



**APPIN AREA 9
LONGWALL 902
END OF PANEL REPORT
SEPTEMBER 2019**



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Attachments

Attachment A1: Appin Area 9 (Longwalls 901 to 904) Extraction Plan Approval
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Attachment B: End of Panel Subsidence Monitoring Report for Appin Longwall 902
Attachment C1: Appin Area 9 Longwall 902 End of Panel Landscape Report
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Attachment D: Area 9 Longwall 902 End of Panel Surface Water and Groundwater Monitoring review
Attachment E: Appin Areas 7 and 9 Aquatic Ecology Monitoring 2003 to 2017

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
EP	Extraction Plan
EP&A Act 1979	<i>Environmental Planning and Assessment Act 1979</i>
IC	Illawarra Coal
ICEFT	Illawarra Coal Environmental Field Team
PAC	Planning and Assessment Commission
SMP	Subsidence Monitoring Program
WMP	Water Management Plan

1. Introduction

South32 Illawarra Coal (IC) 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 (DP&E) granted approval for the AA9 Longwall 901 – 904 Extraction Plan on 10 September 2014. Illawarra Coal subsequently shortened the commencing (i.e. western) end of Longwall 902 by 911 m from the extent indicated in the Extraction Plan Application. The modified commencing end of Longwall 902 was approved by the DP&E on the 6 July 2017. Extraction of Longwall 902, which is the second longwall in the series, commenced on 12 May 2018 and was completed on 3 April 2019.

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. The Illawarra Coal Measures contain several seams, the uppermost of which is the Bulli Seam.

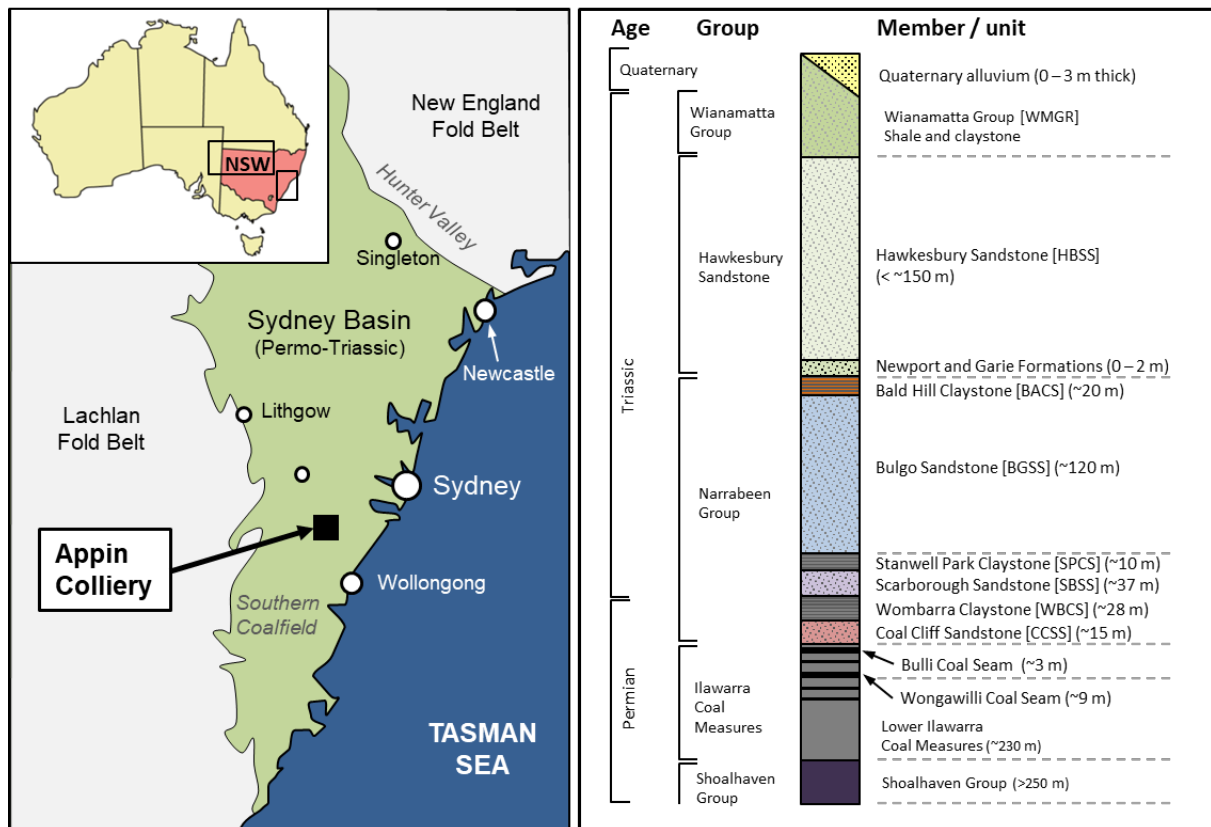


Figure 1-1: Stratigraphy and location of the Southern Coalfields within the Sydney Basin (Source: HGEO 2019).

The depth of cover to the Bulli Seam directly above Longwall 902 varies between a minimum of 510 m above the commencing end of the longwall, and a maximum of 590 m above the maingate towards the eastern end 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 generally falls from the north to the south. The natural drainage lines located directly above Longwall 902 flow into the Nepean River to the south of the longwall. Harris Creek is located approximately 420 m to the east of the finishing end of Longwall 902. Razorback Range is located to the north of the longwall.

The thickness of the Bulli Seam varies between 2.8 and 2.9 m within the extents of Longwall 902. IC extracted 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 the proposed mining of Longwalls 901 to 904 in AA9 (Figure 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, therefore, 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 upsidence 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 Outcomes

The extraction of underground coal reserves from AA9 provides benefits at national, state and local levels. Illawarra Coal provides coking coal to BlueScope Steel for its domestic steelmaking production, and for export to overseas customers.

South32 IC provides 70% of BlueScope Steel's coking coal requirements. Mining operations at Appin Colliery represents continuing significant capital and operating investments in the Southern Coalfield of New South Wales.

Appin Mine supports approximately 1000 employees and contractors. 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 you also include consumption-induced effects (Lawrence Consulting 2016).

