



**APPIN MINE
LONGWALL 905
END OF PANEL REPORT**

June 2023

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Attachments

- Attachment A: Appin Area 7 and 9 Longwalls 709 to 711 and 905 Extraction Plan Approval
- Attachment B: Appin Area 9 Longwall 905 Subsidence Monitoring Review
- Attachment C1: Appin Area 9 Longwall 905 End of Panel Landscape Report
- Attachment C2: Appin Area 9 Longwall 905 Private Property Reports
- Attachment D: Area 9 Longwall 905 End of Panel Surface Water and Groundwater Monitoring Review
- Attachment E: Appin Area 9 Longwall 905 End of Panel Report - Aquatic Flora and Fauna Review
- Attachment F: Appin Area 9 Longwall 905 Geotechnical Observations

Abbreviations

AA7	Appin Area 7
AA9	Appin Area 9
ALS	Airborne Laser Scan
ARTC	Australian Rail and Track Corporation
BFMP	Built Feature Management Plan
BSO	Bulli Seam Operations
DPE	Department of Planning and Environment
BCD	Biodiversity and Conservation Division
MEG	Department of Mining, Exploration and Geosciences
DPI	Department of Primary Industries – Fisheries
EP	Extraction Plan
EP&A Act 1979	<i>Environmental Planning and Assessment Act 1979</i>
IMC	Illawarra Metallurgical Coal
IMCEFT	Illawarra Metallurgical Coal Environmental Field Team
PAC	Planning and Assessment Commission

1. Introduction

South32 Illawarra Metallurgical Coal (IMC) 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 the BSO Project (MP 08_0150) under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act 1979) to continue mining operations until 31 December 2041.

The Department of Planning and Environment (DPE) granted approval for the Appin Longwalls 709 to 711 and 905 Extraction Plan (EP) on 29 July 2022. Extraction of Longwall 905, the first longwall in the EP, commenced on 25 September 2022 and was completed on 28 February 2023.

Appin Colliery is located within the Southern Coalfield within the Sydney Geological Basin. The Bulli and Wongawilli Coal Seams are the primary target seams in the top part of the Illawarra Coal Measures. The Coal Measures are overlain by Triassic sandstones, siltstones and claystones of the Narrabeen Group, the Hawkesbury Sandstone and the Wianamatta Group (Figure 1-1).

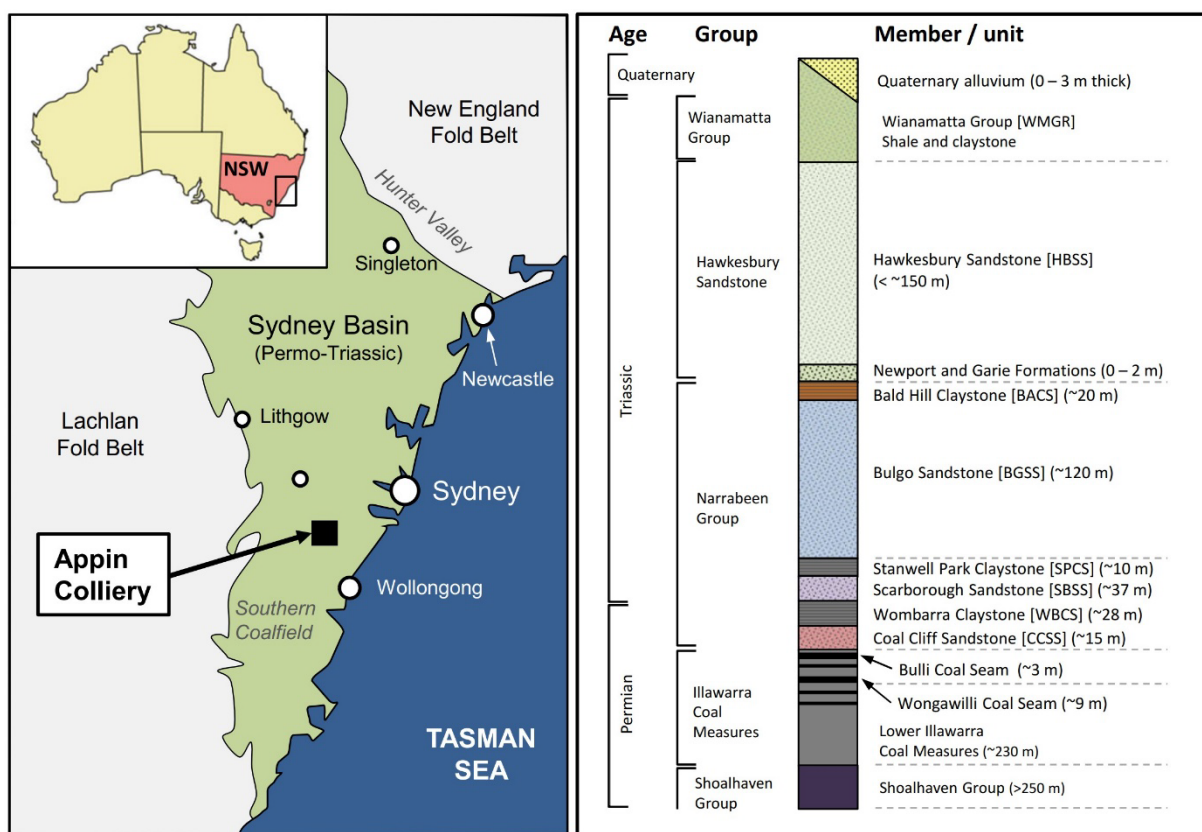


Figure 1-1: Stratigraphy of the Southern Sydney Basin (Source: HGEO 2022).

The depth of cover to the Bulli Seam directly above Longwall 905 varies between a minimum of 585 m above the tailgate towards the finishing (i.e. eastern) end of the longwall, and a maximum of 715 m above the maingate near the mid-length of the longwall. The seam floor within the mining area generally dips from the south to the north, with an average dip of approximately 2 % or 1 in 50.

The natural surface above the mining area generally falls from the north towards the south. The natural drainage lines above the western end of Longwall 905 flow into the Nepean River which is more than 1

km south of the longwall tailgate. The drainage lines above the eastern end of Longwall 905 flow into Harris Creek which is more than 600 m east of the finishing end of the longwall. Razorback Range is partially located above the western end of Longwall 905 and the toe of this range extends across the eastern end of this longwall.

