SIMEC Mining:

Tahmoor South Longwalls S3A to S7A

Management Plan for potential impacts to Picton Weir

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Date	Report No.	Rev	Comments
Jul-24	MSEC1193-12	A	Draft for review by Tahmoor Coal
Aug-24	MSEC1193-12	B	Draft for submission to Wollondilly Shire Council
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This Management Plan has been prepared by Mine Subsidence Engineering Consultants on behalf of the Infrastructure Management Group. The Infrastructure Management Group acknowledges contributions from a project team that is comprised of specialists in a variety of fields. The following organisations have contributed to this plan:

- Tahmoor Coal
- Crown Lands
- Wollondilly Shire Council
- Geomatix
- Mine Subsidence Engineering Consultants
- Pells Sullivan Meynink
- SweetingConsulting
- Worley

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Drawings

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

Drawing No.	***Description***	***Revision***
MSEC1193-12-01	General layout	A
MSEC1193-12-02	Surface levels and cliffs	A
MSEC1193-12-03	Geological structures	A
MSEC1193-12-04	Subsidence Monitoring Plan	A
MSEC1193-12-05	Picton Weir Monitoring Plan	A

1.1. Background

Tahmoor Coal Pty Ltd (Tahmoor Coal), owns and operates Tahmoor Mine, an existing underground coal mine located approximately 80 km southwest of Sydney in the Southern Coalfields of New South Wales (NSW). Tahmoor Coal is a wholly owned entity within the SIMEC Mining division of the GFG Alliance group. Tahmoor Coal has extracted 39 longwalls and completed extraction of LW S3A.

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

Tahmoor Coal subsequently received approval to shorten the commencing (i.e. southern) ends of LWs S3A and S4A by 104 metres from the positions that were approved in the Extraction Plan.

Tahmoor Coal has submitted an application to modify the development consent to extract LW S7A to the side of LW S6A.

Picton Weir is owned by Crown Lands. A map showing the location of the Picton Weir in relation to LWs S1A-S7A is shown in Drawing No. MSEC1193-12. An aerial photograph showing the location of the Picton Weir relative to the LW S1A-S7A is shown in Fig. 1.1.

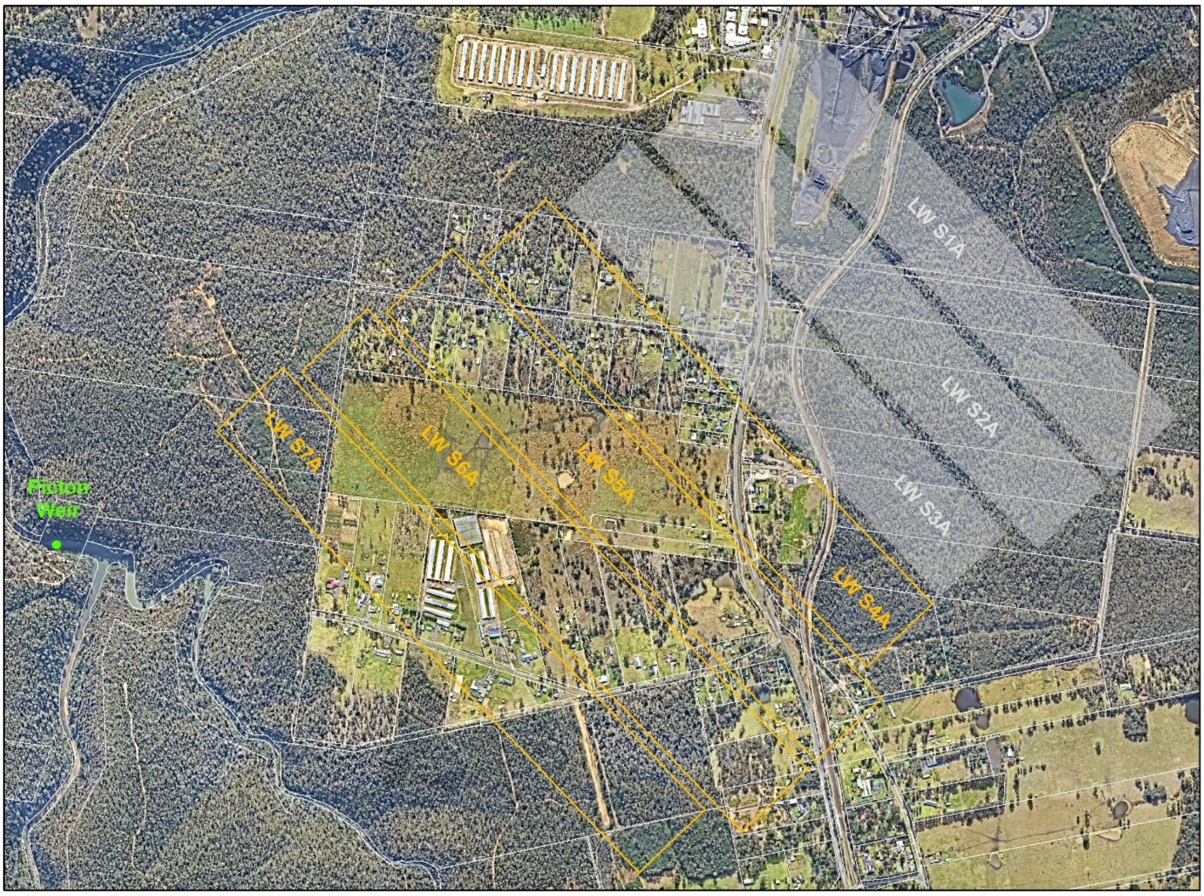


Fig. 1.1 Location of Picton Weir relative to LWs S1A to S7A

It can be seen from Fig. 1.1 that the extraction of LWs S1A to S7A will not mine directly beneath the Picton Weir. The mine will progressively extract closer to the Picton Weir with each successive longwall.

A summary of the dimensions of LW S1A-S7A and closest distances to the Picton Weir are provided in Table 1.1.

Table 1.1 Longwall dimensions and closest distances to Picton Weir

Longwall	Overall void length including the installation heading (m)	Overall void width including the first workings (m)	Overall tailgate chain pillar width (m)	Closest distance to Picton Weir (m)
LW S1A (extracted)	1,711	283	-	2,580
LW S2A (extracted)	1,768	285	38	2,250
LW S3A (extracted)	1,704	285	36	1,930
LW S4A	1,756	285	36	1,605
LW S5A	1,949	285	36	1,275
LW S6A	1,999	285	36	940
LW S7A (submitted for approval)	1,918	285	36	605

Tahmoor Coal consulted widely among state government agencies to determine the “owner” of the Picton Weir. On 1 April 2025, the Department of Planning, Housing and Infrastructure – Crown Lands confirmed that they will take responsibility as the asset owner for Picton Weir and advised that the Asset Management Team is the point of contact for Tahmoor Coal.

This Management Plan provides detailed information about how the risks associated with mining adjacent to the Picton Weir will be managed by Tahmoor Coal and Crown Lands.

The Management Plan is a live document that can be amended at any stage of mining, to meet the changing needs of Tahmoor Coal and Crown Lands.

1.2. Picton Weir

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 not used for water supply. Water retained by the weir is released at its base through a seized open valve and outlet pipe.

The Picton Weir is listed on Wollondilly Shire Council's Wollondilly Local Environmental Plan 2011 (Listing Number 141). As described on the NSW government heritage inventory, Picton Weir has local significance as evidence of the attempts by State and Local governments to provide reliable potable water sources to towns and regional areas in the late 19th century. It is an excellent example of late 19th century civil engineering and is an important component of the historic cultural landscape of Bargo. It is a good early example of early water technology, for controlling water flows on the Bargo River.

Photographs of the Weir, taken in September 2023, are shown in Fig. 1.2.

Photograph courtesy MNC Consulting

Fig. 1.2 Close up view of Picton Weir

Photograph courtesy MNC Consulting

Fig. 1.3 Wide angle view of Picton Weir

Photograph courtesy MNC Consulting

Fig. 1.4 Bird's eye view of Picton Weir

Fig. 1.5 Seized open valve and outlet pipe at base of Weir

Silt has built up behind the dam wall. A photograph during a period of drought in 2003 is shown in Fig. 1.6. Photographs of the Picton Weir posted on the internet showed similar silt levels in January 2020 during a period of drought.

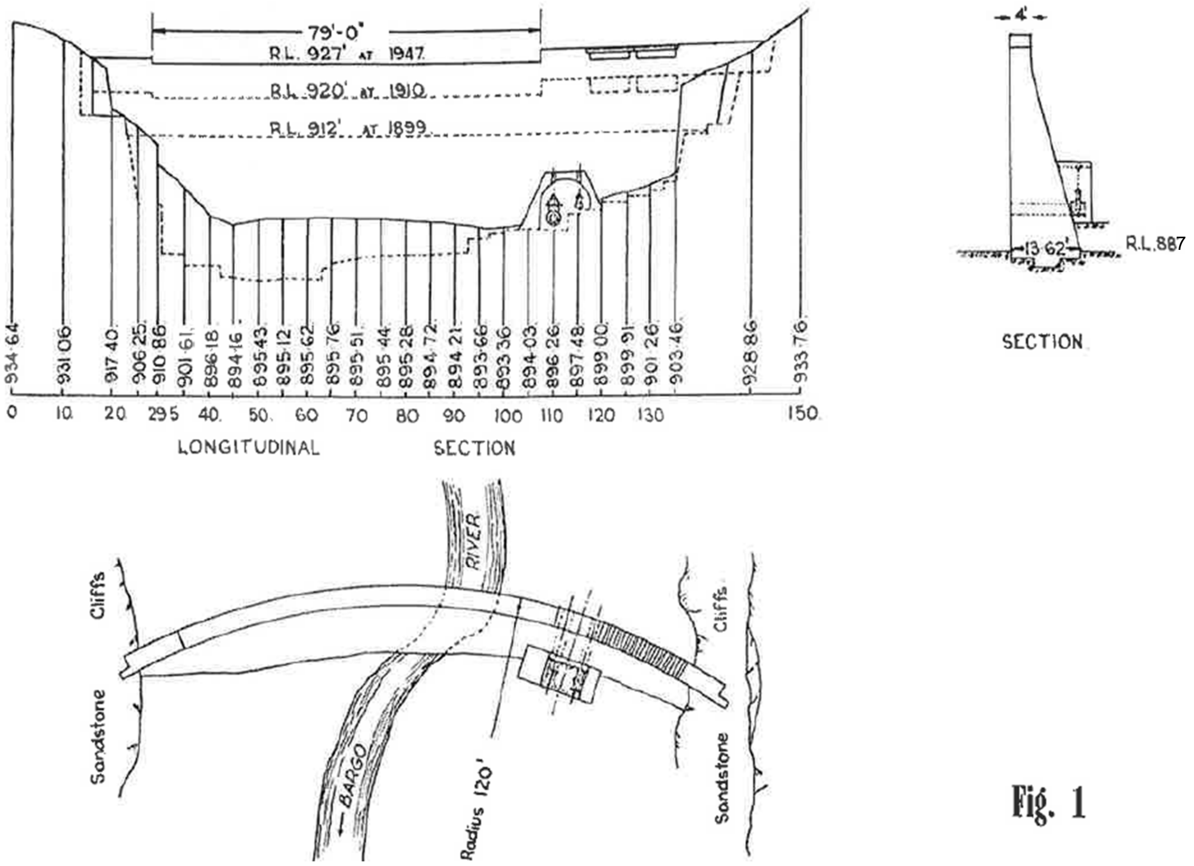
Fig. 1.6 Silt levels behind Picton Weir in February 2003

The Picton Weir is located approximately 605 metres from LW S7A at its closest point. As shown in Fig. 1.7, 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. 1.7 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 (2.4 m) to RL 920 in 1910 and raised a further 7 ft (2.1 m) in 1947 to RL 927. Drawings describing the weir's dimensions were provided by Haigh (1954) and are produced in Fig. 1.8. The lowest foundation level at RL 887 was reported by the Picton Post (1945) to be a few feet below the river bed level. The overall height is approximately 13 metres (Worley , 2024).

Worley Consulting have found a reasonable correlation between the elevations shown in Fig. 1.8 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. 1.8 Construction drawings of Picton Weir

1.3. Consultation

A summary of consultation regarding the Picton Weir is provided below.

- 17/02/2022 – Email to Sydney Water to determine ownership of weir;
- 01/03/2022 – Email to Crown Lands for access to weir;
- 01/04/2022 – Email from Sydney Water declining ownership or lease of weir;
- 19/04/2022 – Executed land access agreement with Crown Land for subsidence monitoring at weir including borehole and GNSS units;
- 20/11/2022 – GNSS units installed at weir
- 17/08/2023 – Email to Wollondilly Shire Council seeking confirmation of weir ownership/asset owner
- 24/08/2023 – Email from Wollondilly Shire Council confirming ownership of weir
- 22/01/2024 – Risk assessment with Wollondilly Shire Council
- July 2024 – Wollondilly Shire Council inspection of weir
- 07/08/2024 – Email to Wingecarribee Shire Council seeking confirmation of weir ownership / asset owner

- 9/08/2024 - Draft Subsidence Management Plan emailed to Wollondilly Shire Council and Resources Regulator for review and approval
- 29/08/2024 - Resources Regulator inspected Picton Weir
- 9/09/2024 - Email from Wingecarribee Shire Council declining ownership of Picton Weir
- 18/09/2024 - Email from Wollondilly Shire Council declining ownership of Picton Weir following further investigation and confirmed the Management Plan could not be signed by council
- 18/09/2024 - Email to Department of Planning and WaterNSW to further investigate asset owner
- 6/01/2025 - Email from WaterNSW declining ownership of Picton Weir and recommended the involvement of a property lawyer to assist
- 31/03/2025 - Email letter to NSW Crown Lands to review asset ownership of Picton Weir
- 1/04/2025 - Meeting held with NSW Crown Lands, Tahmoor Coal and property solicitor to discuss the asset. NSW Crown Lands confirmed asset ownership and contact point for the Management Plan

1.3.1. Consultation with Government Agencies & Key Infrastructure Stakeholders

Government agencies including the NSW Department of Planning & Environment, Resources Regulator, Mine Safety Operations, Subsidence Advisory NSW and key infrastructure stakeholders including Wollondilly Shire Council, Endeavour Energy, Sydney Water, Telstra and Jemena have also been consulted as part of the Extraction Plan approval process.

1.4. Limitations

This Management Plan is based on the predictions of the effects of mining on surface infrastructure as provided in Report No. MSEC1192 (MSEC, 2022) and Report No. MSEC1348 (MSEC, 2024) by Mine Subsidence Engineering Consultants. Predictions are based on the planned configuration of LW S1A-S7A at Tahmoor South (as shown in Drawing No. MSEC1193-12-01), along with available geological information and data from numerous subsidence studies for longwalls previously mined in the area.

Infrastructure considered in this Plan has been identified from site visits and aerial photographs and from discussions between Tahmoor Coal representatives and its engineering specialists.

The impacts of mining on the Picton Weir have been assessed in detail. However, it is recognised that the prediction and assessment of subsidence can be relied upon only to a certain extent. The limitations of the prediction and assessment of mine subsidence are discussed in report MSEC1192 and MSEC1348 by Mine Subsidence Engineering Consultants.

As discussed in the report, there is a low probability that ground movements and their impacts could exceed the predictions and assessments. However, if these potentially higher impacts are considered prior to mining, they can be managed. This Management Plan will not necessarily prevent impacts from longwall mining, but will limit the impacts by establishing appropriate procedures that can be followed should evidence of increased impacts emerge.

1.5. Objectives

The objectives of this Management Plan are to establish procedures to measure, control, mitigate and repair potential impacts that might occur to the Picton Weir.

The objectives of the Management Plan have been developed to:

- Ensure the safe and serviceable operation of the Weir infrastructure. Public and workplace safety is paramount. Ensure that the health and safety of people who may be present at the Picton Weir or downstream of the Picton Weir are not put at risk due to mine subsidence;
- Avoid disruption and inconvenience, or, if unavoidable, keep to minimal levels;
- Monitor ground movements and the condition of the Picton Weir during mining;
- Initiate action to mitigate or remedy potential significant impacts that are expected to occur on the surface;
- Provide a plan of action in the event that the impacts of mine subsidence are greater than those that are predicted. The plan would consider impacts on the heritage value of the Picton Weir;
- Establish a clearly defined decision-making process to ensure timely implementation of risk control measures for high consequence but low likelihood mine subsidence induced hazards that involve potential serious injury or illness to a person or persons that may require emergency evacuation, entry or access restriction or suspension of work activities;
- Provide a forum to report, discuss and record impacts to the surface. This will involve Tahmoor Coal, Crown Lands, relevant government agencies as required, and consultants as required; and
- Establish lines of communication and emergency contacts.

1.6. Scope

The Management Plan is to be used to protect and monitor the condition of the Picton Weir identified to be at risk due to mine subsidence and to ensure that the health and safety of people who may be present at the Picton Weir or downstream of the Picton Weir are not put at risk due to mine subsidence.

The Management Plan only covers the Picton Weir as a result of mining LWs S1A to S7A only. The management plan does not include other infrastructure owned by Crown Lands, which are managed in accordance with Management Plan No. MSEC1193-03.

1.7. Proposed mining schedule

It is planned that LW S1A-S7A will extract coal working northwest from the southeastern ends. This Management Plan covers longwall mining until completion of mining in LW S7A and for sufficient time thereafter to allow for completion of subsidence effects. The current schedule of mining is shown in Table 1.2.

Table 1.2 Schedule of Mining

Longwall	Start Date	Completion Date
LW S1A (complete)	October 2022	July 2023
LW S2A (complete)	August 2023	April 2024
LW S3A (commenced)	May 2024	December 2024
LW S4A	May 2025	January 2026
LW S5A	February 2026	October 2026
LW S6A	November 2026	June 2027
LW S7A	July 2027	February 2028

Please note the above schedule is subject to change due to unforeseen impacts on mining progress. Tahmoor Coal will keep Crown Lands informed of changes.

1.8. Definition of Active Subsidence Zone

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

This is termed the "active subsidence zone" for the purposes of this Management Plan, where surface monitoring is generally conducted. The active subsidence zone for each longwall is defined by the area bounded by the predicted 20 mm subsidence contour for the active longwall and a distance of 150 metres in front and 450 metres behind the active longwall face, as shown by Fig. 1.9.

The Picton Weir will not be located within the Active Subsidence Zone during the mining of LWs S3A to S7A. The definition of the Active Subsidence Zone in this Management Plan is, however, relevant to defining the start and finish of monitoring at other locations, which will provide information to assist with the management of potential impacts at the Picton Weir.

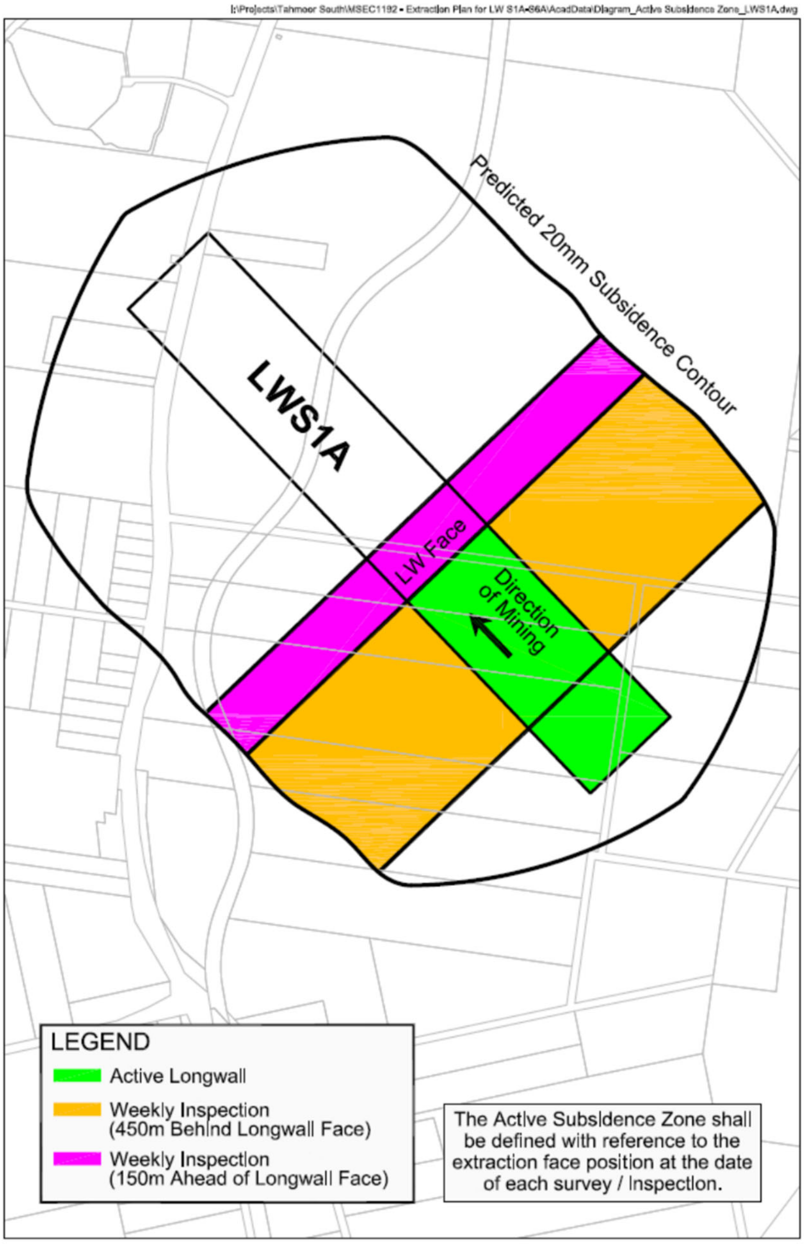


Fig. 1.9 Diagrammatic Representation of Active Subsidence Zone

1.9. Compensation

The *Coal Mine Subsidence Compensation Act 2017* (MSC Act) is administered by Subsidence Advisory NSW.

Currently, under the *Coal Mine Subsidence Compensation Act 2017*, any claim for mine subsidence damage needs to be lodged with Subsidence Advisory NSW. Subsidence Advisory 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 will be prepared and compensation will be determined. For further details please refer to *Guidelines – Process for Claiming Mine Subsidence Compensation* at www.subsidenceadvisory.nsw.gov.au .

2.1. NSW Work Health & Safety Legislation

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

The *Work Health and Safety (Mines and Petroleum Sites) Regulation 2014* commenced on 1 February 2015 and contains specific regulations in relation to mine subsidence.

As outlined in the Guide by the NSW Department of Trade & Investment Mine Safety:

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

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

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

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

Detailed guidelines have also been released by the NSW Department of Planning & Environment, Resources Regulator, Mine Safety Operations (MSO, 2017).

The risk management process has been carried out in accordance with guidelines published by the NSW Department of Planning & Environment, Resources Regulator, Mine Safety Operations (MSO, 2017). The following main steps of subsidence risk management have been and will be undertaken, in accordance with the guidelines.

1. identification and understanding of subsidence hazards
2. assessment of risks of subsidence
3. development and selection of risk control measures
4. implementation and maintenance of risk control measures, and
5. continual improvement and change management.

Each of the above steps have been or will be conducted together with the following processes.

1. consultation, co-operation and co-ordination, and
2. monitoring and review.

This Management Plan documents the risk control measures that are planned to manage risks to health and safety associated with the mining of LW S3A-S7A in accordance with the WHS laws.

2.2. General

The method of assessing potential mine subsidence impacts in the Management Plan is consistent with the Australian/New Zealand Standard for Risk Management (AS/NZS ISO 31000:2009). The Standard defines the terms used in the risk management process, which includes the identification, analysis, assessment, treatment and monitoring of potential mine subsidence impacts. In this context:-

2.2.1. Consequence

'The outcome of an event expressed qualitatively or quantitatively, being a loss, injury, disadvantage or gain. There may be a range of possible outcomes associated with an event.' The consequences of a hazard are rated from negligible to catastrophic.

2.2.2. Likelihood

'Used as a qualitative description of probability or frequency.' The likelihood can range from rare to almost certain.

2.2.3. Hazard

'A source of potential harm or a situation with a potential to cause loss.'

2.2.4. Method of assessment of potential mine subsidence impacts

The method of assessing potential mine subsidence impacts combines the likelihood of an impact occurring with the consequence of the impact occurring. In this Management Plan, the likelihood and consequence are combined via the SIMEC Risk Matrix to determine an estimated level of risk for particular events or situations. A copy of the Risk Matrix is included in the Appendix of this Management Plan.

3.1. Predicted conventional subsidence parameters

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.

3.2. Predicted non-conventional valley closure and upsidence movements

Predictions of non-conventional valley closure and upsidence movements along the Bargo River and Hornes Creek are shown in Fig. 3.1.

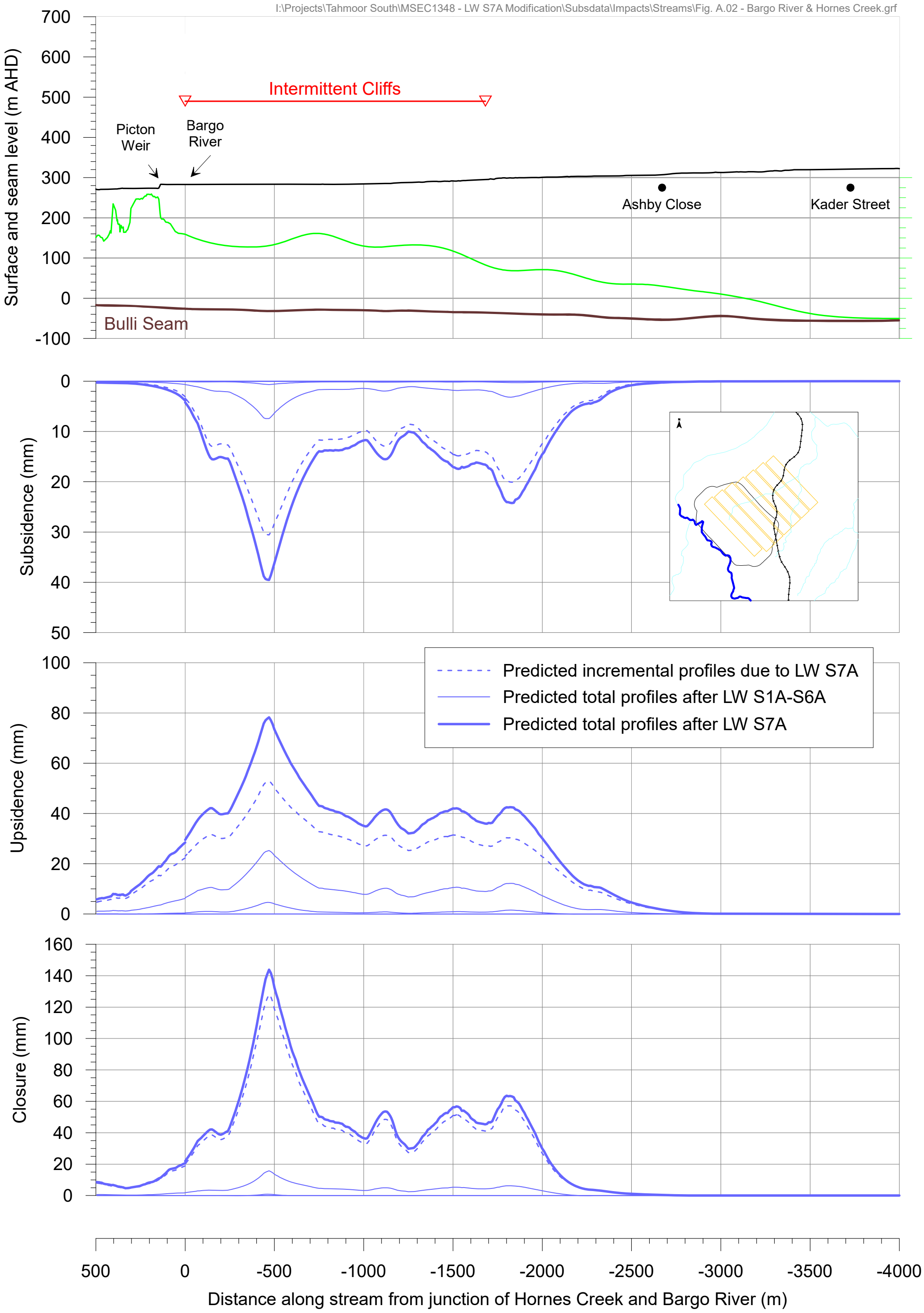


Fig. 3.1 Predicted subsidence, upsidence and closure along Bargo River and Hornes Creek

As shown in Fig. 3.1, 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 LWs S1A to 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 3.1 and the predicted total values of vertical subsidence, upsidence and closure at the Picton Weir is provided in Table 3.2.

Table 3.1 Predicted incremental vertical subsidence, upsidence and closure at Picton Weir

Longwall	Predicted incremental vertical subsidence (mm)	Predicted incremental upsidence (mm)	Predicted incremental closure (mm)
LW S7A	< 20	< 20	< 20

Table 3.2 Predicted total vertical subsidence, upsidence and closure at Picton Weir

Stage of Mining	Predicted total vertical subsidence (mm)	Predicted total upsidence (mm)	Predicted total closure (mm)
LWs S1A to S6A	< 20	< 20	< 20
LWs S1A to S7A	< 20	20	< 20

3.2.1. 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 LWs S1A-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. 3.2. 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. 3.2 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.

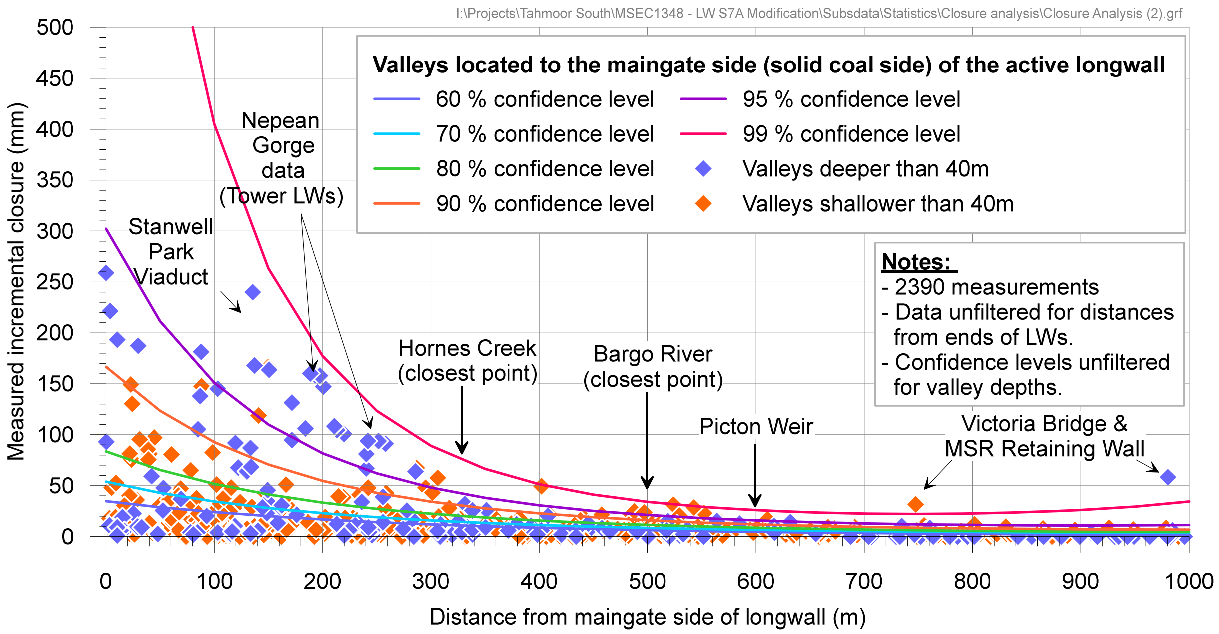


Fig. 3.2 Observed incremental valley closure against distance from the maingate edge of the active longwall over solid, unmined coal

It can be seen from Fig. 3.2 that observed valley closure increases as the distance of the sites to the extracted longwalls reduce, as expected. 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. For example, the predicted maximum incremental valley closure along Hornes Creek is 130 mm at a distance of 330 metres from the maingate edge of LW S7A, which is well above 99% confidence level.

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. 3.3, 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.

