Appin Mine Area 7

Longwalls 712 to 716

Land Management Plan

29 July 2026

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DOCUMENT CONTROL

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Mine:	Appin Mine
Name of operator:	Gear M Illawarra Met Coal Pty Ltd trading as GM^3
Project approval:	MP08_0150
Mining leases:	Consolidated Coal Lease 767, Mine Lease 1698, Mine Lease 1433, Mine Lease 1832, Mine Lease 1847 and Mine Lease 1874
Document Title:	Appin Mine Area 7 Longwalls 712 to 716 Extraction Plan Land Management Plan

NAME OF PERSONS AUTHORISING THIS PLAN

NAME	TITLE	DATE
Gary Brassington	Director Sustainability and Government	December 2025

DOCUMENT REVISIONS

REVISION	DESCRIPTION OF CHANGES	DATE
1	New document for consultation	December 2025

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1. INTRODUCTION

1.1 Project Background

Illawarra Coal Holdings Pty Ltd (ICHPL) operates the Bulli Seam Operations (BSO) Appin Mine extracting hard coking coal used for steel production. On 22 December 2011 the Planning and Assessment Commission (PAC), under delegation of the Minister for Planning, approved BSO (MP 08_0150) under Part 3A of the Environmental Planning and Assessment Act 1979 (EP&A Act) to continue mining operations until 2041.

This Land Management Plan (LMP) supports the Longwalls 712 to 716 Extraction Plan for mining of coal in Appin Area 7 (AA7) mining domain.

1.2 Scope

The scope of this LMP includes the proposed management of potential impacts and environmental consequences on land with a focus on cliffs and steep slopes within the Study Area as a result of the mining of Longwalls 712 to 716.

1.3 Study Area

The Study Area for the Extraction Plan is defined in accordance with MSEC (2025) as the surface area predicted to be affected by the proposed mining of Longwalls 712 to 716 and encompasses the areas bounded by the following limits (**Error! Reference source not found.**):

- A 35° angle of draw line from the maximum depth of cover, which equates to a horizontal distance varying between 555 m and 800 m around the limits of the proposed extraction areas for Longwalls 712 to 716, and
- The predicted limit of vertical subsidence, taken as the 20 mm subsidence contour, resulting from the extraction of the proposed Longwalls 712 to 716.

Additionally, features potentially sensitive to far field movements, which includes horizontal, valley closure and upsidence movements that may be outside the 20 mm subsidence zone or 35° angle of draw line have been assessed.

1.4 Objectives

The objectives of this LMP are to identify at risk land geomorphology and manage the potential impacts and/or environmental consequences of the proposed workings on the land.

Specific focus will be on cliffs and steep slopes including cliffs of 'special significance' (i.e. longer than 200 m and/or higher than 40 m and cliff-like rock faces higher than 5 m that constitute waterfalls, as defined by BSO approval Condition 1, Schedule 3), and other cliffs flanking the Nepean River, as shown in

Figure 2 and the drawing in MSEC (2025), Drawing No. MSEC1459-09.

1.5 Consultation

The LMP will be developed in consultation with:

- Department of Planning, Housing and Infrastructure (DPHI);
- Resources Regulator; and
- Wollondilly Shire Council (WSC).

Arrangements for individual private properties and assets will be described in the relevant Property Subsidence Management Plans (PSMPs) and or asset agreements to be negotiated with the property owners.

ICHPL will make the LMP and other relevant environmental documentation publicly available on the GM3 website (Condition 11, Schedule 6).

Figure 1 Appin Area 7 (Longwalls 712 to 716) Study Area

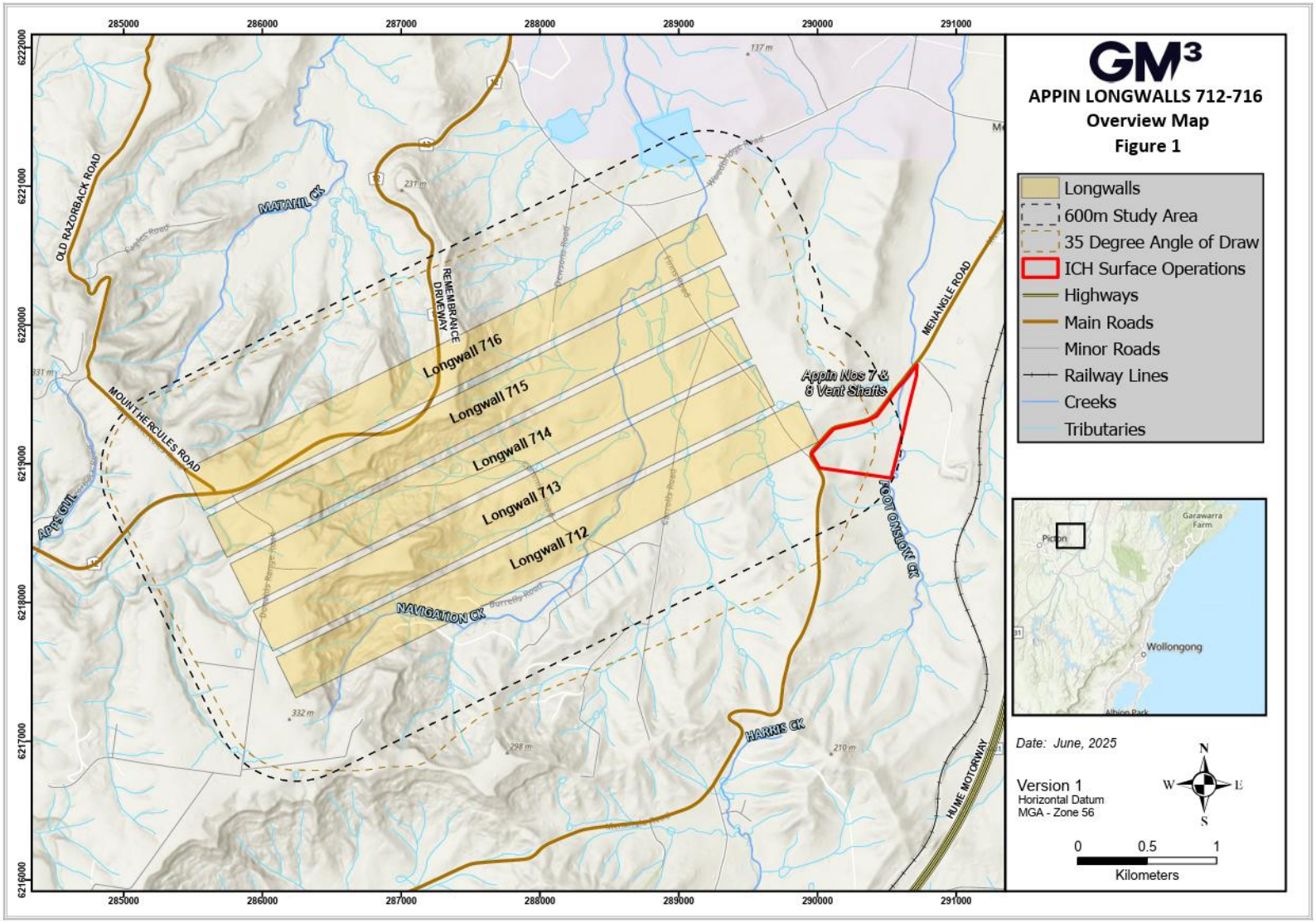
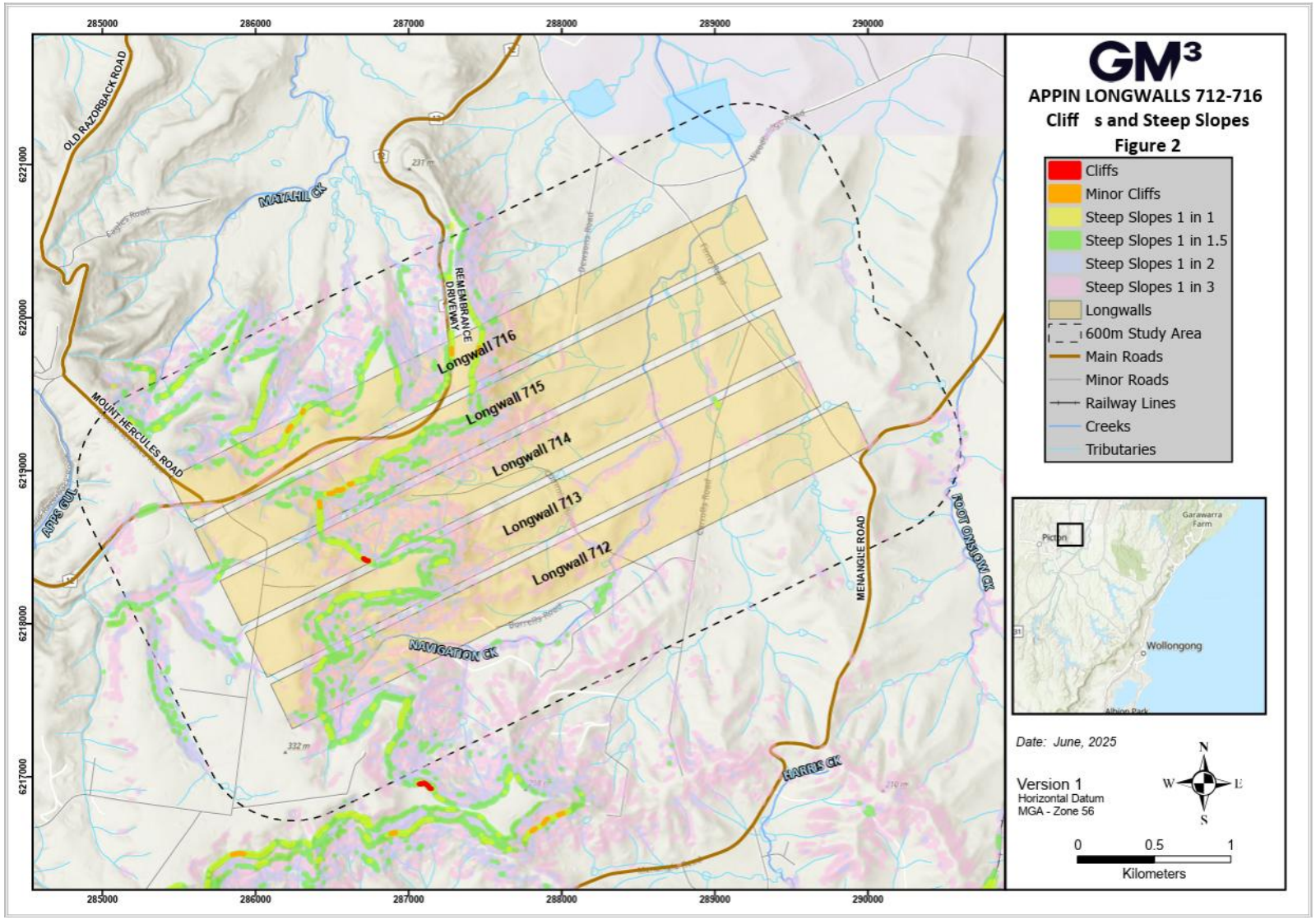


Figure 2: Appin Area 7 Longwall 712 to 716 Location of Cliffs and Steep Slopes



2. STATUTORY REQUIREMENTS

Extraction of coal from Longwalls 712 to 716 will be in accordance with the conditions set out in the BSO Approval, applicable legislation as detailed in Section 2.2 and the requirements of relevant licenses and permits, including conditions attached to mining leases.

2.1 BSO Approval

Condition 5 (j), Schedule 3 of the BSO Approval requires the preparation of a LMP to manage the potential impacts and/or environmental consequences of the proposed workings on land, including a specific focus on cliffs and steep slopes as shown in Table 1.

Table 1: Key Conditions of the BSO Approval MP 08_0150

No.	Condition Requirement	Section
C3.5(j)	The Proponent shall prepare and implement an Extraction Plan for first and second workings within each longwall mining domain to the satisfaction of the Planning Secretary. Each extraction plan must: include a Land Management Plan, which has been prepared in consultation with any affected public authorities, to manage the potential impacts and/or environmental consequences of the proposed second workings on land in general with a specific focus on cliffs and steep slopes.	This Plan Section **Error! Reference source not found.**

This LMP also addresses the requirements detailed in Condition 6, Schedule 3 and Condition 2, Schedule 6 of the BSO Approval as shown in Table 2.

Table 2: Management Plan Requirements

Project Approval Conditions	Section

Condition 6, Schedule 3 The Proponent shall ensure that the management plans required under Condition 5 (g)-(l) above include: a) an assessment of the potential environmental consequences of the Extraction Plan, incorporating any relevant information that has been obtained since this approval; b) a detailed description of the measures that would be implemented to remediate predicted impacts.	Section 4 Section **Error! Reference source not found.**
Condition 2, Schedule 6 The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include: (a) detailed baseline data; (b) a description of: - the relevant statutory requirements (including any relevant approval, licence or lease conditions); - any relevant limits or performance measures/criteria; - the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures; (c) a description of the measures that would be implemented to comply with the relevant statutory, limits, requirements or performance measures/criteria; (d) a program to monitor and report on the: - impacts and environmental performance of the project; - effectiveness of any management measures (see c above); (e) a contingency plan to manage any predicted impacts and their consequences and to ensure that ongoing impacts reduce to levels below relevant impact assessment criteria as quickly as possible; (f) a program to investigate and implement ways to improve the environmental performance of the project over time; (g) a protocol for managing and reporting any:	Section **Error! Reference source not found.** Section **Error! Reference source not found.** Section 5 Section 5 to 8 Section 5 to 8 Section **Error! Reference source not found.**

- incidents; - complaints; - non-compliances with statutory requirements; and - exceedances of the impact assessment criteria and/or performance criteria; and (h) a protocol for periodic review of the plan.	Section 8 Section **Error! Reference source not found.** Section **Error! Reference source not found.** Section **Error! Reference source not found.**

Due consideration has been given to all BSO Approval Conditions in the preparation of this LMP, including those relating to auditing, rehabilitation and environmental management.

2.2 Legislation and Guidelines

This LMP has been developed with due regard to the requirements of the relevant legislation and advisory documents and guidelines including:

- Australian Geomechanics Society Landslide Risk Management Guidelines, 2007.
- Australian Soil and Land Survey Field Handbook, 2009.

2.3 Relevant Leases and Licences

The following licences or permits are applicable to ICHPL operations in AA7:

- Mining Leases as per Table 3.
- Environment Protection Licence (EPL) 2504 which applies to BSO, including Appin and West Cliff Mines. A copy of the licence can be accessed at the EPA website.
- All relevant Occupational Health, Safety, Environment and Community approvals.
- Any additional leases, licences and approvals resulting from the BSO Approval.

Table 3: Appin Mine Lease

MINING LEASE – DOCUMENT NUMBER	START	FINISH
CCL 767	29 OCT 1991	08 JUL 2029
ML 1433	24 JULY 1998	24 JULY 2043
ML 1698	26 JUN 2014	26 JUN 2035
ML 1832	9 AUG 2022	9 AUG 2043
ML 1874	20 FEB 2020	20 FEB 2045
ML 1892	4 SEP 2025	4 SEP 2046

3. BASELINE ASSESSMENT

A Major Cliff Risk Assessment was conducted by IMC (2009) for the BSO EA based on information provided by MSEC, Gilbert & Associates, FloraSearch and Biosis Research.

The Cliff Risk Assessment included a description of the BSO mine parameters and likely types of subsidence impacts that might occur, the identification of significant natural features including major cliff lines, cliff lines of special significance, and an assessment of the risk of impacts and consequences to each cliff line. The Study Area for the Major Cliff Risk Assessment included the Longwalls 712 to 716 Study Area.

A revised baseline assessment of the cliffs, rock outcrops and steep slopes within the Study Area was conducted by MSEC (2025).

The definition of "Cliffs" provided in the BSO Approval is: "Continuous rock face, including overhangs, having a minimum height of 10 metres and a minimum slope of 2 to 1, i.e. having a minimum angle to the horizontal of 63° ".

MSEC (2025) define a "cliff" as "a continuous rock face with a minimum slope of 2 in 1 (V:H, i.e. 63.4°), minimum height of 10 m and minimum continuous length of 20 m" and a "minor cliff" as "a continuous rock face with a minimum slope of 2 in 1 (V:H, i.e. 63.4°), a height between 5 and 10 m and minimum continuous length of 20 m".

"Steep slopes" are defined in the BSO Approval as "an area of land having a gradient between 1 in 3 (33% of 18.3°) and 2 in 1 (200% or 63.4°)".

Cliffs, minor cliffs and steep slopes within the Study Area have been identified from the LiDAR surface level contours and from site investigations and are shown in

Figure 2.

Appin Area 7 Proposed Longwalls 712 to 716 Landslide Risk Assessment relating to Mine Subsidence Influences was prepared by SLR (2025) to support the Extraction Plan. Section 3 of this report details the assessment methodology and process undertaken to initially categorise landslide risks to properties and features within the Extraction Plan area. From the review of various formats of data and preliminary observations across the Extraction Plan area, the residential sites identified as being within 'steep slope' terrain have been categorised to develop a preliminary appraisal of the existing landslide hazards, site susceptibility and potential impact of mine subsidence upon the existing landslide risk levels.

These categories ranged from Category A (No apparent slope issue relevant to the house structure – not likely to require assessment for slope instability) through to Category F (Sites close to the Razorback escarpment, and/or sites with slopes greater than 15° – these will be the sites requiring detailed LRM assessment).

3.1 Cliffs, Steep Slopes and Rock Outcrops

3.1.1 Existing Environment

Cliffs and minor cliffs have been identified within the Longwalls 712 to 716 Study Area and surrounds at locations described in Table 4.

Table 4: Details of Cliffs within the vicinity of the Study Area (MSEC, 2025)

Cliff reference	Overall length (m)	Maximum height (m)	Description
CLIFFS			
RR-CL5	100	20	Directly above the previously extracted Longwall 710A
RR-CL8	40	10	Directly above Longwall 714
MINOR CLIFFS			
MCL01	43	7	Directly above Longwall 715
MCL02	35	8	Directly above Longwall 715
MCL03	50	8	Directly above Longwall 715
MCL04	26	7	Directly above Longwall 715
MCL05	46	9	Directly above Longwall 716
MCL06	23	7	Directly above Longwall 716
MCL07	41	5	Directly above Longwall 716
MCL08	25	6	Directly above Longwall 716
MCL09	35	6	Directly above Longwall 716

The characteristics of cliffs, steep slopes and rock outcrops within the Study Area include:

- Cliffs have been identified in the western part of the Study Area along Razorback Range. These cliffs have formed in the sandstone members of the Wianamatta Group.
- Rock outcrops are defined as exposed rockfaces with heights of less than 5 m or slopes of less than 2 in 1. There are rock outcrops located across the Study Area, primarily along the Razorback Range and the incised creeks and tributaries.
- The steep slopes within the Study Area have been identified along Razorback Range above the western end of the proposed longwalls.
- No individual cliff lines in the Study Area are considered to be sufficiently unique or different to require identification as 'special significance' and thus requiring special consideration in a risk assessment framework.

3.1.2 Nepean River Cliffs

Cliffs have also been identified along the Nepean River; however, these features are located outside the Study Area and are at distances of more than 2 km from Longwall 712 and are not considered further in this Land Management Plan.

3.2 Baseline Recording

3.2.1 Slope Stability Assessment

Steep slopes within the Study Area were identified by MSEC (2025). Slope instability has historically occurred along Razorback Range as part of the natural processes that occur in the region.

A slope stability assessment was therefore undertaken at these locations by SLR (2025) to assess the potential effects of longwall mining on the known hazards at these slopes.

Mass movement of steep slopes is unlikely to be induced by the proposed mining activities. Notwithstanding, ICHPL will develop and implement ongoing monitoring in consultation with potentially affected landowners through the PSMP process. Any mitigation or management measures would also be developed and implemented in consultation with, and agreement of, the affected landowner through this process.

4. PREDICTED IMPACTS

In accordance with the findings of the Southern Coal Field Inquiry (2009) and Independent Expert Panel for Mining in the Catchment (2019a), subsidence impacts are defined as:

- **Subsidence effects** are defined as the deformation of ground mass such as horizontal and vertical movement, curvature and strains.
- **Subsidence impacts** are the physical changes to the ground that are caused by subsidence effects, such as tensile and sheer cracking and buckling of strata.
- **Environmental consequences** are then identified, for example, as a loss of surface water flows and standing pools.

4.1 Subsidence Effects

The potential impacts from mine subsidence include:

- Increase in the profile of slopes as a result of tilting of the landform during generation of the mine subsidence 'bowl'. The increase in tilt represents a marginal adverse influence on potential instability by way of increased likelihood, as discussed in Coffey (2013).
- Re-initiation of previous landslides through shearing produced by mine subsidence strains being localised along the basal plane of existing landslides and doing so at residual shear strength. The likelihood of the mechanics of this occurring are not considered higher than the potential for downslope displacements under natural conditions, and the generation of a re-mobilised landslide with residual strength over its base.
- Valley closure effects are a process whereby shearing is produced in the rock mass as a result of the phenomenon of lateral straining towards incisions in the landform, such as creek lines, but also man-made civil engineering features such as railway or road cuttings. Strain concentration occurs at these features.
- Alteration of the near-surface groundwater table is potentially a mechanism that modifies the porewater distribution within sloping ground as a result of mine subsidence changing the rock mass permeability during accommodation of mine subsidence.
- Rockfalls are a viable landslide mechanism due to mine subsidence, principally due to the potential for an increase in tilt of marginally stable blocks of bedded cliff-forming sandstone units. In addition, horizontal valley closure displacements routinely occur at the boundaries of geological units, leading to a concentration at bedding planes. The potential for lateral strains induced by valley closure leads to an increase in the likelihood of rockfalls as a result of mine subsidence. The magnitude of critical strains to instigate rockfall instability depends upon the capacity of the rockface to accommodate lateral strains, which is an individual case-by-case assessment.

4.2 Cliffs and Overhangs

4.2.1 Subsidence Predictions

The cliffs and minor cliffs within the Study Area have been identified from the LiDAR surface level contours and from site investigations. Cliffs have been identified in the western part of the Study Area along Razorback Range. These cliffs have formed in the sandstone members of the Wianamatta Group.

A summary of the maximum predicted values of total vertical subsidence, tilt and curvature for the cliffs within the Study Area is provided in Table 5.

There are rock outcrops located across the Study Area, primarily along the Razorback Range and the incised creeks and tributaries. The rock outcrops are located across the Study Area and, therefore, are expected to experience the full range of predicted subsidence movements.

Table 5: Maximum Predicted Vertical Subsidence, Tilt and Curvatures for the Cliffs and Minor Cliffs within the Study Area (MSEC, 2025)

Reference	Maximum predicted total conventional subsidence (mm)	Maximum predicted total conventional tilt (mm/m)	Maximum predicted total curvature hogging curvature (km^{-1})	Maximum predicted total conventional sagging curvature (km^{-1})
CLIFFS				
RR-CL5	275	3.0	0.03	<0.01
RR-CL8	900	1.5	0.04	0.01
MINOR CLIFFS				
MCL01	1100	3.0	0.04	0.06
MCL02	1150	3.0	0.02	0.08
MCL03	1150	3.0	0.02	0.07
MCL04	1150	3.0	0.02	0.08
MCL05	650	5.5	0.05	0.02
MCL06	350	3.5	0.06	<0.01
MCL07	800	6.0	0.05	0.06
MCL08	70	0.5	<0.01	<0.01
MCL09	950	5.0	0.02	0.09

The experience from Appin, Tower and Tahmoor Collieries indicates that the cliff instabilities were less than 5 % of the total length located directly above the mining area, and less than 3 % of the

total face area of cliffs located directly above the mining area. It is anticipated that a similar rate of impact would occur for the cliffs and minor cliffs located above the proposed longwalls.

The two cliffs (Refs. RR-CL5 and RR-CL8) and eight of the minor cliffs (Refs. MCL01 to MCL07 and MCL09) are located above the mining area. The total length of these cliffs and minor cliffs is approximately 440 m and the total face area is approximately 4550 m^2.

MSEC (2025) assess that the impacts on the cliffs and minor cliffs located directly above the mining area (Refs. RR-CL5, RR-CL8, MCL01 to MCL07 and MCL09) would represent a total length of less than approximately 22 m and a total face area of less than approximately 137 m^2.

There are no building structures or other built features located directly beneath the cliffs or minor cliffs within the Study Area. The risk to public safety, therefore, is considered to be low. However, it is recommended that, subject to landholder access, ICHPL carry out periodic inspections of the minor cliffs at a safe distance during active subsidence, to identify any fracturing, unstable rocks and rockfalls.

Minor cliff MCL08 is located 275 m north of the proposed LW716. At this distance, adverse impacts are not anticipated at this minor cliff due to the proposed mining.

Minor cliff MCL07 is located adjacent to the eastern side of Remembrance Drive along the Razorback Range and is directly above the proposed Longwall 716. While the potential for impacts on this minor cliff is considered low, ICHPL will carry out periodic inspections of the minor cliffs along Remembrance Drive during active subsidence, to identify any fracturing, unstable rocks and rockfalls.

4.2.2 Environmental Consequences

Environmental consequences of a rock fall could potentially include changes to the visual landscape of the Study Area. A rock fall or landslide may result in the exposure of a fresh face of rock and debris scattered around the base of the cliff. As with naturally occurring instabilities, the exposed fresh rock-face weathers and erodes over time to a point where it blends in with the remainder of the cliff face and in time the vegetation below the cliff regenerates.

Cliff and overhang instabilities as well as surface cracking have potential to impact public safety. Public safety is addressed in the Public Safety Management Plan. Other potential environmental consequences of cliff/overhang instabilities may include impacts on stream water quality, flora and fauna or their habitats, and Aboriginal heritage sites. These potential environmental consequences are addressed in the Water Management Plan, Biodiversity Management Plan and Heritage Management Plan.

The extraction of the proposed longwalls is likely to result in fracturing of the rock outcrops and, where the rock is marginally stable, this could then result in instabilities. Previous experience in the Southern Coalfield indicates that the percentage of rock outcrops that are likely to be impacted by mining is very small, representing on average less than 3 % of the total surface area.

The potential for isolated rockfalls, however, could result in a public safety risk where houses or infrastructure are located beneath large rock outcrops.

SLR (2025) has undertaken a Landslide Risk Assessment (Appendix A) for Appin Area 7 Longwalls 712 to 716 which describes the monitoring, response action, reporting and public safety for this aspect.

4.2.3 Other Impacts

Although mining is unlikely to significantly increase the risk of cliffs and steep slope instabilities, the cliffs in the area are already inherently unstable. Consequently there is the possibility that a rock fall associated with the cliffs may occur naturally during or following the period of mining.

Natural hazards and mechanisms have been identified as root jacking, tree growth, soil wash-out/erosion, and weathering of rock mass or defects. In a few cases, minor movement such as that induced by mining related non-systematic subsidence could potentially exacerbate or further develop existing hazards by the following mechanisms:

- Altering/steepening the centres of gravity of a dislocated block or boulders.
- Further tilting or steepening of blocks or boulders already at their angle of repose.
- Exacerbating basal crushing on weak seams.

4.3 Steep Slopes

4.3.1 Subsidence Predictions

The steep slopes within the Study Area have been identified along Razorback Range above the western ends of the proposed longwalls.

The maximum predicted total subsidence for the steep slopes along Razorback Range after the extraction of Longwalls 712 to 716, as determined by MSEC (2025) is provided in Table 6.

Table 6: Maximum Predicted Vertical Subsidence, Tilt and Curvatures for the Steep Slopes along Razorback Range after the Extraction of the proposed longwalls (MSEC, 2025)

Longwall	Maximum predicted total conventional subsidence (mm)	Maximum predicted total conventional tilt (mm/m)	Maximum predicted total curvature hogging curvature (km^{-1})	Maximum predicted total conventional sagging curvature (km^{-1})
Longwall 712	900	6.0	0.07	0.12
Longwall 713	1200	6.0	0.07	0.13
Longwall 714	1300	6.0	0.07	0.13

Longwall	Maximum predicted total conventional subsidence (mm)	Maximum predicted total conventional tilt (mm/m)	Maximum predicted total curvature hogging curvature (km^{-1})	Maximum predicted total conventional sagging curvature (km^{-1})
Longwall 715	1300	5.5	0.07	0.13
Longwall 716	1300	6.0	0.07	0.13

4.3.2 Environmental Consequences

Slopes and the alignments of the tributaries within the Study Area would be likely to remain stable during and after mining, and the chance of soil slippage is small (MSEC, 2009).

Past slope failures on the Razorback Range have typically occurred on the upper slopes well above any infrastructure. The visible flow paths and toe lobes do not, in all but a few cases, reach infrastructure which are generally confined to the foot-slopes.

There is extensive experience of mining beneath steep slopes in the Southern Coalfield. These include steep slopes along the Cataract, Nepean, Bargo and Georges Rivers. No large-scale slope failures have been observed along these slopes in the Southern Coalfield where longwalls have been mined directly beneath them. Although no large-scale slope failures have been observed in the Southern Coalfield, tension cracking has been observed at the tops and along the sides of steep slopes due to the increased horizontal movements in the downslope direction (MSEC, 2025).

The steep slopes are more likely to be impacted by the mining-induced curvatures and strains. The potential impacts would generally result from the increased horizontal movements in the downslope direction, causing tension cracks to appear at the tops and along the sides of the slopes and compression ridges to form at the bottoms of the slopes.

As the slopes along the Razorback range are steep, exhibit natural soil erosion and are predicted to experience the full range of predicted subsidence movements, it is likely that the extraction of the proposed longwalls would result in large surface cracks near the tops and along the sides of these slopes.

While in most cases, impacts on steep slopes are likely to consist of surface cracks, there remains a low probability of large-scale downslope movements. Experience indicates that the probability of mining induced large-scale slippages is extremely low due to the significant depth of cover within the Study Area.

Notwithstanding, slope instabilities, as well as surface cracking, have potential to impact public safety. Public safety is addressed in the Public Safety Management Plan. Other potential environmental consequences of slope instabilities may include impacts on stream water quality, flora and fauna or their habitats, and Aboriginal heritage sites. These potential environmental

consequences are addressed in the Water Management Plan, Biodiversity Management Plan and Heritage Management Plan.

If required, remediation works will be undertaken to ensure that mining-induced cracking does not result in significant soil erosion or an increase in water infiltration. In some cases, erosion protection measures may be needed, such as the planting of additional vegetation in order to stabilise the slopes in the longer term.

SLR (2025) conducted a landslide risk assessment for Longwall 712 to 716 Study Area which concludes that the necessary obligations under the BSOP Approval and DPE guidelines have been met to continue to support mining. Specifically:

- Landslide risk has been appropriately characterised in accordance with the Australian Geomechanics Society (AGS) 2007 guidelines.
- There is no evidence to suggest that mine subsidence will materially increase landslide risk beyond tolerable thresholds when managed with recommended mitigation measures.
- Monitoring and management measures are in place and functioning effectively.
- Recommendations made by the Independent Advisory Panel on Underground Mining (IAPUM) in regard to the Extraction Plan for Longwalls 709 to 711 and 905 have been incorporated (in the Landslide Risk Assessment) and will be used in the Land Management Plan.

Accordingly, SLR (2025) considers the Landslide Risk Assessment and this management plan provides a sound and defensible basis for the regulated continuation of longwall mining in Appin Area 7.

5. PERFORMANCE MEASURES AND INDICATORS

The BSO Approval provides subsidence impact performance measures (Condition 1, Schedule 3). Table 7 below details the conditions relevant to the general land surface, cliffs and steep slopes.

Performance indicators specific to each performance measure have been developed to judge the performance of, and guide the implementation of, the project or any management measures.

The term negligible is defined within the Project Approval as "s*mall and unimportant, such as not to be worth considering*" or as otherwise defined in Table 7 for cliffs of 'special significance' and those flanking the Nepean River.

Table 7 Subsidence Impact Performance Measures and indicators

Land	Performance Measure	Performance Indicators
Cliffs of 'Special Significance' (i.e. cliffs longer than 200 m and/or higher than 40 m; and cliff-like rock faces higher than 5 m that constitute waterfalls).	Negligible environmental consequences (that is occasional rock falls, displacement or dislodgement of boulders or slabs, or fracturing, that in total do not impact more than 0.5% of the total face area of such cliffs within any longwall mining domain)	Not applicable – There are no cliffs of 'special significance' identified in the Study Area.
Other cliffs flanking the Nepean River.	Negligible environmental consequences (that is occasional rock falls, displacement or dislodgement of boulders or slabs, or fracturing, that in total do not impact more than 0.5% of the total face area of such cliffs within any longwall mining domain).	Not applicable – Cliffs along the Nepean River are well outside the Study Area.
Other cliffs	Minor environmental consequences (that is occasional rock falls, displacement or dislodgement of boulders or slabs, or fracturing, that in total do not impact more than 3% of the total face area of	Mining results in more than minor environmental consequences (that is occasional rockfalls, displacement or dislodgment of boulders or slabs or fracturing, that in total impact more than 3% of the total face area of such cliffs within the Study Area)

	such cliffs within any longwall mining domain).	

As noted in Sections 4.2.2 and 4.3.2 the environmental consequences of rock falls, fracturing and other impacts may include consequences to other environmental components or systems such as groundwater, biodiversity or heritage. As such a range of other impact performance measures related to those environmental factors are applicable to this LMP, and are discussed in the relevant Management Plan.

In order to mitigate the potential subsidence impacts and environmental consequences from the mining of Longwalls 712 to 716, monitoring and recording will be undertaken prior to mining, throughout the extraction and at the completion of subsidence (refer Section 6).

In the event that any subsidence impact is recorded, consideration would be given to implementing appropriate management, remediation and/or mitigation measures in consultation with relevant stakeholders (refer Section 6.2) and where agreement of the landholder is provided.

If the subsidence impact performance measures are exceeded, ICHPL will notify the appropriate stakeholders and with agreement of the landholder, implement the Contingency Plan (Section 8).

6. MONITORING AND REPORTING

6.1 Monitoring Program

General landscape monitoring will be undertaken by ICHPL as a part of routine subsidence monitoring. This will include inspections of the land and monitoring subsidence movements for comparison with the predictions along selected survey lines. Specific monitoring for slope instability will be added to this program as required.

The monitoring is designed in consideration of surveys undertaken prior to mining, discussions with landholders and infrastructure owners as well as studies by SLR (2025). Monitoring will be undertaken on the Razorback Range and near steep slopes that may be susceptible to failure. Monitoring implemented on private property will be undertaken in consultation and with the agreement of the landowner.

The Landslide Risk Assessment (LRA), SLR (2025) appraised 207 properties that have been identified across the Study Area. The structures are identified by address and MGA co-ordinates in the spreadsheet tabulation presented in Appendix B of SLR (2025). The categorisation descriptions adopted for the structures are illustrated in Table 8.

Table 8: Category descriptors for properties by SLR (2025)

Category	Description
A	No apparent slope issue relevant to the house structure - not likely to require assessment for slope instability. (Not used in the SLR (2025) assessment).
B	Property, including house, has been assessed previously - may require brief walkover and review.
C	Sites over or close to areas already mined - not likely to require assessment since additional impacts unlikely to influence slope instability.
D	Sites over solid coal - not proposed for mining – not likely to require assessment as additional impacts unlikely to adversely influence slope instability.
E	Sites on gentle slopes (<15°) on isolated hills or ridges, but not close to the Razorback Escarpment slopes - Pre-mining condition assessment not likely to require landslide risk assessment (confirmed during pre-mining condition inspection)..
F	Sites close to the Razorback escarpment, or on or close to steep mid to lower slopes of the escarpment or steeply sloping ridges (>15°) forming the foot-slopes of the escarpment - these will be the sites further requiring detailed LRA.

Depending on the categorisation of each property, as determined by SLR (2025), slope monitoring will be undertaken as in 9 (in consultation with the landowner where necessary).

Table 9 – Cliff and Steep Slope Management

Priority	Monitoring Method
1 Moderate to High Risk	Detailed site investigation and site-specific LRA will be conducted prior to mining impacts to the property. Advanced planning and implementation of risk mitigation measures prior to and during mining influence period required to reduce the overall level of risk to a tolerable level. Any treatment measures required will be implemented prior to the first subsidence influence period.
2 Moderate Risk	Detailed, site-specific LRA will be conducted prior to mining impacts to the property. Planning and implementation of risk mitigation measures prior to and during mining influence period required to reduce the overall level of risk to 'As Low As Reasonably Practical' or ALARP.
3 Moderate – Previously Assessed	Site specific LRA already completed and assessed as 'Moderate' risk with additional risk mitigation measures already recommended and/or in place. For those LW710A, LW710B and LW711 properties, continue as per current management plan during LW711 and re-assess requirement for forward monitoring prior to commencement of the mining influence period for LW712. For those LW712 onwards properties assessed as part of this study – formalise LRA as part of pre-mining condition inspections.
4 Low – Confirm Rating	Existing assigned 'Low' relative risk to be during pre-mining condition inspections. Where confirmed as 'Low' risk, no site-specific landslide risk mitigation measures are expected to be required.
5 Low – Previously Assessed	Site specific LRA already completed and assessed as 'Low' risk with additional risk mitigation measures already recommended and/or in place. Continue as per current management plan during LW711 and re-assess requirement for forward monitoring prior to commencement of the mining influence period for LW712.

6 Very Low to Low	Assigned 'Very Low to Low' relative risk, where no site-specific landslide risk mitigation measures are expected to be required. Pre-mining condition inspections will be conducted prior to commencement of the mining influence period for LW712.

* Additional notes:

Undeveloped properties with steep slopes and historic landslides will be re-assessed if developed prior to their first subsidence influence period include: S06, S07, S08, S30.

Properties considered low and very low risk, but which have deeply incised creek lines running through property, will be assessed for localised stability during pre-mining condition inspections include: F34, F43, K04, K05, S13, S14, F36, F41, F45, F46, F55, F56, F57, S36.

The monitoring program will target those areas of sensitive terrain in close proximity to buildings or other infrastructure, identified as Category F and the cliffs identified in Table 4.

Sites and features which have been categorised as requiring further assessment in SLR (2025) are reviewed in detail and the findings of these assessments included in the PSMP. ICHPL contracts suitably qualified experts to undertake assessments to inform the PSMP for baseline assessment and monitoring throughout active subsidence. A summary of the assessments and management process which will be undertaken for the 72 houses identified as Category F in SLR (2025) is as follows (noting that 36 of the 72 properties are also Cat B, C, D or E or a combination of multiple categories):

- Structural Assessment - a pre-mining inspection of the property and any dwellings will be undertaken by a suitability qualified structural engineer. This report is used as a baseline for the condition of the property (including photographs) and to refer to during active subsidence and post active subsidence to determine if any impacts related to mining have occurred. The structural assessment will indicate if there are any opportunities to complete early structural works to the property to mitigate potential impacts and ensure the property remains safe and serviceable.
- Geotechnical Assessment - a pre-mining inspection of the property and any dwellings will be undertaken by a suitability qualified geotechnical engineer. The purpose of the assessment is to investigate slope risk and condition of existing ground surface features within the property boundary and to identify any existing hazards, as well as potential new hazards that may be created as a result of possible mining induced surface movement; including, subsidence influence, tilting impacts, strain, strength reduction of a slope profile, water concentration and regional landslide processes and mechanisms. A qualitative risk assessment will be undertaken to assess the potential risk of slope instability to the

property during the mining influence period. This is then used to assess acceptability and appropriate treatments and/or monitoring requirements for the identified slope hazards.

- Survey of ground and residence – a pre-mining high resolution 2D survey will be undertaken of the property and residence. Fixed survey marks are placed on the grounds and structures to capture a pre-mining baseline profile. During active subsidence and post mining, repeat surveys of the fixed marks will indicate the magnitude of subsidence experienced at the property. This will also inform the structural and geotechnical assessments.

In cases where monitoring is required to manage subsidence and landslide risk to features which may be impacted by subsidence, ICHPL will use the following monitoring methods (where landowner access is granted) to monitor and manage risks where appropriate:

- Routine visual structural and/or slope assessment as described above.
- Routine high resolution 2D survey as described above.
- Real time 3D Global Navigation Satellite System (GNSS) monitoring – GNSS units provide the absolute positions (vertical and horizontal) and are measured at regular intervals (nominally every 10 seconds) which are used to calculate four-hour running averages.
- Inclinometer monitoring - inclinometers are instruments for measuring relative horizontal displacements affecting the shape of a guide casing embedded in the ground or structure. Inclinometer probes usually measure displacement in two perpendicular planes; therefore, displacement magnitudes and directions (vectors) can be calculated.