Continuing benefits occur through continuity of employment, expendable income, export earnings and government revenue. From the operations of Appin Mine, IC paid approximately \$48.4 Million in government royalties during the 2018/2019 financial year.

Longwall 902 is located within Consolidated Coal Lease 767, which amalgamated a number of long-standing head leases for mining coal in 1991.

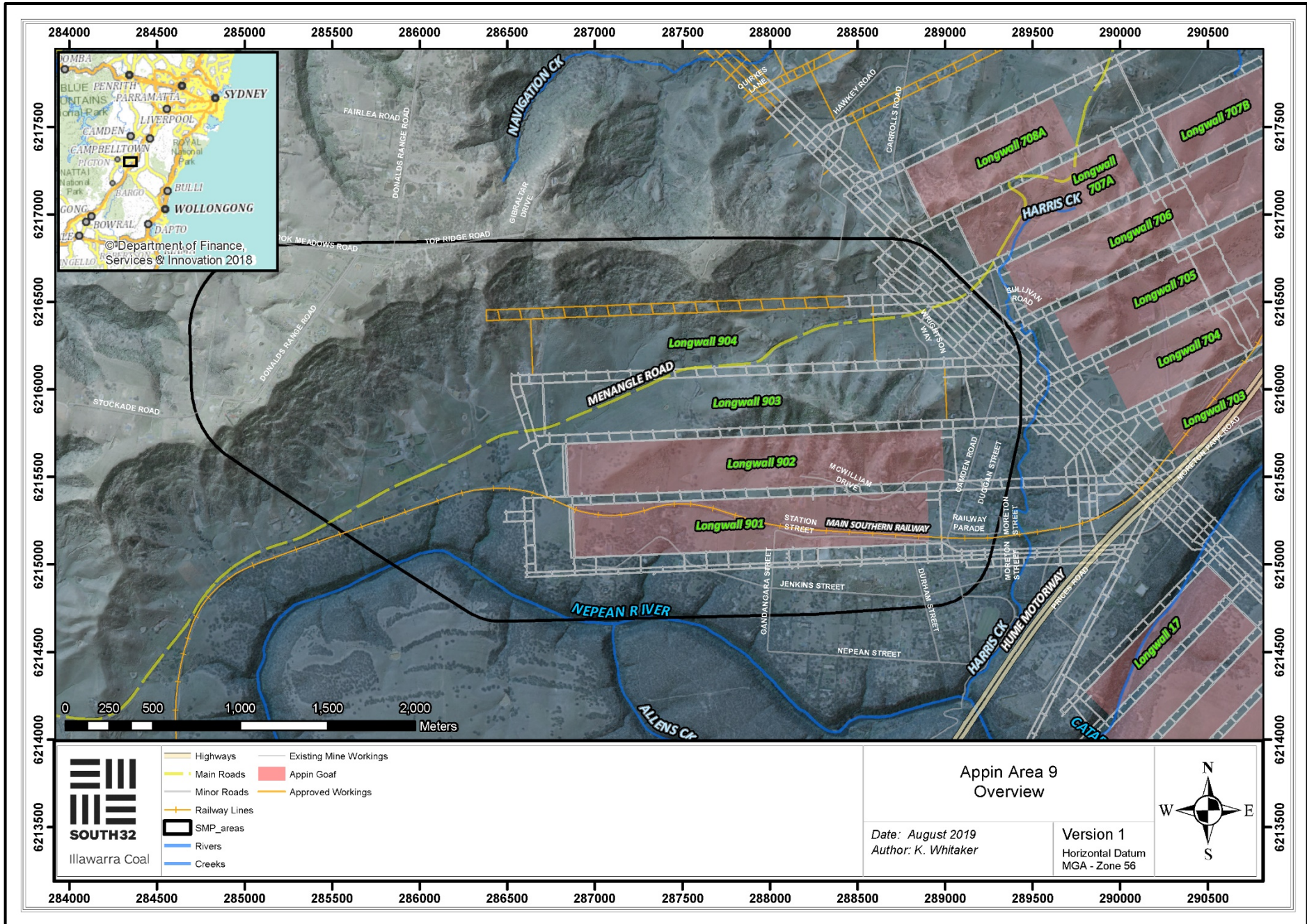


Figure 1-2: Map showing the AA9 Study Area.

2. Stakeholder Engagement

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

- Community information sheets and letter box drops;
- Media releases and other media activities;
- General community surveys and reports;
- Illawarra Coal Community Newsletter – a periodical IC publication distributed to the community;
- Internet site - <http://www.south32.net/our-operations/australia/illawarra-coal>
- Illawarra Coal Community Consultative Committee meetings for BSOP (meeting minutes provided on the South32 website and emailed direct to interested stakeholders);
- Landholder relations program;
- Annual Environmental Assessment Report; and
- Information days.

Illawarra 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	<p>Level of community concern relating to subsidence.</p> <p>Awareness of subsidence and its effects and management.</p> <p>Level of perceived community risk associated with subsidence effects.</p> <p>Level of satisfaction with the company's subsidence management practices.</p> <p>The extent to which the community attributes environmental, social and economic change occurring within the community to mining activities.</p>	<p>Longwall progress maps displayed on local notice board, letters and community newsletters.</p> <p>Illawarra Coal Community Consultative Committee meetings for BSOP. Douglas Park Advisory Panel.</p> <p>A biennial survey of residents and stakeholders in the communities in which IC operates. The survey aims to determine the community's perception of the company's overall performance.</p> <p>Development of individual Built Feature Management Plans (BFMPs) in consultation with landowners within the mine subsidence zone.</p> <p>Meetings and on-going consultation with landowners during mining and in accordance with individual BFMPs.</p>

The management of subsidence impacts on private properties is addressed in BFMPs. The BFMPs have been prepared in consultation with individual property owners. For any impacts to properties in relation to Longwall 902, landholders have been advised to lodge claims with the Subsidence Advisory NSW. Illawarra Coal is available to assist landholders throughout the process of making a claim and is continuing to assist in the management of the impacts of the 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 902. For further details, refer to Mine Subsidence Engineering Consultants (MSEC) 2019, which is provided as **Attachment B**.

Predictions of subsidence movements relating to the extraction of Longwall 902 were obtained by MSEC using the Incremental Profile Method based on prediction curves for the Southern Coalfield.