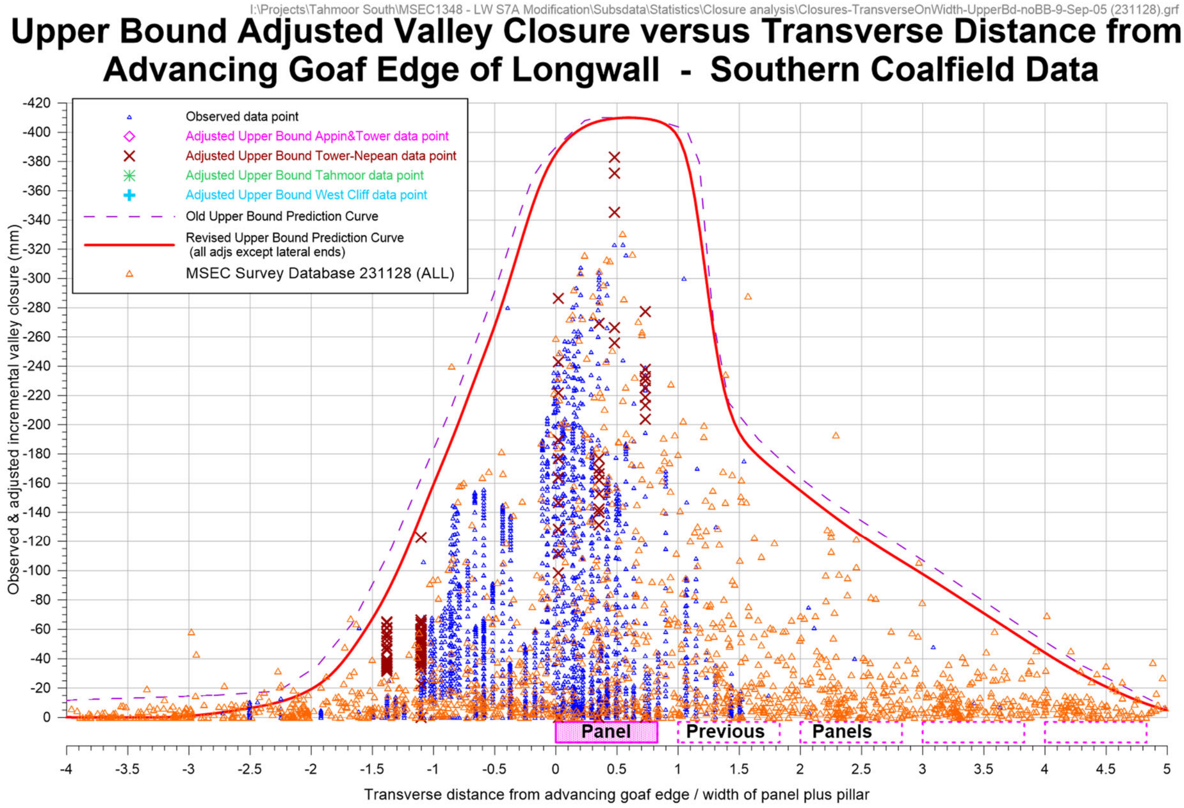


Fig. 3.3 Observed incremental valley closure against normalised transverse distance from maingate edge of longwalls and ACARP prediction model

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. 3.2, 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. 3.3 and also in Fig. 3.4 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. 3.2, but becomes an outlier when the distance is normalised due to the narrowness of the extracted panel.

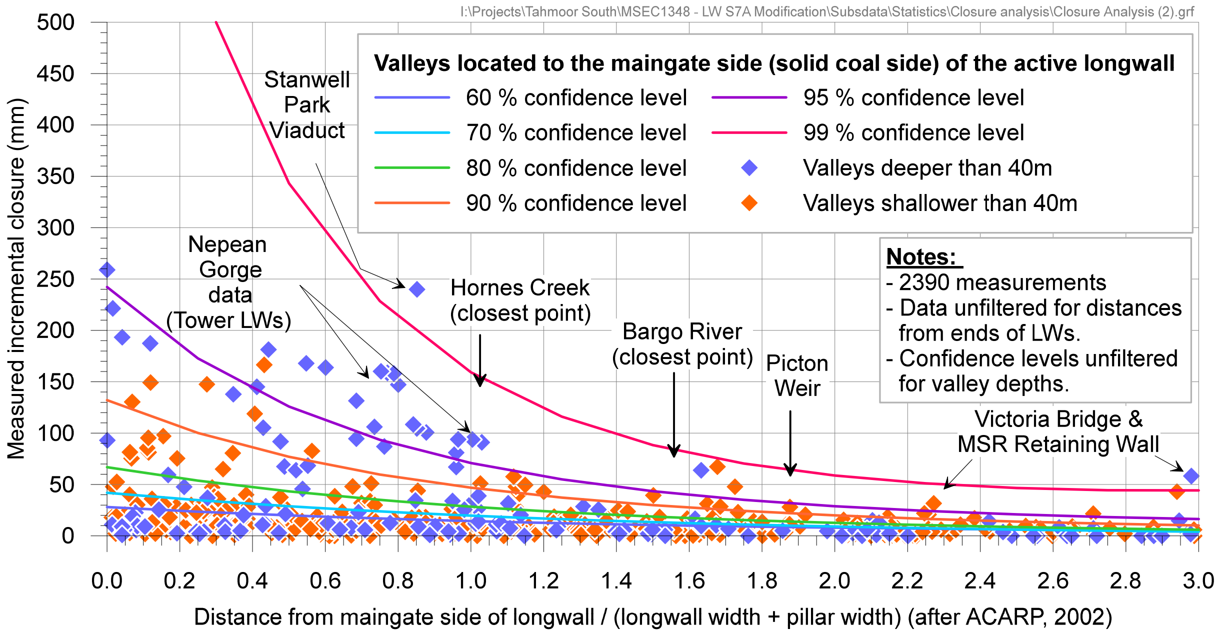


Fig. 3.4 Observed incremental valley closure against normalised distance from the maingate edge of longwalls / (longwall width + pillar width)

The results of the statistical analyses 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.

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 3.3.

Table 3.3 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. 3.2. 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. 3.5.

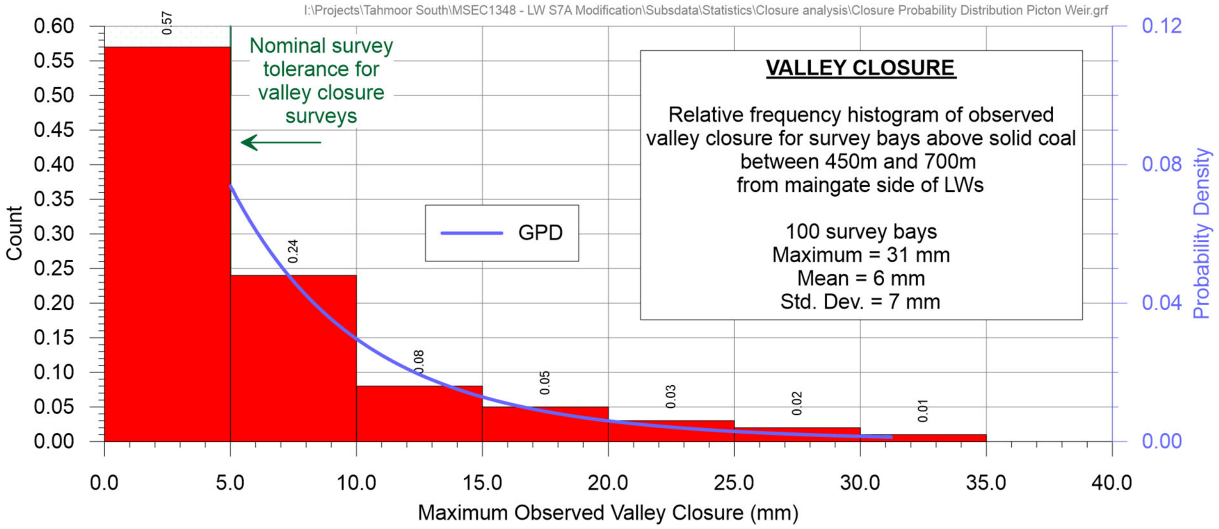


Fig. 3.5 Frequency distribution of observed valley closure for survey bays between 450m and 750m from maingate side of previously extraction LWs in Southern Coalfield

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 3.6.

As discussed earlier, 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. 3.4.

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 3.4.

Table 3.4 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.

3.3. 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. 3.2 and Fig. 3.4 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 (owned by Transport for NSW) and a Retaining Wall at 84.687 km on the Main Southern Railway (operated by the Australian Rail Track Corporation, ARTC).

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. 3.6. 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. 3.6 and Fig. 3.7);
- 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.

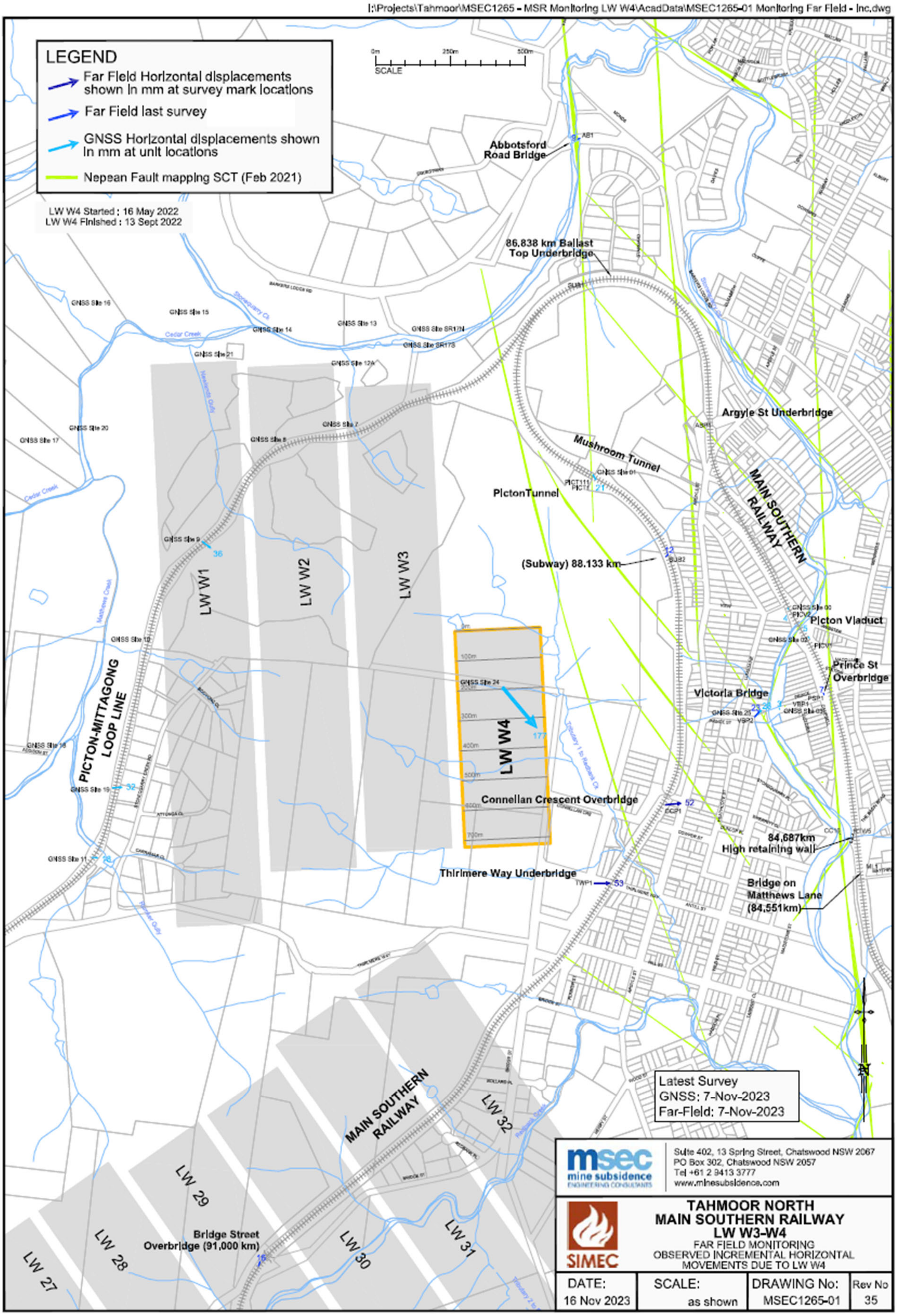


Fig. 3.6 Observed incremental horizontal movements during the mining of LW W4

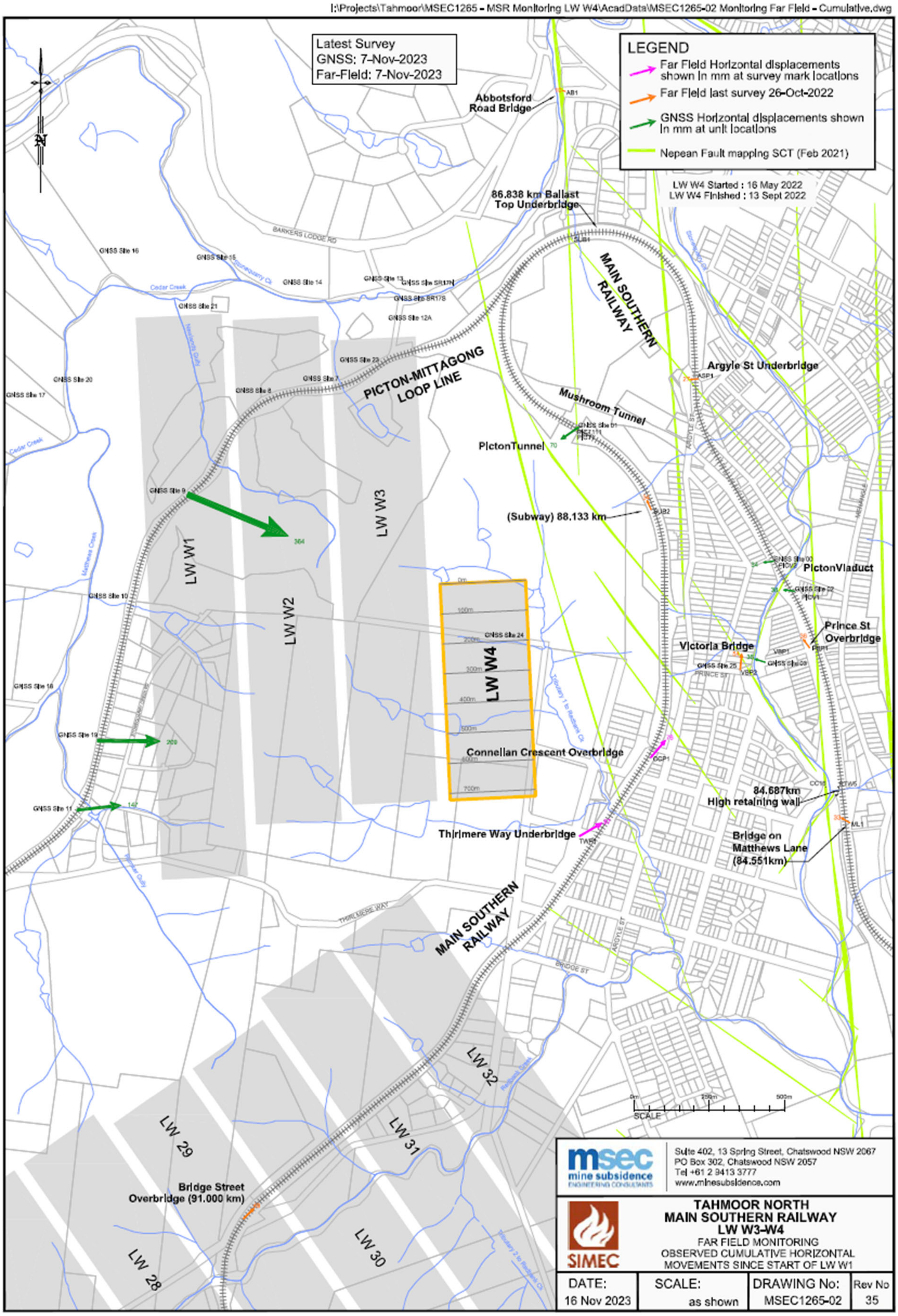


Fig. 3.7 Observed total horizontal movements during the mining of LW W1-W4

The observed development of valley closure across Stonequarry Creek at Victoria Bridge is shown in Fig. 3.8. 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. 3.9. 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. 3.10. 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 as the Picton Weir from LWs S5A to S7A. They 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 Rail 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.

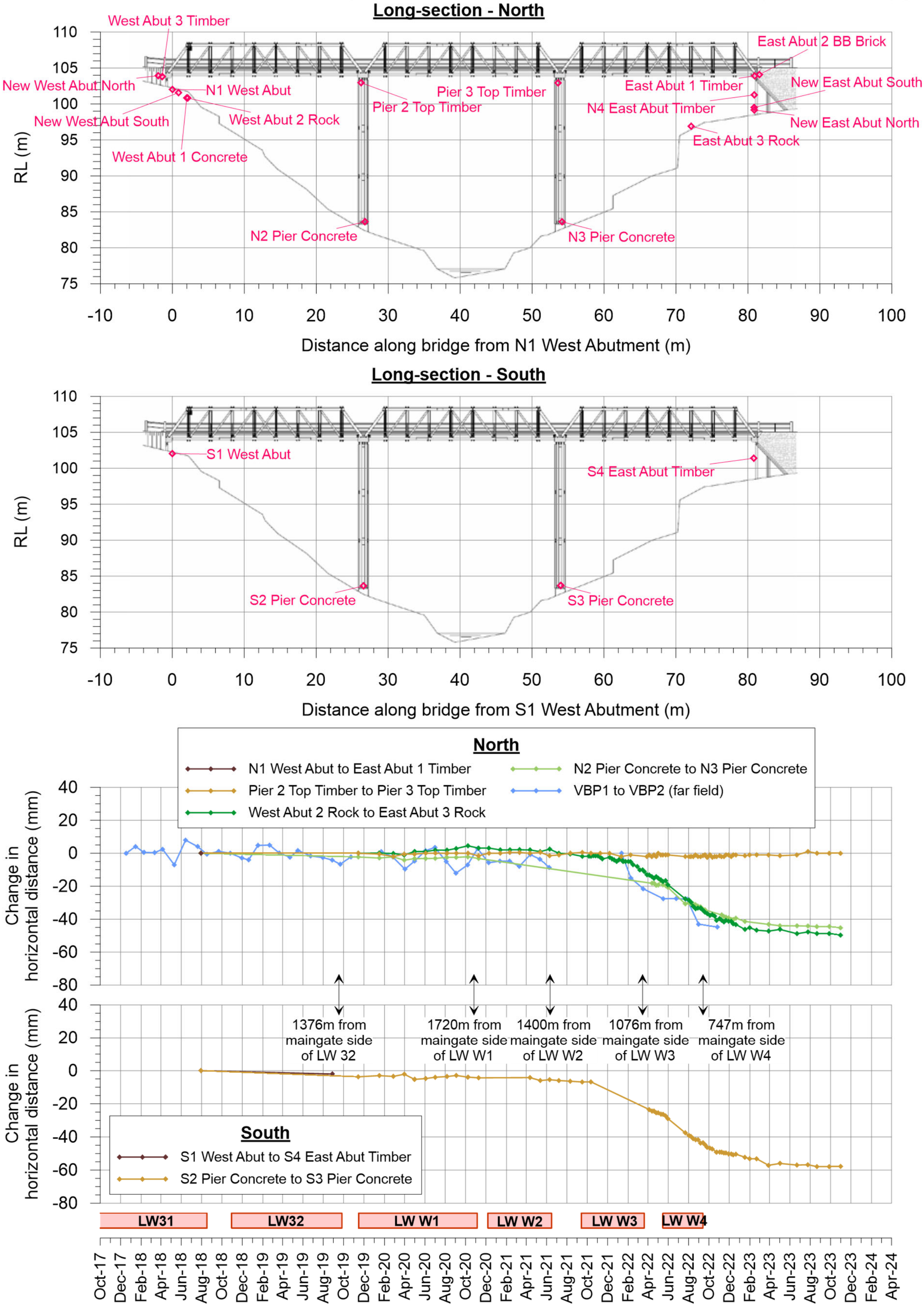


Fig. 3.8 Observed development of closure across Stonequarry Creek at Victoria Bridge during the mining of LWs 31, 32 and LW W1-W4

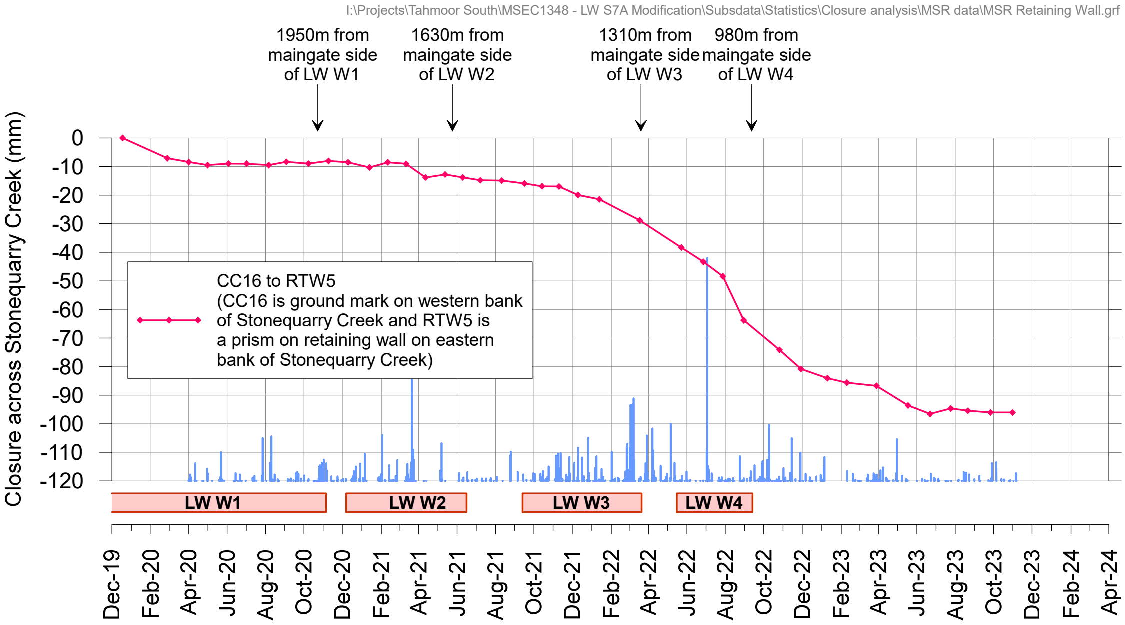


Fig. 3.9 Observed development of closure across Stonequarry Creek at Retaining Wall at 84.687 km on the Main Southern Railway during the mining of LW W1-W4

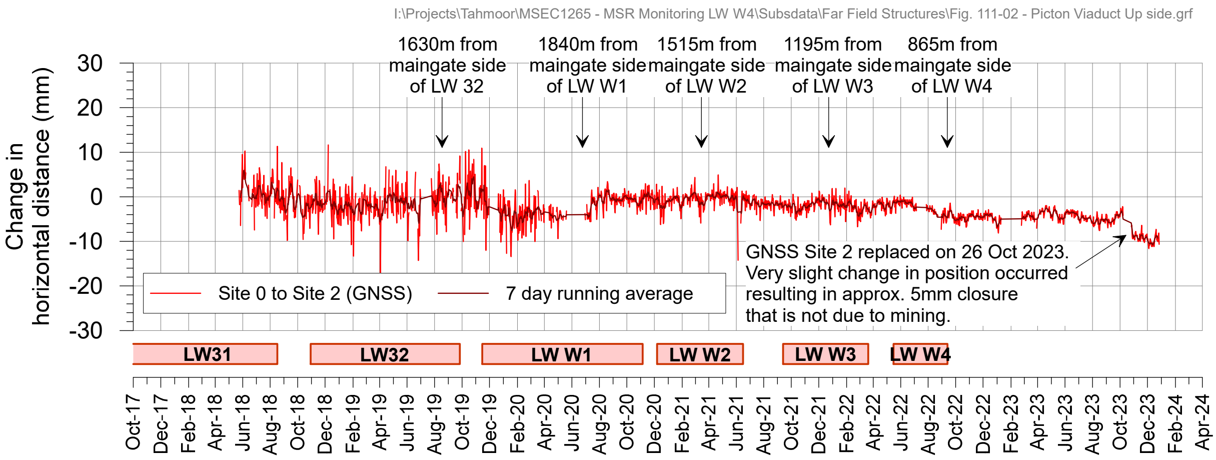


Fig. 3.10 Observed changes in horizontal distance across Stonequarry Creek at Picton Viaduct on the Main Southern Railway during the mining of LWs 31, 32 and LW W1-W4

3.4. Predicted far-field horizontal 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 built environments, except where they are experienced by large structures which are very sensitive to differential horizontal movements.

In some cases, higher levels of far-field horizontal movements have been observed where steep slopes or surface incisions exist nearby, as these features influence both the magnitude and the direction of ground movement patterns. Similarly, increased horizontal movements are often observed around sudden changes in geology or where blocks of coal are left between longwalls or near other previously extracted series of longwalls. In these cases, the levels of observed subsidence can be slightly higher than normally predicted, but these increased movements are generally accompanied by very low levels of tilt and strain.

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. 3.11.

The observed incremental far-field horizontal movements above solid coal only, i.e. outside the extents of extracted longwalls, are provided in Fig. 3.12. Survey lines have been selected from Tahmoor, Appin, West Cliff and Tower Collieries. Observed incremental far-field horizontal movements during the extraction of LWs S1A and S2A are overlaid in Fig. 3.12, along with the offset distances of Picton Weir relative to the Tahmoor South longwalls. It can be seen that observed horizontal movements during the mining of LWs S1A and S2A were within the normal observed range. The Picton Weir likely experienced far field movements due to the previous extraction of LWs 14B to 19 but surveys were not conducted at the Weir.

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. 3.11 and Fig. 3.12 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. The total far-field horizontal movement may be less, therefore, than the sum of the incremental far-field horizontal movements for the individual longwalls.

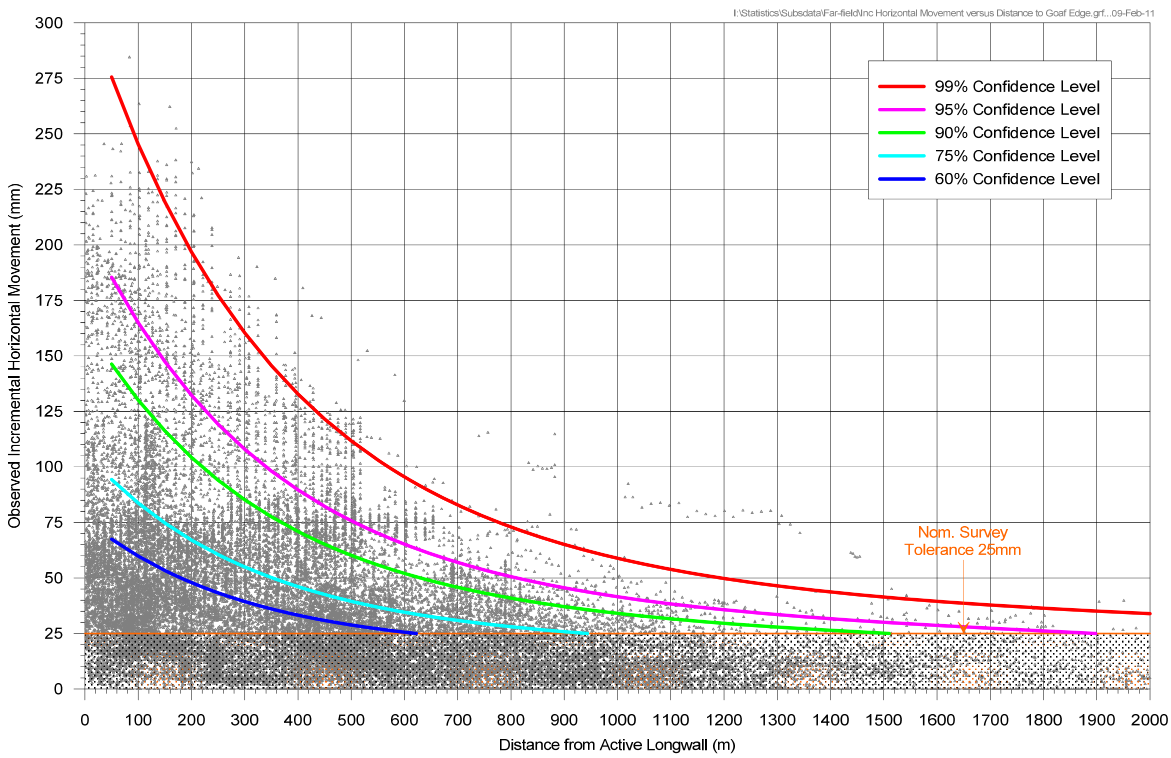


Fig. 3.11 Observed incremental far-field horizontal movements above goaf or solid coal

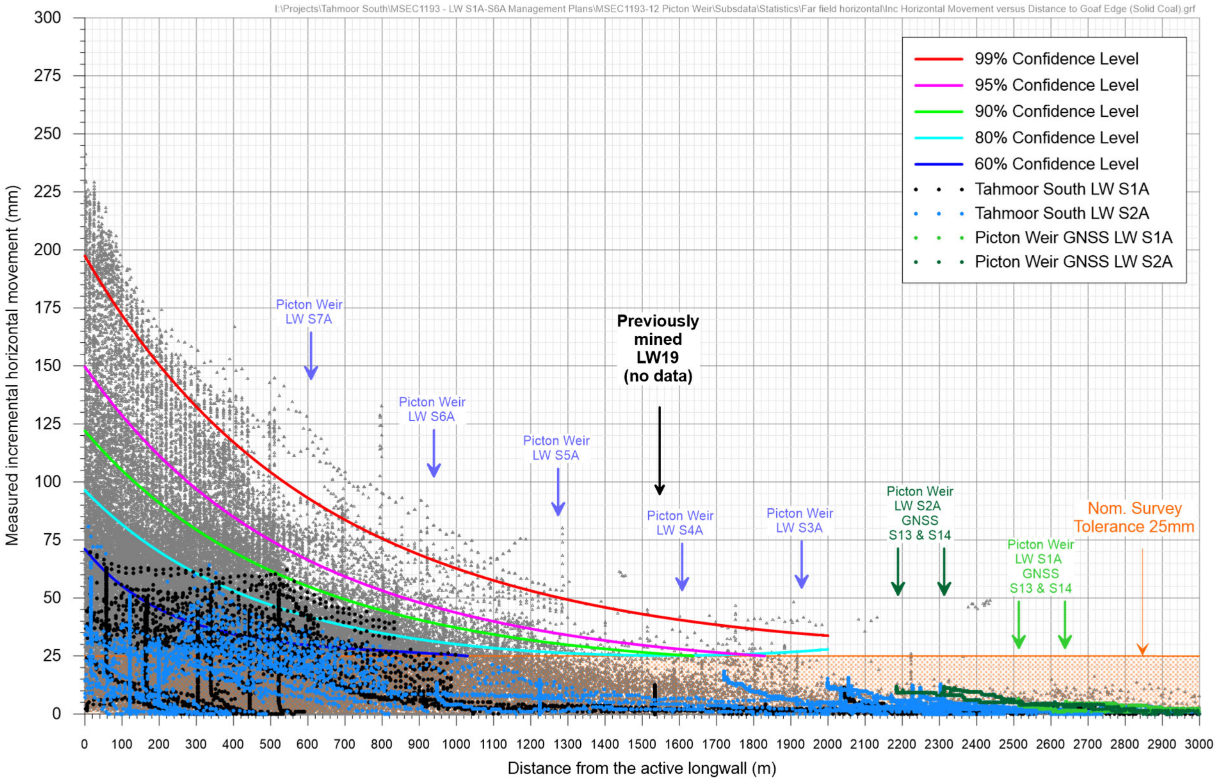


Fig. 3.12 Observed incremental far-field horizontal movements above solid coal only

Confidence levels have been determined from the selected empirical horizontal movement data from Tahmoor, Appin, West Cliff and Tower Collieries, using the fitted GPDs. In the cases where survey bays were measured multiple times during a longwall extraction, the maximum measured horizontal movement was used in the analysis. A summary of incremental horizontal movements within the 95% and 99% confidence levels are shown in Table 3.5.

Table 3.5 Confidence levels for incremental horizontal movement for survey marks above solid coal for monitoring lines at Tahmoor, Appin, West Cliff and Tower Collieries

Distance from active longwall (m)	Incremental horizontal movement within 95% confidence level (mm)	Incremental horizontal movement within 99% confidence level (mm)
200	110	145
400	90	120
600	75	100
800	60	80
1000	50	65
1200	40	50
1400	30	45
1600	26	35
1800	23	30
2000	22	27

The Picton Weir has experienced far field horizontal movements as a result of the extraction of LWs S1A to S2A and will experience far field movements as a result of the extraction of LWs S3A to S7A. 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 for impacts on the Picton Weir do not result from absolute far-field horizontal movements, but rather from differential horizontal movements over the length of the structure. Observed changes in horizontal distances between pegs spaced between 30 and 50 metres apart are shown in Fig. 3.13. The 30 to 50 metre bay length was selected as the length of Picton Weir is approximately 40 metres. It can be seen that potential for differential horizontal movements increases with each successive longwall as the mine approaches the Picton Weir. Statistical analyses were not conducted for offset distances greater than 1800 metres as there are insufficient measurements beyond the nominal survey tolerance of 3 mm.