The pre-mining assessments are used to inform and establish a specific set of monitoring triggers and management actions for each property. The monitoring data which is routinely collected is assessed by the ICHPL Structural Review Group to determine the trigger level and if additional monitoring, management or mitigation measures are required to keep properties safe and serviceable.

Note. On site activities will be undertaken as described above where access to the property is granted by the property owner/s.

Structures Management Plan

ICHPL has a Structures Management Plan for each active longwall at Appin Colliery. A Structures Management Plan will prepared for each successive longwall within the Study Area prior to the commencement of extraction of each longwall similar to what has previously been prepared for LW711. The objectives of the Management Plan will be to establish procedures to measure, control, mitigate and repair impacts that could occur to structures:

- ensure the safety and serviceability of all building structures and infrastructure. Public safety is paramount. Ensure that the health and safety of people who may be present in structures 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 conditions of the building structures and associated infrastructure during mining;
- establish procedures to measure, monitor, control, mitigate and repair building structures and associated infrastructure;
- initiate and coordinate action to mitigate or remedy potential impacts that are expected to occur to the building structures;
- provide a plan of action in the event that the impacts of mine subsidence are greater than those that are predicted;
- 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 the potential for injury or illness to a person or persons at the properties that may require emergency evacuation, entry restriction or suspension of work activities;
- provide a forum to report, discuss and record impacts to the surface. This will involve ICHPL, the affected landowner and/or resident, relevant government agencies and consultants, as required; and
- establish lines of communication and emergency contacts.

In addition, specific Management Plans also exist for significant infrastructure e.g., for public roads.

6.2 Reporting

ICHPL Structural Review Group (SRG)

As part of the Structures Management Plan and Built Features Management Plan (prepared for and appended to the LW712-716 Extraction Plan) the SRG meets regularly to review the results of all subsidence monitoring associated with the active longwalls at Appin Colliery, currently Longwall 711.

The SRG comprises representatives of the specialist consultants that inspect/measure/report on the monitoring. The SRG reviews the monitoring data in relation to all built features e.g., private property, public roads, as well as natural features (e.g., steep slopes and cliff lines). The SRG review and issue a weekly report to the Resource Regulator. The Resource Regulator maintains oversight of potential subsidence impacts through this process and maintains the authority under the *Mining Act 1992* to halt or stop mining if an impact, realized or predicted occurs. The weekly report reviews the progress of the longwall, the latest available monitoring data and the response to triggers due to movement or rainfall.

The BSO Approval provides subsidence impact performance measures (Condition 3, Schedule 3). In order to mitigate the potential subsidence impacts and environmental consequences from the mining of Longwalls 712 to 716; monitoring and recording will be undertaken prior to mining, throughout the extraction and at the completion of subsidence.

In the event a subsidence impact is recorded, consideration would be given to implementing appropriate management, remediation and/or mitigation measures in consultation with relevant stakeholders.

If the subsidence impact performance measures are exceeded, ICHPL will notify the appropriate stakeholders and implement the Contingency Plan as described in the Built Features Management Plan.

Monitoring results will also be presented and reviewed at the monthly ICHPL Subsidence Management Meeting. However, if the findings of monitoring are deemed to warrant an immediate response the Superintendent Infrastructure Protection will initiate the requirements of the Trigger Action Response Plan (TARP).

7. MANAGEMENT AND MITIGATION STRATEGIES

7.1 Properties in Areas of Sensitive Terrain

Sensitive terrain is defined as areas which may be sensitive to changes in slope conditions and are a reflection of existing conditions in combination with possible changes following longwall mining in the Study Area.

Monitoring, management and mitigation measures for properties that are located in areas of sensitive terrain will be undertaken where appropriate and in consultation and agreement with the landowner where required. These measures will be provided as part of the Structures Management Plan and PSMPs processes.

Mitigation of any subsidence cracks by infilling and re-profiling will be conducted where required with the approval of the landholder in any areas of high susceptibility (e.g. steep slopes) to minimise the ingress of water into the soil profile.

Where slope instability on areas of sensitive terrain is ongoing or increasing, or where a property exists on a hillside or close to a steep hillside, measures that may be implemented (where appropriate and identified as a requirement of a risk assessment) with the approval of the landholder to reduce the risk to property resulting from slope instability include:

- The installation of subsoil drains.
- Regrading of slopes and sealing of tension cracks in active landslides.
- Provision of surface water cut-off drains above potential landslides.
- Provision of shear piles through the slide zone.
- Improvements to vegetation including slashing of thick matted grass and planting of suitable trees.
- Removal or re-shaping of the soil slope to reduce loads within the sliding mass.
- Provision of toe support and associated drainage to support the soil mass depending on the scale of the landslide.
- Diverting overland flows around the slide area and providing localised drainage improvements e.g. repair leaking drains or re-direct drains that may discharge into landslide areas, or improvements to septic seep-away systems.
- Redirect stock where tracks are disturbing slope or creating flow paths in landslide areas.
- Restrict grazing in areas where slope instability is indicated by monitoring.

The implementation of management measures will be related to the scale of impacts and the ability for and value in undertaking mitigation measures on a case by case basis, as negotiated

with the landowner and described in the relevant PSMP. This means that management measures will be considered and implemented prior to the land performance measure being exceeded.

Management measures will be implemented, as appropriate, to comply with the relevant statutory requirements and the subsidence performance measures.

Under the NSW WHS legislation the mine proprietor is responsible for managing the safety of any landholders in the area of subsidence influence. This would include responding to and managing structural damages. Any financial costs incurred will be paid by ICHPL in accordance with the Coal Mines Subsidence Compensation Act 2017.

7.2 Nepean River Cliff Lines

The Nepean River cliff lines are located outside the Study Area and are at distances of more than 2 km from Longwall 712. The cliff line is not proposed to be monitored as part of this Extraction Plan.

7.3 Trigger Action Response Plans

The Land TARP for the Longwall 712 to 716 Study Area is shown as Table 9.

Detailed TARPs for individual properties will be developed (if required) during the PSMP process. Monitoring will be undertaken in consultation and with the agreement of the landowner where necessary.

Longwall 711 is currently being extracted in accordance with the Longwall 711 Structures Management Plan. The Structures Management Plan is a subordinate document that clearly references structures with quantitative triggers and commitments to defined corrective actions for each Longwall or series of Longwalls. The management plan is considered to be a "live" document which may be subject to changes by the ICHPL Structural Review Group to allow for decisive response in managing structures which are subject to subsidence influence to ensure they are safe and serviceable. The Resource Regulator maintains oversight of potential subsidence impacts through this process and maintains the authority under the *Mining Act 1992* to halt or stop mining if an impact, realised or predicted occurs.

Structures Management Plans will be developed and updated prior to the commencement of each longwall (or series of longwalls) included in the Extraction Plan application.

Table 9 Appin Area 7 Longwalls 712 to 716 LMP Trigger Action Response Plan

Performance Measure	Potential Impacts	Monitoring sites	Parameters	Monitoring Frequency	Reporting Trigger	Trigger Response
LANDSCAPE FEATURES						
Cliffs: Minor environmental consequences (that is occasional rock falls, displacement or dislodgement of boulders or slabs, or fracturing, that in total do not impact more than 3% of the total face area of such cliffs within any longwall mining domain).	Occasional rock falls, displacement or dislodgement of boulders or slabs, or soil fracturing.	**Cliffs and Steep Slopes** • Razorback Range Cliffs • Sensitive terrain near built features (Razorback Range) Monitoring locations on private properties to be determined as appropriate/required in consultation with landowner	Visual observations Comparisons with historical and pre-mining photos Lidar assessment	Monthly when mining is within 1km of cliff or steep slope Weekly when mining is within 200 m (leading up to) and 400 m (past) cliff or steep slope Post-mining	***Level 1**** • Rock fall from a single cliff where the cliff is left mostly intact (<10% length of any single cliff) • Surface movement or rock displacement where any exposed soil surface is stable • Crack at the surface which does not result in ongoing erosion or ground movement • Erosion which stabilises within the period of monitoring without CMA • Crack or fracture up to 100 mm width • Crack or fracture up to 10 m length	• Continue monitoring program • Submit an Impact Report to CPHR, DPHI and the Resources Regulator • Report in End of Panel Report • Summarise actions and monitoring in Annual Review
					Level 2* • Rock fall from single cliff where the characteristics of the cliff change (>10% length of any single cliff) • Ground disturbance that is unlikely to stabilise within the period of monitoring without CMA • Mass movement of a slope causing areas of exposed soil • Crack or fracture between 100 – 300 mm width • Crack or fracture between 10 – 50 m length	• *Actions as stated for Level 1* • Report trigger to key stakeholders • Review monitoring program • Notify relevant technical specialists and seek advice on any CMA required • Provide safety signage and barricades where appropriate in areas as required for public safety (refer PSMP) • Implement agreed CMAs as approved *Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. impacts to aquatic habitat with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts.*
					Level 3* • Rock fall or cliff collapse at a singular cliff (100% length of any single cliff but less than 3% of total cliff face area in the longwall mining domain) • Ground disturbance that does not stabilise within the period of monitoring	• *Actions as stated for Level 2* • Notify CPHR, DPHI and the Resources Regulator, relevant resource managers and technical specialists and seek advice on any CMA required. • Invite stakeholders for site visit • Develop site CMA (subject to stakeholder feedback) This may include: – Erosion prevention works

Performance Measure	Potential Impacts	Monitoring sites	Parameters	Monitoring Frequency	Reporting Trigger	Trigger Response
					• Mass movement of a slope causing areas of exposed soil that does not stabilise within the period of monitoring • Crack or fracture over 300 mm width • Crack or fracture over 50 m length	– Establishment of vegetation • Completion of works following approvals, including monitoring and reporting on success • Review the TARP and Management Plan in consultation with key stakeholders *Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. impacts to aquatic habitat with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts.*
					Performance Indicator • Cliffs – mining results in more than minor environmental consequences (that is rockfalls, displacement or dislodgment of boulders or slabs or fracturing, that in total impact more than 3% of the total face area of such cliffs within any longwall mining domain).	• *Actions stated for Level 3* • Make area safe • Investigate reasons for exceedance • Update future predictions based on the outcomes of the investigation • Provide environmental offset if CMAs are unsuccessful

* These may be revised in consultation with DPE and other key stakeholders following analysis of natural variability within the pre-mining baseline data.

Note: The NSW Development Coordination Authority (DCA) was established on 1 July 2026 and centralises several NSW Agencies in responses to development applications and post-approval matters. Where agencies that are included within DCA have been listed as stakeholders (or are required to be notified under a TARP trigger response) notifications and impact reports will be provided to the DCA.

8. CONTINGENCY RESPONSE PLAN

In the event the Subsidence Performance Measures detailed in Section 5 of this LMP are considered to have been exceeded, or are likely to be exceeded, ICHPL will implement a Contingency Plan to manage any unpredicted impacts and their consequences.

This would generally involve:

- Capture photographic record.
- Notify relevant stakeholders soon as practicable.
- Notify relevant agencies and specialists soon as practicable.
- Offer site visits with stakeholders.
- Contract specialists to investigate and report on changes identified.
- Provide incident report to relevant agencies.
- Establish weekly monitoring frequency where appropriate until stabilised.
- Updates from specialists on investigation process.
- Inform relevant agencies and stakeholders of results of investigation.
- Develop site CMA in consultation with key stakeholders if required, (pending stakeholder availability) and seek approvals.
- Implement CMA as agreed with stakeholders following approvals.
- Conduct initial follow up monitoring and reporting of CMA completion.
- Review Management Plan.
- Report in regular reporting and Annual Review.

ICHPL will consult with appropriate specialists, landholders and relevant agencies in order to devise an appropriate response in respect to any identified exceedance.

The development and implementation of contingency measures will be specifically designed to address the circumstances of the exceedance and assessment of environmental consequences.

If the contingency measures implemented by ICHPL fail to remediate the impact or the Secretary determines that it is not reasonable or feasible to remediate the impact, ICHPL will provide a suitable offset to compensate for the impact to the satisfaction of the Secretary in accordance with the BSO Approval Conditions 2 and 4, Schedule 3.

9. COMPLAINTS AND COMPLIANCE MANAGEMENT

9.1 Incidents

An incident is defined in the BSO Approval as "An occurrence or set of circumstances that causes, or threatens to cause, material harm to the environment, and as a consequence of that environmental harm, may cause harm to the safety of human beings, and which may or may not be or cause a non-compliance".

The reporting of incidents will be conducted in accordance with Condition 7, Schedule 6 of the BSO Approval. ICHPL will notify the Secretary of the DPHI via the NSW Planning Portal and any other relevant agencies of any incident associated with the BSO within 24 hours after ICHPL becomes aware of the incident. Within seven days of the date of the incident, ICHPL will provide the Secretary of the DPHI and relevant agencies with a detailed report on the incident.

An Incident Report will be prepared in accordance with Appendix 7 (3) of the BSO Approval and will:

- identify how the incident was detected;
- identify when ICHPL became aware of the incident;
- identify any actual or potential non-compliance with conditions of consent;
- details on the nature of the incident (including survey results, photographs and date of the incident);
- results of investigation(s) to identify/evaluate the contributing factors to and the cause of the incident;
- proposed course of action (including proposed timeline for implementation of corrective and preventative actions to address the incident and prevent recurrence) and development of contingency measures;
- details of any communication with other stakeholders regarding the incident; and
- relevant ICHPL contact details to obtain further information on the incident.

9.2 Complaints and Dispute Resolution

ICHPL has a readily accessible contact point through a 24-hour toll-free Community Call Line (1800 102 210) and email address (community@gm3.au). The number is displayed on the GM^3 website, prominently on ICHPL Projects and Mine sites in a position visible by the public as well as on publications, letters and other correspondence provided to the local community. The call line is for all complaints and general enquiries regarding environmental or community issues associated with ICHPL operations.

Community complaints and enquiries may also be received in person by any employee of ICHPL, with details to be immediately shared with the Community Team for investigation. All complaints received in relation to Dendrobium Mine will be managed in accordance with the Handling Community Complaints, Enquiries and Disputes Procedure.

Upon receipt of a community complaint, preliminary investigations will commence as soon as practicable to determine the likely cause of the complaint. An initial response will be provided to the complainant within 24 hours of the complaint being made, with a follow up response being provided as soon as practicable once a more detailed investigation is complete.

A summary of all complaints received during the reporting year will be provided as part of the Annual Review. A log of complaints is also maintained on the GM^3 website.

9.3 Non-Compliance, Corrective Action and Preventative Action

Non-compliances will be notified and reported in accordance with Condition 7A of Schedule 6 of the BSO Approval. ICHPL will notify the DPHI in writing via the NSW Planning Portal and will include the following information:

- the development including the development application number and name;
- the condition of consent that the development is non-compliant with and why it does not comply;
- the reasons for the non-compliance (if known);
- what actions have been undertaken or will be undertaken to address the non-compliance.

The BSO Approval states that "a non-compliance which has been notified as an incident does not need to also be notified as a non-compliance".

10. PLAN ADMINISTRATION

This LMP will be administered in accordance with the requirements of the Appin Mine Environmental Management Strategy (EMS) and the BSO Approval Conditions. A summary of the administrative requirements is provided below.

10.1 Roles and Responsibilities

Statutory obligations applicable to this Plan are identified and managed via an online compliance management system (TICKIT).

The overall responsibility for the implementation of this LMP resides with the Manager Approvals who is the LMP's authorising officer.

Parties responsible for environmental management in AA7 and the implementation of the LMP include:

Director Sustainability and Government

- Ensure that the requisite personnel and equipment are provided to enable this LMP to be implemented effectively.
- Authorise the LMP and any amendments thereto.

Principal Approvals

- Delegate to an appropriately qualified person the responsibility to document any changes to the LMP, recognising the potential for those changes to affect other aspects of the LMP.
- Provide regular updates to ICHPL on the results of the LMP.
- Arrange information forums for key stakeholders as required.
- Prepare any report in accordance with the LMP. Maintain records required by the LMP.
- Organise and participate in assessment meetings called to review mining impacts.
- Within 24 hours, respond to any queries or complaints made by members of the public in relation to aspects of this LMP.
- Organise audits and reviews of the LMP.
- Address any identified non-conformances, assess improvement ideas submitted and implement if considered appropriate.
- Arrange for the implementation of any agreed actions. Responses or remedial measures.
- Ensure surveys required by this LMP are conducted and record details of instances where circumstances prevent these from taking place.

Coordinator Environment

- Instruct suitable person(s) in the required standards for inspections, recording and reporting and be satisfied that these standards are maintained.
- Investigate significant subsidence impacts.
- Identify and report any non-conformances with the LMP.
- Participate in any other assessment meetings called to review subsidence impacts in the area affected by mining.

Survey Coordinator

- Collate survey data and present in an acceptable form for review at assessment meetings.
- Bring to the attention of the Principal Approvals any findings indicating an immediate response may be warranted.
- Bring to the attention of the Principal Approvals any non-conformances identified with the Plan provisions or ideas aimed at improving the LMP.

Structures Response Group

The Structures Response Group (SRG) is responsible for taking the necessary actions required to manage the risks that are identified from monitoring of structures. The SRG's key members are:

- GM3;
- Mine Subsidence Engineering Consultants;
- Inglis Engineering; and
- SLR.

Technical Experts

- Conduct the roles assigned to them in a competent and timely manner to the satisfaction of the Principal Approvals and formally provide expert opinion as requested.
- Person(s) Performing Inspections
- Formally bring to the attention of the Coordinator Environment any nonconformances identified with the Plan, or ideas aimed at improving the Plan.
- Conduct inspections in a safe manner.

10.2 Resources Required

The Director Sustainability and Government provides resources sufficient to support this LMP.

Equipment may be needed for the TARPs provisions of this LMP. Where this equipment is of a specialised nature, it will be provided by the supplier of the relevant service. All equipment is to be appropriately maintained, calibrated and serviced as required in operation manuals.

It is the responsibility of the Manager Approvals to ensure that personnel and equipment are provided as required to allow the provisions of this Plan to be implemented.

10.3 Training

All staff and contractors working on ICHPL sites are required to complete the ICHPL training program which includes:

- An initial site induction (including all relevant aspects of environment, safety and community).
- Safe Work Methods Statements and Job Safety Analyses, Toolbox Talks and Preshift communications.
- On-going job specific training and re-training (where required).

All training records are maintained by the ICHPL Training Department.

It is the responsibility of the Manager Approvals to ensure that all persons and organisations having responsibilities under this Plan are trained and understand their responsibilities.

The person(s) performing regular inspections will be under the supervision of the Coordinator Environment and be trained in observation and reporting. The Coordinator Environment will be satisfied that the person(s) performing the inspections are capable of meeting and maintaining this standard.

10.4 Review and Update

In accordance with Condition 5 of Schedule 6 of the BSO Approval, the Extraction Plan will be reviewed, and if necessary revised, within three months, of:

- the submission of an Annual Review;
- the submission of an incident report;
- the submission of an Independent Environmental Audit report; or
- any modification to the conditions of the BSO Approval (unless the conditions require otherwise).

If significant deficiencies in this Plan are identified in the interim period, the plans will be modified as required. This process has been designed to ensure that environmental documentation continues to meet current environmental requirements, including changes in technology and operational practice, and expectations of stakeholders.

11. REFERENCES

BHPBIC, 2009. Major Cliff Line Assessment, Bulli Seam Operation Environmental Assessment. Appendix R.

Coffey Geotechnics, 2013. Landslide Risk Assessment from Mine Subsidence Effects - Appin Area 9 Proposed Longwalls, Razorback Range, Douglas Park, NSW. Report prepared for BHP Billiton Illawarra Coal.

Mine Subsidence Engineering Consultants, 2009, *Bulli Seam Operations Subsidence Assessment*. Report for BHP Billiton Illawarra Coal.

MSEC 2025, Appin Longwalls 712 to 716: Subsidence Predictions and Impact Assessments for the Natural and Built Features due to the Extraction of the Proposed Longwalls 712 to 716 at Appin Colliery. Report Number MSEC1459, July 2025.

SLR (2025). Appin Area 7 Longwalls 712 to 716 Landslide Risk Assessment. Report for Illawarra Coal Holdings Pty Ltd – GM3, August 2025.

12. APPENDICES

Appendix A- SLR, 2025. Appin Area 7 Appin Area 7 Longwalls 712 to 716 Landslide Risk Assessment

Appin Area 7 Longwalls 712 to 716 Landslide Risk Assessment

Illawarra Coal Holdings Pty Ltd – GM[3]

Prepared by:

SLR Consulting Australia Pty Ltd

SLR Project No.: 660.030515.00001

1 August 2025

Revision: 2.0

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
2.0	23 July 2025	Anthony Rayner	Chris Meikle	Chris Meikle
2.0	1 August 2025	Anthony Rayner	Chris Meikle	Chris Meikle

Basis of Report

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Illawarra Coal Holdings Pty Ltd – GM3 (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

Executive Summary

Project Overview

SLR Consulting Australia Pty Ltd has been engaged by GM3 (Illawarra Coal Holdings Pty Ltd) to undertake a preliminary Landslide Risk Assessment (LRA) in support of the Extraction Plan for Appin Area 7, Longwalls (LW) 712 to 716. The assessment aligns with regulatory requirements, including Schedule 3 Condition 5 of the Bulli Seam Operations Project (BSOP) Approval and the 2022 NSW DPE Extraction Plan Guidelines.

SLR has categorised over 200 properties in the Study Area using a tiered risk profiling approach aligned with Australian Geomechanics Society (AGS) 2007 guidelines. Out of these, 21 detailed site-specific LRA assessments have been completed to date, providing sufficient confidence to conclude that residual landslide risk across the area remains within acceptable or tolerable levels.

Key Observations

- **Steep Slopes and Razorback Escarpment** - The most significant geomorphological features within the Study Area are the steep slopes and cliff lines of the Razorback Escarpment. These areas show evidence of historical landslides and are inherently susceptible to natural slope instability, primarily driven by pore pressure rise due to high antecedent rainfall, triggered by heavy rainfall events.
- **Subsidence Predictions** - The predicted subsidence effects from the proposed longwalls fall within the range of outcomes previously experienced in earlier Area 7 and 9 longwalls, with maximum vertical movement estimated at 1,450 mm and horizontal strains remaining below established risk thresholds. Observed subsidence during extraction of LW905 and LW710A showed that measured ground movements were gradual, consistent with predictions, and did not exceed management trigger levels in most cases.
- **Mine-Induced Groundwater Changes** - Localised responses to mining (e.g., groundwater fluctuations in piezometer S2533) have been observed. However, these responses are consistent with mechanisms described in previous assessments and are expected to be manageable within the existing risk mitigation framework.
- **Observed Landslides** - Several landslides were recorded during active mining periods, but all were assessed to be triggered by extreme rainfall events associated with the 2020–2022 La Niña cycle rather than directly caused by mine subsidence.
- **Monitoring and Ground Truthing** - A total of 21 site-specific LRA assessments have been completed, and site inspections at over 70 properties confirm consistency between desktop predictions and observed field conditions. Through a combination of desktop analysis, field inspection of key properties, and review of extensive historical monitoring data, SLR was able to characterise the dominant landslide mechanisms across the Study Area. These included rock topples from cliff lines, rotational and translational slides, debris flows, and slow-moving soil creep - all processes are well understood and consistent with prior assessments in the region.
- **Risk Assessment Results** - The majority of properties within the Study Area fall within acceptable or tolerable risk categories under AGS (2007) guidelines. Risk levels at isolated high risk locations are considered manageable to within tolerable levels with appropriate risk mitigation.

Recommendations

- **Ongoing Monitoring** - Continue the current GNSS and vibrating wire piezometer monitoring program. Expand monitoring in key areas where mining-induced impacts or groundwater responses may present elevated risk.
- **Pre-Mining Inspections** - Complete site-specific LRA assessments at remaining high-susceptibility properties (particularly Priority 1 and 2 sites as highlighted in **Table 9**) prior to the commencement of mining for each longwall.
- **Trigger Action Response Plans (TARPs)** - Update TARPs within the Land Management Plan to include quantitative thresholds for observed movements, rainfall, or groundwater changes. Ensure clear responsibilities for corrective actions.
- **Community Engagement** - Maintain a transparent communication strategy with property owners in the Study Area, especially those on or near steep slopes, to manage expectations and share monitoring outcomes.
- **Groundwater Response Evaluation**: Further evaluate potential mining-induced groundwater flow paths, especially where cracking may influence pore pressures. Adjust management actions accordingly.

Compliance with Extraction Plan Obligations

The assessment concludes that the current Extraction Plan for LW712 to LW716 meets the necessary obligations under the BSOP Approval and DPE guidelines to support continued mining. Specifically:

- Landslide risk has been appropriately characterised in accordance with the Australian Geomechanics Society (AGS) 2007 guidelines.
- There is no evidence to suggest that mine subsidence will materially increase landslide risk beyond tolerable thresholds when managed with recommended mitigation measures.
- Monitoring and management systems are in place and functioning effectively.
- Recommendations made by the Independent Advisory Panel on Underground Mining (IAPUM) have been incorporated and will be used in the Land Management Plan.

Accordingly, SLR consider the Extraction Plan provides a sound and defensible basis for the regulated continuation of longwall mining in Appin Area 7.

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1.0 Introduction

Illawarra Coal Holdings Pty Ltd - GM^3 (GM^3) are in the process of developing the Extraction Plan for Appin Area 7, Longwalls 712 to 716 (LW712 to LW716) to demonstrate their proposed management, mitigation, monitoring and reporting of potential subsidence impacts and environmental consequences during extraction.

A key aspect of the Extraction Plan includes development of a Land Management Plan, which is "*prepared in consultation with any affected public authorities, to manage the potential impacts and/or environmental consequences of the proposed second workings on land in general, with a specific focus on cliffs and steep slopes*" (1).

GM^3 has engaged SLR Consulting Australia Pty Ltd (SLR) to undertake a preliminary landslide risk assessment (LRA), and to assess the landslide risks, identify site susceptibility and potential impacts of mine subsidence to residential properties located above, below and on 'steep slopes' within the Study Area.

The LRA is to be prepared in line with the NSW Department of Planning and Environment's Extraction Plan Guideline, 2022 (2) and Schedule 3 Condition 5 of the Bulli Seam Operations Project (BSOP) Approval 08_0150 (3).

1.1 Background

GM^3 (previously Illawarra Metallurgical Coal, or IMC, a subsidiary of South32) has extensive experience in mining beneath residences and associated structures at Appin Mine. It has developed and acted in accordance with risk management plans to manage potential impacts to residential and associated structures during the mining of LW701 to LW710B and LW901 to LW905.

The most recent approved Extraction Plan, prepared by IMC was for LW709 to LW711 and LW905, which included a LRA relating to mine subsidence influences for that Study Area, prepared by GHD in July 2021 (4).

In the GHD 2021 report, it is highlighted that "*in regard to landslide risk assessment, the then NSW Department of Primary Industries - Mineral Resources, through their Principal Subsidence Engineer, has previously nominated the following minimum requirements, and it is assumed that their application remains, requiring:*

1 *An assessment of risks of slope instability that may affect any dwellings and/or other building structures located in the sloping area, primarily those along the watercourses within the SMP [Subsidence Management Plan] Application Area. Such structures to be assessed should be limited to those which may be affected by subsidence arising from the proposed extraction of Longwall Panels. In other words, the specific geotechnical investigation should be undertaken taking into full consideration the predicted subsidence movements.*

2 *A recommendation of adequate prevention, mitigation and/or remediation or any other relevant management measure that need to be implemented prior to, during and/or post the proposed longwall mining, where applicable and appropriate, to ensure the safety and serviceability of the dwellings/buildings within the above specified Study Areas."*

An assessment of the risk of slope instability for dwellings and other building structures located in identified "steep slope" areas within the application area, is therefore required, along with determination of appropriate risk mitigation measures.

The definition of a 'steep slope' provided by the BSOP Approval is land having a steeper gradient than 3H:1V (33% or 18º relative to horizontal), with surface landforms previously

identified as being potentially prone to instability as a result of the proposed underground mining the focus of previous landslide risk assessments.

2.0 Scope of Assessment

To assist GM[3] with the above-mentioned project objectives, SLR has undertaken the following:

Desktop Review

- Undertaken a desktop review of pertinent background information, including but not limited to:
  - Previous Extraction Plan submission documents and IAPUM and SANSW feedback, LRA reports and slope stability analysis.
  - Regional geology, geological setting and mapped geological structures.
  - Background monitoring data including relevant GNSS unit performance, ground survey monitoring data from LW709, LW710A, LW710B and LW905 and vibrating wire piezometers within the vicinity of the Study Area.
- Compiled spatial data (both publicly available and data provided by GM[3]) into a suite of figures to aid in the LRA, including but not limited to:
  - Study Area layout displaying surface contours, aerial imagery, mine plans, property references and residential structures.
  - Geomorphological plans showing shaded relief, slope inclination analysis, landslide mapping, mine plans and properties and infrastructure as well as other pertinent features over the Study Area.
- Identification of the likely landslide hazards, mechanisms and geomorphic processes within the Study Area and considered how these mechanisms may be influenced by mine subsidence effects.
- Conducted an initial appraisal to determine areas of interest (AOI's) and develop a plan for targeted site inspections.

Site Inspections and Ground Truthing

- Undertaken visual inspections over the Study Area, to ground truth the understanding derived from the desktop review. This included:
  - Drive around full Study Area, with general mapping and observation carried out wherever possible.
    - Conducted inspections at seven (7) AOI's to ground truth the presence of cliff lines, confirmation of landslide hazard mechanisms, evidence and frequency of rock falls, extent and activity of existing landslides.

Landslide Risk Assessment and Reporting

- Compiled a concise summary of the desktop review and project background.
- Presented reference figures including landslide susceptibility mapping.
- Presented findings from the site inspections and ground truthing.
- Characterised landslide hazards, mechanisms and determine how these mechanisms may be influenced by mine subsidence effects.
- Presented an appraisal of landslide distribution and characterise steep slope susceptibility to landsliding within the Study Area.

- Categorised each property in regard to the inferred geomorphic and potential landslide setting, known site features from previous site visits and previous reporting in terms of instability and hazard identification, the extent of previous and proposed future underground mining.
- Undertaken a landslide risk assessment for the seven (7) AOI's in general accordance with the Australian Geomechanics Society Guidelines for Landslide Risk Management (2007), including but not limited to:
    - Providing a clear explanation on the methodology used in the assessment.
    - Consideration of desktop review findings.
    - Field observations.
    - Geological type sections and identification of landslide hazards, mechanisms and relevant slope forming processes.
    - Considered expected groundwater response, including range of effects associated with modification of groundwater due to mining induced subsidence, including:
        - Captured baseline observations from site inspections and vibrating wire piezometers.
        - Changes to groundwater induced by extreme wet weather events i.e., using records and observations from the previous 2020-2022 La Nina events which coincided with recent Longwall mining
- Profile the properties within the wider Study Area in terms of relative risk, with the aim of identifying residential properties and infrastructure which should be subjected to a site-specific detailed landslide risk assessment which would include determination of appropriate risk mitigation measures for during the mining influence period.
- Provided recommendations for developing and expanding on the existing monitoring program.
- Provided recommendations regarding typical corrective management actions.
- Compiled the above findings and recommendations into a report (this report) for inclusion in the Land Management Plan.

3.0 Desktop Review

3.1 Available Data

The key data sources provided by GM[3] to inform this desktop review included:

- 2022 detailed LiDAR over the Study Area.
- Aerial imagery from previous 5 years.
- Subsidence predictions contours, property refences, mapped infrastructure layers over Study Area (from MSEC 2025 (5)).
- Background monitoring data e.g., Global Navigation Satellite System (GNSS) units, ground survey, vibrating wire piezometers.
- Geology data.
- Other pertinent background information including previous LRA reports (Coffey, GHD), previous extraction plan documents and associated IAPUM advice.

Publicly available resources utilised included:

- ELVIS 1m contour data from 2019[1].
- Aerial imagery accessed via Nearmap[2].
- Regional geological maps accessed via MinView[3].
- Technical papers and reports referenced in **Section 16**.

3.2 GHD 2021 LRA LW709 to LW711 and LW905

GHD completed a desktop LRA relating to mine subsidence influences to determine the distribution of landslide hazards within the LW709 to LW711 and LW905 for Appin Colliery in 2021 (4).

The study was based upon information provided by Mine Subsidence Engineering Consultants (MSEC 2021 (6)) in the development of the subsidence predictions and impact assessment for the natural and built features across the Study Area. In addition, previous assessments conducted in the Study Area were made available to assist the study. That data was combined with published publicly available information and base maps provided by ICHPL.

A street level ‘drive-by’ assessment was conducted across the Study Area as a first-pass appraisal of landslide hazards. Using the available data and preliminary observations, the residential sites identified as being within ‘steep slope’ terrain were categorised to develop a way-forward in appraisal of the existing landslide hazards, site susceptibility and potential impact of mine subsidence upon the existing landslide risk levels.

[1] https://elevation.fsdf.org.au/

[2] https://apps.nearmap.com/maps/#/kRxLBDywQBy8DFZixLopDg/@-34.1751042,150.6764601,13.00z,11d/V/20231022

[3] https://minview.geoscience.nsw.gov.au/#/?lon=148.5&lat=-32.5&z=7&l=

The first pass landslide categorisation was included on the basis of the below categories (from GHD, 2021):

Table 4.2: Category descriptors for table in Appendix B

Category	Description
Cat A	No apparent slope issue relevant to the house structure - not likely to require assessment for slope instability.
Cat B	Property, including house, has been assessed previously - may require brief walkover and review.
Cat C	Sites over or close to areas already mined - not likely to require assessment since additional impacts unlikely to influence slope instability.
Cat D	Sites over solid coal - not proposed for mining – not likely to require assessment as additional impacts unlikely to adversely influence slope instability.
Cat E	Sites on gentle slopes on isolated hills or ridges or close to watercourse gullies, but not close to the Razorback Escarpment slopes - likely to require viewing (possibly brief in best circumstances), as whole of site could not be viewed clearly from roadway.
Cat F	Sites close to the Razorback escarpment, or on or close to steep mid to lower slopes of the escarpment or steeply sloping ridges forming the foot-slopes of the escarpment - these will be the sites requiring detailed LRM assessment.
Cat G	Sites for which LRM recently (2020) conducted.

Which ultimately, resulted in the following categorisation (from GHD, 2021):

Table 4.3: Distribution of categorisation from first-pass desktop appraisal.

	Cat A	Cat B	Cat C	Cat D	Cat E	Cat F	Cat G	Sum
Category totals	12	15	18	13	34	11	9	**112**
Brief site visit required to confirm setting	10	12	11	11	33	0	0	**77**
Category adopted as stands	2	3	7	2	1	11	9	**35**

Notes:
1) Indicated requirement for site visit is subject to having approval to visit the site by way of access granted by the owner / occupier
2) "Brief" site visit is to confirm site setting and category as not visible from roadway. Expect short visit, and not likely to require access into dwelling. Likely could be conducted without owner/occupier being present. Outcome may require additional detailed LRM assessment, as inferred site conditions dictate.
3) Comprehensive LRM assessment (Cat F, and possibly some Cat E) would benefit from being conducted in the presence of owner/occupier to enhance knowledge of site history, dwelling foundation system, and site history.

It was concluded that mine subsidence may create a minor increase in the likelihood of instability within soil slopes, existing landslides or existing debris flows, noting that "*in the risk assessment of the landslide hazards, the likelihood may be increased to a minor extent, but the consequences of landslides, should they occur, would remain unchanged*".

The phenomenon of valley closure could produce surface cracking of slopes which may require remediation. The phenomenon of valley closure, and tilting due to mine subsidence, will have a more severe adverse impact, particularly upon rockfaces. To this end MSEC (5) provided a statistical appraisal of the likelihood of such instability.

The results of the preliminary investigations of structures located upon 'steep slopes', reported in the study and within the limitations of the study, indicated that landslide hazards induced by longwall mining should be amenable to effective management using the established methodologies.

Pragmatically, the expectation was that the residential sites that require additional appraisals (to confirm their categorisation) and detailed LRA's should be conducted on a longwall-by-longwall basis for each longwall across the Study Area. Therefore, the hazards were managed through each subordinate longwall's Structures Management Plan.

3.3 IAPUM Advice on LW709 to LW711 and LW905 Extraction Plan

In their report of 4 March 2022, the Independent Advisory Panel for Underground Mining (IAPUM) advised that the NSW Department of Planning and Environment (DPE) had requested advice be provided in relation to the Appin Area 7 and Area 9 Extraction Plan (EP). Specifically, it was reported that NSW DPE requested advice on:

- *The reliability of the damage predictions outlined in MSEC's Subsidence Assessment for houses on top of the Razorback Escarpment and within 25 m of steep slopes in the EP Study Area."* (Note - topic not covered in detail herein).
- *The adequacy of GHD's Landslide Risk Assessment to assess the landslide risks, site susceptibility and potential impact of mine subsidence with no supporting field-based geotechnical assessments at the potentially impacted houses," and*
- *The appropriateness of IMC's proposed monitoring for the management of mine subsidence and slope instability for houses and its additional commitment to undertake geotechnical assessments at potentially impacted residences prior to the extraction of the first influencing longwall.* (Note that the issues refer to residential dwellings only).

Specifically in relation to subsidence consequences for slope stability, the panel concluded:

- *Mining-induced changes in the slope (i.e. local gradients) of hillsides are very unlikely to change the risk profile for land instability.*
- *Mining-induced rockfalls from the Escarpment are very unlikely to present a risk to structures. This should be confirmed for each structure prior to mining of the relevant panel(s).*
- *A very low (but finite) likelihood of irreversible damage to structures cannot be excluded. On this basis, the costs of responding to such damage should be specifically addressed in the Landscape Management Plan (LMP).*
- *Traditional monitoring may not provide forewarning of damage to structures as points monitored are not likely to coincide with locations of damage (both being quite local). It is usual for the structures themselves to provide the best leading indicator of consequential damage. On this basis, the Panel considers that detailed dilapidation surveys are essential for detecting early warning indicators such that the LMP Trigger*

Action Response Plan (TARP) responds in a timely manner, including keeping inhabitants informed.

The Panel subsequently recommended:

- GHD:
  - *Complete the last three objectives of its Landslide Risk Assessment (LRA) as set out in Section 2.3 of its (2021) report.*
  - *Provides advice on the expected range of effects associated with modification of groundwater due to mining-induced subsidence and how these effects can be mitigated.*
- The EP be refined to include the following:
  - *Reconciliation of the number of potentially affected properties.*
  - *Provision in management plans, if need be, for any new significant matters arising out of the completion by GHD of the last three objectives of its LRA and arising out of its advice on the expected range of effects associated with modification of groundwater due to mining-induced subsidence and how these effects may be mitigated.*
  - *A statement clearly identifying the limitations of the GHD LRA being a desktop, first pass and/or preliminary assessment and, therefore, the degree of reliance that can be placed upon it.*
  - *Provision for undertaking site inspections (ground truthing) prior to the commencement of mining in the subject area of at least some of the Category E and Category F structures possibly affected by longwall mining in the EP. This is for the purpose of providing a level of confidence in GHD's preliminary assessments and the appropriateness of the associated advice provided on the likelihood and magnitude of damage, especially irreversible damage, and proposed triggers and corrective actions.*
  - *Identification by GHD of "the techniques and management tools available and previously employed in similar geotechnical circumstances" referred to in its LRA, where each has been adopted, why it was adopted and how successful it was.*
  - *A commitment to the installation of any piezometers or inclinometers, including documented past usage and effectiveness and clear triggers for when and where these would be installed.*
  - *Revision of the LMP TARP to clearly reference structures with quantitative triggers and commitments to defined corrective actions.*
  - *Clarification in the LMP on accountability for the costs of responding to structural damage.*

Specifically in relation to appropriateness of monitoring and management of mine subsidence and slope instability, the panel concluded:

- *It is reasonable to expect that the EP will satisfactorily address the monitoring of the management of mine subsidence and slope instability provided that:*
  - *Associated PSMPs are developed in a timely manner to at the least the standard evidenced in the documentation provided to the Panel under covering letter of 8 June 2020;*
  - *Due consideration is given to the Panel's recommendations in relation to the EP; and*

- *The IMC Structural Review Group, established as part of the Built Structures Management Plan, meets regularly to review all results of subsidence monitoring.*

GHD subsequently responded to Approval Condition 2 in their response letters dated 29 September 2022 (LW905), 8 September 2023 (LW710A) and 30 April 2024 (LW710B) on a longwall-by-longwall basis, clarifying that dot point one and two of Condition 2 were satisfied in Section 6, “Risk Control Procedures” of the “Management Plan for Potential Impacts to Building Structures” developed for LW905 (6) and for LW710A and LW710B (7) by MSEC. GHD’s response for LW711 was provided on 26 March 2025, with further information provided on 21 May 2025 and 4 June 2025, with Condition approval received on 17 June 2025.

