



Illawarra Metallurgical Coal
End of Panel Report



**APPIN AREA 9
LONGWALL 904
END OF PANEL REPORT**

December 2022



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Attachments

- Attachment A1: Appin Area 9 (Longwalls 901 to 904) Extraction Plan Approval
- Attachment A2: Appin Area 9 (Longwalls 901 to 904) Built Features Management Plan Approval
- Attachment B: Appin Area 9 Longwall 904 Subsidence Monitoring Review
- Attachment C1: Appin Area 9 Longwall 904 End of Panel Landscape Report
- Attachment C2: Appin Area 9 Longwall 904 Impact Report
- Attachment C3: Appin Area 9 Longwall 904 Private Property Reports
- Attachment D: Area 9 Longwall 904 End of Panel Surface Water and Groundwater Monitoring Review
- Attachment E: Appin Area 9 Longwall 904 End of Panel Report - Aquatic Flora and Fauna Review

Abbreviations

AA7	Appin Area 7
AA9	Appin Area 9
ALS	Airborne Laser Scan
ARTC	Australian Rail and Track Corporation
BFMP	Built Feature Management Plans
BSO	Bulli Seam Operations
DP&E	Department of Planning and Environment
DPIE	Department of Planning, Industry and Environment
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 Area 9 (AA9) Longwalls 901 to 904 Extraction Plan (EP) on 10 September 2014. IMC subsequently changed the extents of a number of these longwalls via an extraction plan variation approval to optimize longwall extraction continuity. Extraction of Longwall 904, which is the fourth longwall in the series, commenced on 20 May 2021 and was completed on 9 August 2022. IMC sought an overall reduction in the length of Longwall 904, with the final longwall length being 2038 m. This was approved by DPIE on 18 December 2020.

The AA9 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 of Late Permian age (Figure 1-1). The Illawarra Coal Measures contain several seams, the uppermost of which is the Bulli Seam.

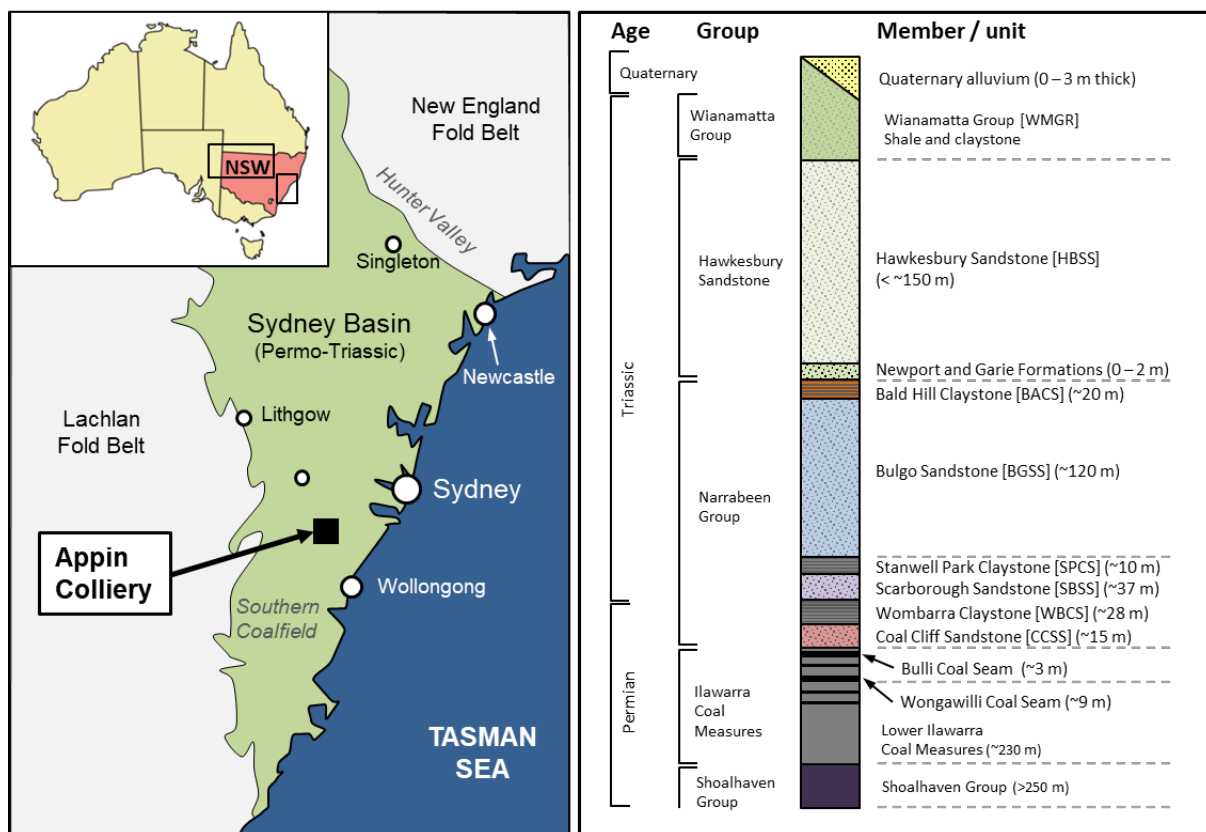


Figure 1-1: Stratigraphy and location of the Southern Coalfields within the Sydney Basin (Source: HGEO 2022).

The depth of cover to the Bulli Seam directly above Longwall 904 varies between a minimum of 535 m above the tailgate towards the commencing (i.e. western) end of the longwall, and a maximum of 630 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 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 904 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 904 flow into Harris Creek which is more than 600 m east of the finishing end of the longwall. Razorback Range is located on the northern side of Longwall 904. The thickness of the Bulli Seam varies between 2.7 m and 3.0 m within the extents of Longwall 904. IMC mined the full thickness of the seam.

1.1. Study Area

The AA9 Study Area is defined as the surface area that is likely to be affected by mining of Longwalls 901 to 904 in AA9 (Figure 1-2). The extent of the AA9 Study Area has been calculated by combining the areas bounded by the following limits:

- A 35-degree angle of draw line from the proposed extents of Longwalls 901 to 904; and
- The predicted limit of vertical subsidence, taken as the 20 mm subsidence contour, resulting from the extraction of the proposed Longwalls 901 to 904.

The 35-degree angle of draw line, has been determined by drawing a line that is a horizontal distance varying between 345 m and 510 m around the limits of the proposed extraction areas.

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:

- Watercourses, within the predicted limits of 20 mm upside and 20 mm closure;
- Cliffs;
- The Twin Bridges over the Nepean River;
- Moreton Park Road Bridge (South) and Harris Creek Bridge;
- Groundwater bores; and
- Survey control marks.

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 employees over 1800 employees and contractors, of which 92% live locally. 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 2020-21, we spent more than \$180 million with locally-based suppliers, purchasing from more than 220 local businesses.

Continuing benefits occur through continuity of employment, expendable income, export earnings and government revenue. From the operation of Appin Mine, IMC paid government royalties of:

- \$44 Million in FY20,
- \$32 Million in FY21, and
- \$126 Million in FY22.