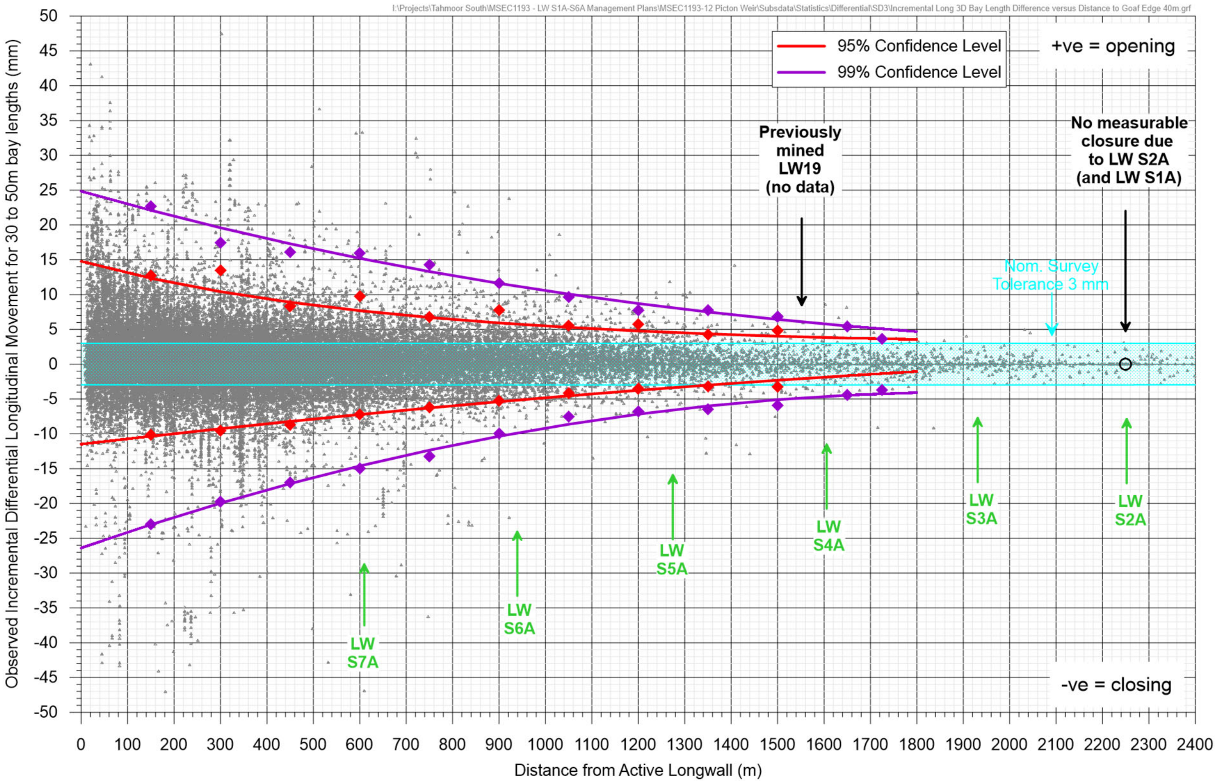


Fig. 3.13 Observed incremental differential longitudinal horizontal movements versus distance from active longwall for marks spaced between 30 and 50 metres

A summary of the probabilities of exceedance for incremental differential horizontal movements for survey bays at offset distances that are relevant to Picton Weir, based on the fitted General Pareto Distribution function, is provided in Table 3.6. As discussed previously, there is insufficient data to estimate probabilities greater than 1800 metres as there are insufficient measurements beyond the nominal survey tolerance of 3 mm.

Table 3.6 Probabilities of exceedance for incremental differential horizontal movements for survey bays located from the nearest goaf edge in the Southern Coalfield

LW	Offset distance from Picton Weir (m)	Probability of Exceedance			
		1 in 20 (0.05)		1 in 100 (0.01)	
		Opening (mm)	Closure (mm)	Opening (mm)	Closure (mm)
LW S1A	2580	<3	<3	<3	<3
LW S2A	2250	<3	<3	<3	<3
LW S3A	1930	<3	<3	<3	<3
LW S4A	1605	4	<3	6	5
LW S5A	1275	5	3	8	7
LW S6A	940	6	5	11	10
LW S7A	605	8	7	15	15

It is noted that the results of statistical analyses for valley closure in Table 3.3 and Table 3.4 suggest a higher likelihood of closure compared to the results in Table 3.6. This may be explained by the fact that the statistical analyses for valley closure is not restricted to bay lengths between 30 and 50 metres, and the datasets are restricted to observations across valleys only.

The statistical analyses provided from the far field movement data includes sites that are located in valleys and plateau areas. As the Picton Weir is located within a deeply incised valley, the likelihood of tensile opening is extremely small. While the possibility of opening cannot be ruled out, it is considered that the calculated probabilities for opening are not applicable to the Weir.

It is possible that Picton Weir could experience shear deformations as a result of differential far field movements. 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 solid coal, for previously extracted longwalls in the Southern Coalfield, is provided in Fig. 3.14.

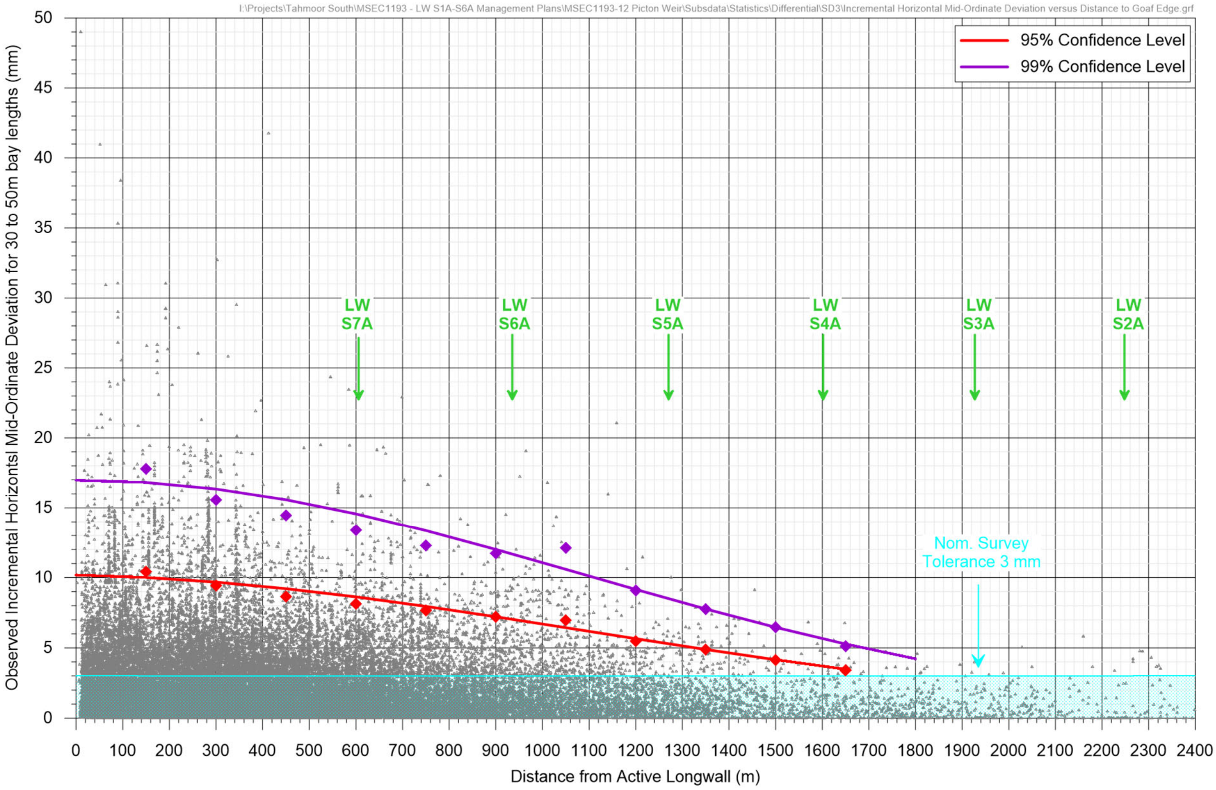


Fig. 3.14 Observed incremental differential horizontal mid-ordinate deviation versus distance from active longwall for marks spaced between 30 and 50 metres

A summary of the probabilities of exceedance for incremental horizontal mid-ordinate deviations for survey bays at offset distances that are relevant to Picton Weir, based on the fitted General Pareto Distribution function, is provided in Table 3.7. As discussed previously, there is insufficient data to estimate probabilities greater than 1800 metres as there are insufficient measurements beyond the nominal survey tolerance of 3 mm.

Table 3.7 Probabilities of exceedance for incremental horizontal mid-ordinate deviations for survey bays located from the nearest goaf edge in the Southern Coalfield

LW	Offset distance from Moreton Park Road (North) (m)	Probability of Exceedance	
		1 in 20 (0.05)	1 in 100 (0.01)
		Incremental horizontal mid-ordinate deviation (mm)	Incremental horizontal mid-ordinate deviation (mm)
LW S1A	2580	<3	<3
LW S2A	2250	<3	<3
LW S3A	1930	<3	<3
LW S4A	1605	4	6
LW S5A	1275	5	8
LW S6A	940	6	12
LW S7A	605	9	15

The results suggest that measured changes at the equivalent offset distances for LWs S1A to S5A have typically been close to survey tolerance and that the results of the statistical analyses for the low probability events (i.e. 1 in 20 and 1 in 100) have likely been influenced by survey tolerance. The results for LWs S6A and S7A have likely been influenced by a greater body of results that are outside survey tolerance.

3.5. Observed movements at the Picton Weir and along Hornes Creek during the mining of LWs S1A to S3A

Tahmoor Coal is currently monitoring ground movements at Picton Weir and along Hornes Creek according to the Subsidence Monitoring Plan. The results for the GNSS units up to April 2025 are provided in Fig. 3.15 to Fig. 3.27.

- 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. A very small seasonal trend is observed in the results.
- Six GNSS units have been installed along the tops of Hornes Creek in three pairs across the valley. The purpose of monitoring is to detect and track the development of valley closure, if any, along Hornes Creek as longwalls extract from the south-east to north-west, towards the Picton Weir.

  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. A very small seasonal trend is observed between GNSS S24 and S25 in the results but a trend is less apparent for the other two pairs of GNSS units.

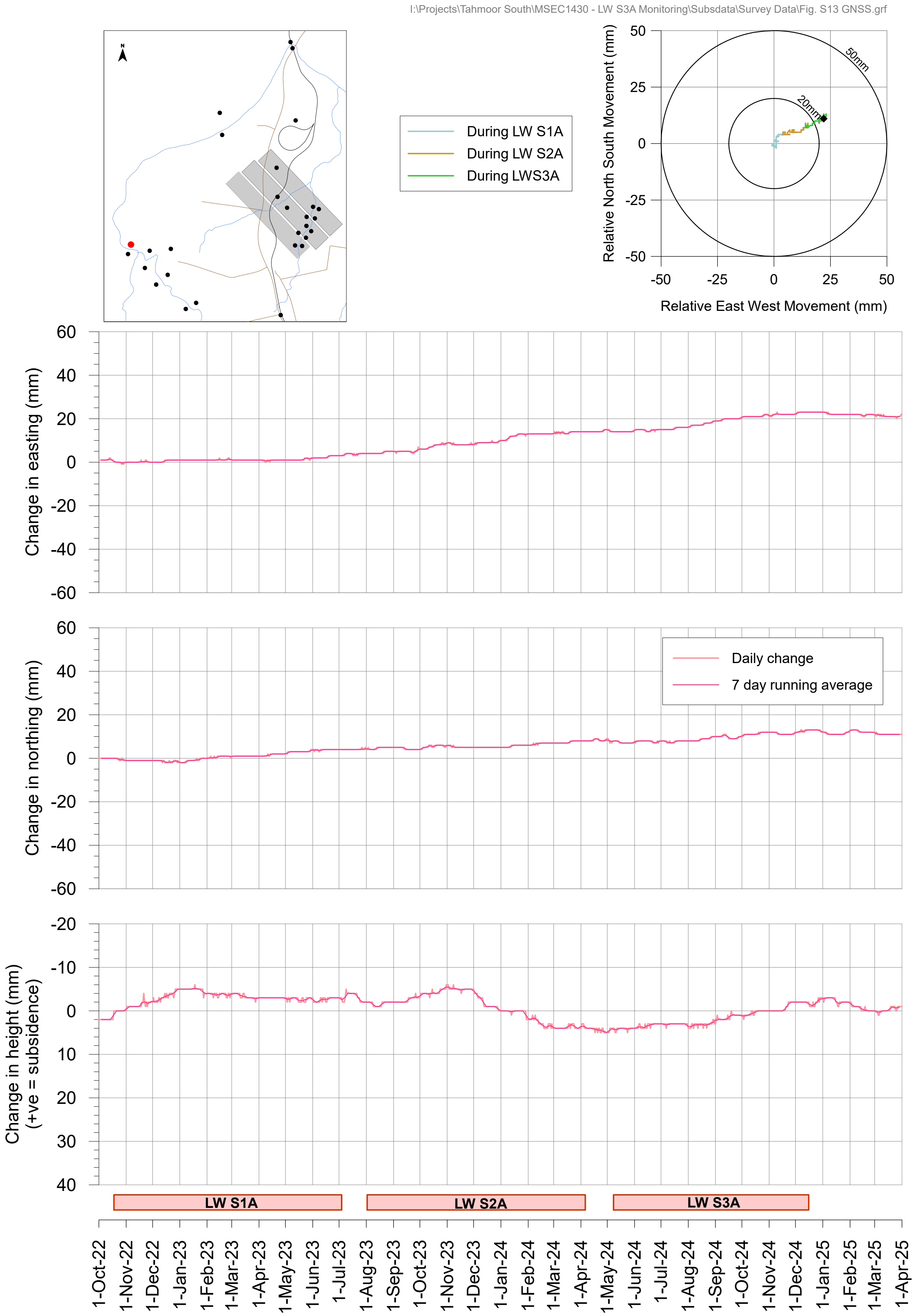


Fig. 3.15 Observed changes in easting, northing and height at GNSS S13 on northern side of Picton Weir

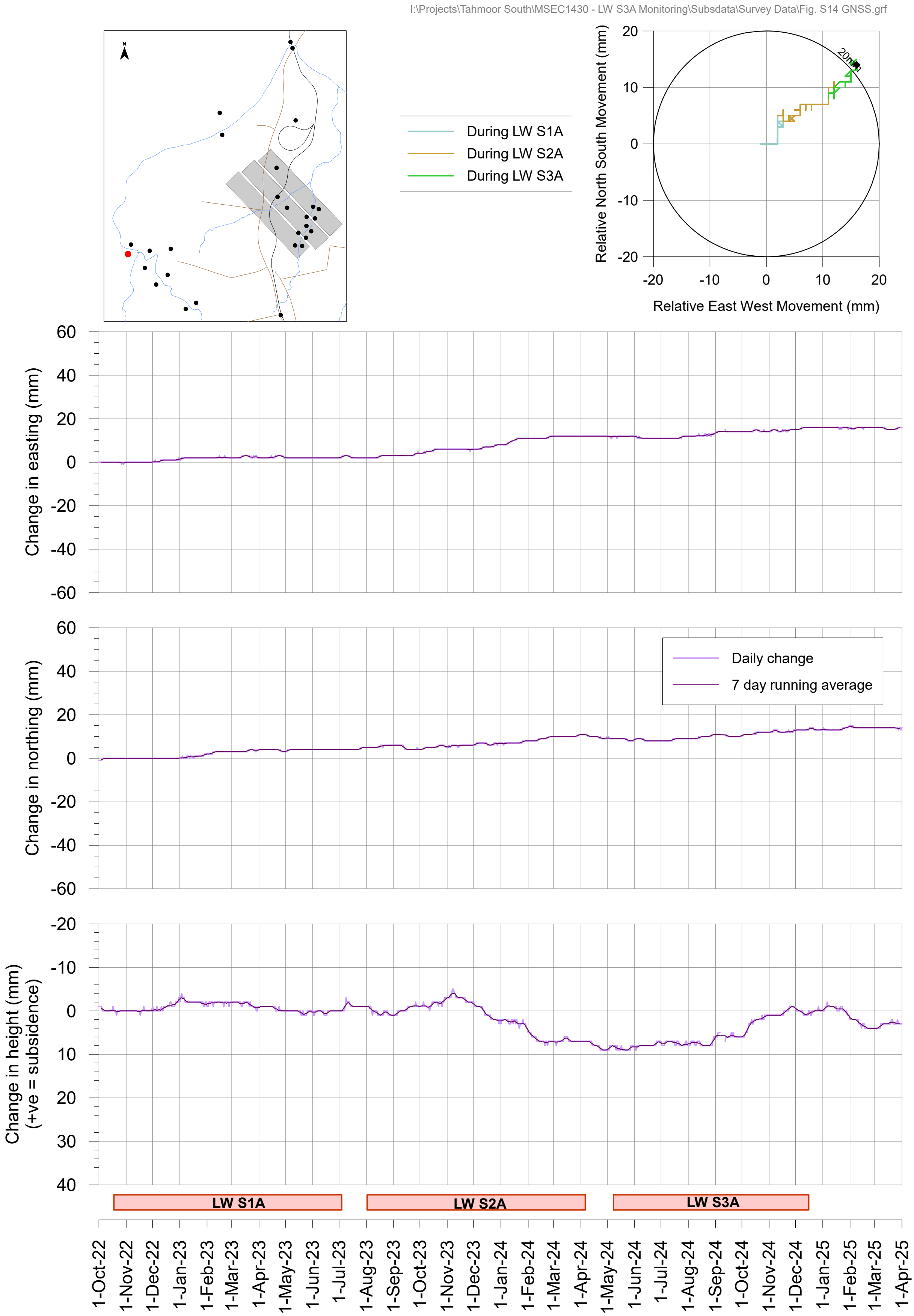


Fig. 3.16 Observed changes in easting, northing and height at GNSS S14 on southern side of Picton Weir

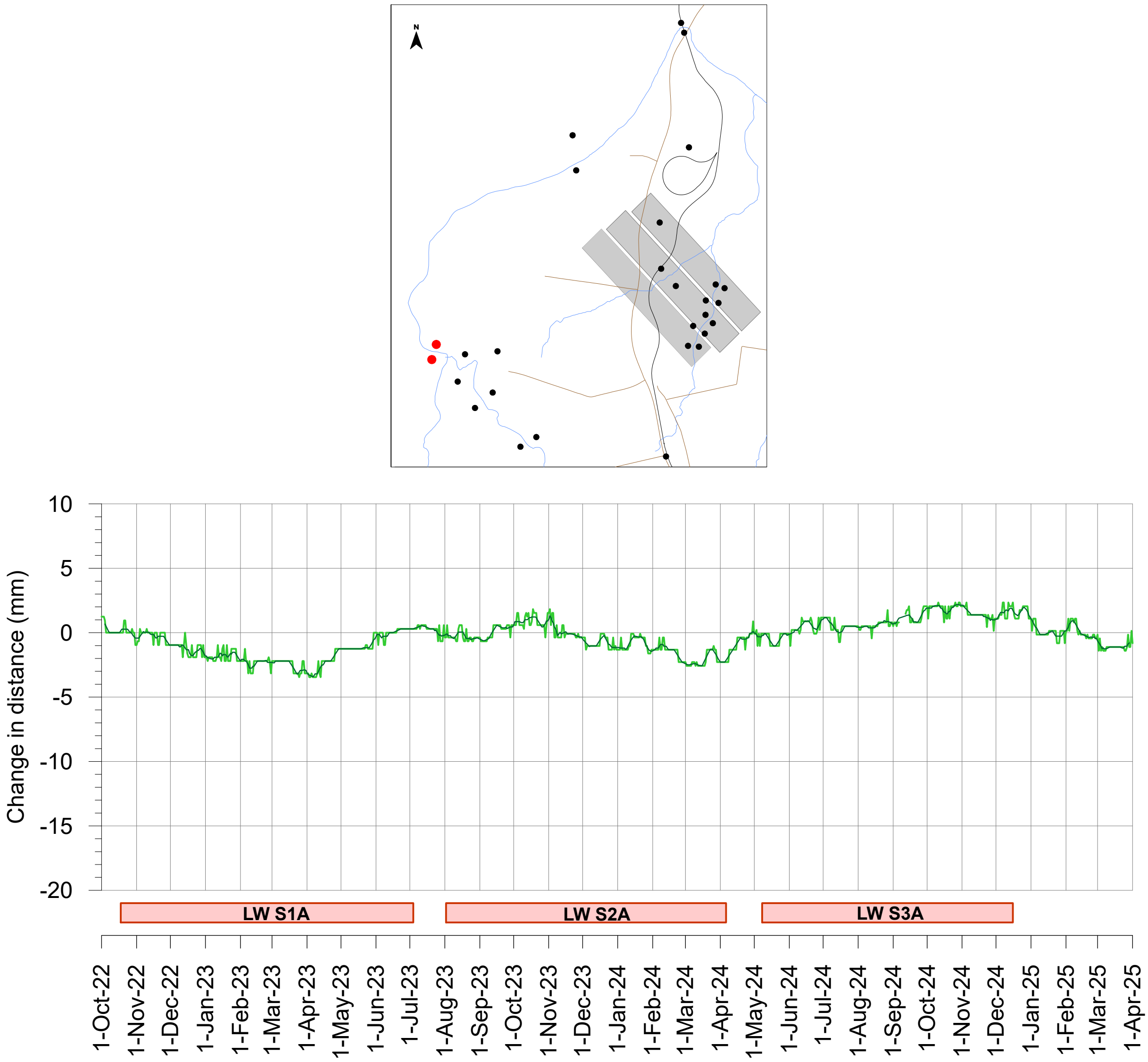


Fig. 3.17 Observed changes in distance between GNSS S13 and S14 across Picton Weir

It can be seen from Fig. 3.17 that the seasonal peaks occur in October and April. Given that two and a half years of data have been recorded, the results have been based on the average distance over the last two years. It can be seen that the observed changes oscillate about zero in December/January and May/June each year.

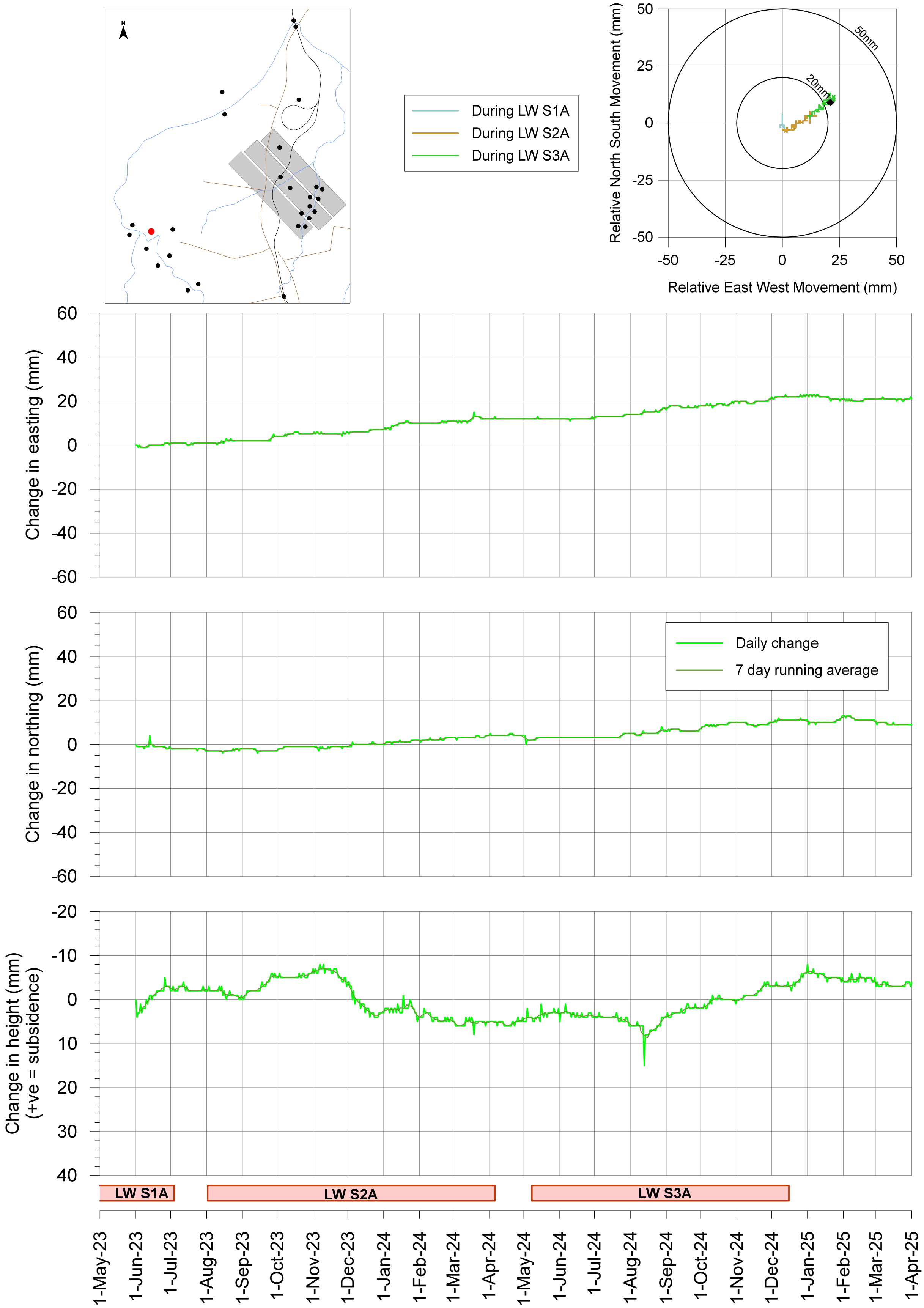


Fig. 3.18 Observed changes in easting, northing and height at GNSS S20 on northern side of Hornes Creek

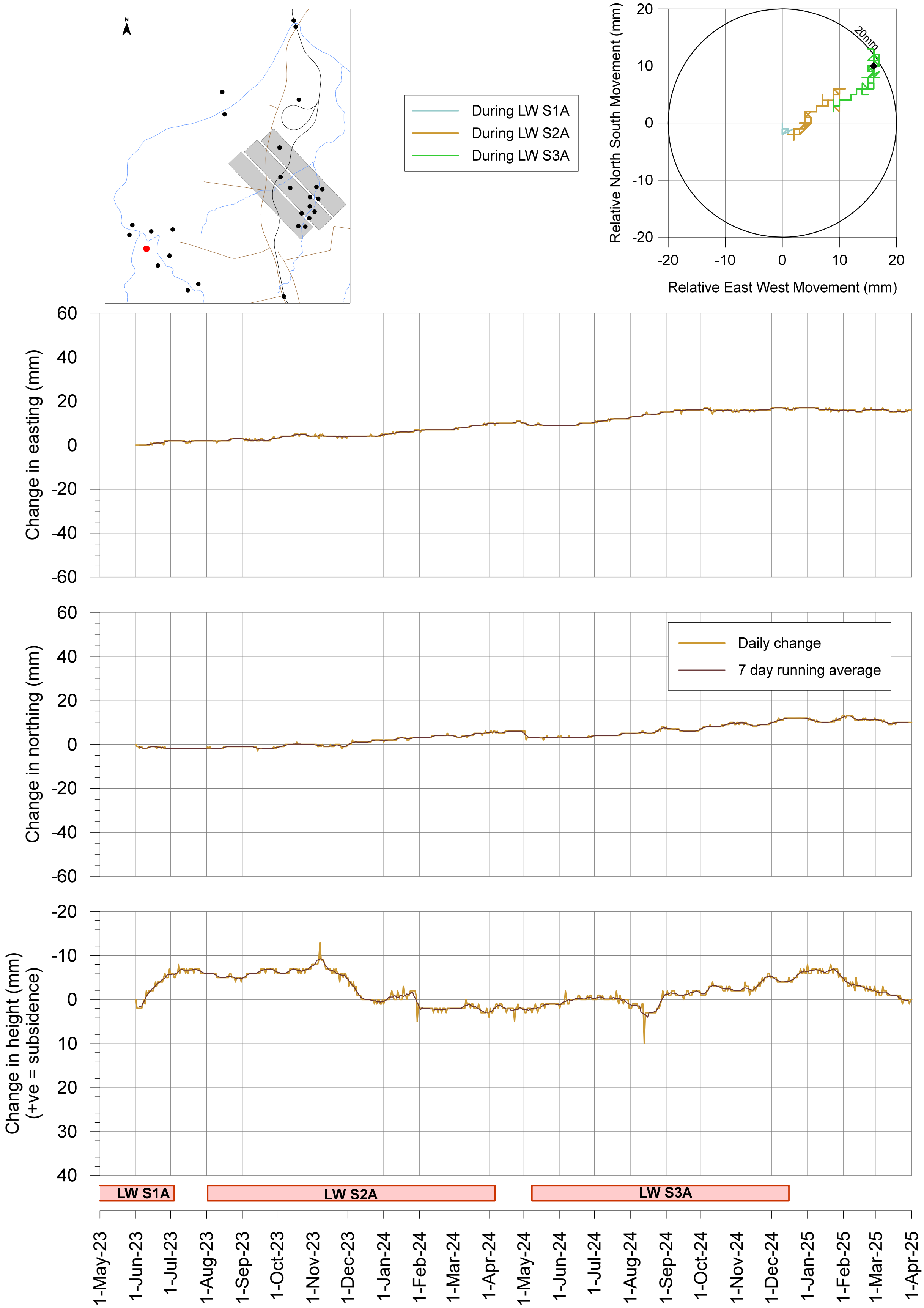


Fig. 3.19 Observed changes in easting, northing and height at GNSS S21 on southern side of Hornes Creek

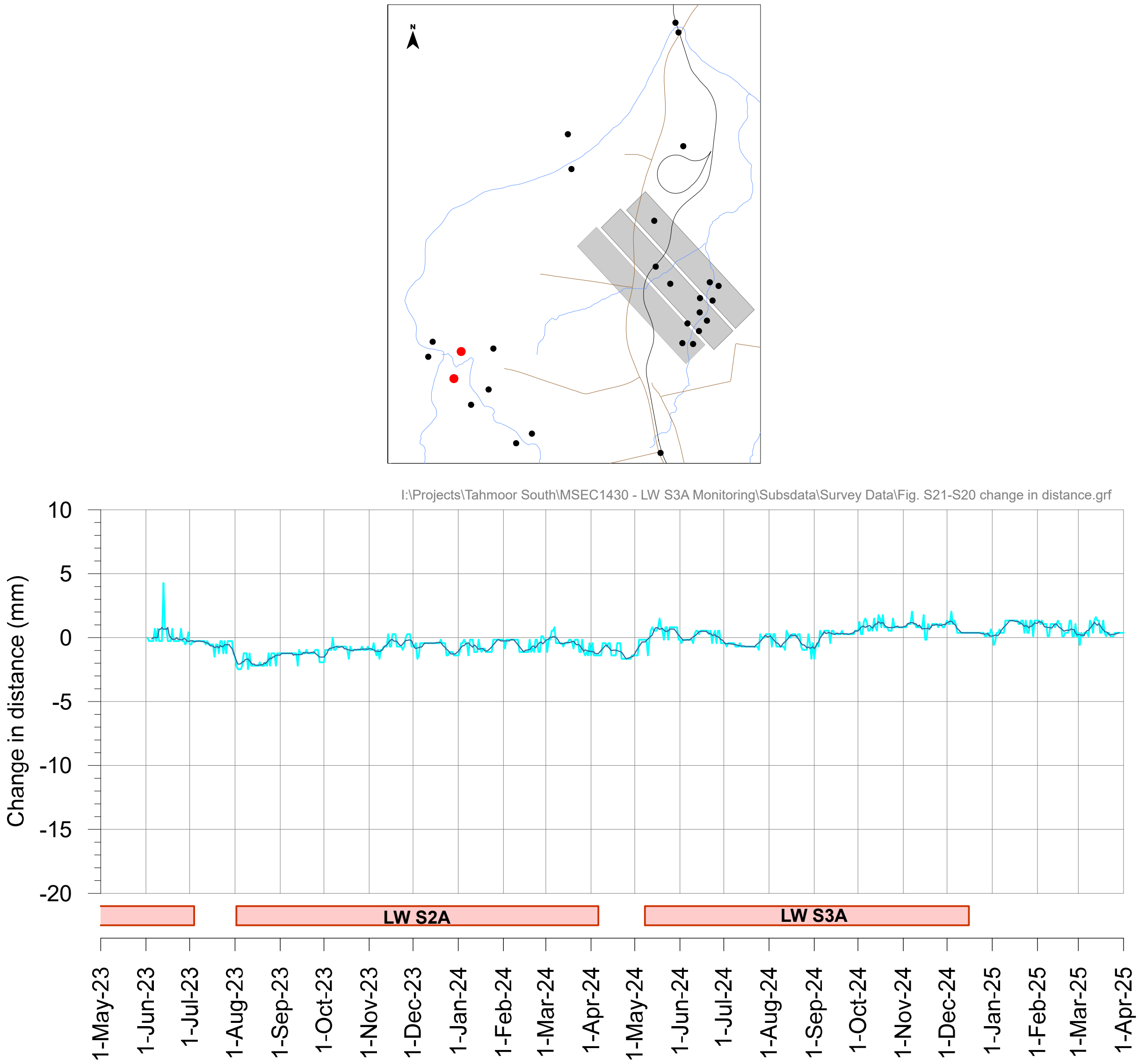


Fig. 3.20 Observed changes in distance between GNSS S20 and S21 across Hornes Creek

