movements along Remembrance Drive due to LW S7A are summarised in Table 3.16 and the maximum predicted total conventional subsidence movements after extraction of LW S7A are summarised in Table 3.17.

As discussed in relation to Remembrance Drive, any additional subsidence movements due to extraction of LW S7A under the *Modified Layout* are slight when compared to the *Approved Layout*, and the locations of the predicted maxima do not change along the pipelines.

Tahmoor Coal and Sydney Water have implemented extensive measures to manage potential impacts on the sewer infrastructure due to the extraction of LWs S1A to S6A under the *Approved Layout*, in accordance with a Subsidence Management Plan. This plan will be updated to include potential impacts due to the extraction of LW S7A under the *Modified Layout*.

With an appropriate management plan in place, it is considered that the sewer infrastructure will remain safe and serviceable at all times during and after the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

3.10. Picton Weir

3.10.1. Description and location

The Picton Weir is located on the Bargo River just downstream of the confluence with Hornes Creek. The weir was constructed in the late 19th century and it was built to provide water to the surrounding townships. It is now heavily silted and is no longer used for water supply. Water retained by the weir is released at its base through a seized open valve and outlet pipe. Photographs of the Weir, taken in September 2023, are shown in Fig. 3.27.

Photograph courtesy MNC Consulting

Fig. 3.27 Close up view of Picton Weir

Photograph courtesy MNC Consulting

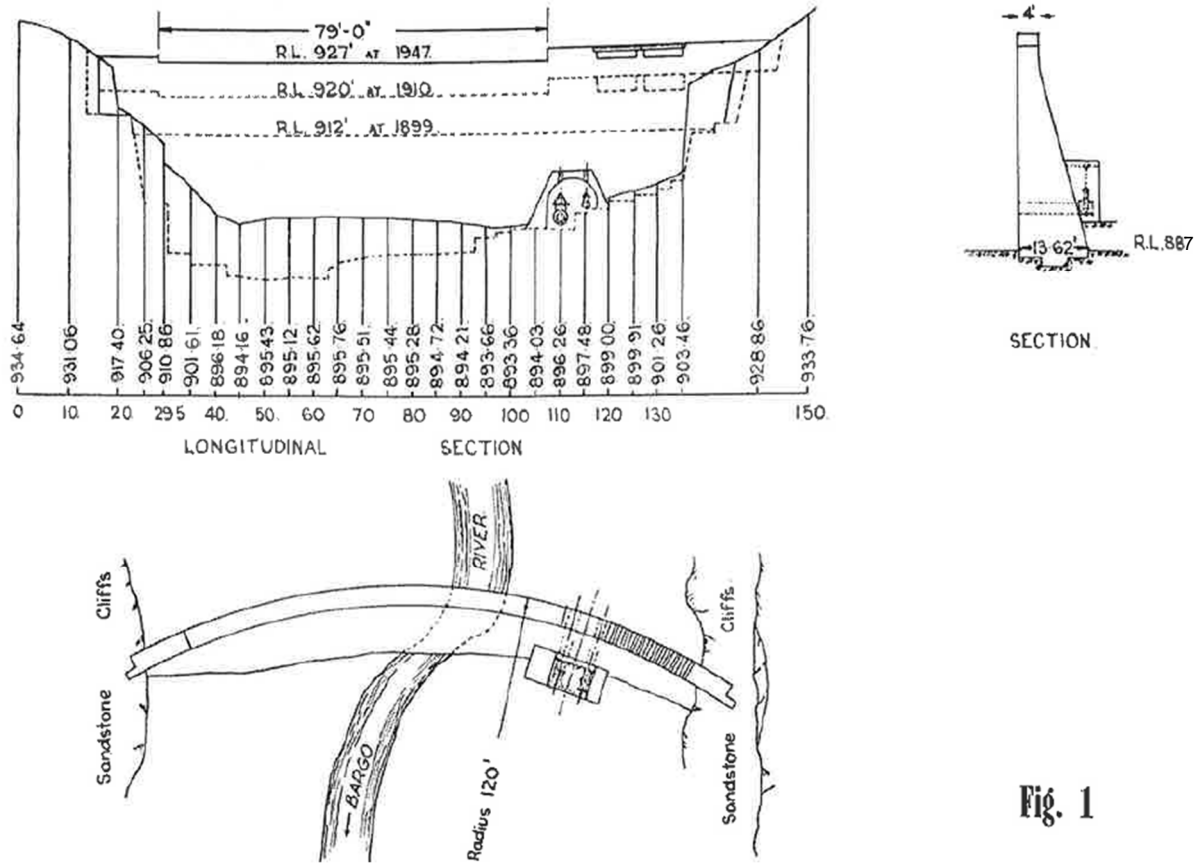
Fig. 3.28 Wide angle view of Picton Weir

The Picton Weir is located approximately 605 metres from LW S7A at its closest point. As shown in Fig. 3.29, LW S7A is proposed to approach the Weir from the southeast but stops approximately 75 metres before it is directly square with the Weir. No impacts were reported on the Picton Weir during the mining of previously extracted Longwalls 14 to 19, the closest of which was approximately 1.5 kilometres from the Weir (Longwall 19).

Fig. 3.29 Location of Picton Weir relative to LW S7A

The Picton Weir was constructed in 1899 at RL 912 (Imperial units) (Haigh, 1954). The level was raised by 8 ft to RL 920 in 1910 and raised a further 7 ft in 1947 to RL 927. Drawings describing the weir's dimensions were provided by Haigh (1954) and are produced in Fig. 3.30. The lowest foundation level at RL 887 was reported by the Picton Post (1945) to be a few feet below the river bed level.

Worley Consulting have found a reasonable correlation between the elevations shown in Fig. 3.30 and a photogrammetry survey of the Weir by MNC Consulting, allowing for the fact that the foundation level of RL 887 is below the river bed and water that is pooling at the downstream base of the Weir.



Source: Haigh (1954) from Sydney Water Board Journal

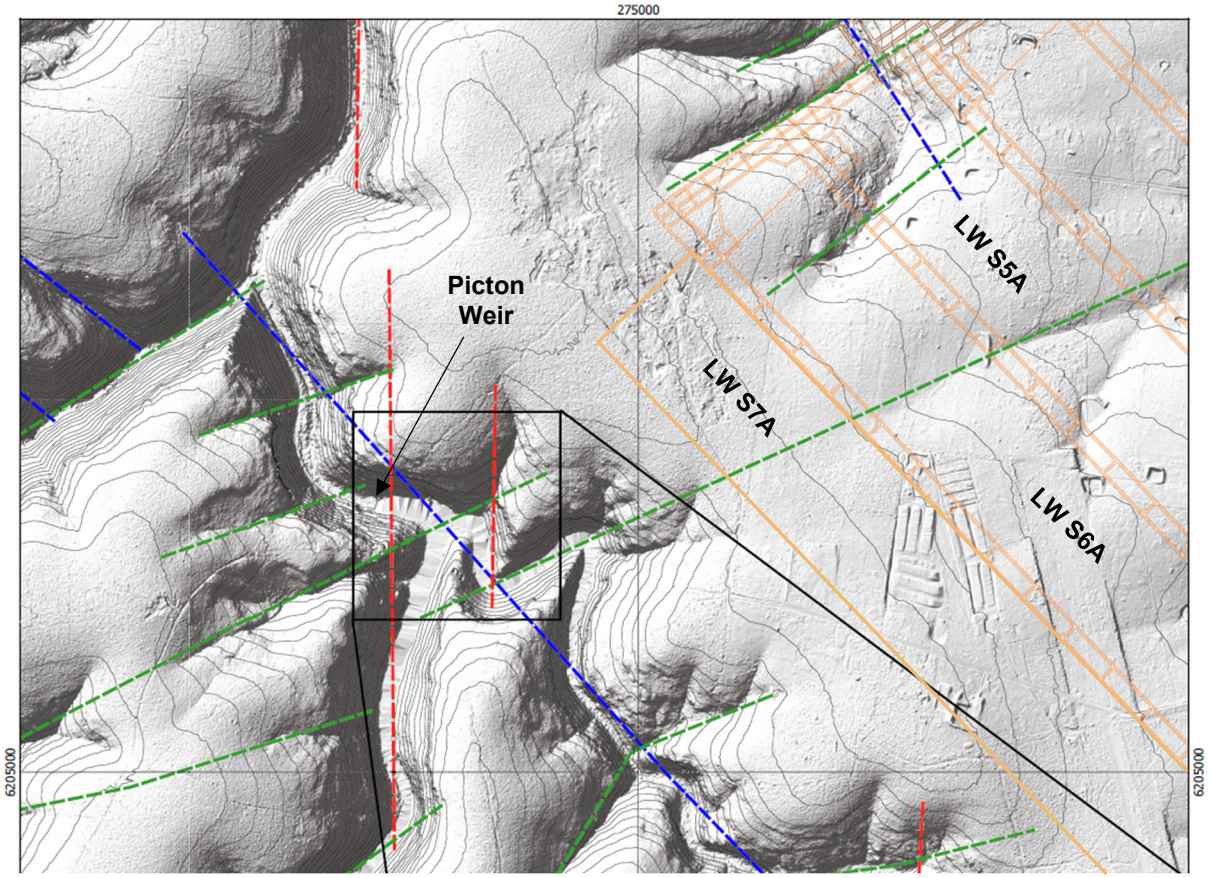
Fig. 3.30 Construction drawings of Picton Weir

3.10.2. Geotechnical assessment

Tahmoor Coal has engaged geotechnical engineer PSM (2023) to conduct a geotechnical investigation and assessment of the rock mass surrounding the Picton Weir. The investigation includes a review of available geological, geomorphological and mining reports, identification of potential geological structures, site inspections and logging and interpretation of two vertical boreholes that have been drilled by Tahmoor Coal on either side of Picton Weir.

Picton Weir near the Central Fault complex, which lies to the south and west of the proposed LW S7A. The fault was described by MBGS (2013) and PSM (2023) as a normal fault trending northwest with vertical displacement up to 20 metres, east side up (laying over the west side). The fault was identified in the 2D seismic lines and was also intercepted in one drill hole (JB06) where the Wongawilli Seam has been displaced. The fault was not observed by PSM during the geological field mapping and the boreholes did not intercept it.

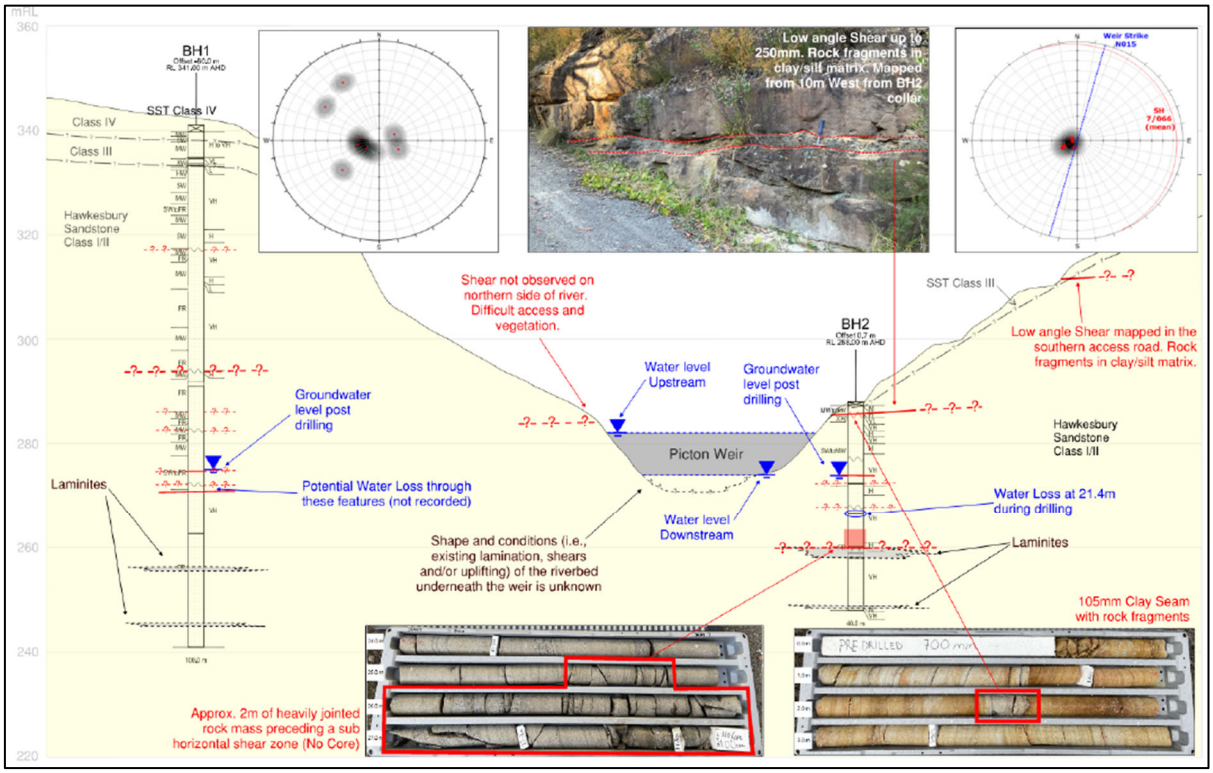
The Gordon Geotechniques (2013) report advised that the Central Fault zone was associated with a number of features including a change in Bulli Seam fluidity and thinning of the Balgownie to Bulli Seam interburden. The downstream part of Hornes Creek follows the surface expression of the Central Fault. PSM (2023) advised that the double kink in Hornes Creek, upstream of the Picton Weir could be attributable to conjugated lineaments sub-perpendicular to the Central Fault complex, as shown in Fig. 3.31.



Source: Marked up extract from Figure 3 of PSM (2023) to include LW S7A

Fig. 3.31 PSM Lineament Assessment (PSM, 2023)

PSM (2023) has developed a conceptual geological model based on the results of field investigations and borehole mapping. A cross-section through the Weir structure is reproduced in Fig. 3.32.



Source: Figure 5 of PSM (2023)

Fig. 3.32 PSM Conceptual Geological Model – Cross Section through Picton Weir (PSM, 2023)

The key findings of the assessment by PSM (2023) are summarised below.

- The ground conditions encountered are consistent with those associated with natural valley bulging;
- Low angle shears were observed in both boreholes and mapped from field investigations. There does not appear to be persistence of any single structure that is continuous beneath the entire width of the Weir;
- Initial groundwater readings suggest that current levels are lower than expected in a valley of this depth, which suggests that there is a network of interconnected structures that cause water levels to drain rapidly towards the valley;
- There is, therefore, a potential for movement along sub-horizontal bedding and, in particular, along low angle shears in response to mining-induced valley closure and upsidence. Concentrated movements along a single defect, however, appears unlikely.
- There is also a potential for movement along sub-vertical joints and/or cross begging in response to mining-induced valley closure and upsidence. The movements are likely to be limited due to the low persistence of sub-vertical joints that generally terminate against bedding partings and shears. Movements along cross bedding is possible but likely where defects are already showing some dilation, such as those observed at the base of the abutments.

3.10.3. Subsidence predictions

The Picton Weir is located approximately 605 metres from LW S7A at its closest point. The Weir is located outside the predicted limit of subsidence and is, therefore, predicted to experience negligible conventional subsidence movements.

Predictions of non-conventional valley closure and upsidence movements along the Bargo River were provided in Section 3.2. As shown in Fig. A.02, the Bargo River is predicted to experience less than 20 mm of incremental valley closure and upsidence at the Picton Weir due to the proposed extraction of LW S7A.

A summary of the predicted values of incremental vertical subsidence, upsidence and closure at the Picton Weir on the Bargo River is provided in Table 3.22 and the predicted total values of vertical subsidence, upsidence and closure at the Picton Weir is provided in Table 3.23.

Table 3.22 Predicted incremental vertical subsidence, upsidence and closure at Picton Weir

Layout	Longwall	Predicted incremental vertical subsidence (mm)	Predicted incremental upsidence (mm)	Predicted incremental closure (mm)
Modified Layout	LW S7A	< 20	< 20	< 20

Table 3.23 Predicted total vertical subsidence, upsidence and closure at Picton Weir

Layout	Longwall	Predicted total vertical subsidence (mm)	Predicted total upsidence (mm)	Predicted total closure (mm)
Approved Layout	After LW S6A	< 20	< 20	< 20
Modified Layout	After LW S7A	< 20	20	< 20

3.10.4. Statistical analyses of valley closure movements at Picton Weir

Statistical analyses of previously measured valley closure in the Southern Coalfield have been conducted based on monitoring data from Tahmoor Colliery and nearby Appin and West Cliff Collieries, where depths of cover and extraction heights are similar to those proposed for LW S7A. The results of the statistical analyses are described in Section 3.3 of this report and can be applied to the Picton Weir.

It is noted, however, that LW S7A is proposed to be extracted up to but stop short of the Weir, while the analyses includes sites where previously extracted longwalls had mined past them. The analyses, therefore, are expected to provide a conservative assessment.

Observed incremental valley closure at sites located above solid, unmined coal, are shown relative to their distances from the maingate edges of previously extracted longwalls in Fig. 3.13. A total of 2390 measurements have been plotted, sorted into groups based on valley depths that are greater than or less than 40 metres. Where surveys were conducted on multiple occasions during the extraction of a longwall, only the maximum measured incremental closure for each longwall has been plotted.

The confidence levels, based on fitted *Generalised Pareto Distributions* (GPDs), have also been shown in Fig. 3.13 to illustrate the spread of the data. The GPD and confidence levels have been calculated without filtering the data based on valley depths, nor the locations of the sites relative to the sides or ends of the longwalls.

A summary of the probabilities of exceedance for valley closure for survey bays at distance that is relevant to the distance between the Picton Weir and LW S7A, based on the fitted General Pareto Distribution function, is provided in Table 3.24.

Table 3.24 Probabilities of exceedance for valley closure for survey bays located at distance of 600 m from the nearest goaf edge in the Southern Coalfield

Statistical parameter	Probability of Exceedance	Incremental valley closure (mm)
Offset distance from maingate of active LW of 600 m	1 in 2.5 (0.4)	5
	1 in 3.3 (0.3)	7
	1 in 5 (0.20)	9
	1 in 10 (0.10)	12
	1 in 20 (0.05)	16
	1 in 100 (0.01)	26

When compared against the ACARP prediction of maximum incremental closure of <20 mm, it can be seen that the prediction of valley closure is reasonably conservative.

An alternative statistical approach was conducted to check the fitted confidence level curves that are shown in Fig. 3.13. A histogram showing the distribution of observed valley closure for a subset of sites that were located between 450 metres and 750 metres from the maingate side of previously extracted longwalls is shown in Fig. 3.33.

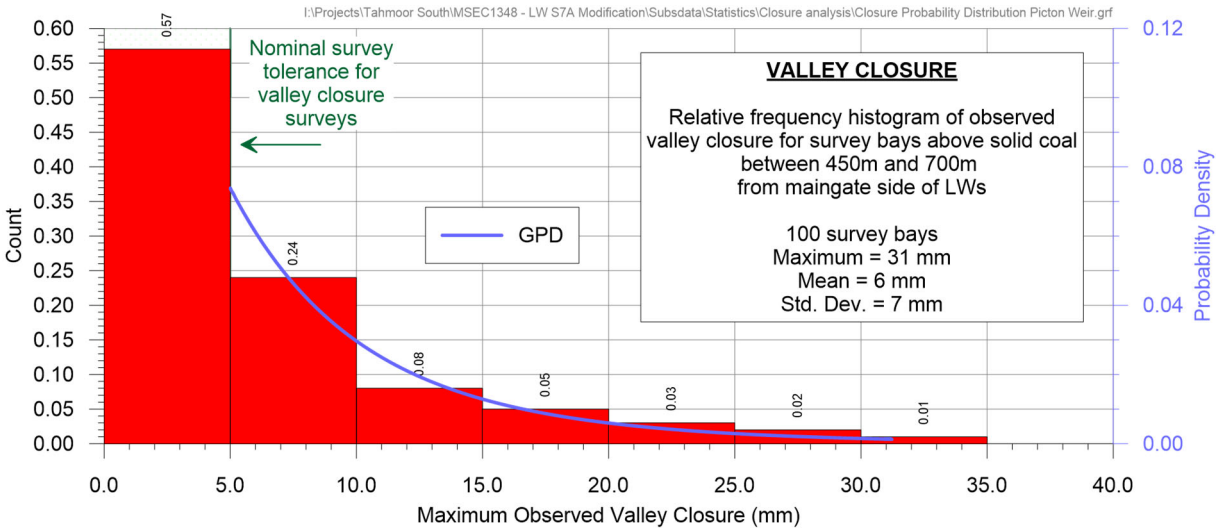


Fig. 3.33 Frequency distribution of observed valley closure for survey bays between 450m and 750m from maingate side of previously extraction LWs in Southern Coalfield

The average measured closure within the dataset was 6 mm and maximum observed closure was 31 mm, with 95 % of sites recording less 21 mm of closure and 99 % of sites recording less than 29 mm of closure. The results compare reasonably well with the values in Table 3.24.

As discussed in Section 3.3 of this report, the reason for the more conservative prediction by the ACARP method can be explained by the way in which the ACARP normalises the offset distances by dividing them by the sum of the longwall panel width and chain pillar width.

Observed incremental valley closure at sites located above solid, unmined coal, are shown relative to their normalised distances from the maingate edges of previously extracted longwalls in Fig. 3.15.

A summary of the probabilities of exceedance for valley closure for survey bays at a normalised distance that is relevant to the normalised distance between the Picton Weir and LW S7A, based on the fitted General Pareto Distribution function, is provided in Table 3.25.

Table 3.25 Probabilities of exceedance for valley closure for survey bays located at normalised distance of 1.875 from the nearest goaf edge in the Southern Coalfield

Statistical parameter	Probability of Exceedance	Incremental valley closure (mm)
Normalised Offset distance from maingate of active LW / (LW width + pillar width) of 600/(283+37) = 1.875	1 in 2.5 (0.4)	2.5
	1 in 3.3 (0.3)	10
	1 in 5 (0.20)	14
	1 in 10 (0.10)	22
	1 in 20 (0.05)	32
	1 in 100 (0.01)	64

When compared against the ACARP prediction of maximum incremental closure of <20 mm, it can be seen that the prediction of valley closure is conservative but less when compared to statistical analyses based on distances that are not normalised.

Closer examination of the statistical analyses found that the calculated confidence levels based on normalised distances were influenced by two outliers, which relate to recently observed closure during the mining of Tahmoor LW W3 and LW W4 across Stonequarry Creek at the Victoria Bridge and a Retaining Wall at 84.687 km on the Main Southern Railway. The observations are discussed in the following section.

3.10.5. Case study of observed valley closure movements during the mining of LW W1-W4

While the statistical analyses show that the valley closure prediction at Picton Weir is likely to be conservative, the empirical data presented in Fig. 3.13 and Fig. 3.15 shows that there are two outliers at distances greater than 600 metres from previously extracted longwalls. These relate to recently observed closure during the mining of Tahmoor LW W3 and LW W4 across Stonequarry Creek at the Victoria Bridge and a Retaining Wall at 84.687 km on the Main Southern Railway.

The case study is relevant to the extraction of LW S7A to the side of the Picton Weir as both sites involve a regionally significant valley (Stonequarry Creek compared to Bargo River) and both are located near a major geological fault system (Nepean Fault compared to the Central Fault).

Tahmoor Coal extracted LW W1-W4 in the Western Domain, which is located to the west of the township of Picton. LW W1-W4 were extracted between November 2019 and September 2022.

LW W1-W4 were bounded by Stonequarry Creek to the north, Matthews and Cedar Creek to the west, previously extracted LWs 22 to 32 to the south, and the Main Southern Railway, Stonequarry Creek and the Nepean Fault complex to the east. A map showing the location of LW W1-W4 relative to these features is provided in Fig. 3.34. The longwall panels were extracted from north to south.

Valley closure was observed to gradually develop across Stonequarry Creek between the bridge abutments and piers at Victoria Bridge and across Stonequarry Creek at the Retaining Wall at 84.867 km during the mining of LW W3 and LW W4. The closure commenced when the western abutment, closest to the longwalls, no longer moved in concert with the eastern abutment towards the longwalls and started to move northeast into the valley. The observed valley closure coincided with:

- Observed absolute horizontal movement of Thirlmere Way Underbridge and Connellan Crescent Overbridge in a north-easterly direction away from LWs W1-W4 and LW32 (refer Fig. 3.34 and Fig. 3.35);
- Observed absolute horizontal movement in a north-easterly direction at survey pegs spaced every 20 metres along the Main Southern Railway from 89.5 km (south of Thirlmere Way Underbridge) to the north beyond Connellan Crescent Overbridge, away from LWs W1-W4 and LW32. The magnitude of horizontal movements diminished along the railway corridor to the north, transitioning gradually between approximately 88.6 km and 88.8 km, such that measured ground strains and changes over long bay lengths did not result in measurable changes in rail stress on the track, with minor lateral shearing across the railway corridor at 88.750 km.

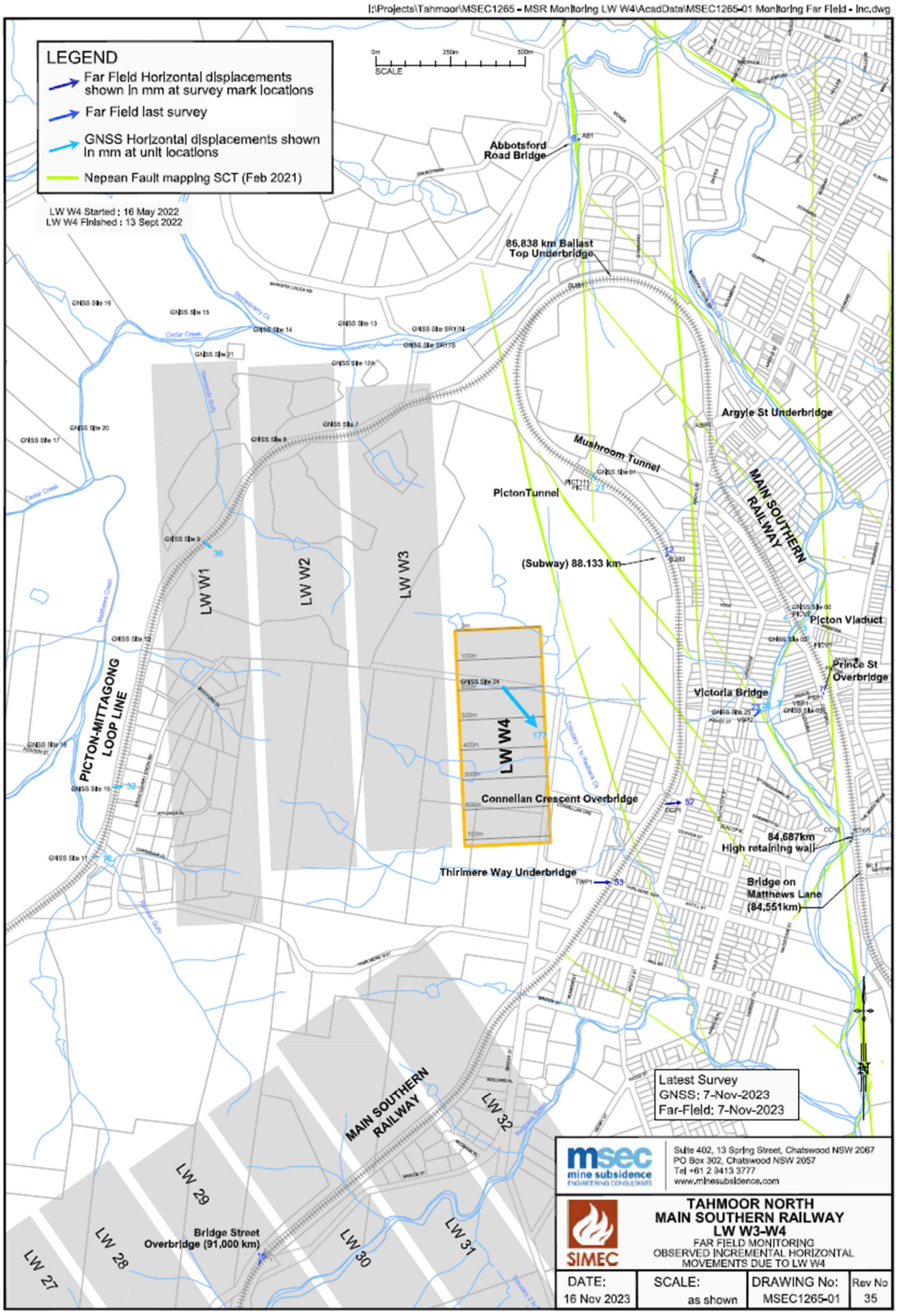


Fig. 3.34 Observed incremental horizontal movements during the mining of LW W4

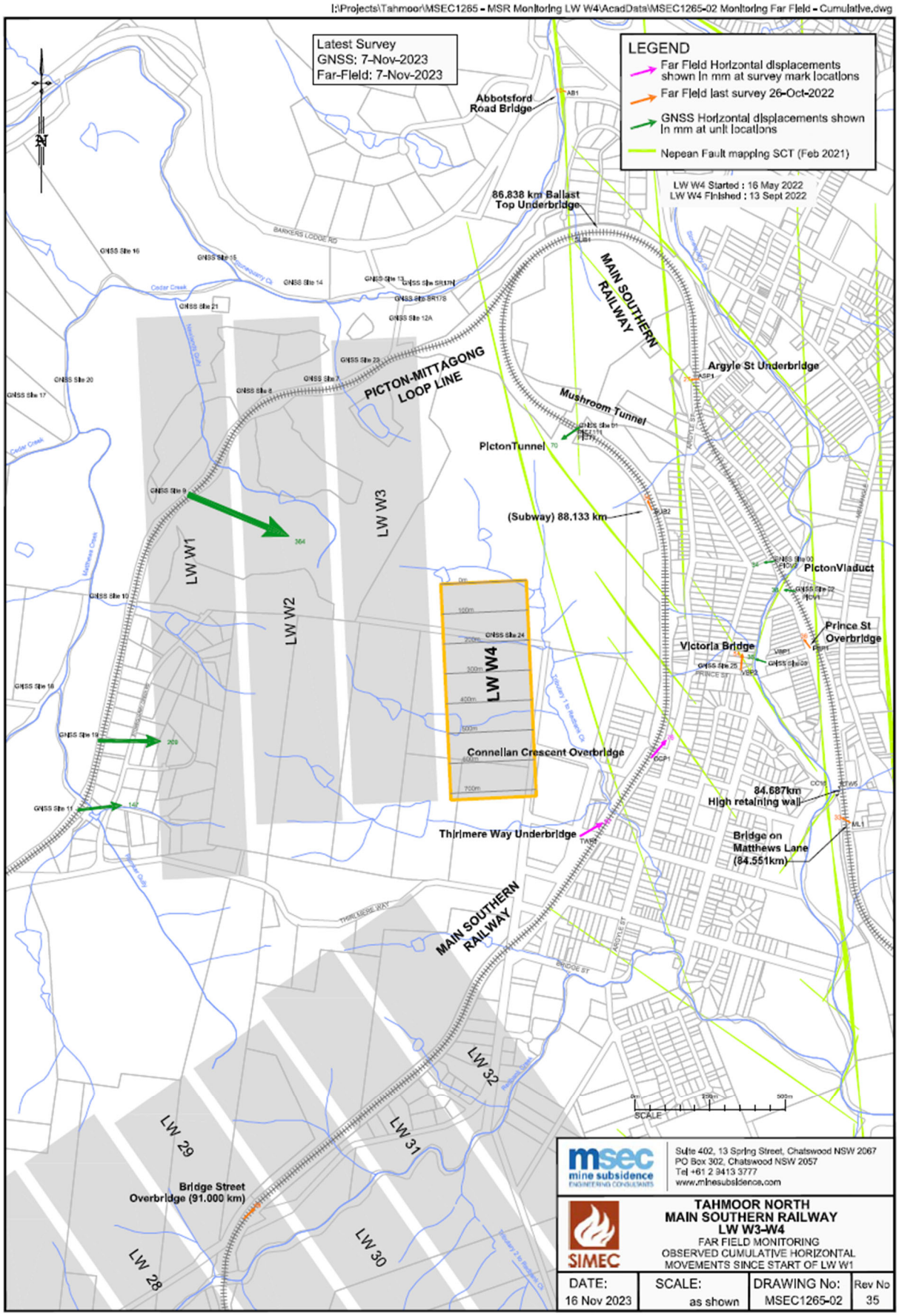


Fig. 3.35 Observed total horizontal movements during the mining of LW W1-W4

The observed development of valley closure across Stonequarry Creek at Victoria Bridge is shown in Fig. 3.36. The distances between Victoria Bridge from the maingate edges of each longwall are annotated on the graph.

The Retaining Wall at 84.867 km was monitored by Tahmoor Coal at the request of the Australian Rail Track Corporation during the mining of LW W1-W4. The main purpose of the surveys was to confirm that the wall was not deforming in response to differential far field movements. The survey consisted of a series of survey marks mounted on the wall, which were surveyed from the opposite side of Stonequarry Creek. The survey was measured in relative 3D coordinates and did not measure changes in the absolute 3D position of the survey marks.

While no measurable differential movements were observed between the marks on the wall, the measured distances between the wall and a survey mark on the opposite side of Stonequarry Creek gradually closed.

The observed development of valley closure across Stonequarry Creek at Retaining Wall at 84.867 km is shown in Fig. 3.37. The distances between the Retaining Wall from the maingate edges of each longwall are annotated on the graph.

Approximately 300 metres upstream (northeast) of Victoria Bridge, Tahmoor Coal extensively monitored changes at the Picton Viaduct during the mining of LWs 31, 32 and LW W1-W4. No measurable differential movements were observed across or along the Viaduct. A summary graph showing the observed changes in horizontal distances between two GNSS units on either side end of the Viaduct across Stonequarry Creek is shown in Fig. 3.38. Less than 10 mm of valley closure was observed, which is close to survey tolerance, taking into account that the GNSS units were installed in 2018. While the installed units were the best available at the time, GNSS technology has improved with later models.

The key lessons from the case study are provided below.

- Valley closure developed at the Victoria Bridge and Retaining Wall at a considerable distance away from LW W3 and LW W4. The represent outliers within the Southern Coafield empirical database.
- LW W4 was relatively short in length and incremental valley closure would likely have been greater if LW W4 had been longer, particularly at the Retaining Wall as the longwall panels were not extraction south of them.
- LW W4 was also the last longwall to be extracted in this mining domain. Valley closure would likely have continued to develop at a greater magnitude if additional longwalls had been extracted closer to the monitoring sites.
- The observed closure, however, only developed along one arm of Stonequarry Creek, where less than 10 mm of valley closure was observed where the Picton Viaduct crosses Stonequarry Creek, 300 metres upstream of Victoria Bridge.
- The observed valley closure movements coincided with an observation of horizontal movements towards Stonequarry Creek, away from the longwall mining area.
- The observed horizontal movements and valley closure developed gradually during mining.

The case study is a reminder that while the prediction model for valley closure is generally conservative, actual valley closure movements can sometimes exceed predictions. The movements can, however, be detected early as each successive longwall approaches Picton Weir. The potential for greater than predicted movements is considered when conducting impact assessments for the Picton Weir.

Tahmoor Coal is currently monitoring ground movements at Picton Weir and along Hornes Creek according to the Subsidence Monitoring Plan. The monitoring locations are shown in Drawing No. MSEC1348-15.

- A pair of GNSS units have been installed at the tops of the Bargo River at each end of the Picton Weir. The GNSS units have continuously monitored changes during mining since the commencement of LW S1A. While the GNSS units have measured minor horizontal movements towards the active mining area, changes in horizontal distances between the units are less than 5 mm and within survey tolerance.
- Six GNSS units have been installed along the tops of Hornes Creek in pairs across the valley. The GNSS units have continuously monitored changes during mining since the commencement of LW S2A. While the GNSS units have measured minor horizontal movements towards the active mining area, changes in horizontal distances between the units are less than 5 mm and within survey tolerance.

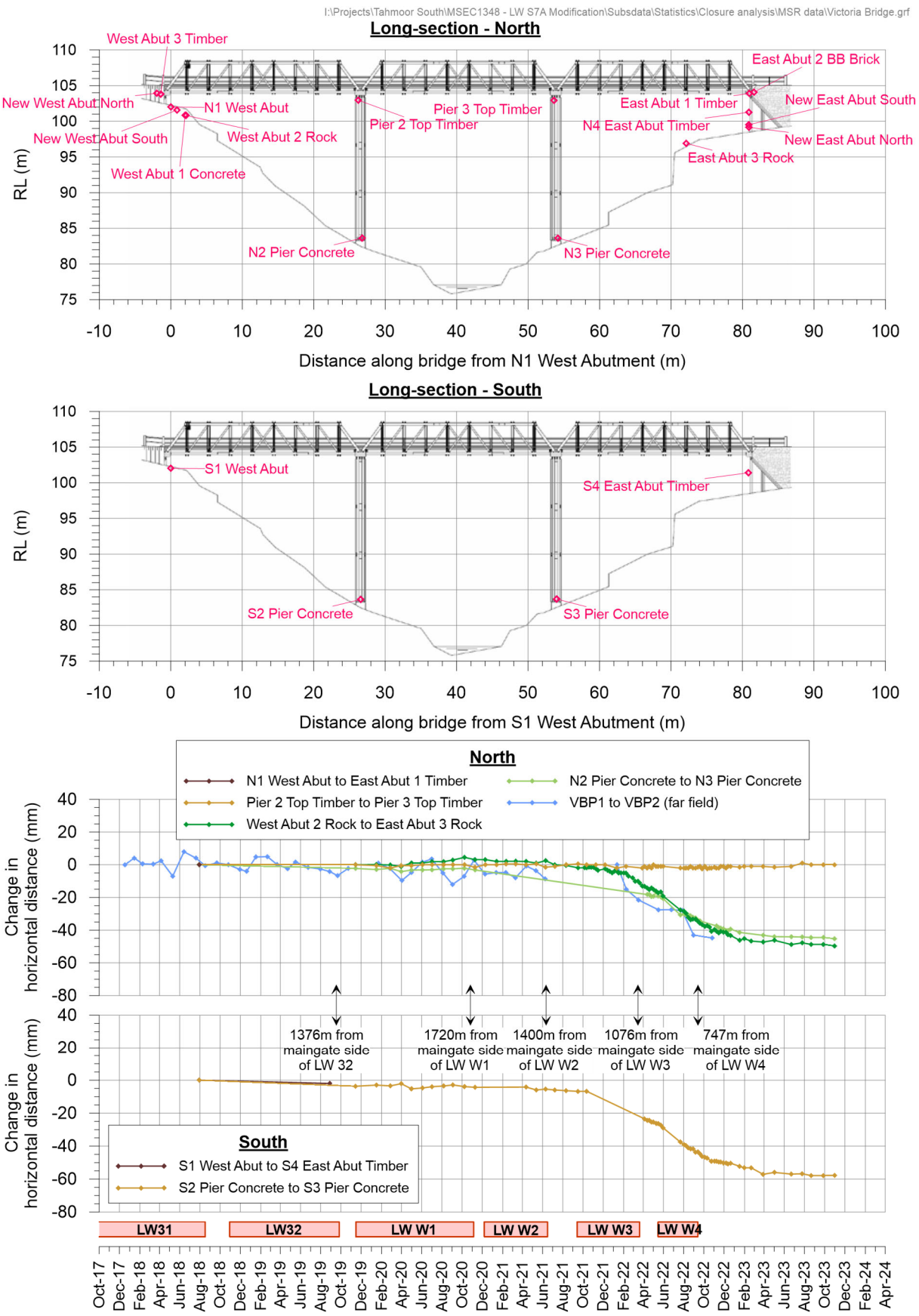


Fig. 3.36 Observed development of closure across Stonequarry Creek at Victoria Bridge during the mining of LWs 31, 32 and LW W1-W4

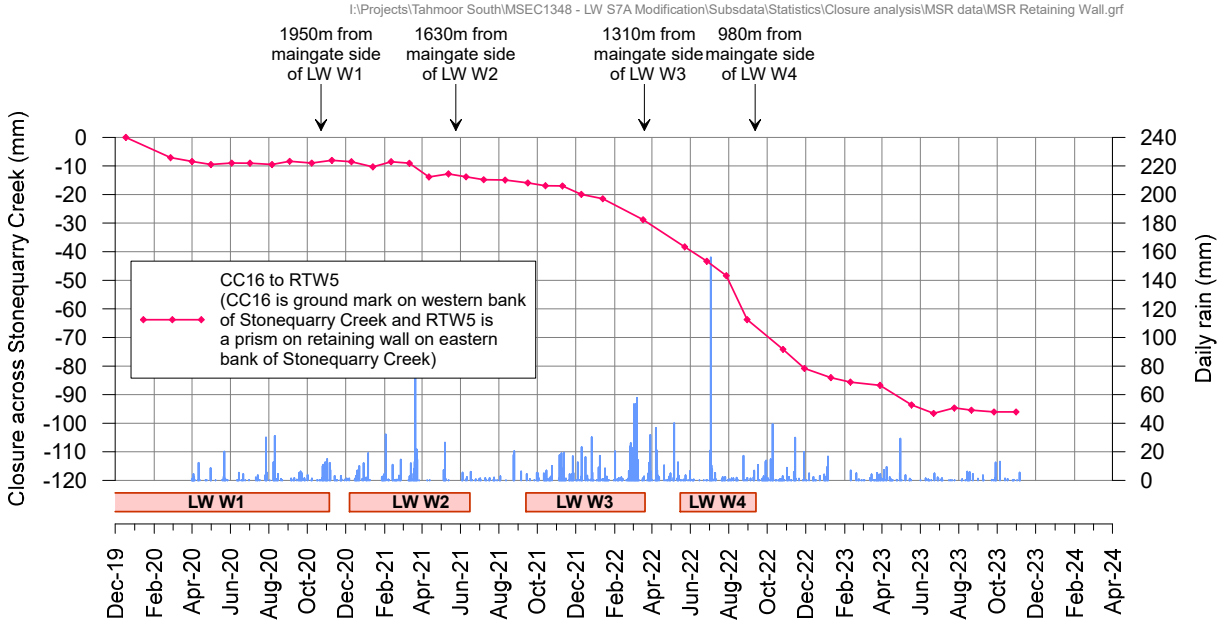


Fig. 3.37 Observed development of closure across Stonequarry Creek at Retaining Wall at 84.687 km on the Main Southern Railway during the mining of LW W1-W4

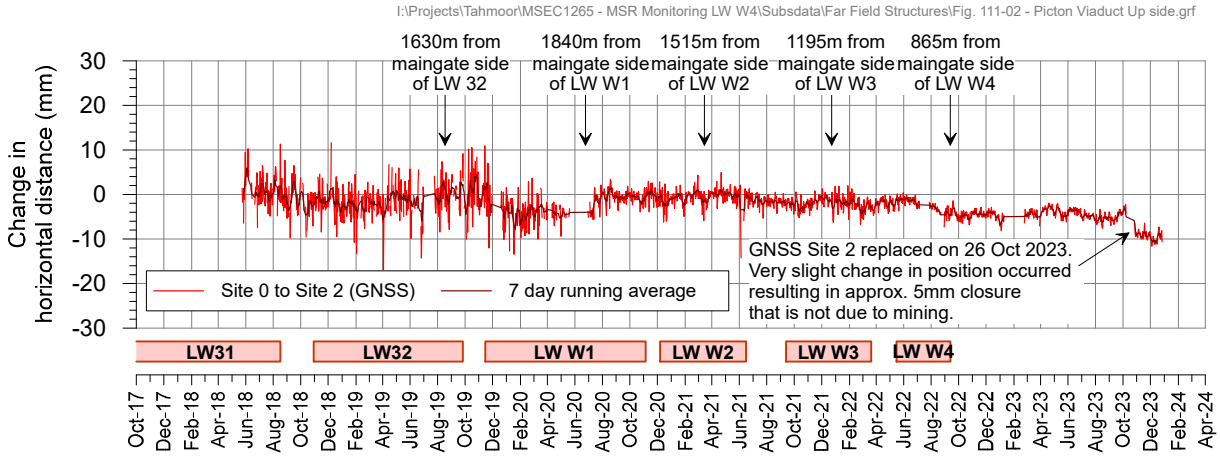


Fig. 3.38 Observed changes in horizontal distance across Stonequarry Creek at Picton Viaduct on the Main Southern Railway during the mining of LWs 31, 32 and LW W1-W4

3.10.6. Managing potential far field impacts on the Picton Weir

Tahmoor Coal has engaged Worley Consulting to develop a 3D structural model of the Weir, to assess its existing condition and assess potential structural impacts from potential mine subsidence movements. The assessment includes a sensitivity analysis that incrementally assesses the effects of valley closure at values up to and greater than predictions.

Tahmoor Coal is currently consulting with Wollondilly Shire Council to develop a Subsidence Management Plan to manage the potential for impacts to the Picton Weir due to the extraction of LWs S1A to S6A under the *Approved Layout*. This plan will be updated to include potential impacts due to the extraction of LW S7A under the *Modified Layout*.

Tahmoor Coal is currently developing management measures to ensure that it remains safe throughout the mining period and that impacts on the Picton Weir do not result in environmental consequences on the Bargo River due to the extraction of LWs S3A to S7A. The study requires input from structural, geotechnical and subsidence engineers. The management measures may include a combination of:

- Mitigation or strengthening measures prior to mining;
- Installation of a monitoring system, which includes, among other things:
    - GNSS monitoring at both ends of the Picton Weir (Sites S13 and S14, both installed),
    - GNSS monitoring at a location between LWs S1A to S7A and the Picton Weir (Site S19, installed);
    - GNSS monitoring at three pairs across Hornes Creek (Sites S20 to S25, installed);
    - Survey marks on rockfaces on both sides of the Picton Weir (installed);
    - Survey marks on the Picton Weir (to be installed prior to start of LW S3A);
    - Photogrammetric survey of shape of dam wall and surrounding rockfaces on both sides of the Picton Weir (baseline survey completed);
    - Vertical inclinometers in boreholes at mine side of the Picton Weir (boreholes drilled, inclinometer tubing to be installed prior to start of LW S3A);
    - Groundwater level monitoring in vertical inclinometers at mine side of the Picton Weir (to be installed prior to start of LW S3A);
    - Water level monitoring upstream of Picton Weir (to be installed prior to start of LW S3A);
    - Detailed visual inspection of Picton Weir and surrounding rockfaces by UAV (baseline inspection completed); and
    - Visual inspections during mining.
    - Install crack monitoring of existing gauges
- Conduct regular visual inspections of the Picton Weir; and
- Implement planned responses if triggered by monitoring and inspections.

As Tahmoor Mine will progressively approach the Picton Weir, it will be possible to review observations during the mining of each longwall and adjust the mine plan, if necessary to reduce the potential for impacts on Picton Weir. Picton Weir is also located beyond the finishing ends of the longwalls and it will be possible to stop the longwall face early, if necessary based on actual monitoring observations.

With an appropriate management plan in place, it is considered that the Picton Weir will remain safe and serviceable at all times due to the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

3.11. Rural structures

3.11.1. Descriptions of the rural structures

The locations of the rural structures (Structure Type R) within the Study Area are shown in Drawing No. MSEC 1348-11.

There are 276 rural structures which have been identified on private properties within Study Area, of which 48 structures (17 % of the total number of rural structures) will be mined directly beneath by the proposed LW S7A. There are a further 145 rural structures within the Study Area which will be mined directly beneath by longwalls S1A to S6A under the *Approved Layout*. The rural structures include sheds, garages, carports, gazebos, pergolas, greenhouses, shade structures and other non-residential structures. The locations and sizes of the rural structures were determined from aerial photographs of the area.

3.11.2. Predictions for rural structures

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and at the vertices of each rural structure, as well as at eight equally spaced points placed radially around the centroid and vertices at a distance of 20 metres. In the case of a rectangular shaped structure, predictions have been made at a minimum of 45 points within and around the structure.

A summary of the maximum predicted values of incremental conventional subsidence, tilt and curvature for each of the rural structures within the Study Area due to extraction of LW S7A is provided in Table C.04, in Appendix C. A summary of the maximum predicted values of total conventional subsidence, tilt and curvature for each of the rural structures within the Study Area after extraction of LWs S1A to S7A is also provided in Table C.04. The predicted tilts provided in this table are the maxima in any direction after the completion of each longwall. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each longwall.

Distributions of the maximum predicted incremental conventional subsidence and tilt for the rural structures due to extraction of LW S7A are illustrated in Fig. 3.39, while Fig. 3.40 shows the corresponding distributions of maximum predicted total conventional subsidence and final tilt after extraction of LWs S1A to S7A under the *Modified Layout*.

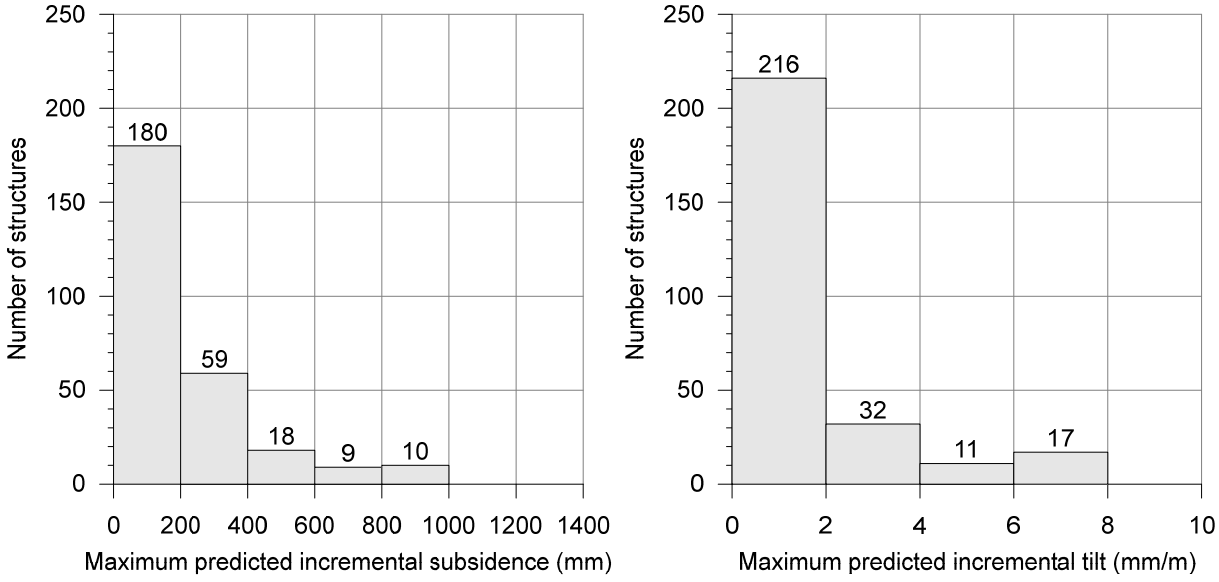


Fig. 3.39 Maximum predicted incremental conventional subsidence and tilt for the rural structures within the Study Area due to extraction of LW S7A

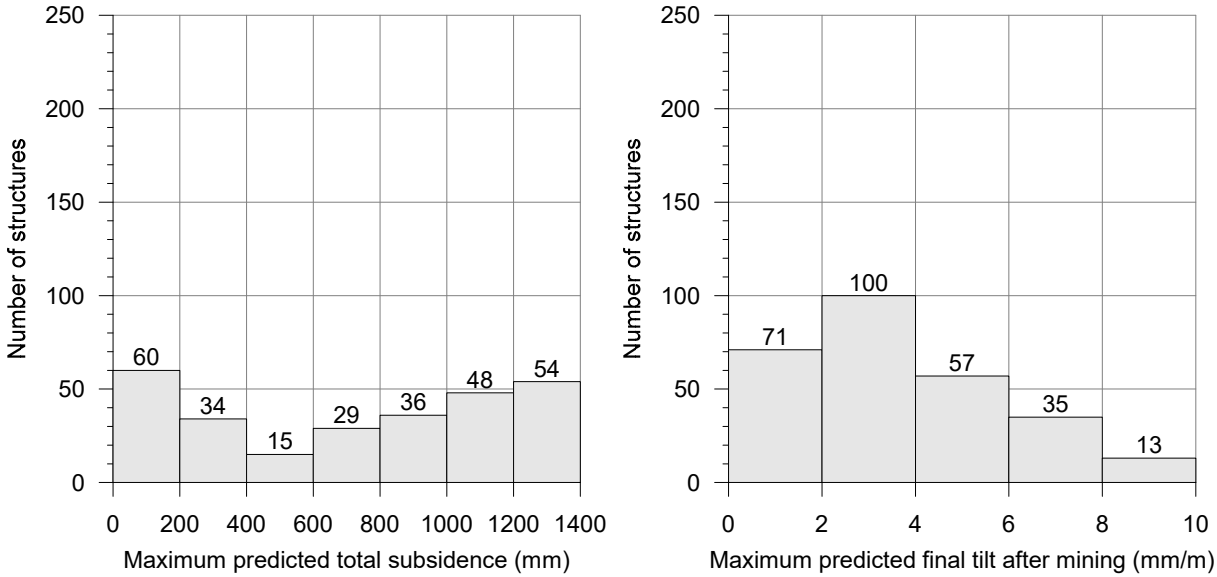


Fig. 3.40 Maximum predicted total conventional subsidence and tilt for the rural structures within the Study Area after extraction of LWs S1A to S7A

These distributions indicate that for a large number of the rural structures in the Study Area (180 out of 276 structures, or 65% of the total), the maximum predicted incremental subsidence due to LW S7A is less than 200 mm and thus a relatively small proportion of the maximum predicted total subsidence after extraction of LWs S1A to S7A. Similarly, the maximum predicted incremental tilt due to LW S7A is relatively small (< 2 mm/m) for most structures in the Study Area (216 out of 276 structures, or 78% of the total).

Distributions of the maximum predicted incremental conventional hogging and sagging curvatures for the structures due to extraction of LW S7A are illustrated in Fig. 3.41, while Fig. 3.42 shows the corresponding distributions of maximum predicted total conventional hogging and sagging curvatures after extraction of LWs S1A to S7A under the *Modified Layout*.

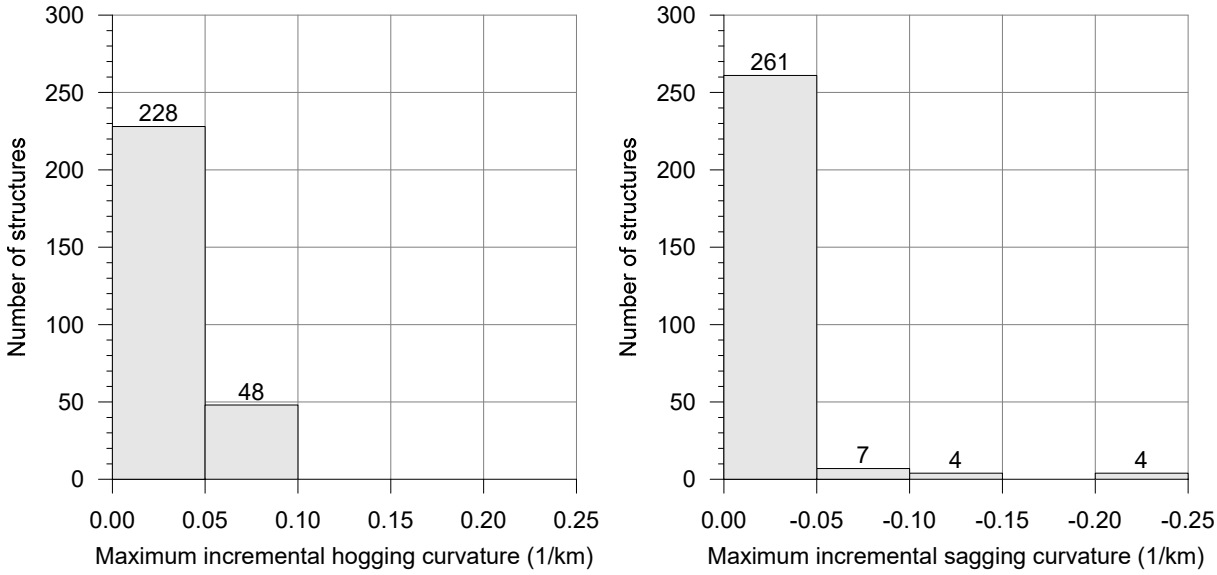


Fig. 3.41 Maximum predicted incremental conventional hogging curvature (left) and sagging curvature (right) for the farm dams within the Study Area due to extraction of LW S7A

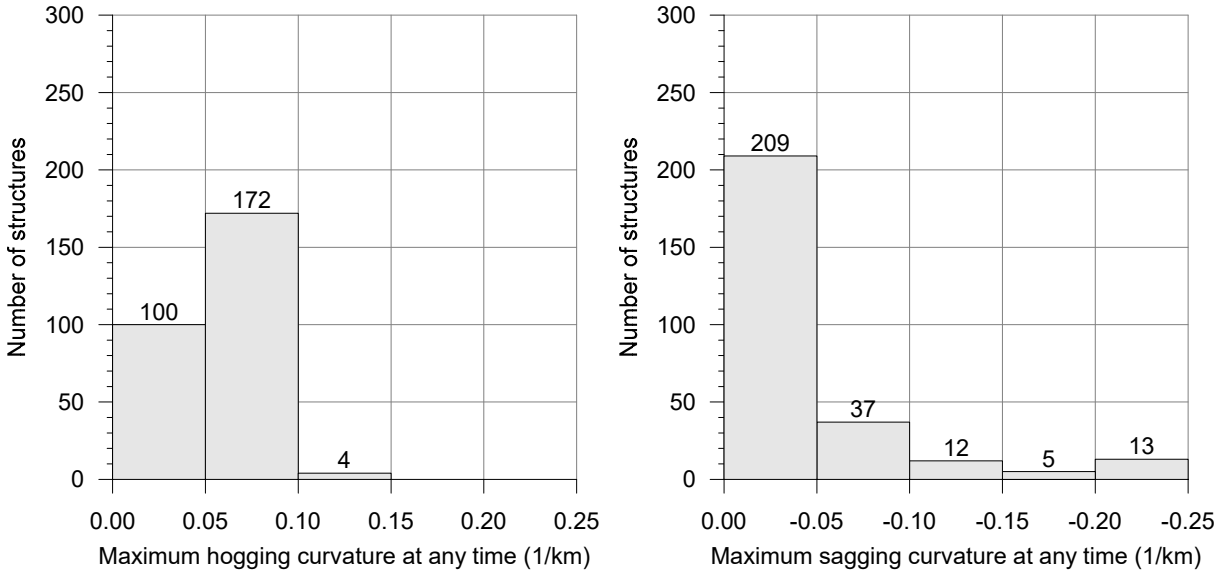


Fig. 3.42 Maximum predicted conventional hogging curvature (left) and sagging curvature (right) for tanks within the Study Area due to extraction of LW S7A

These distributions show that the maximum predicted incremental curvatures due to LW S7A are relatively small for most of the rural structures in the Study Area (of the 276 structures there are a total of 228 structures or 83% with hogging curvature < 0.05 km^{-1} and 261 structures or 95% with sagging curvature < 0.05 km^{-1}).

The maximum predicted conventional curvatures for the rural structures are 0.12 km^{-1} hogging and 0.23 km^{-1} sagging, which equate to minimum radii of curvature of 8.3 kilometres and 4.3 kilometres, respectively. The maximum predicted conventional strains for the rural structures, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1.8 mm/m tensile and 3.5 mm/m compressive. Non-conventional movements can also occur as a result of, among other things, anomalous movements. The analysis of strains provided in Section 2.5 includes those resulting from both conventional and non-conventional anomalous movements.

The rural structures are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 2.5. The results for survey bays located above goaf are provided in Fig. 2.6 and the results for survey bays located above solid coal are provided in Fig. 2.8.

3.11.3. Impact assessments for rural structures

The maximum predicted tilt for the rural structures is 8.5 mm/m (i.e. 0.85 %), which represents a change in grade of 1 in 118. The majority of the rural structures within the Study Area are of lightweight construction and able to tolerate mining-induced tilt. It has been found from past longwall mining experience that tilts of the magnitudes predicted within the Study Area generally do not result in adverse impacts on rural structures. Some minor serviceability impacts could occur at the higher levels of predicted tilt, including door swings and issues with roof and pavement drainage, all of which can be remediated using normal building maintenance techniques.

There is extensive experience of mining directly beneath rural structures in the Southern Coalfield which indicates that the incidence of impacts on these structures is very low and the structures have remained in safe and serviceable conditions. This is not surprising as rural structures are generally small in size and of light-weight construction, which makes them less susceptible to impact than houses which are typically more rigid.

Tahmoor Mine has mined directly beneath more than 2000 rural structures of similar construction during the mining of LWs 22 to 32 and LW W1-W3. It has managed the mining induced impacts with the implementation of suitable management strategies. The structures have remained safe and serviceable during mining.

Whilst the predicted subsidence parameters for the proposed longwalls are greater than those at Tahmoor North, it would still be expected that the rates of impact would be low and could be managed with the implementation of suitable management strategies. Impacts on rural structures have been successfully managed elsewhere in the NSW Coalfields, where the predicted subsidence parameters were similar to or greater than those predicted for the proposed longwalls.

Based on previous experiences, it is expected that the rural structures within the Study Area would remain safe and serviceable during the mining period, provided that they are in sound existing condition. The risk of impact is clearly greater if the structures are in poor existing condition, though the chances of there being a public safety risk remains very low. A number of rural structures which were in poor existing condition have been directly mined beneath and these structures have not experienced impacts during mining.

Impacts on the rural structures that occur as the result of the extraction of the proposed longwalls are expected to be remediated using well established building techniques. With these remediation measures available, it is unlikely that there would be long term impacts on rural structures resulting from the extraction of the proposed longwalls.

3.11.4. Impact assessments for rural structures based on increased predictions

If the actual tilts exceeded those predicted by a factor of 2 times, the maximum tilt at the rural structures would be 17 mm/m (i.e. 1.7 %), or a change in grade of 1 in 59. In this case, the incidence of serviceability impacts, such as door swings and issues with gutter and pavement drainage, would increase in the locations of greatest tilt, such as adjacent to the active longwall maingate and adjacent to the ends of the proposed longwalls. It would still be unlikely that stabilities of these rural structures would be affected by tilts of these magnitudes.

If the actual curvatures exceeded those predicted by a factor of 2 times, the incidence of impacts would increase for the rural structures located directly above the proposed longwalls. Since rural structures are generally small in size and of light-weight construction, they would still be expected to remain safe, serviceable and repairable using normal building maintenance techniques. With the implementation of any necessary remediation measures, it is unlikely that there would be any substantial long-term impacts on the rural structures.

While the predicted ground movements are important parameters when assessing the potential impacts on the rural structures, it is noted that the impact assessments were primarily based on historical observations from previous longwall mining in the Southern Coalfield. The overall levels of impact on the rural structures, resulting from the extraction of the proposed longwalls, are expected to be similar to those observed where longwalls have previously mined directly beneath rural structures in the Southern Coalfield.

3.11.5. Management of potential impacts on rural structures

Tahmoor Coal has developed a Subsidence Management Plan to manage potential impacts to farm buildings during the mining of LWs S1A to S6A under the *Approved Layout*. The management plan provides for identification of buildings in poor pre-mining condition that are hazardous or may become hazardous due to mining, and monitoring of structures during active subsidence. If impacts occur, the structure will be repaired in accordance with the *Coal Mine Subsidence Compensation Act 2017*.

The Subsidence Management Plan will be updated to include potential impacts due to the extraction of LW S7A under the *Modified Layout*.

With an appropriate management plan in place, it is considered that rural structures can be maintained at all times due to the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

3.12. Tanks

3.12.1. Descriptions of the tanks

The locations of the tanks (Structure Type T) within the Study Area are shown in Drawing No. MSEC1348-11. These include both septic tanks and potable water storage tanks, and which comprise in-ground and above ground tanks of concrete or steel or polyethylene construction.

There are 67 tanks which have been identified within the Study Area, of which 16 are located directly above LW S7A. A further 27 tanks are located directly above longwalls S1A to S6A under the *Approved Layout* and 24 tanks will not be directly mined beneath by the planned longwalls. The locations and sizes of the tanks were determined from aerial photographs of the area and kerb side inspections. There are also a number of smaller rainwater tanks associated with the houses which are not shown in these drawings.

3.12.2. Predictions for the tanks

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and at points located around the perimeter of each tank, as well as at points located at a distance of 20 metres from the perimeter of each tank.

A summary of the maximum predicted values of incremental conventional subsidence, tilt and curvature for each tank within the Study Area due to extraction of LW S7A is provided in Table C.05, in Appendix C. A summary of the maximum predicted values of total conventional subsidence, tilt and curvature for each tank within the Study Area after extraction of LWs S1A to S7A is also provided in Table C.07. The predicted tilts provided in this table are the maxima in any direction after the completion of each longwall. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each longwall.

Distributions of the maximum predicted incremental conventional subsidence and tilt for the tanks due to extraction of LW S7A are illustrated in Fig. 3.43, while Fig. 3.44 shows the corresponding distributions of maximum predicted total conventional subsidence and final tilt after extraction of LWs S1A to S7A under the *Modified Layout*.

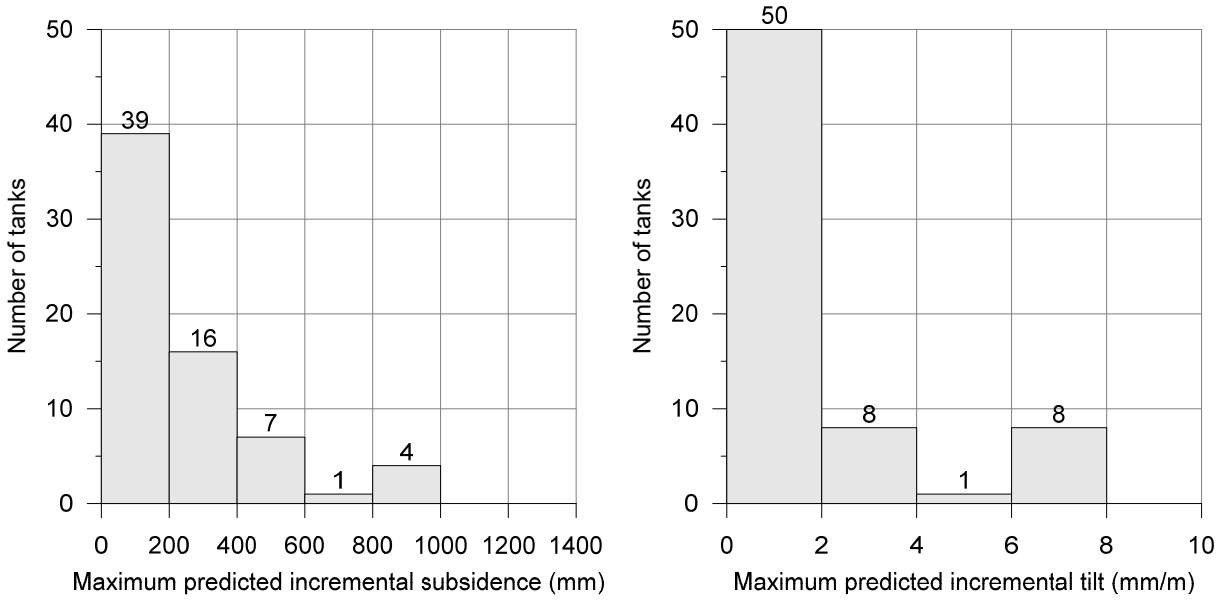


Fig. 3.43 Maximum predicted incremental conventional subsidence and tilt for the tanks within the Study Area due to extraction of LW S7A

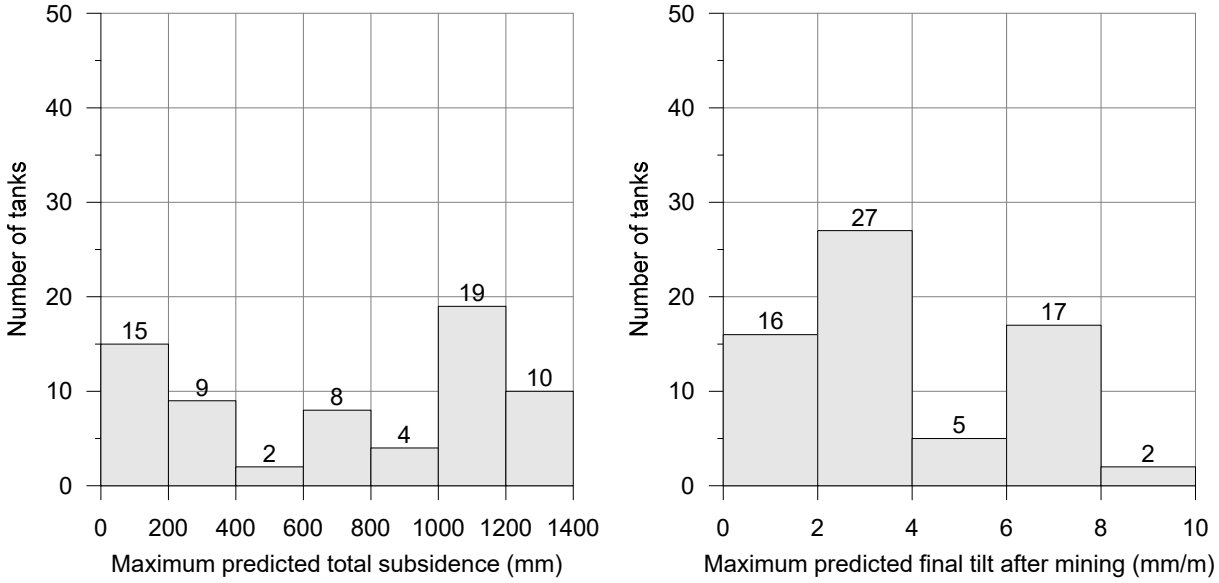


Fig. 3.44 Maximum predicted total conventional subsidence and tilt for the tanks within the Study Area after extraction of LWs S1A to S7A

These distributions indicate that for most tanks in the Study Area (55 out of 67 tanks, or 82% of the total), the maximum predicted incremental subsidence due to LW S7A is a relatively small proportion of the maximum predicted total subsidence after extraction of LWs S1A to S7A. Similarly, the maximum predicted incremental tilt due to LW S7A is relatively small (< 2 mm/m) for most tanks in the Study Area (50 out of 67 tanks, or 75% of the total).

Distributions of the maximum predicted incremental conventional hogging and sagging curvatures for the tanks due to extraction of LW S7A are illustrated in Fig. 3.45, while Fig. 3.46 shows the corresponding distributions of maximum predicted total conventional hogging and sagging curvatures after extraction of LWs S1A to S7A under the *Modified Layout*.

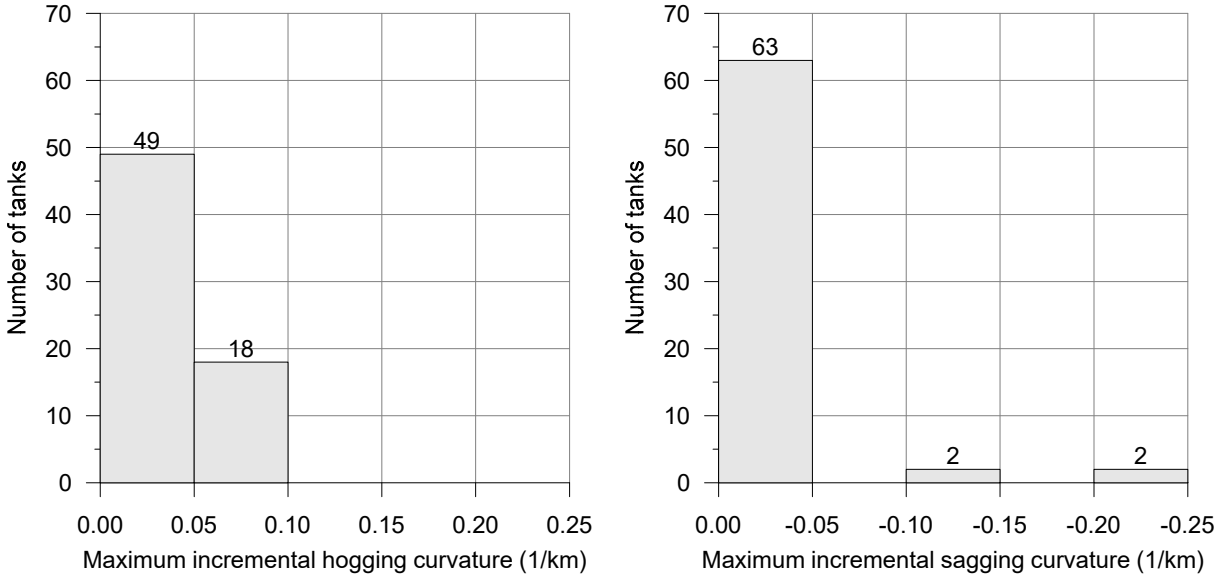


Fig. 3.45 Maximum predicted incremental conventional hogging curvature (left) and sagging curvature (right) for the farm dams within the Study Area due to extraction of LW S7A

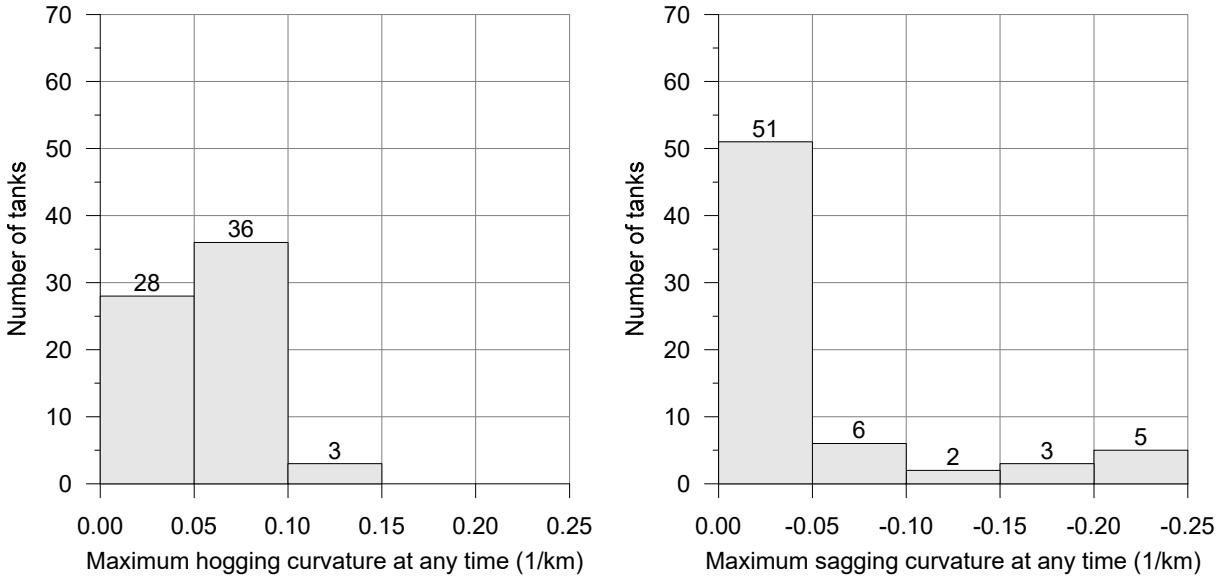


Fig. 3.46 Maximum predicted conventional hogging curvature (left) and sagging curvature (right) for tanks within the Study Area due to extraction of LW S7A

These distributions show that the maximum predicted incremental hogging curvature due to LW S7A is < 0.10 km^{-1} for almost all of the tanks in the Study Area (64 out of 67 pools, or 96% of the total), and the maximum predicted incremental sagging curvature due to LW S7A is < 0.05 km^{-1} for 51 out of 67 tanks (or 76 %).

The maximum predicted conventional strains for the tanks, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1.8 mm/m tensile and 3.5 mm/m compressive. Non-conventional movements can also occur as a result of, among other things, anomalous movements. The analysis of strains provided in Section 2.5 includes those resulting from both conventional and non-conventional anomalous movements.

The tanks are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 2.5. The results for survey bays located above goaf are provided in Fig. 2.6 and the results for survey bays located above solid coal are provided in Fig. 2.8.

3.12.3. Impact assessments for the tanks

Tilt can potentially affect the serviceability of tanks by altering the water levels in the tanks, which can in turn affect the minimum level of water which can be released from the outlets. The maximum predicted conventional tilt for the tanks within the Study Area is 8.5 mm/m (i.e. 0.85 %), which represents a change in grade of 1 in 118. The predicted changes in grade are small and unlikely, therefore, to result in any adverse impacts on the serviceability of the tanks.

The tanks are typically constructed above ground level and, therefore, are unlikely to experience the curvatures and ground strains resulting from the extraction of the proposed longwalls. It is possible that any buried water pipelines associated with the tanks within the Study Area could be impacted by the ground strains, if they are anchored by the tanks, or by other structures in the ground.

Any impacts are expected to be of a minor nature, including leaking pipe joints, and could be easily repaired. With these remedial measures in place, it would be unlikely that there would be any adverse impacts on the pipelines associated with the tanks.

3.12.4. Impact assessments for the tanks based on increased predictions

If the actual tilts exceeded those predicted by a factor of 2 times, the maximum tilt at the tanks would be 17 mm/m (i.e. 1.7 %), or a change in grade of 1 in 59. In this case, the incidence of serviceability impacts, such as changes in the minimum water levels which can be released from the outlets, could increase in the locations of greatest tilt, such as adjacent to the active longwall maingate and adjacent to the ends of the proposed longwalls. Impacts would be expected to be remediated by relevelling the tanks.

If the actual curvatures exceeded those predicted by a factor of 2 times, the incidence of impacts on the tank structures would not be expected to change substantially, as they are not expected to experience these ground movements. The incidence of impacts on the buried pipelines would, however, be expected to increase in the locations directly above the proposed longwalls. Impacts would still be expected to be of a minor nature which could be easily repaired. With these remediation measures in place, it would be unlikely that there would be long term impacts on the pipelines associated with the tanks.

3.12.5. Management of potential impacts on the tanks

Tahmoor Coal has developed a Subsidence Management Plan to manage potential impacts to tanks during the mining of LWs S1A to S6A under the *Approved Layout*. The management plan provides for identification of tanks in poor pre-mining condition that are hazardous or may become hazardous due to mining, and monitoring of structures during active subsidence. If impacts occur, the structure will be repaired in accordance with the *Coal Mine Subsidence Compensation Act 2017*.

The Subsidence Management Plan will be updated to include potential impacts due to the extraction of LW S7A under the *Modified Layout*.

With an appropriate management plan in place, it is considered that tanks can be maintained at all times due to the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

3.13. Farm dams

There are 20 farm dams (Structure Type D) which have been identified within the Study Area and their locations are shown in Drawing No. MSEC1348-11. The maximum plan dimensions and plan areas for these dams are provided in Table C.07, in Appendix C.

The locations and sizes of the farm dams were determined from aerial photographs of the area. The distributions of the longest lengths and surface areas of the farm dams within the Study Area are shown in Fig. 3.47.

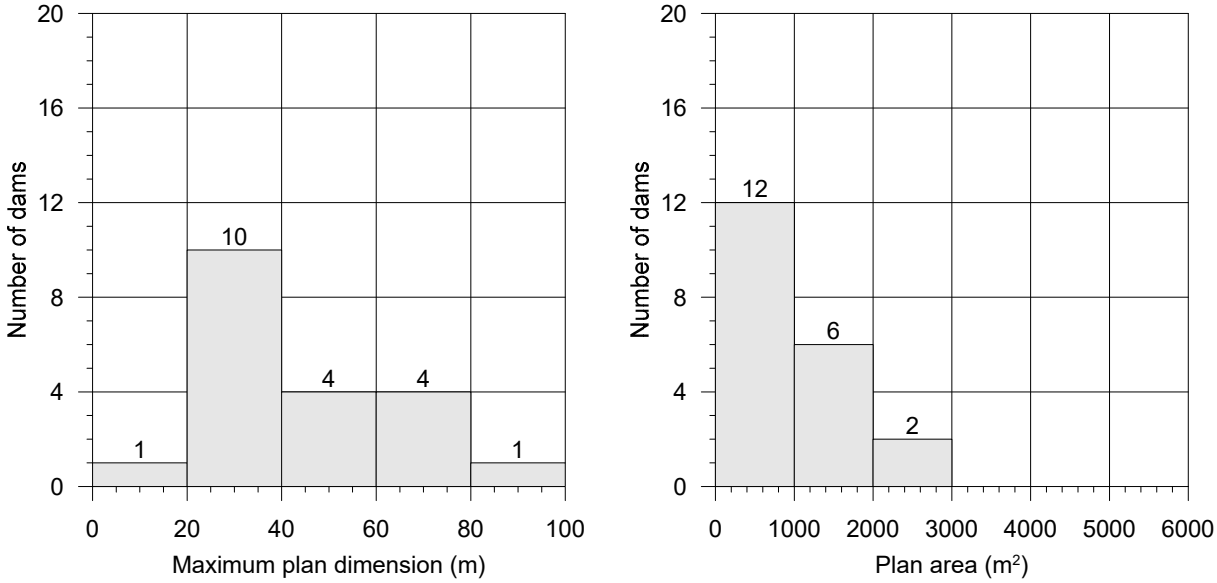


Fig. 3.47 Distributions of longest lengths and surface areas of the farm dams

The longest lengths of the farm dams within the Study Area vary between 16 metres and 99 metres and the plan areas vary between 170 m^2 and 2,925 m^2.

The dams are typically of earthen construction and have been established by localised cut and fill operations within the natural streams. The farm dams are generally shallow, with the dam wall heights generally being less than 3 metres.

Only one of these dams is located directly above the proposed LW S7A under the *Modified Layout*. This dam is identified as BYR_095_d01, with a maximum plan dimension of 43 m and a plan area 1,003 m^2. All of the remaining 19 dams located within the current Study Area were predicted to experience some subsidence movements due to extraction of LWs S1A to S6A under the *Approved Layout.*

3.13.1. Predictions for the farm dams

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and around the perimeters of each farm dam, as well as at points located at a distance of 20 metres from the perimeter of each dam.

A summary of the maximum predicted values of incremental conventional subsidence, tilt and curvature for each farm dam within the Study Area due to extraction of LW S7A is provided in Table C.07, in Appendix C. A summary of the maximum predicted values of total conventional subsidence, tilt and curvature for each farm dam within the Study Area after extraction of LWs S1A to S7A is also provided in Table C.07. The predicted tilts provided in this table are the maxima in any direction after the completion of each longwall. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each longwall.

Distributions of the maximum predicted incremental conventional subsidence and tilt for the farm dams due to extraction of LW S7A are illustrated in and Fig. 3.51, while Fig. 3.49 shows the corresponding distributions of maximum predicted total conventional subsidence and final tilt after extraction of LWs S1A to S7A under the *Modified Layout*.

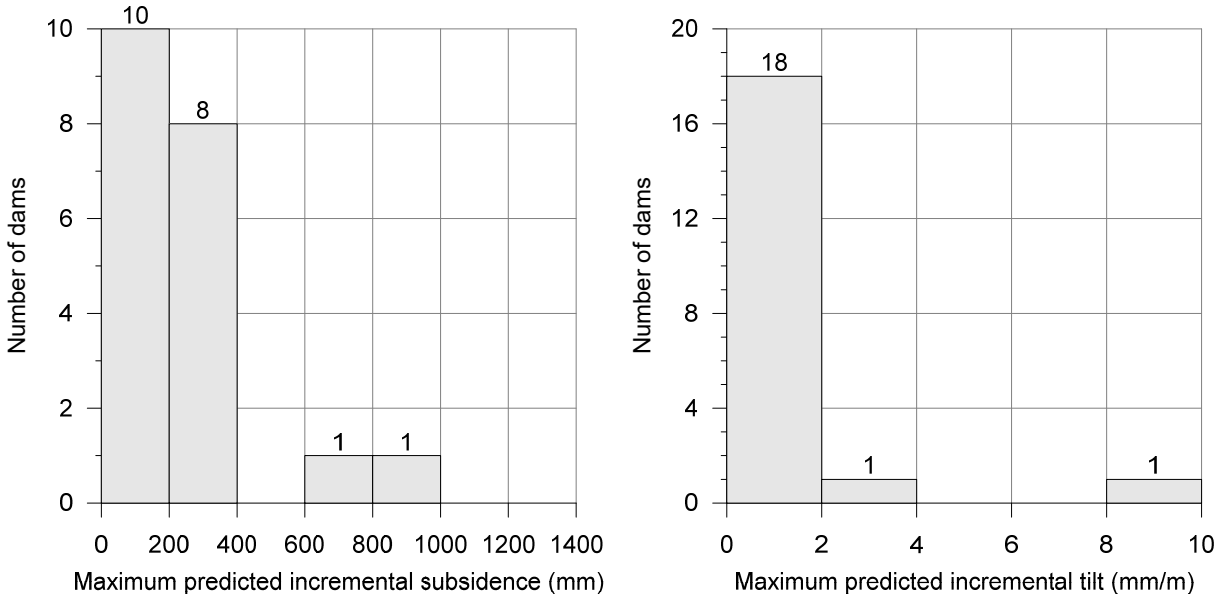


Fig. 3.48 Maximum predicted incremental conventional subsidence and tilt for the farm dams within the Study Area due to extraction of LW S7A

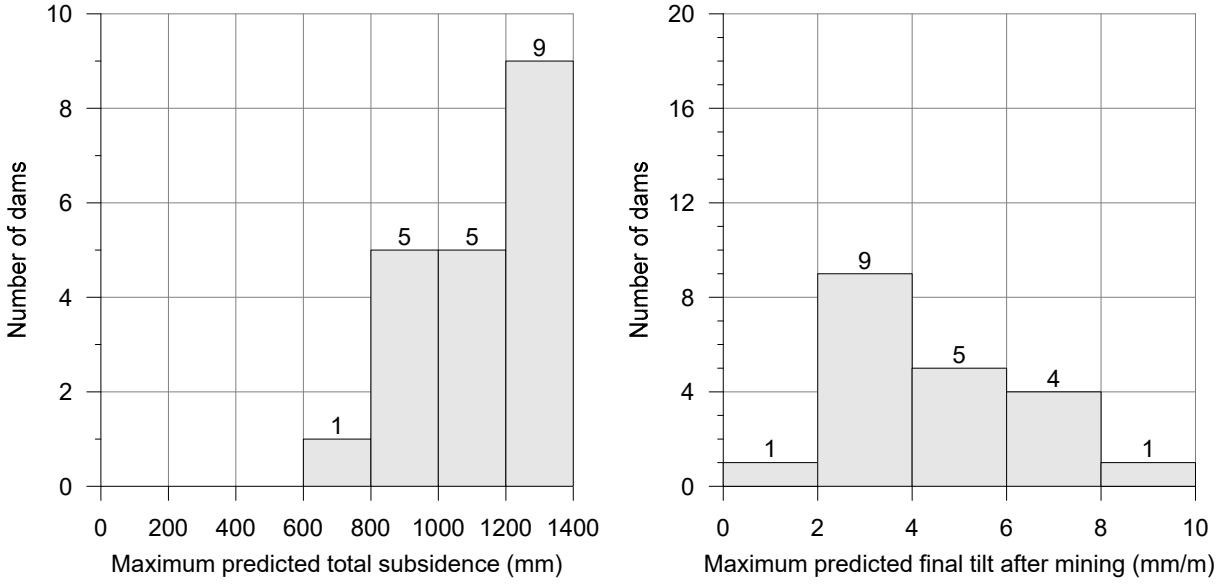


Fig. 3.49 Maximum predicted total conventional subsidence and tilt for the farm dams within the Study Area after extraction of LWs S1A to S7A

These distributions indicate that for most dams in the Study Area (18 out of 20 dams, or 90% of the total), the maximum predicted incremental subsidence due to LW S7A is a relatively small proportion of the maximum predicted total subsidence after extraction of LWs S1A to S7A. Similarly, the maximum predicted incremental tilt due to LW S7A is relatively small (< 2 mm/m) for most dams in the Study Area (18 out of 20 dams, or 90% of the total).

Distributions of the maximum predicted incremental conventional hogging and sagging curvatures for the farm dams due to extraction of LW S7A are illustrated in Fig. 3.50, while Fig. 3.51 shows the corresponding distributions of maximum predicted total conventional hogging and sagging curvatures after the extraction of LWs S1A to S7A under the *Modified Layout*.

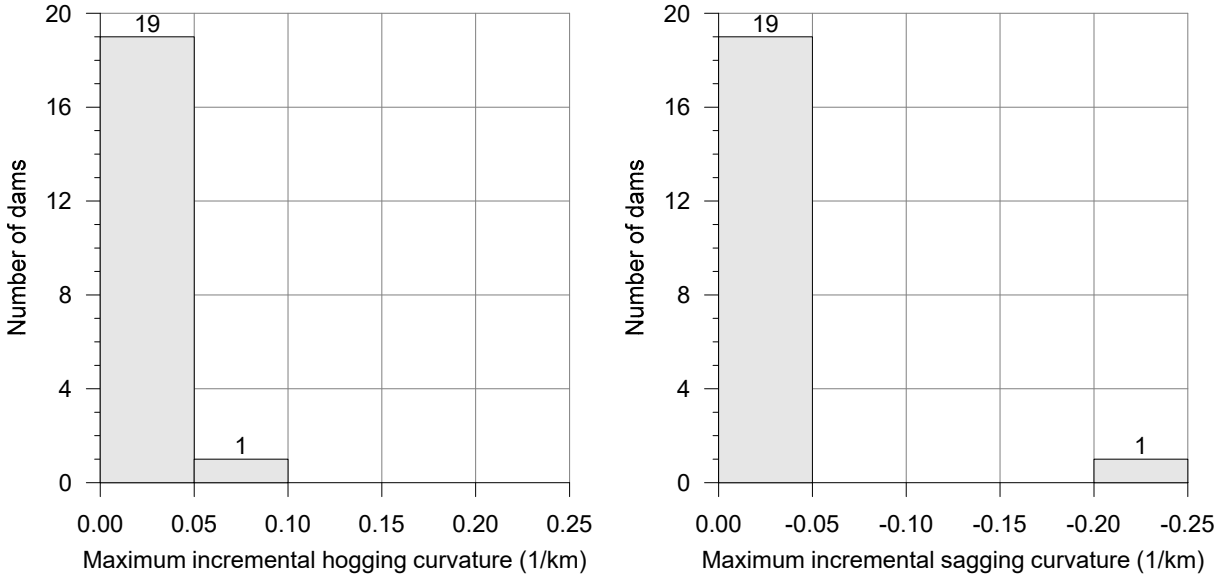


Fig. 3.50 Maximum predicted incremental conventional hogging curvature (left) and sagging curvature (right) for the farm dams within the Study Area due to extraction of LW S7A

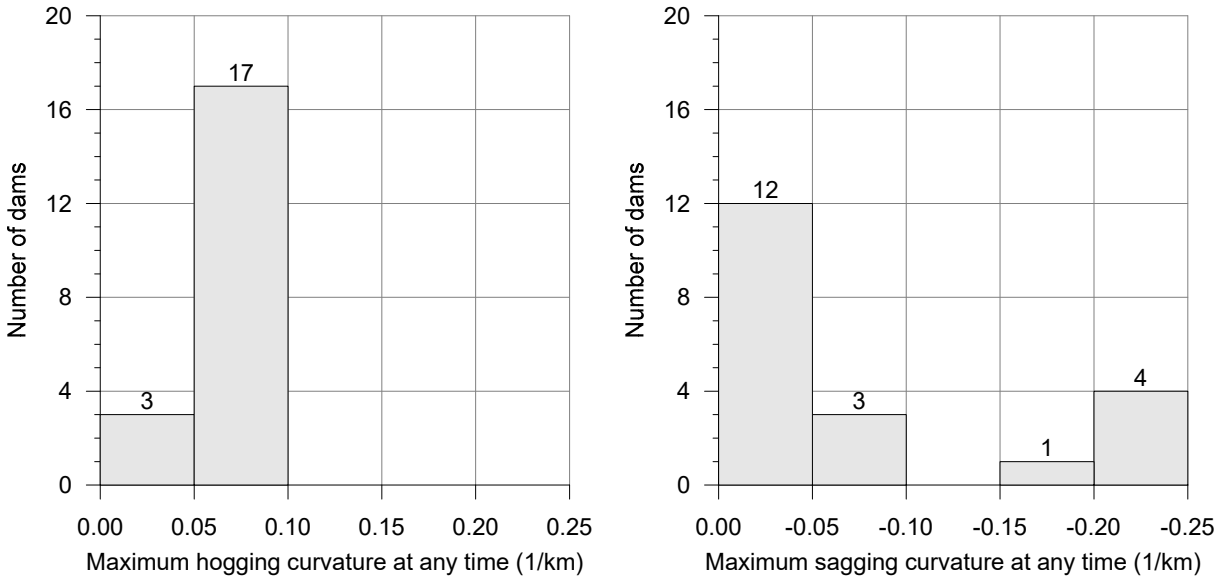


Fig. 3.51 Maximum predicted total conventional hogging curvature (left) and sagging curvature (right) for the farm dams after extraction of LWs S1A to S7A

These distributions show that for most dams in the Study Area (19 out of 20 dams, or 95% of the total), the maximum predicted incremental curvatures due to LW S7A are relatively small (< 0.05 km^{-1}) for both hogging and sagging curvatures. It is only the dam located directly above LW S7A where predicted incremental curvature exceeds 0.05 km^{-1}.