Longwall 904 is located within Consolidated Coal Lease 767, which amalgamated a number of long-standing head leases for mining coal in 1991.

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 \(south32.net\)](http://south32.net);
- Bi-monthly Appin Mine Community Consultative Committee meetings for BSOP (meeting minutes available on the South32 website; [Illawarra Coal documents \(south32.net\)](http://south32.net));
- Regular meeting with the Wollondilly Shire;
- Community information sheets and letter box drops;
- Social Pinpoint - [S32Illawarra Community | Social Pinpoint](http://south32.net);
- 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 displayed on local notice board and included in personalised letters and community newsletters.
	Awareness of subsidence and its effects and management.	Illawarra Metallurgical Coal Community Consultative Committee meetings for BSOP. Douglas Park Advisory Panel.
	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.	Development of individual Built Feature Management Plans (BFMPs) in consultation with landowners within the mine subsidence area.
	The extent to which the community attributes environmental, social and economic change occurring within the community to mining activities.	Pre-mining meetings with landholders 6-12 months 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 BFMPs. The BFMPs were prepared in consultation with individual property owners. In relation to Longwall 904, 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 904. For further details, refer to MSEC 2022, which is provided as **Attachment B**.

Predictions of subsidence movements relating to the extraction of Longwall 904 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 904 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;
- Early warning monitoring lines;
- Camden Road monitoring line;
- Menangle Road monitoring line;
- Telstra optical fibre cable monitoring line;
- 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; and
- ALS / LiDAR surveys.

Table 3-1: Comparison summary of predicted and measured subsidence during the extraction of Longwall 904.

Feature	Monitoring Types	Approximate Location/ Distance from Longwall 904	Assessment of Measured Subsidence vs Predictions / Trigger Levels (MSEC 2021)
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.	Maximum measured incremental vertical subsidence of 14 mm is consistent with the maximum predicted value of less than 20 mm. Maximum measured incremental tilt (0.5mm/m) is similar but greater than predicted values, however noted as only localised movements where there is variability in the measured vertical subsidence profile. Maximum compressive strains (0.3 mm/m) and tensile strains (0.4 mm/m) which are similar to the order of survey tolerance. No adverse impacts observed at cuttings. Minor differential movements at culverts typically similar to the order of survey tolerance. Differential vertical and horizontal movements at Douglas Park Station typically similar to the order of survey tolerance.
Telstra OFC	2D and 3D monitoring line	South of the commencing end of Longwall 904.	The vertical subsidence was greater than the predicted values during the mining on Longwall 904; however, the measured subsidence later reduced, and the final measured values are similar to the predicted values. While the maximum measured values are greater than the predicted values in some locations, the exceedances are within the order of accuracy of the prediction method of ± 50 mm
Menangle Road	2D and 3D monitoring line	Crosses above the western end of Longwall 903 and above the eastern end of Longwall 904.	Maximum measured incremental vertical subsidence (649 mm) is approximately half of the maximum predicted value (1250 mm). Maximum measured tilt (4.1mm/m) is similar to but less than the predicted maximum value (4.2mm/m). 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. Maximum measured compressive strain is greater than the maximum predicted value based on conventional ground movements however, these movements are anomalous and likely due to valley related effects.
Camden Road	2D and 3D monitoring line	Minimum distance of 640 m from Longwall 904 finishing end.	Measured incremental vertical subsidence within the order of survey tolerance for absolute level (less than 15 mm).
Nepean River	2D closure monitoring lines	Located 1.1 km south-west of Longwall 904 at its closest point.	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
Harris Creek Cliff Line	2D closure monitoring lines	Located 1.6 km south of the finishing end of Longwall 904 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 904 (41 mm) was less than the maximum predicted value (50 mm).
Blades Bridge	Two fixed prisms	Located 1.6 km south of the finishing end of Longwall 904 at its closest point.	The measured incremental closure due to the mining of Longwall 904 is only -2 mm (opening). Final incremental closure is in the order of survey tolerance and, therefore, is not measurable.

Feature	Monitoring Types	Approximate Location/ Distance from Longwall 904	Assessment of Measured Subsidence vs Predictions / Trigger Levels (MSEC 2021)
Far-Field Monitoring points	Absolute 3D monitoring points	Various locations in AA9.	Maximum measured incremental horizontal movement is on the side of Razorback Range (150 mm). Measured incremental horizontal movements are generally within range of movements that have been measured elsewhere in the Southern Coalfields. Higher movements greater than the survey tolerance were measured and were influenced by the concurrent mining in Appin Area 7.
Nepean Twin Bridges	Absolute 3D points Relative 3D points Inclinometer Bridge joint monitoring Visual monitoring	2 km south of the finishing end of Longwall 904.	The maximum measured absolute horizontal movement (94 mm) at Marks DPBN and DPBS was less than the Level 1 Trigger (100 mm) at the completion of Longwall 904.
Moreton Park Road (South)	Absolute 3D points Relative 3D points Visual monitoring	1.5 km south-east from the finishing end of Longwall 904.	The maximum measured absolute horizontal movement (129 mm) at Marks MPBE and MPBW was less than the Level 1 Trigger (150 mm) at the completion of Longwall 904. 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 904.

4. Impacts to Built Features

MSEC provided an assessment of potential built features impacts from the extraction of Longwall 904 (MSEC448, MSEC829, MSEC1176 and MSEC1285), which supported the EP and Modification 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 904 (Source: MSEC 2022).

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 heaving of road surface observed to gradually develop near marks MR9033, MR9049, MR9054, MR9064 to MR9065 and MR9069 to MR9070. A bump and minor cracking of the road pavement developed within the cutting between Marks MR9085 and MR9086. Minor deterioration of road pavement between Marks MR9090 and MR9097.
Camden Road	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.
Business establishments	Adverse impacts unlikely.	No reported impacts.
Rural structures	Minor impacts on rural structures located directly above longwalls.	IMC reported very slight to slight wall and floor cracking of two garages (Property Refs. N14 and N16)
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. H14) including cracking of pool shell and pool surrounds, and leaking of water
Farm dams	Incidence of impact (cracking and leakage) expected to be extremely low.	No reported impacts.
Groundwater bores	Impacts likely including lowering of piezometric surface, blockage and change in groundwater quality.	No reported impacts
Aboriginal heritage sites	Adverse impacts unlikely.	No Aboriginal heritage sites located within the Study Area for Longwall 904.
Other Heritage sites	Adverse impacts unlikely.	No reported impacts.

Built Feature	MSEC-assessed Impacts	Observed 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 cracking (Category R1 and R2) for three houses (Property Refs. N11, N14 and N15)

4.1. Private Properties

Built Feature Management Plans have been prepared by IMC for landholders above AA9. 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 904 were undertaken at properties Lot 1 DP810978, Lot 9 DP810978, Lot 3 DP1133989, Lot 22 DP803255. Lot 15 DP803255 was also reinspected following a recommendation in the Longwall 903 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 904 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 2022).