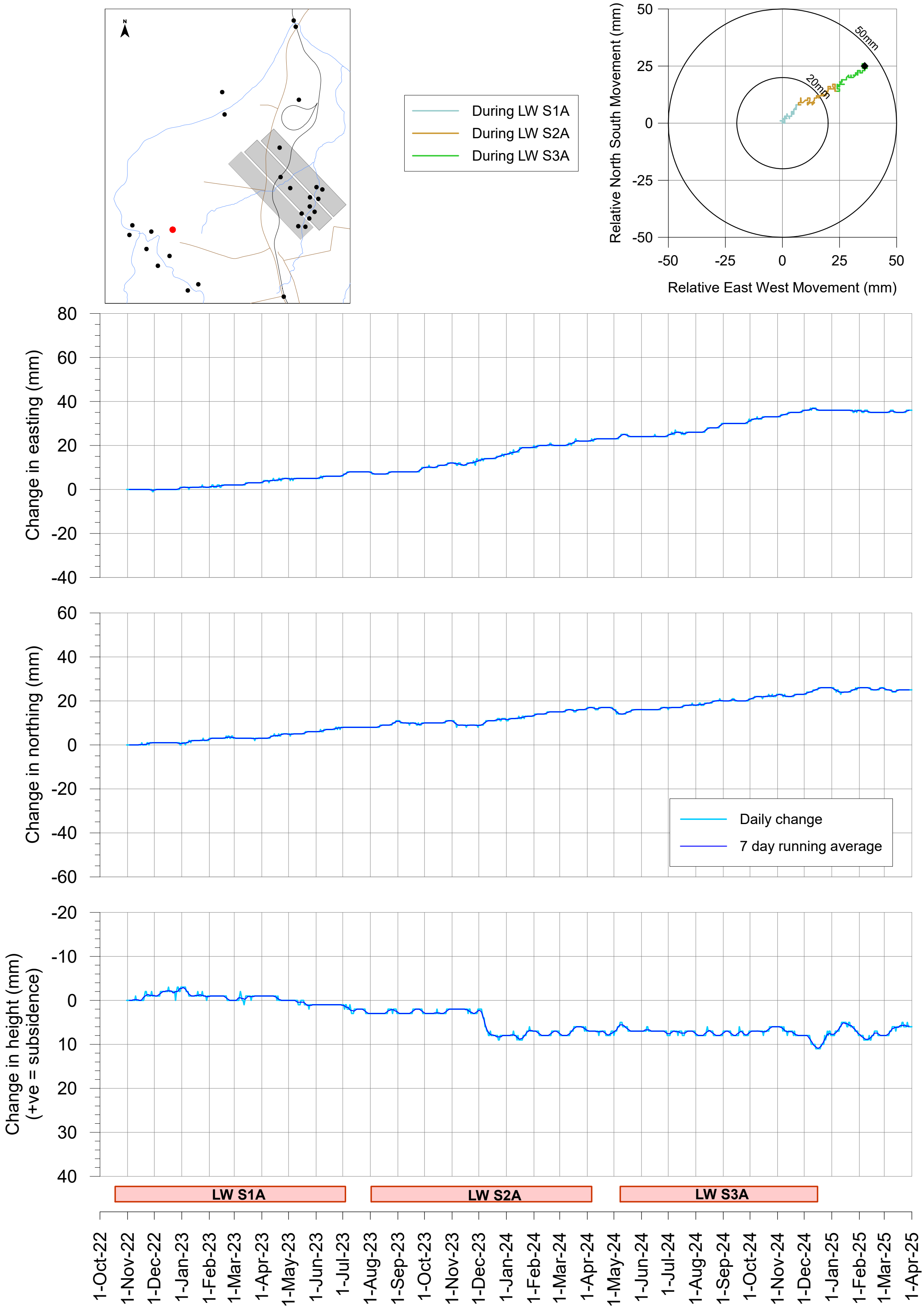


Fig. 3.21 Observed changes in easting, northing and height at GNSS S19 near Hornes Creek

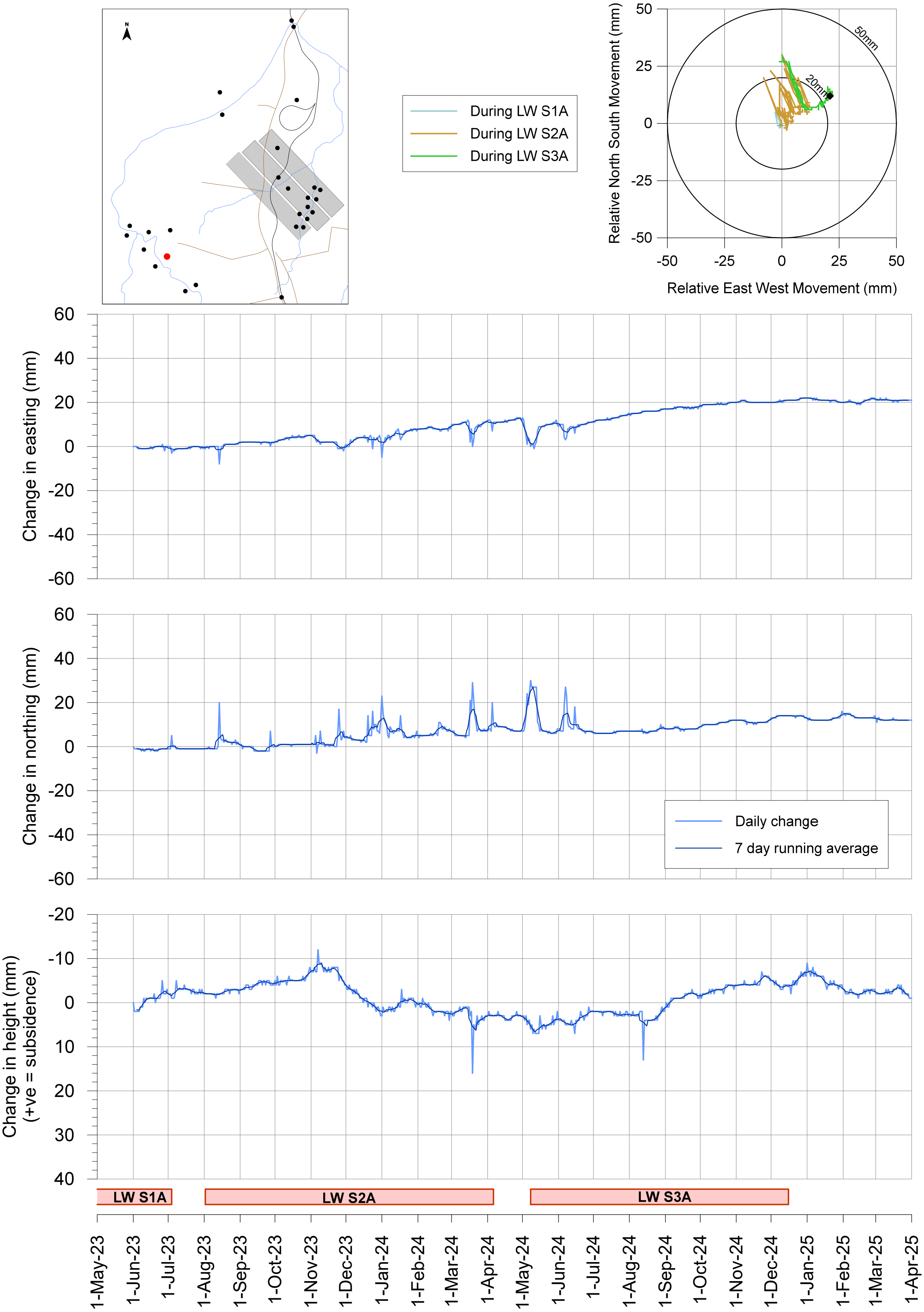


Fig. 3.22 Observed changes in easting, northing and height at GNSS S22 on northern side of Hornes Creek

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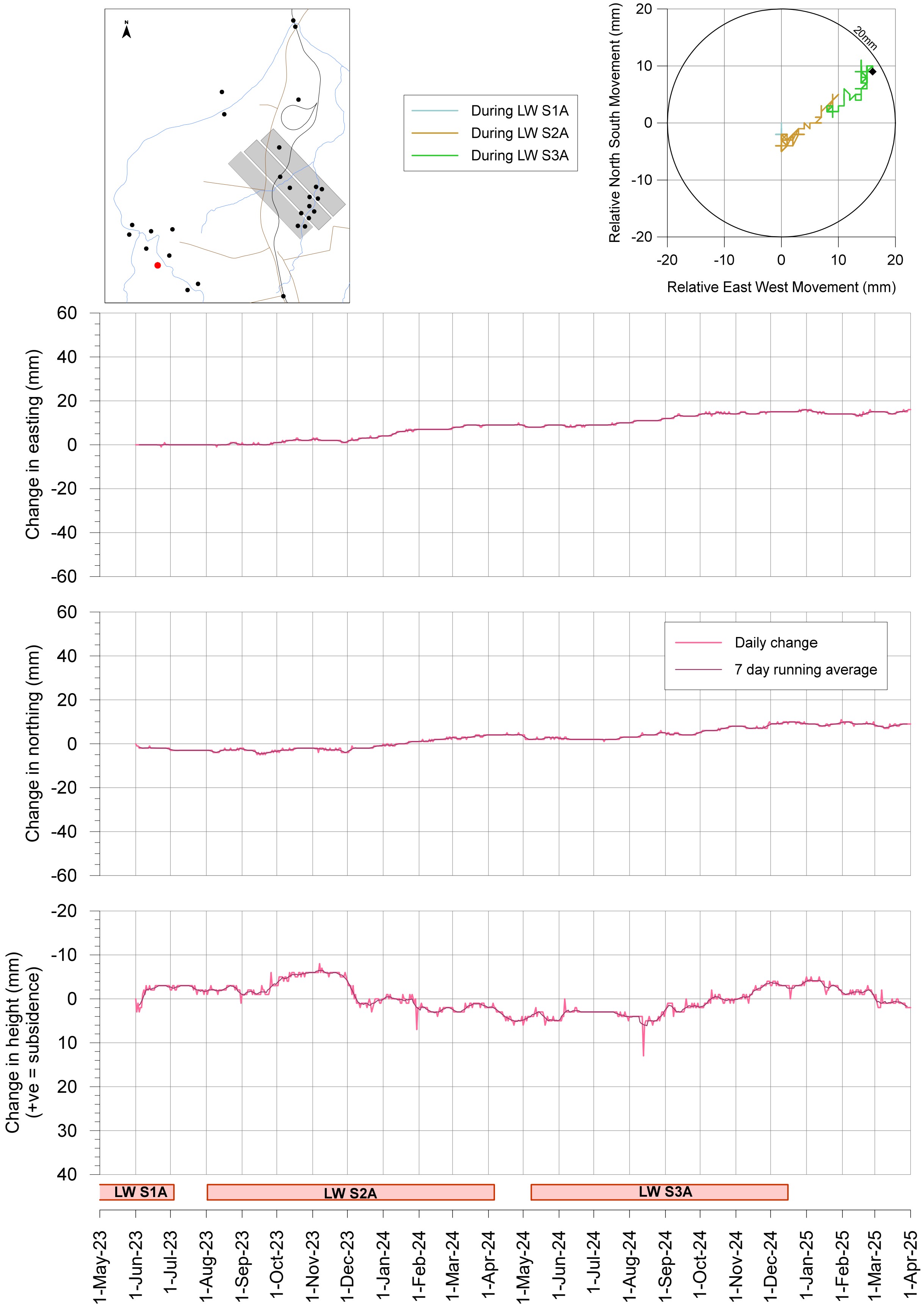
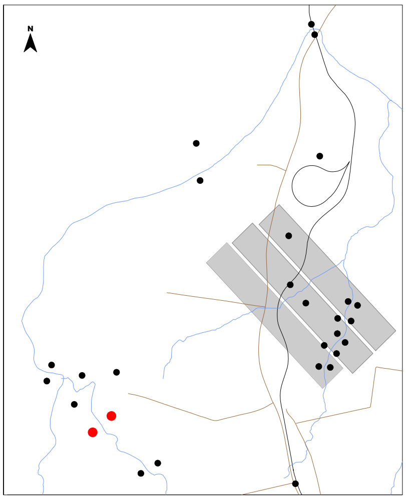


Fig. 3.23 Observed changes in easting, northing and height at GNSS S23 on southern side of Hornes Creek



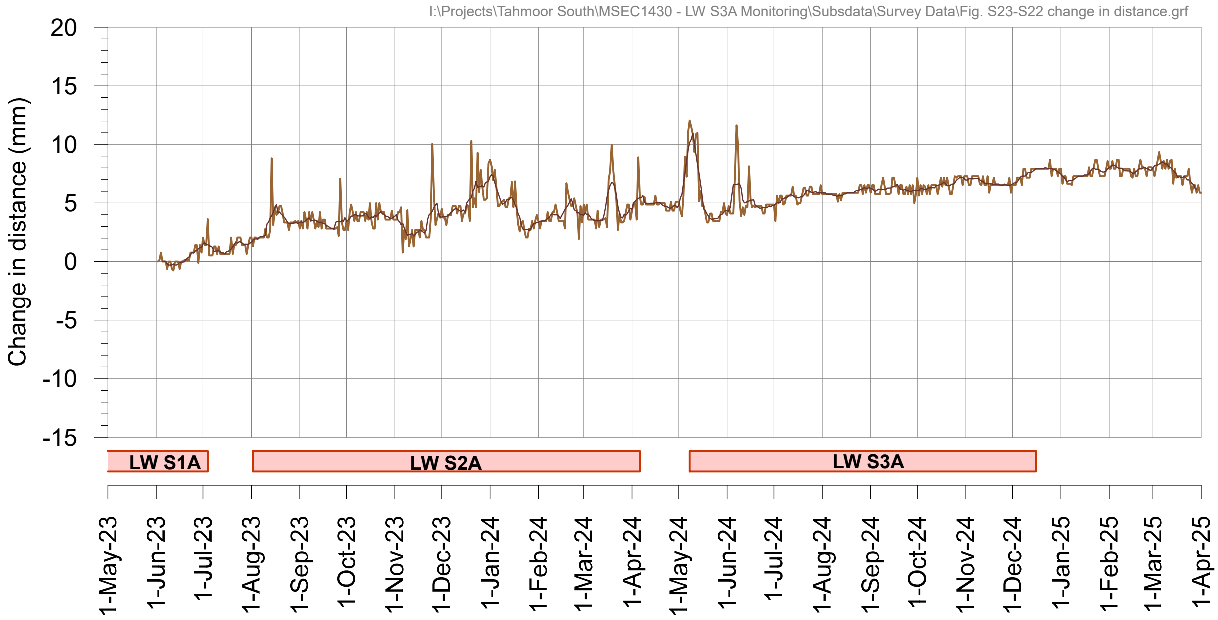


Fig. 3.24 Observed changes in distance between GNSS S22 and S23 across Hornes Creek

GNSS S22 produced erratic results up until mid-June 2024, when it was replaced. An ongoing trend continued to be observed until recently in March 2025 when readings returned to 2024 levels. Further monitoring is required to determine whether there is a general trend of ground extension.

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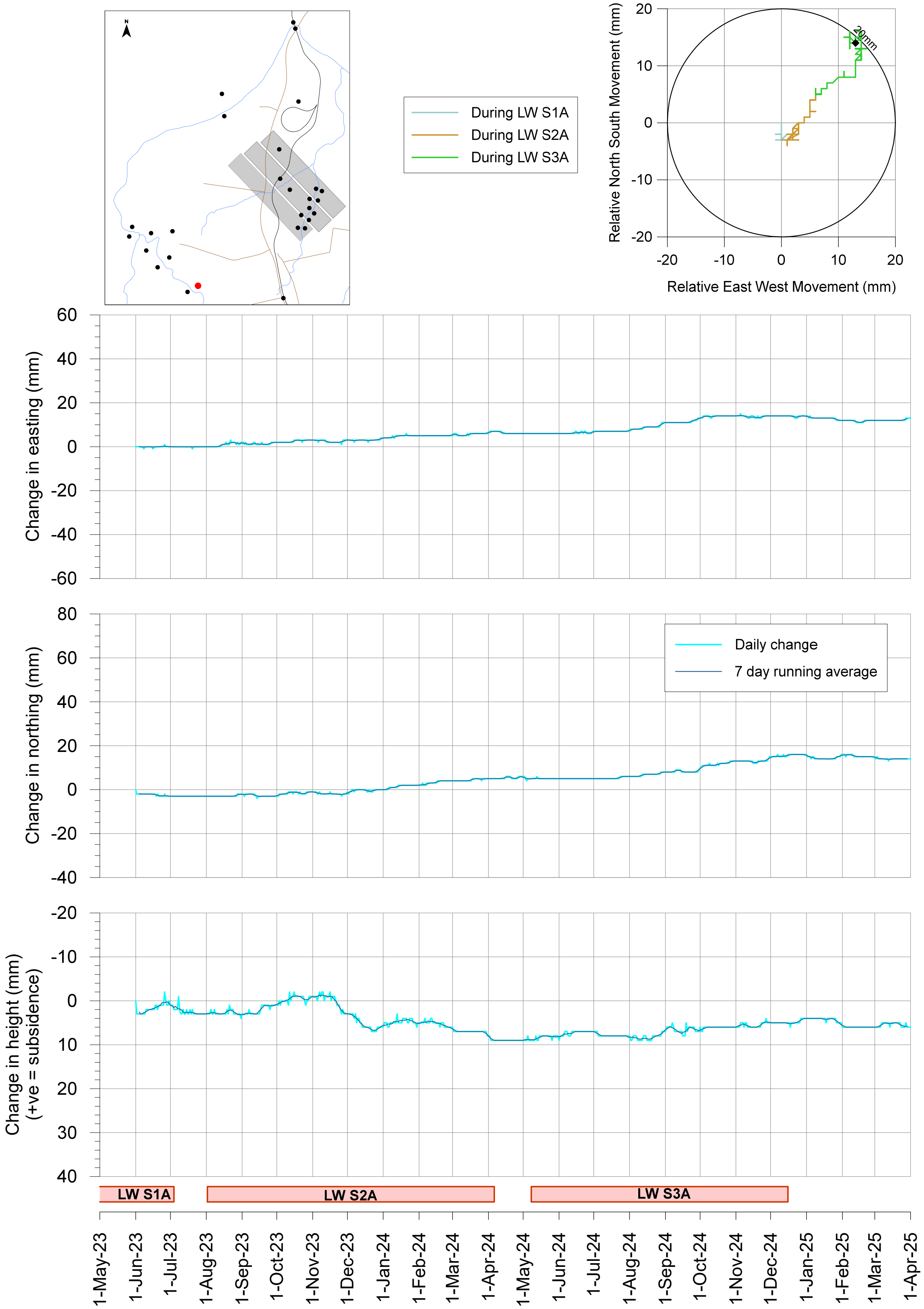


Fig. 3.25 Observed changes in easting, northing and height at GNSS S24 on northern side of Hornes Creek

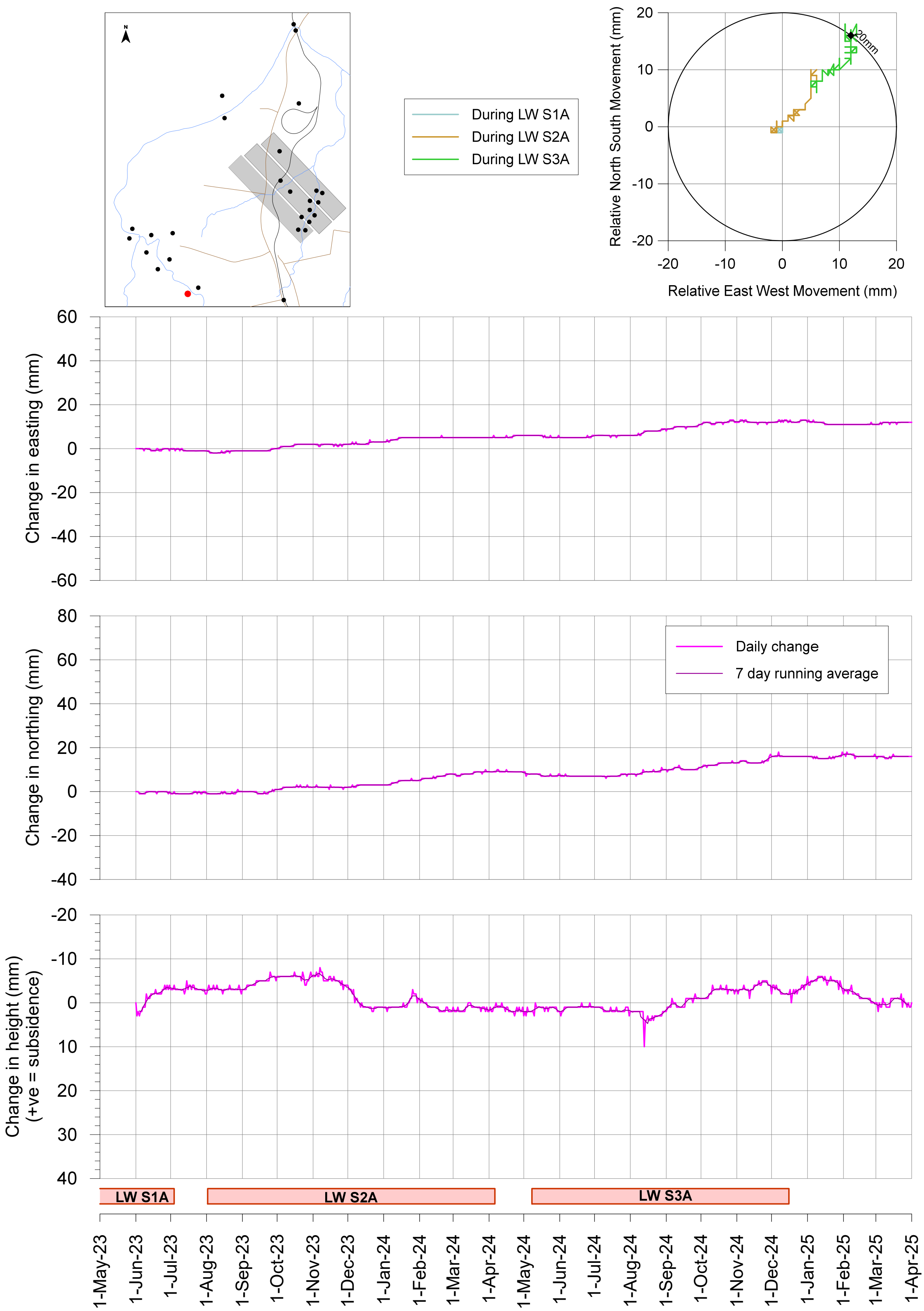


Fig. 3.26 Observed changes in easting, northing and height at GNSS S25 on southern side of Hornes Creek

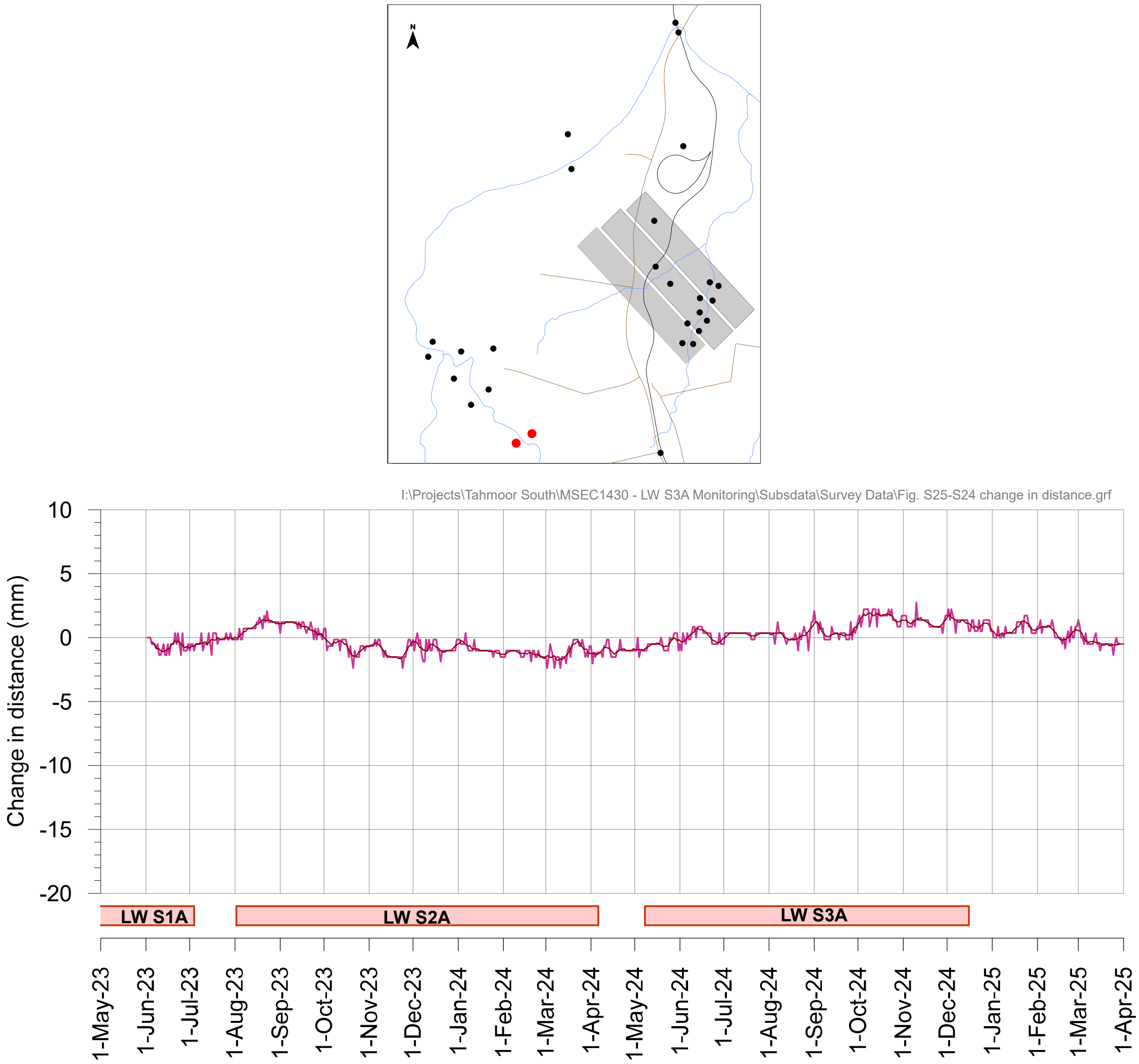


Fig. 3.27 Observed changes in distance between GNSS S24 and S25 across Hornes Creek

3.6. Managing public safety

The primary risk associated with mining adjacent to the Picton Weir is public safety. Tahmoor Coal has previously directly mined beneath or adjacent to more than 2000 houses and civil structures, commercial and retail properties, the Main Southern Railway and local roads and bridges. It has implemented extensive measures prior to, during and after mining to ensure that the health and safety of people have not been put at risk due to mine subsidence. People have not been exposed to immediate and sudden safety hazards as a result of impacts that have occurred due to mine subsidence movements.

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 repair the structure.

In the case of this Subsidence Management Plan, the potential for impacts on public safety has been assessed on a case by case basis. The assessments include those of a geotechnical engineer for steep slopes.

3.6.1. Subsidence Impact Management Process for Infrastructure

Tahmoor Coal has developed and acted in accordance with subsidence management plans to manage potential impacts during the mining of Longwalls 22 to 32 and Longwalls W1-W4 at Tahmoor North and Longwalls S1A to S3A at Tahmoor South. The management strategy has been reviewed and updated based on experiences gained during the mining of these longwalls and the strategy for LW S3A-S7A at Tahmoor South includes the following process:

1. Regular consultation with Crown Lands before, during and after mining;
2. Site-specific investigations;
3. Implementation of mitigation measures following inspections by a structural engineer, a mine subsidence engineer, and, if required, a geotechnical engineer or other specialist engineer; and
4. Surveys and inspections during mining:
    - Continuous monitoring at Picton Weir;
    - Detailed surveys at Picton Weir;
    - Detailed visual inspections;
    - Ground surveys along streets and across Hornes Creek; and
    - Specific ground surveys and visual inspections, where recommended by an engineer based on the inspections and assessments.

A flowchart illustrating the subsidence impact management process prior to, during and after the Picton Weir experiences differential mine subsidence movements is shown in Fig. 3.28.

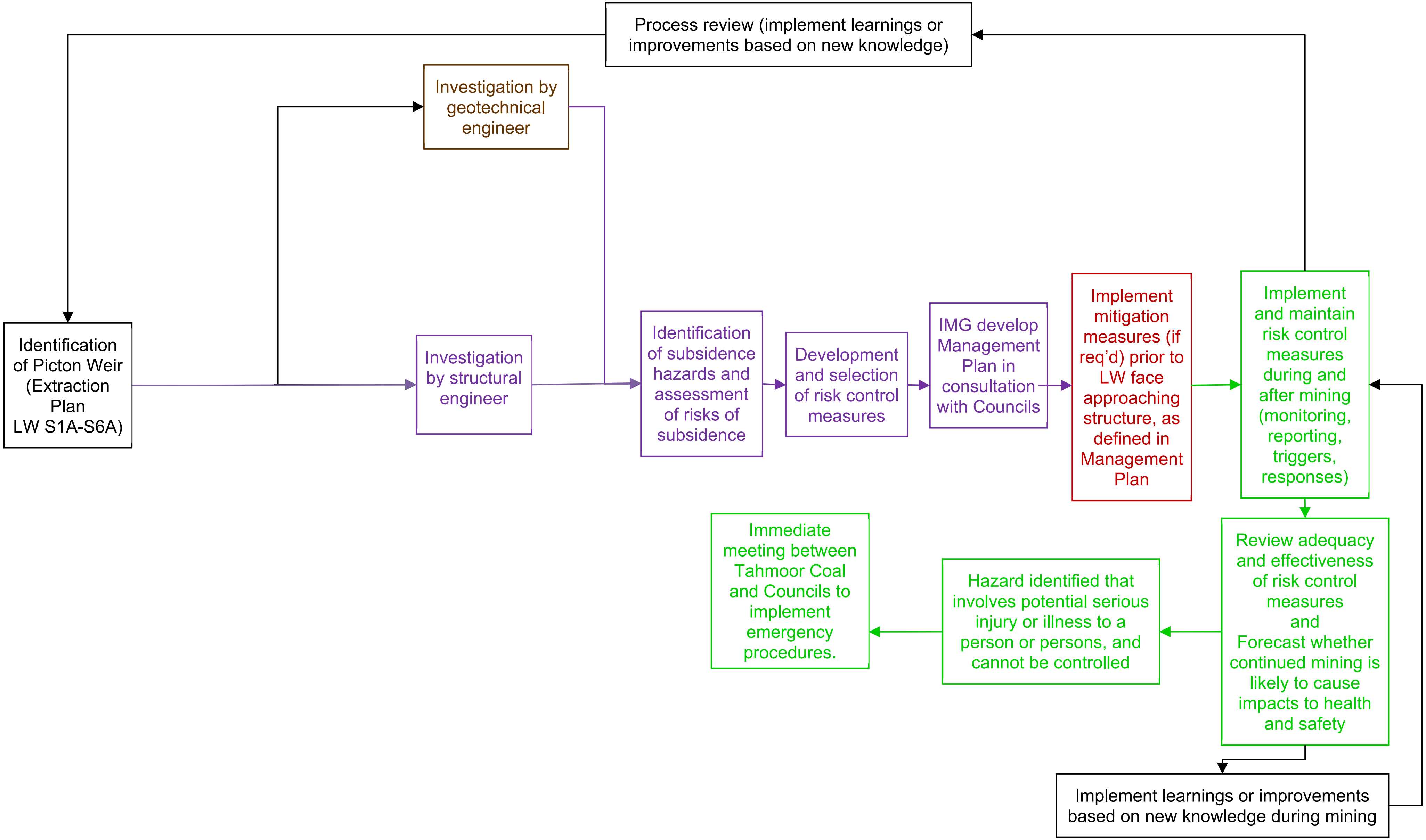


Fig. 3.28 Flowchart for Subsidence Impact Management Process

3.7. Summary of potential impacts

A risk assessment for the extraction of LWs S3A to S7A adjacent to the Picton Weir was attended on 22 January 2024 by representatives of Wollondilly Shire Council, Tahmoor Coal, PSM, Worley Consulting, GNSS Monitoring and MSEC, and facilitated by Axys Consulting (2024). A summary of results of the risk assessment Weir is provided in Table 3.8. The results of the risk assessment are included in the Appendix.

Table 3.8 Summary of potential mine subsidence impacts

Risk	Likelihood	Consequence	Level of potential impact
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.	UNLIKELY	MINOR	LOW

Additional information supporting the risk assessment is provided below.

3.8. Identification of subsidence hazards that could give rise to risks to health and safety

Clause 34 of the Work Health and Safety Regulation (2017) requires that the duty holder (in this case Tahmoor Coal), in managing risks to health and safety, must identify reasonably foreseeable hazards that could give rise to risks to health and safety.

This section of the Management Plan summarises hazards that have been identified in Chapter 3, which could give rise to risks to health and safety of people on Crown Lands infrastructure.

Using the processes described in Section 3.6 of this Management Plan, mine subsidence hazards have been identified, investigated and analysed in a systematic manner by examining each aspect of infrastructure, as described in Sections 3.9 to 3.11 of this Management Plan. The Picton Weir could potentially experience mine subsidence movements that give rise to risks to the health and safety of people.

The following mine subsidence hazards were identified that could give rise to risks to health and safety due to impacts on the Picton Weir due to the extraction of LW S3A-S7A:

- Dam break due to structural failure (refer Sections 3.10 and 3.11);

The identification and risk assessment process took into account the location of infrastructure relative to LWs S3A to S7A and the associated timing and duration of the subsidence event, as described in Section 1.8 of this Management Plan.

Whilst mine subsidence predictions and extensive past experiences from previous mining at Tahmoor Mine were taken into account, the identification and risk assessment process recognised that there are uncertainties in relation to predicting subsidence movements, and uncertainties in how mine subsidence movements may adversely impact the Picton Weir, as discussed in Section 1.4 and Chapter 3 of this Management Plan. In this case, the Picton Weir is located across the base of a deeply incised valley near the Central Fault.