Measurements of subsidence movements resulting from the extraction of Longwall 902 were obtained using monitoring lines, monitoring points and other methods at the following locations:

- Main Southern Railway, including monitoring associated with the track, embankments, cuttings, culverts, sewer horizontal bore and Douglas Park Station;
- Telstra Optical Fibre Cable (OFC) monitoring line;
- Menangle Road monitoring line;
- Camden Road 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; and
- Moreton Park Road Bridge South monitoring points.

Table 3-1: Comparison summary of predicted and measured subsidence during the extraction of Longwall 902.

Feature	Monitoring Types	Approximate Distance from Longwall 902	Assessment of Measured Subsidence vs Predictions / Trigger Levels (MSEC 2019)
Main Southern Railway	ARTC monitoring line Automated track monitoring Embankment monitoring points Cutting monitoring points Culvert monitoring points Sewer horizontal bore monitoring points Douglas Park Station monitoring points.	Overlies previously extracted Longwall 901.	Maximum vertical subsidence (263 mm), tilts (1.2 mm), compressive strains (0.8 mm/m) and tensile strains (0.7 mm/m) were less than predicted values. False alarms were triggered due to malfunction. However, mining-induced stress readings did not exceed trigger levels. No adverse impacts observed at cuttings Differential movements at culverts typically in order of survey tolerance Incremental changes in Sewer horizontal bore length within order of survey tolerance Differential vertical and horizontal movements at Douglas Park Station typically within the order of survey tolerance
Telstra OFC	2D and 3D monitoring line	Minimum distance of 70 m from Longwall 902 commencing end.	The maximum measured incremental vertical subsidence at the southern end (50 mm) was similar to the maximum predicted value outside and adjacent to Longwall 902 (50 mm or less). At the northern end the measured value (86 mm) exceeded the predicted value; however, was only associated with low levels of strain.
Menangle Road	2D and 3D monitoring line	Minimum distance of 100 m from Longwall 902 commencing end.	Maximum measured incremental vertical subsidence (50 mm) similar to the maximum predicted value outside and adjacent to Longwall 902 (50 mm or less).
Camden Road	2D and 3D monitoring line	Minimum distance of 100 m from Longwall 902 finishing end.	Measured incremental vertical subsidence typically within the order of survey tolerance (less than 20 mm)
Nepean River	2D closure monitoring lines	Located 650 m south of Longwall 902 at its closest point.	The measured incremental closure at the Nep X 9B-Line of 23 mm was slightly greater than the predicted value of 20 mm. The measured incremental closure at the Nep X 9G-Line of 59 mm was also slightly greater than the predicted value of 58 mm. However, the exceedances at B-Line and G-Line are within the order of accuracy of the prediction method. The maximum measured incremental closure at the Nep X 9F-Line (78 mm) was less than the maximum predicted incremental value for this monitoring line (98 mm). The measured incremental closures for the other monitoring lines were typically similar to or less than their predicted values.
Harris Creek Cliff Line	2D closure monitoring lines	Located 860 m south of the finishing end of Longwall 902 at its closest point.	The maximum measured incremental closure due to Longwall 902 was 10 mm at the HCCL D-Line, which was less than the maximum predicted incremental closure (20 mm). The maximum measured total closure measured after Longwall 902 (40 mm) was less than the revised maximum predicted value of 50 mm.
Blades Bridge	2D fixed prisms	Located 860 m south of the finishing end of Longwall 902 at its closest point.	Maximum total closure less than the predicted closure value of (20 mm).

Feature	Monitoring Types	Approximate Distance from Longwall 902	Assessment of Measured Subsidence vs Predictions / Trigger Levels (MSEC 2019)
Far-Field Monitoring points	Absolute 3D monitoring points	Various locations in AA9.	Typically, less than movements measured at similar distances elsewhere in the southern coalfields. The greatest movements were located at marks along Razorback Range. See Attachment B (MSEC 2019) for further analysis.
Nepean Twin Bridges	Absolute 3D points Relative 3D points Inclinometer Bridge joint monitoring Visual monitoring	1.3 km south-east from the finishing end of Longwall 902.	The maximum measured absolute horizontal movement (88 mm) at Marks DPBN and DPBS was less than the Level 1 Trigger (100 mm) at the completion of Longwall 902.
Moreton Park Road (South)	Absolute 3D points Relative 3D points Visual monitoring	1 km south-east from the finishing end of Longwall 902.	The maximum measured absolute horizontal movement at Marks MPBE and MPBW was less than the Level 1 Trigger at the completion of Longwall 902. The total changes in horizontal distance between the bridge abutments were less than +/- 2 mm, i.e. in the order of survey tolerance.

4. Impacts to Built Features

MSEC provided an assessment of potential built features impacts from the extraction of Longwall 902 (MSEC448 and MSEC743), which supported the Extraction Plan 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 predicted and observed impacts for built features in relation to the extraction of Longwall 902 (Source: MSEC 2019).

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 observed impacts on safety or serviceability.
Menangle Road	Minor cracking and localised heaving of the road surface directly above the longwalls.	No observed impacts (the road was not directly mined beneath by Longwall 902).
Nepean Twin Bridges	Impacts unlikely after the implementation of the preventive, monitoring and management strategies.	No observed impacts.
Moreton Park Road Bridge (South) and Blades Bridge	Impacts unlikely.	No observed impacts.
Water and sewer pipelines	Minor leakages could occur.	No observed impacts.
66 kV and 11 kV powerlines	Minor impacts possible requiring some adjustments of cables and poles.	No reported impacts due to mining. Tilt of a private pole was observed; however, investigations found that it was not mining related.
Optical fibre and copper telecommunications cables	Impacts unlikely with the implementation of monitoring and management strategies.	No observed impacts.
Survey control marks	Vertical and horizontal movements which could require re-establishment.	No observed damage to the survey control marks. The marks are to be re-established after completion of mining.
Business establishments	Impacts unlikely.	No observed impacts.
Rural structures	Minor impacts on rural structures located directly above longwalls.	No observed impacts.
Farm dams	Incidence of impact (cracking and leakage) expected to be low.	One claim submitted to SA NSW for potential impact on a farm dam. An investigation found that the changes were due to low rainfall and was not related to the longwall mining.
Groundwater bores	Impacts likely including lowering of piezometric surface, blockage and change in groundwater quality.	One confirmed impact to private borehole; WMP developed with landholder in accordance with the BFMP. One pump retracted from borehole prior to active subsidence for shearing mitigation. Further inspections will be conducted following the extraction of Longwall 903.
Archaeological sites	Impacts unlikely.	No observed impacts.
Heritage sites	Impacts unlikely.	No observed impacts.
Houses	Houses will remain safe and serviceable.	Houses have remained in safe and serviceable conditions. There were three claims submitted to SA NSW relating to the houses: 1. Differential movement between a veranda slab and a residential structure (not occupied); 2. minor (non-structural) cracking inside a house; and 3. sticky internal doors and leaking bathroom waterproofing (house with an existing claim from Longwall 901). Other claims are related to a pool and pool gates, groundwater bores, a broken stormwater pipe and cracking of an external pavement.

