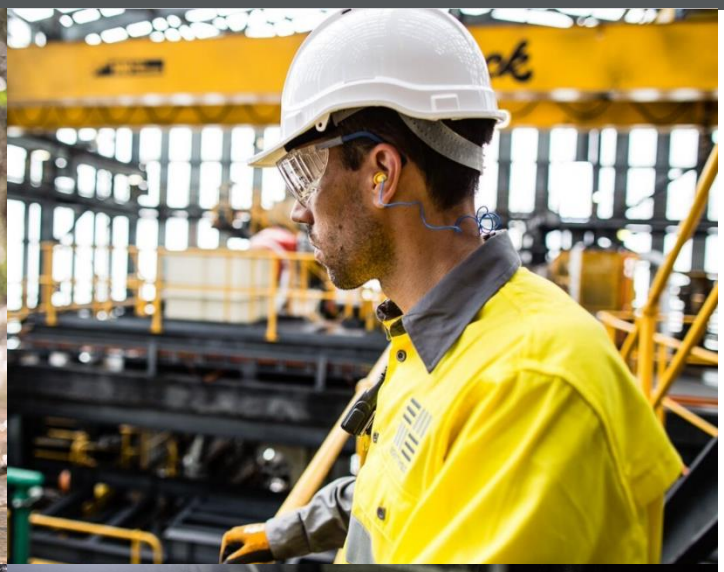
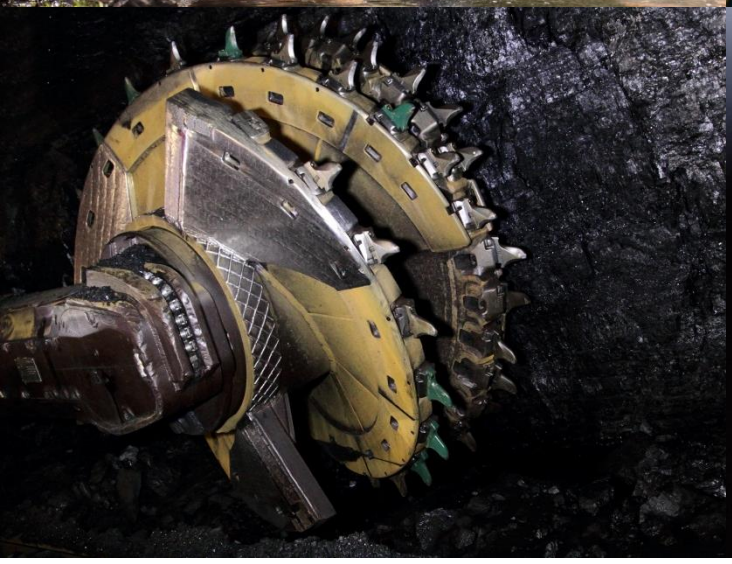
Illawarra Coal
End of Panel Report


Appin Area 9 Longwall 901 End of Panel Report

July 2018

Executive Summary

This End of Panel (EoP) report has been prepared in accordance with the Appin Area 9 (AA9) Longwalls 901- 904 Extraction Plan. This report outlines the measured and observed impacts relevant to the extraction of Longwall 901 and summarises a comparison of observed impacts to predictions and performance criteria.

South32 Illawarra Coal (IC), formerly BHPB Illawarra Coal, operates the Bulli Seam Operations (BSO) extracting hard coking coal used for steel production. On the 22nd 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) to continue mining operations until 31 December 2041.

Illawarra Coal commenced extraction of Longwall 901 on 19th January 2016 and completed extraction on 8th September 2017.

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, Illawarra Coal paid approximately $49.6 Million in government royalties during the 2016/2017 financial year.

Longwall 901 is located within Consolidated Coal Lease 767 which amalgamated a number of long standing head leases for mining coal in 1991.

Measurements of subsidence movements resulting from the extraction of Longwall 901 were obtained using a variety of monitoring techniques for features within the AA9 Study Area.

Measured closure exceeded predicted closure at six of the ten closure lines on the Nepean River. The maximum measured closure (193 mm at the Nep X 9F-Line) exceeded the maximum predicted closure of 120 mm across the Nepean River Valley. Measured closure exceeded predicted closure of 20 mm at two of the five closure lines on Harris Creek, the highest of which, was 27 mm at the Harris Creek Cliff Line Closure Lines (HCCL) D-Line.

The results from the far-field monitoring indicate that regional horizontal movement north of the Nepean River and Harris Creek is orientated towards the south-east; movement south of the Nepean

River is orientated towards the north to north east; and movement east of Harris Creek is at low levels. These AA9 far-field horizontal movement vectors are indicative of ‘plate-type’ regional movements defined by the Nepean River, and to a lesser extent, Harris Creek. The greater than predicted closure at survey lines on the Nepean River and Harris Creek may be due to ‘plate type’ regional movements.

Measurements of subsidence related movements relevant to the Main Southern Railway were generally less than predicted or in the order of survey tolerance.

At the Douglas Park Railway Station, minor differential vertical and horizontal movements were measured along the platform, typically in the order of survey tolerance (MSEC 2018).

The measured vertical subsidence along the Camden Road monitoring line was less than 15 mm, which is in the order of survey tolerance. Measured tensile and compressive strains were typically up to 0.3 mm/m, which is in order of survey tolerance.

The maximum measured strains for the Telstra Optical Fibre Cable (OFC) were 0.2 mm/m tensile and 0.9 mm/m compressive. The conventional strains outside the extents of Longwall 901 were predicted to be less than the order of survey tolerance of 0.25 mm/m tensile and compressive. The maximum compressive strain along the Telstra OFC occurred at a crossing with a small drainage line and, therefore, was likely due to valley closure effects. Elsewhere, the measured strains were in the order of survey tolerance.

The maximum measured closure at the Blades Bridge monitoring line of 7 mm was less than the predicted closure of 20 mm.

After the completion of Longwall 901, the maximum measured absolute horizontal movement associated with the Nepean Twin Bridges was 82 mm, less than the level 1 TARP trigger level of 100 mm. The absolute horizontal movements at marks DPBN and DPBS remained below the Monitoring Review Point Trigger. The maximum measured incremental closure associated with the Nepean Twin Bridges was 8 mm, less than the maximum predicted closure of less than 20 mm. Following the completion of Longwall 901, the total change in horizontal distance between abutments and piers was generally less than 2 mm, which is in the order of survey tolerance. The maximum measured total differential movements, at any time during the extraction of Longwall 901, were 2.3 mm at PSM6 – RST and 3.1 mm at PSM6 – SAA; both were lower than the Level 1 TARP trigger of 5 mm. During the extraction of Longwall 901, the maximum measured differential movement across any of the three movement joints did not exceed any of the TARP triggers.

