



Appin Area 7 Longwall 709 End of Panel Report



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Attachment E- Longwall 709 Post-mining Property Reports

Attachment F- Longwall 709 Aquatic Flora and Fauna Assessment

Abbreviations

AA7 Appin Area 7

AA9 Appin Area 9

ARTC Australian Rail and Track Corporation

BCD Biodiversity Conservation and Science Division

BFMP Built Feature Management Plan

BSO Bulli Seam Operations

EA Environmental Assessment

EoP End of Panel

EP Extraction Plan

HBSS Hawkesbury Sandstone

IMC Illawarra Metallurgical Coal

IMCEFT Illawarra Metallurgical Coal Environmental Field Team

PSMPs Property Subsidence Management Plans

1. Introduction

South32 Illawarra Metallurgical Coal (IMC) operates the Appin Colliery, extracting hard coking coal used for steel production. Appin Colliery is an underground mine located near the township of Douglas Park in the Southern Coalfield of New South Wales (Figure 1). Mining is currently underway in Appin Areas 7 (AA7) as part of IMC Bulli Seam Operations (BSO), approved on 22 December 2011. IMC originally received Subsidence Management Plan (SMP) approval to extract Longwalls 707 to 710 in AA7 on 28 September 2012. There have been a number of variations and extensions to the approval since that date. A consolidated Extraction Plan (EP) for Longwalls 709 to 711 (AA7) and Longwall 905 (Appin Area 9; AA9) was prepared in accordance with Conditions 5 and 6, Schedule 3 of the BSO Approval and this plan was approved 29 July 2022.

Extraction of Longwall 709 commenced on 22 February 2022 and was completed on 8 October 2023, overlapping in time with the extraction of Longwall 905 in AA9 which was completed on 28 February 2023. This End of Panel (EoP) Report has been prepared in accordance with the Longwall 709 to 711 and 905 EP, granted on 29 July 2022. The EoP Report outlines the measured and observed impacts of Longwall 709 and analyses the monitoring results against relevant impact assessment criteria and predictions made in the EP and associated management plans.

The AA7 mining area lies in the southern part of the Permo-Triassic Sydney Basin, within which the main coal bearing sequence is the Illawarra Coal Measures, which are Late Permian of age (Figure 1). The Illawarra Coal Measures contain several seams, the uppermost of which is the Bulli Seam from which AA7 panels are extracted.

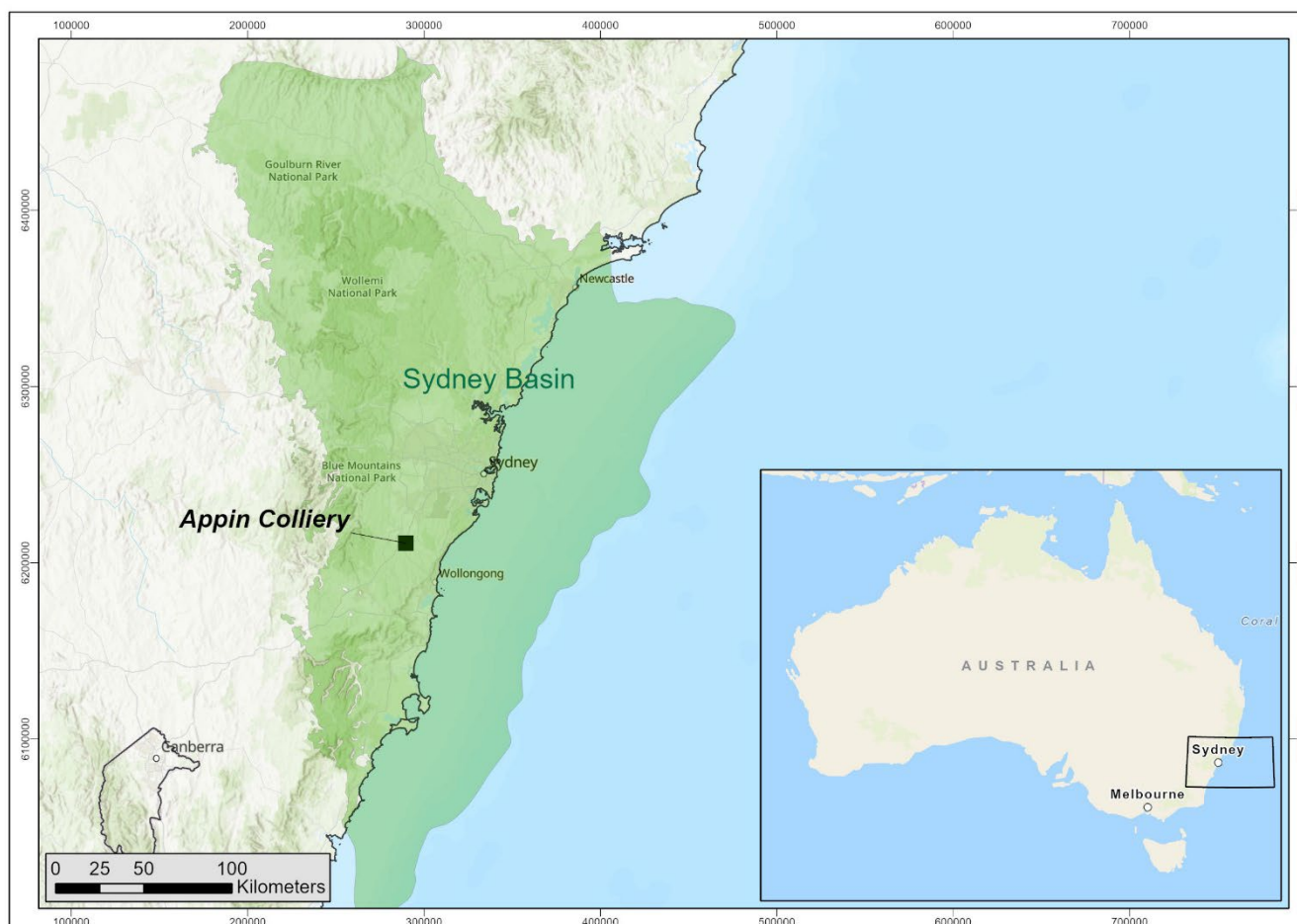


Figure 1: Location of the Appin Colliery within the Sydney Basin.

The depth of cover to the Bulli Seam varies between a minimum of 530 m near the finishing (i.e. eastern) end of Longwall 709 and a maximum of 615 m near the commencing (i.e. western) end of the longwall.

The surface above AA7 is generally undulating on the plateau and is incised by the Nepean River gorge which can be up to 70 m high, with vertical cliff faces up to 30 m. The gorge is steep sided with sandstone cliffs and steep slopes. The Nepean River is part of the Hawkesbury-Nepean River system which originates in the uplands west of Wollongong and flows northward past Camden to its junction with the Hawkesbury River near Wallacia.

The seam thickness varies between 2.8 m and 3.3 m within the extents of Longwall 709. IMC extracted the full thickness of the Bulli Seam.

1.1. Economic Benefits

The extraction of coal reserves from AA7 provides benefits at national, state and local levels. IMC provides coking coal to BlueScope Steel for its domestic steelmaking production, and for export to overseas customers. IMC is the largest supplier of coal to BlueScope Steel. Mining operations at Appin Colliery represents continuing significant capital and operating investments in the Southern Coalfield of New South Wales.

IMC employs more than 2,000 people with more than 90 per cent of wages paid to workers living in the Illawarra and Macarthur regions. The mining industry tends to have high employment multiplier effects with around 3.5 additional jobs supported by a mining job and up to 5.5 if consumption-induced effects are included (Lawrence Consulting 2016). In FY22, IMC spent around \$300 million with locally based suppliers, purchasing from more than 200 local businesses.

Continuing benefits occur through continuity of employment, expendable income, export earnings and government revenue. IMC contributes more than \$1 million per year supporting local community groups and organisations. From the operations of Appin Mine, IMC paid approximately \$156.3 million in government royalties during the extraction of Longwall 709 with approximately \$97.2 million attributable to Longwall 709. Longwall 709 is located within Consolidated Coal Lease 767, which amalgamated a number of long-standing head leases for mining coal in 1991.