4.1. Private Properties

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

The claims submitted to Subsidence Advisory NSW as a result of Longwall 902 are currently on hold due to ongoing ground movements associated with future mining. One claim is outside of the influence of future mining and since the completion of Longwall 902 the relevant claim is under determination. The current claims will be assessed after ground movements have ceased as per the requirements of the *Coal Mine Subsidence Compensation Act 2017*.

Post-mining inspections were undertaken at properties Lot 15 DP 803255 and Lot 22 DP203255 (**Figure 4-1**). This included collection of in-situ water quality data and water samples for laboratory analysis. Results of water quality sampling are included in the Surface Water and Groundwater Assessment of the Longwall 902 EoP Report. Post-mining inspections were unable to be undertaken at properties Lot 59-64 DP1321 and Lot 2 DP8999 due to access issues.

Table 4-2: Summary Table of predicted and observed impacts to private property surface and groundwater quality.

Potential Impact	Description	Impact Prediction	Observed Impact
Reduced groundwater yield	Six 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.	Impacts to water level likely (GeoTerra, 2011).	One confirmed impact to private borehole; WMP developed with landholder in accordance with the BFMP. One pump retracted from borehole prior to active subsidence for shearing mitigation. Further inspections will be conducted following the extraction of Longwall 903.
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 to dam water levels likely (Ecoengineers, 2012).	No impacts observed.
Gas emissions	There is potential for strata gas emissions into private bores. Any bores with gas releases are decommissioned during the mining period.	Gas releases from any deep bores likely (GeoTerra, 2011).	No impacts observed.

4.2. Cultural Heritage

Cultural heritage sites within the AA9 Study Area are outlined in Annex F (Heritage Management Plan) of the AA9 Longwall 901 – 904 EP. One site has been identified, Bradcorp 1 (Aboriginal archaeological site - Shelter with Art). No impacts were reported at the site.

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. The IC Community Team attempted to contact the resident (by site visit and letter-box drop) to conduct a baseline inspection. However, no contact was made, thus, no baseline property inspection was conducted. No impacts have been reported by the resident.

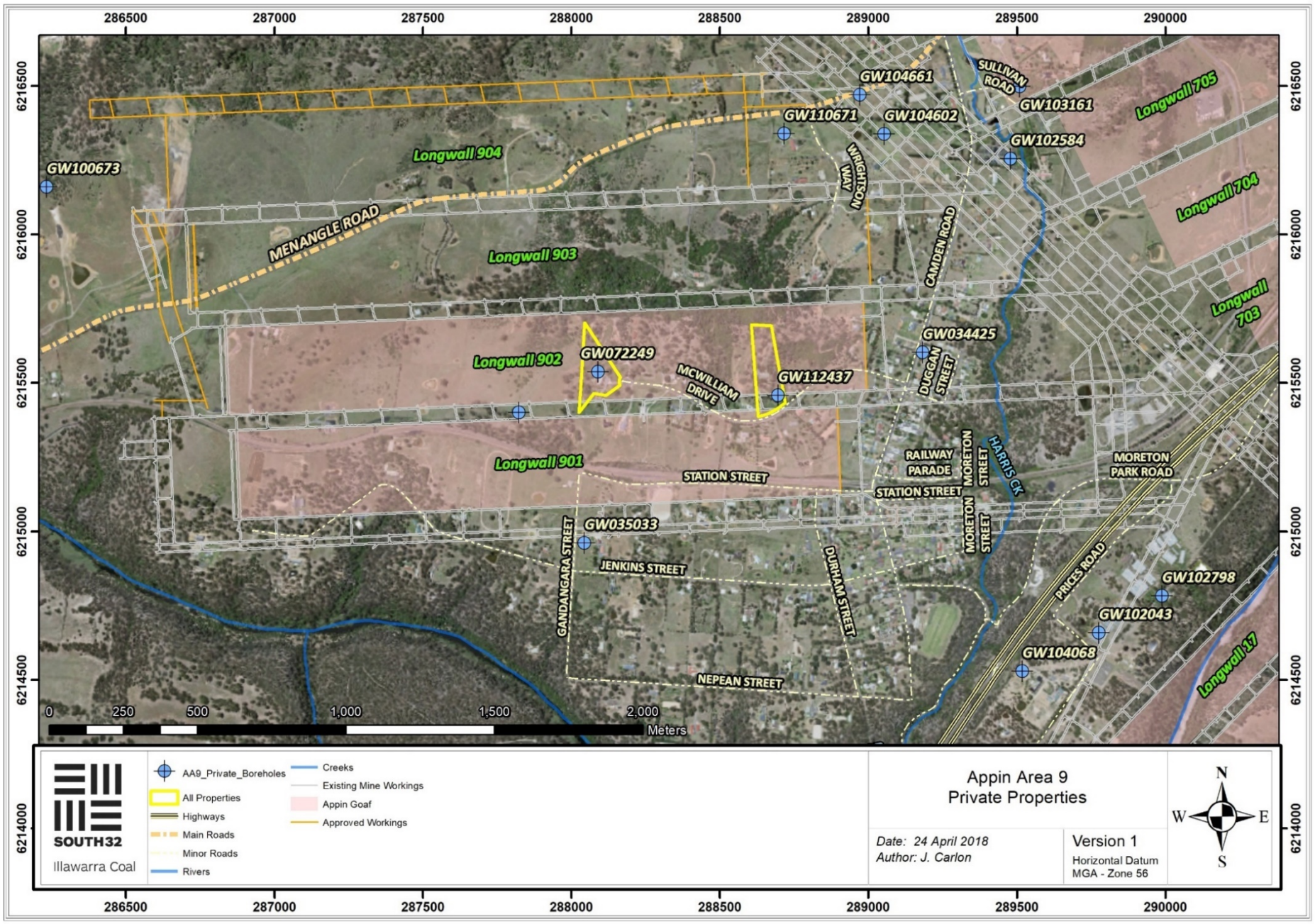


Figure 4-1: Private boreholes relevant to AA9. Properties relevant to this report are highlighted.