The measured incremental horizontal movement on the Moreton Park Road Bridge, at Marks MPBE and MPBW, at the completion of Longwall 901, were 15 mm and 19 mm, respectively. The measured movements, therefore, were in the order of survey tolerance. The absolute horizontal movements at marks MPBE and MPBW exceeded the Monitoring Review Point Trigger on two occasions during mining in both AA7 and AA9. These triggers were reviewed by the M31 Hume Motorway Technical Committee on these occasions and were subsequently increased. Following the extraction of Longwall 901, the maximum measured absolute horizontal movement at MPBE and MPBW was 136 mm, less

than the Level 1 trigger of 150 mm. Following the completion of Longwall 901, the total changes in horizontal distance between the bridge abutments were less than ±2 mm, which is in the order of survey tolerance.

Monitoring of potential impacts, due to the extraction of Longwall 901, was conducted in accordance with the AA9 Subsidence Monitoring Program (SMP).

Impacts to two private properties boreholes were reported during the extraction of Longwall 901. In response to the impacted boreholes on each property, a Water Management Plan (WMP) was implemented in order to compensate the landholders, providing them with a water supply comensurate with pre-mining conditions.

There were no observed or reported impacts to cultural heritage features within the AA9 Study Area during the extraction of Longwall 901.

Analyses of water level measurements, made by the Illawarra Coal Environmental Field Team (ICEFT), show that during the reporting period, water levels at monitoring sites on the Nepean River typically lie within the baseline range (HGEO 2018). However, site 'NR0', exhibited a decline in water level compared to the baseline period, which was also reflected at the reference site 'NR110', approximately 3.5 km upstream of Longwall 901. Due to a dislocated reference datum at 'NR110', in May 2016, it was difficult to attribute a cause to the observed reduction in water level at 'NR0' (HGEO 2018).

During the reporting period, the Nepean River exhibited highly variable water quality within the study reach. On several occasions during the monitoring period, multiple water parameters deviated from the baseline mean by more than one or two standard deviations (HGEO 2018). Level 2 TARP trigger levels were recorded at 'NR0', 'SW3/NR1' and 'NR2' for Electrical Conductivity (EC) a measure of salinity- during December 2016 and July 2017. However, these levels were also reflected at the upstream reference site 'NR110' during the same period. This increase is associated with periods of low rainfall in the region, and are not attributed to the extraction of Longwall 901 (HGEO 2018).

Minor gas emissions were predicted as likely to occur within the AA9 study reach of the Nepean River due to the extraction of Longwalls 901 – 904 (Ecoengineers 2012). During the reporting period, ICEFT identified 26 gas release zones within the AA9 study reach on the Nepean River. Each of the 26 gas release zones had estimated emission rates of < 3000 L/min, and were classified as Level 1 TARP triggers.

Within the AA9 Study Area, a decline in groundwater level was identified in the Hawkesbury Sandstone at two monitoring bores, S2281 and S1941, 190 m and 980 m from Longwall 901 respectively (HGEO 2018). The reduction in groundwater level, at both bores, was less than the predicted maximum reduction of 10 m outlined in the WMP.

No significant changes in groundwater chemistry were observed during the monitoring period (HGEO 2018).

The calculated groundwater inflow into the Appin Mine workings ranged between 0.2 to 1 ML/day (20-day moving average), less than the Level 1 TARP trigger of 2.7 ML/day (HGEO 2018).

The results of the latest aquatic ecology survey, conducted by Cardno in November 2017, were compared with those obtained in November 2008, December of 2010, 2011, 2012, 2013 and 2014 and November of 2015 and 2016. There were no impacts or changes to key aquatic ecology indicators that were attributable to mining in AA7 and AA9 (Cardno 2018).

Apart from gas release zones identified on the Nepean River, the ICEFT did not observe any surface impacts that have been deemed as having the potential to impact the terrestrial ecology in the AA9 Study Area. The ICEFT did not observe any additional impacts, such as decreases in vegetation health, associated with gas release zones on the Nepean River. Thus, it has been concluded that the extraction of Longwall 901 has resulted in negligible impacts to terrestrial ecology within the AA9 Study Area.

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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	Environmental Planning and Assessment Act 1979
IC	Illawarra Coal
ICEFT	Illawarra Coal Environmental Field Team
IPM	Incremental Profile Method
PAC	Planning and Assessment Commission
SMP	Subsidence Monitoring Program
WMP	Water Management Plan

1. Introduction

South32 Illawarra Coal (IC), formerly BHP Illawarra Coal, operates the Bulli Seam Operations (BSO) (Appin Mine) extracting hard coking coal used for steel production. On 22nd December 2011, the Planning and Assessment Commission (PAC), under delegation of the Minister for Planning, approved 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 10th September 2014. IC subsequently shortened the commencing (i.e. western) end of Longwall 901, the first longwall in the series, by 418 m from the extent indicated in the Extraction Plan Application. Report No. MSEC743 (Rev. A) was issued in February 2015 in support of the modification. The modified commencing end of Longwall 901 was approved by the DP&E on 29th April 2015. IC commenced extraction of Longwall 901 19th January 2016 and completed the extraction 8th September 2017.

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.

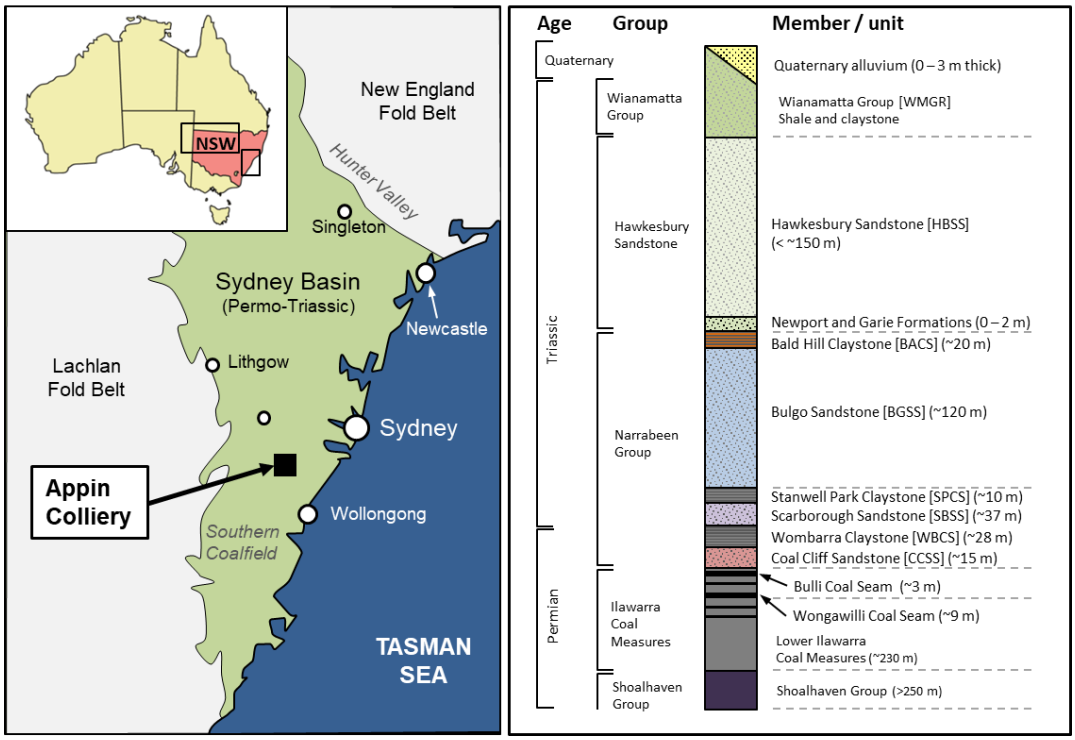

Figure 1: Stratigraphy and location of the Southern Coalfields within the Sydney Basin (Source: HGEO 2018).