Potential Impact	Description	Impact Prediction	Observed Impact
Reduced groundwater yield	Six NSW Office of Water (NoW) registered bores within or near the proposed Longwalls 901 to 904 may be affected by subsidence, where the bores predominantly obtain water from the Hawkesbury Sandstone, rather than the overlying Wianamatta Group shale and sandstones. Groundwater levels in the Hawkesbury Sandstone are predicted to reduce by up to 10 m.	Impacts to water level likely (GeoTerra, 2011).	No impacts observed.
Groundwater quality impacts	It is likely that some [minor and localised] water quality changes will occur but there is a relatively low level of groundwater resource use in the area. Monitoring of potentially affected bores within AA9 is conducted in consultation with the owners.	Impacts to groundwater quality likely (GeoTerra, 2011).	No impacts observed.
Impacts to streams and farm dams	Many farm dams have been mined under and monitored, with only a small number of dams exhibiting impacts (becoming dry) following mining. It is predicted that the impact on farm dams from mining Longwalls 901 to 904 will be similar.	Impact: Minor Likelihood: Likely (Ecoengineers, 2012)	No impacts observed.

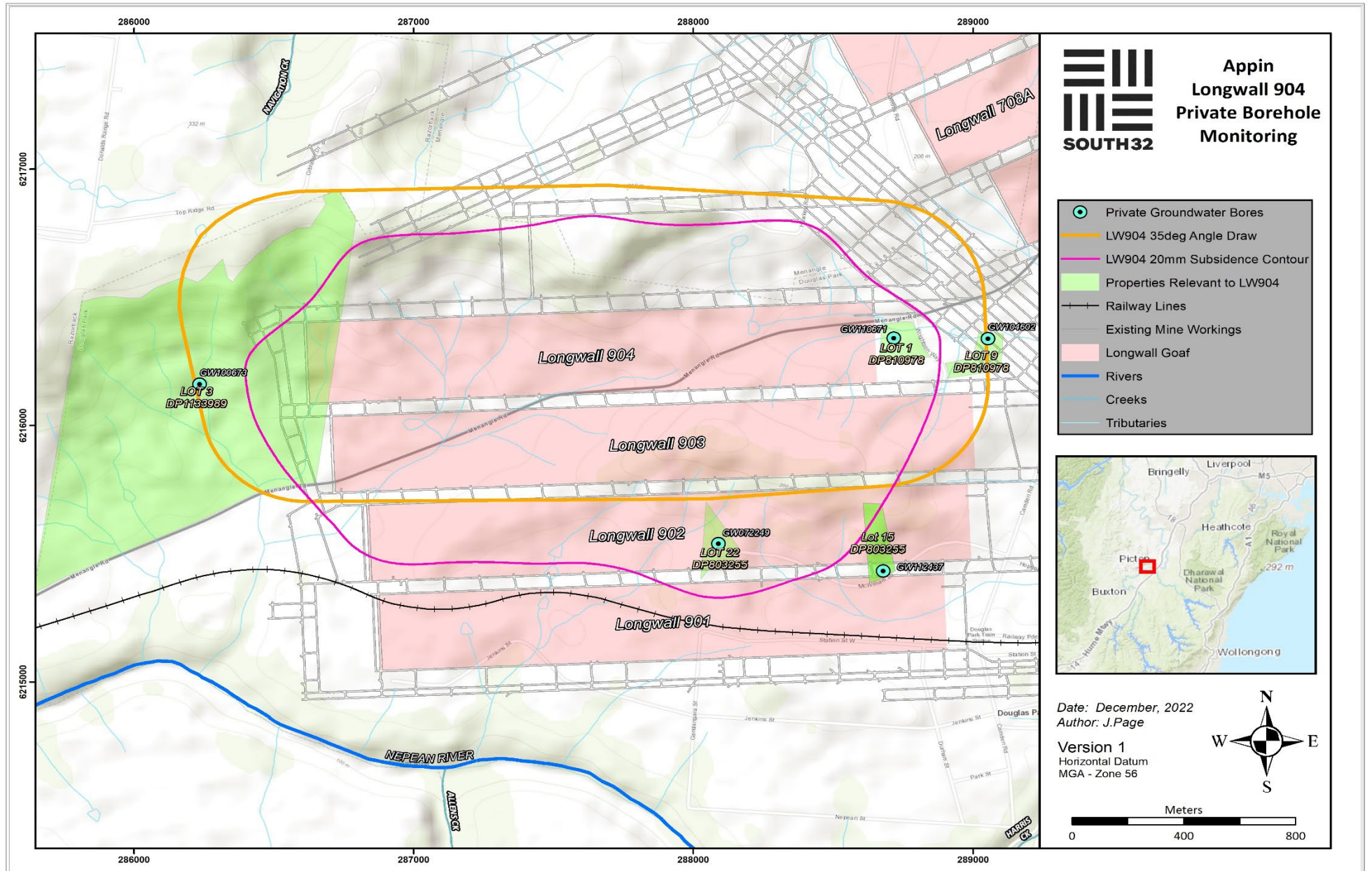
Potential Impact	Description	Impact Prediction	Observed Impact
Gas emissions	There is potential for strata gas emissions into private bores. Any bores with gas releases are decommissioned during the mining period.	Impact: Negligible Likelihood: Likely (GeoTerra, 2011)	No impacts observed.

4.2. Cultural Heritage

No Registered Aboriginal Archaeological Sites are located within the Study Area. There is one Shelter with Art which has been identified just outside the Study Area, as shown in MSEC (2012) Drawing No. MSEC448-33. 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.



This map does not include the Longwall 905 Goaf for the purpose of this being a Longwall 904 EoP Report

Figure 4-1: Private properties with boreholes relevant to Longwall 904.

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). The Longwall 904 reporting period was characterised by widely variable water quality in the Nepean River. In general water quality has improved during Longwalls 903 and 904 due to high rainfall and runoff since 2020. High total iron and manganese is noted at several locations, including TARP locations SW3 and NR2, representing level 2 TARP triggers. A summary of these triggers is presented in Appendix A, with details included in the Longwall 904 Surface Water and Groundwater Assessment. A comparison between potential and observed impacts for Longwall 904 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 2022).