The third dot point, “*assess cumulative effects*” is completed in the respective reports above for properties identified as requiring site-specific structure inspection plans, whereby the cumulative hazards that should be acknowledged in the assessments contained within the individual PSMPs are highlighted.

Under Condition 3, DPE requires advice to be provided before extraction of LW711, recognising the work involved with the task. To address this condition, a GHD report supplemental to their 2021 LRA (4) has been prepared (8), which was submitted on 18 June 2024, and approved on 17 June 2025.

4.0 Study Area Setting

The Study Area has been defined in MSEC1459 Report (9), as the surface area enclosed by the 35° angle of draw line from the extents of the proposed LW712 to LW716; and the predicted additional 20 mm subsidence contour due to the extraction of the proposed longwalls. The Study Area therefore covers the already competed LW710A and LW710B and soon to commence LW711 footprints.

Razorback Escarpment is the dominant topographic feature within the Study Area, with a defined Escarpment separating the upper plateau from the lower east and north facing slopes. The elevation across the Study Area falls from approximately 320 m above sea level in the south (atop Razorback Escarpment) to approximately 100 m above sea level in the northeast.

A large portion of the Study Area includes the steep, forested east facing slopes and gullies which form the western tributaries of Navigation Creek. These slopes become flatter to the east where they are mostly occupied with agricultural land and lifestyle blocks. Navigation Creek flows in a northerly direction through the eastern portion of the Study Area, where the surrounding slopes in the catchment floor are very shallow and gently undulating to essentially flat, except for the incised creek banks themselves.

West of the Escarpment, the upper plateau slopes gently to the west, which drains out to the west through the Apps Gully catchment, while the northwest corner of the Study Area is characterised by the steep north facing slopes in the headwaters of Matahil Creek.

Generally, the steep slopes below the Escarpment, in the headwaters of drainage gullies and along creek banks are covered in dense forest and scrub. Elsewhere, most lower slopes are mostly grassed with concentrations of larger trees typically found along fence lines, roads and driveways and surrounding residential dwellings.

The layout of proposed LW712 to LW716 is shown on **Figure 1**, which display's the Study Area layout, surface contours, aerial imagery, mine plans, property references and residential structures.

Additionally, SLR has processed the 2022 LiDAR survey provided by GM[3], to create a shaded relief (**Figure 2**) of the surface topography, which assists in visualising the slope morphology and presence of existing landslides which is otherwise obscured by vegetative cover. This clearly demonstrates the magnitude of historical landsliding which has developed as part of natural slope forming processes over the preceding hundreds to thousands of years.

Similarly, SLR has undertaken a slope inclination analysis (**Figure 3**), to highlight the extent of steep slopes, which is to be used as a first-pass filter for identification of 'steep slopes' in this LRA.

These figures indicate the longwalls are proposed to continue extraction north of the approved LW711. Like the already mined LW710A and future LW711, the western end of longwalls is proposed to commence west of the Razorback Escarpment, with retreat occurring in a northeast direction, beneath the Escarpment and below the lower east and north facing slopes.

As indicated in the Figures, the focus for this LRA is around the Razorback Escarpment and the steep slopes below it, which includes most of the currently observable landslide activity within the Study Area. **Section 8.0** and **10.0** includes further discussion on historical landslide activity. Terrain views across the foot slopes of the Razorback Escarpment are included in **Figure 18** to **Figure 21** in **Appendix A**.

Client: GM^3
Project Number: 660.030515.00001
Scale: 1:20,000
Projection: GDA94 /MGA zone 56
Drawn by: AR
Date: 15/05/2025
Sheet Size: A3

LEGEND

- Goaf
- Existing Mine Workings
- Proposed Mine Workings
- Property Boundaries LW712 to LW716
- Study Area Extent
- 2019 ELVIS Surface Contours (20m)

Structures

- Basketball Court
- Commercial
- Dam
- House
- Pool
- Public Amenity
- Rural
- Tank
- Tennis Court

0 200 400 m

SLR

GM^3

APPIN AREA 7 LW712 TO LW716
STUDY AREA FEATURES
AERIAL IMAGE WITH CONTOURS

FIGURE 1

\\au.slr.local\Corporate\Projects-SLR\660-SrvWOL\660-WOL\660.030515.00001 GM3 - LW712 - 716 Extraction P\06 SLR Data\01 GIS\GIS\Site Features LW712-716.qgz

284050 284550 285050 285550 286050 286550 287050 287550 288050 288550 289050 289550 290050 290550 291050 291550

6221050 6220550 6220050 6219550 6219050 6218550 6218050 6217550 6217050

LONGWALL719
LONGWALL718
LONGWALL717
LONGWALL716
LONGWALL715
LONGWALL714
LONGWALL713
LONGWALL712
LONGWALL711
LONGWALL710A
LONGWALL710B
LONGWALL709
LONGWALL708A
LONGWALL708B
LONGWALL707A
LONGWALL707B
LONGWALL706

Client: GM[3]
Project Number: 660.030515.00001
Scale: 1:20,000
Projection: GDA94 /MGA zone 56
Drawn by: AR
Date: 15/05/2025
Sheet Size: A3

LEGEND

- Goaf
- Existing Mine Workings
- Proposed Mine Workings
- Property Boundaries LW712 to LW716
- Study Area Extent

Structures

- Basketball Court
- Commercial
- Dam
- House
- Pool
- Public Amenity
- Rural
- Tank
- Tennis Court

0 200 400 m

SLR

GM[3]

APPIN AREA 7 LW712 TO LW716
STUDY AREA FEATURES
HILLSHADE WITH CONTOURS

FIGURE 2

\\au.slr.local\Corporate\Projects-SLR\660-SrvWOL\660-WOL\660.030515.00001 GM3 - LW712 - 716 Extraction P\06 SLR Data\01 GIS\GIS\Site Features LW712-716.qgz

284050 284550 285050 285550 286050 286550 287050 287550 288050 288550 289050 289550 290050 290550 291050 291550

6221050 6220550 6220050 6219550 6219050 6218550 6218050 6217550 6217050

LONGWALL719
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LONGWALL709
LONGWALL708A
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LONGWALL707A
LONGWALL707B
LONGWALL706

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Project Number: 660.030515.00001
Scale: 1:20,000
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LEGEND

- Goaf
- Existing Mine Workings
- Proposed Mine Workings
- Property Boundaries LW712 to LW716
- Study Area Extent

Structures
- Basketball Court
- Commercial
- Dam
- House
- Pool
- Public Amenity
- Rural
- Tank
- Tennis Court

2023 LiDAR Slope Degrees
- <= 15 Degrees
- 15 - 20 Degrees
- 20 - 25 Degrees
- 25 - 30 Degrees
- 30 - 35 Degrees
- 35 - 40 Degrees
- 40 - 45 Degrees
- 45 - 50 Degrees
- 50 - 55 Degrees
- 55 - 60 Degrees
- 60 - 85 Degrees

0 200 400 m

SLR
GM[3]

APPIN AREA 7 LW712 TO LW716
STUDY AREA FEATURES
HILLSHADE WITH SLOPE ANALYSIS

FIGURE 3

\\au.slr.local\Corporate\Projects-SLR\660-SrvWOL\660-WOL\660.030515.00001 GM3 - LW712 - 716 Extraction P\06 SLR Data\01 GIS\GIS\Site Features LW712-716.qgz

5.0 Regional Geology and Geological Setting

Much of the Study Area is underlain by the Middle Triassic Bringelly Shale (Rwb), which is the upper unit of the Triassic-aged Wianamatta Group (Rw) in the central Sydney Basin. This unit typically consists of terrestrial deposits of laminated siltstones, carbonaceous claystones, and non-descript laminate constituents, transitioning towards laminated shales near the base.

The Bringelly Shale, contains three predominant sandstone members, most notably the Mount Hercules Sandstone (Rwbh) and Razorback Sandstone (Rwbr) members which are fine to medium grained quartz-lithic sandstones and are the dominate cliff forming units near the crest of the Razorback Escarpment. Less spatially consistent sandstone lenses can be found throughout (10), (11). Along the eastern fringe, the near surface bedrock is comprised of the underlying Minchinbury Sandstone (Rwm) and the Ashfield Shale (Rwa), which make up the lower units of the Wianamatta Group (12).

Underlying the Wianamatta Group is the main regional aquifer, the Hawkesbury Sandstone, which typically a medium- to coarse-grained quartz sandstone, that is granule-rich and pebbly with minor shale and laminite lenses. It exhibits high porosity but low pore connectivity and commonly contains clearly defined cross-bedding and displays well-developed, steeply dipping joint sets (13).

The Hawkesbury Sandstone underlies the entirety of the Study Area at depth, outcropping within the Nepean River Gorge and within the Harris Creek cliff line beside Douglas Park Drive, where it crosses the Nepean River. Below the Hawkesbury Sandstone is the Narrabeen Group and the Illawarra Coal Measures. The Ashfield Shale is known to act as an effective regional aquitard where present, hydrogeologically separating the steep Bringelly Shale slopes within the Study Area from the underlying stratigraphy (8). The regional dip of the rock strata is about 003/350, i.e., 3° to the north (10).

The regional geological setting is illustrated in the geological long section taken north south through the Study Area and along the Razorback Escarpment, shown in **Figure 5.** The section is essentially an extension to the north of the type section presented in the GHD 2021 LRA Report (4).

The upper plateau of the Razorback Escarpment is overlain by a relatively thin (i.e., <5m thick) layer of residual clays derived in-situ from weathering of the uppermost portions of the Bringelly Shale. Shrink/swell movements resulting in surface cracking due to drying of the clay are commonly observed.

The flanks of the Escarpment below the upper cliffs are typically comprised of a variable thickness of colluvium, derived during to the process of slope development and formation of the Escarpment, through erosion, weathering, sediment deposition and ultimately landsliding over many thousands of years. The colluvium typically comprises a silty to sandy clay matrix containing sandstone and shale particles ranging in size from fine gravel to large boulders.

The lowest elevation slopes, along the creek lines are overlain by quaternary alluvium deposits, typically comprised of gravel, sand, silt and clay predominantly transported and deposited by alluvial processes (12).

Structurally, the Study Area is affected by a series of northwest to southeast striking faults, with occasional cross-cutting, west to east striking faults. Commonly, northwest to southeast trending dykes are associated with the faulting at a similar orientation. There are to NNW-SSE orientated dykes with thicknesses up to approximately 3.5 m and minor faults with displacements up to approximately 3 m that cross the western ends of LW712 to LW716 and the eastern end of LW712 and possibly extending through the eastern ends of the other proposed longwalls. Elsewhere, minor faults with displacements up to approximately 1 m cross the proposed LW712 to LW716.

283550 284050 284550 285050 285550 286050 286550 287050 287550 288050 288550 289050 289550 290050 290550 291050 291550 292050

6221550 6221050 6220550 6220050 6219550 6219050 6218550 6218050 6217550 6217050 6216550

A'

LONGWALL 719
LONGWALL 718
LONGWALL 717
LONGWALL 716
LONGWALL 715
LONGWALL 714
LONGWALL 713
LONGWALL 712
LONGWALL 711
LONGWALL 710B
LONGWALL 710A
LONGWALL 709
LONGWALL 708B
LONGWALL 708A
LONGWALL 707B
LONGWALL 707A
LONGWALL 706
LONGWALL 705
LONGWALL 704
LONGWALL 905

A

Client: GM[3]
Project Number: 660.030515.00001
Scale: 1:22,500
Projection: GDA94 /MGA zone 56
Drawn by: AR
Date: 15/05/2025
Sheet Size: A3

LEGEND

- Q_a - Quaternary Alluvium
- Rwbh (Mount Hercules Sandstone Member)
- Rwbr (Razorback Sandstone Member)
- Rwb (Bringelly Shale)
- Rwm (Minchinbury Sandstone)
- Rwa (Ashfield Shale)
- Rh (Hawkesbury Sandstone)
- Goaf
- Existing Mine Workings
- Proposed Mine Workings
- Property Boundaries LW712 to LW716
- Study Area Extent
- Fold Axis
- Fault
- Dyke

Structures

- Basketball Court
- Commercial
- Dam
- House
- Pool
- Public Amenity
- Rural
- Tank
- Tennis Court

Geological Long Section A-A'

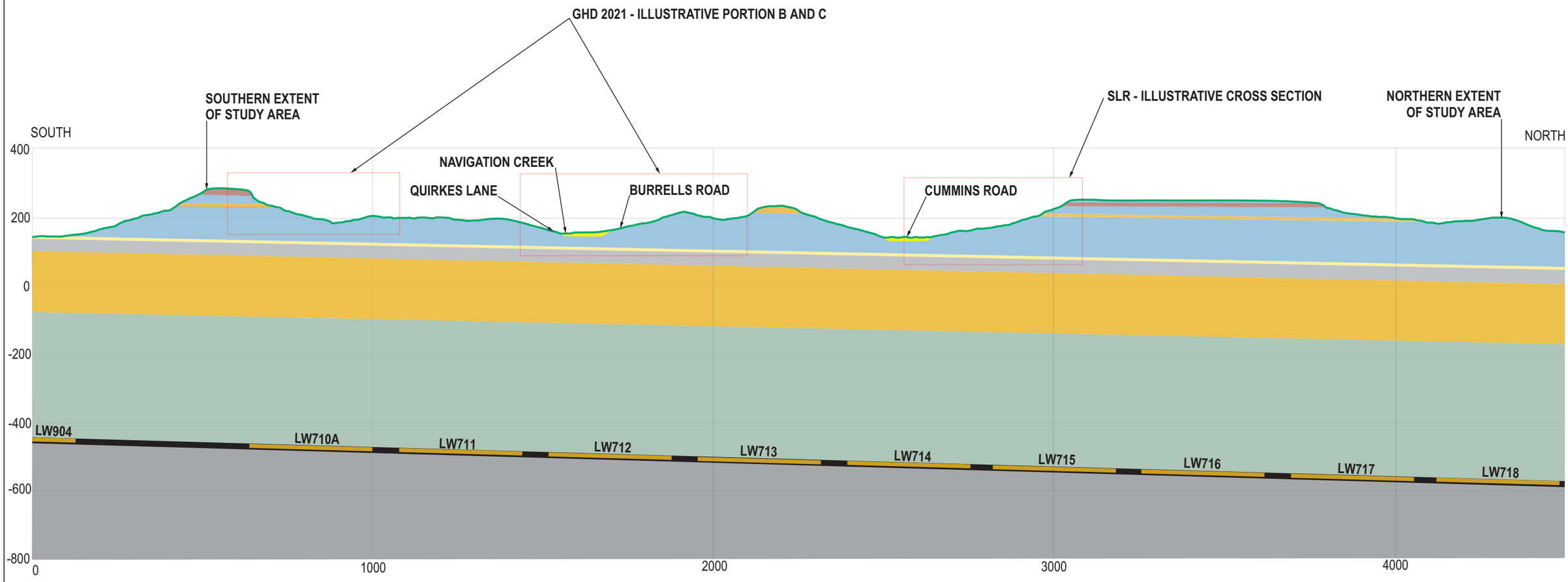
0 200 400 m

SLR
GM[3]

APPIN AREA 7 LW712 TO LW716
STUDY AREA GEOLOGY

FIGURE 4

\\au.slr.local\Corporate\Projects-SLR\660-SrvWOL\660-WOL\660.030515.00001 GM3 - LW712 - 716 Extraction P\06 SLR Data\01 GIS\GIS\Site Features LW712-716.qgz



Client: GM[3]
Project Number: 660.030515.00001
Scale: NTS
Projection: GDA94 /MGA zone 56
Drawn by: AR
Date: 15/05/2025
Sheet Size: A3

LEGEND

- Q_a - Quaternary Alluvium
- Rwbh (Mount Hercules Sandstone Member)
- Rwbr (Razorback Sandstone Member)
- Rwb (Bringelly Shale)
- Rwm (Minchinbury Sandstone)
- Rwa (Ashfield Shale)
- Rh (Hawkesbury Sandstone)
- Rn (Narrabeen Group, Undifferentiated)
- Pi (Illawarra Coal Measures, Undifferentiated)
- Bulli Coal Seam
- Longwall

SLR
GM[3]

APPIN AREA 7 LW712 TO LW716 GEOLOGICAL LONG SECTION

FIGURE 5

\\au.slr.local\Corporate\Projects-SLR\660-SrvWOL\660-WOL\660.030515.00001 GM3 - LW712 - 716 Extraction P\06 SLR Data\01 GIS\GIS\Site Features LW712-716.qgz

6.0 Climate

The region experiences a temperate oceanic climate characterised by warm summers and cool winters with average minimum and maximum temperatures ranging between 4°C to 17°C and 17°C to 30°C, respectively.

Rainfall is relatively evenly distributed throughout the year, receiving an average annual rainfall of approximately 800 mm. The wettest months are typically February and March, coinciding with the end of summer and the start of autumn, where monthly rainfall can exceed 100 mm. Conversely, the driest months are August and September, in the middle of winter, when monthly rainfall averages around 35 to 40 mm.

The region is also influenced by weather patterns such as the East Coast Low (ECL) systems, which can bring heavy rain and strong winds. These systems are more common in the cooler months and can lead to significant rainfall over short periods.

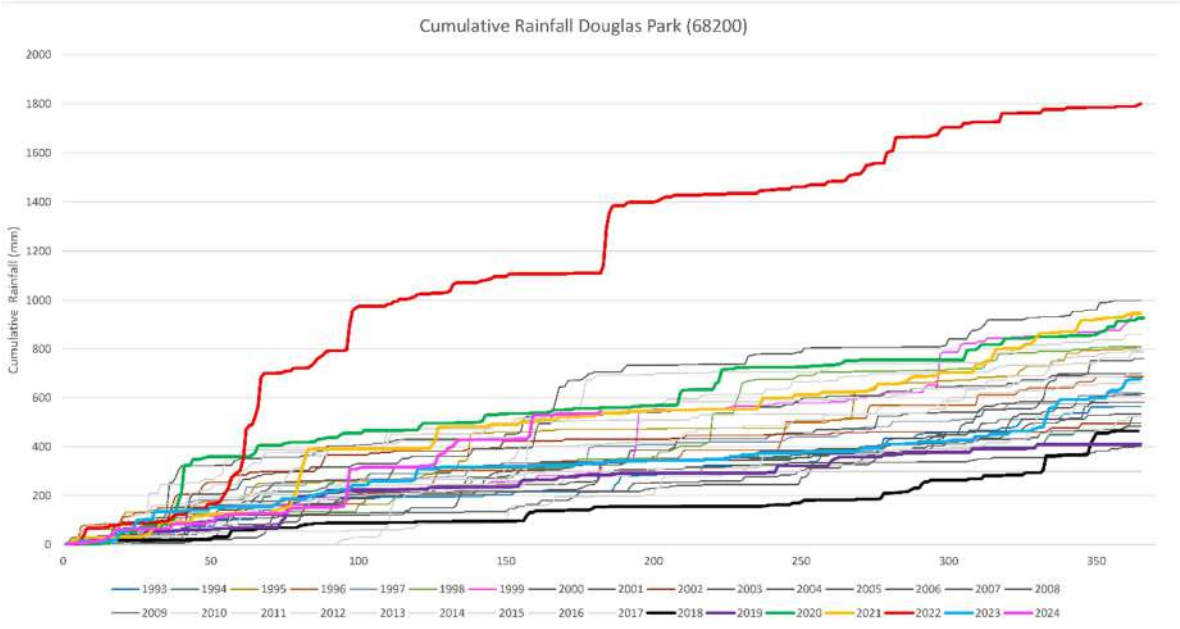
6.1 Contemporary Rainfall

During three consecutive La-Niña weather patterns between 2020 and 2022, the east coast of New South Wales experienced exceptionally high annual rainfall totals, with some areas receiving their highest annual rainfall totals on record in 2022.

The nearest Bureau of Meteorology (BOM) weather station to the site is located at Douglas Park (St Marys Towers), where rain station 068200 recorded monthly rainfall totals of 496.2 mm, 232.4 mm and 317.3 mm in March, April and July 2022 respectively. This is equivalent to more than 3.5 to 7 times greater than the corresponding long term monthly averages.

The cumulative annual rainfall that occurred between 1993 and 2025 measured at the Douglas Park rain station is presented in **Figure 6**, using rainfall data from the BOM website.

Figure 6: Cumulative Rainfall Douglas Park 1993 to 2025



7.0 Regional Hydrogeology Context

The Razorback Escarpment, being the focus area of this LRA, exhibits a complex hydrogeological framework influenced by its geological formation and topography.

The subsurface geology is characterised by the three primary geological formations described in **Section 5.0**. These formations create a stratified groundwater system, with the Hawkesbury Sandstone facilitating significant groundwater flow, while the overlying Wianamatta shales act as confining layers, affecting recharge and discharge dynamics. Generally, these formations act as follows:

Wianamatta Group: Comprising shales and claystones, this group underlies the elevated areas, including the Razorback Escarpment. Its low permeability typically restricts groundwater movement, leading to perched water tables, which is expected to be the primary interaction of groundwater influencing slope stability in the context of the Razorback Escarpment. These perched groundwater systems are typically associated with fractures and bedding planes and may be ephemeral and/or disconnected from the deeper groundwater systems.

Hawkesbury Sandstone: This formation is prominent east of the Study Area near the Nepean River Gorge and serves as a significant aquifer due to its high permeability and contributes to shallow groundwater systems via layered water-bearing zones.

Narrabeen Group: Located at greater depths, this group consists of interbedded sandstones and shales, contributing to the region's deep, stratified aquifer systems.

Groundwater flow is generally associated with secondary porosity in the form of joints, bedding partings and shears at shallow depths, which dominates over primary porosity (interstitial voids in the rock matrix). These discontinuities become a preferential path for groundwater and where this flow ‘exits’ into lower elevation sloping areas, can contribute to higher porewater pressure, which is a known mechanism for contributing to slope instability. This is common within colluvium soils, at their basal interface with underlying bedrock and in some instances can lead to deeper sliding along low strength bedding-surface shears within/at the base of shale and claystone units.

Field observations across the Study Area indicate that groundwater seepage is limited and occurs only occasionally, primarily on lower elevation slopes and in drainage gullies, usually following rainfall. As described by GHD (8), perpetually flowing creeks are not known within the Study Area, spring fed or otherwise, noting that the surface flows drain along intermittent or ephemeral flow paths or watercourses.

8.0 Landslide Processes and Mechanisms

8.1 Geomorphology

As highlighted extensively in the earlier LRA studies completed as part of previous EP approvals related to LW901 to LW904 (i.e., Coffey, 2013 (14)) and LW709 to LW711 and LW905 (GHD, 2021 (4)), the majority of observable landslide activity in the Study Area is concentrated on the steep slopes below the Razorback Escarpment.

As described in the above-mentioned reports, below the Escarpment, the slopes are covered by colluvium derived from erosion of the Escarpment and include large blocks of sandstone (being rockfall debris from the cliffs) intermixed with the clayey materials produced from weathering of the bedrock.

A complex arrangement of historical landsliding has been mapped in earlier studies i.e., Flentje et al (15), within the basins separated by pronounced ridgelines. The morphology of the basins is typically hummocky, with evidence of previous slides and debris flows, inclusive of landslide scarps and creep instability (14).

The toe areas of the landslides are frequently characterised by defined lobe features, though also the landslide debris runout into the colluvial valley slopes without clear toes. Smaller landslides tend to be discrete slides located either between the two sandstone, cliff-forming members or lower on the slopes. However, historically, multiple slides have occurred, becoming a complex landslide (4).

8.2 Landslide Hazard Mechanisms

SLR has previously undertaken engineering geomorphological mapping of key surface features, landforms and observed slope forming processes within the Study Area as well as undertaken a thorough desktop review of background information, including undertaking a GIS based landslide mapping appraisal.

The aim of the mapping exercise was to assess zones of interest to be targeted for visual inspections and ground truthing, identify any pertinent features, i.e. old landslides, anthropogenic structures, materials, and drainage channels, and ultimately to identify slopes susceptible to instability, which will influence this LRA.

A range of distinct geomorphic features and slope processes were recorded across the Study Area and are depicted on the illustrative cross section included in **Figure 7**.

Several landslide hazards are identified for the Study Area which relate to a slopes susceptibility to instability and therefore form the basis for this LRA. These hazards can be broadly described in terms of typical landslide terminology as defined in AGS 2007c, and as illustrated in **Figure 7**, including:

Rock topple:

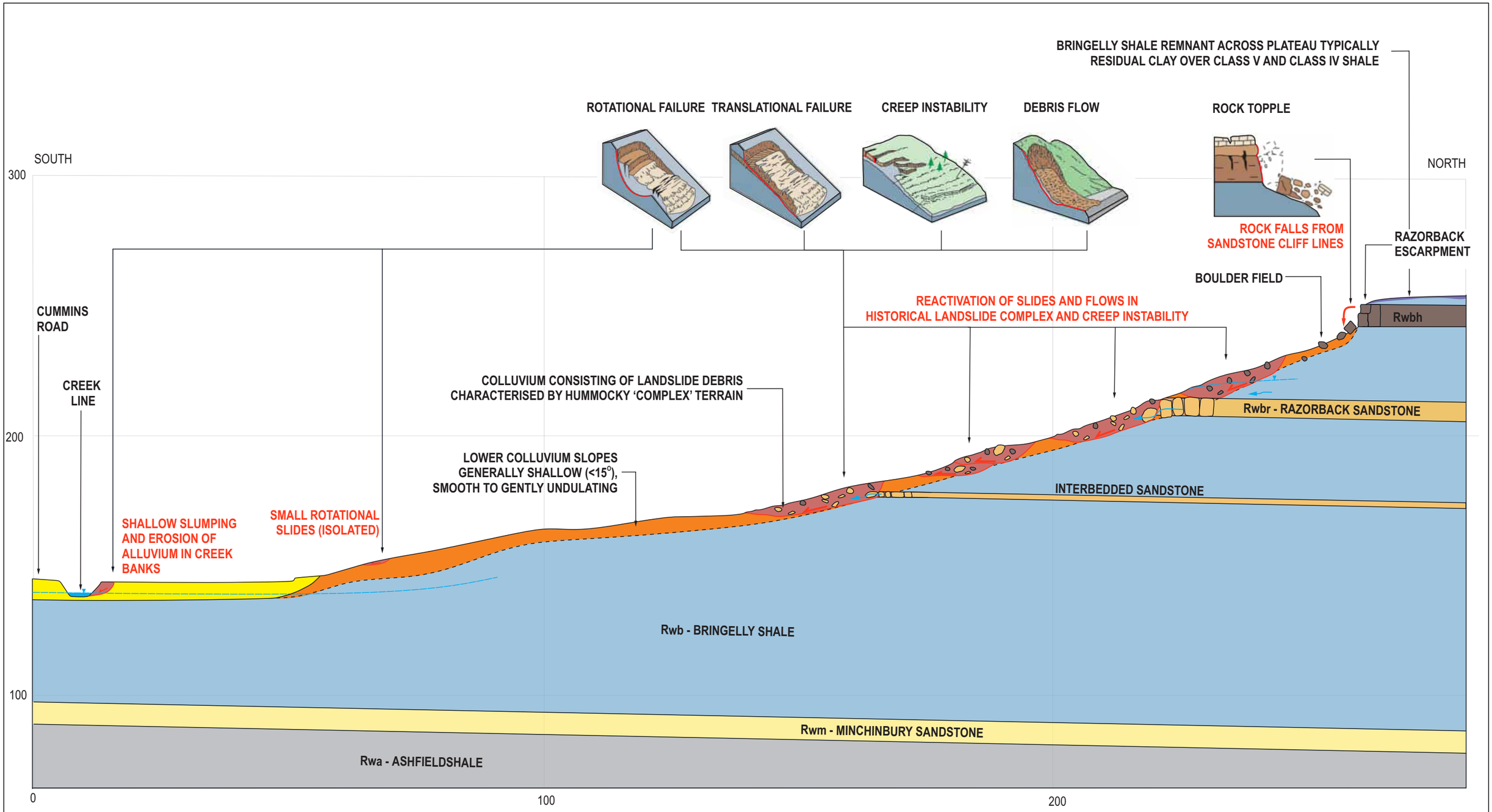
- Block or column of rock rotates forward and falls due to gravity, occurring primarily in steep, jointed rock masses associated with rock mass degradation and cliff line regression.

In the context of the Study Area, rock fall is a natural slope forming process associated with the instability of the sandstone, siltstone and shale cliffs, which is typically driven by a number of factors including; surface water runoff causing erosion and its ingress into joints and fractures, tree root jacking; seismic effects, and long-term deterioration leading to weaking of the rock fabric.

Slide and Slide-Flow Landslide Complexes, consisting of two or more of:

- Rotational landslide; in which the surface of rupture is curved concavely upward, and the slide movement is roughly rotational about an axis that is parallel to the ground surface and transverse across the slide;
- Translational landslide; occurring over low angle failure planes, typically occurring on low strength relict bedding planes or where water concentrates on the soil/rock interface;
- Debris and Earth flow; shallow slumping and subsequent fluidisation of saturated or partially saturated debris. Typically, associated with downslope movement of material disturbed by slides as outlined above; and
- Creep Instability; imperceptibly slow, steady, downward movement of slope-forming soil or rock. Movement is caused by shear stress, sufficient to produce permanent deformation, but too small to produce shear failure.

In general terms, instability within the colluvial slopes is often triggered by high porewater pressures which are induced by high rainfall events. The deeper-seated instability is typically associated with periods of high continuous antecedent rainfall for 3 to 6 months, and where the depth of rainfall approaches a considerable proportion of the average annual rainfall (4).



NOTE:
This figure depicts the existing natural landside hazards on slopes within the study area and does not show additional landslide hazards related to anthropogenic influences e.g., such as those associated with cut, fill and building of structures.

Client: GM[3]
Project Number: 660.030515.00001
Scale: NTS
Projection: GDA94 /MGA zone 56
Drawn by: AR
Date: 15/05/2025
Sheet Size: A3

LEGEND

- Colluvium
- Q_a - Quaternary Alluvium
- Rwbh (Mount Hercules Sandstone Member)
- Rwbr (Razorback Sandstone Member)
- Rwb (Bringelly Shale)
- Rwm (Minchinbury Sandstone)
- Rwa (Ashfield Shale)
- Landsldie Debris
- Existing Inferred Landslide Features
- Natural Landslide Hazards
- Seepage Path

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GM[3]

APPIN AREA 7 LW712 TO LW716
ILLUSTRATIVE CROSS SECTION
- LANDSLIDE HAZARDS

FIGURE 7

\\au.slr.local\Corporate\Projects-SLR\660-SrvWOL\660-WOL\660.030515.00001 GM3 - LW712 - 716 Extraction P\06 SLR Data\01 GIS\GIS\Site Features LW712-716.qgz

9.0 Mine Subsidence Effects

9.1 Historical Monitoring Data

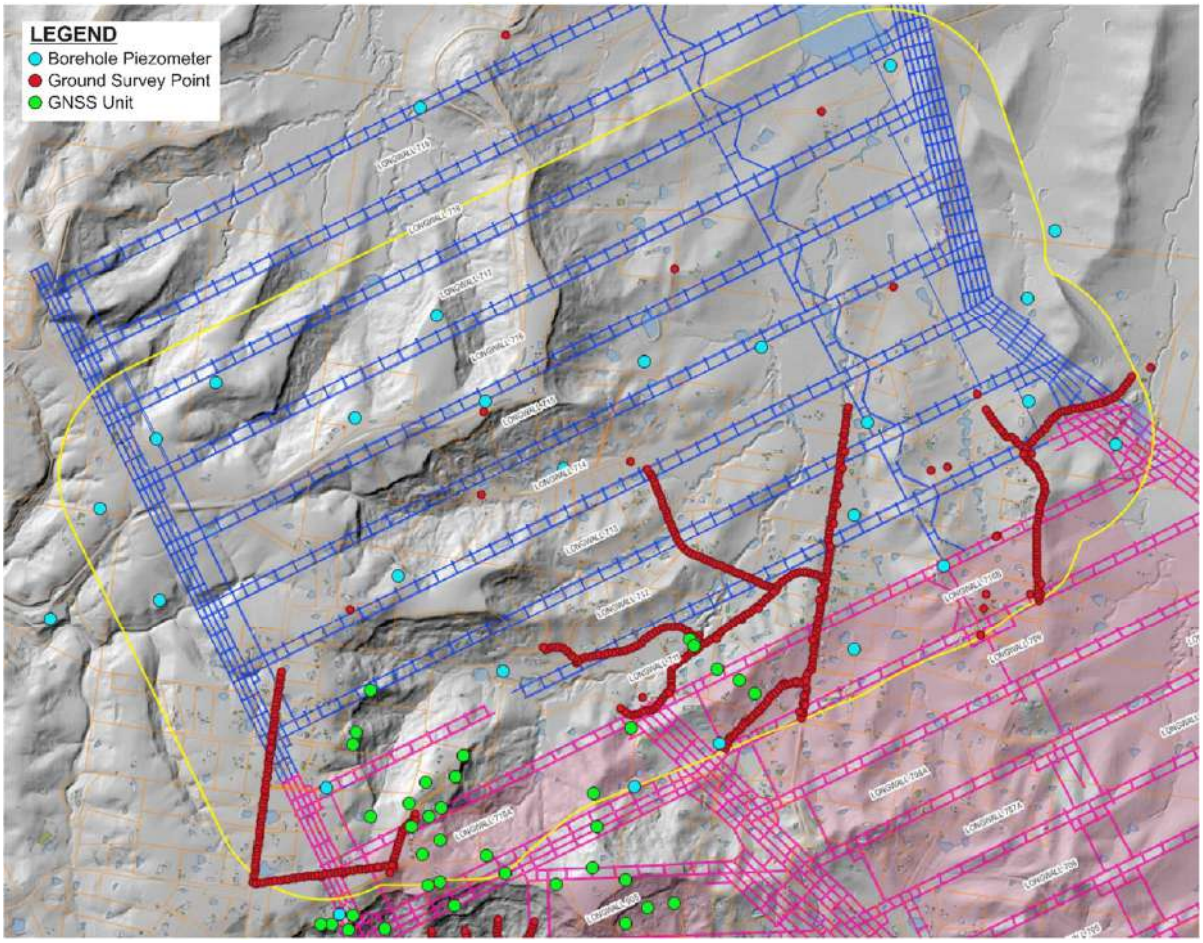
Existing monitoring measures are detailed in the MSEC1476 (16) Report, titled “Appin Area 7 Longwall 711 Management Plan for Potential Impacts to Building Structures”. This plan, specifically Section 6, outlines risk control procedures and monitoring measures regarding impacts on residential properties and builds upon a similar one developed for LW710A.

Further discussion and assessment is also included in the MSEC1459 (5), Report titled “Appin – Longwalls 712 to 716 Subsidence Predictions and Impact Assessments for Appin LW712 to LW716”, which includes the wider monitoring layout at Appin Mine in Drawing 1 in Appendix E.

9.1.1 Ground Movement Monitoring

Assessment and monitoring of the slopes and cliffs to date has included pre-mining assessment, guidance on preferred locations for monitoring, and appraisal of the monitoring of ground movement and slope conditions during mining, together with post-mining observations by way of proof-of-assessment. **Figure 8** provides an example of the existing monitoring being undertaken by GM[3] within the Study Area. The wider monitoring network which extends outside the Study Area is shown in Drawing 1 in Appendix E of MSEC 1459 (5).

Figure 8: Existing Monitoring Network



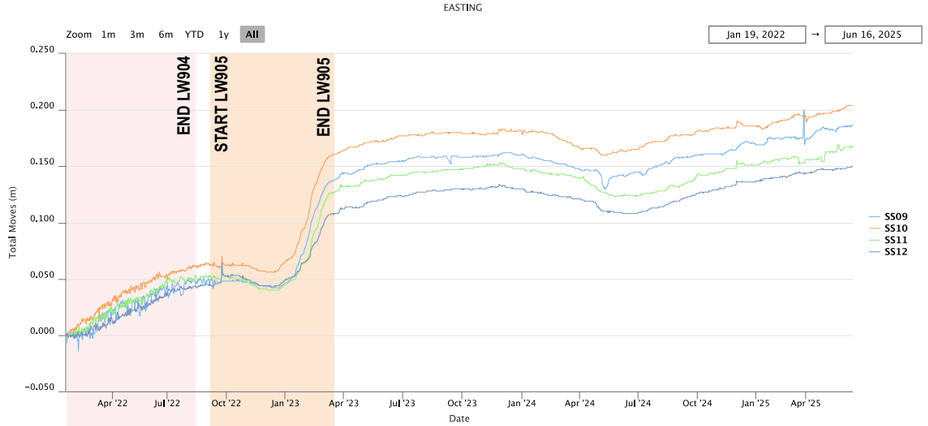
Ground survey of steep slopes and GNSS unit monitoring along Razorback Escarpment during the mining of LW905 and LW710A measured typical vertical and horizontal movements, which developed gradually and inline with longwall progression. Exceedance of triggers was uncommon, and while occasional minor ‘steps’ in the data have occurred, these have been interpreted as being related to environmental effects rather than due to subsidence.

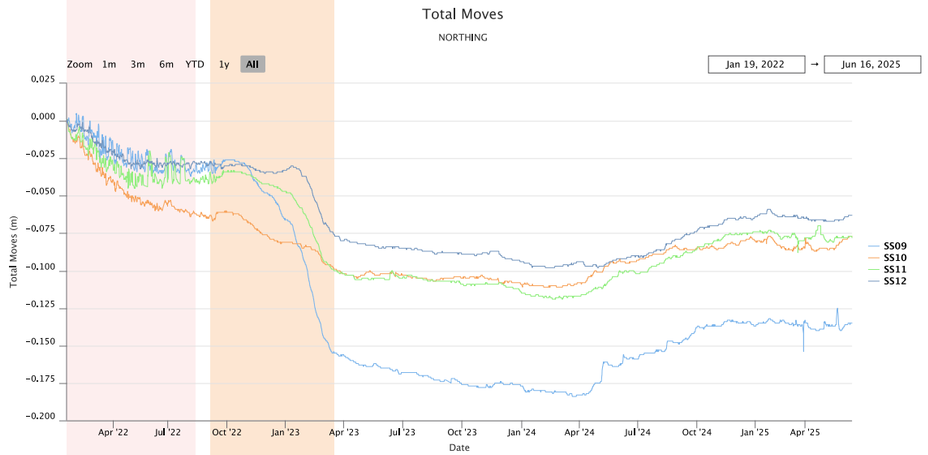
Steep slope survey lines A to E on the south facing slopes below the Razorback Escarpment measured total subsidence between 200 mm to 600 mm, which was close to predicted, horizontal movements up to around 175 to 225 mm toward LW904, with tensile and compressive strains measured less than 1mm/m and 1.5mm/m, respectively.

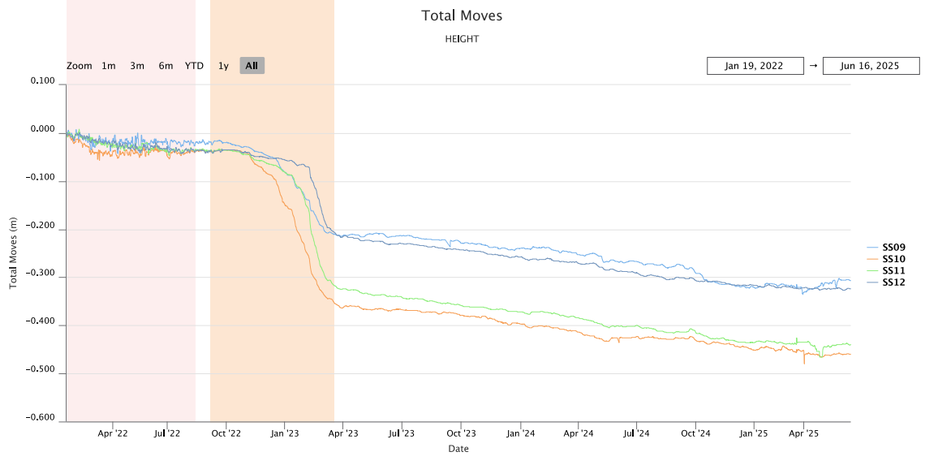
An example of the horizontal and vertical movements measured during LW905 and LW710A in GNSS units SS09, 10,11,12 and SS20, 21 and 28, respectively are shown in **Figure 9**.

GNSS monitoring and survey line results and the associated movement triggers, are compared with regular field-based observation data during mining, with additional inspections completed following a trigger exceedance. Current trigger levels for corrective management actions for areas most at risk of landslide are included in MSEC1476 in particular Table 6.2.