5. Impacts to Natural Features

5.1. Surface Water Assessment

Table 5-1: Summary table of potential and observed impacts to surface water quality within natural features (Source: HGEO 2019).

Potential Impact	Description	Impact Prediction	Observations	TARP Level
Gas emissions in the Nepean River and other areas	Based on observations at 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).	Six gas release zones were observed during the extraction of Longwall 902. Twenty-five gas release zones were observed during the previously extracted Longwall 901.	Each gas release zone constitutes a Level 1 TARP trigger.
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.	NR0 decline in water level relative to benchmark. Other sites had water levels within baseline range (HGEO 2019). The flow at Maldon Weir increased relative to flow at the downstream Menangle Weir from June 2018 (limited data available for assessment).	No relevant TARP.

5.2. Groundwater Assessment

Table 5-2: Summary table of potential and observed impacts to groundwater.

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.	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).	Groundwater levels typically within the predicted range. Observed reductions exceeded predictions at two sensors; however, the reductions were below the TARP triggers threshold.	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 water quality as a result of mining at Longwalls 901 and 902.	Not triggered.

Potential Impact	Description	Impact Prediction	Observations	TARP Level
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 remained below the Level 1 TARP trigger (increase of inflow between 2.7 and 3.0 ML/day) during the extraction of Longwall 902.	Not triggered.

5.3. Aquatic Ecology Assessment

Cardno (formerly The Ecology Lab Pty Ltd) was commissioned by South32 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 5-3**). The aims of the monitoring program are to:

- Determine the occurrence of fish and macroinvertebrates and assess the condition of aquatic habitat that may be affected by subsidence-related impacts; and
- Determine whether any changes observed in aquatic habitat or biota may be linked to subsidence-related impacts.

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
- Species of aquatic macrophytes.

Limited in situ water quality sampling is undertaken to assist with interpretation of trends in the above indicators.

Post-mining aquatic ecology data was collected following the commencement of Longwall 902 at downstream potential impact sites (Sites 1 and 2) in November of 2018. No changes to aquatic ecology indicators, that could be associated with extraction of Longwall 902, were detected. The gas releases, changes in water quality and water levels identified in the Nepean River during extraction of Longwall 902, do not appear to have had any measurable effect on macroinvertebrates, fish and macrophytes in the Nepean River at these sites (Cardno 2019).

Further monitoring will be undertaken at all Appin Area 9 potential impact and control sites in November/December 2019. This will include a full assessment of any changes to aquatic habitat and biota that may have occurred here during and following extraction of Longwall 902 (Cardno 2019).

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 ICEFT 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 ICEFT 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 902 has resulted in negligible impacts to terrestrial ecology within the AA9 Study Area