Potential Impact	Description	Impact Prediction	Observations	TARP Level
Gas emissions in the Nepean River and other areas	Based on observations at Appin Area 7 (AA7) it is likely that “minor” gas emissions will appear in the Nepean River as a consequence of mining Longwalls 901 to 904. Potential effects may include Dissolved Oxygen “sags”, and visible iron precipitates (localised iron staining).	Minor gas releases in the Nepean River are likely to occur (Ecoengineers, 2012).	During the monitoring period for Longwall 904, 15 gas release zones were found to be active along the river. Of those 15 active zones, 14 were previously reported. One new gas release zone was noted in the Cataract River (AA9_LW904_001)	Each gas release zone constitutes a Level 1 TARP.
Groundwater outflows and ferruginous springs	The appearance of ferruginous springs due to mining has been noted in some Bulli Seam mining areas especially along margins of outcropping Wianamatta Shale. Ferruginous springs have not been detected in relation to mining of Longwalls 701 and 702, either in the Nepean River gorge or along adjacent tributaries.	The likelihood of ferruginous springs in the Nepean River gorge is low (Ecoengineers, 2012).	None identified	Not triggered.
Sub-bed flow diversions and un-natural pool drainage	Section 1 of the Nepean River is characterised by boulder fields, which are less susceptible to fracturing than rockbars. Two rockbars have been identified in the AA9 Study Area: Rockbar NR-A9-RB01 is located 370 m from the nearest longwall. Rockbar NR-A9RB02 is submerged at times of high flow, and therefore does not restrict the surface water at these times.	The likelihood of impacts to the rockbars is low (Ecoengineers, 2012). Impacts to the Nepean River Tributary are likely.	Decline in water level noted at NR0 however a similar decline also experienced at upstream reference site NR110. Access to NR0 is restricted during high flow events and consequently results may appear skewed. Other sites had water levels within baseline range. Gauging at Maldon weir, Menangle weir, and the Cataract River at Broughtons Pass, show zero no-flow days recorded during the extraction of Longwall 904.	No relevant TARP.

5.2. Groundwater Assessment

Groundwater levels and quality are monitored at seven IMC monitoring bores within and surrounding AA9. Groundwater inflow to the mine is also monitored. Minor changes to groundwater quality are noted in some private groundwater bores. In most cases those changes reflect normal variation between sampling events and do not represent a change in beneficial use category. A comparison between potential and observed impacts for Longwall 904 is provided below (Table 5-2). Details are included in the Longwall 904 Surface Water and Groundwater Assessment (**Attachment D**).

Table 5-2: Summary table of potential and observed impacts to groundwater (Source: HGEO 2022).

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 Hawksebury Sandstone and Wianamatta Group.	5 – 10 m water level reduction predicted in the Wianamatta Group. Up to 10 m water level reduction predicted in the Hawkesbury Sandstone (GeoTerra 2011).	None identified.	Not triggered.
Changes to Groundwater chemistry	Changes to groundwater chemistry within the Wianamatta Group, Hawkesbury Sandstone and Bulgo Sandstone.	It is likely that some changes to groundwater chemistry will occur, although the impact will most likely be negligible (GeoTerra 2011).	No significant change in groundwater chemistry is noted for Longwall 904.	Not triggered.
Groundwater Inflows to the Mine	The horizontal permeability of the Hawkesbury Sandstone and Bulgo Sandstone may be enhanced after subsidence.	The potential for inflow of surface water to mine workings is low. No free draining direct vertical hydraulic connection to the Bulli Seam workings is anticipated.	Groundwater inflows (twenty-day moving average) to the mine fluctuated between 0 and ~1.2 ML/day during the extraction of Longwall 904; well below the Level 1 TARP (2.7 ML/day).	Not triggered.

5.3. Aquatic Ecology Assessment

Cardno NSW/ACT (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 ecology assessment (Cardno Ecology Lab 2012) and Extraction Plan for Longwalls 901 to 904 (BHPBIC 2013).

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 potential impact sites (X3 and X4) near Longwalls 901 to 904, and at control sites (X5 to X8) upstream and downstream of AA9 on the Nepean River. Data from Sites 1 and 2, collected in November 2020, 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 904, were detected.

The gas releases, changes in water quality and water levels identified in the Nepean River during extraction of Longwall 904, do not appear to have had any measurable effect on macroinvertebrates, fish and macrophytes in the Nepean River (Cardno 2022).

Further monitoring will be undertaken at all AA9 potential impact and control sites in November/December 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 904 (Cardno 2022). The Appin Longwall 904 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 Biosis (2012), which were largely consistent with those outlined within the BSO Environmental Assessment (EA). Generally, the risks are lower in the Longwall 901 to 904 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. Subsidence effects are most likely to result in impacts to natural features through loss of surface water flows and the impacts to groundwater dependant ecological features (PAC 2010).

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 904 has resulted in negligible impacts to terrestrial ecology within the AA9 Study Area.