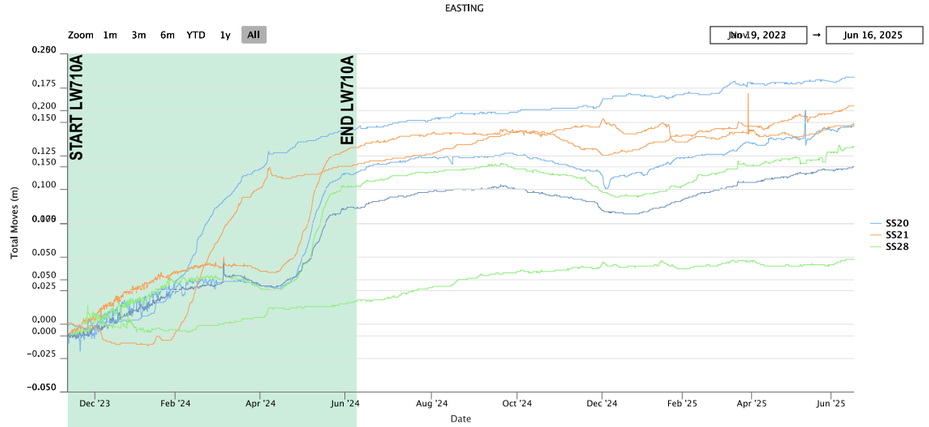
GNSS09, 10, 11, 12 Total Moves

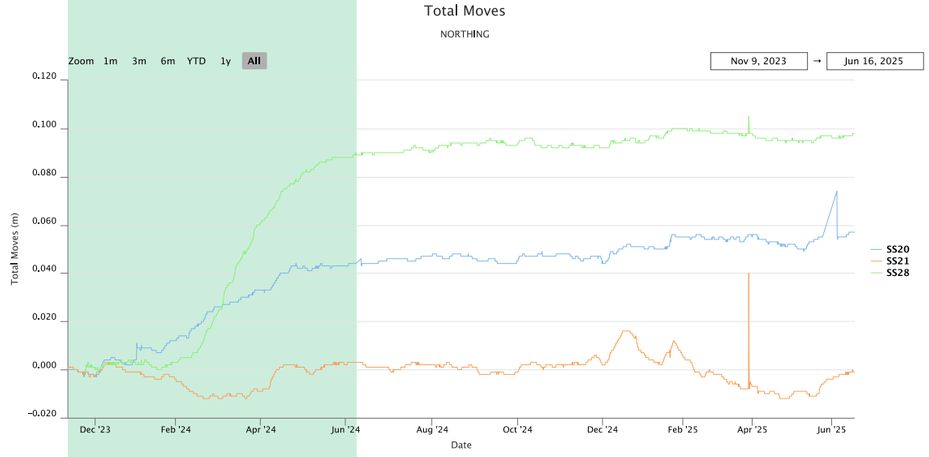


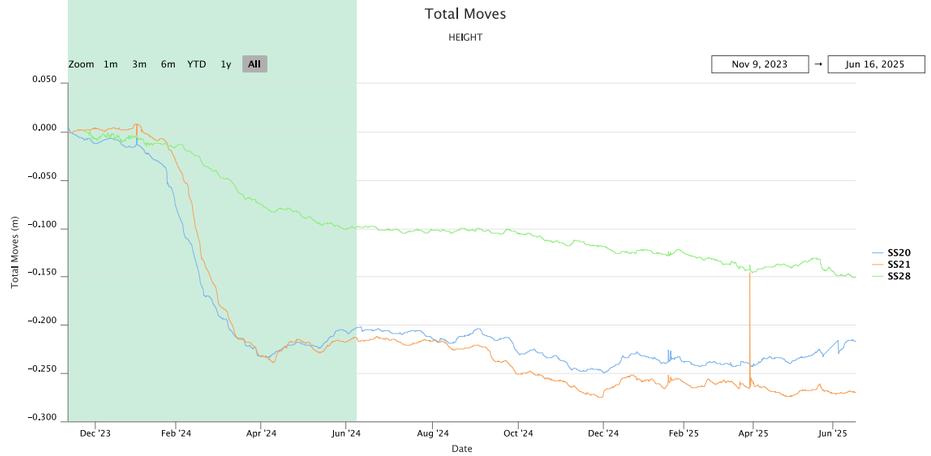




GNSS20, 21, 28







Client: GM[3]
Project Number: 660.030515.00001
Scale: -
Projection: -
Drawn by: AR
Date: 15/05/2025
Sheet Size: A3

APPIN AREA 7 LW712 TO LW716 EXAMPLE GNSS RESPONSE - HISTORICAL LANDSLIDES

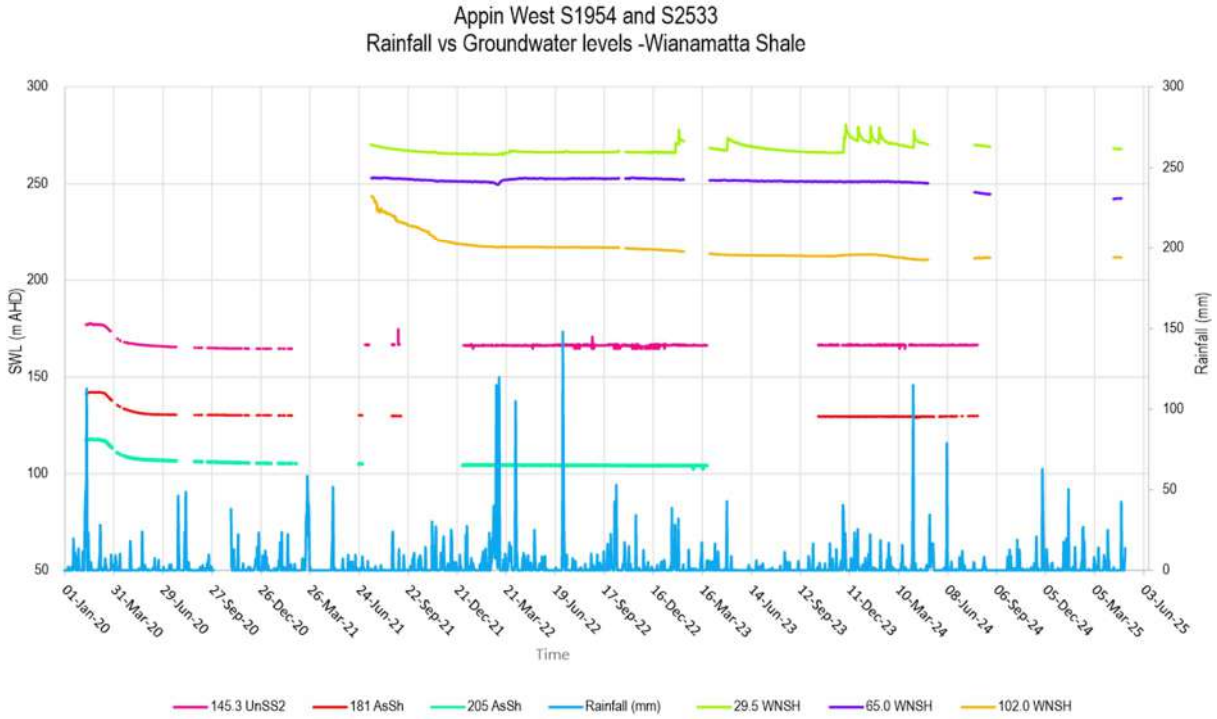
FIGURE 9

\\au.slr.local\Corporate\Projects-SLR\660-SrvWOL\660-WOL\660.030515.00001 GM3 - LW712 - 716 Extraction P\06 SLR Data\01 GIS\GIS\Site Features LW712-716.qgz

9.1.2 Vibrating Wire Piezometers

Within the Study Area to date, the groundwater response for the Razorback Escarpment has been primarily monitored through downhole piezometer arrays installed within boreholes S1954 and S2533, plotted versus rainfall since 2020 in **Figure 10** below.

Figure 10: Rainfall versus Groundwater Levels



As illustrated in **Figure 10** above, and as described by GHD (8), the response of S2533 suggests that the upper piezometer at a depth of 30 m, which previously did not respond to rainfall prior to the mining of LW905, has recorded sharp increases in groundwater levels following rainfall events greater than about 40 mm over 24-hours, with this change becoming apparent from the start of February 2023, at a time when the active mining face of LW905 was nearing the end of panel (EOP).

This suggests a shallow groundwater recharge pathway may have formed due to mining (i.e., by cracking and/or dilation of existing discontinuities), as the rapid response timeframe indicates this is most likely occurring through fracture flow rather than through the porous geological medium. The groundwater response at S2533 takes months to dissipate and appears unaffected by minor rainfall events. It is unclear if this is the water pressure dissipating from fractures into the porous media or groundwater leaving the wider groundwater system as seepage.

The other notable response is the response in the deeper piezometer sensor at a depth of 192 m, which shows a slight draw down of groundwater by around 6 m since October 2022, which coincides broadly with the end of LW904 and start of LW905. A reduction in groundwater levels decreases pore water pressure, enhancing slope stability where this occurs near slopes

9.2 Subsidence Predictions

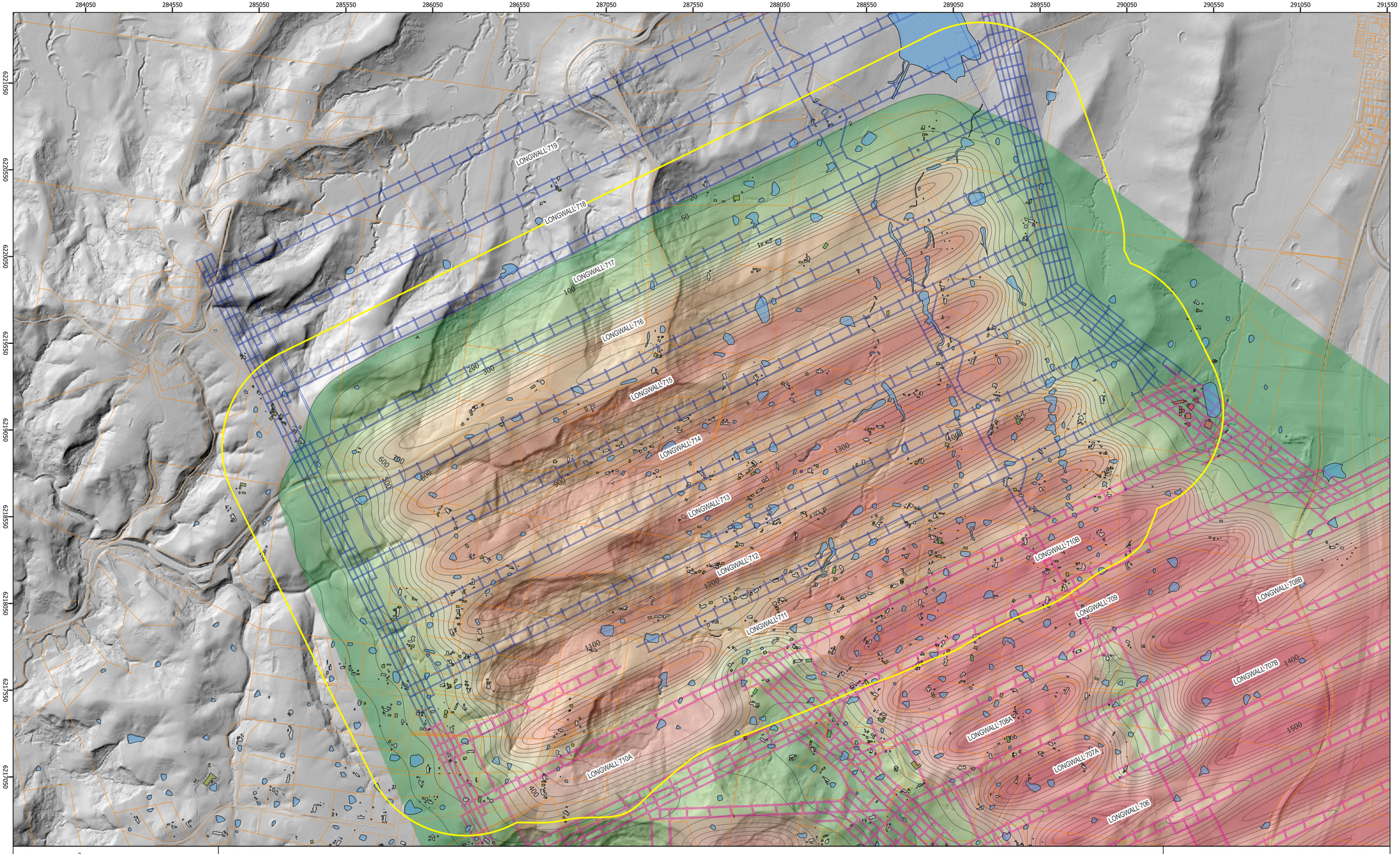
LW712 to LW716 are proposed to be extracted via retreat from west to east, with overall void lengths ranging between 4030 m to 4195 m, void width (including first workings) of 425m and overall tailgate chain pillar width of 51 m to 53 m [see MSEC1459 Tabel 1.1, (9)].

Subsidence predictions within the Study Area due to the proposed LW712 to LW716 are detailed in MSEC1459 (9). Therein, the maximum predicted total subsidence effects are; 1450 mm vertical subsidence, 6.5 mm/m tilt (i.e. 0.65 % or 1 in 154), 0.07 km^{-1} hogging curvature (i.e. minimum radius of curvature of 14 km) and 0.14 km^{-1} sagging curvature (i.e. minimum radius of curvature of 7 km). The maximum predicted strains (excluding valley-related effects) are 1.0 mm/m tensile and 1.6 mm/m compressive based on 95% confidence levels. The predictions for total vertical subsidence estimates developed by MSEC are presented on **Figure 11.**

The assessed impacts for the natural and built features within the Study Area are similar to those assessed and observed for similar features located above the existing longwalls in Areas 7 and 9.

Increased vertical subsidence is not anticipated at zones of geological structure, as it was not observed when LW703 to LW706, LW709 and LW901 to LW904 previously mined through these zones. Localised irregular surface movements (i.e. compressive strain and heaving) were observed near these zones; however, these appear to be due to surface topography (i.e. drainage lines and cuttings) rather than the geological structures.

Subsidence predictions for the cliffs and steep slopes within the Study Area are provided in Section 5.5 and 5.7 in MSEC1459 (9) and indicate the magnitude of predictions vary significantly depending on the location relative to the proposed longwalls. Generally, the maximum predicted total subsidence effects are; 1450 mm vertical subsidence, 6.0 mm/m tilt (i.e. 0.60 % or 1 in 167), 0.06 km^{-1} hogging curvature (i.e. minimum radius of curvature of 17 km) and 0.19 km^{-1} sagging curvature (i.e. minimum radius of curvature of 11 km). The maximum predicted strains (excluding valley-related effects) are 1.0 mm/m tensile and 1.6 mm/m compressive based on 95 % confidence levels.



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Project Number: 660.030515.00001
Scale: 1:20,000
Projection: GDA94 /MGA zone 56
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Sheet Size: A3

LEGEND

- Goaf
- Existing Mine Workings
- Proposed Mine Workings
- Property Boundaries LW712 to LW716
- Study Area Extent
- Total Predicted Subsidence after LW716

Structures

- Basketball Court
- Commercial
- Dam
- House
- Pool
- Public Amenity
- Rural
- Tank
- Tennis Court

Total Subsidence Prediction (mm)

1,500
15

0 200 400 m

SLR
GM[3]

APPIN AREA 7 LW712 TO LW716 TOTAL SUBSIDENCE PREDICTION

FIGURE 11

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9.3 Mine Subsidence Effects on Slope Stability

9.3.1 Cliff Lines

MSEC1459 (9), estimate that around 3% to 5% of the total length of cliff lines within the Study Area may be affected by instability caused by subsidence induced cracking, with frequency estimates based on past experience mining beneath cliff lines in the Southern Coalfield. This frequency prediction is in line with the performance measures for cliff lines set out in the BSOP approval.

However, underground mining at Appin Mine to date has resulted in very little subsidence induced rock falls occurring, with only one minor rock fall reported along Cliff RR-CL5 during the mining of LW905 and LW710A. This low incidence of rock falls suggests that, while the predicted frequency of cliff instability aligns with past experience and approved performance measures, the actual impacts observed to date have been minimal.

Notwithstanding the above, it is possible that instability may occur in a cliff during mining that may be attributable to either natural causes, mine subsidence, or both.

9.3.2 Steep Slopes

The predicted changes in grade due to mining-induced tilts are small when compared to the natural grades of the steep slopes, which are greater than 3H:1V and, therefore, tilt alone is unlikely to result in adverse impacts on the stability of the steep slopes. However, slopes with existing low shear strength horizons and/or previous failure planes could become sensitive to movement in combination with other contributing factors such as undercutting from erosion, or prolonged rainfall events.

Rather, the steep slopes are more likely to be impacted by the mining-induced curvatures and strains. The potential impacts would generally result from the increased horizontal movements in the downslope direction, causing tension cracks to appear at the tops and along the sides of the slopes and compression ridges to form at the bottoms of the slopes, which has been observed during previous mining beneath steep slopes within the Southern Coalfield (9).

Tension cracking can reduce the shear strength (resistance) of a slope or rock mass, and horizontal movements can induce shear movements along low angle bedding planes or previous failure surfaces which can contribute to instability.

Lastly, as described in **Section 9.4** below, the potential for increased water infiltration due to cracking, which would have an adverse effect on slope stability due to the potential for increase pore pressure within the slope, which is the key triggering mechanism as described above.

Ultimately however, the most likely trigger event for landslide activity (other than oversteepening of the slope by manmade activities) remains significant rainfall events e.g. intense or prolonged rain.

Generally, it is considered unlikely that the additional influence of mine subsidence will instigate new landslides or increase landslide activity within the Study Area.

9.4 Mine Induced Modification of Groundwater

GHD (8), prepared a report “examining the potential expected range of effects associated with mine-induced modification of groundwater on slope instability”, in response to Condition 3 of the previous Extraction Plan approval for LW709 to 711 and LW905.

Ultimately, it was concluded (i.e., Section 5), that subsidence will cause mine-induced modification of groundwater which may locally increase the likelihood of slope instability, particularly if increased groundwater recharge into bedrock or the soil/rock interface via

subsidence induced cracking results in increased discharge of groundwater into colluvium or residual soil slopes.

Therefore, the plausible range of mining induced groundwater effects and their potential impact on slope stability considered in this assessment include:

- Surface and near surface cracking leads to increased infiltration during rainfall events and subsequent increased short term shallow groundwater level / pore pressure rise:
    - This mechanism was potentially observed in downhole piezometer at 30m depth in S2533 during mining of LW905, which demonstrated an increase in groundwater levels following rainfall events, that has been attributed to impact due to mine subsidence.
    - Increased shallow groundwater levels / pore pressure rise increases likelihood of localised cliff instability i.e., rock fall.
    - Pressure changes from induced strains leads to increased likelihood of deeper-seated cliff line instability i.e., cliff line regression.
    - Larger discharge through sandstone units may accelerate weathering and undercutting of siltstones/shales.
- Elevated rock permeability, reduction in pore pressure at depth, but a corresponding increase in potential for lateral groundwater flow toward lower slopes:
    - Increased lateral groundwater flow exits rock into colluvial material creating an adverse effect on stability, i.e., contributing to increased likelihood of re-activation of historical landslides (i.e., slide flow complexes) on foot slopes below Razorback Escarpment.
    - The interbedded siltstone and sandstone create alternating aquitards and aquifers, limiting the ability for infiltration from the upper plateau to penetrate lower elevation sandstone members.
- Regionally, the reduction of groundwater levels / pore pressure in the majority of the Study Area:
    - Improvement to overall slope stability and somewhat reduced likelihood of instability under adverse conditions.

While it is unlikely that these mechanisms can be conclusively proven (due to limitations in the spatial and temporal resolution of available monitoring data), this should not preclude it from being considered a potentially significant process. Additionally, forward monitoring of the groundwater response within the wider monitoring program which is currently in place to assist with mitigating the potential mine induced impacts on slope stability, will play an important role as mining continues to the north.

Predicting the number of landslides potentially attributable to mining-induced groundwater effects, is not considered realistic to quantify with any real confidence, noting that based on the observed performance to date longwall mining has had very little influence upon landslide frequency or extent of landsliding along parts of the Razorback Escarpment cliffs and steep slopes affected by mine subsidence.

Regardless, it is considered prudent to relate the potential effects that mine induced modification of groundwater (as well as other subsidence related effects) may have on increasing the likelihood of slope instability to the landslide risk profile.

9.5 Observed Landslides During Active Mining

SLR has been undertaking observations of properties located on and near the steep slopes of the Razorback Escarpment, during both pre mining and active mining periods since 2020, corresponding with the extraction of LW903 to LW905 and LW708B to LW710B.

Generally, it is apparent that longwall mining to date has not had a demonstrable influence upon landslide frequency or extent of landsliding along parts of the Razorback Escarpment, with no clear evidence of instability having been triggered directly by mine subsidence effects.

That being said, several landslides have occurred on the steep slopes whilst mine subsidence effects have been active. Whilst the effects of mine subsidence contributing to those landslides can't be ruled out, the key contributing triggering mechanism has been heavy rainfall following periods of high antecedent rainfall in all cases.

As shown in **Figure 6**, the mining of LW709, LW904 and LW905 coincided with above average rainfall affecting the east coast of New South Wales, with Douglas Park receiving, well above average rainfall during 2020 and 2021, followed by the wettest year on record in 2022.

In particular, three very large rainfall events in March 2022, April 2022 and July 2022 occurred during extraction of LW709 and LW904. These rainfall events occurred following a period of high antecedent rainfall conditions and were a known trigger for extensive slope instability along the East Coast of New South Wales, as well as across the wider Razorback Escarpment and surrounding areas.

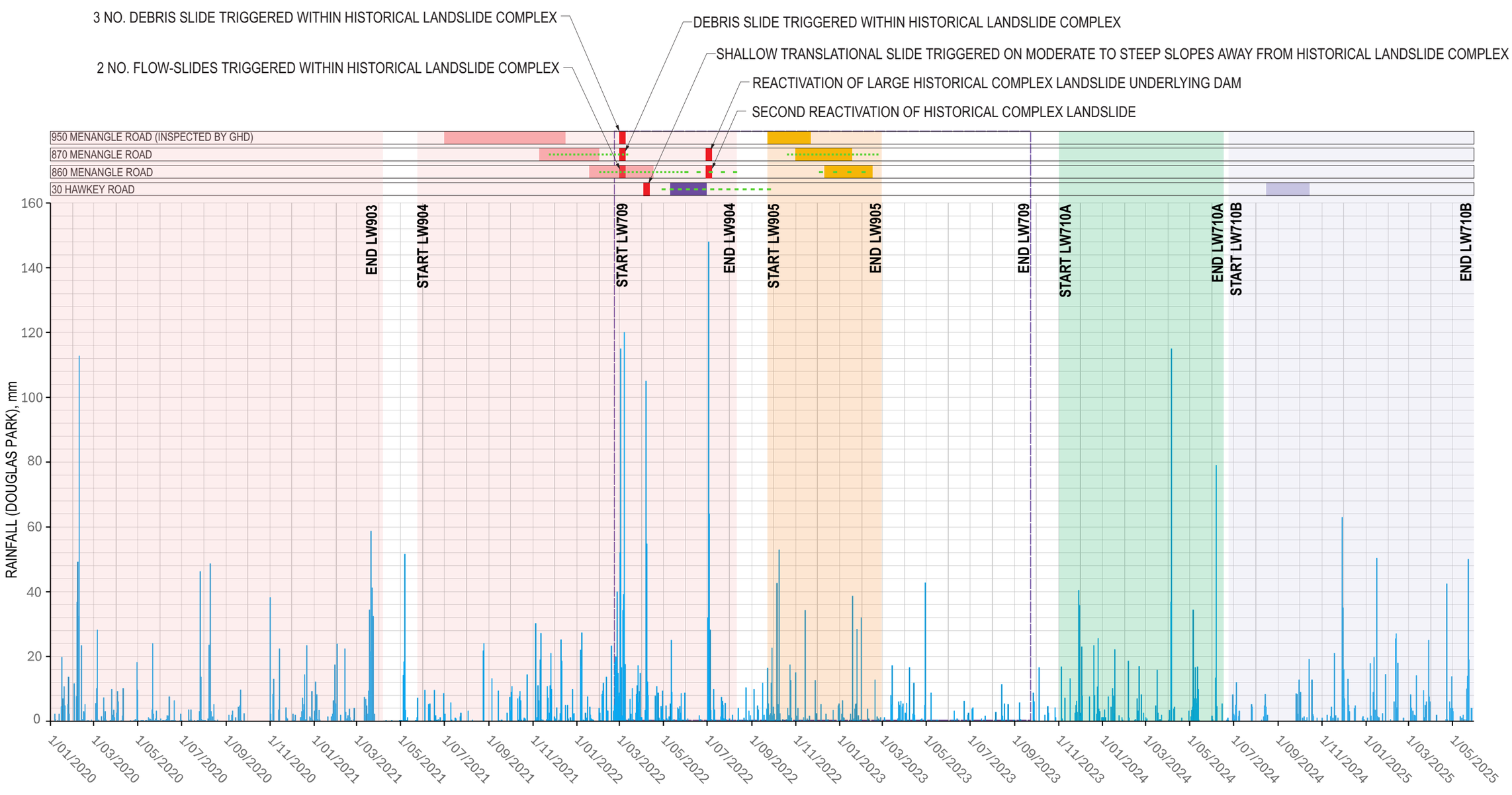
A timeline of landslide events observed by SLR during the active longwall mining influence period(s) is presented in **Figure 12**. Distribution of the observed landslides are shown on **Figure 13**.

Visual observations made by SLR shortly after a number of these events indicate these landslides were all associated with high degrees of soil saturation and softening (i.e., loss of soil strength), which is interpreted to have triggered the initiation of movement.

In some cases, free flowing seepage from within and at the toe of the displaced landslide debris persisted for weeks and even months, probably due to continued rainfall. This also led to continued creep movement of the displaced landslide debris following the initial triggering event.

In all but the shallow translational landslide on 30 Hawkey Road, the observed landslides occurred on the steep foot slopes below the Razorback Escarpment and within a mapped historical landslide complex.

Notably, all landslides were assessed to present a low level of risk to both people and property.



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Project Number: 660.030515.00001
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Date: 15/05/2025
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LEGEND

- Peak subsidence effects due to LW904 (approx.)
- Peak subsidence effects due to LW905 (approx.)
- Peak subsidence effects due to LW709 (approx.)
- Peak subsidence effects due to LW710B (approx.)
- Inferred landslide event
- SLR active mining inspections
- Rainfall - Douglas Park Station 068200 (mm)

SLR
GM[3]

APPIN AREA 7 LW712 TO LW716
RAINFALL AND LANDSLIDES
MINING PERIOD LW903 TO LW905
AND LW709 TO LW710B

FIGURE 12

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D - DEBRIS SLIDE TRIGGERED WITHIN HISTORICAL LANDSLIDE COMPLEX



I - REACTIVATION OF LARGE HISTORICAL COMPLEX LANDSLIDE UNDERLYING DAM



G - SHALLOW TRANSLATIONAL SLIDE TRIGGERED ON MODERATE TO STEEP SLOPES AWAY FROM HISTORICAL LANDSLIDE COMPLEX

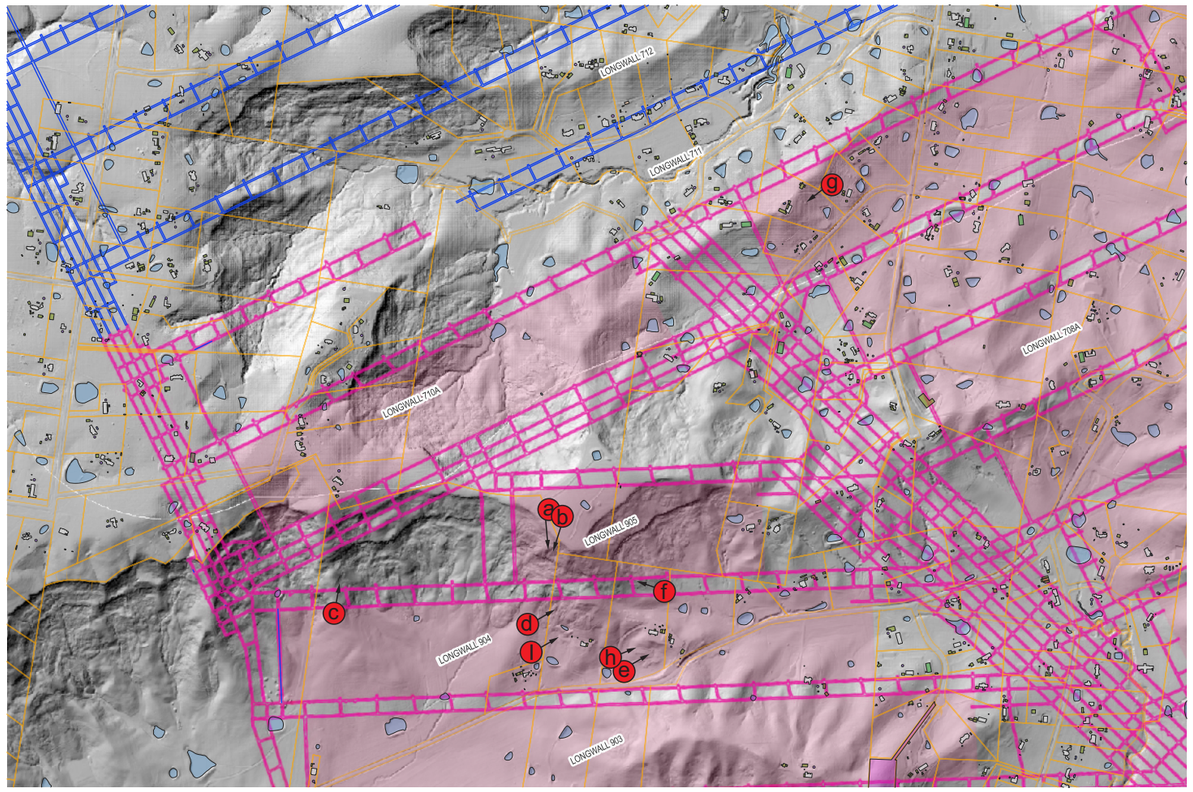


H - SECOND REACTIVATION OF HISTORICAL COMPLEX LANDSLIDE





A TO C - 3 NO. DEBRIS SLIDE TRIGGERED WITHIN HISTORICAL LANDSLIDE COMPLEX MARCH 2022







E AND F - 2 NO. FLOW-SLIDES TRIGGERED WITHIN HISTORICAL LANDSLIDE COMPLEX

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APPIN AREA 7 LW712 TO LW716
OBSERVED LANDSLIDES
MINING PERIOD LW903 TO LW905
AND LW709 TO LW710B

FIGURE 13

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10.0 Site Inspections and Ground Truthing

Following the desktop review, SLR conducted an initial appraisal to determine areas of interest (AOI's) for targeted site inspections, to expand on SLR's existing inspection database of properties within the Study Area. Key aspects derived from the site inspections included:

- Ground truth the findings of the completed desktop review to assist with calibrating the relative risk profile of properties across the Study Area.
- Identification of cliff lines, confirmation of landslide hazard mechanisms, evidence and frequency of rock falls, extent and activity of existing landslides at key selected AOI's.
- Enable preliminary risk assessment at selected AOI's.
- Inspect properties previously inspected by GHD in previous LRA studies.

As such, SLR has undertaken the following visual inspections over the Study Area to date, which have been utilised to inform this LRA:

- Detailed inspection at seven (7) AOI's as part of this study, including completion of 5 detailed LRA's.
- Detailed inspection at sixty-five (65) properties as part of LW710A, LW710B and LW711 pre-mining condition inspections, which included nine (9) detailed LRA's.
- Drive around full Study Area, with general mapping and observation carried out wherever possible.

The distribution of the above inspections and completed LRA's are shown in the plan included in **Appendix A**. A summary of the site observations made as part of this study are included in **Table 1**, with accompanying photographs also included in **Appendix A**.

Table 1: Site Observation Summary

Property Identification	Key Geomorphological and Landslide Related Features	Photo Ref.
Properties on Plateau Behind Razorback Escarpment		
16 Gibraltar Drive, O05	• Property is terraced, with main dwelling situated in western portion on a cut to fill platform, over gentle to moderate sloping plateau, situated back from the crestal cliff-line that forms the Razorback Escarpment. • Dam and shed located on lower terrace, approximately 20 m horizontally back from the Escarpment. Dam may be founded on rock which would leave it susceptible to cracking. • Sandstone block retaining wall up to 2 m high constructed along crest of Escarpment for a length of approximately 30 m. • No visible indication of active deep-seated instability or cliff line regression on slopes behind the Escarpment. • Rill erosion evident in areas of exposed soil. • Sandstone of the Mount Hercules Sandstone member outcrops at the crest of the Escarpment, forming small, localised cliffs (<5 m height). • Adjacent and lower slopes are very steep (>30^{o}), and soil creep is also evident. • The cliff face displays detachment of rock mass from the cliff-line, and debris field upon the steep slopes below the cliff-line, characterised by accumulations of sandstone boulders, which are sub-angular, <1 m diameter with run out distances in the order of <10 to 20 m. • Structures have an expectation of shallow depth to shale bedrock and are remote from the steep slopes of the Escarpment and are therefore geotechnically isolated from the natural, historical slope instability that has occurred on the steep Escarpment slopes. • Thick, scrubby vegetative cover on lower slopes makes meaningful observation impractical. • No indication of active use by land users on slopes below the Escarpment.	1 to 2
19 Gibraltar Drive, O06	• Main dwelling situated in western portion on a shallow cut to fill platform, over gentle sloping plateau, situated at least 40 m back from the crestal cliff-line that forms the Razorback Escarpment. • Dam located lower down, approximately 7 m horizontally back from the Escarpment. Dam may be founded on rock which would leave it susceptible to cracking. Seepage was apparent at toe of downstream embankment. • Shallow sandstone block retaining wall constructed along crest of Escarpment for a length of approximately 30 m. • No visible indication of active deep-seated instability or cliff line regression on slopes behind the Escarpment. • Sandstone of the Mount Hercules Sandstone member outcrops at the crest of the Escarpment, forming small, localised cliffs (generally <5 m height, possibly <10 m toward the north). • Adjacent and lower slopes appeared very steep (>30^{o}), and largely inaccessible due to cliff line and very thick vegetation. • Structures have an expectation of shallow depth to shale bedrock and are remote from the steep slopes of the Escarpment and are therefore geotechnically isolated from the natural, historical slope instability that has occurred on the steep Escarpment slopes. • Thick, scrubby vegetative cover on lower slopes makes meaningful observation impractical. • No indication of active use by land users on slopes below the Escarpment.	3 to 4
85 Donalds Range Road, R09	• Main dwelling situated in western portion on a shallow cut to fill platform, over gentle sloping plateau, situated at least 40 m back from the slope crest that forms the Razorback Escarpment. • Dam located immediately behind Escarpment, near head of gully, along slope from structures. • No visible indication of active deep-seated instability or regression on slopes behind the Escarpment. • Sandstone of the Mount Hercules Sandstone member outcrops at the crest of the Escarpment, forming small, localised outcrops. Adjacent lower slopes relatively steep (<30^{o}), partly inaccessible due to thick vegetation. • Structures have an expectation of shallow depth to shale bedrock and are remote from the steep slopes of the Escarpment and are therefore geotechnically isolated from the natural, historical slope instability that has occurred on the steep Escarpment slopes. • Thick, scrubby vegetative cover on lower slopes makes meaningful observation impractical. • No indication of active use by land users on slopes below the Escarpment. • Creep movement of fill batter below shed apparent. Shed is constructed on cut to fill platform behind head of moderate sloping gully along southern portion of property. No indication of deep-seated instability observed. • Creep movement of slope in head of gully below driveway in northern portion of the property associated with persistent groundwater seepage. Isolated from any structures and considered unlikely to undermine driveway in the short to medium term.	5 to 10

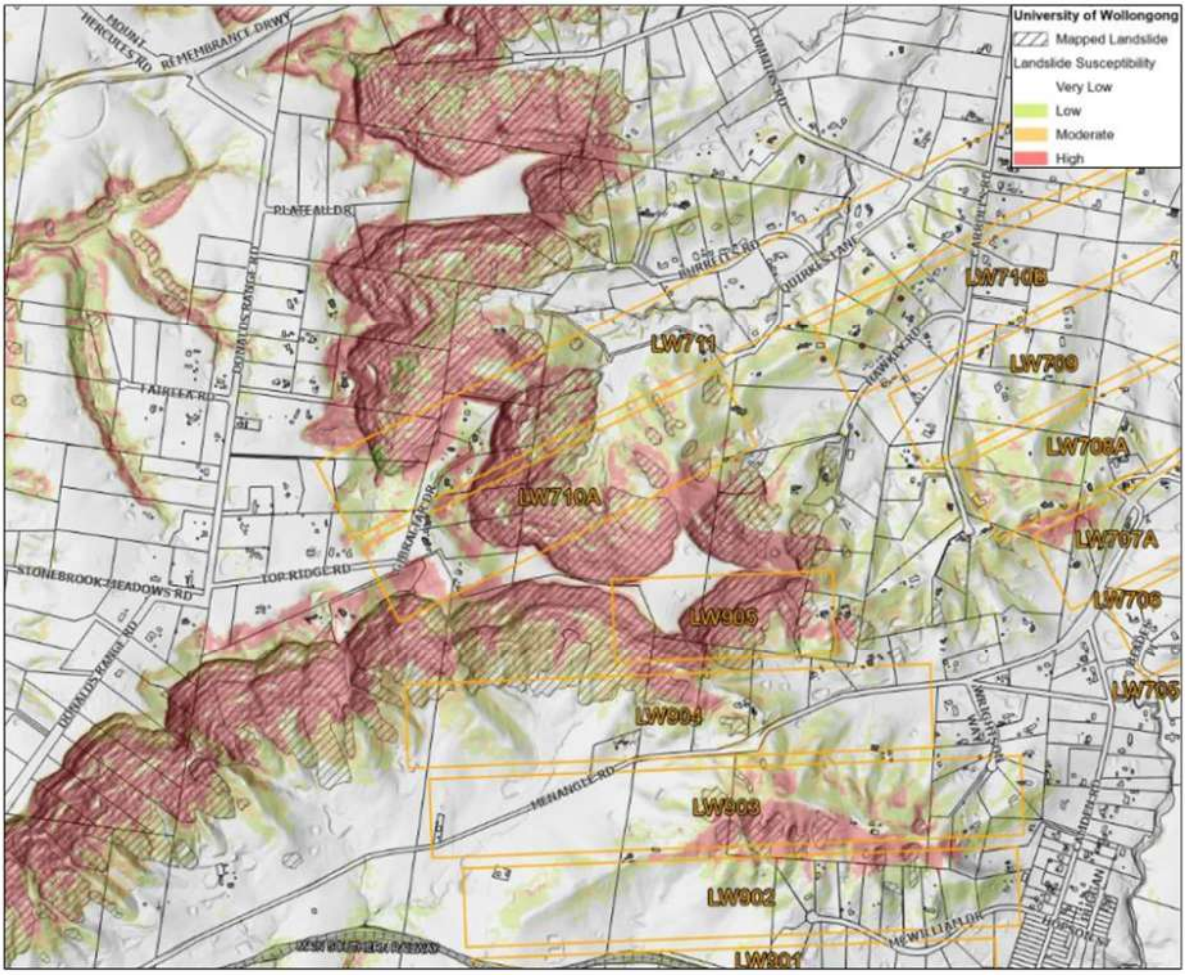
Property Identification	Key Geomorphological and Landslide Related Features	Photo Ref.
Properties on Foot slopes of Razorback Escarpment		
120 Dawsons Road, S48	• Property spans from Razorback Escarpment, across the steep lower slopes and out onto gentle slopes toward the valley floor. • The main (upper) dwelling situated on the toe of the steep slopes but on a cut to fill platform on a broad ridgeline. Secondary dwelling lower down the same ridge surrounded by gentle slopes. • Slopes behind (upslope) and adjacent to the upper dwelling are relatively steep and undulating to hummocky, flattening out below the downslope fill batter. These slopes are covered in colluvium, with common sandstone boulders embedded and lying on the surface. • No indication of deep-seated instability since the dwellings construction some 30 years ago was reported by the landowner. The fill batter appears to be prone to minor creep instability. • Upper slopes along western portion of the property are steep and covered in thick vegetation restricting ability to inspect. Toe of slope has been cleared for grazing, where the degraded lobes of historic landslides can be deduced. • An area of more active landsliding (debris flow) and erosion was observed along slope from the main dwelling, and this feature is clearly identifiable on the hill shade images. This feature was also highlighted by the landowner as a known area of more recent instability. Feature is isolated from any structures and does not result in any real consequence to the function of the property other than an area of increased erosion. Sandstone bedrock was observed outcropping in the base of the scarp. • The Escarpment was not accessed due to the coverage with thick vegetation. Rock fall derived from cliff-line instability impacting the dwelling is considered 'possible', and detailed rock fall simulation would be beneficial. No reports of boulders having rolled downslope onto the lower slopes over the previous ~30 years. • Only sporadic active use by land users on lower portion of steep slopes, and no real indication of land users accessing the upper slopes below the Escarpment.	11 to 14
130 Cummins Road, S29	• Property straddles a prominent ridgeline leading down from Razorback Escarpment and includes the steep upper slopes each side of the ridgeline below the Escarpment. • The main dwelling is situated on a cut to fill platform which straddles the ridgeline. The upslope cut is retained by a ~1.5 m to 2 m high concrete panel wall south of the dwelling which changes to a brick wall of around 1m to 1.5m high behind the dwelling. • The fill batter below the dwelling is effectively benched by the fact an access track has been cut across the batter mid slope. Individual batters are formed at approximately 1H:1V to 2H:1V, and the upper batter has had the toe undercut to facilitate construction of the track. These batters were undulating to slightly hummocky, which may be an indication of previous minor instability or creep. • The lower side slopes of the ridgeline surrounding the main dwelling are grassed and appeared relatively smooth to very gently undulating, no indication of recent instability observed. • An access track is constructed from the dwelling along the slope behind the retaining wall and onto the ridge where it provides access to the Escarpment at the western property boundary. • The upper gully side slopes are very steep (>30^{o}) and covered in very thick scrub, which makes meaningful observation impractical. • Sandstone of the Mount Hercules Sandstone member outcrops at the crest of the Escarpment, forming small, localised outcrops. The outcrops displays detachment of rock mass, and debris field upon the steep slopes below, characterised by accumulations of sandstone boulders, which are sub-angular, <1 m diameter with run out distances in the order of <10 to 20 m. • Further down the slope, Sandstone of the Razorback Sandstone member outcrops along the access track, forming small, localised cliffs / outcrops <2m high. • Cliff-line instability impacting the dwelling is considered 'rare' due to the off-set distance to the cliff-line near the western property boundary (300m+) and the topographical isolation of the dwelling being constructed on a ridgeline. • No indication of active use by land users on slopes below the Escarpment. Occasional use of the access track to the rear of the property is likely.	15 to 18
156 Cummins Road, S27	• Property situated across the lower two-thirds of the south facing steep slopes below an east trending ridgeline which leads down from Razorback Escarpment. • The main dwelling is situated on a cut to fill platform near to toe of the steep slopes. • The upslope cut is retained by a ~0.5 m high timber wall which transitions to a sandstone block wall at the northern end of about the same height. • The fill batter below the dwelling is formed at approximately 2H:1V, well grassed and relatively unfirm and smooth. • A basketball court has also recently been cut into the slope north of the dwelling. Soft, wet colluvium soil was exposed in the cut, with some rill erosion apparent. • The cut to fill platform for the dwelling appears to have been constructed 'over' the southern edge of the toe of a large, complex historic flow-slide landslide feature. Wet ground (possible seepage) was observed on the lower slope about where the fill batter abuts the landslide debris lobe. This feature is clearly identifiable on the hill shade images. • A degraded scarp is apparent to the north of the dwelling, above the debris lobe. • A more localised translational / rotational landslide in the colluvium slope immediately behind shed was observed. The landslide appears to be active, with a defined head scarp, and extensive tension cracking within the lower displaced soil mass. Discussions with the landowner indicates this landslide was initially triggered during a heavy rainfall event in 2022, with the debris hitting the back of the shed but not causing any significant damage. The debris has since been cleaned up and the toe of the landslide removed. Continued instability is considered almost certain. Surface run off into the landslide resulting in rill erosion within the landslide was also apparent. This feature is clearly identifiable on the hill shade images. • The upper gully side slopes are very steep (>30^{o}) and covered in very thick scrub, which makes meaningful observation impractical. • Rock fall derived from cliff-line instability impacting the dwelling is considered 'possible', and detailed rock fall simulation would be beneficial. • No indication of active use by land users on the steep slopes below the Escarpment.	19 to 24