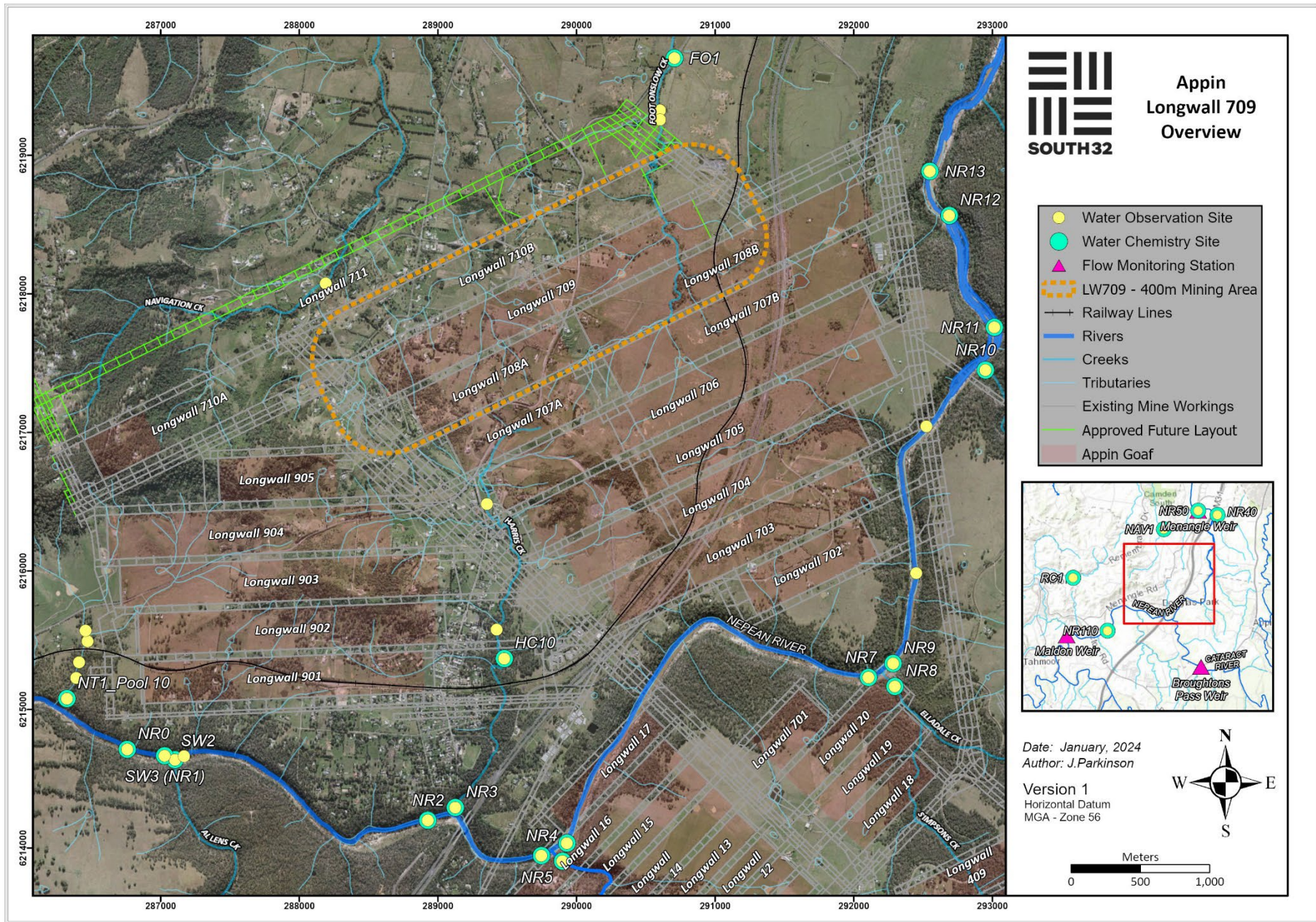


Figure 2: Map showing the Appin Area 7 Study Area and Environmental Monitoring Locations.

2. Stakeholder Engagement

Monitoring data and other information has been made available to the community by IMC during the extraction of AA7. Information on IMC operations is provided to the community via:

- IMC Community Newsletter – a periodical IMC publication distributed to the community;
- South32 website – [Illawarra Metallurgical Coal – South32](#);
- Bi-monthly Appin Mine Community Consultative Committee meetings for BSOP (meeting minutes available on the South32 website; [Appin Mine documents \(south32.net\)](#));
- Regular meetings with the Wollondilly Shire Council;
- Community information sheets and letter box drops;
- Community Portal – [Illawarra Metallurgical Coal | Community South32](#) (with interactive operational maps);
- Media releases; and
- Annual Report.

IMC aims to mitigate the potential impacts subsidence may cause to community members through various means outlined in Table 2-1.

Table 2-1: Social Impact Variables Associated with Subsidence.

Potential Impact	Monitoring Variables	Mechanism
Subsidence Impacts	Level of community concern relating to subsidence.	Longwall progress maps and landholder specific information is available on the IMC Community Portal (website), and is included in personalised letters and community newsletters.
	Awareness of subsidence and its effects and management.	Appin Mine Community Consultative Committee.
	Level of perceived community risk associated with subsidence effects.	A triennial survey of residents and stakeholders in the communities in which IMC operates. The survey aims to determine the community's perception of the company's overall performance.
	Level of satisfaction with the company's subsidence management practices.	A five-yearly social and human rights impact assessment. The assessment informs our social impact management plan.
	The extent to which the community attributes environmental, social and economic change occurring within the community to mining activities.	Development of individual Property Subsidence Management Plans (PSMPs) in consultation with landowners within the mine subsidence area. Pre-mining meetings with landholders prior to mining potentially effecting properties. Meetings include predicted mine subsidence movement, timing and effects, and the offer of pre-mining assessments. On-going contact with landholders during mining and support through the claims process post-mining.

The management of subsidence impacts on private properties is addressed in PSMPs. The PSMPs were prepared in consultation with individual property owners. In relation to Longwall 709, property owners were advised to lodge a claim with the Subsidence Advisory NSW where there was an effect to built features on the property. IMC continues to assist landholders through the Subsidence Advisory NSW claim lodgement process and other effects from mining operations associated with AA7.

3. Comparison of Measured and Predicted Subsidence

This section provides comparisons between predicted and measured subsidence movements relating to the extraction of Longwall 709. For further details, refer to MSEC 2024, which is provided as Attachment C.

Predictions of subsidence movements relating to the extraction of Longwall 709 were obtained by MSEC using the Incremental Profile Method (IPM) based on prediction curves for the Southern Coalfield Bulli Coal Seam.

The mine subsidence effects due to the mining of Longwall 709 were monitored along several monitoring lines and monitoring points including the:

- Menangle Road monitoring line
- Hawkey Road monitoring line
- Carrolls Road monitoring line
- M31 Hume Motorway East and West Lines
- ARTC monitoring line, strain gauges and tilt sensors
- ARTC embankment and culvert points
- Highway cutting points
- Partridge VC Rest Area monitoring points
- Far-field 3D marks
- Absolute and relative 3D monitoring points adjacent to and on the Douglas Park Twin Bridges
- Absolute and relative 3D monitoring points adjacent to and on the Moreton Park Road Bridge (South) and Moreton Park Road Bridge (North)
- Light Detecting and Ranging (LiDAR) surveys

Table 3-1: Comparison summary of predicted and measured subsidence during the extraction of Longwall 709 (MSEC 2024).

Feature	Monitoring Types	Approximate Location/ Distance from Longwall 709	Assessment of Measured Subsidence vs Predictions / Trigger Levels (MSEC 2024)
Menangle Road	3D monitoring line	Crosses directly above Longwall 709	<p>The maximum measured incremental vertical subsidence of 509 mm is less than the maximum predicted incremental vertical subsidence of 900 mm. The maximum measured incremental tilt of 4.8 mm/m occurs adjacent to the tailgate of Longwall 709 and it locally exceeds the predicted value in this location. However, it is less than the maximum predicted incremental tilt of 5.5 mm/m which occurs adjacent to the longwall maingate. The maximum measured incremental strains are 0.7 mm/m tensile and 3.0 mm/m compressive. The predicted incremental strains based on conventional ground movements are 1 mm/m tensile and 2 mm/m compressive. The maximum measured incremental compressive strain is therefore greater than that predicted based on conventional ground movements. Elsewhere, the measured incremental tensile and compressive strains are in the range based on conventional ground movements.</p> <p>The monitoring line is located close to the coal blocks located between the adjacent Longwall 708A and Longwall 708B and, therefore, the end effects from these existing longwalls could have reduced the subsidence more than that predicted. It is considered that the ground movements measured using the Menangle Road monitoring line are consistent with the predictions.</p>
Hawkey Road	2D monitoring line	Located 100m north-west of Longwall 709	<p>The maximum measured incremental vertical subsidence (50mm) and tilt (0.5mm/m) along the Hawkey Road monitoring line are the same as, or less than, the predicted values (80mm and 0.5mm/m). The maximum measured incremental strains are 0.4 mm/m tensile and 0.4 mm/m compressive, which are very small in magnitude and close to survey tolerance, as expected.</p>
Carrolls Road	2D monitoring line	Crosses the western end of Longwall 709	<p>The maximum measured incremental vertical subsidence of 423 mm is less than the predicted incremental vertical subsidence of 650 mm. The maximum measured incremental tilt of 3.3 mm/m occurs adjacent to the maingate of Longwall 709 and it compares reasonably well with the predicted maximum value of 3.6 mm/m. The maximum measured incremental strains are 0.6 mm/m tensile and 2.2 mm/m compressive. The predicted incremental strains based on conventional ground movements are 1 mm/m tensile and 2 mm/m compressive. The maximum measured incremental compressive strain is therefore greater than that predicted based on conventional ground movements. Elsewhere, the measured incremental tensile and compressive strains are in the range based on conventional ground movements.</p> <p>It is considered that the ground movements measured using the Carrolls Road monitoring line are consistent with the predictions.</p>
M31 Hume Motorway	3D monitoring line	Located 500m east of Longwall 709	<p>The maximum measured incremental vertical subsidence along the M31 East and M31 West Lines of 59 mm, respectively, are slightly greater than the maximum predicted value of less than 20 mm. The movements are considered to be due to long-term residual subsidence from the extraction of previous Longwall 708B. The maximum measured incremental tilts of 1.0 mm/m for the M31 East Line and 0.8 mm/m for the M31 West Line are slightly greater than the maximum predicted value of less than 0.5 mm/m. The measured movements are likely to include survey tolerance and possible disturbed marks. The maximum measured incremental compressive strains along the M31 East Line are 0.6 mm/m tensile and 0.6 mm/m compressive. The maximum measured incremental compressive strains along the M31 West Line are 0.6 mm/m tensile and 1.0 mm/m compressive. The strains appear to be related to environmental effects on the survey marks. It is considered that the ground movements measured along the M31 East and M31 West monitoring lines are consistent with the predictions.</p>