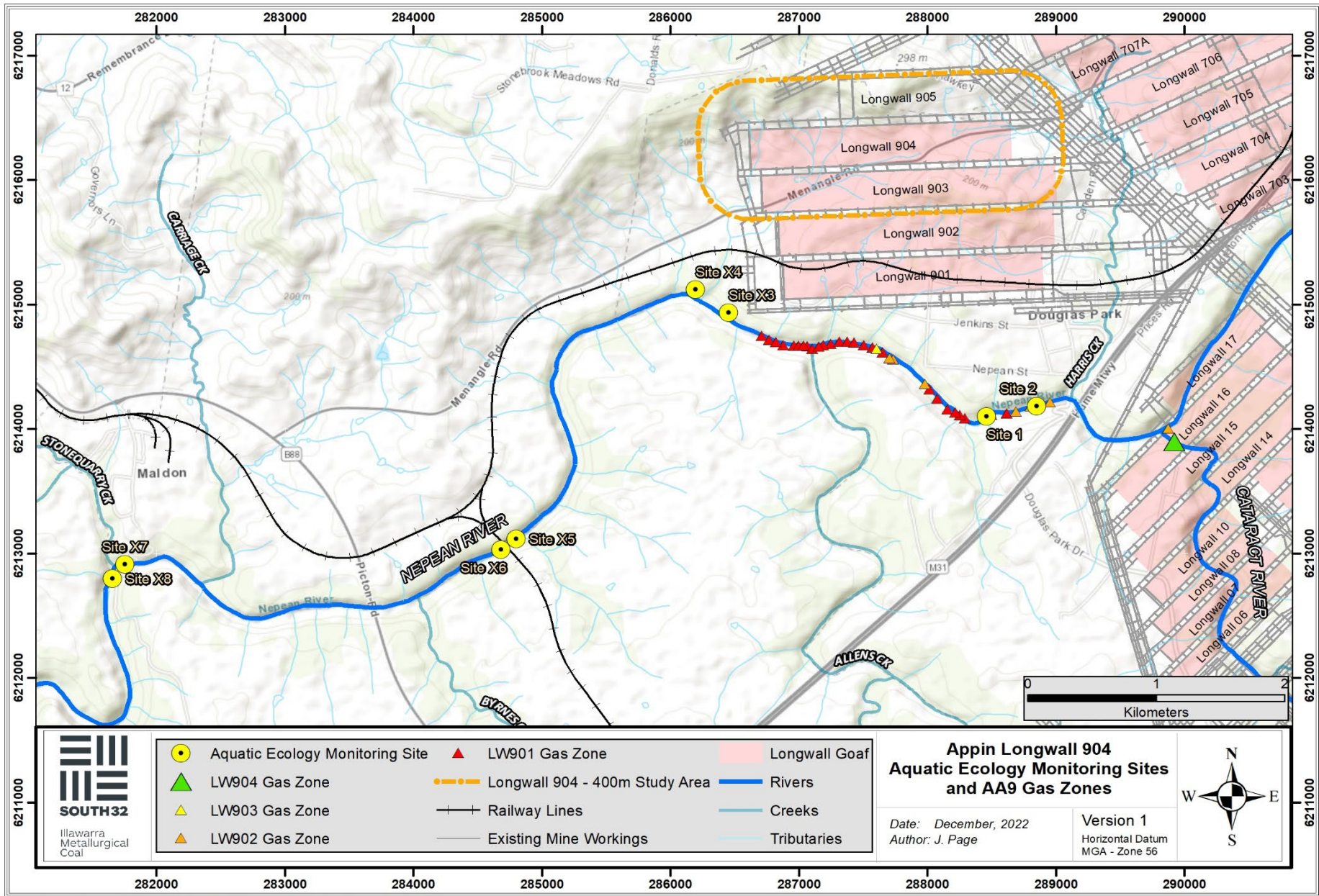
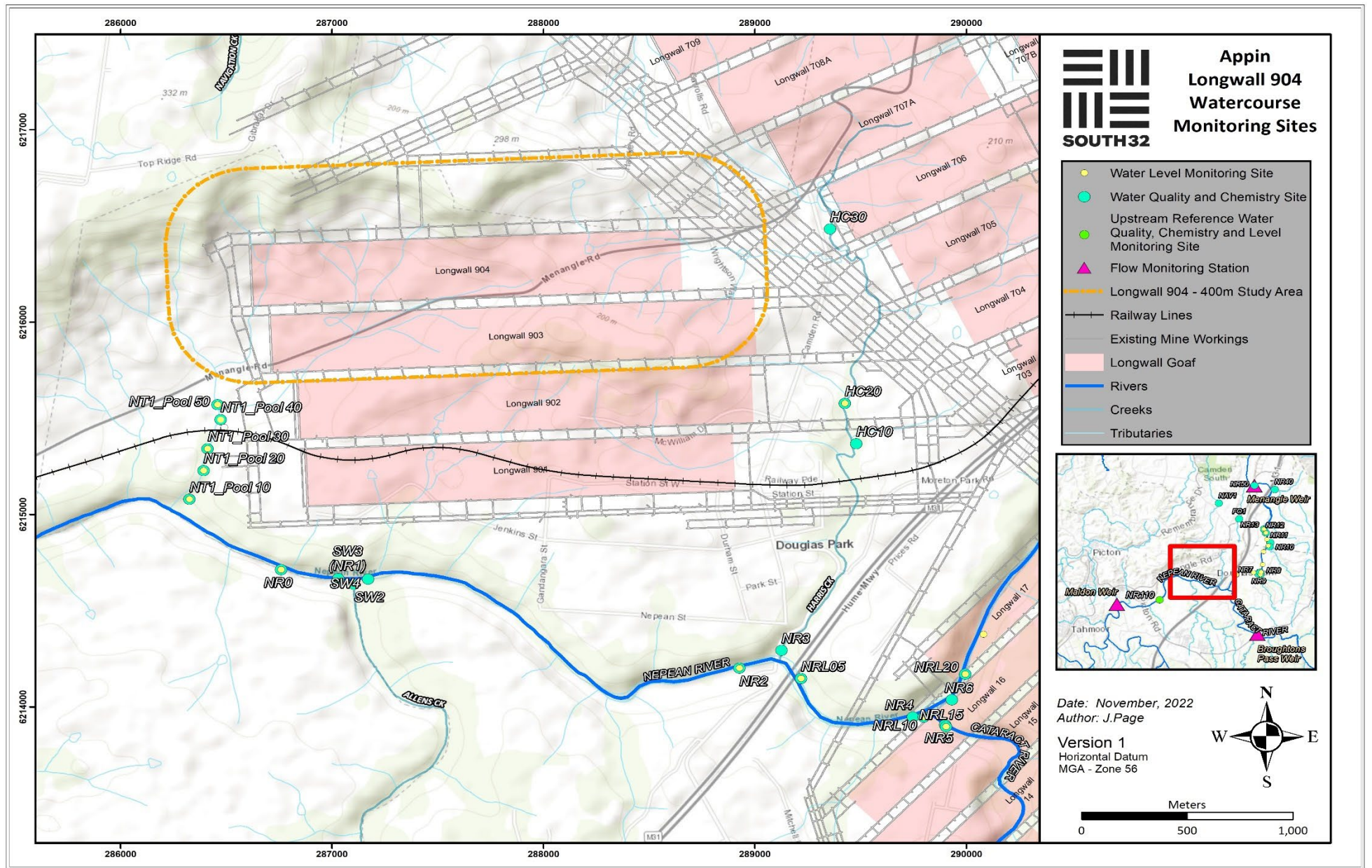


Figure 5-1: Map showing aquatic ecology monitoring sites and subsidence impacts and triggers relevant to Longwall 904.



Longwall 905 not displayed as this is a Longwall 904 Report

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

6. Longwall 904 Monitoring Program

Table 6-1: Summary of the Longwall 904 monitoring program and future monitoring.

MONITORING SITE	MONITORING TYPE	MONITORING FREQUENCY	PARAMETERS	FUTURE MONITORING (LONGWALL 709 TO 711 AND 905)
SURFACE WATER				
<p>Nepean River and tributaries</p> <ul style="list-style-type: none"> • NR110 (Lab, Field, Level, Obs) • NR0 (Lab, Field, Level, Obs) • SW2 (Lab, Field, Obs) • SW3 (NR1) (Field, Obs) • SW4 (Field, Obs) • NR2 (Lab, Field, Obs) • NR3 (Lab, Field, Obs) • NT1_Pool 10 (Lab, Field, Level, Obs) • NT1_Pool 20 (Field, Level, Obs) • NT1_Pool 30 (Field, Level, Obs) • NT1_Pool 40 (Field, Level, Obs) • NT1_Pool 50 (Field, Level, Obs) <p>If and where strata gas emission plumes above 3000 L/min are detected (Lab, Field, Obs)</p>	<ul style="list-style-type: none"> • Laboratory analysis (Lab) • Field parameters (Field) • Water levels (Level) (where a suitable stricture 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 	<p>Field Parameters:</p> <ul style="list-style-type: none"> • Temperature • Dissolved Oxygen (DO) • Specific Conductivity • pH • ORP <p>Standard Lab Sample:</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 	<p>Foot Onslow Creek</p> <ul style="list-style-type: none"> • FO1 (Lab, Field, Level, Obs) • FO2 (Obs) <p>Harris Creek</p> <ul style="list-style-type: none"> • HC10 (Lab, Field, Obs) • HC20 (Level, Obs) • HC30 (Obs) <p>Navigation Creek</p> <ul style="list-style-type: none"> • NAV1 (Lab, Field, Level, Obs) • NAV2 (Obs) <p>Nepean River</p> <ul style="list-style-type: none"> • 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, Obs) • NR9 (Lab, Field, Level, Obs) • NR10 (Lab, Field, Obs) • NR11 (Lab, Field, Obs) • NR12 (Lab, Field, Obs)