Property Identification	Key Geomorphological and Landslide Related Features	Photo Ref.
790 Remembrance Drive, R42	• Very large rural property spans from the northern end of the Razorback Escarpment and staddles two north trending drainage gullies with a well-defined ridgeline through middle. • The main dwelling(s) and structures are situated on the toe of the well-defined north trending ridgeline which descends down from the Razorback Escarpment. Surrounding slopes are gentle and smooth. • Heads and side slopes of the drainage gullies are moderately sloping toward the base, becoming very steep in the upper half, with well-defined crestal cliff lines around the perimeter, which form the Razorback Escarpment. • Heads and steep side slopes of the gullies are covered in thick vegetation restricting ability to inspect. • A large complex landslide feature can be observed on the eastern side slopes, with a defined debris lobe jutting out into the lower slope, with a toe immediately adjacent to the driveway. The head of this landside appears to have undermined the western edge of Remembrance Driveway. This feature is clearly identifiable on the hill shade images. • A second area of somewhat active landsliding (debris flow) and erosion was observed on the steep slopes on the western side of the middle ridgeline, above the large dam in the southwest portion of the property. This feature is clearly identifiable on the hill shade images. Feature is isolated from any structures and does not result in any real consequence to the function of the property other than an area of increased erosion. Sandstone bedrock was observed outcropping in the base of the scarp. • Sandstone of the Mount Hercules Sandstone member outcrops at the crest of the Escarpment, forming small, localised cliffs (<5 m height). • Adjacent and lower slopes are very steep (>30^{o}), and soil creep is also evident. • The cliff face displays detachment of rock mass from the cliff-line, and debris field upon the steep slopes below the cliff-line, characterised by accumulations of sandstone boulders, which are sub-angular, <1 m diameter with run out distances in the order of <10 to 20 m. • The drainage gullies were often deeply incised with very steep banks. A deep incision has also formed in the drainage line below the spillway in the southwestern dam. • Only sporadic active use by land users on lower portion of steep slopes associated with livestock grazing, and no real indication of land users accessing the upper slopes below the Escarpment. • The upper plateau is undeveloped other than the presence of a shallow earth dam, set well back from the Escarpment. • Cliff-line instability impacting the dwelling is not considered a credible hazard due to the off-set distance to the cliff-line near the western property boundary (500m+) and the topographical isolation of the dwelling being constructed on a shallow ridgeline. • Structures are also geotechnically isolated from areas of historical landslide activity as they are situated on gentle slopes offset by some 200 m+.	25 to 30

11.0 Landslide Distribution

These earlier studies typically included supporting figures which displayed landslide mapping, with reference to landslide susceptibility classification, which was derived from a fairly sophisticated and in-depth GIS-based data management process, as presented by Flentje et al, 2011 (15), with an example reproduced in **Figure 14**.

Figure 14: Landslide Inventory and Susceptibility Interpretation (14)



As the landslide susceptibility mapping was not made available to SLR, we have undertaken a simplified appraisal of the distribution of historical landslides along the Razorback Escarpment and lower slopes within the Study Area.

The historical landslide complexes are clearly identifiable in the hill shade and can often be observed in the field where not obscured by the thick vegetative cover which obscures most of these slopes.

It is apparent that the vast majority of medium to high susceptibility slopes identified in previous studies overlap with mapped historical landslides, with peripheral areas of medium to high susceptibility (where not overlapping with mapped landslides) being typically associated with slopes steeper than about 25^{o}.

As such, in a simplified sense, overlaying the mapped landslides with the slope inclination analysis (**Figure 15**) is considered a sound alternate for assessing landslide susceptibility within the Study Area and is validated with field observations where practical (refer to **Section 10.0**).

284050 284550 285050 285550 286050 286550 287050 287550 288050 288550 289050 289550 290050 290550 291050 291550

6221050 6220550 6220050 6219550 6219050 6218550 6218050 6217550 6217050

NOT MAPPED

LONGWALL 719
LONGWALL 718
LONGWALL 717
LONGWALL 716
LONGWALL 715
LONGWALL 714
LONGWALL 713
LONGWALL 712
LONGWALL 711
LONGWALL 710A
LONGWALL 710B
LONGWALL 709
LONGWALL 708A
LONGWALL 708B
LONGWALL 707A
LONGWALL 707B
LONGWALL 706

NOT MAPPED

NOT MAPPED

Client: GM[3]
Project Number: 660.030515.00001
Scale: 1:20,000
Projection: GDA94 /MGA zone 56
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Sheet Size: A3

LEGEND

- Goaf
- Existing Mine Workings
- Proposed Mine Workings
- Property Boundaries LW712 to LW716
- Study Area Extent
- Historical Landslide and Landslide Complex

Structures
- Basketball Court
- Commercial
- Dam
- House
- Pool
- Public Amenity
- Rural
- Tank
- Tennis Court

2023 LiDAR Slope Degrees
- <= 15 Degrees
- 15 - 20 Degrees
- 20 - 25 Degrees
- 25 - 30 Degrees
- 30 - 35 Degrees
- 35 - 40 Degrees
- 40 - 45 Degrees
- 45 - 50 Degrees
- 50 - 55 Degrees
- 55 - 60 Degrees
- 60 - 85 Degrees

0 200 400 m

SLR
GM[3]

APPIN AREA 7 LW712 TO LW716 LANDSLIDE APPRAISAL

FIGURE 15

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12.0 Landslide Risk Assessment

12.1 General Approach

1 Undertake a desktop review of all pertinent background information (**Section 3.0** to **9.0**) and compile spatial data into a suite of informative Figures.

2 Understand slope forming and geomorphic processes, identify likely landslide hazard mechanisms and susceptibility to landsliding within the Study Area; and consider how these mechanisms may be influenced by mine subsidence effects (**Section 8.0** & **9.0**):

   a) Identify possible consequences associated landslide hazards within the Study Area (**Section 8.2**).

   b) Develop an appreciation of the impact's resultant from mine subsidence on slope instability (**Section 9.3**).

   c) Consider expected groundwater response, including range of effects associated with modification of groundwater due to mining induced subsidence (**Section 9.4**).

3 Conduct an initial appraisal to determine areas of interest (AOI's) for detailed site inspections to build on SLR's existing knowledge base of the Study Area.

4 Undertaken visual inspections over the Study Area, to ground truth the understanding of the area derived from the completed desktop review and existing knowledge base (**Section 10.0**). This included:

   a) Drive around full Study Area, with general mapping and observation carried out wherever possible.

   b) Detailed inspection at seven (7) properties (AOI's) to ground truth the findings of the completed desktop review including; identification of presence of cliff lines, confirmation of landslide hazard mechanisms, evidence and frequency of rock falls, extent and activity of existing landslides.

5 Present an appraisal of landslide distribution and characterise steep slope susceptibility to landsliding within the Study Area (**Section 11.0**).

6 Categorise each property in regard to the inferred geomorphic and potential landslide setting, known site features from previous site visits and previous reporting in terms of instability and hazard identification, the extent of previous and proposed future underground mining.

7 Undertake a landslide risk assessment for the seven (7) AOI's in general accordance with the Australian Geomechanics Society Guidelines for Landslide Risk Management (2007).

8 Profile the properties within the wider Study Area in terms of relative risk, with the aim being to identify residential properties and infrastructure which should be subjected to a site-specific detailed landslide risk assessment which would include determination of appropriate risk mitigation measures for during the mining influence period.

9 Provide recommendations for developing and expanding on the existing monitoring program.

10 Provide recommendations regarding typical corrective management actions.

12.2 First Pass Categorisation

As a first pass categorisation of the 207 properties within the Study Area, SLR adopted a similar process to that used in the 2021 LRA by GHD. The categories adopted were as shown in **Table 2**.

Table 2: Property Category Descriptors

Category	Description	Implications
~~A~~	~~No apparent slope issue relevant to house.~~	Not used by SLR in this assessment.
B	Property, including structures previously assessed by SLR and/or GHD.	May require updated inspection depending on location relative to future Longwalls.
C	Sites near or above already mined Longwalls.	Sites situated on or adjacent to high susceptibility slopes / historic landslide terrain may require updated inspection depending on location relative to future Longwalls.
D	Site's over solid coal and not proposed for mining beneath.	Not likely to require landslide risk assessment unless situated on or adjacent to high susceptibility slopes / historic landslide terrain and close to future Longwalls.
E	Sites on gentle slopes <15^{o} and ridgelines away from Razorback Escarpment.	Pre-mining condition assessment, not likely to require landslide risk assessment (confirmed during pre-mining condition inspection).
F	Sites with slopes steeper than 15^{o} and/or close to the Razorback Escarpment.	Further assessment required to determine relative risk. Significant proportion likely to require detailed, site specific LRA.
~~G~~	~~Sites for which LRM recently completed.~~	Not used by SLR in this assessment.

The first pass categorisation is useful means of understanding the distribution of the various properties across the Study Area and their basic parameters. A full breakdown of the categorisation is included in the Excel spreadsheet output included in **Appendix B**. A summary of the first pass property categorisation is shown in **Table 3**.

Table 3: First Pass Property Categorisation

Category	Outcomes
B	• 65 properties previously inspected by SLR, including 9 with detailed LRA. • 7 properties previously inspected by GHD with existing LRA, 2 visited by SLR as part of this study. • 5 additional properties visited by SLR as part of this study with detailed LRA.
C	• 35 properties above or near previously mined Longwall.
D	• 32 properties over solid coal, not proposed for mining beneath.
E	• 147 with gentle slopes <15^{o} and on ridgelines away from Razorback Escarpment.
F	• 72 properties with slopes steeper than 15^{o} and/or close to the Razorback Escarpment, noting that 36 of the 72 properties are also Cat B, C, D or E or a combination of multiple.

12.3 Risk Assessment

As indicated in **Table 3**, a combined total of 16 LRA's have previously been undertaken by GHD and SLR within the Study Area, with an additional 5 completed by SLR as part of this study.

These 21 LRA's provide the context for appraisal of the geomorphological setting with a view to assessing the landslide risk profile across the Study Area and additionally assessing the impacts that mine subsidence may produce. This is then utilised to derive a relative landslide risk profile for all residential properties within the Study Area. This relative risk profiling can then be utilised to identify those properties which require an on-site, detailed LRA prior to mining to determine appropriate risk mitigation measures required during the subsidence influence period.

The results of the LRA for the 7 properties assessed by SLR as part of this study are presented in an abridged format in **Section 12.3.2**. Detailed LRA worksheets are included in **Appendix C**.

A summary of the relative risk profile over the wider Study Area is presented in **Section 12.3.3,** with the corresponding relative risk ratings also included in the categorisation output included in **Appendix B.**

12.3.1 Methodology

The risk assessment procedure adopted below is based on the AGS Practice Note Guidelines for Landslide Risk Management (2007), (17), and the AS/NZS ISO 31000:2018 Risk Management – Principles and Guidelines (18).

The AGS 2007 guidelines, outline an approach that includes a semi-quantitative risk assessment for risk to property and a quantitative assessment for risk to persons.

As presented in AGS (2007), the semi-quantitative level of risk to property resulting from a landslide event is based on a measure of the likelihood, i.e., the frequency estimate, expressed as an annualized probability and taking into account the probability of spatial impact, shown in **Table 4**, combined with the consequence to property, shown as qualitative terms in **Table 5**.

Likelihood and consequence are combined in the matrix shown in **Table 6**, resulting in risk level that can range from very low (VL) to very high (VH). The standard definitions of the risk levels from AGS (2007c) are presented in **Table 7**.

The quantitative risk to life assessment is the annual probability of loss of life for the person most at risk from the landslide(s), estimated using the equation:

$$\mathbf{R_{(LoL)} = P_{(H)} \times P_{(S:H)} \times P_{(T:S)} \times V_{(D:T)}} \quad (2)$$

Where

$\mathbf{R_{(LoL)}}$	is the risk (annual probability of loss of life (death) of an individual).
$\mathbf{P_{(H)}}$	is the annual probability of the landslide.
$\mathbf{P_{(S:H)}}$	is the probability of spatial impact of the landslide impacting a building (location) taking into account the travel distance and travel direction given the event.
$\mathbf{P_{(T:S)}}$	is the temporal spatial probability (e.g. of the building or location being occupied by the individual) given the spatial impact and allowing for the possibility of evacuation given there is warning of the landslide occurrence.
$\mathbf{V_{(D:T)}}$	is the vulnerability of the individual (probability of loss of life of the individual given the impact).

and where;

$P_{(H)}$ - Probability of detachment - Adapted from RTA Guide to Slope Risk Analysis, Version 4, 2012

$P_{(S:H)}$ - Travel distances estimated from Richie (1963), Site Observations and RTA Guide to Slope Risk Analysis, Version 4, 2012

$P_{(T:S)}$ - Probability that a given failure will interact with the element at risk (e.g., that a road, building or space will be occupied) - Adapted from RTA Guide to Slope Risk Analysis, Version 4, 2012

$V_{(D:T)}$ - Vulnerability estimated from AGS 2007c - Appendix F.

Table 4: Qualitative Measures of Likelihood

Level	Approximate Annual Probability	Description	Descriptor
A	10^{-1}	The event is expected to occur over the design life	Almost Certain
B	10^{-2}	The event will probably occur under adverse conditions over the design life	Likely
C	10^{-3}	The event could occur under adverse conditions over the design life	Possible
D	10^{-4}	The event might occur under very adverse circumstances over the design life	Unlikely
E	10^{-5}	The event is conceivable but only under exceptional circumstances over the design life	Rare
F	10^{-6}	The event is inconceivable or fanciful over the design life	Barely Credible

Table 5: Qualitative Measures of Consequences

Level	Descriptor	Consequence to Property
1	Catastrophic	Structure(s) destroyed and/or large-scale damage requiring major engineering works for stabilisation. Could cause at least one adjacent property major consequence damage.
2	Major	Extensive damage to most of structure, and/or extending beyond site boundaries requiring significant stabilisation works. Could cause at least one adjacent property medium consequence damage.
3	Medium	Moderate damage to some of structure, and/or significant part of site requiring large stabilisation works. Could cause at least one adjacent property minor consequence damage.
4	Minor	Limited damage to part of structure, and/or part of site requiring reinstatement stabilisation works.
5	Insignificant	Little damage.

Table 6: Qualitative Risk Analysis Matrix

Likelihood		Consequence				
		Catastrophic	Major	Medium	Minor	Insignificant
Almost Certain	10^{-1}	VH	VH	VH	H	M or L
Likely	10^{-2}	VH	VH	H	M	L
Possible	10^{-3}	VH	H	M	M	L
Unlikely	10^{-4}	H	M	L	L	VL
Rare	10^{-5}	M	L	L	VL	VL
Barely Credible	10^{-6}	L	VL	VL	VL	VL

12.3.1.1 Acceptability Criteria

It is important to distinguish between “acceptable risks” and “tolerable risks”. Tolerable risks are risks within a range that society can live with to secure certain benefits. The range of risk is regarded as non-negligible and needs to be kept under review and reduced further if practicable.

Acceptable risks are risks that everyone affected is prepared to accept. Action to further reduce such risk is usually not required unless reasonably practicable measures are available at low cost in terms of money, time and effort.

AGS suggests that for most development in existing urban areas, criteria based on Tolerable Risks levels are applicable because of the trade-off between the risks, the benefits of development and the cost of risk mitigation. Whilst the properties being assessed within the Study Area are not strictly in an urban setting, the principal of the assessment is fundamentally the same. By utilizing this approach, the outcome is likely to be more conservative, which is considered appropriate considering the available information.

As indicted in **Table 7**, and considering the relatively short-term nature of the risk period during mining, a risk of moderate or lower is considered a tolerable level, whilst risk mitigation measures should be implemented to lower any risk to 'As Low As Reasonably Practical' or ALARP. A risk of low or very low is considered acceptable.

Table 7: Risk Level Implications

Risk Level		Example Implications
VH	Very High	Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low; may be too expensive and not practical.
H	High	Unacceptable without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to Low.
M	Moderate	May be tolerated in certain circumstances (subject to regulator's approval) but requires investigation, planning and implementation of treatment options to reduce risk to Low.
L	Low	Usually acceptable to regulators. Where treatment has been required to reduce the risk to this level, ongoing maintenance is required.
VL	Very Low	Acceptable. Manage by normal slope maintenance procedures.

The AGS suggested tolerable level of risk for loss of life is as summarised below:

Table 1: AGS Suggested Tolerable loss of life individual risk.

Situation	Suggested Tolerable Loss of Life Risk for the person most at risk
Existing Slope (1) / Existing Development (2)	10^{-4} / annum
New Constructed Slope (3) / New Development (4) / Existing Landslide (5)	10^{-5} / annum

Acceptable risks are usually considered to be one order of magnitude lower than the Tolerable Risks.

12.3.2 Quantitative and Semi-Quantitative Risk Assessment Results

The risk assessment considers the cumulative effects from the natural hazards identified across the Study Area, and existing man-made (anthropogenic) features, combined with the potential contribution from mine subsidence in the appraisal of landslide likelihood and the associated consequence in the event of instability.

Table 8 summarises the assessment of landslide risk to property and person(s) prior to any risk mitigation measures. Detailed LRA worksheets are included in **Appendix C**.

Table 8: Quantitative and Semi-Quantitative Risk Assessment Summary

Property	Inherent Landslide Risk Profile - Pre Mining			Landslide Risk Profile – With Underground Mining Induced Subsidence			
	Landslide Hazard Context	Cumulative Qualitative Risk to Property	Combined Quantitative Risk to Life	Potential Adverse Subsidence Influence	Cumulative Qualitative Risk to Property	Combined Quantitative Risk to Life	Comparison with Acceptability Criteria
O05 - 16 Gibraltar Drive	Dwelling situated upon plateau area set back from crestal cliff line that forms the Razorback Escarpment. Instability and regression of cliff line presents the predominant overall landslide hazard(s).	Very Low to Low	$7.4x10^{-6}$	Increased tilt. Increased curvature and strain. Reduction in shear strength. Increased surface water infiltration via subsidence induced cracking.	Low	$3.7x10^{-5}$	Acceptable
O06 - 19 Gibraltar Drive	Dwelling situated upon plateau area set back from crestal cliff line that forms the Razorback Escarpment. Instability and regression of cliff line presents the predominant overall landslide hazard(s).	Very Low	$6.4x10^{-6}$		Very Low to Low	$3.2x10^{-5}$	Acceptable
R09 - 85 Donalds Range Road	Dwelling situated upon plateau area set back from crestal cliff line that forms the Razorback Escarpment. Instability within fill slope below shed, dam embankment and creep of existing landslide below driveway present the predominant overall landslide hazard(s).	Very Low to Low	$1.2x10^{-5}$		Very Low (Dwelling), Moderate (Shed, Dam)	$2.3x10^{-5}$	Tolerable - ALARP
S48 - 120 Dawsons Rd (Razorback Stud)	Main dwelling situated upon toe of steep slopes below the Razorback Escarpment, historical landslide complexes either side. Instability within steep slopes upslope form the main dwelling presents the predominant overall landslide hazard. As dwelling is below and within reasonable proximity below the Escarpment rock fall presents a possible hazard.	Very Low to Moderate	$6.1x10^{-5}$	Increased tilt. Increased curvature and strain. Reduction in shear strength. Increased surface water infiltration via subsidence induced cracking. Increased lateral groundwater flow.	Low to Moderate	$3.0x10^{-4}$	Tolerable - ALARP
S29 - 130 Cummins Road	Main dwelling situated upon side spur below the Razorback Escarpment with steep slopes and historical landslide complexes either side. Instability within steep slopes upslope form the main dwelling presents the predominant overall landslide hazard.	Low to Moderate	$4.2x10^{-6}$		Low to Moderate	$6.2x10^{-5}$	Tolerable - ALARP
S27 - 156 Cummins Road	Main dwelling situated upon steep south facing side slope below the Razorback Escarpment, with Main Dwelling constructed on a cut to fill platform over a large historical complex landslide. Recent translational slide impacted shed (during 2022 storm events). Instability within landslide complex upslope and beneath the main dwelling present the predominant overall landslide hazard(s). As dwelling is below and within reasonable proximity below the Escarpment rock fall presents a possible hazard.	Moderate to High	$2.5x10^{-4}$	Increased tilt. Increased curvature and strain. Reduction in shear strength. Increased surface water infiltration via subsidence induced cracking. Increased lateral groundwater flow.	Moderate to High	$1.3x10^{-3}$	Unacceptable without Risk Mitigation
R42 - 790 Remembrance Drive	Main dwelling situated upon gentle slopes at toe of north trending ridgeline which leads down from the Razorback Escarpment with steep slopes and historical complex landslide upslope and east of driveway (outside Study Area presents the predominant overall landslide hazard.	Very Low (Dwelling), Moderate (Driveway)	$2.0x10^{-5}$		Very Low (Dwelling), Moderate (Driveway)	$2.0x10^{-5}$	Tolerable - ALARP

As discussed in **Section 9.3**, and as demonstrated in **Table 8,** mine subsidence may create a minor increase in the likelihood of instability on steep slopes and/or existing landslides, noting that the consequences of landslides, should they occur, would remain unchanged. This indicates the inherent risk of a property will govern the risk profile during the subsidence influence period, with only occasional examples of where the risk rating may be increased in the short term due to a short-term increase in the likelihood.

Subsidence induced cracking is considered the most likely impact, which may affect rockfaces, and while the consequences associated with these hazards is typically 'Minor'' to ‘Insignificant’ in the context of the Razorback Escarpment, the higher likely hood results in a ‘Moderate’ at some properties. Additionally, other properties with ‘Moderate’ landslide risk, whilst typically considered tolerable, are recommended to be included in the planning and implementation of risk mitigation measures during the mining influence period to reduce the overall level of risk to ‘As Low As Reasonably Practical’ or ALARP.

Further, it is apparent that an inherent ‘High’ landslide risk exists at some properties within the Study Area (e.g., 156 Cummins Road), which is considered unacceptable under the AGS 2007c guidelines. Detailed investigation, planning and implementation of treatment options will be required to reduce risk to a tolerable level during the subsidence influence period.

Further discussion of appropriate risk mitigation measures is included in **Section 13.0**.

12.3.3 Study Area Relative Risk Profiling

Using the outcomes from **Section 12.3.2**, and the data and observations presented in the earlier sections of this report, the residential sites across the Study Area have been assessed in terms of a relative risk profile.

The aim of the relative risk profiling is to identify residential properties and infrastructure in higher risk environments which should be prioritised and subjected to a site-specific detailed LRA, which would include identification of landslide hazards, assessment of the risk and determination of appropriate risk mitigation measures for implementation during the mining influence period.

It is envisioned that assessment of the residential sites that require detailed LRA could be completed as part of the pre mining condition inspections, currently conducted on a longwall-by-longwall basis for each longwall across the Study Area, with the risk mitigation measures controlled within the Built Features Management Plan. Higher risk sites may require additional investigation and would benefit from early assessment.

A summary of the relative risk profiling is included in **Table 9**, and visually represented in **Figure 16.** The full breakdown of the categorisation and relative risk rating is included in the Excel spreadsheet output included in **Appendix B.**

Table 9: Relative Risk Profiling Summary

Priority	Indicative Relative Risk Rating	Closest Longwall - Property References	Commentary and Recommendations
1	Moderate to High	**LW712** - S09, S10 **LW713 -** S15 **LW714 -** S19, S22, S23, S24, S25, S26, S27, S28 **LW715 -** S21	• Detailed, site-specific LRA recommended as part of pre-mining condition inspections. • Detailed site investigation and monitoring prior to subsidence influence period recommended. Longer lead time prior to mining recommended. • Advanced planning and implementation of risk mitigation measures prior to and during the mining influence period required to reduce the overall level of risk to a tolerable level. • Treatment measures may be required prior to subsidence influence period.
2	Moderate	**LW713** - S17 **LW714** - S18, S32 **LW716** - R40, R41 **LW717** - S50	• Detailed, site-specific LRA recommended as part of pre-mining condition inspections. Longer lead time prior to mining recommended. • Planning and implementation of risk mitigation measures during the mining influence period to reduce the overall level of risk to 'As Low As Reasonably Practical' or ALARP.
3	Moderate – Previously Assessed	**LW710A** - F20 **LW710B** - F22 **LW711** - O15, R01, S11 **LW712** - R09, S48 **LW714** - S29 **LW716** - R42	• Site specific LRA already completed and assessed as 'Moderate' risk with additional risk mitigation measures already recommended and/or in place. • For those LW710A, LW710B and LW711 properties, continue as per current management plan during LW711 and re-assess requirement for forward monitoring prior to commencement of LW712. • For those LW712 onwards properties assessed as part of this study – formalise LRA as part of pre-mining condition inspections.
4	Low – Confirm Rating	**LW711** - F31 **LW712** - F35, K02, K03, R03, S01, S02, S03, S04, S05 **LW713** - R14, R16, R34, R35, S16, S43, S44 **LW714** - R33, S31, S33 **LW715** - R20, S20, S45, S46 **LW716** - R38, S47	• Assigned 'Low' relative risk but where confirmation of site setting and assumed 'Low' risk to be confirmed during pre-mining condition inspections. • Where confirmed as 'Low' risk, no site-specific landslide risk mitigation measures are expected to be required.
5	Low – Previously Assessed	**LW709** - C11 **LW710A** - O02, O03, O04, O05, O17, O18 **LW711 -** O06, O07, O08, O19, O20, O22 **LW712** – R02	• Site specific LRA already completed and assessed as 'Low' risk with additional risk mitigation measures already recommended and/or in place. • Continue as per current management plan during LW711 and re-assess requirement for forward monitoring prior to commencement of LW712.
6	Very Low to Low	**LW709 -** C10, D19, D27, D30, D34, D39, D40, F11, F12 **LW710A -** F19, O01, O09 **LW710B -** D13, D17, D18, D20, D21, D23, D25, D26, D31, D32, D33, D56, F10, F21, F23, F24, F25, F27, F28, F32, F33, L01, VS **LW711 -** D09, D10, D11, D12, D14, D15, D16, D22, D24, F26, F29, F30, F34, F37, F39, F43, K01, K04, K05, O11, O13, O14, P42, S13, S14 **LW712 -** C18, C20, D03, D04, D05, D06, D07, D08, F36, F40, F41, F45, F50, F51, F52, S06, S07, S08, P43, P47, P48, S12 **LW713 -** F46, F55, F56, F57, F65, R04, R05, R06, R10, R11, S36, S37, S38, S39 **LW714 -** C23, F59, R15, R17, R31, R32, S30, S34, S35 **LW715 -** C23, F60, F61 **LW716 -** R24, R25, R27, R28, R39, S49 **LW717 onwards -** C26, R22, F62	• Assigned 'Very Low to Low' relative risk, where no site-specific landslide risk mitigation measures are expected to be required. • Pre-mining condition inspections expected as part of SMP. • All properties over LW709, LW710A, LW710B except O01 previously inspected. Just over half of the properties over LW711 previously inspected with remaining in progress or planned at time of writing.
7	N/A	**LW711** - O10, O12, P40, P41 **LW712** - O16, O21, P44, P45, P46 **LW713** - F63, F64, R07, R36, R37, S40, S41 **LW714** - F58, R12,R13, R18 **LW716** – C24, R21, R26	• No credible landslide hazards identified that may affect people or property. • Pre-mining condition inspections expected as part of SMP.

Priority	Indicative Relative Risk Rating	Closest Longwall - Property References	Commentary and Recommendations
	Additional notes: • Undeveloped properties with steep slopes and historic landslides which should be re-assessed if developed prior to subsidence influence period include: o S06, S07, S08, S30. • Properties considered low and very low risk, but which have deeply incised creek lines running through property, which should be assessed for localised stability during pre-mining condition inspections include: o F34, F43, K04, K05, S13, S14, F36, F41, F45, F46, F55, F56, F57, S36		

284050 284550 285050 285550 286050 286550 287050 287550 288050 288550 289050 289550 290050 290550 291050 291550

6219450 6218950 6218450 6217950 6217450 6217050

RELATIVE LANDSLIDE RISK AREAS

- Moderate to High - Detailed LRA with Site Specific Risk Mitigation (Priority)
- Moderate - Detailed LRA with Site Specific Risk Mitigation
- Moderate - Previously Assessed and LRA completed
- Low - Confirmation of Site Setting and Risk Rating
- Low - Previously Assessed and Risk Mitigation Established
- Very Low to Low - Baseline PMI with No Specific Landslide Risk Mitigation
- Low - No Structures on Property - Re-Assess if Developed

LONGWALL719 LONGWALL718 LONGWALL717 LONGWALL716 LONGWALL715 LONGWALL714 LONGWALL713 LONGWALL712 LONGWALL711 LONGWALL710A LONGWALL710 LONGWALL709 LONGWALL708B LONGWALL708A LONGWALL707B LONGWALL707A LONGWALL706

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LEGEND

- Goaf
- Existing Mine Workings
- Proposed Mine Workings
- Property Boundaries LW712 to LW716
- Study Area Extent
- Historical Landslide and Landslide Complex

Structures
- Basketball Court
- Commercial
- Dam
- House
- Pool
- Public Amenity
- Rural
- Tank
- Tennis Court

0 200 400 m

SLR
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APPIN AREA 7 LW712 TO LW716 LANDSLIDE RELATIVE RISK

FIGURE 16

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13.0 Risk Mitigation

Risk mitigation and control procedures are well established within the Study Area with existing measures detailed in the MSEC1476 (16) Report, titled “Appin Area 7 Longwall 711 Management Plan for Potential Impacts to Building Structures”. This plan, specifically Section 6, outlines risk control procedures and monitoring measures regarding impacts on residential properties and builds upon a similar one developed for LW710A.

As longwall mining progresses to the north, the risk mitigation and monitoring program contained within the Built Features Management Plan will expand progressively to capture new structures and integrate the findings of this and future, site-specific LRA’s for the LW712 to LW716 Study Area.

To this end, it is envisioned that the relative risk ratings summarised in **Table 9** can be used to inform the site-specific structure inspection plan, and specifically, identification of those properties which require ‘pre-mining geotechnical inspections of steep slopes’, that being properties rated as Priority 1 to 5 in **Table 9**. These properties will include landslide risk assessments in recognition of the natural and man-made hazards in accordance with the concepts and guidelines provided within AGS (2007), together with appraisal of the cumulative effects from mining induced subsidence.

Continuation of monitoring in line with current practice is recommended during active mining. To date, these measures have been successfully implemented to assess whether any evidence of adverse ground movement associated with the development of subsidence is occurring and whether there is any indication that this is contributing to slope instability, particularly in the vicinity of steep, sensitive slopes and historic landslide features. Existing measures being implemented by GM^3 during active mining include:

- Ground and structure survey monitoring.
- Global Navigation Satellite System (GNSS) monitoring for ground movement.
- Groundwater monitoring wells (piezometers).
- Rainfall records (e.g., VS6 and MSR).
- Conducting scheduled (i.e., weekly and monthly) and triggered visual inspections by experienced geotechnical engineers or engineering geologists experienced with both landslide behaviour and subsidence impacts during the active mining period.
- Determining and adjusting the frequency of follow up inspections and monitoring as required depending on the performance of slopes during the subsidence influence period, i.e., based on:
    - Rainfall triggers;
    - GNSS unit and ground survey monitoring triggers.
    - Visual observation triggers informed by observations by geotechnical and/or structural engineer and/or survey, or in response to advice from owner.
    - Structures Review Group (SRG) meetings and review.

As part of future Built Features Management Plan updates, the risk control measures should be reviewed and determined in consultation with geotechnical practitioners based on the outcomes of site-specific LRA’s.

Further, we recommended that additional measures that should be considered on a site-specific basis to address slope instability concerns where a specific hazard to a property has been identified:

- Detailed, geotechnical investigation at identified higher risk hazards, including installation of:
  - Groundwater monitoring wells on steep slopes and historical landslides behind and in the vicinity of dwellings; and
  - Borehole inclinometers.
- Rock fall simulation and stability analysis.
- Determination of requirement for treatment measures such as surface and sub-soil drainage improvements, slope remedial treatments prior to the mining influence period.
- Regular scheduled and triggered geotechnical monitoring and inspections.
- Installation of additional GNSS units and steep slope survey lines.

Commensurate to the required effort to undertake the above, we recommend those properties listed as ‘Priority 1’ in **Table 9** be subjected to a detailed LRA and advanced planning to determine the requirement for the above measures well in advance of the active mining period.

To this end, pre-mining monitoring of certain areas is likely to be beneficial to develop an improved understanding of slope behaviour.

13.1 Corrective Management Actions

Current trigger levels for corrective management actions for areas most at risk of landslide are included in MSEC1476 (16) in particular Table 6.2. Triggering mechanisms considered include:

- Rainfall triggers.
- GNSS unit and ground survey monitoring triggers.
- Visual observation triggers informed by observations by geotechnical and/or structural engineer and/or survey, or in response to advice from owner.
- Detailed dilapidation surveys for detecting early warning indicators such that the LMP Trigger Action Response Plan (TARP) responds in a timely manner, including keeping inhabitants informed.

Additional measures which may be considered for future corrective management actions include:

- Groundwater level rise detected in groundwater wells.
- Slope movement detected in borehole inclinometers.

As part of future Built Features Management Plan updates, corrective management actions and relevant trigger levels should be reviewed and determined in consultation with geotechnical practitioners based on the outcomes of site-specific LRA’s.

14.0 Closing

We trust this report meets your immediate requirements. Should you have any comments or questions, please do not hesitate to contact our office. Lastly, we draw your attention to our standard limitations overleaf which provides some further information in relation to the content of this report.