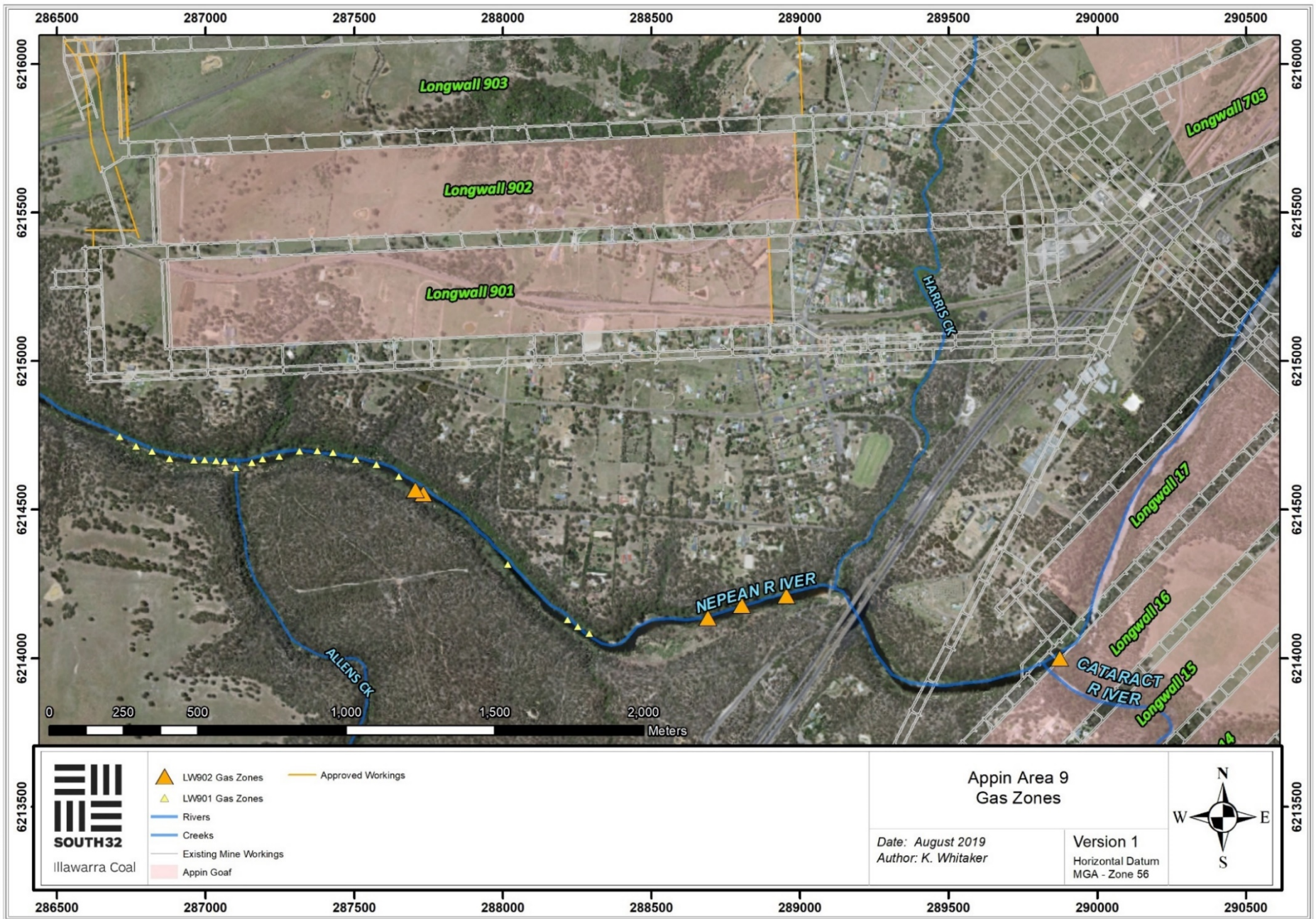


Figure 5-1: Map showing gas release zones on the Nepean River observed during the extraction of Longwalls 901 and 902.

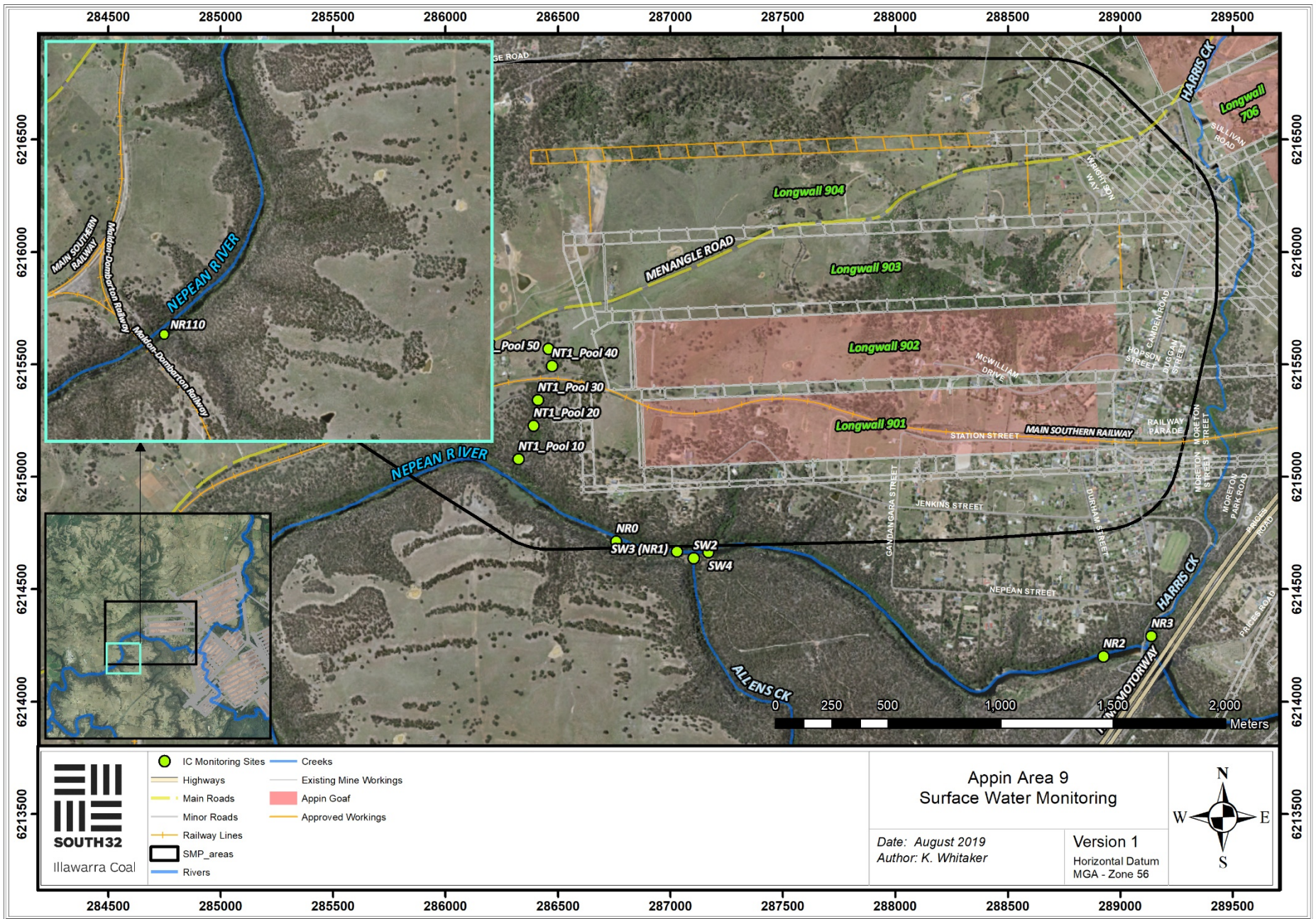


Figure 5-2: Appin Area 9 surface water monitoring sites; upstream reference site NR110 displayed on inset frame.