MONITORING SITE	MONITORING TYPE	MONITORING FREQUENCY	PARAMETERS	FUTURE MONITORING (LONGWALL 709 TO 711 AND 905)
			<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • NR13 (Lab, Field, Obs) • NR40 (Lab, Field, Obs) • NR50 (Lab, Field, Obs) Nepean Tributary 1 • NT1_POOL10 (Lab, Field, Level, Obs) • NT1_POOL20 (Field, Level, Obs) • NT1_POOL30 (Field, Level, Obs) • NT1_POOL40 (Field, Level, Obs) • NT1_POOL50 (Field, Level, Obs) Remembrance Drive • RC1 (Lab, Field, Level, Obs) – Reference Site

MONITORING SITE	MONITORING TYPE	MONITORING FREQUENCY	PARAMETERS	FUTURE MONITORING (LONGWALL 709 TO 711 AND 905)
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 	Analysis: <ul style="list-style-type: none"> • 51 baseline dry weather recession periods for Menangle minus Maldon minus Broughtons Pass Weirs with recession curve slope ranging from 0.76 to 0.99 • Recession curves calculated during and post mining • These recessions will be compared from the period of mining to the pre-mining period • Monitoring undertaken by WaterNSW. Observational data to be compared with flow records at weir sites. 	<ul style="list-style-type: none"> • Maldon Weir • Broughtons Pass Weir • Menangle Weir • Foot Onslow Creek (to be established) • Navigation Creek (to be established)
GROUNDWATER				
Private Bores <ul style="list-style-type: none"> • GW34425 • GW35033 • GW72249 • GW100673 • GW101133 • GW102043 • GW102584 • GW102798 • GW103161 • GW104068 • GW104602 • GW104661 • GW110671 • GW12437 <p><i>(in consultation with bore owner and if accessible and access is granted)</i></p>	<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"> • Temperature • Dissolved Oxygen (DO) • Specific Conductivity • pH • ORP Standard Lab Sample: <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 	Private Bores <ul style="list-style-type: none"> • GW108990 • GW100289 • GW072874 • GW100673 • GW101986 • GW105531 • GW105534 • GW106675 • GW111781 • GW112381 • GW105376 • GW105574 • GW106574 • GW107791 • GW108907 • GW108990 • GW072196 • GW110671

MONITORING SITE		MONITORING TYPE	MONITORING FREQUENCY	PARAMETERS	FUTURE MONITORING (LONGWALL 709 TO 711 AND 905)
				<ul style="list-style-type: none"> Trace Phenols Sulphide 	<i>(in consultation with bore owner; if accessible and access is granted)</i>
IMC Piezometers: <ul style="list-style-type: none"> Potentiometric head; <ul style="list-style-type: none"> EAW9 (S1941) EAW18 (S1954) EAW5 (S1913) EAW7 (S1936) EAW58 (S2080) Piezometers and water samples between Longwall 901 and the Nepean River <ul style="list-style-type: none"> S2280 (Harris Ck 7) S2281 (Harris Ck 6) 	<ul style="list-style-type: none"> Lab sample Field parameters Water levels Observations 	<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 	Observations: <ul style="list-style-type: none"> Iron or salinity staining (e.g. orange or white staining in water or in the bores) 	IMC Piezometers <ul style="list-style-type: none"> S1913 S1936 S1941 S1954 S2157 S2315 S2536 S2536A S2537 S2538 S2632 	
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 (analyzed as a moving average i.e. 20 day average)	No Changes	
AQUATIC ECOLOGY					
Nepean River <ul style="list-style-type: none"> Sites 1 and 2 (downstream) Sites X3 and X4 (adjacent to Longwalls 901 and 902) Sites X5 and X6 (upstream) Sites X7 and X8 (upstream) 	<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 	Impact Sites <ul style="list-style-type: none"> Sites 5, 6, X3 and X4 Control Sites <ul style="list-style-type: none"> Sites 1, 2, 7, 8, X5, X6, X7 and X8 	
TERRESTRIAL ECOLOGY					

MONITORING SITE	MONITORING TYPE	MONITORING FREQUENCY	PARAMETERS	FUTURE MONITORING (LONGWALL 709 TO 711 AND 905)
<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				
<ul style="list-style-type: none"> Impacts to the cliff lines on the southern side of the Nepean River will trigger an inspection of Bradcorp 1 and any adjacent sections of the river and creek valleys that have not been inspected 	<ul style="list-style-type: none"> Observational and photographic monitoring 	<ul style="list-style-type: none"> In accordance with Landscape TARP 	<ul style="list-style-type: none"> Subsidence Impacts to cliff lines on the southern side of the Nepean River (e.g. directly north of Bradcorp 1) 	<ul style="list-style-type: none"> No sites requiring monitoring
EUROPEAN HERITAGE				
<ul style="list-style-type: none"> Douglas Park Railway Cottage Item 30 	<ul style="list-style-type: none"> Observational monitoring 	<ul style="list-style-type: none"> Baseline archival recording prior to commencement of mining Impact assessment recording following the identification of impacts or when a SA NSW claim is lodged Final assessment recording following the completion of mining of Longwalls 901 and 902 and/or after any repairs 	<ul style="list-style-type: none"> With the consent of the owner, the subsidence monitoring program will include: Pre-mining inspection and assessment (as part of PSMP) Observational monitoring to identify potential subsidence impacts to the fabric of the building and/or its interior (if required) Assessment of heritage impacts by a suitably qualified heritage expert (if required) 	<ul style="list-style-type: none"> 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

MONITORING SITE	MONITORING TYPE	MONITORING FREQUENCY	PARAMETERS	FUTURE MONITORING (LONGWALL 709 TO 711 AND 905)
			<ul style="list-style-type: none"> This assessment would be made available to the SA NSW and include recommendations for management of heritage value during any repairs 	
LANDSCAPE FEATURES				
<ul style="list-style-type: none"> Nepean River cliff lines Harris Creek cliff lines Sensitive terrain near built features (Razorback Range, Douglas Park Ridge) <p>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 	<ul style="list-style-type: none"> Harris Creek and Nepean River cliff lines <ul style="list-style-type: none"> Baseline recording once prior to mining. Monthly routine inspections with weekly inspections during critical periods Low Terrain Sensitivity (visual inspection) <ul style="list-style-type: none"> 6 months prior to mining 6 months after active subsidence Medium Terrain Sensitivity <ul style="list-style-type: none"> 6 to 12 months prior to mining 3 monthly during active subsidence 6 months after active subsidence High Terrain Sensitivity <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 Installation of piezometers and inclinometers as required and in consultation with landowners as part of PSMP process 	<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

7. Appendix A

Table 7-1: Summary table of Longwall 904 TARP levels and observed impacts.