The thickness of the Bulli Seam varies between 2.95 m and 3.05 m within the extents of Longwall 905. IMC mined the full thickness of the seam.

1.1. Study Area

The Study Area for the Extraction Plan and this assessment is defined as the surface area predicted to be affected by the proposed mining of Longwalls 709 to 711 and 905 and encompasses the areas bounded by the following limits (Figure 1-2):

- A 35° angle of draw line from the maximum depth of cover, which equates to a horizontal distance varying between 530 m and 750 m around the extents of Longwalls 709 to 711 and 905.
- The predicted limit of vertical subsidence, taken as the 20 mm subsidence contour, resulting from the extraction of the proposed Longwalls 709 to 711 and 905.
- A 600 m buffer around all longwalls, which is a conservative envelope to encompass potential far field effects beyond the 20 mm subsidence zone and 35° angle of draw line.

There are areas that lie outside the Study Area that are expected to experience either far-field movements, or valley related movements. The surface features which could be sensitive to such movements have been identified and have been included in the assessments provided in this report.

1.2. Economic Benefits

The extraction of coal reserves from AA9 provides benefits at national, state and local levels. Illawarra Metallurgical Coal provides coking coal to BlueScope Steel for its domestic steelmaking production, and for export to overseas customers. South32 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 directly employs more than 1,800 employees with more than 90 per cent of wages paid to workers living in the Illawarra region. 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 2021/22, 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 a year supporting local community groups and organisations. IMC paid approximately \$41.5 million in government royalties during the general period of Longwall 905 extraction (for Appin and Dendrobium) i.e. the months September 2022 to February 2023.

Longwall 905 is located within Consolidated Coal Lease 767, which amalgamated a number of long-standing head leases for mining coal in 1991.

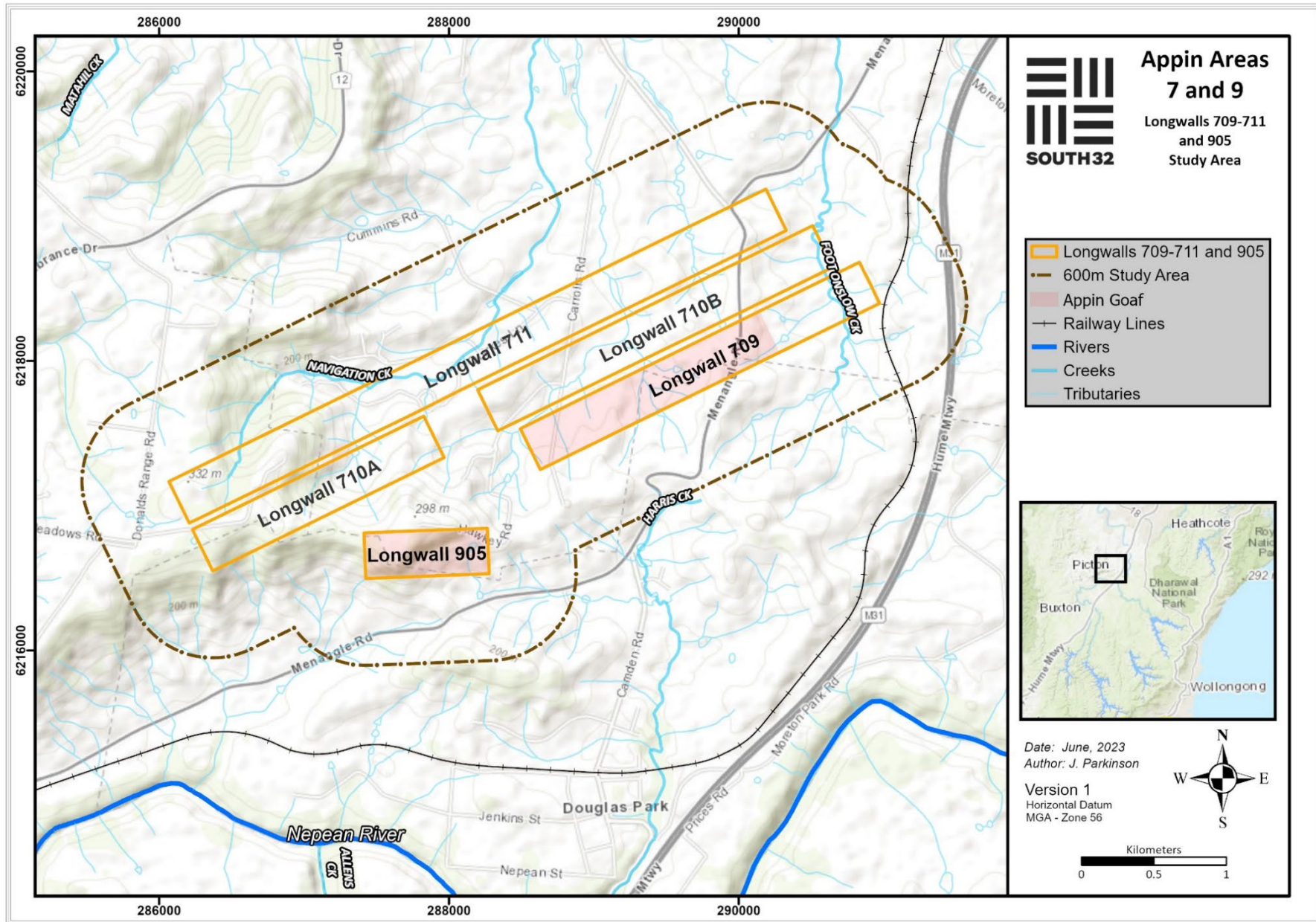


Figure 1-2: Appin Longwalls 709 to 711 and 905 Study Area.