15.0 Limitations

This Document has been provided by SLR Consulting ("SLR") subject to the following limitations:

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Appendix A Site Observations and Ground Truthing

Client: GM[3]
Project Number: 660.030515.00001
Scale: 1:20,000
Projection: GDA94 /MGA zone 56
Drawn by: AR
Date: 15/05/2025
Sheet Size: A3

LEGEND

- Goaf
- Existing Mine Workings
- Proposed Mine Workings
- Property Boundaries LW712 to LW716
- Study Area Extent

Structures
- Basketball Court
- Commercial
- Dam
- House
- Pool
- Public Amenity
- Rural
- Tank
- Tennis Court

Property Inspections
- Property Reference Code
- Category F Sites
- Previously Inspected by GHD with LRA
- Previously Inspected by SLR
- SLR Extraction Plan Inspections
- LRA Already Completed

0 200 400 m

SLR
GM[3]

APPIN AREA 7 LW712 TO LW716 STUDY AREA INSPECTION STATUS

FIGURE 17

\\au.slr.local\Corporate\Projects-SLR\660-SrvWOL\660-WOL\660.030515.00001 GM3 - LW712 - 716 Extraction P\06 SLR Data\01 GIS\GIS\Site Features LW712-716.qgz

Photo 1: Sandstone cliff line / outcrops forming Razorback Escarpment, with detached boulders evident – 16 Gibraltar Drive



Photo 2: Gentle plateau behind Escarpment (drops away at right edge of photograph) – 16 Gibraltar Drive



Photo 3: Gentle plateau behind Escarpment (drops away at right edge of photograph) – 19 Gibraltar Drive



Photo 4: Larger cliff <10m high below northern end of 19 Gibraltar Drive



Photo 5: Fill batter below shed, behind moderate sloping plateau, set back from Escarpment, where creep occurring - 85 Donalds Range Road



Photo 6: Indicative of 'set-back' of structures on gentle plateau behind Razorback Escarpment – 85 Donalds Range Road



Photo 7: Typical incision into colluvium / landslide debris in gullies on steep slopes. Siltstone / shale bedrock exposed in base - 85 Donalds Range Road



Photo 8: Sandstone outcrop forming crest of Razorback Escarpment - 85 Donalds Range Road



Photo 9: Dam Situated Immediately Behind Steep Slopes near Crest of Escarpment – 85 Donalds Range Road



Photo 10: Area of Creep in Gently Sloping head of Gully. Wet Ground Indicative of Seepage - 85 Donalds Range Road



Photo 11: Southwest corner of property where toe of debris lobes from ancient landslides visible in cleared foot slopes - 120 Dawsons Road



Photo 12: Colluvium slope behind main dwelling - 120 Dawsons Road



Photo 13: Head scarp of active complex / debris flow landslide on steep slopes north (along slopes) from dwelling - 120 Dawsons Road



Photo 14: Relative positioning of main dwelling relative to steep slopes - 120 Dawsons Road



Photo 15: Retained cut along upslope of dwelling - 130 Cummins Road



Photo 16: Fill batter below dwelling at 130 Cummins Road

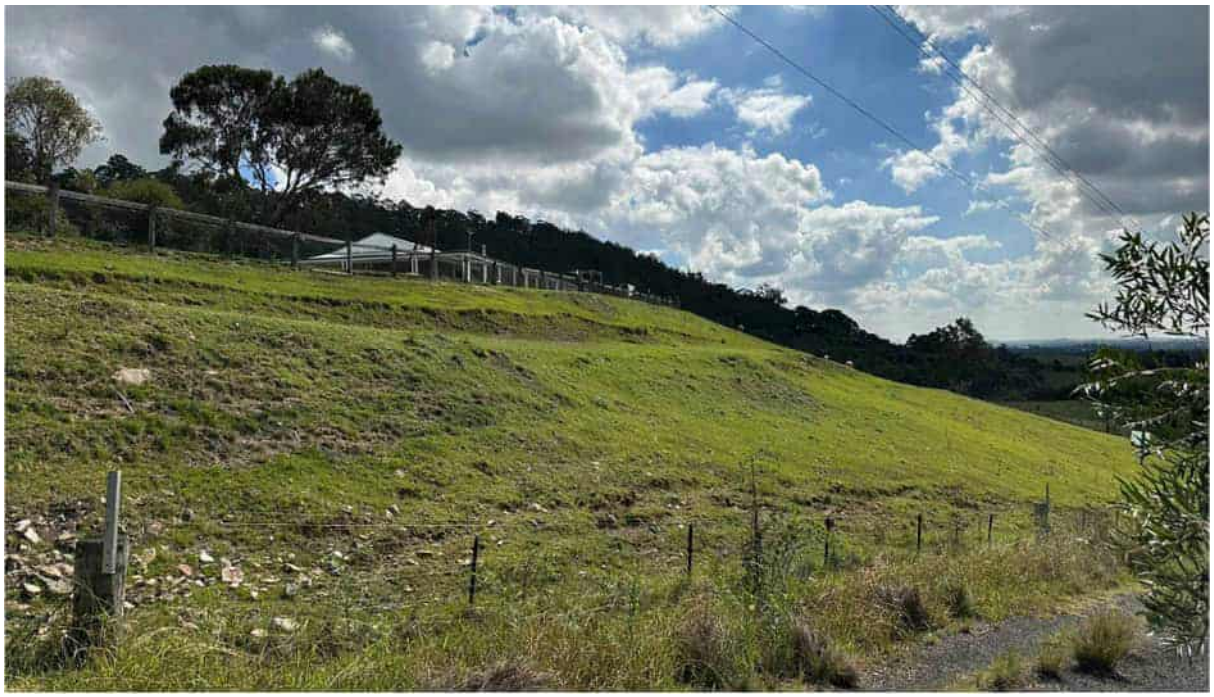


Photo 17: Steep upper slopes below Razorback Escarpment and boulder debris field - 130 Cummins Road



Photo 18: Sandstone outcrop forming Razorback Escarpment and plateau at rear of 865 and 975 Remembrance Drive - taken from 130 Cummins Road



Photo 19: Retain shallow cut along upslope side of dwelling - 156 Cummins Road



Photo 20: Cut into colluvium slope north of dwelling - 156 Cummins Road



Photo 21: Head of recent rotational / translational slide in colluvium at rear of shed - 156 Cummins Road



Photo 22: Degraded scarp within historic landslide complex at northern edge of dwelling - 156 Cummins Road



Photo 23: Looking down ancient landslide complex at northern edge of dwelling - 156 Cummins Road



Photo 24: Looking up and across to ancient landslide complex along northern edge of dwelling - 156 Cummins Road



Photo 25: Toe of ancient landslide debris lobe - 790 Remembrance Driveway



Photo 26: Steeply incised drainage gully - 790 Remembrance Driveway



Photo 27: Cliff line forming Razorback Escarpment - 790 Remembrance Driveway



Photo 28: Boulder debris field below cliff line - 790 Remembrance Driveway



Photo 29: Scarp in ancient landslide complex on north facing slope - 790 Remembrance Driveway

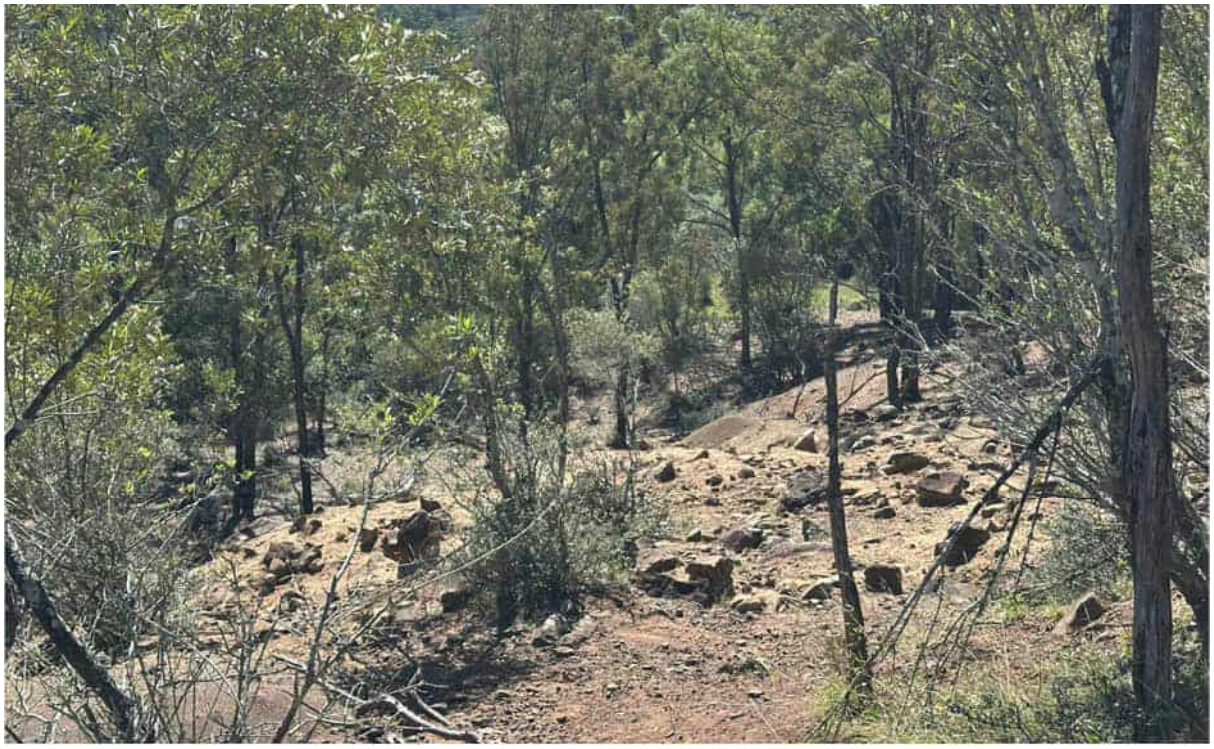


Photo 30: Head of erosion gully below dam spillway - southwest dam 790 Remembrance Driveway



Figure 18: View to the Central Portion of Study Area Looking Northwest Across to Razorback Escarpment Behind Burrells Road from Quirkes Lane

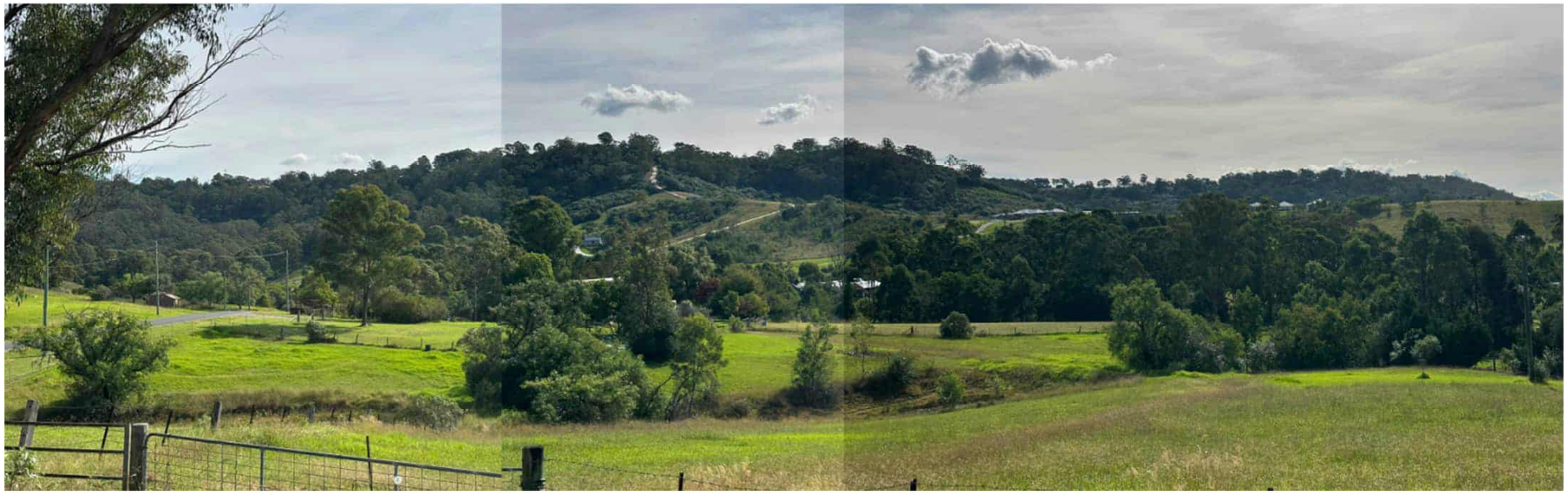


Figure 19: View to the Southern Portion of Study Area Looking South Across Eastern Foot Slopes of Razorback Range from 85 Burrells Road



Figure 20: View to the Central and Southern Portion of Study Area Looking South Across Eastern Foot Slopes of Razorback Range from 130 Cummins Road



Figure 21: View of the Northern Portion of Study Area Looking North Across Eastern Foot Slopes of Razorback Range from 130 Cummins Road



Appendix B Property Catergorisation and Relative Risk Ratings

Address	Property Code	x coord (centroid)	y coord (centroid)	LW	Closest LW	Cat B: Property including house previously assessed by SLR.	Cat C: Sites near or above previously mined Longwall.	Cat D: Solid coal - not proposed for mining beneath.	Cat E: Site's on gentle slopes predominantly <15°, away from Razorback Escarpment	Cat F: Sites close to Razorback Escarpment, and/or slopes predominantly >15°	Comments	Indicative **relative** landslide risk ranking	Detailed LRA required	Additional Recommendations
475 Menangle Rd, Menangle 2568	C10	290130	6218355	LW709 & LW710B	LW709	Yes	Yes		Yes		Previously inspected by SLR, already mined beneath, with shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
465 Menangle Rd, Menangle 2568	C11	290540	6218627	LW709 to LW711	LW709	Yes	Yes		Yes		Previously inspected by SLR and LRA completed for abandoned Quarry (which is outside study area). Remaining slopes within study area are shallow and over LW711 (will have been mined beneath). Considered 'Low' risk of landslide.	Low	Completed	
486 Menangle Rd, Menangle 2568	D19	289879	6218245	LW709 and LW710B	LW709	Yes	Yes		Yes		Previously inspected by SLR, already mined beneath, with shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
510 Menangle Rd, Menangle 2568	D27	289834	6218140	LW709 and LW710B	LW709	Yes	Yes		Yes		Previously inspected by SLR, already mined beneath, with shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
516 Menangle Rd, Douglas Park 2569	D30	289503	6218024	LW709 and LW710B	LW709	Yes	Yes		Yes		Previously inspected by SLR, already mined beneath, with shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
205 Carrolls Rd, Menangle 2568	D34	289166	6217863	LW709 and LW710B	LW709	Yes	Yes		Yes		Previously inspected by SLR, already mined beneath, with shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
229 Carrolls Rd, Menangle 2568	D39	288957	6217717	LW709	LW709	Yes	Yes		Yes		Previously inspected by SLR, already mined beneath, with shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
225 Carrolls Rd, Menangle 2568	D40	288833	6217729	LW709 and LW710B	LW709	Yes	Yes		Yes		Previously inspected by SLR, already mined beneath, with shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
25 Hawkey Rd, Menangle 2568	F11	288602	6217631	LW709 and LW710B	LW709	Yes	Yes		Yes		Previously inspected by SLR, already mined beneath, with shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
45 Hawkey Rd, Menangle 2568	F12	288481	6217500	LW709 and LW710B	LW709	Yes	Yes		Yes		Previously inspected by SLR, already mined beneath, with shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
50 Hawkey Rd, Menangle 2568	F19	288069	6217445	LW710A	LW710A	Yes	Yes			Yes	Previously inspected by SLR, already mined beneath by LW710A / LW710B and majority of property over middle chain pillar between LW710A and LW710B, shallow to moderate slopes. Considered ' Low' risk of landslide.	Low	No	
135 Quirkes Lane, Menangle 2568	F20	287472	6217238	LW710A and LW711 and LW905	LW710A	Yes				Yes	Previously inspected by SLR, with vast area of high susceptibility slopes and mapped landslides, although remote from main dwelling, assessed as 'Low' to 'Moderate' risk of Landslide due to LW710A / 711. Majority of property mined beneath. Expected to be at 'Low' risk of landslide during LW712 onwards.	Low to Moderate	Completed	Continue as per current management plan until completion of LW711. Re-assess risk at completion of LW711 to confirm 'Low' risk for LW712 onwards.
4 Top Ridge Rd, Razorback 2571	O01	286172	6216745	West of LW710A	LW710A		Yes		Yes		West of LW710A, structures over solid coal, with shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
10 Gibraltar Dr, Razorback 2571	O02	286892	6216845	LW710A	LW710A	No - previously assessed by GHD	Yes			Yes	Assessed in GHD (2023) as 'Low' indicative hazard rating for landslide hazards. Structures situated "back" from crestal cliff line that forms Razorback Escarpment on relatively flat plateau. Dwellings situated above footprint of LW710A, having already been undermined with no recorded instability related to mining effects of natural processes.	Low	Completed	
12 Gibraltar Dr, Razorback 2571	O03	286853	6216973	LW710A	LW710A	No - previously assessed by GHD	Yes			Yes	Assessed in GHD (2023) as 'Low' indicative hazard rating for landslide hazards. Structures situated "back" from crestal cliff line that forms Razorback Escarpment on relatively flat plateau. Dwellings situated above footprint of LW710A, having already been undermined with no recorded instability related to mining effects of natural processes.	Low	Completed	
14 Gibraltar Dr, Razorback 2571	O04	286871	6217097	LW710A	LW710A	No - previously assessed by GHD	Yes			Yes	Assessed in GHD (2023) as 'Low' indicative hazard rating for landslide hazards. Structures situated "back" from crestal cliff line that forms Razorback Escarpment on relatively flat plateau. Dwellings situated above footprint of LW710A, having already been undermined with no recorded instability related to mining effects of natural processes.	Low	Completed	
16 Gibraltar Dr, Razorback 2571	O05	286929	6217232	LW710A and LW711	LW710A	No - previously assessed by GHD, visited by SLR as part of this study				Yes	Inspected by SLR 10/04/2025. Assessed in GHD (2023) as 'Low' indicative hazard rating for landslide hazards. Structures situated "back" from crestal cliff line that forms Razorback Escarpment on relatively flat plateau. Situated over the footprint of LW711 which is to the north of LW710A. Risk profile validated by SLR inspection 9/4/2025.	Low	Completed	
7 Top Ridge Rd, Razorback 2571	O09	286457	6216979	West End LW710A and 711	LW710A	Yes	Yes		Yes		Previously inspected by SLR, already mined beneath, with shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	

Address	Property Code	x coord (centroid)	y coord (centroid)	LW	Closest LW	Cat B: Property including house previously assessed by SLR.	Cat C: Sites near or above previously mined Longwall.	Cat D: Solid coal - not proposed for mining beneath.	Cat E: Site's on gentle slopes predominantly <15°, away from Razorback Escarpment	Cat F: Sites close to Razorback Escarpment, and/or slopes predominantly >15°	Comments	Indicative **relative** landslide risk ranking	Detailed LRA required	Additional Recommendations
8 Gibraltar Dr, Douglas Park 2569	O17	286473	6216738	West of LW710A	LW710A	No - previously assessed by GHD	Yes	Yes		Yes	Assessed in GHD (2023) as 'Low' indicative hazard rating for landslide hazards. Structures situated "back" from crestal cliff line that forms Razorback Escarpment on relatively flat plateau. Dwellings situated west of LW710A, having already been undermined with no recorded instability related to mining effects of natural processes. Monitored during LW904 and LW905 with no detected subsidence impact to dwellings in a landslide context. Geotechnically isolated from natural slope instability that occurred on the lower steep escarpment slopes, which was associated with natural slope forming processes triggered by intense rainfall events during 2022.	Low	Completed	
5 Gibraltar Dr, Douglas Park 2569	O18	286133	6216608	West End LW710A	LW710A	No - previously assessed by GHD	Yes			Yes	Assessed in GHD (2023) as 'Low' indicative hazard rating for landslide hazards. Structures situated "back" from crestal cliff line that forms Razorback Escarpment on relatively flat plateau. Dwellings situated west of LW710A, having already been undermined with no recorded instability related to mining effects of natural processes. Monitored during LW904 and LW905 with no detected subsidence impact to dwellings in a landslide context. Geotechnically isolated from natural slope instability that occurred on the lower steep escarpment slopes, which was associated with natural slope forming processes triggered by intense rainfall events during 2022.	Low	Completed	
450 Menangle Rd, Menangle 2568	D13	289753	6218719	LW710B and LW711	LW710B				Yes		Very shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
460 Menangle Rd, Menangle 2568	D17	289705	6218555	LW710B and LW711	LW710B	Yes			Yes		Previously inspected by SLR with very shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
470 Menangle Rd, Menangle 2568	D18	289879	6218446	LW710B	LW710B	Yes	Yes		Yes		Previously inspected by SLR, already mined beneath, with shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
490 Menangle Rd, Menangle 2568	D20	289779	6218321	LW710B	LW710B	Yes	Yes		Yes		Previously inspected by SLR, already mined beneath, with shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
474 Menangle Rd, Menangle 2568	D21	289541	6218387	LW710B and LW711	LW710B	Yes	Yes		Yes		Previously inspected by SLR, already mined beneath, with shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
155 Carrolls Rd, Menangle 2568	D23	289187	6218431	LW710B and LW711	LW710B	Yes			Yes		Previously inspected by SLR with very shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
175 Carrolls Rd, Menangle 2568	D25	289112	6218221	LW710B and LW711	LW710B	Yes			Yes		Previously inspected by SLR with very shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
514 Menangle Rd, Menangle 2568	D26	289542	6218185	LW710B	LW710B	Yes	Yes		Yes		Previously inspected by SLR, already mined beneath, with shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
185 Carrolls Rd, Menangle 2568	D31	288993	6218112	LW710B	LW710B	Yes	Yes		Yes		Previously inspected by SLR, already mined beneath, with shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
203 Carrolls Rd, Menangle 2568	D32	288922	6217950	LW710B	LW710B	Yes	Yes		Yes		Previously inspected by SLR, already mined beneath, with shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
215 Carrolls Rd, Menangle 2568	D33	288906	6217850	LW710B	LW710B	Yes	Yes		Yes		Previously inspected by SLR, already mined beneath, with shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
165 Carrolls Rd, Menangle 2568	D56	289272	6218293	LW710B and LW711	LW710B	Yes	Yes		Yes		Previously inspected by SLR, already mined beneath, with shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
15 Hawkey Rd, Menangle 2568	F10	288690	6217757	LW710B	LW710B	Yes	Yes		Yes		Previously inspected by SLR, already mined beneath, with shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
115 Quirkes Lane, Menangle 2568	F21	288123	6217652	West End LW710A	LW710B	Yes	Yes			Yes	Previously inspected by SLR, majority of property over middle chain pillars between LW710A and LW710B, already mined, shallow to moderate slopes. Considered ' Low' risk of landslide.	Low	No	
105 Quirkes Lane, Menangle 2568	F22	288185	6217897	LW710B and LW711	LW710B	Yes			Yes		Previously inspected by SLR with LRA . Isolated portion of property has slopes >15 degrees but <20 degrees and uniform. Localised steeper areas associated with dam embankments. Assessed as 'Low to Moderate' risk of landslide due to previously unstable slopes.	Low to Moderate	Completed	Continue as per current management plan until completion of LW711. Re-assess risk at completion of LW711 to confirm risk profile for LW712 onwards.
30 Hawkey Rd, Menangle 2568	F23	288386	6217801	LW710B and LW711	LW710B	Yes	Yes			Yes	Previously inspected by SLR, majority of property over LW710B, already mined, shallow to moderate slopes. Small landslide occurred in 2022 on slope east of main dwelling due to rainfall, does not pose a risk to dwelling. Considered 'Low' risk of landslide.	Low	No	
26 Hawkey Rd, Menangle 2568	F24	288551	6217858	LW710B	LW710B	Yes	Yes			Yes	Previously inspected by SLR, majority of property over LW710B, already mined, shallow to moderate slopes. Small landslides occurred in 2022 on slope north of main dwelling due to rainfall, does not pose a risk to dwelling. Considered 'Low' risk of landslide.	Low	No	
210 Carrolls Rd, Menangle 2568	F27	288723	6218016	LW710B and LW711	LW710B	Yes	Yes		Yes		Previously inspected by SLR, already mined beneath, with shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
190 Carrolls Rd, Menangle 2568	F28	288722	6218174	LW710B and LW711	LW710B				Yes		Shallow slopes. Considered ' Low' risk of landslide.	Low	No	

Address	Property Code	x coord (centroid)	y coord (centroid)	LW	Closest LW	Cat B: Property including house previously assessed by SLR.	Cat C: Sites near or above previously mined Longwall.	Cat D: Solid coal - not proposed for mining beneath.	Cat E: Site's on gentle slopes predominantly <15°, away from Razorback Escarpment	Cat F: Sites close to Razorback Escarpment, and/or slopes predominantly >15°	Comments	Indicative **relative** landslide risk ranking	Detailed LRA required	Additional Recommendations
10 Hawkey Rd, Menangle 2568	F32	288645	6217928	LW710B	LW710B	Yes	Yes			Yes	Previously inspected by SLR, already mined beneath by LW710B, shallow to moderate slopes, minor steeper areas associated with cut and fill batters. Considered ' Low' risk of landslide.	Low	No	
40 Hawkey Rd, Menangle 2568	F33	288370	6217668	LW710B	LW710B	Yes	Yes			Yes	Previously inspected by SLR, already mined beneath by LW710B, shallow slopes, minor steeper areas associated with cut and fill batters. Considered ' Low' risk of landslide.	Low	No	
195 Carrolls Rd, Menangle 2568	L01	289160	6218040	LW710B	LW710B	Yes	Yes		Yes		Previously inspected by SLR, already mined beneath, with shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
345 Menangle Rd, Menangle 2568	VS	290378	6219178	East of LW711	LW710B			Yes	Yes		Structures are east of LW711 over eastern chain pillars, with shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
65 Quirkes Lane, Menangle 2568	F25	288397	6217980	LW710B and LW711	LW710B and LW711				Yes		Previously inspected by SLR. Isolated portion of property has slopes >15 degrees but <20 degrees and uniform. Localised steeper areas associated with dam embankments and cut to fill batters. Considered 'Low' risk of landslide.	Low	No	
5 Finns Rd, Menangle 2568	D09	289706	6218953	LW711 and LW712	LW711	Yes			Yes		Previously inspected by SLR, already mined beneath, with shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
3 Finns Rd, Menangle 2568	D10	289916	6218953	LW711	LW711	Yes			Yes		Previously inspected by SLR with very shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
430 Menangle Rd, Menangle 2568	D11	289921	6218848	LW711	LW711	Yes			Yes		Previously inspected by SLR with very shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
436 Menangle Rd, Menangle 2568	D12	289901	6218751	LW711	LW711	Yes			Yes		Previously inspected by SLR with very shallow natural slopes, localised fill batters. Considered 'Low' risk of landslide.	Low	No	
454 Menangle Rd, Menangle 2568	D14	289536	6218763	LW711	LW711				Yes		Very shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
115 Carrolls Rd, Menangle 2568	D15	289216	6218812	LW711 and LW712	LW711	Yes			Yes		Previously inspected by SLR with shallow slopes. Considered 'Low' risk of landslide.	Low	No	
125 Carrolls Rd, Menangle 2568	D16	289201	6218629	LW711 and LW712	LW711				Yes		Very shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
145 Carrolls Rd, Menangle 2568	D22	289012	6218521	LW711	LW711	Yes			Yes		Previously inspected by SLR with very shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
163 Carrolls Rd, Menangle 2568	D24	289011	6218336	LW711	LW711	Yes			Yes		Previously inspected by SLR with very shallow slopes, considered 'Very Low' risk of landslide.	Very Low	No	
35 Quirkes Lane, Menangle 2568	F26	288536	6218129	LW711	LW711	Yes			Yes		Previously inspected by SLR with shallow slopes. Considered 'Low' risk of landslide.	Low	No	
174 Carrolls Rd, Menangle 2568	F29	288724	6218270	LW711	LW711	Yes			Yes		Previously inspected by SLR with shallow slopes. Considered 'Low' risk of landslide.	Low	No	
170 Carrolls Rd, Menangle 2568	F30	288761	6218357	LW711	LW711	Yes			Yes		Previously inspected by SLR with shallow slopes. Considered 'Low' risk of landslide.	Low	No	
120 Quirkes Lane, Menangle 2568	F31	287608	6217798	LW711 and LW712	LW711	Yes			Yes		Previously inspected by SLR with shallow slopes. Considered 'Low' risk of landslide. Confirm risk due to downstream impacts from landslides originating from 135 Quirkes Lane is 'Low' as being assessed by GHD.	Low	No - subject to confirmation	Confirm risk due to downstream impacts from landslides originating from 135 Quirkes Lane is 'Low' as being assessed by GHD.
30 Quirkes Lane, Menangle 2568	F34	288412	6218303	LW711 and LW712	LW711	Yes			Yes		Previously inspected by SLR with shallow slopes. Generally considered 'Low' risk of landslide.	Low	No	Recommend creek bank stability assessment be included in updated pre mining inspections.
10 Cummins Rd, Menangle 2568	F37	288602	6218547	LW711 and LW712	LW711	Yes			Yes		Previously inspected by SLR with shallow slopes. Generally considered 'Low' risk of landslide. Additional recommendations are provided in SLR report regarding creek bank instability and possible influence on northern Dam.	Low	No	
150 Carrolls Rd, Menangle 2568	F39	288758	6218506	LW711 and LW712	LW711				Yes		Very shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	

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80 Quirkes Lane, Menangle 2568	F43	287974	6217833	LW711	LW711	Yes			Yes		Previously inspected by SLR. Isolated portion of property has slopes >15 degrees but <20 degrees and uniform. Localised steeper areas associated with dam embankments and creek banks north of residential dwelling. Structures considered at 'Very Low' risk of landslide.	Low	No	Recommend creek bank stability assessment be included in updated pre mining inspections.
10 Burrells Rd, Menangle 2568	K01	288211	6218208	LW711 and LW712	LW711				Yes		Isolated northern corner of property has slopes >15 degrees but <20 degrees and uniform. Localised steeper areas associated with creek banks east of residential dwelling. Considered ' Low' risk of landslide.	Low	No	
15 Burrells Rd, Menangle 2568	K04	288084	6218059	LW711	LW711				Yes		Very shallow to flat slopes with the exception of the steeply incised creek line along southern boundary. Structures considered at 'Very Low' risk of landslide.	Very Low	No	Recommend creek bank stability assessment be included in pre mining inspections.
35 Burrells Rd, Menangle 2568	K05	287933	6217970	LW711	LW711				Yes		Very shallow to flat slopes with the exception of the steeply incised creek line along southern boundary. Structures considered at 'Very Low' risk of landslide.	Very Low	No	Recommend creek bank stability assessment be included in pre mining inspections.
19 Gibraltar Dr, Razorback 2571	O06	286990	6217390	LW711	LW711	No - previously assessed by GHD, visited by SLR as part of this study				Yes	Inspected by SLR 10/04/2025. Assessed in GHD (2023) as 'Low' indicative hazard rating for landslide hazards. Structures situated "back" from crestal cliff line that forms Razorback Escarpment on relatively flat plateau. Situated over the footprint of LW711 which is to the north of LW710A. Risk profile validated by SLR inspection 9/4/2025.	Low	Completed	
17 Gibraltar Dr, Razorback 2571	O07	286835	6217439	LW711	LW711	No - previously assessed by GHD.			Yes	Yes	Assessed in GHD (2023) as 'Low' indicative hazard rating for landslide hazards. Property situated over LW711, structures on shallow plateau, set well back from Razorback Escarpment. Considered 'Low' risk of landslide.	Low	Completed	
15 Gibraltar Dr, Razorback 2571	O08	286744	6217272	LW711	LW711	No - previously assessed by GHD.			Yes	Yes	Assessed in GHD (2023) as 'Low' indicative hazard rating for landslide hazards. Property situated over LW711, structures on shallow plateau, set well back from Razorback Escarpment. Considered 'Low' risk of landslide.	Low	Completed	
3 Top Ridge Rd, Razorback 2571	O10	286191	6216957	West End LW710A and 711	LW711				Yes		Partly over western chain pillar of LW711, essentially flat slopes. No credible landslide hazard.	N/A	No	
1 Top Ridge Rd, Razorback 2571	O11	285968	6216875	West of LW711	LW711	Yes	Yes	Yes	Yes		Previously inspected by SLR, west of LW710A, structures over solid coal with shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
185 Donalds Range Rd, Razorback 2571	O12	285986	6217000	West of LW711	LW711			Yes	Yes		West of LW711 over solid coal, essentially flat. No credible landslide hazard.	N/A	No	
175 Donalds Range Rd, Razorback 2571	O13	286030	6217110	West of LW711	LW711	Yes		Yes	Yes		Previously inspected by SLR, west of LW711, structures over solid coal with shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
165 Donalds Range Rd, Razorback 2571	O14	286058	6217188	West of LW711	LW711	Yes		Yes	Yes		Previously inspected by SLR, west of LW711, structures over western pillars with essentially flat slope. Considered 'Very Low' risk of landslide.	Very Low	No	
159 Donalds Range Rd, Razorback 2571	O20	286486	6217184	LW711	LW711	Yes				Yes	Inspected by SLR 16/04/2025 - LRA assessed risk as 'Low'. No structures but assets include dam and driveway, which are situated "back" from crestal cliff line that forms Razorback Escarpment on relatively flat plateau, with observed shallow sandstone bedrock. Assessed as 'Low' landslide risk.	Low	Completed	
155 Donalds Range Rd, Razorback 2571	O15	286470	6217397	LW711 and LW712	LW711	Yes				Yes	Inspected by SLR 18/06/2025 - LRA assessed risk to Main Dwelling as 'Low'. Structures are situated "back" from crest of steep slopes on relatively flat plateau, with an epxectation of shallow bedrock. Geotechnically isolated from complex terrain and historic landslides on the lower steep escarpment slopes. 'Moderate' overall landslide risk due to the high likelihood of future instability within uncontrolled fill pushed out of crest of steep slopes, however consequence is low.	Moderate	Completed	Implement risk mitgation measures included within report.
163 Donalds Range Rd, Razorback 2571	O19	286257	6217180	West End LW711	LW711	Yes			Yes		Previously inspected by SLR, west of LW711, structures over western pillars with very shallow slopes. Considered at 'Very Low' risk of landslide.	Very Low	Completed	
157 Donalds Range Rd, Razorback 2571	O22	286269	6217335	LW711 and LW712	LW711	Yes				Yes	Previously inspected by SLR and LRA completed which assessed property as 'Low' risk of landslide as structures situated "back" from crestal cliff line that forms Razorback Escarpment on relatively flat plateau	Low	Completed	
210 Donalds Range Rd, Razorback 2571	P40	285767	6216858	West of LW711	LW711			Yes	Yes		West of LW711 over solid coal, essentially flat. No credible landslide hazard.	N/A	No	
190 Donalds Range Rd, Razorback 2571	P41	285788	6216999	West of LW711	LW711			Yes	Yes		West of LW711 over solid coal, essentially flat. No credible landslide hazard.	N/A	No	
180 Donalds Range Rd, Razorback 2571	P42	285504	6217060	West of LW711	LW711			Yes	Yes		West of LW711 and LW712 over soil coal, with shallow slopes in head of narrow gully. Structures outside study area boundary. Considered 'Very Low' risk of landslide.	Very Low	No	

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135 Donalds Range Rd, Razorback 2571	R01	286522	6217594	LW711 and LW712	LW711	Yes				Yes	Inspected by SLR 16/04/2025 - LRA assessed risk to Main Dwelling as 'Low'. Structures are situated "back" from crestal cliff line that forms Razorback Escarpment on relatively flat plateau, with observed shallow sandstone bedrock. Assessed as 'Low' landslide risk. Existing minor instability occured in fill batter below water tank and access track, which create a 'Moderate' overall landslide risk due to the high likelihood of future instability.	Moderate	Completed	Implement risk mitgation measures included within report.
205 Quirkes Lane, Menangle 2568	S11	286968	6217725	LW711 and LW712	LW711	Yes				Yes	Previously inspected by SLR, with vast area of high susceptibility slopes and mapped landslides immediately behind dwelling, assessed as "Moderate' risk of Landslide due to LW711.	Moderate	Completed	Continue as per current management plan until completion of LW711. Re-assess risk at completion of LW711 to confirm risk profile for LW712 onwards.
75 Burrells Rd, Menangle 2568	S13	287520	6217903	LW711 and LW712	LW711				Yes		Essentially flat slopes with the exception of the steeply incised creek line along southern boundary, no dwellings on property. Considered 'Very Low' risk of landslide.	Very Low	No	Recommend creek bank stability assessment be included in pre mining inspections.
55 Burrells Rd, Menangle 2568	S14	287725	6217938	LW711	LW711				Yes		Very shallow to flat slopes with the exception of the steeply incised creek line along southern boundary. Structures considered at 'Very Low' risk of landslide.	Very Low	No	Recommend creek bank stability assessment be included in pre mining inspections.
310 Menangle Rd, Menangle 2568	C18	290095	6219777	East of LW712 to 714	LW712			Yes	Yes		East of LW712 to LW714, mostly over solid coal / eastern chain pillars, shallow slopes and no structures. Considered 'Very Low' risk of landslide.	Very Low	No	
30 Finns Rd, Menangle 2568	C20	289896	6219212	LW712	LW712				Yes		Very shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
45 Carrolls Rd, Menangle 2568	D03	289187	6219285	LW712 and LW713	LW712				Yes		Very shallow to flat slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
45 Finns Rd, Menangle 2568	D04	289469	6219366	LW712 and LW713	LW712				Yes		Very shallow to flat slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
85 Carrolls Rd, Menangle 2568	D05	289249	6219033	LW712 and LW713	LW712				Yes		Very shallow to flat slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
95 Carrolls Rd, Menangle 2568	D06	289062	6218998	LW712	LW712				Yes		Very shallow to flat slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
35 Finns Rd, Menangle 2568	D07	289565	6219126	LW712	LW712				Yes		Very shallow to flat slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
15 Finns Rd, Menangle 2568	D08	289738	6219114	LW712	LW712				Yes		Very shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
35 Cummins Rd, Menangle 2568	F35	288166	6218404	LW712	LW712					Yes	Structures situated on toe of north east trending ridgeline, constructed on cut to fill platform, with uniform, shallow to moderate slopes <20 degrees. No apparent slope issue identified. Expected to be 'Low' risk of landslide.	Low	No - subject to confirmation	Confirm site setting and assumed 'Low' risk rating during pre mining inspections.
30 Cummins Rd, Menangle 2568	F36	288379	6218617	LW712 and LW713	LW712	Yes			Yes		Shallow slopes with the exception of the steeply incised creek line along eastern boundary. Structures considered at 'Very Low' risk of landslide.	Very Low	No	Recommend creek bank stability assessment be included in pre mining inspections.
130 Carrolls Rd, Menangle 2568	F40	288797	6218642	LW712	LW712				Yes		Very shallow to flat slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
120 Carrolls Rd, Menangle 2568	F41	288604	6218803	LW712 and LW713	LW712	Yes			Yes		Recently inspected by SLR, shallow slopes with the exception of the steeply incised creek line through middle of property. Structures considered at 'Very Low' risk of landslide.	Very Low	No	Recommend creek bank stability assessment be included in updated pre mining inspections.
106 Carrolls Rd, Menangle 2568	F45	288686	6218938	LW712 and LW713	LW712				Yes		Very shallow slopes with the exception of the steeply incised creek line through middle of property. Structures considered at 'Very Low' risk of landslide.	Very Low	No	Recommend creek bank stability assessment be included in pre mining inspections.
50 Cummins Rd, Menangle 2568	F50	288142	6218658	LW712 and LW713	LW712				Yes		Very shallow to flat slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
47 Cummins Rd, Menangle 2568	F51	287972	6218538	LW712 and LW713	LW712				Yes		Shallow to very shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
45 Cummins Rd, Menangle 2568	F52	287784	6218460	LW712 and LW713	LW712	Yes			Yes		Very shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	

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20 Burrells Rd, Menangle 2568	K02	288021	6218248	LW712	LW712					Yes	Structures situated on flat ground at toe of slope. Slopes behind appear uniform, shallow to moderate sloping, <20 degrees. No apparent slope issue identified. Expected to be 'Low' risk of landslide.	Low	No - subject to confirmation	Confirm site setting and assumed 'Low' risk rating during pre mining inspections.
30 Burrells Rd, Menangle 2568	K03	287901	6218231	LW712	LW712					Yes	Straddles, shallow east trending ridgeline. Structures situated on flat ground at toe of slope. Slopes behind appear uniform, shallow to moderate sloping, <20 degrees. No apparent slope issue identified. Expected to be 'Low' risk of landslide.	Low	No - subject to confirmation	Confirm site setting and assumed 'Low' risk rating during pre mining inspections.
100 Burrells Rd, Menangle 2568	S07	287310	6218314	LW712 and 713	LW712	Yes				Yes	Inspected by SLR on 18/06/2025. No dwellings or structures present on the property other than concrete driveway on ridgleine. Majority of property underlain by complex terrain, steep slopes and historic landslides.	Low	No	Re-assess if property becomes developed.
110 Burrells Rd, Menangle 2568	S08	286954	6218337	LW712 to 714	LW712					Yes	No dwellings or structures present on the property other than concrete driveway on ridgleine. Majority of property underlain by complex terrain, steep slopes and historic landslides.	Low	No	Re-assess if property becomes developed.
145 Donalds Range Rd, Razorback 2571	O16	285994	6217418	West of LW712	LW712			Yes	Yes		West of LW7112 over western chain pillar, essentially flat. No credible landslide hazard.	N/A	No	
151 Donalds Range Rd, Razorback 2571	O21	286046	6217423	West End LW712	LW712	Yes			Yes		Over chain pillar and western end of LW712, essentially flat slopes. No credible landslide hazard.	N/A	No	
176 Donalds Range Rd, Razorback 2571	P43	285542	6217207	West of 711 and 712	LW712			Yes	Yes		West of LW711 and LW712 over solid coal, essentially flat either side of narrow north trending gully. No structures on the property, other than two dams. Considered ' Low' risk of landslide.	Low	No	
170 Donalds Range Rd, Razorback 2571	P44	285734	6217244	West of LW711 and 712	LW712			Yes	Yes		West of LW712 over solid coal, essentially flat. No credible landslide hazard.	N/A	No	
150 Donalds Range Rd, Razorback 2571	P45	285867	6217385	West of LW712	LW712			Yes	Yes		West of LW712 over solid coal, essentially flat. No credible landslide hazard.	N/A	No	
25 Fairlea Rd, Razorback 2571	P46	285747	6217401	West of LW712	LW712			Yes	Yes		West of LW712 over solid coal, essentially flat. No credible landslide hazard.	N/A	No	
35 Fairlea Rd, Razorback 2571	P47	285573	6217426	West of LW712	LW712			Yes	Yes		West of LW712 over solid coal, essentially flat (where within study area). Considered ' Low' risk of landslide.	Very Low	No	
45 Fairlea Rd, Razorback 2571	P48	285234	6217481	West of LW712	LW712			Yes	Yes		West of LW712 over soil coal, with moderate slopes in narrow gully (outside study area). Structures outside study area boundary. Considered 'Very Low' risk of landslide.	Very Low	No	
133 Donalds Range Rd, Razorback 2571	R02	286250	6217588	LW712	LW712	Yes			Yes	Yes	Property situated over LW712, structures on shallow plateau, set well back from Razorback Escarpment. Considered 'Low' risk of landslide. Inspected by SLR 13/06/2025 and confirmed 'Low' risk of landslide.	Low	No	
131 Donalds Range Rd, Razorback 2571	R03	286268	6217712	LW712 and LW713	LW712				Yes	Yes	Property situated over LW712 and LW713, structures on shallow plateau, set well back from Razorback Escarpment. Dam situated behind head of moderate sloping gully with historic landslides, although set back a reasonable distance. Considered 'Low' risk of landslide.	Low	No - subject to confirmation	Confirm site setting and assumed 'Low' risk rating during pre mining inspections.
85 Donalds Range Rd, Razorback 2571	R09	286499	6217883	LW712 and LW713	LW712	Visited as part of this study.				Yes	Inspected by SLR on 9/4/2025 as part of ground truthing exercise within current study. Preliminary LRA assessed risk as 'Low'. Structures are situated "back" from crestal cliff line that forms Razorback Escarpment on relatively flat plateau, with observed shallow sandstone bedrock. Assessed as 'Low' landslide risk. Existing minor instability has been observed associated with creep of fill batter below shed and creep of slow moving shallow slide in head of gully, north of dam, which create a 'Moderate' overall landslide risk.	Moderate	Completed	Formalise LRA during deveopment of PSMP.
40 Burrells Rd, Menangle 2568	S01	287803	6218209	LW712	LW712					Yes	Property straddles, shallow east trending ridgeline. Structures situated on flat ground at toe of slope. Slopes behind appear uniform, shallow to moderate sloping, <20 degrees. Possible small slump type feature on mid to upper slope, set back from structures. Expected to be 'Low' risk of landslide.	Low	No - subject to confirmation	Confirm site setting and assumed 'Low' risk rating during pre mining inspections.
50 Burrells Rd, Menangle 2568	S02	287718	6218114	LW712	LW712	Yes				Yes	Structures situated on flat ground at toe of slope. Slopes behind appear mostly uniform, shallow to moderate sloping, <20 degrees. One small area of steeper slope / old scarp at property boundary. Expected to be 'Low' risk of landslide.	Low	No - subject to confirmation	Confirm site setting and assumed 'Low' risk rating during pre mining inspections.