Feature	Monitoring Types	Approximate Location/ Distance from Longwall 709	Assessment of Measured Subsidence vs Predictions / Trigger Levels (MSEC 2024)
Main Southern Railway	3D ground monitoring lines 3D Embankment monitoring points Railway cutting points Stain gauges	Located < 50m south-east of Longwall 709	The maximum measured incremental vertical subsidence along the ARTC Line of 136 mm is greater than the maximum predicted value of 100 mm. A portion of the movements are considered to be due to long-term residual subsidence. The maximum measured incremental tilt of 0.8 mm/m is similar to but slightly greater than the maximum predicted value of less than 0.5 mm/m. The maximum measured incremental strains along the ARTC Line are 0.3 mm/m tensile and 0.7 mm/m compressive. Rail stress transducers false alarms were triggered during mining, due to malfunction or damage to transducers, the actual stress readings did not exceed the trigger levels. The ground movements measured using the ARTC Line are consistent with the predictions.
Highway Cutting 2	3D monitoring points	Located 750m south-east of Longwall 709	The maximum measured absolute incremental horizontal movement for W114 to W158 was 23mm, for G101 to G110 was 12mm and for E146R to E160R was 17mm. The measured incremental horizontal movements are very small and in the order of survey accuracy for absolute position of 25 mm.
Partridge VC Rest Area	2D and 3D monitoring	Located 750m east of Longwall 709	Only minor changes were observed during the mining of Longwall 709.
Far-Field Monitoring points	3D monitoring points	Various locations around AA7	The maximum measured incremental horizontal movements are 171 mm and 162 mm at Marks MR2 and MR1 along Menangle Road located above Longwall 709 and Longwall 904, respectively. The maximum measured incremental horizontal movement outside the mining areas is 78 mm at Mark BURRELL1 located downslope of Razorback Range. The incremental horizontal movement measured at MR1 is greater than those typically measured at similar distances from the active longwall elsewhere in the Southern Coalfield. However, this mark is located in Area 9 and therefore its movement was affected by the concurrent mining of Longwall 905. Elsewhere, the measured incremental horizontal movements at the other far-field 3D marks and monitoring lines are similar to those typically measured in the Southern Coalfield.
Nepean Twin Bridges	Absolute 3D points Relative 3D points Bridge joint monitoring Visual monitoring	located approximately 3.1 km south of the commencing end of Longwall 709	The maximum measured absolute horizontal movement (92 mm) at Marks DPBN and DPBS was less than the Level 1 Trigger (100 mm) at the completion of Longwall 709. The measured differential movements at the bridge joints did not exceed the Level 1 triggers during the extraction of Longwall 709.
Moreton Park Road Bridge (South)	Absolute 3D points Relative 3D points Visual monitoring	located approximately 2.5 km south-east of the commencing end of Longwall 709	The maximum measured total absolute horizontal movements at Marks MPBE (110mm) and MPBW (145mm) were less than the Level 1 trigger (150mm) at the completion of Longwall 709. The measured total changes in horizontal distance between the bridge abutments were less than +2 mm at the completion of Longwall 709. The total measured movements, therefore, were within the order of survey tolerance.
Moreton Park Road Bridge (North)	Absolute 3D points Relative 3D points Visual monitoring	located approximately 1.5 km north-east of the finishing end of Longwall 709	The maximum measured total absolute horizontal movements at Marks MPRBNE (46mm) and MPRBNW (62mm) were less than the revised Level 1 trigger (60mm) at the completion of Longwall 709. The measured total changes in horizontal distance between the bridge abutments were less than 4 mm at the completion of Longwall 709. The total measured movements, therefore, were within the order of survey tolerance.
LiDAR Surveys	Light Detection and Ranging (LiDAR)	AA7	The accuracy of the measured changes in surface level (i.e. the difference between two surveys) is in the order of ± 200 mm. There are localised areas where these differences exceed the measurement tolerance; however, these are artefacts of the LiDAR surveys and are not real movements. It is considered that the ground movements measured using the LiDAR surveys are consistent with the predictions.

4. Impacts to Built Features

The MSEC assessments for impacts to built features, due to the mining of Longwall 709 to Longwall 711 and Longwall 905, are provided in Report No. MSEC1117. Comparisons between the assessed and observed impacts for the built features located near Longwall 709, as listed above, are provided in (Table 4-1).

Table 4-1: Summary table comparing assessed and reported impacts for built features in relation to the extraction of Longwall 709 (Source: MSEC 2024).

Built Feature	MSEC Assessed Impacts	Observed Impacts
Menangle Road, Carrolls Road and Hawkey Road	Minor cracking and localised heaving of the road surface may occur in some locations above the longwalls	Roads remained safe and serviceable. Localised heaving and cracking occurred in the road pavements between Marks MR7105 and MR7106 along Menangle Road and between Marks CAR36 to CAR37 along Carrolls Road. The road pavement along Menangle Road impacted by Longwall 709 is scheduled to be remediated in February 2024.
M31 Hume Motorway	No impacts on the safety or serviceability of the motorway after the implementation of the management strategies	Road remained safe and serviceable. No adverse impacts to safety or serviceability
Main Southern Railway	No impacts on the safety or serviceability of the railway after the implementation of the management strategies	Track remained safe and serviceable. Changes in track geometry recorded during the mining of Longwall 709 and these were remediated in accordance with the Management Plan.
Douglas Park Twin Bridges	Impacts unlikely after the implementation of the TARP	No adverse impacts observed due to the mining of Longwall 709
Moreton Park Road Bridge (South)	Impacts unlikely after the detailed investigation, analysis and implementation of the TARP	No adverse impacts observed due to the mining of Longwall 709
Moreton Park Road Bridge (North)	Impacts unlikely after the detailed investigation, analysis and implementation of the TARP	No adverse impacts observed due to the mining of Longwall 709
Low voltage powerlines	Impacts unlikely, but minor mitigation measures may be required	No adverse impacts observed due to the mining of Longwall 709
Copper telecommunications cables	Impacts unlikely	No adverse impacts observed due to the mining of Longwall 709
Optical fibre cables	Impacts unlikely with the implementation of the management strategies including OTDR monitoring and mitigation	No adverse impacts observed due to the mining of Longwall 709
Building structures	Assess that approximately 17 % to 23 % of houses will experience Category R1 or R2 impacts, approximately 7 % to 11 % will experience Category R3 or R4 impacts and approximately 2 % to 3 % will experience Category R5 impacts	Building structures remained in safe and serviceable conditions. Impacts observed to houses during the mining of Longwall 709 comprise very slight to slight impacts (Category R1 or R2) at 7 houses (Refs. D33, D35, D50, D52, F08, F32 and F33) and moderate or greater impacts (Category R3) at 3 houses (Refs. A24, C09 and D38). Claims that have been lodged are being managed by Subsidence Advisory (SA) NSW through the relevant legislation.
Pools	Inground pools could be more susceptible to ground strains causing cracking and/or loss of water	Impacts observed to pools during the mining of Longwall 709 comprise cracking of the shells or surrounds or loss of water at 4 locations (Refs. C09, D18, D41 and F32). Claims that have been lodged are being managed by SA NSW through the relevant legislation. Pool gates not closing or latching correctly at several properties (Refs. A24, D26, D33, D41, D44, D45, F06 and F32) which were remediated by IMC or the property owner.
Water tanks	Impacts unlikely	No adverse impacts observed due to the mining of Longwall 709
Farm dams	Potential for minor cracking or leakage	No adverse impacts observed due to the mining of Longwall 709
Heritage structures	No heritage structures located near Longwall 709	No adverse impacts observed due to the mining of Longwall 709

Built Feature	MSEC Assessed Impacts	Observed Impacts
Groundwater bores	Potential for blockage or reduction in the capacity of the groundwater bores	No adverse impacts observed to groundwater bores due to the mining of Longwall 709. Refer to the accompanying Groundwater Report by HGEO.
Survey control marks	Small fair-field horizontal movements which could require re-establishment	Small far-field horizontal movements

4.1. Private Properties

Property Subsidence Management Plans (PSMPs) are prepared by IMC for landholders prior to them being impacted by Longwalls 709 to 711 and 905, as covered in the Built Feature Management Plan (BFMP). Post-mining inspection of dams, boreholes and natural features set out in the BFMP are conducted by the Illawarra Metallurgical Coal Environmental Field Team (IMCEFT) with the consent of the relevant property/infrastructure owner and tenant (if applicable). Post-mining inspections were undertaken at properties where access was granted. These include Lot 16 DP251063, Lot 73 DP883462, Lot 11 DP7754437 and Lot 900 DP1072947 (Figure 3). No report was completed for Lot 11 DP775437, since the property does not have a pump installed in the bore and has no dam. Inspections included collection of in-situ water quality parameters and water samples for laboratory analysis. Results of water quality and piezometer data are included in the Surface Water and Groundwater Assessment of the Longwall 709 EoP Report (Attachment D).

Table 4-2: Summary Table of predicted and observed impacts to private property surface and groundwater quality (Source: HGEO 2024).