2. Stakeholder Engagement

Monitoring data and other information has been made available to the community by IMC during the extraction of AA9. Information on IMC operations is provided to the community through the following mechanisms:

- Illawarra Metallurgical Coal 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; [Illawarra Metallurgical Coal Documents \(south32.net\)](#));
- Regular meeting with the Wollondilly Shire Council;
- Community information sheets and letter box drops;
- Social Pinpoint - [S32Illawarra Community | Social Pinpoint](#)
- Media releases; and
- Annual Environmental Assessment Report

Illawarra Metallurgical Coal 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, is displayed on local notice board, and is included in personalised letters and community newsletters.
	Awareness of subsidence and its effects and management.	Appin Mine Community Consultative Committee. Douglas Park Advisory Panel (Note: the DPAP was disbanded in December 2022).
	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 (PSMP) 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 905, property owners were advised to lodge a claim with the Subsidence Advisory NSW where there was 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 AA9.

3. Comparison of Measured and Predicted Subsidence

The following section provides comparisons between predicted and measured subsidence movements relating to the extraction of Longwall 905. For further details, refer to MSEC (2023), which is provided as **Attachment B**.

Predictions of subsidence movements relating to the extraction of Longwall 905 were obtained by MSEC using the Incremental Profile Method based on prediction curves for the Southern Coalfield Bulli Coal Seam.

Measurements of subsidence movements resulting from the extraction of Longwall 905 were obtained using ground monitoring lines, monitoring points and other methods at the following locations:

- Main Southern Railway, including monitoring associated with the track, embankments, cuttings, culverts and Douglas Park Station
- Hawkey Road private extension monitoring line
- Menangle Road monitoring line
- Steep Slopes monitoring lines
- Indara Razorback Complex
- Nepean River closure lines
- Harris Creek Cliff Line closure lines
- Blades Bridge monitoring points
- Far-field monitoring points
- Nepean Twin Bridges monitoring points and bridge joint monitoring
- Moreton Park Road Bridge South monitoring points
- Global Navigation Satellite System (GNSS) monitoring
- ALS / LiDAR surveys

Table 3-1: Comparison summary of predicted and measured subsidence during the extraction of Longwall 905.

Feature	Monitoring Types	Approximate Location/ Distance from Longwall 905	Assessment of Measured Subsidence vs Predictions / Trigger Levels (MSEC 2023)
Main Southern Railway	GNSS monitoring and ARTC monitoring line; Embankment monitoring points; Cutting monitoring points; Culvert monitoring points; Douglas Park Station monitoring points.	Overlies previously extracted Longwall 901.	<p>Maximum measured incremental vertical subsidence of 26mm is very small and in the same order of magnitude as the prediction of less than 20 mm.</p> <p>The maximum measured incremental tilt of 0.6 mm/m is greater than the maximum predicted value of less than 0.5 mm/m. However, the greatest measured tilts are partly due to localised movements of the survey marks, mostly associated with railway embankments.</p> <p>Maximum compressive strains (0.2 mm/m) and tensile strains (0.2 mm/m) which are similar to the order of survey tolerance.</p> <p>No adverse impacts observed at cuttings.</p> <p>Minor differential movements at culverts typically similar to the order of survey tolerance.</p> <p>Differential vertical and horizontal movements at Douglas Park Station typically similar to the order of survey tolerance.</p>
Hawkey Road private extension	2D and 3D monitoring line	East of Longwall 905, minimum distance 25m.	<p>The measured incremental vertical subsidence of is 55 mm nearest to longwall 905 is less than the maximum prediction of 75 mm.</p> <p>The measured incremental strains are 0.4 mm/m tensile and 0.4 mm/m compressive are the same or less than the predicted strains based on the 95 % confidence levels.</p> <p>Movements measured along the Hawkey Road private extension monitoring line are consistent with the predictions</p>
Menangle Road	2D and 3D monitoring line	Crosses above the western end of Longwall 903 and above the eastern end of Longwall 904. Minimum distance of 150m south of Longwall 905.	<p>Maximum measured incremental vertical subsidence (656 mm) is approximately half of the maximum predicted value (1250 mm).</p> <p>Maximum measured tilt (4.4mm/m) is similar to but less than the predicted maximum value (4.5mm/m).</p> <p>Maximum measured tilt is due to a localised bump in the subsidence profile above the chain pillar between Longwall 903 and 904 and therefore, doesn't represent overall movements above the mining area.</p> <p>Maximum measured compressive strain (1.2 mm/m) is less than the maximum predicted value (1.6 mm/m)</p>
Steep Slopes	2D and 3D monitoring line.	To the west and south of Longwall 905.	<p>The maximum measured values of incremental vertical subsidence are 101 mm and 143 mm</p> <p>The measured vertical subsidence is similar to or greater than the maximum predicted incremental vertical subsidence of 100 mm. The measured incremental subsidence is within the order of accuracy of the prediction method for monitoring lines located outside the extents of the active longwall.</p>
Indara Razorback Complex	3D monitoring techniques	Above maingate of Longwall 905.	<p>The maximum measured incremental vertical subsidence (253 mm) is less than the maximum predicted value (320 mm). The maximum measured tilt (1.1 mm/m) is also less than the maximum predicted value (3.5 mm/m).</p>
Nepean River	2D closure monitoring lines	Located 1.8 km south of the tailgate of Longwall 905.	<p>The incremental movements were in the order of survey tolerance of ± 3 mm. That is the mining-related movements were not measurable outside of the survey tolerance</p>