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 depth of cover directly above the proposed longwalls varies between a minimum of 490 m, above the western end of Longwall 901, and a maximum of 725 m, above the western end of Longwall 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.

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).

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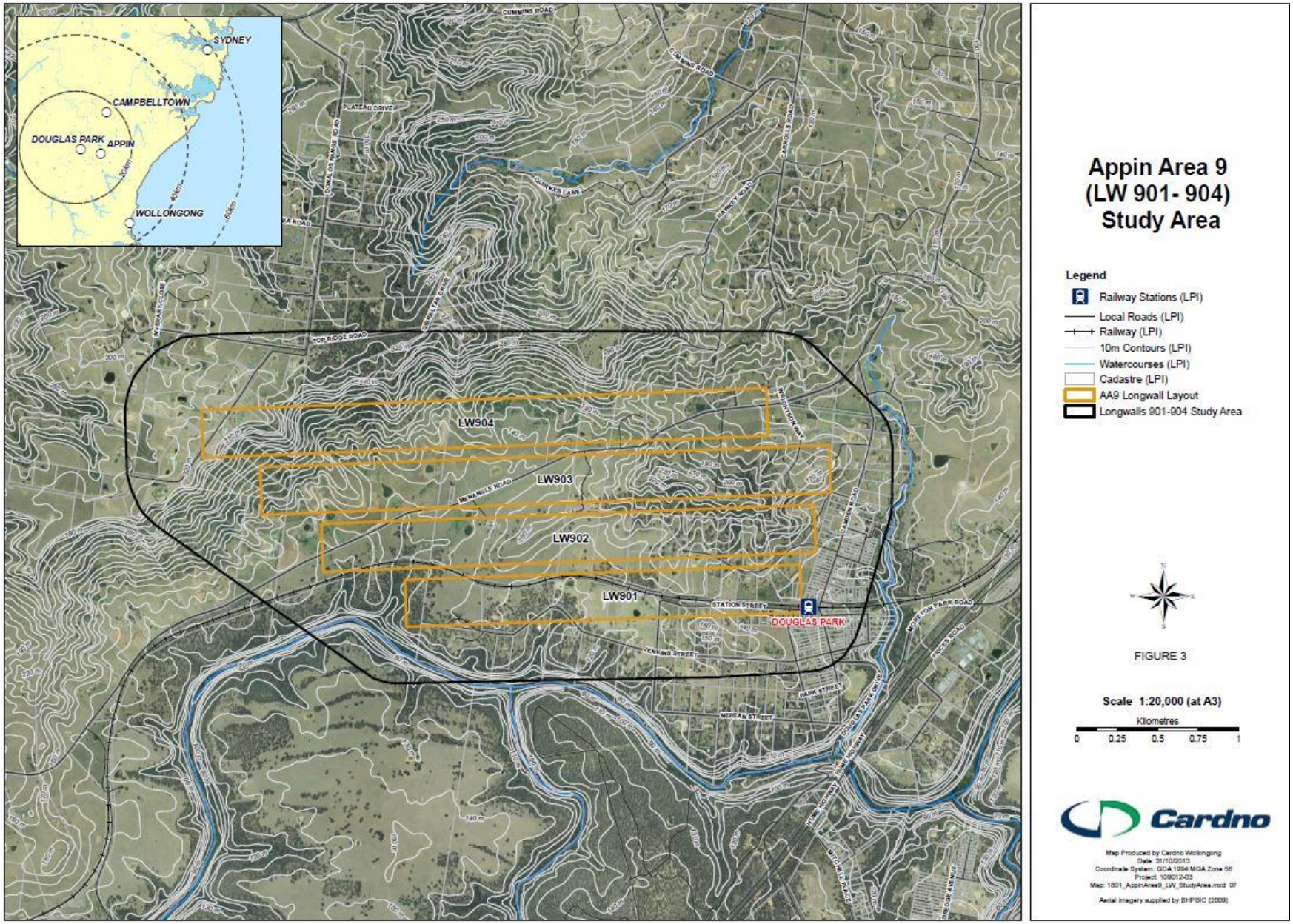

Figure 2: Map showing the AA9 Study Area. Source: Cardno.

3. Stakeholder Engagement

Monitoring data and other information has been made available to the community by Illawarra Coal during the extraction of AA9. Information on Illawarra Coal 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 Illawarra Coal 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 review; and
- Information days.

Illawarra Coal aims to mitigate the potential impacts subsidence may cause to community members through various means outlined in Table 1.

Table 1: Social Impact Variables Associated with Subsidence.

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

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 901, 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.

4. Predicted and Measured Subsidence

The following section provides a summary of comparisons between predicted and measured subsidence movements relating to the extraction of Longwall 901. For further details, refer to the report MSEC927, which is provided as **Attachment B.**

Predictions of subsidence movements relating to the extraction of Longwall 901 were obtained by MSEC using the Incremental Profile Method (IPM) based on prediction curves for the Southern Coalfield.

Measurements of subsidence movements resulting from the extraction of Longwall 901 were obtained using monitoring lines, monitoring points and other methods at the following locations (Figure 3):

- Main Southern Railway, including the track, embankments and culverts;
- Sewer horizontal bore and Douglas Park Station;
- Telstra optical fibre cable 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;
- Moreton Park Road Bridge South monitoring points; and
- ALS surveys.

4.1. Main Southern Railway

The Main Southern Railway crosses directly above the entire length of Longwall 901 (Figure 3); associated monitoring includes:

- Australian Rail and Track Corporation (ARTC) monitoring line;
- automated track monitoring;
- embankment monitoring points;
- cutting monitoring points;
- culvert monitoring points;
- sewer horizontal bore monitoring points; and
- Douglas Park Station monitoring points.