Potential Impact	Description	Observed Impact
Reduced groundwater yield	There are 49 registered bores within 5 km of the Appin Mine/Project area. No depressurisation is predicted within the overlying Wianamatta Group shale and sandstones. Up to 11 m of depressurisation was predicted at landholder bores due to mining at Longwalls 709 to 711 and Longwall 905. Regional depressurisation of aquifers including the lower Hawkesbury Sandstone, Bulgo Sandstone and Scarborough Sandstone is likely to occur (SLR 2022).	No TARPs triggered.
Groundwater quality impacts	The groundwater model predicted drawdowns in Hawkesbury Sandstone (lower) groundwater source. Therefore, impacts on the water quality within the Hawkesbury Sandstone are possible. Although there is limited data on water quality within the coal measures at Appin, ongoing monitoring of site mine water is recommended (SLR 2022).	No impacts observed.
Impacts to streams and farm dams	There are negligible predicted impacts on surface water bodies including stream baseflow due to depressurisation of the coal measures (SLR 2022). Incidence of impact (cracking and leakage) expected to be extremely low (MSEC 2024).	No impacts observed.

4.2. Cultural Heritage

No known Aboriginal cultural heritage sites sensitive to subsidence movements are within the Longwall 709 mining area.

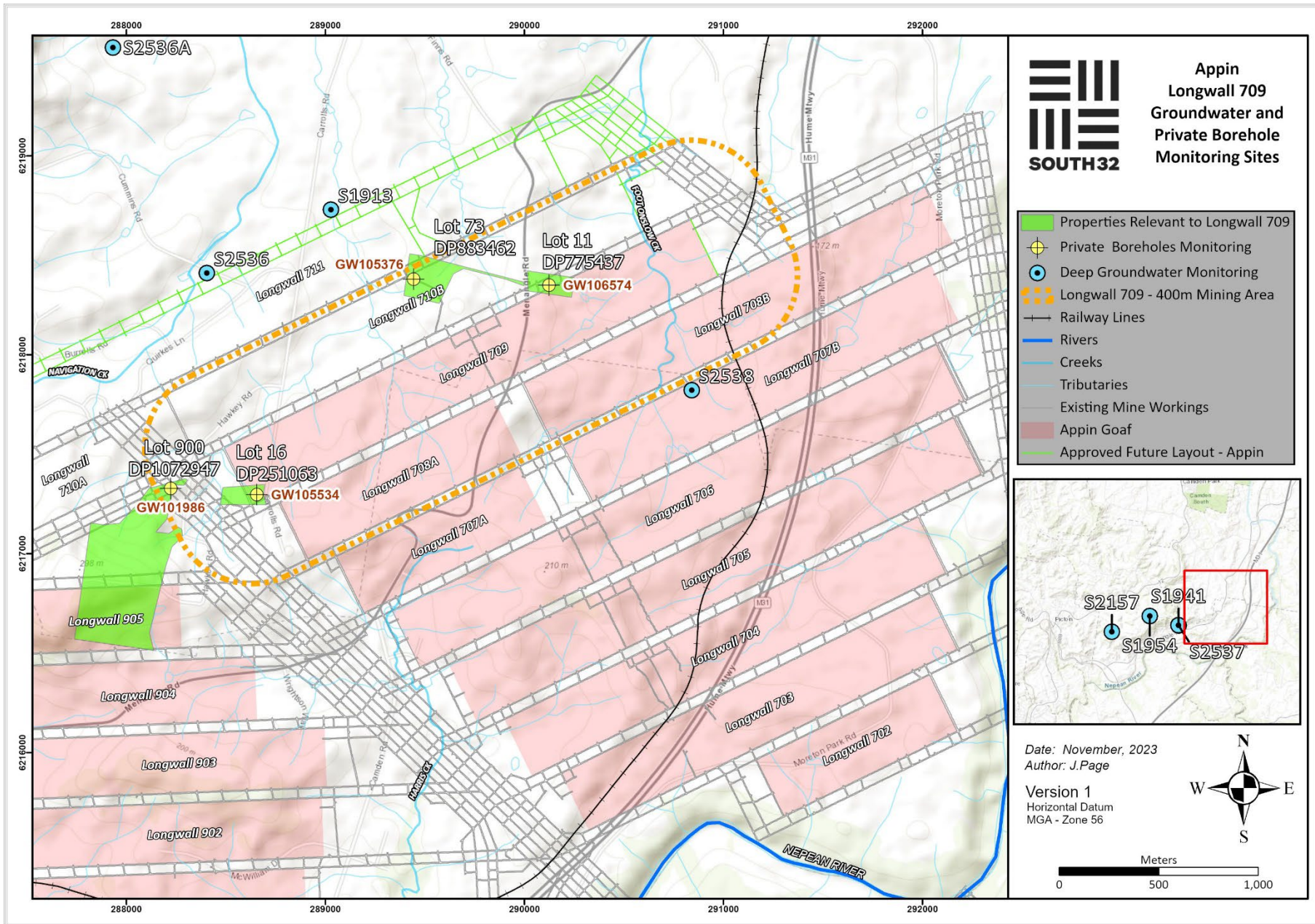


Figure 3: Groundwater monitoring relevant to Longwall 709.

5. Impacts to Natural Features

5.1. Surface Water Assessment

Monitoring and inspections of the Nepean River and its associated tributaries is undertaken in accordance with the approved Appin Longwall 709 to 711 and Longwall 905 EP (Figure 2). Monitoring is conducted by the IMCEFT on a monthly basis. Water quality and water levels are recorded along with photographic records and observational notes. Observations of cliffs, steep slopes and flora along the Nepean gorge are also undertaken.

During the reporting period for Longwall 709 water quality TARPs were triggered at five impact sites with similar exceedances noted at two control sites. The triggers relate to elevated electrical conductivity (EC), decreased dissolved oxygen (DO) and pH relative to baseline. The triggers are accompanied by trends of increasing EC during 2023, including at control sites at Appin and Dendrobium and reflect the return to low rainfall and low-flow conditions in 2023. A summary of these triggers is presented in Appendix A. During the extraction of Longwall 709, no new Nepean River gas zones were identified. Three existing gas zones were observed to be active at some stage during Longwall 709 (Figure 4).

The assessment of surface water is presented in the Appin Longwall 709 End of Panel Surface Water and Groundwater Monitoring Assessment (Attachment D). A summary of this is included in (Table 5-1).

Table 5-1: Summary table of potential and observed impacts to surface water quality within natural features (Source: HGEO 2024 and MSEC 2024).

Potential Impact	Assessed impact	Observations	TARP Level
Gas emissions in the Nepean River and other areas.	Negligible gas releases.	No new gas releases were observed during Longwall 709. Three previously identified AA7 gas releases were active during the extraction of the Longwall 709.	Each gas release zone remains a Level 1 TARP.
Groundwater outflows and ferruginous springs.	Negligible iron staining or negligible increase in water cloudiness.	None identified.	Not triggered.
Sub-bed flow diversions and unnatural pool drainage.	Negligible diversion of flows or changes in the natural drainage behaviour of pools.	Of the sites where water levels are measured, most show water levels during the reporting period that are within the baseline range, noting that at many sites, pool levels were at their lowest in the latter part of 2023 due to the dry weather conditions. Nepean River monitoring site NR0 shows an apparent decline in water level of ~0.5 m during the extraction of Longwalls 901 to 903 relative to the baseline range. The change does not appear to be related to a change in flow, and previous reviews identified similar water level changes at the upstream control site NR110. This suggests the changes are unrelated to mining and may be related to changes in riverbed morphology during floods. No subsidence related impacts have been observed at the site. Gauging at Maldon weir, Menangle weir, and the Cataract River at Broughtons Pass, show zero no-flow days recorded during the extraction of Longwall 709.	No relevant TARP.

5.2. Groundwater Assessment

HGEO was commissioned by IMC to report on the predicted and any observed groundwater changes resulting from extraction of Longwall 709. A comparison between potential and observed impacts for Longwall 709 is provided below (Table 5-2). Details are included in the Longwall 709 Surface and Groundwater Assessment (Attachment D).

Following the review of End of Panel Report for Longwall 708, Biodiversity Conservation and Science Division (BCD) requested further information regarding monitoring bore S2308, specifically in relation to the reliability of the VWP sensor installed at 70 m depth within the Hawkesbury Sandstone (HBSS). An assessment has been completed and it is concluded that the 70 m sensor should be regarded as unreliable. The remaining sensors within the HBSS appear to be functioning correctly and consistently, further explanation can be found in Attachment D. VWP sensors are grouted into the strata and therefore can not be replaced or serviced once installed.

Table 5-2: Summary table of potential and observed impacts to groundwater (Source: HGEO 2024).

Potential Impact	Description	Impact Prediction	Observations	TARP Level
Reduction in groundwater level	Reductions in groundwater level which impact water supply from bores, particularly within the Hawkesbury Sandstone and Wianamatta Group.	Bores that directly overlie or are adjacent to extracted longwalls may experience adverse impacts including lowering of bore water level, blockage caused by strata movement, and changes to groundwater quality (SLR 2022).	None identified.	Not triggered
Changes to Groundwater chemistry	Changes to groundwater chemistry within the Wianamatta Group, Hawkesbury Sandstone and Bulgo Sandstone.	Previous observations indicate that water quality of subsided boreholes in the Southern Coalfields have not been adversely affected. May be increased iron and/or manganese carbonates and changes in pH. (GeoTerra 2008).	Borehole S2537 elevated EC when compared with previous measurements. S2537 is a relatively new monitoring bore. Groundwater quality can take several months to stabilise following installation due to influences from drilling and bore construction materials.	Not triggered
Groundwater Inflows to the Mine	The horizontal permeability of the Hawkesbury Sandstone and Bulgo Sandstone may be enhanced after subsidence.	Numerical groundwater model predictions indicate that the average total mine inflow rate over the duration of mining Longwalls 709-711 and 905 will be approximately 0.45 ML/day, peaking in 2024 (SLR, 2022).	The average inflow over the longwall review period was 0.99 ML/day, slightly above the predicted inflow of 0.45. However, the 20-day rolling average inflow remained well below the TARP Level 1 trigger of 2.7 ML/day during the longwall review period. There is an apparent slight declining trend in net water make since July 2022 which may reflect the relatively dry conditions in 2023 compared with the very high rainfall in 2022.	Not triggered

5.3. Aquatic Ecology Assessment

Stantec (formerly Cardno and The Ecology Lab) was commissioned by IMC to undertake an Aquatic Flora and Fauna Review (AFFR) in relation to the extraction of Longwall 709 to support the End of Panel (EoP) reporting for Longwall 709. Stantec has been undertaking ongoing monitoring of aquatic habitat and biota in the section of the Nepean River adjacent to the Appin Area 7 mining area. The overall objective of the monitoring is to determine whether the extent and nature of observed impacts, primarily subsidence-induced fracturing of bedrock, flow diversion and loss of aquatic habitat, if any, are consistent with the predictions made in the aquatic ecology assessment and EP.