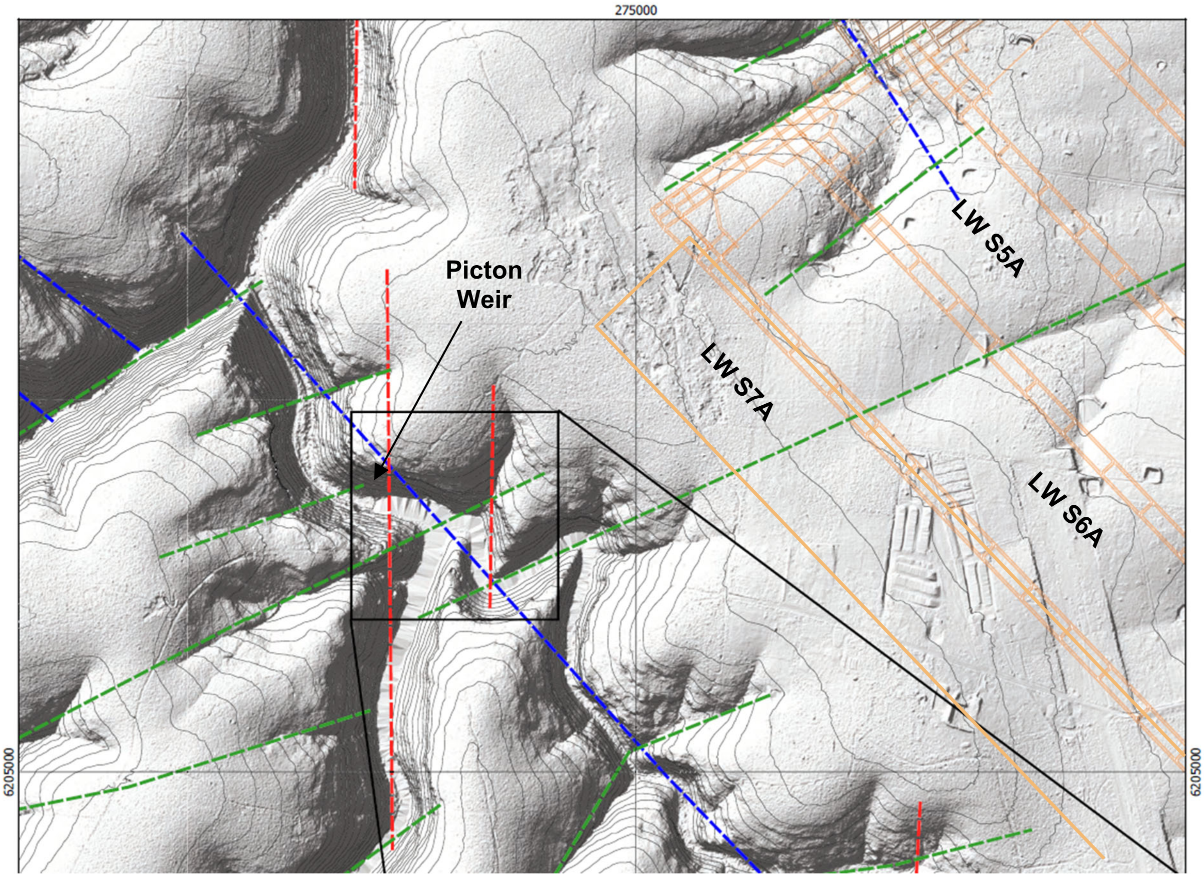
Tahmoor Coal has considered the outcomes of the hazard identification and risk assessment process when developing measures to manage potential impacts on the health and safety of people due to potential impacts on the Picton Weir. These are described in Chapter 4 of this Management Plan.

3.9. Geotechnical investigation and assessment of Picton Weir

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 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.

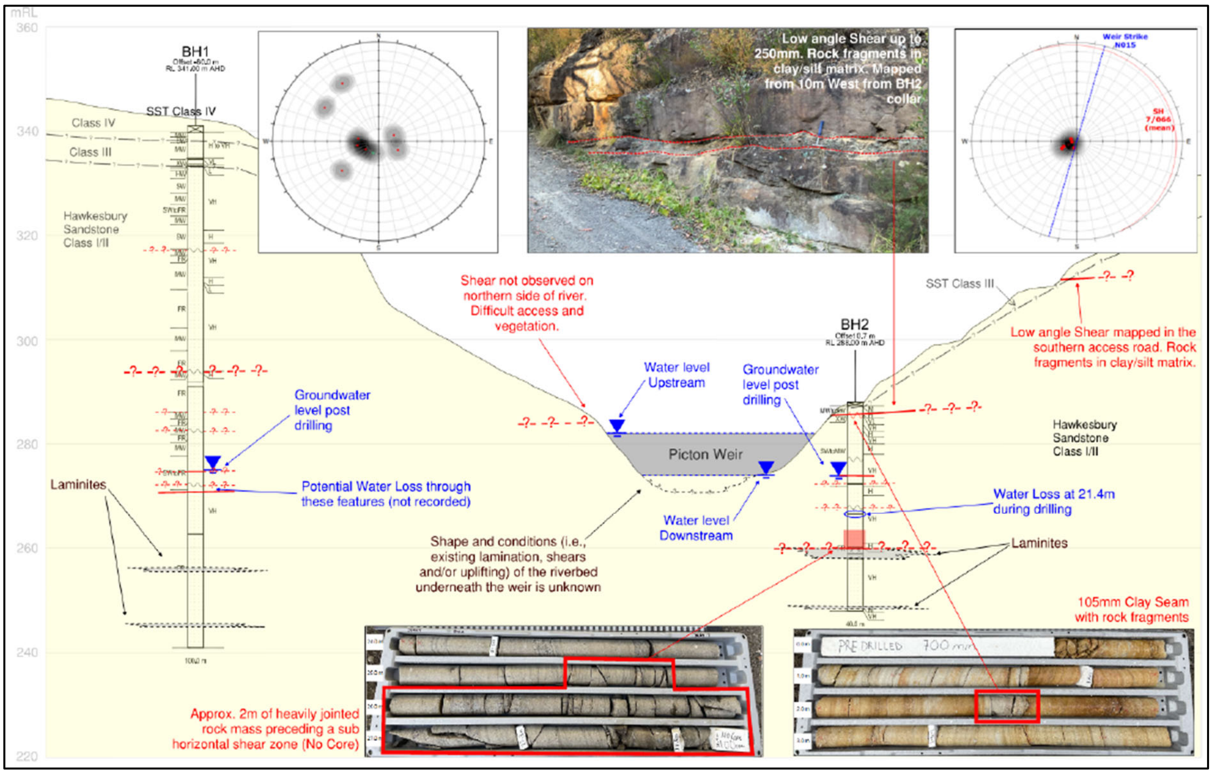
Gordon Geotechniques (2013) advised that the Central Fault zone was associated with a number of features including a change in Bulli Seam fluidity and thinning of the Balgownie to Bulli Seam interburden. The downstream part of Hornes Creek follows the surface expression of the Central Fault. PSM (2023) 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. 3.29.



Source: Marked up extract from Figure 3 of PSM (2023) to include LW S7A

Fig. 3.29 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. 3.30.



Source: Figure 5 of PSM (2023)

Fig. 3.30 PSM Conceptual Geological Model – Cross Section through Picton Weir (PSM, 2023)

The key findings of the assessment by PSM (2023) are summarised below.

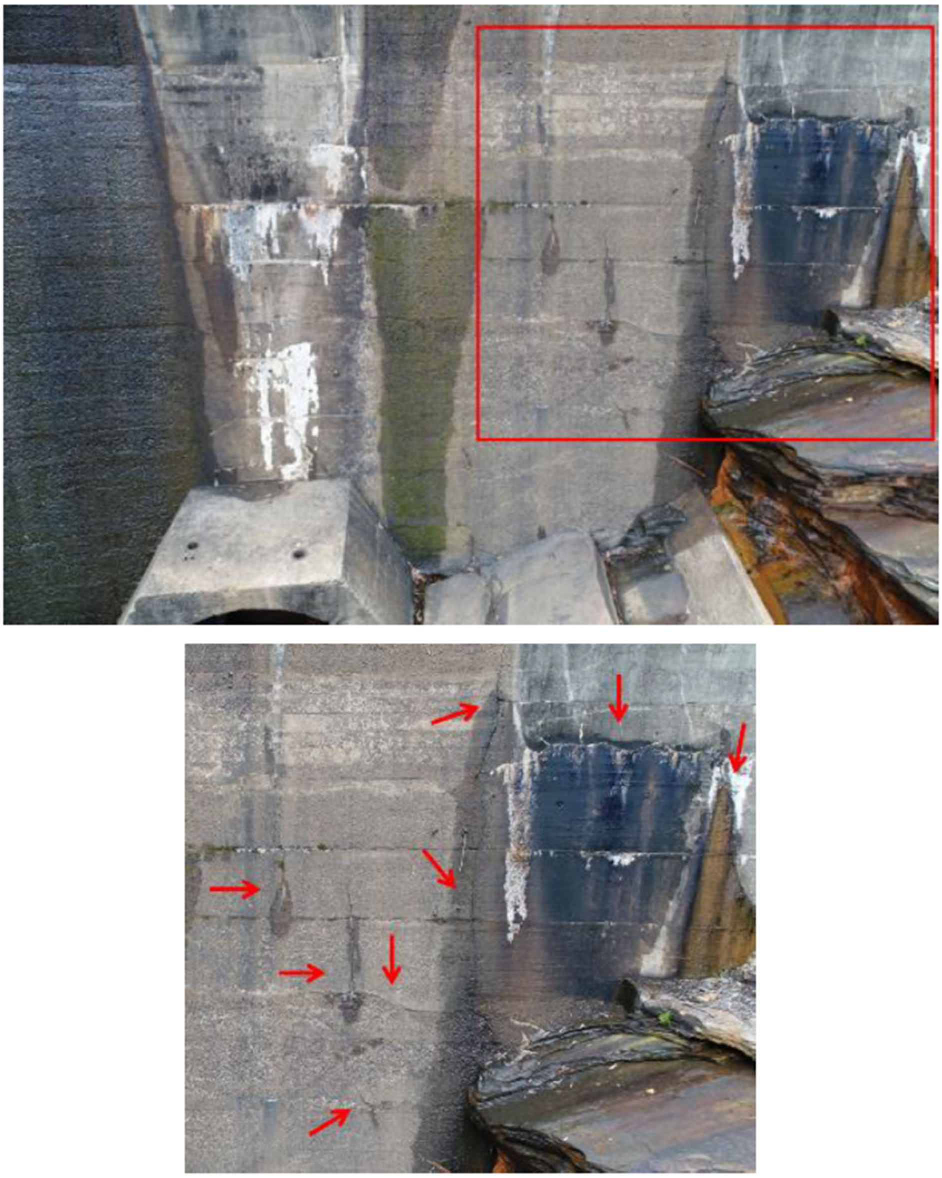
- The ground conditions encountered are consistent with those associated with natural valley bulging;
- Low angle shears were observed in both boreholes and mapped from field investigations. There does not appear to be persistence of any single structure that is continuous beneath the entire width of 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. Structural assessment of Picton Weir

Tahmoor Coal has engaged dam structural engineer Worley (2024) to conduct a structural investigation and assessment of the Picton Weir. The investigation includes a series of non-liner 3D finite element analyses to assess the potential impacts due to a range of possible mine subsidence scenarios.

Worley (2024) advise that the Weir is approximately 13 metres high, located in a Hawkesbury Sandstone gorge. The Weir is a mass concrete gravity arch structure, with a radius of 120 ft (36.58 metres), where the abutment is keyed into the sandstone cliffs. The crest is 4 ft (1.22 m) wide and the maximum thickness of the Weir is 13.62 ft (4.15 m) wide at its base. There is a shear key at the base of the Weir.

The existing condition of the Picton Weir was described in the report by Worley (2024) based on photographs captured by UAV by GNSS Monitoring in 2023 and a dam surveillance report by the NSW Department of Commerce in 2004 (DOC, 2004). The dam surveillance report in 2004 described the Picton Weir as being in a satisfactory condition. Cracks were identified along the crest of the wall and near the abutments. An example is provided in Fig. 3.31.

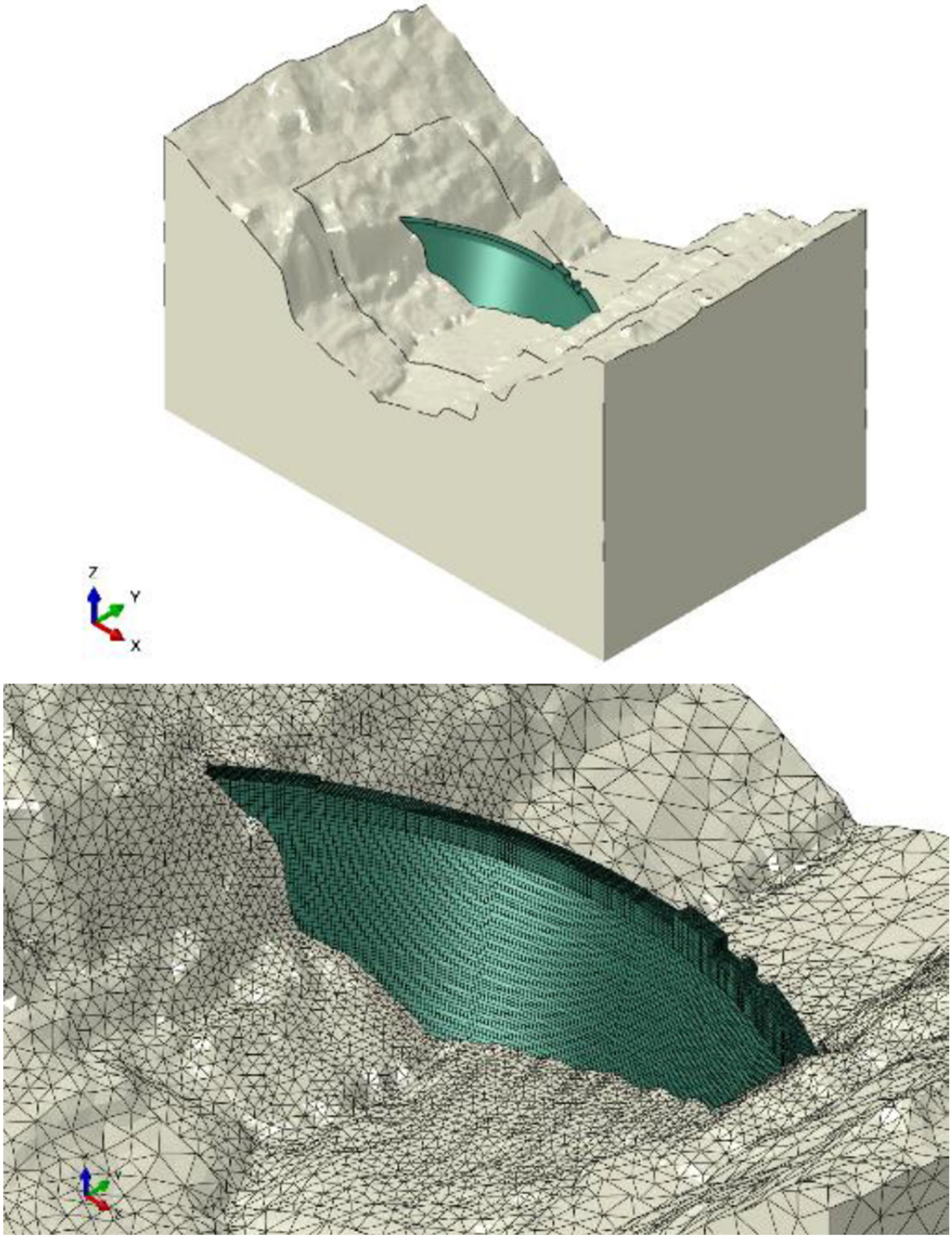


Source: GNSS Monitoring and Worley (2024)

Fig. 3.31 Existing cracks identified by UAV photography

Further information on the existing condition was gathered from a Risk Analysis that was conducted by the NSW Department of Land & Water Conservation (DLWC, 2002). Worley (2024) advise that the Risk Analysis identified that the spillway was inadequate unless an impact slab or apron is installed downstream of the Weir, placing the Weir at risk under extreme floods.

The geometry and dimensions of the Weir were based on the supplied drawings, which were cross-checked with a photogrammetric survey by GNSS Consulting. The shape of the surrounding rockmass was based on the photogrammetric survey by GNSS Consulting. An overview of the terrain and Weir model is shown in Fig. 3.32.



Source: Worley (2024)

Fig. 3.32 3D terrain and Weir model

Material properties for the Class I/II Hawkesbury Sandstone were based on advice from PSM (2023). In-situ rock stresses were applied to the rock according to published literature. No rock defects or joints were explicitly included in the model, based on the advice provided by PSM. Worley (2024 advise that while there is no material test data available for the Weir, concrete strengths in the model were based on results from testing of concrete at other sites that were constructed in that era.

Worley (2024) applied the following loads to the Weir:

- Dead load;
- Hydrostatic load with water storage at full supply level
- Dam crest flood event; and
- Silt

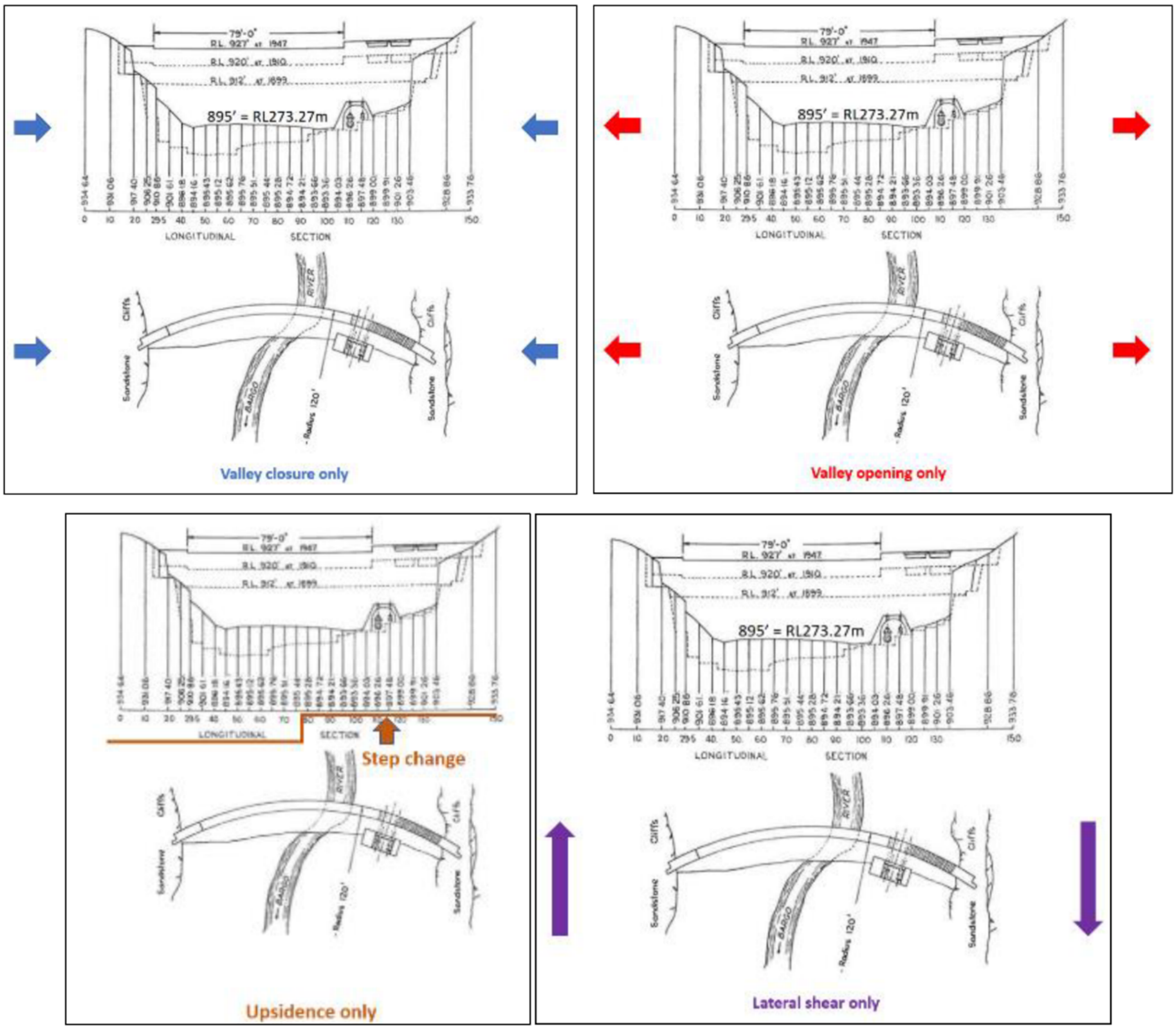
Three baseline cases were considered:

- Water storage is at full supply level;
- Storage is empty; and
- Flood discharge with upstream water level at 0.9 metres above the spillway crest and downstream water level at 6.52 metres below the spillway crest.

The following types of mining-induced differential ground movement were applied to the model:

- Valley closure only;
- Valley opening only;
- Valley upsidence only;
- Lateral shear only; and
- Valley closure and upsidence.

The upsidence profile was idealised as a vertical step at the middle of the Weir, which is conservative. For each movement type, the mining-induced differential ground movement was incrementally increased until it reached 40 mm in magnitude.



Source: Worley (2024)

Fig. 3.33 Mining-induced ground movements applied to the model

Worley (2024) advise that under baseline conditions, modelled stresses were less than the assessed concrete strength capacities for the Weir, which were assessed to be 20 MPa for compressive strength and 2 MPa for tensile strength.

Worley estimated the amount of mining-induced movement required to result in damage to the Weir, based on the modelled strength mobilisation of concrete at selected locations. A summary of the levels of mining-induced differential ground movement estimated to result in damage to the Weir are shown in Table 3.9. Recommended trigger levels are also included in Table 3.9.

The modelling found that the Weir would be most susceptible to valley opening and upsidence only compared to valley closure or lateral shear, as expected. While valley opening across the Weir could potentially result in instability and collapse, the likelihood of tensile opening occurring is considered to be extremely small, with valley closure consistently observed across valleys in response to mining. Similarly, the potential for upsidence to develop alone without valley closure is considered to be remote. Upsidence typically develops in response to valley closure.

The Weir is more likely to experience valley closure, either by itself or in combination with upsidence and/or lateral shear. The modelling found that in these situations, the Weir could experience cracking and leakage near the base of the wall. The extent and severity of cracking is predicted to increase as closure increases in magnitude. It is difficult to predict how much closure could result in instability and collapse of the Weir. Cracking would result in increased leakage through the Weir. The modelling results show that cracking is predicted to become widespread along the base of the Weir between 20 mm and 28 mm of closure (without upsidence or lateral shear).

Worley (2024) provided a number of options that could be considered to mitigate against or repair potential impacts on the Picton Weir. These include:

- Investigate removal of the Picton Weir

  As the Picton Weir has no practical use, the Weir could be removed. The removal of the Weir would restore the Bargo River and downstream sections of Hornes Creek to their natural conditions. This option would need to be assessed with respect to the controlled release of natural sediments behind the Weir. Tahmoor Coal will seek an agreement in principle to remove the Weir from Crown Lands before commencing investigations and submitting approvals.

- Lower the Picton Weir

  As the Picton Weir has no practical use, the Weir could be lowered either temporary or permanently. The lowering of the Weir would ensure a reduced storage behind the Bargo River and downstream sections of Hornes Creek during the mining period. An engineered slot would be formed on the southern side of the Weir wall, which could be left permanently or reinstated after mining. This option would need to be assessed with respect to the controlled release of natural sediments behind the Weir. Tahmoor Coal will seek an agreement in principle to lower the Weir from Crown Lands before commencing investigations and submitting approvals.

- Strengthen Weir with post-tension anchors

  The Weir could be strengthened by drilling post-tension anchors vertically through the dam wall from the Weir crest into the base rock, as shown conceptually in Fig. 3.34. The steel reinforcement would provide ductility and strength to the Weir structure to improve the Weir's ability to accommodate mining-induced differential movements and improve the Weir's resistance to sliding and overturning. The anchors could be installed prior to or after mining.

  The post-tensioned anchors would be hidden inside the mass concrete structure in a manner that results in minor noticeable change to the overall fabric of the structure, thereby maintaining its heritage value.

  Post-tensioned anchors have commonly been used to improve the safety of existing concrete dams in Australia including Wellington Dam, Keepit Dam, Lake Manchester Dam, Moogerah Dam, Fairbairn Dam, Catagunya Dam and Tinaroo Falls Dam.

  Further assessment and analysis would be required to determine the magnitude of differential mining-induced movements that could be accommodated by the Weir if it is strengthened using post-tensioned anchors.

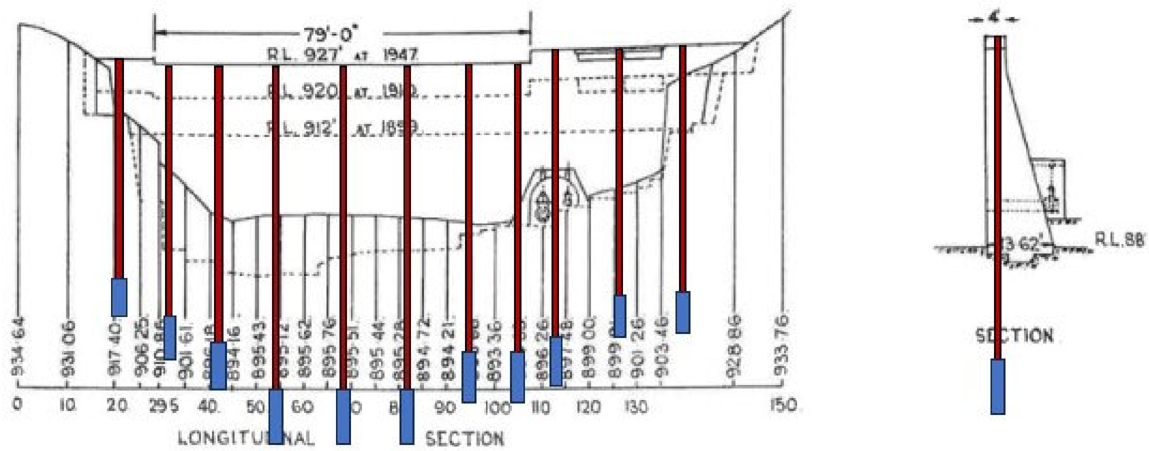


Image courtesy Worley

Fig. 3.34 Conceptual design showing post-tensioning of Picton Weir

- Strengthen Weir by placing mass concrete downstream of the Weir

  Worley (2024) advise that mass concrete blocks or concrete buttresses could be placed at the downstream base of the Picton Weir to improve the Weir's stability against sliding and overturning. Conceptual designs are shown in Fig. 3.35 and Fig. 3.36. The additional concrete structure could be placed prior to or after mining.

  The concrete placement would modify the appearance of the main Weir structure, thereby affecting its heritage value.

  Mass concrete blocks have been retrofitted at Moogerah Dam and Hume Dam. Mass concrete buttresses have been designed, but not yet constructed at Mount Bold Dam.

  Further assessment and analysis would be required to determine the magnitude of differential mining-induced movements that could be accommodated by the Weir if it is strengthened using concrete placement.

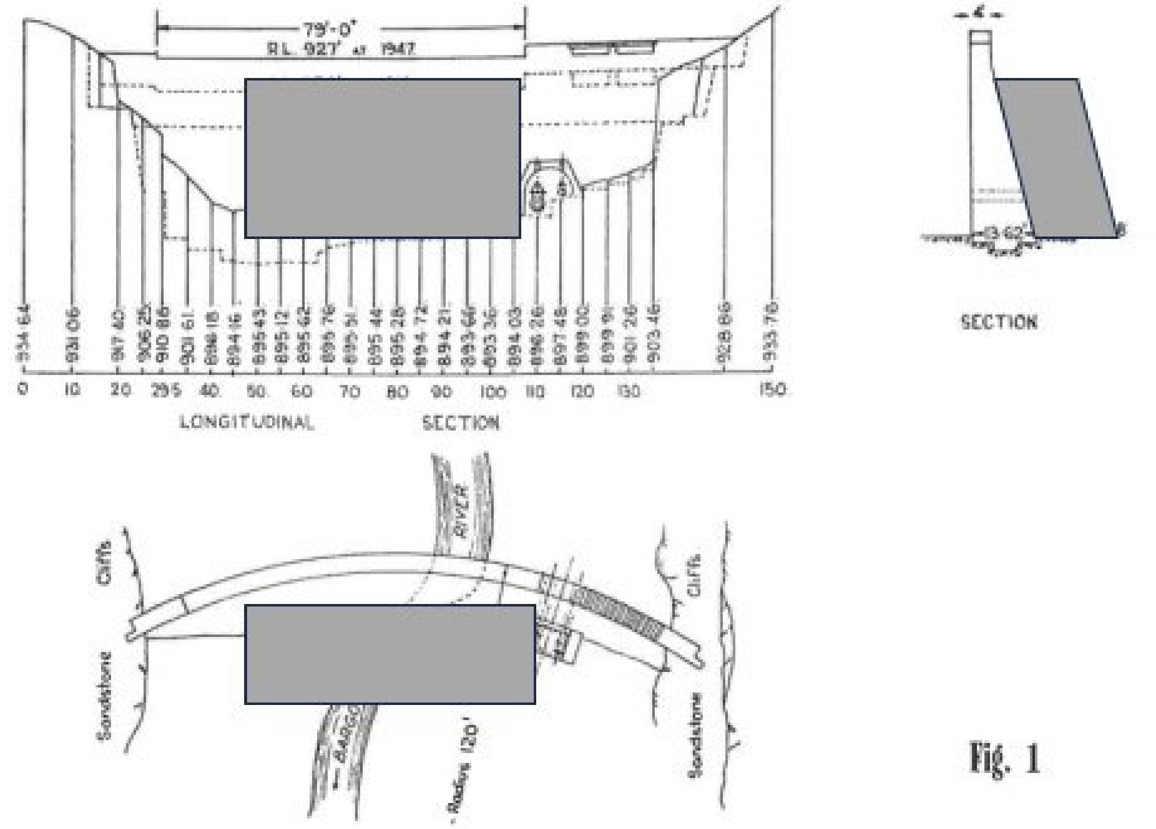


Image courtesy Worley

Fig. 3.35 Conceptual design showing downstream mass concrete stabilisation of Picton Weir

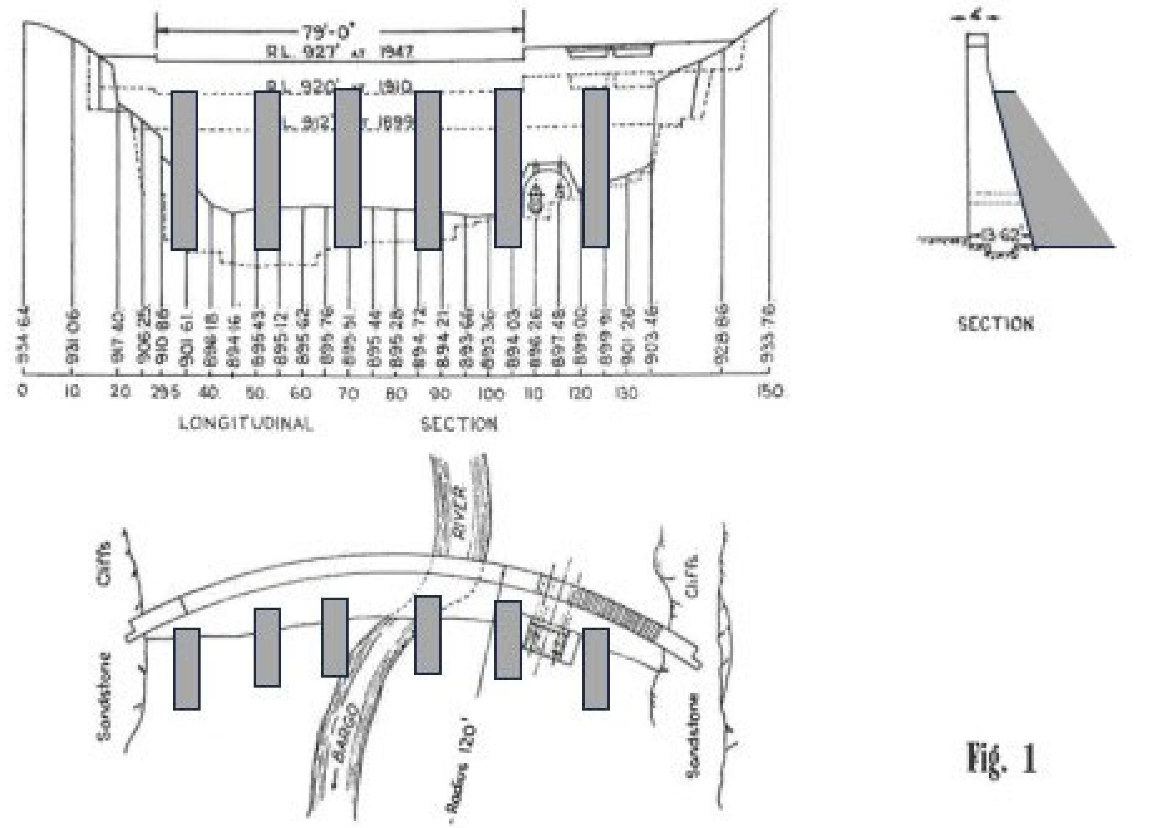


Image courtesy Worley

Fig. 3.36 Conceptual design showing mass concrete buttresses on Picton Weir

- Reduce potential impact on the Weir by cutting a control joint or slot

  A slot could be cut into the rock beside the Picton Weir to provide an open space within the rockmass that could accommodate potential valley closure movements. The slot could be installed along the access road on the southern side of the Picton Weir. A conceptual design is shown in Fig. 3.37.

  The slot cut would not modify the main Weir structure, thereby maintaining its heritage value.