Feature	Monitoring Types	Approximate Location/ Distance from Longwall 905	Assessment of Measured Subsidence vs Predictions / Trigger Levels (MSEC 2023)
Harris Creek Cliff Line	2D closure monitoring lines	Located 2 km south-east of the finishing end of Longwall 905 at its closest point.	The measured incremental movements in the final survey are less than ± 2 mm. These movements were therefore in the order of the nominal tolerance for survey accuracy and environmental effects. That is the mining-related movements were not measurable outside of the nominal tolerance The maximum measured total closure due to the mining of Longwall 901 to 905 (43 mm) was less than the maximum predicted value (50 mm).
Blades Bridge	Two fixed prisms	Located 2 km south of the finishing end of Longwall 905 at its closest point.	The measured incremental closure due to the mining of Longwall 905 is only +2 mm (closure). Final incremental closure is in the order of survey tolerance and, therefore, is not measurable.
Far-Field Monitoring points	Absolute 3D monitoring points	Various locations in AA9.	The maximum measured incremental movement outside the extent of Longwall 905 was 230 mm. Elsewhere, the measured incremental far-field horizontal movements were less than 100 mm. The movements measured at distances greater than 1.1 km from Longwall 905 were typically less than 25 mm and therefore, were in the order of survey tolerance. The incremental far-field horizontal movements due to the mining of Longwall 905 are within the range of movements measured elsewhere in the Southern Coalfield at similar distances from the active longwall.
Nepean Twin Bridges	Absolute 3D points Relative 3D points Bridge joint monitoring Visual monitoring	2.5 km southeast of the finishing end of Longwall 905.	The maximum measured absolute horizontal movement (86 mm) at Marks DPBN and DPBS was less than the Level 1 Trigger (100 mm) at the completion of Longwall 905.
Moreton Park Road (South)	Absolute 3D points Relative 3D points	2.2 km south-east from the finishing end of Longwall 905.	The maximum measured absolute horizontal movement (134 mm) at Marks MPBE and MPBW was less than the Level 1 Trigger (150 mm) at the completion of Longwall 905. The total changes in horizontal distance between the bridge abutments were less than +/- 2 mm. The total measured movements, therefore, were in the order of the survey tolerance at the completion of the Longwall 905.

4. Impacts to Built Features

MSEC provided an assessment of potential built features impacts from the extraction of Longwall 905 (MSEC448 and MSEC1117), which supported the EP applications. A comparison between potential and observed impacts for built features is provided below (Table 4-1).

Table 4-1: Summary table comparing assessed and reported impacts for built features in relation to the extraction of Longwall 905 (Source: MSEC 2023).

Built Feature	MSEC-assessed Impacts	Observed Impacts
Main Southern Railway	No impacts on the safety or serviceability of the railway after the implementation of the monitoring and management strategies.	No reported impacts on safety or serviceability.
Menangle Road	Minor cracking and localised heaving of the road surface directly above the mining area.	Localised mining-related impacts to the road pavement and fretting of the cutting. Minor dip and wear in eastbound lane occurred near MR9078. A bump and minor cracking of the road pavement developed within the cutting between Marks MR9085 and MR9086. Minor deterioration of the road pavement elsewhere. The impacts developed gradually during the mining of Longwall 905 with no impacts to safety. No repairs were necessary for Menangle Road as a direct result of Longwall 905. Subsequent maintenance may occur due to the completion of mining activities in AA9 (unrelated to LW905).
Hawkey Road private extension	Impacts unlikely.	No reported impacts.
Nepean Twin Bridges	Impacts unlikely after the implementation of the preventive, monitoring and management strategies.	No reported impacts.
Moreton Park Road Bridge (South) and Blades Bridge	Impacts unlikely.	No reported impacts.
Water and sewer pipelines	Minor leakages could occur.	No reported impacts.
66 kV and 11 kV powerlines	Minor impacts possible requiring some adjustments of cables and poles.	No reported impacts.
Optical fibre and copper telecommunications cables	Impacts unlikely with the implementation of monitoring and management strategies.	No reported impacts.
Survey control marks	Vertical and horizontal movements which could require re-establishment.	No reported damage to the survey control marks. The marks to be re-established after completion of mining.
Rural structures	Minor impacts on rural structures located directly above longwalls.	IMC reported moderate settlement and loss of subgrade beneath one shed (Property Ref. N15) which was not related to the mining of Longwall 905.
Pools	Assessed impacts for approximately 15 % of pools above the mining area including cracking and loss of water.	IMC reported impacts for one pool (Property Ref. N14) where several coping pavers had lifted off.

Built Feature	MSEC-assessed Impacts	Observed Impacts
Farm dams	Incidence of impact (cracking and leakage) expected to be extremely low.	No reported impacts including the dam on Property Ref. N13 above the eastern end of Longwall 905.
Groundwater bores	Impacts likely including lowering of piezometric surface, blockage and change in groundwater quality.	Refer to the groundwater assessment and the IMC Landscape Report.
Aboriginal heritage sites	Adverse impacts unlikely.	No Aboriginal heritage sites located within the Study Area for Longwall 905.
Other Heritage sites	Adverse impacts unlikely.	No reported impacts.
Houses	Remain safe and serviceable, assessed impacts: 92 % no claim or Category R0, 6 % Category R1 or R2, 2 % Category R3 or R4, and <0.5 % Category R5.	Houses have remained in safe and serviceable conditions. No mining-related impacts reported for the houses along Gibraltar Drive at the top of Razorback Range (Property Refs. O02, O17 and O18). IMC reported minor impacts not related to mining including very slight internal wall cracking, movements of the driveway, retaining walls and poly tanks. IMC reported very slight to slight internal and external wall, ceiling and cornice cracking (Category R1 and R2) of eight houses during Longwall 905 that were associated with the current or previous longwalls in Area 9.

4.1. Private Properties

Built Feature Management Plans (BFMP) have been prepared by IMC for landholders above AA9 and AA7. Post-mining inspection of dams, boreholes and natural features set out in the BFMPs are conducted by the IMC Environmental Field Team (IMCEFT) with the consent of the relevant property/infrastructure owner and tenant, if applicable (Figure 4-1).

Post-mining inspections for Longwall 905 were undertaken at properties Lot 900 DP1072947, Lot 16 DP251063. Lot 1 DP810978 and Lot 22 DP803255 were also reinspected following a recommendation in the Longwall 904 EoP Report. The inspections included recording key observations for private bores and dams, collection of in-situ water quality data and water samples for laboratory analysis. Results of water quality sampling are included in the Appin Longwall 905 Surface Water and Groundwater Assessment (**Attachment D**), and summarised below (Table 4-2). Individual property reports are provided in **Attachment C3**.

Table 4-2: Summary Table of predicted and observed impacts to private property surface and groundwater quality (Source: HGEO 2023).

Potential Impact	Description and Impact Prediction	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 Hawksbury Sandstone, Bulgo Sandstone and Scarborough Sandstone is likely to occur (SLR 2022)	No impacts observed.