The maximum predicted conventional strains for the farm dams, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1.5 mm/m tensile and 3.3 mm/m compressive. Non-conventional movements can also occur as a result of, among other things, anomalous movements. The analysis of strains provided in Section 2.5 includes those resulting from both conventional and non-conventional anomalous movements.

The farm dams are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 2.5. The results for survey bays located above goaf are provided in Fig. 2.6 and the results for survey bays located above solid coal are provided in Fig. 2.8.

The farm dams have typically been constructed within the streams and, therefore, may be subjected to valley related movements resulting from the extraction of the proposed longwalls. The equivalent valley heights at the dams are very small and it is expected, therefore, that the predicted valley related upsidence and closure movements at the dam walls would be much less than the predicted conventional subsidence movements and would not be substantial.

3.13.2. Impact Assessments for the farm dams

The maximum predicted final tilt for the farm dams is 8.5 mm/m (i.e. 0.85 %), which represents a change in grade of 1 in 118. Mining induced tilts can affect the water levels around the perimeters of farm dams, with the freeboard increasing on one side, and decreasing on the other. Tilt can potentially reduce the storage capacity of farm dams, by causing them to overflow, or can affect the stability of the dam walls.

The predicted changes in freeboard at the farm dams within the Study Area were determined by taking the difference between the maximum predicted subsidence and the minimum predicted subsidence anywhere around the perimeter of each farm dam. The predicted maximum changes in freeboard at the farm dams within the Study Area after the completion of longwalls S1A to S7A under the *Modified Layout*, are provided in Table C.07, in Appendix C, and are illustrated in Fig. 3.52.

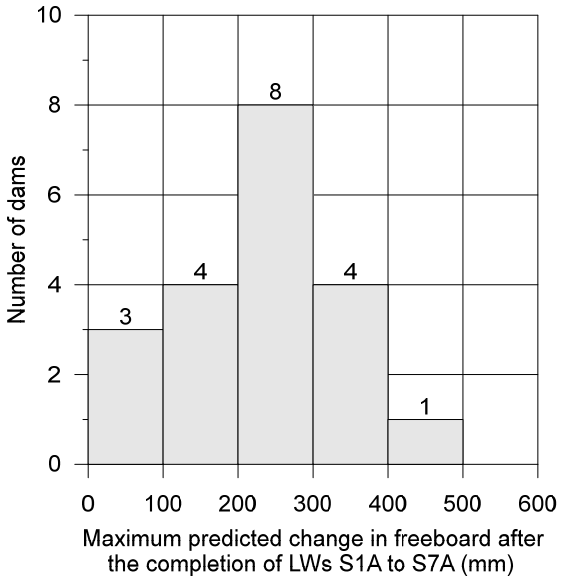


Fig. 3.52 Predicted changes in freeboards for the farm dams within the Study Area

It can be seen from the above figure, that the predicted changes in freeboard are less than 300 mm at 15 of 20 dams (i.e. 75 % of the total), and less than 500 mm at all 20 dams located within the Study Area, including the dam located directly above LW S7A. It is unlikely that the majority of the farm dams within the Study Area would experience adverse impacts on the storage capacities due to these small changes in freeboard. However, any reduced storage levels could be remediated by increasing the height of the affected dam wall.

The maximum predicted conventional curvatures for farm dams under the *Modified Layout* are 0.10 km^{-1} hogging and 0.23 km^{-1} sagging, which represent minimum radii of curvature of 10.0 kilometres and 4.3 kilometres, respectively. These are similar to the maximum predicted curvatures (0.14 km^{-1} hogging and 0.22 km^{-1}) and minimum radii of curvature (7.1 kilometres and 4.5 kilometres, respectively) under the *Approved Layout*. The predicted curvatures and strains could be sufficient to result in cracking in the bases and walls of some farm dams within the Study Area.

There is extensive experience of mining directly beneath farm dams in the Southern Coalfield, which indicates that the incidence of impacts on these features is very low. Farm dams are commonly constructed with cohesive materials in the bases and walls which can absorb the conventional subsidence movements typically experienced in the Southern Coalfield without the development of substantial cracking. Non-conventional movements can result in localised cracking and deformations at the surface and, where coincident with farm dams, could result in adverse impacts.

Tahmoor Coal has mined LW22 to LW32 and LW W1-W3 beneath approximately 110 dams. While a small number of landowners have advised of impacts, there has been one claim to SA NSW for impacts on farm dams at the time of the report.

Similarly, South32 Illawarra Coal has mined directly beneath more than 200 farm dams in Appin Area 3, Appin Area 4, Appin Area 7, Appin Area 9 and West Cliff Area 5. Loss of water was reported for one dam in Appin Area 7, however, it was noted that this dam was of poor, shallow construction and seepage was observed at the base of the dam wall prior to mining.

Whilst the predicted subsidence parameters for the proposed longwalls are greater than those at Tahmoor North and at Appin and West Cliff Collieries, it would still be expected that the rates of impact on the farm dams would be very low and could be managed with the implementation of suitable management strategies.

Any substantial cracking in the dam bases or walls could be repaired by reinstating with cohesive materials. If any farm dams were to lose water as a result of mining, the mine would provide an alternative water source until the completion of repairs in accordance with the *Coal Mine Subsidence Compensation Act 2017*.

3.13.3. Impact assessments for the farm dams based on increased predictions

If the actual tilts exceeded those predicted by a factor of 2 times, the maximum tilt at the farm dams, at the completion of mining, would be 17 mm/m (i.e. 1.7 %), or a change in grade of 1 in 59. In this case, there would be 9 dams within the *Study Area* (i.e. 45 % of the total) where the predicted change in freeboard was greater than 500 mm. In some cases, the tilts could be sufficient to reduce the capacities of the farm dams below acceptable levels, however, these could be remediated by increasing the heights of the affected dam walls.

If the actual curvatures or strains exceeded those predicted by a factor of 2 times, the likelihood and extent of cracking would increase for the farm dams located directly above the proposed longwalls. Any surface cracking would still be expected to be of a minor nature and could be readily repaired by reinstating with cohesive materials. If any farm dams were to lose water as a result of mining, the mine would provide an alternative water source until the completion of repairs in accordance with the *Coal Mine Subsidence Compensation Act 2017*.

3.13.4. Management of potential impacts on the farm dams

Tahmoor Coal has developed a Subsidence Management Plan to manage potential impacts to farm dams during the mining of LWs S1A to S6A under the *Approved Layout*. The management plan includes an assessment of potential environmental or safety consequences as a result of dam breach. The management plan provides for visual monitoring of dams immediately prior to and after active subsidence at each dam.

If impacts occur to the dams, Tahmoor Coal will supply water to the landowner on a temporary basis until the dam is repaired in accordance with the *Coal Mine Subsidence Compensation Act 2017*.

The Subsidence Management Plan will be updated to include potential impacts due to the extraction of LW S7A under the *Modified Layout*.

With an appropriate management plan in place, it is considered that dams can be maintained at all times due to the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

3.14. Commercial and business establishments

A total of 29 structures are located within the Study Area that are used for commercial or business purposes by three different establishments. These are Bargo Valley Produce, Ingham Turkey Farm and the Canine Country Club and Cattery. These establishments were included within the Study Area for LWs S1A to S6A under the *Approved Layout*.

As shown in Drawing No. MSEC1348-11, the structures are all located on properties along Yarran Road and 26 of the 29 structures (90 %) will be directly mined beneath by LW S7A under the *Modified Layout*.

3.14.1. Predictions for the commercial and business establishments

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and at points located around the perimeter of each structure, as well as at points located at a distance of 20 metres from the perimeter of each structure.

A summary of the maximum predicted values of incremental conventional subsidence, tilt and curvature for each of the commercial structures within the Study Area due to extraction of LW S7A is provided in Table C.09, in Appendix C. A summary of the maximum predicted values of total conventional subsidence, tilt and curvature for each of the commercial structures within the Study Area after extraction of LWs S1A to S7A is also provided in Table C.09. The predicted tilts provided in this table are the maxima in any direction after the completion of each longwall. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each longwall.

Distributions of the maximum predicted incremental conventional subsidence and tilt for the commercial structures due to extraction of LW S7A are illustrated in Fig. 3.53, while Fig. 3.54 shows the corresponding distributions of maximum predicted total conventional subsidence and final tilt after extraction of LWs S1A to S7A under the *Modified Layout*.

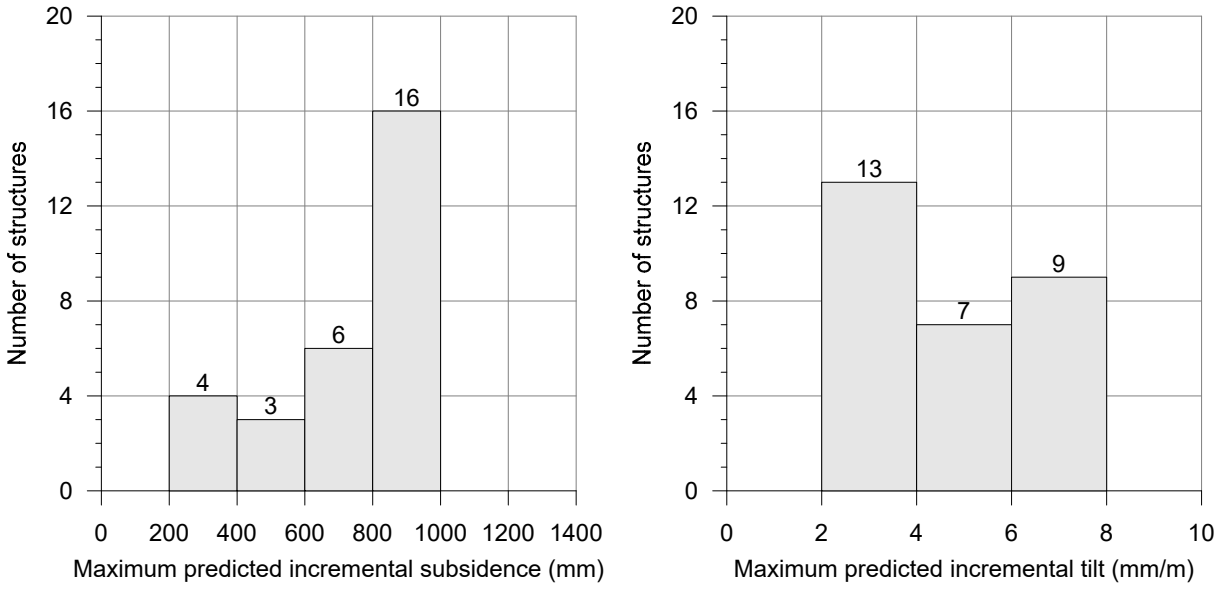


Fig. 3.53 Maximum predicted incremental conventional subsidence and tilt for the commercial structures within the Study Area due to extraction of LW S7A

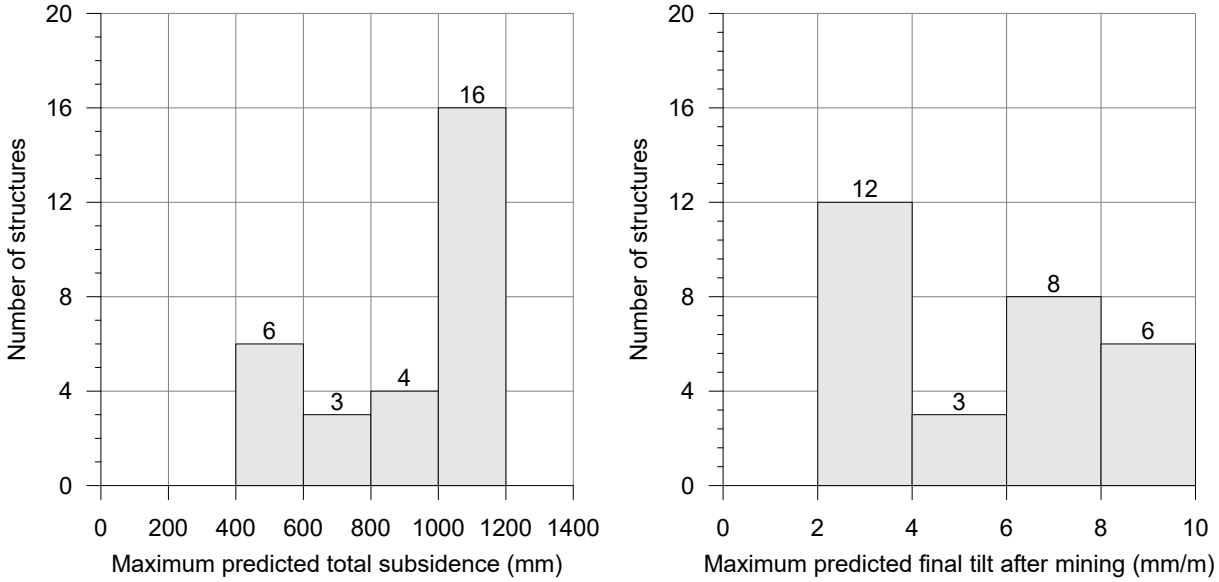


Fig. 3.54 Maximum predicted total conventional subsidence and tilt for the commercial structures within the Study Area after extraction of LWs S1A to S7A

These distributions indicate that, for the commercial structures in the Study Area the maximum predicted incremental subsidence due to LW S7A is a relatively large proportion of the maximum predicted total subsidence after extraction of LWs S1A to S7A. This is to be expected, as the commercial establishments are located along Yarran Road and most will be directly mined beneath by the proposed LW S7A. Similarly, the distribution of the maximum predicted incremental tilt due to LW S7A is similar to the distribution of the maximum predicted final tilt after extraction of all LWs S1A to S7A under the *Modified Layout.*

Distributions of the maximum predicted incremental conventional hogging and sagging curvatures for the commercial structures due to extraction of LW S7A are illustrated in Fig. 3.55, while Fig. 3.56 shows the corresponding distributions of maximum predicted total conventional hogging and sagging curvatures after extraction of LWs S1A to S7A under the *Modified Layout*.

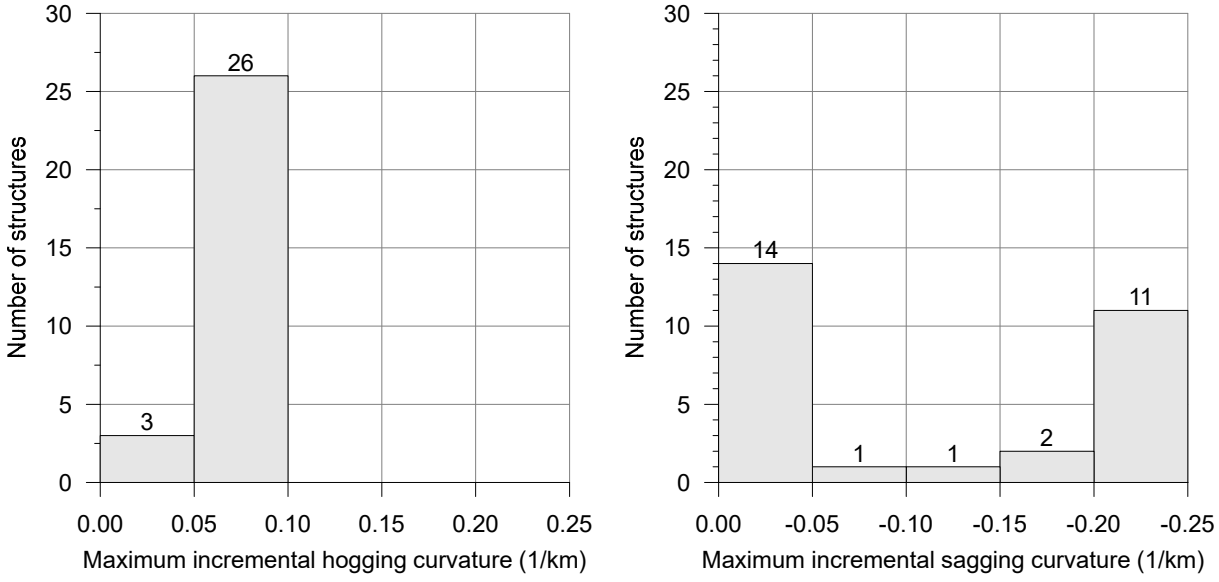


Fig. 3.55 Maximum predicted incremental conventional hogging (left) and sagging (right) curvatures for commercial structures within the Study Area due to extraction of LW S7A

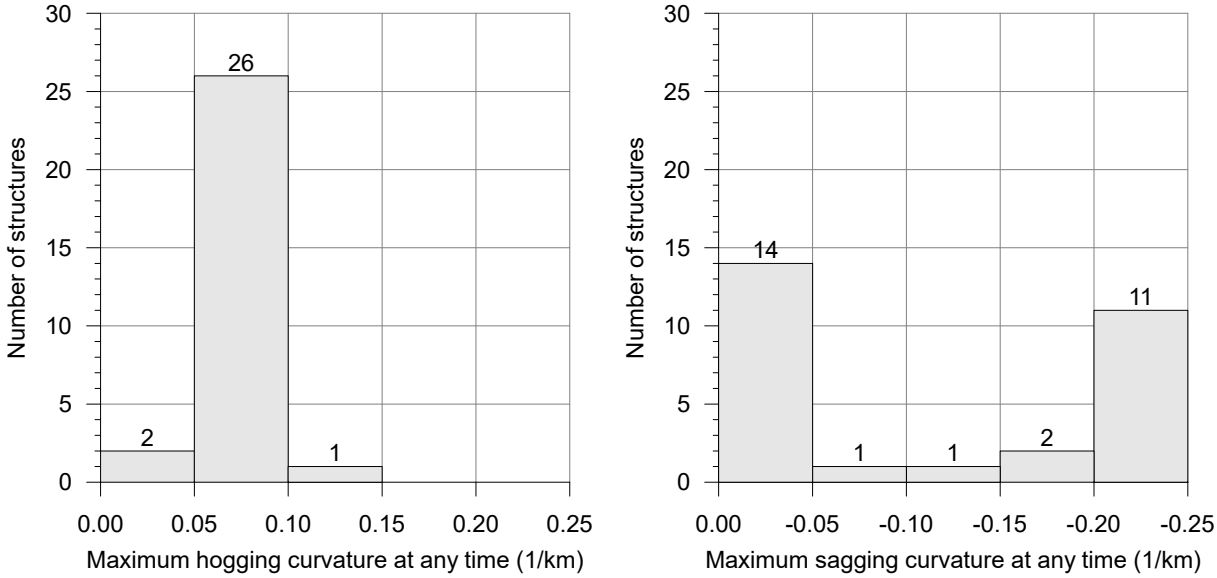


Fig. 3.56 Maximum predicted total conventional hogging curvature (left) and sagging curvature (right) for the commercial structures after extraction of LWs S1A to S7A

As expected, these distributions are almost identical for the maximum predicted incremental and total conventional hogging curvatures. The distributions are in fact identical for the maximum predicted incremental and total conventional sagging curvatures.

The maximum predicted conventional strains for the commercial and business establishments, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1.8 mm/m tensile and 3.3 mm/m compressive. Non-conventional movements can also occur as a result of, among other things, anomalous movements. The analysis of strains provided in Section 2.5 includes those resulting from both conventional and non-conventional anomalous movements.

The structures are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 2.5. The results for survey bays located above goaf are provided in Fig. 2.6 and the results for survey bays located above solid coal are provided in Fig. 2.8.

Tahmoor Coal has previously developed and acted in accordance with risk management plans to successfully manage potential impacts to industrial, commercial and business establishments during the mining of LWs 22 to 32, including a turkey processing plant, a large shopping centre, horticultural businesses, industrial and commercial establishments and a variety of shops.

Each business is unique in terms of the structures on the property and the activities that are conducted on each property. For this reason, Tahmoor Coal has committed to developing individual subsidence management plans in consultation with the owners of each business that are predicted to experience more than 20 mm of subsidence due to the extraction of LWs S5A and S6A under the *Approved Layout*. The subsidence management plans will be extended to include the extraction of the proposed LW S7A.

The management strategy for each business would include:

- Consultation with the owner of each business
- Pre-mining hazard identification inspection of each structure by structural engineer
- Identification and assessment of potential impacts to the operation of each business and safety of workers and the general public
- Consideration of mitigation measures to reduce risk prior to the commencement of subsidence movements
- Consideration of appropriate monitoring measures
- Consideration of appropriate triggered responses during mining
- Development of an agreed detailed subsidence management plan between Tahmoor Coal and the owners of each business

Each management plan would be reviewed periodically by Tahmoor Coal and the owners of each business. With an appropriate management plan in place, it is considered that commercial and business establishments can be maintained at all times due to the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non-conventional movements occurred.

3.15. Swimming pools

The locations of the swimming pools (Structure Type P) within the Study Area are shown in Drawing No. MSEC1348-11. There are 13 swimming pools have been identified within the Study Area, of which 3 are located directly above LW S7A. A further 8 pools are located directly above longwalls S1A to S6A under the *Approved Layout*. Two pools will not be directly mined beneath by the planned longwalls. The locations and sizes of the pools were determined from orthophotographs of the area.

All of the swimming pools located within the current Study Area were predicted to experience some subsidence movements due to extraction of LWs S1A to S6A under the *Approved Layout*.

One above-ground pool previously identified above the proposed LW S7A has been removed since the structures were previously identified in Report No. MSEC1192 (BYR_055-p01).

3.15.1. Predictions for the swimming pools

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and at points located around the perimeter of each pool, as well as at points located at a distance of 20 metres from the perimeter of each pool.

A summary of the maximum predicted values of incremental conventional subsidence, tilt and curvature for each swimming pool within the Study Area due to extraction of LW S7A is provided in Table C.06, in Appendix C. A summary of the maximum predicted values of total conventional subsidence, tilt and curvature for each swimming pool within the Study Area after extraction of LWs S1A to S7A is also provided in Table C.06. The predicted tilts provided in this table are the maxima in any direction after the completion of each longwall. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each longwall.

Distributions of the maximum predicted incremental conventional subsidence and tilt for the swimming pools due to extraction of LW S7A are illustrated in Fig. 3.57, while Fig. 3.58 shows the corresponding distributions of maximum predicted total conventional subsidence and final tilt after extraction of LWs S1A to S7A under the *Modified Layout*.

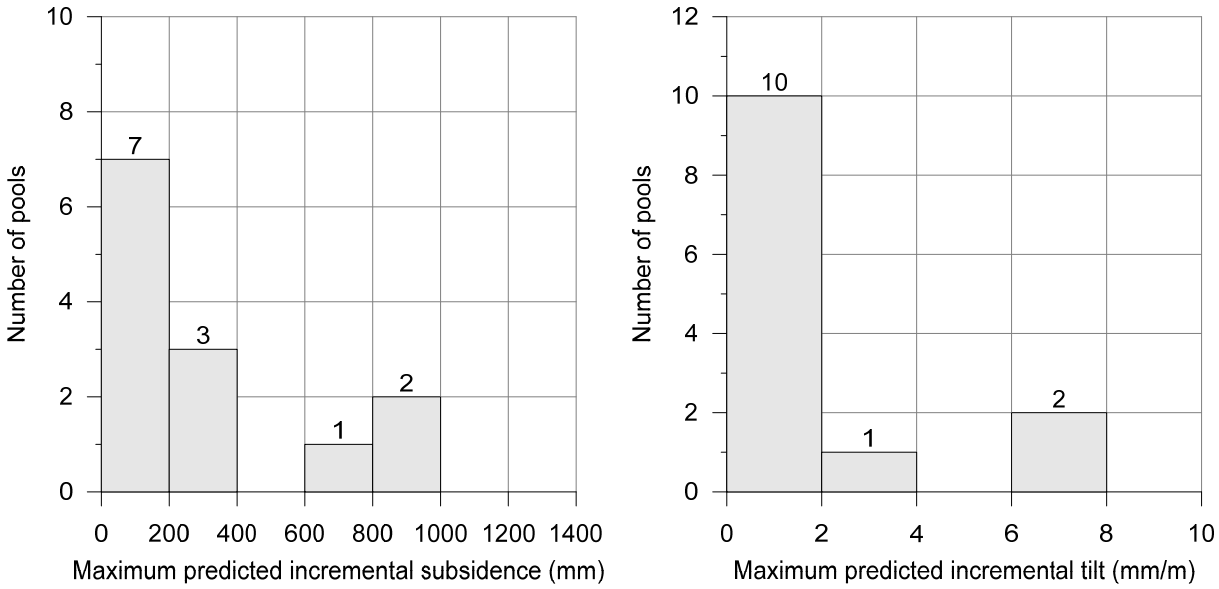


Fig. 3.57 Maximum predicted incremental conventional subsidence and tilt for the swimming pools within the Study Area due to extraction of LW S7A

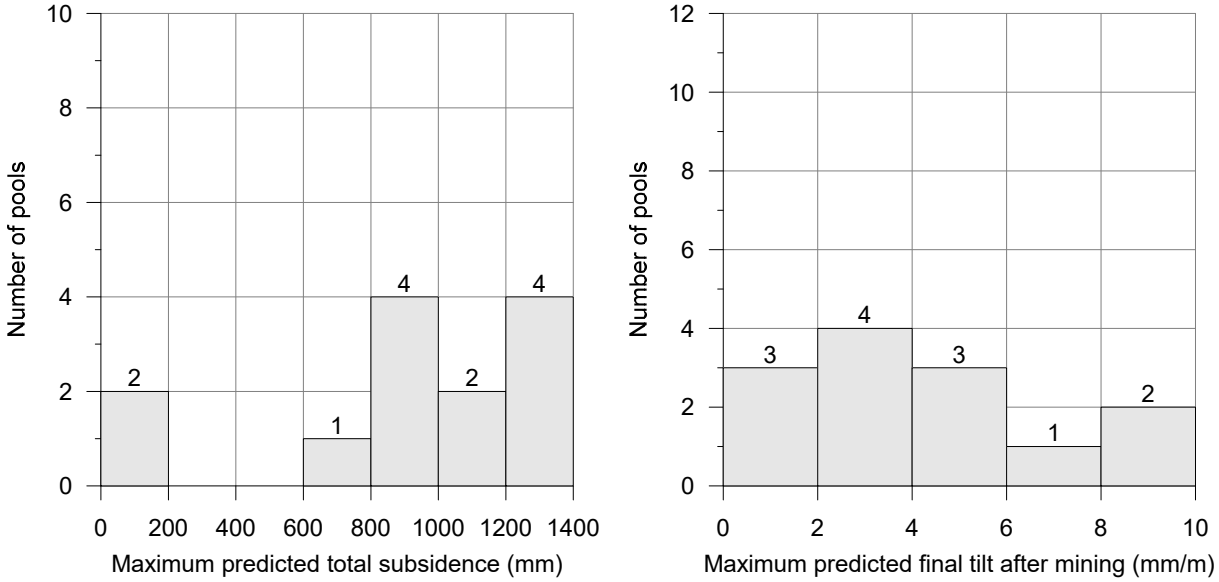


Fig. 3.58 Maximum predicted total conventional subsidence and tilt for the swimming pools within the Study Area after extraction of LWs S1A to S7A

These distributions indicate that for most swimming pools in the Study Area (10 out of 13 pools, or 77% of the total), the maximum predicted incremental subsidence due to LW S7A is a relatively small proportion of the maximum predicted total subsidence after extraction of LWs S1A to S7A. Similarly, the maximum predicted incremental tilt due to LW S7A is relatively small (< 2 mm/m) for most swimming pools in the Study Area (10 out of 13 pools, or 77% of the total).

Distributions of the maximum predicted incremental conventional hogging and sagging curvatures for the swimming pools due to extraction of LW S7A are illustrated in Fig. 3.59, while Fig. 3.60 shows the corresponding distributions of maximum predicted total conventional hogging and sagging curvatures after extraction of LWs S1A to S7A under the *Modified Layout*.

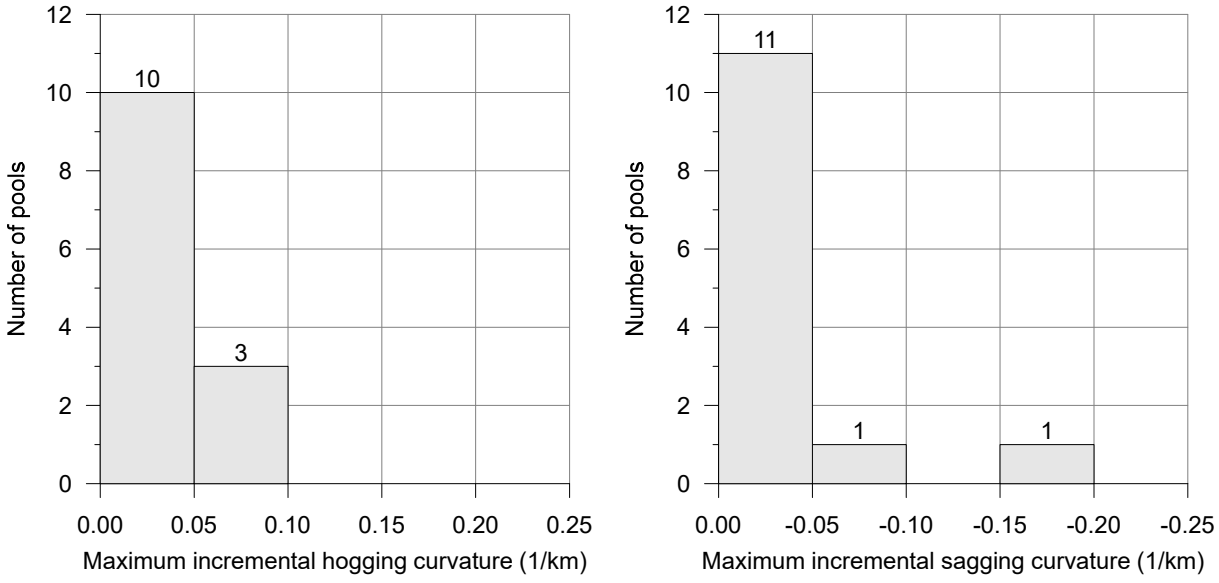


Fig. 3.59 Maximum predicted incremental conventional hogging curvature (left) and sagging curvature (right) for the swimming pools within the Study Area due to extraction of LW S7A

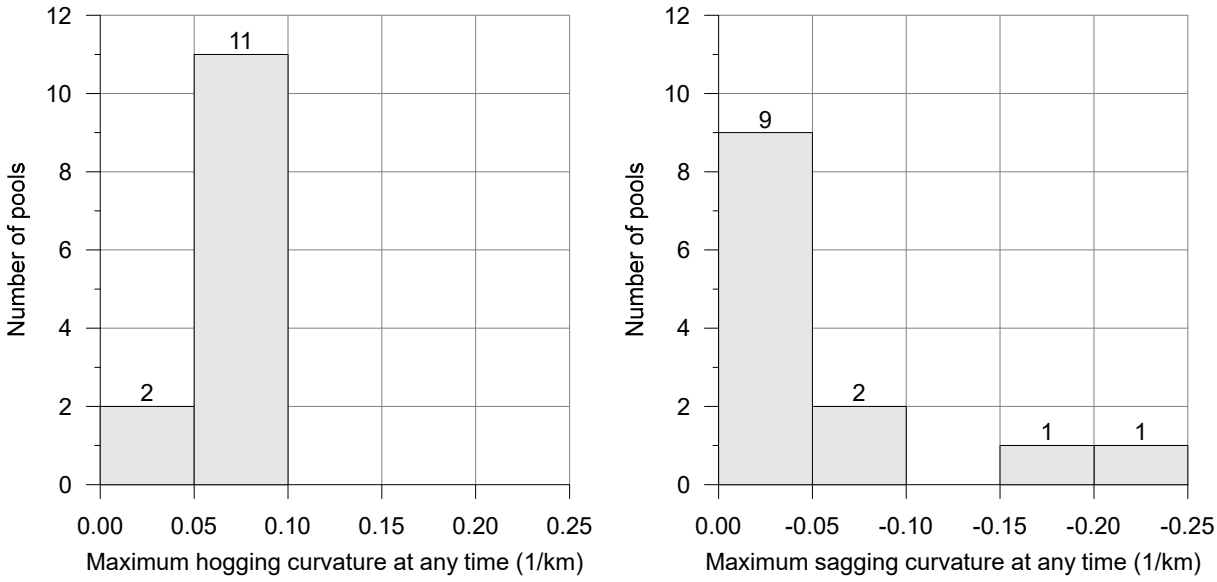


Fig. 3.60 Maximum predicted total conventional hogging curvature (left) and sagging curvature (right) for the swimming pools after extraction of LWs S1A to S7A

These distributions show that for most swimming pools in the Study Area, the maximum predicted incremental hogging curvature due to LW S7A is relatively small (< 0.05 km^{-1} for 10 out of 13 pools, or 77% of the total), and the maximum predicted incremental sagging curvature due to LW S7A is also relatively small (< 0.05 km^{-1} for 11 out of 13 pools, or 85 %).

The maximum predicted conventional strains for the pools, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1.4 mm/m tensile and 3.5 mm/m compressive. Non-conventional movements can also occur as a result of, among other things, anomalous movements. The analysis of strains provided in Section 2.5 includes those resulting from both conventional and non-conventional anomalous movements.

The pools are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 2.5. The results for survey bays located above goaf are provided in Fig. 2.6 and the results for survey bays located above solid coal are provided in Fig. 2.8.

3.15.2. Impact assessments for the swimming pools

Mining-induced tilts are more noticeable in pools than other structures due to the presence of the water line and the small gap to the edge coping, particularly when the pool lining has been tiled. Skimmer boxes are also susceptible of being lifted above the water line due to mining tilt.

The Australian Standard AS2783-1992 (Use of reinforced concrete for small swimming pools) requires that pools be constructed level ± 15 mm from one end to the other. This represents a tilt of approximately 3 mm/m for pools that are 10 metres in length. Australian Standard AS/NZS 1839:1994 (Swimming pools – Pre-moulded fibre-reinforced plastics – Installation) also requires that pools be constructed with a tilt of 3 mm/m or less.

There are 3 pools within the *Study Area* (i.e. 23 % of the total) which are predicted to experience final tilts of 3 mm/m or less, at the completion of the proposed longwalls, which is similar to or less than the Australian Standard.

There are 7 pools (i.e. 54 % of the total) predicted to experience final tilts between 3 mm/m and 7 mm/m and 3 pools (i.e. 23 % of the total) predicted to experience final tilts greater than 7 mm/m. The maximum predicted final tilt for the pools is 8.5 mm/m (i.e. 0.85 %), which represents a change in grade of 1 in 118. It is likely that a number of these pools would require some remediation of the pool copings.

The maximum predicted conventional curvatures for the pools are 0.09 km^{-1} hogging and 0.23 km^{-1} sagging, which equate to minimum radii of curvature of 10.8 kilometres and 4.3 kilometres, respectively. Whilst the predicted subsidence parameters for the proposed longwalls are greater than those at Tahmoor North, it would still be expected that the rates of impact on pools at Tahmoor North would provide a reasonable guide to the likely levels of impact.

Observations during the mining of Tahmoor Mine LWs 22 to 32 have shown that pools, particularly in-ground pools, are more susceptible to severe impacts than houses and other structures. Pools cannot be easily repaired and most of the impacted pools need to be replaced.

As of June 2017, a total of 157 pools have experienced mine subsidence movements during the mining of Tahmoor Mine Longwalls 22 to 30, of which 141 were located directly above the extracted longwalls. A total of 36 pools have reported impacts, all of which were located directly above the extracted longwalls. This represents an impact rate of approximately 23 %. A higher proportion of impacts have been observed for in-ground pools, particularly fibreglass pools. The majority of the impacts related to tilt or cracking, though in a small number of cases the impacts were limited to damage to skimmer boxes or the edge coping.

It is expected that the rate of impact on the pools within the Study Area would be similar, but, slightly greater than those previously experienced at Tahmoor North. Impacts to the pools would be repaired or, if required the pool would be replaced in accordance with the *Coal Mine Subsidence Compensation Act 2017*.

3.15.3. Impact assessments for the swimming pools based on increased predictions

If the actual tilts exceeded those predicted by a factor of 2 times, the final tilts would be 3 mm/m or less at 2 pools within the Study Area (i.e. 15 % of the total) at the completion of mining. In this case, there would be 3 pools (i.e. 23 % of the total) predicted to experience final tilts between 3 mm/m and 7 mm/m and 8 pools (i.e. 62 % of the total) predicted to experience final tilts greater than 7 mm/m. It is possible that most of the pools within the Study Area would require some remediation of the coping due to the mining induced tilt, if the actual tilts exceeded those predicted by a factor of 2 times.

If the actual curvatures exceeded those predicted by a factor of 2 times, the incidence of impacts would increase for the pools located directly above the proposed longwalls. While the predicted ground movements are important parameters when assessing the potential impacts on the pools, it is noted that the impact assessments were primarily based on observed rate of impact from Tahmoor North. The overall levels of impact on the pools, resulting from the extraction of the proposed longwalls, are expected to be similar to, but, slightly greater than those observed at Tahmoor North.

3.15.4. Management of potential impacts on the swimming pools

Tahmoor Coal has developed a Subsidence Management Plan to manage potential impacts to swimming pools during the mining of LWs S1A to S6A under the *Approved Layout*. This includes a pre-mining inspection of pools, pool fences and gates and measurement of levels around the pools.

While not strictly related to the pool structure, a number of pool gates have been impacted as the result of the previous extraction of longwalls beneath pools. While the gates can be easily repaired, the worst-case consequence of breaching pool fence integrity could be severe. As a result, Tahmoor Coal inspects the integrity of pool fences once a week for pools that are experiencing active subsidence during mining.

The Subsidence Management Plan will be updated to include potential impacts due to the extraction of LW S7A under the *Modified Layout*.

With an appropriate management plan in place, it is considered that pools and pool fences can be maintained at all times due to the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non- conventional movements occurred.

3.16. Houses

3.16.1. Descriptions of the houses

There are 62 houses that have been identified within the Study Area under the *Modified Layout.* Of these, 49 houses are located directly above the proposed longwalls. The locations of the houses are shown in Drawing No. MSEC1348-11 and details are provided in Tables C.02 and C.03, in Appendix C.

The locations, sizes, and construction details of the houses were determined from orthophotographs of the area in 2017, 2021 and 2023, kerbside inspections in 2013 and *Google Street View*® in February 2021. In some cases, the houses were inspected at the request or consent of the landowners.

Given the medium-term nature of the proposed mining activity, it is likely that there will be a growth and renewal of houses over time. It is likely the total number of houses affected by the extraction of the proposed longwalls will be greater than currently identified. Two houses within the Study Area had been extended since the structures were previously identified in Report No. MSEC1192.

The following provides further discussions on the details of the houses within the Study Area.

Locations

Under the *Approved Layout* there were 65 houses located directly above the proposed LWs S1A to S6A, as shown in Table 3.26. An additional 11 houses are located directly above the proposed S7A under the *Modified Layout*. All of the houses located directly above the proposed LW S7A were already predicted to experience some subsidence movements due to extraction of LWs S1A to S6A under the *Approved Layout.*

Table 3.26 Number of houses located directly above each longwall

Layout	Longwall	Number of houses directly above each proposed longwall
Approved Layout LWs S1A to S6A	LW S1A	0
	LW S2A	1
	LW S3A	13
	LW S4A	20
	LW S5A	20
	LW S6A	11
	Total (LWs S1A to S6A)	**65**
Modified Layout LWs S1A to S7A	LW S7A	11
	Total (LWs S1A to S7A)	**76**

Maximum plan dimension, plan area and height

Distributions of the maximum plan dimensions and plan areas of the houses within the Study Area are provided in Fig. 3.61. The majority of the houses are between 10 metres and 30 metres in length, with an average of 21 metres. The majority of the houses have plan areas between 100 m^2 and 300 m^2, with an average of 240 m^2. These distributions of houses by maximum plan dimension and plan area are similar to the distributions of houses by plan dimension and plan area under the *Approved Layout*.

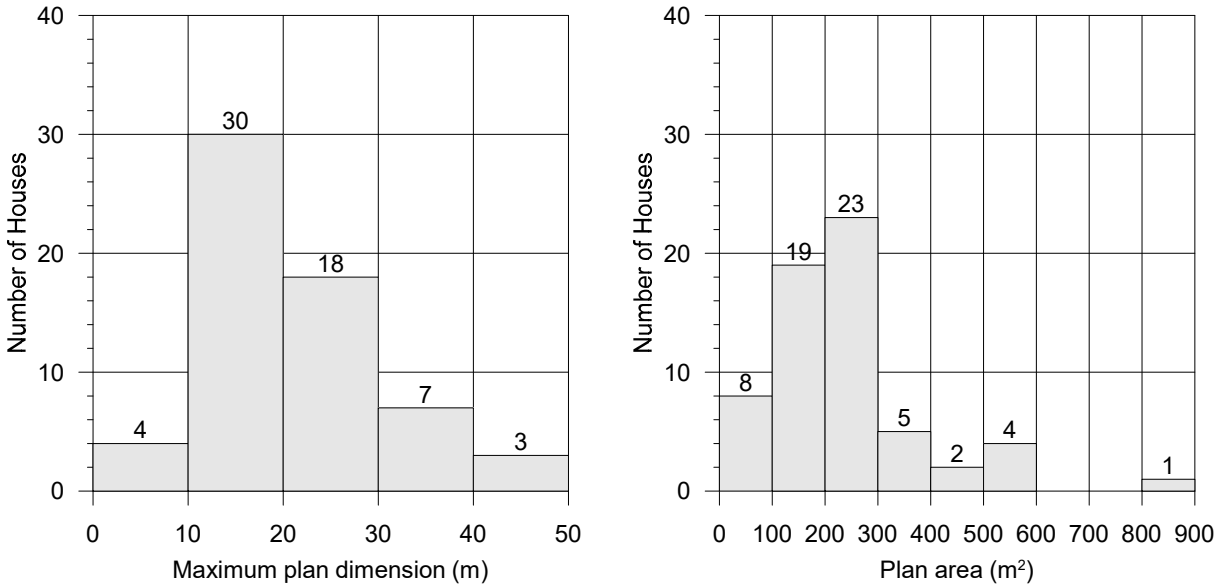


Fig. 3.61 Distribution of houses by maximum plan dimension and plan area

The houses have been categorised into four groups, on the basis of their maximum plan dimension and the number of stories. A summary of these house type categories is provided in Table 3.27 below. It is noted that two-storey houses include split-level houses.

Table 3.27 House type categories

House type	Description	Number	Percentage
H1	Single-storey with maximum plan dimension less than 30 metres	49	79 %
H2	Single-storey with maximum plan dimension of 30 metres or greater	9	15 %
H3	Two-storey with maximum plan dimension less than 30 metres	3	4.5 %
H4	Two-storey with maximum plan dimension of 30 metres or greater	1	1.5 %

It can be seen from the above table that the majority of houses within the Study Area are single-storey with a maximum plan dimension less than 30 metres (i.e. Type H1). There is one two-storey house with a maximum plan dimension greater than 30 metres (i.e. Type H4), which is located on Wellers Road and not directly above the proposed LWs S1A to S7A.

Type of construction

Distributions of the wall and footing construction of the houses within the Study Area are provided in Fig. 3.62. The most common construction method among the houses within the Study Area is brick or brick-veneer (38 houses, or approximately 60 %), followed by weatherboard (20 houses or approximately 32 %). Half of the houses within the Study Area are supported by slab on ground, while 17 of the remaining houses (27 %) have either brick piers or strip footings. The footing type for the remaining houses could not be determined at this point in time from street survey.

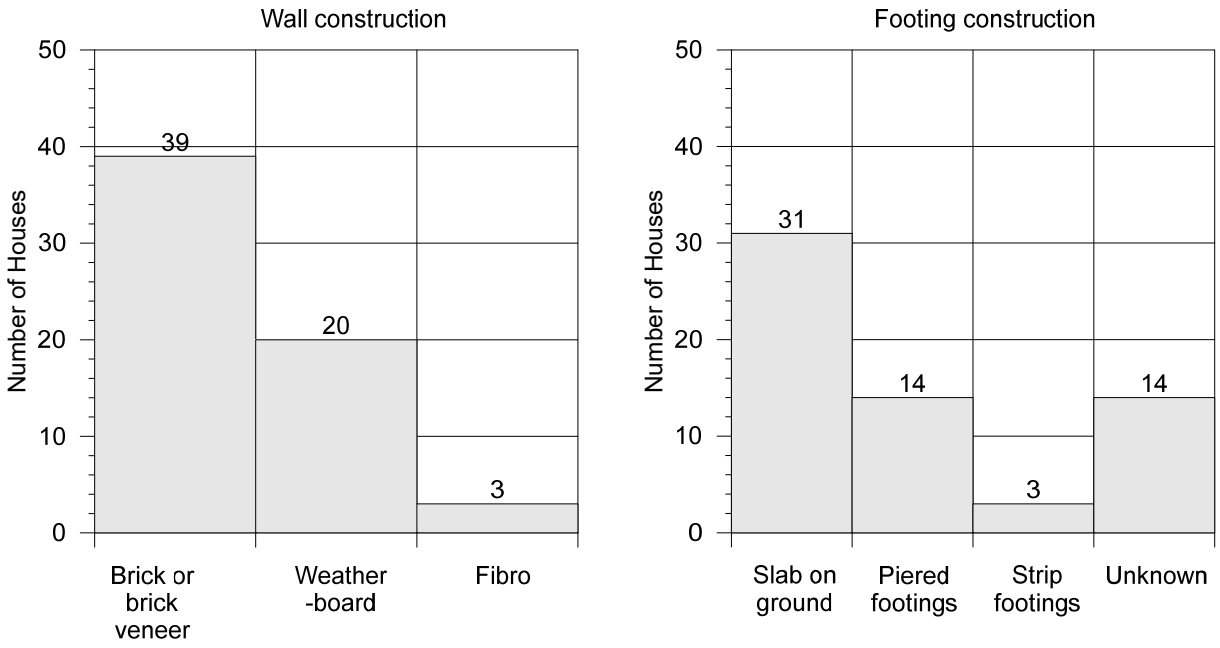


Fig. 3.62 Distributions of wall and footing construction for houses within the Study Area

Following a review of impacts to houses during the mining of Tahmoor Mine Longwalls 22 to 25, it was found that there was a noticeable difference in structural performance in response to mine subsidence movements between the following construction types:-

- Brick or brick-veneer houses constructed on a ground slab;
- Brick or brick-veneer houses constructed on strip footings or piers; and
- Weatherboard or fibro houses constructed on either ground slabs, strip footings or piers.

The distribution of houses construction type within the Study Area is provided in Table 3.28.

Table 3.28 Distribution of houses by construction type

Description	Number of houses	Percentage of houses
Brick or brick-veneer houses constructed on a ground slab	28	45%
Brick or brick-veneer houses constructed on strip footings or piers or foundation type is currently unknown	11	18 %
Weatherboard or fibro houses constructed on ground slabs, strip footings, piers	23	37 %

A map showing the spatial distribution of structures by construction type is provided in Fig. 3.63.

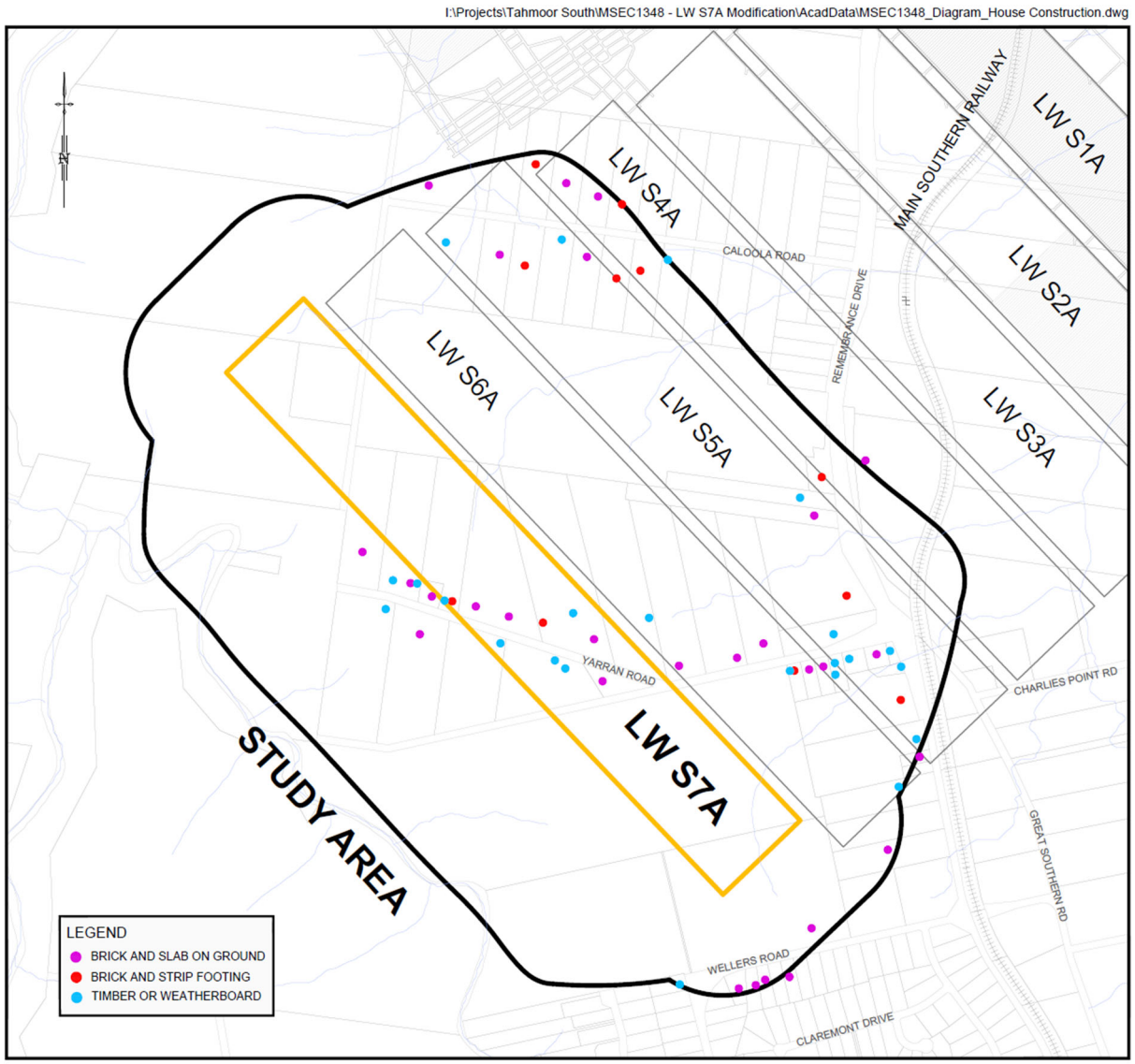


Fig. 3.63 Location of houses by construction type

The information on construction types has been undertaken using *Google Street View*® images and front of house inspections. It is possible that some houses will be renovated or rebuilt before the proposed longwalls are extracted.

As discussed in Section 3.16.3, construction type is an input parameter to the probabilistic method of assessment of impacts.

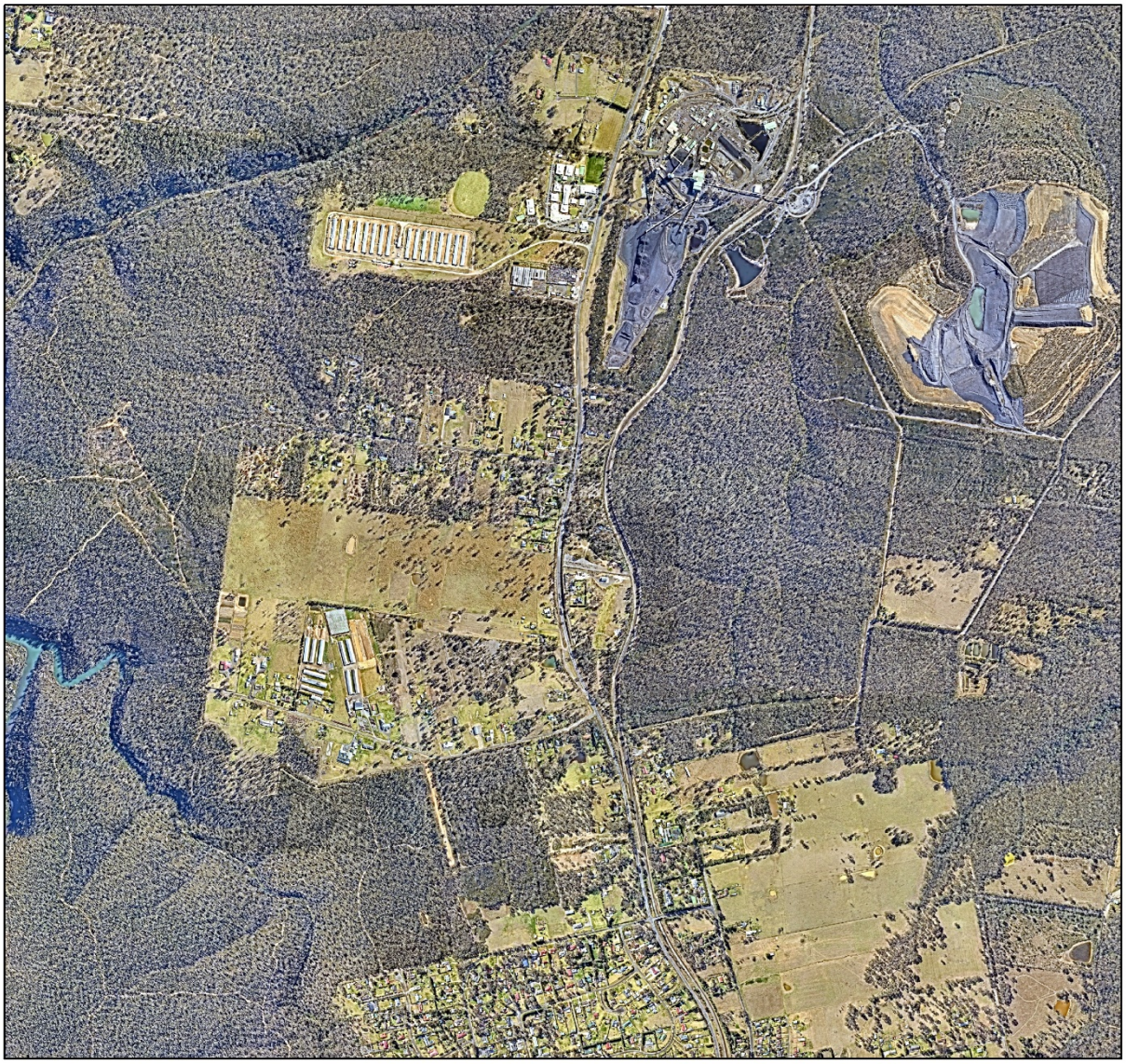
Age of houses

The Bargo area has expanded from a rural township to an urban village, as demonstrated by the following two images. An aerial photograph taken in 1975 is shown in Fig. 3.64. The most recent available aerial photograph in 2021 is shown in Fig. 3.65 for comparison. A large proportion of the houses in the Study Area (65 %) have been built since the Bargo Mine Subsidence District was declared in 1975.

House age has been determined by examination of a series of historical aerial photographs provided by Land and Property Information. The photographs that were available over the Study Area were taken in 1963, 1975, 1984, 1994, 2002 and Tahmoor Mine commissioned orthophotographs over the Study Area in 2013. A Nearmap image taken in 2017 was used to identify houses with the Study Area at the time MSEC's report in support of the original EIS was submitted. A Nearmap image taken in 2021 was used to identify new houses with the Study Area at the time of preparing the Extraction Plan. A Nearmap images taken in 2023 was used to identify new houses with the Study Area at the time of preparing this report.

Photograph courtesy Department of Lands (now Spatial Services NSW)

Fig. 3.64 Aerial photograph of Study Area in 1975 when Mine Subsidence District was declared



Photograph courtesy Nearmap

Fig. 3.65 Aerial photograph of Study Area in 2023

A map showing the spatial distribution of houses by age is provided in Fig. 3.67 and it can be seen that the older houses (tan and magenta coloured marks) are located throughout the Study Area. A histogram showing the distribution of houses by age is shown in Fig. 3.66.

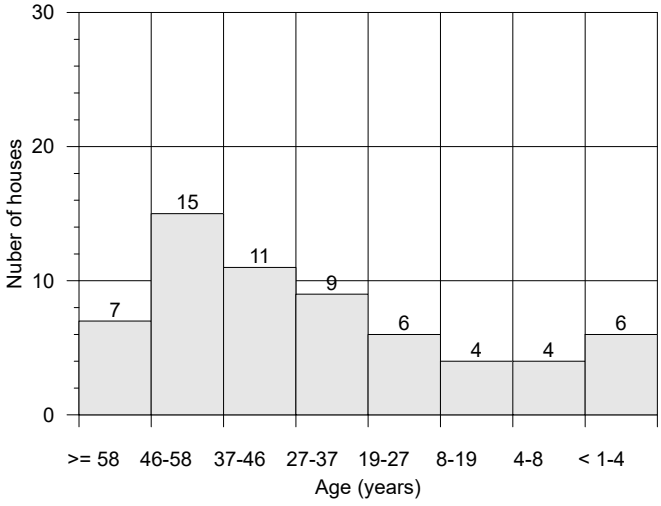


Fig. 3.66 Distribution of Houses by Age as at 2023

It can be seen from Fig. 3.66 that, as at 2021, a large proportion of houses were constructed between 27 and 58 years ago, that is between 1975 and 1994.

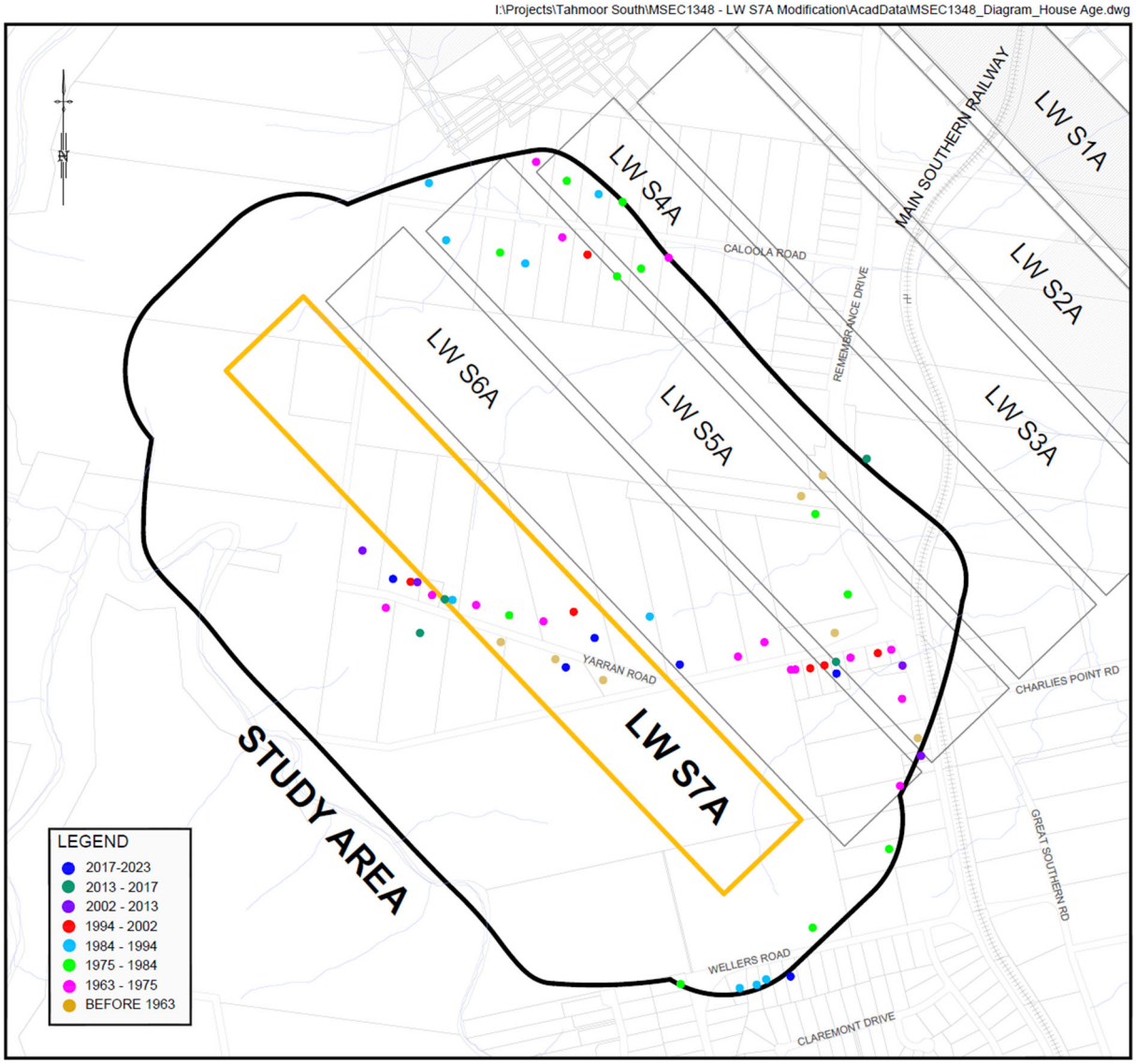


Fig. 3.67 Location of houses by age

3.16.2. Predictions for the houses

Predictions of conventional subsidence, tilt and curvature have been made at the centroid and at the vertices of each house, as well as eight equally spaced points placed radially around the centroid and vertices at a distance of 20 metres. In the case of a rectangular shaped structure, predictions have been made at a minimum of 45 points within and around the structure.

A summary of the maximum predicted values of conventional subsidence, tilt and curvature for each house within the Study Area, resulting from the extraction of the proposed longwalls, is provided in Table C.03, in Appendix C. The predicted tilts provided in this table are the maxima in any direction after the completion of each longwall. The predicted curvatures are the maxima in any direction at any time during or after the extraction of each longwall.

Distributions of the maximum predicted incremental conventional subsidence for the houses due to extraction of LW S7A are illustrated in Fig. 3.68, while Fig. 3.69 shows the corresponding distributions of maximum predicted total conventional subsidence after extraction of LWs S1A to S7A under the *Modified Layout*.

Distributions of the maximum predicted incremental conventional tilt for the houses due to extraction of LW S7A are illustrated in Fig. 3.70, while Fig. 3.71 shows the corresponding distributions of maximum predicted total conventional tilt during and after extraction of LWs S1A to S7A under the *Modified Layout*.

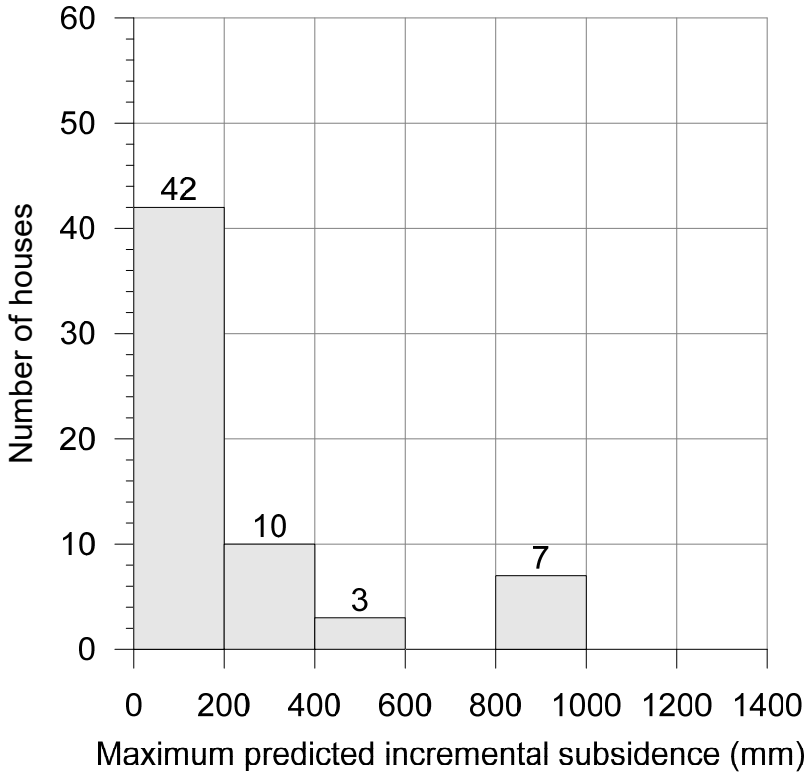


Fig. 3.68 Maximum predicted incremental conventional subsidence for the houses within the Study Area due to extraction of LW S7A

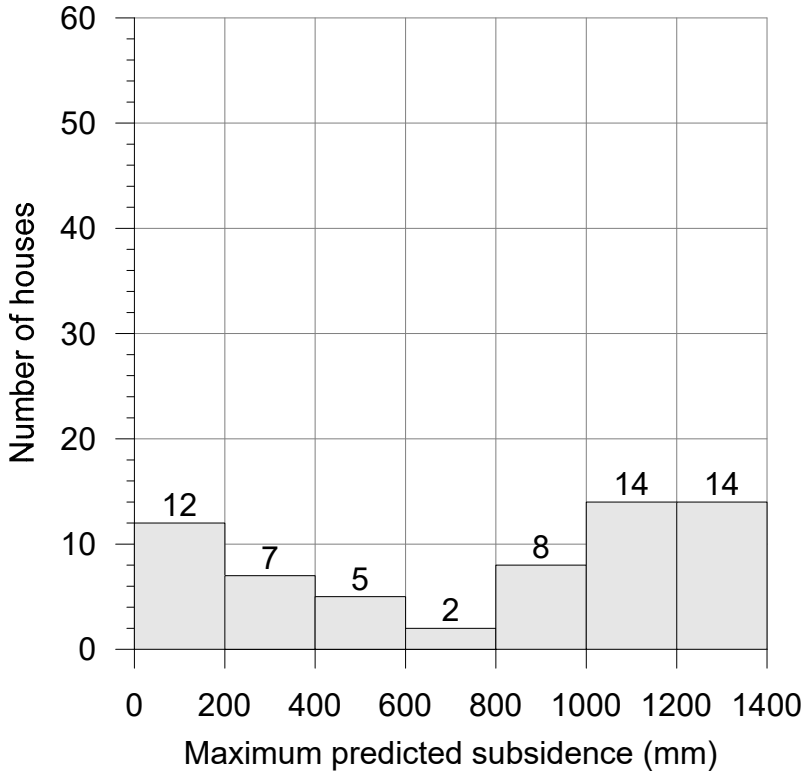


Fig. 3.69 Maximum predicted total conventional subsidence for the houses within the Study Area after extraction of LWs S1A to S7A

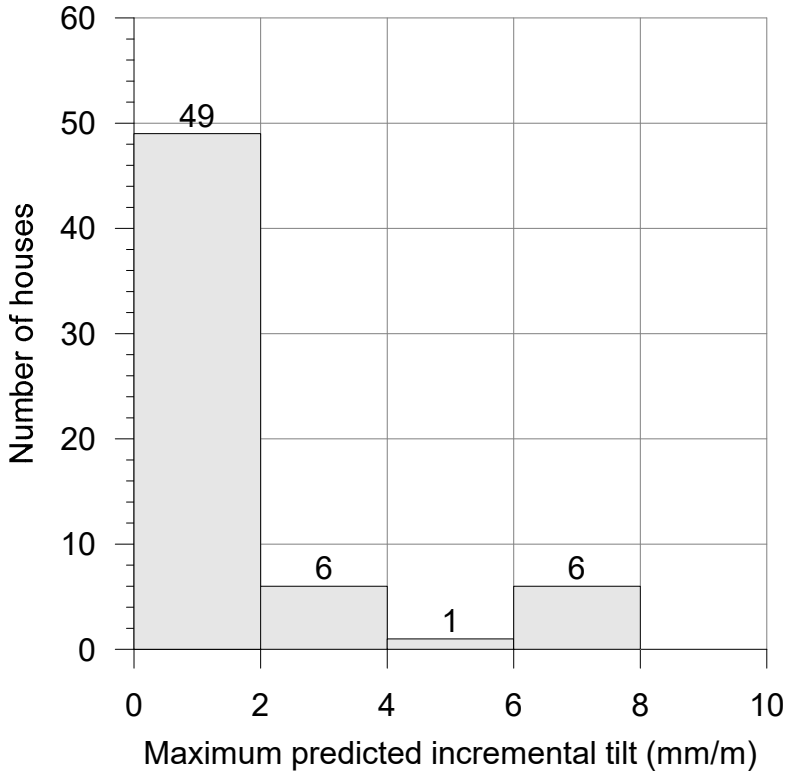


Fig. 3.70 Maximum predicted incremental conventional tilts for the houses within the Study Area due to extraction of LW S7A

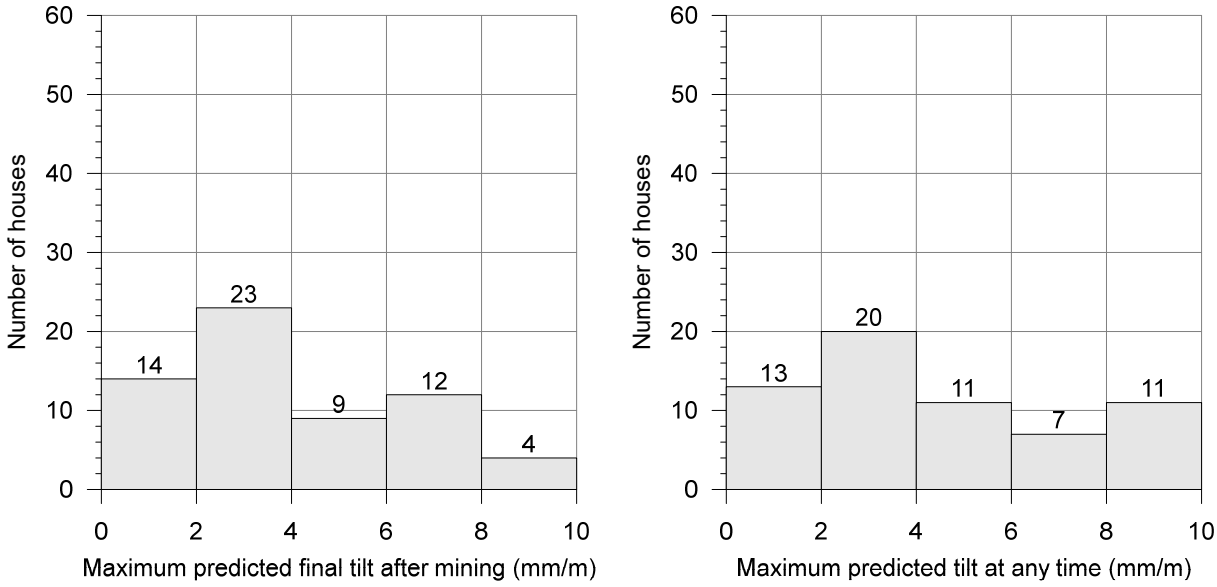


Fig. 3.71 Maximum predicted conventional tilts after the extraction of longwalls S1A to S7A (left) and maximum predicted conventional tilts after extraction of any longwall (right)

These distributions indicate that for most houses in the Study Area (52 out of 62 houses, or 84% of the total), the maximum predicted incremental subsidence due to LW S7A is a relatively small proportion of the maximum predicted total subsidence after extraction of LWs S1A to S7A. Similarly, the maximum predicted incremental tilt due to LW S7A is relatively small (< 2 mm/m) for most houses in the Study Area (49 out of 62 houses, or 79% of the total).

Distributions of the maximum predicted incremental conventional hogging and sagging curvatures for the houses due to extraction of LW S7A are illustrated in Fig. 3.72, while Fig. 3.73 shows the corresponding distributions of maximum predicted total conventional hogging and sagging curvatures after extraction of LWs S1A to S7A under the *Modified Layout*.

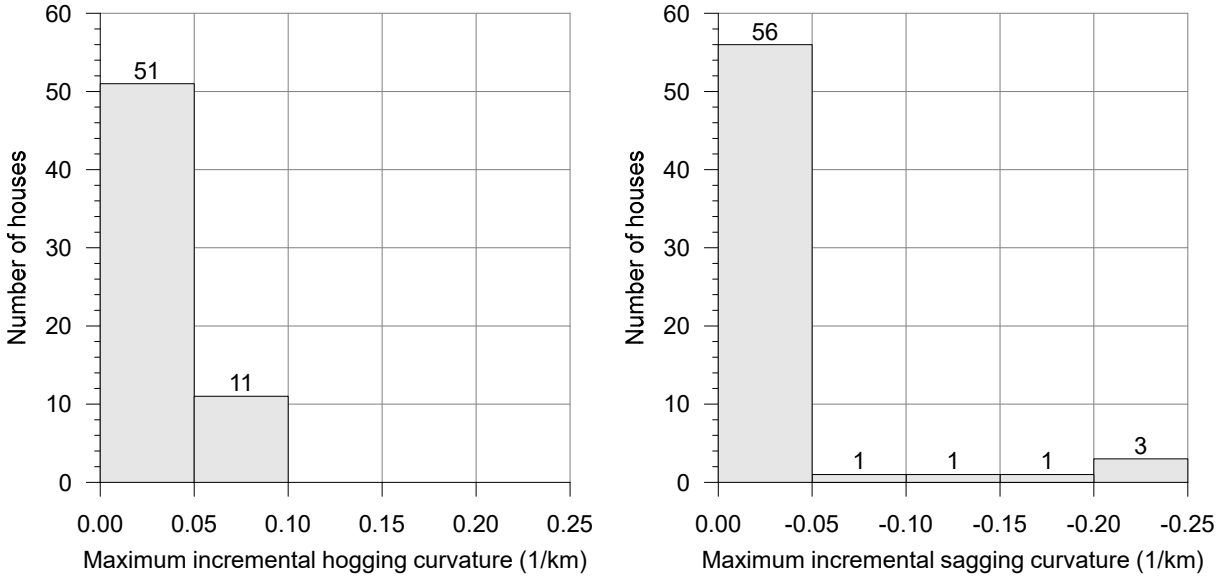


Fig. 3.72 Maximum predicted incremental conventional hogging curvature (left) and sagging curvature (right) for the houses within the Study Area due to extraction of LW S7A

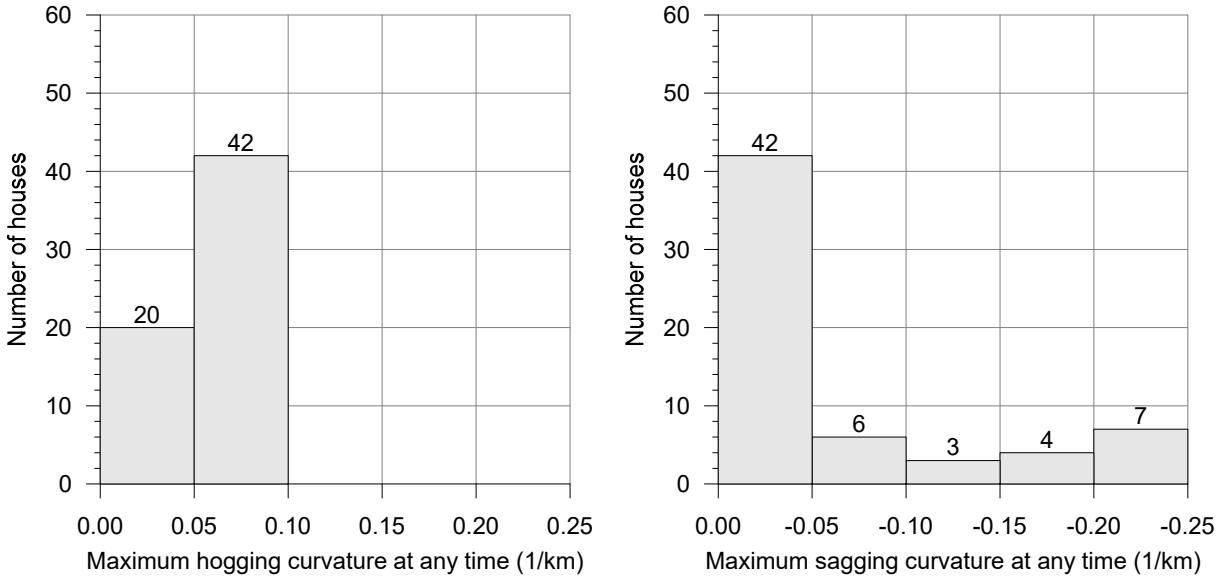


Fig. 3.73 Maximum predicted conventional hogging curvature (left) and sagging curvature (right) for the houses within the Study Area after extraction of LWs S1A to S7A

These distributions show that the maximum predicted incremental hogging curvature due to LW S7A is < 0.10 km^{-1} for all of the houses in the Study Area, and the maximum predicted incremental sagging curvature due to LW S7A is < 0.05 km^{-1} for 56 out of 62 tanks (or 84 %).

The maximum predicted conventional strains for the houses, based on applying a factor of 15 to the maximum predicted conventional curvatures, are 1.4 mm/m tensile and 3.5 mm/m compressive. Non-conventional movements can also occur as a result of, among other things, anomalous movements. The analysis of strains provided in Section 2.5 includes those resulting from both conventional and non-conventional anomalous movements.

The houses are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 2.5. The results for survey bays located above goaf are provided in Fig. 2.6 and the results for survey bays located above solid coal are provided in Fig. 2.8.

3.16.3. Impact assessments for the houses

The following sections provide the impact assessments for the houses within the Study Area.

Potential impacts resulting from vertical subsidence

Vertical subsidence does not directly affect the stability or serviceability of houses. The potential for impacts on houses is affected by differential subsidence, which includes tilt, curvature and strain, and the impact assessments based on these parameters are described in the following sections.

Vertical subsidence may affect the heights of some the houses above the flood level. The potential impacts on the houses resulting from the changes in flood level from the proposed mining has been assessed as part of the flood model, which is described in the Water Management Plan (Tahmoor Coal, 2023a).

Potential impacts resulting from tilt

It has been found from past longwall mining experience that tilts of less than 7 mm/m generally do not result in any substantial impacts on houses. Some minor serviceability impacts can occur at these levels of tilt, including door swings and issues with roof gutter and wet area drainage, all of which can be remediated using normal building maintenance techniques. Tilts greater than 7 mm/m can result in greater serviceability impacts which may require more substantial remediation measures, including the relevelling of wet areas or, in some cases, the relevelling of the building structure.

The predicted maximum tilts are less than 7 mm/m at 53 of the houses within the Study Area (i.e. 85 % of the total) at the completion of mining. It is expected that only minor serviceability impacts would occur at these houses, as the result of tilt, which could be remediated using normal building techniques.

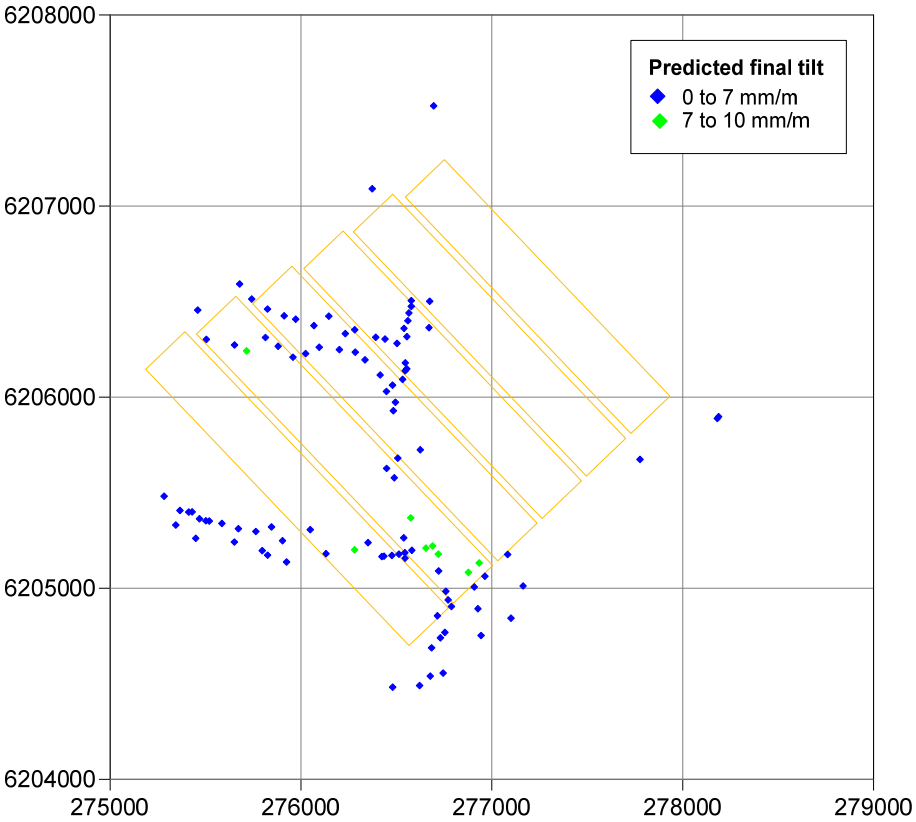
The maximum predicted tilt for the houses is 8.5 mm/m (i.e. 0.85 %, or 1 in 118). A total of 9 houses (i.e. 15 % of the total) are predicted to experience tilts greater than 7 mm/m. The potential for serviceability impacts is greater for these houses. In some cases, more substantial remediation measures may be required, such as relevelling of the building structure.

It should be noted that the effect of extracting LW S7A under the *Modified Layout* is predicted to result in a reduction of tilt for some houses when compared to be *Approved Layout*. This is because mining-induced tilts due to the extraction of LWs S1A to S6A is predicted to be reversed due to the extraction of LW S7A.

The distribution of predicted final tilts for the houses within the Study Area after the extraction of LW S6A is provided in Fig. 3.74 and LW S7A is provided in Fig. 3.75.

It can be seen that some houses that were predicted to experience more than 7 mm/m tilt after the extraction of LW S6A are predicted to experience a reduction in tilt after the extraction of LW S7A.

Houses located above previously extracted longwalls at Tahmoor have experienced mining-induced tilts within the predicted range for the *Amended Layout*. This includes tilts at magnitudes of 10 mm/m and greater, which were observed above Tahmoor Mine LW 24A and above the south-eastern ends of LWs 25 and 26, in the areas of increased subsidence. To date, there have been very few claims to SA NSW for impacts on houses as a result of mining induced tilt. Claims in these areas have mainly been based on impacts resulting from mining induced curvatures or strains.



Note: the image is reproduced from Report No. MSEC1192

Fig. 3.74 Distribution of predicted final tilts for the houses at the completion of LW S6A

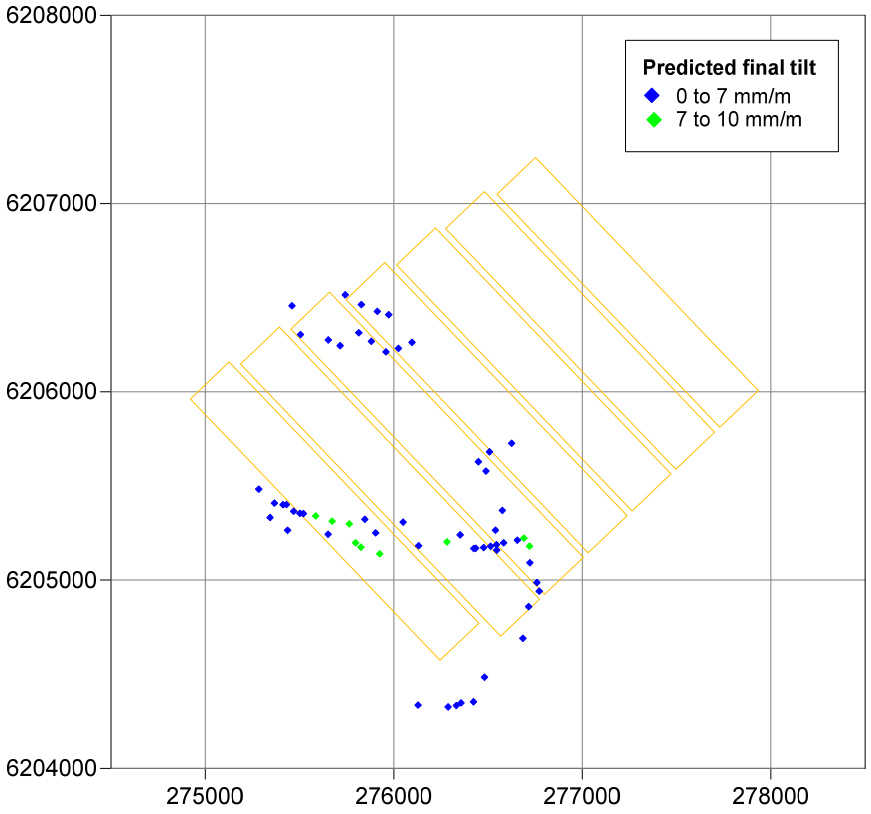


Fig. 3.75 Distribution of predicted final tilts for the houses at the completion of LW S7A

The distribution of measured tilts for the survey bays located in the area of increased subsidence above LWs 24B, 25 and 26, is provided in Fig. 3.76. A gamma function has also been fitted to the observed data which is shown by the blue curve.

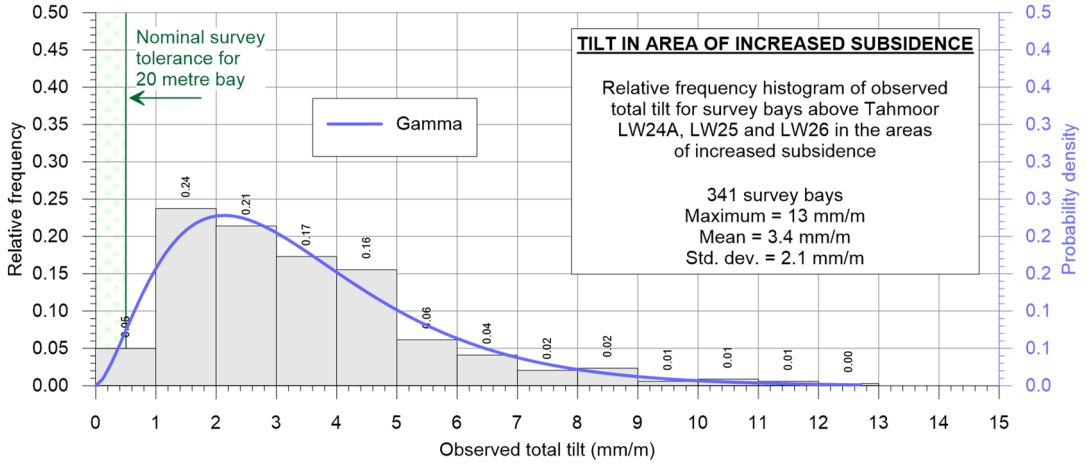


Fig. 3.76 Distribution of measured tilts for survey bays located in the areas of increased subsidence above Tahmoor Mine longwalls 24A, 25 and 26

It can be seen from the above figure, that the maximum observed total tilt for the survey bays in the areas of increased subsidence was 13 mm/m, which is greater than the maximum predicted tilt at the houses directly above the proposed longwalls, which is 9 mm/m.

The range of predicted tilts for the houses within the Study Area, therefore, is less than that observed above previously extracted longwalls at Tahmoor Mine, including LW 24A and above the south-eastern ends of LWs 25 and 26, in the areas of increased subsidence. It is expected that the incidence of claims for impacts resulting from the mining induced tilt would be low, due to the extraction of the proposed longwalls, as was previously experienced in the areas of increased subsidence.

It is expected that, in all cases, the houses within the Study Area will remain in safe and serviceable conditions as the result of the mining induced tilts as tilts by themselves rarely impact on the stability of building structures at the levels that are predicted to occur.

Potential impacts resulting from curvature and strain

It has been found from past longwall mining experience that the majority of mining-induced impacts on houses are a result of curvature and strain.

All 62 houses within the *Study Area* are predicted to experience hogging curvatures less than 0.10 km^{-1} and 48 houses (i.e. 77 % of the total) are predicted to experience sagging curvatures less than 0.10 km^{-1}, which represent minimum radii of curvature of 10 kilometres.

The maximum predicted curvatures for the houses within the *Study Area* are 0.10 km^{-1} hogging and 0.23 km^{-1} sagging, which represent minimum radii of curvature of 10.5 kilometres and 4.3 kilometres, respectively.

The distribution of predicted curvatures for the houses within the Study Area is provided in Fig. 3.77.

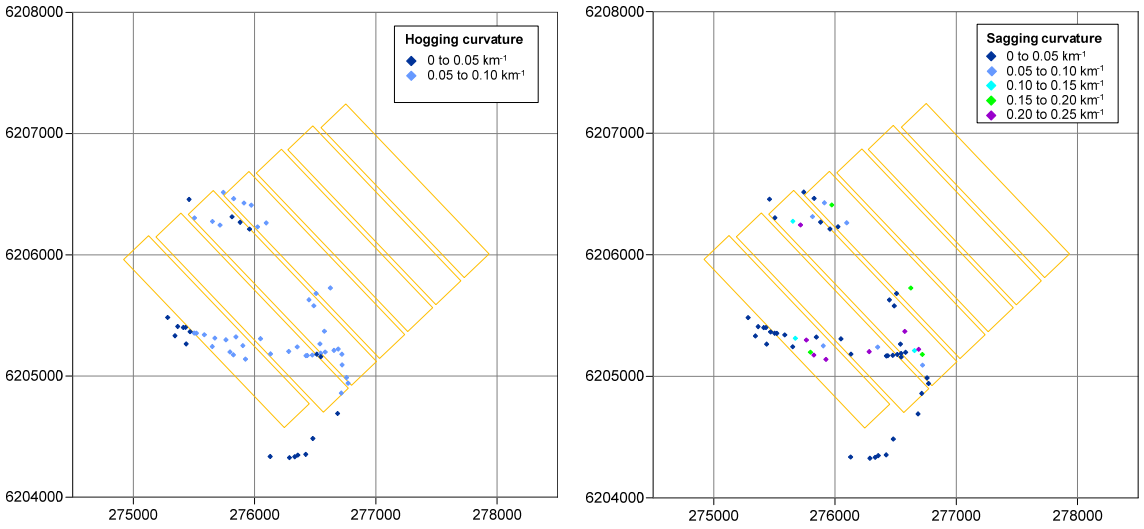


Fig. 3.77 Distribution of predicted hogging curvatures (left) and sagging curvatures (right) for houses at the completion of mining

The above figure shows that the greatest predicted curvatures occur directly above the proposed longwalls.

Houses located above previously extracted longwalls at Tahmoor have experienced mining-induced curvatures within the predicted range for the *Amended Layout*. This includes curvatures greater than 0.10 km^{-1}, which were observed above Tahmoor Mine LW 24A and above the south-eastern ends of LWs 25 and 26, in the areas of increased subsidence. The distributions of measured hogging and sagging curvatures for the survey bays located in the area of increased subsidence above LW 24A, LWs 25 and 26, is provided in Fig. 3.78. Generalised Pareto Distributions (GDPs) have also been fitted to the observed data which are shown by the blue curves.

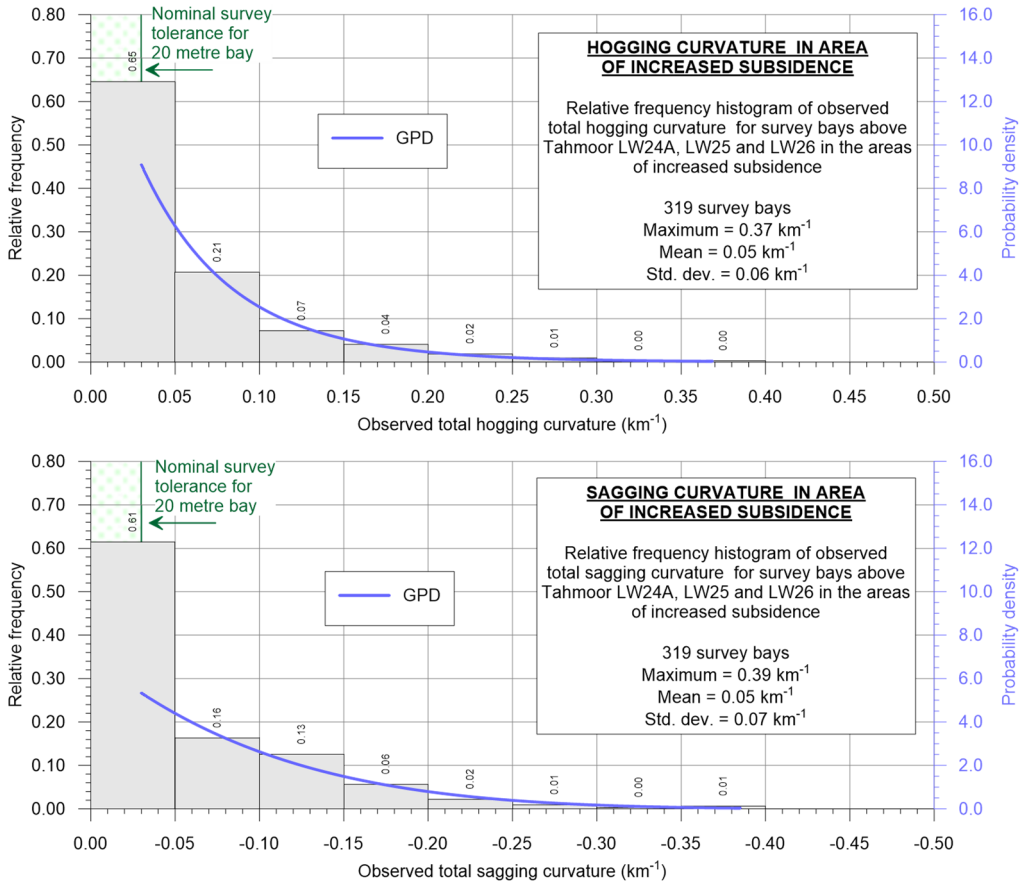


Fig. 3.78 Distributions of measured curvatures for survey bays located in the areas of increased subsidence above Tahmoor Mine LWs 24A, 25 and 26

It can be seen from the above figure, that the maximum observed total curvatures for the survey marks in the areas of increased subsidence were 0.37 km^{-1} hogging and 0.39 km^{-1} sagging, which are greater than the maximum predicted curvatures at the houses within the Study Area of 0.10 km^{-1} hogging and 0.23 km^{-1} sagging.