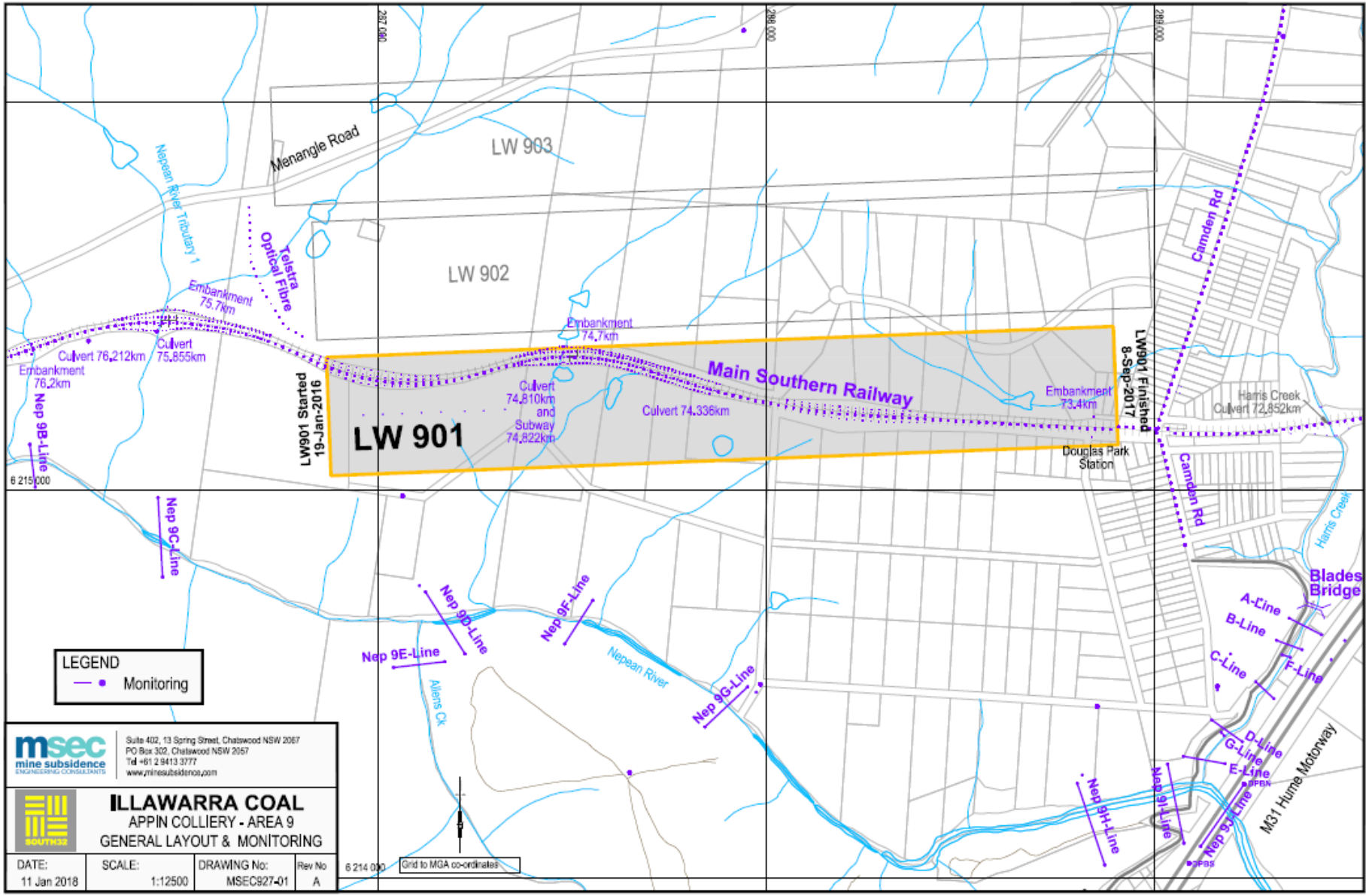

Figure 3: Map showing subsidence monitoring sites relevant to Longwall 901 (Source: MSEC 2018)

The ARTC monitoring line is located along the section of the Main Southern Railway that crosses Longwall 901, and is monitored using 2D and 3D survey techniques. The maximum measured vertical subsidence was 287 mm, considerably less than the maximum predicted vertical subsidence (575 mm). This observed difference was particularly apparent directly over Longwall 901, and is primarily due to the use of the IPM, which generally produces conservative subsidence predictions for the first longwall in a series (MSEC 2018). To a lesser degree, the discrepancy between measured and predicted subsidence above Longwall 901 may be due to the monitoring line being located relatively close to the maingate (to the west) and tailgate (to the east) of the longwall (MSEC 2018).

Measured vertical subsidence was slightly greater than predicted towards the western extent of the monitoring line but was not associated with measurable tilts, curvatures or strains. This low-level subsidence (i.e. less than 50 mm) was in the order of survey tolerance (MSEC 2018).

During extraction, maximum uplift of 70 mm was observed in front of the Longwall 901 extraction face. Following the completion of Longwall 901, the uplift reduced to approximately 30 mm.

The maximum measured tilt of 1.7 mm was less than the maximum predicted tilt of 2.5 mm. The maximum measured tensile (0.5 mm/m) and compressive (1.1 mm/m) strains were comparable to the maximum predicted tensile (0.5 mm/m) and compressive (1.0 mm/m) strains (MSEC 2018).

Rail stress transducers are located along all four rails of the railway, spaced every 25 to 60 m. The transducers measured changes in rail stress every 5 minutes during the mining of Longwall 901. While some false alarms were triggered during mining, due to malfunction or damage to transducers, actual stress readings did not exceed trigger levels (MSEC 2018).

Displacement sensors have been installed at each expansion switch. Measurements were recorded every 5 minutes during the mining of Longwall 901. While some low-level (Blue) alarms were triggered during mining, responses had already been planned in anticipation of the alarms (MSEC 2018).

Embankments in AA9 are located at railway chainages 74.7 km, 75.7 km and 76.2 km. The embankment at 74.7 km is located directly above Longwall 901 and the embankments at 75.7 km and 76.2 km are located at minimum distances of 0.3 km and 0.7 km, respectively, to the west of Longwall 901. The mine subsidence movements at the embankments were measured by IC using 3D ground monitoring lines along their crests and toes. Only minor differential vertical and horizontal movements were measured along the embankments, typically similar to survey tolerance. Fixed-in place inclinometers, piezometers and extensometers have also been installed at the embankments at 74.7 km and 75.7 km. Only minor movements were recorded during the mining of Longwall 901 (MSEC 2018).

The mine subsidence movements at the cuttings were measured by IC using 3D ground monitoring lines along their tops and toes. Closure developed across each of the cuttings that resulted in changes in track geometry. The changes in track geometry were managed in accordance with the

Management Plan and there were no adverse impacts on the safety or serviceability of the railway. There were no adverse impacts on the cuttings (MSEC 2018).

The mine subsidence movements at the culverts were measured by IC using 3D ground monitoring lines along their main axes. Only minor differential vertical and horizontal movements were measured along the culverts, typically similar to survey tolerance (MSEC 2018).

Douglas Park Station is located immediately to the east of the finishing end of Longwall 901. The mine subsidence movements at the station platform were measured by IC using 3D monitoring points along its length. Only minor differential vertical and horizontal movements were measured along the platform, typically in the order of survey tolerance (MSEC 2018).