Potential Impact	Description and Impact Prediction	Observed Impact
Groundwater quality impacts	The groundwater model predicted drawdowns in Hawksbury Sandstone (lower) groundwater source. Therefore, impacts on the water quality within the Hawksbury 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).	An increase in dissolved and total iron was recorded at one borehole. The concentration of other metals (copper, manganese, nickel, zinc, and aluminium) from the sample were at similar concentrations to previous inspections, including the pre-mining sample. There was also no reported increase in iron staining or colouration during sampling. Elevated iron is not uncommon in bore water and is not necessarily a mining effect. Bore water salinity and pH have increased slightly following the passage of Longwall 902.
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 2023).	No impacts observed.

4.2. Cultural Heritage

No Registered Aboriginal Archaeological Sites are located within the Study Area. There are no declared Aboriginal Places under the National Parks and Wildlife Act 1974 or identified Aboriginal Sites within the Study Area.

4.3. Douglas Park Railway Cottage

Heritage Sites listed in the Study Area comprise the Railway Cottage at Douglas Park Station, which is listed in the Wollondilly Local Environmental Plan 1999. No impacts have been reported by the resident.

4.4. Geotechnical Observations

Following completion of the mining of Longwall 905, GHD undertook site inspections of properties above or in proximity to the Razorback escarpment cliffs and/or steep slopes. These inspections follow earlier pre-mining inspections of the same properties. Some ground movements and erosion were observed at various properties, but this was found to be a result heavy rainfall and subsequent drying out of clay soils following wet periods prior to 2023. No mining related changes were observed (GHD 2023).

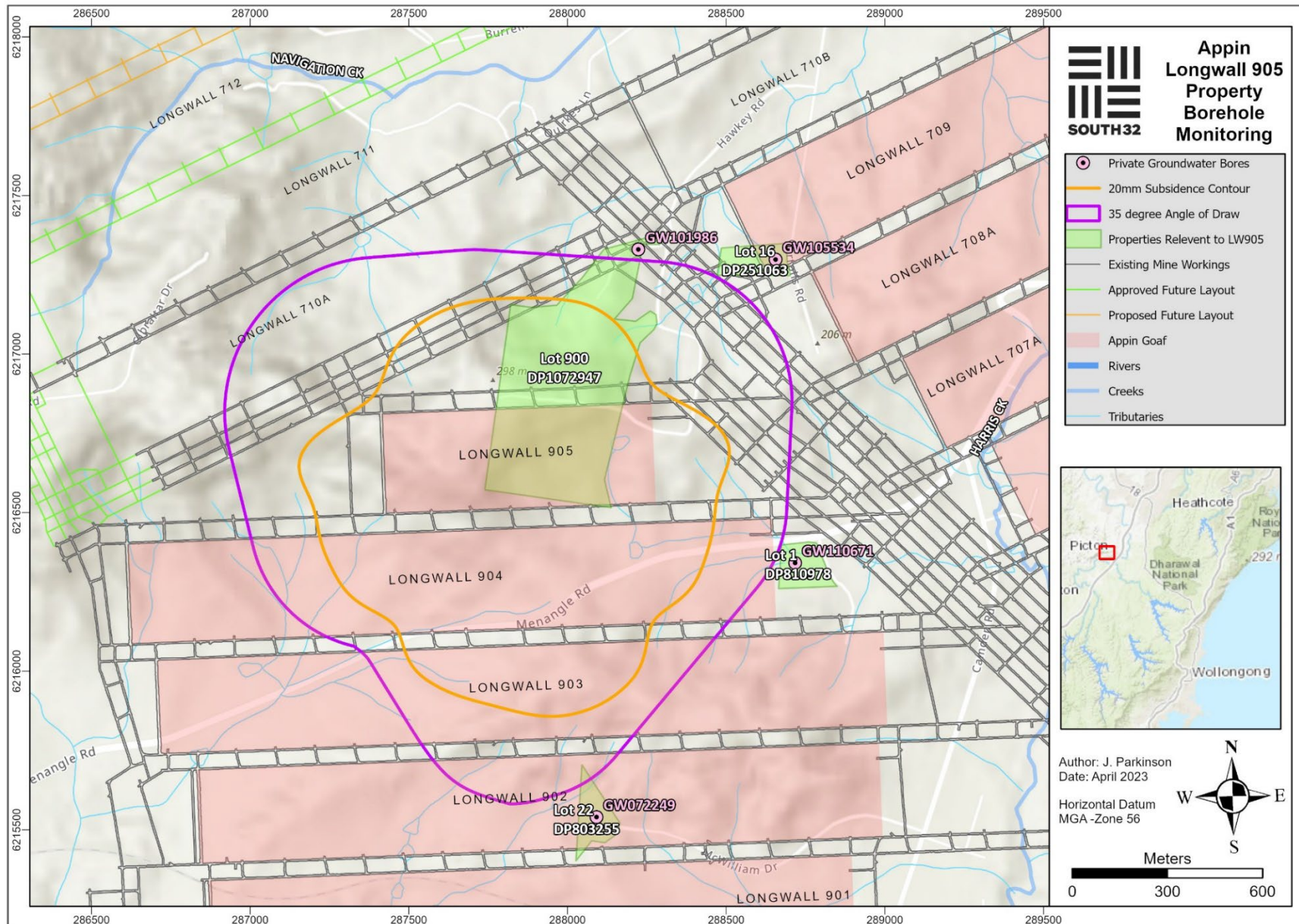


Figure 4-1: Private properties with boreholes relevant to Longwall 905.

5. Impacts to Natural Features

5.1. Surface Water Assessment

Monthly surface water monitoring is undertaken by the IMCEFT along watercourses within and surrounding AA9 (Figure 5-2). During the reporting period for Longwall 905 there were no consecutive TARP threshold exceedances at any of the impact sites. The timeseries plots do not show significant adverse trends in electrical conductivity (EC), pH or dissolved oxygen (DO). In general water quality has improved over recent years due to the higher rainfall between 2020 and 2022. EC is trending slightly higher at some locations as a result of drier conditions in 2023 (e.g. NAV1, NR10); however in those cases the trend is due to values returning to baseline conditions after the high rainfall period. No anomalous changes to the appearance of water in the Nepean River or its tributaries were observed during routine inspections; however increased erosion of riverbanks, loss of vegetation and sediment movement were noted by the IMCEFT following the very high rainfall and runoff events of 2022. In summary, no surface water quality TARPs were triggered for the period. A comparison between potential and observed impacts for Longwall 905 is provided below (Table 5-1).