The range of predicted curvatures for the houses within the Study Area are, therefore, less than those observed above previously extracted longwalls at Tahmoor Mine, including LW 24A and above the eastern ends of LWs 25 and 26 in the areas of increased subsidence. It is expected, therefore, that the incidence of claims for impacts resulting from the mining induced curvature and strain for the proposed longwalls would be similar to but slightly less than those previously experienced in the areas of increased subsidence. The methods for predicting and assessing impacts on building structures have developed over time as knowledge and experience has grown. MSEC has provided predictions and impact assessments for the houses within the Study Area using the latest methods available at the time of writing.

Building structures have been directly mined beneath at a number of collieries throughout the NSW Coalfields. The experience gained has provided substantial information that has been used to continually develop the methods of impact assessment for houses. The assessments provided in this report are based on the latest research, which is summarised in Appendix C of Report No. MSEC1192.

Trend analyses were conducted following the mining of Tahmoor Mine LWs 22 to 29. The analyses indicated that the chance of impact is higher for the following houses:-

- Houses predicted to experience higher strains and curvatures,
- Houses with masonry walls,
- Masonry walled houses that are constructed on strip footings,
- Larger houses, and
- Houses with variable foundations, such as those with extensions added.

The probabilities of impacts for each house within the Study Area have been assessed using the method developed as part of ACARP Research Project C12015 (Waddington, 2009) and it has been updated based on observations of impacts at Tahmoor up to 2016 when the extraction of Longwall 29 was completed. This method uses the primary parameters of ground curvature and type of construction and is described in Appendix C of Report No. MSEC1192. The parameter of strain is indirectly used in this method due to its relationship with curvature. A summary of the predicted movements and the assessed impacts for each house within the Study Area is provided in Table C.03, in Appendix C.

The overall distribution of the assessed impacts for the houses within the Study Area is provided in Table 3.29. The assessed impacts have been determined based on the existing construction type of each house, as described in Section 3.16.1.

Table 3.29 Assessed impacts for houses within the Study Area

Group	Repair category			
	No Claim or R0	R1 or R2	R3 or R4	R5
All houses (total of 62)	41 (66 %)	14 (23 %)	6 (9 %)	1 (1 %)
Directly above proposed longwalls (total of 49)	30 (59 %)	13 (26 %)	5 (10 %)	1 (2 %)
Directly above solid coal (total of 13)	11 (83 %)	2 (13 %)	0 (4 %)	< 1 (< 0.5 %)

In comparison, extensive data has come from the extraction of Tahmoor Mine Longwalls 22 to 29, where approximately 1,900 houses have experienced mine subsidence movements. A summary of the observed distribution of impacts for all houses within a 35° angle of draw of previously extracted Longwalls 22 to 29 as at 2016 is provided in Table 3.30.

Table 3.30 Observed frequency of impacts for building structures resulting from the extraction of Tahmoor Mine longwalls 22 to 29

Group	Repair category			
	No Claim or R0	R1 or R2	R3 or R4	R5
All houses within 35 degree angle of draw of LWs 22 to 29 (total of 1890)	1430 (76 %)	329 (17 %)	111 (6 %)	20 (1 %)
All houses, located directly above LWs 24A to 27 in Zone of Increased Subsidence (total of 432)	235 (54 %)	128 (30 %)	55 (13 %)	14 (3 %)

As discussed previously, the range of predicted curvatures for the houses within the Study Area are less than but similar to those observed above Tahmoor Mine Longwalls 24A to 27 within the observed zone of increased subsidence.

When the assessed distribution of impacts for the houses located directly above the proposed longwalls (second row of Table 3.29) are compared with the observed distribution of impacts of houses and major civil structures located directly above Longwalls 24A to 27 within the zone of increased subsidence (bottom row of Table 3.30), it can be seen that these are reasonably similar.

As mentioned earlier, the assessed impacts have been undertaken based on the existing construction type of each house. It is recognised that houses may be rebuilt in the future before the proposed mining occurs. The proportion of houses impacted by mining would, for example, increase if a greater proportion of houses are constructed directly above the proposed longwalls, or if a greater proportion of houses are constructed with brick walls rather than timber-framed weatherboard style structures. The most vulnerable style of house affected by mine subsidence movements above Tahmoor Mine Longwalls 22 to 29 were constructed as brick or brick-veneer houses on strip footings.

Severe impacts have previously occurred as a result of substantial non-conventional movements and in plateau areas away from incised valleys, such as where the houses are located within the Study Area. The precise location of non-conventional movements cannot be predicted prior to mining. The impacts, however, develop gradually such that they can be detected early and repairs can be undertaken incrementally to ensure that the houses remain safe and serviceable during mining.

As noted in Appendix C of Report No. MSEC1192, at the time of writing ACARP Research Project C12015 (Waddington, 2009), the observed proportion of houses where the Mine Subsidence Board (MSB, now SA NSW) and affected landowners had agreed to rebuild rather than repair, i.e. Category R5 impacts was less than 0.5 %. Since the publication of the research report, the proportion of houses where a decision has been made to rebuild has increased to approximately 1.1 % overall and 3.2 % above Longwalls 24A to 27 within the observed zone of increased subsidence.

The observed proportion of houses with Category R1 to R4 impacts have also increased since the original ACARP study. This is partly due to the time lag effect between the mining impact, when damage is claimed by residents and when the nature and level of the damage requiring repairs is assessed in detail by SA NSW. The latest review includes observations up to the end of Longwall 29 in 2016, which was approximately two years after the completion of Longwall 27 and one year after the completion of Longwall 28, which was the last panel to directly mine beneath the urban areas of Tahmoor.

The primary risk associated with mining beneath houses is public safety. Residents have not been exposed to immediate and sudden safety hazards as a result of impacts that occur due to mine subsidence movements in the NSW Coalfields, where the depths of cover were greater than 350 metres, such as the case above the proposed longwalls. This includes the recent experience at Tahmoor Mine, which has affected more than 1,950 houses, and the experiences at Appin, Teralba, West Cliff and West Wallsend Collieries, which have affected around 500 houses.

Emphasis is placed on the words “immediate and sudden” as in rare cases, some structures have experienced severe impacts, but the impacts did not present an immediate risk to public safety as they developed gradually with ample time to temporarily relocate residents.

All houses within the Study Area are expected to remain safe and repairable throughout the mining period, provided that effective management measures are adopted during mining and these are described in Section 3.16.4.

3.16.4. Management of potential impacts on the houses

Tahmoor Mine has extensive experience of mining beneath urban areas. It has developed and acted in accordance with a risk management process to manage potential impacts to residential structures during the mining of LWs 22 to 32, LWs W1-W4 and LWs S1A and S2A.

The Subsidence Management Process has been developed in consideration of the following facts and observations:

1. Australian standards have been available for use in the design of structures since 1948. The great majority of structures at Tahmoor and Thirlmere (approximately 80 %) have been constructed after the declaration of the Bargo Mine Subsidence District in November 1975.
2. There is sufficient redundancy in structural design such that ductile deformation will develop and be noticeable to residents before structural failure occurs.
3. Subsidence movements develop gradually over time at Tahmoor Mine as they have above other previously extracted longwalls at similar depths of cover.
4. Experiences during the mining of LWs 22 to 32 and LWs W1-W3 have found that the most effective method of managing potential impacts on the safety and serviceability of structures are by way of community consultation. Residents living within the active subsidence zone have often provided early feedback to Tahmoor Mine and/or SA NSW about impacts developing at their houses or along their local roads. Contact is made well before impacts develop to a level of severity sufficient to become a safety hazard.
5. On the basis of the above, there is sufficient time for residents to notify Tahmoor Mine or SA NSW of significant displacement or deflection well before structural failure will occur.
6. The conclusions are supported by the observation that residents have not been exposed to immediate and sudden safety hazards as a result of impacts that occur due to mine subsidence movements at Tahmoor Mine and above other previously extracted longwalls at similar depths of cover. This includes the recent experience at Tahmoor Mine during the mining of LWs 22 to 32 and LWs W1-W4, which have affected more than 2000 houses and civil structures.

While severe impacts have developed during the mining of LWs 22 to 32, there is sufficient redundancy in structural design such that when structures have experienced severe impacts, they have developed gradually with ample time for residents to notify Tahmoor Mine or SA NSW to repair the structure and/or relocate residents before structural failure occurs.

While the three most important factors in managing risks to public safety are redundancy in structural design, gradual development of subsidence movements and an effective community consultation program, a number of additional management measures have been undertaken, including site specific investigations, regular surveys and inspections during mining and triggered response measures.

Tahmoor Coal has developed a Subsidence Management Plan to manage potential impacts to houses during the mining of LWs S1A to S6A under the *Approved Layout*. It is recommended that Tahmoor Coal continues its current practice of ensuring that built structures remain safe and serviceable at all times during mining. It is recommended that Tahmoor Coal, in consultation with landowners, study the potential for impacts on the structures and other infrastructure and develop management measures. The study would require input from structural and subsidence engineers. The risk management process includes the following processes:-

1. Regular consultation, cooperation and coordination with the community before, during and after mining. This includes letters and door knocking to all residents of structures that will soon be affected by subsidence. The letters offer a free pre-mining inspection and hazard identification inspection by a structural engineer;
2. Site-specific investigations, where they are necessary and appropriate, into the conditions of buildings and associated structures and their surrounding environment (where access is allowed). The site-specific investigations have been and will continue to be undertaken early so that there is adequate time, if required, to arrange additional inspections and/or surveys and implement any mitigation measures before mining-induced impacts are experienced;

   For properties located directly above the first 300 metres of the commencing end of a longwall, the investigations are targeted to be undertaken prior to extraction or at the latest, they will be undertaken prior to the first 200 metres of extraction of the longwall.

   The site-specific investigations include the following:

   a) Identification of structures from aerial photographs and kerbside inspections;
   b) Front of house risk and visual screening inspections by Tahmoor Coal in company with a structural engineer for all properties that are predicted to experience more than 20 mm of incremental vertical subsidence due to the extraction of each upcoming longwall. The purpose of the inspections is to identify hazards where access has not been granted by the landowner.

In some cases, particularly in semi-rural and rural areas, it is difficult to inspect a structure that is remote from the street front. Where these cases involve properties that are located directly above a longwall, Tahmoor Coal will request access to conduct a pre-mining inspection and hazard identification inspection by a structural engineer;

c) Tahmoor Coal will request access to conduct pre-mining geotechnical inspections of structures located on or immediately adjacent to steep slopes that are predicted to experience more than 20 mm of incremental vertical subsidence due to the extraction of each longwall;

d) Tahmoor Coal will request access to conduct pre-mining hazard identification inspections by a structural engineer (where access is allowed by the landowner) to properties with structures that have been specifically targeted on the basis that may be more sensitive to mine subsidence movements. These include:

   i) Commercial and business establishments, public amenities and public utilities;

   ii) Structures of heritage significance;

   iii) Structures that are located above hidden creeks (none identified within the *Study Area*);

   iv) Structures that are located above mapped geological structures (none identified within the *Study Area*);

   v) Structures that are located on or adjacent to steep slopes or that have been recommended for structural inspection by the geotechnical engineer;

   vi) Structures that have been identified as being potentially unstable or unsafe by landowners (Item 1), or from the front of house inspections (Item 2b);

   vii) Houses and units located outside the declared Mine Subsidence Districts; and

   viii) Houses and units estimated to have been constructed prior to the declaration of the Bargo Mine Subsidence District (in November 1975).

3. Implementation of pre-mining mitigation measures following inspections by the geotechnical engineer and the structural engineer, in consultation and agreement with the landowner.

4. Surveys and inspections during mining within the active subsidence area:

   a) detailed visual inspections and vehicle-based inspections along the streets;

   b) ground surveys along the streets;

   c) specific ground surveys for selected properties, where recommended by the geotechnical engineer or structural engineer due to their proximity to steep slopes or pre-existing condition;

   d) visual inspections of residential structures that are either: located on or adjacent to steep slopes, are in poor existing condition (based on the hazard identification inspections), have previously reported impacts, or where recommended by the Structures Response Group;

   e) visual inspections of pool fences and gates; and

   f) visual inspections of commercial, industrial and business establishments, public amenities and public utilities.

With appropriate management plans in place, it is considered that the houses will remain safe and serviceable at all times due to the extraction of the proposed LW S7A, even if actual subsidence movements were greater than the predictions or substantial non- conventional movements occurred.

The Subsidence Management Plan will be updated to include potential impacts due to the extraction of LW S7A under the *Modified Layout*.

3.17. Archaeological Sites

There are no lands within the Study Area declared as an Aboriginal Place under the *National Parks and Wildlife Act 1974*.

There are 9 archaeological sites which have been recently identified along Hornes Creek by heritage consultant EMM (2024) within the 600m Study Area for Natural Features. Their locations are shown in Drawing No. MSEC1348-10. The proposed LW S7A will not extract directly beneath the sites.

- 7 rockshelter sites were recorded, of which 6 sites contained potential archaeological deposits. No art was identified, although indeterminate charcoal markings were observed on the walls of two shelters.
- One grinding groove site was identified on a rockbar within Hornes Creek.
- One isolated find was identified on a fire track.

Detailed descriptions of the archaeological sites within the Study Area are provided in the Aboriginal Cultrual Heritage Assessment.

3.17.1. Predictions for the archaeological sites

The predicted conventional subsidence, tilts and curvatures for the archaeological sites within the Study Area are provided in Table C.10, in Appendix D. A summary of the maximum predicted conventional subsidence parameters for the archaeological sites is provided in Table 3.31. The predicted tilts are the maxima after the completion of any or all of the proposed longwalls. The predicted curvatures are the maxima at any time during or after the extraction of the proposed longwalls.

Table 3.31 Maximum Predicted Total Conventional Subsidence Parameters for the Archaeological Sites

Site Type	Maximum predicted total conventional subsidence (mm)	Maximum predicted total conventional tilt (mm/m)	Maximum predicted total conventional hogging curvature (km^{-1})	Maximum predicted total conventional sagging curvature (km^{-1})
Rock Shelter Site (WP1258RS)	50	< 0.5	< 0.01	< 0.01
Grinding Grooves (WP1263GG)	20	< 0.5	< 0.01	< 0.01
Isolated Find (48-2-0275)	20	< 0.5	< 0.01	< 0.01

The maximum predicted conventional strains for the archaeological sites, based on applying a factor of 15 to the maximum predicted conventional curvatures, are less than 0.2 mm/m tensile and compressive. Non-conventional movements can also occur as a result of, among other things, anomalous movements. The analysis of strains provided in Chapter 2.0 includes those resulting from both conventional and non-conventional anomalous movements.

The archaeological sites are at discrete locations and, therefore, the most relevant distributions of strain are the maximum strains measured in individual survey bays from previous longwall mining. The analysis of strains in survey bays during the mining of previous longwalls in the Southern Coalfield is discussed in Section 2.5.1. The results for survey bays above solid coal are provided in Fig. 2.8.

The grinding groove site is located on a rockbar within the valley and, therefore, could experience valley-related movements. A summary of the maximum predicted upsidence and closure movements for the stream at the location of this site is provided in Table 3.32.

Table 3.32 Maximum predicted total upsidence and closure for the archaeological sites

Site Type	Stream	Maximum predicted total upsidence (mm)	Maximum predicted total closure (mm)
Grinding Grooves (WP1263GG)	Hornes Creek	45	65

3.17.2. Impact assessments for the rock shelter

There are 9 rock shelters identified within the 600m Study Area for Natural Features to the west of LW S7A on Hornes Creek. The closest site is located approximately 330 metres to the side of LW S7A.

The maximum predicted conventional tilts and curvatures for the rock shelters are negligible and unlikely to result in adverse impacts on the rock shelter sites.

It is extremely difficult to assess the likelihood of instabilities for the rock shelters based upon predicted ground movements. The likelihood of the shelters becoming unstable is dependent on a number of factors which are difficult to fully quantify. These factors include jointing, inclusions, weaknesses within the rockmass, groundwater pressure and seepage flow behind the rockface. Even if these factors could be determined, it would still be difficult to quantify the extent to which these factors may influence the stability of the shelter naturally or when it is exposed to mine subsidence movements.

In this case, the shelters are located away from the proposed LW S7A, with the closest distance of 330 metres. As discussed in the assessment for cliffs in Section 3.5, no cliff instabilities have previously been observed above solid, unmined coal, during previous longwall mining in the Southern Coalfield at similar depths of cover. It is, therefore, unlikely that cliffs beyond the extent of the longwall panels will experience large instabilities. It is possible that isolated rock falls could occur during the mining period due to natural weathering processes. Any impacts are expected to represent less than 0.5 % of the total face area of the cliffs. The identified aboriginal rock shelter sites are a small proportion of the overall total face area of the cliffs, and any impacts are, therefore, expected to be even less 0.5 %.

Based on the experience from the Southern Coalfield, the likelihood of substantial physical impacts on rock shelters within the Study Area is very low.

3.17.3. Impact assessments for the Grinding Groove site

The grinding groove site is located approximately 520 metres to the side of LW S7A.

The maximum predicted conventional tilts and curvatures for the grinding groove site are negligible and unlikely to result in adverse impacts on the grinding groove site.

Hornes Creek is predicted to experience valley closure, including at the rockbar that hosts the grinding grooves. As discussed in Section 3.3, given the offset distance of the grinding site relative to LW S7A, the likelihood of fracturing occurring is considered to be low and in the unlikely event that it occurs, the fractures are expected to be minor and isolated. The identified grooves are a small proportion of the rockbar and, therefore, the likelihood of a fracture intersecting the griding grooves is considered to be extremely low.

3.17.4. Impact assessments for the Isolated Find site

The isolated find site is located approximately 520 metres to the side of LW S7A.

The maximum predicted conventional tilts and curvatures for the isolated find site are negligible and unlikely to result in adverse impacts on the isolated find site.

Given the offset distance of the site relative to LW S7A, the potential for cracking of the surface soils as a result of mine subsidence movements is extremely low. It is unlikely, however, that the isolated finds themselves would be impacted by surface cracking.

3.17.5. Impact assessments for the archaeological sites based on increased predictions

If the actual mine subsidence movements exceeded those predicted values by a factor of 2 times, the likelihood of impacts would still be expected to be very low.

While the predicted ground movements are important parameters when assessing the potential impacts on the rock shelters on cliffs, it is noted that the impact assessments for cliff instabilities have primarily been based on historical observations from previous longwall mining in the Southern Coalfield.

Similarly, while the predicted conventional and non-conventional ground movements at the grinding groove site are very small, it is noted that the impact assessments for rockbars have primarily been based on historical observations from previous longwall mining in the Southern Coalfield.

3.17.6. Management of potential impacts on the archaeological sites

Tahmoor Coal has developed a Heritage Management Plan to manage potential impacts to Aboriginal heritage sites for LWs S1A to S6A. The management plan included consultation with the community, monitoring and reporting. Tahmoor Coal will develop a Heritage Management Plan as part of the Mod 3 application for LW S7A, in consultation with the community, to manage the potential impacts on Aboriginal heritage sites during the extraction of the proposed longwalls.

3.18. Heritage Sites

There are no heritage sites located within the Study Area, as shown in Drawing No. MSEC1348-10.

The Wellers Road Overbridge and Picton Weir are items of heritage significance and their locations relative to the Study Area are shown in Drawing No. MSEC1348-10.

As discussed in Section 3.7, Tahmoor Coal and ARTC have implemented extensive measures to manage potential impacts on the Main Southern Railway and the associated railway structures due to the extraction of LW S1A to S6A, in accordance with a Railway Management Plan. The Railway Management Plan includes measures to manage potential impacts on Wellers Road Overbridge.

As discussed in Section 3.7, while the Wellers Road Overbridge is predicted to experience additional absolute horizontal movements as a result of the extraction of LW S7A, the potential for impacts on Wellers Road Overbridge due to differential horizontal movements does not materially change.

While the potential for impacts due to the extraction of LW S7A under the *Modified Layout* does not materially change from the potential for impacts under the *Approved Layout*, Tahmoor Coal will continue to implement the planned measures to manage the potential for impacts on the Main Southern Railway, as is currently planned during the extraction of LW S1A to S6A. The Railway Management Plan will be extended to include management of potential impacts due to the extraction of LW S7A.

As discussed in Section 3.10, Tahmoor Coal and Wollondilly Shire Council are developing measures to manage potential impacts on the Picton Weir due to the extraction of LW S1A to S6A, in accordance with a Picton Weir Management Plan, which is required prior to the commencement of LW S3A.

While the potential for impacts on the Picton Weir due to the extraction of LW S7A is higher than the potential for impacts under the *Approved Layout*, the methods of managing potential impacts on the Weir does not materially change. The Picton Weir Management Plan will be extended to include management of potential impacts due to the extraction of LW S7A.

3.19. Summary

The maximum predicted subsidence parameters within the Study Area, based on the *Modified Layout*, are similar to those based on the *Approved Layout*.

The potential for impacts has been assessed based on the predicted subsidence movements, consultation with infrastructure owners and experiences gained during the extraction of previous longwalls at Tahmoor Mine and more broadly from experiences during the extraction of previous longwalls at similar depths of cover at nearby mines in the Southern Coalfield.

The overall findings of the assessments undertaken by MSEC are that the levels of impact and damage to all identified natural features and built infrastructure are manageable and can be controlled by the preparation and implementation of Subsidence Management Plans (or Extraction Plans), many of which have been successfully implemented during previous mining at Tahmoor Mine. These management plans are developed in consultation with the owners of infrastructure and are approved by relevant government agencies. The findings in this report should be read in conjunction with all other associated consultant reports.

Recommended management measures generally include monitoring of ground movements and the condition of surface features. Some mitigation measures are recommended to mitigate or avoid the risk of serious consequences should impacts occur to some critical surface features.

It is recommended that Tahmoor Coal continues to develop management plans to manage the potential impacts for the surface features due to the extraction of the proposed LW S7A.

4.0 REFERENCES

ATC (2024). *Tahmoor South Domain Longwalls South 1A – South 7A Flood Study*, ATC Williams, Report No. 121171-23R002-Rev 1, March 2024.

APCRC (1997). *Geochemical and isotopic analysis of soil, water and gas samples from Cataract Gorge*. George, S. C., Pallasser, R. and Quezada, R. A., APCRC Confidential Report No. 282, June 1997.

ATC Williams (2022). *Tahmoor South LW S1A-S6A Water management Plan – Myrtle Creek and Redbank Creek Remediation program Review*, May 2022, document 121171.17-R02d.

Australian Standards Association, AS 2870 - 1996, *Residential Slabs and Footings – Construction.*

Barbato, J., et al. (2016). "*Prediction of horizontal movement and strain at the surface due to longwall coal mining*". International Journal of Rock Mechanics & Mining Sciences. Vol 84, April 2016, pp 105-118.

Barbato, J., et al. (2017). *Development of Predictive Methods for Horizontal Movement and Strain at the Surface due to Longwall Mining.* Mining Technology, October 2017

DPIE (2008a). *Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield – Strategic Review.* Department of Planning, Industry and Environment, 2008.

DPIE (2008b). *Strategic Review of Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield.* Department of Planning, Industry and Environment, 2008.

DPIE (2011). *Major Project Assessment: Bulli Seam Operations Project*, Director-General's Environmental Assessment Report Section 75I of the Environmental Planning and Assessment Act 1979. Department of Planning, Industry and Environment, December 2011.

Douglas Partners (2022). *Report on Geotechnical Assessment, Longwalls S1A to S6A, Bargo*, prepared for Tahmoor Coal, May 2022, document R.001

EMM (2020a), *Tahmoor South Project, Second Amendment Report and Response to Submissions.* EMM Consulting Pty Limited, 2020.

EMM (2020b), *Tahmoor South Project: Wirrimbirra Sanctuary, Statement of Heritage Impact.* EMM Consulting Pty Limited, 2020.

EMM (2024), Tahmoor Mod 3 – Heritage survey outcomes summary, EMM, 28 February 2024.

Fluvial Systems (2013). *Tahmoor South Project – Geomorphology*. Fluvial Systems Pty Ltd, 2013.

Gale, W., Sheppard, I. (2011). *Investigation into Abnormal Increased Subsidence above Longwall Panels at Tahmoor Colliery NSW*.

Gale, W., Page,J. (2004). *Mining and the Bargo River, Presentation to MSTS*.

Gilbert & Associates, 2014, *Tahmoor South Project Surface Water Baseline Study*

Gilbert & Associates, 2014, *Tahmoor South Project Water Management System and Site Water Balance, J1210-1*

Gordon Geotechniques (2013). *Feasibility Geotechnical Assessment – Tahmoor South Project. Gordon Geotechniques*. Report No. TahmoorSth13 – R1, July 2013.

Grainger, M.A. (1993). *Effects of mining on railway infrastructure and developments in their control*. Proceedings of the Institution of Civil Engineers, Transport, 100, May, pp. 83-93.

Haigh, C. B. (1954). *Picton Water Supply*. Sydney Water Board Journal, April 1954.

Holla, L. and Armstrong, M., (1986). *Measurement of Sub-Surface Strata Movement by Multi-wire Borehole Instrumentation*. Proc. Australian Institute of Mining and Metallurgy, 291, pp. 65-72.

Holla, L. (1991). *Reliability of Subsidence Prediction Methods for Use in Mining Decisions in New South Wales.* Conference on Reliability, Production and Control in Coal Mines, Wollongong.

Holla, L. and Barclay, E. (2000). *Mine Subsidence in the Southern Coalfield, NSW, Australia.* Published by the Department of Mineral Resources, NSW.

Hydro Engineering and Consulting (2020a). *Tahmoor South Project Surface Water Baseline Study*. Hydro Engineering and Consulting, 2020.

Hydro Engineering and Consulting (2020b). *Tahmoor South Project Flood Study*. Hydro Engineering and Consulting, 2020.

HydroSimulations (2020). *Tahmoor South Second Amended Project: Groundwater Assessment for Tahmoor Coal Pty Ltd*. HydroSimulations, 2020.

JMA (2014). *Bridges over Main Southern Rail, Bargo*. John Matheson & Associates Pty Ltd, Report No. R0237, May 2014.

Kapp (1982). *Subsidence from Deep Longwall Mining of Coal Overlain by Massive Sandstones*. Kapp, W.A. Proc. Australasian Ins. Min. Met., 7/1 – 7/9.

Kay, D.J., et al. (2017). *Experiences from Longwall Mining beneath Railway Cuttings.* Kay, D.J.; Pidgeon, A.; Bloor, C.; Christie, D.; Leventhal, A.; Matheson, J.; Robinson, G.; Rolles, J.; Pinkerton, R.; Barber, R.; Sheppard, I.; Talbert, D.; Brunero, C.; Patterson, D., Proceedings of the 10th Triennial Mine Subsidence Technological Society Conference, Pokolbin, Hunter Valley, NSW, 5-7 November 2017 (pp. 95-110).

Kratzsch, H. (1983). *Mining Subsidence Engineering*, Published by Springer - Verlag Berlin Heidelberg New York.

Lea, K.R. (1991). *Technical Considerations with respect to Longwall Mining beneath Railways in particular panels 9 & 10 from Teralba Colliery*. Report to State Rail Authority of New South Wales, Cityrail.

Leventhal, et al. (2011). *Management of Mine Subsidence Impact upon Mainline Railway Infrastructure - The Flirtation of Tahmoor Longwall 25 with Myrtle Creek Culvert*. Leventhal, A., Matheson, J., Kay, D., Christie, D., Hull, T., Steindler, A., Robinson, G., Sheppard, I. Mine Subsidence Technological Society Eighth Triennial Conference, May 2011.

Leventhal, et al. (2017). *Valley Closure - How Much Can a Culvert Bear?* Leventhal, A.; Matheson, J.; Hull, A.; Steindler, A.; Sheppard, I. Mine Subsidence Technological Society Tenth Triennial Conference, November 2017.

Lohe, E.M. et al. (1992). *Sydney Basin – Geological Structure and Mining Conditions, Assessment for Mine Planning*. NERDDC Project No. 1239.

McElroy Bryan Geological Services, (2013). *Tahmoor South Project Feasibility Study Section 8: Geology and Coal Resources*. McElroy Bryan Geological Services Pty Ltd. August 2013.

Minister for Planning (2011). *Project Approval for Bulli Seam Operations Project*, Application Number 08_0150, Minister for Planning and Infrastructure, 22 December 2011.

McGill (2007). *Mitigating the Effects of Mine Subsidence Due to Coal Mining on Major Infrastructure Assets Critical to Sydney*. Proceedings of the MSTS Mine Subsidence Technological Society 7th Triennial Conference on Mine Subsidence, 26th to 27th November 2007.

Mills, K. (2003). *WRS1 monitoring results* – End of Longwall 9. SCT Operations Report: MET2659.

Mills, K. (2007). *Subsidence Impacts on River Channels and Opportunities for Control*. SCT Operations Report: MET2659.

Mills, K. and Huuskes, W. (2004). *The Effects of Mining Subsidence on Rockbars in the Waratah Rivulet at Metropolitan Colliery*. Proc. 6th Triennial Conference, Subsidence Management Issues, Mine Subsidence Technological Society, Maitland.

MSEC (2002). "WKA - *Handbook on the Undermining of Cliffs, gorges and River*. ACARP Project No. C8005 & C9067

MSEC (2006). *Tahmoor Colliery Longwalls 24 to 26 - The Prediction of Subsidence Parameters and the Assessment of Mine Subsidence Impacts on Surface and Sub-Surface Features due to mining Longwalls 24 to 26 at Tahmoor Colliery in support of an SMP Application.* Mine Subsidence Engineering Consultants, Report MSEC157, Revision C, March 2006.

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

MSEC (2017). *Tahmoor Mine – Tahmoor South Project Longwalls 101 to 206 – 2017 Mine Plan*. Mine Subsidence Engineering Consultants, 14 December 2017.

Niche (2020a). *Tahmoor South Project – Terrestrial Ecology Assessment.* Niche Environment and Heritage, 2020.

Niche (2020b). *Tahmoor South Project – Aquatic Ecology Assessment.* Niche Environment and Heritage, 2020.

Niche (2020c). *Tahmoor South Project – Aboriginal Cultural Heritage Assessment*. Niche Environment and Heritage, 2020.

Niche (2020d). *Tahmoor South Project – Historical Heritage Assessment*. Niche Environment and Heritage, 2020.

Niche (2020e). *Tahmoor South Project – Biodiversity Assessment Update.* Niche Environment and Heritage, 2020.

NRAtlas (2010). *Natural Resource Atlas* website, viewed 23rd April 2010. The Department of Natural Resources. http://nratlas.nsw.gov.au/

Patton and Hendren (1972). *General Report on Mass Movements*. Patton F.D. & Hendren A.J. Proc. 2nd Intl. Congress of International Association of Engineering Geology, V-GR1-V-GR57.

Reid, P. (1991). *Coal Mining Beneath Dams in NSW Australia.* 1991 ASDSO Annual Conference, September 1991, San Diego, USA pp 240-245.

Regal Heritage (2022). *Southern Coalfields Shelter Monitoring Statistical Analysis*, March 2022.

Robinson, M. (2007). *West Wallsend Colliery - A Coordinated Approach to Managing Subsidence Impacts on Multiple High Risk Sensitive Surface Features: LW27 Case Study*. Robinson, M. Proceedings of the MSTS Mine Subsidence Technological Society 7th Triennial Conference on Mine Subsidence, Nov 2007 (pp. 11-22).

SEA (2002). *A Review of the Likely Ground Conditions and the Appropriate Controls which need to be Considered as Part of the Mine Design Process in Tahmoor North*. Report No. 97083 (TAH)-23a.

Sefton (2000). *Overview of the Monitoring of Sandstone Overhangs for the Effects of Mining Subsidence Illawarra Coal Measures, for Illawarra Coal.* C.E. Sefton Pty Ltd, 2000.

SCIMS (2010). *SCIMS Online* website, viewed 23rd April 2010. The Land and Property Management Authority. http://www.lands.nsw.gov.au/survey_maps/scims_online

SCI (2008). *Inquiry into the Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield Strategic Review*, Southern Coalfield Inquiry, July 2008.

SCT (2013a). *Review of the Hydraulic Conductivity and Geotechnical Characteristics of the Overburden at Tahmoor South*. Strata Control Technologies. Report No. TAH4083, Revision 1, December 2013.

SCT (2013b). *Subsidence Impact Assessment for Selected Archaeological Heritage Sites at Tahmoor South Project*. Strata Control Technologies. Report No. TAH4090, December 2013.

SCT (2014). *Peer Review of Tahmoor South Subsidence Assessment*. Strata Control Technologies. Letter dated 24 March 2014.

SCT (2017). *Peer Review of Tahmoor South Preferred Project Layout Subsidence Assessment*. Strata Control Technologies. Letter dated 11 December 2017.

SCT (2018a). *Investigation into the Potential Impact of the Nepean Fault on Subsidence Adjacent to LW32*. Strata Control Technologies. TAH4851, 2 May 2018.

SCT (2018b). *Structural Determinations of the Nepean Fault Adjacent to Tahmoor Mine*. Strata Control Technologies. TAH4817, 2 May 2018.

SLR (2022a). *LW S1A-S6A Extraction Plan - Groundwater Technical Report*, prepared for Tahmoor Coal, May 2022, document 610.30637.00000-R01-v3.0.

SLR (2022b). *Tahmoor South - Baseline Private Bore Assessment Report*, prepared for Tahmoor Coal, May 2022, document 310.30637.00000-R01-v3.0.

SLR (2022c). *Tahmoor Extraction Plan LW S1A-S6A Land and Agricultural Resource Assessment*, prepared for Tahmoor Coal, April 2022, document 630.12732.002-R01-v1.0.

Swarbrick, et al., (2007). *Subsidence Monitoring at Cataract Tunnel Portal: Lessons Learnt*. Swarbrick, G., Vergara, M., Pinkster, H., and Landon-Jones, I. Proceedings of the MSTS Mine Subsidence Technological Society 7th Triennial Conference on Mine Subsidence, Wollongong, 2007, pp 43-51.

Tahmoor Coal (2022a). *Water Management Plan for LW S1A-S6A*, 2022.

Tahmoor Coal (2022b). *Land Management Plan for LW S1A-S6A*, 2022.

Tahmoor Coal (2022c). *Biodiversity Management Plan for LW S1A-S6A*, 2022.

Tahmoor Coal (2022d). *Heritage Management Plan for LW S1A-S6A*, 2022.

Tahmoor Coal (2022e). *Built Features Management Plan for LW S1A-S6A*, 2022.

Tahmoor Coal (2022f). *Public Safety Management Plan for LW S1A-S6A*, 2022.

Waddington, A.A (2009). *MSEC276 - The Prediction of Mining Induced Movements in Building Structures and the Development of Improved Methods of Subsidence Impact Assessment (ACARP C12015)*. ACARP Project C12015 (Australian Coal Association Research Program). pp 1-207.

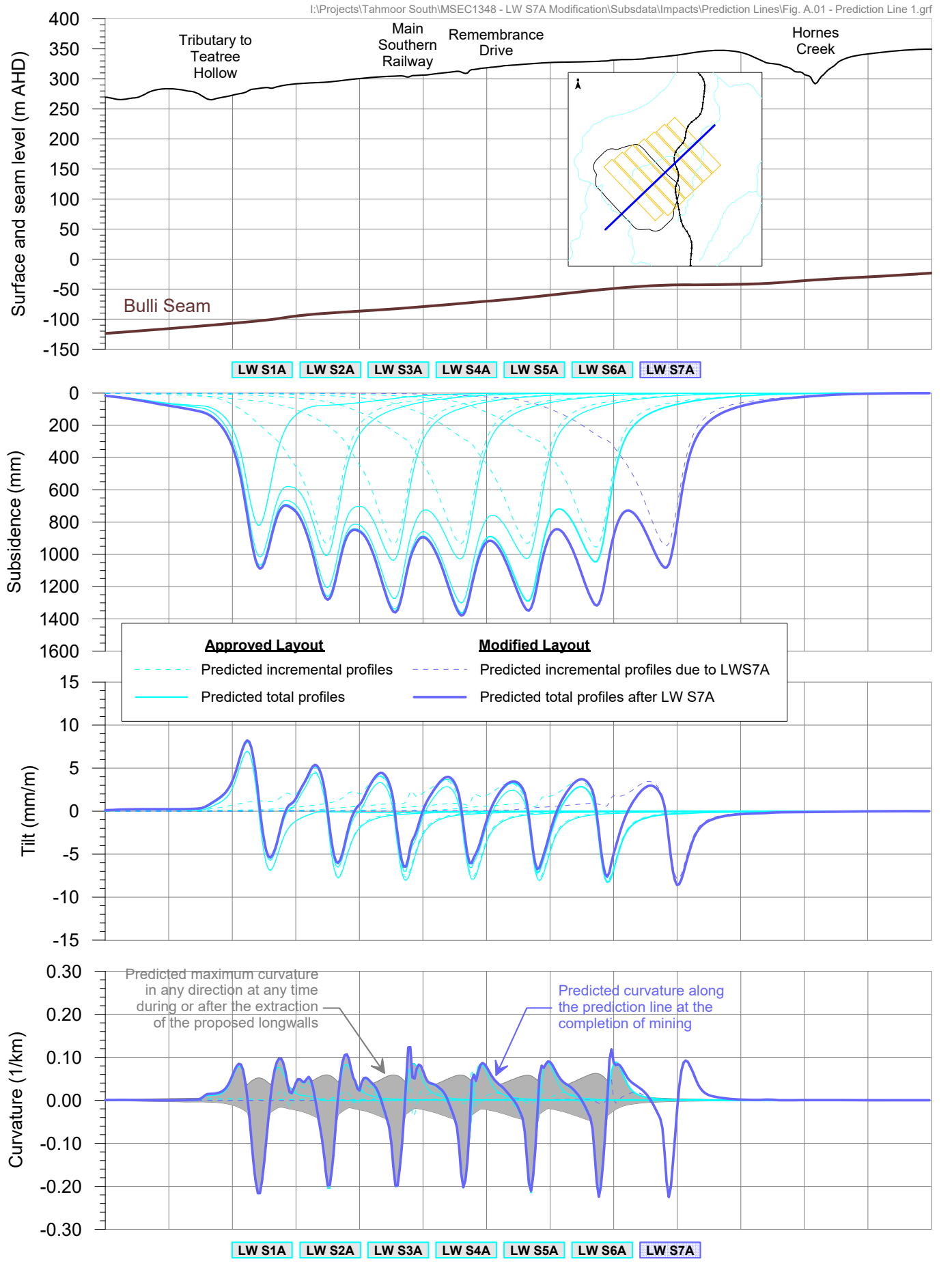
Waddington, A.A. and Kay, D.R. (2002). *Management Information Handbook on the Undermining of Cliffs, Gorges and River Systems*. ACARP Research Projects Nos. C8005 and C9067, September 2002.

Whittaker and Reddish (1989). *Subsidence – Occurrence, Prediction and Control.* Whittaker, B.N. and Reddish, D.J. Elsevier.

WSC (2011). *Growth Management Strategy*. Wollondilly Shire Council, 2011.

APPENDIX A. FIGURES

Predicted profiles of conventional subsidence, tilt and curvature along Prediction Line 1 resulting from the extraction of Longwalls S1A to S7A

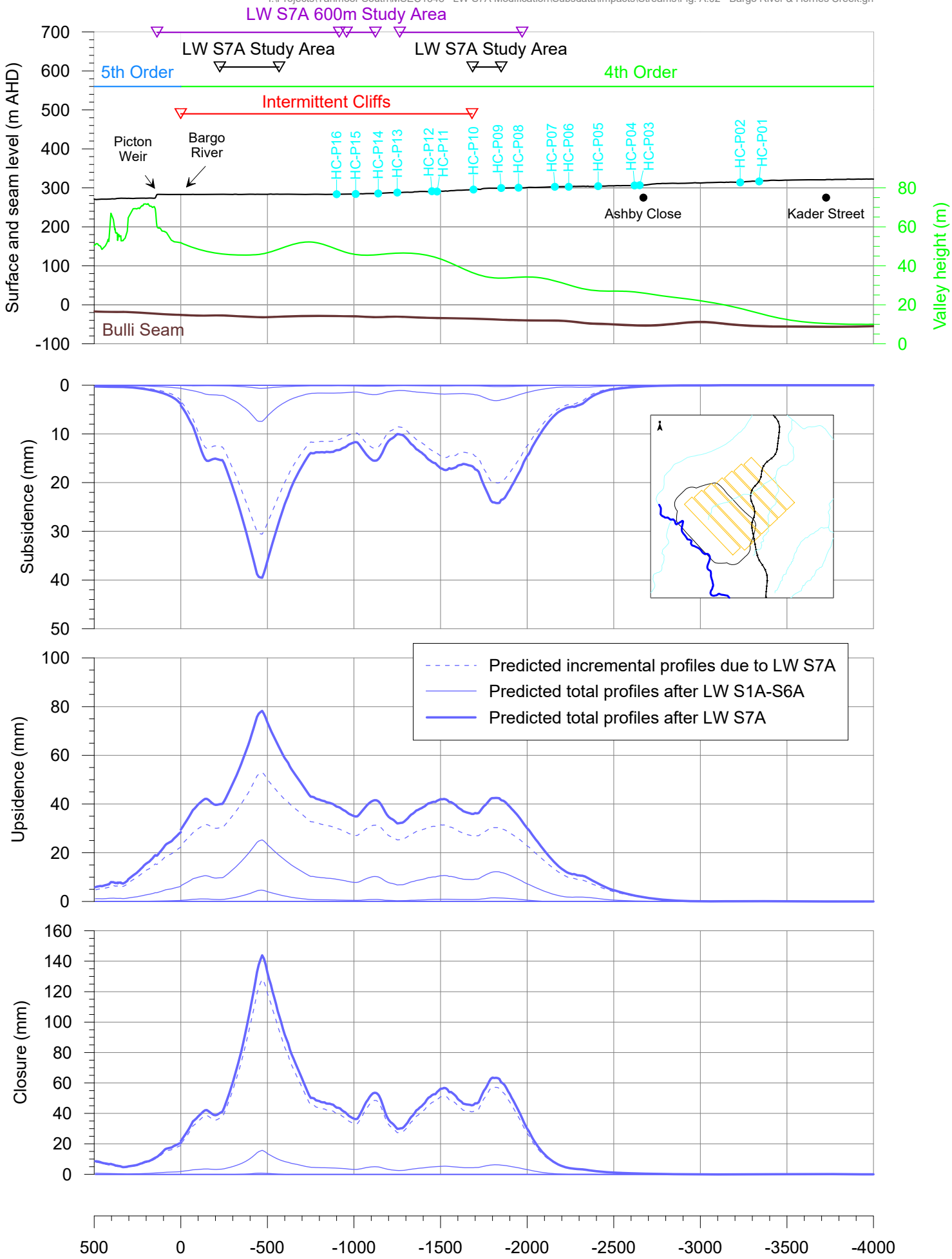


msec

Fig. A.01

Predicted profiles of subsidence, upsidence and closure along Bargo River and Hornes Creek resulting from the extraction of Longwalls S1A to S7A

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\Subsdata\Impacts\Streams\Fig. A.02 - Bargo River & Hornes Creek.grf

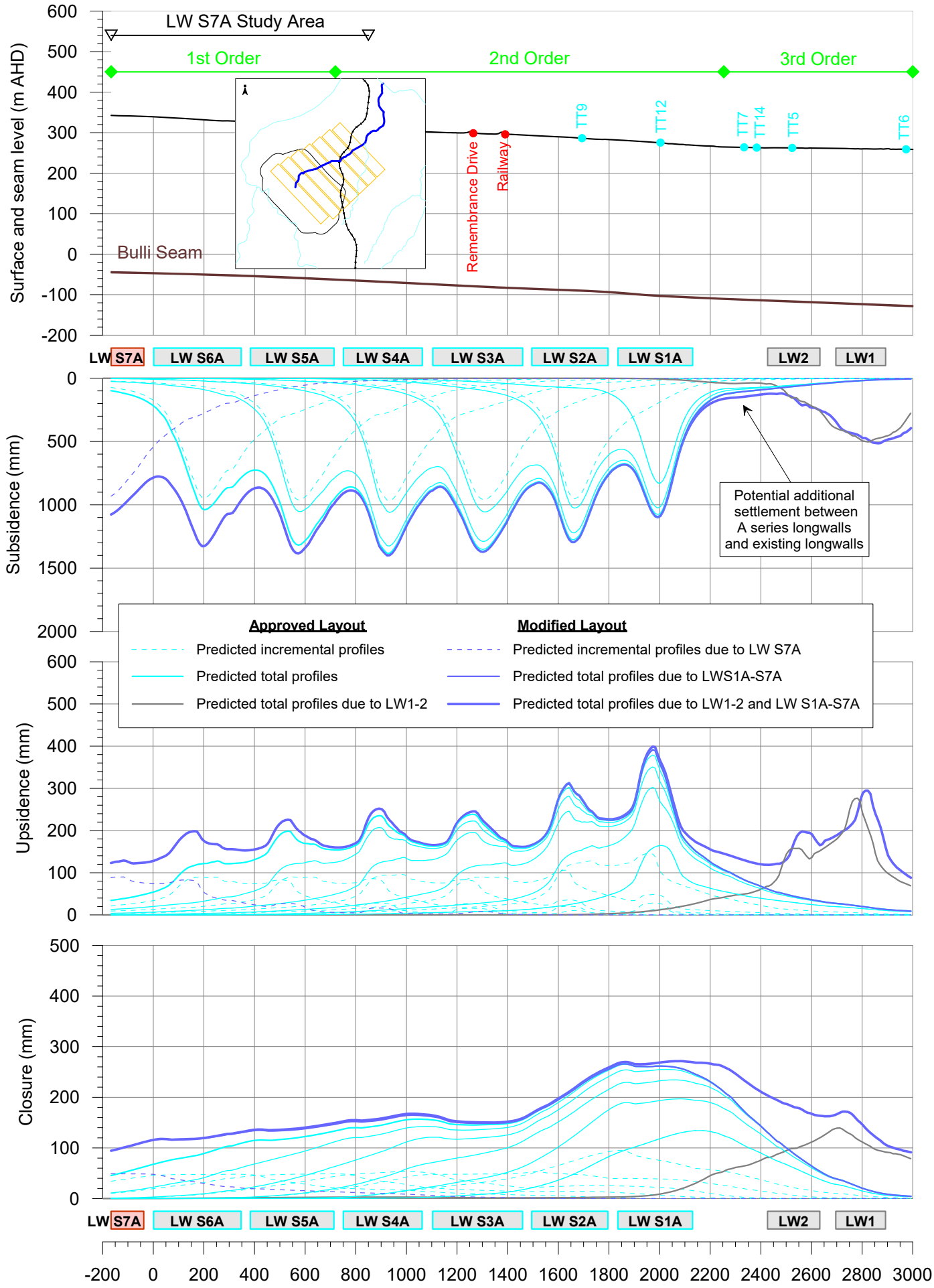


msec

Fig. A.02

Predicted profiles of subsidence, upsidence and closure along Teatree Hollow resulting from the extraction of Longwalls S1A to S7A

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\Subsdata\Impacts\Streams\Fig. A.03 - Teatree Hollow.grf



msec

Fig. A.03

Predicted profiles of subsidence, upsidence and closure along Tributary of Teatree Hollow resulting from the extraction of Longwalls S1A to S7A

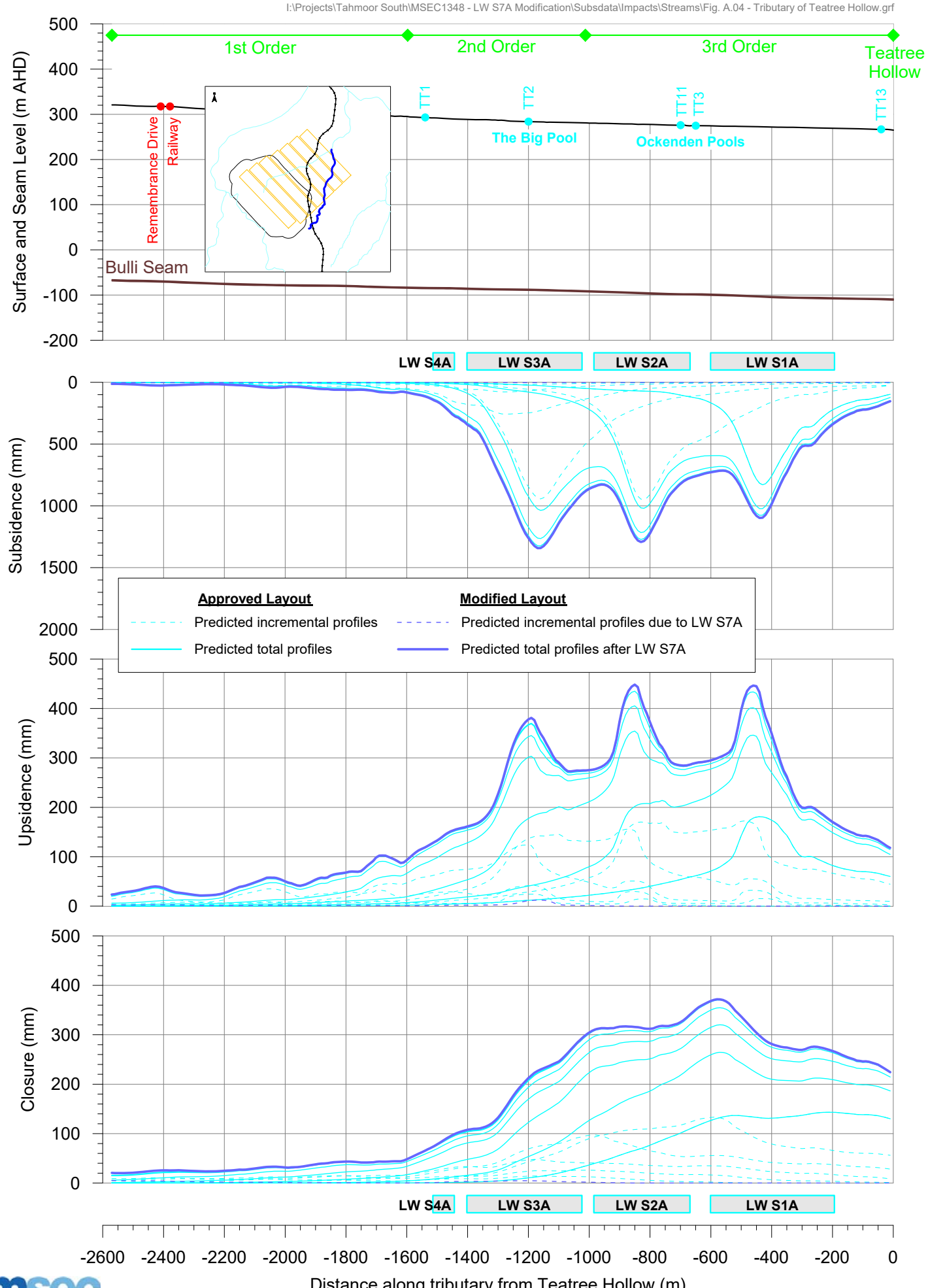


Fig. A.04

Predicted profiles of conventional subsidence, tilt and change in grade along the Main Southern Railway due to the extraction of Longwalls S1A to S7A

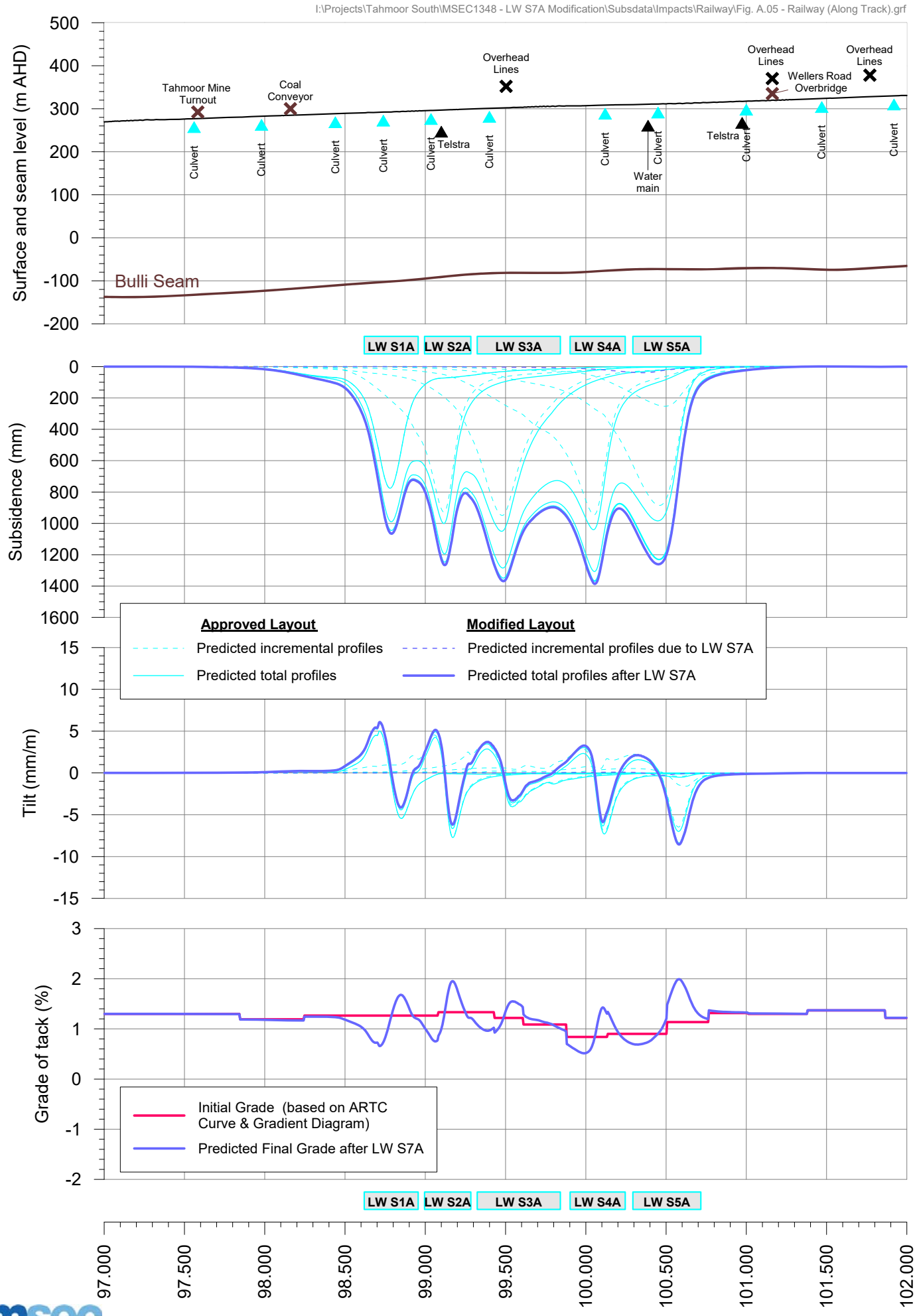


Fig. A.05

Predicted profiles of conventional cross tilt, change in track cant and long twist along the Main Southern Railway due to the extraction of Longwalls S1A to S7A

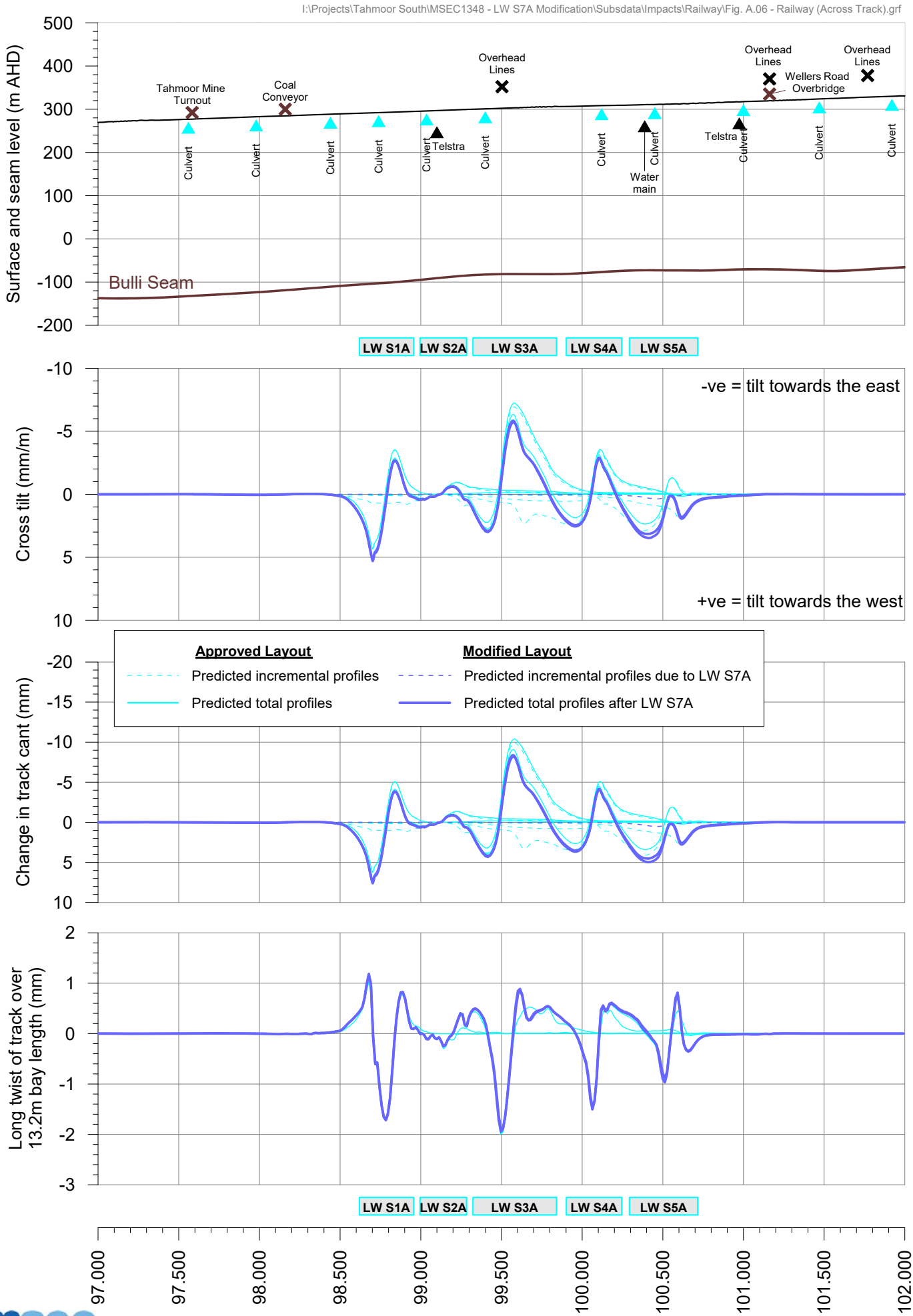


Fig. A.06

Predicted profiles of conventional horizontal movement along track, change in 100 metre long bay length and change in SFT for the Main Southern Railway due to the extraction of Longwalls S1A to S7A

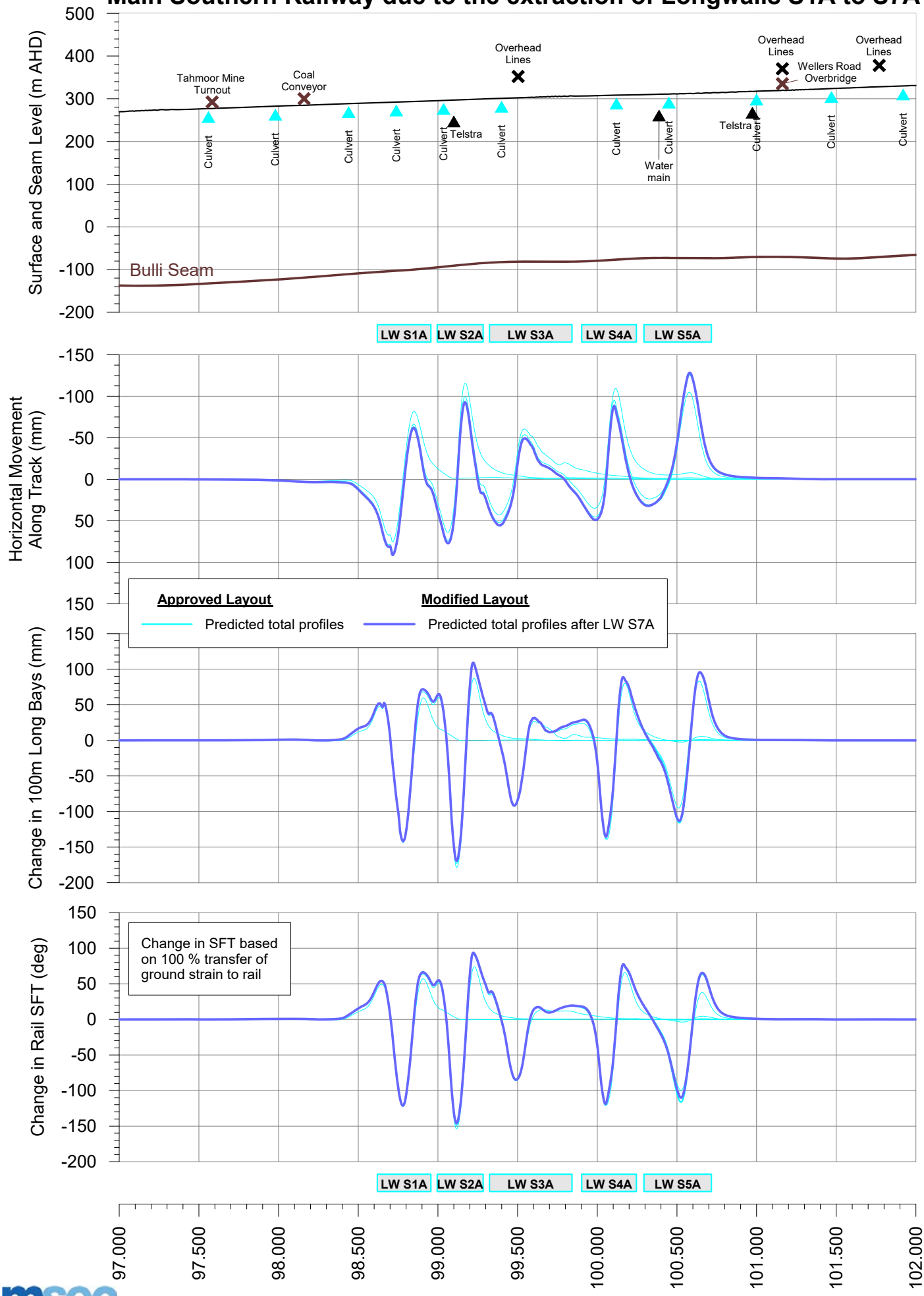
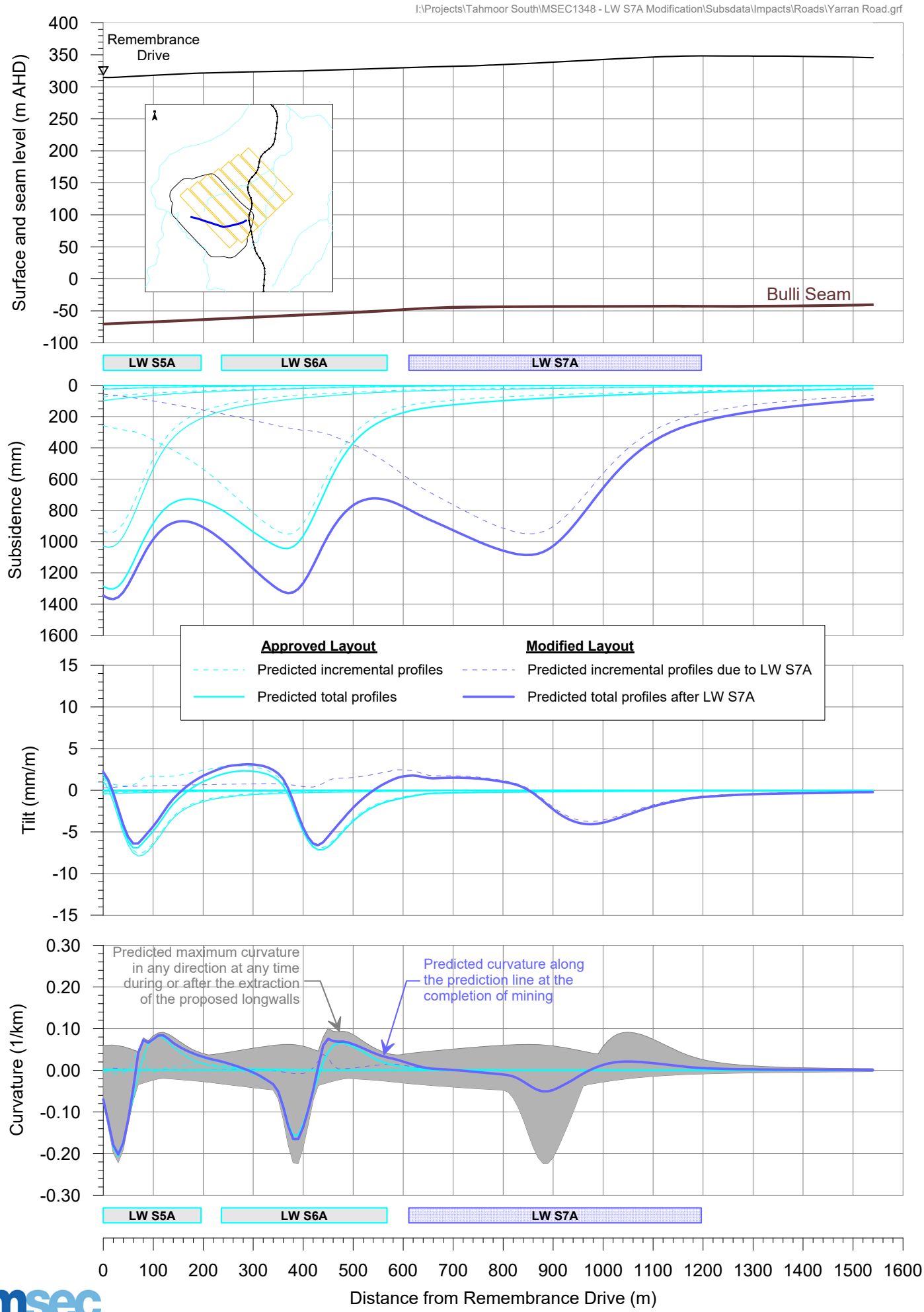


Fig. A.07

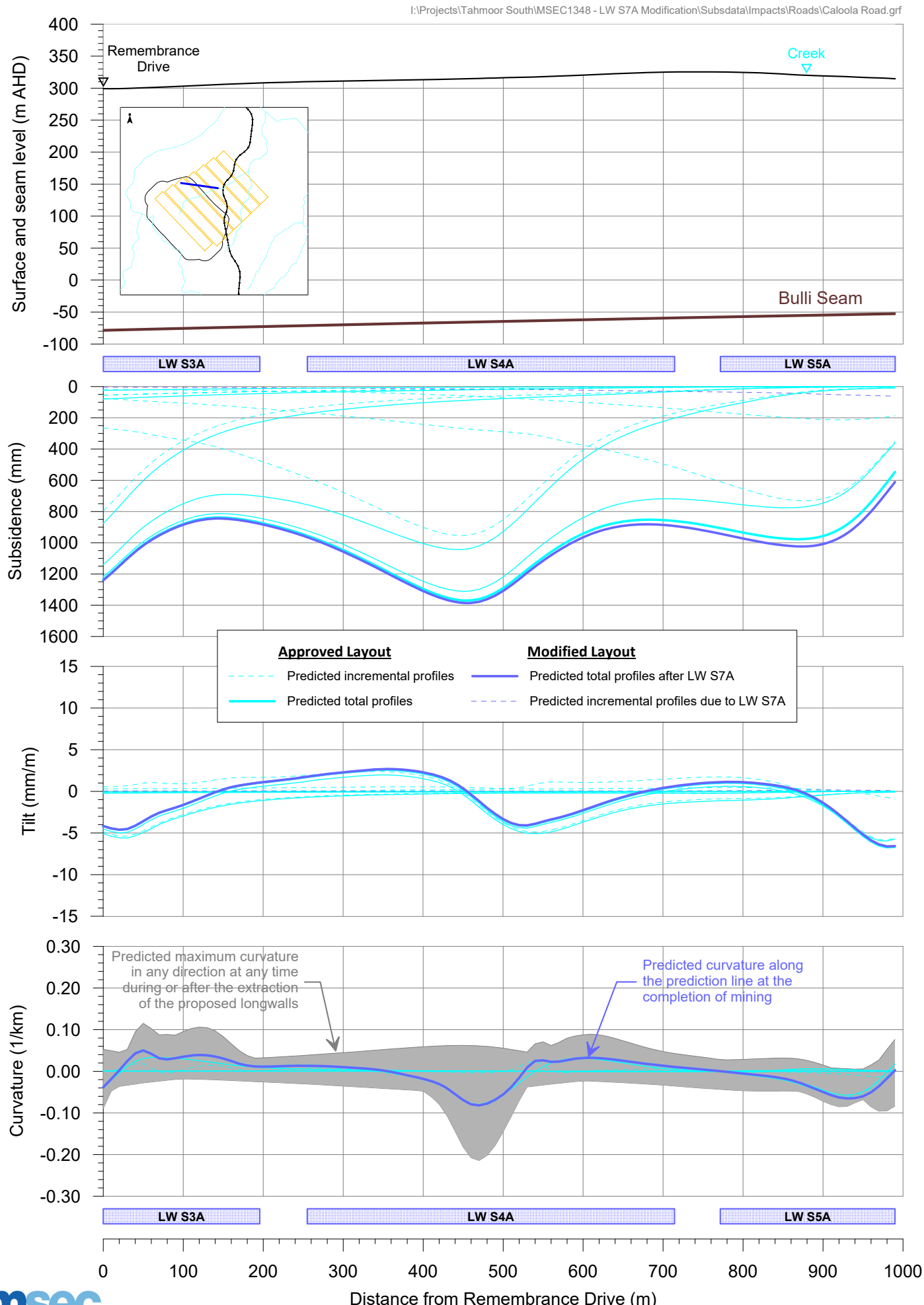
Predicted profiles of conventional subsidence, tilt and curvature along Yarran Road resulting from the extraction of Longwalls S1A to S7A



msec

Fig. A.08

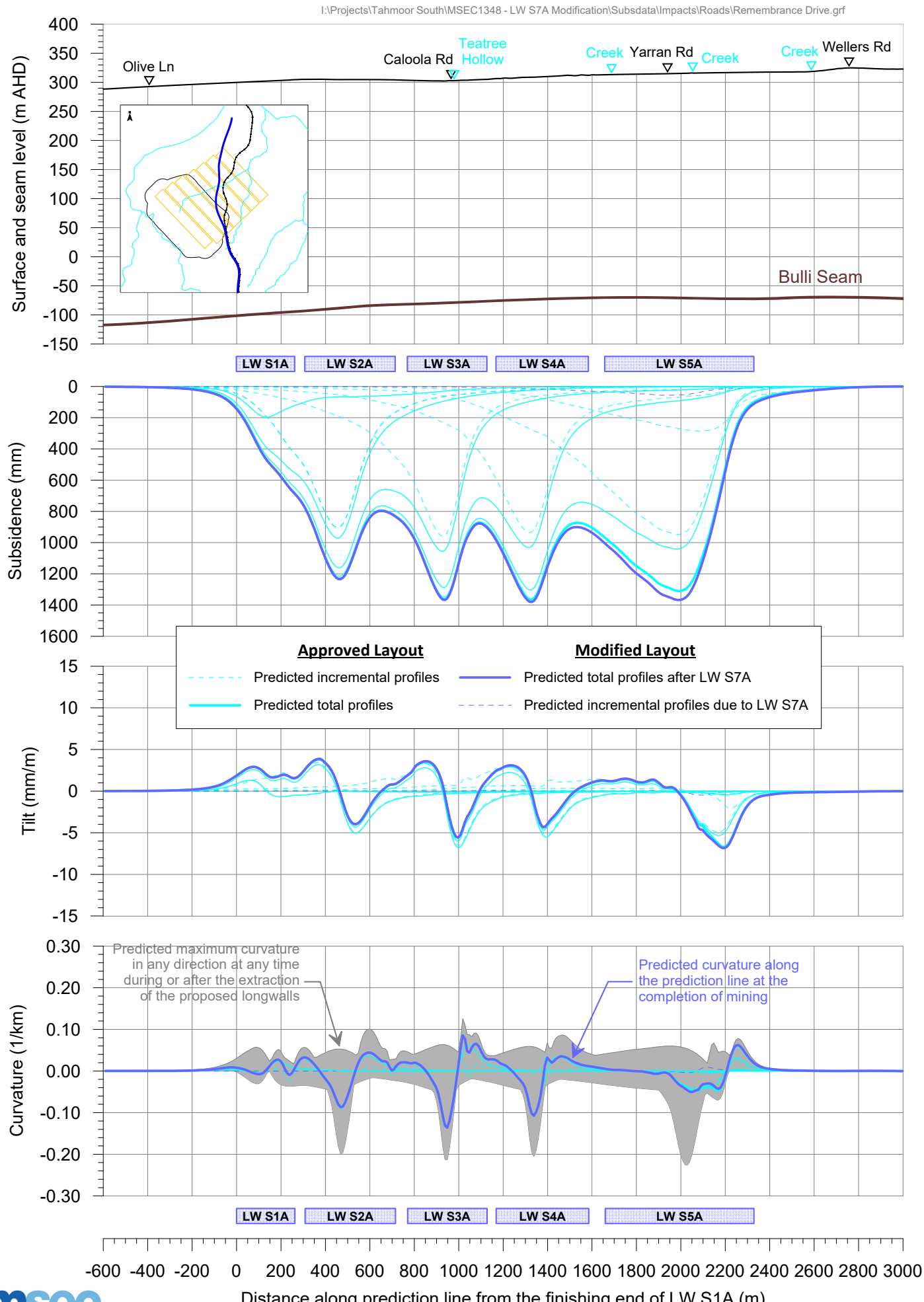
Predicted profiles of conventional subsidence, tilt and curvature along Caloola Road resulting from the extraction of Longwalls S1A to S7A



msec

Fig. A.09

Predicted profiles of conventional subsidence, tilt and curvature along Remembrance Drive resulting from the extraction of Longwalls S1A to S7A

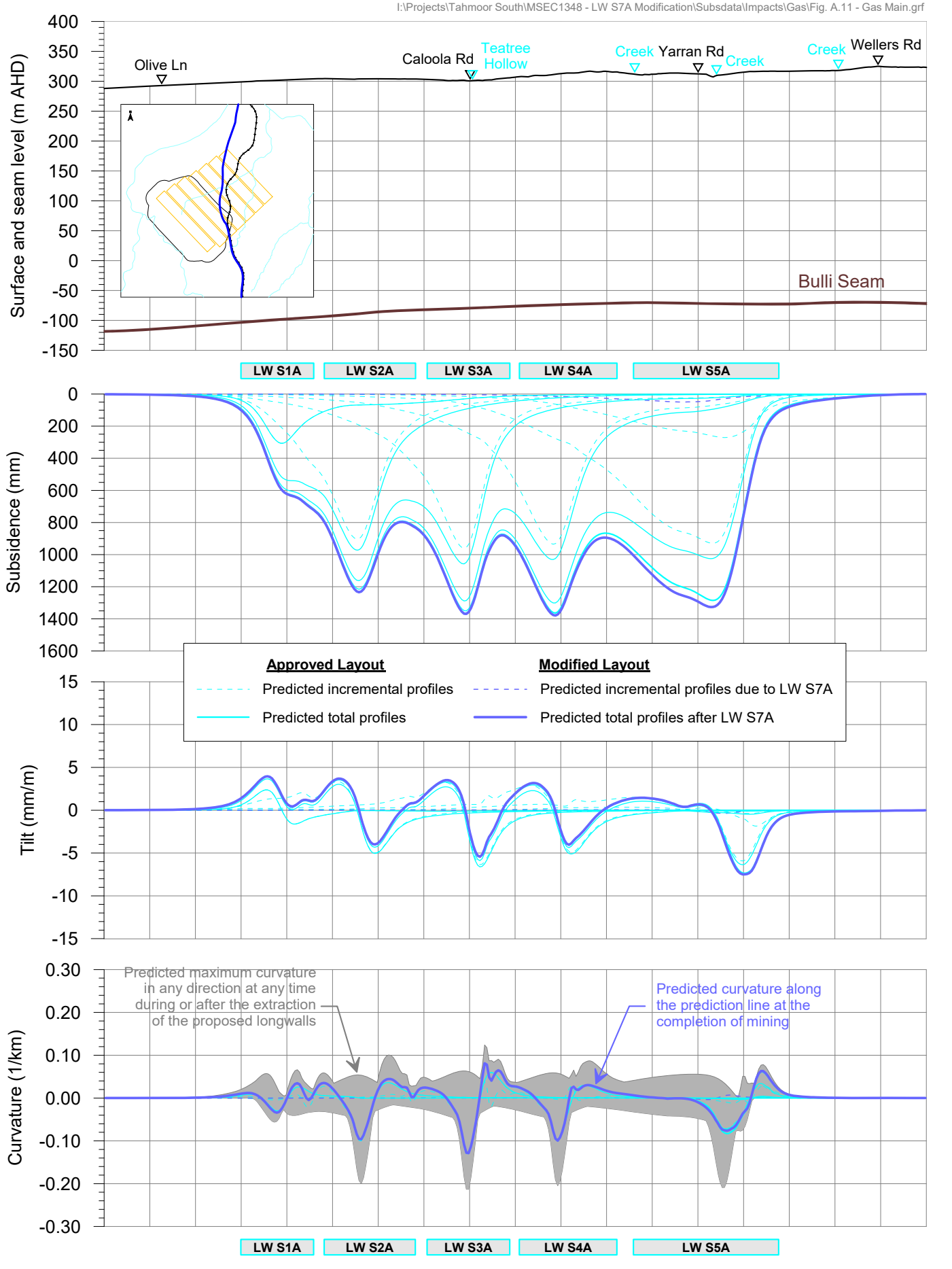


msec

Fig. A.10

Predicted profiles of conventional subsidence, tilt and curvature along Remembrance Drive and the 150mm steel gas main resulting from the extraction of Longwalls S1A to S7A

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\Subsdata\Impacts\Gas\Fig. A.11 - Gas Main.grf



msec

Fig. A.11

APPENDIX B. DRAWINGS

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-01 General Layout.dwg

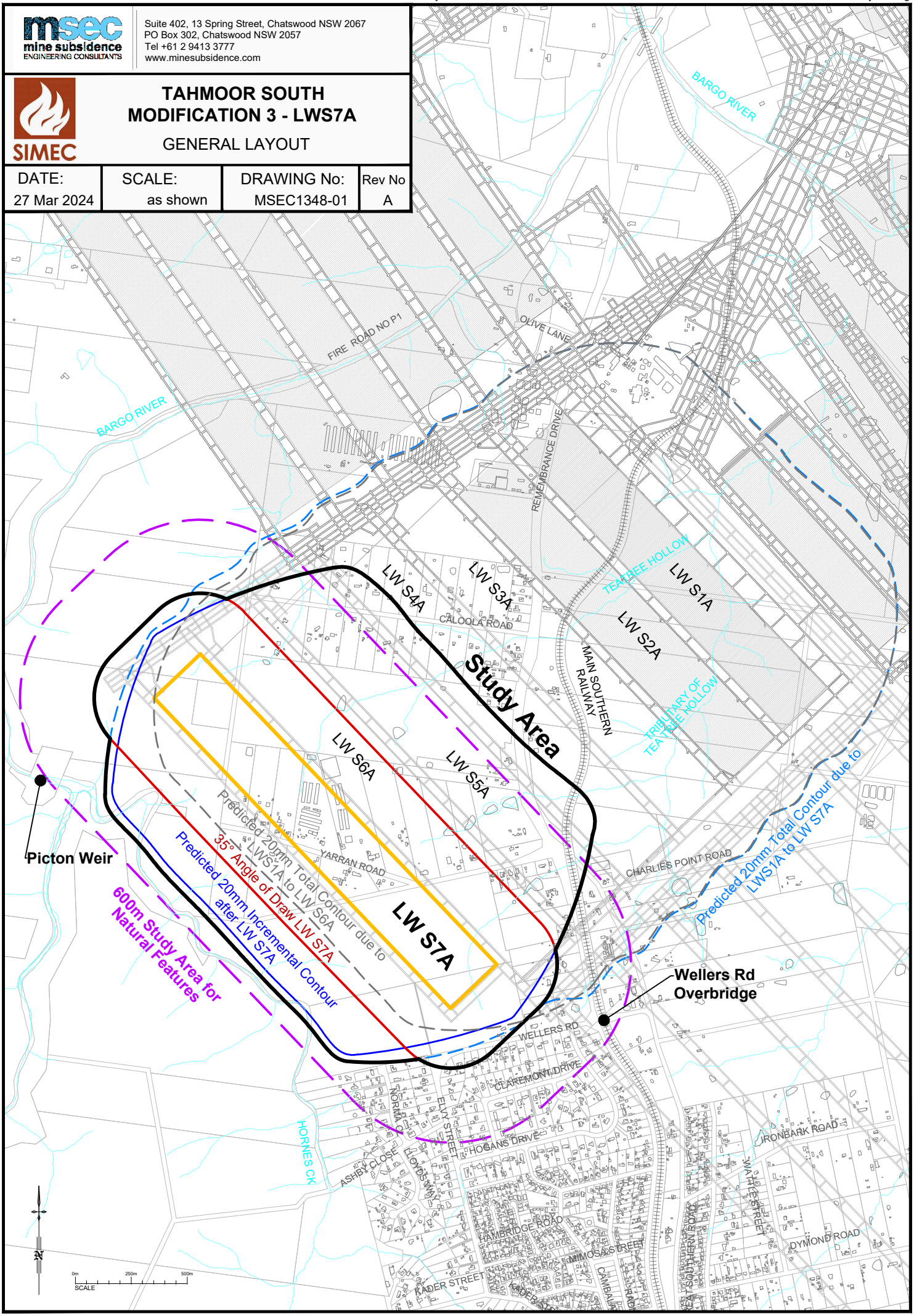
msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH MODIFICATION 3 - LWS7A

GENERAL LAYOUT

DATE:	SCALE:	DRAWING No:	Rev No
27 Mar 2024	as shown	MSEC1348-01	A



I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-02 Surface Level Contours.dwg

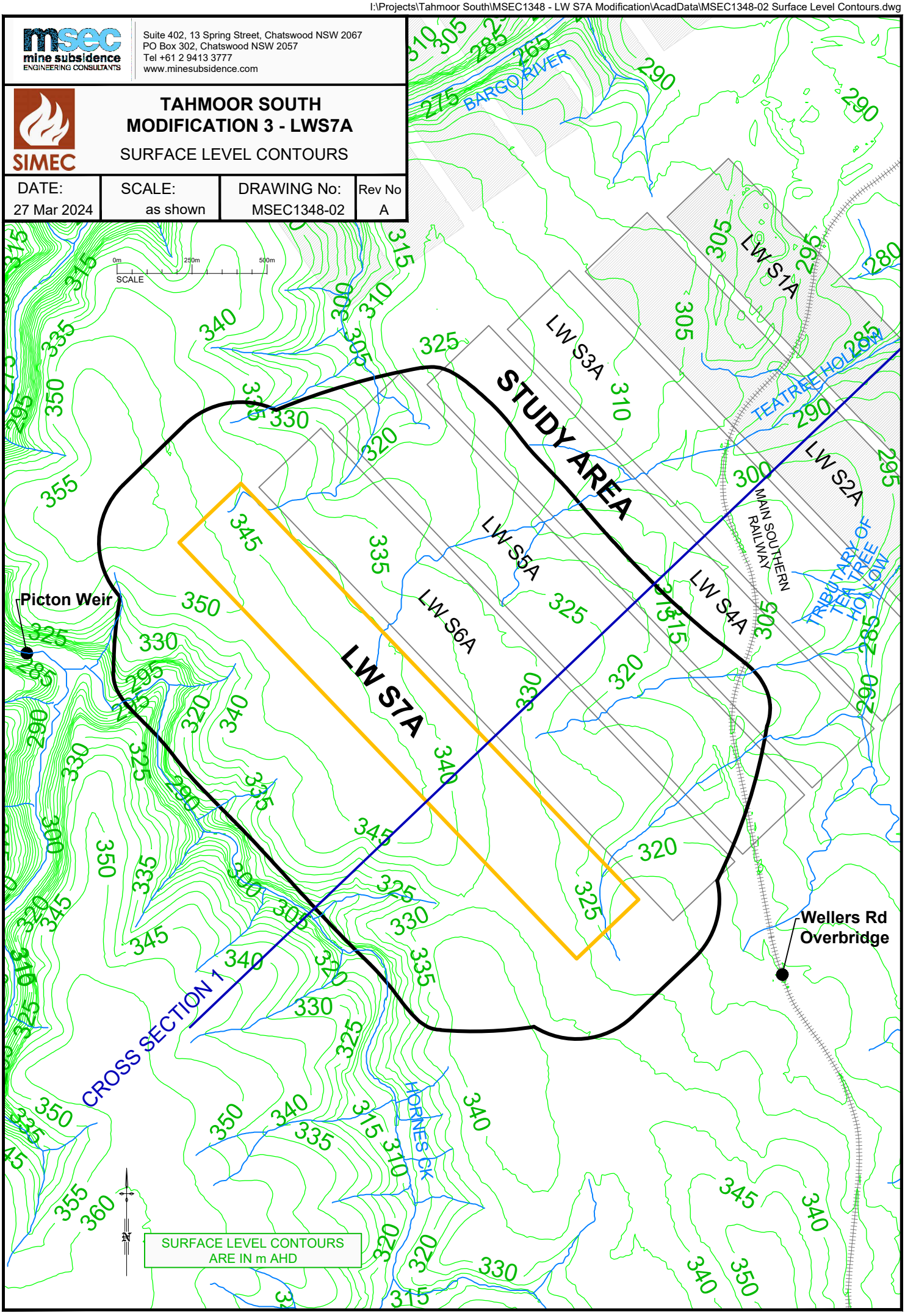
msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH MODIFICATION 3 - LWS7A

SURFACE LEVEL CONTOURS

DATE:	SCALE:	DRAWING No:	Rev No
27 Mar 2024	as shown	MSEC1348-02	A



I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-03 Seam Roof Contours.dwg

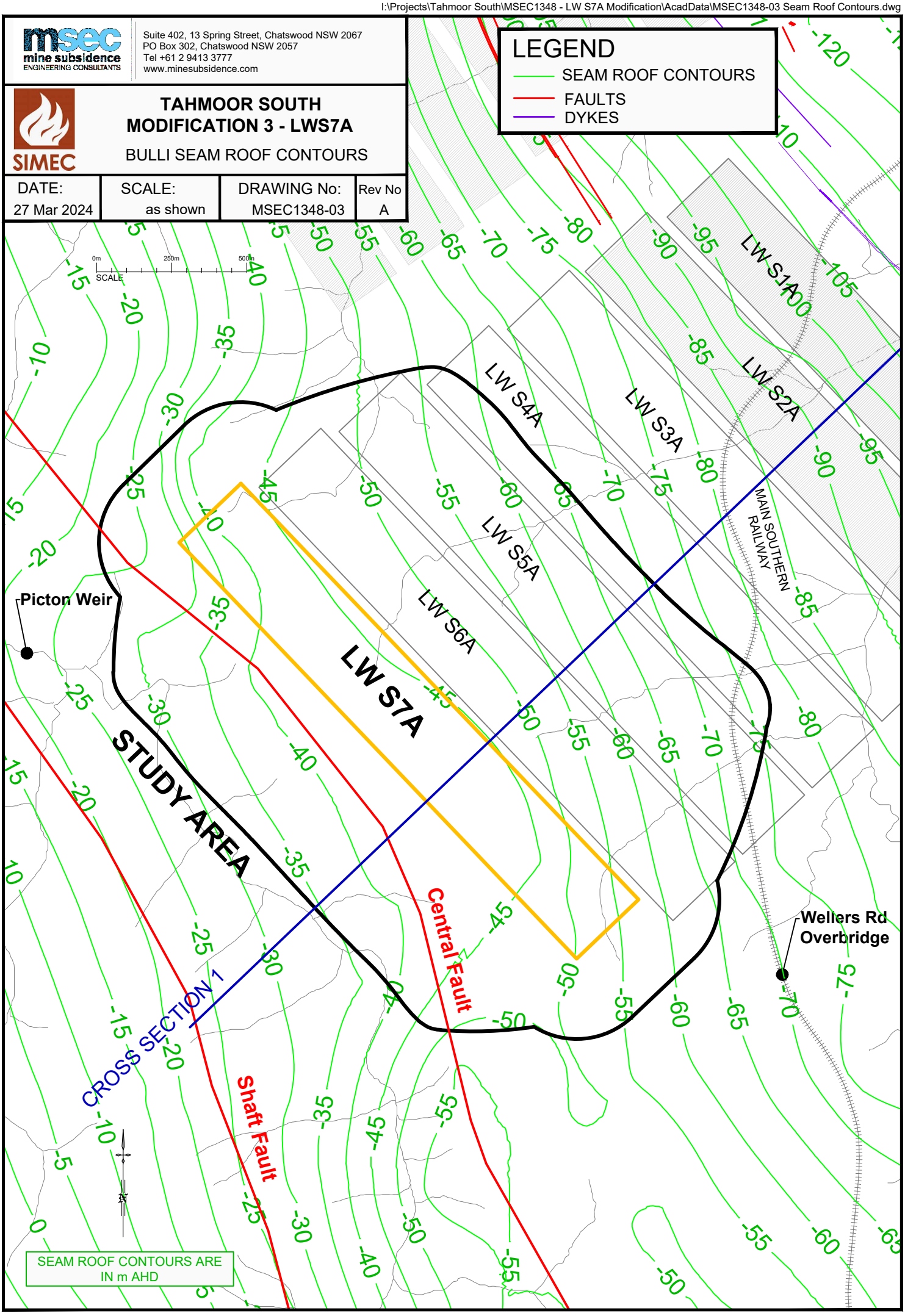
msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH MODIFICATION 3 - LWS7A

BULLI SEAM ROOF CONTOURS

DATE:	SCALE:	DRAWING No:	Rev No
27 Mar 2024	as shown	MSEC1348-03	A



I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-04 Depth of Cover Contours.dwg

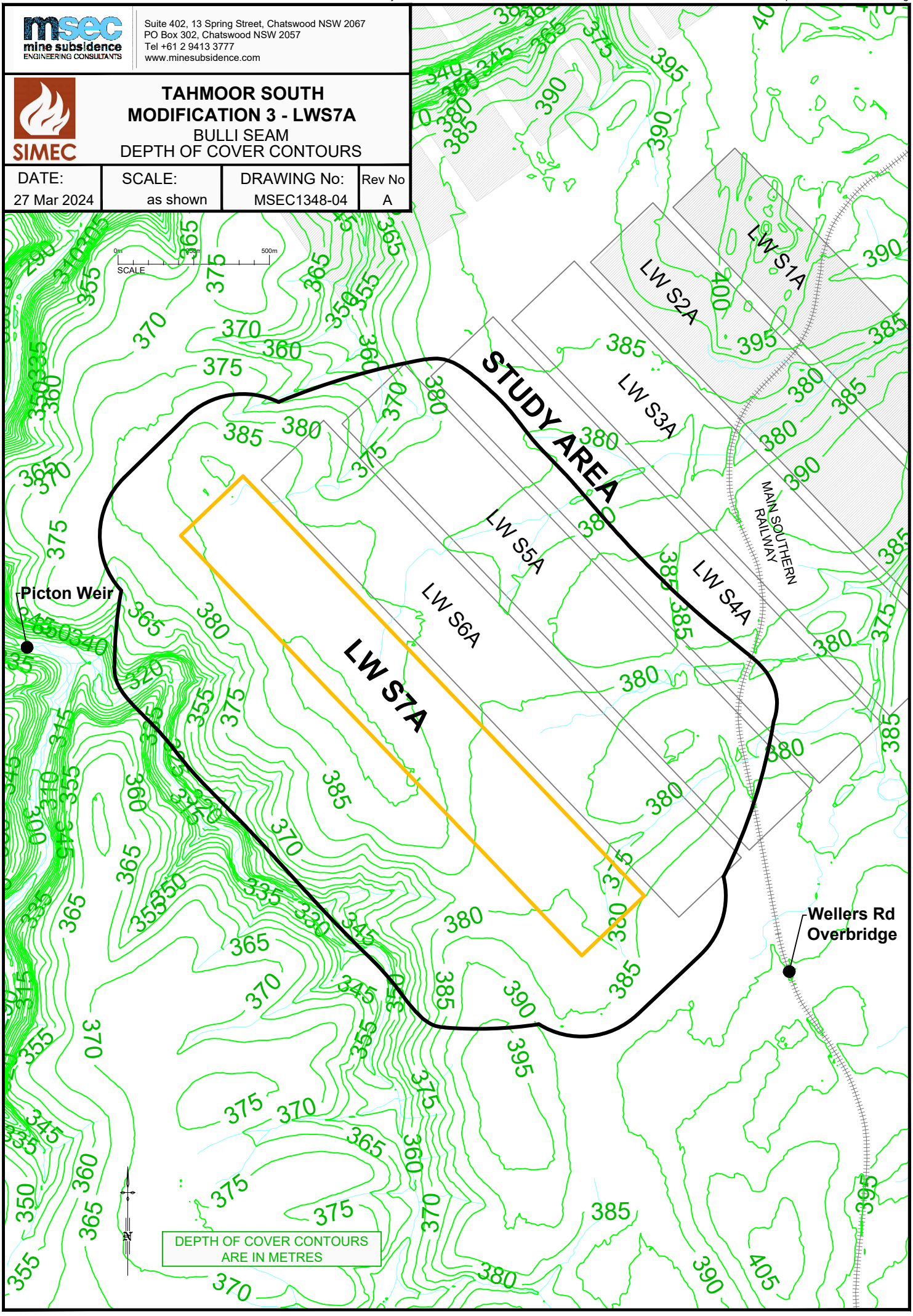
msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH MODIFICATION 3 - LWS7A

BULLI SEAM
DEPTH OF COVER CONTOURS

DATE:	SCALE:	DRAWING No:	Rev No
27 Mar 2024	as shown	MSEC1348-04	A



I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-05 Extraction Height.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH MODIFICATION 3 - LWS7A

EXTRACTION HEIGHT

DATE:	SCALE:	DRAWING No:	Rev No
27 Mar 2024	as shown	MSEC1348-05	A

0m 250m 500m
SCALE

LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
LW S7A
STUDY AREA
MAIN SOUTHERN RAILWAY
Picton Weir
Wellers Rd Overbridge

LEGEND

- 2.15m - 2.2m
- 2.2m - 2.25m
- 2.25m - 2.3m
- 2.3m - 2.35m
- 2.35m - 2.4m
- 2.45m - 2.5m
- 2.5m - 2.55m
- 2.55m - 2.6m

N

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-06 Geology.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH MODIFICATION 3 - LWS7A

GEOLOGICAL STRUCTURES AT BULLI SEAM LEVEL

DATE:	SCALE:	DRAWING No:	Rev No
27 Mar 2024	as shown	MSEC1348-06	A

0m 250m 500m
SCALE

LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
LW S7A
STUDY AREA

Picton Weir
Wellers Rd Overbridge

Central Fault
Shaft Fault

OLIVE LANE
REMEMBRANCE DRIVE
FIRE ROAD NO P1
CALOOLA ROAD
MAIN SOUTHERN RAILWAY
YARRAN ROAD
CHARLIES POINT RD
GREAT SOUTHERN RD
WELLERS ROAD
CLAREMONT DRIVE
NORMA CLOSE
ELVY STREET
ASHBY CLOSE
LLOYDSWAY
HOGANS DRIVE
HAMBRIDGE ROAD
MIMOSA STREET

LEGEND
FAULT
DYKE

N

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-07 Natural Features.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH MODIFICATION 3 - LWS7A

NATURAL FEATURES

DATE:	SCALE:	DRAWING No:	Rev No
27 Mar 2024	as shown	MSEC1348-07	A

LEGEND
- POOLS
- CLIFFS
- STEEP SLOPES
- WATERCOURSE

Pool locations, cliffs and steep slopes were identified courtesy Fluvial Systems

BARGO RIVER
TEATREE HOLLOW
TRIBUTARY OF TEA TREE HOLLOW
HORNES CK
MAIN SOUTHERN RAILWAY
STUDY AREA
LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
LW S7A
600m Study Area for Natural Features
Picton Weir
Wellers Rd Overbridge
C_02680
C_01570
C_01060
C_01210
C_04580
C_07630
C_03210
C_00590
C_00910
C_00580
C_01280
C_07410
C_00800
C_03370
C_00720
C_04750
C_01360
C_02070
C_11150
C_00130
C_02060
C_01610
C_07220
C_02020
C_02920
C_00710
C_00830
C_00920
C_05140
C_01640
C_00630
C_08660
C_07810
C_05210
C_01150
C_04290
C_00430
C_00470
C_00660
C_01160
C_02670
C_11590
C_02240
HC-P16
HC-P15
HC-P14
HC-P13
HC-P12
HC-P11
HC-P10
HC-P09
HC-P08
HC-P07
HC-P06
HC-P05
HC-P04
HC-P03
HC-P02
HC-P01
TH-P01
TTH-P02
TTH-P01
0m
250m
500m
SCALE

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-08 Railways.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH MODIFICATION 3 - LWS7A

MAIN SOUTHERN RAILWAY

DATE:	SCALE:	DRAWING No:	Rev No
27 Mar 2024	as shown	MSEC1348-08	A

0m 250m 500m
SCALE

LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
LW S7A
STUDY AREA
MAIN SOUTHERN RAILWAY
Picton Weir
Wellers Rd Overbridge (101.162km)
OLIVE LANE
REMEMBRANCE DRIVE
FIRE ROAD NO P1
CALOOLA ROAD
YARRAN ROAD
CHARLIES POINT RD
GREAT SOUTHERN RD
WELLERS ROAD
CLAREMONT DRIVE
NORMA CLOSE
ELVY STREET
ASHBY CLOSE
LLOYDS WAY
HOGANS DRIVE
HAMBRIDGE ROAD
MIMOSA STREET

98.445 98.4 km 98.5 km 98.6 km 98.739 98.7 km 98.8 km 98.9 km 99.035 99 km 99.1 km 99.2 km 99.3 km 99.338 99.4 km 99.5 km 99.6 km 99.7 km 99.8 km 99.9 km 100 km 100.121 100.1 km 100.2 km 100.3 km 100.4 km 100.425 100.5 km 100.6 km 100.7 km 100.8 km 100.9 km 101 km 101.000 101.1 km 101.2 km 101.3 km 101.4 km 101.470 101.5 km 101.6 km 101.7 101 101 101.920 102 102.1 102.2 102.244 102.279 102.3

LEGEND
EMBANKMENT
CUTTING

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-09 Surface Infrastructure.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH MODIFICATION 3 - LWS7A

SURFACE INFRASTRUCTURE

DATE:	SCALE:	DRAWING No:	Rev No
27 Mar 2024	as shown	MSEC1348-09	A

LEGEND
- POWERLINES
- GAS PIPELINES
- POTABLE WATER PIPELINES
- SEWER PIPELINES
- TELECOMMUNICATIONS
- GROUND WATER BORES
- BOREHOLES

0m 250m 500m
SCALE

LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
LW S7A
STUDY AREA
MAIN SOUTHERN RAILWAY
Picton Weir
NBN Tower
BARGO SHAFT
No3 SHAFT
Wellers Rd Overbridge (101.162km)
98.445
98.739
99.035
99.338
100.121
100.425
101.000
101.470
101.920
102.244
102.279
OLIVE LANE
FIRE ROAD NO P1
CALOOLA ROAD
YARRAN ROAD
CHARLIES POINT RD
GREAT SOUTHERN RD
WELLERS ROAD
CLAREMONT DRIVE
HOGANS DRIVE
ELVY STREET
NORMA CLOSE
ASHBY CLOSE
LLOYDSWAY
HAMBRIDGE ROAD
MIMOSA STREET

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-10 Arch & Heritage Sites.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH MODIFICATION 3 - LWS7A

ARCHAEOLOGICAL & HERITAGE SITES

DATE:	SCALE:	DRAWING No:	Rev No
27 Mar 2024	as shown	MSEC1348-10	A

0m 250m 500m
SCALE

N

No3 SHAFT
OLIVE LANE
REMEMBRANCE DRIVE
Tahmoor Mine
LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
LW S7A
52-2-3968
CALOOLA ROAD
MAIN SOUTHERN RAILWAY
Wirrimbirra Sanctuary
Picton Weir
WP1253 RS
WP1255 RS
WP1261 RS
WP1258 RS
WP1260 RS
WB1257 RS
WP1256 RS
YARRAN ROAD
STUDY AREA
Cemetery
CHARLIES POINT RD
GREAT SOUTHERN RD
Kalinya Gardens
WP1263 GG
WP1264 IF
Wellers Road bridge
WELLERS ROAD
Wellers Rd Overbridge (101.162km)
CLAREMONT DRIVE
NORMA CLOSE
ELVY STREET
HOGANS DRIVE
ASHBY CLOSE
LLOYDS WAY
HAMBRIDGE ROAD
MIMOSA ST
Homestead
FIRE ROAD NO P1
BARGO SHAFT

LEGEND
- ARCHAEOLOGICAL SITES
- HERITAGE SITES

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-11 Built Features.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH MODIFICATION 3 - LWS7A

BUILT FEATURES

DATE:	SCALE:	DRAWING No:	Rev No
27 Mar 2024	as shown	MSEC1348-11	A

0m 250m 500m
SCALE

N

No3 SHAFT
OLIVE LANE
Tahmoor Mine
REMEMBRANCE DRIVE
Wollondilly Anglican College
Inghams Bargo Chicken Breeder Production Complex
Auto Wreckers
Bargo Petroleum and Hill Top Pit Stop
FIRE ROAD NO P1
Tahmoor Garden Centre
MAIN SOUTHERN RAILWAY
LW S1A
LW S4A
CALOOLA ROAD
LW S2A
LW S6A
Australian Wildlife Sanctuary
LW S5A
LW S3A
Picton Weir
Bargo Valley Produce
MKD Machinery
Inghams Turkey Farm
NBN Tower
Bargo Cemetery
YARRAN ROAD
Canine Country Club and Cattery
CHARLIES POINT RD
LW S7A
STUDY AREA
GREAT SOUTHERN RD
WELLERS ROAD
Wellers Rd Overbridge (101.162km)
CLAREMONT DRIVE
NORMA CLOSE
ELVY STREET
HOGANS DRIVE
ASHBY CLOSE
LLOYDS WAY
Sydney Water Reservoir
HAMBRIDGE ROAD
MIMOSA ST
BARGO SHAFT
Existing Mine shaft of Historical workings

LEGEND
- COMMERCIAL
- PUBLIC AMENITIES
- PUBLIC UTILITIES
- HOUSES
- RURAL STRUCTURES
- POOLS
- DAMS

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-12 Pred Inc Subs due to LW S7A.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH MODIFICATION 3 - LWS7A

PREDICTED INCREMENTAL SUBSIDENCE DUE TO LWS7A

DATE:	SCALE:	DRAWING No:	Rev No
27 Mar 2024	as shown	MSEC1348-12	A

0m 250m 500m
SCALE

BARGO RIVER

LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
LW S7A

Picton Weir

Prediction Line 1

MAIN SOUTHERN RAILWAY

Wellers Rd Overbridge (101.162km)

1050mm

HORNES CK

LEGEND
SUBSIDENCE CONTOUR COLOUR SCALE (mm)

900
800
700
600
500
400
300
200
100
50
20

NOTE:
The value of the Subsidence Contours, from the outside to the inside of the panels, are 20mm, 50mm, 100mm, 200mm, and so forth, in 100mm increments.