  A slot was previously installed by Illawarra Coal at Marhnyes Hole in the Georges River, directly above longwalls extracted at West Cliff Colliery (Mills, K. et al, 2004). The slot successfully reduced the amount of closure that would have been experienced at the rockbar.

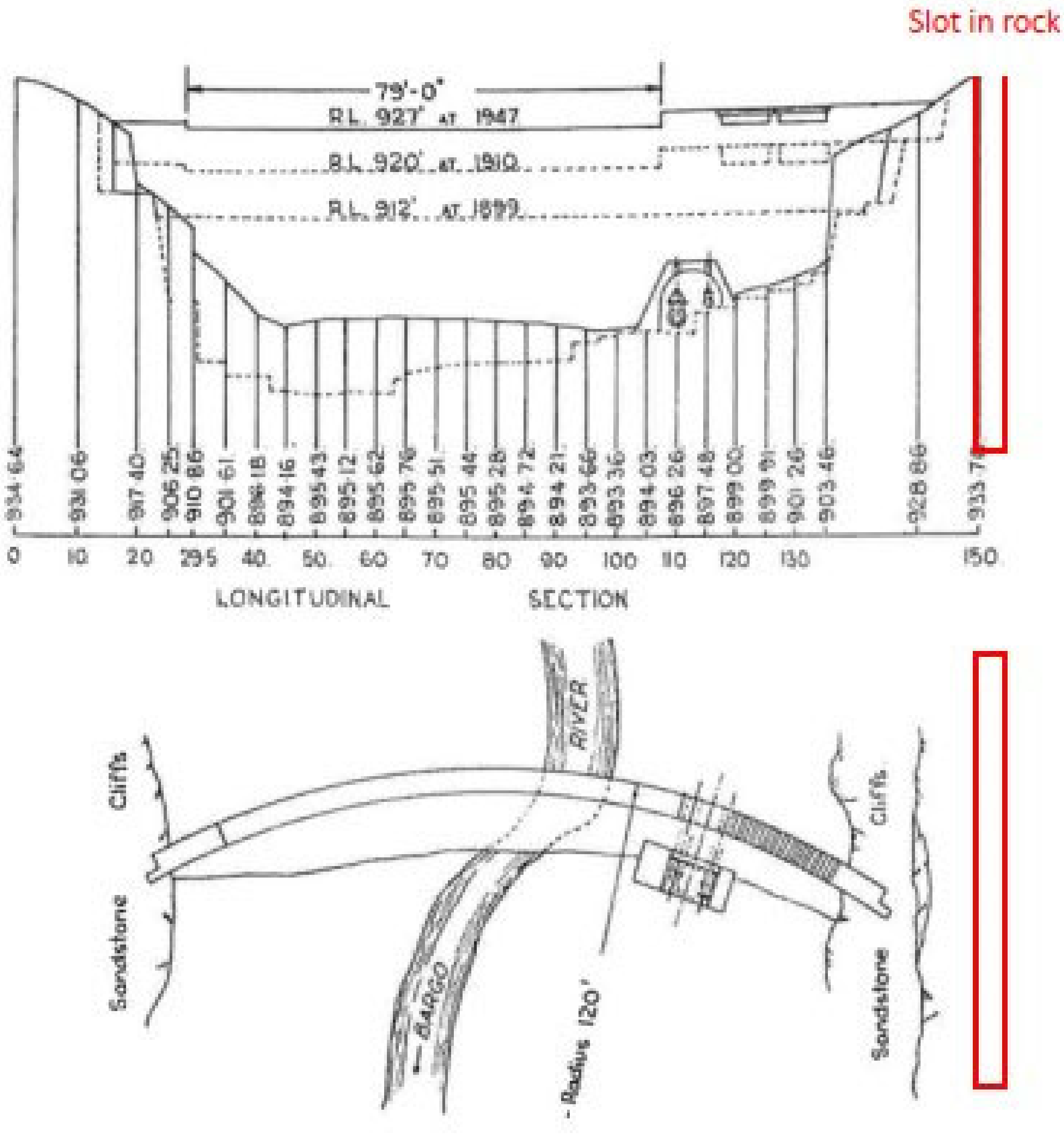


Image courtesy Worley

Fig. 3.37 Conceptual design showing slot in rock to the side of the Picton Weir

- Improve water-retention capacity of Weir

  The water retaining capacity of the Weir could be improved by applying spray shotcrete to the upstream wall of the Weir. Water could be prevented from flowing through existing and potential mining-induced cracks in the wall, which would minimise the deterioration of the Weir structure and improve its ability to accommodate mining-induced movements.

  Spraying shotcrete is an accepted method of strengthening dam walls and has previously been applied at Lake Parramatta Dam and Lithgow No. 2 Dam.

Tahmoor Coal will investigate the feasibility and effectiveness of the above risk control options in consultation with Crown Lands prior to the length of extraction of LW S5A exceeding 500 metres. Tahmoor Coal and Crown Lands will then consider selecting and implementing a risk control option to manage potential impacts on the Picton Weir. The targeted timing for implementation would be prior to the influence of LWs S6A and S7A.

Table 3.9 Summary of failure modes and suggested mitigation during and post mining

Valley movement type	Likelihood of movement	Weir damaged at	Potential failure mode	Suggested trigger level	Actions	Post-mining actions
Valley Opening Only	Unlikely	8 mm	Cracks in D/S face at base; cracks along U/S rock interface. Leakage through crack zone. Through cracks at base in middle of weir. Wall in the middle becomes unstable & collapse.	4 mm	Review survey data. Review weir condition. Lower storage. Stop mining. Cut slot - isolate weir from further movement	Repair cracks. Strengthen weir with post-tension anchors and/or concrete placement D/S of weir. Decommission weir: remove entire weir or remove partial (centre) weir.
Upsidence Only	Unlikely	8 mm	Cracks in left U/S face from top to base; cracks in left D/S face near top. Leakage through the damaged left side. Localised collapse of the left weir section.	4 mm	Review survey data. Review weir condition. Lower storage. Stop mining.	Repair cracks. Strengthen weir with post-tension anchors and/or concrete placement D/S of weir. Decommission weir: remove entire weir or remove partial (centre) weir.
Valley Closure & Upsidence	Likely	10 mm	Cracks in right D/S face along rock interface. Leakage through cracks.	5 mm	Review survey data. Review weir condition. Lower storage. Stop mining. Cut slot - isolate weir from further movement	Repair cracks. Strengthen weir with post-tension anchors and/or concrete placement D/S of weir. Decommission weir: remove entire weir or remove partial (centre) weir.
Lateral Shear Only	Possible	15 mm	Cracks in right D/S face at base; cracks at U/S along dam/rock interface in the middle. Leakage through cracked base.	7.5 mm	Review survey data. Review weir condition. Lower storage. Stop mining. Cut slot - isolate weir from further movement	Repair cracks. Strengthen weir with post-tension anchors and/or concrete placement D/S of weir. Decommission weir: remove entire weir or remove partial (centre) weir.
Valley Closure Only	Likely	15 mm	Cracks in D/S face on both sides of weir at and above rock interface. Leakage through localised crack zones.	7.5 mm	Review survey data. Review weir condition. Lower storage. Stop mining. Cut slot - isolate weir from further movement	Repair cracks. Strengthen weir with post-tension anchors and/or concrete placement D/S of weir. Decommission weir: remove entire weir or remove partial (centre) weir.

Source: Worley (2024)

3.11. Dam Break study

Tahmoor Coal has engaged hydrologist and hydraulic engineer Worley (2024b) to conduct a Dam Break study for the Picton Weir. The Dam Break study built upon flood studies recently conducted for Wollondilly Shire Council. The purpose of the Dam Break study is to estimate the potential Population at Risk (PAR) and Potential Loss of Life (PLL) due to a sudden dam break.

Worley (2024b) identified the following features downstream of Picton Weir:

- Primarily undeveloped bushland characterised by incised and steep valley walls and dense vegetation;
- Fire Road No. P1, which starts at Bargo River Road and follows the Bargo River upstream to Picton Weir;
- Two houses located near the start of the fire trail;
- The Main Southern Railway Viaduct crossing the Bargo River; and
- Remembrance Drive Bridge crossing the Bargo River.

A map showing the location of the above features was produced by Worley (2024b) and reproduced in Fig. 3.38.

Source: Worley (2024b)

Fig. 3.38 Features identified downstream of Picton Weir

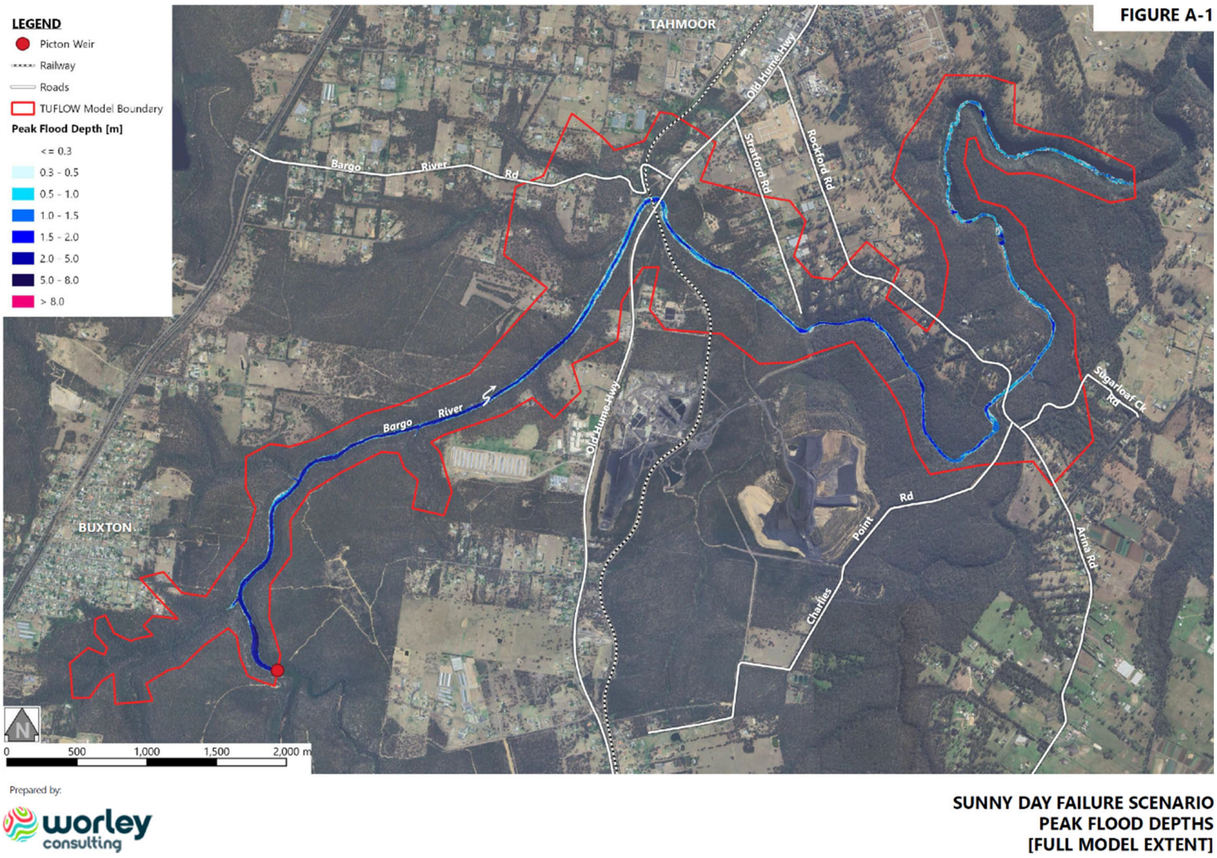
A summary of the methodology adopted by Worley (2024b) for the Dam Break study is provided below.

- The Dam Break study assessed failure of Picton Weir for both Sunny Day conditions as well as during a Probable Maximum Flood (PMF) event.
- For the PMF model, Worley (2024b) determined that a 3-hour PMF was the critical duration event and most suitable for the Dam Break study.
- When developing the relationship between Storage Levels (RL) and Storage (ML), the shapes of the valleys upstream of Picton Wier were estimated based on LiDAR data. The shapes of the riverbeds were estimated and adjusted such that the full storage capacity was 150 ML, which was the estimated storage capacity that was advised in the dam surveillance report by the NSW Department of Commerce in 2004 (DOC, 2004).
- No silt was included in the Dam Break study, which is a conservative assumption.
- The hydraulic model (TUFLOW) was based on the model that was provided by Worley for Wollondilly Shire Council's flood study.

A summary of the findings by Worley (2024b) from the Dam Break study is provided below.

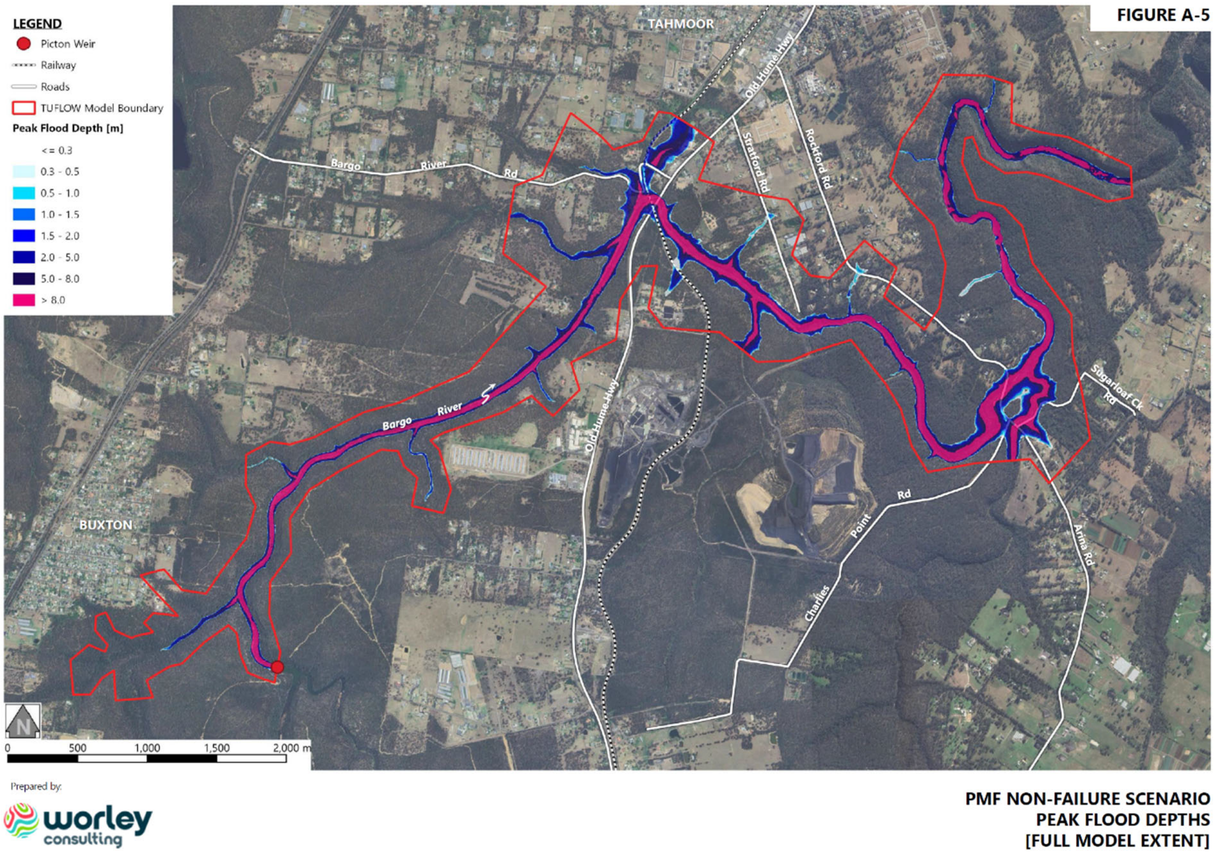
- The flood wave due to dam failure was predicted to remain largely within the confines of the Bargo River channel during a sunny day failure of Picton Weir, as shown in Fig. 3.39. The flood wave is predicted to inundate some sections of the fire trail within the first 1.6 kilometres downstream of the Weir. The flood wave is not predicted to inundate any houses nor any other roads or railways downstream of the Weir.
- In the event of a PMF without dam failure, floodwaters are predicted to overtop the banks of the Bargo River. Large portions of the fire trail and the two houses near the start of the fire trail are predicted to be inundated, along with parts of Bargo River Road near the start of the fire trail, as shown in Fig. 3.40. The flood levels are predicted to be lower than the Main Southern Railway Viaduct and the Remembrance Drive Bridge over of the Bargo River but flooding is predicted to occur to a section of the Railway north of the Bargo River and sections of local roads that cross the Bargo River further downstream of the Railway and Remembrance Drive crossing.
- The failure of the Picton Weir during a PMF event is predicted to increase flood levels by approximately 2.5 metres in areas immediately downstream of the Weir, reducing to less than 0.3 metres after a distance of approximately 5.2 kilometres downstream of the Weir, as shown in Fig. 3.41 and Fig. 3.42.

  The flood levels at the two houses, which would already be inundated during a PMF event, are predicted to increase by 0.3 to 0.4 metres with only minor changes to the predicted extent of floodings, as shown in Fig. 3.43. Flood levels due to failure of the Picton Weir during a PMF event are predicted to remain lower than the Main Southern Railway Viaduct and the Remembrance Drive Bridge over of the Bargo River.
- The potential Population at Risk (PAR) and Potential Loss of Life (PLL) during a Sunny Day failure are attributed only to the possibility of bushwalkers along the fire trail as the flood wave is not predicted to inundate houses or local roads. Worley (2024b) advise that the estimated PAR of 0.11 and PLL 0.09 are "low".
- The potential increase in PAR and PLL due to dam failure during a PMF event is estimated to be 0.92 and 0.01, respectively. Worley (2024b) advised that the predicted increase is relatively small as both houses are already affected during a PMF event without dam failure.



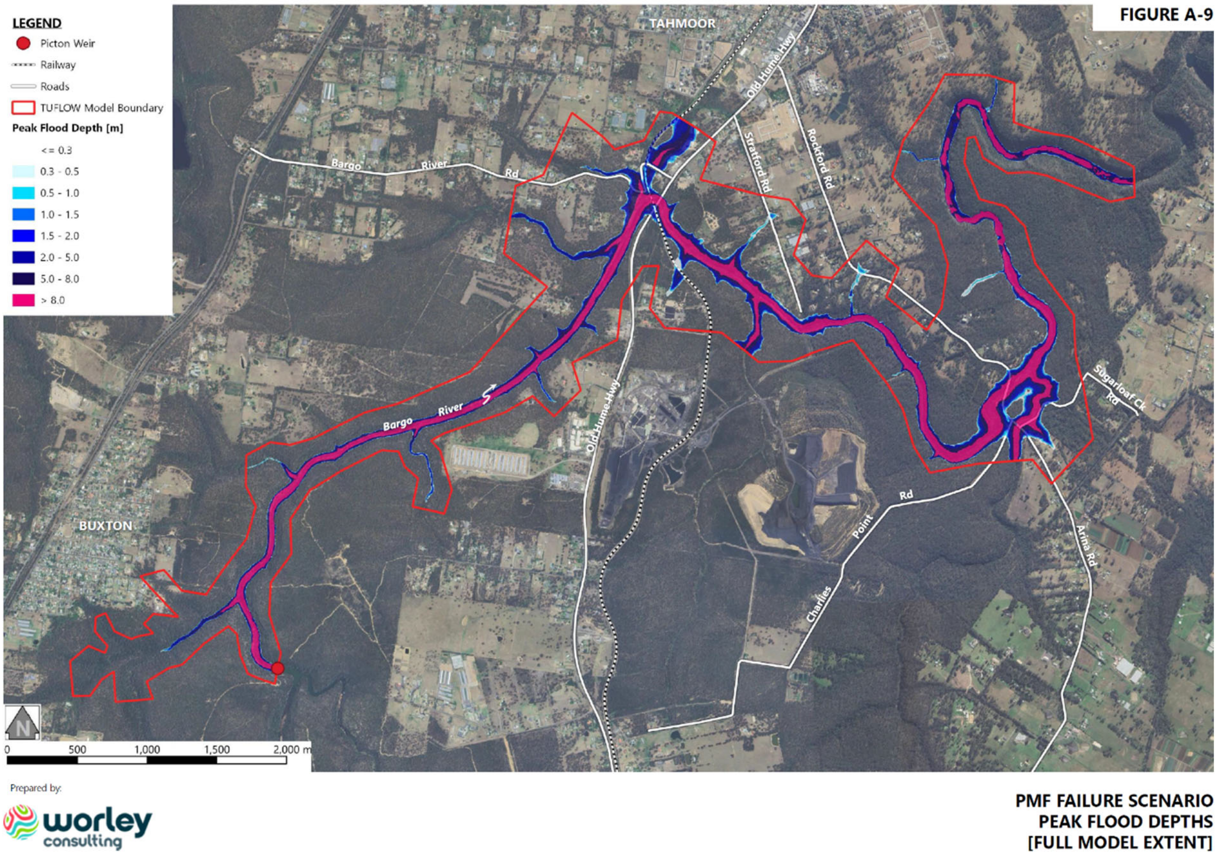
Source: Worley (2024b)

Fig. 3.39 Predicted peak flood depths due to failure of Picton Weir during Sunny Day



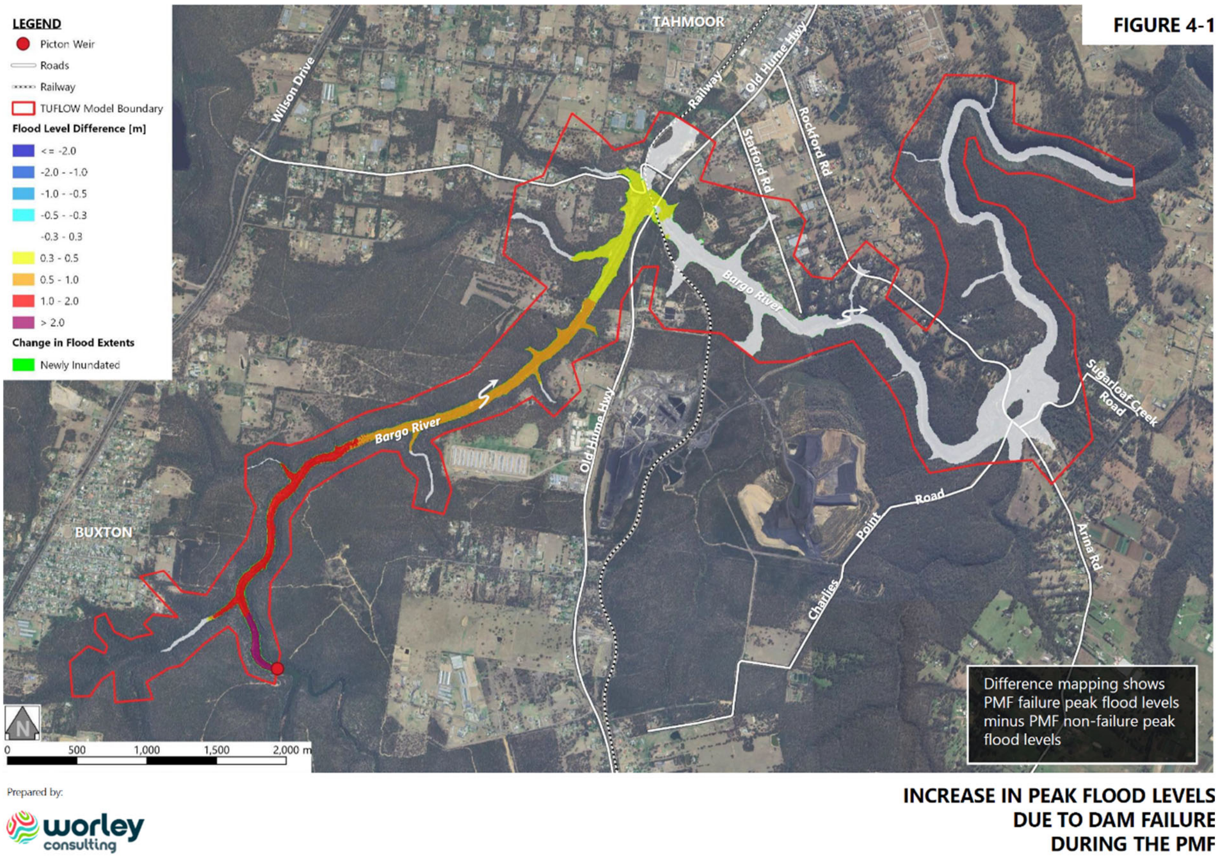
Source: Worley (2024b)

Fig. 3.40 Predicted peak flood depths due to PMF event without failure of Picton Weir



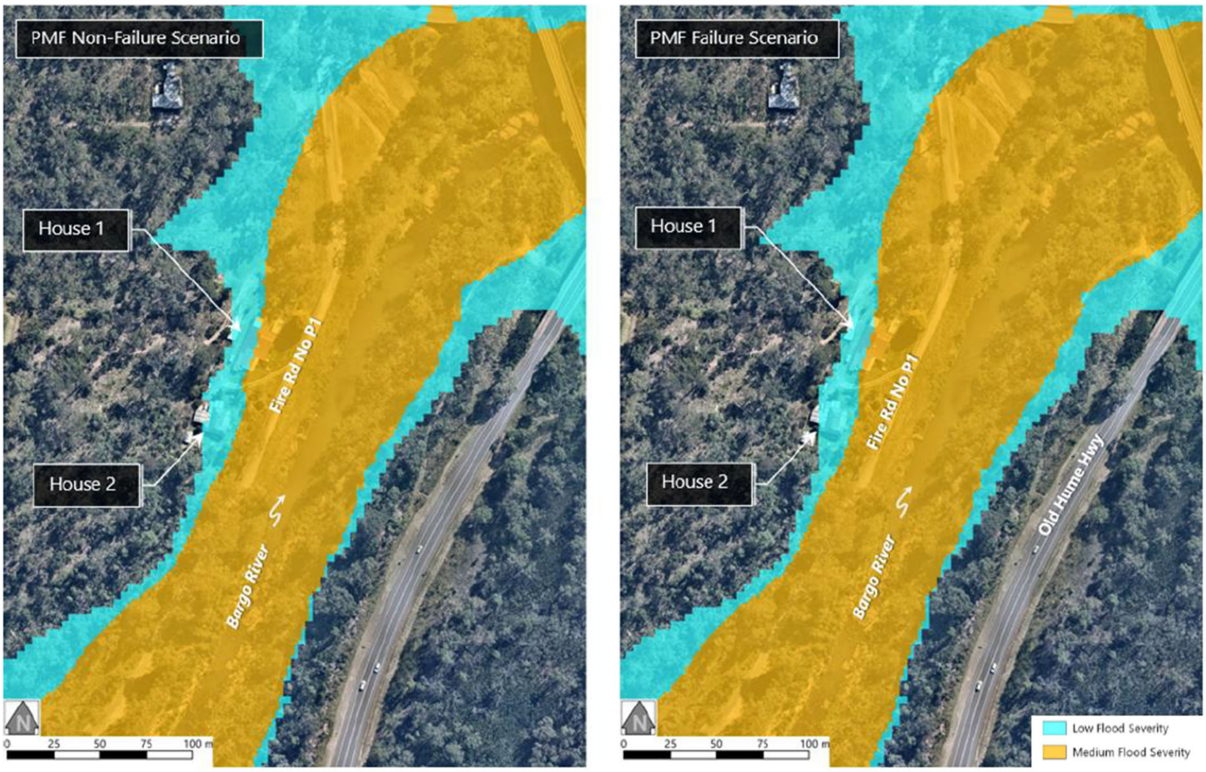
Source: Worley (2024b)

Fig. 3.41 Predicted peak flood depths due to failure of Picton Weir during PMF event



Source: Worley (2024b)

Fig. 3.42 Predicted increase in peak flood depths due to failure of Picton Weir during PMF event



Source: Worley (2024b)

Fig. 3.43 Comparison of predicted peak flood depths at downstream houses on fire trail due to failure of Picton Weir during PMF event

4.1. Infrastructure Management Group (IMG)

The Infrastructure Management Group (IMG) is responsible for taking the necessary actions required to manage the risks that are identified from monitoring the infrastructure and to ensure that the health and safety of people who may be present near or downstream of the Picton Weir are not put at risk due to mine subsidence. The IMG develops and reviews this management plan, collects and analyses monitoring results, determines potential impacts and provides advice regarding appropriate actions. The members of the IMG are highlighted in Chapter 8.

4.2. Development and selection of risk control measures

Tahmoor Coal has developed and selected risk control measures in consultation, co-ordination and co-operation with the infrastructure owner in accordance with WHS legislation. In accordance with Clauses 35 and 36 in Part 3.1 of the Work Health and Safety regulation (2017) and the guidelines (MSO, 2017), a hierarchy of control measures has been considered and selected where reasonably practicable, using the following process:

1. Eliminate risks to health and safety so far as is reasonably practicable, and
2. If it is not reasonably practicable to eliminate risks to health and safety – minimise those risks so far as is reasonably practicable, by doing one 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;
3. If a risk then remains, minimise the remaining risk, so far as is reasonably practicable, by implementing administrative controls; and
4. 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.

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.

There are primarily two different methods to control the risks of subsidence, namely:

- Method A – Selection of risk control measures to be implemented prior to the development of subsidence, (Items 1 and 2 above); and
- Method B – Selection of risk control measures to be implemented during the development of subsidence (Items 3 and 4 above).

Method A and B risk control measures are described in Sections 4.3 to Section 4.6. Prior to selecting Method B risk control measures, Tahmoor Coal has investigated and confirmed that the measures are feasible and effective for the site-specific conditions during the extraction of LW S3A to S7A.

4.3. Selection of risk control measures for Crown Lands infrastructure

Based on its own assessments, and the assessments by the structural dam engineer, and the geotechnical engineer, Tahmoor Coal considered Method A and Method B risk control measures, in accordance with the process described in Section 4.2.

Elimination

Tahmoor Coal will investigate, in consultation with Crown Lands, the feasibility of removing the Weir prior to the influence of LWs S6A and S7A, or removing the Weir after mining if it is damaged.

Substitution

Tahmoor Coal will investigate, in consultation with Crown Lands, the feasibility of temporarily or permanently lowering the Picton Weir.

Isolation

In this instance, no reasonably practicable controls could be identified to isolate a hazard from any person exposed to it.

Engineering Controls

In this instance, the following engineering control options could be identified to put in place a structure or item that prevents or minimises risks.

- Lower water levels behind the Weir by pump and/or install a slot or gate;
- Install vertical post-tensioned anchors;
- Place concrete blocks or buttresses downstream of the Weir; and
- Install rock slot to the side of Picton Weir.

Tahmoor Coal will investigate the feasibility and effectiveness of the engineering control options prior to the length of extraction of LW S5A exceeding 500 metres.

Administrative Controls

The following Administrative Controls were identified and selected that will put in place procedures on site to minimise the potential of impacts on the safety of people in relation to mining-induced damage to the Picton Weir:

- Implementation of a Monitoring Plan and Trigger Action Response Plan (TARP)
  As described in the Management Plan, Tahmoor Coal and Crown Lands has developed and implemented a management strategy of detecting early the development of potential adverse subsidence movements in the ground, so that contingency response measures can be implemented before impacts on the safety and serviceability develop. The TARP includes the following:
    - 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 and baseline surveyed);
    - Survey marks on the Picton Weir (to be installed prior to start of LW S3A);
    - Laser distancemeter monitoring across the Picton Weir near the crest and base of the Weir (to be installed prior to start of LW S4A);
    - Photogrammetric survey of shape of dam wall and surrounding rockfaces on both sides of the Picton Weir (baseline survey completed);
    - Vertical inclinometers in borehole BH01 at northern side of the Picton Weir (boreholes drilled, inclinometer tubing installed and baseline surveyed prior to start of LW S3A);
    - Groundwater level monitoring in borehole BH01 at northern side of the Picton Weir (installed);
    - Surface water level monitoring upstream of Picton Weir (to be installed prior to start of LW S4A);
    - Detailed visual inspection of Picton Weir and surrounding rockfaces by UAV (baseline inspection completed); and
    - Visual inspections during mining.

- Implementation of planned responses, if triggered by monitoring results. These may include:
  - Increase monitoring and reporting procedures;
  - Additional inspections of Picton Weir by structural dam engineer and geotechnical engineer;
  - Repair cracks;
  - Spray shotcrete to seal cracks on upstream face of Weir;
  - Install post-tensioned anchors to reduce impacts from further differential mining-induced movements;
  - Place concrete blocks or buttresses downstream of the Weir to reduce impacts from further differential mining-induced movements;
  - Install rock slot to the side of Picton Weir to reduce impacts from further valley closure and upsidence;
  - Prevent public access to the Picton Weir and install signage;
  - As a last resort emergency response measure if a hazard has been identified that involves potential serious injury or illness to a person or persons and cannot be controlled, stop mining. An Emergency Response Plan will be prepared by Tahmoor Coal prior to 500 metres of extraction of LW S5A.

4.4. Monitoring measures

A number of monitoring measures will be undertaken during mining.

4.4.1. Continuous GNSS monitoring

Global Navigation Satellite System (GNSS) units are fixed survey stations that continuously measure their absolute horizontal and vertical positions in near real time. The locations of GNSS units are shown in Drawings No. MSEC1193-12-04.

As shown in Fig. 3.17, closure measurements across the Picton Weir can be calculated to an accuracy of ± 3 mm, with seasonal variation observed.