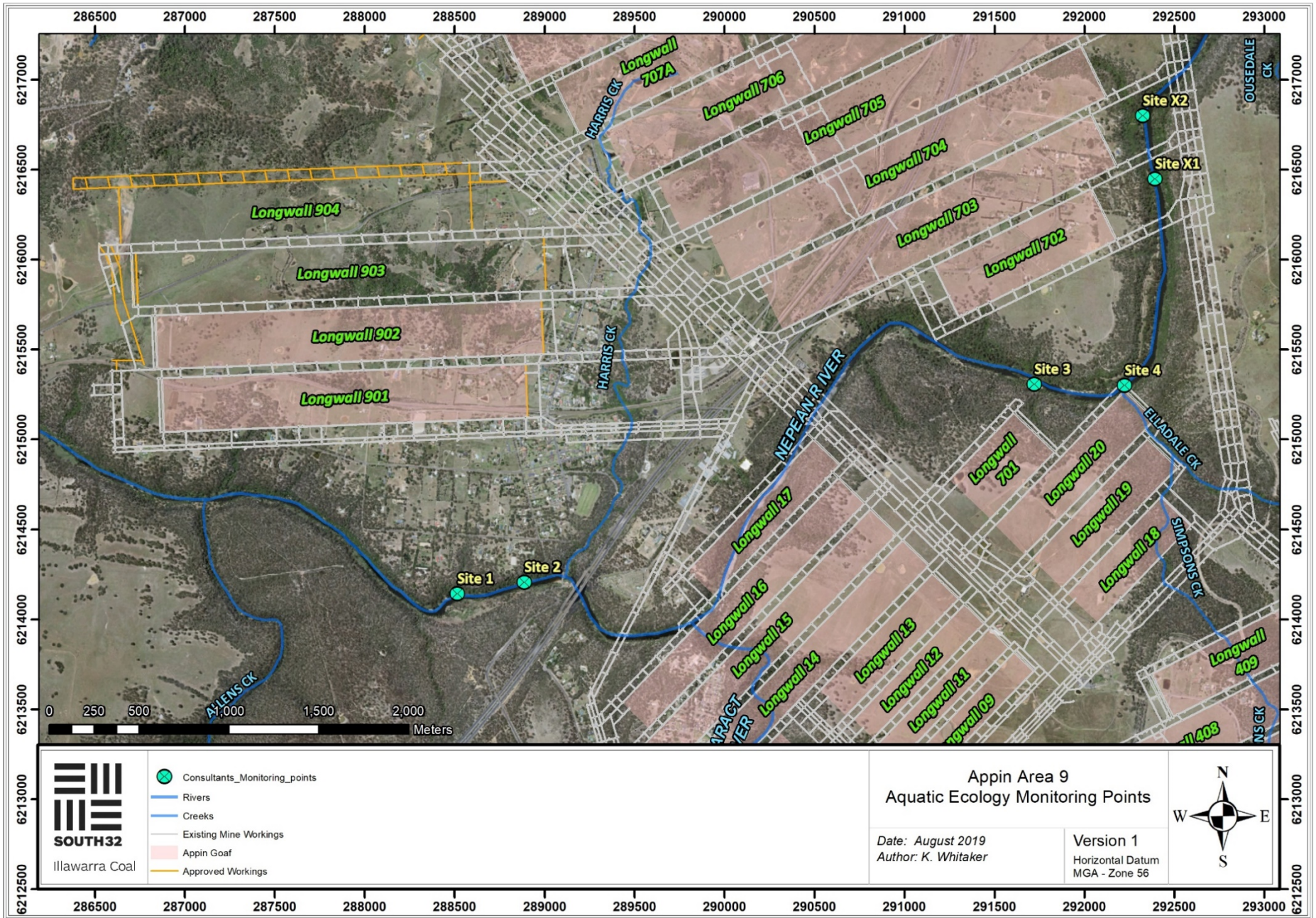


Figure 5-3: Aerial image displaying the aquatic ecology monitoring sites on the Nepean River and their respective Reaches in relation to AA7 and AA9 Longwalls. Sites 3, 4, X1 and X2 were not visited in the current study.

6. Longwall 902 Monitoring Program

Table 6-1: Summary of the Longwall 902 monitoring program; observations and recommendations for future monitoring (specifically Longwall 903) are also included

Monitoring Site	Monitoring Type	Monitoring Frequency	Parameters	Future Monitoring (Longwall 903)
SURFACE WATER				
<p style="text-align: center;">AREA 9</p> <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) • If and where strata gas emission plumes above 3000 L/min are detected (Lab, Field, Obs) 	<ul style="list-style-type: none"> • Lab sample • Field parameters • Water levels • Observations 	<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 • Visual signs of impacts (i.e. cracking, fracturing, vegetation changes, increased erosion, changes in water colour etc) • Stream flow and pool water level • Impacts determined from comparing photo points taken prior to, during and post mining 	<p>No changes</p>

AREA 9	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 	These sites are no longer monitored by WaterNSW
GROUNDWATER					
AREA 9	Private Bores <ul style="list-style-type: none"> • 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 <i>(in consultation with bore owner)</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"> • 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 • 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) • Evidence of inflows to the bores e.g. sound of falling water • Visual signs of impacts (i.e. cracking, fracturing near the bore or changes in water colour etc.) 	No Changes
	BHPBIC Piezometers: <ul style="list-style-type: none"> • Potentiometric head; <ul style="list-style-type: none"> – EAW9 – EAW18 – EAW58 • Piezometers and water samples between Longwall 901 and the Nepean River <ul style="list-style-type: none"> – S2280 (POSP A) – S2281 (POSP B) 	<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 		No Changes

	Groundwater inflows to the mine	<ul style="list-style-type: none"> • Mine water budget • Observations 	<ul style="list-style-type: none"> • Flow meters 	Water flow from the goaf to the mine (analyzed as a moving average i.e. 20-day average)	No Changes
AQUATIC ECOLOGY					
AREA 9	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 to be identified (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 	No Changes

TERRESTRIAL ECOLOGY

AREA 9	<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
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ABORIGINAL ARCHAEOLOGY

AREA 9	<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) 	No Changes
	<ul style="list-style-type: none"> Bradcorp 1 (if required) 	<ul style="list-style-type: none"> Observational and photographic monitoring 	<ul style="list-style-type: none"> Baseline archival recording (when triggered by above) During the extraction of Longwalls 901, 902 and 903 Final impact assessment recording twelve months after final subsidence movement at the site 	<ul style="list-style-type: none"> Macro and micro recording using digital photography Detailed elevation plans of shelter walls recording structural and surface features including but not limited to the art, graffiti, joints, bedding planes, exfoliation scars, cracks, mineral and micro-organism growth, drip line and water seepage locations 	No Changes

EUROPEAN HERITAGE

AREA 9	<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 MSB 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 • Assessment of heritage impacts by a suitably qualified heritage expert (if required) • This assessment would be made available to the MSB and include recommendations for management of heritage value during any repairs 	No Changes
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LANDSCAPE FEATURES

AREA 9	<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
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7. Appendix A

Table 7-1: Summary table of Longwall 901 TARP levels and observed impacts.