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60 Burrells Rd, Menangle 2568	S03	287611	6218076	LW712	LW712					Yes	Structures situated on flat ground at toe of slope. Slopes behind appear uniform, shallow to moderate sloping, <20 degrees. Possible small slump type feature on mid to upper slope, set back from structures. Expected to be 'Low' risk of landslide.	Low	No - subject to confirmation	Confirm site setting and assumed 'Low' risk rating during pre mining inspections.
70 Burrells Rd, Menangle 2568	S04	287648	6218254	LW712	LW712					Yes	Structures situated on top of shallow north trending ridgeline, with gentle to moderate, uniform slopes below to the north and south. No apparent slope issue identified. Expected to be 'Low' risk of landslide.	Low	No - subject to confirmation	Confirm site setting and assumed 'Low' risk rating during pre mining inspections.
80 Burrells Rd, Menangle 2568	S05	287550	6218280	LW712 and LW713	LW712					Yes	Structures situated on top of shallow north trending ridgeline, with gentle to moderate, uniform slopes below to the north and south. No apparent slope issue identified. Expected to be 'Low' risk of landslide.	Low	No - subject to confirmation	Confirm site setting and assumed 'Low' risk rating during pre mining inspections.
90 Burrells Rd, Menangle 2568	S06	287448	6218249	LW712 and 713	LW712	Yes				Yes	Inspected by SLR on 18/06/2025. Property straddles, shallow east trending ridgeline. No structures on property except fordriveway on ridgeline and dam in northern portion, which is constructed in base of gully below toe of historic landslide.	Low	No	Re-assess if property becomes developed.
120 Burrells Rd, Menangle 2568	S09	287158	6218130	LW712 and LW713	LW712					Yes	Structures built on a cut to fill platform on moderate to steep slopes at toe of complex terrain and historical landslides, below Razorback Escarpment. Expected to be 'Moderate' to 'High' landslide risk due to inherent nature of site setting.	Moderate to High	Yes	Complete detailed LRA and develop PSMP. Detailed site investigation and monitoring prior to subsidence influence period recommended. Advance planning and implementation of risk mitigation measures prior to and during the mining influence period required to reduce the overall level of risk to a tolerable level. Treatment
130 Burrells Rd, Menangle 2568	S10	286893	6218070	LW712 and LW713	LW712					Yes	Structures built on a cut to fill platform on steep slopes overlying / at toe of complex terrain and historical landslides, below Razorback Escarpment. Expected to be 'Moderate' to 'High' landslide risk due to inherent nature of site setting.	Moderate to High	Yes	Complete detailed LRA and develop PSMP.
85 Burrells Rd, Menangle 2568	S12	287326	6217938	LW712	LW712	Yes			Yes		Previously inspected by SLR, shallow slopes, with the exception of locally steeper areas associated with cut and fill batters and creek banks south of structures. Considered 'Low' risk of landslide.	Low	No	
Razorback Stud 120 Dawsons Rd, Menangle 2568	S48	287678	6219903	LW715 to 717	LW712	Visited as part of this study.				Yes	Inspected by SLR on 9/4/2025 as part of ground truthing exercise within current study. Preliminary LRA assessed risk as 'Moderate', due to inherent nature of main dwelling being situated on lower slopes below areas of complex terrain with recent examples of historical landslide reactivation on property (albeit remote to structures). No reported issues surrounding dwellings in preceding 30+ years of occupancy, other than minor creep movement of fill batter below driveway / veranda.	Moderate	Completed	Formalise LRA during deveopment of PSMP.
90 Carrolls Rd, Menangle 2568	F46	288650	6219121	LW713 and LW714	LW713				Yes		Very shallow slopes with the exception of the steeply incised creek line through middle of property. Structures considered at 'Very Low' risk of landslide.	Very Low	No	Recommend creek bank stability assessment be included in pre mining inspections.
100 Carrolls Rd, Menangle 2568	F55	288488	6219022	LW713	LW713				Yes		Very shallow to flat slopes with the exception of the steeply incised creek line through western edge of property. Structures considered 'Very Low' risk of landslide.	Very Low	No	Recommend creek bank stability assessment be included in pre mining inspections.
80 Carrolls Rd, Menangle 2568	F56	288673	6219279	LW713 and LW714	LW713				Yes		Very shallow to essentially flat surrounding structures. Some steeper areas associated with creek banks. Considered 'Low' risk of landslide.	Low	No	Recommend creek bank stability assessment be included in pre mining inspections.
40-60 Carrolls Rd, Menangle 2568	F57	288550	6219635	LW713 to LW716	LW713				Yes		Very shallow to essentially flat surrounding structures. Some steeper areas associated with north trending creek lines. Considered 'Low' risk of landslide.	Low	No	Recommend creek bank stability assessment be included in pre mining inspections.
47 Carrolls Rd, Menangle 2568	F63	289156	6219448	LW713	LW713				Yes		Essentially flat. No credible landslide hazard.	N/A	No	
25 Carrolls Rd, Menangle 2568	F64	289257	6219674	LW713 and LW714	LW713				Yes		Very shallow slopes to essentially flat. No credible landslide hazard.	N/A	No	
65 Finns Rd, Menangle 2568	F65	289432	6219604	LW713 and LW714	LW713				Yes		Very shallow slopes with the exception on steeper localised cut and fill batters. Considered 'Very Low' risk of landslide.	Very Low	No	
125 Donalds Range Rd, Razorback 2571	R04	286070	6217600	West End LW712 and 713	LW713				Yes		Very shallow slopes to essentially flat. Considered 'Very Low' risk of landslide.	Very Low	No	
115 Donalds Range Rd, Razorback 2571	R05	286085	6217699	West End LW713	LW713				Yes		Shallow slopes with the exception of localised moderate sloping areas in head of gully in western portion. Considered 'Low' risk of landslide.	Low	No	
105 Donalds Range Rd, Razorback 2571	R06	286099	6217799	LW713	LW713				Yes		Very shallow slopes to essentially flat. Considered 'Very Low' risk of landslide.	Very Low	No	
95 Donalds Range Rd, Razorback 2571	R07	286113	6217899	LW713	LW713				Yes		Very shallow slopes to essentially flat. No credible landslide hazard.	N/A	No	
130 Donalds Range Rd, Razorback 2571	R10	285905	6217656	West End LW713	LW713				Yes		Very shallow to flat surrounding structures. Shallow to moderate slopes in head of gully in northern portion, offset from structures. Considered 'Low' risk of landslide.	Low	No	

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20 Fairlea Rd, Razorback 2571	R11	285755	6217678	West of LW713	LW713			Yes	Yes		West of LW713, mostly over soil coal, with very shallow slopes surrounding structures. Considered 'Very Low' risk of landslide.	Very Low	No	
50 Fairlea Rd, Razorback 2571	R14	285438	6217722	West of LW713	LW713			Yes	Yes	Yes	West of LW713, over soil coal, structures sit on flat plateau although proximate to moderate slopes below and west of structures. Considered 'Low' risk of landslide.	Low	No - subject to confirmation	Confirm site setting and assumed 'Low' risk rating during pre mining inspections.
118 Donalds Range Rd, Razorback 2571	R16	285872	6217864	West End LW713	LW713				Yes	Yes	Very shallow to flat surrounding structures. Shallow to moderate slopes in head of gully in western portion, remote from structures. Considered 'Low' risk of landslide.	Low	No - subject to confirmation	Confirm site setting and assumed 'Low' risk rating during pre mining inspections.
40 Plateau Dr, Razorback 2571	R34	286518	6218156	LW713 and LW714	LW713					Yes	Structures situated "back" from crestal cliff line that forms Razorback Escarpment on relatively flat plateau. Dams situated behind steep slopes which lead down to cliff line associated with Razorback Escarpment. Some indication of historic landslide and complex terrain in the gully below the dam, but remote from structures. Geotechnically isolated from complex terrain and historic landslides on the lower steep escarpment slopes. Expected to be 'Low' risk of landslide.	Low	No - subject to confirmation	Confirm site setting and assumed 'Low' risk rating during pre mining inspections.
20 Plateau Dr, Razorback 2571	R35	286341	6218129	LW713 and LW714	LW713					Yes	Structures situated "back" from crestal cliff line the forms Razorback Escarpment on relatively flat plateau, and over chain pillar between LW713 and LW714. Geotechnically isolated from complex terrain and historic landslides on the lower steep escarpment slopes. Expected to be 'Low' risk of landslide.	Low	No - subject to confirmation	Confirm site setting and assumed 'Low' risk rating during pre mining inspections.
10 Plateau Dr, Razorback 2571	R36	286147	6218151	LW713 and LW714	LW713				Yes		Very shallow slopes to essentially flat. No credible landslide hazard.	N/A	No	
89 Donalds Range Rd, Razorback 2571	R37	286128	6217999	LW713	LW713				Yes		Very shallow slopes to essentially flat. No credible landslide hazard.	N/A	No	
149 Cummins Rd, Menangle 2568	S15	287436	6218594	LW713 and LW714	LW713					Yes	Structures situated on cut to fill platform which straddles shallow east trending ridgeline leading down from Razorback Escarpment. Complex terrain and steep slopes with historic and recent landslides on slopes west, above dwelling, with one slide toe apparent at edge of driveway above dam on neighbouring property. Expected to be at 'Moderate' to possibly 'High' risk due to inherent nature of site setting.	Moderate to High	Yes	Complete detailed LRA and develop PSMP.
145 Cummins Rd, Menangle 2568	S16	287503	6218781	LW713 and LW714	LW713				Yes		Shallow slopes, structures sit on shallow ridgeline. Some landslide activity on neighbouring property to the south. Considered 'Low' risk of landslide.	Low	No - subject to confirmation	Confirm site setting and assumed 'Low' risk rating during pre mining inspections.
165 Cummins Rd, Menangle 2568	S17	287191	6218635	LW713 and LW714	LW713					Yes	Structures and dam build on relatively flat ground adjacent to creek at toe of steep slopes characterised by complex terrain and historic landslides. Expected to be at 'Moderate' risk of landslide due to inherent nature of site setting.	Moderate	Yes	Complete detailed LRA and develop PSMP.
80 Cummins Rd, Menangle 2568	S36	288174	6218983	LW713 and LW714	LW713				Yes		Very shallow to flat slopes with the exception of the steeply incised creek line through south east of property. Structures considered 'Very Low' risk of landslide.	Very Low	No	Recommend creek bank stability assessment be included in pre mining inspections.
60 Cummins Rd, Menangle 2568	S37	288193	6218809	LW713	LW713				Yes		Shallow slopes. Structures considered at ' Low' risk of landslide.	Low	No	
75 Cummins Rd, Menangle 2568	S38	287940	6218667	LW713	LW713				Yes		Shallow slopes with the exception on steeper localised cut and fill batters. Considered 'Low' risk of landslide.	Low	No	
85 Cummins Rd, Menangle 2568	S39	287913	6218764	LW713	LW713				Yes		Shallow slopes with the exception on steeper localised cut and fill batters. Considered 'Low' risk of landslide.	Low	No	
89 Cummins Rd, Menangle 2568	S40	287886	6218920	LW713 and LW714	LW713				Yes		Very shallow slopes to essentially flat. No credible landslide hazard.	N/A	No	
115 Cummins Rd, Menangle 2568	S41	287797	6218890	LW713 and LW714	LW713				Yes		Very shallow slopes to essentially flat. No credible landslide hazard.	N/A	No	
135 Cummins Rd, Menangle 2568	S43	287613	6218845	LW713 and LW714	LW713				Yes		Shallow slopes, however neighbouring dam situated upslope from auxiliary shed. Considered 'Low' risk of landslide.	Low	No - subject to confirmation	Confirm assumed 'Low' risk rating due to neighbouring dam during pre mining inspections.
125 Cummins Rd, Menangle 2568	S44	287686	6218704	LW713 and LW714	LW713					Yes	Structures situated on shallow east trending ridgeline(s), on a relatively flat plateau, some apparent filling along southern side for shed. Slopes below appear mostly uniform, shallow to moderately sloping <20 degrees. No apparent slope issue identified. Expected to be 'Low' to possibly 'Moderate' risk of landslide.	Low	No - subject to confirmation	Confirm site setting and assumed 'Low' risk rating during pre mining inspections.
110 Finns Rd, Menangle 2568	C23	290457	6220877	LW714 to 716	LW714			Yes	Yes		Very large property mostly outside study area and over soil coal / eastern chain pillars. Very shallow slopes. Considered 'Low' risk of landslide.	Very Low	No	
30 Carrolls Rd, Menangle 2568	F58	289068	6219786	LW714	LW714				Yes		Very shallow slopes to essentially flat. No credible landslide hazard.	N/A	No	
10 Carrolls Rd, Menangle 2568	F59	289087	6219881	LW714	LW714				Yes		Very shallow slopes to essentially flat with exception of dam embankment. Considered 'Very Low' risk of landslide.	Very Low	No	

Address	Property Code	x coord (centroid)	y coord (centroid)	LW	Closest LW	Cat B: Property including house previously assessed by SLR.	Cat C: Sites near or above previously mined Longwall.	Cat D: Solid coal - not proposed for mining beneath.	Cat E: Site's on gentle slopes predominantly <15°, away from Razorback Escarpment	Cat F: Sites close to Razorback Escarpment, and/or slopes predominantly >15°	Comments	Indicative **relative** landslide risk ranking	Detailed LRA required	Additional Recommendations
30 Fairlea Rd, Razorback 2571	R12	285598	6217701	West of LW713	LW714			Yes	Yes		West of LW713 over solid coal, essentially flat. No credible landslide hazard.	N/A	No	
40 Fairlea Rd, Razorback 2571	R13	285510	6217733	West of LW713	LW714			Yes	Yes		West of LW713 over solid coal, essentially flat. No credible landslide hazard.	N/A	No	
Remembrance Drwy, Razorback 2571	R15	285536	6218300	LW714 and LW715 and to west	LW714				Yes		Large property, with half located over soil coal. Covers a number of drainage gullies with moderate to steep slopes. No structures present. Considered 'Low' risk of landslide.	Low	No	
116 Donalds Range Rd, Razorback 2571	R17	285890	6217989	West End LW713 and 714	LW714				Yes		Very shallow to flat surrounding structures. Shallow to moderate slopes in head of gully in western portion, remote from structures. Considered 'Low' risk of landslide.	Low	No	
114 Donalds Range Rd, Razorback 2571	R18	285903	6218088	LW714	LW714				Yes		Very shallow slopes to essentially flat. No credible landslide hazard.	N/A	No	
49 Donalds Range Rd, Razorback 2571	R31	286140	6218426	LW714 and LW715	LW714				Yes		Very shallow to essentially flat surrounding structures. Some shallow slopes in head of gully in southern portion. Considered 'Very Low' risk of landslide.	Very Low	No	
15 Plateau Dr, Razorback 2571	R32	286250	6218429	LW714 and LW715	LW714				Yes	Yes	Property situated over LW714, structures on shallow plateau, set well back from Razorback Escarpment. Dam situated at head of moderate sloping gully. Considered 'Low' risk of landslide.	Low	No	
25 Plateau Dr, Razorback 2571	R33	286466	6218424	LW714	LW714					Yes	Structures situated on shallow sloping plateau, set back from shallow to moderate sloping gullies above Razorback Escarpment. Two dams in gully at eastern side of dwelling, the northern most which is situated behind a cliff line associated with Razorback Escarpment. Some indication of historic landslide and complex terrain in the northern gully, but remote from structures. Expected to be 'Low' risk of landslide.	Low	No - subject to confirmation	Confirm site setting and assumed 'Low' risk rating during pre mining inspections.
189 Cummins Rd, Menangle 2568	S18	286896	6218669	LW714	LW714					Yes	Structures and dam build on relatively flat ground adjacent to creek at toe of steep slopes characterised by complex terrain and historic landslides. Expected to be at 'Moderate' risk of landslide due to inherent nature of site setting.	Moderate	Yes	Complete detailed LRA and develop PSMP.
195 Cummins Rd, Menangle 2568	S19	286430	6218783	LW714 and LW715	LW714					Yes	Large property in head of gully leading up to Razorback Escarpment. Lower slopes characterised by complex terrain with historic landslides and steep slopes. Apparent small structure on south facing slope near entrance off Cummins Rd. Expected to be at least 'Moderate' risk of landslide, possible 'High' depending on nature of structures and land use.	Moderate to High	Yes	Complete detailed LRA and develop PSMP.
186 Cummins Rd, Menangle 2568	S22	286914	6218915	LW714 and LW715	LW714					Yes	Structures built on a platform on steep slopes overlying complex terrain and historical landslides, below Razorback Escarpment. Expected to be 'Moderate' to 'High' landslide risk due to inherent nature of site setting.	Moderate to High	Yes	Complete detailed LRA and develop PSMP.
184 Cummins Rd, Menangle 2568	S23	286999	6218980	LW714 and LW715	LW714					Yes	Structures built on a cut to fill platform on steep slopes overlying / at toe of complex terrain and historical landslides, below Razorback Escarpment. Active erosion gully formation possible along western side of dwelling. Expected to be 'Moderate' to 'High' landslide risk due to inherent nature of site setting.	Moderate to High	Yes	Complete detailed LRA and develop PSMP.
180 Cummins Rd, Menangle 2568	S24	287090	6219046	LW714 and LW715	LW714					Yes	Structures built on a cut to fill platform on steep slopes overlying / at toe of complex terrain and historical landslides, below Razorback Escarpment. Active erosion gully formation possible along western side of dwelling. Expected to be 'Moderate' to 'High' landslide risk due to inherent nature of site setting.	Moderate to High	Yes	Complete detailed LRA and develop PSMP.
170 Cummins Rd, Menangle 2568	S25	287251	6219110	LW714 and LW715	LW714					Yes	Structures built on a cut to fill platform on steep slopes overlying / at toe of complex terrain and historical landslides, below Razorback Escarpment. Active erosion gully formation possible along western side of dwelling. Expected to be 'Moderate' to 'High' landslide risk due to inherent nature of site setting.	Moderate to High	Yes	Complete detailed LRA and develop PSMP.
160 Cummins Rd, Menangle 2568	S26	287433	6219000	LW714 and LW715	LW714					Yes	Structures built on a cut to fill platform on steep slopes overlying / at toe of complex terrain and historical landslides, below Razorback Escarpment. Active erosion gully formation possible along western side of property. Expected to be 'Moderate' to 'High' landslide risk due to inherent nature of site setting.	Moderate to High	Yes	Complete detailed LRA and develop PSMP.
156 Cummins Rd, Menangle 2568	S27	287483	6219155	LW714 and LW715	LW714	Visited as part of this study.				Yes	Inspected by SLR on 9/4/2025 as part of ground truthing exercise within current study. Preliminary LRA assessed risk as 'High', due to structures being constructed on cut and fill platform over historical landslide. There is also an existing rotational / translational slide upslope of the shed which impacted the back of the structure in 2022, without causing damage but requiring clean up works.	High	Completed	Formalise LRA during deveopment of PSMP.
140 Cummins Rd, Menangle 2568	S28	287625	6219100	LW714 and LW715	LW714					Yes	Structures built on a cut to fill platform on steep slopes at toe of complex terrain. Historical landslide apparent immediately west of structures and dam, with smaller slide feature apparent on slope upslope from main dwelling, somewhat set back. Expected to be 'Moderate' to 'High' landslide risk due to inherent nature of site setting.	Moderate to High	Yes	Complete detailed LRA and develop PSMP.
130 Cummins Rd, Menangle 2568	S29	287548	6219361	LW714 and LW715	LW714	Visited as part of this study.				Yes	Inspected by SLR on 9/4/2025 as part of ground truthing exercise within current study. Preliminary LRA assessed risk as 'Moderate', due to inherent nature of main dwelling being situated on lower slopes below areas of complex terrain, dwelling is formed but cutting into toe of upslope area with construction of retaining walls. Downslope fill batter is relatively steep. Examples of historical landslide on property, but remote to structures.	Moderate	Completed	Formalise LRA during deveopment of PSMP.
126 Cummins Rd, Menangle 2568	S30	287712	6219427	LW714 and LW715	LW714					Yes	No dwellings or structures present on the property, just a driveway and dam. Situated at toe of moderate slopes with some hummocky appearance.	Low	No	Re-assess if property becomes developed.
118 Cummins Rd, Menangle 2568	S31	287769	6219090	LW714	LW714					Yes	Structures situated on cut to fill platform on relatively shallow lower slopes, which appear uniform, shallow to moderate sloping, <20 degrees. Expected to be 'Low' risk of landslide.	Low	No - subject to confirmation	Confirm site setting and assumed 'Low' risk rating during pre mining inspections.
110 Cummins Rd, Menangle 2568	S32	287912	6219313	LW714 and LW715	LW714					Yes	Structures situated on cut to fill platform on moderately sloping lower slopes, which appear relatively uniform, <25 degrees. Apparent small slide feature on slope above driveway to shed. Expected to be 'Moderate' risk of landslide.	Moderate	Yes	Complete detailed LRA and develop PSMP.
106 Cummins Rd, Menangle 2568	S33	288000	6219203	LW714	LW714				Yes		Shallow slopes and very shallow surrounding structures. Driveway crosses dam embankment. Considered 'Low' risk of landslide.	Low	No - subject to confirmation	Confirm assumed 'Low' risk rating where driveway crosses dam embankment during pre mining inspections.
100 Cummins Rd, Menangle 2568	S34	288052	6219129	LW714	LW714				Yes		Shallow slopes and very shallow surrounding structures. Considered 'Low' risk of landslide.	Low	No	

Address	Property Code	x coord (centroid)	y coord (centroid)	LW	Closest LW	Cat B: Property including house previously assessed by SLR.	Cat C: Sites near or above previously mined Longwall.	Cat D: Solid coal - not proposed for mining beneath.	Cat E: Site's on gentle slopes predominantly <15°, away from Razorback Escarpment	Cat F: Sites close to Razorback Escarpment, and/or slopes predominantly >15°	Comments	Indicative **relative** landslide risk ranking	Detailed LRA required	Additional Recommendations
90 Cummins Rd, Menangle 2568	S35	288214	6219275	LW714	LW714				Yes		Shallow slopes and very shallow surrounding structures. Considered 'Low' risk of landslide.	Low	No	
110 Finns Rd, Menangle 2568	C23	289260	6220258	LW715	LW715				Yes		Very shallow slopes to essentially flat. Considered 'Very Low' risk of landslide.	Very Low	No	
125 Finns Rd, Menangle 2568	F60	288598	6220082	LW715 and LW716	LW715				Yes		Shallow slopes, main structures situated on shallow ridgeline with localised steeper fill batters. Driveway crosses two dams and a shallow water course. Considered 'Low' risk of landslide.	Low	No	
25 Finns Rd, Menangle 2568	F61	288507	6220554	LW715 to 718	LW715				Yes		Very large property, slopes shallow to flat, with exception of steeper cut batters surrounding main dwelling. Multiple dams across the property. Considered 'Very Low' risk of landslide.	Very Low	No	
40 Mount Hercules Rd, Razorback 2571	R20	285901	6219492	LW715 to 719	LW715					Yes	Structures situated "back" from steep slopes on relatively flat plateau. Geotechnically isolated from complex terrain and historic landslides on the lower steep escarpment slopes. Expected to be 'Low' risk of landslide.	Low	No - subject to confirmation	Confirm site setting and assumed 'Low' risk rating during pre mining inspections.
1075 Remembrance Drwy, Razorback 2571	S20	286558	6219129	LW715 and LW716	LW715				Yes		Very shallow to essentially flat with exception of dam embankments and north eastern corner. House situated behind moderate slopes which slope down to Razorback Escarpment. Considered 'Low' risk of landslide.	Low	No - subject to confirmation	Confirm site setting and assumed 'Low' risk rating during pre mining inspections.
190 Cummins Rd, Menangle 2568	S21	286696	6218975	LW715	LW715					Yes	Structures built on a platform on steep slopes overlying complex terrain and historical landslides, below Razorback Escarpment. Expected to be 'Moderate' to 'High' landslide risk due to inherent nature of site setting.	Moderate to High	Yes	Complete detailed LRA and develop PSMP.
995 Remembrance Drwy, Razorback 2571	S45	286974	6219193	LW715	LW715					Yes	Structures situated "back" from crestal cliff line that forms Razorback Escarpment on relatively flat plateau. Geotechnically isolated from complex terrain and historic landslides on the lower steep escarpment slopes. Expected to be 'Low' risk of landslide.	Low	No - subject to confirmation	Confirm site setting and assumed 'Low' risk rating during pre mining inspections.
975 Remembrance Drwy, Razorback 2571	S46	287265	6219399	LW715 and LW716	LW715					Yes	Structures situated "back" from crestal cliff line that forms Razorback Escarpment on relatively flat plateau. Geotechnically isolated from complex terrain and historic landslides on the lower steep escarpment slopes. Expected to be 'Low' risk of landslide.	Low	No - subject to confirmation	Confirm site setting and assumed 'Low' risk rating during pre mining inspections.
Trevone 285 Woodbridge Rd, Menangle 2568	C24	289262	6220825	LW716 and LW717	LW716				Yes		Very shallow slopes to essentially flat. No credible landslide hazard.	N/A	No	
30 Mount Hercules Rd, Razorback 2571	R21	285460	6218980	North chain pillar west end of LW716	LW716				Yes		Very shallow slopes to essentially flat. No credible landslide hazard.	N/A	No	
75 Mount Hercules Rd, Razorback 2571	R24	284906	6219000	West of LW716 and 717	LW716			Yes	Yes		West of LW716 and LW717, mostly over solid coal, structures on essentially flat ground over western edge of chain pillar. Moderate slopes in gully at south of property. Considered 'Low' risk of landslide.	Low	No	
75 Mount Hercules Rd, Razorback 2571	R25	284942	6219262	West of LW716 and 717	LW716			Yes	Yes		West of LW716 and LW717, over solid coal, no structures other than one dam on very shallow slopes. Shallow slopes in gully at south of property. Considered 'Very Low' risk of landslide.	Very Low	No	
55 Mount Hercules Rd, Razorback 2571	R26	285096	6219149	West of LW716 and 717	LW716			Yes	Yes		West of LW716 over solid coal, essentially flat. No credible landslide hazard.	N/A	No	
45 Mount Hercules Rd, Razorback 2571	R27	285090	6218922	West of LW716 and 717	LW716			Yes	Yes		West of LW716 and LW717, mostly over solid coal, structures on essentially flat ground over western edge of chain pillar. Shallow to moderate slopes in gully at south of property. Considered 'Low' risk of landslide.	Low	No	
43 Mount Hercules Rd, Razorback 2571	R28	285327	6218896	West End of LW716 and 717	LW716				Yes		Very shallow slopes to essentially flat surrounding structures, with exception of shallow to moderate slopes in remote southern corner in head of gully. Considered 'Very Low' risk of landslide.	Very Low	No	
1225 Remembrance Drwy, Razorback 2571	R38	285035	6218329	West of LW716	LW716			Yes		Yes	West of LW716 over solid coal, structures on cut platform essentially on plateau. Moderate to steep slopes in drainage gully along western boundary, including two dams. Some apparent indication of hummocky slopes indicating past instability, but remote from structures. Dwellings considered at 'Low' risk of landslide.	Low	No - subject to confirmation	Confirm site setting and assumed 'Low' risk rating during pre mining inspections.
1220 Remembrance Drwy, Razorback 2571	R39	284716	6218514	West of LW716	LW716			Yes		Yes	West of LW716 over solid coal, structures on plateau. Moderate to steep slopes in drainage gullies western side of property, including one dam. Some apparent indication of hummocky slopes indicating past instability, but remote from structures. Dwellings considered at 'Low' risk of landslide.	Low	No	
1070 Remembrance Drwy, Razorback 2571	R40	286251	6219146	LW716	LW716					Yes	Structures situated on relatively flat plateau but proximate to moderate to steep slopes below. Expected to be 'Moderate' risk of landslide due to inherent nature of site setting.	Moderate	Yes	Complete detailed LRA and develop PSMP.
1060 Remembrance Drwy, Razorback 2571	R41	286445	6219361	LW716 and LW717	LW716					Yes	Structures situated behind relatively steep slopes on relatively flat plateau. Geotechnically isolated from complex terrain and historic landslides on the lower steep slopes. Expected to be 'Low' risk of landslide, but possibly 'Moderate', pending site specific assessment.	Low to Moderate	Yes	Complete detailed LRA and develop PSMP.
790 Remembrance Drwy, Razorback 2571	R42	286780	6220188	LW716 to LW719	LW716	Visited as part of this study.				Yes	Inspected by SLR on 9/4/2025 as part of ground truthing exercise within current study. Preliminary LRA assessed risk as 'Moderate', due to historic very large flow / slide landslide along eastern boundary immediately upslope of driveway but outside study area. Potential for instability within southern dam due to under cutting of embankment toe by erosion of spillway channel. Structures considered as 'Very Low' risk as situated on shallow slopes remote from complex terrain, steep slopes and historic landslides and outsdie study area..	Very Low to Moderate	Completed	Formalise LRA during deveopment of PSMP.
965 Remembrance Drwy, Razorback 2571	S47	287349	6219811	LW716 and LW717	LW716					Yes	Structures situated "back" from crestal cliff line that forms Razorback Escarpment on relatively flat plateau. Geotechnically isolated from complex terrain and historic landslides on the lower steep escarpment slopes. Expected to be 'Low' risk of landslide.	Low	No - subject to confirmation	Confirm site setting and assumed 'Low' risk rating during pre mining inspections.
90 Dawsons Rd, Menangle 2568	S49	287954	6220164	LW716 and 717	LW716				Yes		Shallow slopes with exception of localised cut and fill batters. Considered 'Low' risk of landslide.	Low	No	

Address	Property Code	x coord (centroid)	y coord (centroid)	LW	Closest LW	Cat B: Property including house previously assessed by SLR.	Cat C: Sites near or above previously mined Longwall.	Cat D: Solid coal - not proposed for mining beneath.	Cat E: Site's on gentle slopes predominantly <15°, away from Razorback Escarpment	Cat F: Sites close to Razorback Escarpment, and/or slopes predominantly >15°	Comments	Indicative **relative** landslide risk ranking	Detailed LRA required	Additional Recommendations
360 Finns Rd, Menangle 2568	C26	288761	6222227	LW717 to 719	LW717				Yes		Very large property, mostly north and outside of study area. Southern portion has a very large dam, very shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	
40 Mount Hercules Rd, Razorback 2571	R22	285228	6219782	LW717 to LW719	LW717					Yes	Structures situated "back" from steep slopes on relatively flat plateau, and over chain pillar west of LW718. Geotechnically isolated from complex terrain and historic landslides on the lower steep slopes. Expected to be 'Low' risk of landslide. Structures outside study area.	Low	No	
20 Dawsons Rd, Menangle 2568	S50	287721	6220588	LW717 and LW718	LW717					Yes	Structures situated on lower slopes below steep slopes, complex terrain and historical landslides. Expected to be at 'Low' to possibly 'Moderate' risk of landslide due to inherent nature of site setting.	Low to Moderate	Yes	Complete detailed LRA and develop PSMP.
255 Finns Rd, Menangle 2568	F62	288264	6220968	LW718	LW718				Yes		Very shallow slopes. Considered 'Very Low' risk of landslide.	Very Low	No	

Appendix C LRA Work Sheets

LANDSLIDE RISK ASSESSMENT - QUANTITATIVE RISK TO LIFE AND SEMI-QUANTITATIVE RISK TO PROPERTY

LOCATION: O05 - 16 Gibraltar Drive

INHERENT LANDSLIDE RISK PROFILE										SUBSIDENCE INFLUENCE PERIOD					
Identified Hazard	**Element at Risk**	**Annual Probability[1] $P_{(H)}$**	**Spatial Probability[2] $P_{(S:H)}$**	**Temporal Probability[3] $P_{(T:S)}$**	**Likelihood[4] $P_{(Likelihood)}$**	**Qualitative Likelihood**	**Vulnerability[5]**	**Qualitative Consequence[6]**	**Risk Level Implication[7]**	**Potential Adverse Subsidence Influence**	**Annual Probability[1] $P_{(H)}$**	**Likelihood[4] $P_{(Likelihood)}$**	**Qualitative Likelihood**	**Risk Level Implication[7]**	**Comparison with Acceptability Crtieria[6]**
Re-activation of historical flow-slide features on slopes below Razorback Escarpment.	None.	0.01	NO STRUCTURES WITHIN ZONE OF POTENITAL INFLUENCE FROM HAZARD							Increased tilt. Increased curvature and strain. Reduction in shear strength. Increased lateral groundwater flow.	0.05	NO STRUCTURES WITHIN ZONE OF POTENITAL INFLUENCE FROM HAZARD			
	Property users (risk to life).		0.1	0.001	1.0E-06	-	0.9	-	9.0E-07			5.0E-06	-	4.5E-06	Acceptable
Rock fall from cliff lines / rock outcrops within Razorback Escarpment.	None.	0.1	NO STRUCTURES WITHIN ZONE OF POTENITAL INFLUENCE FROM HAZARD							Subsidence induced cracking. Increased surface water infiltration via subsidence induced cracking.	0.5	NO STRUCTURES WITHIN ZONE OF POTENITAL INFLUENCE FROM HAZARD			
	Property users (risk to life).		0.1	0.001	1.0E-05	-	0.5	-	5.0E-06			5.0E-05	-	2.5E-05	Acceptable
Regression of the Razorback Escarpment associated with complex deep-seated rock / earth slide.	Structures (shed, dam).	0.001	0.01	1.0	1.0E-05	Rare	-	Medium	Low	Increased tilt. Increased curvature and strain. Reduction in shear strength. Increased surface water infiltration via subsidence induced cracking.	0.005	5.0E-05	Rare	Low	Acceptable
	Property users (risk to life).		0.1	0.01	1.0E-06	-	0.5	-	5.0E-07			5.0E-06	-	2.5E-06	Acceptable
Shallow rotational-translational slide in cut / fill batters surrounding structures.	Structures (shed, dwelling, dam).	0.01	0.01	1.0	1.0E-04	Unlikely	-	Minor	Low	Increased tilt. Reduction in shear strength. Increased surface water infiltration via subsidence induced cracking.	0.05	5.0E-04	Unlikely	Low	Acceptable
	Property users (risk to life).		0.01	0.1	1.0E-05	-	0.1	-	1.0E-06			5.0E-05	-	5.0E-06	Acceptable
Dam embankment instability and loss of containment.	Dam.	0.0001	0.1	1.0	1.0E-05	Rare	-	Minor	Very Low	Increased tilt. Reduction in shear strength. Increased surface water infiltration via subsidence induced cracking.	0.001	1.0E-04	Unlikely	Low	Acceptable
	Property users (risk to life).		0.01	0.1	1.0E-07	-	0.1	-	1.0E-08			1.0E-06	-	1.0E-07	Acceptable

1 - Probability of detachment - Adapted from RTA Guide to Slope Risk Analysis, Version 4, 2012
2 - Travel distances estimated from Richie (1963), Site Observations and RTA Guide to Slope Risk Analysis, Version 4, 2012
3 - Probability that a given failure will interact with the element at risk (e.g., that a road, building or space will be occupied) - Adapted from RTA Guide to Slope Risk Analysis, Version 4, 2012
4 - Quantitative Measure of Likelihood, **$P(Likelihood) = P_{(H)} * P_{(S:H)} * P_{(T:S)}$** - Adapted from AGS 2007c
5 - Vulnerability estimated from AGS 2007c - Appendix F.
6 - Qualitative Measure of Consequence - Worst Case of Outcomes as Per Severity Table
7 - Risk Level Implication - Adapted from AGS 2007c

Likelihood		Consequence				
		Catastrophic	Major	Medium	Minor	Insignificant
Almost Certain	10^{-1}	VH	VH	VH	H	M or L
Likely	10^{-2}	VH	VH	H	M	L
Possible	10^{-3}	VH	H	M	M	L
Unlikely	10^{-4}	H	M	I	I	VI
Rare	10^{-5}	M	I	I	VI	VI
Barely Credible	10^{-6}	L	VL	VL	VL	VL

Level	Descriptor	Consequence to Property
1	Catastrophic	Structure(s) destroyed and/or large-scale damage requiring major engineering works for stabilisation. Could cause at least one adjacent property major consequence damage.
2	Major	Extensive damage to most of structure, and/or extending beyond site boundaries requiring significant stabilisation works. Could cause at least one adjacent property medium consequence damage.
3	Medium	Moderate damage to some of structure, and/or significant part of site requiring large stabilisation works. Could cause at least one adjacent property minor consequence damage.
4	Minor	Limited damage to part of structure, and/or part of site requiring reinstatement stabilisation works.
5	Insignificant	Little damage.

APPENDIX F- EXAMPLE OF VULNERABILITY VALUES

SUMMARY OF HONG KONG VULNERABILITY RANGES FOR PERSONS, AND RECOMMENDED VALUES FOR LOSS OF LIFE FOR LANDSLIDING IN SIMILAR SITUATIONS

The following table is adapted from P J Finlay, G R Mostyn & R Fell (1999). *Landslides: Prediction of Travel Distance and Guidelines for Vulnerability of Persons*. Proc 8th Australia New Zealand Conference on Geomechanics, Hobart. Australian Geomechanics Society, ISBN 1 86445 0029, Vol 1, pp 105-113.

Case	Range in Data	Recommended Value	Comments
Person in Open Space			
If struck by a rockfall	0.1 – 0.7	0.5	May be injured but unlikely to cause death
If buried by debris	0.8 – 1.0	1.0	Death by asphyxia almost certain
If not buried	0.1 – 0.5	0.1	High chance of survival
Persons in a Vehicle			
If the vehicle is buried/crushed	0.9 – 1.0	1.0	Death is almost certain
If the vehicle is damaged only	0 – 0.3	0.3	High chance of survival
Person in a Building			
If the building collapses	0.9 – 1.0	1.0	Death is almost certain
If the building is inundated with debris and the person buried	0.8 – 1.0	1.0	Death is highly likely
If the debris strikes the building only	0 – 0.1	0.05	Very high chance of survival

Risk Level		Example Implications
VH	Very High	Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low; may be too expensive and not practical. Work will likely cost more than the value of the property.
H	High	Unacceptable without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to Low. Work would cost a substantial sum in relation to the value of the property.
M	Moderate	May be tolerated in certain circumstances (subject to regulator's approval) but requires investigation, planning and implementation of treatment options to reduce risk to Low.
L	Low	Usually acceptable to regulators. Where treatment has been required to reduce the risk to this level, ongoing maintenance is required.
VL	Very Low	Acceptable. Managed by normal slope maintenance procedures.