Monitoring	Trigger	Action (if impact is observed)	Impacts Observed
WATER QUALITY			
Adjacent and downstream sites: <ul style="list-style-type: none"> • Nepean River: <ul style="list-style-type: none"> – NR0 – SW3 (NR1) – NR2 – If and where strata gas emission plumes above 3000 L/min are detected 	Level 1* Impact monitoring sites when comparing the baseline period to the mining period for that site: <ul style="list-style-type: none"> • pH reduction greater than 1 standard deviation but less than 2 standard deviation from pre-mining mean resulting from the mining for two consecutive months • DO reduction greater than 1 standard deviation but less than 2 standard deviation from pre-mining mean resulting from the mining for two consecutive months • Identification of strata gas plume of flow rate < 3000 L/min 	<ul style="list-style-type: none"> • Continue monitoring program • Submit an Impact Report to OEH, DoPI, DPI and other relevant resource managers • Report in the End of Panel Report • Summarise actions and monitoring in AEMR 	<ul style="list-style-type: none"> • 1 new gas release zone identified on the Cataract River, consistent with Level 1 criteria, named 'AA9_LW904_001'. • Level 1 TARP for pH at SW3. The slightly lower pH corresponds to generally improved water quality as a result of increased runoff; therefore, not attributed to mining activities.
	Level 2* Impact monitoring sites when comparing the baseline period to the mining period for that site: <ul style="list-style-type: none"> • pH reduction greater than 2 standard deviation from pre-mining mean resulting from the mining for two consecutive months • DO reduction greater than 2 standard deviation from pre-mining mean resulting from the mining for two consecutive months • EC, total Fe and total Mn increases greater than 2 standard deviation from pre-mining mean resulting from the mining for two consecutive months • Identification of strata gas plume of flow rate >3000 L/min 	<ul style="list-style-type: none"> • Actions 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 TARPs for Total Iron at NR2 and SW3 and upstream control site (NR110); therefore, not attributed to mining activities. <p><i>Level 2 TARP for Total Manganese at NR2 which is associated with elevated total iron which was identified at upstream control site (NR110); therefore, not attributed to mining activities. Likely as a result of high runoff and mobilisation of clays, silts and associated sorbed metals.</i></p>
	Level 3* Impact monitoring sites when comparing the baseline period to the mining period for that site: <ul style="list-style-type: none"> • Level 2-type reduction in water quality resulting from the mining observed for more than 6 consecutive months 	<ul style="list-style-type: none"> • Actions stated for Level 2 • Notify OEH, DP&I, NoW, DPI, DRE, 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

Monitoring	Trigger	Action (if impact is observed)	Impacts Observed
	<p>Exceeding Performance Measures</p> <ul style="list-style-type: none"> Mining results in more than negligible gas releases, iron staining or water cloudiness 	<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> <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
GROUNDWATER			
<p>Groundwater flow into the mine</p> <p>Groundwater Level:</p> <p>GW 34425 GW 35033 GW 72249 GW 100673 GW 101133 GW 102043 GW 102584 GW 102798 GW 103161 GW 104068 GW 104602 GW 104661 GW 110671</p> <p>BHPBIC Piezometers:</p> <p>NGW3 NGW4 NGW5 NGW6 EAW5 EAW7 EAW9 EAW18 EAW58</p> <p>Notes:</p> <p><i>Impact monitoring data during longwall mining is compared to predicted groundwater levels from the BSOP (or later updates) groundwater model, during preparation of the End of Panel Report</i></p> <p><i>Privately owned water supplies are monitored as agreed with landowners</i></p>	<p>Level 1*</p> <ul style="list-style-type: none"> Increase in water flow from the goaf between 2.7 to 3 ML/day (over 20-day average) 5.0 – 7.5 m reduction in the Hawkesbury Sandstone greater than predicted standing water level or pressure (outside of pumping influences in private bores) over a minimum 2-month period <p>Level 2*</p> <ul style="list-style-type: none"> Increase in water flow from the goaf between 3 to 3.4 ML (over 20-day average) 7.5 – 10 m reduction in the Hawkesbury Sandstone greater than predicted standing water level or pressure (outside of pumping influences in private bores) over a minimum 2-month period <p>Level 3*</p> <ul style="list-style-type: none"> Abnormal increase in water flow from the goaf >3.4 ML (20-day average) >10 m reduction in the Hawkesbury Sandstone greater than predicted standing water level or pressure (outside of pumping influences in private bores) over a minimum 2-month period Mining results in groundwater bores unsafe, unserviceable or damaged 	<p>• Continue monitoring program</p> <p>• Submit an Impact Report to OEH, DoPI, DPI and other relevant resource managers</p> <p>• Report in the End of Panel Report</p> <p>• Summarise actions and monitoring in AEMR</p> <p>Actions stated for Level 1</p> <p>• Review monitoring program</p> <p>• Notify relevant technical specialists and seek advice on any CMA required</p> <p>• Implement agreed CMAs as approved</p> <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>Actions stated for Level 2</p> <p>• Notify OEH, DP&I, DPI, NoW, DRE, relevant resource managers and technical specialists and seek advice on any CMA required.</p> <p>• Invite stakeholders for site visit</p> <p>• Develop site CMA (subject to stakeholder feedback). This may include:</p> <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 MSB to repair any infrastructure damaged by mining <p>• Completion of works following approvals, including monitoring and reporting on success</p> <p>• Review the Groundwater Model, TARP and Management Plan in consultation with key stakeholders</p> <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 No such impacts observed No such impacts observed

Monitoring	Trigger	Action (if impact is observed)	Impacts Observed
<p><i>in the Built Feature Management Plans</i></p>			
LANDSCAPE FEATURES			
<p>Cliffs and Steep Slopes</p> <ul style="list-style-type: none"> • Nepean River cliff lines • Harris Creek cliff lines • Sensitive terrain near built features (Razorback Range, Douglas Park Ridge) <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 OEHL, DoPI, DPI and other relevant resource managers • Report in the End of Panel Report • Summarise actions and monitoring in AEMR 	<ul style="list-style-type: none"> • <i>No such impacts observed</i>
	<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 stated for Level 1</i> • Report trigger to key stakeholders • Review monitoring program • Notify relevant specialists and develop and implement any CMA required. • Provide safety signage and barricades where appropriate in areas as required for public safety (refer PSMP) • Implement agreed CMA's 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"> • <i>No such impacts observed</i>
	<p>Level 3 *</p>	<ul style="list-style-type: none"> • <i>Actions stated for Level 2</i> • Notify OEHL, DP&I, DPI, NoW, DRE, 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"> • <i>No such impacts observed</i>

Monitoring	Trigger	Action (if impact is observed)	Impacts Observed
	<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"> – 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>	
	<p>Exceeding Performance Measures</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 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"> • <i>No such impacts observed</i>
AQUATIC ECOLOGY			
<p>Nepean River</p> <ul style="list-style-type: none"> • Sites 1 and 2 (downstream) • Sites X3 and X4 (adjacent to Longwalls 901 and 902) 	<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 OEH, DoPI, DPI and other relevant resource managers • Report in the End of Panel Report • Summarise actions and monitoring in AEMR 	<ul style="list-style-type: none"> • <i>No such impacts observed</i>
	<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"> • <i>Actions stated for Level 1</i> • Report trigger to key stakeholders • Review monitoring program • Notify relevant specialists and develop and implement any CMA required. • Implement agreed CMA's 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"> • <i>No such impacts observed</i>
	<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"> • <i>Actions stated for Level 2</i> • Notify OEH, DP&I, DPI, NoW, DRE, relevant resource managers and technical specialists and seek advice on any CMA required. • Invite stakeholders for site visit 	<ul style="list-style-type: none"> • <i>No such impacts observed</i>