Monitoring	Trigger	Action (if impact is observed)	Impacts Observed
WATER QUALITY			
<ul style="list-style-type: none"> • Adjacent and downstream sites: • 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 • 	<p>Level 1*</p> <p>Impact monitoring sites when comparing the baseline period to the mining period for that site:</p> <ul style="list-style-type: none"> • 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"> • 6 gas release zones identified on the Nepean River, consistent with Level 1 criteria, named 'AA9_LW902_001' – AA9_LW902_006'
	<p>Level 2*</p> <p>Impact monitoring sites when comparing the baseline period to the mining period for that site:</p> <ul style="list-style-type: none"> • 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 style="text-align: center;"><i>Strata Gas Emission Plume:</i></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
	<p>Level 3*</p> <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 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 	<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"> 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> <ul style="list-style-type: none"> Mining results in more than negligible gas releases, iron staining or water cloudiness 	<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</p>	<ul style="list-style-type: none"> Level 1* 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 	<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"> One confirmed impact to private borehole; WMP developed with landholder in accordance with the BFMP One pump retracted from borehole prior to active subsidence for shearing mitigation. Further inspections will be conducted following the extraction of Longwall 903
	<ul style="list-style-type: none"> Level 2* 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 	<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. 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

Monitoring	Trigger	Action (if impact is observed)	Impacts Observed
<p>GW 110671</p> <p>BHPBIC Piezometers:</p> <p>NGW3</p> <p>NGW4</p> <p>NGW5</p> <p>NGW6</p> <p>EAW5</p> <p>EAW7</p> <p>EAW9</p> <p>EAW18</p> <p>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 in the Built Feature Management Plans</i></p>	<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 	<ul style="list-style-type: none"> Actions stated for Level 2 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"> 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 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 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 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"> No such impacts observed
	<p>Level 2</p> <ul style="list-style-type: none"> Rock fall from cliff where the characteristics of the cliff change (>10% length of any single cliff) Ground disturbance that is unlikely to stabilise within the period of monitoring without CMA Mass movement of a slope causing areas of exposed soil 	<ul style="list-style-type: none"> Actions stated for Level 1 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 	<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"> Crack or fracture between 100 – 300 mm width Crack or fracture between 10 – 50 m length 	<p><i>Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. cracking at the surface with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts</i></p>	
	<p>Level 3 *</p> <ul style="list-style-type: none"> Cliff collapse (100% length of any single cliff) Ground disturbance that does not stabilise within the period of monitoring Mass movement of a slope causing areas of exposed soil that does not stabilise within the period of monitoring Crack or fracture over 300 mm width Crack or fracture over 50 m length 	<ul style="list-style-type: none"> Actions stated for Level 2 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 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 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 dislodgement 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"> Actions stated for Level 3 Make area safe Investigate reasons for the exceedance Update future predictions based on the outcomes of the investigation Provide environmental offset if CMAs are unsuccessful 	<ul style="list-style-type: none"> No such impacts observed

AQUATIC ECOLOGY			
Nepean River <ul style="list-style-type: none"> Sites 1 and 2 (downstream) Sites X3 and X4 (adjacent to Longwalls 901 and 902) 	Level 1* <ul style="list-style-type: none"> Reduction in aquatic habitat resulting from the mining over 1 season 	<ul style="list-style-type: none"> Continue monitoring program Submit an Impact Report to 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"> No such impacts observed
	Level 2* <ul style="list-style-type: none"> Reduction in aquatic habitat resulting from the mining over 2 seasons 	<ul style="list-style-type: none"> Actions stated for Level 1 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"> No such impacts observed
	Level 3* <ul style="list-style-type: none"> Reduction in aquatic habitat resulting from the mining for >2 consecutive seasons or complete loss of habitat 	<ul style="list-style-type: none"> Actions stated for Level 2 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"> 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> 	<ul style="list-style-type: none"> No such impacts observed
	Exceeding Performance Measures <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 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			
	Level 1*	<ul style="list-style-type: none"> Continue monitoring program 	<ul style="list-style-type: none"> No such impacts observed

<p>Visual inspections as part of landscape and water monitoring programs in active mining areas</p> <ul style="list-style-type: none"> • 	<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"> • 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 	
	<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 <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 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"> • 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 • 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 ecology 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>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"> • <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>
ABORIGINAL ARCHAEOLOGY			
<ul style="list-style-type: none"> • Impacts to the cliff lines on the southern side of the Nepean River (directly north of the site) will 	<p>Level 1*</p> <ul style="list-style-type: none"> • Change in shelter conditions not attributable to natural weathering or preservation that do 	<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) 	<ul style="list-style-type: none"> • <i>No such impacts observed</i>

trigger an inspection of Bradcorp 1	not alter the heritage values of the place e.g. mineral growth or micro-organism growth	<ul style="list-style-type: none"> • Summarise impacts and report in the End of Panel Report and AEMR 	
	<ul style="list-style-type: none"> • Changes external to shelter conditions that effect the sites context e.g. ground cracking, boulder slumping, rock and/or tree falls 		
	<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"> • <i>Actions stated for Level 1</i> • 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"> • <i>No such impacts observed</i>
	<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"> • <i>Actions stated for Level 2</i> • Investigate reasons for impacts • Update future predictions based on outcomes of the investigation 	<ul style="list-style-type: none"> • <i>No such impacts observed</i>
	<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"> • <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>
EUROPEAN HERITAGE			
<ul style="list-style-type: none"> • Douglas Park Railway Cottage – Item 30 from the BSOP EA 	<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"> • <i>No such impacts observed</i>
	<p>Level 2*</p> <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"> • <i>Actions stated for Level 1</i> • Review monitoring program • Review impacts against the Performance Measures • Develop site management plan to mitigate effects in consultation with stakeholders, where appropriate 	<ul style="list-style-type: none"> • <i>No such impacts observed</i>
	<p>Level 3*</p> <ul style="list-style-type: none"> • Continuous cracking or warping of weatherboards 	<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. 	<ul style="list-style-type: none"> • <i>No such impacts observed</i>

	<ul style="list-style-type: none"> • 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"> • Consultation with stakeholders (undertake site inspection if required). • Review the relevant TARP and Management Plan in consultation with key stakeholders 	
	<p><i>Exceeding Performance Measures</i></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

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