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-13 Pred Total Subs due to LW S7A.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH MODIFICATION 3 - LWS7A

PREDICTED TOTAL SUBSIDENCE DUE TO LW S1A TO LW S7A

DATE:	SCALE:	DRAWING No:	Rev No
27 Mar 2024	as shown	MSEC1348-13	A

0m 250m 500m
SCALE

BARGO RIVER

LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
LW S7A

MAIN SOUTHERN RAILWAY

Picton Weir

Prediction Line 1

1350mm

1200mm

Wellers Rd Overbridge (101.162km)

HORNES CK

LEGEND
SUBSIDENCE CONTOUR COLOUR SCALE (mm)
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
50
20

NOTE:
The value of the Subsidence Contours, from the outside to the inside of the panels, are 20mm, 50mm, 100mm, 200mm, and so forth, in 100mm increments.

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-14 Pred Total Subs due to LW S6B.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH MODIFICATION 3 - LWS7A

PREDICTED TOTAL SUBSIDENCE DUE TO LW S1A TO LW S6B

DATE:	SCALE:	DRAWING No:	Rev No
27 Mar 2024	as shown	MSEC1348-14	A

0m 500m 1000m
SCALE

N

BARGO RIVER

LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
LW S7A
MAIN SOUTHERN RAILWAY

Picton Weir

1350mm

1200mm

Prediction Line 1

Wellers Rd Overbridge (101.162km)

LW S1B
LW S2B
LW S3B
LW S4B
LW S5B
LW S6B

HORNESCK

LEGEND

SUBSIDENCE CONTOUR COLOUR SCALE (mm)

1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
50
20

NOTE:
The value of the Subsidence Contours, from the outside to the inside of the panels, are 20mm, 50mm, 100mm, 200mm, and so forth, in 100mm increments.

I:\Projects\Tahmoor South\MSEC1348 - LW S7A Modification\AcadData\MSEC1348-15 Subsidence Monitoring.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

SIMEC

TAHMOOR SOUTH PROJECT EXTRACTION PLAN LW S1A TO LW S7A

SUBSIDENCE MONITORING

DATE:	SCALE:	DRAWING No:	Rev No
27 Mar 2024	1:25000	MSEC1348-15	A

Series of survey marks (one on each side of bank) above previously extracted longwalls, subject to access by land owners & available lines of sight.

STUDY AREA

LW S1A
LW S2A
LW S3A
LW S4A
LW S5A
LW S6A
LW S7A

Railway Viaduct
MAIN SOUTHERN RAILWAY
BARGO RIVER ROAD
REMEMBRANCE DR
STRATFORD RD
ROCKFORD ROAD
OLIVE GROVE
FIRE ROAD NO P1
BARGO RIVER GORGE
Tahmoor Colliery
Wollondilly Anglican College
Poultry Sheds
Wrecker
Igloos
Service Station
Gantry
Hidden creek
TEATREE HOLLOW
Tahmoor Garden Centre
CALOOLA ROAD
Along Tahmoor Mine property boundary
Teatree 3
Teatree 2
Australian Wildlife Sanctuary
Concrete materials plant
Picton Weir
NBN Tower
YARRAN ROAD
CHARLIES POINT RD
Wellers Rd Bridge
WELLERS RD
HOGANS DRIVE
GLAREMONT DRIVE
ASHBY CL
ELVY STREET
LLOYDS WAY
HAMBRIDGE ROAD
KADER STREET
MIMOSA STREET
CAMBALAN STREET
RADNOR ROAD
GWYNN HUGHES STREET
NOONGAH ST
BINGARRA PLACE
NOORAL STREET
GREAT SOUTHERN RD
ANTHONY ROAD
IRONBARK ROAD
WATTLE STREET
DYMOND ROAD
GOVERNMENT ROAD
BARGO ROAD
JOHNSTON RD
HORNES CK
BARGO RIVER
DOG TRAP

S01 S02 S03 S04 S05 S06 S07 S08 S09 S10 S11 S12 S13 S14 S15 S16 S17 S18 S19 S20 S21 S22 S23 S24 S25 S26 S27

TT9 TT12

278 000
6 208 000
6 206 000
6 204 000

LEGEND

- WATER MONITORING SITE
- INSTALLED MONITORING LINES
- INSTALLED MONITORING PEGS
- PROPOSED MONITORING LINES
- PROPOSED CREEK MONITORING PEGS
- PROPOSED CREEK CROSSLINES
- INSTALLED GNSS
- CRITICAL POLES MONITORING
- WATERCOURSE

APPENDIX C. TABLES

Table C.01 - Predictions for Stream Pools

Stream	Pool	Predicted Total Subsidence after all Longwalls (mm)	Predicted Total Upsidence after all Longwalls (mm)	Predicted Total Closure after all Longwalls (mm)
Hornes Creek	HC-P01	< 20	< 20	< 20
	HC-P02	< 20	< 20	< 20
	HC-P03	< 20	< 20	< 20
	HC-P04	< 20	< 20	< 20
	HC-P05	< 20	< 20	< 20
	HC-P06	< 20	< 20	< 20
	HC-P07	< 20	< 20	< 20
	HC-P08	< 20	40	50
	HC-P09	20	40	60
	HC-P10	< 20	40	50
	HC-P11	< 20	40	60
	HC-P12	< 20	40	50
	HC-P13	< 20	30	30
	HC-P14	< 20	40	50
	HC-P15	< 20	40	40
	HC-P16	< 20	40	50
Teatree Hollow	TT9	1300	275	225
	TT12	1100	400	250
	TT7	100	90	175
	TT14	100	80	150
	TT5	70	50	100
	TT6	< 20	< 20	< 20
	TT4	< 20	< 20	< 20
	TT8	< 20	< 20	< 20
Tributary of Teatree Hollow	TT1	125	125	70
	TT2	1300	375	225
	TT11	850	300	325
	TT3	800	300	350
	TT13	200	125	250

Table C.02 - Details of Houses

House Ref.	Maximum Plan Dimension (m)	Plan Area (m2)	Number of Stories	Wall Construction	Footing Construction	Wall and Footing Construction	Roof Constructtion	House Located Above Goaf	House Located Above Solid Coal
BCA_001_h01	21	234	1	Fibro	Slab on Ground	Timber Framed	Metal	1	
BCA_010_h01	24	252	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Metal	1	
BCA_015_h01	18	227	1	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Metal	1	
BCA_020_h01	17	217	1	Weatherboard	N/A	Timber Framed	Metal	1	
BCA_025_h01	30	298	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Metal	1	
BCA_030_h01	32	291	1	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Tiled	1	
BCA_035_h01	17	181	1	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Tiled	1	
BCA_040_h01	14	159	1	Weatherboard	Suspended on Piers	Timber Framed	Metal	1	
BCA_095_h01	22	279	1	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Tiled	1	
BCA_100_h01	31	370	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Metal	1	
BCA_105_h01	22	259	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BCA_110_h01	23	189	1	Brick or Brick-Veneer	Strip Footing	Brick with Strip Footings	Metal		1
BCA_120_h01	19	230	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Metal		1
BEL_001_h01	19	293	1	Fibro	Suspended on Piers	Timber Framed	Metal		1
BRE_140_h01	28	361	1	Brick or Brick-Veneer	Strip Footing	Brick with Strip Footings	Metal	1	
BRE_143_h01	17	176	1	Weatherboard	Suspended on Piers	Timber Framed	Metal	1	
BRE_148_h01	20	303	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BRE_154_h01	19	174	1	Brick or Brick-Veneer	Strip Footing	Brick with Strip Footings	Tiled	1	
BRE_165_h01	9	63	1	Weatherboard	N/A	Timber Framed	Metal	1	
BRE_167_h01	19	160	2	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Tiled	1	
BRE_177_h01	14	158	1	Weatherboard	Suspended on Piers	Timber Framed	Metal	1	
BRE_187_h01	29	396	2	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BRE_191_h01	15	134	1	Weatherboard	N/A	Timber Framed	Metal	1	
BRE_201_h01	22	272	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Metal		1
BRE_515_h02	26	401	2	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BWE_019_h02	35	519	2	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Metal	1	
BWE_023_h01	26	296	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BWE_025_h01	18	225	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BWE_027_h01	18	208	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled		1
BWE_051_h01	22	201	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled		1
BYR_001_h01	10	95	1	Weatherboard	Suspended on Piers	Timber Framed	Tiled	1	
BYR_005_h01	22	165	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BYR_015_h01	17	232	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BYR_025_h01	35	538	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Metal	1	
BYR_035_h01	17	119	1	Weatherboard	N/A	Timber Framed	Metal	1	
BYR_045_h01	18	152	1	Weatherboard	Suspended on Piers	Timber Framed	Metal	1	
BYR_045_h02	50	819	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Metal	1	
BYR_055_h01	19	275	1	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Tiled	1	
BYR_065_h01	18	245	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BYR_065_h02	15	131	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Metal	1	
BYR_075_h01	21	264	1	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Tiled	1	

Table C.02 - Details of Houses

House Ref.	Maximum Plan Dimension (m)	Plan Area (m2)	Number of Stories	Wall Construction	Footing Construction	Wall and Footing Construction	Roof Constructtion	House Located Above Goaf	House Located Above Solid Coal
BYR_075_h02	10	80	1	Weatherboard	Suspended on Piers	Timber Framed	Metal	1	
BYR_084_h01	17	171	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled		1
BYR_085_h01	19	200	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled		1
BYR_085_h02	8	45	1	Weatherboard	Suspended on Piers	Timber Framed	Metal		1
BYR_085_h03	18	147	1	Weatherboard	Slab on Ground	Timber Framed	Metal		1
BYR_095_h01	37	591	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Metal		1
BYR_105_h01	11	87	1	Fibro	Suspended on Piers	Timber Framed	Metal		1
BYR_115_h02	48	592	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Metal		1
BYR_125_h01	18	156	1	Weatherboard	Suspended on Piers	Timber Framed	Metal	1	
BYR_135_h01	16	141	1	Weatherboard	Suspended on Piers	Timber Framed	Tiled	1	
BYR_135_h02	41	484	1	Weatherboard	Slab on Ground	Timber Framed	Metal	1	
BYR_145_h01	21	215	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BYR_150_h01	12	102	1	Brick or Brick-Veneer	N/A	Brick with Unknown Footings	Tiled	1	
BYR_150_h02	7	39	1	Weatherboard	N/A	Timber Framed	Tiled	1	
BYR_152_h01	20	257	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BYR_154_h01	27	327	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BYR_156_h01	22	268	1	Weatherboard	Suspended on Piers	Timber Framed	Metal	1	
BYR_156_h02	12	95	1	Weatherboard	Suspended on Piers	Timber Framed	Metal	1	
BYR_158_h01	14	77	1	Weatherboard	Suspended on Piers	Timber Framed	Metal	1	
BYR_160_h01	30	285	1	Brick or Brick-Veneer	Slab on Ground	Brick with Slab on Ground	Tiled	1	
BYR_162_h01	18	156	1	Weatherboard	N/A	Timber Framed	Metal	1	

Table C.03 - Predictions for Houses

House Ref.	Predicted Incremental Subsidence due to LW S7A (mm)	Predicted Incremental Tilt due to LW S7A (mm/m)	Predicted Incremental Hogging Curvature due to LW S7A (1/km)	Predicted Incremental Sagging Curvature due to LW S7A (1/km)	Predicted Total Subsidence after LW S1A to S7A (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature after LW S1A to S7A (1/km)	Predicted Total Sagging Curvature after LW S1A to S7A (1/km)	Predicted Probability of Nil or Category R0 Impact (%)	Predicted Probability of Category R1 or R2 Impact (%)	Predicted Probability of Category R3 or R4 Impact (%)	Predicted Probability of Category R5 Impact (%)
BCA_001_h01	125	1.0	< 0.01	0.01	550	5.5	5.5	0.05	0.03	71.6	19.4	8.6	0.4
BCA_010_h01	100	0.5	< 0.01	< 0.01	1200	6.5	8.0	0.09	0.14	49.5	35.8	13.6	1.0
BCA_015_h01	90	< 0.5	< 0.01	< 0.01	1350	7.0	8.0	0.09	0.22	42.2	35.2	15.7	6.9
BCA_020_h01	50	< 0.5	< 0.01	< 0.01	1200	4.0	4.0	0.05	0.05	71.3	19.6	8.7	0.4
BCA_025_h01	40	< 0.5	< 0.01	< 0.01	1150	4.0	4.0	0.05	0.04	66.3	26.3	7.0	0.5
BCA_030_h01	40	< 0.5	< 0.01	< 0.01	1100	3.5	3.5	0.05	0.04	54.7	28.2	13.5	3.7
BCA_035_h01	30	< 0.5	< 0.01	< 0.01	950	2.0	4.5	0.09	0.03	46.4	32.7	15.2	5.7
BCA_040_h01	20	< 0.5	< 0.01	< 0.01	1250	6.5	8.0	0.09	0.10	69.0	21.4	9.1	0.5
BCA_095_h01	20	< 0.5	< 0.01	< 0.01	1300	6.5	8.0	0.08	0.18	43.0	34.7	15.6	6.7
BCA_100_h01	30	< 0.5	< 0.01	< 0.01	1050	6.0	7.5	0.08	0.06	58.3	31.3	9.8	0.6
BCA_105_h01	30	< 0.5	< 0.01	< 0.01	700	4.0	4.0	0.05	0.03	65.4	26.9	7.2	0.5
BCA_110_h01	30	< 0.5	< 0.01	< 0.01	425	5.0	5.0	0.06	0.01	51.8	29.5	14.5	4.2
BCA_120_h01	30	< 0.5	0.01	< 0.01	100	1.5	1.5	0.02	< 0.01	77.2	18.3	4.2	0.3
BEL_001_h01	< 20	< 0.5	< 0.01	< 0.01	< 20	< 0.5	< 0.5	< 0.01	< 0.01	95.7	3.3	0.8	0.1
BRE_140_h01	30	< 0.5	< 0.01	< 0.01	1000	3.0	3.0	0.06	0.03	50.6	30.1	15.0	4.4
BRE_143_h01	50	< 0.5	< 0.01	< 0.01	1300	3.5	3.5	0.06	0.04	70.9	19.8	8.8	0.5
BRE_148_h01	50	< 0.5	< 0.01	< 0.01	1300	4.0	4.0	0.06	0.05	63.5	28.5	7.9	0.1
BRE_154_h01	80	< 0.5	< 0.01	< 0.01	1350	7.0	8.0	0.06	0.22	42.1	35.2	15.7	6.9
BRE_165_h01	70	1.0	< 0.01	< 0.01	1300	7.0	8.0	0.08	0.19	66.3	23.0	10.2	0.5
BRE_167_h01	50	1.0	0.02	< 0.01	850	5.0	6.0	0.09	0.05	46.5	32.6	15.2	5.7
BRE_177_h01	< 20	< 0.5	< 0.01	< 0.01	425	6.0	6.0	0.08	< 0.01	69.1	21.1	9.3	0.5
BRE_187_h01	< 20	< 0.5	< 0.01	< 0.01	275	5.0	5.0	0.08	< 0.01	58.6	31.2	9.7	0.6
BRE_191_h01	< 20	< 0.5	< 0.01	< 0.01	225	4.0	4.0	0.08	< 0.01	69.1	21.2	9.2	0.5
BRE_201_h01	< 20	< 0.5	< 0.01	< 0.01	60	0.5	0.5	< 0.01	< 0.01	91.5	7.4	1.0	0.2
BRE_515_h02	20	< 0.5	< 0.01	< 0.01	1300	6.5	8.0	0.09	0.17	47.2	36.4	15.2	1.2
BWE_019_h02	< 20	< 0.5	< 0.01	< 0.01	< 20	< 0.5	< 0.5	< 0.01	< 0.01	95.3	4.4	0.2	0.1
BWE_023_h01	< 20	< 0.5	< 0.01	< 0.01	< 20	< 0.5	< 0.5	< 0.01	< 0.01	95.4	4.3	0.2	0.1
BWE_025_h01	< 20	< 0.5	< 0.01	< 0.01	< 20	< 0.5	< 0.5	< 0.01	< 0.01	95.4	4.3	0.2	0.1
BWE_027_h01	< 20	< 0.5	< 0.01	< 0.01	< 20	< 0.5	< 0.5	< 0.01	< 0.01	95.4	4.3	0.2	0.1
BWE_051_h01	< 20	< 0.5	< 0.01	< 0.01	30	< 0.5	< 0.5	< 0.01	< 0.01	94.0	5.4	0.5	0.1
BYR_001_h01	150	0.5	< 0.01	< 0.01	950	3.5	6.0	0.09	0.02	69.0	21.3	9.2	0.5
BYR_005_h01	250	1.0	0.02	0.01	1300	4.0	4.0	0.06	0.08	59.4	30.8	9.3	0.5
BYR_015_h01	300	1.0	0.05	0.02	1350	7.5	8.5	0.08	0.23	43.6	37.1	17.3	2.0
BYR_025_h01	550	3.0	0.04	0.03	750	2.0	3.5	0.08	0.03	58.9	31.0	9.5	0.5
BYR_035_h01	450	2.0	0.03	0.02	800	3.5	5.5	0.09	0.02	69.0	21.3	9.2	0.5
BYR_045_h01	900	3.5	0.06	0.04	1050	3.0	3.0	0.06	0.04	70.9	19.8	8.8	0.5
BYR_045_h02	950	3.5	0.06	0.09	1100	3.0	3.0	0.06	0.09	57.1	32.0	10.3	0.6
BYR_055_h01	950	7.5	0.06	0.21	1100	8.0	8.0	0.06	0.22	42.2	35.2	15.7	6.9
BYR_065_h01	800	8.0	0.09	0.13	950	8.5	8.5	0.09	0.13	50.3	35.6	13.1	1.0
BYR_065_h02	450	6.5	0.09	0.02	550	7.0	7.0	0.09	0.02	56.6	32.3	10.5	0.7
BYR_075_h01	300	4.0	0.07	0.02	375	4.5	4.5	0.08	0.02	47.4	32.1	15.1	5.4
BYR_075_h02	225	2.5	0.05	0.01	300	3.0	3.0	0.05	0.01	71.2	19.7	8.7	0.4
BYR_084_h01	200	2.0	0.03	< 0.01	250	2.5	2.5	0.04	< 0.01	70.4	23.4	6.0	0.3
BYR_085_h01	175	1.5	0.02	< 0.01	225	2.0	2.0	0.03	< 0.01	75.6	19.5	4.6	0.3
BYR_085_h02	200	1.5	0.03	< 0.01	250	2.0	2.0	0.03	< 0.01	77.7	15.5	6.5	0.3
BYR_085_h03	150	1.0	0.01	< 0.01	200	1.5	1.5	0.01	< 0.01	87.4	8.9	3.6	0.1
BYR_095_h01	150	1.0	0.01	< 0.01	175	1.0	1.0	0.01	< 0.01	84.3	12.9	2.5	0.3
BYR_105_h01	90	< 0.5	< 0.01	< 0.01	125	0.5	0.5	< 0.01	< 0.01	93.2	5.0	1.7	0.1
BYR_115_h02	100	0.5	< 0.01	< 0.01	150	1.0	1.0	< 0.01	< 0.01	88.7	9.5	1.5	0.3
BYR_125_h01	350	5.0	0.08	0.02	425	5.5	5.5	0.09	0.02	69.0	21.3	9.2	0.5

Table C.03 - Predictions for Houses

House Ref.	Predicted Incremental Subsidence due to LW S7A (mm)	Predicted Incremental Tilt due to LW S7A (mm/m)	Predicted Incremental Hogging Curvature due to LW S7A (1/km)	Predicted Incremental Sagging Curvature due to LW S7A (1/km)	Predicted Total Subsidence after LW S1A to S7A (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature after LW S1A to S7A (1/km)	Predicted Total Sagging Curvature after LW S1A to S7A (1/km)	Predicted Probability of Nil or Category R0 Impact (%)	Predicted Probability of Category R1 or R2 Impact (%)	Predicted Probability of Category R3 or R4 Impact (%)	Predicted Probability of Category R5 Impact (%)
BYR_135_h01	850	8.0	0.08	0.16	1000	8.5	8.5	0.09	0.17	66.8	22.7	10.0	0.5
BYR_135_h02	900	8.0	0.09	0.21	1050	8.5	8.5	0.09	0.22	65.6	23.4	10.5	0.5
BYR_145_h01	950	6.5	0.06	0.22	1100	7.5	7.5	0.06	0.23	43.6	37.1	17.3	2.0
BYR_150_h01	250	1.0	0.02	0.01	1300	3.5	3.5	0.06	0.05	50.9	30.0	14.8	4.3
BYR_150_h02	275	1.0	0.02	0.01	1300	3.5	3.5	0.06	0.05	70.6	20.1	8.8	0.5
BYR_152_h01	225	1.0	0.02	0.01	1200	4.0	4.0	0.05	0.04	64.6	27.6	7.5	0.3
BYR_154_h01	200	1.0	0.01	0.01	1100	3.5	3.5	0.05	0.04	66.5	26.1	6.9	0.4
BYR_156_h01	175	1.0	0.01	< 0.01	1000	3.0	3.0	0.06	0.03	70.4	20.2	8.9	0.5
BYR_156_h02	200	1.0	0.01	< 0.01	1000	3.5	3.5	0.04	0.04	73.3	18.4	8.0	0.3
BYR_158_h01	150	0.5	< 0.01	< 0.01	900	2.0	4.5	0.09	0.03	69.0	21.3	9.2	0.5
BYR_160_h01	100	0.5	< 0.01	< 0.01	1250	7.0	8.5	0.10	0.10	54.4	33.4	11.4	0.8
BYR_162_h01	80	0.5	< 0.01	< 0.01	1350	7.0	8.5	0.08	0.23	65.5	23.5	10.5	0.5
Maxima:	**950**	**8.0**	**0.09**	**0.22**	**1350**	**8.5**	**8.5**	**0.10**	**0.23**				

Table C.04 - Predictions for Rural Structures

Structure Ref.	Maximum Plan Dimension (m)	Predicted Incremental Subsidence due to LW S7A (mm)	Predicted Incremental Tilt due to LW S7A (mm/m)	Predicted Incremental Hogging Curvature due to LW S7A (1/km)	Predicted Incremental Sagging Curvature due to LW S7A (1/km)	Predicted Total Subsidence after LW S1A to S7A (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature after LW S1A to S7A (1/km)	Predicted Total Sagging Curvature after LW S1A to S7A (1/km)
BCA_001_r01	8	125	1.0	< 0.01	0.01	500	5.0	5.0	0.05	0.01
BCA_001_r02	17	225	1.0	0.01	0.01	1000	6.0	6.0	0.02	0.07
BCA_001_r03	7	225	1.0	0.01	0.01	1050	4.5	4.5	0.03	0.06
BCA_001_r04	6	250	1.0	0.01	0.01	1150	5.0	5.0	0.04	0.06
BCA_001_r05	15	250	1.5	0.01	0.02	1000	8.0	8.0	0.03	0.12
BCA_001_r07	4	150	1.0	< 0.01	0.01	600	6.0	6.0	0.04	0.04
BCA_001_r09	3	250	1.0	0.01	0.01	1150	5.0	5.0	0.04	0.06
BCA_001_r10	4	250	1.0	0.02	0.01	1200	5.0	5.0	0.04	0.06
BCA_010_r01	10	100	0.5	< 0.01	< 0.01	1100	6.5	8.0	0.09	0.05
BCA_010_r02	12	125	0.5	< 0.01	< 0.01	900	4.5	6.5	0.09	0.05
BCA_010_r03	7	125	0.5	< 0.01	< 0.01	950	5.0	7.0	0.09	0.04
BCA_010_r04	6	100	0.5	< 0.01	< 0.01	1100	6.5	8.0	0.09	0.04
BCA_010_r05	4	100	0.5	< 0.01	< 0.01	1150	6.5	8.0	0.09	0.05
BCA_010_r06	11	100	0.5	< 0.01	< 0.01	1150	6.5	8.0	0.09	0.05
BCA_010_r07	6	100	0.5	< 0.01	< 0.01	1100	6.5	8.0	0.09	0.05
BCA_010_r08	10	175	0.5	0.01	< 0.01	950	3.0	3.0	0.05	0.04
BCA_010_r09	6	125	0.5	< 0.01	< 0.01	900	4.5	6.5	0.09	0.04
BCA_015_r01	16	100	0.5	< 0.01	< 0.01	1250	7.0	8.0	0.09	0.13
BCA_015_r02	18	100	0.5	< 0.01	< 0.01	1300	7.0	8.0	0.09	0.13
BCA_015_r03	4	100	0.5	< 0.01	< 0.01	1150	6.5	8.0	0.09	0.05
BCA_020_r02	4	50	< 0.5	< 0.01	< 0.01	1200	4.0	4.0	0.05	0.05
BCA_020_r03	6	50	< 0.5	< 0.01	< 0.01	1250	4.0	4.0	0.05	0.05
BCA_020_r07	6	40	< 0.5	< 0.01	< 0.01	1150	4.0	4.0	0.04	0.05
BCA_020_r08	20	50	< 0.5	< 0.01	< 0.01	1250	4.0	4.0	0.05	0.05
BCA_020_r09	4	50	< 0.5	< 0.01	< 0.01	1250	4.0	4.0	0.05	0.05
BCA_020_r10	5	50	< 0.5	< 0.01	< 0.01	1300	4.0	4.0	0.05	0.05
BCA_020_r11	2	60	< 0.5	< 0.01	< 0.01	1300	4.5	4.5	0.05	0.06
BCA_020_r12	2	60	< 0.5	< 0.01	< 0.01	1300	4.0	4.0	0.05	0.06
BCA_020_r13	2	60	< 0.5	< 0.01	< 0.01	1300	4.0	4.0	0.05	0.08
BCA_020_r14	2	60	< 0.5	< 0.01	< 0.01	1350	4.0	4.0	0.05	0.11
BCA_020_r15	2	60	< 0.5	< 0.01	< 0.01	1350	4.0	4.0	0.05	0.14
BCA_020_r16	2	60	< 0.5	< 0.01	< 0.01	1350	4.0	4.0	0.05	0.18
BCA_020_r17	2	70	< 0.5	< 0.01	< 0.01	1350	3.5	3.5	0.05	0.20
BCA_020_r18	2	70	< 0.5	< 0.01	< 0.01	1350	3.5	3.5	0.06	0.22
BCA_025_r01	12	40	< 0.5	< 0.01	< 0.01	1150	4.0	4.0	0.05	0.04
BCA_025_r03	4	50	< 0.5	< 0.01	< 0.01	1250	4.0	4.0	0.05	0.04
BCA_025_r04	4	50	< 0.5	< 0.01	< 0.01	1250	4.0	4.0	0.05	0.05
BCA_025_r05	9	50	< 0.5	< 0.01	< 0.01	1300	4.0	4.0	0.06	0.05
BCA_025_r07	3	60	< 0.5	< 0.01	< 0.01	1300	4.0	4.0	0.06	0.05
BCA_025_r08	4	60	< 0.5	< 0.01	< 0.01	1350	4.0	4.0	0.06	0.05
BCA_025_r09	3	40	< 0.5	< 0.01	< 0.01	1200	4.0	4.0	0.05	0.04
BCA_030_r01	7	40	< 0.5	< 0.01	< 0.01	1050	3.5	3.5	0.04	0.03
BCA_030_r02	10	50	< 0.5	< 0.01	< 0.01	1300	4.0	4.0	0.06	0.05

Table C.04 - Predictions for Rural Structures

Structure Ref.	Maximum Plan Dimension (m)	Predicted Incremental Subsidence due to LW S7A (mm)	Predicted Incremental Tilt due to LW S7A (mm/m)	Predicted Incremental Hogging Curvature due to LW S7A (1/km)	Predicted Incremental Sagging Curvature due to LW S7A (1/km)	Predicted Total Subsidence after LW S1A to S7A (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature after LW S1A to S7A (1/km)	Predicted Total Sagging Curvature after LW S1A to S7A (1/km)
BCA_030_r03	13	40	< 0.5	< 0.01	< 0.01	1150	3.5	3.5	0.05	0.04
BCA_030_r04	6	40	< 0.5	< 0.01	< 0.01	1150	4.0	4.0	0.05	0.04
BCA_035_r01	11	30	< 0.5	< 0.01	< 0.01	900	1.5	4.0	0.08	0.03
BCA_035_r02	13	40	< 0.5	< 0.01	< 0.01	1100	3.5	3.5	0.05	0.04
BCA_035_r03	3	40	< 0.5	< 0.01	< 0.01	1150	4.0	4.0	0.05	0.04
BCA_035_r04	3	30	< 0.5	< 0.01	< 0.01	950	2.0	3.0	0.07	0.03
BCA_040_r02	10	20	< 0.5	< 0.01	< 0.01	1150	6.0	8.0	0.09	0.03
BCA_040_r03	5	20	< 0.5	< 0.01	< 0.01	1100	5.5	8.0	0.09	0.03
BCA_040_r04	5	20	< 0.5	< 0.01	< 0.01	1050	5.0	7.5	0.09	0.03
BCA_040_r05	7	30	< 0.5	< 0.01	< 0.01	1050	5.0	7.5	0.09	0.03
BCA_040_r06	6	30	< 0.5	< 0.01	< 0.01	1000	4.0	6.0	0.09	0.02
BCA_095_r02	9	20	< 0.5	< 0.01	< 0.01	1200	6.0	7.5	0.07	0.14
BCA_095_r03	11	20	< 0.5	< 0.01	< 0.01	1250	6.5	8.0	0.07	0.16
BCA_100_r01	9	20	< 0.5	< 0.01	< 0.01	800	5.5	6.5	0.07	0.05
BCA_100_r02	7	20	< 0.5	< 0.01	< 0.01	800	6.0	6.5	0.06	0.05
BCA_100_r03	6	20	< 0.5	< 0.01	< 0.01	800	6.0	6.5	0.06	0.05
BCA_100_r04	3	30	< 0.5	< 0.01	< 0.01	800	4.5	5.5	0.07	0.05
BCA_100_r05	5	30	< 0.5	< 0.01	< 0.01	800	4.5	5.5	0.07	0.05
BCA_105_r01	11	30	< 0.5	< 0.01	< 0.01	850	4.5	4.5	0.03	0.04
BCA_105_r02	14	30	< 0.5	< 0.01	< 0.01	500	4.5	4.5	0.04	0.02
BCA_105_r03	16	30	< 0.5	< 0.01	< 0.01	750	4.5	4.5	0.03	0.04
BCA_105_r04	8	30	< 0.5	< 0.01	< 0.01	750	4.0	4.0	0.06	0.04
BCA_105_r05	3	30	< 0.5	< 0.01	< 0.01	700	4.5	4.5	0.06	0.03
BCA_110_r01	12	30	< 0.5	< 0.01	< 0.01	425	5.0	5.0	0.06	< 0.01
BCA_110_r02	7	20	< 0.5	< 0.01	< 0.01	400	4.5	4.5	0.04	0.01
BCA_110_r04	9	20	< 0.5	< 0.01	< 0.01	375	4.0	4.0	0.04	< 0.01
BCA_110_r07	11	40	< 0.5	< 0.01	< 0.01	850	5.0	5.0	0.03	0.04
BCA_120_r01	7	30	< 0.5	0.01	< 0.01	125	1.5	1.5	0.03	< 0.01
BCA_120_r02	5	30	0.5	0.01	< 0.01	125	1.5	1.5	0.03	< 0.01
BCA_120_r03	3	30	0.5	0.01	< 0.01	125	1.5	1.5	0.03	< 0.01
BCA_120_r04	5	< 20	< 0.5	< 0.01	< 0.01	70	0.5	0.5	< 0.01	< 0.01
BCA_120_r05	11	20	< 0.5	< 0.01	< 0.01	100	1.0	1.0	0.02	< 0.01
BCA_120_r06	7	20	< 0.5	< 0.01	< 0.01	90	1.0	1.0	0.02	< 0.01
BCA_120_r07	4	< 20	< 0.5	< 0.01	< 0.01	70	0.5	0.5	< 0.01	< 0.01
BCA_120_r09	3	< 20	< 0.5	< 0.01	< 0.01	90	1.0	1.0	0.01	< 0.01
BCA_120_r10	3	20	< 0.5	< 0.01	< 0.01	100	1.5	1.5	0.02	< 0.01
BEL_001_r01	17	< 20	< 0.5	< 0.01	< 0.01	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BEL_001_r02	11	< 20	< 0.5	< 0.01	< 0.01	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BEL_001_r04	4	< 20	< 0.5	< 0.01	< 0.01	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BEL_001_r05	8	< 20	< 0.5	< 0.01	< 0.01	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BEL_001_r06	3	< 20	< 0.5	< 0.01	< 0.01	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BNO_043_r04	9	< 20	< 0.5	< 0.01	< 0.01	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BRE_090_r01	10	40	< 0.5	< 0.01	< 0.01	1250	3.5	3.5	0.06	0.04

Table C.04 - Predictions for Rural Structures

Structure Ref.	Maximum Plan Dimension (m)	Predicted Incremental Subsidence due to LW S7A (mm)	Predicted Incremental Tilt due to LW S7A (mm/m)	Predicted Incremental Hogging Curvature due to LW S7A (1/km)	Predicted Incremental Sagging Curvature due to LW S7A (1/km)	Predicted Total Subsidence after LW S1A to S7A (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature after LW S1A to S7A (1/km)	Predicted Total Sagging Curvature after LW S1A to S7A (1/km)
BRE_140_r01	11	30	< 0.5	< 0.01	< 0.01	1000	3.0	3.0	0.05	0.03
BRE_140_r02	6	30	< 0.5	< 0.01	< 0.01	1050	3.0	3.0	0.04	0.03
BRE_143_r01	3	50	< 0.5	< 0.01	< 0.01	1300	3.5	3.5	0.06	0.04
BRE_143_r02	6	50	< 0.5	< 0.01	< 0.01	1300	3.5	3.5	0.06	0.05
BRE_143_r03	7	50	< 0.5	< 0.01	< 0.01	1300	3.5	3.5	0.06	0.05
BRE_148_r01	7	50	< 0.5	< 0.01	< 0.01	1300	3.5	3.5	0.06	0.06
BRE_148_r02	8	50	< 0.5	< 0.01	< 0.01	1350	3.5	3.5	0.06	0.08
BRE_148_r03	7	60	< 0.5	< 0.01	< 0.01	1350	3.0	3.0	0.06	0.22
BRE_148_r04	2	50	< 0.5	< 0.01	< 0.01	1350	3.5	3.5	0.06	0.06
BRE_148_r05	6	50	< 0.5	< 0.01	< 0.01	1350	3.5	3.5	0.06	0.12
BRE_154_r01	6	80	< 0.5	< 0.01	< 0.01	1350	7.0	8.0	0.07	0.22
BRE_154_r02	9	90	0.5	< 0.01	< 0.01	1350	7.0	8.0	0.08	0.20
BRE_154_r03	10	90	< 0.5	< 0.01	< 0.01	1350	7.0	8.0	0.08	0.22
BRE_154_r04	11	100	0.5	< 0.01	< 0.01	1300	7.0	8.0	0.09	0.15
BRE_154_r05	5	100	0.5	< 0.01	< 0.01	1200	7.0	8.0	0.09	0.05
BRE_154_r06	4	100	0.5	< 0.01	< 0.01	1150	7.0	8.0	0.09	0.04
BRE_154_r07	10	100	0.5	< 0.01	< 0.01	1200	7.0	8.0	0.09	0.06
BRE_167_r01	11	60	1.0	0.02	< 0.01	900	5.0	6.5	0.09	0.05
BRE_167_r02	9	70	1.0	0.02	< 0.01	850	4.0	5.5	0.09	0.04
BRE_167_r03	12	70	1.0	0.02	< 0.01	800	3.5	4.5	0.08	0.04
BRE_167_r04	12	80	1.0	0.02	< 0.01	800	3.0	4.0	0.08	0.04
BRE_167_r06	9	70	1.0	0.02	< 0.01	800	3.0	3.5	0.07	0.04
BRE_167_r07	7	70	1.0	0.02	< 0.01	800	3.0	3.0	0.07	0.05
BRE_167_r08	6	60	1.0	0.02	< 0.01	800	3.5	4.5	0.08	0.05
BRE_167_r09	6	50	1.0	0.02	< 0.01	750	3.5	3.5	0.07	0.05
BRE_167_r10	3	50	1.0	0.02	< 0.01	750	3.5	4.5	0.08	0.05
BRE_167_r12	3	50	1.0	0.02	< 0.01	750	3.5	3.5	0.06	0.05
BRE_167_r13	4	50	1.0	0.02	< 0.01	750	3.5	3.5	0.06	0.05
BRE_167_r14	3	60	1.0	0.02	< 0.01	750	3.5	3.5	0.06	0.05
BRE_167_r15	29	50	1.0	0.02	< 0.01	800	4.5	4.5	0.05	0.06
BRE_167_r16	19	60	1.0	0.02	< 0.01	800	4.0	4.0	0.05	0.05
BRE_167_r17	14	90	1.5	0.02	< 0.01	900	4.0	4.0	0.04	0.05
BRE_167_r18	3	60	1.0	0.02	< 0.01	800	3.5	4.5	0.08	0.05
BRE_167_r19	6	80	1.5	0.02	< 0.01	900	4.5	4.5	0.03	0.05
BRE_177_r01	6	< 20	< 0.5	< 0.01	< 0.01	450	6.0	6.0	0.08	0.01
BRE_187_r01	9	< 20	< 0.5	< 0.01	< 0.01	350	6.0	6.0	0.09	< 0.01
BRE_189_r01	12	< 20	< 0.5	< 0.01	< 0.01	200	3.5	3.5	0.08	< 0.01
BRE_191_r01	13	< 20	< 0.5	< 0.01	< 0.01	225	3.5	3.5	0.08	0.01
BRE_191_r02	4	< 20	< 0.5	< 0.01	< 0.01	275	4.5	4.5	0.10	0.02
BRE_195_r02	12	< 20	< 0.5	< 0.01	< 0.01	125	1.0	1.0	0.02	0.01
BRE_195_r03	8	< 20	< 0.5	< 0.01	< 0.01	125	1.5	1.5	0.03	0.02
BRE_195_r04	4	< 20	< 0.5	< 0.01	< 0.01	80	1.0	1.0	< 0.01	< 0.01
BRE_195_r06	8	< 20	< 0.5	< 0.01	< 0.01	150	2.0	2.0	0.03	0.02

Table C.04 - Predictions for Rural Structures

Structure Ref.	Maximum Plan Dimension (m)	Predicted Incremental Subsidence due to LW S7A (mm)	Predicted Incremental Tilt due to LW S7A (mm/m)	Predicted Incremental Hogging Curvature due to LW S7A (1/km)	Predicted Incremental Sagging Curvature due to LW S7A (1/km)	Predicted Total Subsidence after LW S1A to S7A (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature after LW S1A to S7A (1/km)	Predicted Total Sagging Curvature after LW S1A to S7A (1/km)
BRE_195_r07	7	< 20	< 0.5	< 0.01	< 0.01	80	0.5	0.5	< 0.01	< 0.01
BRE_195_r08	6	< 20	< 0.5	< 0.01	< 0.01	70	0.5	0.5	< 0.01	< 0.01
BRE_195_r12	4	< 20	< 0.5	< 0.01	< 0.01	125	1.5	1.5	0.03	0.02
BRE_195_r13	2	< 20	< 0.5	< 0.01	< 0.01	100	1.0	1.0	0.01	0.01
BRE_195_r14	7	< 20	< 0.5	< 0.01	< 0.01	100	1.0	1.0	0.02	0.01
BRE_195_r15	4	< 20	< 0.5	< 0.01	< 0.01	100	1.0	1.0	0.01	0.01
BRE_201_r01	17	< 20	< 0.5	< 0.01	< 0.01	50	< 0.5	< 0.5	< 0.01	< 0.01
BRE_201_r02	5	< 20	< 0.5	< 0.01	< 0.01	50	< 0.5	< 0.5	< 0.01	< 0.01
BRE_201_r03	4	< 20	< 0.5	< 0.01	< 0.01	60	0.5	0.5	< 0.01	< 0.01
BRE_201_r04	2	< 20	< 0.5	< 0.01	< 0.01	60	0.5	0.5	< 0.01	< 0.01
BRE_201_r05	12	< 20	< 0.5	< 0.01	< 0.01	50	0.5	0.5	< 0.01	< 0.01
BWE_023_r01	10	< 20	< 0.5	< 0.01	< 0.01	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_025_r01	8	< 20	< 0.5	< 0.01	< 0.01	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_025_r02	10	< 20	< 0.5	< 0.01	< 0.01	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_027_r01	12	< 20	< 0.5	< 0.01	< 0.01	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_027_r08	9	< 20	< 0.5	< 0.01	< 0.01	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_027_r09	6	< 20	< 0.5	< 0.01	< 0.01	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_029_r03	4	< 20	< 0.5	< 0.01	< 0.01	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_029_r04	7	< 20	< 0.5	< 0.01	< 0.01	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_041_r04	30	< 20	< 0.5	< 0.01	< 0.01	30	< 0.5	< 0.5	< 0.01	< 0.01
BWE_051_r01	18	< 20	< 0.5	< 0.01	< 0.01	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_051_r02	5	< 20	< 0.5	< 0.01	< 0.01	20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_051_r03	10	< 20	< 0.5	< 0.01	< 0.01	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_051_r04	10	< 20	< 0.5	< 0.01	< 0.01	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_051_r05	2	< 20	< 0.5	< 0.01	< 0.01	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_051_r07	7	< 20	< 0.5	< 0.01	< 0.01	20	< 0.5	< 0.5	< 0.01	< 0.01
BYR_001_r02	19	150	0.5	< 0.01	< 0.01	950	4.0	6.0	0.09	0.02
BYR_001_r03	8	125	0.5	< 0.01	< 0.01	1000	5.0	7.0	0.09	0.03
BYR_001_r05	5	125	0.5	< 0.01	< 0.01	1050	5.0	7.5	0.09	0.03
BYR_005_r01	7	250	1.0	0.02	0.01	1300	3.5	3.5	0.06	0.09
BYR_005_r02	13	250	1.0	0.02	0.01	1300	4.0	4.0	0.06	0.07
BYR_005_r03	17	250	1.0	0.02	0.01	1300	4.0	4.0	0.06	0.06
BYR_005_r04	6	250	1.0	0.02	0.01	1300	3.5	3.5	0.06	0.10
BYR_005_r05	9	225	1.0	0.02	0.01	1200	4.0	4.0	0.06	0.04
BYR_005_r06	4	200	1.0	0.01	0.01	1150	4.0	4.0	0.05	0.04
BYR_015_r01	12	275	1.0	0.02	0.01	1350	6.0	6.5	0.06	0.23
BYR_015_r02	12	300	1.0	0.02	0.02	1350	7.5	8.0	0.06	0.23
BYR_015_r06	4	250	1.0	0.02	0.01	1300	3.5	3.5	0.06	0.15
BYR_015_r07	29	300	1.5	0.05	0.02	1350	8.0	8.5	0.11	0.23
BYR_025_r05	4	475	2.5	0.03	0.03	750	1.5	3.5	0.08	0.03
BYR_025_r08	6	550	3.0	0.04	0.03	750	2.0	2.5	0.05	0.03
BYR_025_r09	24	350	1.5	0.06	0.02	1150	8.0	8.5	0.12	0.05
BYR_035_r02	7	475	2.0	0.03	0.02	800	3.0	5.0	0.08	0.02

Table C.04 - Predictions for Rural Structures

Structure Ref.	Maximum Plan Dimension (m)	Predicted Incremental Subsidence due to LW S7A (mm)	Predicted Incremental Tilt due to LW S7A (mm/m)	Predicted Incremental Hogging Curvature due to LW S7A (1/km)	Predicted Incremental Sagging Curvature due to LW S7A (1/km)	Predicted Total Subsidence after LW S1A to S7A (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature after LW S1A to S7A (1/km)	Predicted Total Sagging Curvature after LW S1A to S7A (1/km)
BYR_035_r03	7	450	2.0	0.03	0.02	800	3.0	5.0	0.08	0.02
BYR_035_r04	12	450	2.0	0.03	0.02	850	4.0	5.5	0.09	0.02
BYR_035_r05	7	400	2.0	0.03	0.02	900	5.0	7.0	0.09	0.03
BYR_035_r06	9	400	2.0	0.04	0.02	900	5.5	7.5	0.11	0.03
BYR_035_r07	7	375	2.0	0.06	0.02	1050	7.5	8.5	0.12	0.03
BYR_035_r08	12	425	2.0	0.03	0.02	900	5.0	7.0	0.09	0.02
BYR_035_r09	5	400	2.0	0.03	0.02	900	5.0	7.0	0.09	0.02
BYR_035_r10	2	400	2.0	0.03	0.02	900	5.0	7.0	0.09	0.03
BYR_035_r12	4	425	2.0	0.03	0.02	800	4.0	5.5	0.09	0.02
BYR_035_r13	11	500	2.5	0.03	0.03	750	1.5	3.5	0.07	0.03
BYR_045_r10	7	950	3.5	0.06	0.06	1050	3.0	3.0	0.06	0.06
BYR_045_r11	21	900	3.5	0.06	0.05	1050	3.0	3.0	0.06	0.05
BYR_065_r01	12	750	8.0	0.09	0.07	850	8.5	8.5	0.09	0.07
BYR_065_r02	9	800	8.0	0.08	0.11	900	8.5	8.5	0.09	0.11
BYR_065_r03	4	350	4.5	0.08	0.02	425	5.0	5.0	0.09	0.02
BYR_065_r04	3	425	6.0	0.09	0.02	500	6.5	6.5	0.09	0.02
BYR_065_r05	21	850	8.0	0.09	0.14	950	8.5	8.5	0.09	0.14
BYR_065_r06	18	750	8.0	0.09	0.08	900	8.5	8.5	0.09	0.08
BYR_065_r07	7	550	7.5	0.09	0.03	650	8.0	8.0	0.09	0.03
BYR_065_r08	4	350	5.0	0.08	0.02	425	5.5	5.5	0.09	0.02
BYR_065_r09	2	350	5.0	0.08	0.02	425	5.5	5.5	0.09	0.02
BYR_065_r10	4	750	8.0	0.09	0.07	850	8.5	8.5	0.09	0.07
BYR_065_r11	3	650	8.0	0.09	0.03	800	8.5	8.5	0.09	0.03
BYR_065_r12	6	600	7.5	0.09	0.03	700	8.5	8.5	0.09	0.03
BYR_075_r01	15	325	4.5	0.08	0.02	400	5.0	5.0	0.08	0.02
BYR_075_r02	11	350	5.0	0.08	0.02	425	5.5	5.5	0.09	0.02
BYR_075_r03	11	400	5.5	0.09	0.02	475	6.0	6.0	0.09	0.02
BYR_075_r04	11	650	8.0	0.09	0.03	750	8.5	8.5	0.09	0.03
BYR_075_r05	10	275	3.5	0.07	0.01	350	4.0	4.0	0.07	0.01
BYR_075_r06	3	250	3.0	0.06	0.01	325	3.5	3.5	0.06	0.01
BYR_075_r07	3	300	4.0	0.08	0.02	375	4.5	4.5	0.08	0.02
BYR_075_r08	14	250	3.0	0.06	0.01	325	3.0	3.0	0.06	0.01
BYR_075_r09	6	225	2.0	0.04	0.01	275	2.5	2.5	0.05	0.01
BYR_075_r10	2	250	3.0	0.06	0.01	325	3.0	3.0	0.06	0.01
BYR_075_r11	4	225	2.5	0.05	0.01	300	3.0	3.0	0.05	0.01
BYR_075_r12	3	300	4.0	0.07	0.01	375	4.5	4.5	0.08	0.01
BYR_075_r13	14	450	6.0	0.09	0.02	500	6.5	6.5	0.09	0.02
BYR_084_r01	8	200	2.0	0.04	0.01	275	2.5	2.5	0.04	0.01
BYR_084_r02	8	275	3.5	0.06	0.01	350	3.5	3.5	0.07	0.01
BYR_084_r03	8	250	3.0	0.06	0.01	325	3.5	3.5	0.06	0.01
BYR_084_r04	14	225	2.0	0.04	0.01	275	2.5	2.5	0.04	0.01
BYR_084_r05	9	250	3.0	0.06	0.01	325	3.5	3.5	0.06	0.01
BYR_084_r06	7	300	3.5	0.07	0.01	350	4.0	4.0	0.07	0.01

Table C.04 - Predictions for Rural Structures

Structure Ref.	Maximum Plan Dimension (m)	Predicted Incremental Subsidence due to LW S7A (mm)	Predicted Incremental Tilt due to LW S7A (mm/m)	Predicted Incremental Hogging Curvature due to LW S7A (1/km)	Predicted Incremental Sagging Curvature due to LW S7A (1/km)	Predicted Total Subsidence after LW S1A to S7A (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature after LW S1A to S7A (1/km)	Predicted Total Sagging Curvature after LW S1A to S7A (1/km)
BYR_085_r01	16	175	1.5	0.02	< 0.01	225	1.5	1.5	0.02	< 0.01
BYR_085_r03	19	175	1.5	0.02	< 0.01	225	2.0	2.0	0.03	< 0.01
BYR_085_r04	4	250	3.0	0.06	0.01	325	3.5	3.5	0.06	0.01
BYR_085_r05	4	200	2.0	0.03	0.01	250	2.5	2.5	0.04	0.01
BYR_085_r06	17	400	5.5	0.09	0.02	500	6.0	6.0	0.09	0.02
BYR_085_r08	4	275	3.0	0.06	0.01	325	3.5	3.5	0.07	0.01
BYR_085_r09	6	150	1.0	0.01	< 0.01	200	1.5	1.5	0.02	< 0.01
BYR_085_r10	9	150	1.0	0.02	< 0.01	200	1.5	1.5	0.02	< 0.01
BYR_085_r11	5	200	2.0	0.03	< 0.01	250	2.0	2.0	0.03	< 0.01
BYR_085_r12	10	300	3.5	0.07	0.01	375	4.0	4.0	0.08	0.01
BYR_085_r13	5	350	5.0	0.08	0.02	425	5.5	5.5	0.09	0.02
BYR_085_r14	5	600	7.5	0.09	0.03	700	8.5	8.5	0.09	0.03
BYR_085_r15	6	225	2.0	0.04	0.01	275	2.5	2.5	0.04	0.01
BYR_085_r16	3	200	1.5	0.03	< 0.01	250	2.0	2.0	0.03	< 0.01
BYR_095_r02	12	200	1.5	0.03	< 0.01	250	2.0	2.0	0.03	< 0.01
BYR_095_r03	12	200	2.0	0.03	< 0.01	250	2.0	2.0	0.03	< 0.01
BYR_095_r04	19	225	2.5	0.05	0.01	300	3.0	3.0	0.05	0.01
BYR_095_r05	16	250	2.5	0.05	0.01	300	3.0	3.0	0.05	0.01
BYR_095_r06	4	125	0.5	< 0.01	< 0.01	150	1.0	1.0	< 0.01	< 0.01
BYR_105_r01	11	90	< 0.5	< 0.01	< 0.01	125	0.5	0.5	< 0.01	< 0.01
BYR_105_r02	10	80	< 0.5	< 0.01	< 0.01	100	0.5	0.5	< 0.01	< 0.01
BYR_105_r03	15	70	< 0.5	< 0.01	< 0.01	100	< 0.5	< 0.5	< 0.01	< 0.01
BYR_105_r07	5	80	< 0.5	< 0.01	< 0.01	100	0.5	0.5	< 0.01	< 0.01
BYR_105_r09	3	80	< 0.5	< 0.01	< 0.01	125	0.5	0.5	< 0.01	< 0.01
BYR_105_r10	2	80	< 0.5	< 0.01	< 0.01	125	0.5	0.5	< 0.01	< 0.01
BYR_115_r01	18	125	1.0	0.01	< 0.01	175	1.0	1.0	0.01	< 0.01
BYR_115_r02	6	100	0.5	< 0.01	< 0.01	150	1.0	1.0	< 0.01	< 0.01
BYR_115_r04	5	100	0.5	< 0.01	< 0.01	125	0.5	0.5	< 0.01	< 0.01
BYR_115_r08	14	100	0.5	< 0.01	< 0.01	150	1.0	1.0	< 0.01	< 0.01
BYR_115_r09	9	90	< 0.5	< 0.01	< 0.01	125	0.5	0.5	< 0.01	< 0.01
BYR_115_r10	6	100	0.5	< 0.01	< 0.01	125	0.5	0.5	< 0.01	< 0.01
BYR_115_r11	2	125	1.0	0.01	< 0.01	175	1.0	1.0	0.01	< 0.01
BYR_125_r04	9	275	3.5	0.06	0.01	350	3.5	3.5	0.07	0.01
BYR_135_r01	9	800	8.0	0.09	0.09	900	8.5	8.5	0.09	0.09
BYR_135_r02	9	800	8.0	0.09	0.11	900	8.5	8.5	0.09	0.11
BYR_135_r03	3	700	8.0	0.09	0.04	850	8.5	8.5	0.09	0.04
BYR_135_r04	7	500	7.0	0.09	0.03	600	8.0	8.0	0.09	0.03
BYR_145_r01	11	950	3.0	0.06	0.22	1100	3.0	3.0	0.06	0.23
BYR_145_r02	11	950	5.5	0.06	0.22	1100	6.5	6.5	0.06	0.23
BYR_145_r03	12	950	3.5	0.06	0.12	1100	3.0	3.0	0.06	0.13
BYR_145_r05	3	950	5.0	0.06	0.22	1100	5.5	5.5	0.06	0.23
BYR_145_r06	4	950	6.0	0.06	0.22	1100	7.0	7.0	0.06	0.23
BYR_145_r07	2	950	3.5	0.06	0.09	1100	3.0	3.0	0.06	0.09

Table C.04 - Predictions for Rural Structures

Structure Ref.	Maximum Plan Dimension (m)	Predicted Incremental Subsidence due to LW S7A (mm)	Predicted Incremental Tilt due to LW S7A (mm/m)	Predicted Incremental Hogging Curvature due to LW S7A (1/km)	Predicted Incremental Sagging Curvature due to LW S7A (1/km)	Predicted Total Subsidence after LW S1A to S7A (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature after LW S1A to S7A (1/km)	Predicted Total Sagging Curvature after LW S1A to S7A (1/km)
BYR_150_r01	7	275	1.0	0.02	0.01	1300	3.5	3.5	0.06	0.05
BYR_150_r02	8	250	1.0	0.02	0.01	1300	3.5	3.5	0.06	0.05
BYR_150_r03	12	250	1.0	0.02	0.01	1300	3.5	3.5	0.06	0.05
BYR_150_r04	10	275	1.0	0.02	0.01	1350	3.5	3.5	0.06	0.09
BYR_152_r01	8	200	1.0	0.01	0.01	1100	3.5	3.5	0.05	0.04
BYR_152_r02	7	225	1.0	0.01	0.01	1150	4.0	4.0	0.05	0.04
BYR_152_r03	15	225	1.0	0.02	0.01	1200	4.0	4.0	0.05	0.04
BYR_152_r04	3	250	1.0	0.02	0.01	1250	4.0	4.0	0.06	0.05
BYR_152_r05	5	250	1.0	0.02	0.01	1300	4.0	4.0	0.06	0.05
BYR_152_r06	12	275	1.0	0.02	0.01	1300	4.0	4.0	0.06	0.05
BYR_152_r07	3	250	1.0	0.02	0.01	1250	4.0	4.0	0.06	0.04
BYR_154_r01	9	225	1.0	0.01	0.01	1150	4.0	4.0	0.05	0.04
BYR_156_r01	10	175	1.0	0.01	< 0.01	1000	3.0	3.0	0.05	0.03
BYR_158_r01	3	150	0.5	< 0.01	< 0.01	900	1.5	3.5	0.08	0.03
BYR_158_r02	14	150	0.5	< 0.01	< 0.01	900	1.5	4.0	0.09	0.03
BYR_160_r01	9	90	1.0	< 0.01	< 0.01	1200	7.0	8.5	0.10	0.07
BYR_160_r02	11	100	0.5	< 0.01	< 0.01	1150	7.0	8.5	0.10	0.04
BYR_162_r01	9	70	0.5	< 0.01	< 0.01	1350	7.0	8.0	0.06	0.23
Maxima:		**950**	**8.0**	**0.09**	**0.22**	**1350**	**8.5**	**8.5**	**0.12**	**0.23**

Table C.05 - Predictions for Tanks

Structure Ref.	Maximum Plan Dimension (m)	Predicted Incremental Subsidence due to LW S7A (mm)	Predicted Incremental Tilt due to LW S7A (mm/m)	Predicted Incremental Hogging Curvature due to LW S7A (1/km)	Predicted Incremental Sagging Curvature due to LW S7A (1/km)	Predicted Total Subsidence after LW S1A to S7A (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature after LW S1A to S7A (1/km)	Predicted Total Sagging Curvature after LW S1A to S7A (1/km)
BCA_001_t01	7	100	1.5	0.015	< 0.01	325	5.0	5.0	0.06	< 0.01
BCA_001_t02	2	125	1.0	< 0.01	< 0.01	550	5.0	5.0	0.04	0.03
BCA_010_t01	3	90	< 0.5	< 0.01	< 0.01	1250	6.5	8.0	0.09	0.18
BCA_010_t02	2	100	0.5	< 0.01	< 0.01	1150	6.5	8.0	0.09	0.06
BCA_010_t03	2	100	0.5	< 0.01	< 0.01	1100	6.5	8.0	0.09	0.04
BCA_010_t04	2	175	0.5	0.011	< 0.01	950	3.0	3.0	0.05	0.04
BCA_015_t01	4	80	< 0.5	< 0.01	< 0.01	1350	6.5	8.0	0.05	0.22
BCA_015_t02	3	100	0.5	< 0.01	< 0.01	1150	7.0	8.0	0.09	0.04
BCA_015_t03	3	100	0.5	< 0.01	< 0.01	1150	7.0	8.0	0.09	0.05
BCA_025_t01	1	40	< 0.5	< 0.01	< 0.01	1100	3.5	3.5	0.04	0.04
BCA_100_t01	4	20	< 0.5	< 0.01	< 0.01	1000	6.5	7.0	0.07	0.07
BCA_105_t01	2	30	< 0.5	< 0.01	< 0.01	650	4.0	4.0	0.04	0.02
BCA_105_t02	2	20	< 0.5	< 0.01	< 0.01	700	5.0	5.0	0.06	0.02
BCA_120_t01	3	20	< 0.5	< 0.01	< 0.01	90	1.0	1.0	0.02	< 0.01
BCA_120_t02	2	30	0.5	0.011	< 0.01	125	1.5	1.5	0.03	< 0.01
BRE_148_t01	2	60	< 0.5	< 0.01	< 0.01	1350	3.0	3.0	0.06	0.22
BRE_154_t01	4	80	< 0.5	< 0.01	< 0.01	1350	6.5	7.5	0.06	0.22
BWE_027_t01	2	< 20	< 0.5	< 0.01	< 0.01	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BWE_027_t02	2	< 20	< 0.5	< 0.01	< 0.01	< 20	< 0.5	< 0.5	< 0.01	< 0.01
BYR_001_t01	1	125	0.5	< 0.01	< 0.01	900	3.0	5.5	0.09	0.02
BYR_001_t02	3	125	0.5	< 0.01	< 0.01	950	3.5	5.5	0.09	0.02
BYR_005_t01	3	250	1.0	0.017	0.013	1300	3.5	3.5	0.06	0.08
BYR_015_t01	8	325	1.5	0.052	0.017	1250	8.0	8.5	0.11	0.16
BYR_015_t02	3	250	1.0	0.017	0.014	1350	3.5	3.5	0.06	0.17
BYR_025_t01	3	325	1.5	0.054	0.018	1100	8.0	8.5	0.12	0.04
BYR_055_t03	6	400	2.0	0.076	0.022	1000	6.5	8.0	0.12	0.03
BYR_065_t01	9	500	7.0	0.086	0.025	600	7.5	7.5	0.09	0.03
BYR_065_t02	3	550	7.0	0.086	0.026	600	8.0	8.0	0.09	0.03
BYR_065_t03	2	450	6.5	0.086	0.022	550	7.0	7.0	0.09	0.02
BYR_075_t01	3	250	3.0	0.060	0.013	325	3.5	3.5	0.06	0.01
BYR_075_t02	2	225	2.5	0.049	0.012	300	3.0	3.0	0.05	0.01
BYR_075_t03	2	600	7.5	0.087	0.029	700	8.5	8.5	0.09	0.03
BYR_075_t04	2	650	8.0	0.087	0.031	750	8.5	8.5	0.09	0.03
BYR_075_t05	2	300	4.0	0.075	0.015	375	4.5	4.5	0.08	0.02
BYR_075_t06	2	300	4.0	0.075	0.015	375	4.5	4.5	0.08	0.02
BYR_084_t01	3	275	3.0	0.063	0.013	325	3.5	3.5	0.07	0.01
BYR_085_t01	3	500	7.0	0.088	0.025	600	8.0	8.0	0.09	0.03
BYR_085_t02	3	550	7.5	0.088	0.027	650	8.0	8.0	0.09	0.03
BYR_085_t03	3	150	1.0	0.013	< 0.01	200	1.5	1.5	0.02	< 0.01
BYR_085_t04	3	150	1.0	0.014	< 0.01	200	1.5	1.5	0.02	< 0.01
BYR_085_t05	2	125	1.0	< 0.01	< 0.01	175	1.0	1.0	< 0.01	< 0.01
BYR_085_t06	2	150	1.0	0.016	< 0.01	200	1.5	1.5	0.02	< 0.01
BYR_095_t01	3	200	2.0	0.028	< 0.01	250	2.0	2.0	0.03	< 0.01

Table C.05 - Predictions for Tanks

Structure Ref.	Maximum Plan Dimension (m)	Predicted Incremental Subsidence due to LW S7A (mm)	Predicted Incremental Tilt due to LW S7A (mm/m)	Predicted Incremental Hogging Curvature due to LW S7A (1/km)	Predicted Incremental Sagging Curvature due to LW S7A (1/km)	Predicted Total Subsidence after LW S1A to S7A (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature after LW S1A to S7A (1/km)	Predicted Total Sagging Curvature after LW S1A to S7A (1/km)
BYR_095_t02	3	200	2.0	0.031	< 0.01	250	2.0	2.0	0.03	< 0.01
BYR_095_t03	2	100	0.5	< 0.01	< 0.01	150	1.0	1.0	< 0.01	< 0.01
BYR_105_t01	2	90	< 0.5	< 0.01	< 0.01	125	0.5	0.5	< 0.01	< 0.01
BYR_115_t01	4	125	1.0	0.011	< 0.01	175	1.0	1.0	0.01	< 0.01
BYR_115_t02	4	125	1.0	0.011	< 0.01	175	1.0	1.0	0.01	< 0.01
BYR_115_t03	2	80	< 0.5	< 0.01	< 0.01	100	0.5	0.5	< 0.01	< 0.01
BYR_115_t04	2	80	< 0.5	< 0.01	< 0.01	100	0.5	0.5	< 0.01	< 0.01
BYR_115_t05	2	100	0.5	< 0.01	< 0.01	125	0.5	0.5	< 0.01	< 0.01
BYR_115_t06	3	80	< 0.5	< 0.01	< 0.01	125	0.5	0.5	< 0.01	< 0.01
BYR_145_t01	2	950	6.5	0.063	0.222	1100	7.5	7.5	0.06	0.23
BYR_145_t02	2	950	2.5	0.064	0.220	1100	2.5	2.5	0.06	0.23
BYR_145_t03	2	950	3.5	0.064	0.132	1100	3.0	3.0	0.06	0.14
BYR_145_t04	2	950	3.5	0.064	0.119	1100	3.0	3.0	0.06	0.12
BYR_150_t01	2	275	1.0	0.018	0.014	1350	3.5	3.5	0.06	0.09
BYR_152_t01	2	275	1.0	0.017	0.014	1300	4.0	4.0	0.06	0.05
BYR_152_t02	2	275	1.0	0.017	0.014	1300	4.0	4.0	0.06	0.05
BYR_152_t03	2	225	1.0	0.015	0.012	1150	4.0	4.0	0.05	0.04
BYR_152_t04	2	225	1.0	0.015	0.012	1150	4.0	4.0	0.05	0.04
BYR_154_t01	2	200	1.0	0.014	0.011	1100	3.5	3.5	0.05	0.04
BYR_154_t02	2	200	1.0	0.013	0.010	1100	3.5	3.5	0.05	0.04
BYR_156_t01	2	175	1.0	0.012	< 0.01	1000	3.0	3.0	0.04	0.03
BYR_156_t02	2	175	1.0	0.012	< 0.01	1000	3.0	3.0	0.04	0.03
BYR_156_t03	2	175	1.0	0.012	< 0.01	1000	3.5	3.5	0.04	0.03
BYR_156_t04	2	175	1.0	0.012	< 0.01	1000	3.5	3.5	0.04	0.04
	Maxima:	**950**	**8.0**	**0.09**	**0.22**	**1350**	**8.5**	**8.5**	**0.12**	**0.23**

Table C.06 - Predictions for Pools

Structure Ref.	Maximum Plan Dimension (m)	Predicted Incremental Subsidence due to LW S7A (mm)	Predicted Incremental Tilt due to LW S7A (mm/m)	Predicted Incremental Hogging Curvature due to LW S7A (1/km)	Predicted Incremental Sagging Curvature due to LW S7A (1/km)	Predicted Total Subsidence after LW S1A to S7A (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature after LW S1A to S7A (1/km)	Predicted Total Sagging Curvature after LW S1A to S7A (1/km)
BCA_035_p01	7	30	< 0.5	< 0.01	< 0.01	950	2.0	3.0	0.07	0.03
BCA_100_p01	10	20	< 0.5	< 0.01	< 0.01	1000	6.0	7.0	0.08	0.06
BCA_105_p01	9	30	< 0.5	< 0.01	< 0.01	700	4.0	4.5	0.05	0.03
BCA_120_p01	9	20	< 0.5	< 0.01	< 0.01	100	1.0	1.0	0.02	< 0.01
BRE_148_p01	9	50	< 0.5	< 0.01	< 0.01	1300	3.5	3.5	0.06	0.05
BRE_167_p01	8	60	1.0	0.02	< 0.01	850	4.0	5.5	0.09	0.04
BYR_005_p01	10	250	1.0	0.02	0.01	1300	4.0	4.0	0.06	0.05
BYR_015_p01	9	300	1.0	0.04	0.02	1300	8.0	8.5	0.06	0.23
BYR_045_p01	11	900	3.5	0.06	0.05	1050	3.0	3.0	0.06	0.05
BYR_065_p01	6	900	8.0	0.06	0.19	1000	8.5	8.5	0.06	0.20
BYR_095_p01	9	150	1.0	0.01	< 0.01	200	1.5	1.5	0.02	< 0.01
BYR_135_p01	10	750	8.0	0.09	0.06	850	8.5	8.5	0.09	0.06
BYR_152_p01	12	250	1.0	0.02	0.01	1250	4.0	4.0	0.06	0.04
Maxima:		**900**	**8.0**	**0.09**	**0.19**	**1300**	**8.5**	**8.5**	**0.09**	**0.23**

Table C.07 - Predictions for Farm Dams

Dam Ref.	Maximum Length (m)	Plan Area (m2)	Predicted Incremental Subsidence due to LW S7A (mm)	Predicted Incremental Tilt due to LW S7A (mm/m)	Predicted Incremental Hogging Curvature due to LW S7A (1/km)	Predicted Incremental Sagging Curvature due to LW S7A (1/km)	Predicted Total Subsidence after LW S1A to S7A (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature after LW S1A to S7A (1/km)	Predicted Total Sagging Curvature after LW S1A to S7A (1/km)	Predicted Change in Freeboard (mm)
BCA_001_d01	25	345	250	1.0	0.02	0.01	1175	5.5	5.5	0.03	0.07	300
BCA_010_d01	21	251	150	0.5	< 0.01	< 0.01	875	3.5	5.5	0.09	0.04	100
BCA_015_d01	26	342	60	< 0.5	< 0.01	< 0.01	1250	5.0	5.0	0.04	0.08	250
BCA_110_d01	24	414	30	< 0.5	< 0.01	< 0.01	625	6.5	6.5	0.06	0.05	350
BRE_090_d01	52	1889	150	0.5	< 0.01	< 0.01	975	4.5	6.5	0.09	0.03	100
BRE_090_d02	24	310	30	< 0.5	< 0.01	< 0.01	975	2.5	3.0	0.07	0.03	100
BRE_090_d03	69	1849	225	1.0	0.01	0.01	1200	3.5	3.5	0.05	0.04	300
BRE_090_d04	36	508	300	1.0	0.04	0.01	1275	6.5	7.0	0.04	0.22	250
BRE_143_d01	29	534	125	0.5	< 0.01	< 0.01	925	3.5	5.5	0.09	0.03	50
BRE_148_d01	35	693	225	1.0	0.01	0.01	1200	3.5	3.5	0.06	0.04	250
BRE_148_d02	22	170	225	1.0	0.01	0.01	1225	3.5	3.5	0.06	0.04	200
BRE_154_d01	76	2658	70	< 0.5	< 0.01	< 0.01	1375	6.5	7.5	0.06	0.23	200
BRE_154_d02	64	1554	100	0.5	< 0.01	< 0.01	1325	7.0	8.5	0.10	0.20	500
BRE_167_d01	99	2924	175	1.5	0.01	0.02	1075	4.0	5.0	0.09	0.05	300
BRE_167_d02	16	180	225	2.0	0.01	0.02	1300	4.0	4.0	0.06	0.08	200
BYR_005_d01	28	404	250	1.0	0.02	0.01	1275	4.0	4.0	0.06	0.05	250
BYR_005_d02	73	1662	175	1.0	0.01	< 0.01	1050	3.5	3.5	0.08	0.04	200
BYR_015_d01	50	1415	250	1.0	0.02	0.01	1325	4.0	4.0	0.06	0.16	300
BYR_065_d01	44	790	650	3.0	0.04	0.03	825	2.0	3.5	0.07	0.03	50
BYR_095_d01	43	1003	950	8.0	0.06	0.21	1100	8.5	8.5	0.06	0.22	350
		Maxima:	**950**	**8.0**	**0.06**	**0.21**	**1375**	**8.5**	**8.5**	**0.10**	**0.23**	**500**

Table C.08 - Predictions for Public Utilities

Structure Ref.	Description	Structure Type	Predicted Incremental Subsidence due to LW S7A (mm)	Predicted Incremental Tilt due to LW S7A (mm/m)	Predicted Incremental Hogging Curvature due to LW S7A (1/km)	Predicted Incremental Sagging Curvature due to LW S7A (1/km)	Predicted Total Subsidence after LW S1A to S7A (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature after LW S1A to S7A (1/km)	Predicted Total Sagging Curvature after LW S1A to S7A (1/km)
BYR_200_pu01	Comms shed - NBN - 2574006	Shed	175	1.0	0.01	< 0.01	1050	3.5	3.5	0.05	0.21
BYR_200_pu02	Comms tower - NBN - 2574006	Tower	175	1.0	0.01	< 0.01	1050	3.5	3.5	0.05	0.22
		Maxima:	**175**	**1.0**	**0.01**	**0.00**	**1050**	**3.5**	**3.5**	**0.05**	**0.22**

Table C.09 - Predictions for Commercial and Business Establishments

Structure Ref.	Maximum Plan Dimension (m)	Description	Structure Type	Predicted Incremental Subsidence due to LW S7A (mm)	Predicted Incremental Tilt due to LW S7A (mm/m)	Predicted Incremental Hogging Curvature due to LW S7A (1/km)	Predicted Incremental Sagging Curvature due to LW S7A (1/km)	Predicted Total Subsidence after LW S1A to S7A (mm)	Predicted Final Tilt after all Longwalls (mm/m)	Predicted Maximum Tilt after any Longwall (mm/m)	Predicted Total Hogging Curvature after LW S1A to S7A (1/km)	Predicted Total Sagging Curvature after LW S1A to S7A (1/km)
BYR_055_c01	29	Bargo Valley Produce	Shed	950	3.5	0.06	0.21	1050	3.0	3.0	0.06	0.21
BYR_055_c02	41	Bargo Valley Produce	Shed	950	6.0	0.06	0.21	1050	6.5	6.5	0.06	0.22
BYR_055_c03	89	Bargo Valley Produce	Poultry Shed	900	3.5	0.06	0.08	1050	3.0	3.0	0.06	0.08
BYR_055_c04	89	Bargo Valley Produce	Poultry Shed	900	3.5	0.06	0.04	1050	3.0	3.0	0.06	0.04
BYR_055_c05	89	Bargo Valley Produce	Poultry Shed	750	3.5	0.05	0.04	900	2.5	2.5	0.05	0.04
BYR_055_c06	89	Bargo Valley Produce	Poultry Shed	650	3.0	0.04	0.03	850	2.5	3.0	0.07	0.03
BYR_055_c07	91	Bargo Valley Produce	Greenhouse	650	3.0	0.07	0.03	1000	6.0	8.0	0.12	0.03
BYR_055_t01	8	Bargo Valley Produce	Tank	950	2.5	0.06	0.20	1050	2.5	2.5	0.06	0.21
BYR_055_t02	3	Bargo Valley Produce	Tank	750	3.5	0.05	0.04	950	2.5	2.5	0.05	0.04
BYR_065_c06	91	Ingham Turkey Farm	Poultry Shed	950	8.0	0.09	0.21	1050	8.5	8.5	0.09	0.22
BYR_065_c07	96	Ingham Turkey Farm	Poultry Shed	950	8.0	0.08	0.21	1050	8.5	8.5	0.09	0.22
BYR_065_c08	83	Ingham Turkey Farm	Poultry Shed	950	8.0	0.06	0.21	1050	8.5	8.5	0.06	0.22
BYR_065_c09	11	Ingham Turkey Farm	Poultry Shed	950	2.5	0.06	0.21	1050	2.5	2.5	0.06	0.21
BYR_065_c10	15	Ingham Turkey Farm	Poultry Shed	950	3.0	0.06	0.19	1050	2.5	2.5	0.06	0.19
BYR_065_c11	26	Ingham Turkey Farm	Poultry Shed	950	7.0	0.06	0.21	1100	7.5	7.5	0.06	0.22
BYR_065_c12	91	Ingham Turkey Farm	Poultry Shed	950	5.5	0.06	0.21	1100	6.0	6.0	0.06	0.22
BYR_065_c13	90	Ingham Turkey Farm	Poultry Shed	950	3.5	0.06	0.21	1100	3.0	3.0	0.06	0.22
BYR_065_c14	91	Ingham Turkey Farm	Poultry Shed	950	3.5	0.06	0.11	1050	2.5	2.5	0.06	0.12
BYR_065_t02	5	Ingham Turkey Farm	Tank	950	2.5	0.06	0.21	1100	3.0	3.0	0.06	0.22
BYR_065_t03	4	Ingham Turkey Farm	Tank	850	8.0	0.06	0.16	1000	8.5	8.5	0.07	0.17
BYR_135_c01	14	Canine Country Club and Cattery	Shed	700	8.0	0.09	0.03	800	8.5	8.5	0.09	0.03
BYR_135_c02	20	Canine Country Club and Cattery	Shed	350	4.5	0.08	0.02	425	5.0	5.0	0.09	0.02
BYR_135_c03	9	Canine Country Club and Cattery	Shed	650	8.0	0.09	0.03	750	8.5	8.5	0.09	0.03
BYR_135_c04	17	Canine Country Club and Cattery	Shed	400	5.5	0.09	0.02	475	6.0	6.0	0.09	0.02
BYR_135_c05	26	Canine Country Club and Cattery	Shed	400	5.5	0.09	0.02	475	6.0	6.0	0.09	0.02
BYR_135_c06	3	Canine Country Club and Cattery	Shed	400	5.5	0.09	0.02	475	6.0	6.0	0.09	0.02
BYR_135_c07	14	Canine Country Club and Cattery	Shed	500	7.0	0.09	0.03	600	7.5	7.5	0.09	0.03
BYR_135_c08	25	Canine Country Club and Cattery	Awning	400	5.5	0.09	0.02	500	6.5	6.5	0.09	0.02
BYR_135_c09	6	Canine Country Club and Cattery	Shed	350	4.5	0.08	0.02	425	5.0	5.0	0.09	0.02
			Maxima:	**950**	**8.0**	**0.09**	**0.21**	**1100**	**8.5**	**8.5**	**0.12**	**0.22**

Table C.10 - Tahmoor South - Predictions for Archaeological Sites

Site ID	Type	Predicted Total Subsidence after all Longwalls (mm)	Predicted Total Tilt after all Longwalls (mm/m)	Predicted Total Hogging Curvature after all Longwalls (1/km)	Predicted Total Sagging Curvature after all Longwalls (1/km)	Predicted Total Upsidence after all Longwalls (mm)	Predicted Total Closure after all Longwalls (mm)
WP1253 RS	Rock shelter	20	< 0.5	< 0.01	< 0.01	-	-
WP1255 RS	Rock shelter	40	< 0.5	< 0.01	< 0.01	-	-
WP1256 RS	Rock shelter	40	< 0.5	< 0.01	< 0.01	-	-
WB1257 RS	Rock shelter	40	< 0.5	< 0.01	< 0.01	-	-
WP1258 RS	Rock shelter	50	< 0.5	< 0.01	< 0.01	-	-
WP1260 RS	Rock shelter	20	< 0.5	< 0.01	< 0.01	-	-
WP1261 RS	Rock shelter	30	< 0.5	< 0.01	< 0.01	-	-
WP1263 GG	Grinding grooves	20	< 0.5	< 0.01	< 0.01	45	65
WP1264 IF	Isolated find	20	< 0.5	< 0.01	< 0.01	-	-
		50	**< 0.5**	**< 0.01**	**< 0.01**	**45**	**65**

APPENDIX C – Master Trigger Action Response Plan

WATER MANAGEMENT PLAN TARP – WMP1 STREAM WATER QUALITY FOR ALL WATERCOURSES WITHIN THE SUBSIDENCE AREA[1]

Performance Measure and Indicator, TARP Objective and Assessment Criteria

Performance Measure Feature
All watercourses within the Subsidence Area[1].

Performance Measure
No greater subsidence impact or environmental consequences to water quality, water flows (including baseflow) or stream health (including riparian vegetation), than predicted in the EIS.

The EIS concludes that where the longwalls directly mine beneath the streams, it is considered likely that fracturing would result in surface water flow diversion and that localised and transient increases in water quality constituents would occur[2]. The performance measure will be considered to be exceeded if subsidence impacts cannot be repaired in a manner that restores pool water holding capacity and stream health. Remediation measures will be developed as required and detailed in the Watercourse Corrective Action Management Plan (C12 of the SSD 8445). These plans will contain relevant performance indicators specific to remediation performance measures.

Performance Indicator
Exceedance of the site specific guideline values (SSGVs), as defined in the Level 1 to Level 3 trigger, where a Level 3 trigger denotes progression towards a potential exceedance of the performance measure.

TARP Objective
This TARP defines levels of variation in surface water quality from normal conditions[3] and the actions required to be implemented in response to each level of variation.

Assessment Criteria
SSGV as listed in table below.

Monitoring Program

Locations

Longwall	Potential Impact Sites	Reference Sites
LW S1A	TT7-QLa TT12-QLa TT13-QLa TT14-QLa	TT1-QLa
LW S2A	TT9-QLa TT3-QLa[4] All sites above	
LW S3A	TT2-QLa All sites above	
LW S4A LW S5A LW S6A LW S7A	BR3-QLa TT1-QLa All sites above	DT4-QLa DT3-QLa

All monitoring locations are shown in Figure 19 of the Water Management Plan.

Monitoring Frequency

Pre-mining
Monthly sampling prior to secondary extraction of relevant longwall.

During Mining
Monthly sampling and analysis or as required by a specified action relevant to a trigger level.

Post-mining
Monthly sampling and analysis for a minimum of 12 months following the completion of LW S7A or as required in accordance with a Watercourse Corrective Action Management Plan.