4.2. Sewer Horizontal Bore

The measured changes in length for the horizontal bore were within the order of survey tolerance. The 3D measurements indicate that the ground had moved towards the south-east by approximately 50 mm. The change in absolute level was less than 20 mm and, therefore, was in the order of survey tolerance (MSEC 2018).

4.3. Camden Road Monitoring Line

During the extraction of Longwall 901, up to 50 mm of uplift was observed along the southern extent of the monitoring line, which reduced to approximately 40 mm of uplift following the completion of Longwall 901.

The measured vertical subsidence along the Camden Road monitoring line was less than 15 mm, which is in the order of survey tolerance. Measured tensile and compressive strains were typically up to 0.3 mm/m, which is in order of survey tolerance.

4.4. Telstra Optical Fibre Cable

The Telstra OFC monitoring line is located north-west of Longwall 901, at a minimum distance of approximately 0.1 km from the longwall commencing end. This monitoring line was measured using 2D and 3D survey techniques. The measured subsidence from the final survey was typically less than survey tolerance.

The maximum measured strains for the Telstra OFC were 0.2 mm/m tensile and 0.9 mm/m compressive. The conventional strains outside the extents of Longwall 901 were predicted to be less than survey tolerance of 0.25 mm/m tensile and compressive. The maximum compressive strain along the Telstra OFC occurred at a crossing with a small drainage line and, therefore, was likely due to valley closure effects. Elsewhere, the measured strains were in the order of survey tolerance.

4.5. Nepean River Closure Lines

The Nepean River Closure lines (Nep X 9A-Line to Nep X 9J-Line) are a series of 2D monitoring lines that run across the Nepean River Valley, except the Nep X9E Line, which runs across Allens Creek, near the confluence with the Nepean River. Measured closure exceeded predicted closure at six of the ten closure lines. The maximum measured closure of 193 mm at the Nep X 9F-Line exceeded the

maximum predicted final closure of 120 mm at any monitoring line across the Nepean River Valley. Ground movement vectors derived from far-field monitoring suggest that regional 'plate type' movements may have contributed to the valley closure movements.

4.6. Harris Creek Cliff Line Closure Lines

The HCCL A-Line to HCCL E-Line are a series of 2D monitoring lines that run across the valley of Harris Creek. Measured closure was greater than predicted closure of 20 mm at two of the five HCCL monitoring lines, the highest of which, was 27 mm at the HCCL D-Line. The greater than predicted closure may be due to 'plate type' regional movements defined by the Nepean River and Harris Creek.

4.7. Blades Bridge Monitoring Points

Blades Bridge runs across the valley of Harris Creek; the Blades Bridge monitoring points consist of two prisms affixed to abutments on the bridge. The maximum measured closure of 7 mm was less than the predicted closure of 20 mm.

4.8. Far-Field Monitoring

Far-field horizontal movements in proximity to Longwall 901 were measured in 3D using an array of far-field monitoring points over AA9. The largest measured horizontal movements were observed along the ARTC monitoring line, directly above Longwall 901; these movement vectors were orientated towards the south to south-east. The measured incremental horizontal movements at the AA9 far-field marks adjacent to the Nepean River and Razorback Range were at the upper end of the range of movements measured elsewhere in the Southern Coalfield (Figure 4). These marks have been affected by valley closure effects and the steep topography. The results from the far-field monitoring indicate that regional horizontal movement north of the Nepean River and Harris Creek is orientated towards the south-east; movement south of the Nepean River is orientated towards the north to north east; and movement east of Harris Creek is at low levels. These AA9 far-field horizontal movement vectors are indicative of 'plate-type' regional movements defined by the Nepean River, and to a lesser extent, Harris Creek.

4.9. Nepean Twin Bridges Monitoring Points

The Nepean Twin Bridges are located approximately 0.9 km south-east of the finishing end of Longwall 901. The Nepean Twin Bridges have experienced far-field movements due to the extraction of both Longwall 901 and the adjacent Appin Area 7 longwall series. Monitoring associated with the Nepean Twin Bridges includes:

- Absolute 3D bridge monitoring points;
- Relative 3D bridge monitoring points;
- Inclinometer monitoring;
- Bridge joint monitoring; and
- Visual inspections.

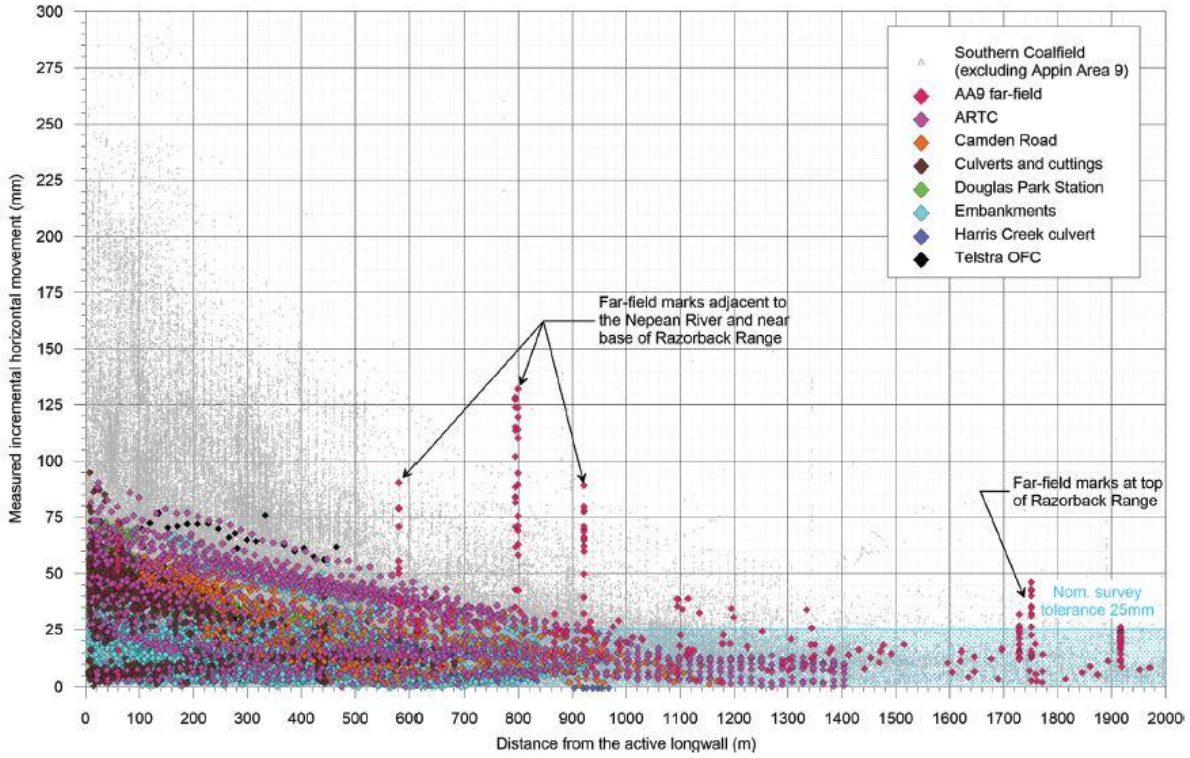

Figure 4: Comparison between the measured incremental horizontal movements at AA9 with those measured elsewhere in the Southern Coalfield (Source: MSEC 2018).