The monitoring program focuses on the following indicators:

- Aquatic habitat, including fish habitat and riparian vegetation.
- Aquatic macroinvertebrates sampled in accordance with the Australian River Assessment System (AUSRIVAS) and derived biotic indices.
- Fish sampled using bait traps.
- Limited in-situ water quality sampling; and
- Species composition of aquatic macrophytes.

IMCEFT identified no new impacts associated with the extraction of Longwall 709. No gas releases, fracturing, changes in water levels, flow or water quality have been attributed to mining of Longwall 709. An increase in EC and reduction in pH was observed at some sites on the Nepean River and/or tributaries during extraction of Longwall 709. Although these constituted triggers in the water quality TARPs, these relate to a general reduction in rainfall and flow, and an increase in evaporative conditions in the Nepean River catchment and therefore are likely not related to mining. Three existing gas zones, identified during previous panels, were observed to be active during the Longwall 709 mining period.

No changes to aquatic ecology indicators that could be associated with extraction of Longwall 709 have been detected in aquatic ecology data collected in the Nepean River in December 2022 and December 2023. This was expected given only minor gas releases have been observed in the Nepean River associated with mining. The gas releases in the Nepean River active during extraction of Longwall 709 do not appear to have had any measurable effect on water quality, aquatic macroinvertebrates, fish and macrophytes in the Nepean River. Further details can be found in the Appin Area 7 Longwall 709 End of Panel Report - Aquatic Flora and Fauna Review (Attachment F).

Further monitoring will be undertaken at all Appin Area 7 potential impact and control sites in Spring 2024. This will include a further assessment of any changes to aquatic habitat and biota that may have occurred at Appin Area 7 monitoring sites following the completion of Longwall 709 and subsequent longwalls (Stantec 2024).

5.4. Terrestrial Ecology Assessment

Potential impacts to terrestrial ecology in the AA7 Study Area were assessed by Niche (2021), which were largely consistent with those outlined within the BSO Environmental Assessment (EA). Generally, the risks are lower in the Longwall 709 to 711 and 905 Study Area when compared to the broader BSO EA area as there are fewer sensitive vegetation communities in the locality and substantial areas cleared of native vegetation. The proposed extraction did not involve significant vegetation clearing.

The IMCEFT did not observe any gas releases other than those in the Nepean River and did not observe any surface impacts with potential to impact the terrestrial ecology in the AA7 Study Area. The IMCEFT did not observe decreases in vegetation health associated with gas release zones on the Nepean River. Thus, it has been concluded that the extraction of Longwall 709 has resulted in negligible impacts to terrestrial ecology within the AA7 Study Area.

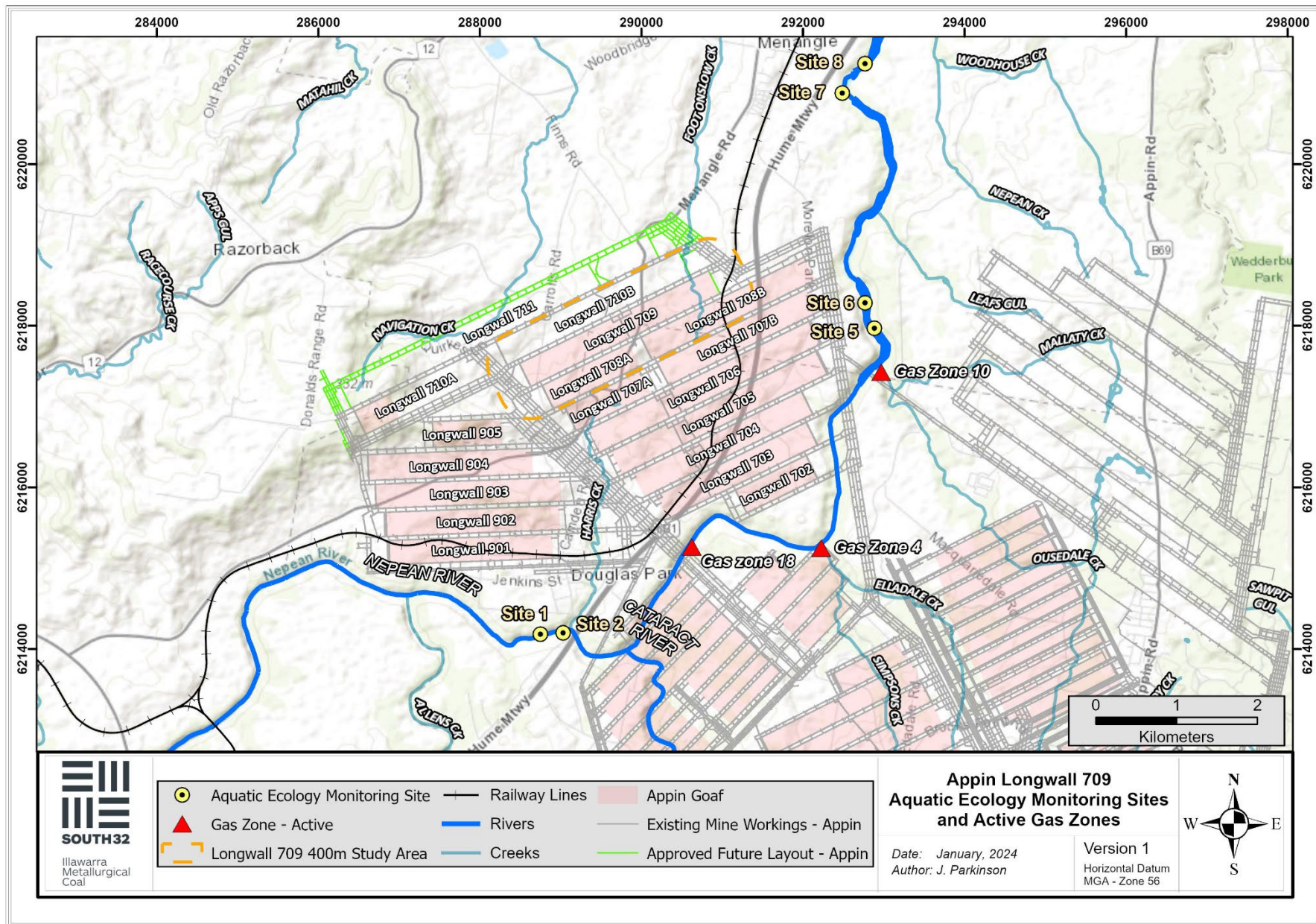


Figure 4: Map displaying the aquatic ecology monitoring sites and active gas zones on the Nepean River in relation to Appin Area 7.

6. Longwall 709 Monitoring Program

Table 6-1: Longwall 709 to 711 and 905 Environmental management Plan.

MONITORING SITE	MONITORING TYPE	MONITORING FREQUENCY	PARAMETERS	FUTURE MONITORING (LONGWALL 710)
SURFACE WATER				
<p>Foot Onslow Creek FO1 (Lab, Field, Level, Obs) FO2 (Obs) FO3 (Field, Obs)</p> <p>Harris Creek HC10 (Lab, Field, Obs) HC20 (Level, Obs) HC30 (Obs)</p> <p>Navigation Creek NAV1 (Lab, Field, Level, Obs) NAV2 (Obs)</p> <p>Nepean River NR110 (Lab, Field, Level, Obs) NR0 (Lab, Field, Level, Obs) SW2 (Lab, Field, Obs) SW3 (Lab, Field, Obs) SW4 (Field, Obs) NR2 (Lab, Field, Level, Obs) NR3 (Lab, Field, Obs) NR4 (Lab, Field, Level, Obs) NR5 (Lab, Field, Obs) NR6 (Lab, Field, Obs) NR7 (Lab, Field, Obs) NR8 (Lab, Field, Level, Obs) NR9 (Lab, Field, Level, Obs) NR10 (Lab, Field, Obs) NR11 (Lab, Field, Obs) NR12 (Lab, Field, Level, Obs) NR13 (Lab, Field, Level, Obs) NR40 (Lab, Field, Obs)</p>	<ul style="list-style-type: none"> • Laboratory analysis (Lab) • Field parameters (Field) • Water levels (Level) (where a suitable structure exists) • Observations (Obs) 	<ul style="list-style-type: none"> • Monthly baseline monitoring prior to mining • Weekly observations and field analysis during active subsidence • Monthly laboratory analysis during active subsidence • Monthly monitoring for two years post mining • If required as a result of assessment of mining impacts 	<p>Field Parameters:</p> <ul style="list-style-type: none"> • Temperature • Dissolved Oxygen (DO) • Specific Conductivity • pH • ORP <p>Laboratory analysis:</p> <ul style="list-style-type: none"> • pH and EC • Filtered, Na, K, Ca, Mg, Cl, Ni, Zn, Fe, Mn, Al, SO₄ • Total Fe, Mn, Al • Total Alkalinity • TKN, TP, NH₃-N, NO_x-N (TON), FRP, TSS, DOC <p>Lab Sample for Gas Releases#:</p> <ul style="list-style-type: none"> • CH₄ • C₂H₆ • Trace Phenols • Sulphide <p>Observations:</p> <ul style="list-style-type: none"> • Iron or salinity staining (e.g. orange or white staining in water or on banks/seeps) • Evidence of springs in the Nepean River • Visual signs of impacts (i.e. cracking, fracturing, vegetation changes, increased erosion, changes in water colour etc) • Stream flow and pool water level • Impacts determined from comparing photo points taken prior to, during and post mining 	<p>No changes</p>