Management

Trigger	Action	Response
Normal Condition		
• Exceedance of an SSGV does not occur or occurs for less than three consecutive months.	• Continue monitoring and review of data as per monitoring program.	• No response required.
Level 1		
• Exceedance of an SSGV occurs at a given potential impact site in three consecutive months and the same has not occurred at the reference site(s).	• *Actions as required for Normal Condition.* • Assess if the trigger was exceeded during the baseline period prior to commencement of mining activities. • Review water quality trends along watercourse (upstream to downstream) to identify spatial changes with consideration to climatic conditions. • Discuss findings with and obtain other relevant information from key specialists (e.g. subsidence monitoring results, groundwater quality monitoring results) necessary to inform assessment. • Consider and decide on reasonable and feasible options for remediation as relevant (e.g. limestone cobbles for increasing pH level).	• Report trigger exceedance to DPHI and key stakeholders. • Report trigger exceedance and investigation outcomes in Annual Review. • Provide DPHI and key stakeholders with proposed corrective management actions (CMAs) for consultation (e.g. limestone cobbles for increasing pH level). • Implement CMAs, subject to land access. • Monitor and report on success of CMAs in Annual Review.
Level 2		

• Exceedance of an SSGV occurs at a given potential impact site in four or five consecutive months and the same has not occurred at the reference site(s).	• *Actions as stated in Level 1.*
	• Consider increasing monitoring and review of data frequency at sites where Level 2 has been reached or at other relevant sites, subject to land access, as follows:
	  ○ Fortnightly, for sites within the active subsidence zone.
	  ○ Monthly, outside of the active subsidence period.
	Reasons for not increasing monitoring frequency could include confident identification of causation (e.g. singular, anthropogenic, non-mining related change or confirmed as a mining-related impact that resulted in a water quality change).
	• If increased monitoring is adopted, undertake further analysis of water quality trends along creek (upstream to downstream) to identify spatial changes with consideration to climatic conditions.
	• Review CMAs in light of findings from further investigations and consider additional remediation options.
	• Review Water Management Plan and modify if necessary.
		• *Responses as stated in Level 1.*
		• Advise DPHI and key stakeholders of any required amendments to Water Management Plan.
		• Provide findings of CMA review to DPHI and key stakeholders for consultation.
		• Implement additional CMAs, subject to land access.

Level 3		

• Exceedance of an SSGV occurs at a given potential impact site in six consecutive months and the same has not occurred at the reference site(s).	• *Actions as stated in Level 2.*
	• If mining related impact unconfirmed, increase monitoring and review of data frequency at sites where Level 3 has been reached or at other relevant sites, subject to land access, as follows:
	  ○ Fortnightly, for sites within the active subsidence zone.
	  ○ Monthly, outside of the active subsidence period.
	• Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing), other catchment changes, effects unrelated to mining or the prevailing climate.
		• *Responses as stated in Level 2.*
		If it is concluded from the detailed investigation that watercourses have been damaged by subsidence impacts:
		• Offer site visit with DPHI and other key stakeholders.
		• Develop Watercourse Corrective Action Management Plan (WCAMP) in consultation with the Resources Regulator, DPHI and other key stakeholders (in accordance with C12 of SSD 8445). The stream remediation measures in the WCAMP could include grout curtain and grout pattern injection.
		• Implement approved WCAMP, subject to land access.

Site Specific Guideline Value (SSGV)								
Parameter	**TT1-QLa**	**TT2-QLa**	**TT7-QLa**	**TT12-QLa**	**TT13-QLa**	**TT14-QLa**	**DT3**	**DT4**
No. of Values[5]	56	12	35	13	13	13	49	44
pH (pH units)	6.5 – 8	6 – 8	6.5 – 8	6.5 – 8	6.5 – 8	6.5 – 8	6.5 - 8	6.5 - 8
EC (µS/cm)	512	350	359	350	350	350	350	350
Dissolved Aluminium (mg/L) pH > 6.5	0.1	0.17	0.06	0.1	0.092	0.11	0.08	0.2
Dissolved Copper (mg/L)	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014
Dissolved Iron (mg/L)	0.76	0.55	0.81	0.64	0.47	0.57	0.48	0.60
Dissolved Manganese (mg/L)	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Dissolved Nickel (mg/L)	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Dissolved Zinc (mg/L)	0.03	0.02	0.03	0.008	0.008	0.008	0.008	0.008

Notes:
[1] Subsidence Area is defined as the 'Subsidence Study Area' as illustrated in Figure 1 of Appendix 2 of SSD 8445.
[2] Due to the predicted surface fracturing of watercourses which directly overlie the longwall panels.
[3] As defined by the site specific guideline value (SSGV).
[4] SSGVs have not been derived for TT3-QLa as the pool was dry on five of eight sampling occasions.
[5] Minimum number of values used in SSGV derivation – for some constituents, a greater number of values were adopted.

WATER MANAGEMENT PLAN TARP – WMP2 STREAM WATER QUALITY FOR OTHER WATERCOURSES (BARGO RIVER AND HORNES CREEK)

<table>
<tr><th rowspan="2">Performance Measure and Indicator, TARP Objective and Assessment Criteria</th><th rowspan="2">Monitoring Program</th><th colspan="3">Management</th></tr>
<tr><th>Trigger</th><th>Action</th><th>Response</th></tr>
<tr><td rowspan="8"><u>Performance Measure Feature</u>
Other watercourses.

<u>Performance Measure</u>
Negligible environmental consequences including beyond those predicted in the EIS.

<u>Performance Indicator</u>
The performance measure will be considered to be exceeded if a Level 3 TARP is triggered in relation to water quality changes and the investigation outcomes indicate a mining related impact based on monitoring data for sites in Hornes Creek and the Bargo River.

<u>TARP Objective</u>
This TARP defines levels of variation in surface water quality from normal conditions[1], indicators of exceedance of the performance measure and the actions required to be implemented in response to each level of variation or exceedance of the performance measure.

<u>Assessment Criteria</u>
SSGV as listed in table below.</td><td rowspan="8"><u>Locations</u>
<table><tr><th>Longwall</th><th>Potential Impact Sites</th><th>Reference Sites</th></tr><tr><td>LW S1A</td><td>BR12-QLa
BR13-QRLa</td><td rowspan="3">BR16-QLa</td></tr><tr><td>LW S2A</td><td>BR18-QLa
All sites above</td></tr><tr><td>LW S3A</td><td>BR17-QLa
All sites above</td></tr><tr><td>LW S4A</td><td rowspan="2">BR6-QLa
All sites above</td><td rowspan="2">DT4-QLa
DT3-QLa
All sites above</td></tr><tr><td>LW S5A</td></tr><tr><td>LW S6A</td><td rowspan="2">HC13-QLa
HC15-QLa
HC4-QRLa
HC9-QLa
HC3-QLa
All sites above</td><td rowspan="2">HC2-QLa
HC17-QLa
HC1-QLa
All sites above</td></tr><tr><td>LW S7A</td></tr></table>
All monitoring locations are shown in Figure 19 of the Water Management Plan.

<u>Monitoring Frequency</u>
Pre-mining
Monthly sampling prior to secondary extraction or other relevant mining activity.

During Mining
Monthly sampling and analysis or as required by a specified action relevant to a trigger level.

Post-mining
Monthly sampling and analysis for a minimum of 12 months following the completion of LW S7A or as required in accordance with a Watercourse Corrective Action Management Plan.</td><td>Normal Condition</td><td></td><td></td></tr>
<tr><td>• Exceedance of an SSGV does not occur or occurs for less than three consecutive months.</td><td>• Continue monitoring and review of data as per monitoring program.</td><td>• No response required.</td></tr>
<tr><td>Level 1</td><td></td><td></td></tr>
<tr><td>• Exceedance of an SSGV occurs at a given potential impact site in three consecutive months and the same has not occurred at the reference site(s).</td><td>• Actions as required for Normal Condition.
• Assess if the trigger was exceeded during the baseline period prior to commencement of mining activities.
• Review water quality trends along watercourse (upstream to downstream) to identify spatial changes with consideration to climatic conditions.
• Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, groundwater quality monitoring results) necessary to inform assessment.
• Consider and decide on reasonable and feasible options for remediation as relevant (e.g. limestone cobbles for increasing pH level).</td><td>• Report trigger exceedance to DPHI and key stakeholders.
• Report trigger exceedance and investigation outcomes in Annual Review.
• Provide DPHI and key stakeholders with proposed CMAs for consultation (e.g. limestone cobbles for increasing pH level).
• Implement CMAs, subject to land access.
• Monitor and report on success of CMAs in Annual Review.</td></tr>
<tr><td>Level 2</td><td></td><td></td></tr>
<tr><td>• Exceedance of an SSGV occurs at a given potential impact sites in four or five consecutive months and the same has not occurred at the reference site(s).</td><td>• Actions as stated in Level 1.
• Consider increasing monitoring and review of data frequency at sites where Level 2 has been reached or at other relevant sites, subject to land access, as follows:
o Fortnightly, for sites within the active subsidence zone.
o Monthly, outside of the active subsidence period.
Reasons for not increasing monitoring frequency could include confident identification of causation (e.g. singular, anthropogenic, non-mining related change or confirmed as a mining-related impact that resulted in a water quality change).
• If increased monitoring is adopted, undertake further analysis of water quality trends along creek (upstream to downstream) to identify spatial changes with consideration to climatic conditions.
• Review CMAs in light of findings from further investigations and consider additional remediation options.
• Review Water Management Plan and modify if necessary.</td><td>• Responses as stated in Level 1.
• Advise DPHI and key stakeholders of any required amendments to Water Management Plan.
• Provide findings of CMA review to DPHI and key stakeholders for consultation.
• Implement additional CMAs, subject to land access.</td></tr>
<tr><td>Level 3</td><td></td><td></td></tr>
<tr><td>• Exceedance of an SSGV occurs at a given potential impact site in six consecutive months and the same has not occurred at the reference site(s).</td><td>• Actions as stated in Level 2.
• If mining related impact unconfirmed, increase monitoring and review of data frequency at sites where Level 3 has been reached or at other relevant sites, subject to land access, as follows:
o Fortnightly, for sites within the active subsidence zone.
o Monthly, outside of the active subsidence period.
• Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing), other catchment changes, effect unrelated to mining or the prevailing climate.
• Undertake an investigation to determine if an exceedance of the performance measure is likely.</td><td>• Responses as stated in Level 2.
• If relevant, notify Commonwealth DCCEEW of any predictions of an exceedance of a performance measure within two business days.</td></tr>
<tr><td>Exceeds Performance Measure</td><td></td><td></td></tr>
<tr><td>• It is concluded from the Level 3 investigation that mining results in exceedance of an SSGV at a given potential impact site for six or more consecutive months.</td><td>• Investigate reasons for the performance measure exceedance.
• Based on the outcomes of the investigation, review predictions of subsidence impacts and environmental consequences associated with future longwall extraction.</td><td>• Submit a report to DPHI (in accordance with E4 of SSD 8445) within 14 days of the exceedance occurring (or other timeframe agreed by DPHI).
• Notify Commonwealth DCCEEW of any detection or predictions of an exceedance of a performance measure within two business days.</td></tr>
</table>

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	**Action**	**Response**
				• Submit an Impact Response Plan to Commonwealth DCCEEW (in accordance with Condition 11 of the DAWE (now Commonwealth DCCEEW) Consent for the Tahmoor South Project). • Offer site visit with DPHI and other key stakeholders. • Develop Watercourse Corrective Action Management Plan (WCAMP) in consultation with the Resources Regulator, DPHI and other key stakeholders (in accordance with C12 of SSD 8445). The stream remediation measures in the WCAMP could include grout curtain and grout pattern injection. • Implement approved WCAMP, subject to land access.

Site Specific Guideline Value (SSGV)

Parameter	TT1-QLa	TT2-QLa	TT7-QLa	TT12-QLa	TT13-QLa	TT14-QLa	DT3-QLa	DT4-QLa
No. of Values[2]	56	12	35	13	13	13	49	44
pH (pH units)	6.5 – 8	6 – 8	6.5 – 8	6.5 – 8	6.5 – 8	6.5 – 8	6.5 - 8	6.5 - 8
EC (µS/cm)	512	350	359	350	350	350	350	350
Dissolved Aluminium (mg/L) pH > 6.5	0.1	0.17	0.06	0.1	0.092	0.11	0.08	0.2
Dissolved Copper (mg/L)	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014
Dissolved Iron (mg/L)	0.76	0.55	0.81	0.64	0.47	0.57	0.48	0.60
Dissolved Manganese (mg/L)	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Dissolved Nickel (mg/L)	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Dissolved Zinc (mg/L)	0.03	0.02	0.03	0.008	0.008	0.008	0.008	0.008

Notes:
[1] As defined by the SSGV.
[2] Minimum number of values used in SSGV derivation - for some constituents, a greater number of values were adopted.

WATER MANAGEMENT PLAN TARP – WMP3 POOL WATER LEVEL FOR ALL WATERCOURSES WITHIN THE SUBSIDENCE AREA[1]

Performance Measure and Indicator, TARP Objective and Assessment Criteria

Performance Measure Feature
All watercourses within the Subsidence Area[1].

Performance Measure
No greater subsidence impact or environmental consequences to water quality, water flows (including baseflow) or stream health (including riparian vegetation), than predicted in the EIS.

The EIS concludes that where the longwalls directly mine beneath the streams, it is considered likely that fracturing would result in surface water flow diversion and that localised and transient increases in water quality constituents would occur[2]. The performance measure will be considered to be exceeded if subsidence impacts cannot be repaired in a manner that restores pool water holding capacity and stream health. Remediation measures will be developed as required and detailed in the Watercourse Corrective Action Management Plan (C12 of the SSD 8445). These plans will contain relevant performance indicators specific to remediation performance measures.

Performance Indicator
Water level decline as defined in the Level 1 to Level 3 trigger, where a Level 3 trigger denotes progression towards a potential exceedance of the performance measure.

TARP Objective
This TARP defines levels of variation in pool water level from normal conditions[3] and the actions required to be implemented in response to each level of variation.

Assessment Criteria
- Comparison of baseline and operational recorded water level data (all levels).
- Water level recession analysis for Level 2 and above.

Monitoring Program

Locations

Longwall	Potential Impact Sites	Reference Sites
LW S1A	TT7-QLa TT12-QLa TT13-QLa TT14-QLa	TT1-QLa
LW S2A	TT9-QLa TT3-QLa All sites above	
LW S3A	TT2-QLa All sites above	
LW S4A	BR3-QLa TT1-QLa All sites above	DT4-QLa DT3-QLa
LW S5A		
LW S6A		
LW S7A		

All monitoring locations are shown in Figure 19 of the Water Management Plan.

Monitoring Frequency

Pre-mining
Continuous record and monthly manual measurements. Data downloaded prior to the commencement of secondary extraction of the relevant longwall.

During Mining
Continuous record and monthly manual measurements. Data downloaded and reviewed monthly.

Post-mining
Continuous record and monthly manual measurements for a minimum of 12 months following the completion of LW S7A or as required in accordance with a Watercourse Corrective Action Management Plan.

Management

Trigger	Action	Response
Normal Condition		
• The recorded water level has not declined below the recorded baseline minimum level (for more than one 24 hour period for automated pool water level).	• Continue monitoring and review of data as per monitoring program.	• No response required.
Level 1		
• The recorded water level has declined by greater than 10 centimetres (cm) below the recorded baseline minimum level (for more than one 24 hour period for automated pool water level) and the same has not occurred at the reference site(s).	• *Actions as required for Normal Condition.* • Review water level trends along watercourse (upstream to downstream) to identify spatial changes with consideration to climatic conditions. • Review streamflow data recorded at TT-F1 and conduct streamflow reduction assessment. • Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, groundwater level monitoring results) necessary to inform assessment.	• Report trigger exceedance to DPHI and key stakeholders. • Report trigger exceedance and investigation outcomes in Annual Review.
Level 2		

• The recorded water level has declined atypically[4] below the recorded baseline minimum level for less than one month (as a consecutive period) and the same has not occurred at the reference site(s).	• *Actions as stated in Level 1.*
	• Consider increasing monitoring and review of data frequency at sites where Level 2 has been reached or at other relevant sites, subject to land access, as follows:
	  ○ Fortnightly, for sites within the active subsidence zone.
	  ○ Monthly, outside of the active subsidence period.
	• Reasons for not increasing monitoring frequency could include confident identification of causation (e.g. singular, anthropogenic, non-mining related change or confirmed as a mining-related impact that resulted in a water level change).
	• If increased monitoring is undertaken, conduct further analysis of water level trends along creek (upstream to downstream) to identify spatial changes with consideration to climatic conditions.
	• Review Water Management Plan and modify if necessary.
		• *Responses as stated in Level 1.*
		• Advise DPHI and key stakeholders of any required amendments to Water Management Plan.

Level 3		

• The recorded water level has declined atypically[4] below the recorded baseline minimum level for greater than one month (as a consecutive period) and the same has not occurred at the reference site(s).	• *Actions as stated in Level 2.*
	• If mining related impact unconfirmed, increase monitoring and review of data frequency at sites where Level 3 has been reached or at other relevant sites, subject to land access, as follows:
	  ○ Fortnightly, for sites within the active subsidence zone.
	  ○ Monthly, outside of the active subsidence period.
	• Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing), other catchment changes, effect unrelated to mining or the prevailing climate.
		• *Responses as stated in Level 2.*
		If it is concluded from the detailed investigation that watercourses have been damaged by subsidence impacts:
		• Offer site visit with DPHI and other key stakeholders.
		• Develop Watercourse Corrective Action Management Plan (WCAMP) in consultation with the Resources Regulator, DPHI and other key stakeholders (in accordance with C12 of SSD 8445). The stream remediation measures in the WCAMP could include grout curtain and grout pattern injection.
		• Implement approved WCAMP, subject to land access.

Notes:
[1] Subsidence Area is defined as the 'Subsidence Study Area' as illustrated in Figure 1 of Appendix 2 of SSD 8445.
[2] Due to the predicted surface fracturing of watercourses which directly overlie the longwall panels.
[3] As indicated by the baseline water level and recession rate.
[4] 'Atypical' surface water characteristics relate to a notable and/or rapid water level decline or change in the slope of the falling limb of the hydrograph or the water level recessionary behaviour below the cease to flow level which is inconsistent with baseline conditions and cannot be attributed to climatic conditions

WATER MANAGEMENT PLAN TARP – WMP4 POOL WATER LEVEL FOR OTHER WATERCOURSES (BARGO RIVER AND HORNES CREEK)

Performance Measure and Indicator, TARP Objective and Assessment Criteria

Performance Measure Feature
Other watercourses.

Performance Measure
Negligible environmental consequences including beyond those predicted in the EIS, including:
- Negligible diversion of flows or changes in the natural drainage behaviour of pools.

Performance Indicator
The performance measure will be considered to be exceeded if a Level 3 TARP is triggered in relation to water level changes and the investigation outcomes indicate a mining related impact based on monitoring data for sites in Hornes Creek and the Bargo River.

TARP Objective
This TARP defines levels of variation in pool water level from normal conditions[1] and the actions required to be implemented in response to each level of variation.

Assessment Criteria
- Comparison of baseline and operational recorded water level data (all levels).
- Water level recession analysis for Level 2 and above.

Monitoring Program

Locations

Longwall	Potential Impact Sites	Reference Sites
LW S1A	BR12-QLa BR13-QRLa	BR16-QLa[2]
LW S2A	BR18-QLa All sites above	
LW S3A	BR17-QLa All sites above	
LW S4A LW S5A	BR6-QLa All sites above	DT4-QLa DT3-QLa All sites above
LW S6A LW S7A	HC13-QLa HC15-QLa HC4-QRLa HC9-QLa HC3-QLa All sites above	HC2-QLa HC17-QLa HC1-QLa All sites above

All monitoring locations are shown in Figure 19 of the Water Management Plan.

Monitoring Frequency

Pre-mining
Continuous record and monthly manual measurements. Data downloaded prior to the commencement of secondary extraction of the relevant longwall.

During Mining
Continuous record and monthly manual measurements. Data downloaded and reviewed monthly.

Post-mining
Continuous record and monthly manual measurements for a minimum of 12 months following the completion of LW S7A or as required in accordance with a Watercourse Corrective Action Management Plan.

Management

Trigger	Action	Response
Normal Condition		
• The recorded water level has not declined below the recorded baseline minimum level (for more than one 24 hour period for automated pool water level).	• Continue monitoring and review of data as per monitoring program.	• No response required.
Level 1		
• The recorded water level has declined by greater than 10 centimetres (cm) below the recorded baseline minimum level (for more than one 24 hour period for automated pool water level) and the same has not occurred at the reference site(s).	• *Actions as required for Normal Condition.* • Review water level trends along watercourse (upstream to downstream) to identify spatial changes with consideration to climatic conditions. • Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, groundwater level monitoring results) necessary to inform assessment.	• Report trigger exceedance to DPHI and key stakeholders. • Report trigger exceedance and investigation outcomes in Annual Review.
Level 2		

• The recorded water level has declined atypically[3] below the recorded baseline minimum level for less than one month (as a consecutive period) and the same has not occurred at the reference site(s).	• *Actions as stated in Level 1.*
	• Consider increasing monitoring and review of data frequency at sites where Level 2 has been reached or at other relevant sites, subject to land access, as follows:
	  ○ Fortnightly, for sites within the active subsidence zone.
	  ○ Monthly, outside of the active subsidence period.
	Reasons for not increasing monitoring frequency could include confident identification of causation (e.g. singular, anthropogenic, non-mining related change or confirmed as a mining-related impact that resulted in a water level change).
	• If increased monitoring is adopted, undertake further analysis of water level trends along creek (upstream to downstream) to identify spatial changes with consideration to climatic conditions.
	• Complete water level recession analysis for sites where Level 2 has been reached.
	• Review Water Management Plan and modify if necessary.
		• *Responses as stated in Level 1.*
		• Advise DPHI and key stakeholders of any required amendments to Water Management Plan.

Level 3		

• The recorded water level has declined atypically[3] below the recorded baseline minimum level for greater than one month (as a consecutive period) and the same has not occurred at the reference site(s).	• *Actions as stated in Level 2.*
	• If mining related impact unconfirmed, increase monitoring and review of data frequency at sites where Level 3 has been reached or at other relevant sites, subject to land access, as follows:
	  ○ Fortnightly, for sites within the active subsidence zone.
	  ○ Monthly, outside of the active subsidence period.
	• Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing), other catchment changes, effect unrelated to mining or the prevailing climate.
	• Undertake an investigation to determine if an exceedance of the performance measure is likely.
		• *Responses as stated in Level 2.*
		• If relevant, notify Commonwealth DCCEEW of any predictions of an exceedance of a performance measure within two business days.

Exceeds Performance Measure		
• It is concluded from the detailed investigation that mining has resulted in an atypical[2] decline in water level for greater than one month (as a consecutive period).	• Investigate reasons for the performance measure exceedance. • Based on the outcomes of the investigation, review predictions of subsidence impacts and environmental consequences associated with further longwall extraction.	• Submit a report to DPHI (in accordance with Condition E4 of SSD 8445) within 14 days of the exceedance occurring (or other timeframe agreed by DPHI). • Notify Commonwealth DCCEEW of any detection or predictions of an exceedance of a performance measure within two business days. • Submit an Impact Response Plan to Commonwealth DCCEEW (in accordance with Condition 11 of the DAWE (now Commonwealth DCCEEW) Consent for the Tahmoor South Project).

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	**Action**	**Response**
				• Offer site visit with DPHI and other key stakeholders. • Develop Watercourse Corrective Action Management Plan (WCAMP) in consultation with the Resources Regulator, DPHI and other key stakeholders (in accordance with C12 of SSD 8445). The stream remediation measures in the WCAMP could include grout curtain and grout pattern injection. • Implement approved WCAMP, subject to land access.

Notes:
[1] As indicated by the baseline water level and recession rate.
[2] Data collected from BR11-QLa (water quality data collected between 2012-2021 and water level data collected between 2013-2021) will be used in combination with data from BR16-QLa to provide a long-term baseline dataset for the Bargo River upstream of mining activities.
[3] 'Atypical' surface water characteristics relate to a notable and/or rapid water level decline or change in the slope of the falling limb of the hydrograph or the water level recessionary behaviour below the cease to flow level which is inconsistent with baseline conditions and cannot be attributed to climatic conditions.

WATER MANAGEMENT PLAN TARP – WMP5 PHYSICAL FEATURES AND NATURAL BEHAVIOUR OF WATERCOURSES WITHIN THE SUBSIDENCE AREA[1]

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	**Action**	**Response**
Performance Measure Feature All watercourses within the Subsidence Area[1]. **Performance Measure** No greater subsidence impact or environmental consequences to water quality, water flows (including baseflow) or stream health (including riparian vegetation), than predicted in the EIS. The EIS concludes that where the longwalls directly mine beneath the streams, it is considered likely that fracturing would result in surface water flow diversion and that localised and transient increases in water quality constituents would occur[2]. The performance measure will be considered to be exceeded if subsidence impacts cannot be repaired in a manner that restores pool water holding capacity and stream health. Remediation measures will be developed as required and detailed in the Watercourse Corrective Action Management Plan (C12 of the SSD 8445). These plans will contain relevant performance indicators specific to remediation performance measures. **Performance Indicator** Variation in pool physical features and natural behaviour, as defined in the Level 1 to Level 3 trigger, where a Level 3 trigger denotes progression towards a potential exceedance of the performance measure. **TARP Objective** This TARP defines levels of variation in pool physical features and natural behaviour and the actions required to be implemented in response to each level of variation. **Assessment Criteria** Comparison of baseline and operational pool physical features and natural behaviour.	**Locations** Accessible pools and reaches in Teatree Hollow, Teatree Hollow Tributary and Bargo River Tributary (subject to land access). All monitoring locations are shown in Figure 20 of the Water Management Plan. Channel morphology site CM7, refer Figure 21. **Monitoring Frequency** **Pre-mining** One observation prior to mining using fixed location photo points. **During Mining** Observations every month during the active subsidence period (after 200 m of secondary extraction of relevant longwall) for sites within the active subsidence zone[3] using fixed location photo points. **Post-mining** Quarterly observations over 12 months for pools that are no longer within the active subsidence zone or as required in accordance with a Watercourse Corrective Action Management Plan.	**Normal Condition**		
		• No observed impact to pool water level, overland connected flow, iron staining, gas release or turbidity - as compared with baseline conditions.	• Continue monitoring and review of data as per monitoring program.	• No response required.
		Level 1		
		• Visually observed anomalous change in water level, overland connected flow, iron staining, gas release or turbidity - as compared with baseline conditions - occurs in one month and the same has not occurred at the reference site(s)[3]. AND/OR • Visual observation of fracturing.	• *Actions as required for Normal Condition.* • Assess visual change along watercourse (upstream to downstream) to observe any spatial changes with consideration to climatic conditions. • Discuss findings with and obtain other relevant information from key specialists (e.g. subsidence monitoring results, surface water monitoring results, groundwater monitoring results) necessary to inform assessment. • Consider increasing monitoring and review of data frequency at sites where Level 1 has been reached or at other relevant sites, subject to land access, as follows: o Fortnightly, for sites within the active subsidence zone. o Monthly, outside of the active subsidence period. Reasons for not increasing monitoring frequency could include confident identification of causation (e.g., surface fracturing of weathered bedrock that does not affect water holding capacity of rockbar control or pool base or confirmed as a mining-related impact).	• Report trigger exceedance to DPHI and key stakeholders. • Report trigger exceedance and investigation outcomes in Annual Review.
		Level 2		
		• Visually observed anomalous change in water level, overland connected flow, iron staining, gas release or turbidity - as compared with baseline conditions - occurs for two consecutive months and the same has not occurred at the reference site(s).	• *Actions as stated in Level 1.* • Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing other catchment changes, effect unrelated to mining or the prevailing climate). • Review Water Management Plan and modify if necessary. • If mining related impact unconfirmed, increase monitoring and review of data frequency at sites where Level 2 has been reached or at other relevant sites, subject to land access, as follows: o Fortnightly, for sites within the active subsidence zone. o Monthly, outside of the active subsidence period.	• *Responses as stated in Level 1.* • Advise DPHI and key stakeholders of any required amendments to Water Management Plan.
		Level 3		
		• Visually observed anomalous change in water level, overland connected flow, iron staining, gas release or turbidity - as compared with baseline conditions - occurs for three consecutive months and the same has not occurred at the reference site(s). AND • The change in behaviour has been investigated and confirmed to be related to mining effects.	• *Actions as stated in Level 2.*	• *Responses as stated in Level 2.* • Offer site visit with DPHI and other key stakeholders. • Develop Watercourse Corrective Action Management Plan (WCAMP) in consultation with the Resources Regulator, DPHI and other key stakeholders (in accordance with C12 of SSD 8445). The stream remediation measures in the WCAMP could include grout curtain and grout pattern injection. • Implement approved WCAMP, subject to land access.

Notes:
[1] Subsidence Area is defined as the 'Subsidence Study Area' as illustrated in Figure 1 of Appendix 2 of SSD 8445.
[2] Due to the predicted surface fracturing of watercourses which directly overlie the longwall panels.
[3] Survey area to include upstream, downstream and adjacent pools (to the extent of the potential impact) where a trigger exceedance has occurred at a potential impact site(s) in accordance with the TARPs.

WATER MANAGEMENT PLAN TARP – WMP6 PHYSICAL FEATURES AND NATURAL BEHAVIOUR OF POOLS FOR OTHER WATERCOURSES (BARGO RIVER AND HORNES CREEK)

<table>
<tr><th rowspan="2">Performance Measure and Indicator, TARP Objective and Assessment Criteria</th><th rowspan="2">Monitoring Program</th><th colspan="3">Management</th></tr>
<tr><th>Trigger</th><th>Action</th><th>Response</th></tr>
<tr><td rowspan="6"><u>Performance Measure Feature</u>
Other watercourses.

<u>Performance Measure</u>
Negligible environmental consequences including beyond those predicted in the EIS, including:
• Negligible diversion of flows or changes in the natural drainage behaviour of pools;
• Negligible gas releases and iron staining; and
• Negligible increase in water turbidity.

<u>Performance Indicator</u>
The performance measure will be considered to be exceeded if changes in physical features and natural behaviour of pools occur for three consecutive months and the investigation outcomes indicate a mining related impact based on visual observation records for sites in Hornes Creek and the Bargo River.

<u>TARP Objective</u>
This TARP defines levels of variation in pool physical features and natural behaviour and the actions required to be implemented in response to each level of variation.

<u>Assessment Criteria</u>
Comparison of baseline and operational pool physical features and natural behaviour.</td><td rowspan="6"><u>Locations</u>
<table><tr><th>Longwall</th><th>Potential Impact Sites</th><th>Reference Sites</th></tr><tr><td>LW S1A</td><td>BR12-QLa
BR13-QRLa</td><td rowspan="4">BR16-QLa</td></tr><tr><td>LW S2A</td><td>BR18-QLa
All sites above</td></tr><tr><td>LW S3A</td><td>BR17-QLa
All sites above</td></tr><tr><td>LW S4A
LW S5A</td><td>BR6-QLa
All sites above</td><td>DT4-QLa
DT3-QLa
All sites above</td></tr><tr><td>LW S6A
LW S7A</td><td>HC13-QLa
HC15-QLa
HC4-QRLa
HC9-QLa
HC3-QLa
All sites above</td><td>HC2-QLa
HC17-QLa
HC1-QLa
All sites above</td></tr></table>
All monitoring locations are shown in Figure 20 of the Water Management Plan.

Pre-mining
One observation prior to mining using fixed location photo points.

During Mining
Observations every month during the active subsidence period (after 200 m of secondary extraction of relevant longwall) for sites within the active subsidence zone using fixed location photo points.

Post-mining
Quarterly observations over 12 months for pools that are no longer within the active subsidence zone or as required in accordance with a Watercourse Corrective Action Management Plan.</td><td>Normal Condition</td><td></td><td></td></tr>
<tr><td>• No observed impact to pool water level, overland connected flow, iron staining, gas release, turbidity or channel stability - as compared with baseline conditions.</td><td>• Continue monitoring and review of data as per monitoring program.</td><td>• No response required.</td></tr>
<tr><td>Level 1</td><td></td><td></td></tr>
<tr><td>• Visually observed anomalous change in water level, overland connected flow, iron staining, gas release or turbidity - as compared with baseline conditions - occurs in one month and the same has not occurred at the reference site(s).
AND/OR
• Visual observation of fracturing.</td><td>• Actions as required for Normal Condition.
• Assess visual change along watercourse (upstream to downstream) to observe any spatial changes with consideration to climatic conditions.
• Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, surface water monitoring results, groundwater monitoring results) necessary to inform assessment.
• Consider increasing monitoring and review of data frequency at sites where Level 1 has been reached or at other relevant sites, subject to land access, as follows:
o Fortnightly, for sites within the active subsidence zone.
o Monthly, outside of the active subsidence period.
Reasons for not increasing monitoring frequency could include confident identification of causation (e.g. surface fracturing of weathered bedrock that does not affect water holding capacity of rockbar control or pool base or confirmed as a mining-related impact).</td><td>• Report trigger exceedance to DPHI and key stakeholders.
• Report trigger exceedance and investigation outcomes in Annual Review.</td></tr>
<tr><td>Level 2</td><td></td><td></td></tr>
<tr><td>• Visually observed anomalous change in water level, overland connected flow, iron staining, gas release or turbidity - as compared with baseline conditions - occurs for two consecutive months and the same has not occurred at the reference site(s).</td><td>• Actions as stated in Level 1.
• Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing other catchment changes, effect unrelated to mining or the prevailing climate).
• Review Water Management Plan and modify if necessary.
• If mining related impact unconfirmed, increase monitoring and review of data frequency at sites where Level 2 has been reached or at other relevant sites, subject to land access, as follows:
o Fortnightly, for sites within the active subsidence zone.
o Monthly, outside of the active subsidence period.
• Undertake an investigation to determine if an exceedance of the performance measure is likely.</td><td>• Responses as stated in Level 1.
• Advise DPHI and key stakeholders of any required amendments to Water Management Plan.
• If relevant, notify Commonwealth DCCEEW of any predictions of an exceedance of a performance measure within two business days.</td></tr>
<tr><td>Exceeds Performance Measure</td><td></td><td></td></tr>
<tr><td>• Visually observed anomalous change in water level, overland connected flow, iron staining, gas release or turbidity - as compared with baseline conditions - occurs for three consecutive months and the same has not occurred at the reference site(s).
AND
• The change in behaviour has been investigated and confirmed to be related to mining effects.</td><td>• Actions as stated in Level 2.
• Investigate reasons for the performance measure exceedance.
• Based on the outcomes of the investigation, review predictions of subsidence impacts and environmental consequences associated with further longwall extraction.</td><td>• Responses as stated in Level 2.
• Submit a report to DPHI (in accordance with Condition E4 of SSD 8445) within 14 days of the exceedance occurring (or other timeframe agreed by DPHI).
• Notify Commonwealth DCCEEW of any detection or predictions of an exceedance of a performance measure within two business days.
• Submit an Impact Response Plan to Commonwealth DCCEEW (in accordance with Condition 11 of the DAWE (now Commonwealth DCCEEW) Consent for the Tahmoor South Project).
• Offer site visit with DPHI and other key stakeholders.
• Develop Watercourse Corrective Action Management Plan (WCAMP) in consultation with the Resources Regulator, DPHI and other key stakeholders (in accordance with C12 of SSD 8445). The stream</td></tr>
</table>

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	Action	Response
				remediation measures in the WCAMP could include grout curtain and grout pattern injection. • Implement approved WCAMP, subject to land access.

WATER MANAGEMENT PLAN TARP – WMP7 CHANNEL STABILITY, SEDIMENTATION AND EROSION

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	**Action**	**Response**
Performance Measure Feature No performance measure relevant[1,2,3]. **TARP Objective** This TARP defines levels of variation in channel stability, erosion and sedimentation and the actions required to be implemented in response to each level of variation. **Assessment Criteria** Comparison of baseline and operational condition of headwater streams and soft knickpoints.	**Locations** As shown in Figure 21 of the Water Management Plan: • 10 headwater sites • Channel morphology sites CM1, CM4 and CM6 • Soft knickpoints **Monitoring Frequency** **Pre-mining** • One observation prior to mining using fixed location photo points. • One inspection of 10 headwater sites. **During Mining** • Observations of knickpoint formation every month during the active subsidence period for sites within the active subsidence zone using fixed location photo points. • Annual inspection of 10 headwater sites. **Post-mining** • One observation of knickpoint formation at sites that are no longer within the active subsidence zone using fixed location photo points. • One inspection of 10 headwater sites. • Post-mining geomorphology survey following completion of mining.	**Normal Condition**		
		• No further development of soft knickpoints or increased erosion of headwater streams.	• Continue monitoring and review of data as per monitoring program.	• No response required.
		Level 1		

		• Visually observed minor increase in knickpoint development and/or minor erosion and sedimentation of headwater streams.	• *Actions as required for Normal Condition.*
			• Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, biodiversity monitoring results) necessary to inform assessment.
			• Consider increasing monitoring and review of data frequency at sites where Level 1 has been reached or at other relevant sites, subject to land access, as follows:
			  ○ Fortnightly, for sites within the active subsidence zone.
			  ○ Monthly, outside of the active subsidence period.
			Reasons for not increasing monitoring frequency could include confident identification of causation (e.g. singular, anthropogenic, non-mining related change or confirmed as a mining-related impact that resulted in increased erosion).
			• Consider and decide on reasonable and feasible options for remediation as relevant (e.g. enhanced vegetation establishment, rock armouring).
				• Report trigger exceedance to DPHI and key stakeholders.
				• Report trigger exceedance and investigation outcomes in Annual Review.
				• Provide DPHI and key stakeholders with proposed corrective management actions (CMAs) for approval (e.g. enhanced vegetation establishment, rock armouring).
				• Implement CMAs, subject to land access.
				• Monitor and report on success of CMAs in Review.

		Level 2		

		• Visually observed moderate increase in knickpoint development and/or moderate or greater increase in erosion and sedimentation of headwater streams.	• *Actions as stated in Level 1.*
			• If mining related impact unconfirmed, increase monitoring and review of data frequency at sites where Level 2 has been reached or at other relevant sites, subject to land access, as follows:
			  ○ Fortnightly, for sites within the active subsidence zone.
			  ○ Monthly, outside of the active subsidence period.
			• Undertake an investigation to assess if the change in behaviour is related to mining effects (e.g. subsidence induced, other catchment changes, effect unrelated to mining or the prevailing climate).
			• Obtain specialist advice on further CMAs.
			• Review CMAs in light of findings from further investigations and consider additional remediation options.
			• Review Water Management Plan and modify if necessary.
				• *Responses as stated in Level 1.*
				• Advise DPHI and key stakeholders of any required amendments to Water Management Plan.
				If it is concluded from the detailed investigation that watercourses have been damaged by subsidence impacts:
				• Offer site visit with DPHI and other key stakeholders.
				• Provide findings of CMA review to DPHI and key stakeholders for consultation.
				• Implement additional CMAs, subject to land access.

Notes:
[1] Subsidence Area is defined as the 'Subsidence Study Area' as illustrated in Figure 1 of Appendix 2 of SSD 8445.
[2] It is noted that SSD 8445 does not specify a performance measure in relation to channel stability, sedimentation and erosion for all watercourses within the Subsidence Area[1].
[3] It is noted that no soft knickpoints have been mapped in Hornes Creek or Bargo River. Therefore, assessment of 'decline in baseline channel stability' for these watercourses is not applicable.

WATER MANAGEMENT PLAN TARP – WMP8 SHALLOW GROUNDWATER LEVELS (OPEN STANDPIPES AND PRIVATE BORES)

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	**Action**	**Response**
Performance Measure Feature No performance measure relevant. **TARP Objective** This TARP defines levels of deviation in groundwater level from 'normal' or baseline conditions and the actions to be implemented in response to each level deviation. This TARP supports TARP WMP13, where groundwater levels as they pertain to groundwater dependent ecosystems (GDEs) (Thirlmere Lakes) are covered. **Assessment Criteria** Bore specific trigger values based on baselines data for each reporting level.	**Locations** **Open standpipes** Existing sites: P51a, P51b, P52, REA4, P53a, P53b, P53c, P54a, P54b, P54c, P55a, P55b, P55c, P56a, P56b, P56c P50a, P50b, P50c, P57a, P57b, P57c[3] **Private bores** GW109257, GW104008, GW112473, GW104659, GW104323 All monitoring locations are shown in Figure 324 of the Water Management Plan. **Monitoring Frequency** **Pre-mining** Continuous logger (hourly intervals) and monthly manual measurements of water level. **During Mining** Continuous logger (hourly intervals) and monthly manual measurements of water level. **Post-mining** Continuous record (where loggers installed) and quarterly manual measurements of water level for a minimum of 12 months following the completion of active dewatering or as deemed necessary in consideration to the status of aquifer recovery or as required for future extraction activities.	**Normal Condition**		
		• Groundwater level remains consistent with baseline variability and pre-mining trends with reductions in groundwater level less than two meters.	• Continue monitoring and review of data as per monitoring program.	• No response required.
		Level 1		
		• Greater than 2 m water level reduction[1] for a period of greater than 6 months following the commencement of extraction.	For Private Bores and Open Standpipe Monitoring Bores • *Actions as required for Normal Condition.* • Undertake an investigation to assess cause and determine if mining related. • Undertake investigation to demonstrate if the decline will impact the long-term viability of the affected water supply works. • Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, surface water level results). The investigation will be commenced/completed as efficiently as practicable. If the changes have been confirmed to be related to mining effects: For Private Bores: • Where impact is deemed attributable to mining, initiate negotiations with impacts landowners as soon as practicable. Consider all reasonable and feasible options for remediation as relevant (e.g. extending the depth of the bore, establishment of additional bores, etc - as per Section 6.2.1.4 of the Water Management Plan). For Open Standpipe Monitoring Bores • For monitoring sites relevant to Thirlmere Lakes or associated with surface water monitoring sites, initiate groundwater – surface water interaction TARP.	For Private Bores and Open Standpipe Monitoring Bores: • Report trigger exceedance to DPHI and key stakeholders. • Report trigger exceedance and investigation outcomes in Annual Review. If the changes have been confirmed to be related to mining effects: For Private Bores: • Provide DPHI and key stakeholders with proposed corrective management actions (CMAs) for consultation (e.g. extending the depth of the bore, establishment of additional bores, compensation to affected landowners as detailed in Section 6.2.1.4 of the Water Management Plan). • Implement CMAs, subject to land access (finalise negotiations and implement the agreed "make-good" arrangements) • Monitor and report on success of CMAs in Annual Review.
		Level 2		
		• Water level declines below the average between the 'maximum modelled drawdown' (Level 3 trigger) and the '2 m drawdown' (Level 1 trigger)[1] for a period of greater than 6 months following the commencement of extraction. AND • The reduction in water level is determined not to be controlled by climatic or external anthropogenic factors.	For Private Bores and Open Standpipe Monitoring Bores: • *Actions as stated in Level 1.* • Consider increasing frequency of monitoring and review of data frequency at sites where Level 2 has been reached or at other relevant sites, subject to land access., as follows: ○ Fortnightly, for sites within the active subsidence zone. • Reasons for not increasing monitoring frequency could include confident identification causation that do not require further monitoring (e.g. singular anthropogenic impact resulting in water level change, or confirmed as a mining-related impact). Increased monitoring could be beneficial where commensurate responses in paired surface water monitoring locations have been observed. • Compare against base case and deterministic model scenarios[2]. • Review Water Management Plan and modify if necessary. For Private Bores: • Review CMAs in light of findings from further investigations and consider additional reasonable and feasible options.	For Private Bores and Open Standpipe Monitoring Bores: • *Responses as stated in Level 1.* • Advise DPHI and key stakeholders of any required amendments to Water Management Plan. For Private Bores: • Provide findings of CMA review to DPHI and key stakeholders for consultation. • Implement additional CMAs, subject to land access.

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	**Action**	**Response**
		Level 3		
		• Water level reduction greater than the maximum modelled drawdown[1] for a period of greater than 6 months following the commencement of extraction. AND • The reduction in water level is determined not to be controlled by climatic or external anthropogenic factors.	For Private Bores and Open Standpipe Monitoring Bores: • *Actions as stated in Level 2.* • Increase monitoring and review of data frequency for sites where Level 3 has been reached, and cause is unknown, Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing, other catchment changes, effect unrelated to mining or the prevailing climate).	For Private Bores and Open Standpipe Monitoring Bores: • *Responses as stated in Level 2.* For Private Bores: • Develop a Rehabilitation Management Plan in consultation with DPHI and key stakeholders. • Implement Rehabilitation Management Plan, subject to land access.

Notes:
[1] Level 1, 2 and 3 triggers for water level reduction is provided in Table 6-3 in Appendix E of the Water Management Plan.
[2] "Deterministic" model scenario refers to the predictive scenario modelling utilised to determine the trigger level.
[3] Trigger levels to be defined for P50 and P57 bores when suitable baseline data available

WATER MANAGEMENT PLAN TARP – WMP9 SHALLOW GROUNDWATER PRESSURE (VWP SENSORS < 200 m DEPTH)

<table>
<tr><th rowspan="2">Performance Measure and Indicator, TARP Objective and Assessment Criteria</th><th rowspan="2">Monitoring Program</th><th colspan="3">Management</th></tr>
<tr><th>Trigger</th><th>Action</th><th>Response</th></tr>
<tr><td rowspan="8"><u>Performance Measure Feature</u>
No performance measure relevant.

<u>TARP Objective</u>
This TARP defines levels of deviation in groundwater level from ‘normal’ or baseline conditions and the actions to be implemented in response to each level deviation.

<u>Assessment Criteria</u>
Bore specific trigger values based on baselines data for each reporting level.</td><td rowspan="8"><u>Locations</u>
TBC032, TBC033, TBC009, TBC018, TBC0039
Monitoring of all VWP < 200 m depth intakes.

Reference Sites: TBC027, TBC034, TBC038

All monitoring locations are shown in Figure 23 of the Water Management Plan.

<u>Monitoring Frequency</u>
Pre-mining
VWPs recording pressure readings hourly. The system is telemetered so that data is transmitted continuously and can be accessed at any point in time.

During Mining
VWPs recording pressure readings hourly. The system is telemetered so that data is transmitted continuously and can be accessed at any point in time.

Post-mining
Continuous record of water level/pressure for a minimum of 12 months following the completion of active dewatering or as deemed necessary in consideration to the status of aquifer recovery or as required for future extraction activities.</td><td>Normal Condition</td><td></td><td></td></tr>
<tr><td>• No observable mining induced change at VWP intakes.
• Up to 5 m water level reduction in VWP intakes[1] following the commencement of extraction for a period of less than six months.</td><td>• Continue monitoring and review of data as per monitoring program.</td><td>• No response required.</td></tr>
<tr><td>Level 1</td><td></td><td></td></tr>
<tr><td>• Greater than 5 m water level reduction in VWP intakes[1] following the commencement of extraction for a period of greater than six months.</td><td>• Actions as required for Normal Condition.
• Undertake an investigation to assess cause and determine if mining related, commence/complete as soon as practicable.
• Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, surface water level results).</td><td>• Report trigger exceedance to DPHI and key stakeholders.
• Report trigger exceedance and investigation outcomes in Annual Review.</td></tr>
<tr><td>Level 2</td><td></td><td></td></tr>
<tr><td>• Water level declines below the calculated Level 2 trigger – being the average of Level 1 (the ‘5 m drawdown’[1]) and Level 3 (the ‘maximum modelled drawdown’) – following the commencement of extraction for a period of greater than six months.
AND
• The reduction in water level is determined not to be controlled by climatic or external anthropogenic factors.</td><td>• Actions as stated in Level 1.
• Review deeper VWP data at monitored sites. Determine whether additional review of data is required. Determine if review of additional existing VWP sites is required.
• Consider increasing frequency of data review at sites where Level 2 has been reached or at other relevant sites.
Reasons for not increasing monitoring frequency could include confident identification causation that do not require further monitoring (e.g. singular anthropogenic impact resulting in water level change, or confirmed as a mining-related impact). Increased monitoring could be beneficial where commensurate responses in paired surface water monitoring locations have been observed.
• Compare against base case and deterministic model scenarios[2].
• Review Water Management Plan and modify if necessary.</td><td>• Responses as stated in Level 1.
• Advise DPHI and key stakeholders of any required amendments to Water Management Plan.</td></tr>
<tr><td>Level 3</td><td></td><td></td></tr>
<tr><td>• Water level reduction greater than the maximum modelled drawdown[1] following the commencement of extraction for a period of greater than six months.
AND
• The reduction in water level is determined not to be controlled by climatic or external anthropogenic factors.</td><td>• Actions as stated in Level 2.
• Increase review of data frequency for sites where Level 3 has been reached and the cause is unknown.
• Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing, other catchment changes, effect unrelated to mining or the prevailing climate). Commence/complete as soon as practicable
• Undertake investigative to review model results in conjunction with field data.</td><td>• Responses as stated in Level 2.</td></tr>
<tr><td colspan="4">Notes:
[1] Level 1, 2 and 3 triggers for water level reduction is provided in Table 6-4 in Appendix E of the Water Management Plan).
[2] “Deterministic” model scenario refers to the predictive scenario modelling utilised to determine the trigger level.</td></tr>
</table>

WATER MANAGEMENT PLAN TARP – WMP10 GROUNDWATER LEVEL / PRESSURE DEEP VWPS (> 200 m DEPTH EXCLUDING MONITORING THE BULLI COAL SEAM)

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	**Action**	**Response**
Performance Measure Feature No performance measure relevant. **TARP Objective** This TARP defines levels of deviation in groundwater level from 'normal' or baseline conditions and the actions to be implemented in response to each level deviation. **Assessment Criteria** Bore specific trigger values based on modelled data for each reporting level. Model layers utilised to define predicted drawdown for each VWP logger provided in Table below.	**Locations** TBC009, TBC0018, TBC020, TBC026, TBC032, TBC033, TBC039 Reference sites: TBC027, TBC034, TBC038 Monitoring of all VWP > 200 m depth intakes excluding those monitoring the Bulli Coal Seam. All monitoring locations are shown in Figure 23 of the Water Management Plan. **Monitoring Frequency** **Pre-mining** VWPs recording pressure readings hourly. The system is telemetered so that data is transmitted continuously and can be accessed at any point in time. **During Mining** VWPs recording pressure readings hourly. The system is telemetered so that data is transmitted continuously and can be accessed at any point in time. **Post-mining** Continuous record of water level/pressure for a minimum of 12 months following the completion of active dewatering or as deemed necessary in consideration to the status of aquifer recovery or as required for future extraction activities.	**Normal Condition**		
		• Observed data does not exceed modelled impacts predicted drawdown by greater than 30 metres[1]. • Observed drawdown exceeds the modelled predicted drawdown[1], by greater than 30 metres for less than three consecutive months	• Continue monitoring and review of data as per monitoring program.	• No response required.
		Level 1		
		• Observed drawdown exceeds the modelled predicted drawdown[1], by greater than 30 metres for greater than three consecutive months.	• *Actions as required for Normal Condition.* • Undertake an investigation to assess cause and determine if mining related to be commenced/completed as soon as practicable. • Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, surface water level monitoring results).	• Report trigger exceedance to DPHI and key stakeholders. • Report trigger exceedance and investigation outcomes in Annual Review.
		Level 2		
		• Observed drawdown exceeds modelled predicted drawdown[1] by more than 30 metres greater than 6 consecutive months.	• *Actions as stated in Level 1.* • Consider increasing frequency of data review at sites where Level 2 has been reached or at other relevant sites. Reasons for not increasing monitoring frequency could include confident identification causation that do not require further monitoring (e.g. singular anthropogenic impact resulting in water level change, or confirmed as a mining-related impact). Increased monitoring could be beneficial where commensurate responses in paired surface water monitoring locations have been observed. Consider review data in conjunction with VWP data from additional existing VWP sites. • Compare against base case and deterministic model scenarios[2]. • Review Water Management Plan and modify if necessary.	• *Responses as stated in Level 1.* • Inclusion of more regional VWPs into data review to determine likely extent and depth of depressurisation. • Advise DPHI and key stakeholders of any required amendments to Water Management Plan.
		Level 3		
		• Observed drawdown exceeds modelled predicted drawdown[1] by 30 metres, for 12 consecutive months or more.	• *Actions as stated in Level 2.* • Increase review of data frequency for sites where Level 3 has been reached if the cause is unknown • Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing, other catchment changes, effect unrelated to mining or the prevailing climate). To be commenced/completed as soon as practicable. • Review base case and deterministic model scenarios[2] in conjunction with water pressure data and report findings.	• *Responses as stated in Level 2.*

Notes:
[1] Predicted drawdown refers to the drawdown as generated by the groundwater model and varies over time as extraction progresses. Observed drawdown will be plotted on a monthly basis against the predicted drawdown to determine if a trigger has occurred. Therefore, as the predicted drawdown will be constantly changing according to extraction progression, it is not possible to set a specific trigger limit.
[2] "Deterministic" model scenario refers to the predictive scenario modelling utilised to assess the trigger level.

Sensor	Model Layer	Model Geology	Sensor	Model Layer	Model Geology
TBC09_322	8	BUSS Mid	TBC26_344	8	BUSS Mid
TBC09_343	8	BUSS Mid	TBC26_409	13	WBCS
TBC09_357	12	SBSS Lower	TBC26_432	15	Bulli Seam
TBC09_381	10	SPCS	TBC26_440	16	Eckersley
TBC09_391	15	Bulli Seam	TBC26_460	16	Eckersley
TBC09_397	17	Wongawilli	TBC32_200	8	BUSS Mid
TBC18_282	8	BUSS Mid	TBC32_237	8	BUSS Mid

Performance Measure and Indicator, TARP Objective and Assessment Criteria			Monitoring Program			Management		
						Trigger	Action	Response
TBC18_366	80..0	BUSS Mid	TBC32_257	8	BUSS Mid			
TBC18_377	13	WBCS	TBC32_294	8	BUSS Mid			
TBC18_404	15	Bulli Seam	TBC32_314	8	BUSS Mid			
TBC18_426	17	Wongawilli	TBC33_247	8	BUSS Mid			
TBC18_432	17	Wongawilli	TBC33_306	8	BUSS Mid			
TBC20_211	8	BUSS Mid	TBC33_363	11	SBSS Upper			
TBC20_293	8	BUSS Mid	TBC33_384	16	Eckersley			
TBC20_375	8	BUSS Mid	TBC33_408	16	Eckersley			
TBC20_397	13	WBCS	TBC39_243	8	BUSS Mid			
TBC20_411	7	BUSS Upper	TBC39_299	8	BUSS Mid			
TBC20_434	17	Wongawilli	TBC39_354	11	SBSS Upper			
TBC20_439	4	HBSS Mid	TBC39_375	16	Eckersley			
TBC26_211	8	BUSS Mid	TBC39_402	16	Eckersley			
TBC26_278	8	BUSS Mid						

WATER MANAGEMENT PLAN TARP – WMP11 GROUNDWATER QUALITY (OPEN STANDPIPES AND PRIVATE BORES)

<table>
<tr><th rowspan="2">Performance Measure and Indicator, TARP Objective and Assessment Criteria</th><th rowspan="2">Monitoring Program</th><th colspan="3">Management</th></tr>
<tr><th>Trigger</th><th>Action</th><th>Response</th></tr>
<tr><td rowspan="8"><u>Performance Measure Feature</u>
No performance measure relevant.

<u>TARP Objective</u>
This TARP defines levels of deviation in groundwater level from ‘normal’ or baseline conditions and the actions to be implemented in response to each level deviation.
This TARP supports TARP WMP13, where groundwater quality as it pertains to groundwater dependent ecosystems (GDEs) (Thirlmere Lakes) is covered.

<u>Assessment Criteria</u>
Bore specific trigger values based on baselines data for each reporting level.</td><td rowspan="8"><u>Locations</u>
Open standpipes
Existing sites:
P51a, P51b, P52, REA4, P53a, P53b, P53c, P54a, P54b, P55a, P55b, P55c, P56a, P56b, P56c, P50a, P50b, P50c, P57a, P57b, P57c[2]

Private bores
GW109257, GW104008, GW112473, GW104659, GW104323

All monitoring locations are shown in Figure 23 of the Water Management Plan.

<u>Monitoring Frequency</u>
Pre-mining
Monthly water quality sampling.

During Mining
Monthly water quality sampling

Post-mining
Quarterly sampling and analysis for a minimum of 12 months following the completion of active dewatering or as deemed necessary in consideration to the status of aquifer recovery or as required for future extraction activities.

Water Quality sample parameters:
Field Parameters
PH
EC
TDS
DO
Laboratory Analysis
Total alkalinity as CaCO3, HCO3, CO3, DOC
Dissolved Major Cations (Ca, K, Na, Mg, F, Cl, SO4)
Dissolved Metals (Al, As, Ba, Co, Cu, Pb, Li, Mn, Ni, Se, Sr, Zn, Fe)
Total Metals (Al, As, Ba, Co, Cu, Pb, Li, Mn, Ni, Se, Sr, Zn, Fe)
Total Nitrogen
Total Phosphorus
Ionic Balance (Total Anions and Total Cations)</td><td colspan="3">Normal Condition</td></tr>
<tr><td>• No observable changes in salinity, pH or metals outside of the baseline variability.</td><td>• Continue monitoring and review of data as per monitoring program.</td><td>• No response required.</td></tr>
<tr><td colspan="3">Level 1</td></tr>
<tr><td>• Observed salinity and/or metals or pH outside of defined trigger levels[1] for 3 consecutive months or more. The effect does not persist after a significant rainfall recharge event.
AND
• A similar trend or response is noted at other monitored bores or private groundwater bores.</td><td>For Private Bores and Open Standpipe Monitoring Bores
• Actions as required for Normal Condition.
• Undertake an investigation to assess cause and determine if mining related.
• Undertake investigation to demonstrate if the change in quality will impact the long-term viability of the affected water supply works.
• Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, surface water level results).
If the changes have been confirmed to be related to mining effects:
For Private Bores:
• Initiate negotiations with impacted landholders as soon as practicable. Consider all reasonable and feasible options for remediation as relevant. This could include potential for implementation of make-good provisions as per Section 6.2.1.4 of the Water Management Plan for affected private bore owners (e.g. provision of access to an alternative source of water).
For Open Standpipe Monitoring Bores
• For monitoring sites relevant to Thirlmere Lakes or associated with surface water monitoring sites, initiate groundwater – surface water interaction TARP.</td><td>For Private Bores and Open Standpipe Monitoring Bores
• Report trigger exceedance to DPHI and key stakeholders.
• Report trigger exceedance and investigation outcomes in Annual Review.
If the changes have been confirmed to be related to mining effects:
For Private Bores:
• Provide DPHI and key stakeholders with proposed corrective management actions (CMAs) for consultation (e.g. provision of access to an alternative source of water as detailed in Section 6.2.1.4 of the Water Management Plan).
• Implement CMAs, subject to land access.
• Monitor and report on success of CMAs in Annual Review.</td></tr>
<tr><td colspan="3">Level 2</td></tr>
<tr><td>• Observed salinity and/or metals or pH outside of defined trigger levels[1], for 3 consecutive months or more. The effect persists after a significant rainfall recharge event.
AND
• The change in water quality is determined not to be controlled by climatic or external anthropogenic factors.</td><td>For Private Bores and Open Standpipe Monitoring Bores
• Actions as stated in Level 1.
• Consider increasing frequency of monitoring and review of data at sites where Level 2 has been reached or at other relevant sites, subject to land access and feasibility.
Reasons for not increasing monitoring frequency could include confident identification causation that do not require further monitoring (e.g. singular anthropogenic impact resulting in water level change, or confirmed as a mining-related impact). Increased monitoring could be beneficial where commensurate responses in paired surface water monitoring locations have been observed
• Review Water Management Plan and modify if necessary.
For Private Bores:
• Review CMAs in light of findings from further investigations and consider additional reasonable and feasible options.</td><td>For Private Bores and Open Standpipe Monitoring Bores
• Responses as stated in Level 1.
• Advise DPHI and key stakeholders of any required amendments to Water Management Plan.
For Private Bores:
• Provide findings of CMA review to DPHI and key stakeholders for consultation.
• Implement additional CMAs, subject to land access.</td></tr>
<tr><td colspan="3">Level 3</td></tr>
<tr><td>• Observed salinity and/or metals or pH outside of defined trigger levels[1], for greater than 6 consecutive months.
AND
• The change in water quality is determined not to be controlled by climatic or external anthropogenic factors.</td><td>For Private Bores and Open Standpipe Monitoring Bores
• Actions as stated in Level 2.
• Increase monitoring and review of data frequency for sites where Level 3 has been reached, and cause is unknown, subject to land access.
• Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing, other catchment changes, effect unrelated to mining or the prevailing climate).</td><td>For Private Bores and Open Standpipe Monitoring Bores
• Responses as stated in Level 2.
For Private Bores:
If ascertained impact is due to mining activities and has potential to impact long-term viability of supply for private groundwater bores:
• Develop a Rehabilitation Management Plan in consultation with DPHI and landowner.
• Implement Rehabilitation Management Plan, subject to land access.</td></tr>
</table>

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	**Action**	**Response**
			• Undertake investigative report to demonstrate if the water quality change will impact the long-term viability of any affected water supply works.	
Notes: 1 Defined trigger levels for groundwater quality are listed in Table 6-5 of Appendix E of the Water Management Plan. 2 Trigger levels to be defined for P50 and P57 bores when suitable baseline data available				

WATER MANAGEMENT PLAN TARP – WMP12 GROUNDWATER - SURFACE WATER INTERACTION

<table>
<tr><th rowspan="2">Performance Measure and Indicator, TARP Objective and Assessment Criteria</th><th rowspan="2">Monitoring Program</th><th colspan="3">Management</th></tr>
<tr><th>Trigger</th><th>Action</th><th>Response</th></tr>
<tr><td rowspan="8"><u>Performance Measure Feature</u>
No performance measure relevant.

<u>TARP Objective</u>
This TARP defines levels of deviation in surface water - groundwater interactions from ‘normal’ conditions and the actions to be implemented in response to each level deviation.
The instigation of this TARP will be dictated by triggers exceedances in pertinent groundwater or surface water sites requiring further investigation of groundwater – surface water interactions.

Where groundwater – surface water connectivity indicates in a gaining stream, there is potential for groundwater supporting riparian vegetation. Consequently, Riparian vegetation in these situations could be a Groundwater Dependent Ecosystem (GDE), and the pertinent Performance Measure applicable:
Negligible impacts including:
• Negligible change in groundwater levels; and
• Negligible change in groundwater quality.

Riparian GDEs are addressed through the Riparian Vegetation TARP (BMP3). Consultation through the ERG will link this TARP (WMP12) to BMP3 via actions in BMP3 to consider groundwater – surface water relationships when pertinent.

<u>Assessment Criteria</u>
Bore specific trigger values based on baselines data for each reporting level. For this TARP, the aligned groundwater and surface water sites would be considered collectively to interpret potential changes/impacts to groundwater – surface water interaction.</td><td rowspan="8"><u>Locations</u>
Open standpipes
P51a, P51b, P52, REA4, P53a, P53b, P53c
P54a, P54b, P54c, P55a, P55b, P55c

The aligned surface water and groundwater sites are as follows:
• P51a, P51b with surface water site BR2-Qla
• P52, REA4 with surface water site-TT14-QLa
• P53a, P53b, P53c with surface water site-TT14-Qla
• P54a, P54b, P54c with surface water site TT3-QLa
• P55a, P55b, P55c with surface water site TT1-QLa

All monitoring locations are shown in Figure 23 of the Water Management Plan.

<u>Monitoring Frequency</u>
Pre-mining
Monthly manual measurements of water level and water quality.

During Mining
Monthly manual measurements of water level and water quality.

Post-mining
Continuous record (where loggers installed) and quarterly manual measurements of water level for a minimum of 12 months following the completion of active dewatering or as deemed necessary in consideration to the status of aquifer recovery or as required for future extraction activities.</td><td>Normal Condition</td><td></td><td></td></tr>
<tr><td>• Observed (or inferred where not immediately neighbouring a surface water site) groundwater and surface water interaction remains consistent with baseline variability and/pre-mining trends, and decrease in groundwater inflow not persisting after significant rainfall recharge events.</td><td>• Continue monitoring and review of data as per monitoring program.</td><td>• No response required.</td></tr>
<tr><td>Level 1</td><td></td><td></td></tr>
<tr><td>• Observed (or inferred where not immediately neighbouring a surface water site) groundwater levels at surface water monitoring site decline below Level 1 (in TARP WMP8) following the commencement of extraction.</td><td>• Actions as required for Normal Condition.
• Undertake an investigation to assess cause and determine if mining related.
• Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, surface water level results).</td><td>• Report trigger exceedance to DPHI and key stakeholders.
• Report trigger exceedance and investigation outcomes in Annual Review.
If the changes have been confirmed to be related to mining effects:
• Provide DPHI and key stakeholders with proposed corrective management actions (CMAs) for consultation (e.g. extending the depth of the bore, establishment of additional bores, compensation to affected landowners as detailed in Section 6.2.1.4 of the Water Management Plan).
• Implement CMAs, subject to land access.
• Monitor and report on success of CMAs in Annual Review.</td></tr>
<tr><td>Level 2</td><td></td><td></td></tr>
<tr><td>• Observed (or inferred where not immediately neighbouring a surface water site) groundwater levels at aligned surface water monitoring site decline below Level 2 (in TARP WMP8) following the commencement of extraction.
AND
• The reduction in water level is determined not to be controlled by climatic or external anthropogenic factor.</td><td>• Actions as stated in Level 1.
• Consider increasing frequency of monitoring and review of data at sites where Level 2 has been reached or at other relevant sites, subject to land access and feasibility.
Reasons for not increasing monitoring frequency could include confident identification causation that do not require further monitoring (e.g. singular anthropogenic impact resulting in water level change, or confirmed as a mining-related impact).
• Compare against base case and deterministic model scenarios[1].
• Review manual water level measurements for additional monitoring sites to identify potential spatial trends in water level decline.
• Review surface water data to assess for surface water level decline at relevant site.
• Review CMAs in light of findings from further investigations and consider additional reasonable and feasible options.
• Review Water Management Plan and modify if necessary.</td><td>• Responses as stated in Level 1.
• Provide findings of CMA review to DPHI and key stakeholders for consultation.
• Implement additional CMAs, subject to land access.
• Advise DPHI and key stakeholders of any required amendments to Water Management Plan, including reporting on relationship of observations to baseline and deterministic model scenarios, as necessary.</td></tr>
<tr><td>Level 3</td><td></td><td></td></tr>
<tr><td>• Inferred groundwater levels at surface water monitoring site decline below Level 3 (in TARP WMP8) following the commencement of extraction.
AND
• The reduction in water level is determined not to be controlled by climatic or external anthropogenic factor.</td><td>• Actions as stated in Level 2.
• Increase frequency of data review for sites where Level 3 has been reached and cause is unknown, subject to land access.
• Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing, other catchment changes, effect unrelated to mining or the prevailing climate). Report to be commenced and completed as soon as practicable.</td><td>• Responses as stated in Level 2.
• Develop a Rehabilitation Management Plan in consultation with DPHI and key stakeholders.
• Implement Rehabilitation Management Plan, subject to land access.</td></tr>
<tr><td colspan="5">Notes:
1 [1]“Deterministic” model scenario refers to the predictive scenario modelling utilised to determine the trigger level.</td></tr>
</table>

WATER MANAGEMENT PLAN TARP – WMP13 GROUNDWATER BORES MONITORING FOR THIRLMERE LAKES

<table>
<tr><th rowspan="2">Performance Measure and Indicator, TARP Objective and Assessment Criteria</th><th rowspan="2">Monitoring Program</th><th colspan="3">Management</th></tr>
<tr><th>Trigger</th><th>Action</th><th>Response</th></tr>
<tr><td rowspan="8"><u>Performance Measure Feature</u>
GDEs including Thirlmere Lakes[1].

<u>Performance Measure</u>
Negligible impacts including:
• Negligible change in groundwater levels; and
• Negligible change in groundwater quality.

<u>Performance Indicator</u>
The performance measure will be considered to be exceeded if the groundwater levels or groundwater quality decline below Level 3 (in the relevant groundwater TARP triggers for water level and water quality – TARP WMP8 or WMP11) following the commencement of extraction, and the investigation outcomes indicate a mining related impact based on monitoring data for the Thirlmere Lakes.

<u>TARP Objective</u>
This TARP defines levels of deviation at Thirlmere Lakes from ‘normal’ conditions and the actions to be implemented in response to each level deviation.

<u>Assessment Criteria</u>
Bore specific trigger values based on baselines data for each reporting level.</td><td rowspan="8"><u>Locations</u>
“Early warning” bores
Existing sites:
GW104659, TBC039 (sensor at 65 metres in Hawkesbury Sandstone (HBSS)), P50a, P50b, P50c[2]
Thirlmere Lakes bores (not trigger bores)
Existing sites:
GW075409–1, GW075409–2, GW075410, GW075411 (paired with gauging station 212066)

All monitoring locations are shown in Figure 23 of the Water Management Plan.

<u>Monitoring Frequency (for “early warning” bores)</u>
Pre-mining
Monthly manual measurements of water level and water quality.

During Mining
Monthly manual measurements of water level and water quality.

Post-mining
Continuous record (where loggers installed) and quarterly manual measurements of water level for a minimum of 12 months following the completion of active dewatering or as deemed necessary in consideration to the status of aquifer recovery or as required for future extraction activities.

Water Quality sample parameters:
<table><tr><th>Field Parameters</th></tr><tr><td>PH
EC
TDS
DO</td></tr><tr><th>Laboratory Analysis</th></tr><tr><td>Total alkalinity as CaCO3, HCO3, CO3, DOC
Dissolved Major Cations (Ca, K, Na, Mg, F, Cl, SO4)
Dissolved Metals (Al, As, Ba, Co, Cu, Pb, Li, Mn, Ni, Se, Sr, Zn, Fe)
Total Metals (Al, As, Ba, Co, Cu, Pb, Li, Mn, Ni, Se, Sr, Zn, Fe)
Total Nitrogen
Total Phosphorus
Ionic Balance (Total Anions and Total Cations)</td></tr></table></td><td colspan="3">Normal Condition</td></tr>
<tr><td>• Groundwater levels and quality remain consistent with baseline variability and/pre-mining trends, and changes in groundwater levels/quality not persisting after significant rainfall recharge events.</td><td>• Continue monitoring and review of data as per monitoring program.</td><td>• No response required.</td></tr>
<tr><td colspan="3">Level 1</td></tr>
<tr><td>• Level 1 trigger of TARP WMP8 for a minimum of two “early warning” bores.
OR
• Level 1 trigger of TARP WMP11 for a minimum of two “early warning” bores.</td><td>• Actions as required for Normal Condition.
• Undertake an investigation to assess cause and determine if mining related.
• Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, surface water level results).
If the changes have been confirmed to be related to mining effects:
• Consider all reasonable and feasible options for remediation as relevant (e.g. extending the depth of the bore, establishment of additional bores). This could include potential for implementation of make-good provisions as per Section 6.2.1.4 of the Water Management Plan for affected private bore owners.
• For monitoring sites relevant to Thirlmere Lakes or associated with surface water monitoring sites, initiate groundwater – surface water interaction TARP.</td><td>• Report trigger exceedance to DPHI and key stakeholders.
• Report trigger exceedance and investigation outcomes Annual Review.
If the changes have been confirmed to be related to mining effects:
• Provide DPHI and key stakeholders with proposed corrective management actions (CMAs) for consultation (e.g. extending the depth of the bore, establishment of additional bores, compensation to affected landowners as detailed in Section 6.2.1.4 of the Water Management Plan).
• Implement CMAs, subject to land access.
• Monitor and report on success of CMAs in Annual Review.</td></tr>
<tr><td colspan="3">Level 2</td></tr>
<tr><td>• Level 2 trigger of TARP WMP8 for a minimum of three bores “early warning” bores
OR
• Level 2 trigger of TARP WMP11 for a minimum of three bores (“early warning” bores and Thirlmere Lakes bores).</td><td>• Actions as stated in Level 1.
• Consider increasing frequency of monitoring and review of data at sites where Level 2 has been reached or at other relevant sites, subject to land access and feasibility.
Reasons for not increasing monitoring frequency could include confident identification causation that do not require further monitoring (e.g. singular anthropogenic impact resulting in water level change, or confirmed as a mining-related impact). Increased monitoring could be beneficial where commensurate responses in paired surface water monitoring locations have been observed
Review Thirlmere Lakes monitoring bore data
• Compare against base case and deterministic model scenarios[2].
• Review manual water level measurements for additional monitoring sites to identify potential spatial trends in water level decline.
• Review surface water data to assess for surface water level decline at relevant site.
• Review CMAs in light of findings from further investigations and consider additional reasonable and feasible options.
• Review Water Management Plan and modify if necessary.
• Undertake an investigation to determine if an exceedance of the performance measure is likely. To be commenced/completed as soon as practicable.</td><td>• Responses as stated in Level 1.
• Provide findings of CMA review to DPHI and key stakeholders for consultation.
• Implement additional CMAs, subject to land access.
• Advise DPHI and key stakeholders of any required amendments to Water Management Plan.
• If relevant, notify Commonwealth DCCEEW of any predictions of an exceedance of a performance measure within two business days.</td></tr>
<tr><td colspan="3">Exceeds Performance Measure</td></tr>
<tr><td>• Level 3 trigger of TARPs WMP8 for a minimum of four bores “early warning” bores)
OR
• Level 3 trigger of TARPs WMP11 for a minimum of four bores (“early warning” bores and Thirlmere Lakes bores).
AND
• Review of Thirlmere Lakes bores indicated potential impacts resulting from extraction</td><td>• Actions as stated in Level 2.
If the changes have been confirmed to be related to mining effects:
• Investigate reasons for the performance measure exceedance. To be commenced/completed as soon as practicable.
• Review predictions of subsidence impacts and environmental consequences associated with further longwall extraction based on the outcomes of the investigation.
• Consider modifying mine plan.</td><td>• Responses as stated in Level 2.
• Submit a report to DPHI (in accordance with Condition E4 of SSD 8445) within 14 days of the exceedance occurring (or other timeframe agreed by DPHI) describing remediation options and any preferred remediation measures or other course of action.
• Implement any reasonable remediation measures as directed by DPHI, subject to land access.
• Notify Commonwealth DCCEEW of any detection or predictions of an exceedance of a performance measure within two business days.</td></tr>
</table>

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	**Action**	**Response**
				• Submit an Impact Response Plan to Commonwealth DCCEEW (in accordance with Condition 11 of the DAWE (now Commonwealth DCCEEW) Consent for the Tahmoor South Project). • Update numerical groundwater model and re-run predictive scenarios to determine the likely extent and depth of depressurisation in the vicinity of Thirlmere Lakes, and to determine whether any additional management actions are required such as modifying the mine plan

Notes:
[1] It is noted that the only Groundwater Dependent Ecosystem (GDE) pertinent to the Tahmoor South Project is that of Thirlmere Lakes[2] "Deterministic" model scenario refers to the predictive scenario modelling utilised to determine the trigger level.
[2] Trigger levels for P50 bores to be developed when suitable baseline data available.

LAND MANAGEMENT PLAN TARP – LMP1 CLIFFS

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	**Action**	**Response**
Performance Measure Feature Any cliff within Subsidence Area[1] beyond the extent of longwalls[2]. **Performance Measure** Negligible environmental consequences (that is occasional rockfalls, displacement or dislodgement of boulders or slabs, or fracturing, that in total do not impact more than 0.5% of the total face area of such cliffs within Subsidence Area). **Performance Indicator** This performance measure will be considered to be triggered if more than 0.5% of the total face area of the cliffs within the 600 m Environmental Features Study Area is impacted by mining (e.g. by occasional rockfalls, displacement or dislodgement of boulders or slabs, or fracturing). **TARP Objective** This TARP defines measures to manage potential impacts on cliff lines and the actions required to be implemented in response to exceedance of defined trigger levels. **Assessment Criteria** Extent of surface cracking, rockfalls, displacement or dislodgement of boulders or slabs observed.	**Locations** Cliffs (BC1 to BC20) within the 600 m Environmental Features Study Area as illustrated in Figure 3 of the Land Management Plan. **Monitoring Frequency** **Prior to the commencement of each panel** Visual inspection baseline by a geotechnical engineer, subject to land access Timing: - Cliff BC1 prior to LW S6A and LW S7A, - Cliff BC2 prior to LW S3A S4A, S5A and S6A, - Cliff BC3 to BC20 prior to LW S7A. **During Mining of each panel** None required (as the identified cliffs are located near the finishing ends of the longwalls). **At the completion of each panel**Visual inspection by a geotechnical engineer, subject to land access Timing: - Cliff BC1 prior to LW S6A and LW S7A, - Cliff BC2 prior to LW S3A S4A, S5A and S6A, - Cliff BC3 to BC20 prior to LW S7A. **Note: inspections can be combined depending in the timing between completion of panels and commencement of new panels**	**Normal Range of Condition**		
		• Surface cracking < 10 mm wide above the cliff line, on the cliff face, or in the underside of overhangs. AND/OR • No rockfalls, displacement or dislodgement of boulders or slabs observed.	• Continue monitoring and review of data as per monitoring program.	• No response required.
		Level 1		
		• Surface cracking > 10 mm wide above the cliff line, on the cliff face, or in the underside of overhangs. AND/OR • No rockfalls, displacement or dislodgement of boulders or slabs observed.	• *Actions as required for Normal Condition.* • Undertake an investigation to assess cause and determine if mining related. • Discuss findings and obtain other relevant information from key specialises (e.g. subsidence monitoring results). If it is concluded that the cliff has been damaged by subsidence impacts: • Consider and decide on reasonable and feasible options to support the cliff line, where relevant (e.g. repairing cracks, installation of support (e.g. rockbolts)). • Erect hazard/warning signs and restrict access to areas where necessary. • Consider increasing monitoring and review of data frequency at sites where Level 1 has been reached, subject to land access. Considerations will take into account position of LW face relative to impact site, rate of longwall retreat, current weather conditions, development of conventional subsidence above longwall, consequences of potential cliff instability and monitoring results relevant to the cliff locations.	• Report trigger exceedance to DPHI and key stakeholders. • Report trigger exceedance and investigation outcomes in the Annual Review. • Provide DPHI and key stakeholders with proposed corrective management actions (CMAs) for consultation (e.g. repairing cracks, installation of support). • Implement CMAs, subject to land access. • Monitor and report on success of CMAs in the Annual Review.
		Level 2		
		• Rockfalls, collapse of overhang, displacement or dislodgement of boulders or slabs observed.	• *Actions as stated in Level 1.* • Determine the percentage area of impacted area relative to the total face area. • Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing, or the effect is unrelated to mining such as environmental effects, tree root jacking). If it is concluded that cliff line has been damaged by subsidence impacts: • Increase frequency of monitoring by geotechnical consultant during active subsidence period at sites where Level 2 has been reached, subject to land access. Considerations will take into account position of LW face relative to impact site, rate of longwall retreat, current weather conditions, development of conventional subsidence above longwall, consequences of potential cliff instability and monitoring results relevant to the cliff locations. • Notify and consult with affected landowner(s). • Review CMAs in light of findings from further investigations and consider additional reasonable and feasible options. • Review Land Management Plan and modify if necessary. • Undertake an investigation to determine if an exceedance of the performance measure is likely.	• *Responses as stated in Level 1.* If it is concluded that cliffs have been damaged by subsidence impacts: • Offer site visit with DPHI and key stakeholders. • Develop a Rehabilitation Management Plan in consultation with DPHI and key stakeholders if relevant. • Notify Commonwealth DCCEEW of any predictions of an exceedance of a performance measure (if relevant) within two business days. • Provide findings of CMA review to DPHI and key stakeholders for consultation. • Implement additional CMAs, subject to land access. • Advise DPHI and key stakeholders of any required amendments to Land Management Plan.
		Exceeds Performance Measure		
		• More than 0.5% of the total face area of the cliffs within the 600 m Environmental Features Study Area is impacted due to mining (e.g. by occasional rockfalls, displacement or dislodgement of boulders or slabs, or fracturing).	• *Actions as stated in Level 2.* • Investigate reasons for the performance measure exceedance. • Review predictions of subsidence impacts and environmental consequences associated with further longwall extraction based on the outcomes of the investigation. • Consider modifying mine plan for future longwalls located near cliffs.	• *Responses as stated in Level 2.* • Submit a report to DPHI (in accordance with Condition E4 of SSD 8445) within 14 days of the exceedance occurring (or other timeframe agreed by DPHI) describing remediation options and any preferred remediation measures or other course of action. • Implement reasonable remediation measures as directed by DPHI, subject to land access. • Notify Commonwealth DCCEEW of any detection or predictions of an exceedance of a performance measure within two business days.

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	Action	Response
				• Submit an Impact Response Plan to Commonwealth DCCEEW (in accordance with Condition 11 of the DAWE (now Commonwealth DCCEEW) Consent for the Tahmoor South Project).

Notes:
[1] Subsidence Area is defined as the 'Subsidence Study Area' as illustrated in Figure 1 of Appendix 2 of SSD 8445.
[2] It is noted that there are no cliff lines located directly above Longwalls S1A-S7A. Therefore, the performance measure for 'Any cliff located directly above longwalls' is not relevant.

LAND MANAGEMENT PLAN TARP – LMP2 NATURAL STEEP SLOPE (EXCLUDING CONSTRUCTED STEEP SLOPES ASSOCIATED WITH ROADS, RAILWAY AND THE TAHMOOR MINE SITE)

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	**Action**	**Response**
Performance Measure Feature All land within the Subsidence Area[1,2]. **Performance Measure** No greater subsidence impact or environmental consequences than predicted in the EIS[3]. **Performance Indicator** This performance measure will be considered to be triggered if mining results in mine subsidence-induced slope instability, which would be a greater subsidence impact or consequence than predicted in the EIS. **TARP Objective** This TARP defines measures to manage potential impacts on natural steep slopes[4,5] and the actions required to be implemented in response to exceedance of defined trigger levels. **Assessment Criteria** Extent of surface cracking and stepping, ground bulging, buckling and shearing for steep slopes[4].	**Locations** Natural steep slopes (RS1 to RS7 and WC1 to WC3) Locations of natural steep slopes shown in Figure 3 of the Land Management Plan. **Monitoring Frequency** **Prior to the commencement of each panel** Visual inspection baseline one month before active subsidence period by a geotechnical engineer, subject to land access. **During mining of each panel** Monthly visual inspection during active subsidence period by a geotechnical engineer, subject to land access. **At the completion of each panel** Quarterly visual inspection for 12 months following active subsidence period by a geotechnical engineer, or as required in accordance with a Rehabilitation Management Plan, subject to land access. **Note: inspections can be combined depending in the timing between completion of panels and commencement of new panels**	**Normal Range of Condition**		
		• Discontinuous surface cracking < 10 mm wide on steep slope (e.g. other than natural desiccation cracking). AND/OR • No localised ground bulging, buckling or shearing.	• Continue monitoring and review of data as per monitoring program.	• No response required.
		Level 1		
		• Persistent[6] surface cracking 10 - 20 mm, or stepping (including shearing) across a crack 10 – 20 mm high on steep slope. AND/OR • Localised ground bulging or buckling (between 100 – 200 mm) is observed on steep slope.	• *Actions as required for Normal Condition.* • Geotechnical consultant inspection to assess cause and determine need for further action/investigation. • Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results). If it is concluded that the slope has been damaged by subsidence impacts: • Consider and decide on reasonable and feasible options for remediation as relevant (e.g. backfilling or grout filling of surface cracking, re-profiling of compression humps). • Erect warning signs and restrict access to areas where necessary. • Consider increasing monitoring and review of data frequency at sites where Level 1 has been reached, subject to land access. Considerations will take into account position of LW face relative to impact site, rate of longwall retreat, current weather conditions, development of conventional subsidence above longwall, consequences of potential slope instability and monitoring results relevant to the steep slope locations. • Consider additional specific monitoring at the impact site and implement if feasible and effective.	• Report trigger exceedance to DPHI and key stakeholders. • Report trigger exceedance and investigation outcomes in Annual Review. • Provide DPHI and key stakeholders with proposed corrective management actions (CMAs) for consultation (e.g. backfilling or grout filling of surface cracking, re-profiling of compression humps, re-direct drainage) • Implement CMAs, subject to land access. • Monitor and report on success of CMAs in Annual Review.
		Level 2		
		• Persistent[5] surface cracking > 20 mm wide or stepping > 20 mm high on slope. AND/OR • Localised ground bulging or buckling > 200 mm is observed on steep slope. AND/OR • Slope instability < 300 m^3 is observed or assessed as likely by a geotechnical engineer based on the extent of surface cracking or deformation.	• *Actions as stated in Level 1.* • Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced cracking, or the effect is unrelated to mining such as wet weather or other environmental effects). If it is concluded that the slope has been damaged by subsidence impacts: • Increase frequency of monitoring by geotechnical consultant during active subsidence period at sites where Level 2 has been reached, subject to land access. Considerations will take into account position of LW face relative to impact site, rate of longwall retreat, current weather conditions, development of conventional subsidence above longwall, consequences of potential slope instability and monitoring results relevant to the steep slope locations. • Assess potential for slope instability (and if an exceedance of the performance measure is possible). • Consider actions to avoid or reduce the likelihood and/or consequence of slope instability and implement if feasible and effective. • Notify and consult with affected landowner(s). • Review CMAs with regards to the findings from further investigations and consider additional remediation options. • Review Land Management Plan and modify if necessary.	• *Responses as stated in Level 1.* If it is concluded that the slope has been damaged by subsidence impacts: • Offer site visit with DPHI and key stakeholders. • Develop a Rehabilitation Management Plan in consultation with DPHI and key stakeholders if relevant. • Notify Commonwealth DCCEEW of any predictions of an exceedance of a performance measure (if relevant) within two business days. • Provide findings of CMA review to DPHI and key stakeholders for consultation. • Implement additional CMAs, subject to land access. • Advise DPHI and key stakeholders of any required amendments to Land Management Plan.
		Exceeds Performance Measure		
		• Subsidence-induced impacts or environmental consequences that result in slope instability > 300 m^3.	• *Actions as stated in Level 2.* • Investigate reasons for the performance measure exceedance. • Review predictions of mine subsidence impacts and environmental consequences associated with further longwall extraction based on the outcomes of the investigation.	• *Responses as stated in Level 2.* • Submit a report to DPHI (in accordance with Condition E4 of SSD 8445) within 14 days of the exceedance occurring (or other timeframe agreed with DPHI) describing temporary protection measures and long-term remediation options and any preferred remediation measures or other course of action. • Implement reasonable remediation measures as directed by DPHI, subject to land access. • Notify Commonwealth DCCEEW of any detection or predictions of an exceedance of a performance measure within two business days.

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	Action	Response
				• Submit an Impact Response Plan to Commonwealth DCCEEW (in accordance with Condition 11 of the DAWE (now Commonwealth DCCEEW) Consent for the Tahmoor South Project).

Notes:
[1] Subsidence Area is defined as the 'Subsidence Study Area' as illustrated in Figure 1 of Appendix 2 of SSD 8445.
[2] Steep slopes are defined as greater than 18.4°. There are three steep slopes identified within the 600 m Environmental Features Study Area that are also located within the Subsidence Area[1]. As no other steep slopes have been identified within the 600 m Environmental Features Study Area, the performance measure for 'all land outside the subsidence area' is not relevant.
[3] EIS predictions are summarised in the Subsidence Predictions and Impact Assessment Report by MSEC (2022) and MSEC (2024), and the relevant predictions for steep slopes is provided in Section 4.2 of the Land Management Plan.
[4] All road embankments and road cutting identified in Figure 3 of the Land Management Plan will be managed in accordance with the Wollondilly Shire Council Management Plan. All railway embankments within the Study Area will be managed in accordance with the Main Southern Railway Management Plan. All steep slopes on the Tahmoor Mine Site will be managed in accordance with the Tahmoor Mine Site Management Plan.
[5] TARPs for the management of constructed steep slopes will be provided as part of the Wollondilly Shire Council Management Plan (road embankments and cuttings), Main Southern Railway Management Plan (rail embankments) and the Tahmoor Mine Site Management Plan (mine site slopes). These yet to be prepared TARPs will be included in Appendix B Master TARP following preparation and approval by the infrastructure owner.
[6] For the purpose of this TARP, persistent cracking is a tension crack/s that combine to form a potential backscarp or failure plane for slope instability. The length is proportional to the size of the failure surface.

LAND MANAGEMENT PLAN TARP – LMP3 FARM DAMS

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	**Action**	**Response**
Performance Measure Feature Other privately-owned built features and improvements, including… farm dams. **Performance Measure** • Always safe. • Serviceability should be maintained wherever practicable. • Loss of serviceability must be fully compensated. • Damage must be fully repairable, and must be fully investigated and repaired or else replaced or fully compensated at the cost of the Applicant. **Performance Indicator** This performance measure will be considered to be triggered if mining results in damage to a farm dam such that the dam is not safe and serviceable and/or any damages cannot be fully repairable and/or compensated. **TARP Objective** This TARP defines measures to manage potential impacts on farm dams and the actions required to be implemented in response to exceedance of defined trigger levels. **Assessment Criteria** Dam embankment integrity, water level and seepage observations.	**Locations** Identified farm dams within the Study Area (FD1 to FD45). Locations shown in Figure 8 of the Land Management Plan. **Monitoring Frequency** **Prior to the commencement of each panel** Dam embankment integrity and water level observation by a geotechnical consultant one month before active subsidence period using fixed location photo points. **During mining of each panel** Dam embankment integrity and water level observation every month during the active subsidence period by a geotechnical consultant, using fixed location photo points, subject to land access. **At the completion of each panel** Dam embankment integrity and water level observation using fixed location photo points on a quarterly basis for 12 months following completion of active subsidence by a geotechnical consultant, or as required in accordance with a Rehabilitation Management Plan. **Note: inspections can be combined depending in the timing between completion of panels and commencement of new panels**	**Normal Range of Condition**		
		• No cracks develop within dam embankment (e.g. other than natural desiccation cracking).	• Continue monitoring and review of data as per monitoring program.	• No response required.
		Level 1		
		• Development of isolated cracks (> 10 mm wide) within the dam wall (e.g. other than natural desiccation cracking). AND/OR • Development of isolated seepage without suspended solids (e.g. clear water) from the face or toe of the farm dam embankment.	• *Actions as required for Normal Condition.* • Geotechnical consultant inspection to assess cause and determine need for further action/investigation. • Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results). If it is concluded that dam has been damaged by subsidence impacts: • Consider and decide on reasonable and feasible options for remediation as relevant (e.g. backfilling surface cracking, reinstatement). • Notify and consult with affected landowner. • Erect warning signs and restrict access to areas where necessary and permitted by the landowner.	• Report trigger exceedance to DPHI, SA NSW and key stakeholders. • Report trigger exceedance and investigation outcomes in Annual Review. • Provide DPHI, SA NSW and landowner with proposed corrective management actions (CMAs) for consultation (e.g. backfilling surface cracking, reinstatement). • Implement CMAs, subject to land access. • Monitor and report on success of CMAs in Annual Review.
		Level 2		
		• Development of persistent longitudinal or arcuate cracking within dam wall > 20 mm. AND • Development of seepage with suspended solids (e.g. turbid water) from the face or toe of the farm dam embankment.	• *Actions as stated in Level 1.* • Consider increasing monitoring and review of data frequency at sites where Level 2 has been reached, subject to land access. Considerations will take into account position of LW face relative to impact site, rate of longwall retreat, current weather conditions, development of conventional subsidence above longwall, consequence of potential dam break, and monitoring results relevant to the dam locations. • Review CMAs in light of findings from further investigations and consider additional reasonable and feasible options. • Review Land Management Plan and modify if necessary. • Geotechnical Consultant to advise on the need for a reduction in the dam water level (e.g. half dam volume) to reduce the risk of a dam break failure.	• *Responses as stated in Level 1.* • Advise DPHI, SA NSW and key stakeholders of any required amendments to Land Management Plan. • Provide findings of CMA review to DPHI, SA NSW and landowner for consultation. • Implement additional CMAs, subject to land access.
		Level 3		
		• Development of persistent longitudinal or arcuate cracking within dam wall > 20 mm. AND • Subsidence monitoring identifies subsidence-induced impacts or environmental consequences that result in any slope instability to the farm dam embankment.	• *Actions as stated in Level 2.* • Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing, or the effect is unrelated to mining such as environmental effects). If it is concluded that the dam has been damaged by subsidence impacts: • Increase frequency of monitoring by geotechnical consultant during active subsidence period at sites where Level 3 has been reached, subject to land access. Considerations will take into account position of LW face relative to impact site, rate of longwall retreat, current weather conditions, development of conventional subsidence above longwall, consequence of potential dam break, and monitoring results relevant to the dam locations. • Reduction of dam water level in accordance with advice from Geotechnical Consultant. • Review predictions of mine subsidence impacts and environmental consequences associated with further longwall extraction based on the outcomes of the investigation. • Assess potential for the safety and serviceability of the dam to be lost (and if an exceedance of the performance measure is possible).	• *Responses as stated in Level 2.* If it is concluded that the dam has been damaged by subsidence impacts: • Offer site visit with DPHI and key stakeholders. • Repair or replace farm dam in consultation with DPHI and SA NSW and landowner. • Provide alternate water supply for landowner, if required. • Notify Commonwealth DCCEEW of any predictions of an exceedance of a performance measure (if relevant) within two business days.

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	**Action**	**Response**
		Exceeds Performance Measure		
		• Mining results in damage to a farm dam such that the dam is not safe and serviceable and/or any damages cannot be fully repairable and/or compensated.	• *Actions as stated in Level 3.* • Investigate reasons for the performance measure exceedance. • Review predictions of mine subsidence impacts and environmental consequences associated with further longwall extraction based on the outcomes of the investigation.	• *Responses as stated in Level 3.* • Submit a report to DPHI (in accordance with Condition E4 of SSD 8445) within 14 days of the exceedance occurring (or other timeframe agreed with DPHI) describing temporary protection measures and long-term remediation options and any preferred remediation measures or other course of action. • Implement reasonable remediation measures as directed by DPHI, subject to land access. • Notify Commonwealth DCCEEW of any detection or predictions of an exceedance of a performance measure within two business days. • Submit an Impact Response Plan to Commonwealth DCCEEW (in accordance with Condition 11 of the DAWE (now Commonwealth DCCEEW) Consent for the Tahmoor South Project).