The absolute 3D horizontal movements at the Nepean Twin Bridges were monitored at marks DPBN and DPBS, which are located at the northern and southern ends, respectively, of the twin bridges.

The measured incremental horizontal movements at marks DPBN and DPBS, at the completion of Longwall 901, were 27 mm and 39 mm, respectively. The vectors were orientated towards the north-east and, therefore, are likely to have been influenced by the concurrent mining in Appin Area 7 (MSEC 2018). After the completion of Longwall 901, the maximum measured absolute horizontal movement associated with the Nepean Twin Bridges was 82 mm, less than the level 1 TARP trigger level of 100 mm. The absolute horizontal movements at Marks DPBN and DPBS remained below the Monitoring Review Point Trigger. This trigger was reviewed by the M31 Hume Motorway Technical Committee and increased on two occasions.

The maximum measured incremental closure associated with the Nepean Twin Bridges was 8 mm, in line with the maximum predicted closure of less than 20 mm.

The mine subsidence movements of the Nepean Twin Bridges were measured by IC using relative 3D marks fixed directly to the bridges structures.

Following the completion of Longwall 901, the total change in horizontal distance between abutments and piers was generally less than 2 mm, which is in the order of survey tolerance.

The differential tilt and inclination of the Nepean River Twin Bridges was measured at Site PSM6, using inclinometers (PSM6 – RST and PSM6 – SAA), which consists of a cased borehole and

measuring probe. The inclinometer was installed by Pells Sullivan and Meynink (PSM), measured by IC, and the results interpreted by PSM.

The maximum measured total differential movements, at any time during the extraction of Longwall 901, were 2.3 mm at PSM6 – RST and 3.1 mm at PSM6 – SAA; both are lower than the Level 1 TARP trigger of 5 mm.

Differential movements along three movement joints (Joint 1, Joint 2 and Joint 3) on the Nepean River Twin Bridges were measured by PSM. During the extraction of Longwall 901, the maximum measured differential movement across any of the three movement joints did not exceed any of the respective Level 1 TARP triggers.

4.10. Moreton Park Road Bridge (South)

The bridge experienced far-field movements due to the extraction of Longwall 901 and the concurrent mining in the adjacent Appin Area 7. The monitoring associated with Moreton Park Road Bridge (South) included the following:

- absolute 3D monitoring points;
- relative 3D monitoring points; and
- visual monitoring.

The absolute 3D horizontal movements at Moreton Road Bridge South have been monitored at marks MPBE and MPBW, which are located adjacent to the eastern and western ends, respectively, of the bridge.

The measured incremental horizontal movement at marks MPBE and MPBW, at the completion of Longwall 901, were 15 mm and 19 mm, respectively. The measured movements, therefore, were in the order of survey tolerance.

The absolute horizontal movements at marks MPBE and MPBW exceeded the Monitoring Review Point Trigger on two occasions during mining in both AA7 and AA9. These triggers were reviewed by the M31 Hume Motorway Technical Committee on these two occasions and subsequently increased.

Following the extraction of Longwall 901, the maximum measured absolute horizontal movement at MPBE and MPBW was 136 mm, less than the Level 1 trigger of 150 mm.

The mine subsidence movements of the Moreton Park Road Bridge (South) were measured by IC using relative 3D marks fixed directly to the bridge structure.

Following the completion of Longwall 901, the total changes in horizontal distance between the bridge abutments were less than ±2 mm, which is within survey tolerance.

4.11. Airborne Laser Scan surveys

Airborne Laser Scan surveys were used to measure changes in surface level within the AA9 Study Area. An initial ALS survey was conducted June 2017, prior to the extraction of Longwall 901. In

November 2017, approximately two months after the extraction of Longwall 901, a post-mining ALS survey was conducted.

The measured incremental change in surface level, due to the extraction of Longwall 901, was determined by calculating the difference between the initial baseline survey and the post-mining survey. The calculated difference is used to develop contours, which represent changes in surface level relative to a fixed position in space, i.e. eastings and northings.

The ALS-derived contours differ from traditional subsidence contours, which include both the vertical and horizontal components of the movements of points fixed to the surface. Horizontal movements are usually included in the subsidence profiles, as traditional ground monitoring data is based on the movements of survey marks that are fixed to the ground. Thus, when ALS contours are developed, horizontal far-field movements can be manifested as an apparent increase in vertical subsidence. Due to Longwall 901 being the first longwall in a mining block, the levels of subsidence are reduced and therefore the survey tolerance of the ALS scan, being in the order of 300mm, represents a significant portion of the actual subsidence movements. This technique is therefore not particularly informative in this circumstance.

5. Impacts to Built Features

MSEC provided an assessment of potential built features impacts from the extraction of Longwall 901 (MSEC448 2012 and MSEC743), which supported the Extraction Plan and Modification Applications. A comparison between potential and observed impacts for built features is provided below (Table 2).

Table 2: Summary table comparing predicted and observed impacts for built features in relation to the extraction of Longwall 901 (Source: MSEC 2018).

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 901)
Nepean Twin Bridges	Impacts unlikely after the implementation of the preventive, monitoring and management strategies	No observed adverse 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 observed impacts
Optical fibre and copper telecommunications cables	Impacts unlikely with the implementation of monitoring and management strategies	No observed impacts

Built feature	MSEC assessed impacts	Observed impacts
Survey control marks	Vertical and horizontal movements which could require re-establishment	No observed damage to the survey control marks. The marks 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	No observed impacts
Groundwater bores	Impacts likely including lowering of piezometric surface, blockage and change in groundwater quality	Impacts on two groundwater bores comprising reduction in water level and reduction in bore water pressure. Refer to the *AA9 Longwall 901 End of Panel Landscape Report*
Archaeological sites	Impacts unlikely	Access to site could not be secured from landholder, but no impacts reported
Heritage sites	Impacts unlikely	No observed impacts
Houses	Houses will remain safe and serviceable	Houses have remained in safe and serviceable condition. Claims that have been lodged are being managed by SA NSW through the relevant legislation.

5.1. 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 ICEFT with the consent of the relevant property/infrastructure owner and tenant, if applicable (Figure 5).

The claims submitted to Subsidence Advisory NSW as a result of Longwall 901 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 901 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.

Impacts to two private properties boreholes were reported during the extraction of Longwall 901. In response to the impacted boreholes on each property, a Water Management Plan (WMP) was implemented in order to compensate the landholders, providing them with a water supply comensurate with pre-mining conditions. These impacts are described below; more detailed information can be found in the relevant property report **(Attachment C3)**.