MONITORING SITE	MONITORING TYPE	MONITORING FREQUENCY	PARAMETERS	FUTURE MONITORING (LONGWALL 710)
<p>NR50 (Lab, Field, Obs)</p> <p>Racecourse Creek, Remembrance Drive RC1 (Lab, Field, Level, Obs) – Reference Site</p> <p>#If and where strata gas emission plumes above 3000 L/min are detected (Lab, Field, Obs)</p>				

MONITORING SITE	MONITORING TYPE	MONITORING FREQUENCY	PARAMETERS	FUTURE MONITORING (LONGWALL 710)
Flow monitoring <ul style="list-style-type: none"> Maldon Weir Broughtons Pass Weir Menangle Weir 	<ul style="list-style-type: none"> Gauged flow station 	<ul style="list-style-type: none"> Daily flow 	<ul style="list-style-type: none"> Monitoring undertaken by WaterNSW. Observational data to be compared with flow records at weir sites. 	No Changes
Foot Onslow Creek FO1 (qualitative obs) FOS1 (gauge with logger) Navigation Creek NAV1 (qualitative obs) NAVS1 (gauge with logger)	<ul style="list-style-type: none"> Visual observation of inflow and outflow Gauged flow site 	<ul style="list-style-type: none"> Monthly/weekly inspection (obs sites) Daily flow (logger sites) 	<ul style="list-style-type: none"> Inspection for potential fracturing for observable loss of surface water flow 	
GROUNDWATER				
Private Bores GW108990 GW100289 GW072874 GW100673 GW101986 GW105531 GW105534 GW106675 GW111781 GW112381 GW105376 GW105574 GW106574 GW107791	<ul style="list-style-type: none"> Lab sample Field parameters Water levels Observations 	<ul style="list-style-type: none"> Where access is available and granted, water level and water quality monitoring at least once before and once after the bore is mined under 	Field Parameters: <ul style="list-style-type: none"> Electrical Conductivity pH Laboratory analysis: <ul style="list-style-type: none"> pH and EC Filtered, Na, K, Ca, Mg, Cl, Ni, Zn, Fe, Mn, Al, SO₄ Total Fe, Mn, Al Total Alkalinity TKN, TP, NH₃-N, NO_x-N (TON), FRP, TSS, TDS, DOC Lab Sample for Gas Releases: <ul style="list-style-type: none"> CH₄ C₂H₆ 	No Changes

MONITORING SITE	MONITORING TYPE	MONITORING FREQUENCY	PARAMETERS	FUTURE MONITORING (LONGWALL 710)
GW108907 GW108990 GW072196 GW110671 <i>(in consultation with bore owner and if accessible and access is granted)</i>			<ul style="list-style-type: none"> Trace Phenols Sulphide <p>Observations:</p> <ul style="list-style-type: none"> Iron or salinity staining (e.g. orange or white staining in water or in the bores) 	
IMC Boreholes S1913 S1941 S1954 S2157 S2536 S2536A S2537 S2538		<ul style="list-style-type: none"> Water levels to be logged at least twice daily in the pre-mining baseline, impact and post-mining period At least one appropriately purged sample pre-mining and post mining, where access permits, tested for the analytes in the previous column 		No Changes
Groundwater inflows to the mine	<ul style="list-style-type: none"> Mine water budget Observations 	<ul style="list-style-type: none"> Flow meters 	Water flow from the goaf to the mine (analysed as a moving average i.e. 20 day average)	No Changes
AQUATIC ECOLOGY				
Impact Sites Sites 5, 6, X3 and X4 Control Sites Sites 1, 2, 7, 8, X5, X6, X7 and X8	<ul style="list-style-type: none"> Water quality - field parameters Survey and sampling Observations 	<ul style="list-style-type: none"> Twice in spring for two years prior to the commencement of mining Once every two years during mining Once every two years after mining 	<ul style="list-style-type: none"> Habitat surveys Aquatic macrophyte observations Macroinvertebrate monitoring AUSRIVAS sampling Fish sampling Observations of threatened species Assessments of: <ul style="list-style-type: none"> Water quality Flow River morphology 	No Changes

MONITORING SITE	MONITORING TYPE	MONITORING FREQUENCY	PARAMETERS	FUTURE MONITORING (LONGWALL 710)
TERRESTRIAL ECOLOGY				
<ul style="list-style-type: none"> • Inspection of the area will be conducted as outlined in the Landscape TARP 	<ul style="list-style-type: none"> • As indicated in the Landscape TARP 	<ul style="list-style-type: none"> • Prior to mining provide pre-mining baseline survey of vegetation communities and threatened flora populations for comparison with post-mining • Monthly prior to mining • Weekly during active subsidence • In response to any identified impacts on flora/fauna or threatened species, communities or populations. 	<ul style="list-style-type: none"> • Observations of threatened species and endangered ecological communities • Changes in vegetation condition • Stressed or dead vegetation not readily explained by natural processes (causes may include rock / cliff falls or mass movement, gas emissions, changes in flooding/ponding) 	No Changes
ABORIGINAL ARCHAEOLOGY				
No sites requiring monitoring				

MONITORING SITE	MONITORING TYPE	MONITORING FREQUENCY	PARAMETERS	FUTURE MONITORING (LONGWALL 710)
EUROPEAN HERITAGE				
No non-Aboriginal heritage sites were identified in the Longwalls 709 to 711 and 905 Study Area during the assessments undertaken for the BSO EA				
LANDSCAPE FEATURES				
<p>Nepean River cliff lines - Sensitive terrain near built features (Razorback Range)</p> <p>Razorback Range Cliffs Monitoring locations on private properties to be determined as appropriate/required in consultation with landowner/s</p>	<ul style="list-style-type: none"> • Observational and photographic monitoring • Piezometers • Slope inclinometers 	<p>Harris Creek and Nepean River cliff lines</p> <ul style="list-style-type: none"> - Baseline recording once prior to mining. - Monthly routine inspections with weekly inspections during critical periods <p>Low Terrain Sensitivity (visual inspection)</p> <ul style="list-style-type: none"> - 6 months prior to mining - 6 months after active subsidence <p>Medium Terrain Sensitivity</p> <ul style="list-style-type: none"> - 6 to 12 months prior to mining - 3 monthly during active subsidence - 6 months after active subsidence <p>High Terrain Sensitivity</p> <ul style="list-style-type: none"> - 12 months before commencement of subsidence for visual and on ground survey - Monthly for visual during active subsidence - 3 monthly for ground survey during active subsidence 	<ul style="list-style-type: none"> • Visual inspections • Photographic records • Ground survey (mid to high terrain sensitivity) • Piezometers (high terrain sensitivity) • Slope inclinometers (high terrain sensitivity) 	No Changes

MONITORING SITE		MONITORING TYPE	MONITORING FREQUENCY	PARAMETERS	FUTURE MONITORING (LONGWALL 710)
			- Installation of piezometers and inclinometers as required and in consultation with landowners as part of PSMP process		

1 Fortnightly targeted monitoring of relevant sites when impacts are observed.

2 Analytes tested at closest downstream sample site following Level 2 and above trigger for gas release.

7. Appendix A

Appendix A: Appin Longwalls 709 to 711 and 905 Trigger Action Response Plan.