Table 1: AGS Suggested Tolerable loss of life individual risk.

Situation	Suggested Tolerable Loss of Life Risk for the person most at risk
Existing Slope (1) / Existing Development (2)	10^{-4} / annum
New Constructed Slope (3) / New Development (4) / Existing Landslide (5)	10^{-5} / annum

LANDSLIDE RISK ASSESSMENT - QUANTITATIVE RISK TO LIFE AND SEMI-QUANTITATIVE RISK TO PROPERTY

LOCATION: O06 - 19 Gibraltar Drive

INHERENT LANDSLIDE RISK PROFILE										SUBSIDENCE INFLUENCE PERIOD					
Identified Hazard	Element at Risk	Annual Probability[1] $P_{(H)}$	Spatial Probability[2] $P_{(S:H)}$	Temporal Probability[3] $P_{(T:S)}$	Likelihood[4] $P_{(Likelihood)}$	Qualitative Likelihood	Vulnerability[5]	Qualitative Consequence[6]	Risk Level Implication[7]	Potential Adverse Subsidence Influence	Annual Probability[1] $P_{(H)}$	Likelihood[4] $P_{(Likelihood)}$	Qualitative Likelihood	Risk Level Implication[7]	Comparison with Acceptability Crtieria[6]
Re-activation of historical flow-slide features on slopes below Razorback Escarpment.	None.	0.01	NO STRUCTURES WITHIN ZONE OF POTENITAL INFLUENCE FROM HAZARD							Increased tilt. Increased curvature and strain. Reduction in shear strength. Increased lateral groundwater flow.	0.05	NO STRUCTURES WITHIN ZONE OF POTENITAL INFLUENCE FROM HAZARD			
	Property users (risk to life).		0.1	0.001	1.0E-06	-	0.9	-	9.0E-07			5.0E-06	-	4.5E-06	Acceptable
Rock fall from cliff lines / rock outcrops within Razorback Escarpment.	None.	0.1	NO STRUCTURES WITHIN ZONE OF POTENITAL INFLUENCE FROM HAZARD							Subsidence induced cracking. Increased surface water infiltration via subsidence induced cracking.	0.5	NO STRUCTURES WITHIN ZONE OF POTENITAL INFLUENCE FROM HAZARD			
	Property users (risk to life).		0.1	0.001	1.0E-05	-	0.5	-	5.0E-06			5.0E-05	-	2.5E-05	Acceptable
Regression of the Razorback Escarpment associated with complex deep-seated rock / earth slide.	Structures, house, shed etc.	0.001	0.0001	1.0	1.0E-07	Barely Credible	-	Medium	Very Low	Increased tilt. Increased curvature and strain. Reduction in shear strength. Increased surface water infiltration via subsidence induced cracking.	0.005	5.0E-07	Barely Credible	Very Low	Acceptable
	Property users (risk to life).		0.1	0.01	1.0E-06	-	0.5	-	5.0E-07			5.0E-06	-	2.5E-06	Acceptable
Dam embankment instability and loss of containment.	Dam.	0.0001	0.1	1.0	1.0E-05	Rare	-	Minor	Very Low	Increased tilt. Reduction in shear strength. Increased surface water infiltration via subsidence induced cracking.	0.001	1.0E-04	Unlikely	Low	Acceptable
	Property users (risk to life).		0.01	0.1	1.0E-07	-	0.1	-	1.0E-08			1.0E-06	-	1.0E-07	Acceptable

1 - Probability of detachment - Adapted from RTA Guide to Slope Risk Analysis, Version 4, 2012
2 - Travel distances estimated from Richie (1963), Site Observations and RTA Guide to Slope Risk Analysis, Version 4, 2012
3 - Probability that a given failure will interact with the element at risk (e.g., that a road, building or space will be occupied) - Adapted from RTA Guide to Slope Risk Analysis, Version 4, 2012
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6 - Qualitative Measure of Consequence - Worst Case of Outcomes as Per Severity Table
7 - Risk Level Implication - Adapted from AGS 2007c

Likelihood		Consequence				
		Catastrophic	Major	Medium	Minor	Insignificant
Almost Certain	10^{-1}	VH	VH	VH	H	M or L
Likely	10^{-2}	VH	VH	H	M	L
Possible	10^{-3}	VH	H	M	M	L
Unlikely	10^{-4}	H	M	I	I	VI
Rare	10^{-5}	M	I	I	VI	VI
Barely Credible	10^{-6}	L	VL	VL	VL	VL

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4	Minor	Limited damage to part of structure, and/or part of site requiring reinstatement stabilisation works.
5	Insignificant	Little damage.

APPENDIX F- EXAMPLE OF VULNERABILITY VALUES

SUMMARY OF HONG KONG VULNERABILITY RANGES FOR PERSONS, AND RECOMMENDED VALUES FOR LOSS OF LIFE FOR LANDSLIDING IN SIMILAR SITUATIONS

The following table is adapted from P J Finlay, G R Mostyn & R Fell (1999). *Landslides: Prediction of Travel Distance and Guidelines for Vulnerability of Persons*. Proc 8th Australia New Zealand Conference on Geomechanics, Hobart. Australian Geomechanics Society, ISBN 1 86445 0029, Vol 1, pp 105-113.

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Persons in a Vehicle			
If the vehicle is buried/crushed	0.9 – 1.0	1.0	Death is almost certain
If the vehicle is damaged only	0 – 0.3	0.3	High chance of survival
Person in a Building			
If the building collapses	0.9 – 1.0	1.0	Death is almost certain
If the building is inundated with debris and the person buried	0.8 – 1.0	1.0	Death is highly likely
If the debris strikes the building only	0 – 0.1	0.05	Very high chance of survival

Risk Level		Example Implications
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VL	Very Low	Acceptable. Managed by normal slope maintenance procedures.

Table 1: AGS Suggested Tolerable loss of life individual risk.

Situation	Suggested Tolerable Loss of Life Risk for the person most at risk
Existing Slope (1) / Existing Development (2)	10^{-4} / annum
New Constructed Slope (3) / New Development (4) / Existing Landslide (5)	10^{-5} / annum

LANDSLIDE RISK ASSESSMENT - QUANTITATIVE RISK TO LIFE AND SEMI-QUANTITATIVE RISK TO PROPERTY

LOCATION: R09 - 85 Donalds Range Road

INHERENT LANDSLIDE RISK PROFILE										SUBSIDENCE INFLUENCE PERIOD					
Identified Hazard	**Element at Risk**	**Annual Probability[1] $P_{(H)}$**	**Spatial Probability[2] $P_{(S:H)}$**	**Temporal Probability[3] $P_{(T:S)}$**	**Likelihood[4] $P_{(Likelihood)}$**	**Qualitative Likelihood**	**Vulnerability[5]**	**Qualitative Consequence[6]**	**Risk Level Implication[7]**	**Potential Adverse Subsidence Influence**	**Annual Probability[1] $P_{(H)}$**	**Likelihood[4] $P_{(Likelihood)}$**	**Qualitative Likelihood**	**Risk Level Implication[7]**	**Comparison with Acceptability Crtieria[6]**
Re-activation of historical flow-slide features on slopes below Razorback Escarpment.	None.	0.01	NO STRUCTURES WITHIN ZONE OF POTENITAL INFLUENCE FROM HAZARD							Increased tilt. Increased curvature and strain. Reduction in shear strength. Increased lateral groundwater flow.	0.05	NO STRUCTURES WITHIN ZONE OF POTENITAL INFLUENCE FROM HAZARD			
	Property users (risk to life).		0.1	0.001	1.0E-06	-	0.9	-	9.0E-07			5.0E-06	-	4.5E-06	Acceptable
Regression of the Razorback Escarpment associated with complex deep-seated rock / earth slide.	Structures (house, shed).	0.001	0.0001	1.0	1.0E-07	Barely Credible	-	Medium	Very Low	Increased tilt. Increased curvature and strain. Reduction in shear strength. Increased surface water infiltration via subsidence induced cracking.	0.005	5.0E-07	Barely Credible	Very Low	Acceptable
	Dam.		0.1	1.0	1.0E-04	Rare	-	Medium	Low			5.0E-04	Unlikely	Low	Acceptable
	Property users (risk to life).		0.1	0.01	1.0E-06	-	0.5	-	5.0E-07			5.0E-06	-	2.5E-06	Acceptable
Shallow rotational-translational slide fill batter below shed	Structures (shed).	0.05	0.01	1.0	5.0E-04	Unlikely	-	Minor	Low	Increased tilt. Reduction in shear strength. Increased surface water infiltration via subsidence induced cracking.	0.1	1.0E-03	Possible	Moderate	Tolerable - ALARP
	Property users (risk to life).		0.01	0.1	5.0E-05	-	0.1	-	5.0E-06			1.0E-04	-	1.0E-05	Acceptable
Creep movement of previously unstable area in head of gully north of dam.	Driveway damage.	0.5	0.001	1.0	5.0E-04	Unlikely	-	Minor	Low	Increased tilt. Reduction in shear strength. Increased surface water infiltration via subsidence induced cracking.	0.5	5.0E-04	Unlikely	Low	Acceptable
	Property users (risk to life).		0.01	0.01	5.0E-05	-	0.1	-	5.0E-06			5.0E-05	-	5.0E-06	Acceptable
Dam embankment instability and loss of containment.	Dam.	0.001	0.1	1.0	1.0E-04	Unlikely	-	Minor	Low	Increased tilt. Reduction in shear strength. Increased surface water infiltration via subsidence induced cracking.	0.01	1.0E-03	Possible	Moderate	Tolerable - ALARP
	Property users (risk to life).		0.01	0.1	1.0E-06	-	0.1	-	1.0E-07			1.0E-05	-	1.0E-06	Acceptable

1 - Probability of detachment - Adapted from RTA Guide to Slope Risk Analysis, Version 4, 2012

2 - Travel distances estimated from Richie (1963), Site Observations and RTA Guide to Slope Risk Analysis, Version 4, 2012

3 - Probability that a given failure will interact with the element at risk (e.g., that a road, building or space will be occupied) - Adapted from RTA Guide to Slope Risk Analysis, Version 4, 2012

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5 - Vulnerability estimated from AGS 2007c - Appendix F.

6 - Qualitative Measure of Consequence - Worst Case of Outcomes as Per Severity Table

7 - Risk Level Implication - Adapted from AGS 2007c

Likelihood		Consequence				
		Catastrophic	Major	Medium	Minor	Insignificant
Almost Certain	10^{-1}	VH	VH	VH	H	M or L
Likely	10^{-2}	VH	VH	H	M	L
Possible	10^{-3}	VH	H	M	M	L
Unlikely	10^{-4}	H	M	L	L	VL
Rare	10^{-5}	M	L	L	VL	VL
Barely Credible	10^{-6}	L	VL	VL	VL	VL

Level	Descriptor	Consequence to Property
1	Catastrophic	Structure(s) destroyed and/or large-scale damage requiring major engineering works for stabilisation. Could cause at least one adjacent property major consequence damage.
2	Major	Extensive damage to most of structure, and/or extending beyond site boundaries requiring significant stabilisation works. Could cause at least one adjacent property medium consequence damage.
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4	Minor	Limited damage to part of structure, and/or part of site requiring reinstatement stabilisation works.
5	Insignificant	Little damage.

APPENDIX F- EXAMPLE OF VULNERABILITY VALUES

SUMMARY OF HONG KONG VULNERABILITY RANGES FOR PERSONS, AND RECOMMENDED VALUES FOR LOSS OF LIFE FOR LANDSLIDING IN SIMILAR SITUATIONS

The following table is adapted from P J Finlay, G R Mostyn & R Fell (1999). *Landslides: Prediction of Travel Distance and Guidelines for Vulnerability of Persons*. Proc 8th Australia New Zealand Conference on Geomechanics, Hobart. Australian Geomechanics Society, ISBN 1 86445 0029, Vol 1, pp 105-113.

Case	Range in Data	Recommended Value	Comments
Person in Open Space			
If struck by a rockfall	0.1 – 0.7	0.5	May be injured but unlikely to cause death
If buried by debris	0.8 – 1.0	1.0	Death by asphyxia almost certain
If not buried	0.1 – 0.5	0.1	High chance of survival
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If the vehicle is buried/crushed	0.9 – 1.0	1.0	Death is almost certain
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Person in a Building			
If the building collapses	0.9 – 1.0	1.0	Death is almost certain
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If the debris strikes the building only	0 – 0.1	0.05	Very high chance of survival

Risk Level		Example Implications
VH	Very High	Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low; may be too expensive and not practical. Work will likely cost more than the value of the property
H	High	Unacceptable without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to Low. Work would cost a substantial sum in relation to the value of the property
M	Moderate	May be tolerable in certain circumstances (subject to regulator's approval) but requires investigation, planning and implementation of treatment options to reduce risk to Low.
L	Low	Usually acceptable to regulators. Where treatment has been required to reduce the risk to this level, ongoing maintenance is required
VL	Very Low	Acceptable. Managed by normal slope maintenance procedures.

Table 1: AGS Suggested Tolerable loss of life individual risk.

Situation	Suggested Tolerable Loss of Life Risk for the person most at risk
Existing Slope (1) / Existing Development (2)	10^{-4} / annum
New Constructed Slope (3) / New Development (4) / Existing Landslide (5)	10^{-5} / annum

LANDSLIDE RISK ASSESSMENT - QUANTITATIVE RISK TO LIFE AND SEMI-QUANTITATIVE RISK TO PROPERTY

LOCATION: S48 - 120 Dawsons Rd (Razorback Stud)

INHERENT LANDSLIDE RISK PROFILE										SUBSIDENCE INFLUENCE PERIOD					
Identified Hazard	Element at Risk	Annual Probability[1] $P_{(H)}$	Spatial Probability[2] $P_{(S:H)}$	Temporal Probability[3] $P_{(T:S)}$	Likelihood[4] $P_{(Likelihood)}$	Qualitative Likelihood	Vulnerability[5]	Qualitative Consequence[6]	Risk Level Implication[7]	Potential Adverse Subsidence Influence	Annual Probability[1] $P_{(H)}$	Likelihood[4] $P_{(Likelihood)}$	Qualitative Likelihood	Risk Level Implication[7]	Comparison with Acceptability Crtieria[6]
Re-activation of historical flow-slide features on slopes below Razorback Escarpment (away from dwelling).	Structures (main dwelling).	0.01	0.01	1.0	1.0E-04	Unlikely	-	Medium	Low	Increased tilt. Increased curvature and strain. Reduction in shear strength. Increased lateral groundwater flow.	0.05	5.0E-04	Unlikely	Low	Acceptable
	Property users (risk to life).		0.01	0.01	1.0E-06	-	0.9		9.0E-07			5.0E-06	-	4.5E-06	Acceptable
Deep-seated rock / earth slide on complex terrain upslope of main dwelling.	Structures (main dwelling).	0.001	0.1	1.0	1.0E-04	Unlikely	-	Major	Moderate	Increased tilt. Increased curvature and strain. Reduction in shear strength. Increased lateral groundwater flow.	0.005	5.0E-04	Unlikely	Moderate	Tolerable - ALARP
	Property users (risk to life).		0.1	0.1	1.0E-05	-	0.9		9.0E-06			5.0E-05	-	4.5E-05	Acceptable
Debris Flow from steep slopes (complex terrain / historical flow slide areas)	Structures (main dwelling).	0.01	0.01	1.0	1.0E-04	Unlikely	-	Medium	Low	Increased surface water infiltration via subsidence induced cracking. Increased lateral groundwater flow.	0.05	5.0E-04	Unlikely	Low	Acceptable
	Property users (risk to life).		0.01	0.01	1.0E-06	-	0.9		9.0E-07			5.0E-06	-	4.5E-06	Acceptable
Rock fall from rock outcrops on steep slopes / Razorback Escarpment.	Structures (main dwelling).	0.1	0.01	1.0	1.0E-03	Possible	-	Minor	Moderate	Subsidence induced cracking. Increased surface water infiltration via subsidence induced cracking.	0.5	5.0E-03	Possible	Moderate	Tolerable - ALARP
	Property users (risk to life).		0.01	0.1	1.0E-04	-	0.5		5.0E-05			5.0E-04	-	2.5E-04	Tolerable - ALARP
Dam embankment instability and loss of containment.	Dam.	0.0001	0.1	1.0	1.0E-05	Rare	-	Minor	Very Low	Increased tilt. Reduction in shear strength. Increased surface water infiltration via subsidence induced cracking.	0.001	1.0E-04	Unlikely	Low	Acceptable
	Property users (risk to life).		0.01	0.01	1.0E-08	-	0.1		1.0E-09			1.0E-07	-	1.0E-08	Acceptable

1 - Probability of detachment - Adapted from RTA Guide to Slope Risk Analysis, Version 4, 2012
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Likely	10^{-2}	VH	VH	H	M	L
Possible	10^{-3}	VH	H	M	M	L
Unlikely	10^{-4}	H	M	L	L	VL
Rare	10^{-5}	M	L	L	VL	VL
Barely Credible	10^{-6}	L	VL	VL	VL	VL

Level	Descriptor	Consequence to Property
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Risk Level		Example Implications
VH	Very High	Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low; may be too expensive and not practical. Work will likely cost more than the value of the property.
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Table 1: AGS Suggested Tolerable loss of life individual risk.

Situation	Suggested Tolerable Loss of Life Risk for the person most at risk
Existing Slope (1) / Existing Development (2)	10^{-4} / annum
New Constructed Slope (3) / New Development (4) / Existing Landslide (5)	10^{-3} / annum

LANDSLIDE RISK ASSESSMENT - QUANTITATIVE RISK TO LIFE AND SEMI-QUANTITATIVE RISK TO PROPERTY

LOCATION: S29 - 130 Cummins Road

INHERENT LANDSLIDE RISK PROFILE										SUBSIDENCE INFLUENCE PERIOD					
Identified Hazard	Element at Risk	Annual Probability[1] $P_{(H)}$	Spatial Probability[2] $P_{(S:H)}$	Temporal Probability[3] $P_{(T:S)}$	Likelihood[4] $P_{(Likelihood)}$	Qualitative Likelihood	Vulnerability[5]	Qualitative Consequence[6]	Risk Level Implication[7]	Potential Adverse Subsidence Effects	Annual Probability[1] $P_{(H)}$	Likelihood[4] $P_{(Likelihood)}$	Qualitative Likelihood	Risk Level Implication[7]	Comparison with Acceptability Crtieria[6]
Re-activation of historical flow-slide features on slopes below Razorback Escarpment (away from dwelling).	Structures (main dwelling, shed).	0.01	0.01	1	1.0E-04	Unlikely	-	Medium	Low	Increased tilt. Increased curvature and strain. Reduction in shear strength. Increased lateral groundwater flow.	0.05	5.0E-04	Likely	Low	Acceptable
	Property users (risk to life).		0.01	0.01	1.0E-06	-	0.9	-	9.0E-07			5.0E-06	-	4.5E-06	Acceptable
Deep-seated rock / earth slide on steep slope upslope of main dwelling.	Structures (main dwelling, shed).	0.0001	0.1	1	1.0E-05	Rare	-	Major	Moderate	Increased tilt. Increased curvature and strain. Reduction in shear strength. Increased lateral groundwater flow.	0.005	5.0E-04	Unlikely	Moderate	Tolerable - ALARP
	Property users (risk to life).		0.1	0.1	1.0E-06	-	0.9	-	9.0E-07			5.0E-05	-	4.5E-05	Acceptable
Debris Flow from steep slopes (complex terrain / historical flow slide areas)	Structures (main dwelling, shed).	0.01	0.01	1	1.0E-04	Unlikely	-	Medium	Low	Increased surface water infiltration via subsidence induced cracking. Increased lateral groundwater flow.	0.05	5.0E-04	Unlikely	Low	Acceptable
	Property users (risk to life).		0.01	0.01	1.0E-06	-	0.9	-	9.0E-07			5.0E-06	-	4.5E-06	Acceptable
Rock fall from rock outcrops on steep slopes / Razorback Escarpment.	Structures (main dwelling, shed).	0.1	0.0001	1	1.0E-05	Rare	-	Medium	Low	Subsidence induced cracking. Increased surface water infiltration via subsidence induced cracking.	0.5	5.0E-05	Rare	Low	Acceptable
	Property users (risk to life).		0.0001	0.1	1.0E-06	-	0.5	-	5.0E-07			5.0E-06	-	2.5E-06	Acceptable
Shallow rotational- translational slide in fill batter below structures.	Structures (main dwelling, shed).	0.01	0.01	1	1.0E-04	Unlikely	-	Minor	Low	Increased tilt. Reduction in shear strength. Increased surface water infiltration via subsidence induced cracking.	0.05	5.0E-04	Unlikely	Low	Acceptable
	Property users (risk to life).		0.01	0.1	1.0E-05	-	0.1	-	1.0E-06			5.0E-05	-	5.0E-06	Acceptable

1 - Probability of detachment - Adapted from RTA Guide to Slope Risk Analysis, Version 4, 2012
2 - Travel distances estimated from Richie (1963), Site Observations and RTA Guide to Slope Risk Analysis, Version 4, 2012
3 - Probability that a given failure will interact with the element at risk (e.g., that a road, building or space will be occupied) - Adapted from RTA Guide to Slope Risk Analysis, Version 4, 2012
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6 - Qualitative Measure of Consequence - Worst Case of Outcomes as Per Severity Table
7 - Risk Level Implication - Adapted from AGS 2007c

Likelihood		Consequence				
		Catastrophic	Major	Medium	Minor	Insignificant
Almost Certain	10^{-1}	VH	VH	VH	H	M or L
Likely	10^{-2}	VH	VH	H	M	L
Possible	10^{-3}	VH	H	M	M	L
Unlikely	10^{-4}	H	M	I	I	VI
Rare	10^{-5}	M	I	I	VI	VI
Barely Credible	10^{-6}	L	VL	VL	VL	VL

Level	Descriptor	Consequence to Property
1	Catastrophic	Structure(s) destroyed and/or large-scale damage requiring major engineering works for stabilisation. Could cause at least one adjacent property major consequence damage.
2	Major	Extensive damage to most of structure, and/or extending beyond site boundaries requiring significant stabilisation works. Could cause at least one adjacent property medium consequence damage.
3	Medium	Moderate damage to some of structure, and/or significant part of site requiring large stabilisation works. Could cause at least one adjacent property minor consequence damage.
4	Minor	Limited damage to part of structure, and/or part of site requiring reinstatement stabilisation works.
5	Insignificant	Little damage.

APPENDIX F- EXAMPLE OF VULNERABILITY VALUES

SUMMARY OF HONG KONG VULNERABILITY RANGES FOR PERSONS, AND RECOMMENDED VALUES FOR LOSS OF LIFE FOR LANDSLIDING IN SIMILAR SITUATIONS

The following table is adapted from P J Finlay, G R Mostyn & R Fell (1999). *Landslides: Prediction of Travel Distance and Guidelines for Vulnerability of Persons*. Proc 8th Australia New Zealand Conference on Geomechanics, Hobart. Australian Geomechanics Society, ISBN 1 86445 0029, Vol 1, pp 105-113.

Case	Range in Data	Recommended Value	Comments
Person in Open Space			
If struck by a rockfall	0.1 – 0.7	0.5	May be injured but unlikely to cause death
If buried by debris	0.8 – 1.0	1.0	Death by asphyxia almost certain
If not buried	0.1 – 0.5	0.1	High chance of survival
Persons in a Vehicle			
If the vehicle is buried/crushed	0.9 – 1.0	1.0	Death is almost certain
If the vehicle is damaged only	0 – 0.3	0.3	High chance of survival
Person in a Building			
If the building collapses	0.9 – 1.0	1.0	Death is almost certain
If the building is inundated with debris and the person buried	0.8 – 1.0	1.0	Death is highly likely
If the debris strikes the building only	0 – 0.1	0.05	Very high chance of survival

Risk Level		Example Implications
VH	Very High	Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low; may be too expensive and not practical. Work will likely cost more than the value of the property
H	High	Unacceptable without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to Low. Work would cost a substantial sum in relation to the value of the property
M	Moderate	May be tolerated in certain circumstances (subject to regulator's approval) but requires investigation, planning and implementation of treatment options to reduce risk to Low
L	Low	Usually acceptable to regulators. Where treatment has been required to reduce the risk to this level, ongoing maintenance is required
VL	Very Low	Acceptable. Managed by normal slope maintenance procedures.

Table 1: AGS Suggested Tolerable loss of life individual risk.

Situation	Suggested Tolerable Loss of Life Risk for the person most at risk
Existing Slope (1) / Existing Development (2)	10^{-4} / annum
New Constructed Slope (3) / New Development (4) / Existing Landslide (5)	10^{-5} / annum

LANDSLIDE RISK ASSESSMENT - QUANTITATIVE RISK TO LIFE AND SEMI-QUANTITATIVE RISK TO PROPERTY

LOCATION: S27 - 156 Cummins Road

INHERENT LANDSLIDE RISK PROFILE										SUBSIDENCE INFLUENCE PERIOD					
Identified Hazard	Element at Risk	Annual Probability[1] $P_{(H)}$	Spatial Probability[2] $P_{(S:H)}$	Temporal Probability[3] $P_{(T:S)}$	Likelihood[4] $P_{(Likelihood)}$	Qualitative Likelihood	Vulnerability[5]	Qualitative Consequence[6]	Risk Level Implication[7]	Potential Adverse Subsidence Influence	Annual Probability[1] $P_{(H)}$	Likelihood[4] $P_{(Likelihood)}$	Qualitative Likelihood	Risk Level Implication[7]	Comparison with Acceptability Crtieria[6]
Re-activation of historical flow-slide features on slopes below Razorback Escarpment (underlying dwelling).	Structures (main dwelling).	0.01	0.1	1.0	1.0E-03	Possible	-	Major	High	Increased tilt. Increased curvature and strain. Reduction in shear strength. Increased lateral groundwater flow.	0.05	5.0E-03	Possible	High	Unacceptable Without Risk Mitigation
	Property users (risk to life).		0.1	0.1	1.0E-04	-	0.9	-	9.0E-05			5.0E-04	-	4.5E-04	Tolerable - ALARP
Deep-seated rock / earth slide on complex terrain upslope of main dwelling.	Structures (main dwelling, shed).	0.001	0.1	1.0	1.0E-04	Unlikely	-	Major	Moderate	Increased tilt. Increased curvature and strain. Reduction in shear strength. Increased lateral groundwater flow.	0.01	1.0E-03	Possible	High	Unacceptable Without Risk Mitigation
	Property users (risk to life).		0.1	0.1	1.0E-05	-	0.9	-	9.0E-06			1.0E-04	-	9.0E-05	Tolerable - ALARP
Debris Flow from steep slopes (complex terrain / historical flow slide areas)	Structures (main dwelling).	0.01	0.1	1.0	1.0E-03	Possible	-	Medium	Moderate	Increased surface water infiltration via subsidence induced cracking. Increased lateral groundwater flow.	0.05	5.0E-03	Possible	Moderate	Tolerable - ALARP
	Property users (risk to life).		0.1	0.1	1.0E-04	-	0.9	-	9.0E-05			5.0E-04	-	4.5E-04	Tolerable - ALARP
Rock fall from rock outcrops on steep slopes / Razorback Escarpment.	Structures (main dwelling).	0.1	0.01	1.0	1.0E-03	Possible	-	Minor	Moderate	Subsidence induced cracking. Increased surface water infiltration via subsidence induced cracking.	0.5	5.0E-03	Possible	Moderate	Tolerable - ALARP
	Property users (risk to life).		0.01	0.1	1.0E-04	-	0.5	-	5.0E-05			5.0E-04	-	2.5E-04	Tolerable - ALARP
Continued failure of active translational / rotational slide upslope of shed	Structures (shed).	0.1	0.1	1.0	1.0E-02	Likely	-	Minor	Moderate	Increased tilt. Reduction in shear strength. Increased lateral groundwater flow.	0.5	5.0E-02	Likely	Moderate	Tolerable - ALARP
	Property users (risk to life).		0.1	0.01	1.0E-04	-	0.1	-	1.0E-05			5.0E-04	-	5.0E-05	Tolerable - ALARP
Shallow rotational-translational slide fill batters below structures.	Structures (shed, dwelling).	0.01	0.1	1.0	1.0E-03	Possible	-	Minor	Moderate	Increased tilt. Reduction in shear strength. Increased surface water infiltration via subsidence induced cracking.	0.05	5.0E-03	Possible	Moderate	Tolerable - ALARP
	Property users (risk to life).		0.01	0.1	1.0E-05	-	0.1	-	1.0E-06			5.0E-05	-	5.0E-06	Acceptable

1 - Probability of detachment - Adapted from RTA Guide to Slope Risk Analysis, Version 4, 2012
2 - Travel distances estimated from Richie (1963), Site Observations and RTA Guide to Slope Risk Analysis, Version 4, 2012
3 - Probability that a given failure will interact with the element at risk (e.g., that a road, building or space will be occupied) - Adapted from RTA Guide to Slope Risk Analysis, Version 4, 2012
4 - Quantitative Measure of Likelihood, **$P(Likelihood) = P_{(H)} * P_{(S:H)} * P_{(T:S)}$** - Adapted from AGS 2007c
5 - Vulnerability estimated from AGS 2007c - Appendix F.
6 - Qualitative Measure of Consequence - Worst Case of Outcomes as Per Severity Table
7 - Risk Level Implication - Adapted from AGS 2007c

Likelihood		Consequence				
		Catastrophic	Major	Medium	Minor	Insignificant
Almost Certain	10^{-1}	VH	VH	VH	H	M or L
Likely	10^{-2}	VH	VH	H	M	L
Possible	10^{-3}	VH	H	M	M	L
Unlikely	10^{-4}	H	M	L	L	VL
Rare	10^{-5}	M	L	L	VL	VL
Barely Credible	10^{-6}	L	VL	VL	VL	VL

Level	Descriptor	Consequence to Property
1	Catastrophic	Structure(s) destroyed and/or large-scale damage requiring major engineering works for stabilisation. Could cause at least one adjacent property major consequence damage.
2	Major	Extensive damage to most of structure, and/or extending beyond site boundaries requiring significant stabilisation works. Could cause at least one adjacent property medium consequence damage.
3	Medium	Moderate damage to some of structure, and/or significant part of site requiring large stabilisation works. Could cause at least one adjacent property minor consequence damage.
4	Minor	Limited damage to part of structure, and/or part of site requiring reinstatement stabilisation works.
5	Insignificant	Little damage.

APPENDIX F- EXAMPLE OF VULNERABILITY VALUES

SUMMARY OF HONG KONG VULNERABILITY RANGES FOR PERSONS, AND RECOMMENDED VALUES FOR LOSS OF LIFE FOR LANDSLIDING IN SIMILAR SITUATIONS

The following table is adapted from P J Finlay, G R Mostyn & R Fell (1999). *Landslides: Prediction of Travel Distance and Guidelines for Vulnerability of Persons*. Proc 8th. Australia New Zealand Conference on Geomechanics, Hobart. Australian Geomechanics Society, ISBN 1 86445 0029, Vol 1, pp 105-113.

Case	Range in Data	Recommended Value	Comments
Person in Open Space			
If struck by a rockfall	0.1 – 0.7	0.5	May be injured but unlikely to cause death
If buried by debris	0.8 – 1.0	1.0	Death by asphyxia almost certain
If not buried	0.1 – 0.5	0.1	High chance of survival
Persons in a Vehicle			
If the vehicle is buried/crushed	0.9 – 1.0	1.0	Death is almost certain
If the vehicle is damaged only	0 – 0.3	0.3	High chance of survival
Person in a Building			
If the building collapses	0.9 – 1.0	1.0	Death is almost certain
If the building is inundated with debris and the person buried	0.8 – 1.0	1.0	Death is highly likely
If the debris strikes the building only	0 – 0.1	0.05	Very high chance of survival

Risk Level		Example Implications
VH	Very High	Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low; may be too expensive and not practical. Work will likely cost more than the value of the property
H	High	Unacceptable without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to Low. Work would cost a substantial sum in relation to the value of the property
M	Moderate	May be tolerable in certain circumstances (subject to regulator's approval) but requires investigation, planning and implementation of treatment options to reduce risk to Low
L	Low	Usually acceptable to regulators. Where treatment has been required to reduce the risk to this level, ongoing maintenance is required
VL	Very Low	Acceptable. Managed by normal slope maintenance procedures.

Table 1: AGS Suggested Tolerable loss of life individual risk.

Situation	Suggested Tolerable Loss of Life Risk for the person most at risk
Existing Slope (1) / Existing Development (2)	10^{-4} / annum
New Constructed Slope (3) / New Development (4) / Existing Landslide (5)	10^{-5} / annum

LANDSLIDE RISK ASSESSMENT - QUANTITATIVE RISK TO LIFE AND SEMI-QUANTITATIVE RISK TO PROPERTY

LOCATION: R42 - 790 Remembrance Drive

INHERENT LANDSLIDE RISK PROFILE										SUBSIDENCE INFLUENCE PERIOD					
Identified Hazard	Element at Risk	Annual Probability[1] $P_{(H)}$	Spatial Probability[2] $P_{(S:H)}$	Temporal Probability[3] $P_{(T:S)}$	Likelihood[4] $P_{(Likelihood)}$	Qualitative Likelihood	Vulnerability[5]	Qualitative Consequence[6]	Risk Level Implication[7]	Potential Adverse Subsidence Influence	Annual Probability[1] $P_{(H)}$	Likelihood[4] $P_{(Likelihood)}$	Qualitative Likelihood	Risk Level Implication[7]	Comparison with Acceptability Crtieria[6]
Re-activation of historical flow-slide features on steep slopes southern portion of property	None.	0.01	NO STRUCTURES WITHIN ZONE OF POTENITAL INFLUENCE FROM HAZARD							Increased tilt. Increased curvature and strain. Reduction in shear strength. Increased lateral groundwater flow.	0.05	NO STRUCTURES WITHIN ZONE OF POTENITAL INFLUENCE FROM HAZARD			
	Property users (risk to life).		0.01	0.01	1.0E-06	-	0.9	-	9.0E-07			5.0E-06	-	4.5E-06	Acceptable
Re-activation of large flow-slide feature along eastern boundary upslope of driveway.	Structures (driveway).	0.01	0.1	1.0	1.0E-03	Possible	-	Minor	Moderate	Increased tilt. Increased curvature and strain. Reduction in shear strength. Increased lateral groundwater flow.	0.02	2.0E-03	Possible	Moderate	Tolerable - ALARP
	Property users (risk to life).		0.1	0.01	1.0E-05	-	0.9	-	9.0E-06			2.0E-05	-	1.8E-05	Tolerable - ALARP
Debris Flow from steep slopes (complex terrain / historical flow slide areas)	None.	0.01	NO STRUCTURES WITHIN ZONE OF POTENITAL INFLUENCE FROM HAZARD							Increased surface water infiltration via subsidence induced cracking. Increased lateral groundwater flow.	0.05	NO STRUCTURES WITHIN ZONE OF POTENITAL INFLUENCE FROM HAZARD			
	Property users (risk to life).		0.01	0.01	1.0E-06	-	0.9	-	9.0E-06			5.0E-06	-	4.5E-06	Acceptable
Rock fall from cliff lines along Escarpment.	None.	0.1	NO STRUCTURES WITHIN ZONE OF POTENITAL INFLUENCE FROM HAZARD							Subsidence induced cracking. Increased surface water infiltration via subsidence induced cracking.	0.5	NO STRUCTURES WITHIN ZONE OF POTENITAL INFLUENCE FROM HAZARD			
	Property users (risk to life).		0.0001	0.1	1.0E-06	-	0.5	-	5.0E-07			5.0E-06	-	2.5E-06	Acceptable
New, shallow rotational / translational slide on slopes surrounding structures.	Structures (dwellings).	0.0001	0.01	1.0	1.0E-06	Barely Credible	-	Minor	Very Low	Increased tilt. Reduction in shear strength. Increased lateral groundwater flow.	0.0002	2.0E-06	Barely Credible	Very Low	Acceptable
	Property users (risk to life).		0.01	0.1	1.0E-07	-	0.1	-	1.0E-08			2.0E-07	-	2.0E-08	Acceptable
Dam embankment instability and loss of containment.	Dam.	0.001	0.1	1.0	1.0E-04	Unlikely	-	Minor	Low	Increased tilt. Reduction in shear strength. Increased surface water infiltration via subsidence induced cracking.	0.005	5.0E-04	Unlikely	Low	Acceptable
	Property users (risk to life).		0.01	0.01	1.0E-07	-	0.1	-	1.0E-08			5.0E-07	-	5.0E-08	Acceptable

1 - Probability of detachment - Adapted from RTA Guide to Slope Risk Analysis, Version 4, 2012

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Unlikely	10^{-4}	H	M	I	I	VI
Rare	10^{-5}	M	I	I	VI	VI
Barely Credible	10^{-6}	L	VL	VL	VL	VL

Level	Descriptor	Consequence to Property
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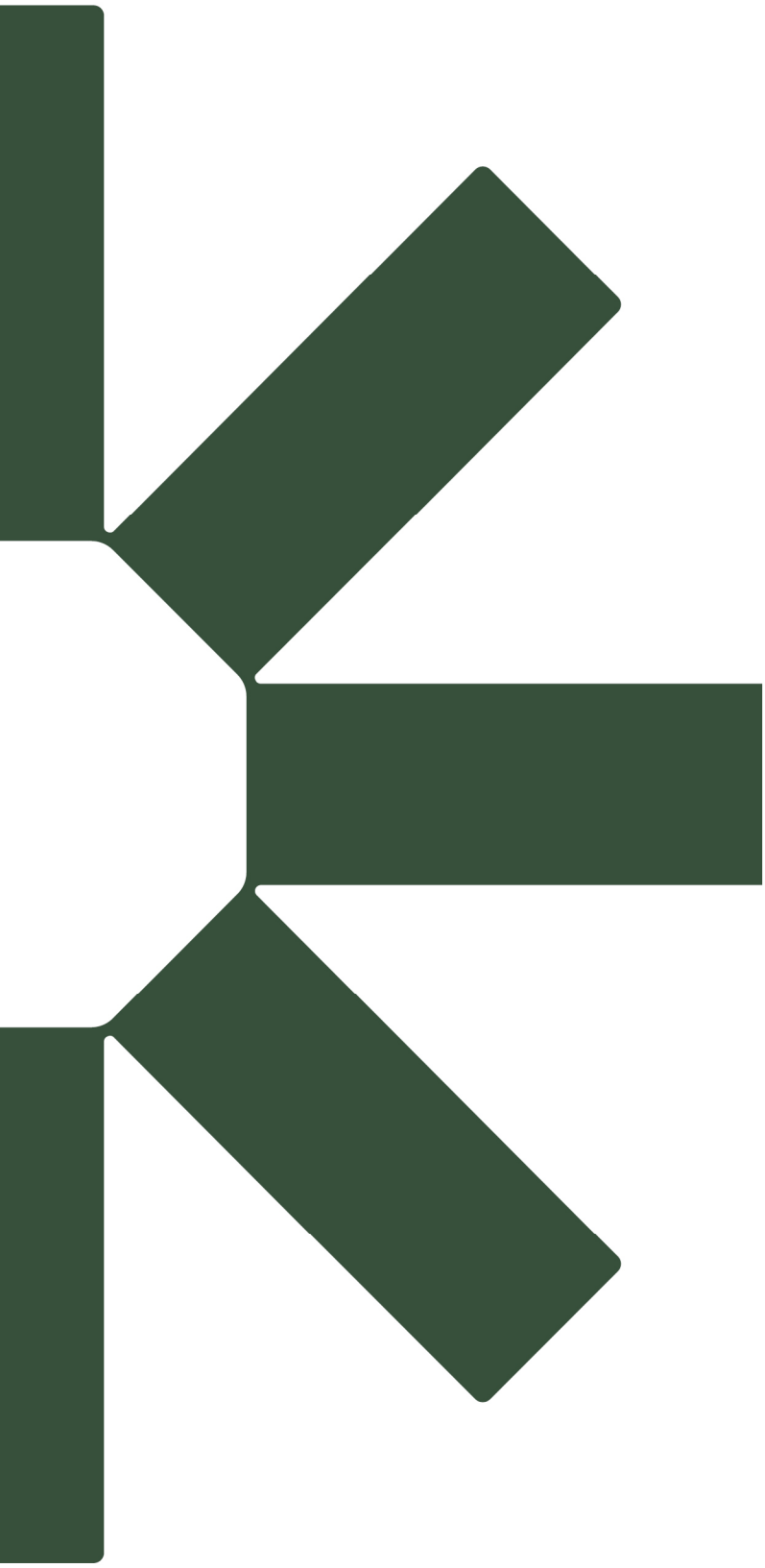
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