Table 5-1: Summary table of potential and observed impacts to surface water quality within natural features (Source: HGEO 2023 and MSEC 2023).

Potential Impact	Assessed impact	Observations	TARP Level
Sub-bed flow diversions and unnatural pool drainage.	Negligible diversion of flows or changes in the natural drainage behaviour of pools.	No reported impacts. Monitoring site NR0 shows an apparent decline in water level of ~0.5 m 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 Relevant TARP.
Gas emissions in the Nepean River and other areas.	Negligible gas releases.	No new gas release zones were observed along the Nepean River during the mining of Longwall 905. However, there were 11 active gas release zones that developed during the mining of previous longwalls in Area 9 and continued during the mining of Longwall 905. Refer to the IMC Landscape Report.	Each gas release zone constitutes a Level 1 TARP.
Groundwater outflows and ferruginous springs.	Negligible iron staining or negligible increase in water cloudiness.	No changes.	Not Triggered.

5.2. Groundwater Assessment

Groundwater levels are monitored at fifteen bores within and surrounding AA7 and AA9 as part of a much wider groundwater monitoring network covering the Appin, West Cliff and Dendrobium mining areas. Groundwater inflow to the mine is also monitored. In general, groundwater levels in the Hawksbury Sandstone were slightly higher during Longwall 905 compared with the previous 12 months due to the relatively high rainfall during 2022. No groundwater level TARPs were triggered during the review period. A comparison between potential and observed impacts for Longwall 905 is provided below (Table 5-2). Details are included in the Longwall 905 Surface Water and Groundwater Assessment (**Attachment D**).

Table 5-2: Summary table of potential and observed impacts to groundwater (Source: HGEO 2023).

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.	Impacts likely including lowering of piezometric surface, blockage and change in groundwater quality. (MSEC 2023)	None identified.	Not triggered.
Changes to Groundwater chemistry.	Changes to groundwater chemistry within the Wianamatta Group, Hawkesbury Sandstone and Bulgo Sandstone.	Impacts likely including lowering of piezometric surface, blockage and change in groundwater quality. (MSEC 2023)	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.	No specific TARP.
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 0.79 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 during the longwall review period.	Not triggered.

5.3. Aquatic Ecology Assessment

Stantec (formerly Cardno) was commissioned by IMC to assess the potential impact of mine subsidence on ecological indicators of the Nepean River within the AA7 and AA9 mine areas through the implementation of an aquatic ecological monitoring program (Figure 5-1). 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 assessment (Cardno 2021) and Extraction Plan for Longwalls 709 to 711 and 905 (South32 2022).

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 and backpack electrofishing;
- Limited in-situ water quality sampling; and
- Species composition of aquatic macrophytes.

Aquatic ecology data was collected in December 2021 following the commencement of Longwall 904 at two Nepean River impact monitoring sites (X3 and X4) adjacent to AA9, and at control monitoring sites (X5 to X8), upstream of AA9. Data from Sites 1 and 2, collected in November 2022, located just upstream of Douglas Park Weir were also used to provide a measure of potential downstream impacts (monitored annually for AA7).

No changes to aquatic ecology indicators, that could be associated with extraction of Longwall 905, were detected.

The gas releases, changes in water quality and water levels identified in the Nepean River during extraction of Longwall 905, do not appear to have had any measurable effect on macroinvertebrates, fish and macrophytes in the Nepean River (Stantec 2023).

Further monitoring will be undertaken at all AA9 impact and control sites in late 2023. This will include a full assessment of any changes to aquatic habitat and biota that may have occurred at AA9 monitoring sites following the completion of Longwall 905. The Appin Longwall 905 End of Panel Aquatic Flora and Fauna Review is provided as **Attachment E**.

5.4. Terrestrial Ecology Assessment

Potential impacts to terrestrial ecology in the AA9 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 of cleared vegetation. The proposed extraction also does not require 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 AA9 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 905 has resulted in negligible impacts to terrestrial ecology within the AA9 Study Area.