Lots 59 – 63, DP1321

Longwall 901 passed by Lots 59 – 63, DP1321 from 16th April 2016 to 6th August 2016. The landowner requested an inspection of a borehole 13th February 2017; and an inspection of the same borehole and two dams 29th September 2017. The landowner noted that the water level of the bore had decreased and the turbidity of one of the dams had increased. Groundwater level data from a nearby IC monitoring bore (S2281) was used to determine that mining had likely reduced the amount

of water accessible from the private bore. A WMP has been implemented in response to the impacts. Due to the nature of any likely impact, mining was not attributed to the high turbidity in the property dams. However, quarterly water quality monitoring will be carried out on the dams to inform the likelihood of any mining-related impact.

Lot 22, DP203255

Longwall 901 passed Lot 22, DP203255 27th September 2016, at an approximate distance of 150 m. On 2nd November 2017, a post-mining inspection of the property borehole GW072249 (Lot 22 DP803255) was undertaken. Observations showed that the borehole pressure had reduced relative to pre-mining observations. A WMP was implemented in response to the impacted bore.

Table 3: 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)	Reduced yield and water pressure from two private boreholes
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

5.2. 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)

Due to the distance from the longwalls, low levels of subsidence movements predicted and the negligible risk of impacts to the site, it was predicted that there would be negligible consequences for the heritage value of the site from mining. Impacts to the cliff lines on the southern side of the Nepean

River (directly north of the site) are used to trigger an inspection of Bradcorp 1. Given there were no observed impacts to the cliff lines on the Nepean River, it was deemed that there was no impact to Bradcorp 1. The landowner has refused access to the site.

5.3. Douglas Park Railway Cottage

The Railway Cottage is located within an area that has been identified as potentially affected by subsidence. It is currently being used as a residence. The Illawarra Coal Community team attempted to contact the resident (letter box drop and site visit) but were unable to gain access to the property to perform a baseline inspection. Further requests to inspect the property following the extraction of Longwall 901 were made, however, access permission was not granted; there have been no notifications of potential impacts made by the landholder.

6. Impacts to Natural Features

6.1. Surface Water Assessment

Drainage lines in the AA9 Study Area principally flow into the Nepean River. The AA9 Study Reach of the Nepean River is categorised into two main sections based on morphology (MSEC 2012):

- Section 1 (upstream of the Allens Creek confluence), where flow is controlled by boulderfields, two rockbars and a small weir.
- Section 2 (downstream of the Allens Creek confluence), where the river is a flooded valley, controlled by the Douglas Park Causeway.

The Nepean River AA9 Study Reach receives flow from multiple sources, including perennial discharge from the Avon, Nepean and Cordeaux Dams; the licensed discharge from Appin Colliery (via Clements and Allens Creeks) and Tahmoor Colliery (via the Bargo River); and agricultural and urban stormwater runoff. Upstream of the Study Reach, flow is primarily controlled by Maldon Weir. Downstream of the study reach, delineated by the Douglas Park Causeway, flow is primarily controlled by Menangle Weir (Ecoengineers 2012 and GeoTerra 2011). Flow in the Nepean River is highly sensitive to rainfall events due to the large catchment area, reaching very high levels during sustained storm events (Ecoengineers 2012). The median (50 percentile) flow rate within the study reach has been estimated at 30 ML/day, whilst the minimum flow rarely falls below 1.5 ML/day (Ecoengineers 2012). Cease to flow conditions only occur on rare occasion, during drought conditions when the rate of pumping extraction exceeds inflow (Ecoengineers 2012).

Within AA9, tributaries that drain into the Nepean River include:

- Nepean River Tributary 1.
- Harris Creek, located east of the proposed longwalls and 400 m from Longwall 903 at its closest point. It is located just outside the AA9 Study Area, although Harris Creek has experienced valley related movements.

Relatively small first and second order streams, which are located along the Nepean River gorge, discharging during periods of relatively high rainfall.

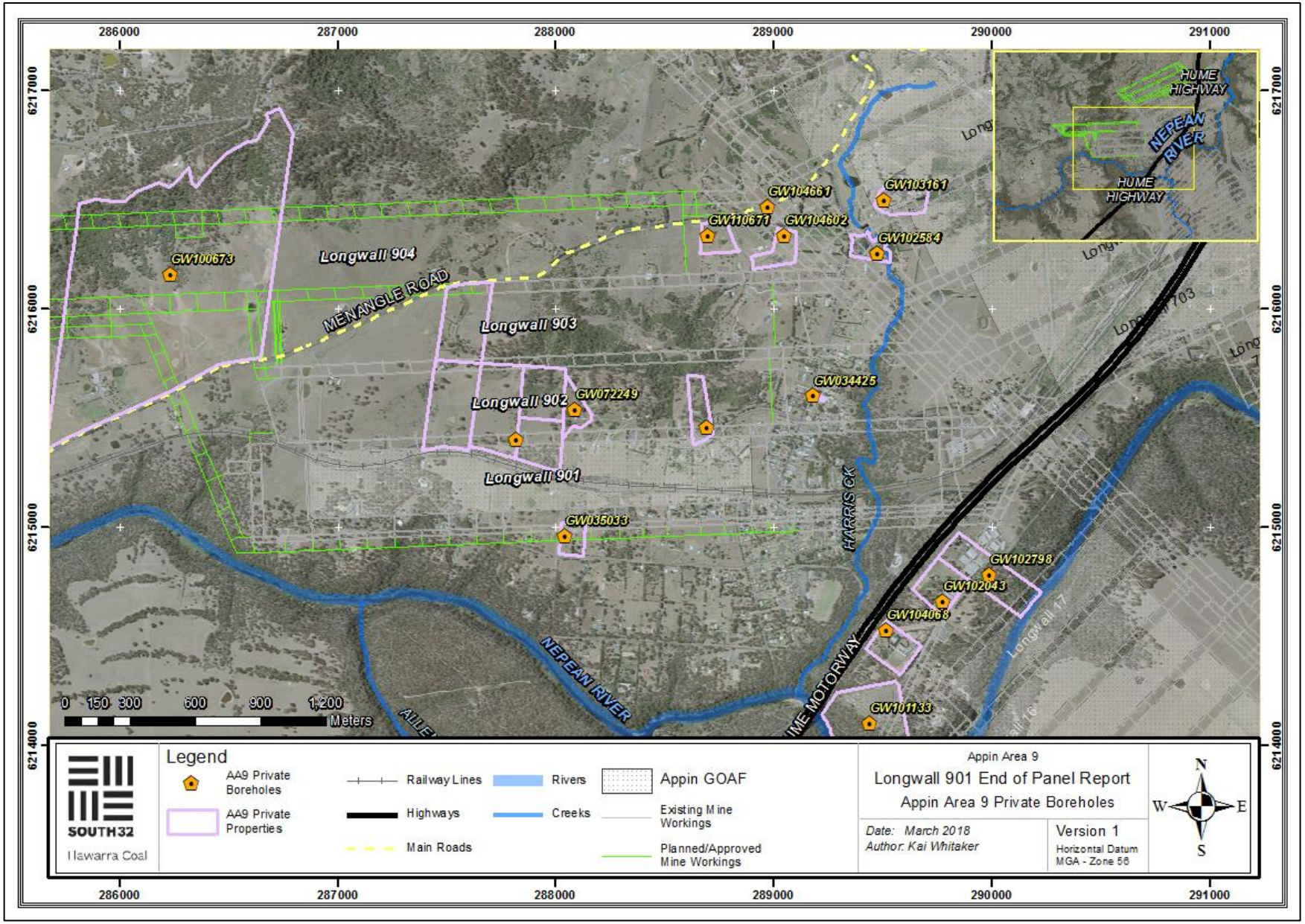

Figure 5: Map showing private properties with boreholes relevant to Longwall 901.