Monitoring	Trigger	Action (if impact is observed)	Impacts Observed
		<ul style="list-style-type: none"> • 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 • <i>Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. impacts to aquatic ecology with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts</i> 	
	<p>Exceeding Performance Measures</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"> • <i>Actions stated for Level 3</i> • 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"> • <i>No such impacts observed</i>
TERRESTRIAL ECOLOGY			
Visual inspections as part of landscape and water monitoring programs in active mining areas	<p>Level 1*</p> <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 OEH, DoPI, DPI and other relevant resource managers • Report in the End of Panel Report • Summarise actions and monitoring in AEMR 	<ul style="list-style-type: none"> • <i>No such impacts observed</i>
	<p>Level 2*</p> <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"> • <i>Actions stated for Level 1</i> • Report trigger to key stakeholders • Review monitoring program • Notify relevant specialists and develop and implement any CMA required. • Implement agreed CMA's as approved • <i>Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. impacts to terrestrial with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts</i> 	<ul style="list-style-type: none"> • <i>No such impacts observed</i>
	<p>Level 3*</p> <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"> • <i>Actions stated for Level 2</i> • Notify OEH, DP&I, DPI, NoW, DRE, 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"> • <i>No such impacts observed</i>

Monitoring	Trigger	Action (if impact is observed)	Impacts Observed
	<p>Exceeding Performance Measures</p> <ul style="list-style-type: none"> Mining results in more than negligible environmental consequences on threatened species, threatened populations, or endangered ecological communities 	<ul style="list-style-type: none"> Review the TARP and Management Plan in consultation with key stakeholders <i>Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. impacts to terrestrial ecology with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts</i> 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
ABORIGINAL ARCHAEOLOGY			
<p>Impacts to the cliff lines on the southern side of the Nepean River (directly north of the site) will trigger an inspection of Bradcorp 1</p>	<p>Level 1*</p> <ul style="list-style-type: none"> Change in shelter conditions not attributable to natural weathering or preservation that do not alter the heritage values of the place e.g. mineral growth or micro-organism growth Changes external to shelter conditions that effect the sites context e.g. ground cracking, boulder slumping, rock and/or tree falls 	<ul style="list-style-type: none"> Continue with monitoring program Condition assessment and photographic record Notify relevant specialists and key stakeholders (e.g. Registered Aboriginal Parties) Summarise impacts and report in the End of Panel Report and AEMR 	<ul style="list-style-type: none"> No such impacts observed
	<p>Level 2*</p> <ul style="list-style-type: none"> Change in shelter conditions not attributable to natural weathering or preservation e.g. change in drip line or seepage, cracking or exfoliation of overhang or shelter, movement or opening of existing planes and joints 	<ul style="list-style-type: none"> Actions stated for Level 1 Review monitoring program Review impacts against the Performance Measures Develop site management plan to mitigate effects in consultation with Registered Aboriginal Parties and the landowner 	<ul style="list-style-type: none"> No such impacts observed
	<p>Level 3*</p> <ul style="list-style-type: none"> Change in shelter conditions not attributable to natural weathering or preservation e.g. cracking or exfoliation of art panel, movement of existing planes and joints at panel, block fall within shelter or overhang, shelter or overhang collapse 	<ul style="list-style-type: none"> Actions stated for Level 2 Investigate reasons for impacts Update future predictions based on outcomes of the investigation 	<ul style="list-style-type: none"> No such impacts observed
	<p>Exceeding Performance Measures</p> <ul style="list-style-type: none"> More than 10% of sites across the mining area are affected by subsidence impacts (other than negligible impacts or environmental consequence) 	<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 	<ul style="list-style-type: none"> No such impacts observed
EUROPEAN HERITAGE			
<p>Douglas Park Railway Cottage – Item 30 from the BSOP EA</p>	<p>Level 1*</p> <ul style="list-style-type: none"> Cracks or warping of external weatherboards, Cracks or movement < 5 mm in width in any external or internal wall claddings, linings, or finish Isolated cracked, loose, or drummy floor or wall tiles No impact to heritage values of the site 	<ul style="list-style-type: none"> Continue monitoring program Condition assessment and photographic record Notify relevant specialists and key stakeholders Summarise impacts and report in the End of Panel Report and AEMR 	<ul style="list-style-type: none"> No such impacts observed
	<p>Level 2*</p>	<ul style="list-style-type: none"> Actions stated for Level 1 Review monitoring program 	<ul style="list-style-type: none"> No such impacts observed

Monitoring	Trigger	Action (if impact is observed)	Impacts Observed
	<ul style="list-style-type: none"> • Continuous cracking or warping of weatherboards, • Slippage along the damp proof course of 5 to 15 mm • Loss of bearing to isolated walls, piers, columns, or other load-bearing elements • Loss of stability of isolated structural elements • Loss of heritage value no greater than predicted in HMP 	<ul style="list-style-type: none"> • Review impacts against the Performance Measures • Develop site management plan to mitigate effects in consultation with stakeholders, where appropriate 	
	<p>Level 3*</p> <ul style="list-style-type: none"> • Continuous cracking or warping of weatherboards • Slippage along the damp proof course of 15 mm or greater anywhere in the total external façade • Re-levelling of building • Loss of stability of several structural elements • Loss of heritage value greater than predicted in HMP 	<ul style="list-style-type: none"> • <i>Actions stated for Level 2</i> • Investigate reason for impacts • Notify DP&I and MSB as soon as practicable • Seek advice on any CMA required. • Consultation with stakeholders (undertake site inspection if required). • Review the relevant TARP and Management Plan in consultation with key stakeholders 	<ul style="list-style-type: none"> • <i>No such impacts observed</i>
	<p>Exceeding Performance Measures</p> <ul style="list-style-type: none"> • Loss of heritage value greater than predicted under the Heritage Management Plan 	<ul style="list-style-type: none"> • <i>Actions stated for Level 3</i> • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation 	<ul style="list-style-type: none"> • <i>No such impacts observed</i>

8. References

- BHP Billiton Illawarra Coal (2013), *Appin Area 9 Longwalls 901 to 904 Extraction Plan*, prepared by Cardno on behalf of BHP Billiton Illawarra Coal.
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- MSEC (2012), *Appin Colliery - Longwalls 901 to 904: Subsidence predictions and impact assessments for natural features and surface infrastructure in support of the Extraction Plan*, Report by Mine Subsidence Engineering Consultants for BHP Billiton Illawarra Coal. Report Number - MSEC448
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