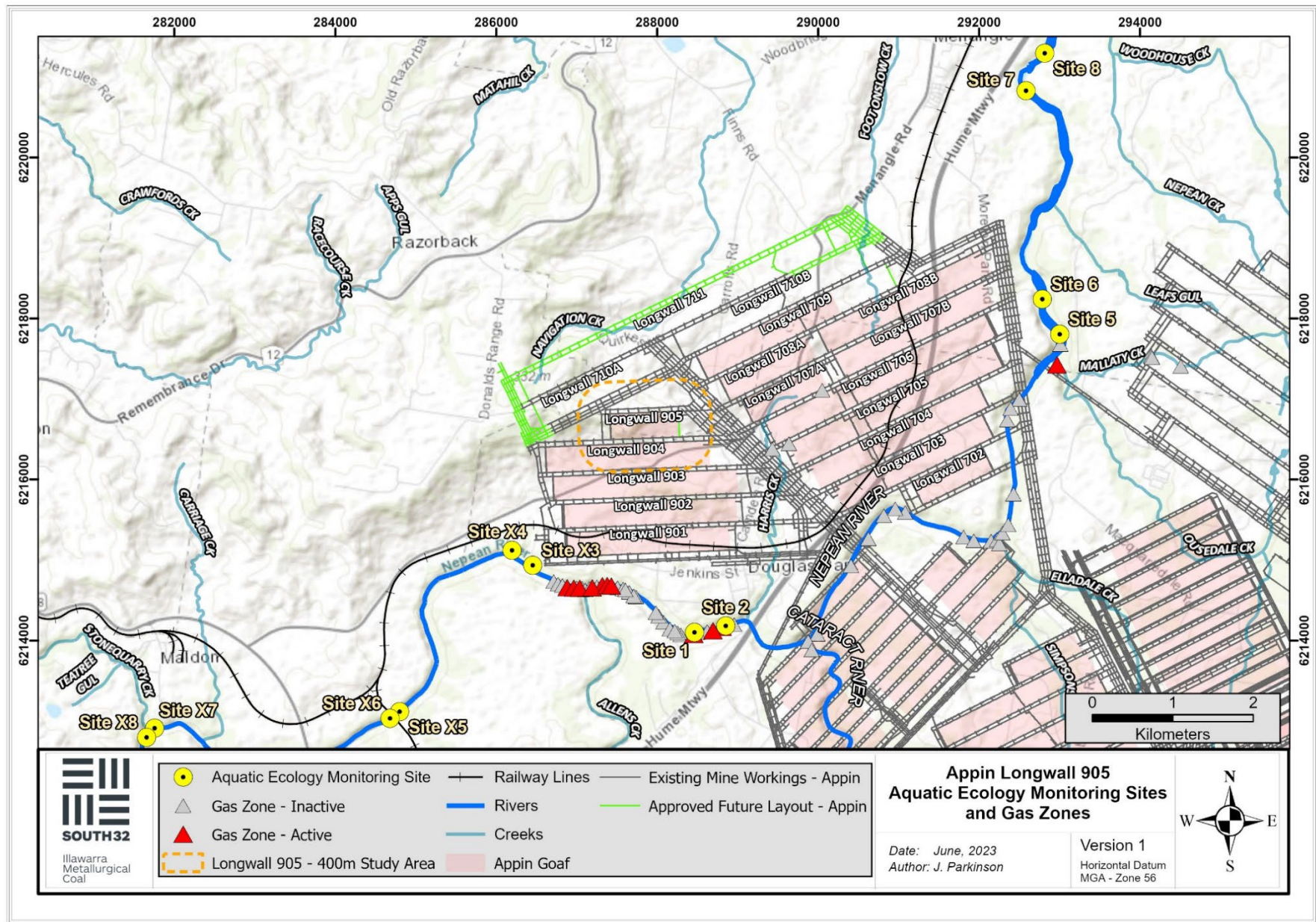


Figure 5-1: Aquatic ecology monitoring sites and gas zones relative to Appin longwalls.

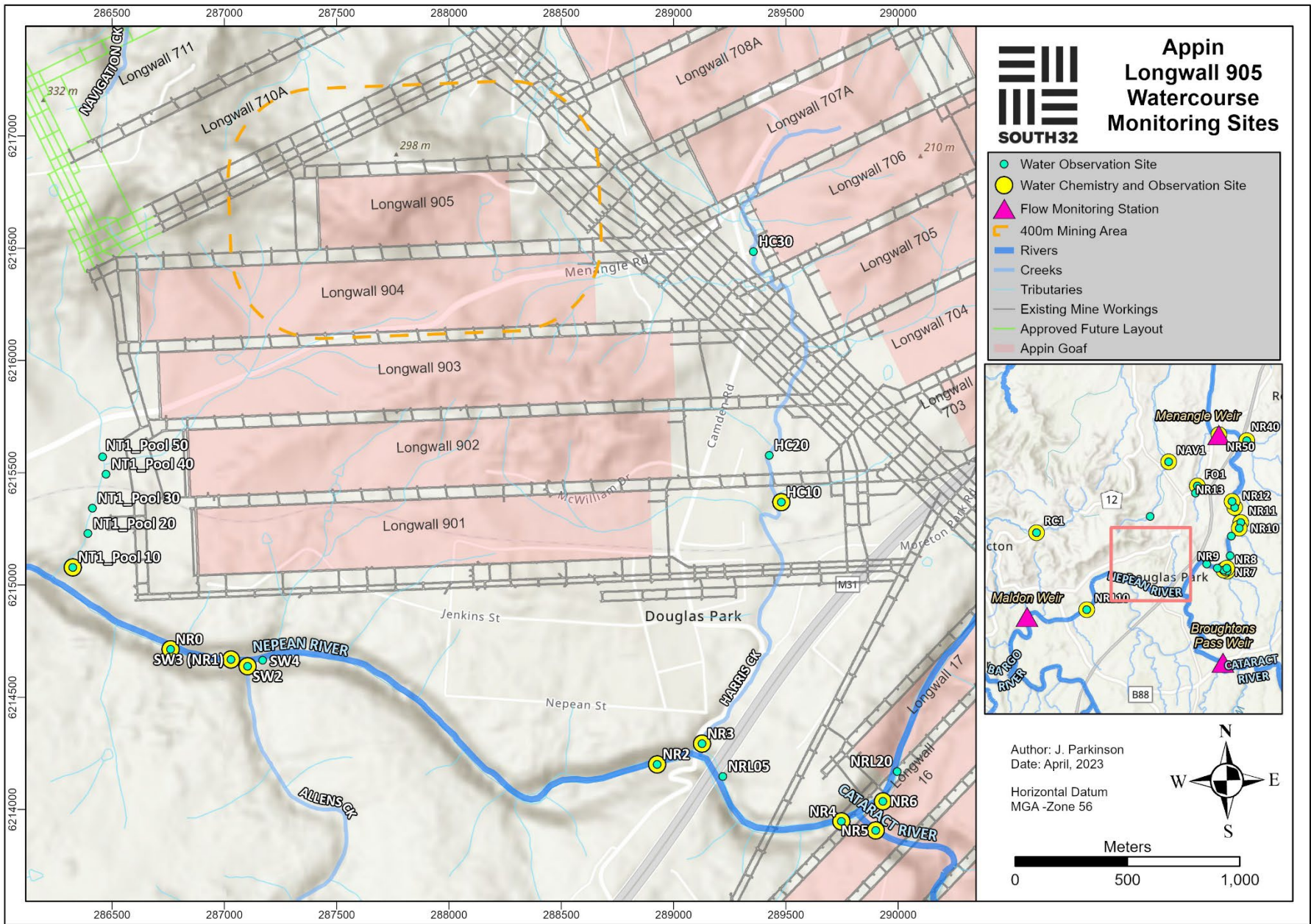


Figure 5-2: Appin Area 7 and 9 surface water monitoring sites.

6. Longwall 905 Monitoring Program

Table 6-1: Summary of the Longwall 905 monitoring program and future monitoring.