4.4.2. Ground Surveys along streets and the Main Southern Railway

Survey lines have been installed along the Main Southern Railway, Remembrance Drive, Caloola Road, Yarran Road, Charlies Point Road and Great Southern Road, as shown in Drawing No. MSEC1193-12-04. The surveys are relevant to Picton Weir in that they provide general information on subsidence behaviour above and adjacent to the longwall panels.

The survey lines consist of pegs spaced nominally every 20 metres. 2D surveys will measure levels and horizontal distances between adjacent pegs. Survey pegs along Remembrance Drive will be surveyed in 2D and 3D (level, eastings and northings). The purpose of the 3D surveys is primarily to assist with monitoring potential impacts on pipelines that run along the road.

Any work within the road reserve, including survey, must be done under an approved Road Occupancy Permit (under Section 138 of the Roads Act) via an application to Council. Tahmoor Coal will ensure that its surveyors will apply to Council prior to conducting surveys within the road reserves.

4.4.3. Survey marks on rockfaces on both sides of the Picton Weir

Survey marks have been installed on rock faces upstream and downstream of the Picton Weir. The marks have been surveyed in Absolute 3D and in high precision local 3D, which allows closure to be measured to high degree of accuracy.

4.4.4. Laser distancemeters

Two laser distancemeters will be placed to continuously measure distances across the Picton Weir. The laser distancemeters will be mounted on rock faces downstream of the Weir. One will be placed near the crest of the Weir and the second laser distancemeter will monitor changes near the base of the Weir.

4.4.5. Photogrammetric survey

A baseline photogrammetric survey has been conducted of the Picton Weir and surrounding rock faces. Additional surveys can be conducted if triggered by monitoring results.

4.4.6. Vertical inclinometer surveys

A vertical inclinometer tube was installed inside a borehole on the northern side of Picton Weir. Baseline surveys have been completed and will be regularly surveyed during mining to facilitate monitoring of valley closure and potential bedding plane shear or displacements in the sandstone rock strata.

4.4.7. Groundwater level monitoring

A piezometer has been installed to measure groundwater levels within the inclinometer borehole. Changes in groundwater levels will be monitored and reported during mining.

4.4.8. Surface Water level monitoring

A piezometer will be installed upstream of Picton Weir on the southern side for the purposes of measuring changes in water storage levels over time prior to the commencement of LW S4A. Changes in surface water levels will be monitored and reported during mining.

4.4.9. Detailed visual inspections

Baseline photographs and videos were conducted of the Picton Weir by UAV by MNC Consulting. A systematic and repeatable methodology has been designed and implemented. Additional inspections will be conducted if triggered by monitoring results. The detailed visual inspections could be used to measure changes in crack widths, if required.

4.4.10. Visual inspections

Visual inspections will be undertaken regularly during mining by an experienced inspector appointed by Tahmoor Coal who is familiar with mine subsidence impacts. The inspector will undertake the following:

- Visual inspections of the Picton Weir from a safe vantage point; and
- Visual inspections of the surrounding rock faces and access road from a safe vantage point.

4.4.11. Geotechnical inspections

Geotechnical engineer PSM conducted a baseline inspection of the Picton Weir and surrounding rock faces. Additional inspections can be conducted if triggered by monitoring results.

4.4.12. Structural dam inspections

Structural dam engineer Worley conducted an inspection of Picton Weir. Additional inspections can be conducted if triggered by monitoring results.

4.4.13. Changes to monitoring frequencies

Monitoring frequencies will continue at the Picton Weir during the extraction of LW S3A-S7A. Monitoring, will continue after mining until observed rates of change reduce to negligible levels.

4.5. Triggers and Responses

Trigger levels have been developed by Tahmoor Coal based on engineering assessments and consultation with Crown Lands.

Trigger levels for each monitoring parameter are described in the risk control procedures in Table 4.1.

Immediate responses, if triggered by monitoring results, may include:

- Increase in survey and inspection frequencies if required by the IMG;
- Additional inspections of Picton Weir by structural engineer and geotechnical engineer;
- Repair cracks;
- Lower water levels behind the Weir by pump and/or install a slot or gate
- Spray shotcrete to seal cracks on upstream face of Weir;
- Install post-tensioned anchors to reduce impacts from further differential mining-induced movements;
- Place concrete blocks or buttresses downstream of the Weir to reduce impacts from further differential mining-induced movements;
- Install rock slot to the side of Picton Weir to reduce impacts from further valley closure and upsidence;
- Prevent public access to the Picton Weir and install signage;
- As a last resort emergency response measure if a hazard has been identified that involves potential serious injury or illness to a person or persons and cannot be controlled, stop mining. An Emergency Response Plan will be prepared by Tahmoor Coal prior to 500 metres of extraction of LW S5A.

The risk control measures described in this Management Plan have been developed to ensure that the health and safety of people near or downstream of Picton Weir are not put at risk due to mine subsidence. It is also an objective to avoid disruption to services, or if unavoidable, keep disruption and inconvenience to minimal levels.

With respect to the extraction of LW S3A to S7A, potential hazards have been identified that could reasonably give rise to the need for an emergency response. The hazards relate to differential mining-induced movements impacting directly on Picton Weir.

As demonstrated in Section 3.5, mine subsidence movements will develop gradually and there will be time to identify the development of potentially adverse differential subsidence movements early, consider whether any additional management measures are required in close consultation with Crown Lands.

As documented in Section 4.6, Tahmoor Coal and the IMG will review and assess monitoring reports and consider whether any additional management measures are required on a weekly basis. If potentially adverse differential subsidence movements are detected, it is anticipated that a focussed inspection will be undertaken in the affected area, and a decision will likely be made to increase the frequency of surveys and/or inspections. Additional management measures may also be implemented. It is therefore expected that, as a potential adverse situation escalates, Tahmoor Coal will be present on site on a more frequent basis to survey or inspect the affected site, and that Crown Lands will be consulted on a more frequent basis.

Notwithstanding the above, if a hazard has been identified that involves potential serious injury or illness to a person or persons on public property or Crown Lands infrastructure, and cannot be controlled, the immediate response is to remove people from the hazard. If such a situation is observed or is forecast to occur by either Tahmoor Coal or by people on public property, Tahmoor Coal and Crown Lands will immediately meet and implement emergency procedures. An Emergency Response Plan will be prepared by Tahmoor Coal prior to 500 metres of extraction of LW S5A.

4.6. Subsidence Impact Management Procedures

The procedures for the management of potential impacts to the Picton Weir are provided in Table 4.1.

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 structural and geotechnical assessment of Picton Weir	Complete	Worley and PSM
				Develop Emergency Response Plan in consultation with Crown Lands and Wollondilly Shire Council	Prior to 500m of extraction of LW S5A	500m of extraction of LW S5A
				Investigate feasibility and implement mitigation works at Picton Weir, including removal, lowering or strengthening works	Prior to 500m of extraction of LW S5A	Tahmoor Coal / Crown Lands
				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 End of LWs S3A and S4A Monthly during extraction of LWs S5A 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
				Visual inspections of Picton Weir by structural engineer and geotechnical engineer	Prior to 500m of extraction for LWs S5A, S6A and S7A	Worley and PSM
				Analyse and report results to IMG and Crown Lands	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 - lower water behind Weir via pump and/or install slot or gate - 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 in accordance with Emergency Response Plan	Within 24 hours	IMG
				Report trigger exceedance and actions taken to IMG, Crown Lands, 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 - lower water behind Weir via pump and/or install slot or gate - 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 in accordance with Emergency Response Plan	Within 24 hours	IMG
				Report trigger exceedance and actions taken to IMG, Crown Lands, 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, Crown Lands 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 in accordance with Emergency Response Plan - 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

5.1. Consultation, co-operation and co-ordination

Consultation, co-operation and co-ordination has taken place between Tahmoor Coal and Crown Lands prior to the development of this Management Plan, as detailed in Section 1.3.

The following procedures will be implemented during and after active subsidence of the property to ensure the continued effective consultation, co-operation and co-ordination of action with respect to subsidence between Tahmoor Coal and Crown Lands:

- Reporting of observed impacts to Tahmoor Coal either during the weekly visual inspection or at any time directly to Tahmoor Coal;
- Distribution of monitoring reports, which will provide the following information on a weekly basis during active subsidence:
    - Position of longwall;
    - Summary of management actions since last report;
    - Summary of consultation with Crown Lands since last report;
    - Summary of observed or reported impacts, incidents, service difficulties, complaints;
    - Summary of subsidence development;
    - Summary of adequacy, quality and effectiveness of management process;
    - Any additional and/or outstanding management actions; and
    - Forecast whether there will be any subsidence impacts to the health and safety of people due to the continued extraction of LW S3A-S7A.
- Convening of meetings between Tahmoor Coal and Crown Lands at any time as required, as discussed in Section 5.2;
- Arrangements to facilitate timely repairs, if required; and
- Immediate contact between Tahmoor Coal and Crown Lands if a mine subsidence induced hazard has been identified that involves potential serious injury or illness to a person or persons on public property or Crown Lands property and may require emergency evacuation, entry restriction or suspension of work activities.

5.2. IMG meetings

The IMG undertakes reviews and, as necessary, revises and improves the risk control measures to manage risks to health and safety, and potential impacts to infrastructure.

The reviews are undertaken at the completion of LWs S3A and S4A, and monthly during the extraction of LWs S5A to S7A based on the results of the surveys and visual inspections and summarised in the monitoring reports, as described in Section 5.1.

The purpose of the reviews are to:

- Detect changes, including the early detection of potential impacts on health and safety and impacts to Crown Lands infrastructure;
- Verify the risk assessments previously conducted;
- Ensure the effectiveness and reliability of risk control measures; and
- Support continual improvement and change management.

IMG meetings may be held between Tahmoor Coal and Crown Lands for discussion and resolution of issues raised in the operation of the Management Plan. The frequency of IMG Meetings will be as agreed between Tahmoor Coal and Crown Lands.

IMG Meetings will discuss any incidents reported in relation to the relevant infrastructure, the progress of mining, the degree of mine subsidence that has occurred, and comparisons between observed and predicted ground movements.

It will be the responsibility of the meeting representatives to determine whether the incidents reported are due to the impacts of mine subsidence, and what action will be taken in response.

In the event that a significant mine subsidence impact is observed, any party may call an emergency IMG Meeting, with one day's notice, to discuss proposed actions and to keep other parties informed of developments in the monitoring of the infrastructure.

6.0 AUDIT AND REVIEW

This Management Plan has been agreed between parties and can be reviewed and updated to continually improve the risk management systems based on audit, review and learnings from the development of subsidence during mining and manage changes in the nature, likelihood and consequence of subsidence hazards.

The review process will be conducted to achieve the following outcomes:

- Gain an improved understanding of subsidence hazards based on ongoing subsidence monitoring and reviews, additional investigations and assessments as necessary, ongoing verification of risk assessments previously conducted, ongoing verification of assumptions used during the subsidence hazard identification and risk assessment process, ongoing understanding of subsidence movements and identified geological structures at the mine;
- Revise risk control measures in response to an improved understanding of subsidence hazards;
- Gain feedback from stakeholders in relation to managing risks, including regular input from business or property owners;
- Ensure on-going detection of early warnings of changes from the results of risk assessments to facilitate corrective or proactive management actions or the commencement of emergency procedures in a timely manner; and
- Ensure timely implementation of a contingency plan in the event that the implemented risk control measures are not effective.

Some examples where review may be applied include:

- Observation of greater impacts on surface features due to mine subsidence than was previously expected;
- Observation of fewer impacts or no impacts on surface features due to mine subsidence than was previously expected; and
- Observation of significant variation between observed and predicted subsidence.

Should an audit of the Management Plan be required during that period, an auditor shall be appointed by Tahmoor Coal to review the operation of the Management Plan and report at the next scheduled Plan Review Meeting. The Management Plan shall be audited for compliance with ISO 31000, or alternative standard agreed with Crown Lands.

7.0 RECORD KEEPING

Tahmoor Coal will keep and distribute minutes of any IMG Meeting.

8.0 CONTACT LIST

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* denotes member of Infrastructure Management Group

9.0 REFERENCES

	AS/NZS ISO 31000:2009 Risk Management – Principles and guidelines
Axys (2024)	*SIMEC Mining - Tahmoor Mine – Longwall LWS3A to LWS7A Subsidence Impacts to the Picton Weir – Risk Assessment*, Axys Consulting, Report No. AR3819, Revision 1, 22 January 2024.
DOC (2004)	*Bargo Dam Surveillance Report*, NSW Department of Commerce and State Water, Report No. DC040047, March 2004.
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Mills. K. et al (2004)	*Mitigation of subsidence Impacts at Marhnyes Hole Rockbar*, Mills, K.; Brassington, G.; Poole, G.; Walsh, R.; Wood, J.; Riley, P.; Fredericks, L., Proceedings of the MSTS Mine Subsidence Technological Society 6th Triennial Conference on Mine Subsidence, Maitland 31 Oct to 2 Nov 2004. Pp 41-46.
MSO (2017)	*Managing risks of subsidence – Guide | WHS (Mines and Petroleum Sites) Legislation*, NSW Department of Planning & Environment, Resources Regulator, Mine Safety Operations, February 2017.
MSEC (2022)	*Tahmoor South- Longwalls S1A to S6A - Subsidence ground movement predictions and subsidence impact assessments for natural features and surface infrastructure in support of the Extraction Plan Application.* Mine Subsidence Engineering Consultants, Report No. MSEC1192, Revision A, May 2022.
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PSM (2023)	*SIMEC Mining – Picton Weir Geotechnical Assessment and Investigation*, Pells Sullivan Meynink, Report No. PSM3139-32R, 18 October 2023.
Worley (2024)	*Mine Subsidence Impact on Picton Weir – Structural Investigation - Finite Element Analysis*, Worley , Report No. 311023-50344 RP001, Rev. 0, July 2024
Worley (2024b)	*Picton Weir Dam Failure Analysis – PAR / PLL Assessment*, Worley , Report No. 311023-50344 RP002, Rev. 0, May 2024.

APPENDIX A. Drawings and Supporting Documentation

The following supporting documentation is provided in Appendix A.

Drawings

Drawing No.	*Description*	*Revision*
MSEC1193-12-01	General layout	A
MSEC1193-12-02	Surface levels and cliffs	A
MSEC1193-12-03	Geological structures	A
MSEC1193-12-04	Subsidence Monitoring Plan	A
MSEC1193-12-05	Picton Weir Monitoring Plan	A

Supporting Documentation

Axys (2024)	*SIMEC Mining - Tahmoor Mine – Longwall LWS3A to LWS7A Subsidence Impacts to the Picton Weir – Risk Assessment*, Axys Consulting, Report No. AR3819, Revision 1, 22 January 2024.
PSM (2023)	*SIMEC Mining – Picton Weir Geotechnical Assessment and Investigation*, Pells Sullivan Meynink, Report No. PSM3139-32R, 18 October 2023.
Worley (2024)	*Mine Subsidence Impact on Picton Weir – Structural Investigation - Finite Element Analysis*, Worley , Report No. 311023-50344 RP001, Rev. 0, July 2024
Worley (2024b)	*Picton Weir Dam Failure Analysis – PAR / PLL Assessment*, Worley , Report No. 311023-50344 RP002, Rev. 0, May 2024.

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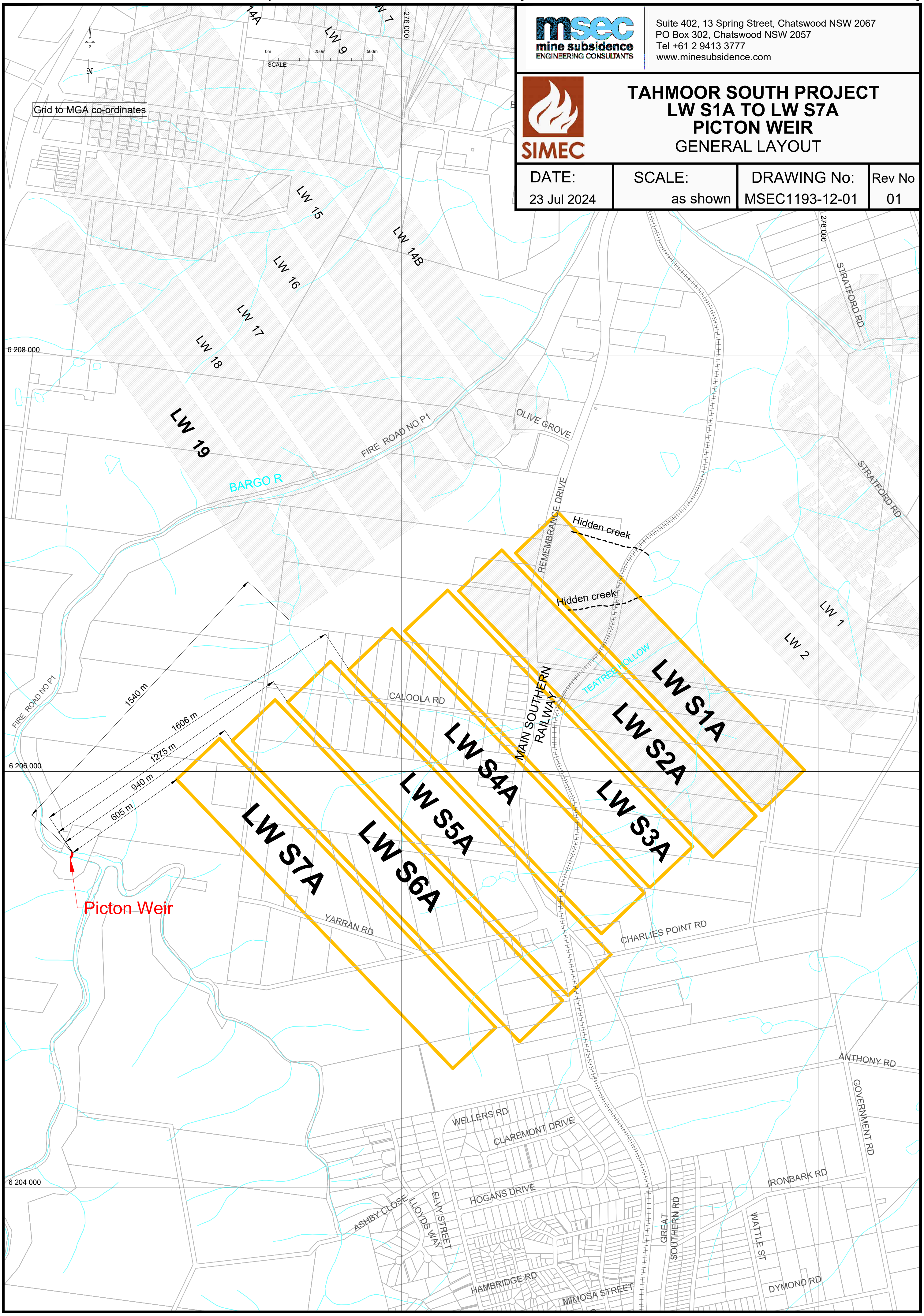

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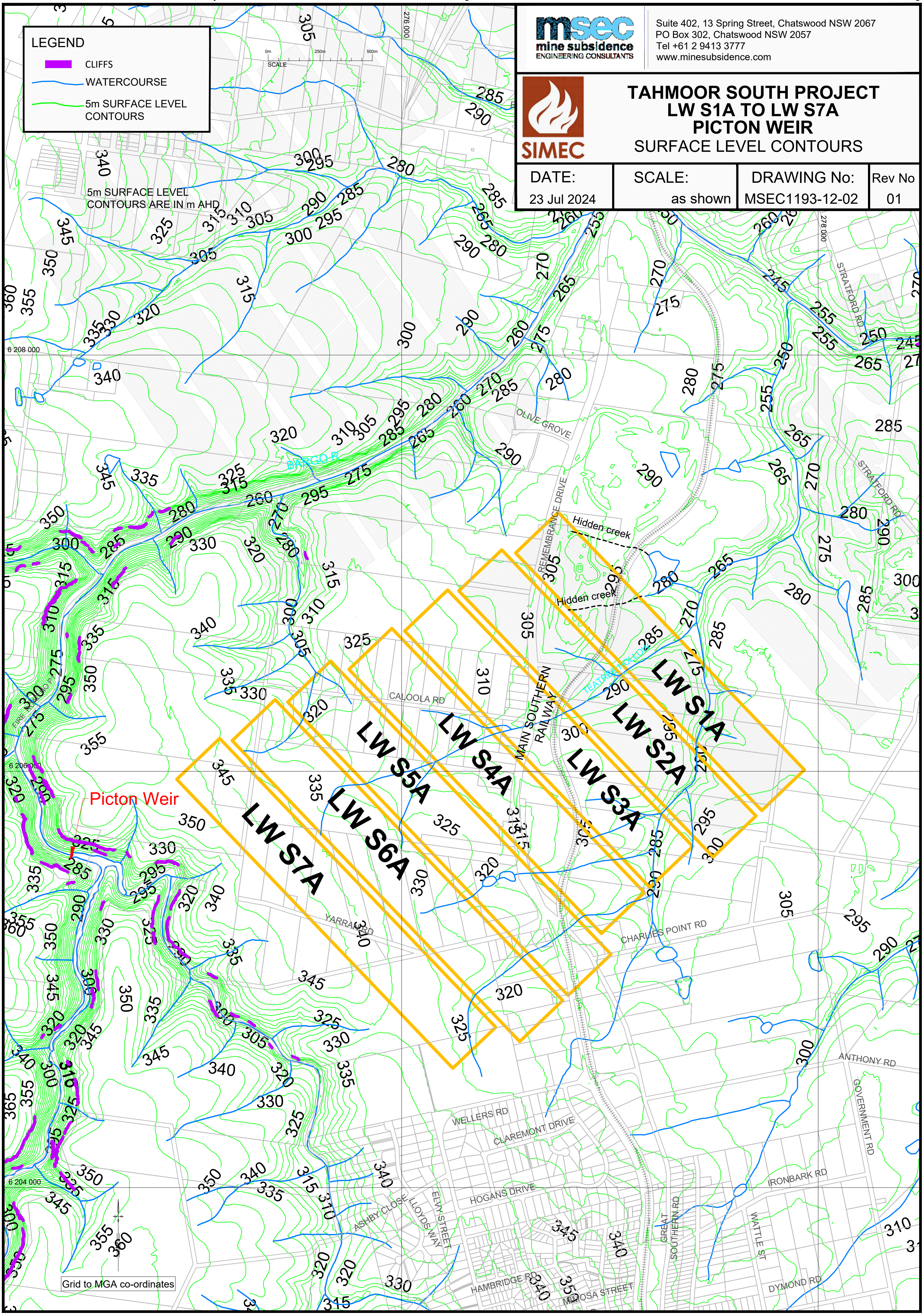

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TAHMOOR SOUTH PROJECT
LW S1A TO LW S7A
PICTON WEIR
GEOLOGICAL STRUCTURES AT BULLI SEAM LEVEL

DATE:	SCALE:	DRAWING No:	Rev No
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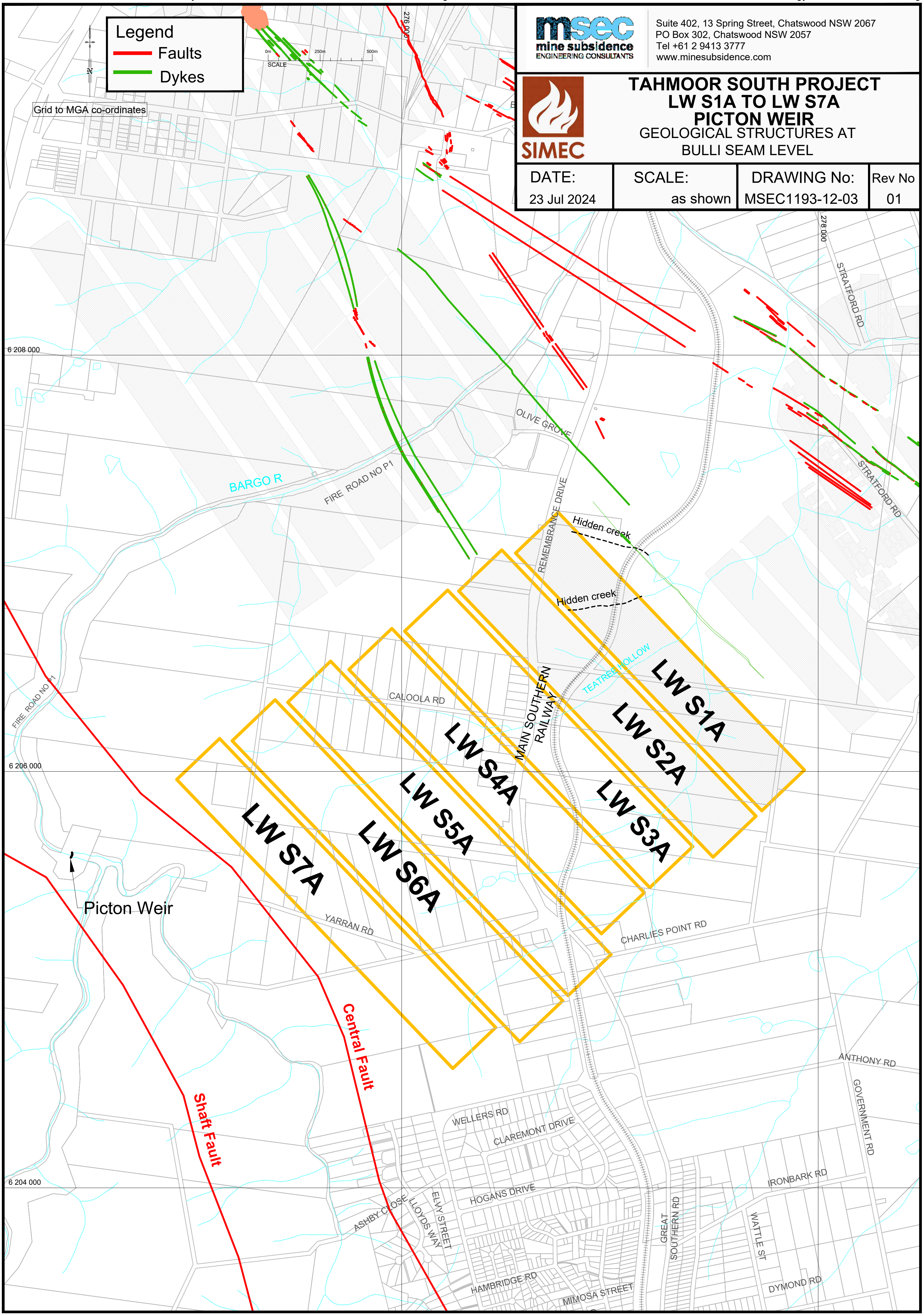

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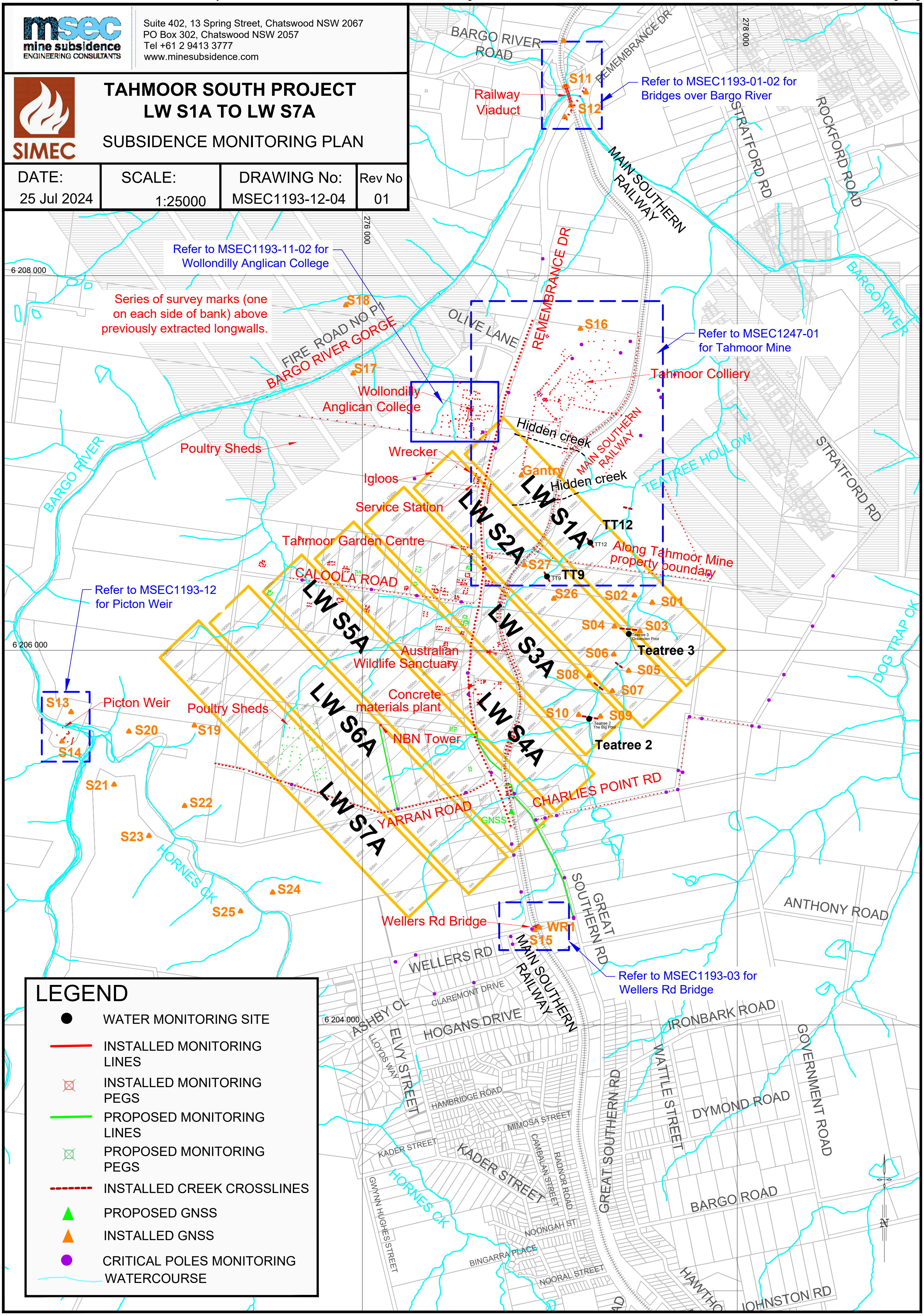
TAHMOOR SOUTH PROJECT
LW S1A TO LW S7A
SUBSIDENCE MONITORING PLAN

DATE:	SCALE:	DRAWING No:	Rev No
25 Jul 2024	1:25000	MSEC1193-12-04	01



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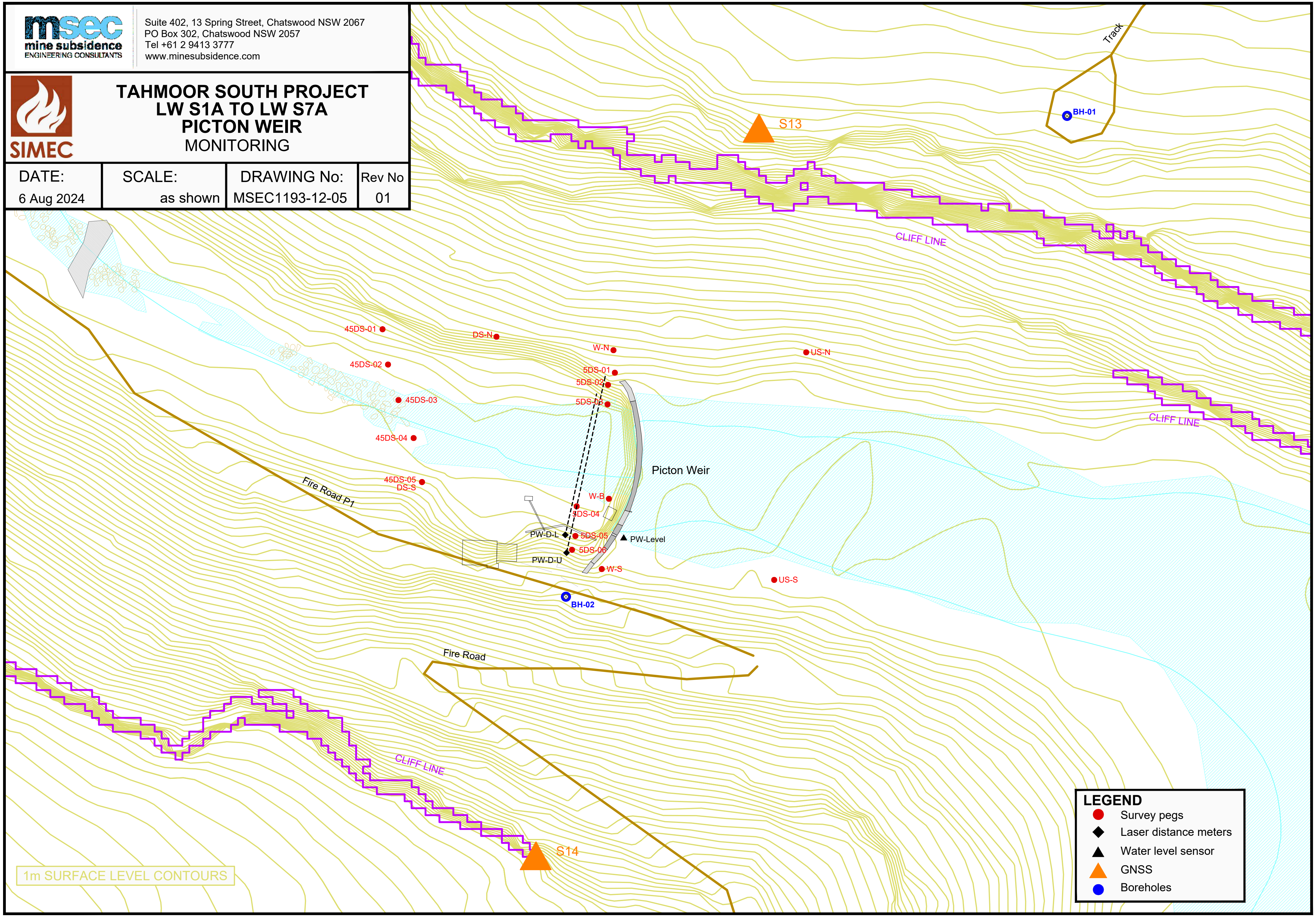
TAHMOOR SOUTH PROJECT
LW S1A TO LW S7A
PICTON WEIR
MONITORING

DATE:	SCALE:	DRAWING No:	Rev No
6 Aug 2024	as shown	MSEC1193-12-05	01



SIMEC Mining - Tahmoor Mine

Longwall LWS3A to LWS7A Subsidence Impacts to the Picton Weir

Risk Assessment Report

AR3819

Revision 1

22 January 2024

Assessment and report completed by;
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1. Revisions

Rev No	Date	Description
1	22 January 2024	Initial Release

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2. Participants

Name	Position	Relevant Years' Experience
Ross Barber	SIMEC - Tahmoor Coal Pty Ltd Project Manager Subsidence	39 Years
Amanda Fitzgerald	SIMEC - Tahmoor Coal Pty Ltd Environment and Community Officer	6 Years
Daryl Kay	MSEC Ming Subsidence Engineer	20 Years
David Ho	Worley Consulting Principal Consultant	20 Years
Stefano Casartelli	PSM Associate Engineering Geologist	11 Years
Edrick Lo		
Michael Nicholson	Surveying Consultant GNSS Monitoring	30 Years
Peter Nunn		

3. Introduction

This risk assessment was undertaken for Tahmoor Coking Coal Operations (Tahmoor), on potential subsidence impacts of Tahmoor's South Project longwalls LWS3A through to LWS7A on the Jemena 150mm medium pressure (MP) steel gas pipeline. The gas pipeline supplies gas to the townships of Tahmoor and Picton in the Macarthur Region of New South Wales.