LAND MANAGEMENT PLAN TARP – LMP4 AGRICULTURAL LAND

<table>
<tr><th rowspan="2">Performance Measure and Indicator, TARP Objective and Assessment Criteria</th><th rowspan="2">Monitoring Program</th><th colspan="3">Management</th></tr>
<tr><th>Trigger</th><th>Action</th><th>Response</th></tr>
<tr><td rowspan="6"><u>Performance Measure Feature</u>
No performance measures relevant.

<u>TARP Objective</u>
This TARP defines measures to manage potential impacts on agricultural land and the actions required to be implemented in response to exceedance of defined trigger levels.

<u>Assessment Criteria</u>
Changes to agricultural land such as to impact the use of the land for agricultural productivity[1].</td><td rowspan="6"><u>Locations</u>
Identify agricultural land uses within the Study Area (refer to Figure 8 in the Land Management Plan).

<u>Monitoring Frequency</u>
Pre-mining
Visual inspection prior to the commencement of mining from fixed photo points.

During Mining
Weekly inspections along local roads. Monthly inspections of farm dams by a geotechnical consultant, subject to land access.

Post-mining
Visual inspection at the completion of each longwall for land within the predicted limit of subsidence for each longwall.</td><td colspan="3">Normal Condition</td></tr>
<tr><td>• Negligible impact to agricultural productivity or use of land, negligible effects from mining-induced changes in slope (tilt) on ponding / flooding (reversal of natural slope), or increase in soil / tunnel erosion (increase in slope).</td><td>• Continue monitoring and review of data as per monitoring program.</td><td>• No response required.</td></tr>
<tr><td colspan="3">Level 1</td></tr>
<tr><td>• Minor impact to agricultural land from subsidence resulting in increased flooding or ponding within predicted impacts.
AND/OR
• Minor impact to drainage systems due to increased ponding / flooding or increased soil / tunnel erosion that can be remediated.
AND/OR
• Surface cracking affecting safety of livestock.</td><td>• Actions as required for Normal Condition.
• Undertake an investigation to assess cause and determine if mining related.
• Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, surface water monitoring results).
• Consider and decide on reasonable and feasible options for remediation as relevant (e.g. adjustment of farm gate levels, fence tensioning, backfilling of surface cracking).
• Consider increasing monitoring and review of data frequency at sites where Level 1 has been reached, subject to land access. Considerations will take into account position of LW face relative to impact site, rate of longwall retreat, current weather conditions, development of conventional subsidence above longwall, consequences of further impacts on agricultural land use and monitoring results relevant to the agricultural land.</td><td>• Report trigger exceedance to DPHI and key stakeholders.
• Report trigger exceedance and investigation outcomes in Annual Review.
• Provide DPHI and key stakeholders with proposed corrective management actions (CMAs) for consultation (e.g. adjustment of farm gate, fence tensioning, backfilling of surface cracking).
• Implement CMAs, subject to land access.
• Monitor and report on success of CMAs in Annual Review.</td></tr>
<tr><td colspan="3">Level 2</td></tr>
<tr><td>• Significant impact and change to agricultural land functionality or agricultural productivity greater than predicted (e.g. excessive subsidence and mining-induced changes in slope (tilt), resulting in substantial ponding / flooding (reversal in natural slope), excessive soil / tunnel erosion (increase in slope), or excessive surface cracking affecting safety of livestock that require livestock to be relocated from a property in order to rehabilitate the land.</td><td>• Actions as stated in Level 1.
• Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing, or the effect is unrelated to mining such as environmental effects).
If it is concluded that agricultural land has been damaged by subsidence impacts:
• Increase frequency of monitoring during active subsidence period at sites where Level 2 has been reached, subject to land access. Considerations will take into account position of LW face relative to impact site, rate of longwall retreat, current weather conditions, development of conventional subsidence above longwall, consequences of further impacts on agricultural land use and monitoring results relevant to the agricultural land.
• Review CMAs in light of findings from further investigations and consider additional reasonable and feasible options.
• Review Land Management Plan and modify if necessary.</td><td>• Responses as stated in Level 1.
If it is concluded that the agricultural land has been damaged by subsidence impacts:
• Offer site visit with DPHI and key stakeholders.
• Develop a Rehabilitation Management Plan in consultation with DPHI and key stakeholders if relevant.
• Provide findings of CMA review to DPHI and key stakeholders for consultation.
• Implement additional CMAs, subject to land access.
• Advise DPHI and key stakeholders of any required amendments to Land Management Plan.</td></tr>
<tr><td colspan="6">Notes:
[1] It is noted that the management of rural structures used for agricultural and farming purposes located in the Study Area are discussed in the Built Features Management Plan (e.g. poultry sheds, greenhouses, greenhouses, hothouses, irrigation systems, and tanks), the Water Management Plan (e.g. watercourses and groundwater bores), and the separate TARP for farm dams as part of this Land Management Plan.</td></tr>
</table>

BIODIVERSITY MANAGEMENT PLAN TARP – BMP1 AQUATIC HABITAT AND MACROINVERTEBRATE INDICATORS (STREAM HEALTH)

<table>
<tr><th rowspan="2">Performance Measure and Indicator, TARP Objective and Assessment Criteria</th><th rowspan="2">Monitoring Program</th><th colspan="3">Management</th></tr>
<tr><th>Trigger</th><th>Action</th><th>Response</th></tr>
<tr><td rowspan="8"><u>Performance Measure Feature</u>
Aquatic habitat and stream health.

<u>Performance Measure</u>
Negligible environmental consequences to aquatic and riparian ecosystems beyond those predicted in the EIS[1].

<u>Performance Indicator</u>
This performance measure will be considered to be triggered if subsidence impacts cannot be remediated in a manner that restores aquatic habitat.

<u>TARP Objective</u>
This TARP defines levels of deviation in aquatic habitat and associated stream health from normal conditions and the actions required to be implemented in response to each level of deviation.

<u>Assessment Criteria</u>
Reduction in aquatic habitat through loss of pools or associated reduction in stream health (AUSRIVAS assessment).</td><td rowspan="8"><u>Locations</u>
• AUSRIVAS stream health sampling at aquatic ecology monitoring sites HC6, HC7, HC8, TTHt9, TTH12, TTH13, TTH16, TTHt17, BRt6.
• Quantitative macroinvertebrate sampling at aquatic ecology monitoring sites HC6, HC7, HC8, TTHt9, BRt6, TTH12, TTH13, MC14, MC15.

Refer to Figure 9 of the Biodiversity Management Plan for the location of aquatic ecology monitoring sites.

<u>Monitoring Frequency</u>
Pre-mining
Bi-annually (Spring and Autumn).

During Mining
Bi-annually (Spring and Autumn).

Post-mining
Bi-annually (Spring and Autumn) for 12 months following the completion of LW S7A or as required in accordance with a Rehabilitation Management Plan and/or if required to monitor a corrective management action(s).</td><td colspan="3">Normal conditions</td></tr>
<tr><td>• Visual monitoring indicates aquatic pool habitat parameters are similar to baseline observations at aquatic ecology monitoring sites.
AND
• AUSRIVAS score equal to or greater than Band C.</td><td>• Continue monitoring and review of data as per monitoring program.</td><td>• No response required.</td></tr>
<tr><td colspan="3">Level 1</td></tr>
<tr><td>• Visual monitoring indicates reduction in aquatic pool habitat compared to baseline observations at aquatic ecology monitoring sites for two consecutive sampling occasions.
OR
• AUSRIVAS score of Band D recorded for two consecutive sampling occasions at one or more aquatic ecology monitoring site(s).</td><td>• Actions as required for Normal Condition.
• Undertake an investigation of BACI quantitative macroinvertebrate data to assess Level 1 observations and determine if mining related or the response to environmental conditions (e.g. drought) within the catchment.
• Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, surface water monitoring results, groundwater monitoring results).
• Consider and decide on reasonable and feasible options for remediation, where relevant (e.g. limestone cobble for pH management).
• Following investigation, any declines detected that are not attributable to mining impacts (e.g. are a result of environmental conditions or stochastic events) are to be considered ‘normal condition’ and are continued to be included in the ongoing development of the ecological monitoring dataset.</td><td>• Report trigger exceedance to DPHI and key stakeholders.
• Report trigger exceedance and investigation outcomes in Annual Review.
• Provide DPHI and key stakeholders with proposed corrective management actions (CMAs) for consultation (e.g. limestone cobbles for pH management).
• Implement CMAs, subject to land access.
• Monitor and report on success of CMAs in Annual Review.
• Continue monitoring to determine if a Level 2 TARP trigger will occur.</td></tr>
<tr><td colspan="3">Level 2</td></tr>
<tr><td>• Visual monitoring indicates reduction in aquatic pool habitat compared to baseline observations at aquatic ecology monitoring sites for three consecutive sampling occasions.
OR
• AUSRIVAS score of Band D recorded for three consecutive sampling occasions at one or more aquatic ecology monitoring site(s).</td><td>• Actions as stated in Level 1.
• Consider increasing monitoring and review of data frequency where Level 2 has been reached and at other relevant sites, subject to land access.
• Consider the inclusion of additional sites within impact area.
• Review CMAs in light of findings from further investigations and consider additional reasonable and feasible options.
• Review Biodiversity Management Plan and modify if necessary.</td><td>• Responses as stated in Level 1.
• Provide findings of CMA review to DPHI and key stakeholders for consultation.
• Implement additional CMAs, subject to land access.
• Advise DPHI and key stakeholders of any required amendments to Biodiversity Management Plan.
• Continue monitoring to determine if a Level 3 TARP trigger will occur.</td></tr>
<tr><td colspan="3">Level 3</td></tr>
<tr><td>• Visual monitoring indicates reduction in aquatic pool habitat compared to baseline observations at aquatic ecology monitoring sites for four consecutive sampling occasions.
OR
• AUSRIVAS score of Band D recorded for four consecutive sampling occasions at one or more aquatic ecology monitoring site(s).</td><td>• Actions as stated in Level 2.
• Increase monitoring frequency for sites where Level 3 has been reached and at corresponding reference sites, subject to land access.
• Add additional monitoring sites as required.
• Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing, other catchment changes, effects unrelated to mining or the prevailing climate).
• Undertake an investigation to determine if an exceedance of the performance measure is likely.</td><td>• Responses as stated in Level 2.
If it is concluded that pools/aquatic habitat have been damaged by subsidence impacts:
• Offer site visit with DPHI and key stakeholders.
• If relevant, notify Commonwealth DCCEEW of any predictions of an exceedance of a performance measure within two business days.
• Develop a Rehabilitation Management Plan in consultation with DPHI and key stakeholders.
• Implement Rehabilitation Management Plan, subject to land access.
• Continue monitoring to determine if an exceedance of the performance measure will occur.</td></tr>
<tr><td colspan="3">Exceeds Performance Measure</td></tr>
<tr><td>• Structural integrity of the bedrock base of permanent pools or controlling rockbars in third order and above reaches of Teatree Hollow and Teatree Hollow tributary and/or pool TT2 cannot be restored e.g. pool holding capacity is not reinstated to pre-mining conditions after WCAMP completion.</td><td>• Actions as stated in Level 3.
• Investigate reasons for the performance measure exceedance.
• Review predictions of subsidence impacts and environmental consequences associated with further longwall extraction based on the outcomes of the investigation.</td><td>• Responses as stated in Level 3.
• Submit a report to DPHI (in accordance with Condition E4 of SSD 8445) within 14 days of the exceedance occurring (or other timeframe agreed by DPHI).
• Implement reasonable remediation measures as directed by DPHI, subject to land access.</td></tr>
</table>

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	**Action**	**Response**
				• Notify Commonwealth DCCEEW of any detection or predictions of an exceedance of a performance measure within two business days. • Submit an Impact Response Plan to Commonwealth DCCEEW (in accordance with Condition 11 of the DAWE (now Commonwealth DCCEEW) Consent for the Tahmoor South Project).
Notes: [1] EIS predictions for aquatic habitat are summarised in Table 19 of the Biodiversity Management Plan.				

BIODIVERSITY MANAGEMENT PLAN TARP – BMP2 AMPHIBIAN POPULATIONS

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	**Action**	**Response**
Performance Measure Feature No performance measures relevant. **TARP Objective** This TARP defines levels of deviation in amphibian populations and habitat from normal conditions and the actions required to be implemented in response to each level of deviation. **Assessment Criteria** • Decline in amphibian populations (species abundance and richness) attributed to mining effects. • The presence of a significant interaction (P-value <0.05) between Before/After and Control/Impact indicates an effect on amphibian assemblages[1,2].	**Locations** Amphibian monitoring and photo-point monitoring at all amphibian monitoring sites (sites i01-i03, i09 and c04-c08). Refer to Figure 10 of the Biodiversity Management Plan for the location of amphibian monitoring sites. **Monitoring Frequency** **Pre-mining** Bi-annually (Spring and Autumn). **During Mining** Bi-annually (Spring and Autumn). **Post-mining** Bi-annually (Spring and Autumn) for 12 months following the completion of LW S7A or as required in accordance with a Rehabilitation Management Plan and/or if required to monitor a corrective management action(s).	**Normal Condition**		
		• Monitoring indicates amphibian populations (richness and abundance) are stable[3] and habitat parameters are predominantly within a reasonable range of baseline data (supported by statistical analyses).	• Continue monitoring and review of data as per monitoring program.	• No response required.
		Level 1		
		• Monitoring indicates amphibian populations (species abundance) have reduced significantly below baseline values[4].	• *Actions as required for Normal Condition.* • Undertake an investigation of quantitative/qualitative monitoring data to assess the cause and determine if differences are mining related or are in the response to environmental conditions (e.g. drought) within the catchment. Cross check biodiversity monitoring data against other related environmental data (e.g. aquatic monitoring results or subsidence monitoring results) upon identification of the potential trigger. • Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, surface water monitoring results, groundwater monitoring results). • Investigate whether any surface water TARP indicators have been triggered. • Consider and decide on reasonable and feasible options for remediation, where relevant. • Following investigation, any significant differences detected that are not attributable to mining impacts (e.g. are a result of environmental conditions or stochastic events) are to be considered 'normal condition' and are continued to be included in the ongoing development of the ecological monitoring dataset.	• Report trigger exceedance to DPHI and key stakeholders. • Report trigger exceedance and investigation outcomes in Annual Review. • Provide DPHI and key stakeholders with proposed corrective management actions (CMAs) for consultation. • Implement CMAs, subject to land access. • Monitor and report on success of CMAs Annual Review. • Continue monitoring to determine if a Level 2 TARP trigger will occur.
		Level 2		
		• Monitoring indicates amphibian populations (species abundance and richness) have reduced significantly below baseline values[4] over two consecutive sampling seasons that, following investigation, is attributed to mining impacts[5].	• *Actions as stated in Level 1.* • Consider increasing monitoring and review of data frequency where Level 2 has been reached and at other relevant sites, subject to land access. • Consider the addition of monitoring sites within impact area. • Review CMAs in light of findings from further investigations and consider additional reasonable and feasible options. • Review Biodiversity Management Plan and modify if necessary.	• *Responses as stated in Level 1.* • Provide findings of CMA review to DPHI and key stakeholders for consultation. • Implement additional CMAs, subject to land access. • Advise DPHI and key stakeholders of any required amendments to Land Management Plan. • Continue monitoring to determine if a Level 3 TARP trigger will occur.
		Level 3		
		• Monitoring indicates amphibian populations (species abundance and richness) have reduced significantly below baseline values[4] over four consecutive sampling seasons that, following investigation, is attributed to mining impacts[5].	• *Actions as stated in Level 2.* • Increase monitoring and review of data frequency for sites where Level 3 has been reached and at other relevant sites, subject to land access. • Consider the addition of monitoring sites within impact area, where relevant. • Undertake a detailed investigation to assess if the change in behaviour is related to mining effects.	• *Response as stated in Level 2.* If it is concluded that amphibian habitat have been damaged by subsidence impacts: • Develop a Rehabilitation Management Plan in consultation with DPHI and key stakeholders. • Implement Rehabilitation Management Plan, subject to land access.
Notes:				

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	Action	Response

[1] Multivariate statistical analyses have been performed to test whether there is a difference between frog assemblages at future control and impact (using the baseline data). The non-significant interaction (P-value of >/= 0.05) between Control/Impact sites indicates that established future Control and Impact sites are suitable for mining and post-mining monitoring purposes, as they support similar amphibian assemblages (taxa and numbers of individuals), and similar microhabitats.

[2] Baseline amphibian surveys did not identify the presence of Red-crowned Toadlet (*Pseudophryne australis*) (listed as Vulnerable under the BC Act) or Giant Burrowing Frog (*Heleioporus australiacus*) (listed as Vulnerable under the BC Act and EPBC Act) within the LW S1A-S7A Study Area. Red-crowned Toadlet was recorded within the Study Area for LW S1A–S7A during the Tahmoor Amphibian Monitoring Program in 2013, during which the Giant Burrowing Frog was also recorded outside the Study Area for LW S1A–S7A. Giant Burrowing Frog was recorded at Cow Creek, and Red-crowned Toadlet was recorded at Hornes Creek (Niche, 2018a). Neither species has been recorded within the Study Area for LW S1A–S7A since the commencement of biannual (Spring and Autumn) amphibian monitoring that has been ongoing since 2013. If recorded in the future during amphibian monitoring, the presence of threatened frog species would be reported, and further investigations will be initiated to determine ongoing presence of threatened species in the locality and assess whether updates to the BMP and associated TARPs are required.

[3] Stable is defined as no significant interaction between Before/After and Control/Impact indicating the mining activity has not affected amphibian assemblages (which comprises of all detected amphibian species recorded during monitoring surveys).

[4] Determined by BACI interaction analyses. Significantly below baseline values is determined to be a P-value result of less than or equal to 0.05 for Before, After, either/or Control and Impact groups. The detection of a significant interaction between Before/After and Control/Impact indicates the mining activity has an effect on amphibian assemblages. All detected amphibian species are to be recorded during monitoring surveys. The amphibian data will be subject to statistical hypothesis testing. Species richness and abundance are population metrics used to assess amphibian populations in the locality.

[5] Mining impacts results in a decline in water quantity or quality influencing habitats.

BIODIVERSITY MANAGEMENT PLAN TARP – BMP3 RIPARIAN VEGETATION

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	**Action**	**Response**
Performance Measure Feature 1. Aquatic habitat. 2. GDEs including Thirlmere Lakes[1]. **Performance Measure** 1. Negligible environmental consequences to aquatic and riparian ecosystems beyond those predicted in the EIS[2]. 2. Negligible impacts including: • Negligible change in groundwater levels; and • Negligible change in groundwater quality. **Performance Indicator** 1. This performance measure will be considered to be triggered if subsidence impacts cannot be remediated in a manner that restores habitat. 2. The performance measure will be considered to be exceeded if the groundwater levels or groundwater quality decline below Level 3 (in the relevant groundwater TARP triggers for water level and water quality – TARP WMP8 or WMP11) following the commencement of extraction, and the investigation outcomes indicate a mining related impact based on monitoring data for riparian vegetation. **TARP Objective** This TARP defines levels of deviation in riparian vegetation condition from normal conditions and the actions required to be implemented in response to each level of deviation. **Assessment Criteria** Dieback and reduced condition of riparian vegetation community within the Study Area.	**Locations** Permanent floristic plots, vegetation condition assessment, photo-point monitoring and plant taxonomy at all riparian vegetation monitoring sites (sites i01-i03, i09 and c04-c08). Refer to Figure 10 of the Biodiversity Management Plan for the location of monitoring sites. **Monitoring Frequency** **Pre-mining** Bi-annually (Spring and Autumn). **During Mining** Bi-annually (Spring and Autumn). **Post-mining** Bi-annually (Spring and Autumn) for 12 months following the completion of LW S7A or as required in accordance with a Rehabilitation Management Plan and/or if required to monitor a corrective management action(s).	**Normal Condition**		
		• Monitoring indicates riparian vegetation parameters are predominantly within a reasonable range of baseline data[3], specifically that Vegetation Integrity (VI) scores are within 10% of baseline. AND • Monitoring indicates native vegetation cover (percent cover) is within a reasonable range of baseline data[4].	• Continue monitoring and review of data as per monitoring program.	• No response required.
		Level 1		
		• Monitoring indicates the VI score has reduced further than 10 % of average baseline score, over two consecutive sampling event (and cannot be attributed to climatic conditions or natural attrition). AND • Monitoring indicates native vegetation cover (percent cover) has reduced significantly below baseline values[4] over two consecutive sampling event.	• *Actions as required for Normal Condition.* • Undertake an investigation of quantitative/qualitative data to assess the cause and determine if mining related or the response to environmental conditions (e.g. drought) within the catchment. • Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, surface water monitoring results, groundwater monitoring results). • Consider and decide on reasonable and feasible options for remediation, where relevant. • Following investigation, any significant differences detected that are not attributable to mining impacts (e.g. are a result of environmental conditions or stochastic events) are to be considered 'normal condition' and are continued to be included in the ongoing development of the ecological monitoring dataset.	• Report trigger exceedance to DPHI and key stakeholders. • Report trigger exceedance and investigation outcomes in Annual Review. • Provide DPHI and key stakeholders with proposed corrective management actions (CMAs) for consultation. • Implement CMAs, subject to land access. • Monitor and report on success of CMAs in Annual Review. • Continue monitoring to determine if a Level 2 TARP trigger will occur.
		Level 2		
		• Monitoring indicates the VI score has reduced further than 10 % of baseline score, over four consecutive sampling event (and cannot be attributed to climatic conditions or natural attrition). AND • Monitoring indicates native vegetation cover (percent cover) has reduced significantly below baseline values[4].	• Actions as stated in Level 1. • Consider increasing monitoring and review of data frequency where Level 2 has been reached and at other relevant sites, subject to land access. • Consider the addition of monitoring sites within impact area. • Review CMAs in light of findings from further investigations and consider additional reasonable and feasible options. • Review Biodiversity Management Plan and modify if necessary.	• *Responses as stated in Level 1.* • Provide findings of CMA review to DPHI and key stakeholders for consultation. • Implement additional CMAs, subject to land access. • Advise DPHI and key stakeholders of any required amendments to Land Management Plan. • Continue monitoring to determine if a Level 3 TARP trigger will occur.
		Level 3		
		• Monitoring indicates the VI score has reduced further than 10 % of baseline score, over six consecutive sampling event (and cannot be attributed to climatic conditions or natural attrition). AND • Monitoring indicates native vegetation cover (percent cover) has reduced significantly below baseline values[4] over six consecutive sampling events.	• *Actions as stated in Level 2.* • Increase monitoring and review of data frequency for sites where Level 3 has been reached and at other relevant sites, subject to land access. • Consider the addition of monitoring sites within impact area, where relevant. • Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing, other catchment changes, effect unrelated to mining or the prevailing climate). • Undertake an investigation to determine if an exceedance of the performance measure is likely.	• *Response as stated in Level 2.* If it is concluded that riparian habitat have been damaged by subsidence impacts: • Offer site visit with DPE and key stakeholders. • Develop a Rehabilitation Management Plan in consultation with DPHI and key stakeholders. • Implement Rehabilitation Management Plan, subject to land access. • If relevant, notify Commonwealth DCCEEW of any predictions of an exceedance of a performance measure within two business days. • Continue monitoring to determine if an exceedance of the performance measure will occur.

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	**Action**	**Response**
		Exceeds Performance Measure		
		• This performance measure will be triggered if subsidence impacts cannot be remediated in a manner that restores habitat. AND/OR • A mining related impact has occurred to riparian vegetation (Level 3 triggered of this TARP) and a Level 3 TARP trigger has occurred for groundwater levels or groundwater quality (Level 3 of TARP WMP8 or WMP11) in a corresponding location.	• *Actions as stated in Level 3.* • Investigate reasons for the performance measure exceedance. • Review predictions of subsidence impacts and environmental consequences associated with further longwall extraction based on the outcomes of the investigation. • Consider modifying mine plan.	• *Responses as stated in Level 3.* • Submit a report to DPHI (in accordance with Condition E4 of SSD 8445) within 14 days of the exceedance occurring (or other timeframe agreed by DPHI). • Implement reasonable remediation measures as directed by DPHI, subject to land access. • Notify Commonwealth DCCEEW of any detection or predictions of an exceedance of a performance measure within two business days. • Submit an Impact Response Plan to Commonwealth DCCEEW (in accordance with Condition 11 of the DAWE (now Commonwealth DCCEEW) Consent for the Tahmoor South Project).

Notes:

[1] Where groundwater – surface water connectivity indicates a gaining stream, there is potential for riparian vegetation to be supported by groundwater. Consequently, riparian vegetation in these situations could be a Groundwater Dependent Ecosystem (GDE). Discussion of findings through the Tahmoor Coal Environmental Response Group will enable linkage of this TARP to WMP12 to consider groundwater – surface water relationships when pertinent.

[2] EIS predictions for riparian vegetation are summarised in Table 18 of the Biodiversity Management Plan.

[3] No significant interaction between Before/After and Control/Impact indicating the mining activity has not affected riparian assemblages.

[4] Determined by BACI interaction analyses. Significantly below baseline values is determined to be a P-value result of less than or equal to 0.05 for Before, After, either/or Control and Impact groups. The detection of a significant interaction between Before/After and Control/Impact indicates the mining activity has an effect on riparian assemblages.

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	**Action**	**Response**
Performance Measure Feature Threatened species, threatened populations, or endangered ecological communities. **Performance Measures** No greater subsidence impacts or environmental consequences than predicted in the EIS[1]. Negligible impacts on threatened species, populations, or communities due to remediation of subsidence cracking. **Performance Indicator** This performance measure will be triggered if subsidence impacts cannot be remediated in a manner that restores habitat. **TARP Objective** This TARP defines levels of deviation in Shale Sandstone Transition Forest (STFF) TEC and threatened flora species from normal conditions and the actions required to be implemented in response to each level of deviation. **Assessment Criteria** Decline or significant negative change in condition class of the TEC and threatened flora species (e.g. *Pomaderris brunnea*, *Persoonia bargoensis* and *Grevillea parviflora* subsp. *parviflora*). This TARP excludes the monitoring of threatened fauna species and habitat[2,3].	**Locations** Permanent floristic plots within the 600 m buffer study area, subject to land access. Refer to Figure 10 of the Biodiversity Management Plan for the location of monitoring sites. **Monitoring Frequency** **Pre-mining** Annually **During Mining** Bi-annually (Spring and Autumn). **Post-mining** Bi-annually (Spring and Autumn) for 12 months following the completion of LW S7A or as required in accordance with a Rehabilitation Management Plan and/or if required to monitor a corrective management action(s).	**Normal Condition**		
		• Monitoring indicates STFF TEC parameters are within a reasonable range of average baseline data (Vegetation Integrity (VI) scores are within reasonable range of baseline [within 10 %]). AND • Monitoring indicates target threatened flora species[4] numbers are stable (within reasonable range of baseline numbers).	• Continue monitoring and review of data as per monitoring program.	• No response required.
		Level 1		
		• Monitoring indicates the VI score has reduced further than 10 % of average baseline score. AND/ OR • Monitoring indicates target threatened flora species[4] are in decline or signs dieback are evident.	• *Actions as required for Normal Condition.* • Undertake an investigation of quantitative/qualitative data to assess the cause and determine if mining related or the response to environmental conditions (e.g. drought) within the catchment. • Discuss findings and obtain other relevant information from key specialists (e.g. subsidence monitoring results, surface water monitoring results, groundwater monitoring results). • Consider and decide on reasonable and feasible options for remediation, where relevant.	• Report trigger exceedance to DPHI and key stakeholders. • Report trigger exceedance and investigation outcomes in Annual Review. • Provide DPHI and key stakeholders with proposed corrective management actions (CMAs) for consultation. • Implement CMAs, subject to land access. • Monitor and report on success of CMAs in Annual Review. • Continue monitoring to determine if a Level 2 TARP trigger will occur.
		Level 2		
		• Monitoring indicates the VI score has reduced further than 10 % of the average baseline VI score, over two consecutive sampling events. AND/ OR • Monitoring indicates target threatened flora species[4] are in decline or visual signs of dieback are continued, over two consecutive sampling seasons.	• *Actions stated in Level 1.* • Consider increasing monitoring and review of data frequency where Level 2 has been reached and at other relevant sites, subject to land access. • Consider the addition of monitoring sites within impact area. • Review CMAs in light of findings from further investigations and consider additional reasonable and feasible options. • Review Biodiversity Management Plan and modify if necessary.	• *Responses as stated in Level 1.* • Provide findings of CMA review to DPHI and key stakeholders for consultation. • Implement additional CMAs, subject to land access. • Advise DPHI and key stakeholders of any required amendments to Land Management Plan. • Continue monitoring to determine if a Level 3 TARP trigger will occur.
		Level 3		
		• Monitoring indicates the VI score has reduced further than 10 % of baseline score, over four consecutive sampling event. AND/ OR • Monitoring indicates target threatened flora species[4] are in decline or visual signs of dieback are continued, over four consecutive sampling seasons.	• *Actions as stated in Level 2.* • Increase monitoring and review of data frequency to fortnightly at sites where Level 3 has been reached and at other relevant sites, subject to land access. • Consider the addition of monitoring sites within impact area, where relevant. • Undertake a detailed investigation to assess if the change in behaviour is related to mining effects (e.g. whether there has been subsidence induced fracturing, other catchment changes, effect unrelated to mining or the prevailing climate). • Undertake an investigation to determine if an exceedance of the performance measure is likely.	• *Response as stated in Level 2.* If it is concluded that threatened species, habitats or endangered ecological communities have been damaged by subsidence impacts: • Offer site visit with DPHI and key stakeholders. • Develop a Rehabilitation Management Plan in consultation with DPHI and key stakeholders. • Implement Rehabilitation Management Plan, subject to land access. • If relevant, notify Commonwealth DCCEEW of any predictions of an exceedance of a performance measure within two business days. • Continue monitoring to determine if an exceedance of the performance measure will occur.
		Exceeds Performance Measure		
		• Subsidence impacts cannot be remediated in a manner that restores habitat for TECs, or threatened flora.	• *Actions as stated in Level 3.* • Investigate reasons for the performance measure exceedance. • Review predictions of subsidence impacts and environmental consequences associated with further longwall extraction based on the outcomes of the investigation.	• *Responses as stated in Level 3.* • Submit a report to DPHI (in accordance with Condition E4 of SSD 8445) within 14 days of the exceedance occurring (or other timeframe agreed by DPHI). • Implement reasonable remediation measures as directed by DPHI, subject to land access. • Notify Commonwealth DCCEEW of any detection or predictions of an exceedance of a performance measure within two business days. • Submit an Impact Response Plan to Commonwealth DCCEEW (in accordance with Condition 11 of the DAWE (now Commonwealth DCCEEW) Consent for the Tahmoor South Project).

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	Action	Response

Notes:

[1] EIS predictions for threatened species, threatened populations and endangered ecological communities are summarised in Section 4.1 of the Biodiversity Management Plan.

[2] Baseline amphibian surveys did not identify the presence of Red-crowned Toadlet (*Pseudophryne australis*) (listed as Vulnerable under the BC Act) or Giant Burrowing Frog (*Heleioporus australiacus*) (listed as Vulnerable under the BC Act and EPBC Act) within the LW S1A-S7A Study Area. Red-crowned Toadlet was recorded within the Study Area for LW S1A–S7A during the Tahmoor Amphibian Monitoring Program in 2013, during which the Giant Burrowing Frog was also recorded outside the Study Area for LW S1A–S7A. Giant Burrowing Frog was recorded at Cow Creek, and Red-crowned Toadlet was recorded at Hornes Creek (Niche, 2018a). Neither species has been recorded within the Study Area for LW S1A–S7A since the commencement biannual (Spring and Autumn) amphibian monitoring that has been ongoing since 2013. If recorded in the future during amphibian monitoring, the presence of threatened frog species would be reported, and further investigations will be initiated to determine ongoing presence of threatened species in the locality and assess whether updates to the BMP and associated TARPs are required.

[3] During the 2020 biodiversity surveys, there were 11 threatened fauna species encountered within the LW S1A-S7A Study Area (Niche 2020a). Potential habitat for these species within the Tahmoor South EIS Project Area, includes riparian hollow-bearing trees, potential overhangs (only two cliff lines are being monitored within the project area), and disused buildings. No caves were encountered during surveys completed by Niche, nor have any caves been reported by MSEC (2018; 2022; 2024). Furthermore, cliff line environments which may indicate cave-like habitat, are generally limited to the Nepean River to the north of the Study Area with some scattered cliff lines along the Dogtrap Creek, and Hornes Creek. Given the cliffs are located outside the predicted limit of subsidence as a result of the extraction of LW S1A-S7A, the probability that cave roosting habitat would be impacted is very low. Furthermore, no hollow-bearing trees, bridges or culverts within the Study Area that provide roosting habitat for threatened bats are likely to be substantially impacted by subsidence. As such, roosting habitat for threatened microbats is unlikely to be impacted by the extraction of LW S1A-S7A. Subsidence is unlikely to affect any resources or habitat features on which these species depend such that it would result in any measurable changes to their breeding or foraging behaviour or habitat. Further, individuals have not been incidentally encountered during other baseline monitoring surveys (irregular occurrence in the study area). Therefore, as these threatened fauna species are considered highly mobile (consisting of bats and birds) and the species (and habitat) is considered unlikely to be impacted by mining practices, they have not been addressed further in the biodiversity TARPs.[4] Threatened flora species monitored are *Pomaderris brunnea*, *Persoonia bargoensis* and *Grevillea parviflora* subsp. *Parviflora*.

HERITAGE MANAGEMENT PLAN TARP – HMP1 ABORIGINAL CULTURAL HERITAGE SITES

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	**Action**	**Response**
Performance Measure Feature Aboriginal cultural heritage sites (listed in Appendix 4 of SSD 8445). Aboriginal cultural heritage sites (listed in Appendix D of SSD 8445 Mod 3). **Performance Measure** No greater subsidence impacts or loss of heritage values than predicted in the EIS and/or MOD[1]. **Performance Indicator** **Open camp site (Remembrance Drive 2013.1) and Isolated find (TC14-2-19)** No performance indicators are currently established as impacts are predicted to be negligible[2]. **Rockshelters with art and deposit, art, deposit or artefacts and deposit(Teatree Hollow 2013.1, Hornes Creek RS2, Hornes Creek RS3, Hornes Creek RS4, Hornes Creek RS5, Hornes Creek RS6, Hornes Creek RS7)** This performance measure will be considered to be triggered if more than 10% of rockshelters (i.e. more than two) in the Tahmoor South Domain (including A and B series longwalls) are impacted by: • subsidence monitoring identifies obvious perceptible change, e.g. rockfall, cracking, or toppling within rockshelters; and • these subsidence impacts result in impacts to the heritage values of the site, e.g. cracking, spalling or collapse of the art work panels that result in damage or loss of the art. This performance measure cannot be exceeded during the extraction of the A series longwalls, even if the above-mentioned performance indicators are fully triggered for Teatree Hollow 2013.1. Such impacts would not exceed the 10% threshold of impacts to the 19 total rockshelters in the longwalls A and B Study Area. **Grinding groove site** This performance indicator will be considered to be triggered if cracks (>2 cm) or movement in excess of natural environmental change occur as a result of Tahmoor South Domain (including A and B series longwalls). Impacts include: • subsidence monitoring identifies obvious perceptible change, e.g. cracking, spaces, gaps of movement of joints and rock associated with the grinding grooves; and • these subsidence impacts result in impacts to the heritage values of the site. This performance measure cannot be exceeded during the extraction of the A series longwalls. This performance measure and performance indicator have been incorporated into TARP HMP1 (Aboriginal cultural heritage sites).	**Locations** Teatree Hollow 2013.1. Hornes Creek RS2 Hornes Creek RS3 Hornes Creek RS4 Hornes Creek RS5 Hornes Creek RS6 Hornes Creek RS7 Hornes Creek GG1 Location shown in Figure 3 of the Heritage Management Plan. Monitoring of stone artefact sites Remembrance Drive 2013.1 and TC14-2-19 is not required as impacts are not anticipated. **Monitoring Frequency** **Pre-mining** • Visual inspection by archaeologist with RAPs (completed for Teatree Hollow 2013.1, to be completed for Hornes Creek RS2-RS7 inclusive and Hornes Creek GG1). • Baseline recording, sampling and photogrammetry (completed for Teatree Hollow 2013.1, to be completed for Hornes Creek RS2-RS7 inclusive and Hornes Creek GG1). Structural geotechnical review prior to secondary workings Teatree Hollow 2013.1. **During Mining** Teatree Hollow 2013.1 • Fortnightly visual inspection of the rockshelter (monitoring overall rockshelter stability) during periods of active subsidence for LW S1A, S2A, S3A and S4A, to be completed from a safe distance. • Monitoring of GNSS units / survey lines in proximity to the rockshelter (refer to Subsidence Monitoring Plan for more detail), reviewed on a monthly basis during periods of active subsidence for LW S1A, S2A, S3A and S4A. Hornes Creek RS2-RS7 inclusive, and Hornes Creek GG1 • Monthly visual inspection of the rockshelters and grinding grooves by a geotechnical engineer (PSM) (monitoring overall rockshelter and grinding groove stability) during periods of active subsidence for LW S7A, to be completed from a safe distance. • Monitoring of GNSS units / survey lines in proximity to the rockshelter and Grinding grooves (refer to Subsidence Monitoring Plan for more detail), reviewed on a monthly basis during periods of active subsidence for LW S7A. **Post-mining** Teatree Hollow 2013.1	**Normal Condition**		
		• Aboriginal heritage site monitoring indicates no detectable environmental consequences.	• Continue monitoring and review of data as per monitoring program.	• No response required.
		Level 1		
		Aboriginal heritage site monitoring indicates potential detectable environmental consequences, but with negligible impacts to the heritage value of rockshelter sites[3], and Hornes Creek GG1[4].	• *Actions as required for Normal Condition.* • An archaeologist to inspect the site within the area of potential impact and confirm Level 1 trigger is correct and that art panels have not been affected. • Detailed photographic recording of any damage to be documented and marked on the shelter base plan. • Undertake an investigation to assess cause and determine if mining related. • Consider and decide on reasonable and feasible options for remediation as relevant which could form corrective management actions (CMAs) in consultation with an archaeologist and RAPs. Engage specialists where relevant to address impact types (e.g. consult an engineer to discuss management of rockfall or toppling of shelter). • Consider increasing monitoring and review of data frequency if it is determined that the shelter structural stability or art panels are at an increased risk of impact from the Level 1 trigger event, subject to land access. • Review Heritage Management Plan and modify if necessary.	• Report trigger exceedance to DPE and key stakeholders. • Notify RAPs within seven days of the event and co-ordinate a site inspection with at least one RAP representative. • Report trigger exceedance and investigation outcomes in Annual Review. • Provide DPE, RAPs, and Heritage NSW with proposed corrective management actions (CMAs) for consultation (e.g. structural support for shelter or additional measures for art panels in response to level of increased risk of impacts). • Consider the development of a Rehabilitation Management Plan, and/or an update to the Heritage Management Plan in consultation with DPE, Heritage NSW and RAPs and key stakeholders (e.g. if additional mitigation or alternative methods not covered in the Heritage Management Plan are proposed). • Implement CMAs. • Monitor and report on success of CMAs in Annual Review. • Advise DPE and key stakeholders of any required amendments to Heritage Management Plan.
		Level 2		
		Aboriginal heritage site monitoring indicates environmental consequences to rockshelter sites[5] and Hornes Creek GG1[6].	• *Actions as stated in Level 1.* Increase monitoring and review of data frequency for sites where Level 2 has been reached at rockshelter sites and/or and Hornes Creek GG1, subject to land access • Investigate exceedance of subsidence prediction. • Review mine design/predictions against mine criteria.	• *Responses as stated in Level 1.* If it is concluded that heritage items have been damaged by subsidence impacts: • Offer site visit with DPE and key stakeholders. • Develop a Rehabilitation Management Plan in consultation with DPE and key stakeholders. Developed CMAs are to be incorporated into this plan. • Implement Rehabilitation Management Plan, subject to land access.

TARP Objective This TARP defines levels of impacts to Aboriginal cultural heritage values from existing conditions identified at the time of their discovery, to indicators that subsidence impacts have or may occur, to indicators of exceedance of the performance measure and the actions required to be implemented in response to each level of impact or exceedance of the performance measure. **Assessment Criteria** Discussion of performance measure indicators and their definitions is provided in Section 4.1.2 and Section 5.1 of the Heritage Management Plan.	• Visual inspection by archaeologist with RAPs at the completion of LW S1A, S2A, S3A and S4 Hornes Creek RS2-RS7 inclusive, and Hornes Creek GG1 • Visual inspection by archaeologist with RAPs at the completion of LW S7A.			

Notes:
[1] EIS predictions for aboriginal cultural heritage sites summarised in Section 4.1 of the Heritage Management Plan.
[2] Subsidence movements are not expected to have observable effects on these two sites as they are located in open terrain with a very gently sloping gradient. The predicted likelihood of impact on artefact sites is considered extremely unlikely and subsidence movements are unlikely to constitute 'harm' as defined by the NPW Act. As such, these sites will not be monitored and therefore performance measures cannot be established.
[3] Visible perceptible change, such as rockfall, cracking, or toppling within the rockshelter similar to naturally caused examples and which does not impact the art panels.
[4] Visible perceptible change, such as cracking, gaps, or broader rock movement similar to naturally caused examples and which does not impact the grooves.
[5] Visible perceptible change that results in impacts to the heritage values of the site, such as cracking, spalling or collapse of the art work panels that result in damage or loss of the art.
[6] Visible perceptible change that results in impacts to the heritage values of the site, such as cracking and/or gaps intersecting with a groove feature, and/or movement of the rock exposure that result in damage or loss of the art.

HERITAGE MANAGEMENT PLAN TARP – HMP2 HISTORICAL HERITAGE ITEMS

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	**Action**	**Response**
Performance Measure Feature Historic heritage sites (listed in Appendix 4 of SSD 8445). **Performance Measure** No greater subsidence impacts or loss of heritage values than predicted in the EIS[1]. **Performance Indicator** This performance measure will be considered to be triggered if subsidence impacts cannot be repaired in a manner that preserves the heritage value of the historical heritage items (Wirrimbirra Sanctuary, Bargo Cemetery, Bargo Railway Bridge North, Picton Weir, Tahmoor Mine Site, Bargo Railway Viaduct, Great Southern Road (partial)). **TARP Objective** This TARP defines levels of impacts to historic heritage sites from existing conditions identified at the time of their recording as part of the project EIS, to indicators that subsidence impacts have or may occur, to indicators of exceedance of the performance measure and the actions required to be implemented in response to each level of impact or exceedance of the performance measure. **Assessment Criteria** The historic heritage values related to each site are based on significance assessment criteria adopted as part of the EIS for the project (Niche 2012). TARP assesses impacts in relation to the historically significant values of each heritage item. The significance of each item is summarised in Table 12 of the Heritage Management Plan.	**Locations** • Wirrimbirra Sanctuary (Australian Wildlife Sanctuary). • Bargo Cemetery. • Bargo Railway Bridge North (Wellers Road Overbridge). • Picton Weir. • Tahmoor Colliery (Tahmoor Mine Site). • Bargo Railway Viaduct. • Great Southern Road (partial). Locations of historical heritage items are shown in Figure 4 of the Heritage Management Plan. **Monitoring Frequency** **Wirrimbirra Sanctuary** Pre-mining: • Visual assessment by a heritage consultant as part of SoHI (completed). • Pre-mining condition and structural assessment as per the Australian Wildlife Sanctuary Management Plan. • Install monitoring system as per the Subsidence Monitoring Plan. During mining: Regular monitoring as per the Australian Wildlife Sanctuary Management Plan. Post-mining: • Visual inspection by a heritage consultant at the completion of LW S5A. • Inspections and assessments as per the Australian Wildlife Sanctuary Management Plan. **Bargo Cemetery** Pre-mining: • Baseline recording and visual assessment by heritage consultant (completed, see Appendix D). • Pre-mining assessments as per the Bargo Cemetery Management Plan. • Install monitoring system as per the Subsidence Monitoring Plan. During mining: Regular monitoring as per the Bargo Cemetery Management Plan. Post-mining: • Visual inspection by a heritage consultant at the completion of Longwalls LW S7A. • Inspections and assessments as per the Bargo Cemetery Management Plan. **Bargo Railway Bridge North** Pre-mining: • Visual assessment by a heritage consultant. • Pre-mining condition and structural assessment as per the Main Southern Railway Management Plan. • Install monitoring system as per the Subsidence Monitoring Plan. During mining: Regular monitoring as per the Main Southern Railway Management Plan. Post-mining: • Visual inspection by a heritage consultant at the completion of Longwalls LW S7A. • Inspections and assessments as per the Main Southern Railway Management Plan. **Picton Weir** Pre-mining: • Pre-mining condition and structural assessment as per the Picton Weir Management Plan. • Install monitoring system as per the Subsidence Monitoring Plan. During mining: Regular monitoring as per the Picton Weir Management Plan. Post-mining: Inspections and assessments as per the Picton Weir Management Plan. **Tahmoor Colliery** Pre-mining: • Pre-mining condition and structural assessment as per the Tahmoor Mine Site Management Plan. • Install monitoring system as per the Subsidence Monitoring Plan. During mining: Regular monitoring as per the Tahmoor Mine Site Management Plan. Post-mining: Inspections and assessments as per the Tahmoor Mine Site Management Plan. **Great Southern Road (partial)** Pre-mining: Pre-mining condition as per the Wollondilly Shire Council Management Plan. During mining: Regular monitoring as per the Wollondilly Shire Council Management Plan. Post-mining: Inspections and assessments as per the Wollondilly Shire Council Management Plan. **Bargo Railway Viaduct**	**Normal Condition**		
		• Historical heritage site monitoring indicates no detectable environmental consequences.	• Continue monitoring and review of data as per monitoring program.	• No response required.
		Level 1		
		• Historical heritage site monitoring indicates potential detectable environmental consequences, but with negligible impacts to the heritage value of the heritage site(s).	• *Actions as required for Normal Condition.* • Co-ordinate a site inspection with a structural engineer. • Consult with a qualified archaeologist or heritage architect to determine whether impacts to heritage sites have occurred. • Consider increasing monitoring and review of data frequency for sites subject to a Level 1 trigger event, subject to land access. • Detailed photographic recording of any damage to be documented. • Erect warning signs and restrict access to areas where necessary.	• Report trigger exceedance to DPE and Heritage NSW. • Report trigger exceedance and investigation outcomes in Annual Review.
		Level 2		
		• Historical heritage site monitoring indicates environmental consequences to heritage site(s) but to a level that could be repaired in a manner that preserves the heritage value of the site(s).	• *Actions as stated in Level 1.* • Consider and decide on reasonable and feasible options for remediation as relevant which could form corrective management actions (CMAs) that would result in the repair of the item to a level that preserves the heritage value of the site(s). • Increase monitoring and review of data frequency for sites subject to a Level 2 trigger event, subject to land access. • Review Heritage Management Plan and modify if necessary. • Investigate exceedance of subsidence prediction. • Review mine design/predictions against mine criteria (e.g. for Picton Weir – review environmental consequences after extraction of LW S5A and determine if LW S6A should be shortened). • Undertake an investigation to determine if an exceedance of the performance measure is likely.	• *Responses as stated in Level 1.* • Advise DPE and key stakeholders of any required amendments to Heritage Management Plan. If it is concluded that heritage items have been damaged by subsidence impacts: • Offer site visit with DPE and Heritage NSW. • Provide DPE and Heritage NSW with proposed corrective management actions (CMAs) for consultation. • Implement CMAs, subject to land access. • Monitor and report on success of CMAs in Annual Review. • If relevant, notify DAWE of any predictions of an exceedance of a performance measure within two business days.
		Exceeds Performance Measure		
		• This performance measure will be considered to be triggered if subsidence impacts cannot be repaired in a manner that preserves the heritage value of the historic heritage item.	• *Actions as stated in Level 2.* • Investigate reasons for the performance measure exceedance. • Engage heritage specialist to determine if impacts to the heritage values of the site are irreparable even after reasonable remediation attempts have been made under the TARP. • Review predictions of subsidence impacts and environmental consequences associated with further longwall extraction based on the outcomes of the investigation. • Consider modifying mine plan.	• *Responses as stated in Level 2.* • Submit a report to DPE (in accordance with Condition E4 of SSD 8445) within 14 days of the exceedance occurring (or other timeframe agreed by DPE). • Implement reasonable remediation measures as directed by DPE, subject to land access. • Notify DAWE of any detection or predictions of an exceedance of a performance measure within two business days. • Submit an Impact Response Plan to DAWE (in accordance with Condition 11 of the DAWE Consent for the Tahmoor South Project).

Performance Measure and Indicator, TARP Objective and Assessment Criteria	Monitoring Program	Management		
		Trigger	Action	Response
	Pre-mining: • Visual assessment by a heritage consultant. • Pre-mining condition and structural assessment as per the Main Southern Railway Management Plan. • Install monitoring system as per the Subsidence Monitoring Plan. During mining: Regular monitoring as per the Main Southern Railway Management Plan. Post-mining: • Visual inspection by a heritage consultant at the completion of Longwalls LW S7A. • Inspections and assessments as per the Main Southern Railway Management Plan.			
Notes: [1] EIS predictions for historical heritage sites summarised in Section 4.2 of the Heritage Management Plan.				

Table A. 1 Risk Control Procedures for LWs S1A-S7A

GENERAL TRIGGER LEVELS

Trigger Level	Description
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 site inspection. Action required within 6 hours. 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.

ABBREVIATIONS WITHIN THESE TABLES:

ARTC = Australian Rail Track Corporation

MSO = NSW Department of Planning & Environment, Resources Regulator, Mine Safety Operations

ONRSR = Office of the National Rail Safety Regulator

Globetech = Automated Monitoring Contractor

SRS = Southern Rail Surveys (ground surveys within rail corridor)

SA NSW = Subsidence Advisory NSW

MSEC = Mine Subsidence Engineering Consultants

RMG = Rail Management Group

RMC = Rail Maintenance Contractor

RRG = Rail Response Group

RSRG = Rail Structures Response Group

PCE = Pidgeon Civil Engineering

JMA = JMA Solutions (structural engineer)

SMEC = SMEC (ground surveys beyond rail corridor)

TC = Tahmoor Coal

RISK ISSUE	TRIGGER	CONTROL PROCEDURES	TIMING & FREQ	BY WHOM?
General Procedures				
	GREEN	**EARLY WARNING MONITORING**		
		Continuous GNSS monitoring for S1 to S15 as shown in Drawing No. MSEC1201-03	GNSS units S1 to S15 installed Continuous readings, with data averaged over 24 hours and recorded once per day until end of LW S7A.	Tahmoor Coal (Unit Zero)
		Continuous GNSS monitoring for S28 at 100.52 km	GNSS unit S28 installed Continuous readings, with data averaged over 24 hours and recorded once per day until end of LW S7A.	Tahmoor Coal (Unit Zero)
		2D survey line along Tahmoor Mine property boundary	Pegs installed and baseline survey completed. Monthly survey during LW S1A between 200m and 1300m extraction, and continue if ongoing adverse movements are observed. End of LW S1A (complete).	Tahmoor Coal (SMEC)
		RAILWAY TRACK		
		3D ground survey along rail corridor *Extents for 3D surveys:* *LW S1A: 99.80km to 98.74km (AP2) and then extend to the north to include pegs that are at least 400 metres in front of the LW face, up to 97.70 km. (End of LW from 97.70 km to 99.80km)* LW S2A: *100.20km to 99.46km (AP4) and then extend to the north to include pegs that are at least 400 metres in front of the LW face, up to 98.18 km. (End of LW from 100.20km to 97.70km)* LW S3A: *100.60km to 99.78km (AP5) and then extend to the north to include pegs that are at least 400 metres in front of the LW face, up to 98.38 km. (End of LW from 100.60km to 98.20km)* LW S4A: *101.16km to 100.14km (AP6) and then extend to the north to include pegs that are at least 400 metres in front of the LW face, up to 98.74 km. (End of LW from 100.90km to 98.38km)* LW S5A: *101.16km to 100.14km (AP6) and then extend to the north to include pegs that are at least 400 metres in front of the LW face, up to 99.10 km. (End of LW from 101.16km to 98.92km)* LW S6A: *101.16km to 100.14km (AP6) and then extend to the north to include pegs that are at least 400 metres in front of the LW face, up to 99.46 km. (End of LW from 101.16km to 99.28km)* LW S7A: *101.16km to 100.14km and then extend to the north to include pegs that are at least 400 metres in front of the LW face, up to 99.46 km. (End of LW from 101.16km to 99.28km)*	Pegs installed for LWs S1A-S7A Monthly 3D surveys commencing as per below (Stage 1): LW S1A: start after 700m extraction LW S2A: start after 550m extraction LW S3A: start after 200m extraction LW S4A: at LW start LW S5A: at LW start LW S6A: at LW start LW S7A: at LW start End of LWs S1A-S7A.	SRS
		Focussed 2D ground survey along rail corridor *Extents for focussed 2D surveys:* *LW S1A: 99.80km to 98.74km (AP2) and then extend to the north to include pegs that are at least 200 metres in front of the LW face, up to 97.70 km. (End of LW from 97.70 km to 99.80km)* LW S2A: *100.20km to 99.46km (AP4) and then extend to the north to include pegs that are at least 200 metres in front of the LW face, up to 98.18 km. (End of LW from 100.20km to 97.70km)* LW S3A: *100.60km to 99.78km (AP5) and then extend to the north to include pegs that are at least 200 metres in front of the LW face, up to 98.38 km. (End of LW from 100.60km to 98.20km)* LW S4A: *101.16km to 100.14km (AP6) and then extend to the north to include pegs that are at least 200 metres in front of the LW face, up to 98.74 km. (End of LW from 100.90km to 98.38km)* LW S5A: *101.16km to 100.14km (AP6) and then extend to the north to include pegs that are at least 200 metres in front of the LW face, up to 99.10 km. (End of LW from 101.16km to 98.92km)* LW S6A: *101.16km to 100.14km (AP6) and then extend to the north to include pegs that are at least 200 metres in front of the LW face, up to 99.46 km. (End of LW from 101.16km to 99.28km)* LW S7A: *101.16km to 100.14km and then extend to the north to include pegs that are at least 400 metres in front of the LW face, up to 99.46 km. (End of LW from 101.16km to 99.28km)*	Pegs installed for LW S1A-S7A Weekly 2D surveys commencing as per below (Stage 2): LW S1A: start after 900m extraction LW S2A: start after 750m extraction LW S3A: start after 400m extraction LW S4A-S7A: start after GNSS 28 at 100.52km subsides more than 20mm after LW start or 200m extraction, whichever occurs first End of LWs S1A-S7A.	SRS
		Rail creep surveys of expansion switches, anchor points and CWR track (include all track expansion system zones where ZTL clips have been installed)	Weekly after ZTL clips have been installed	SRS
		Long bay length ground surveys *Extents for long bay length ground surveys as per focussed 2D surveys*	Weekly as per focussed 2D surveys (Stage 2)	SRS
		Continuously monitor rail stress, rail temperature and switch displacement *Extents for active subsidence monitoring:* *LW S1A: 99.78km to 98.74km (AP2) and then extend to the north to include gauges that are at least 200 metres in front of the LW face, up to 97.78 km.* LW S2A: *100.14km to 99.46km (AP4) and then extend to the north to include gauges that are at least 200 metres in front of the LW face, up to 98.14 km.* LW S3A: *100.44km to 99.78km (AP5) and then extend to the north to include gauges that are at least 200 metres in front of the LW face, up to 98.38 km.* LW S4A: *101.10km to 100.14km (AP6) and then extend to the north to include gauges that are at least 200 metres in front of the LW face, up to 98.74 km.* LW S5A: *101.10km to 100.14km (AP6) and then extend to the north to include gauges that are at least 200 metres in front of the LW face, up to 99.10 km.* LW S6A: *101.10km to 100.14km (AP6) and then extend to the north to include gauges that are at least 200 metres in front of the LW face, up to 99.46 km.* LW S7A: *101.10km to 100.14km (AP6) and then extend to the north to include gauges that are at least 200 metres in front of the LW face, up to 99.46 km.*	Gauges installed for LWs S1A to S7A Readings every 5 minutes Alarmed as per below (Stage 2) LW S1A: start after 900m extraction LW S2A: start after 750m extraction LW S3A: start after 400m extraction LW S4A: at LW start LW S5A: at LW start LW S6A: at LW start LW S7A: at LW start	Globetech

RISK ISSUE	TRIGGER	CONTROL PROCEDURES	TIMING & FREQ	BY WHOM?
		Continuously monitor rail stress and rail temperature to monitor residual subsidence effects *Residual subsidence monitoring = at least one working gauge every 120 m along each rail (extent may be reduced from the north based on future assessment)*	Every 5 minutes	Globetech
		Track geometry surveys using Amber track mounted device or equivalent *Extents for track geometry surveys as per focussed 2D surveys*	Weekly as per focussed 2D surveys (Stage 2)	RMC
		Track centre measurements at 98.620 km, 99.600 km and 101.200 km	Monthly when track is in Stage 2	SRS
		Track inspection by qualified track certifier. The inspection will check ARTC infrastructure within the rail corridor, including the track, track expansion system, integrity of monitoring systems, culverts, embankments, cuttings, signals and Loc's and fences *The extent of visual inspections is the same as the extent of track geometry surveys plus dormant expansion switches*	Twice weekly whilst expansion switches are in track Daily as per below (Stage 2) LW S1A: start after 900m extraction LW S2A: start after 750m extraction LW S3A: start after 300m extraction LW S4A-S7A: start after GNSS 28 at 100.52km subsides more than 20mm after LW start or 200m extraction, whichever occurs first	RMC
		RAILWAY CULVERTS AND EMBANKMENTS		
		Absolute 3D and 2D surveys along monitoring line along the railway	Absolute 3D monthly and 2D weekly as described for railway track	SRS
		Absolute 3D surveys and relative 3D surveys along monitoring lines on the crests and/or toes of the embankments on both sides and at culvert inlets and outlets. The layout of survey marks are shown in Drawings Nos. MSEC1201-05 to 12. *Install Culvert and Embankment at 98.445 km prior to 600 metres of extraction of LW S1A* *Install Culvert and Embankment at 98.739 km prior to 600 metres of extraction of LW S1A* *Install Culvert and Embankment at 99.035 km prior to 600 metres of extraction of LW S1A* *Install Culvert and Embankment at 99.338 km prior to 600 metres of extraction of LW S1A* *Install Culvert and Embankment at 100.121 km prior to start of LW S3A* *Install Culvert and Embankment at 100.425 km prior to start of LW S3A* *Install Culvert and Embankment at 101.000 km prior to start of LW S5A*	Monthly when track above each culvert is in Stage 1 Weekly when track above each culvert is in Stage 2 End of LW S1A-S7A	SRS
		Automated, continuously operating horizontal extensometers (or equivalent) across the crests of the Embankments at 99.338 km, 100.121 km and 100.425 km *Install 99.338 km prior to 900 metres of extraction of LW S1A* *Install 100.121 km prior to start of LW S3A* *Install 100.425 km prior to start of LW S3A*	Every 15 minutes Operating as per timings in Drawings Nos. MSEC1201-04-1A to 7A. Alarmed when track above each culvert is in Stage 2	Globetech
		Inclinometer surveys of the Embankments at 99.338 km, 100.121 km and 100.425 km *Install 99.338 km prior to 600 metres of extraction of LW S1A* *Install 100.121 km prior to start of LW S3A* *Install 100.425 km prior to start of LW S3A*	Monthly when track above culvert is in Stage 1 and Stage 2	TC
		Automated, continuously operating water level sensors at culvert inlets to Embankments at 99.338 km, 100.121 km and 100.425 km *Install 99.338 km prior to 600 metres of extraction of LW S1A* *Install 100.121 km prior to start of LW S3A* *Install 100.425 km prior to start of LW S3A*	Every 15 minutes Operating as per timings in Drawings Nos. MSEC1201-04-1A to 7A. Alarmed when track above culvert is in Stage 2	Globetech
		Visual inspection of culverts and embankments by geotechnical engineer	Monthly when track above culvert is in Stage 1 Weekly when track above culvert is in Stage 2	PSM
		CUTTINGS		
		Absolute 3D and 2D surveys along monitoring line along the railway	Absolute 3D monthly and 2D weekly as described for railway track	SRS
		Absolute 3D surveys every 20 metres along the crests and/or toes of the cuttings *Install Cutting at 99.690 km prior to 450 metres of extraction of LW S2A* *Install Cutting at 100.700 km prior to start of LW S4A* *Install Cutting at 101.162 km prior to start of LW S5A*	Monthly when section of track is in Stage 1 Weekly when section of track is in Stage 2 End of LWs S1A-S7A	SRS
		Visual inspection of cuttings by geotechnical engineer	Monthly when section of track is in Stage 1 Weekly when section of track is in Stage 2	PSM

RISK ISSUE	TRIGGER	CONTROL PROCEDURES	TIMING & FREQ	BY WHOM?
	GREEN	**BRIDGES**		
		Pre-mining inspection and structural assessment of Bridges	Complete	JMA
		Geological inspection and mapping at Railway Viaduct, Remembrance Drive Bridge over Bargo River and Bargo River Road Overbridge (Potter's Cutting)	Complete	Newcastle Geotech
		Review by Bridge Technical Committee and modify planned management and monitoring measures for Railway Viaduct, Remembrance Drive Bridge over Bargo River, Bargo River Road Overbridge (Potter's Cutting) and Wellers Road Overbridge and implement, if required	Complete	Bridge Technical Committee / Tahmoor Coal
		Brief ARTC on planned management and monitoring measures for Railway Viaduct, Remembrance Drive Bridge over Bargo River, Bargo River Road Overbridge (Potter's Cutting) and Wellers Road Overbridge	Complete	Tahmoor Coal
		Continuous GNSS monitoring for S11, S12 (Railway Viaduct) and S15 (Wellers Road Overbridge) as shown in Drawing No. MSEC1201-03	GNSS units installed Continuous readings, with data averaged over 24 hours and recorded once per day until end of LW S7A.	Tahmoor Coal (Unit Zero)
		Conduct Absolute 3D survey of structure and ground marks on the Railway Viaduct and Remembrance Drive Bridge over Bargo River as per Drawing No. MSEC1201-13	Complete	Tahmoor Coal (SRS)
		Precision 2D survey of closure between ground marks located in stable ground at both ends of the Railway Viaduct and Remembrance Drive Bridge over Bargo River	Complete	SRS
		Baseline detailed visual inspections of Railway Viaduct by UAV	Complete	TC
		Baseline laser scan of Railway Viaduct and Remembrance Drive Bridge over Bargo River	Complete	TC
		Monitoring of existing cracks with crack gauges on Railway Viaduct	Complete	TC
		Measure gap between deck and northern abutment of Remembrance Drive Bridge over Bargo River	Complete	Tahmoor Coal (SRS)
		Conduct Local 3D survey of structure and ground marks on the Bargo River Road Overbridge (Potter's Cutting) as per Drawing No. MSEC1201-14, with one mark on the Bridge to be surveyed in Absolute 3D	Complete	Tahmoor Coal (SRS)
		Monitoring of existing cracks with crack gauges on Bargo River Road Overbridge (Potter's Cutting)	Complete	TC
		Conduct Local 3D survey of structure and ground marks on the Wellers Road Overbridge as per Drawing No. MSEC1201-15	Baseline survey complete. Monthly after 200m extraction of LWs S4A to S7A End of LWs S1A to S7A.	Tahmoor Coal (SRS)
		Automated, continuous monitoring of laser distancemeters and draw wire displacement sensors along and across the Overbridge at base of arch	Installed and operating Readings every 15 minutes	Tahmoor Coal (Sweeting Consulting)
		Monitoring of existing cracks with crack gauges on Wellers Road Overbridge	Install and baseline survey prior to LW S4A. Monthly after 200m extraction of LWs S4A to S7A End of LWs S1A to S7A.	TC

Table A. 1 Risk Control Procedures for LWs S1A-S7A (continued)

RISK ISSUE	TRIGGER	CONTROL PROCEDURES	TIMING & FREQ	BY WHOM?
General Procedures (continued)				
	GREEN	**COAL CONVEYOR CROSSING (complete)**		
		Survey horizontal distance between conveyor trestles on either side of Railway	Complete	SRS
		Automated, continuously operating laser distancemeter between conveyor trestles on either side of Railway	Installed Hourly	SweetingConsulting
		Visual inspections of conveyor crossing	Daily when track is in Stage 2	RMC
		OTHER MEASURES		
		Undertake investigations as required to assist in identifying potential locations of non-conventional movement. Reconsider management measures in light of new information that becomes available.	Ongoing	RMG
		Dilapidation inspections	Complete	Various
		Standard ARTC maintenance and control procedures - Twice weekly track patrol - AK track recording car - Base Operating Standards Mandatory Responses - Driver reports and temporary speedboards - Signalling and Communications procedures - Ultrasonic rail test (high rail)	As per ARTC procedures	ARTC
		Follow Railway Maintenance Plan including - quarterly manual non-destructive testing of expansion switches - switch inspections and maintenance - clip inspections and maintenance Refer Section 5.8 for details	As per Railway Maintenance Plan	RMC
		Brief and train: - Tahmoor Coal Control Room operators - Relevant ARTC staff Refer Section 5.8 for details	Prior to 900 m of extraction of LW S1A Brief and train new personnel as req'd	Robinson Rail
		Check and Audit maintenance and monitoring system performance	Periodically as determined by RMG	RMG
		Analyse and report results to RMG	Monthly when section of track is in Stage 1 Weekly when section of track is in Stage 2	Section 6.5
		RMG discuss results and consider whether any additional management measures are required	Monthly when section of track is in Stage 1 Weekly when section of track is in Stage 2 or as required by RMG	RMG
		RMG discuss progress with MSO and ONRSR	As required	RMG

Note: Unless specified above, each control procedure will continue until such time that the criteria for Stage 3 (post-active subsidence period) are met, as described in Section 5.4: The RMG may extend the monitoring period beyond the timing and frequency described based on assessment of actual monitoring data.

Table A. 1 Risk Control Procedures for LWs S1A-S7A (continued)

RISK ISSUE	TRIGGER	CONTROL PROCEDURES	TIMING & FREQ	BY WHOM?
Track Geometry exceeds ARTC National Code of Practice, leading to: • Unplanned maintenance response • Temporary speed restrictions • Track closure • Derailment **TRACK GEOMETRY TRIGGERS** **Units in mm** / **Difference from Design Cant** / **Twist** / **Top Mid-ordinate Vertical Deviation from Design Offset** / **Alignment Mid-ordinate Horizontal Deviation from Design Offset in a 10m Chord** **GREEN**: Tangents & R>2000m 0 to < 40; R < 2000m 0 to < 14 / 2m Chord 0 to < 16; 14m Chord 0 to < 40 / 6m Chord 0 to < 26; 20m Chord Inertial 0 to < 28; Krab 0 to < 39 / 0 to < 24 **BLUE**: Tangents & R>2000m ≥ 40 to < 50; R < 2000m (insufficient cant) ≥ 14 to < 20; R < 2000m (excess cant) ≥ 14 to < 50 / 2m Chord ≥ 16 to < 18; 14m Chord ≥ 40 to < 46 / 6m Chord ≥ 26 to < 29; 20m Chord Inertial ≥ 28 to < 32; Krab ≥ 39 to < 44 / ≥ 24 to < 34 **YELLOW**: Tangents & R>2000m ≥ 50 to < 75; R < 2000m (insufficient cant) ≥ 20 to < 40; R < 2000m (excess cant) ≥ 50 to < 75 / 2m Chord ≥ 18 to < 20; 14m Chord ≥ 46 to < 52 / 6m Chord ≥ 29 to < 32; 20m Chord Inertial ≥ 32 to < 35; Krab ≥ 44 to < 49 / ≥ 34 to < 44 **RED**: Tangents & R>2000m ≥ 75; R < 2000m (insufficient cant) ≥ 40; R < 2000m (excess cant) ≥ 75 / 2m Chord ≥ 20; 14m Chord ≥ 52 / 6m Chord ≥ 32; 20m Chord Inertial ≥ 35; Krab ≥ 49 / ≥ 44	**GREEN**	Follow general procedures (including track geometry monitoring)	-	-
	BLUE	Contact RRG and arrange teleconference	Within 15 minutes of determining exceedence of trigger level	Section 6.2 and Section 6.3
		RRG undertake following action(s): - investigate 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 resurface the track - consider whether any other additional management measures are req'd	RRG meet via teleconference within 15 minutes of notification of exceedence of trigger level	RRG
		Inspect track at trigger point for visual signs of impact unless RRG is confident that cause of trigger cannot be due to physical damage to the railway Remain on site until status returns to GREEN level	Immediately following assessment of RRG via teleconference and arrive within 2 hours, if req'd Otherwise within 24 hours	RMC
		Report details of exceedence of trigger level and actions undertaken	Within one week	PCE
	YELLOW	Contact RRG and arrange teleconference	Within 15 minutes of determining exceedence of trigger level	Section 6.2 and Section 6.3
		Contact Train Control & introduce track speed of 20km/h. Inspect track at trigger point.	Immediately	RMC
		RRG undertake following action(s): - investigate cause and assess monitoring data for trends and forecast if and/or when the RED trigger level might be exceeded - decide whether to increase survey and/or inspection frequencies - decide whether to resurface the track - decide whether any other additional management measures are req'd - decide whether to introduce speed restrictions - consider whether to slow or stop mining if impact to rail operations is unacceptable to ARTC	RRG meet via teleconference within 15 minutes of notification of exceedence of trigger level	RRG
		Report exceedence of trigger level & RRG decisions to RMG, ARTC, MSO, ONRSR and SA NSW	Within 24 hours if the alarm is real	TC
		Report details of exceedence of trigger level and actions undertaken	Within one week	PCE
	RED	Contact RRG and arrange teleconference	Within 15 minutes of determining exceedence of trigger level	Section 6.2 and Section 6.3
		Stop trains and implement mandatory responses as required. Inspect track at trigger point.	Immediately	RMC
		RRG undertake following action(s): - investigate cause - decide whether to resurface the track - decide whether any other additional management measures are req'd - decide whether to introduce speed restrictions - consider whether to recommend to TC senior management to slow or stop mining if impact to rail operations is unacceptable to ARTC	RRG meet via teleconference within 15 minutes of notification of exceedence of trigger level	RRG
		Report exceedence of trigger level & RRG decisions to RMG, ARTC, MSO, ONRSR and SA NSW.	Within 24 hours if the alarm is real	TC
		Report details of exceedence of trigger level and actions undertaken	Within one week	PCE

Table A. 1 Risk Control Procedures for LWs S1A-S7A (continued)

RISK ISSUE	TRIGGER	CONTROL PROCEDURES	TIMING & FREQ	BY WHOM?
Mining induced ground movements causes excessive compressive stress resulting in either misalignment of track, broken rail or curve pull-in potentially leading to: • Unplanned maintenance response • Temporary speed restrictions • Track closure • Side swipe • Derailment This risk issue applies to standard CWR track or track with expansion switches and zero toe load clips or **Zero-toe load clips jam** resulting in increase in rail stress potentially leading to: • Unplanned intervention on track ‘	GREEN	Follow general procedures (including rail stress, rail creep and switch displacement monitoring)	-	-
		Install, operate and monitor track expansion system (Note that CWR track will be managed until the track expansion system is installed).	Switches ES4 to ES7 installed for LW S4A. Install ES8 as required in Table 3.3. Install ZTL clips prior to longwall face approaching within 400 m of each switch after monitoring system is commissioned	RMC
	BLUE	Automatically notify RRG as per Alarm Notification Protocol	Within 15 minutes	Section 6.2
		Immediately inspect track at trigger point for visual signs of impact if on site at time of alarm	Within 15 minutes	RMC
		RRG undertake following action(s): - investigate 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 adjust the track or expansion switches - consider whether any other additional management measures are req’d	RRG meet via teleconference within 15 minutes of alarm notification	RRG
		Inspect track at trigger point for visual signs of impact unless RRG is confident that cause of trigger cannot be due to physical damage to the railway Remain on site until status returns to GREEN level	Immediately following assessment of RRG via teleconference and arrive within 2 hours, if req’d Otherwise within 24 hours	RMC
		Report details of alarm and actions undertaken	Within one week	PCE
	YELLOW	Automatically notify RRG as per Alarm Notification Protocol	Within 15 minutes	Section 6.2
		Contact Train Control & introduce track speed of 20km/h. Inspect track at trigger point.	Immediately	RMC
		RRG undertake following action(s): - contact Train Control & introduce track speed of 20km/h if Track Certifier is not on site unless RRG is confident the cause of trigger cannot be due to physical damage to the railway within 5 minutes of alarm notification - investigate cause and assess monitoring data for trends and forecast if and/or when the RED trigger level might be exceeded - decide whether to increase survey and/or inspection frequencies - decide whether to adjust the track or expansion switches - decide whether any other additional management measures are req’d - decide whether to introduce speed restrictions - consider whether to slow or stop mining if impact to rail operations is unacceptable to ARTC	RRG meet via teleconference within 15 minutes of alarm notification	RRG
		Report exceedence of trigger level & RRG decisions to RMG, ARTC, MSO, ONRSR and SA NSW	Within 24 hours if the alarm is real	TC
		Report details of alarm and actions undertaken	Within one week	PCE
	RED	Automatically notify RRG as per Alarm Notification Protocol	Within 15 minutes	Section 6.2
		Stop trains and implement mandatory responses as required unless RRG is confident the cause of trigger cannot be due to physical damage to the railway within 5 minutes of alarm notification. Inspect track at trigger point.	Immediately	RMC
		RRG undertake following action(s): - investigate cause - advise ARTC Area Manager Ingleburn that trains can proceed under caution at 20km/h prior to Track Certifier arriving on site if confident that cause of trigger cannot be due to physical damage to the railway - decide whether to adjust the track or expansion switches - decide whether any other additional management measures are req’d - decide whether to introduce speed restrictions - consider whether to recommend to TC senior management to slow or stop mining if impact to rail operations is unacceptable to ARTC	RRG meet via teleconference within 15 minutes of alarm notification	RRG
		Report exceedence of trigger level & RRG decisions to RMG, ARTC, MSO, ONRSR and SA NSW	Within 24 hours if the alarm is real	TC
		Report details of alarm and actions undertaken	Within one week	PCE

RAIL STRESS TRIGGERS

	Tension		Compression	
	Rail Stress in CWR	Rail Stress in Free Rail	Rail Stress in CWR	Rail Stress in Free Rail
Units	MPa	MPa	MPa	MPa
GREEN	0 to <114.2	0 to < 46.4	0 to > -83.3	0 to > -46.4
BLUE	≥ 114.2 to < 123.8	≥ 46.4 to < 123.8	≤ -83.3 to > -92.8	≤ -46.4 to > -92.8
YELLOW	≥ 123.8 to < 128.5	≥ 123.8 to < 128.5	≤ -92.8 to > -97.6	≤ -92.8 to > -97.6
RED	≥ 128.5	≥ 128.5	≤ -97.6	≤ -97.6

Note: Blue trigger levels transition between CWR and Free Rail sections, as recommended by the RMG.

Table A. 1 Risk Control Procedures for LWs S1A-S7A (continued)

<table>
<tr><th>RISK ISSUE</th><th>TRIGGER</th><th>CONTROL PROCEDURES</th><th>TIMING & FREQ</th><th>BY WHOM?</th></tr>
<tr><td rowspan="5">Switch fails potentially leading to:
Unplanned maintenance response
Speed restrictions
Track closure
Derailment
or
Switch exceeds operational limits due to excessive differential subsidence movements potentially leading to:
Intervention on track
Speed restrictions
TYPE 5 EXPANSION SWITCH DISPLACEMENT TRIGGERS
(TYPE APPROVAL 15/34296)<table><tr><th></th><th>Switch Opening</th><th>Switch Closure</th></tr><tr><th>Units</th><th>mm</th><th>mm</th></tr><tr><td>GREEN</td><td colspan="2">Centre ± 135</td></tr><tr><td>BLUE</td><td>Centre ≤ -135</td><td>Centre ≥ 135</td></tr><tr><td>YELLOW</td><td>N/A due to stop blocks</td><td>N/A due to stop blocks</td></tr><tr><td>RED</td><td>N/A due to stop blocks</td><td>N/A due to stop blocks</td></tr></table>Note: Expansion switch triggers apply to each switch blade and are measured from edge of base plate.</td><td>GREEN</td><td>Follow general procedures (including rail stress, rail creep and switch displacement monitoring, maintenance plan)</td><td>-</td><td>-</td></tr>
<tr><td rowspan="4">BLUE</td><td>Automatically notify RRG as per Alarm Notification Protocol</td><td>Within 15 minutes</td><td>Section 6.2</td></tr>
<tr><td>Immediately inspect track at trigger point for visual signs of impact if on site at time of alarm</td><td>Within 15 minutes</td><td>RMC</td></tr>
<tr><td>RRG undertake following action(s):
- investigate 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 adjust the track or expansion switches
- consider whether any other additional management measures are req’d</td><td>RRG meet via teleconference within 15 minutes of alarm notification</td><td>RRG</td></tr>
<tr><td>Inspect track at trigger point for visual signs of impact unless RRG is confident that cause of trigger cannot be due to physical damage to the railway
Remain on site until status returns to GREEN level</td><td>Immediately following assessment of RRG via teleconference and arrive within 2 hours, if req’d
Otherwise within 24 hours</td><td>RMC</td></tr>
<tr><td>Report details of alarm and actions undertaken</td><td>Within one week</td><td>PCE</td></tr>
<tr><td rowspan="2">Braking / acceleration loads resulting in rail creep that potentially leads to intervention on track (limits function of expansion switch)</td><td rowspan="2">GREEN</td><td>Follow general procedures (including rail stress, rail creep and switch displacement monitoring)</td><td>-</td><td>-</td></tr>
<tr><td>Install anchor points as per design</td><td>-</td><td>RMC</td></tr>
<tr><td>Switch allows excessive opening of a broken rail underneath rail traffic potentially leading to derailment</td><td>GREEN</td><td>Follow general procedures (including quarterly non-destructive testing of welds, maintenance plan). Note that rails are in zero-toe load track, which has effectively unstressed the rail and should not break.
Blue, Yellow and Red triggers and responses under “Switch Failure” also apply to this risk.</td><td>-</td><td>-</td></tr>
<tr><td>Switch becomes unserviceable due to uneven wear, inherent design or quality of steel</td><td>GREEN</td><td>Follow general procedures (including maintenance plan).</td><td>-</td><td>-</td></tr>
<tr><td rowspan="4">Switch or switches destroyed due to unrelated derailment, such that switches are removed and replaced by straight rail, potentially leading to train delays due to undertaking frequent adjustments of CWR track in response to continued mine subsidence movements</td><td rowspan="2">GREEN</td><td>Follow general procedures, including standard ARTC wayside detection, redundant monitoring controls (ground survey, track inspections, amber track geometry and automated monitoring systems) and on call maintenance.</td><td>-</td><td>-</td></tr>
<tr><td>Store critical spare parts on site</td><td>Prior to subsidence</td><td>RMC</td></tr>
<tr><td rowspan="2">Switch or switches destroyed by unrelated derailment</td><td>Notify RMG in accordance with Alarm Notification Protocol</td><td>Immediately</td><td>RMC</td></tr>
<tr><td>RMG meet and consider in consultation with ARTC Incident Management Team, MSO and ONRSR the implementation of additional control measures. These may include:
- repair switches and replace with spare parts as required
- introduce speed restrictions once track is re-opened by ARTC
- consolidate all remaining operational switches to one track and conduct single line working
- spread out all remaining operational switches on both tracks and reassess with smaller trigger levels for switch displacement due to longer free rail lengths
- increase monitoring frequency
- regular cut and re-stress of CWR track based on ground monitoring data
- consider need to stop or slow longwall progress until switches are operational</td><td>Within 24 hours</td><td>RMG</td></tr>
<tr><td rowspan="3">Damage to track circuits, from installation of expansion switches potentially leading to:
Signal failure leading to train delays</td><td>GREEN</td><td>Install appropriate bonding</td><td>During installation of expansion switches</td><td>RMC</td></tr>
<tr><td rowspan="2">Bonding damaged</td><td>Repair bonding</td><td>As required</td><td>RMC</td></tr>
<tr><td>Report impact and actions taken to RMG, ARTC, MSO & ONRSR</td><td>Within one week</td><td>RMC</td></tr>
<tr><td rowspan="3">Damage to signals, potentially leading to:
Signal failure leading to train delays</td><td>GREEN</td><td>Follow general procedures (including visual inspections within rail corridor)</td><td></td><td></td></tr>
<tr><td rowspan="2">Signals damaged</td><td>Repair signals</td><td>As required</td><td>RMC</td></tr>
<tr><td>Report impact and actions taken to RMG, MSO, ONRSR & SA NSW</td><td>Within one week</td><td>TC</td></tr>
</table>

© TAHMOOR COAL PTY LTD AUGUST 2025 | REPORT NUMBER MSEC1201 | REVISION D

Table A. 1 Risk Control Procedures for LWs S1A-S7A (continued)

RISK ISSUE	TRIGGER	CONTROL PROCEDURES	TIMING & FREQ	BY WHOM?
Reduction in track centres at 98.620 km, 99.600 km and 101.200 km, where centre are currently tight	**GREEN**	Follow general procedures (including ground surveys, track centre surveys at 98.620 km, 99.600 km and 101.200 km and visual inspections within rail corridor)	-	-
	Reduction in track centres > 5 mm or Change in Cant in either track > 5 mm	RMG meet and consider whether any additional management measures are required, including: - detailed measurement of track centres - locally redesign track alignment - resurface track in accordance with redesign	As required	RMG
		Report details of RMG decision and actions undertaken	Within one week	Globetech
Loss of track geometry due to **localised ponding, or** **Loss in drainage grade** of culverts due to mining-induced tilts, potentially leading to: • Unplanned maintenance response	**GREEN**	Follow general procedures (including visual inspections within rail corridor)	-	-
	Ponding observed	Regrade drainage line	As required	RMC
		Report impact and actions taken to RMG	Within one week	RMC
Damage to Formation due to mining-induced surface cracks forming a bog hole in formation causing a loss of track geometry, potentially leading to: • Unplanned maintenance response	**GREEN**	Follow general procedures (including visual inspections within rail corridor)	-	-
	Surface crack observed	Repair crack or regrade drainage line or repair sewer pipes	As required	RMC
		Report impact and actions taken to RMG	Within one week	RMC
False alarms from automated monitoring systems potentially leading to: • Unnecessary speed restrictions	**GREEN**	Follow general procedures (including multiple redundancies in monitoring system)	-	-
		Develop maintenance, testing and audit program for automated monitoring systems	Prior to subsidence	Globetech/ PCE-
		Develop alarm programming methods to filter obvious false alarms (refer Section 5.5.5). Reduce number of gauges with alarms enabled, where possible in accordance with the Management Plan.	Prior to subsidence	Globetech / RMG
	Excessive false alarms occur	RMG meet and consider whether any additional management measures are required, including: - reduce incidence of false alarms - replace or adjust gauge or cable - increase monitoring and reporting procedures	As required	RMG
		Report details of RMG decision and actions undertaken	Within one week	Globetech
Loss of all or part of automated monitoring system due to power surge, lightning strike, vandalism, power/comms failure, trackwork	**GREEN**	Follow general procedures (including multiple redundancies in monitoring system)	-	-
		Install back-up systems for power (battery), dual SIM, internet link to Tahmoor Coal Control Centre	Prior to subsidence	Globetech
		Program alarm alerts at off-site computer	Prior to subsidence	Globetech
		Store spare parts on site (gauges, loggers, batteries, router)	Prior to subsidence	Globetech
	GREY	Notify RRG in accordance with Alarm Notification Protocol	Within 15 minutes	Section 6.2
		Inspect track at trigger point if on site at time of alarm	Within 15 minutes	RMC
		RRG meet and consider whether any additional management measures are required, including: - investigate cause - install replacement battery - install secondary wireless network card - replace damaged components - increase monitoring and reporting procedures	RRG meet via teleconference within 15 minutes of alarm notification	RRG
		Inspect track at trigger point for visual signs of impact unless RRG is confident that cause of trigger cannot be due to physical damage to the railway Remain on site until status returns to GREEN level or until approved by RRG	Immediately following assessment of RRG via teleconference and arrive within 2 hours, if req'd Otherwise within 24 hours	RMC
		Report details of alarm and actions undertaken	Within one week	Globetech
False readings due to installation problem, failed gauge, software failure, programming error	**GREEN**	Follow general procedures (including multiple redundancies in monitoring system, regular analysis cross checking and reporting)	-	-
	False readings are found	Repair cause of false reading	As required	Globetech
		Report details of RMG decision and actions undertaken	Within one week	Globetech

Table A. 1 Risk Control Procedures for LWs S1A-S7A (continued)

RISK ISSUE	TRIGGER	CONTROL PROCEDURES	TIMING & FREQ	BY WHOM?
Damage to cutting face potentially leading to: • Blockage of drainage line	**GREEN**	Follow general procedures (including dilapidation survey, visual inspections of cutting, and ground surveys)	-	-
		Clear debris from cesses at base of batter slopes	As required	RMC
	Instability observed to cuttings	Notify RMG in accordance with Alarm Notification Protocol	As required by Track Certifier depending on severity of impact	RMC
		RMG meet and consider whether any additional management measures are required, which may include: - undertake geotechnical inspection - increase monitoring and reporting procedures - clear debris from cess at base of cutting faces	RMG meet via teleconference as required by Track Certifier depending on severity of impact	RMG
		Report impact and actions taken to ARTC, MSO & ONRSR	Within one week	TC
	Cutting closure exceeds 20 mm	Notify RMG in accordance with Alarm Notification Protocol	Within one week	RMC
		RMG meet and consider whether any additional management measures are required, which may include: - undertake geotechnical inspection - increase monitoring and inspections for potential impacts on track geometry and - increase reporting procedures	RMG meet via teleconference within one week	RMG
		Report trigger exceedence and actions taken to ARTC, MSO & ONRSR	Within one week	TC
Damage to optical fibre cable, potentially leading to: • Loss of security monitoring • Lack of train information service • Lack of other commercial use	**GREEN**	Follow general procedures (including visual inspections within rail corridor)	-	-
	Ground strain exceeds 3 mm/m (tensile or compressive	Notify RMG	As required by RMC depending on severity of impact	RMC
		RMG meet and consider whether any additional management measures are required, which may include: - undertake inspection by signalling expert - increase monitoring and reporting procedures - consider undertaking additional tests on optical fibre cable - consider exposure of cable and provide freedom of cable movement in vicinity of ground deformation	As required	RMG
		Report impact and RMG decisions to ARTC, MSO, ONRSR & SA NSW	Within one week	TC
	Cable damage	Repair cable	As required	RMC
		Report impact and actions taken to RMG, ARTC, MSO, ONRSR & SA NSW	Within one week	TC
Breakage of buried copper cable, potentially leading to: • Signal failure leading to train delays • Wrong Side Failure	**GREEN**	Follow general procedures (including dilapidation survey, visual inspections, ground survey, standard ARTC 'failsafe' signalling system, automated monitoring of signal)	-	-
		Inspect condition of cable	Prior to 900m of extraction of LW S1A	TC
		Conduct electrical tests on spare cores	Prior to 900m of extraction of LW S1A End of LWs S1A-S7A	TC
	Ground strain exceeds 3 mm/m (tensile or compressive)	Notify RMG	As required by RMC depending on severity of impact	RMC
		RMG meet and consider whether any additional management measures are required, which may include: - undertake inspection by signalling expert - increase monitoring and reporting procedures - consider undertaking additional electrical tests on signal cable - consider exposure of cable to provide freedom of cable movement in vicinity of ground deformation	As required	RMG
		Report impact and actions taken to RMG, ARTC, MSO, ONRSR & SA NSW	Within one week	MSEC
	Cable damage	Repair cable	As required	RMC
		Report impact and actions taken to RMG, ARTC, MSO, ONRSR & SA NSW	Within one week	MSEC

Table A. 1 Risk Control Procedures for LWs S1A-S7A (continued)

RISK ISSUE	TRIGGER	CONTROL PROCEDURES	TIMING & FREQ	BY WHOM?
Damage to culverts or culvert floor potentially leading to: • Changes in track geometry resulting from loss of support, leading to intervention • Development of sinkhole and undermining track • Loss of culvert integrity, leading to intervention • Cracking and deformation	**GREEN**	Follow general procedures (including dilapidation survey, ground survey, visual inspections of culverts, track geometry monitoring)	-	-
		De-vegetation of the embankment batters and maintain culverts to keep them free flowing	Before track above each culvert is in Stage 1	TC
		Install above track baulks above culverts	Before track above each culvert is in Stage 2	TC
		Seal gap between the brick arch culvert headwall and concrete pipe extension on the Down side of Culvert at 99.035 km and repair sinkhole	Complete	TC
		Reinstate concrete outlet pipe to Culvert at 99.338 km	Complete	TC
		Seal gap between the brick arch culvert headwall and concrete pipe extension on the Down side of Culvert at 100.121 km	Prior to 200m of extraction of LW S4A	TC
	Damage to culvert such as cracking or gaps found at culvert joints or evidence of piping	Notify RMG and ARTC Structures Specialist	As required by RMC depending on severity of impact	RMC
		RMG meet and consider whether any additional management measures are required, which may include: - undertake structural inspection - increase monitoring and reporting procedures - repair culvert or provide additional support to culvert - strengthen track baulk	As required	RMG
		Report impact and RMG decisions to ARTC, MSO, ONRSR and SA NSW	Within one week	TC
		Report details of impact and actions undertaken	Within one week	MSEC
Embankments • Embankment slope failure or collapse of embankment caused by water saturation of fill due to blockage of culvert leading to build up of water, surcharge from impounded water and saturation of fill due to prolonged rainfall. • Displacement / failure of embankment leading to loss of track support. • Surface cracking of crest and embankment batters due to mining-induced vertical or horizontal ground movements, leading to erosion of batters and long-term embankment instability. • Cracking within embankment due to mining-induced vertical or horizontal ground movements and build up of water within embankment, flowing through cracks, leading to piping failure and formation of sink holes under the track • Cracking of culvert causing loss of fill due to pot holing (vertical) due to mining-induced ground movements, particularly valley closure, leading to development of sinkhole and undermining track **Note:** Refer to other sections of the Risk Control Procedures for managing risks associated with changes in track geometry or changes to culverts	**GREEN**	Follow general procedures (including ground surveys, visual inspections, and for Embankments at 99.338 km, 100.121 km and 100.425 km: extensometers, manual inclinometers and culvert water level gauges).	-	-
		Clear vegetation on the embankment batter and maintain culverts to keep them clear of debris to facilitate monitoring of the embankments and culverts.	Before track above each culvert is in Stage 1	-
	LEVEL 1 **Rate of change in crest extensometer distance exceeds 10 mm within 2 hours** **or** **Crest extensometer or ground surveys across crest measure extension of 25 mm** **or** **Visual signs of distress to embankment, such as tension crack along edge of embankment / access road**	For alarms from extensometer: Inspect embankment at trigger point for visual signs of impact.	Immediate callout and arrive as soon as reasonably practicable (target less than 2 hours)	RMC
		If tension crack observed along edge of embankment, Track Certifier to remain on site until such time that RMG agree that continuous 24 hour / 7 days a week presence by Track Certifier is not required.	Immediately following identification of tension crack	RMC
		Undertake additional geotechnical inspection and appraisal	Within 24 hours	PSM
		RSRG meet and review latest monitoring information from automated and manually acquired data for the embankment, culvert and the track, inspections by geotechnical engineer and Track Certifier, and latest weather forecasts. RSRG consider whether any additional management measures are required, which may include: - fill and seal cracks and/or regrade drainage line - increase monitoring and reporting procedures - arrange additional surveys to monitor potential displacement of embankment material	Within 15 minutes	RSRG
		Report trigger exceedance and actions taken to RMG, ARTC, MSO & ONRSR in Railway Status Report	Within 24 hours if tension crack observed Otherwise within one week	TC

Table A. 1 Risk Control Procedures for LWs S1A-S7A (continued)

RISK ISSUE	TRIGGER	CONTROL PROCEDURES	TIMING & FREQ	BY WHOM?
Embankments • Embankment slope failure or collapse of embankment caused by water saturation of fill due to blockage of culvert leading to build up of water, surcharge from impounded water and saturation of fill due to prolonged rainfall. • Displacement / failure of embankment leading to loss of track support. • Surface cracking of crest and embankment batters due to mining-induced vertical or horizontal ground movements, leading to erosion of batters and long-term embankment instability. • Cracking within embankment due to mining-induced vertical or horizontal ground movements and build up of water within embankment, flowing through cracks, leading to piping failure and formation of sink holes under the track • Cracking of culvert causing loss of fill due to pot holing (vertical) due to mining-induced ground movements, particularly valley closure, leading to development of sinkhole and undermining track **Note:** Refer to other sections of the Risk Control Procedures for managing risks associated with changes in track geometry or changes to culverts	**<u>LEVEL 2</u>** **Rate of change in crest extensometer distance exceeds 20 mm within 2 hours or Tension crack observed along the shoulder of the embankment within 4 m of the track, or across the access road, or slide in the crest of the embankment along the access road within 4 m of the track**	Contact Train Control & introduce track speed of 20km/h. If not already on site at time of alarm, inspect track and embankment at trigger point. Remain on site until such time that RMG agree that continuous 24 hour / 7 days a week presence by Track Certifier is not required.	Immediately If not on site at time of alarm, immediate callout and arrive as soon as reasonably practicable (target less than 2 hours)	RMC
		Undertake additional geotechnical inspection and appraisal	As soon as reasonably practicable	PSM
		RSRG meet and review latest monitoring information from automated and manually acquired data for the embankment, culvert and the track, inspections by geotechnical engineer and Track Certifier, and latest weather forecasts. RSRG consider whether any additional management measures are required, which may include: - stop trains - temporarily support the ballast shoulder by placing material on the crest of the embankment - place permanent or temporary fill / rock spall to the base of the embankment - tip fill material into scarp of slide until settlement effectively ceases - increase monitoring and reporting procedures - arrange additional surveys to monitor displacement, if required - consider whether to recommend additional Governance Meeting between Tahmoor Coal and ARTC (emergency response)	Within 15 minutes	RSRG
		Report trigger exceedance and actions taken to RMG, ARTC, MSO & ONRSR	Within 24 hours	TC
	<u>LEVEL 3</u> **Tension crack observed across the access road and under the track, or slump removes access road support for the embankment, or a report of depression in the track by train driver**	Contact Train Control & introduce track speed of 20km/h. If not already on site at time of alarm, inspect track and embankment at trigger point. Remain on site until such time that RMG agree that continuous 24 hour / 7 days a week presence by Track Certifier is not required.	Immediately If not on site at time of alarm, immediate callout and arrive as soon as reasonably practicable (target less than 2 hours)	RMC
		Undertake additional geotechnical inspection and appraisal	As soon as reasonably practicable	PSM
		RSRG meet and review latest monitoring information from automated and manually acquired data for the embankment, culvert and the track, inspections by geotechnical engineer and Track Certifier, and latest weather forecasts. RSRG consider whether any additional management measures are required, which may include: - stop trains - temporarily support the ballast shoulder by placing material on the crest of the embankment - place permanent or temporary fill / rock spall to the base of the embankment - tip fill material into scarp of slide until settlement effectively ceases - add ballast to the railway track and lift track to restore track geometry - provide additional forms of track support under the track as may be appropriate or feasible - increase monitoring and reporting procedures - arrange additional surveys to monitor displacement, if required - consider whether to recommend additional Governance Meeting between Tahmoor Coal and ARTC (emergency response)	Within 15 minutes	RSRG
		Report trigger exceedance and actions taken to RMG, ARTC, MSO & ONRSR	Within 24 hours	TC

Table A. 1 Risk Control Procedures for LWs S1A-S7A (continued)

RISK ISSUE	TRIGGER	CONTROL PROCEDURES	TIMING & FREQ	BY WHOM?
Embankments • Embankment slope failure or collapse of embankment caused by water saturation of fill due to blockage of culvert leading to build up of water, surcharge from impounded water and saturation of fill due to prolonged rainfall. • Displacement / failure of embankment leading to loss of track support. • Surface cracking of crest and embankment batters due to mining-induced vertical or horizontal ground movements, leading to erosion of batters and long-term embankment instability. • Cracking within embankment due to mining-induced vertical or horizontal ground movements and build up of water within embankment, flowing through cracks, leading to piping failure and formation of sink holes under the track • Cracking of culvert causing loss of fill due to pot holing (vertical) due to mining-induced ground movements, particularly valley closure, leading to development of sinkhole and undermining track **Note:** Refer to other sections of the Risk Control Procedures for managing risks associated with changes in track geometry or changes to culverts	**Forecast of extreme wet weather, as observed by RMG or notified by ARTC to RMC**	RMG meet and review latest monitoring information from automated and manually acquired data for the embankment, culverts and the track, inspections by geotechnical engineer and Track Certifier, and details of extreme wet weather forecast. RMG consider whether any additional management measures are required, which may include: - sealing cracks that may have developed during mining, prior to the weather event - additional inspection by geotechnical engineer to assess whether additional work may be required prior to weather event - additional inspection or monitoring equipment to prepare for weather event - bring forward ground surveys if their scheduled timing coincides with weather event - develop extreme wet weather plan, which may include arranging for Track Certifier on site during weather event, periodic checking of automated monitoring data during event, reporting and communication protocol during weather event.	As soon as reasonably practicable depending on severity and timing of weather event (target less than 24 hours)	RMG
		Report outcome of weather event to RMG, ARTC, MSO & ONRSR in Railway Status Report	Within one week	MSEC
	Water level at Culvert Inlets at 99.338 km, 100.121 km and 100.425 km reaches culvert obvert	Inspect embankment for flooding and condition of embankment and culvert	Immediate callout as soon as reasonably practicable (target less than 2 hours)	RMC
		RRG meet and review latest monitoring information from automated and manually acquired data for the embankment, culvert and the track, inspections by geotechnical engineer and Track Certifier, current weather observations and details of latest weather forecast. RRG consider whether any additional management measures are required, which may include: - continue visual monitoring by RMC until end of weather event - remove cause of blockage of culvert (if any and if possible) - decide whether to slow or stop trains based on other monitoring data	Within 15 minutes	RRG
		Report trigger exceedance and actions taken to RMG, ARTC, MSO & ONRSR in Railway Status Report	Within one week	MSEC
Conveyor Crossing • Loss of integrity of conveyor crossing structure.	**GREEN**	Follow general procedures (including trestle survey, laser distancemeters and visual inspections)	-	-
	Closure between trestles exceeds 10 mm	Notify RMG	Within one week	RMC
		RMG meet and consider whether any additional management measures are required, which may include: - undertake structural inspection - increase monitoring and reporting procedures - elongate bolt holes in trestle column baseplates - strengthen trestle columns - install additional cable-stay bracing - erect temporary support structure on the access roadways on either side of railway	RMG meet via teleconference within one week	RMG
		Report trigger exceedence and RMG decisions to ARTC, MSO, ONRSR and SA NSW	Within one week	TC
Damage to boundary fences potentially leading to: • Livestock entry into rail corridor	**GREEN**	Follow general procedures (including visual inspections within rail corridor)	-	-
	Damage to fence	Repair fence	As required	RMC
		Report impact and actions taken to RMG	Within one week	RMC

Table A. 1 Risk Control Procedures for LWs S1A-S7A (continued)

<table>
<tr><th>RISK ISSUE</th><th>TRIGGER</th><th>CONTROL PROCEDURES</th><th>TIMING & FREQ</th><th>BY WHOM?</th></tr>
<tr><td rowspan="8">Bridges
• Impact on serviceability of bridge resulting in unplanned maintenance.