MONITORING SITE	MONITORING TYPE	MONITORING FREQUENCY	PARAMETERS	FUTURE MONITORING (LONGWALL 709)
SURFACE WATER				
<p>Foot Onslow Creek FO1 (Lab, Field, Level, Obs) FO2 (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) NR50 (Lab, Field, Obs) NT1_POOL10 (Lab, Field, Level, 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 longer required as 2-year post mining period has lapsed:</p> <p>NT1_POOL10 NT1_POOL20 NT1_POOL30 NT1_POOL40 NT1_POOL50</p>

MONITORING SITE	MONITORING TYPE	MONITORING FREQUENCY	PARAMETERS	FUTURE MONITORING (LONGWALL 709)
<p>NT1_POOL20 (Field, Level, Obs) NT1_POOL30 (Field, Level, Obs) NT1_POOL40 (Field, Level, Obs) NT1_POOL50 (Field, Level, 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>				
<p>Flow monitoring</p> <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. 	<p>No Changes</p>

MONITORING SITE	MONITORING TYPE	MONITORING FREQUENCY	PARAMETERS	FUTURE MONITORING (LONGWALL 709)
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 (observation sites) Daily flow (logger sites) 	<ul style="list-style-type: none"> Inspection for potential fracturing for observable loss of surface water flow 	No Changes
GROUNDWATER				
Private Bores GW108990 GW100289 GW072874 GW100673 GW101986 GW105531 GW105534 GW106675 GW111781 GW112381 GW105376 GW105574 GW106574 GW107791 GW108907 GW108990 GW072196 GW110671 <i>(in consultation with bore owner and if accessible and access is granted)</i>	<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 (if observed from borehole): <ul style="list-style-type: none"> CH₄ C₂H₆ Trace Phenols Sulphide Observations: <ul style="list-style-type: none"> Iron or salinity staining (e.g. orange or white staining in water or in the bores) 	No Changes
IMC Boreholes S1913 S1936		<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 		No Changes

MONITORING SITE		MONITORING TYPE	MONITORING FREQUENCY	PARAMETERS	FUTURE MONITORING (LONGWALL 709)
S1941 S1954 S2157 S2315 S2536 S2536A S2537 S2538 S2632			<ul style="list-style-type: none"> At least one appropriately purged sample pre-mining and post mining, where access permits, tested for the analytes in the previous column 		
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
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 due to mining) 	No Changes

MONITORING SITE	MONITORING TYPE	MONITORING FREQUENCY	PARAMETERS	FUTURE MONITORING (LONGWALL 709)
ABORIGINAL ARCHAEOLOGY				
No sites requiring monitoring				
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 	<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 709)
			<ul style="list-style-type: none"> - 3 monthly for ground survey during active subsidence - Installation of piezometers and inclinometers as required and in consultation with landowners as part of PSMP process 		

7. Appendix A- Summary of TARPs and Observed Impacts

Table 7-1: Summary table of Longwall 905 TARP levels and observed impacts.

Monitoring	Trigger	Action (If impact is observed)	Impacts Observed
Surface Water Quality*			
Nepean River Control Sites: NR110 (Upstream perturbations) SW2 (Upstream perturbations from Allens Creek) NR5 (Upstream perturbations from Cataract River) NR8 (Upstream perturbations from Elladale Creek) NR10 (Upstream perturbations from Ouesdale Creek) NR40 (Upstream perturbation from Menangle Creek) Impact Sites: NR0 NR4 (assess influence from Harris Creek) NR12 NR13 NR50 Creeks and Tributaries Control Site: RC1 Impact Sites: NAV1 FO1 HC10 NR3	Level 1* Impact monitoring sites when comparing the baseline period to the mining period for that site: <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 BCD, 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* Impact monitoring sites when comparing the baseline period to the mining period for that site: <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"> No such impacts observed
	Level 3*	<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 BCD, 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</p> <p>Mining results in more than negligible gas releases, iron staining or water cloudiness on Nepean River.</p> <p>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</p> <p>Maldon Weir Broughtons Pass Weir Menangle Weir</p> <p>Creeks and Tributaries</p> <p>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 BCD, 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 BCD, 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 Mining results in more than negligible diversion of flows or changes in the natural drainage behaviour of pools in the Nepean River	Actions stated for Level 3 <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
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 BCD, 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 	Actions as stated for Level 1 <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 	Actions stated for Level 2 <ul style="list-style-type: none"> Notify BCD, 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 	Actions stated for Level 3 <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 	
Groundwater			
Groundwater inflows to the mine Private Bores GW072196 GW072874 GW100289 GW100673 GW101986 GW104661 GW105376	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 BCD, 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) 	Actions as stated for Level 1 <ul style="list-style-type: none"> Review monitoring frequency Notify relevant technical specialists and seek advice on any CMA required 	<ul style="list-style-type: none"> No such impacts observed

<p>GW105388 GW105531 GW105534 GW105574 GW106574 (grouted) GW106675 GW108907 GW112381 GW112441 (grouted)</p>	<ul style="list-style-type: none"> >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"> 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>IMC Boreholes S1913 S1941 S1954 S2157 S2315 S2536 S2536A S2537 S2538 S2632</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 	<ul style="list-style-type: none"> Actions as stated for Level 2 Notify BCD, 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

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 	<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

	<ul style="list-style-type: none"> • Crack or fracture up to 10 m length <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 • 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"> • <i>Actions as stated for Level 1</i> • Report trigger to key stakeholders • Review monitoring frequency • 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 <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>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 	<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

	<p>impact more than 0.5% of the total face area of such cliffs within any longwall mining domain</p> <ul style="list-style-type: none"> 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) 		
Aquatic Ecology			
<p>Impact Sites: 5, 6, X3 and X4</p> <p>Control Sites: 1, 2, 7, 8, X5, X6, X7 and X8</p>	<p>Level 1*</p> <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
	<p>Level 2*</p> <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
	<p>Level 3*</p> <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 	<ul style="list-style-type: none"> No such impacts observed

		<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>		
	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 	<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 	<ul style="list-style-type: none"> • No such impacts observed

	Reduction in aquatic habitat resulting from the mining for >2 consecutive seasons or complete loss of habitat	<ul style="list-style-type: none"> 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>	
	<p>Exceeding Prediction</p> <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

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- Lawrence Consulting (2016), *NSW Mining Industry Expenditure Impact Survey 2015/16*, Prepared for NSW Minerals Council November 2016.
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