Tahmoor has mined coal by longwall methods from the Southern Coalfields since 1987 and in that time has maintained a harmonious co-existence with the communities of; Tahmoor to the south-east, Thirlmere to the west and Picton to the north. Subsidence from longwall mining has impacted private dwellings, community and other infrastructure, including; the Main Southern Railway Line and associated bridges, culvert, embankments and cuttings.

All subsidence is monitored commensurate with the criticality of impact and a range of mitigation measures has been devised to provide every means of ensuring that only tolerable and sustainable impacts occur. Mitigation measures include; rail expansion joints and relevelling on the Main Southern Railway Line and uncovering of the gas pipelines to uncouple them from the ground during subsidence.

This report is for the risk assessment of the impacts on the Picton Wier from LWS3A through to LWS7A only.

The overriding objective of this risk assessment was to engage with the asset owner (Wollondilly Shire Council) and subject specialists (subsidence and structural engineers) to identify and assess the risks and to develop mitigation strategies, where necessary, to prevent So Far As Is Reasonably Practicable (SFAIRP) unacceptable or unsustainable subsidence impacts to the Pictor Weir and associated consequential outcomes, e.g., to public safety.

There were no non-consensus items identified during the risk assessment.

4. System Description

Tahmoor is located approximately 80 kilometres south-west of Sydney in the Southern Coalfields of New South Wales, within the Wollondilly Shire Council. Tahmoor has mined in this area employing longwall methods since 1987 and in that time has maintained a harmonious co-existence with the communities of; Tahmoor to the south-east, Thirlmere to the west and Picton to the north.

Tahmoor extracts up to 4Mtpa of Run of Mine (ROM), with up to 33Mt of ROM coal proposed over the remaining Life of the Project. This will produce approximately 2.5Mtpa of Hard Coking Coal for steel production.

The next years of production will focus on the Tahmoor South (Bargo) Area, which contains a further 4 longwall blocks, divided into the A-Series (northern blocks LWA3A – LWS6A) and the B-Series (southern blocks LW1B – LW6B). Tahmoor received Development Consent for both A and B Series blocks in early April 2022. Tahmoor Coal is also seeking approval for Longwall S7A that planned to be extracted after LW S6A.

Tahmoor South undermines private dwellings, businesses and private and government-owned infrastructure, e.g., roads, the Main Southern Railway Line, power, water, sewer, optical fibre communications cables, gas supply pipelines and Picton Weir.

The Picton Weir (also known as Bargo Weir or Bargo Dam) is a mass concrete structure (unreinforced) – arch-gravity dam that was first constructed in 1898 to provide a water supply to the township of Picton and surrounding areas. The height of the Weir was raised in 1910 and again in 1947 to meet increased demand.

The Weir is of a Darley-Wade thin-arch dam design (19th – early 20th century dam design in NSW), with the crest at RL278.45 metres (1899), RL280.89 metres (1910) and RL927’/283.02 metres (1947).

The Wier crest of RL283.92m is 0.9 metres above the spillway crest and approximately 13 metres high from the river bed (upstream). The base width is 4.15 metres and the crest width is 1.22 metres.

A risk analysis report (2002) by Dept. of Land & Water Conservation State Water identified the consequences of dam failure as a Very Low category (ANCOLD 1994 guideline). The existing Dam Safety Committee (DSC) has no requirements for acceptable flood capacity or earthquake stability of a Very Low consequences dam. Ownership of the Picton Weir is currently with the Wollondilly Shire Council.

The Weir provides an upstream water holding capacity of 150 Million Litres, excluding the effects of silting that is known to have occurred upstream of the Weir structure.

Tahmoor has a proven track record for carrying out detailed monitoring, subsidence modelling and prediction and for assessing and mitigating impacts on all public utilities and identified structures.

Subsidence modelling and predictions have been carried out by Mine Subsidence Engineering Consultants (MSEC) and have been provided in a report. Detail engineering analysis and report of the proposed ground movements effects of the Weir has been completed by Worley Consulting. The contents of these reports were presented during the risk assessment and the reader should consult these reports to specific details.

5. Context Summary

5.1 Strategic Context

SIMEC Mining, Tahmoor Colliery, is committed to ensuring safety and environmental compliance within its operation. When new equipment or processes are implemented, SIMEC insist that risk assessment techniques are used to reduce the risks to people, equipment, environment and operations.

5.2 Corporate Context

As SIMEC is committed to safety and environmental compliance, when a change to systems or new equipment or systems are introduced into the operation, management insist that risk assessment techniques are used to identify and minimising exposure to its people and the operations. SIMEC is also committed to implementing risk assessment techniques to identify risk when required by external sources.

5.3 Risk Management Context

The primary objective of this risk assessment is to identify hazards and existing controls associated with the safety and serviceability of the Picton Weir from the mining of Longwalls S3A through to S7A, and to make recommendations for further controls where appropriate.

The main consideration is for personal safety however equipment damage, operational loss and environmental issues will be considered where relevant.

6. Objectives and Scope

The objective of the risk assessment was to facilitate a structured process to enable critical and objective challenge of the subject area to assist Tahmoor fulfil its obligations, namely:

- Public safety by direct or consequential impacts from subsidence on the gas pipeline,

- Obligations imposed by NSW Work Health and Safety legislation, including;
  - Work Health & Safety Regulation 2017, with particular focus on:
    - Part 3.1 Managing risks to health and safety,
  - Work Health & Safety (Mines & Petroleum Sites) Regulation 2014, with particular focus on:
    - Clause 9 Management of risks to health and safety - risk assessment is conducted in accordance with this clause by a person who is competent to conduct the particular risk assessment having regard to the nature of the hazard.
    - Clause 23 Identification of principal hazards and conduct of risk assessments,
    - Clause 33 Notification of high risk activities,
    - Clause 67 Subsidence,
    - Clause 128 Duty to notify regulator of certain incidents, (5) High Potential Incidents (m) any indication from monitoring data of the development of subsidence which may result in damage to any plant or structure or a failure of ground
    - Schedule 1 Principal hazard management plans—additional matters to be considered, 3C Subsidence
    - Schedule 3 High risk activities, 16 Secondary extraction

- Risk assessment process in accordance with AS/NZ ISO 31000:2018 – Risk Management and MDG 1010 - Risk Management Handbook for the Mining Industry, with risk rating in accordance with the Tahmoor Risk Assessment Matrix

- Participation of the asset owner, subsidence and pipeline specialist engineers and Tahmoor,

- Compliance with Planning Approval - Key Performance Measures:
  - The project does not cause any exceedances of the performance measures to the satisfaction of the stakeholders,
  - The Picton Weir as key infrastructure serving the public is always safe and serviceable,
  - Damage that effects safety or serviceability must be fully repaired at the completion of the mining,
  - Arrangements are in place to maintain the serviceability of the asset

7. Assumptions and Constraints

The following assumptions were made during the risk assessment:

- Existing monitoring and control systems will be maintained throughout the project unless otherwise stated.
- Subsidence movements will normally occur gradually over a period of months.
- Stage 1 (Early Subsidence) refers to small movements and limited impacts as longwall extraction approaches the rail line.
- Stage 2 (Active Subsidence) refers to the period of significant movement and potential impacts as extraction occurs beneath the railway.
- Stage 3 (Post Active Subsidence) refers to the limited impacts and movements, reducing to zero over time, experienced as the longwall extraction continues to retreat away from the railway.

8. Risk Treatment

An audit system needs to be in place to ensure all recommendations from this assessment are implemented.

The group were introduced to the Risk Assessment Process at the commencement of the session by the facilitator. The various steps were explained and the group reviewed the Likelihood, Consequence and Risk Ranking matrix.

The risk ranking was done with consideration to existing controls being in place.

Controls were developed using the following forms.

1. Avoidance – avoid the risk by deciding not to proceed with the activity likely to generate the risk (where this is practicable).
2. Reduction – reduce the likelihood of the event.
3. Reduction – reduce the consequences of the event.
4. Accept – accept the risk within the organisation and establish an appropriate plan to manage the consequences of these risk if they are to occur.

The above risk control options were applied by reference to the following control methodologies in a hierarchical sequence.

1. Design – to the extent reasonable and practicable ensure that hazards are designed out when new materials, equipment or work systems are being planned for the workplace.
2. Remove the hazard or substitute less hazardous materials, equipment or substances.
3. Adopt a safer process – alter tool, equipment or work practices to make them safer.
4. Enclose or isolate the hazard – provide guards or remote operation and handling techniques.
5. Provide effective ventilation – install local or general exhaust ventilation systems.
6. Establish appropriate administrative procedures. Set up, document and implement new procedures that provide for:
   - Scheduling of the job so that fewer workers are exposed;
   - Routine maintenance and housekeeping procedures;
   - Training on hazards and correct work procedures.
7. Personal Protective Equipment – provide suitable and properly maintained personal protective equipment and training in its use.

9. Facilitator Qualifications and Experience

Shane Chiddy holds an Associate Diploma in Engineering (Electrical), is an Officer of the Institution of Engineers (Australia) and is a member of the Asset Management Council of Australia (AMC) and the Mining Electrical and Mining Mechanical Engineering Society (MEMMES). He has also completed Contract Law through Macquarie University, Carry out the Risk Management Process (G2) and Establish the Risk Management Systems (Mine 7033 - G3) through Queensland University and is certified as a Functional Safety Engineer by TÜV Rheinland for both Safety Instrumented Systems (#7652/13) and Machine Safety (#9315/14).

Prior to commencing his consulting career, Shane Chiddy qualified as an electrician and worked underground for 9 years. He then occupied a number of engineering roles within Rio Tinto, including such roles as electrical supervisor, Development Engineer and Senior Production Engineer. This latest role was responsible for the Longwall, underground diesel equipment and conveyors.

Additionally Shane Chiddy has been trained and accredited by John Moubray in the UK as a certified RCM II practitioner and has conducted a number of extensive Reliability-centred Maintenance II analyses including underground and surface equipment such as Longwalls, Continuous Miners and conveying systems. He has facilitated RCM II analysis and delivered training in the mining, defence, power distribution and telecommunications industries.

His consulting experience includes the application of Reliability-centred Maintenance II and extensive Risk Management and Project Management assignments.

10. Sub-Systems Considered in the Assessment

Sub-System		STEP IN PROCESS	
1	Far Field subsidence effects from the mining of Longwalls S3A through to S7A on the Picton Weir	A	Impact to Picton Weir due to conventional and non-conventional subsidence

11. Risk Assessment Methodology

11.1 Qualitative Risk Analysis

This Risk Assessment has been performed using Qualitative Risk Analysis techniques and has been performed to align with the principles of the Australian Standard AS31000 - Risk Management Principles and Guidelines and the Department of Mineral Resource Guideline MDG1010.

The Risk Assessment has followed the WRAC (Workplace Risk Assessment and Control) principles as outlined in the guideline.

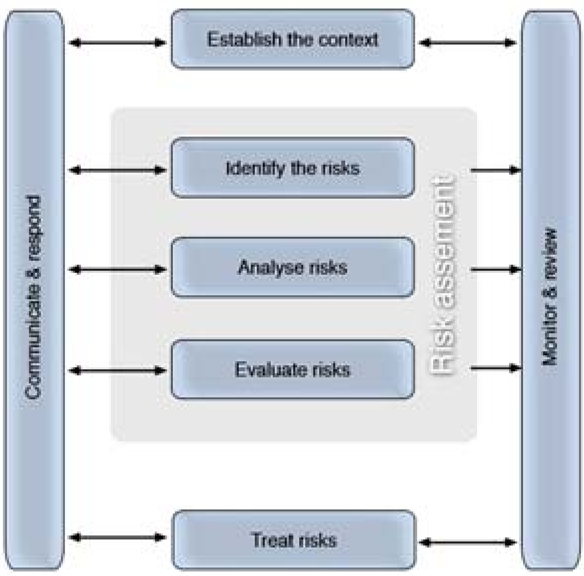
The qualitative approach succeeds by using local expert knowledge and relevant historical data.

This system of analysis uses a participative approach which is very powerful for identifying potential hazard scenarios.

The following steps outline the systematic identification of hazards, ranking of risks, and identification of new and/or improved controls that were used in the Risk Assessment session:

1. Introduce team to the Risk Assessment process and the context of the Risk Assessment. This includes the scope and method of the Risk Assessment.
2. Identify discrete components, or elements, of the Project.
3. Identify and add potential deviation steps.
4. Review each sub-system and identify loss scenarios - (Potential Incidents and Accidents).
5. For those hazards evaluate the risk using the risk rank method by determining the probability, consequence, and risk rank of each loss scenario.
6. Identify existing controls for each hazard.
7. Specify additional controls required to control the hazard(s).
8. Close the Risk Assessment.
9. Document and distribute to the team for proof reading.
10. Undertake verification of the assessment by a nominated person.

The available Standards on Risk Management (including MDG1010) define the Risk Management process as that shown below.



11.2 Establish the Context

This risk analysis has been performed using Qualitative Risk Analysis techniques and is performed in compliance with the Department of Mineral Resources (now the Resources Regulator) Guideline MDG1010.

11.3 Identify Hazards

This step involves identification of all the hazards to be managed. To correctly apply this step a well-structured systematic process must be used, because controls may not be able to be implemented to reduce or eliminate any hazards missed at this point in the analysis.

For each hazard, the team identifies:

1. What Can Happen; and
2. How and Why it Can Happen.

Checklists, Flowcharts and Brainstorming are used to identify hazards.

11.4 Analyse Risks

The main objectives of an analysis is to separate minor risks from major risks and to provide data to assist in the evaluation and treatment of hazards.

Risk Analysis involves considering the following:

1. Likelihood of the Hazard occurring (identified as 'L' within the worksheets).
2. Consequences if the Hazard does occur (identified as 'C' in the worksheets).
3. Determining any existing controls.

The combination of the Likelihood and the Consequence determines the level of the risk involved. The likelihood and consequence categories used are outlined in Section 13.

During the assessment the consequences are categorised as either hazards to personnel, the environment or to the site operations. Additional categories such as reputation and community may also be considered where deemed appropriate.

The consequence category is identified on the Analysis Worksheets in the Column labelled 'T' for Type.

11.5 Evaluate Risks

Evaluation involves comparing the level of risk found during the analysis with previously established risk criteria.

The output of this part of the process is a list of prioritised hazards for further action.

If the resulting hazards fall into the low or tolerable risk categories, they may be accepted with minimal further treatment. Although, low and tolerable hazards should be monitored and periodically reviewed to ensure that they remain tolerable.

If hazards do not fall into the low or tolerable risk category, then they should be treated using other options.

11.6 Treat Risks

Risk treatment involves identifying the range of options for treating risks, assessing the options and preparing risk treatment plans and implementing them.

Risk treatment may be in one of the following forms:

1. Risk Avoidance. Decide not to proceed with the activity.
2. Reduce Likelihood. Reduce the chance of the risk occurring.
3. Reduce the Risk Consequences. Reduce the consequence if the risk occurs.
4. Retain (or accept) the Risk. Plans should be put in place to mitigate the consequences of these risks in the event that they occur.

Risk treatment options should be assessed on the extent of any additional benefits or opportunities created. A number of options may be considered and applied either individually or in a combination.

Risk treatment plans should be developed to identify responsibilities, schedules, budgets and performance measures and the review process that is to be established. If no other actions are identified, as needing to be implemented, the group believed the risk was As Low As Reasonably Practicable (ALARP).

11.7 Monitor and Review

It is essential to monitor the effectiveness of the risk management system and the risk treatment implementation.

Risks and the effectiveness of control measures need to be monitored to ensure that the changing environments do not alter risk priorities. Few risks remain static.

Factors affecting Likelihood and/or Consequence change as do factors regarding suitability of controls.

11.8 Communications and Consultations

Communication and consultation are important during the entire risk management process. It is important to develop a communication plan for both internal and external stakeholders.

This should be a two-way consultation not a one-way flow of information.

Effectiveness of internal and external communications is important to ensure that those responsible for implementing risk management understand the basis on which all decisions have been made, and why particular actions are required.

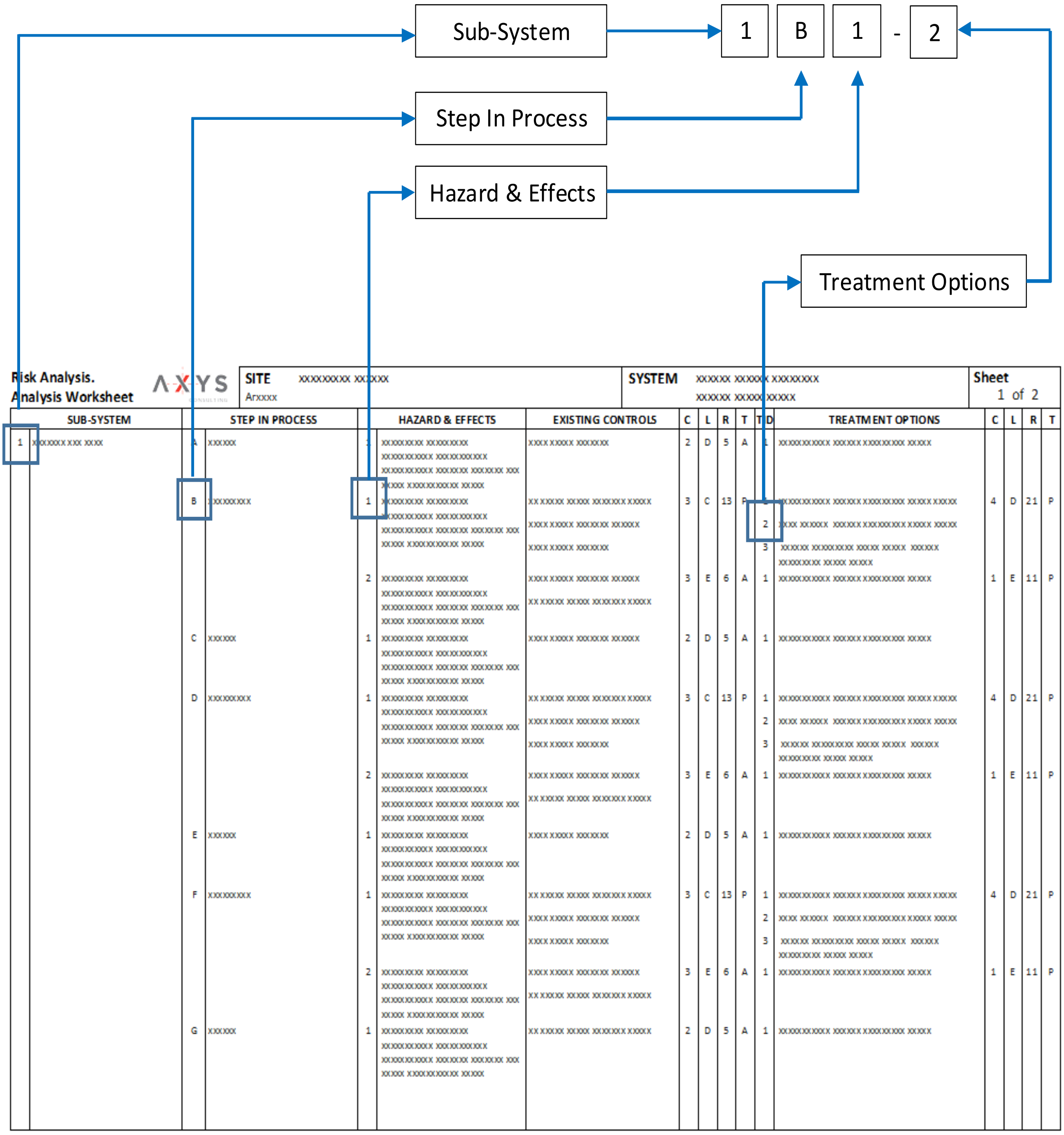
12. Risk Assessment Numbering

The assessment uses an alphanumeric numbering system to differentiate each component, the step in the process, the hazard and the treatment options.

The sub system number is found in the first column of the worksheets, the step is identified as a letter and is found in the third column, the hazard number in the fifth column and the treatment options in the TID (Treatment ID) column.

Using this method each hazard and treatment option throughout the analysis has a distinct identifier. This identifier then flows through all of the worksheets and can be referenced back to the Analysis Worksheets.

The example below shows the distinct identifier for the hazard is 1B1, the treatment option identified below would be identified as 1B1-2.



13. Risk Rank Method

For each event, the Likelihood (a letter A to E) and Consequence (a number 1 to 5) is selected. If an event effects more than one area of consequence (e.g. effects people and operations), the highest rank number is always selected.

Risk Matrix						
Likelihood		**Consequence**				
		Negligible	Minor	Moderate	Major	Catastrophic
A (Almost Certain)	May occur several times per year OR Expected to occur OR Has occurred several times within Glencore	**11 (M)**	**16 (H)**	**20 (H)**	**23 (H)**	**25 (H)**
B (Likely)	May occur about once per year OR More likely to occur than not occur OR Has occurred at least once within Glencore	**7 (M)**	**12 (M)**	**17 (H)**	**21 (H)**	**24 (H)**
C (Possible)	Could occur more than once during a lifetime OR As likely to occur as not to occur OR Has occurred at least once in the mining / commodities trading industries	**4 (L)**	**8 (M)**	**13 (M)**	**18 (H)**	**22 (E)**
D (Unlikely)	Could occur about once during a lifetime OR More likely NOT to occur than to occur OR Has occurred at least once in broader worldwide industry	**2 (L)**	**5 (L)**	**9 (M)**	**14(M)**	**19 (M)**
E (Rare)	Unlikely to occur during a lifetime OR Very unlikely to occur OR No known occurrences in broader worldwide industry	**1 (L)**	**3 (L)**	**6 (L)**	**10 (M)**	**15 (M)**

Area of Effect	**Estimated Level of Consequence**				
	1	**2**	**3**	**4**	**5**
(P) Health and Safety	First Aid Injury (FAI) illness (not considered disease or disorder)	Restricted Work Injury (RWI) / Disease (RWD) or Medical Treatment Injury (MTI) / Disease (MTD)	Lost Time Injury (LTI) / Disease (LTD) - Single incident resulting in multiple RWIs or MTIs	Fatalities (<5) due to a single incident or health cause Permanent disability or disease cases (<5) due to a single incident or health cause (mental or physical)	Multiple fatalities (5+) due to a single incident or health cause Multiple permanent disability or disease cases (5+) due to a single incident or health cause (mental or physical)
(E) Environment	Negligible, and reversible, environmental impact to ecosystems, habitat or species (<1 week to remediate)	Limited, but reversible, environmental impact to ecosystems, habitat or species (<3 months to remediate)	Limited, but reversible, environmental impact to ecosystems, habitat or species (<2 years to remediate)	Widespread, but reversible, environmental impact to ecosystems, habitat or species (2 to 10 years to remediate)	Widespread environmental impact to ecosystems, habitat or species (irreversible, or >10 years to remediate)
(F) Financial Impact	<$1M operating profit <$300k property damage <$1M asset devaluation	$1M to 5M operating profit $300k to $1M property damage $1M to $5M asset devaluation	$5M to $50M operating profit $1M to $5Mproperty damage $5M to $25M asset devaluation	$50M to $100M operating profit $5M to $50M property damage $25M to $250M asset devaluation	>$100M operating profit >$50M property damage >$250M asset devaluation

Area of Effect	Estimated Level of Consequence				
	1	2	3	4	5
(R) Image and Reputation	Negligible interest from media and no local, national or international pick-up Low-level social media pick-up, posts are neutral and isolated Negligible interest from local, regional or national government Negligible interest from NGOs and pressure groups Negligible interest from customers and/or suppliers Negligible interest from investors and/or analysts	Limited but negative media coverage at local / regional level that subsides after 24 hours Negative social media pick-up, but limited to local stakeholders that subsides after 24 hours Queries but no public statements from local, regional or national government Queries but no public statements from NGOs and pressure groups Queries from one or more customers and/or suppliers Queries from one or more investors and/or analysts	Negative media coverage at local / regional and national level for more than 24 hours, limited pick-up internationally Negative social media pick-up, from a mix of local and national stakeholders, limited pick-up internationally Public statements from local and/or regional but not national government Public statements from a limited number of NGOs and pressure groups Queries from multiple customers and/or suppliers Queries from multiple investors and/or analysts	Negative media coverage at local / regional, national and international levels over several days Negative social media internationally with a hostile tone Strongly negative public statements from local, regional and national government, and separately from multiple NGOs and pressure groups Threat of losing business from customers and/or suppliers Strong concerns from multiple investors and/or analysts	Sustained negative international media coverage lCondemnation from heads of state, governments, religious leaders and supranational bodies, e.g. the U.N. Negative social media campaigning reaches into mainstream public awareness Consistent and sustained negative public statements from high-profile NGOs and pressure groups Loss of customers and suppliers Investors consider divestment and analysts publish notes condemning the company and change their ratings
(L) Legal and Compliance	Civil investigation which might result in a non-penal remedy or with potential negligible financial consequences Any litigation or arbitration, license or permit non-compliance, or cancellation of a contract with potential negligible financial consequences	Civil investigation of any member of the Group with potential penalty of minor financial consequences Any litigation or arbitration, license or permit non-compliance, or cancellation of a contract with potential minor financial consequences	Civil investigation of any member of the Group with potential penalty of moderate financial consequences or short-term stop work order Any litigation or arbitration, loss of license or permit, or cancellation of a contract with potential moderate financial consequences	Criminal investigation of a Group company (but not for the Group) or directors or officers of a Group company Civil investigation at Group level or for any Group entity with potential penalty of major financial consequences or extended work stoppage Any litigation or arbitration, loss of license or permit, or cancellation of a contract with potential major financial consequences	Criminal investigation at Glencore Group level or in respect of the Board or senior management Any litigation or arbitration, loss of license or permit, or cancellation of a contract with potential catastrophic financial consequences Default under Group funding arrangements

PMC Category	Consequence Type	Ownership / Action
Cat 5	Catastrophic Hazard / Threat	**Ownership** - Department/Functional/Operational/Asset Leadership. **Action** - Detailed assessment is required to confirm achievement of ALARP ('As Low As Reasonably Practicable'). Critical Control Management is required.
Cat 4 (Health & Safety consequence)	Fatal Control	**Ownership** - Department/Functional/Operational/Asset Leadership **Action** - GCAA Fatal Hazard Protocol implementation is required.

Risk Rank	Risk Rating	Ownership / Action
23 – 25	Very High Risk	**Ownership** - Department/Functional/Operational/Asset Leadership **Escalation and Communication** - COO/CEO
17 – 22	High Risk	**Ownership** - Department/Functional/Operational/Asset Leadership. **Escalation and Communication** - Director/COO
7-16	Medium Risk	**Ownership** - Operation / Asset / Function /Department. **Escalation and Communication** - Operation / Asset / Function / Department
1 - 6	Low Risk	**Ownership** - Operation / Asset / Function /Department. **Escalation and Communication** - Operation / Asset / Function / Department

Attachment 1

Analysis Worksheets

Risk Analysis. Analysis Worksheet	SITE SIMEC Mining - Tahmoor Mine AR3819	SYSTEM Longwall LWS3A to LWS7A Subsidence Impacts to the Picton Weir	Sheet Page 21

	SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS	EXISTING CONTROLS	RCE	PMC	C	L	R	T	TID	TREATMENT OPTIONS
1	Far Field subsidence effects from the mining of Longwalls S3A through to S7A on the Picton Weir	A	Impact to Picton Weir due to conventional and non-conventional subsidence	1	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.	Visual inspections during mining Groundwater level monitoring in vertical inclinometers at mine side of the Picton Weir (installed) Mine plan design includes longwall LS7A located 605 metres away from the Weir Subsidence assessment by MSEC predicts subsidence effects at the Weir Structural assessment of the Weir Geotechnical Investigation of the site Target crack monitoring Detailed visual inspection of Picton Weir and surrounding rockfaces by UAV (baseline inspection completed) Vertical inclinometers in boreholes at mine side of the Picton Weir (boreholes drilled, inclinometer tubing installed) Photogrammetric survey of shape of dam wall and surrounding rockfaces on both sides of the Picton Weir (baseline survey completed) Survey marks on rockfaces on both sides of the Picton Weir (installed) GNSS monitoring at three pairs across Horns Creek (Sites S20 to S25, installed) GNSS monitoring at a location between LWs S1A to S7A and the Picton Weir (Site S19, installed) GNSS monitoring at both ends of the Picton Weir (Sites S13 and S14, both installed) Subsidence Monitoring Controls for assets: includes	Improvement	4	2	D	5	F	1 2 3 4 5	Develop a Picton Weir Management Plan for Longwalls S3A to S7A, including - Monitoring Plan - Mitigation Plan - Response Plan (TARP) Install survey marks on the Picton Weir, and include monitoring and actions within the Picton Weir Management Plan Identify existing cracks where accessible locations and include in monitoring programme Provide water level monitoring upstream of Picton Weir Undertake a Dam Break Analysis, to determine the effects of a Weir Failure, to validate the consequences considered in this assessment and inform the TARP.

Attachment 2

Assessment Worksheets
(Risk Rank Order)

REF	Risk	HAZARD	TID	TREATMENT OPTIONS
1A1	5	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.	1	Develop a Picton Weir Management Plan for Longwalls S3A to S7A, including - Monitoring Plan - Mitigation Plan - Response Plan (TARP)
			2	Install survey marks on the Picton Weir, and include monitoring and actions within the Picton Weir Management Plan
			3	Identify existing cracks where accessible locations and include in monitoring programme
			4	Provide water level monitoring upstream of Picton Weir
			5	Undertake a Dam Break Analysis, to determine the effects of a Weir Failure, to validate the consequences considered in this assessment and inform the TARP.

Attachment 3

Assessment Worksheets (Consequence Order)

REF	Cons	HAZARD	TID	TREATMENT OPTIONS
1A1	2	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.	1	Develop a Picton Weir Management Plan for Longwalls S3A to S7A, including - Monitoring Plan - Mitigation Plan - Response Plan (TARP)
			2	Install survey marks on the Picton Weir, and include monitoring and actions within the Picton Weir Management Plan
			3	Identify existing cracks where accessible locations and include in monitoring programme
			4	Provide water level monitoring upstream of Picton Weir
			5	Undertake a Dam Break Analysis, to determine the effects of a Weir Failure, to validate the consequences considered in this assessment and inform the TARP.

Attachment 4

Risk Treatment Schedule Action Plan

ID	HAZARD	TID	TREATMENT OPTIONS	RESPONSIBILITY	IMPLEMENTATION	COMMENTS	COMPLETED (Sign Off)
1A1	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.	1	Develop a Picton Weir Management Plan for Longwalls S3A to S7A, including - Monitoring Plan - Mitigation Plan - Response Plan (TARP)	Subsidence Project Manager	Friday, 26 April 2024		
		2	Install survey marks on the Picton Weir, and include monitoring and actions within the Picton Weir Management Plan	Subsidence Project Manager	Friday, 28 June 2024		
		3	Identify existing cracks where accessible locations and include in monitoring programme	Subsidence Project Manager	Friday, 28 June 2024		
		4	Provide water level monitoring upstream of Picton Weir	Subsidence Project Manager	Friday, 28 June 2024		
		5	Undertake a Dam Break Analysis, to determine the effects of a Weir Failure, to validate the consequences considered in this assessment and inform the TARP.	Subsidence Project Manager	Friday, 28 March 2025		