Monitoring	Trigger	Action	Impact Observed
Surface Water Quality[#]			
<p>Nepean River</p> <p>Control Sites:</p> <p>NR110 (Upstream perturbations)</p> <p>SW2 (Upstream perturbations from Allens Creek)</p> <p>NR5 (Upstream perturbations from Cataract River)</p> <p>NR8 (Upstream perturbations from Elladale Creek)</p> <p>NR10 (Upstream perturbations from Ouesdale Creek)</p> <p>NR40 (Upstream perturbation from Menangle Creek)</p> <p>Impact Sites:</p> <p>NR0</p> <p>NR4 (assess influence from Harris Creek)</p> <p>NR12</p> <p>NR13</p> <p>NR50</p> <p>Creeks and Tributaries</p> <p>Control Site:</p> <p>RC1</p> <p>Impact Sites:</p> <p>NAV1</p> <p>FO1</p> <p>HC10</p> <p>NR3</p>	<p>Level 1*</p> <p>Impact monitoring sites when comparing the baseline period to the mining period for that site:</p> <ul style="list-style-type: none"> Mining results in pH reduction greater than 1 standard deviation but less than 2 standard deviations from pre-mining mean resulting from the mining for two consecutive months Mining results in DO reduction greater than 1 standard deviation but less than 2 standard deviations from pre-mining mean resulting from the mining for two consecutive months Identification of strata gas plume of flow rate <3000 L/min Trend analysis shows deviation from baseline post mining. 	<ul style="list-style-type: none"> Continue monitoring program Submit an Impact Report to BCS, DPE – Water, WaterNSW and other relevant stakeholders Report in the End of Panel Report Summarise actions and monitoring in Annual Review 	<ul style="list-style-type: none"> Level 1 TARP trigger for pH at FO1. pH has trended slightly lower during the dry conditions of 2023; however, pH values generally remain within the baseline range and there is no long-term adverse trend. <p>The trigger does not represent an adverse trend due to mining.</p>
	<p>Level 2*</p> <p>Impact monitoring sites when comparing the baseline period to the mining period for that site:</p> <ul style="list-style-type: none"> Mining results in pH reduction greater than 2 standard deviations from pre-mining mean resulting from the mining for two consecutive months Mining results in DO reduction greater than 2 standard deviations from pre-mining mean resulting from the mining for two consecutive months Mining results in EC increases greater than 2 standard deviations from pre-mining mean resulting from the mining for two consecutive months Identification of strata gas plume of flow rate >3000 L/min Trend analysis shows significant deviation from baseline post-mining. 	<ul style="list-style-type: none"> Actions as stated for Level 1 Review monitoring program Notify relevant technical specialists and seek advice on any CMA required Implement agreed CMAs as approved <p><i>Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. water quality changes with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts</i></p> <p>Strata Gas Emission Plume:</p> <ul style="list-style-type: none"> Estimate gas emission flow rates. Re-estimate should significant change be observed Take sample of plume (if possible) for: <ul style="list-style-type: none"> chemical composition dissolved methane from exactly above gas plume and at established downriver monitoring site dissolved sulfide and total phenols from exactly above gas plume and at nearest downriver monitoring site 	<ul style="list-style-type: none"> Level 2 TARP trigger for EC at NR0, NR4 and at Upstream control site NR110. The TARP triggers related to elevated and increasing EC in 2023 are most likely related to drying weather conditions and do not reflect a mining impact. Level 2 TARP Trigger for pH at NR3 pH values generally remain within the baseline range and there is no long-term adverse trend. The triggers do not represent an adverse trend due to mining. Level 2 TARP trigger for DO at HC10 and upstream control site NR10 Low-flow during drier conditions is often accompanied by a reduction in DO which is observed at control sites
	<p>Level 3*</p>	<ul style="list-style-type: none"> Actions stated for Level 2 	<ul style="list-style-type: none"> No such impacts observed

	<p>Impact monitoring sites when comparing the baseline period to the mining period for that site:</p> <ul style="list-style-type: none"> Level 2-type reduction in water quality resulting from the mining observed for six consecutive months 	<ul style="list-style-type: none"> Notify BCS, DPE - Water, WaterNSW and 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) Completion of works following approvals, including monitoring and reporting on success Review the TARP and Management Plan in consultation with key stakeholders <p><i>Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. water quality changes with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts</i></p>	
	<p>Exceeding Performance Measures Mining results in more than negligible gas releases, iron staining or water cloudiness on Nepean River. Mining results in greater subsidence impact or environmental consequences than predicted in the EA and PPR</p>	<ul style="list-style-type: none"> Actions stated for Level 3 Investigate reasons for the exceedance Update future predictions based on the outcomes of the investigation Provide environmental offset if CMAs are unsuccessful 	<ul style="list-style-type: none"> No such impacts observed
Surface Water Flow and Level			
<p>Nepean River Maldon Weir Broughtons Pass Weir Menangle Weir Creeks and Tributaries NAV1 FO1 HC10 NR3</p>	<p>Level 1*</p> <ul style="list-style-type: none"> Mining results in observational changes to pool level (dry and/or flooded) in comparison to baseline observations and flows, for less than two consecutive months. 	<ul style="list-style-type: none"> Continue monitoring program Submit an Impact Report to BCS, DPE – Water, WaterNSW and other relevant stakeholders Report in the End of Panel Report Summarise actions and monitoring in Annual Review 	<ul style="list-style-type: none"> No such impacts observed
	<p>Level 2*</p> <ul style="list-style-type: none"> Mining results in observational changes to pool level (dry and/or flooded) in comparison to baseline observations and flows, for more than two consecutive months. 	<p><i>Actions as stated for Level 1</i></p> <ul style="list-style-type: none"> Review monitoring program Notify relevant technical specialists and seek advice on any CMA required Implement agreed CMAs as approved 	<ul style="list-style-type: none"> No such impacts observed
	<p>Level 3*</p> <ul style="list-style-type: none"> Mining results in observational changes to pool level (dry and/or flooded) in comparison to baseline observations and flows, for six consecutive months. 	<p><i>Actions stated for Level 2</i></p> <ul style="list-style-type: none"> Notify BCS, DPE - Water, WaterNSW and 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) Completion of works following approvals, including monitoring and reporting on success Review the TARP and Management Plan in consultation with key stakeholders 	<ul style="list-style-type: none"> No such impacts observed
	<p>Exceeding Performance Measures</p>	<p><i>Actions stated for Level 3</i></p> <ul style="list-style-type: none"> Investigate reasons for the exceedance 	<ul style="list-style-type: none"> No such impacts observed

	Mining results in more than negligible diversion of flows or changes in the natural drainage behaviour of pools in the Nepean River	<ul style="list-style-type: none"> Update future predictions based on the outcomes of the investigation Provide environmental offset if CMAs are unsuccessful 	
Creeks and Tributaries Foot Onslow Creek FO1 FOS1 Navigation Creek NAV1 NAVS1	Level 1* <ul style="list-style-type: none"> Fracturing with no observable loss of surface water flow 	<ul style="list-style-type: none"> Continue monitoring program Submit an Impact Report to BCS, DPE – Water, WaterNSW and other relevant stakeholders Report in the End of Panel Report Summarise actions and monitoring in Annual Review 	<ul style="list-style-type: none"> No such impacts observed
	Level 2* <ul style="list-style-type: none"> Fracturing resulting in loss of surface flow in some creeks or tributary 	<i>Actions as stated for Level 1</i> <ul style="list-style-type: none"> Review monitoring program Notify relevant technical specialists and seek advice on any CMA required Implement agreed CMAs as approved	<ul style="list-style-type: none"> No such impacts observed
	Level 3* <ul style="list-style-type: none"> Fracturing resulting in total loss of surface flow in all sections of a creek or tributary 	<i>Actions stated for Level 2</i> <ul style="list-style-type: none"> Notify BCS, DPE - Water, WaterNSW and 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) Completion of works following approvals, including monitoring and reporting on success Review the TARP and Management Plan in consultation with key stakeholders 	<ul style="list-style-type: none"> No such impacts observed
	Exceeding Performance Measures <ul style="list-style-type: none"> Mining results in greater subsidence impact or environmental consequences than predicted in the EA and PPR 	<i>Actions stated for Level 3</i> <ul style="list-style-type: none"> Investigate reasons for the exceedance Update future predictions based on the outcomes of the investigation Provide environmental offset if CMAs are unsuccessful 	<ul style="list-style-type: none"> No such impacts observed
Groundwater			
Groundwater inflows to the mine Private Bores GW072196 GW072874 GW100289 GW100673 GW101986 GW104661 GW105376 GW105388 GW105531 GW105534 GW105574	Level 1* <ul style="list-style-type: none"> Increase in water flow from the goaf between 2.7 to 3 ML/day (over 20-day average) >10 m reduction in water level/pressure in the HBSS from the average level in the period of 12 months prior to the start of a longwall, over a minimum of two months 	<ul style="list-style-type: none"> Continue monitoring program Submit an Impact Report to BCS, DPE - Water, WaterNSW and other relevant stakeholders Report in the End of Panel Report Summarise actions and monitoring in Annual Review 	<ul style="list-style-type: none"> No such impacts observed
	Level 2* <ul style="list-style-type: none"> Increase in water flow from the goaf between 3 to 3.4ML (over 20-day average) >15 m reduction in water level/pressure in the HBSS from the average level in the period of 12 months prior to the start of a longwall, over a minimum of two months 	<ul style="list-style-type: none"> <i>Actions as stated for Level 1</i> Review monitoring frequency Notify relevant technical specialists and seek advice on any CMA required Implement agreed CMAs as approved <i>Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of</i>	<ul style="list-style-type: none"> No such impacts observed

<p>GW106574 (grouted) GW106675 GW108907 GW112381 GW112441 (grouted)</p> <p>IMC Boreholes S1913 S1941 S1954 S2157 S2536 S2536A S2537 S2538</p>	<p>Level 3*</p> <ul style="list-style-type: none"> Abnormal increase in water flow from the goaf >3.4ML (20-day average) >20 m reduction in water level/pressure in the HBSS from the average level in the period of 12 months prior to the start of a longwall, over a minimum of two months Mining results in groundwater bores unsafe, unserviceable or damaged 	<p><i>mining impacts i.e. cracking at the surface with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts</i></p> <ul style="list-style-type: none"> Actions as stated for Level 2 Notify BCS, DPE - Water, WaterNSW and 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: <ul style="list-style-type: none"> Make area safe Any actions agreed to in the Property Subsidence Management Plan Provisions of alternate water supply where this has been impacted by mining Completion of works following approvals, including monitoring and reporting on success Review the Groundwater Model, TARP and Management Plan in consultation with key stakeholders <p><i>Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. cracking at the surface with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts</i></p>	<ul style="list-style-type: none"> No such impacts observed
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Landscape Features			
<p>Cliffs and Steep Slopes</p> <ul style="list-style-type: none"> Nepean River cliff lines Razorback Range cliffs Sensitive terrain near built features (Razorback Range) <p>Monitoring locations on private properties to be determined as appropriate/required in consultation with landowner</p>	<p>Level 1*</p> <ul style="list-style-type: none"> Rock fall from a 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 	<ul style="list-style-type: none"> Continue monitoring program Submit an Impact Report to BCD, DPE and MEG Report in the End of Panel Report Summarise actions and monitoring in AR 	<ul style="list-style-type: none"> No such impacts observed
	<p>Level 2*</p> <ul style="list-style-type: none"> Rock fall from 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 	<ul style="list-style-type: none"> Actions as stated for Level 1 Report trigger to key stakeholders Review monitoring frequency Notify relevant technical specialists and seek advice on any CMA required 	<ul style="list-style-type: none"> No such impacts observed