<table><tr><th>Trigger Level</th><th>Measured opening or closure between bridge abutments (beyond seasonal fluctuation)</th></tr><tr><td>GREEN</td><td>-</td></tr><tr><td>MONITORING REVIEW POINT TRIGGER</td><td>Remembrance Drive Bridge over Bargo River > 7 mm
Railway Viaduct > 5 mm
Bargo River Road Overbridge (Potter’s Cutting) > 5 mm
Wellers Road Overbridge > 5 mm
Increase in crack widths by more than 3 mm in widths to Viaduct or Bridges</td></tr></table></td><td>GREEN</td><td>Follow general procedures (including GNSS monitoring, ground and structure surveys, and visual inspections).</td><td>-</td><td>-</td></tr>
<tr><td rowspan="3">Monitoring Review Point Trigger for Railway Viaduct</td><td>Notify RMG, Bridge Technical Committee and ARTC (incl. ARTC Structures Specialist)</td><td>Within one week</td><td>MSEC</td></tr>
<tr><td>RMG meet and consider whether any additional management measures are required, which may include:
- undertake structural inspections
- measure changes to crack gauges
- increase frequency of surveys and inspections and reporting
- install temporary track strengthening baulk
- force closure to focus in desired Span 5 by diamond saw cut
- repair cracked masonry
- provide additional support to the arch and parapet walls
- fabricate and erect structural steel supports for the arch
- adjust rail stress
- adjust track geometry
- implement temporary speed restriction or stop trains
- continual review of rate of development of valley closure relative to longwall progress and consider whether to amend the Valley closure trigger of 20 mm
- consider whether to recommend to TC senior management to slow or stop mining if impact to rail operations is unacceptable to ARTC</td><td>As required</td><td>RMG & Bridge Technical Committee</td></tr>
<tr><td>Report trigger exceedence and RMG & Bridge Technical Committee decisions to ARTC, MSO, ONRSR and SA NSW</td><td>Within 24 hours</td><td>Tahmoor Coal</td></tr>
<tr><td rowspan="3">Valley closure at Railway Viaduct > 20 mm

(based on Precision 2D surveys of closure between ground marks located in stable ground at both ends of the Viaduct)</td><td>Stop longwall mining</td><td>Immediately
(subject to mine safety requirements)</td><td>TC</td></tr>
<tr><td>RMG meet and consider whether any additional management measures are required, which may include:
- fabricate and erect structural steel supports for the arch
- consider and implement measures to monitor the condition of the temporary support structures
- consider triggers for adjusting the support structures due to residual subsidence
- adjust the support structures to accommodate residual subsidence movements, if required
- consider works required to permanently restore the Railway Viaduct in consultation and approval by ARTC and government agencies.</td><td>As required</td><td>RMG</td></tr>
<tr><td>Report trigger exceedence and RMG decisions to ARTC, MSO, ONRSR and SA NSW</td><td>Within 24 hours</td><td>TC</td></tr>
<tr><td rowspan="3">Monitoring Review Point Trigger for Remembrance Drive Bridge over Bargo River</td><td>Notify RMG, Bridge Technical Committee and ARTC (incl. ARTC Structures Specialist)</td><td>Within one week</td><td>MSEC</td></tr>
<tr><td>RMG meet and consider whether any additional management measures are required, which may include:
- undertake structural inspections
- increase frequency of surveys and inspections and reporting
- construct temporary props and/or cross-bracing to provide additional support to the piers
- repair cracks in concrete elements
- replace bridge bearings
- resurface affected road pavement
- consider whether to recommend to TC senior management to slow or stop mining if impact to rail operations is unacceptable to ARTC</td><td>As required</td><td>RMG & Bridge Technical Committee</td></tr>
<tr><td>Report trigger exceedence and RMG & Bridge Technical Committee decisions to ARTC, MSO, ONRSR and SA NSW</td><td>Within 24 hours</td><td>Tahmoor Coal</td></tr>
</table>

Table A. 1 Risk Control Procedures for LWs S1A-S7A (continued)

<table>
<tr><th>RISK ISSUE</th><th>TRIGGER</th><th>CONTROL PROCEDURES</th><th>TIMING & FREQ</th><th>BY WHOM?</th></tr>
<tr><td rowspan="3">Bridges
• Impact on serviceability of bridge resulting in unplanned maintenance.

<table><tr><th>Trigger Level</th><th>Measured opening or closure between bridge abutments (beyond seasonal fluctuation)</th></tr><tr><td>GREEN</td><td>-</td></tr><tr><td>MONITORING REVIEW POINT TRIGGER</td><td>Remembrance Drive Bridge over Bargo River > 7 mm
Railway Viaduct > 5 mm
Bargo River Road Overbridge (Potter’s Cutting) > 5 mm
Wellers Road Overbridge > 5 mm
Increase in crack widths by more than 3 mm in widths to Viaduct or Bridges</td></tr></table></td><td rowspan="3">Monitoring Review Point Trigger for Bargo River Road Overbridge or Wellers Road Overbridge</td><td>Notify RMG, Bridge Technical Committee and ARTC (incl. ARTC Structures Specialist)</td><td>Within one week</td><td>MSEC</td></tr>
<tr><td>RMG meet and consider whether any additional management measures are required, which may include:
- undertake structural inspections
- measure changes to crack gauges
- increase frequency of surveys and inspections and reporting
- install roller steel reinforcement straps to the underside of the concrete arch;
- install mesh to underside of the arch;
- install temporary support structure within the road pavement to provide temporary support to arch;
- provide additional support to parapet walls; and/or
- repair cracked brickwork
- consider whether to recommend to TC senior management to slow or stop mining if impact to rail operations is unacceptable to ARTC</td><td>As required</td><td>RMG & Bridge Technical Committee</td></tr>
<tr><td>Report trigger exceedence and RMG & Bridge Technical Committee decisions to ARTC, TfNSW, MSO, ONRSR and SA NSW</td><td>Within 24 hours</td><td>Tahmoor Coal</td></tr>
</table>

Table A. 1 Risk Control Procedures for LW S4A-S7A

GENERAL TRIGGER LEVELS

Trigger Level	Description
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 site inspection. Action required within 6 hours. 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.

ABBREVIATIONS WITHIN THESE TABLES:

CRN = Country Regional Network

ARTC = Australian Rail Track Corporation

MSI = NSW Department of Regional NSW – Mine Safety Inspectorate – Resources Regulator

ONRSR = Office of the National Rail Safety Regulator

SRS = Southern Rail Surveys (ground surveys within rail corridor)

SA NSW = Subsidence Advisory NSW

MSEC = Mine Subsidence Engineering Consultants

RMG = Rail Management Group

RMC = Rail Maintenance Contractor

PCE = Pidgeon Civil Engineering

JMA = JMA Solutions (structural engineer)

SMEC = SMEC (ground surveys beyond rail corridor)

TC = Tahmoor Coal

RISK ISSUE	TRIGGER	CONTROL PROCEDURES	TIMING & FREQ	BY WHOM?
General Procedures				
	GREEN	**EARLY WARNING MONITORING**		
		Continuous GNSS monitoring for S1 to S15 as shown in Drawing No. MSEC1201-03	GNSS units S1 to S15 installed Continuous readings, with data averaged over 24 hours and recorded once per day until end of LW S6A.	Tahmoor Coal (Geomatix)
		Continuous GNSS monitoring at 100.70 km (S28)	Install prior to start of LW S4A Continuous readings, with data averaged over 24 hours and recorded once per day until end of LW S6A.	Tahmoor Coal (Geomatix)
		RAILWAY TRACK		
		3D ground survey along rail corridor *Extents for 3D surveys:* LW S4A: *101.16km to 100.14km (AP6) and then extend to the north to include pegs that are at least 400 metres in front of the LW face, up to 98.74 km. (End of LW from 100.90km to 98.38km)* LW S5A: *101.16km to 100.14km (AP6) and then extend to the north to include pegs that are at least 400 metres in front of the LW face, up to 99.10 km. (End of LW from 101.16km to 98.92km)* LW S6A: *101.16km to 100.14km (AP6) and then extend to the north to include pegs that are at least 400 metres in front of the LW face, up to 99.46 km. (End of LW from 101.16km to 99.28km)* LW S7A: *101.16km to 100.14km (AP6) and then extend to the north to include pegs that are at least 400 metres in front of the LW face, up to 99.46 km. (End of LW from 101.16km to 99.28km)*	Monthly 3D surveys commencing as per below: LW S4A: at LW start LW S5A: at LW start LW S6A: at LW start LW S7A: at LW start Surveys continue until 800m of extraction of each LW unless ongoing adverse changes are observed End of LW S4A-S7A.	SRS
		Focussed 2D ground survey along rail corridor *Extents for focussed 2D surveys:* LW S4A: *101.16km to 100.14km (AP6) and then extend to the north to include pegs that are at least 200 metres in front of the LW face, up to 98.74 km. (End of LW from 100.90km to 98.38km)* LW S5A: *101.16km to 100.14km (AP6) and then extend to the north to include pegs that are at least 200 metres in front of the LW face, up to 99.10 km. (End of LW from 101.16km to 98.92km)* LW S6A: *101.16km to 100.14km (AP6) and then extend to the north to include pegs that are at least 200 metres in front of the LW face, up to 99.46 km. (End of LW from 101.16km to 99.28km)* LW S7A: *101.16km to 100.14km (AP6) and then extend to the north to include pegs that are at least 200 metres in front of the LW face, up to 99.46 km. (End of LW from 101.16km to 99.28km)*	Weekly 2D surveys commencing as per below: LWs S4A-S7A: start after GNSS at 100.70km subsides more than 20mm after LW start or 200m extraction, whichever occurs first Surveys continue until 800m of extraction of each LW unless ongoing adverse changes are observed End of LW S4A-S7A.	SRS
		Continuously monitor rail stress, rail temperature and switch displacement *Extents for active subsidence monitoring:* LW S4A: *101.10km to 100.14km (AP6) and then extend to the north to include gauges that are at least 200 metres in front of the LW face, up to 98.74 km.* LW S5A: *101.10km to 100.14km (AP6) and then extend to the north to include gauges that are at least 200 metres in front of the LW face, up to 99.10 km.* LW S6A: *101.10km to 100.14km (AP6) and then extend to the north to include gauges that are at least 200 metres in front of the LW face, up to 99.46 km.* LW S7A: *101.10km to 100.14km (AP6) and then extend to the north to include pegs that are at least 200 metres in front of the LW face, up to 99.46 km. (End of LW from 101.16km to 99.28km)*	Readings every 5 minutes LWs S4A-S7A: at LW start	Globetech
		Track geometry surveys using Amber track mounted device or equivalent *Extents for track geometry surveys as per focussed 2D surveys*	Weekly as per focussed 2D surveys	RMC
		Track inspection by qualified track certifier. The inspection will check ARTC infrastructure within the rail corridor, including the track, integrity of monitoring systems, cuttings and Wellers Road Overbridge *The extent of visual inspections is the same as the extent of track geometry surveys plus dormant expansion switches*	Daily LWs S4A-S7A: start after GNSS at 100.70km subsides more than 20mm after LW start or 200m extraction, whichever occurs first Inspections continue until 800m of extraction of each LW unless ongoing adverse changes are observed	RMC
		CUTTINGS		
		Absolute 3D surveys every 20 metres along the crests and/or toes of the cuttings *Install Cutting at 101.162 km prior to start of LW S5A*	Monthly / weekly as described for railway track Surveys continue until 800m of extraction of each LW unless ongoing adverse changes are observed End of LW S4A-S7A	SRS
		Visual inspection of cuttings by geotechnical engineer	Monthly / weekly as described for railway track Inspections continue until 800m of extraction of each LW unless ongoing adverse changes are observed	Newcastle Geotech

<table>
<tr><th>RISK ISSUE</th><th>TRIGGER</th><th>CONTROL PROCEDURES</th><th>TIMING & FREQ</th><th>BY WHOM?</th></tr>
<tr><td rowspan="11">General Procedures (continued)</td><td rowspan="11">GREEN</td><td colspan="3">BRIDGES</td></tr>
<tr><td>Pre-mining inspection and structural assessment of Wellers Road Overbridge</td><td>Complete</td><td>JMA</td></tr>
<tr><td>Geological inspection and mapping at Cutting at Wellers Road Overbridge</td><td>Complete</td><td>Newcastle Geotech</td></tr>
<tr><td>Continuous GNSS monitoring including S15 (Wellers Road Overbridge) as shown in Drawing No. MSEC1193-01-01</td><td>GNSS units installed
Continuous readings, with data averaged over 24 hours and recorded once per day until end of LW S7A.</td><td>Tahmoor Coal
(Geomatix)</td></tr>
<tr><td>Conduct Local 3D survey of structure and ground marks on the Wellers Road Overbridge as per Drawing No. MSEC1193-19-02. Survey will include measurement of change in height between track and underside of arch, as requested by ARTC.</td><td>Install and baseline survey prior to LW S1A.
Monthly after 200m extraction of LWs S4A to S7A
Surveys continue until 800m of extraction of each LW unless ongoing adverse changes are observed
End of LW S1A-S7A.</td><td>Tahmoor Coal
(SRS)</td></tr>
<tr><td>Automated, continuous monitoring of laser distancemeters and draw wire displacement sensors along and across the Overbridge at base of arch</td><td>Installed and operating
Readings every 15 minutes</td><td>Tahmoor Coal
(Sweeting Consulting)</td></tr>
<tr><td>Monitoring of existing cracks with crack gauges on Wellers Road Overbridge</td><td>Install and baseline survey prior to LW S4A.
Monthly after 200m extraction of LWs S4A to S7A
Inspections continue until 800m of extraction of each LW unless ongoing adverse changes are observed
End of LW S1A-S7A.</td><td>TC</td></tr>
<tr><td colspan="3">OTHER MEASURES</td></tr>
<tr><td>Undertake investigations as required to assist in identifying potential locations of non-conventional movement. Reconsider management measures in light of new information that becomes available.</td><td>Ongoing</td><td>RMG</td></tr>
<tr><td>Dilapidation inspections</td><td>Complete</td><td>Various</td></tr>
<tr><td>Standard ARTC maintenance and control procedures
- Twice weekly track patrol
- AK track recording car
- Base Operating Standards Mandatory Responses
- Driver reports and temporary speedboards
- Signalling and Communications procedures
- Ultrasonic rail test (high rail)</td><td>As per ARTC procedures</td><td>ARTC</td></tr>
<tr><td>Analyse and report results to RMG</td><td>Monthly</td><td>Section 6.1</td></tr>
<tr><td>RMG discuss results and consider whether any additional management measures are required</td><td>Monthly
LWs S4A-S7A: start after GNSS at 100.70km subsides more than 20mm after LW start or 200m extraction, whichever occurs first</td><td>RMG</td></tr>
<tr><td>RMG discuss progress with MSI and ONRSR</td><td>As required</td><td>RMG</td></tr>
<tr><td rowspan="3">Bridges
Impact on serviceability of bridge resulting in unplanned maintenance.
<table><tr><th>Trigger Level</th><th>Measured opening or closure between bridge abutments (beyond seasonal fluctuation)</th></tr><tr><td>GREEN</td><td>-</td></tr><tr><td>MONITORING REVIEW POINT TRIGGER</td><td>Wellers Road Overbridge > 5 mm
Increase in crack widths by more than 3 mm in widths</td></tr></table></td><td rowspan="3">Monitoring Review Point Trigger</td><td>Notify RMG, Bridge Technical Committee and TfNSW, ARTC (incl. ARTC Structures Specialist)</td><td>Within one week</td><td>MSEC</td></tr>
<tr><td>RMG meet and consider whether any additional management measures are required, which may include:
- undertake additional structural inspections
- install and measure changes to additional crack gauges
- increase frequency of surveys and inspections and reporting
- install roller steel reinforcement straps to the underside of the concrete arch;
- install mesh to underside of the arch;
- install temporary support structure within the road pavement to provide temporary support to arch;
- provide additional support to parapet walls; and/or
- repair cracked brickwork
- consider whether to recommend to TC senior management to reduce vehicle loads if impact to rail operations is unacceptable to TfNSW or ARTC
- consider whether to recommend to TC senior management to amend start position of future longwalls further away from Overbridge based on analysis of monitoring data</td><td>As required</td><td>RMG</td></tr>
<tr><td>Report trigger exceedence and RMG decisions to TfNSW, ARTC, MSI, ONRSR and SA NSW</td><td>Within 24 hours</td><td>Tahmoor Coal</td></tr>
</table>

Table 4.1 Risk Control Procedures during the extraction of Tahmoor LW S1A-S7A

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Local roads	Cracking, heaving or stepping of the pavements or unsealed surfaces	Medium / Low	None	Conduct geotechnical assessment of Remembrance Driveway embankments and cutting	Complete	Douglas Partners
				Continuous GNSS monitoring as shown in Drawing No. MSEC1193-01-01	GNSS units installed Continuous readings, with data averaged over 24 hours and recorded once per day until end of LW S7A.	Tahmoor Coal (Unit Zero)
				2D survey line along Tahmoor Mine property boundary	Pegs installed. Baseline survey complete. Monthly survey during LW S1A between 200m and 1300m extraction, and continue if ongoing adverse movements are observed. End of LW S1A (complete).	Tahmoor Coal (SMEC)
				Conduct 2D / Absolute 3D surveys along Main Southern Railway in accordance with Railway Management Plan	Monthly 3D / Weekly 2D surveys for pegs within active subsidence zone during LWs S1A to S7A	Tahmoor Coal (SRS)
				Conduct 2D survey along Charlies Point Road	Pegs installed. Baseline survey complete Monthly survey during LWs S1A-S5A between 200m and 800m extraction, and continue if ongoing adverse movements are observed. End of LW S1A-S7A.	Tahmoor Coal (SMEC)
				Conduct 2D / Absolute 3D surveys along Remembrance Drive	Pegs installed. Baseline survey complete. Monthly 3D / Weekly 2D surveys for pegs within active subsidence zone commencing as per below: LW S1A: start after 1300m extraction LW S2A: start after 900m extraction LW S3A: start after 500m extraction LW S4A: start after 200m extraction LW S5A: start after GNSS 28 subsides more than 20 mm due to LW S5A or 200m extraction, whichever occurs first LW S6A: start after GNSS 28 subsides more than 20 mm due to LW S5A or 200m extraction, whichever occurs first Continue surveys until outside active subsidence zone or one month after end of LW and continue further if ongoing adverse movements are observed. End of LW S1A-S7A.	Tahmoor Coal (SMEC)
				Conduct 2D surveys along Caloola Road	Pegs installed. Baseline survey complete. Survey at end of LW S1A. Weekly 2D surveys for pegs within active subsidence zone commencing as per below: LW S2A: start after 900m extraction LW S3A: start after 800m extraction LW S4A: start after 800m extraction LW S5A: start after 900m extraction LW S6A: start after 900m extraction Continue surveys until outside active subsidence zone or one month after end of LW and continue further if ongoing adverse movements are observed. End of LW S2A-S7A.	Tahmoor Coal (SMEC)
				Conduct 2D surveys along Yarran Road	Install and baseline survey complete. Survey at end of LW S3A. Weekly 2D surveys for pegs within active subsidence zone commencing as per below: LW S4A: start after 200m extraction LW S5A: start after 200m extraction LW S6A: start after 200m extraction LW S7A: start after 200m extraction Continue if ongoing adverse movements are observed. End of LW S4A-S7A.	Tahmoor Coal (SMEC)

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
				Conduct 2D surveys along Great Southern Road	Install and baseline survey complete. Survey at end of LW S3A. Weekly 2D surveys for pegs within active subsidence zone commencing as per below: LW S4A: start after 200m extraction LW S5A: start after 200m extraction LW S6A: start after 200m extraction Continue if ongoing adverse movements are observed. End of LW S4A-S7A.	Tahmoor Coal (SMEC)
				Conduct Local 3D / Absolute 3D survey of Remembrance Drive Embankment over Teatree Hollow at Caloola Drive (RE4) as per Drawing No. MSEC1193-03-07.	Install and baseline survey complete. Monthly 3D / Weekly 2D surveys within active subsidence zone commencing as per below: LW S2A: start after 900m extraction LW S3A: start after 800m extraction LW S4A: start after 800m extraction LW S5A: start after 900m extraction Continue if ongoing adverse movements are observed. End of LW S2A-S6A.	Tahmoor Coal (SMEC)
				Conduct Local 3D / Absolute 3D survey of Remembrance Drive Embankment over Tributary to Teatree Hollow north of Yarran Road (RE3) as per Drawing No. MSEC1193-03-08.	Install and baseline survey complete. 3D Survey at end of LW S3A. Monthly 3D / Weekly 2D surveys within active subsidence zone commencing as per below: LW S4A: start after 300m extraction LW S5A: start after 400m extraction LW S6A: start after 400m extraction Continue if ongoing adverse movements are observed. End of LW S4A-S7A.	Tahmoor Coal (SMEC)
				Conduct Local 3D / Absolute 3D survey of Remembrance Drive Embankment over Tributary to Teatree Hollow south of Yarran Road (RE2) as per Drawing No. MSEC1193-03-09.	Install and baseline survey complete. 3D Survey at end of LW S3A. Monthly 3D / Weekly 2D surveys within active subsidence zone commencing as per below: LW S4A: start after 200m extraction LW S5A: start after 200m extraction LW S6A: start after 200m extraction Continue if ongoing adverse movements are observed. End of LW S4A-S7A.	Tahmoor Coal (SMEC)
				Conduct Local 3D / Absolute 3D survey of Remembrance Drive Embankment at intersection of Wellers Road (RE1) as per Drawing No. MSEC1193-03-10.	Install and baseline survey prior to LW S5A. 3D Survey at end of LW S5A. Monthly 3D after 200m extraction of LW S6A until 800m of extraction and continue if ongoing adverse movements are observed. End of LW S6A and S7A.	Tahmoor Coal (SMEC)
				Conduct Local 3D / Absolute 3D survey of Remembrance Drive Cutting (RC1) as per Drawing No. MSEC1193-03-11.	Install and baseline survey complete. 3D Survey at end of LW S2A. Monthly 3D / Weekly 2D surveys within active subsidence zone commencing as per below: LW S3A: start after 500m extraction LW S4A: start after 400m extraction LW S5A: start after 400m extraction LW S6A: start after 500m extraction Continue if ongoing adverse movements are observed. End of LW S3A-S7A.	Tahmoor Coal (SMEC)
				Detailed visual inspections of local roads, culverts, embankments and cuttings	Weekly for areas within the active subsidence zone during LWs S1A to S7A and continue if ongoing adverse movements or impacts are observed until one month after the extraction of each LW.	Tahmoor Coal
				Detailed visual inspections by geotechnical engineer along Remembrance Driveway embankments and cutting	Monthly during periods of active subsidence of LW S2A to S7A, and continue if ongoing adverse movements are observed.	Douglas Partners
				Prepare traffic management plan for installation and measurement of survey pegs to satisfaction of WSC	Complete	Tahmoor Coal

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
				Prepare traffic management plan to manage traffic along Remembrance Drive in the event that mining-induced damage requires repair	Complete	Tahmoor Coal
				Apply to Council and obtain an approved Road Occupancy Permit under Section 138 of the Roads Act prior to conducting works in the road reserve, including survey.	Complete	Tahmoor Coal
				Analyse and report results to IMG	Weekly during LW S1A-S7A after the length of the extraction exceeds 200 metres.	Tahmoor Coal
				IMG discuss results and consider whether any additional management measures are required	Weekly during LW S1A-S7A after the length of the extraction exceeds 200 metres.	Tahmoor Coal
Local roads	Cracking, heaving or stepping of the pavements or unsealed surfaces	Medium / Low	Impacts occur to pavement	Notify all stakeholders, including WSC, Tahmoor Coal, Subsidence Advisory NSW and Resources Regulator	Within one week	Tahmoor Coal / WSC
				IMG, Tahmoor Coal and WSC meet to decide whether any additional management measures are required, including: - increase in frequency of surveys and visual inspections - increase in monitoring reporting - repair pavement in accordance with Traffic Management Plans	As required (target within 48 hours)	Tahmoor Coal / WSC
				Repair road in consultation with WSC	As required	Tahmoor Coal
			A hazard has been identified that involves potential serious injury or illness to a person or persons on public property or, or WSC property and cannot be controlled	IMG, Tahmoor Coal and WSC meet to decide whether any additional management measures are required, including: - emergency evacuation of hazardous area - demarcation to prevent people entering hazardous area, including diversion of traffic via Traffic Management Plan	Immediately	Tahmoor Coal / WSC
				Notify SRG of trigger exceedence and any management decisions undertaken (incl Subsidence Advisory NSW, Resources Regulator)	Within 24 hours of decision	Tahmoor Coal
Drainage culverts	Cracking or spalling	Low	None	Conduct baseline CCTV investigations of culverts within the Study Area	Prior to each culvert experiencing active subsidence	Tahmoor Coal
				Conduct Austroads Level 1 inspection of culverts within the Study Area	Prior to each culvert experiencing active subsidence	Tahmoor Coal
				Conduct survey of levels at inlet and outlet of culverts within the Study Area	Prior to each culvert experiencing active subsidence End of LW S7A	Tahmoor Coal (SMEC)
				Conduct ground surveys along streets, which cross over the culverts	Refer local roads section	Tahmoor Coal (SMEC)
				Conduct visual inspection for impacts	Refer local roads section	Tahmoor Coal (SMEC)
			Impacts occur	Notify all stakeholders, including WSC, Tahmoor Coal, Subsidence Advisory NSW and Resources Regulator	Within one week	Tahmoor Coal / WSC
				Repair culvert in consultation with WSC	As required	Tahmoor Coal
Causeway on Government Drive	Cracking or spalling of concrete pavement or culvert	Low	None	Conduct ground survey along causeway	Install and baseline survey by Nov 2022. Survey at end of LWs S1A, S2A and S3A Monthly surveys between 200m and 1000m of extraction of LWs S4A to S7A and continue if ongoing adverse movements are observed. Survey at end of LW S4A-S7A.	Tahmoor Coal (SMEC)
				Visual inspection of causeway	Baseline inspection by Nov 2022 Inspect at end of LWs S1A, S2A and S3A Monthly inspections between 200m and 1000m of extraction of LWs S4A to S7A and continue if ongoing adverse movements are observed. Inspect at end of LW S4A-S7A.	Tahmoor Coal (BIS)
			Impacts occur	Notify all stakeholders, including WSC, Tahmoor Coal, Subsidence Advisory NSW and Resources Regulator	Within one week	Tahmoor Coal / WSC
				Repair causeway in consultation with WSC	As required	Tahmoor Coal

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Remembrance Drive embankments	Displacement / failure of embankment leading to loss of support of pavement	Low	None	Ensure culverts are clear and free flowing	Prior to influence of LWs S1A to S7A and during periods of active subsidence	Tahmoor Coal
				Conduct ground surveys along crest and toe of both sides of Remembrance Drive embankments	Refer local roads section	Tahmoor Coal (SMEC)
				Conduct visual inspection of embankments and culverts	Refer local roads section	Tahmoor Coal (SMEC)
			Level 1 Change in distance across crest exceeds 25 mm Rate of change in distance across crest is greater than 10 mm in a week Visual signs of distress to embankment, such as tension crack along edge of embankment / access road Visual signs of distress to dam walls upstream of Remembrance Drive	Notify IMG	Within 24 hours	Tahmoor Coal
				Undertake additional geotechnical inspection and appraisal	Within 24 hours	Douglas Partners
				IMG meet and review latest monitoring information for the embankment, culvert and the pavement, inspections by geotechnical engineer and building inspector, and latest weather forecasts. IMG consider whether any additional management measures are required, which may include: - fill and seal cracks and/or regrade drainage line - increase monitoring frequency and reporting procedures - arrange additional monitoring locations to monitor potential displacement of embankment material - lower water level of dam(s) upstream of embankment (if relevant) - install variable message signs in preparation of potential traffic management measures	Within 24 hours	IMG
				Report trigger exceedance and actions taken to IMG, WSC, SA NSW & MSO in Status Report	Within 24 hours if tension crack observed Otherwise within one week	Tahmoor Coal
			Level 2 Tension crack observed along the embankment shoulder, or slide in the crest of the embankment	Notify IMG and WSC.	Immediately	Tahmoor Coal
				WSC inspection to consider and implement emergency traffic management measures, if required	Immediately	Tahmoor Coal / WSC
				Undertake additional geotechnical inspection and appraisal	As soon as reasonably practicable	Douglas Partners
				IMG meet and review latest monitoring information for the embankment, culvert and the pavement, inspections by geotechnical engineer and building inspector, and latest weather forecasts. IMG consider whether any additional management measures are required, which may include: - introduce temporary speed restriction or temporarily close affected shoulder and/or travel lane - place permanent or temporary fill / rock spall to the base of the embankment - increase monitoring frequency and reporting procedures - arrange additional monitoring locations to monitor potential displacement of embankment material	As soon as reasonably practicable	IMG
				Report trigger exceedance and actions taken to IMG, WSC, SA NSW & MSO	Within 24 hours	Tahmoor Coal
			Level 3 Tension crack observed across the pavement shoulder and travel lane(s), or slump or depression appears in the pavement	Notify IMG and WSC.	Immediately	Tahmoor Coal
				WSC inspection to consider and implement emergency traffic management measures, if required	Immediately	Tahmoor Coal / WSC
				Undertake additional geotechnical inspection and appraisal	As soon as reasonably practicable	Douglas Partners
				IMG meet and review latest monitoring information for the embankment, culvert and the pavement, inspections by geotechnical engineer and building inspector, and latest weather forecasts. IMG consider whether any additional management measures are required, which may include: - introduce temporary speed restriction or temporarily close affected shoulder and/or travel lane - place permanent or temporary fill / rock spall to the base of the embankment - resurface pavement to restore ride quality along travel lanes - provide additional forms of support under the pavement as may be appropriate or feasible - increase monitoring frequency and reporting procedures - arrange additional monitoring locations to monitor potential displacement of embankment material	As soon as reasonably practicable	IMG
				Report trigger exceedance and actions taken to IMG, WSC, SA NSW & MSO	Within 24 hours	Tahmoor Coal

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Remembrance Drive cutting	Blockage of drainage lines or deformation of pavement in the cutting	Low	None	Scale the cutting batter slopes to remove loose debris and rocks Clear the cutting drainage lines and maintain the drainage lines to ensure that they remain free of debris and vegetation during mining	Prior to LW S2A and as required	Tahmoor Coal
				Conduct ground surveys along crest and toe of both sides of Remembrance Drive cutting	Refer local roads section	Tahmoor Coal (SMEC)
				Conduct visual inspection of cutting	Refer local roads section	Tahmoor Coal (SMEC)
			Closure across cutting exceeds 20 mm	Notify IMG	Within one week	MSEC
				IMG meet and consider whether any additional management measures are required, which may include: - undertake geotechnical engineering inspection - increase monitoring frequency and reporting procedures	Within one week	IMG
				Report trigger exceedance and actions taken to IMG, WSC, SA NSW & MSO in Status Report	Within one week	Tahmoor Coal
			Instability observed to cuttings	Notify IMG and WSC.	Immediately	Tahmoor Coal
				IMG meet and consider whether any additional management measures are required, which may include: - undertake geotechnical engineering inspection - increase monitoring frequency and reporting procedures - clear debris from drainage lines at base of cutting faces	Within 24 hours	IMG
				Report trigger exceedance and actions taken to IMG, WSC, SA NSW & MSO in Status Report	Within one week	Tahmoor Coal
Bridges	Loss of serviceability of Bridges	Low	None	Pre-mining inspection and structural assessment of Bridges	Complete	JMA
				Geological inspection and mapping at Bargo River Road Bridge	Complete	Newcastle Geotech
				Review of monitoring measures for Rockford Road Bridge and Arina Road Bridge and implement, if required	Prior to start of LW S1A (complete)	Bridge Technical Committee / Tahmoor Coal
				Review by Bridge Technical Committee and modify planned management and monitoring measures for Bargo River Bridge and Kader Street Bridge and review planned management measures for Rockford Road Bridge and Arina Road Bridge and implement, if required	Complete	Bridge Technical Committee / Tahmoor Coal
				Brief WSC on planned management and monitoring measures for Bargo River Bridge and Kader Street Bridge and review planned management measures for Rockford Road Bridge and Arina Road Bridge	Prior to 800 m of extraction of LW S1A	Tahmoor Coal
				Conduct Local 3D survey of structure and ground marks on the Bargo River Road Bridge as per Drawing No. MSEC1193-03-03, with one mark on the Bridge to be surveyed in Absolute 3D	Install and baseline survey complete. Monthly surveys between 1000m and one month after end of extraction of LWs S1A to S3A and continue if ongoing adverse movements are observed. End of LW S1A-S3A (complete).	Tahmoor Coal (SRS)
				Visual inspection of Bargo River Road Bridge	Baseline inspection complete Monthly inspections between 1000m and one month after end of extraction of LWs S1A to S3A and continue if ongoing adverse movements are observed. End of LW S1A to S3A (complete)	Tahmoor Coal
				Conduct Local 3D survey of structure and ground marks on the Rockford Road Bridge as per Drawing No. MSEC1193-03-04, with one mark on the Bridge to be surveyed in Absolute 3D	Install and baseline survey complete. Monthly surveys between 200m and 1000m of extraction of LWs S1A to S3A and continue if ongoing adverse movements are observed. End of LW S1A-S3A (complete).	Tahmoor Coal (SRS)
				Measure gaps between parapet kerbs and abutments of the Rockford Road Bridge	Install and baseline survey complete. Monthly surveys between 200m and 1000m of extraction of LWs S1A to S3A and continue if ongoing adverse movements are observed. End of LW S1A-S3A (complete).	Tahmoor Coal (SRS)
				Visual inspection of Rockford Road Bridge	Baseline inspection complete Monthly inspections between 200m and 1000m of extraction of LWs S1A to S3A and continue if ongoing adverse movements are observed. End of LW S1A to S3A (complete)	Tahmoor Coal

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
				Conduct Local 3D survey of structure and ground marks on the Arina Road Bridge as per Drawing No. MSEC1193-03-05, with one mark on the Bridge to be surveyed in Absolute 3D	Install and baseline survey complete. Monthly surveys between 200m and 1000m of extraction of LWs S1A to S3A and continue if ongoing adverse movements are observed. End of LW S1A-S3A (complete).	Tahmoor Coal (SRS)
				Measure gaps between vehicle kerbs and abutments of the Arina Road Bridge	Install and baseline survey complete. Monthly surveys between 200m and 1000m of extraction of LWs S1A to S3A and continue if ongoing adverse movements are observed. End of LW S1A-S3A (complete).	Tahmoor Coal (SRS)
				Visual inspection of Arina Road Bridge	Baseline inspection complete Monthly inspections between 200m and 1000m of extraction of LWs S1A to S3A and continue if ongoing adverse movements are observed. End of LW S1A to S3A (complete)	Tahmoor Coal
				Conduct Local 3D survey of structure and ground marks on the Kader Street Bridge as per Drawing No. MSEC1193-03-12, with one mark on the Bridge to be surveyed in Absolute 3D	Install and baseline survey complete. Survey at end of LWs S1A, S2A and S3A Monthly surveys between 200m and 1000m of extraction of LWs S4A to S7A and continue if ongoing adverse movements are observed. Survey at end of LW S4A-S7A.	Tahmoor Coal (SRS)
				Visual inspection of Kader Street Bridge	Baseline inspection by Nov 2022 Inspect at end of LWs S1A, S2A and S3A Monthly inspections between 200m and 1000m of extraction of LWs S4A to S7A and continue if ongoing adverse movements are observed. Inspect at end of LW S4A-S7A.	Tahmoor Coal
			GNSS unit S11 subsides or moves horizontally more than 20 mm	Conduct additional survey of Bargo River Road Bridge	Within one week	Tahmoor Coal (SRS)
				Visual inspection of Bargo River Road Bridge	Within one week	Tahmoor Coal
			Closure between bridge abutments exceeds 5 mm or transverse shear at Rockford Road Bridge exceeds 5 mm	Notify Bridge Technical Committee and WSC	Within one week	MSEC
				Bridge Technical Committee and WSC meet and consider whether any additional management measures are required, which may include: - undertake structural engineering inspection - increase monitoring frequency and reporting procedures - cut gaps between abutments and kerbs on Rockford Road Bridge or Arina Road Bridge - disconnect the bridge deck from one of the abutments on Bargo River Road Bridge and Kader Street Bridge - reset or replace bridge bearings - provide additional structural support to bridge deck	Within one week	Bridge Technical Committee
				Report trigger exceedance and actions taken to IMG, WSC, SA NSW & MSO in Status Report	Within one week	Tahmoor Coal
			Impacts observed to bridge	Notify Bridge Technical Committee and WSC	Within 24 hours	Tahmoor Coal
				WSC and Tahmoor Coal inspection to consider and implement emergency traffic management measures, if required	Immediately	Tahmoor Coal (JMA) / WSC
				Bridge Technical Committee and WSC meet and consider whether any additional management measures are required, which may include: - undertake structural engineering inspection - increase monitoring frequency and reporting procedures - cut gaps between abutments and kerbs on Rockford Road Bridge or Arina Road Bridge - disconnect the bridge deck from one of the abutments on Bargo River Road Bridge and Kader Street Bridge - reset or replace bridge bearings - repair damage to bridge, pavement approaches, and/or footpath approaches in consultation with WSC - as a last resort, slow or stop the longwall and/or vehicle traffic in accordance with Traffic Management Plan	Within 24 hours	Bridge Technical Committee
				Report trigger exceedance and actions taken to IMG, WSC, SA NSW & MSO in Status Report	Within 24 hours	Tahmoor Coal

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Bargo Cemetery	Damage to Cemetery ground, including grave sites, tombstones, kerbs, memorial wall, gardens and lawns	Low	None	Baseline recording and visual assessment by heritage consultant	Complete	EMM
				Pre-mining detailed visual inspection	Complete	Tahmoor Coal
				Conduct ground surveys along Charlies Point Road and Great Southern Road	Refer local roads section	Tahmoor Coal (SMEC)
				Conduct local 3D survey of survey marks around the Cemetery, including Pegs GSR-09 to GSR-17	Install and baseline survey prior to start of LW S4A Weekly surveys between 200m and 1000m of extraction of LWs S4A to S6A and continue if ongoing adverse movements are observed. Survey at end of LW S4A-S7A.	Tahmoor Coal (SMEC)
				Conduct visual inspection of Cemetery	Weekly inspections between 200m and 1000m of extraction of LWs S4A to S6A and continue if ongoing adverse movements are observed. Inspection at end of LW S7A	Tahmoor Coal
			Impacts observed to Cemetery by TC or notification of impact by member of public	Notify WSC, TC and/or IMG	Immediately	Tahmoor Coal / WSC
				IMG meet and consider whether any additional management measures are required, which may include: - undertake inspection by heritage consultant and WSC - increase monitoring frequency and reporting procedures - repair impacts in consultation with heritage consultant and WSC	As required	IMG
				Report trigger exceedance and actions taken to WSC, IMG, SA NSW & MSO in Status Report	Within one week	Tahmoor Coal

Table 4.1 Risk Control Procedures during the extraction of Tahmoor LW S1A-S7A

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Potable water infrastructure	Impacts to Sydney Water potable water infrastructure	Low to High	None	Follow Sydney Water procedures to monitor and respond to high water pressure levels at water reducing valves	Ongoing	Sydney Water
				Mark out locations of stop valves on site prior to the influence of each longwalls	Prior to active LW face approaching within 150 metres of each water main within predicted limit of incremental subsidence of each active LW.	Sydney Water
				Arrange for reservoirs within the network to be more than 90% capacity during periods of active subsidence of the 450 mm diameter CICL water main	LW S1A: start after 1300m extraction LW S2A: start after 900m extraction LW S3A: start after 500m extraction LW S4A: start after 200m extraction LW S5A: start after 200m extraction LW S6A: start after 200m extraction LW S7A: start after 200m extraction	Sydney Water
				Consider and select options and implement additional risk controls at the creek crossing site for the 450 mm diameter CICL water main (most likely to be installation of expansion joints, subject to ongoing investigations) Selected risk controls - Gibault expansion joints installed at Teatree Hollow crossing at intersection of Remembrance Drive and Caloola Road (Creek 1) - Gibault expansion joints installed at Tributary to Teatree Hollow crossing north of intersection of Remembrance Drive and Yarran Road (Creek 2) - Install Gibault expansion joints at Tributary to Teatree Hollow crossing adjacent to Main Southern Railway at 100.425 km (Creek 3)	Teatree Hollow crossing at intersection of Remembrance Drive and Caloola Road and Tributary to Teatree Hollow crossings north of intersection of Remembrance Drive and Yarran Road (Creek 2) complete Install Gibault joints at Tributary to Teatree Hollow crossing at Main Southern Railway at 100.425 km (Creek 3) prior to start of LW S5A	Tahmoor Coal and Sydney Water
				Consider and select options and implement additional risk controls at the crossing beneath Remembrance Drive and beneath the Main Southern Railway at 100.380 km (most likely to be installation of valve tees and connection points across the rail crossing, subject to ongoing investigations) Selected risk controls at Remembrance Drive road crossing - Gibault expansion joints installed north of Creek 2, which has reduced the potential for impacts on the right angle bend at the southbound (eastern) side of the crossing Selected risk controls at Main Southern Railway crossing - As-built construction investigated, potential Gibault locations identified, sand bedding placed - Installed concrete washout barrier - Construct earth berm - Install Gibault expansion joint north of creek crossing adjacent to Main Southern Railway at 100.425 km (Creek 3)	Remembrance Drive crossing completed Main Southern Railway crossing completed except for planned installation of Gibault joint north of Creek 3, which will be completed prior to start of LW S5A	Tahmoor Coal and Sydney Water
				Continuous monitoring of displacements at Gibault joints	Hourly	Tahmoor Coal (SweetingConsulting)
				Continuous GNSS monitoring as shown in Drawing No. MSEC1193-01-01	GNSS units installed Continuous readings, with data averaged over 24 hours and recorded once per day until end of LW S7A.	Tahmoor Coal (Unit Zero)
				2D survey line along Tahmoor Mine property boundary	Pegs installed. Baseline survey complete Monthly survey during LW S1A between 200m and 1300m extraction, and continue if ongoing adverse movements are observed. End of LW S1A (complete).	Tahmoor Coal (SMEC)
				Conduct 2D / Absolute 3D surveys along Main Southern Railway in accordance with Railway Management Plan	Monthly 3D / Weekly 2D surveys for pegs within active subsidence zone during LWs S1A to S7A	Tahmoor Coal (SRS)
				Conduct 2D / Absolute 3D surveys along Remembrance Drive	Pegs installed from northern boundary of Tahmoor Mine site to Caloola Road. Baseline survey prior to 900m extraction of LW S1A. Extend line and baseline survey pegs within predicted limit of incremental subsidence of each active LW, prior to active LW face approaching within 600 metres of survey line. Monthly 3D / Weekly 2D surveys for pegs within active subsidence zone commencing as per below: LW S1A: start after 1300m extraction LW S2A: start after 900m extraction LW S3A: start after 500m extraction LW S4A: start after 200m extraction LW S5A: start after GNSS 28 subsides more than 20 mm due to LW S5A or 200m extraction, whichever occurs first LW S6A: start after GNSS 28 subsides more than 20 mm due to LW S6A or 200m extraction, whichever occurs first LW S7A: start after 200m extraction Continue surveys until outside active subsidence zone or one month after end of LW and continue further if ongoing adverse movements are observed. End of LW S1A-S7A.	Tahmoor Coal (SMEC)

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Potable water infrastructure	Impacts to Sydney Water potable water infrastructure	Low to High	None	Conduct Local 3D / Absolute 3D survey of Remembrance Drive Embankment over Tributary to Teatree Hollow north of Yarran Road (Creek 2) including water main crossing over Remembrance Drive	Install and baseline survey prior to LW S3A (complete). 3D Survey at end of LW S3A (complete). Monthly 3D / Weekly 2D surveys within active subsidence zone commencing as per below: LW S4A: start after 300m extraction LW S5A: start after 400m extraction LW S6A: start after 400m extraction Continue if ongoing adverse movements are observed. End of LW S4A-S7A.	Tahmoor Coal (SMEC)
				Conduct Local 3D / Absolute 3D survey of Main Southern Railway Embankment over Tributary to Teatree Hollow adjacent to 100.425 km, including water main crossing over Railway	Install and baseline survey prior to LW S3A (complete). 3D Survey at end of LW S3A. Monthly 3D / Weekly 2D surveys within active subsidence zone commencing as per below: LW S4A: start after 200m extraction LW S5A: start after 400m extraction LW S6A: start after 400m extraction Continue if ongoing adverse movements are observed. End of LW S4A-S7A.	Tahmoor Coal (SMEC)
				Conduct 2D surveys along Caloola Road	Pegs installed. Baseline survey prior to 900m extraction of LW S1A.. Survey at end of LW S1A. Weekly 2D surveys for pegs within active subsidence zone commencing as per below: LW S2A: start after 900m extraction LW S3A: start after 800m extraction LW S4A: start after 800m extraction LW S5A: start after 900m extraction LW S6A: start after 900m extraction Continue surveys until outside active subsidence zone or one month after end of LW and continue further if ongoing adverse movements are observed. End of LW S2A-S7A.	Tahmoor Coal (SMEC)
				Conduct 2D surveys along Yarran Road	Install and baseline prior to start of LW S3A. Survey at end of LW S3A. Weekly 2D surveys for pegs within active subsidence zone commencing as per below: LW S4A: start after 200m extraction LW S5A: start after 200m extraction LW S6A: start after 200m extraction LW S7A: start after 200m extraction Continue if ongoing adverse movements are observed. End of LW S4A-S7A.	Tahmoor Coal (SMEC)
				Conduct 2D surveys along Great Southern Road	Install and baseline complete. Survey at end of LW S3A. Weekly 2D surveys for pegs within active subsidence zone commencing as per below: LW S4A: start after 200m extraction LW S5A: start after 200m extraction LW S6A: start after 200m extraction Continue if ongoing adverse movements are observed. End of LW S4A-S7A.	Tahmoor Coal (SMEC)
				Conduct Local 3D survey of structure and ground marks on the Main Southern Railway Viaduct over the Bargo River as per Drawing No. MSEC1193-03-02, with one mark on the Viaduct to be surveyed in Absolute 3D.	Install and baseline survey complete. Monthly surveys between 1000m and one month after end of extraction of LWs S1A to S3A and continue if ongoing adverse movements are observed. End of LW S1A-S3A (complete).	Tahmoor Coal (SRS)
				Visual inspections by Track Certifier along Main Southern Railway, including Tributary to Teatree Hollow crossing adjacent to Main Southern Railway at 100.425 km (Creek 3) and Main Southern Railway crossing at 100.380 km	Daily within the active subsidence zone during LWs S4A to S6A and continue if ongoing adverse movements or impacts are observed.	Tahmoor Coal

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Potable water infrastructure	Impacts to Sydney Water potable water infrastructure	Low to High	None	Visual inspection of Main Southern Railway Viaduct over the Bargo River	Baseline inspection complete Monthly inspections between 1000m and one month after end of extraction of LWs S1A to S3A and continue if ongoing adverse movements are observed. End of LW S1A to S3A (complete)	Tahmoor Coal
				Conduct Local 3D survey of structure and ground marks on the Bargo River Road Bridge over tributary to Bargo River and Bargo River Road Bridge over Main Southern Railway as per Drawing No. MSEC1193-03-03, with one mark on each Bridge to be surveyed in Absolute 3D	Install and baseline complete. Monthly surveys between 1000m and one month after end of extraction of LWs S1A to S3A and continue if ongoing adverse movements are observed. End of LW S1A-S3A (complete).	Tahmoor Coal (SRS)
				Visual inspection of Bargo River Road Bridges	Baseline inspection complete Monthly inspections between 1000m and one month after end of extraction of LWs S1A to S3A and continue if ongoing adverse movements are observed. End of LW S1A to S3A (complete)	Tahmoor Coal
				Detailed visual inspections of local roads, culverts, embankments and cuttings along the routes of the water mains	Weekly for areas within the active subsidence zone during LWs S1A to S7A and continue if ongoing adverse movements or impacts are observed until one month after the extraction of each LW.	Tahmoor Coal (BIS)
				Inform Sydney Water Call Centre of mining in area and possible issues.	Completed	Sydney Water
				Notify residents of potential mine subsidence impacts and contact numbers.	Completed	Tahmoor Coal
				Analyse and report results to IMG, including information on the position of the longwall face.	Weekly during LW S1A-S7A after the length of the extraction exceeds 200 metres.	Tahmoor Coal
			Non-conventional ground movement detected	Notify Sydney Water	Within 24 hours	Tahmoor Coal
				Infrastructure Management Group (IMG) meets to consider whether any additional management measures should be undertaken, including: - increasing the frequency of surveys and visual inspections in vicinity of the non-conventional movement; - investigating for potential of damage occurring to Sydney Water infrastructure; and/or - relieving stresses on the pipes by locally excavating and exposing the pipes in the affected area.	As agreed between Tahmoor Coal and Sydney Water	IMG
			Leakage of water observed	Notify all stakeholders, including Sydney Water, Tahmoor Coal, Subsidence Advisory NSW and Resources Regulator	Within 24 hours	Tahmoor Coal
				Repair leak.	As per Sydney Water procedures (target within 24 hours for 450 mm dia water main)	Sydney Water
				Provide alternative water supply to customers	As required	Tahmoor Coal
				Consider increasing the frequency of surveys and visual inspections in vicinity of water leak, if appropriate.	As agreed between Tahmoor Coal and Sydney Water	Tahmoor Coal
			A hazard has been identified that involves potential serious injury or illness to a person or persons on public property or, or in vicinity of potable water infrastructure and cannot be controlled	IMG, Tahmoor Coal and Sydney Water meet to decide whether any additional management measures are required, including: - emergency evacuation of hazardous area - demarcation to prevent people entering hazardous area	Immediately	Tahmoor Coal and Sydney Water
				Notify SRG of trigger exceedance and any management decisions undertaken (incl Subsidence Advisory NSW, Resources Regulator)	Within 24 hours of decision	Tahmoor Coal

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Potable water infrastructure	Impacts to Sydney Water potable water infrastructure	Low to High	Closure between abutments on Main Southern Rail Viaduct over Bargo River exceeds 7 mm or Closure between GNSS units at ends of Main Southern Rail Viaduct over Bargo River exceeds 7 mm or Closure between abutments Bargo River Road Bridge exceeds 5 mm	Notify Sydney Water	Within one week	MSEC
				Sydney Water and IMG meet and consider whether any additional management measures are required, which may include: - increase monitoring frequency and reporting procedures - install temporary bypass pipeline over creek crossing at Bargo River (Viaduct) or tributary to Bargo River (Bargo River Road Bridge)	Within one week	IMG
				Report trigger exceedance and actions taken to IMG, Sydney Water, SA NSW & MSO in Status Report	Within one week	Tahmoor Coal

Table 4.1 Risk Control Procedures during the extraction of Tahmoor South LW S1A-S7A

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Sewer infrastructure	Impacts to Sydney Water sewer infrastructure	Low	None	Continuous GNSS monitoring as shown in Drawing No. MSEC1193-01-01	GNSS units installed Continuous readings, with data averaged over 24 hours and recorded once per day until end of LW S7A.	Tahmoor Coal (Unit Zero)
				2D survey line along Tahmoor Mine property boundary	Pegs installed. Baseline survey complete. Monthly survey during LW S1A between 200m and 1300m extraction, and continue if ongoing adverse movements are observed (complete). End of LW S1A (complete).	Tahmoor Coal (SMEC)
				Conduct 2D / Absolute 3D surveys along Main Southern Railway in accordance with Railway Management Plan	Monthly 3D / Weekly 2D surveys for pegs within active subsidence zone during LWs S1A to S7A	Tahmoor Coal (SRS)
				Conduct 2D / Absolute 3D surveys along Remembrance Drive	Pegs installed. Baseline survey complete. Extend line and baseline survey pegs within predicted limit of incremental subsidence of each active LW, prior to active LW face approaching within 600 metres of survey line. Monthly 3D / Weekly 2D surveys for pegs within active subsidence zone commencing as per below: LW S1A: start after 1300m extraction (complete) LW S2A: start after 900m extraction (complete) LW S3A: start after 500m extraction (complete) LW S4A: start after 200m extraction LW S5A: start after GNSS 28 subsides more than 20 mm due to LW S5A or 200m extraction, whichever occurs first LW S6A: start after GNSS 28 subsides more than 20 mm due to LW S6A or 200m extraction, whichever occurs first LW S7A: start after 200m extraction Continue surveys until outside active subsidence zone or one month after end of LW and continue further if ongoing adverse movements are observed. End of LW S1A-S7A.	Tahmoor Coal (SMEC)
				Conduct Local 3D / Absolute 3D survey of Remembrance Drive Embankment over Teatree Hollow at Caloola Drive (RE4) as per Drawing No. MSEC1193-03-07.	Install and baseline survey complete. Monthly 3D / Weekly 2D surveys within active subsidence zone commencing as per below: LW S2A: start after 900m extraction LW S3A: start after 800m extraction LW S4A: start after 800m extraction LW S5A: start after 900m extraction Continue if ongoing adverse movements are observed. End of LW S2A-S6A.	Tahmoor Coal (SMEC)
				Conduct Local 3D / Absolute 3D survey of Remembrance Drive Embankment over Tributary to Teatree Hollow north of Yarran Road (RE3) as per Drawing No. MSEC1193-03-08.	Install and baseline survey complete. 3D Survey at end of LW S3A. Monthly 3D / Weekly 2D surveys within active subsidence zone commencing as per below: LW S4A: start after 300m extraction LW S5A: start after 400m extraction LW S6A: start after 400m extraction Continue if ongoing adverse movements are observed. End of LW S4A-S7A.	Tahmoor Coal (SMEC)
				Conduct Local 3D / Absolute 3D survey of Remembrance Drive Embankment over Tributary to Teatree Hollow south of Yarran Road (RE2) as per Drawing No. MSEC1193-03-09.	Install and baseline survey complete. 3D Survey at end of LW S3A. Monthly 3D / Weekly 2D surveys within active subsidence zone commencing as per below: LW S4A: start after 200m extraction LW S5A: start after 200m extraction LW S6A: start after 200m extraction Continue if ongoing adverse movements are observed. End of LW S4A-S7A.	Tahmoor Coal (SMEC)
				Conduct Local 3D / Absolute 3D survey of Remembrance Drive Embankment at intersection of Wellers Road (RE1) as per Drawing No. MSEC1193-03-10.	Install and baseline survey prior to LW S5A. 3D Survey at end of LW S5A. Monthly 3D after 200m extraction of LW S6A until 800m of extraction and continue if ongoing adverse movements are observed. End of LW S6A and S7A.	Tahmoor Coal (SMEC)

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
				Conduct Local 3D / Absolute 3D survey of Remembrance Drive Cutting (RC1) as per Drawing No. MSEC1193-03-11.	Install and baseline survey complete. 3D Survey at end of LW S2A. Monthly 3D / Weekly 2D surveys within active subsidence zone commencing as per below: LW S3A: start after 400m extraction LW S4A: start after 400m extraction LW S5A: start after 500m extraction LW S6A: start after 500m extraction Continue if ongoing adverse movements are observed. End of LW S3A-S7A.	Tahmoor Coal (SMEC)
				Conduct Local 3D survey of structure and ground marks on the Remembrance Drive Bridge over the Bargo River as per Drawing No. MSEC1193-03-02, with one mark on the Bridge to be surveyed in Absolute 3D. The survey includes a measurement of the gap between the deck and the northern abutment.	Install and baseline survey complete. Monthly surveys between 1000m and one month after end of extraction of LWs S1A to S3A and continue if ongoing adverse movements are observed. End of LW S1A-S3A (complete).	Tahmoor Coal (SRS)
				Baseline survey of gaps at expansion joints on sewer main on the Remembrance Drive Bridge over the Bargo River	Baseline survey prior to 400m extraction of LW S1A.	Tahmoor Coal (SRS)
				Visual inspection of Remembrance Drive Bridge over the Bargo River	Baseline inspection complete Monthly inspections between 1000m and one month after end of extraction of LWs S1A to S3A and continue if ongoing adverse movements are observed. End of LW S1A to S3A (complete)	Tahmoor Coal
				Conduct Local 3D survey of structure and ground marks on the Bargo River Road Bridge over tributary to Bargo River and Bargo River Road Bridge over Main Southern Railway as per Drawing No. MSEC1193-03-03, with one mark on each Bridge to be surveyed in Absolute 3D	Install and baseline survey complete. Monthly surveys between 1000m and one month after end of extraction of LWs S1A to S3A and continue if ongoing adverse movements are observed. End of LW S1A-S3A. (complete)	Tahmoor Coal (SRS)
				Visual inspection of Bargo River Road Bridges	Baseline inspection complete Monthly inspections between 1000m and one month after end of extraction of LWs S1A to S3A and continue if ongoing adverse movements are observed. End of LW S1A to S3A (complete)	Tahmoor Coal
				Detailed visual inspections of local roads, culverts, embankments and cuttings along the route of the sewer main along Remembrance Drive	Weekly for areas within the active subsidence zone during LWs S1A to S6A and continue if ongoing adverse movements or impacts are observed until one month after the extraction of each LW.	Tahmoor Coal
				Detailed visual inspections by geotechnical engineer along Remembrance Drive embankments and cutting	Monthly during periods of active subsidence of LW S2A to S7A, and continue if ongoing adverse movements are observed.	Douglas Partners / PSM
				Inform Sydney Water Call Centre of mining in area and possible issues.	Completed	Sydney Water
				Notify residents of potential mine subsidence impacts and contact numbers.	Completed	Tahmoor Coal
				Analyse and report results to IMG, including information on the position of the longwall face.	Weekly during LW S1A-S7A after the length of the extraction exceeds 200 metres.	Tahmoor Coal
			Non-conventional ground movement detected	Notify Sydney Water	Within 24 hours	Tahmoor Coal
				Notify Sydney Water and convene an IMG meeting. Consider additional monitoring and mitigation measures based on observed monitoring results, which may include: - increase frequency of ground surveys at affected site - increase frequency of visual inspections - excavate to expose pipe and reduce distortion or strain on pipe - increase frequency of IMG meetings - any other additional management actions	As required by IMG	Tahmoor Coal

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
			Blockage or leakage of sewage observed	Contact Sydney Water as per contact protocol. Clear blockage as required.	As required by Sydney Water	Sydney Water
				Investigate cause of sewage leak to ascertain whether leak might be due to subsidence	Within 24 hours	Sydney Water
				If blockage is subsidence related, notify all stakeholders, including Sydney Water, Tahmoor Coal, Subsidence Advisory NSW and Resources Regulator	Within 24 hours	Tahmoor Coal
				Convene IMG meeting to consider additional monitoring and mitigation measures based on observed monitoring results, which may include: - increase frequency of surveys along streets - increase frequency of visual inspections - excavate to expose pipe and reduce distortion or strain on pipe - increase frequency of IMG meetings - any other additional management actions	As required by IMG	Tahmoor Coal
			A hazard has been identified that involves potential serious injury or illness to a person or persons on public property or, or in vicinity of sewer water infrastructure and cannot be controlled	IMG, Tahmoor Coal and Sydney Water meet to decide whether any additional management measures are required, including: - emergency evacuation of hazardous area - demarcation to prevent people entering hazardous area	Immediately	Tahmoor Coal and Sydney Water
				Notify IMG of trigger exceedance and any management decisions undertaken (incl Subsidence Advisory NSW, Resources Regulator)	Within 24 hours of decision	Tahmoor Coal
			Closure between abutments on Remembrance Drive Bridge over Bargo River exceeds 7 mm or Closure between abutments Bargo River Road bridges exceeds 5 mm or Impacts observed to bridge	Notify Sydney Water	Within one week	MSEC
				Sydney Water and IMG meet and consider whether any additional management measures are required, which may include: - conduct additional survey of expansion joints on sewer main on Remembrance Drive Bridge over the Bargo River - undertake structural engineering inspection - increase monitoring frequency and reporting procedures - install additional expansion joint on Remembrance Drive Bridge over the Bargo River or Bargo River Road Bridge over tributary to Bargo River - excavate to expose pipe and reduce distortion or strain on pipe on Bargo River Road Bridge over Main Southern Railway - consider potential risks and implement control measures to protect the sewer main if it is decided to conduct modification works on the bridges	Within one week	IMG
				Report trigger exceedance and actions taken to IMG, Sydney Water, SA NSW & MSO in Status Report	Within one week	Tahmoor Coal

Revised Table 4.1: Risk Control Procedures LW S1A-S7A (amended for LW S4A in blue)

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Gas infrastructure	Impacts to Jemena gas infrastructure	Low	None	Excavate and expose 50 metres of gas pipeline along the southbound crest of the Teatree Hollow embankment along Remembrance Drive near the Caloola Road intersection, under supervision from Jemena	Prior to 800m of extraction of LW S3A (complete)	Tahmoor Coal
				Continuous GNSS monitoring as shown in Drawing No. MSEC1193-01-01	GNSS units installed with exception of GNSS on Railway above centreline of LW S5A, which will be installed prior to start of LW S4A Continuous readings, with data averaged over 24 hours and recorded once per day until end of LW S7A.	Tahmoor Coal (Unit Zero)
				2D survey line along Tahmoor Mine property boundary	Pegs installed. Baseline survey complete Monthly survey during LW S1A between 200m and 1300m extraction, and continue if ongoing adverse movements are observed. (complete) End of LW S1A (complete).	Tahmoor Coal (SMEC)
				Conduct 2D / Absolute 3D surveys along Main Southern Railway in accordance with Railway Management Plan	Monthly 3D / Weekly 2D surveys for pegs within active subsidence zone during LWs S1A to S7A	Tahmoor Coal (SRS)
				Conduct 2D / Absolute 3D surveys along Remembrance Drive	Pegs installed from northern boundary of Tahmoor Mine site to No. 3166 Remembrance Drive. Baseline survey complete up to LW S3A. Extend line and baseline survey pegs within predicted limit of incremental subsidence of LWs S4A to LW S7A, prior to start of each LW Monthly 3D / Weekly 2D surveys for pegs within active subsidence zone commencing as per below: LW S1A: start after 1300m extraction (complete) LW S2A: start after 900m extraction (complete) LW S3A: start after 500 m extraction LW S4A: start after GNSS at 100.55km subsides more than 20 mm due to LW S4A or ~~300~~200 m extraction, whichever occurs first LW S5A: start after GNSS at 100.55km subsides more than 20 mm due to LW S5A or 200 m extraction, whichever occurs first LW S6A: start after GNSS at 100.55km subsides more than 20 mm due to LW S6A or 200 m extraction, whichever occurs first LW S7A start after 200 m extraction Continue surveys until outside active subsidence zone or one month after end of LW and continue further if ongoing adverse movements are observed. End of each LW	Tahmoor Coal (SMEC)
				Conduct Local 3D / Absolute 3D survey of Remembrance Drive Embankment over Teatree Hollow at Caloola Drive (RE4) as per Drawing No. MSEC1193-03-07, Remembrance Drive Embankment North of Yarran Road (RE3) as per Drawing No. 1193-03-08, Remembrance Drive Embankment South of Yarran Road (RE2) as per Drawing No. 1193-03-09, and Remembrance Drive Embankment at Wellers Road (RE1) as per Drawing No. MSEC1193-03-10.	Install and baseline survey prior to influence of LWs. Monthly 3D / Weekly 2D surveys within active subsidence zone of each LW Continue if ongoing adverse movements are observed. End of each LW.	Tahmoor Coal (SMEC)
				Conduct Local 3D / Absolute 3D survey of Remembrance Drive Cutting (RC1) as per Drawing No. MSEC1193-03-11.	Install and baseline survey prior to LW S2A. 3D Survey at end of LW S2A. Monthly 3D / Weekly 2D surveys within active subsidence zone commencing as per below: LW S3A: start after 500m extraction LW S4A: start after ~~500~~400m extraction LW S5A: start after 500m extraction LW S6A: start after 500m extraction Continue if ongoing adverse movements are observed. End of LWs S3A to S7A.	Tahmoor Coal (SMEC)
				Conduct Local 3D survey of structure and ground marks on the Remembrance Drive Bridge over the Bargo River as per Drawing No. MSEC1193-03-02, with one mark on the Bridge to be surveyed in Absolute 3D. The survey includes a measurement of the gap between the deck and the northern abutment.	Baseline survey prior to LW S1A. (complete) Monthly surveys between 1000m and one month after end of extraction of LWs S1A to S3A and continue if ongoing adverse movements are observed. End of LWs S1A to S3A.	Tahmoor Coal (SRS)
				Baseline survey of gaps at expansion joints on sewer main on the Remembrance Drive Bridge over the Bargo River	Baseline survey complete	Tahmoor Coal (SRS)

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
				Visual inspection of Remembrance Drive Bridge over the Bargo River	Baseline inspection prior to LW S1A (complete) Monthly inspections between 1000m and one month after end of extraction of LWs S1A to S3A and continue if ongoing adverse movements are observed. End of LWs S1A to S3A	Tahmoor Coal (BIS)
				Detailed visual inspections of pavement, culverts, embankments and cuttings along the route of the gas main along Remembrance Drive	Weekly for areas within the active subsidence zone or one month after end of LW and continue if ongoing adverse movements or impacts are observed.	Tahmoor Coal ~~(BIS)~~
				Detailed visual inspections by geotechnical engineer for Remembrance Drive embankments and cutting	Monthly for areas within the active subsidence zone during periods of active subsidence of each LW, and continue if ongoing adverse movements are observed.	Douglas Partners
				Inform Sydney Water Call Centre of mining in area and possible issues.	Completed	Sydney Water
				Notify residents of potential mine subsidence impacts and contact numbers.	Completed	Tahmoor Coal
				Analyse and report results to IMG, including information on the position of the longwall face.	Weekly during LW S1A-S7A after the length of the extraction exceeds 200 metres.	Tahmoor Coal
			Ground strain along Remembrance Drive exceeds 2 mm/m or Non-conventional ground movement detected along Remembrance Drive	Notify Jemena	Within 24 hours	Tahmoor Coal
				Notify Jemena and convene an IMG meeting. Consider additional monitoring and mitigation measures based on observed monitoring results, which may include: - increase frequency of ground surveys at affected site - increase frequency of visual inspections - conduct additional gas detection surveys - excavate to expose pipe and reduce distortion or strain on pipe (as per contingency plan) - increase frequency of IMG meetings - any other additional management actions	As required by IMG	Tahmoor Coal
			Leakage of gas observed	Contact Jemena as per contact protocol.	As required by Jemena	Jemena
				Investigate cause of gas leak to ascertain whether leak might be due to subsidence	Within 24 hours	Jemena
				If gas leak is subsidence related, notify all stakeholders, including Jemena, Tahmoor Coal, Wollondilly Shire Council, Sydney Water, Telstra, NBN, Endeavour Energy, neighbouring residents and businesses, Subsidence Advisory NSW and Resources Regulator	Within 24 hours	Tahmoor Coal
				Convene IMG meeting to consider additional monitoring and mitigation measures based on observed monitoring results, which may include: - increase frequency of surveys - increase frequency of visual inspections - conduct additional gas detection surveys - excavate to expose pipe and repair with either temporary clamp or full repair - decide whether to backfill pipe or leave exposed during remaining period of active subsidence - increase frequency of IMG meetings - any other additional management actions	As required by IMG	Tahmoor Coal and Jemena
			A hazard has been identified that involves potential serious injury or illness to a person or persons on public property or, or in vicinity of gas infrastructure and cannot be controlled	IMG, Tahmoor Coal and Jemena meet to decide whether any additional management measures are required, including: - shut off gas main and repair damaged pipe, - emergency evacuation of hazardous area - demarcation to prevent people entering hazardous area	Immediately	Tahmoor Coal and Jemena
				Notify stakeholders, including Jemena, Tahmoor Coal, Wollondilly Shire Council, Sydney Water, Telstra, NBN, Endeavour Energy, neighbouring residents and businesses, Subsidence Advisory NSW and Resources Regulator of trigger exceedance and any management decisions undertaken	Within 24 hours of decision	Tahmoor Coal
			Closure between abutments on Remembrance Drive Bridge over	Notify Jemena	Within one week	MSEC

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
			Bargo River exceeds 7 mm or Impacts observed to bridge	Jemena and IMG meet and consider whether any additional management measures are required, which may include: - conduct additional inspection of gas main on Remembrance Drive Bridge over the Bargo River - conduct additional gas detection surveys - undertake structural engineering inspection - increase monitoring frequency and reporting procedures - excavate to expose pipe and reduce distortion or strain on pipe at pipe bend - consider potential risks and implement control measures to protect the gas main if it is decided to conduct modification works on the bridge	Within one week	IMG
				Report trigger exceedance and actions taken to IMG, Jemena, SA NSW & MSO in Status Report	Within one week	Tahmoor Coal

Table 4.1 Risk Control Procedures during the extraction of Tahmoor LW S1A-S7A

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Electrical Infrastructure	Impacts to infrastructure	Low	None	Continuous GNSS monitoring as shown in Drawing No. MSEC1193-01-01	GNSS units installed Continuous readings, with data averaged over 24 hours and recorded once per day until end of LW S7A.	Tahmoor Coal (Unit Zero)
				2D survey line along Tahmoor Mine property boundary	Pegs installed. Baseline survey complete. Monthly survey during LW S1A between 200m and 1300m extraction, and continue if ongoing adverse movements are observed (complete). End of LW S1A (complete).	Tahmoor Coal (SMEC)
				Conduct visual inspections of power poles, conductors, conductor clearances, house connections and local roads within active subsidence zone	Weekly for areas within the active subsidence zone during LWs S1A to S7A and continue if ongoing adverse movements or impacts are observed until one month after the extraction of each LW.	Tahmoor Coal
				Conduct 2D / Absolute 3D surveys along Main Southern Railway in accordance with Railway Management Plan	Monthly 3D / Weekly 2D surveys for pegs within active subsidence zone during LWs S1A to S7A	Tahmoor Coal (SRS)
				Conduct 2D survey along Charlies Point Road	Pegs installed from eastern end survey line to bend at No. 80 Charlies Point Road. Baseline survey prior to start of LW S1A. Extend line and baseline survey to intersection of Great Southern Road prior to start of LW S2A. Monthly survey during LWs S1A-S5A between 200m and 800m extraction, and continue if ongoing adverse movements are observed. End of LW S1A-S7A.	Tahmoor Coal (SMEC)
				Conduct 2D / Absolute 3D surveys along Remembrance Drive	Pegs installed. Baseline survey complete. Extend line and baseline survey pegs within predicted limit of incremental subsidence of each active LW, prior to active LW face approaching within 600 metres of survey line. Monthly 3D / Weekly 2D surveys for pegs within active subsidence zone commencing as per below: LW S1A: start after 1300m extraction (complete) LW S2A: start after 900m extraction (complete) LW S3A: start after 500m extraction (complete) LW S4A: start after 200m extraction LW S5A: start after GNSS 28 subsides more than 20 mm due to LW S5A or 200m extraction, whichever occurs first LW S6A: start after GNSS 28 subsides more than 20 mm due to LW S6A or 200m extraction LW S7A: start after 200m extraction Continue surveys until outside active subsidence zone or one month after end of LW and continue further if ongoing adverse movements are observed. End of LW S1A-S7A.	Tahmoor Coal (SMEC)
				Conduct 2D surveys along Caloola Road	Pegs installed. Baseline survey prior to 900m extraction of LW S1A. Survey at end of LW S1A. Weekly 2D surveys for pegs within active subsidence zone commencing as per below: LW S2A: start after 900m extraction LW S3A: start after 800m extraction LW S4A: start after 800m extraction LW S5A: start after 900m extraction LW S6A: start after 900m extraction Continue surveys until outside active subsidence zone or one month after end of LW and continue further if ongoing adverse movements are observed. End of LW S2A-S7A.	Tahmoor Coal (SMEC)

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
				Conduct 2D surveys along Yarran Road	Install and baseline prior to start of LW S3A (complete). Survey at end of LW S3A (complete). Weekly 2D surveys for pegs within active subsidence zone commencing as per below: LW S4A: start after 200m extraction LW S5A: start after 200m extraction LW S6A: start after 200m extraction LW S7A: start after 200m extraction Continue if ongoing adverse movements are observed. End of LW S4A-S7A.	Tahmoor Coal (SMEC)
				Conduct 2D surveys along Great Southern Road	Install and baseline prior to start of LW S3A (complete). Survey at end of LW S3A (complete). Weekly 2D surveys for pegs within active subsidence zone commencing as per below: LW S4A: start after 200m extraction LW S5A: start after 200m extraction LW S6A: start after 200m extraction Continue if ongoing adverse movements are observed. End of LW S4A-S7A.	Tahmoor Coal (SMEC)
				Conduct pole surveys measuring subsidence at base and vertical offset or tilt of selected critical poles as shown in Table 3.8. * Note: It is noted that some critical poles are located just outside the predicted limit of subsidence for LW S1A-S7A. Tahmoor Coal will these survey poles during the mining of the longwall panel that is closest to them, as if they were in the active subsidence zone (i.e. when each pole is located within a distance of 150 metres in front and 450 metres behind the active longwall face).	Baseline survey of poles identified for by Endeavour Energy for LW S1A-S7A for poles within the predicted limit of incremental subsidence of each active longwall*, prior to active longwall approaching within 600 metres of pole. Monthly for each pole within active subsidence zone and for following three months after leaving active subsidence zone* End of LW S1A-S7A for all poles within predicted limit of incremental subsidence of each active longwall*.	Tahmoor Coal (SMEC)
				Analyse and report results to IMG, including information on the position of the longwall face.	Weekly during LW S1A-S7A after the length of the extraction exceeds 200 metres.	Tahmoor Coal
			Impacts observed to power poles, buried cables or conductor clearance heights	Notify all stakeholders, including Endeavour Energy, Tahmoor Coal, Subsidence Advisory NSW and Resources Regulator	Within 24 hours	Tahmoor Coal
				Repair impact.	As per Endeavour Energy procedures	Endeavour Energy
				Infrastructure Management Group (IMG) meets to consider whether any additional management measures should be undertaken, including: - increasing the frequency of surveys and visual inspections in vicinity of impact site; - investigating for potential of damage occurring to nearby Endeavour Energy infrastructure.	As agreed between Tahmoor Coal and Endeavour Energy	IMG
Electrical Infrastructure	Impacts to infrastructure	Low	A hazard has been identified that involves potential serious injury or illness to a person or persons on public property or, or in vicinity of electrical infrastructure and cannot be controlled	IMG, Tahmoor Coal and Endeavour Energy meet to decide whether any additional management measures are required, including: - emergency evacuation of hazardous area - demarcation to prevent people entering hazardous area	Immediately	Tahmoor Coal and Endeavour Energy
				Notify IMG of trigger exceedance and any management decisions undertaken (incl Subsidence Advisory NSW, Resources Regulator)	Within 24 hours of decision	Tahmoor Coal

Table 5.1 Risk Control Procedures for Telecommunications Infrastructure during the Extraction of LW S3A-S7A (TARP)

Item of Plant	RISK	Trigger	Control Procedures	Timing and Frequency	By Whom
1. Telstra Local cable a) Conduit & Pit Network b) Aerial Cable Network	Low Moderate	Ground Strain > 1.5mm/m and/or anomalous ground movement reported.	Survey Lines along Remembrance Drive, Caloola and Yarran Roads. Visual inspection of aerial cable network with focus on pole tilt and cable tension/sag - report other (non-subsidence) infrastructure damage to asset owner. If triggered complete specific visual inspection refer to IMG.	Baseline prior to LW start. Weekly during active subsidence. Weekly during active subsidence Within 48hrs	SMEC/TC TC TC/IMG
2. Main Copper Network. a) Plastic Sheath Cable b) Lead Sheathed Cable	Low	Ground Strain > 1.5mm/m and/or anomalous ground movement reported.	Survey Lines along Remembrance Drive. Visual inspection of pit top only - report other (non-subsidence) infrastructure damage to asset owner. If triggered complete specific visual inspection based on survey results. Refer to IMG.	Baseline prior to LW start. Weekly during active subsidence. Monthly during active subsidence. Within 48hrs	SMEC/TC TC TC/IMG
3. Telstra direct buried IEN/CAN optical fibre cable (F BRGO 101 12f)	Medium	OTDR loss on fibre <0.3dB and/or ground strain >1.5mm/m or anomalous movement.	Baseline local street surveys along Remembrance Drive and the rail corridor. Visual inspection if triggered - report other (non-subsidence) infrastructure damage to asset owner. Routine real time monitoring of optic fibre performance by Telstra (including triggers in-house technical meetings) If triggered refer to IMG (consider uncoupling), visual inspection, report other (non-subsidence) infrastructure damage to asset owner.	Baseline prior to LW start. Weekly during active subsidence. Weekly Within 48hrs	SMEC/TC Telstra TC/IMG
4. Conduit, Manhole and Pit Network	Low	If survey details show anomalous movement check cables in conduit network.	Survey Lines along Remembrance Drive, Caloola and Yarran Roads. Visual inspection of conduit routes pits and manholes in Remembrance Drive, Caloola Road and Yarran Road whilst in area of active - report other (non-subsidence) infrastructure damage to asset owner. If triggered refer to IMG.	Baseline prior to LW start. Weekly during active subsidence. If triggered only. Within 48hrs	SMEC TC TC/IMG
5. NBN Tower	Medium	Tip rotation exceeds 1° (excluding wind effects)	Baseline local street surveys along Remembrance Drive, Yarran Road and power cable alignment. Weekly visual inspections of power cable route and tower - report other (non-subsidence) infrastructure damage to asset owner. Routine real time monitoring tilt monitoring of tower structure If triggered refer to IMG.	Baseline prior to LW start. Weekly during active subsidence. 24hrs/day Within 48hrs	SMEC TC Sweeting Consulting TC/IMG

Table 6.1 Risk control procedures for built structures for LWs S1A-S7A

Infrastructure	Hazard / impact	Risk	Trigger	Control procedure/s	Timing and frequency	By whom?
Items of heritage significance, public amenities, commercial, business and industrial establishments predicted to experience more than 20 mm of subsidence due to the extraction of LWs S1A-S7A				Refer separate Property Subsidence Management Plans		
Residential structures that will experience mine subsidence effects due to the mining of LWs S1A-S7A	Impacts occur	Low to Moderate	Prior to mining	Community consultation, including letters to landowners offering a Pre-Mining Inspection and Hazard Identification inspection for structures predicted to experience more than 20 mm of subsidence due to the extraction of LWs S1A-S7A.	Complete	Tahmoor Coal
				Front of house screening inspection to identify any potentially unstable structures, for structures predicted to experience more than 20 mm of subsidence due to the extraction of LWs S1A-S7A.	Complete	Tahmoor Coal
				Conduct pre-mining hazard identification inspection and assessment by geotechnical engineer of structures on or near steep slopes to check whether there is any potential for slope instability prior to, during or after mining, for structures predicted to experience more than 20 mm of subsidence due to the extraction of LWs S1A--S7A.	No structures located on or near natural steep slopes within Study Area	-
				Conduct pre-mining hazard identification inspection and assessment by structural engineer, including: • structures requested for inspection by landowner during community consultation • structures directly above LWs S1A-S7A in semi-rural / rural areas remote from street front, where front of house screening is not practicable • structures that have been recommended for structural inspection by the geotechnical engineer • structures that have been recommended for structural inspection during front of house screening inspections • structures built prior to declaration of the Bargo Mine Subsidence District (1975) that are predicted to experience more than 150 mm of subsidence due to the extraction of LWs S1A-S7A • structures above potential hidden creeks that are predicted to experience more than 20 mm of subsidence due to the extraction of LWs S1A-S7A • structures above mapped geological structures that are predicted to experience more than 20 mm of subsidence due to the extraction of LWs S1A-S7A	Complete for LWs S1A-S3A All but one complete for LW S4A Complete remainder prior to active LW face approaching within 300 m of each property	Tahmoor Coal
				Installation of additional monitoring measures or mitigation/strengthening measures as recommended by structural engineer.	Prior to active LW face approaching within 100 m of each property	Tahmoor Coal
				Install ground monitoring lines on streets above LWs S1A-S7A and baseline survey initial levels and strain distances (as shown in Drawing No. MSEC1193-01-01).	Complete Complete within predicted limit of incremental subsidence of each active LW, prior to active LW face approaching within 600 metres of survey line.	Tahmoor Coal (SMEC)
				Install ground pegs for structures as requested by or agreed with landowners	Complete prior to active LW face approaching within 400 m of each property	Tahmoor Coal (SMEC)
				Confirm arrangements for building contractors to remain on standby for immediate call out and service in the event of impacts affecting safety or serviceability.	Complete	Tahmoor Coal
			Discovery of potential structural issue prior to mining	Conduct structural hazard identification inspection and assessment and consider: - any mitigation / strengthening measures to improve the existing structural condition - any management measures that should be undertaken prior to or during mining - any monitoring and inspection measures, triggers and responses during mining	Within 1 week of discovery	Tahmoor Coal
				Advise property owner, Subsidence Advisory NSW and Resources Regulator of findings of structural engineer.	Prior to active LW face approaching within 300 m of each property	Tahmoor Coal
				Undertake mitigation / strengthening measures if decided by SRG.	Prior to active LW face approaching to within 100 m of structure	Tahmoor Coal

Infrastructure	Hazard / impact	Risk	Trigger	Control procedure/s	Timing and frequency	By whom?
Residential structures that will experience mine subsidence effects due to the mining of LWs S1A-S7A	Impacts occur	Low to Moderate	During the mining of LWs S1A-S7A	Surveys of street survey lines within active subsidence area, including Charlies Point Road, Remembrance Drive, Caloola Road, Yarran Road and the Great Southern Road	Weekly for pegs located within active subsidence zone after the length of the extraction exceeds 200 metres (except monthly for pegs along Charlies Point Road)	Tahmoor Coal (SMEC)
				Conduct kerbside visual inspection of streets and structures	Detailed inspection once a week Vehicle based inspection once a week within active subsidence area	Tahmoor Coal
				Conduct inspections during mining for following structures (where access is granted): a) Structures that have previously experienced mine subsidence impacts, where recommended by the SRG b) Pool gates and fences c) Any other structures recommended for regular inspections and/or structure surveys by geotechnical or structural engineer following pre-mining hazard identification inspection and assessment	Weekly within active subsidence zone after the length of the extraction exceeds 200 metres, or as required by geotechnical or structural engineer	Tahmoor Coal
				Conduct ground surveys for structures as requested by or agreed with landowners	One survey per longwall when house is within active subsidence zone, targeted to occur when LW face has passed house between 100 and 200 metres.	Tahmoor Coal (SMEC)
				Analyse and report results of monitoring and inspections to SRG	Weekly during LWs S1A-S7A after the length of the extraction of each LW exceeds 200 metres.	Tahmoor Coal (MSEC)
				SRG discuss results and consider whether any additional management measures are required	Weekly during LWs S1A-S7A after the length of the extraction of each LW exceeds 200 metres.	SRG
			Observed tilts are greater than 7 mm/m or observed curvatures are greater than 0.2 km^{-1} near structure	Conduct inspection of building and provide photographic survey and impact report	Within one week	Tahmoor Coal
				Consider structural inspection/additional monitoring and/or mitigation/strengthening measures	Immediately after building inspection	Tahmoor Coal
			Significant non-conventional movement occurs or Impacts observed to any surface infrastructure (not just structures) or Slope slippage observed	Consider whether any additional management measures are required in light of observations, including additional geotechnical or structural inspections, increase frequency of surveys and inspections, additional community consultation	As required by SRG	SRG
				Notify landowner, Tahmoor Coal, Subsidence Advisory NSW and MSO	Within one week	Tahmoor Coal

Infrastructure	Hazard / Impact	Risk	Trigger	Control procedure/s	Timing and frequency	By whom?
Residential establishments that will experience mine subsidence movements due to the mining of LW S1A-S7A	Impacts occur	Low to Moderate	Any impact occurs to structure	As information can come from many possible sources: If not already done, notify landowner, Tahmoor Coal, Subsidence Advisory NSW	Within 24 hours	Tahmoor Coal
				Inspect impact of subsidence on building	As soon as possible	Tahmoor Coal
				Inspect condition of building by structural engineer, where recommended by the SRG based on feedback from Subsidence Advisory NSW	As recommended by SRG with active subsidence area or as agreed with owner	Tahmoor Coal
				Rectify any adverse impacts that impair upon: - the safety, access and mobility, security or fire egress - any essential services - sensitive equipment	As soon as possible at any stage during mining	Tahmoor Coal
				Repair damage to structure	When subsidence impacts cease	Tahmoor Coal
			Observed impacts meet the criteria under Condition C15 of the Project Approval (refer Section 1.9)	Offer landowner the option to acquire property in accordance with the *Coal Mine Subsidence Compensation Act 2017*.	As soon as possible	Tahmoor Coal
			Observed impacts are greater than predicted impacts	Investigate cause(s) for greater impacts, including possibility of non-conventional or anomalous movements, type of structure. Investigate spatial trends in data to identify any pattern.	Within one week of observation	Tahmoor Coal
			Structure has become or is likely to be become hazardous as a result of subsidence	Notify landowner, Tahmoor Coal, Subsidence Advisory NSW and Resources Regulator	Within 24 hours	Tahmoor Coal
				Inspect structural condition of building.	Within two days and then as recommended by structural engineer	Tahmoor Coal
				Reassess final level of damage based upon likelihood of further damage and structural condition.	Immediately after structural re-inspection.	SRG
				Consider additional monitoring and/or mitigation/strengthening measures	Immediately after structural re-inspection.	SRG
			A hazard has been identified that involves potential serious injury or illness to a person or persons at the property, and cannot be controlled	Provide temporary accommodation for residents in coordinate with Subsidence Advisory NSW	Immediately	Tahmoor Coal
				Notify MSO	Within 24 hours	Tahmoor Coal
				Offer landowner the option to acquire property in accordance with the *Coal Mine Subsidence Compensation Act 2017*.	Immediately	Tahmoor Coal
			Property owner does not accept acquisition	Temporarily relocate residents until building is repaired	Immediately	Tahmoor Coal
Houses	House subsides below 1% AEP flood level	Moderate	Prior to Mining	Conduct flood study to assess potential for floor levels of houses near Teatree Hollow at intersection of Caloola Road and Remembrance Drive to fall below 1% AEP flood level due to mine subsidence	Complete	Tahmoor Coal
				Conduct pre-subsidence survey of surface topography and floor levels of houses near predicted 1% AEP flood level.	LiDAR survey complete Floor level surveys prior to 800m extraction of LW S1A	Tahmoor Coal (SMEC)
			During Mining	Ensure culverts along Teatree Hollow at Remembrance Drive and Main Southern Railway are clear of debris	Ongoing	Tahmoor Coal
			Completion of Mining	Conduct post-mining survey of surface topography and floor levels of houses	End of LW S7A	Tahmoor Coal (SMEC)
				Conduct post-mining flood study to assess whether any houses has subsided below 1% AEP flood level	End of LW S7A	Tahmoor Coal
			House(s) subside below 1% AEP flood level	Raise house(s) or upgrade drainage structures so that floor level(s) are above 1% AEP flood level	As required	Tahmoor Coal
Houses	Impacts to future houses	Low to Moderate	Prior to mining each LW	Contact residents to inform them of commencement of mine subsidence. Request owners for information on whether any new houses have been constructed in the last year.	Prior to subsidence occurring	Tahmoor Coal
			Owner notifies of new house	Conduct subsidence predictions, impact assessment and pre-mining hazard identification inspection, if access provided by landowner	Prior to subsidence occurring	Tahmoor Coal
				Follow risk control procedures, as for other houses	Immediately	Tahmoor Coal (MSEC)