	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • Provide safety signage and barricades where appropriate in areas as required for public safety (refer PSMP) • Implement agreed CMAs as approved <p><i>Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. cracking at the surface with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts</i></p>	
	<p>Level 3*</p> <ul style="list-style-type: none"> • Cliff collapse (100% length of any single cliff) • Ground disturbance that does not stabilise within the period of monitoring • 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 	<ul style="list-style-type: none"> • <i>Actions as stated for Level 2</i> • Notify BCD, DPE, 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: <ul style="list-style-type: none"> – Erosion prevention works – 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 <p><i>Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. cracking at the surface with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts</i></p>	<ul style="list-style-type: none"> • No such impacts observed
	<p>Exceeding Prediction</p> <ul style="list-style-type: none"> • For cliffs of 'special significance' and other cliffs flanking the Nepean River - mining results in more than negligible environmental consequences (i.e. more than occasional rockfalls, displacement or dislodgement of boulders or slabs, or fracturing, that in total impact more than 0.5% of the total face area of such cliffs within any longwall mining domain • Other cliffs – 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 any longwall mining domain 	<ul style="list-style-type: none"> • <i>Actions as stated for Level 3</i> • Make area safe • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation • Provide environmental offset if CMAs are unsuccessful 	<ul style="list-style-type: none"> • No such impacts observed

Aquatic Ecology			
Impact Sites: 5, 6, X3 and X4 Control Sites: 1, 2, 7, 8, X5, X6, X7 and X8	Level 1* <ul style="list-style-type: none"> Reduction in aquatic habitat resulting from the mining over 1 season 	<ul style="list-style-type: none"> Continue monitoring program Submit an Impact Report to BCD, DPE, DPI Fisheries and other relevant resource managers Report in the End of Panel Report Summarise actions and monitoring in AR 	<ul style="list-style-type: none"> No such impacts observed
	Level 2* <ul style="list-style-type: none"> Reduction in aquatic habitat resulting from the mining over 2 seasons 	<ul style="list-style-type: none"> 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 Implement agreed CMAs as approved <p><i>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</i></p>	<ul style="list-style-type: none"> No such impacts observed
	Level 3* <ul style="list-style-type: none"> Reduction in aquatic habitat resulting from the mining for >2 consecutive seasons or complete loss of habitat 	<ul style="list-style-type: none"> Actions as stated for Level 2 Notify BCD, DPE, DPI Fisheries, 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: <ul style="list-style-type: none"> Grouting of fractures which result in flow diversion Completion of works following approvals Completion of works following approvals, including monitoring and reporting on success Review the TARP and Management Plan in consultation with key stakeholders <p><i>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</i></p>	<ul style="list-style-type: none"> No such impacts observed
	Exceeding Prediction <ul style="list-style-type: none"> Mining results in more than negligible environmental consequences for a threatened species, threatened population or endangered ecological communities 	<ul style="list-style-type: none"> Actions as stated for Level 3 Investigate reasons for the exceedance Update future predictions based on the outcomes of the investigation Provide environmental offset if CMAs are unsuccessful 	<ul style="list-style-type: none"> No such impacts observed

Terrestrial Ecology				
Visual inspections as part of landscape and water monitoring programs in active mining areas	Level 1*	<ul style="list-style-type: none"> Impacts detectable via observational monitoring (e.g. canopy thinning, thinning of shrub layer, minor loss of ground cover) to a single vegetation strata Subsidence impacts (such as surface cracking, rock falls) resulting in small areas of disturbance that will mitigate without CMA 	<ul style="list-style-type: none"> Continue monitoring program Submit an Impact Report to BCD, DPE and other relevant resource managers Report in the End of Panel Report Summarise actions and monitoring in AR 	<ul style="list-style-type: none"> No such impacts observed
	Level 2*	<ul style="list-style-type: none"> Impacts detectable via observational monitoring (e.g. canopy thinning with dead branches present, thinning of the shrub layer with dead branches, loss of ground cover in multiple areas) to multiple vegetation strata Subsidence impacts (such as surface cracking, rock falls) resulting in small areas of disturbance that will not mitigate without CMA 	<ul style="list-style-type: none"> 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 Implement agreed CMAs as approved <p><i>Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. impacts to terrestrial habitat with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts</i></p>	<ul style="list-style-type: none"> No such impacts observed
	Level 3*	<ul style="list-style-type: none"> Impacts (e.g. canopy thinning with dead branches present, thinning of the shrub layer with dead branches, loss of ground cover in multiple areas) to multiple vegetation strata caused by subsidence effects Subsidence impacts (such as surface cracking, rock falls) resulting in large areas of disturbance that will not mitigate without CMA Negligible environmental consequences to threatened species, populations or EEC Reduction in aquatic habitat resulting from the mining for >2 consecutive seasons or complete loss of habitat 	<ul style="list-style-type: none"> Actions as stated for Level 2 Notify BCD, DPE, 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: <ul style="list-style-type: none"> Erosion prevention works 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 <p><i>Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. impacts to terrestrial habitat with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts</i></p>	<ul style="list-style-type: none"> No such impacts observed
	Exceeding Prediction	<ul style="list-style-type: none"> Mining results in more than negligible environmental consequences for a threatened species, threatened population or endangered ecological communities 	<ul style="list-style-type: none"> Actions as stated for Level 3 Investigate reasons for the exceedance Update future predictions based on the outcomes of the investigation Provide environmental offset if CMAs are unsuccessful 	<ul style="list-style-type: none"> No such impacts observed

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

The upstream monitoring site NR110 and a series of sites within tributaries of the Nepean River are utilised to indicate non-mining-related perturbations at the proposed Longwalls 709 to 711 and 905 impact monitoring sites within the Nepean River. This provides a means of distinguishing upstream or mid-river effects unrelated to the mining of the proposed longwalls. The following premise applies:

- A TARP at River site NR0 should only be considered to have been triggered whenever an equivalent change (from the long term mean) is not exhibited for the same parameter at the upstream site NR110.
- A TARP at River site NR4 should only be considered to have been triggered whenever an equivalent change (from the long term mean) is not exhibited for the same parameter at the upstream sites NR110 or SW2 (monitors for upstream perturbation from Allens Creek).
- A TARP at River site NR12 and NR13 should only be considered to have been triggered when an equivalent change (from the long term mean) is not exhibited for the same water quality analyte at the upriver sites; NR110, SW2, NR5, NR8 or NR10 (monitors upstream perturbation from Allens Creek, Cataract River, Elladale Creek and Ousedale Creek).
- A TARP at River site NR50 should only be considered to have been triggered when an equivalent change (from the long term mean) is not exhibited for the same water quality analyte at the upriver sites; NR110, SW2, NR5, NR8, NR10 or NR40 (monitors upstream perturbation from Allens Creek, Cataract River, Elladale Creek, Ousedale Creek and Menangle Creek).

8. References

- Geoterra (2008) Appin Area 7 Longwalls 705-710 Groundwater Assessment Douglas Park NSW, Report by Geoterra for BHBBilliton Illawarra Coal
- HGEO (2024), Longwall 709 End of Panel Surface Water and Groundwater Monitoring review, Report by HGEO for South32 Illawarra Metallurgical Coal. Report Number – D23236
- Lawrence Consulting (2016), NSW Mining Industry Expenditure Impact Survey 2015/16, Prepared for NSW Minerals Council November 2016.
- MSEC (2021), Subsidence Predictions and Impact Assessments for the Natural and Built Features due to the Extraction of the Proposed Longwalls 709, 710A, 710B, 711 and 905 at Appin Colliery. Report Number - MSEC1117
- MSEC (2024), End of Panel Subsidence Monitoring Review Report for Appin Longwall 709, Report by Mine Subsidence Engineering Consultants for South32 Illawarra Metallurgical Coal. Report Number – MSEC1394
- Niche (2021), Appin – Longwall 907 to 711 and 905 Biodiversity Impact Assessment, Report by Niche Environment and Heritage for South32 Illawarra Metallurgical Coal. Report Number - 6049
- SLR (2022), Appin Mine Extraction Plan groundwater impact assessment: Report by SLR consulting for South32 Illawarra Metallurgical Coal Report - 665.10015-R01.
- South32 (2022), Appin Area 7 and 9 Longwalls 709 to 711 and 905 Built Features Management Plan.
- South32 (2022), Appin Area 7 and 9 Longwalls 709 to 711 and 905 Extraction Plan.
- South32 (2023), Appin Mine Longwall 709 Landscape Report.
- Stantec (2024), Appin Areas 7 Longwall 709 End of Panel Report - Aquatic Flora and Fauna Review, Report by Stantec (formally Cardno) for South32 Illawarra Metallurgical Coal.