Infrastructure	Hazard / impact	Risk	Trigger	Control procedure/s	Timing and frequency	By whom?
Swimming pools and pool gates	Damage to pool	Low	None	Notify owner of potential impacts to pool	Before mine subsidence impacts occur	Tahmoor Coal
	Pool gate – won't shut	High	None	Notify owner of potential impact to pool gate and fence	Before mine subsidence impacts occur	Tahmoor Coal
				Visually inspect pool gate to check that it is operating properly	Weekly when each pool is within active subsidence zone, and at completion of each longwall	Tahmoor Coal
			Pool gate won't close	Notify resident and/or landowner, contact Subsidence Advisory NSW to repair gate	Immediately	Tahmoor Coal
				Repair gate	As soon as possible	Tahmoor Coal
Farm dams	Loss of water storage due to leakage of dam wall or floor	Low	During mining	Visual inspection of dam by geotechnical engineer, including recording of water levels	Monthly during period of active subsidence at each dam for each LW Quarterly for minimum of 12 months after completion of LW S7A	Tahmoor Coal
			Cracks > 10mm wide observed in dam wall (i.e. other than natural desiccation cracking) AND/OR Isolated seepage without suspended solids (e.g. clear water) from the face or toe of the farm dam embankment	Notify SRG	Within 24 hours	Tahmoor Coal
				Conduct geotechnical inspection of dam to assess cause and determine need for further action / investigation	Within 48 hours	Tahmoor Coal
				SRG meet and review latest monitoring information for the dam, inspections by geotechnical engineer and building inspector, and latest weather forecasts. SRG consider whether any additional management measures are required, which may include: - backfill cracks and/or regrade drainage line - increase monitoring frequency and reporting procedures - arrange additional monitoring locations to monitor potential displacement of dam wall material - lower water level of dam (if relevant) - consider potential consequence of dam break and whether any other management measures are required.	Within 24 hours of geotechnical inspection	SRG
				Notify landowner, Tahmoor Coal, Subsidence Advisory NSW and Resources Regulator	Within 24 hours	Tahmoor Coal
			Persistent longitudinal or arcuate cracking > 20 mm wide observed within dam wall AND Seepage with suspended solids (e.g. turbid water) from the face or toe of the farm dam embankment	Notify SRG	Within 24 hours	Tahmoor Coal
				Conduct geotechnical inspection of dam to assess cause and determine need for further action / investigation	Within 24 hours	Tahmoor Coal
				SRG meet and review latest monitoring information for the dam, inspections by geotechnical engineer and building inspector, and latest weather forecasts. SRG consider whether any additional management measures are required, which may include: - backfill cracks and/or regrade drainage line - increase monitoring frequency and reporting procedures - arrange additional monitoring locations to monitor potential displacement of dam wall material - lower water level of dam (if relevant) - consider potential consequence of dam break and whether any other management measures are required.	Within 24 hours of geotechnical inspection	SRG
				Notify landowner, Tahmoor Coal, Subsidence Advisory NSW and Resources Regulator	Within 24 hours	Tahmoor Coal
			Loss of water supply due to leakage of dam wall or floor	Supply water to landowner	As required	Tahmoor Coal

Table 4.1 Risk Control Procedures during the extraction of Tahmoor LW S1A-S6A

RISK ISSUE	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
IMPACTS ON BUILDINGS, WALLS, PAVEMENTS, FENCES, GATES AND DAM	None	Undertake structural inspections and assessments before subsidence	Complete	Tahmoor Coal (JMA)
		Conduct 2D / Absolute 3D surveys along Remembrance Drive	Baseline survey complete. Monthly 3D / Weekly 2D surveys for pegs within active subsidence zone: Continue surveys until outside active subsidence zone or one month after end of LW and continue further if ongoing adverse movements are observed. End of LW S1A-S6A.	Tahmoor Coal (SMEC)
		Local 3D survey around perimeter of buildings during active subsidence as per Drawing No. MSEC1193-11-02	Pegs installed and baseline survey completed Surveys if triggered by ground surveys and/or visual inspections. End of LW S1A-S4A.	Tahmoor Coal (SMEC)
		2D survey along four monitoring lines between College buildings during active subsidence, as per Drawing No. MSEC1193-11-02	Pegs installed and baseline survey completed Weekly surveys during active subsidence zone as per below: LWs S1A and S2A: after 1500m extraction until one month after end of LW Continue surveys if ongoing adverse movements are observed. End of LW S1A-S4A.	Tahmoor Coal (SMEC)
		Local 3D survey around perimeter of Clifford Warne Auditorium during active subsidence	Pegs installed and baseline survey completed Weekly surveys during active subsidence zone as per below: LWs S1A and S2A: after 1500m extraction until one month after end of LW Continue surveys if ongoing adverse movements are observed. End of LW S1A-S4A.	Tahmoor Coal (SMEC)
		Visually inspect Wollondilly Anglican College by building inspector, including buildings, wall, handrails, pavements, footbridge, fences, gates and the dam and focussed inspections as recommended by structural engineer JMA Solutions in Table 3.4 of this Management Plan.	Weekly inspection during active subsidence zone as per below: LWs S1A and S2A: after 1500m extraction until one month after end of LW Continue inspections if ongoing adverse movements are observed. End of LW S1A-S4A.	Tahmoor Coal (BIS)
		Visually inspect dam by geotechnical engineer (the dam is planned to decommissioned by Wollondilly Anglican College in early 2024)	Weekly inspection during active subsidence zone whilst dam is in operation as per below: LWs S1A and S2A: after 1500m extraction until one month after end of LW Continue inspections if ongoing adverse movements are observed. End of LW S1A-S4A.	Tahmoor Coal (Douglas Partners)
		Maintenance inspection of the lift	Pre-mining inspection complete Maintain as per standard Wollondilly Anglican College procedures End of LW S2A	Wollondilly Anglican College (The Lift Shop)
		Alignment surveys of sensitive school equipment as required by Wollondilly Anglican College	Baseline survey prior 1100m extraction of LW S1A Additional surveys if triggered by ground surveys and/or visual inspections.	Tahmoor Coal (SweetingConsulting)
		Report findings of surveys and inspections to SRG, Wollondilly Anglican College, Subsidence Advisory NSW, Resources Regulator	LWs S1A and S2A: after 1500m extraction until one month after end of LW Continue reporting if ongoing adverse movements are observed End of LW S1A-S4A.	Tahmoor Coal (MSEC)
		Review and assess monitoring report and consider whether any additional management measures are required	LWs S1A and S2A: after 1500m extraction until one month after end of LW Continue reviews if ongoing adverse movements are observed End of LW S1A-S4A.	SRG

RISK ISSUE	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
IMPACTS ON BUILDINGS, WALLS, PAVEMENTS, FENCES, GATES AND DAM (continued)	Non-conventional movements identified from weekly surveys or Visual inspections identify impacts to building	SRG meet and consider whether any additional management measures are required, including: - structural inspection - additional survey around building(s) - increase monitoring and reporting procedures - repair impacts	Within 1 week or as required	SRG
		Notify SRG of trigger exceedence and any management decisions undertaken (incl Wollondilly Anglican College, Subsidence Advisory NSW, Resources Regulator)	Within one week	Tahmoor Coal
	A hazard has been identified that involves potential serious injury or illness to a person or persons on public property, or Wollondilly Anglican College property and cannot be controlled	SRG, Tahmoor Coal and Wollondilly Anglican College meet to decide whether any additional management measures are required, including: - suspension of work activities within the hazardous area - demarcation of workplace to restrict people from entering or working in hazardous area - emergency evacuation of workplace - decide whether to continue LW operation in current LW panel or relocate LW equipment to next LW panel	Immediately	Tahmoor Coal
		Notify SRG of trigger exceedence and any management decisions undertaken (incl Wollondilly Anglican College, Subsidence Advisory NSW, Resources Regulator)	Within 24 hours of decision	Tahmoor Coal
IMPACTS ON FIRE PROTECTION SERVICES, SECURITY SERVICES, ESSENTIAL SERVICES, ACCESS AND MOBILITY, FINISHES, AND PUBLIC SAFETY HAZARDS	None	Follow procedures above	-	-
	Impacts observed	Repair impacts	Immediately as required by Wollondilly Anglican College to avoid interruption to operations (target within 24 hours if required)	Tahmoor Coal
		Notify SRG of trigger exceedence and any management decisions undertaken (incl Wollondilly Anglican College, Subsidence Advisory NSW, Resources Regulator)	Within one week	Tahmoor Coal
IMPACTS ON FOOTBRIDGE	None	Follow procedures above	-	-
	Closure between footbridge abutments exceeds 10 mm or Expansion gaps between footbridge deck and abutments are closed or Visual inspections identify impacts to footbridge	SRG meet and consider whether any additional management measures are required, including: - structural inspection - increase monitoring and reporting procedures - cut additional gap between deck and abutments - repair impacts	Within 1 week or earlier if required	SRG
		Notify SRG of trigger exceedence and any management decisions undertaken (incl Wollondilly Anglican College, Subsidence Advisory NSW, Resources Regulator)	Within one week	Tahmoor Coal
IMPACTS ON MANUFACTURING TRAINING EQUIPMENT	None	Follow procedures above	-	-
	Non-conventional movements identified from weekly surveys near Bradfield College or Visual inspections identify impacts to Bradfield College or Wollondilly Anglican College observed misalignment to equipment	SRG meet and consider whether any additional management measures are required, including: - Additional alignment survey - increase monitoring and reporting procedures - relevel equipment	Within 1 week or earlier if required	SRG
		Notify SRG of trigger exceedence and any management decisions undertaken (incl Wollondilly Anglican College, Subsidence Advisory NSW, Resources Regulator)	Within one week	Tahmoor Coal

© MSEC FEBRUARY 2023 | REPORT NUMBER MSEC1193-11 | REVISION A

RISK ISSUE	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
IMPACTS ON PASSENGER LIFT	None	Follow procedures above	-	-
	Non-conventional movements identified from weekly surveys near Cuthbert College or Visual inspections identify impacts to Cuthbert College or lift	SRG meet and consider whether any additional management measures are required, including: - structural inspection - additional maintenance inspection of lift - increase monitoring and reporting procedures - repair impacts	Within 1 week or earlier if required	SRG
		Notify SRG of trigger exceedence and any management decisions undertaken (incl Wollondilly Anglican College, Subsidence Advisory NSW, Resources Regulator)	Within one week	Tahmoor Coal
IMPACTS ON STORAGE AND MATERIALS HANDLING	None	Follow procedures above	-	-
	Substantial tilt of storage shelves observed	SRG meet and consider whether any additional management measures are required, including: - relevel storage shelves - provide additional support to shelving	As required by Wollondilly Anglican College to avoid interruption to operations (target within 24 hours if required)	Tahmoor Coal
		Notify SRG of trigger exceedence and any management decisions undertaken (incl Wollondilly Anglican College, Subsidence Advisory NSW, Resources Regulator)	Within one week	Tahmoor Coal
IMPACTS ON DAM	None	Follow procedures above	-	-
	Cracks observed in dam wall > 10 mm wide (other than natural desiccation cracking) or Seepage observed in dam wall	SRG meet and consider whether any additional management measures are required, including: - increase in frequency of surveys, visual inspections and reporting - place material at the toe of the embankment - temporarily lower or dewater dam or repair the dam wall - brief Wollondilly Anglican College staff and students to restrict access downstream of dam	As required (target within 48 hours)	Tahmoor Coal
		Notify SRG of trigger exceedence and any management decisions undertaken (incl Wollondilly Anglican College, Subsidence Advisory NSW, Resources Regulator)	Within one week	Tahmoor Coal
	A hazard has been identified that involves potential serious injury or illness to a person or persons and cannot be controlled	SRG, Tahmoor Coal and Wollondilly Anglican College meet to decide whether any additional management measures are required, including: - suspension of work activities within the hazardous area - demarcation of workplace to restrict people from entering or working in hazardous area - emergency evacuation of workplace - dewater	Immediately	Tahmoor Coal
		Notify SRG of trigger exceedence and any management decisions undertaken (incl Wollondilly Anglican College, Subsidence Advisory NSW, Resources Regulator)	Within 24 hours of decision	Tahmoor Coal

Table 5.2 Risk Control Procedures during the extraction of Tahmoor LW S1A-S6A

TRIGGER	CONTROL PROCEDURES	TIMING & FREQ	BY WHOM?
General Procedures			
ABBREVIATIONS WITHIN THESE TABLES: ARTC = Australian Rail Track Corporation MSO = NSW Department of Planning & Environment, Resources Regulator, Mine Safety Operations SRS = Southern Rail Surveys (ground surveys within rail corridor) MSEC = Mine Subsidence Engineering Consultants IMG = Infrastructure Management Group RMC = Rail Maintenance Contractor, Bloor Rail JMA = JMA Solutions (structural engineer) SMEC = SMEC (ground surveys beyond rail corridor) BIS = Building Inspection Services TC = Tahmoor Coal	**None**	**EARLY WARNING MONITORING**		
	Continuous GNSS monitoring for S1 to S15 as shown in Drawing No. MSEC1201-03	GNSS units S1 to S15 installed Continuous readings, with data averaged over 24 hours and recorded once per day	Tahmoor Coal (Unit Zero)
	2D survey line along Tahmoor Mine property boundary and alongside (V Line)	Pegs installed. Baseline survey prior to commencement of LW S1A. Monthly survey during LW S1A between 200m and 1300m extraction, and continue if ongoing adverse movements are observed. End of LW S1A.	Tahmoor Coal (SMEC)
	GENERAL MINE SITE MONITORING		
	Continuous GNSS monitoring at unit S16 near the site survey datum and Shaft No. 3 Continuous GNSS monitoring at unit “Gantry” on top of Pier 2	GNSS unit S16 and Gantry installed Continuous readings, with data averaged over 24 hours and recorded once per day	Tahmoor Coal (Unit Zero)
	Conduct 2D / Absolute 3D surveys along Main Southern Railway in accordance with Railway Management Plan	Monthly 3D / Weekly 2D surveys for pegs within active subsidence zone	Tahmoor Coal (SRS)
	Conduct 2D / Absolute 3D surveys along Rail Loop	Pegs installed. Baseline survey completed. Monthly 3D / Weekly 2D surveys LW S1A and LW S2A: Monthly after 1100m, weekly after 1300m until one month after end of LW, and continue if ongoing adverse movements are observed End of LW S1A-S3A	Tahmoor Coal (SRS)
	Conduct 2D / Absolute 3D surveys along Remembrance Drive in accordance with Wollondilly Shire Council Management Plan	Monthly 3D / Weekly 2D surveys for pegs within active subsidence zone	Tahmoor Coal (SMEC)
	Visual inspections of mine site, including Stockpile Area, overhead conveyors, underground conveyors, building structures, pavements, dams (subsidence inspection in addition to routine inspections by Tahmoor Mine as part of routine operations)	Weekly within the active subsidence zone until one month after end of LW, and continue if ongoing adverse movements are observed	Tahmoor Coal / BIS
	OTHER MEASURES		
	Standard Tahmoor Coal maintenance, monitoring and risk control procedures, including inspections and condition monitoring	As per TC operations and maintenance management system	Tahmoor Coal
	Brief and train workers at Tahmoor Mine Site	Complete	Tahmoor Coal
	Analyse and report results to IMG	LW S1A and LW S2A: Weekly after 1000m until one month after end of LW, and continue if ongoing adverse movements are observed End of LW S1A-S3A	Tahmoor Coal (MSEC)
	IMG discuss results and consider whether any additional management measures are required	LW S1A and LW S2A: Monthly after 1000m, weekly after 1300m until one month after end of LW, and continue if ongoing adverse movements are observed End of LW S1A-S3A	Tahmoor Coal (MSEC)

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Stockpile Area (Conveyors 5C and Reclaim Tunnel Conveyor 6C)	Conveyor 5C: Stress build-up in trestle legs and at bolted connections to gallery Stress in superstructure, particularly T4 to Pier 2 Change in alignment of 5C conveyor and tripper rails Loss of serviceability Reclaim Tunnel Conveyor 6C: Cracking of tunnel structure at isolated locations Change in alignment of 6C conveyor Loss of serviceability and egress	Medium	None	Follow general procedures	-	-
				Conduct structural assessment of Overhead Conveyor 5C and Reclaim Tunnel structure	Complete	JMA
				Temporarily remove Pedestrian Gantry during active subsidence	Prior to 1200m of LW S1A (planned Feb 2023)	Tahmoor Coal
				Strengthen Pier 1 connection	Complete	Tahmoor Coal
				Upgrade expansion joint at T4 and modify services, walkway, tripper rail across expansion joint	Complete	Tahmoor Coal
				Design and Install new sliding bearing at Pier 2 connection	Complete	Tahmoor Coal
				Cut movement joint in Reclaim Tunnel between T6 and Pier 2 and modify services across joint to accommodate movement	Complete	Tahmoor Coal
				Install Tripper rail expansion joint with removable inserts	Complete	Tahmoor Coal
				Check conveyor and tripper rail alignment and correct to within operating tolerances (if required)	Complete	Tahmoor Coal
				Continuous Wander tracking switches (existing)	Operate continuously Conveyor 5C: Prior to 1200m of LW S1A Conveyor 6C complete	Tahmoor Coal
				Dozer proximity alarm to Trestle legs (existing)	Operate continuously	Tahmoor Coal
				Fixed CCTV camera	Operate continuously	Tahmoor Coal
				Relative 3D surveys along Reclaim Tunnel (Conveyor 6C)	Baseline survey prior to 900m of LW S1A LW S1A and LW S2A: Weekly after 1200m until one month after end of LW, and continue if ongoing adverse movements are observed End of LW S1A-S3A	Tahmoor Coal (SMEC)
				Relative 3D surveys along tops of trestles and concrete piers (Conveyor 5C)	Baseline survey prior to 900m of LW S1A LW S1A and LW S2A: Weekly after 1200m until one month after end of LW, and continue if ongoing adverse movements are observed End of LW S1A-S3A	Tahmoor Coal (SMEC)
				Stockpile inclinometers 1 and 2	Installed and baseline surveyed LW S1A and LW S2A: Weekly after 1200m until one month after end of LW, and continue if ongoing adverse movements are observed End of LW S1A-S3A	Tahmoor Coal
				Continuous tilt monitoring at Gantry GNSS unit on top of Pier 2	Installed Continuous readings, with data averaged over 24 hours and recorded once per day	Tahmoor Coal (Unit Zero)
				Continuous expansion joint monitoring by displacement sensor and tilt monitoring at Trestle T4	Installed Continuous readings, with data averaged over 24 hours and recorded once per day	Tahmoor Coal (SweetingConsulting)
				Measure gap in tripper rail at expansion joint	LW S1A and LW S2A: Weekly after 1200m until one month after end of LW, and continue if ongoing adverse movements are observed	Tahmoor Coal
				Continuous stress monitoring at Trestle T4	Installed Continuous readings, with data averaged over 24 hours and recorded once per day	Tahmoor Coal (SweetingConsulting)
				Joint monitoring across movement joint in Reclaim Tunnel between Trestle T6 and Pier 2	Baseline survey prior to 900m of LW S1A LW S1A and LW S2A: Weekly after 1200m until one month after end of LW, and continue if ongoing adverse movements are observed End of LW S1A-S3A	Tahmoor Coal (SMEC)

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Stockpile Area (Conveyors 5C and Reclaim Tunnel Conveyor 6C) (continued)	Conveyor 5C: Stress build-up in trestle legs and at bolted connections to gallery Stress in superstructure, particularly T4 to Pier 2 Change in alignment of 5C conveyor and tripper rails Loss of serviceability Reclaim Tunnel Conveyor 6C: Cracking of tunnel structure at isolated locations Change in alignment of 6C conveyor Loss of serviceability and egress	Medium	A hazard has been identified that involves potential serious injury or illness to a person or persons and cannot be controlled	Notify Tahmoor Coal Senior Management Group and implement any required actions	Immediately	Tahmoor Coal
				IMG and Tahmoor Coal Senior Management Group meet to decide whether any additional management measures are required, including: - emergency evacuation of hazardous area - demarcation to prevent people entering hazardous area - If Conveyor 5C is unserviceable: use Pier 1 Clam Gate and push coal in stockpile until repairs can be completed (may require second Dozer) - If Reclaim Tunnel and Conveyor 6C are unserviceable: Coal to be loaded out of the stock pile via front end loader operation to load trains and/or develop temporary loading facility at base of Conveyor 7C	Immediately	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within 24 hours of decision	Tahmoor Coal
			Displacement sensor at T4 opens or closes more than 30 mm and/or Longitudinal strain within Reclaim Tunnel exceeds 1 mm/m (tensile or compressive) between adjacent prisms and/or Damage observed from visual inspections	Notify IMG and Resources Regulator	Within one week	Tahmoor Coal
				IMG meet to decide whether any additional management measures are required, including: - increase in frequency of surveys, visual inspections and reporting - Adjust rail tripper expansion joint - Adjust sliding bearing at Pier 2 - Adjust connection at Pier 1 - Restrict stockpile operations (staged) - Provide additional structural support to Conveyor 5C (props) - Adjust conveyor alignment - Adjust tripper rail alignment - Repair services - Isolate and Repair with the use of the clam gate - Repair cracks to concrete lining - Provide additional structure support to roof and walls to maintain access and second egress - Restrict stockpile operations to reduce load on tunnel - Excavate and expose tunnel lining and strengthen tunnel externally, repair chutes	As required (target within 48 hours)	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within one week	Tahmoor Coal

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Overhead conveyors (other than Conveyor 5C) and Reclaim Tunnel Conveyor 4F	Overhead conveyors: Stress build-up in trestle legs and at bolted connections Stress in superstructure Change in alignment of conveyor Loss of serviceability Reclaim Tunnel Conveyor 4F: Cracking of tunnel structure at isolated locations Change in alignment of 4F conveyor Loss of serviceability and egress	Low	None	Follow general procedures	-	-
				Conduct structural assessment of overhead conveyors	Complete	JMA
				Check conveyor alignment and correct to within operating tolerances for Conveyors 3R, 4C, 4S, 6C, 7C and 8C (if required)	Complete	Tahmoor Coal
				Local 3D survey along tops and bases of conveyor trestles	Baseline survey prior to 1000m of LW S1A LW S1A and LW S2A: Weekly after 1300m until one month after end of LW, and continue if ongoing adverse movements are observed End of LW S1A-S3A	Tahmoor Coal (SMEC)
				Laser distancemeter across MSR at Conveyor 3R	Installed Continuous readings, with data averaged over 24 hours and recorded once per day	Tahmoor Coal (SweetingConsulting)
				Extensometer monitoring across base of four-legged trestle at Conveyor 3R	Baseline survey complete End of LW S1A-S3A	Tahmoor Coal (SRS)
				Local 3D survey along Reclaim Tunnel 4F	Baseline survey prior to 900m of LW S1A End of LW S1A-S3A	Tahmoor Coal (SMEC)
				Stockpile inclinometer 2	Installed and baseline surveyed LW S1A and LW S2A: Weekly after 1300m until one month after end of LW, and continue if ongoing adverse movements are observed End of LW S1A-S3A	Tahmoor Coal
				Continuous Wander tracking switches (existing)	Operate continuously	Tahmoor Coal
			Opening or Closure between adjacent trestles exceeds 10 mm and/or Damage observed from visual inspections	Notify IMG and Resources Regulator	Within one week	Tahmoor Coal
				Notify ARTC if the trigger was exceeded where Conveyor 3R crosses the Main Southern Railway	Within one week	Tahmoor Coal
				IMG meet to decide whether any additional management measures are required, including: - increase in frequency of surveys, visual inspections and reporting - Adjust hold down bolts and install shims to underside of baseplates - Place concrete block adjacent to trestle bases - Provide additional structural support to trestles (props) - Adjust conveyor alignment - Repair services - Install fencing to prevent access of site staff beneath affected section of conveyor - Repair cracks to concrete lining - Provide additional structure support to roof and walls to maintain access and second egress - Restrict stockpile operations to reduce load on tunnel - Excavate and expose tunnel lining and strengthen tunnel externally, repair chutes	As required (target within 48 hours)	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within one week	Tahmoor Coal
			A hazard has been identified that involves potential serious injury or illness to a person or persons and cannot be controlled	Notify Tahmoor Coal Senior Management Group and implement any required actions	Immediately	Tahmoor Coal
				IMG and Tahmoor Coal Senior Management Group meet to decide whether any additional management measures are required, including: - emergency evacuation of hazardous area - demarcation to prevent people entering hazardous area - If Conveyor 7C or 8C is unserviceable: Coal to be loaded out of the stock pile via front end loader operation to load train - If Conveyor 4C, 4F, 5F or 3R is unserviceable: Stockpile coal in emergency stockpile until repairs can be completed	Immediately	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within 24 hours of decision	Tahmoor Coal

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Drift	Convergence of sides and roof/floor Cracking of portal structure Misalignment of jointed track Misalignment of drift conveyor Loss of egress, temporary closure of mine	Medium	None	Follow general procedures	-	-
				Conduct geotechnical assessment of drift	Complete	Byrnes Geotechnical
				Structural supports, roof bolts and mesh protection where defects have been identified	Complete (existing)	Tahmoor Coal
				Local 3D survey along first 40 metres of Drift	Baseline survey prior to 1000m of LW S1A LW S1A and LW S2A: Weekly after 1500m until one month after end of LW, and continue if ongoing adverse movements are observed End of LW S1A-S3A	Tahmoor Coal (SMEC)
				Visual inspections along Drift	Daily (routine)	Tahmoor Coal
			Opening or Closure between sides of Drift or between marks along length of Drift exceeds 10mm or Visual inspections detect impact to Drift	Notify IMG and Resources Regulator	Within one week	Tahmoor Coal
				IMG meet to decide whether any additional management measures are required, including: - increase in frequency of surveys, visual inspections and reporting - Provide additional mesh and structure support to roof and walls to maintain access - Repair cracks to concrete elements - Adjust track and/or conveyor alignment - Repair services	As required (target within 48 hours)	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within one week	Tahmoor Coal
			A hazard has been identified that involves potential serious injury or illness to a person or persons and cannot be controlled	Notify Tahmoor Coal Senior Management Group and implement any required actions	Immediately	Tahmoor Coal
				IMG and Tahmoor Coal Senior Management Group meet to decide whether any additional management measures are required, including: - cease underground operations - emergency evacuation of hazardous area - demarcation to prevent people entering hazardous area - re-establish safe conditions in Drift - decide whether to continue LW operation in current LW panel or relocate LW equipment to next panel	Immediately	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within 24 hours of decision	Tahmoor Coal
Winder	Twist of Winder Cracks to concrete slab Loss of egress, temporary closure of mine	Low	None	Follow general procedures	-	-
				Condition monitoring of Winder equipment	Ongoing (existing)	Tahmoor Coal
				Continuous tilt monitoring of Winder equipment	Installed Continuous readings, with data averaged over 24 hours and recorded once per day	Tahmoor Coal (SweetingConsulting)
				Local 3D survey around Winder House	Baseline survey prior to 900m of LW S1A End of LW S1A-S3A	Tahmoor Coal (SMEC)
			Non-conventional movements at Winder resulting in measurable twist of Winder or Condition monitoring detects adverse change or Visual inspections detect cracks to concrete slab	Notify IMG and Resources Regulator	Within one week	Tahmoor Coal
				IMG meet to decide whether any additional management measures are required, including: - increase in frequency of surveys, visual inspections and reporting - relevel Winder equipment - Repair cracks to concrete slab - Repair services	As required (target within 48 hours)	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within one week	Tahmoor Coal
			A hazard has been identified that involves potential serious injury or illness to a person or persons and cannot be controlled	Notify Tahmoor Coal Senior Management Group and implement any required actions	Immediately	Tahmoor Coal
				IMG and Tahmoor Coal Senior Management Group meet to decide whether any additional management measures are required, including: - cease underground operations - emergency evacuation of hazardous area - demarcation to prevent people entering hazardous area - re-establish safe operation of Winder - decide whether to continue LW operation in current LW panel or relocate LW equipment to next LW panel	Immediately	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within 24 hours of decision	Tahmoor Coal

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Rail Loop including Rail Overbridge	Impacts on track geometry and rail stress Buckling of Armco structure or reduction in structure clearances below standards	Low	None	Follow general procedures, including rail loop surveys	-	-
				Long bay length ground surveys along Rail Loop	Pegs installed. Baseline survey completed. LW S1A and LW S2A: Weekly after 1300m until one month after end of LW, and continue if ongoing adverse movements are observed End of LW S1A-S3A	Tahmoor Coal (SRS)
				Local 3D survey of entry and exit of culvert	Baseline survey prior to 900m of LW S1A LW S1A and LW S2A: Weekly after 1300m until one month after end of LW, and continue if ongoing adverse movements are observed End of LW S1A-S3A	Tahmoor Coal (SRS)
				Track geometry surveys using track geometry trolley	Baseline survey prior to 900m of LW S1A LW S1A: Weekly after 1300m until one month after end of LW, and continue if ongoing adverse movements are observed LW S2A: Survey after more than 20 mm of vertical subsidence is measured along the Rail Loop during LW S2A, and for every 20 mm of additional vertical subsidence thereafter	Tahmoor Coal (RMC)
				Track inspection by qualified mine track certifier	LW S1A: Daily after 1300 m until one month after end of LW and continue if ongoing adverse movements are observed LW S2A: Inspect after more than 20 mm of vertical subsidence is measured along the Rail Loop during LW S2A, and for every 20 mm of additional vertical subsidence thereafter	Tahmoor Coal / RMC
			Non-conventional ground movements observed from ground surveys or Adverse change in track geometry observed from track geometry trolley or visual inspections	Notify RMG and Resources Regulator	Within one week	Tahmoor Coal
				RMG meet to decide whether any additional management measures are required, including: - investigate cause - assess monitoring data for trends and forecast future adverse changes that might occur - consider whether to increase survey and/or inspection frequencies - consider whether to resurface the track - consider whether any other additional management measures are req'd	As required	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within one week	Tahmoor Coal
			More than 10 mm change in length of long bays or Adverse change in track geometry observed from track geometry trolley or visual inspections	Notify RMG and Resources Regulator	Within one week	Tahmoor Coal
				RMG meet to decide whether any additional management measures are required, including: - investigate cause - assess monitoring data for trends, weather forecasts and forecast future adverse changes that might occur - consider conducting Verse test to measure SFT - consider whether to conduct additional ground surveys and/or track geometry surveys - consider whether to increase survey and/or inspection frequencies - consider whether to cut temporary joint in rail or adjust CWR track - consider whether any other additional management measures are req'd	As required	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within one week	Tahmoor Coal
			A hazard has been identified that involves potential serious injury or illness to a person or persons and cannot be controlled	Notify Tahmoor Coal Senior Management Group and implement any required actions	Immediately	Tahmoor Coal
				IMG and Tahmoor Coal Senior Management Group meet to decide whether any additional management measures are required, including: - stop trains - emergency evacuation of hazardous area - demarcation to prevent people entering hazardous area - repair impacts relating to hazard	Immediately	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within 24 hours of decision	Tahmoor Coal

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Concrete silo bins	Cracking of ground slabs Cracking of silo linings Stress of internal steel frames	Low	None	Follow general procedures	-	-
				Conduct structural assessment of silo bins	Complete	JMA
				Local 3D survey around silo bins, including marks at top to measure tilt	Baseline survey prior to 900m of LW S1A End of LW S1A-S3A	Tahmoor Coal (SMEC)
				Continuous tilt monitoring (or extensometers) of 2 x 1250t raw coal bins across join between bins	Install prior to 1300m of LW S1A Tiltmeters (or extensometers) - Continuous readings, with data averaged over 24 hours and recorded once per day End of LW S1A-S3A	Tahmoor Coal
			New cracks > 0.5 mm observed	Notify IMG and Resources Regulator	Within one week	Tahmoor Coal
				IMG meet to decide whether any additional management measures are required, including: - increase in frequency of surveys, visual inspections and reporting - Repair cracks to concrete slab and/or silo lining - Strengthen internal steel frames - Repair services - Reduce storage capacity of silo bins	As required (target within 48 hours)	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within one week	Tahmoor Coal
			A hazard has been identified that involves potential serious injury or illness to a person or persons and cannot be controlled	Notify Tahmoor Coal Senior Management Group and implement any required actions	Immediately	Tahmoor Coal
				IMG and Tahmoor Coal Senior Management Group meet to decide whether any additional management measures are required, including: - emergency evacuation of hazardous area - demarcation to prevent people entering hazardous area - If 6000t bin is unserviceable, coal to be loaded out of Stockpile Area via front end loaders to load trains - If 2 x 1250t raw coal bins become unserviceable, stockpile coal in emergency stockpile until repairs are completed	Immediately	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within 24 hours of decision	Tahmoor Coal

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Building structures	Stress and twist of steel frames Cracks to concrete slabs	Low	None	Follow general procedures	-	-
				Local 3D survey at base of four legs and at tops of Rail Loader	Baseline survey prior to 900m of LW S1A LW S1A and LW S2A: Weekly after 1200m until one month after end of LW, and continue if ongoing adverse movements are observed End of LW S1A-S3A	Tahmoor Coal (SMEC)
				Local 3D survey at base of four legs and at tops of Reject Bin	Baseline survey prior to 900m of LW S1A LW S1A and LW S2A: Weekly after 1200m until one month after end of LW, and continue if ongoing adverse movements are observed End of LW S1A-S3A	Tahmoor Coal (SRS)
				Local 3D survey around buildings within mine site as per Drawing No. MSEC1247-01	Baseline survey prior to 900m of LW S1A End of LW S1A-S3A	Tahmoor Coal (SMEC)
			Changes in distance between four legs of Rail Loader or Reject Bin exceed 5mm Non-conventional movements identified from general mine site surveys or Visual inspections impacts to building	Notify IMG and Resources Regulator	Within one week	Tahmoor Coal
				IMG meet to decide whether any additional management measures are required, including: - increase in frequency of surveys, visual inspections and reporting - Adjust hold down bolts and install shims to underside of baseplates - Elongating holes in the transoms of Rail Loader - Install horizontal shoring between underpass walls or install rock bolts beneath Rail Loader - Strengthen internal steel frames - Repair services - Reduce storage capacity of Rail Loader or Reject Bin	As required (target within 48 hours)	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within one week	Tahmoor Coal
			A hazard has been identified that involves potential serious injury or illness to a person or persons and cannot be controlled	Notify Tahmoor Coal Senior Management Group and implement any required actions	Immediately	Tahmoor Coal
				IMG and Tahmoor Coal Senior Management Group meet to decide whether any additional management measures are required, including: - emergency evacuation of hazardous area - demarcation to prevent people entering hazardous area - If Washery is unserviceable, stockpile coal in emergency stockpile until repairs are completed - If other buildings become unserviceable, isolate and repair	Immediately	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within 24 hours of decision	Tahmoor Coal

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Overhead crane and monorails	Changes in alignment or rail span leading to loss of serviceability Increased wear on crane rails and wheels	Medium	None	Follow general procedures	-	-
				Conduct engineering assessment of overhead crane and monorails	Complete	WM Consultants
				Machine wheels on overhead crane to widen groove to meet operating tolerances	Complete	Tahmoor Coal
				Anti-derailment device on overhead crane	Complete	Tahmoor Coal
				Baseline alignment survey of overhead crane rails	Complete	Tahmoor Coal (SRS)
				Briefing of operators of overhead crane and monorails	Prior to 1300m of LW S1A	Tahmoor Coal
				Local 3D survey around Washery building as per Drawing No. MSEC1247-01	Baseline survey prior to 900m of LW S1A End of LW S1A-S3A	Tahmoor Coal (SMEC)
				Local 3D survey along crane rails	Baseline survey prior to 900m of LW S1A LW S1A and LW S2A: Weekly after 1300m until one month after end of LW, and continue if ongoing adverse movements are observed End of LW S1A-S3A	Tahmoor Coal (SRS)
				Crane maintenance and inspections by crane technician	LW S1A and LW S2A: Weekly after 1300m until one month after end of LW, and continue if ongoing adverse movements are observed	Tahmoor Coal
			Triggers exceeded for overhead crane or monorails as defined in Table 4.7 or Table 4.8 of this Management Plan	Notify IMG and Resources Regulator	Within one week	Tahmoor Coal
				IMG meet to decide whether any additional management measures are required, including: - increase in frequency of surveys, visual inspections and reporting - Inspect and test operation of overhead crane or monorail by crane engineer - Adjust overhead crane or adjust crane rails - Restrict operation of overhead crane or monorail	As required (target within 48 hours)	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within one week	Tahmoor Coal
			A hazard has been identified that involves potential serious injury or illness to a person or persons and cannot be controlled	Notify Tahmoor Coal Senior Management Group and implement any required actions	Immediately	Tahmoor Coal
				IMG and Tahmoor Coal Senior Management Group meet to decide whether any additional management measures are required, including: - emergency evacuation of hazardous area - demarcation to prevent people entering hazardous area - install temporary stop blocks to prevent crane operation within hazardous area - isolate and repair - use alternate hoists and monorail beams to complete work tasks	Immediately	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within 24 hours of decision	Tahmoor Coal

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Shaft No. 3	Sliding of bedding planes intersecting shaft Reduction in clearance to cage and/or counterweight Tilt of shaft winder Loss of egress, temporary closure of mine	Low	None	Follow general procedures	-	-
				Conduct geotechnical assessment of Shaft No. 3	Complete	Byrnes Geotechnical
				Structural supports of shaft liner where defects have been identified	Complete (existing)	Tahmoor Coal
				Condition monitoring of shaft winder equipment	Ongoing (existing)	Tahmoor Coal
				Continuous tilt monitoring of shaft winder	Installed Continuous readings, with data averaged over 24 hours and recorded once per day	Tahmoor Coal (SweetingConsulting)
				Local 3D survey around Shaft No. 3 at surface	Baseline survey prior to 1000m of LW S1A End of LW S1A-S3A	Tahmoor Coal (SMEC)
				Visual inspections along Shaft No. 3 including clearance measurements each shift	Daily (routine – each shift)	Tahmoor Coal
				Additional clearance measurement at 135m depth at point of min. clearance	LW S1A and LW S2A: Weekly after 1500m until one month after end of LW, and continue if ongoing adverse movements are observed	Tahmoor Coal
			Change in clearance exceeds 10mm (allowing for swing of cage) or Opening of cracks in concrete liners or Lateral movement detected at joins to concrete liners or Noticeable increase or decrease in water make or Cracking of concrete behind exposed mesh	Notify IMG and Resources Regulator	Within one week	Tahmoor Coal
				IMG meet to decide whether any additional management measures are required, including: - increase in frequency of surveys, visual inspections and reporting - Provide additional mesh and structure support to shaft walls - Slow shaft winder speed - Repair services - Reinstate clearances	As required (target within 48 hours)	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within one week	Tahmoor Coal
			A hazard has been identified that involves potential serious injury or illness to a person or persons and cannot be controlled	Notify Tahmoor Coal Senior Management Group and implement any required actions	Immediately	Tahmoor Coal
				IMG and Tahmoor Coal Senior Management Group meet to decide whether any additional management measures are required, including: - cease underground operations - emergency evacuation of hazardous area - demarcation to prevent people entering hazardous area - re-establish safe operation of Shaft No. 3 - decide whether to continue LW operation in current LW panel or relocate LW equipment to next LW panel	Immediately	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within 24 hours of decision	Tahmoor Coal

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Dams	Loss of stability of dam wall Leakage of dam wall Dam break flooding railway track or polluting waterways	Low	None	Follow general procedures	-	-
				Conduct geotechnical assessment of dams	Complete	Douglas Partners
				Clearing of vegetation around dam wall batter slopes, spillway and overflow areas	Dam S4: Prior to 1000m of LW S1A Dams on mine site: Prior to 1200m of LW S1A	Tahmoor Coal
				Clearing of railway culverts downstream of Dams S2 and S3	Complete	Tahmoor Coal (RMC)
				Monitor and maintain dam water levels as per Mine Water Management Plan (e.g. Dam S4 alarmed at 30%, 90% and 100% capacity)	Ongoing	Tahmoor Coal
				Local 3D survey around Dams S2, S3 and S4	Baseline survey prior to 900m of LW S1A Dam S4: LW S1A and LW S2A: Weekly after 1000m until one month after end of LW, and continue if ongoing adverse movements are observed End of LW S1A-S3A Dams S2 and S3: LW S1A and LW S2A: Weekly after 1200m until one month after end of LW, and continue if ongoing adverse movements are observed End of LW S1A-S3A	Tahmoor Coal (SMEC)
				Local 3D survey around Dams M1, M2, M3, M4, T1, T2, STP1 and STP2	Baseline survey prior to 900m of LW S1A End of LW S1A-S3A	Tahmoor Coal (SMEC)
				Visual inspections of Dams S2 and S3 from rail corridor by Track Certifier	Daily during active subsidence as per Railway Management Plan	Tahmoor Coal (RMC)
				Visual inspections of Dams S2 and S3 from rail corridor by geotechnical engineer	Weekly during active subsidence as per Railway Management Plan	Tahmoor Coal (Newcastle Geotech)
				Visual inspection of dams on mine site by building inspector	Weekly for dams within active subsidence zone	Tahmoor Coal (BIS)
				Visual inspection of dams on mine site by geotechnical engineer	Monthly for dams within active subsidence zone	Tahmoor Coal (Douglas Partners)
			Cracks observed in dam wall > 10 mm wide (other than natural desiccation cracking) or Seepage observed in dam wall	Notify IMG and Resources Regulator	Within one week	Tahmoor Coal
				Notify ARTC and Tahmoor Coal's Rail Management Group if impacts relate to Dams S1 and S2	Immediately	Tahmoor Coal
				IMG meet to decide whether any additional management measures are required, including: - increase in frequency of surveys, visual inspections and reporting - place material at the toe of the embankment - raise freeboard of Dam S2 - temporarily lower or dewater a dam or fill to repair the dam wall and divert water via pumps and temporary pipes if required to continue managing water around the mine site for operational and firefighting purposes - brief mine site workers to restrict access downstream of affected dam	As required (target within 48 hours)	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within one week	Tahmoor Coal
			A hazard has been identified that involves potential serious injury or illness to a person or persons and cannot be controlled	Notify Tahmoor Coal Senior Management Group and implement any required actions	Immediately	Tahmoor Coal
				Notify ARTC and Tahmoor Coal's Rail Management Group if impacts relate to Dams S1 and S2	Immediately	Tahmoor Coal
				IMG and Tahmoor Coal Senior Management Group meet to decide whether any additional management measures are required, including: - emergency evacuation of hazardous area - demarcation to prevent people entering hazardous area - emergency dewatering of dam - manage site water requirements to ensure all systems have water supply - manage rail operations under continuous watch by Track Certifier in consultation with ARTC if impact relates to Dams S2 and S3	Immediately	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within 24 hours of decision	Tahmoor Coal

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Reject Emplacement Area	Cracking to batter slopes Cracking to unsealed pavements Cracking to drainage structures	Low	None	Follow general procedures	-	-
				2D survey line along Tahmoor Mine property boundary and alongside (V Line)	Pegs installed. Baseline survey prior to commencement of LW S1A. Monthly survey during LW S1A between 200m and 1300m extraction, and continue if ongoing adverse movements are observed. End of LW S1A.	Tahmoor Coal (SMEC)
			Cracking observed in batter slopes or pavements or drainage structures	Notify IMG and Resources Regulator	Within one week	Tahmoor Coal
				IMG meet to decide whether any additional management measures are required, including: - increase in frequency of surveys, visual inspections and reporting - Repair cracks to batter slopes, pavements and culverts - Repair services	As required (target within 48 hours)	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within one week	Tahmoor Coal
			A hazard has been identified that involves potential serious injury or illness to a person or persons and cannot be controlled	Notify Tahmoor Coal Senior Management Group and implement any required actions	Immediately	Tahmoor Coal
				IMG and Tahmoor Coal Senior Management Group meet to decide whether any additional management measures are required, including: - emergency evacuation of hazardous area - demarcation to prevent people entering hazardous area - repair impacts relating to hazard	Immediately	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within 24 hours of decision	Tahmoor Coal
Site services	Water / sewage leak Gas leak Loss of electrical or communications services	Low	None	Follow general procedures	-	-
				Set alarms to water monitoring line between Dams S2 and S3 in the CHPP Control Room	Prior to 1200m of LW S1A	Tahmoor Coal
				Local 3D survey around Dams S2 and S3, including high pressure water pipeline between Dams S2 and S3	Baseline survey prior to 900m of LW S1A Dams S2 and S3: LW S1A and LW S2A: Weekly after 1200m until one month after end of LW, and continue if ongoing adverse movements are observed End of LW S1A-S3A	Tahmoor Coal (SMEC)
				Local 3D survey around buildings within mine site as per Drawing No. MSEC1247-01	Baseline survey prior to 900m of LW S1A End of LW S1A-S3A	Tahmoor Coal (SMEC)
			Non-conventional movements identified from general mine site surveys or dam surveys or Visual inspections impacts to building or dams or ground surface or Loss of service	Notify IMG and Resources Regulator	Within one week	Tahmoor Coal
				IMG meet to decide whether any additional management measures are required, including: - increase in frequency of surveys, visual inspections and reporting - Loosen saddles clamping above-ground water lines between Dams S2 and S3 - Repair services	As required (target within 48 hours)	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within one week	Tahmoor Coal
			A hazard has been identified that involves potential serious injury or illness to a person or persons and cannot be controlled	Notify Tahmoor Coal Senior Management Group and implement any required actions	Immediately	Tahmoor Coal
				IMG and Tahmoor Coal Senior Management Group meet to decide whether any additional management measures are required, including: - emergency evacuation of hazardous area - demarcation to prevent people entering hazardous area - repair impacts relating to hazard	Immediately	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within 24 hours of decision	Tahmoor Coal

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Hazardous materials and Storage of equipment and materials	Exposure of hazardous materials Tilting of storage shelving	Low	None	Follow general procedures	-	-
				2D survey line along Tahmoor Mine property boundary and alongside (V Line)	Pegs installed. Baseline survey prior to commencement of LW S1A. Monthly survey during LW S1A between 200m and 1300m extraction, and continue if ongoing adverse movements are observed. End of LW S1A.	Tahmoor Coal (SMEC)
				Local 3D survey around buildings within mine site as per Drawing No. MSEC1247-01	Baseline survey prior to 900m of LW S1A End of LW S1A-S3A	Tahmoor Coal (SMEC)
				Visual inspections as per general procedures, including Fuel Storage Area	Weekly within the active subsidence zone until one month after end of LW, and continue if ongoing adverse movements are observed	Tahmoor Coal (BIS)
			Cracking to bunded walls, detection of fuel leak	Notify IMG and Resources Regulator	Within one week	Tahmoor Coal
				IMG meet to decide whether any additional management measures are required, including: - increase in frequency of surveys, visual inspections and reporting - Repair cracks and fuel leaks - Repair services	As required (target within 48 hours)	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within one week	Tahmoor Coal
			A hazard has been identified that involves potential serious injury or illness to a person or persons and cannot be controlled	Notify Tahmoor Coal Senior Management Group and implement any required actions	Immediately	Tahmoor Coal
				IMG and Tahmoor Coal Senior Management Group meet to decide whether any additional management measures are required, including: - emergency evacuation of hazardous area - demarcation to prevent people entering hazardous area - repair impacts relating to hazard	Immediately	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within 24 hours of decision	Tahmoor Coal
Internal roads, pavements and fencing	Cracking to pavements, localised buckling of fencing	Low	None	Follow general procedures	-	-
				Local 3D survey around buildings within mine site as per Drawing No. MSEC1247-01	Baseline survey prior to 900m of LW S1A End of LW S1A-S3A	Tahmoor Coal (SMEC)
			Non-conventional movements identified from general mine site surveys or dam surveys or Visual inspections impacts to roads, pavements of fencing	Notify IMG and Resources Regulator	Within one week	Tahmoor Coal
				IMG meet to decide whether any additional management measures are required, including: - increase in frequency of surveys, visual inspections and reporting - Repair roads, pavements and fencing	As required	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within one week	Tahmoor Coal
			A hazard has been identified that involves potential serious injury or illness to a person or persons and cannot be controlled	Notify Tahmoor Coal Senior Management Group and implement any required actions	Immediately	Tahmoor Coal
				IMG and Tahmoor Coal Senior Management Group meet to decide whether any additional management measures are required, including: - emergency evacuation of hazardous area - demarcation to prevent people entering hazardous area - repair impacts relating to hazard	Immediately	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within 24 hours of decision	Tahmoor Coal

Table 4.1 Control Procedures for Australian Wildlife Sanctuary during the extraction of Tahmoor South Longwalls S1A to S6A and Longwalls S1B to S6B

RISK ISSUE	TRIGGER	CONTROL PROCEDURES	TIMING & FREQUENCY	BY WHOM?
IMPACTS ON BUILDING STRUCTURES, DINGO SANCTUARY, EXTERNAL PAVEMENTS, WALKING TRAILS, FENCES AND GATES	None	Undertake structural inspections and assessments before subsidence.	Inspection completed January 2020. Re-inspection completed February 2022..	Tahmoor Coal
		Undertake inspections and assessments to identify changes and new features and consider whether additional monitoring and management measures are required	Prior to start of LWs S2A, S3A and S4A	Tahmoor Coal
		Undertake heritage assessment	Complete	Tahmoor Coal
		Undertake asbestos materials survey	Prior to start of LW S1A	Tahmoor Coal
		Install protection measures for glass roof panels in glasshouse	Prior to start of LW S2A	Tahmoor Coal
		Continuous GNSS monitoring	Installed Continuous readings, with data average over 24 hours and recorded once per day	Tahmoor Coal
		2D Survey along Charlies Point Road	Install survey pegs and conduct baseline surveys prior to start of LW S1A. Survey monthly for pegs between 200 m and 800 m and continue if ongoing adverse movements are observed.. Survey at end of each LW for pegs located within zone of influence of each LW.	Tahmoor Coal
		3D/2D Survey along Main Southern Railway and Remembrance Drive	Install and baseline survey pegs within predicted limit of incremental subsidence of each active LW, prior to active LW face approaching within 600 m of survey line. Monthly 3D / Weekly 2D during periods of active subsidence and continue if ongoing adverse movements are observed. Survey at end of each LW for pegs located within zone of influence of each LW.	Tahmoor Coal
		Local 3D survey around perimeter of main buildings	Install survey pegs and conduct baseline surveys prior to influence of LW S2A. Survey weekly for pegs located with active subsidence zone and continue if ongoing adverse changes are observed. Survey at end of each LW for pegs located within zone of influence of each LW.	Tahmoor Coal
		Visually inspect the structures, Dingo Sanctuary, external pavements, fences and gates, farm dam, walking trails	Conduct baseline inspections prior to influence of LW S2A. Inspect weekly for areas located with active subsidence zone or for one month after each LW is completed and continue if ongoing adverse changes are observed.	Tahmoor Coal
		Conduct asbestos air monitoring	Weekly for structures located within active subsidence zone until rates of change in subsidence reduce to negligible levels.	Tahmoor Coal
		Report findings of surveys and inspections to National Trust, Australian Wild Sanctuary, Australian Native Dog Conservation Society, AWS SMG, Subsidence Advisory NSW, Resources Regulator	Weekly when Australian Wildlife Sanctuary is within active subsidence zone, unless adverse changes observed.	Tahmoor Coal
		Review and assess monitoring report and consider whether any additional management measures are required	Weekly whilst within active subsidence zone and continue if ongoing adverse changes are observed.	AWS SMG

RISK ISSUE	TRIGGER	CONTROL PROCEDURES	TIMING & FREQUENCY	BY WHOM?
IMPACTS ON BUILDING STRUCTURES, DINGO SANCTUARY, EXTERNAL PAVEMENTS, WALKING TRAILS, FENCES AND GATES (continued)	Adverse analytical finding from asbestos air monitoring	Notify Australian Wildlife Sanctuary	Immediately	Tahmoor Coal
		AWS SMG meet and consider whether any additional management measures are required, including: - inspection by specialist in asbestos repairs and repair cracks if required - increase monitoring and reporting procedures	Within 24 hours	AWS SMG
		Notify AWS SMG of trigger exceedence and any management decisions undertaken (incl Australian Wildlife Sanctuary and Subsidence Advisory NSW, Resources Regulator)	Within 24 hours of decision	Tahmoor Coal
	Impact observed to asbestos containing materials	Notify Australian Wildlife Sanctuary	Immediately	Tahmoor Coal
		AWS SMG meet and consider whether any additional management measures are required, including: - seal fresh cracks by a licensed asbestos contractor - inspection by specialist in asbestos repairs and repair cracks if required - increase monitoring and reporting procedures	Within 24 hours	AWS SMG
		Notify AWS SMG of trigger exceedence and any management decisions undertaken (incl Australian Wildlife Sanctuary and Subsidence Advisory NSW, Resources Regulator)	Within 24 hours of decision	Tahmoor Coal
	Impacts observed on structure	AWS SMG meet and consider whether any additional management measures are required, including: - structural inspection - increase monitoring and reporting procedures - undertake detailed inspections or surveys of impacts - seal fresh cracks by a licensed asbestos contractor - repair impacts, in consultation with heritage specialist if impacts occur to item of heritage significance	Within 1 week or earlier if required	AWS SMG
		Notify AWS SMG of trigger exceedence and any management decisions undertaken (incl Australian Wildlife Sanctuary and Subsidence Advisory NSW, Resources Regulator)	Within 24 hours	Tahmoor Coal
	A hazard has been identified that involves potential serious injury or illness to a person or persons at the property, and cannot be controlled	Tahmoor Coal and Australian Wildlife Sanctuary meet with AWS SMG to decide whether any additional management measures are required, including: - suspension of work activities within the hazardous area - demarcation of workplace to restrict people from entering or working in hazardous area - emergency evacuation of workplace	Immediately	AWS SMG
		Notify AWS SMG of trigger exceedence and any management decisions undertaken (incl Australian Wildlife Sanctuary and Subsidence Advisory NSW, Resources Regulator)	Within 24 hours of decision	Tahmoor Coal
IMPACTS ON FIRE PROTECTION SERVICES, SECURITY SERVICES, INTEGRITY OF FENCES AND GATES IN DINGO SANCTUARY, ESSENTIAL SERVICES, ACCESS AND MOBILITY, FINISHES, AND PUBLIC SAFETY HAZARDS	None	Follow procedures for building structures	-	-
	Impacts observed generally	Repair impacts	As required by Australian Wildlife Sanctuary to avoid interruption to operations (target within 24 hours if required)	Tahmoor Coal

RISK ISSUE	TRIGGER	CONTROL PROCEDURES	TIMING & FREQUENCY	BY WHOM?
IMPACTS ON NATURAL FEATURES **Trigger Level** / **Description** **Level 1** — No observed impacts to pool level, drainage or overland connected flow observed **Level 2** — Visually observed reduction in pool level, drainage or overland connected flow. AND The above has occurred at one of the upstream pools (beyond mining effects). AND Visual monitoring of pools has not noted any mining related impacts. **Level 3** — Rock bar and/or stream base cracking, or gas release, or iron precipitation noted during visual inspection. AND No reduction in pool water level, drainage or overland connected flow, taking into account climatic conditions and observations during baseline monitoring period. **Level 4** — Visually observed reduction in pool water level, drainage or overland connected flow. AND The above change has not occurred at one of the upstream pools (beyond mining effects).	None (Level 1)	Follow procedures for building structures	-	-
		Conduct pre-mining, baseline monitoring of pool water levels and water quality within Wirrimbirra Creek	Prior to start of LW S1A	Tahmoor Coal
		Conduct pre-mining, baseline inspections of small cliffs along Wirrimbirra Creek and provide briefing note to AWS staff and volunteers to avoid standing beneath them	Prior to start of LW S1A	Tahmoor Coal
		Ground surveys across Wirrimbirra Creek, including the controlling dam at Ockenden Pools and rockbar at the Big Pool	Install survey pegs and conduct baseline surveys prior to influence of LW S1A. Survey at end of each LW.	Tahmoor Coal
		Monitoring of water levels and water quality in Ockenden Pools and the Big Pool (and other pools if identified during baseline monitoring)	Continuous readings, downloaded monthly	Tahmoor Coal
		Visual inspections of streams and small cliffs (from safe vantage points)	Inspect monthly for areas within active subsidence zone or for one month after each LW is completed and continue if ongoing adverse changes are observed Inspection at end of each LW.	Tahmoor Coal
	Level 2	Tahmoor Coal consider whether any additional management measures are required, including: - increase monitoring and reporting procedures	Within 1 month or earlier if required	Tahmoor Coal
	Level 3	Tahmoor Coal consider whether any additional management measures are required, including: - investigation whether there has been a reduction in pool water level, drainage or overland connected flow, taking into account climatic conditions and observations during baseline monitoring period - investigation to assess if the observed change is related to mining effects, other catchment changes or the prevailing climate - increase monitoring and reporting procedures	Within 1 week or earlier if required	Tahmoor Coal
		Notify AWS of trigger exceedence and any management decisions undertaken	Within 1 week of decision	Tahmoor Coal
	Level 4	Tahmoor Coal consider whether any additional management measures are required, including: - investigation to assess if the observed change is related to mining effects, other catchment changes or the prevailing climate - increase monitoring and reporting procedures - if it is concluded that the impact is due to mining, implement a corrective management action plan (CMAP) in consultation with Australian Wildlife Sanctuary	Within 1 week or earlier if required	Tahmoor Coal
		Notify AWS of trigger exceedence and any management decisions undertaken	Within 1 week of decision	Tahmoor Coal

Table 4.1 Risk Control Procedures for Picton Weir during the extraction of Tahmoor LW S3A-S7A

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Picton Weir	Subsidence effects such as Valley Closure, Valley Upsidence, Valley Opening or Lateral Bending / Shearer at or below the Weir level, loss of structural integrity of the Weir leading to a rapid loss of water retention.	Low	None	Conduct geotechnical assessment of Picton Weir	Complete	PSM
				Conduct structural assessment of Picton Weir	Complete	Worley
				Continuous GNSS monitoring as shown in Drawing No. MSEC1193-12-04, particularly GNSS units S13, S14, and S19 to S25	GNSS units installed Continuous readings, with data averaged over 24 hours and recorded once per day until end of LW S7A and continue if ongoing adverse movements are observed	Tahmoor Coal (Geomatix)
				Conduct 2D / Absolute 3D surveys along Main Southern Railway in accordance with Railway Management Plan	Monthly 3D / Weekly 2D surveys for pegs within active subsidence zone during LWs S3A to S7A	Tahmoor Coal (SRS)
				Conduct 2D / Absolute 3D surveys along local streets in accordance with Wollondilly Shire Council Management Plan	Monthly 3D / Weekly 2D surveys for pegs within active subsidence zone during LWs S3A to S7A	Tahmoor Coal (SMEC)
				Conduct 2D / Absolute 3D surveys of survey marks on both sides of the Picton Weir as shown in Drawing No. MSEC1193-12-04	Baseline survey complete Monthly during extraction of LWs S4A to S7A and continue if ongoing adverse movements are observed	Tahmoor Coal (Geomatix)
				Automated, continuous measurements across the Picton Weir by laser distancemeters downstream of Picton Weir (rock to rock)	Install and commission prior to start of LW S4A. Hourly readings until end of LW S7A and continue if ongoing adverse movements are observed	Tahmoor Coal (SweetingConsulting)
				Photogrammetric survey of shape of dam wall and surrounding rock faces on both sides of Picton Weir	Baseline survey complete Additional surveys if triggered by monitoring results	Tahmoor Coal (Geomatix)
				Vertical inclinometer monitoring in borehole BH01 at northern side of Picton Weir	Installed and baseline surveyed End of LW S3A and LW S4A Monthly during LWs S5A, S6A and LW S7A and continue if ongoing adverse movements are observed	Tahmoor Coal (Lynton Surveys)
				Groundwater level monitoring in borehole BH01 at northern side of Picton Weir	Installed and commissioned Download end of LW S3A and LW S4A and monthly during LWs S5A to S7A and continue if ongoing adverse movements are observed	Tahmoor Coal (Lynton Surveys)
				Surface water level monitoring upstream of Picton Weir	Install and commission prior to start of LW S4A. Hourly readings until end of LW S7A and continue if ongoing adverse movements are observed and continue if ongoing adverse movements are observed	Tahmoor Coal (SweetingConsulting)
				Detailed visual inspection of Picton Weir and surrounding rockfaces by UAV	Baseline inspection complete End of LW S3A and LW S4A Monthly during LWs S5A to S7A and continue if ongoing adverse movements are observed	Tahmoor Coal (Geomatix)
				Visual inspections of Picton Weir, surrounding rock faces and access road	Monthly during LWs S5A to S7A and continue if ongoing adverse movements are observed	Tahmoor Coal
				Analyse and report results to IMG and Wollondilly Shire Council	Monthly during extraction of LWs S4A and S5A Monthly from start of LWs S6A and S7A, then increase to weekly when distance between LW face and Picton Weir is less than 1000 metres (after length of extraction of LW S6A exceeds 1800 m and LW S7A exceeds 1200 m) and continue if ongoing adverse movements are observed	Tahmoor Coal (MSEC)
				IMG discuss results and consider whether any additional management measures are required	End of LW S3A and LW S4A Monthly during LWs S5A to S7A and continue if ongoing adverse movements are observed	IMG

INFRASTRUCTURE	HAZARD / IMPACT	RISK	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
Picton Weir	Subsidence effects such as Valley Closure, Valley Upsidence, Valley Opening or Lateral Bending / Shearer at or below the Weir level, loss of structural integrity of the Weir leading to a rapid loss of water retention.	Low	Laser distancemeters measure either Opening > 4mm Closure < -5mm (taking into account changes due to environmental factors)	Notify IMG	Within 24 hours	Tahmoor Coal
				Undertake additional visual inspection	Within 24 hours	Tahmoor Coal
				IMG meet and review latest monitoring information for Picton Weir. IMG consider whether any additional management measures are required, which may include: - increase monitoring frequencies and reporting procedures - repair cracks of spray shotcrete to seal cracks on upstream face of Weir - install post-tensioned anchors to reduce impacts - place concrete at the downstream base of the Weir to reduce impacts - install rock slot to the side of Picton Weir - prevent public access to the Picton Weir and install signage	Within 24 hours	IMG
				Report trigger exceedance and actions taken to IMG, Wollondilly Shire Council, SA NSW & MSO in Status Report	Within one week	Tahmoor Coal
			New crack identified in Picton Weir	Notify IMG	Within 24 hours	Tahmoor Coal
				Undertake additional visual inspection by structural dam engineer	Within 24 hours	Worley
				IMG meet and review latest monitoring information for Picton Weir. IMG consider whether any additional management measures are required, which may include: - increase monitoring frequencies and reporting procedures - repair cracks of spray shotcrete to seal cracks on upstream face of Weir - install post-tensioned anchors to reduce impacts - place concrete blocks or buttresses downstream of the Weir to reduce impacts - install rock slot to the side of Picton Weir - prevent public access to the Picton Weir and install signage	Within 24 hours	IMG
				Report trigger exceedance and actions taken to IMG, Wollondilly Shire Council, SA NSW & MSO in Status Report	Within one week	Tahmoor Coal
			A hazard has been identified that involves potential serious injury or illness to a person or persons and cannot be controlled	Notify IMG and Tahmoor Coal Senior Management Group and implement any required actions	Immediately	Tahmoor Coal
				IMG, Wollondilly Shire Council and Tahmoor Coal Senior Management Group meet to decide whether any additional management measures are required, including: - prevent public access to the Picton Weir and install signage - delay or stop mining	Immediately	Tahmoor Coal
				Report details of exceedance of trigger level and actions undertaken to Resources Regulator	Within 24 hours of decision	Tahmoor Coal

Revised Table 4.1: Risk Control Procedures LW S1A-S6A (amended for LW S3A in blue)

RISK ISSUE	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
IMPACTS ON BUILDINGS, FUEL TANKS AND LINES, WALLS, PAVEMENTS, GATES AND DAM	None	Undertake structural inspections and assessments before subsidence	Complete	Tahmoor Coal (JMA)
		Undertake workplace health and safety inspection	Complete	Tahmoor Coal (MSIA)
		Conduct pressure testing of fuel tanks and fuel lines	Baseline test complete Additional test after Tank UST#2 is repaired (complete) End of LW S3A Additional test after end of LW S3A if more than 50 mm additional subsidence develops at the petrol station and for every 50 mm thereafter	Tahmoor Coal (Tanknology)
		Conduct on-site groundwater testing (visual inspection and hydrocarbon testing)	Baseline test complete Monthly test during active subsidence zone as per below: LW S1A-S2A: after 1300m extraction until one month after end of LW LW S3A: after 1200m extraction until one month after end of LW Additional test after end of LW S3A if more than 50 mm additional subsidence develops at the petrol station and for every 50 mm thereafter	Tahmoor Coal (AEC)
		Conduct fuel balance monitoring	Monthly as per standard practice Weekly test during active subsidence zone as per below: LW S1A- S2A: after 1300m extraction until one month after end of LW LW S3A: after 1200m extraction until one month after end of LW	Tahmoor Coal (Bargo Petroleum)
		Conduct 2D / Absolute 3D surveys along Remembrance Drive	Baseline survey complete. Monthly 3D / Weekly 2D surveys for pegs within active subsidence zone: Continue surveys until outside active subsidence zone or one month after end of LW and continue further if ongoing adverse movements are observed. End of LW S1A-S6A.	Tahmoor Coal (SMEC)
		Local 3D survey around perimeter of buildings during active subsidence as per **Error! Reference source not found.**	Baseline survey complete Weekly surveys during active subsidence zone as per below: LW S1A-S2A: after 1300m extraction until one month after end of LW LW S3A: after 1200m extraction until one month after end of LW Continue surveys if ongoing adverse movements are observed. End of LW S1A-S6A.	Tahmoor Coal (SMEC)
		Visually inspect the property, including the petrol station, store, workshop, Wrecker's yard, igloos, dam, pavements, fences and gates	Weekly inspection during active subsidence zone as per below: LWs S1A - S2A: after 1300m extraction until one month after end of LW LW S3A: after 1200m extraction until one month after end of LW Continue inspections if ongoing adverse movements are observed. End of LW S1A-S6A.	Tahmoor Coal (BIS)
		Report findings of surveys and inspections to landowner and tenants, SRG, Subsidence Advisory NSW, Resources Regulator	LWs S1A - S2A: after 1300m extraction until one month after end of LW LW S3A: after 1200m extraction until one month after end of LW Continue reporting if ongoing adverse movements are observed End of LW S1A-S6A.	Tahmoor Coal (MSEC)
		Review and assess monitoring report and consider whether any additional management measures are required	LWs S1A - S2A: after 1300m extraction until one month after end of LW LW S3A: after 1200m extraction until one month after end of LW Continue reviews if ongoing adverse movements are observed End of LW S1A-S6A.	SRG

RISK ISSUE	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
IMPACTS ON BUILDINGS, FUEL TANKS AND LINES, WALLS, PAVEMENTS, GATES AND DAM (continued)	Non-conventional movements identified from weekly surveys or Visual inspections identify impacts to buildings or pavements or Integrity testing of fuel tanks and fuel lines indicates potential leakage of fuel	SRG meet and consider whether any additional management measures are required, including: - structural inspection - additional testing of integrity of fuel tanks and fuel lines - increase monitoring and reporting procedures - repair impacts	Within 1 week or earlier if required	SRG
		Notify SRG of trigger exceedence and any management decisions undertaken (incl landowner and tenants, Subsidence Advisory NSW, Resources Regulator)	Within one week	Tahmoor Coal
	A hazard has been identified that involves potential serious injury or illness to a person or persons at No. 3030 Remembrance Drive, Bargo and cannot be controlled	SRG, Tahmoor Coal, landowner and tenants meet to decide whether any additional management measures are required, including: - suspension of work activities within the hazardous area - demarcation of workplace to restrict people from entering or working in hazardous area - emergency evacuation of workplace	Immediately	Tahmoor Coal
		Notify SRG of trigger exceedence and any management decisions undertaken (incl landowner and tenants, Subsidence Advisory NSW, Resources Regulator)	Within 24 hours of decision	Tahmoor Coal
IMPACTS ON FUELTANKS, FUEL LINES, FIRE PROTECTION SERVICES, SECURITY SERVICES, ESSENTIAL SERVICES, ACCESS AND MOBILITY, FINISHES, AND PUBLIC SAFETY HAZARDS	None	Follow procedures above	-	-
	Impacts observed	Repair impacts	Immediately as required by landowner and tenants to avoid interruption to operations (target within 24 hours if required)	Tahmoor Coal
		Notify SRG of trigger exceedence and any management decisions undertaken (incl landowner and tenants, Subsidence Advisory NSW, Resources Regulator)	Within one week	Tahmoor Coal
IMPACTS ON VEHICLE HOISTS	None	Follow procedures above	-	-
		Baseline alignment survey of vehicle hoists	Complete	Tahmoor Coal (SweetingConsulting)
	Non-conventional movements identified from weekly surveys around Frapen workshop or Visual inspections identify impacts to Frapen workshop or Reduced performance by machine observed	SRG meet and consider whether any additional management measures are required, including: - Additional alignment survey - increase monitoring and reporting procedures - relevel hoist(s)	Within 1 week or earlier if required	SRG
		Notify SRG of trigger exceedence and any management decisions undertaken (incl landowner and Frapen Motorsports, Subsidence Advisory NSW, Resources Regulator)	Within one week	Tahmoor Coal
IMPACTS ON STORAGE AND MATERIALS HANDLING	None	Follow procedures above	-	-
	Substantial tilt of storage shelves and racks observed or Non-conventional movements identified from weekly surveys outside Wrecker's yard	SRG meet and consider whether any additional management measures are required, including: - relevel storage shelves - provide additional support to shelving	As required by landowner and tenants to avoid interruption to operations (target within 24 hours if required)	Tahmoor Coal
		Notify SRG of trigger exceedence and any management decisions undertaken (incl landowner and tenants, Subsidence Advisory NSW, Resources Regulator)	Within one week	Tahmoor Coal

RISK ISSUE	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
IMPACTS ON DAM	None	Follow procedures above	-	-
	Cracks observed in dam wall > 10 mm wide (other than natural desiccation cracking) or Seepage observed in dam wall	SRG meet and consider whether any additional management measures are required, including: - increase in frequency of surveys, visual inspections and reporting - place material at the toe of the embankment - temporarily lower or dewater dam or repair the dam wall	As required (target within 48 hours)	Tahmoor Coal
		Notify SRG of trigger exceedence and any management decisions undertaken (incl landowner and tenants, Subsidence Advisory NSW, Resources Regulator)	Within one week	Tahmoor Coal

Table 4.1 Risk Control Procedures during the extraction of Tahmoor LW S1A-S6A

RISK ISSUE	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
IMPACTS ON BUILDING STRUCTURE AND EXTERNAL PAVEMENTS, FENCES AND GATES	None	Undertake structural inspections and assessments before subsidence	Complete	Tahmoor Coal (JMA)
		Conduct 2D / Absolute 3D surveys along Remembrance Drive	Baseline survey complete. Monthly 3D / Weekly 2D surveys for pegs within active subsidence zone: Continue surveys until outside active subsidence zone or one month after end of LW and continue further if ongoing adverse movements are observed. End of LW S1A-S6A.	Tahmoor Coal (SMEC)
		2D survey along Wollondilly Anglican College property boundary monitoring line during active subsidence, as per Fig. 4.1	Pegs installed and baseline survey completed Weekly surveys during active subsidence zone as per below: LWs S1A and S2A: after 1500m extraction until one month after end of LW Continue surveys if ongoing adverse movements are observed. End of LW S1A-S4A.	Tahmoor Coal (SMEC)
		Local 3D survey around perimeter of poultry sheds during active subsidence, if access is permitted	Install and baseline survey prior to 1300m extraction of LW S1A End of LW S1A-S4A.	Tahmoor Coal (SMEC)
		Visually inspect the structures, external pavements, fences, gates and residence	Baseline inspection complete End of LW S1A-S4A	Tahmoor Coal (BIS)
		Report findings of surveys and inspections to Inghams, SRG, Subsidence Advisory NSW, Resources Regulator	LWs S1A and S2A: after 1500m extraction until one month after end of LW Continue reporting if ongoing adverse movements are observed End of LW S1A-S4A.	Tahmoor Coal
		Review and assess monitoring report and consider whether any additional management measures are required	LWs S1A and S2A: after 1500m extraction until one month after end of LW Continue reviews if ongoing adverse movements are observed End of LW S1A-S4A.	Tahmoor Coal
	Increased or non-conventional movements identified from weekly surveys or Impacts reported on structure	SRG meet and consider whether any additional management measures are required, including: - structural inspection - additional surveys around perimeter of poultry sheds - increase monitoring and reporting procedures - repair impacts	Within 1 week or earlier if required	SRG
		Notify SRG of trigger exceedence and any management decisions undertaken (incl landowner, Subsidence Advisory NSW, Resources Regulator)	Within one week	Tahmoor Coal
	A hazard has been identified that involves potential serious injury or illness to a person or persons on Inghams property and cannot be controlled	SRG, Tahmoor Coal and Inghams meet to decide whether any additional management measures are required, including: - suspension of work activities within the hazardous area - demarcation of workplace to restrict people from entering or working in hazardous area - emergency evacuation of workplace	Immediately	Tahmoor Coal
		Notify SRG of trigger exceedence and any management decisions undertaken (incl landowner, Subsidence Advisory NSW, Resources Regulator)	Within 24 hours of decision	Tahmoor Coal
IMPACTS ON HYGIENCE INTEGRITY, FIRE PROTECTION SERVICES, SECURITY SERVICES, ESSENTIAL SERVICES, AND PUBLIC SAFETY HAZARDS	None	Follow procedures above	-	-
	Impacts observed	Repair impacts	As required by Inghams to avoid interruption to operations (target within 24 hours if required)	Tahmoor Coal
		Notify SRG of trigger exceedence and any management decisions undertaken (incl landowner, Subsidence Advisory NSW, Resources Regulator)	Within one week	Tahmoor Coal
IMPACTS ON STORAGE AND MATERIALS HANDLING	None	Follow procedures above	-	-
	Substantial tilt of storage shelves observed	SRG meet and consider whether any additional management measures are required, including: - relevel storage shelves - provide additional support to shelving	As required by Inghams to avoid interruption to operations (target within 24 hours if required)	Tahmoor Coal
		Notify SRG of trigger exceedence and any management decisions undertaken (incl landowner, Subsidence Advisory NSW, Resources Regulator)	Within one week	Tahmoor Coal

Revised Table 4.1: Risk Control Procedures LW S1A-S6A (amended for LW S4A in blue)

RISK ISSUE	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
IMPACTS ON BUILDING STRUCTURE AND EXTERNAL PAVEMENTS	None	Undertake structural inspections and assessments before subsidence	Complete	Tahmoor Coal (JMA)
		Relevel outdoor storage racks and conduct baseline tilt measurements	Prior to 1300m of extraction of LW S1A (complete)	Tahmoor Coal (BIS)
		Measure tilt of outdoor storage racks	End of LW S1A-S6A	Tahmoor Coal ~~(BIS)~~
		Conduct 2D / Absolute 3D surveys along Remembrance Drive	Baseline survey complete. Monthly 3D / Weekly 2D surveys for pegs within active subsidence zone: Continue surveys until outside active subsidence zone or one month after end of LW and continue further if ongoing adverse movements are observed. End of LW S1A-S6A.	Tahmoor Coal (SMEC)
		Local 3D survey around perimeter of café, gift shop, warehouse and residence during active subsidence	Install and baseline survey prior to 900m extraction of LW S1A Weekly surveys during active subsidence zone as per below: LW S1A: after 1300m extraction until end of LW LW S2A: after 1100m extraction until end of LW LWs S3A and S4A: after 1000m extraction until end of LW LWs ~~S4A-~~ S5A: after 1100m extraction until end of LW Continue surveys if ongoing adverse movements are observed. End of LW S1A-S6A.	Tahmoor Coal (SMEC)
		Visually inspect the structures, external pavements, fences, gates and storage racks, and measure tilts of freestanding brick wall	Weekly inspections at the same frequency as the surveys on the property and continue if ongoing adverse movements are observed	Tahmoor Coal ~~(BIS)~~
		Report findings of surveys and inspections to landowner, SRG, Subsidence Advisory NSW, Resources Regulator	Weekly inspections at the same frequency as the surveys on the property and continue if ongoing adverse movements are observed	Tahmoor Coal
		Review and assess monitoring report and consider whether any additional management measures are required	Weekly inspections at the same frequency as the surveys on the property and continue if ongoing adverse movements are observed	Tahmoor Coal
	Impacts observed on structure	SMG meet and consider whether any additional management measures are required, including: - structural inspection - increase monitoring and reporting procedures, including local 3D survey - undertake detailed inspections or surveys of impacts - repair impacts	Within 1 week or earlier if required	SMG
		Notify SMG of trigger exceedence and any management decisions undertaken (incl landowner, Subsidence Advisory NSW, Resources Regulator)	Within 24 hours of decision	Tahmoor Coal
	A hazard has been identified that involves potential serious injury or illness to a person or persons on public property or, or Tahmoor Garden Centre property and cannot be controlled	SMG, Tahmoor Coal and Tahmoor Garden Centre meet to decide whether any additional management measures are required, including: - suspension of work activities within the hazardous area - demarcation of workplace to restrict people from entering or working in hazardous area - emergency evacuation of workplace	Immediately	Tahmoor Coal
		Notify SRG of trigger exceedence and any management decisions undertaken (incl landowner, Subsidence Advisory NSW, Resources Regulator)	Within 24 hours of decision	Tahmoor Coal
IMPACTS ON FIRE PROTECTION SERVICES, SECURITY SERVICES, ESSENTIAL SERVICES, ACCESS AND MOBILITY, FINISHES, AND PUBLIC SAFETY HAZARDS	None	Follow procedures above	-	-
	Impacts observed generally	Repair impacts	As required by Tahmoor Garden Centre to avoid interruption to operations (target within 24 hours if required)	Tahmoor Coal
IMPACTS ON STORAGE AND MATERIALS HANDLING	None	Follow procedures above	-	-
	Substantial tilt of storage shelves observed	SRG meet and consider whether any additional management measures are required, including: - relevel storage shelves - provide additional support to shelving	As required by Tahmoor Garden Centre to avoid interruption to operations (target within 24 hours if required)	Tahmoor Coal

Table 4.1 Risk Control Procedures for No. 3165 Remembrance Drive, Bargo during the extraction of Tahmoor South LW S2A-S7A

RISK ISSUE	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
IMPACTS ON BUILDINGS, SILO HOPPERS, COMMERCIAL STRUCTURES, TANKS, WALLS, PAVEMENTS, FENCES AND GATES	None	Undertake structural inspections and assessments before subsidence	Complete	Tahmoor Coal (JMA)
		Undertake workplace health and safety inspection	Complete	Tahmoor Coal (MSIA)
		Clean and prepare base of silo hopper tower for future relevelling if required (subject to access provided by landowner)	Prior to 500m extraction of LW S3A (complete)	Tahmoor Coal
		Install missing angle tie to base of silo hopper tower on northern side (subject to access provided by landowner)	Prior to 500m extraction of LW S3A (complete)	
		Provide supplementary support to freestanding steel columns supporting first floor of machinery shed and residence (subject to approval by landowner)	Prior to 500m extraction of LW S3A(complete)	Tahmoor Coal
		Baseline survey of alignment of sliding gate	Prior to 600m extraction of LW S2A (complete)	Tahmoor Coal (SMEC)
		Conduct 2D / Absolute 3D surveys along Remembrance Drive and Main Southern Railway	Baseline survey complete. Monthly 3D / Weekly 2D surveys for pegs within active subsidence zone for LW S2A-S7A: Continue surveys until outside active subsidence zone or one month after end of LW and continue further if ongoing adverse movements are observed. End of LW S2A-S7A.	Tahmoor Coal (SMEC)
		Local 3D survey around perimeter of buildings and commercial structures during active subsidence (refer Fig. 4.1)	Baseline survey prior to 600m extraction of LW S2A End of LW S2A Weekly surveys during periods of active subsidence after 450m extraction for LW S3A and LW S4A and after 550m extraction for LW S5A: Continue surveys if ongoing adverse movements are observed. End of LW S2A-S7A.	Tahmoor Coal (SMEC)
		Install tiltmeters on silo hopper tower and monitor changes in tilt	Install and commission prior to 600m extraction of LW S2A (complete) Readings every 2 hours	Tahmoor Coal (SweetingConsulting)
		Visually inspect the property, including the structures, hopper, concrete plant, pavements, fences and gates	Baseline pre-mining inspection complete Weekly inspections during periods of active subsidence after 450m extraction for LW S3A and LW S4A and after 550m extraction for LW S5A-S6A: Continue inspections if ongoing adverse movements are observed. End of LW S2A-S7A.	Tahmoor Coal
		Report findings of surveys and inspections to landowner, SRG, Subsidence Advisory NSW, Resources Regulator	Weekly reports during periods of active subsidence after 450m extraction for LW S3A and LW S4A and after 550m extraction for LW S5A-S6A: Continue reporting if ongoing adverse movements are observed End of LW S2A-S7A.	Tahmoor Coal (MSEC)
		Review and assess monitoring report and consider whether any additional management measures are required	Weekly during periods of active subsidence after 450m extraction for LW S3A and LW S4A and after 550m extraction for LW S5A-S6A: Continue reporting if ongoing adverse movements are observed	SRG

RISK ISSUE	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
IMPACTS ON BUILDINGS, SILO HOPPERS, COMMERCIAL STRUCTURES, TANKS, WALLS, PAVEMENTS, FENCES AND GATES (continued)	Non-conventional movements identified from weekly surveys or Visual inspections identify impacts to buildings or pavements or Change in distance across diagonal of silo hopper tower exceeds 5mm or Tensile or compressive strain between pegs spaced no closer than 7 m apart on ground slab around silo hopper tower exceeds 0.75mm/m	SRG meet and consider whether any additional management measures are required, including: - structural inspection - relevel hopper tower or adjust baseplate connections - saw cut concrete slab surrounding silo hopper - temporarily reduce materials in hoppers while adjustments are undertaken - increase monitoring and reporting procedures - repair impacts	Within 1 week or earlier if required	SRG
		Notify SRG of trigger exceedance and any management decisions undertaken (incl landowner, Subsidence Advisory NSW, Resources Regulator)	Within one week	Tahmoor Coal
	A hazard has been identified that involves potential serious injury or illness to a person or persons at No. 3165 Remembrance Drive, Bargo and cannot be controlled	SRG, Tahmoor Coal, landowner meet to decide whether any additional management measures are required, including: - suspension of work activities within the hazardous area - demarcation of workplace to restrict people from entering or working in hazardous area - emergency evacuation of workplace	Immediately	Tahmoor Coal
		Notify SRG of trigger exceedance and any management decisions undertaken (incl landowner, Subsidence Advisory NSW, Resources Regulator)	Within 24 hours of decision	Tahmoor Coal
IMPACTS ON SEDIMENTATION TANKS	None	Follow procedures above	-	-
	Impacts observed on water retention tanks	SRG meet and consider whether any additional management measures are required, including: - structural inspection - increase monitoring and reporting procedures including crack width monitoring and local 3D survey - undertake detailed inspections or surveys of impacts - repair impacts - consider installation of waterproof liner	Within 1 week or earlier if required	SRG
		Notify SRG of trigger exceedance and any management decisions undertaken (incl landowner and Subsidence Advisory NSW)	Within 24 hours	Tahmoor Coal
IMPACTS ON FIRE PROTECTION SERVICES, SECURITY SERVICES, ESSENTIAL SERVICES, ACCESS AND MOBILITY, FINISHES, AND PUBLIC SAFETY HAZARDS	None	Follow procedures above	-	-
	Impacts observed	Repair impacts	Immediately as required by landowner to avoid interruption to operations (target within 24 hours if required)	Tahmoor Coal
		Notify SRG of trigger exceedance and any management decisions undertaken (incl landowner, Subsidence Advisory NSW, Resources Regulator)	Within one week	Tahmoor Coal
	Impacts observed to sliding entrance gate	Repair impacts	As required by landowner to avoid service interruption (target within 24 hours if required)	Tahmoor Coal
		Provide alternative security services while security gate is repaired	As required	
IMPACTS ON MACHINERY AND EQUIPMENT	None	Follow procedures above	-	-
		Baseline precision measurement of levels of hoppers and conveyors	Complete	Tahmoor Coal
	Substantial adverse subsidence movements observed, or reduced performance by machine observed	SRG meet and consider whether any additional management measures are required, including: - measurement of alignment of machinery - relevel machinery - undertake additional detailed measurements of machinery	As required by landowner to avoid business interruption (target within 24 hours if required)	Tahmoor Coal

RISK ISSUE	TRIGGER	CONTROL PROCEDURE/S	FREQUENCY	BY WHOM?
IMPACTS ON STORAGE AND MATERIALS HANDLING	None	Follow procedures above	-	-
	Substantial tilt of storage shelves and racks observed	SRG meet and consider whether any additional management measures are required, including: - relevel storage shelves - provide additional support to shelving	As required by landowner to avoid interruption to operations (target within 24 hours if required)	Tahmoor Coal
		Notify SRG of trigger exceedance and any management decisions undertaken (incl landowner, Subsidence Advisory NSW, Resources Regulator)	Within one week	Tahmoor Coal
IMPACTS ON SWIMMING POOL AND POOL GATE	None	Visually inspect the swimming pool and pool gate	Baseline inspection (complete) Weekly inspections during periods of active subsidence after 550m extraction for LW S2A, after 450m extraction for LW S3A and LW S4A and after 550m extraction for LW S5A-S6A Continue inspections if ongoing adverse movements are observed. End of LW S2A-S7A.	Tahmoor Coal
	Impacts observed	Repair impacts	As required	Tahmoor Coal
		Notify SRG of trigger exceedance and any management decisions undertaken (incl landowner, Subsidence Advisory NSW, Resources Regulator)	Within one week	Tahmoor Coal
	Pool gate won't close	Notify resident and/or landowner, contact Subsidence Advisory NSW to repair gate	Immediately	Tahmoor Coal
		Repair gate	As soon as possible	Tahmoor Coal
IMPACTS ON GRASSED AIR STRIP	None	Visually inspect the grassed air strip	Baseline inspection prior to 600m extraction of LW S2A Weekly inspections during periods of active subsidence after 550m extraction for LW S2A, after 450m extraction for LW S3A and LW S4A and after 550m extraction for LW S5A-S6A: Continue inspections if ongoing adverse movements are observed. End of LW S2A-S7A.	Tahmoor Coal
	Mining-induced cracks or humps observed	Fill cracks or resurface air strip	As required	Tahmoor Coal
		Notify SRG of trigger exceedance and any management decisions undertaken (incl landowner, Subsidence Advisory NSW, Resources Regulator)	Within one week	Tahmoor Coal

APPENDIX D – Letter of Endorsement

Planning, Industry & Environment

Ms Zina Ainsworth
Manager Environment and Community
Tahmoor Coal – SIMEC Mining
PO Box 100
TAHMOOR New South Wales 2573

26/11/2021

Dear Ms Ainsworth

Tahmoor South Coal Project (SSD 8445)
Extraction Plan - Endorsement of experts

I refer to your request (SSD-8445-PA-12) for the Secretary's approval of suitably qualified persons to prepare the Longwalls 101A – 106A Extraction Plan for the Tahmoor South Coal Project (SSD-8445) as required under condition C8(a) of Schedule 4.

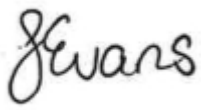
The Department has reviewed the nominations and information you have provided and is satisfied that these persons are suitably qualified and experienced. Consequently, I can advise that the Secretary approves the appointment of the following to prepare the Extraction Plan:

Extraction Plan Component	Person	Company
Main Document and Public Safety Management Plan	• Zina Ainsworth, Environment & Community Manager • April Hudson, Approvals Specialist	• Tahmoor Coal
Subsidence Predictions and Impact Assessment Report, Built Features Management Plan and associated infrastructure management plans, and Subsidence Monitoring Program	• Daryl Kay, Subsidence Specialist	• MSEC
Water Management Plan	• Anthony Marszalek, Water Resources Engineer • Camilla West, Water Resources Scientist	• HEC/ATC Williams
Supporting groundwater documents for the Water Management Plan	• Sharon Hulbert, Hydrogeologist • Maxime Philbert, Hydrogeologist • Will Minchin, Hydrogeologist	• SLR • SLR • Watershed Hydrogeo
Land management plan and supporting documents	• Roderick Haselden, Engineering Geologist • Sean Little, Geologist	• Douglas Partners
Biodiversity Management Plan	• Matthew Russell, Aquatic Ecologist • Jessie Bear, Ecologist • Sian Griffiths, Ecologist	• Niche Environment and Heritage
Heritage Management Plan	• Susan Lampart,	• EMM Consulting

	Archaeologist • Ryan Desic, Archaeologist • Anthony Dakhoul, Heritage Consultant • Pamela Chauvel, Archaeologist	
Graphical Plans	Zachary Burley, Lead Surveyor	Tahmoor Coal

If you wish to discuss the matter further, please contact me on jessie.evans@dpie.nsw.gov.au.

Yours sincerely



Jessie Evans
Director
Resource Assessments

As nominee of the Secretary

Department of Planning, Housing & Infrastructure

Our ref: SSD-8445-PA-142

Ms. Zina Ainsworth
Environment & Community Manager
2975 Remembrance Drive
Tahmoor NSW 2573

01/08/2025

Tahmoor South Coal Project (SSD 8445) - Appointment of suitably qualified persons to prepare an Extraction Plan for Longwalls South 1A to South 7A

Dear Ms. Ainsworth,

I refer to your request (SSD-8445-PA-142) for the Secretary's approval of suitably qualified persons to prepare the Longwalls S1A-S7A Extraction Plan for the Tahmoor South Coal Project (SSD-8445) as required under condition C8(a) of Schedule 4.

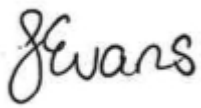
The Department has reviewed the nominations and information you have provided and is satisfied that these persons are suitably qualified and experienced. Consequently, I can advise that the Secretary approves the appointment of the following person to prepare the Extraction Plan:

Extraction Plan Component	Person	Company
Main Document and Public Safety Management Plan	• Zina Ainsworth, Environment & Community Manager • Natalie Brumby, Environmental Specialist	• Tahmoor Coal
	• Nick Le Baut, Project Manager Environmental Projects	• Integrated Project Consulting
Subsidence Predictions and Impact Assessment Report, Built Features Management Plan and associated infrastructure management plans, and Subsidence Monitoring Program	• Daryl Kay, Subsidence Specialist	• MSEC
Water Management Plan	• Anthony Marszalek, Water Resources Engineer • Camilla West, Water Resources Scientist • Makaela McGrath, Senior Environmental Scientist	• HEC/ATC Williams

Supporting groundwater documents for the Water Management Plan	• Sharon Hulbert, Hydrogeologist • Raymond Minnaar, Hydrogeologist	• SLR
Land management plan and supporting documents	• Roderick Haselden, Engineering Geologist • Huw Smith, Engineering Geologist • Jackson Green, Geologist	• Douglas Partners
Biodiversity Management Plan	• Stephen Bloomfield, Ecologist • Luke Stone, Aquatic Ecologist •	• Niche Environment and Heritage
	• Dane Fogliada, Ecologist • Sean Smith, Aquatic Ecologist • Dan Pygas, Aquatic Ecologist	• Stantec
Heritage Management Plan	• Susan Lampart, Archaeologist • Pamela Chauvel, Archaeologist and Heritage Consultant • Alan Williams, Aboriginal Heritage Consultant	• EMM Consulting
Graphical Plans	Justin Smith, Lead Surveyor	Tahmoor Coal

If you wish to discuss the matter further, please contact Gabriel Wardenburg on (02) 9585 6810.

Yours sincerely



Jessie Evans
Director, Resource Assessments
Resource Assessments

As nominee of the Planning Secretary