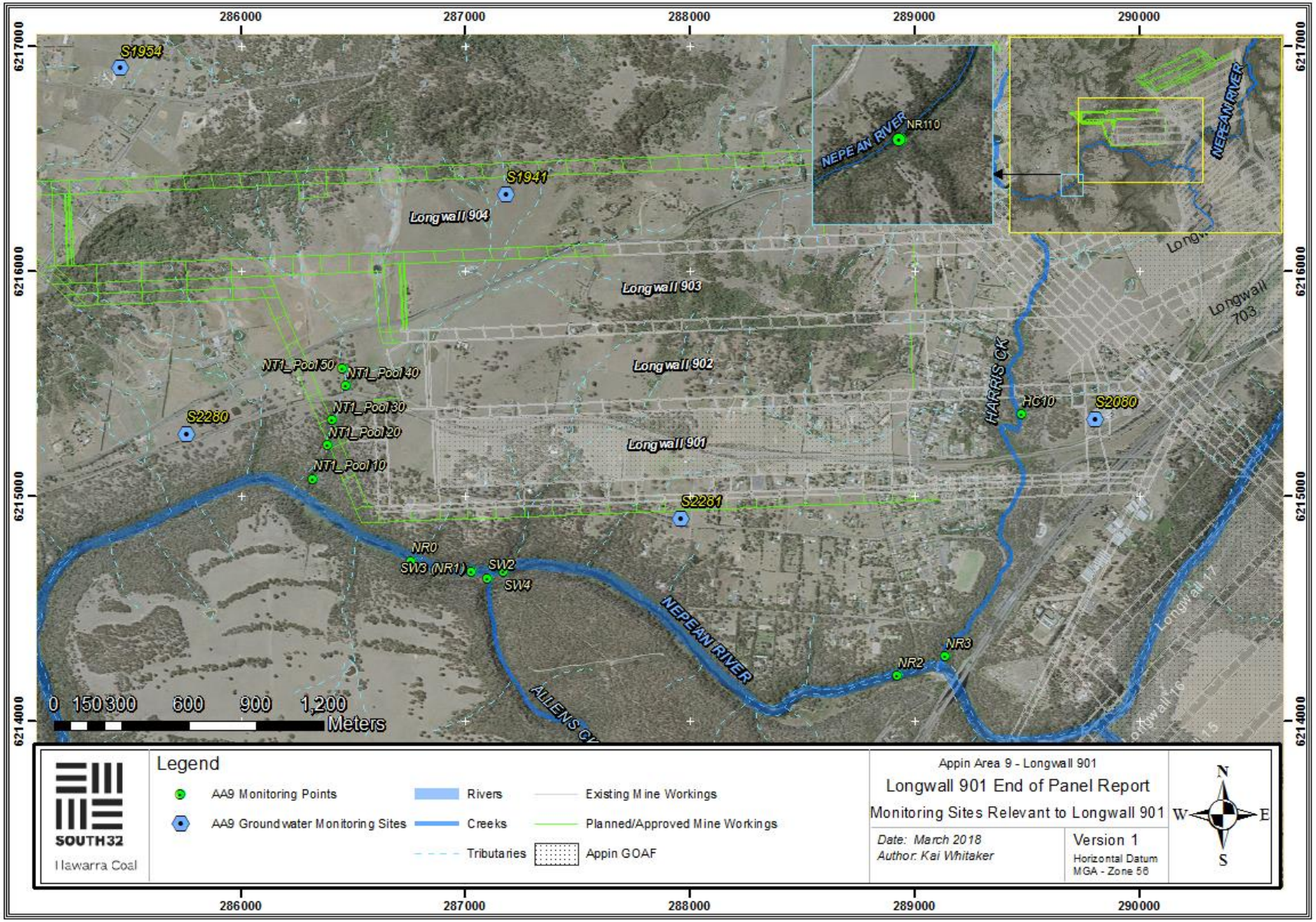

Figure 6: Map showing surface water and deep groundwater monitoring sites.

The WMP recommended a flow monitoring approach for the Nepean River based on dry weather recession characteristics for Broughtons Pass, Maldon and Menangle Weirs, derived from daily flow records, obtained by WaterNSW (Ecoengineers 2012). However, following the release of the WMP in 2014, WaterNSW discontinued flow monitoring at these sites. Thus, the recommended monitoring approach could not be applied.

Regular water level spot measurements, within the Study Reach, are made by ICEFT using installed benchmark datums at several monitoring sites. Analyses show that during the reporting period, water levels at these sites typically lie within the baseline range (HGEO 2018). An exception to this trend was identified at site 'NR0', which showed a decline in water level compared to the baseline period (HGEO 2018). However, this decline was also identified at the reference site 'NR110', approximately 3.5 km upstream of Longwall 901. Notably, due to a dislocated reference datum at 'NR110', water level measurements cease following May 2016. Thus, it is difficult to attribute a cause to the observed reduction in water level at 'NR0' (HGEO 2018). The reference datum has since been reinstalled at 'NR110', as per the recommendation from the Surface Water Assessment.

During the reporting period, the Nepean River exhibited highly variable water quality within the Study Reach. On several occasions during the monitoring period, multiple water parameters deviated from the baseline mean by more than one or two standard deviations (HGEO 2018). Level 2 TARP trigger levels were recorded at 'NR0', 'SW3/NR1' and 'NR2' for EC (salinity) during December 2016 and July 2017. However, these levels were also reflected at the upstream reference site 'NR110' during the same period, and are associated with periods of low rainfall in the region, and are not attributed to the extraction of Longwall 901 (HGEO 2018).

Minor gas emissions were predicted as likely to occur within the AA9 Study Reach of the Nepean River due to the extraction of Longwalls 901 – 904 (Ecoengineers 2012). During the reporting period, ICEFT identified 26 gas release zones within the AA9 Study Reach on the Nepean River. Each of the 26 gas release zones had estimated emission rates of < 3000 L/min, and were classified as Level 1 TARP triggers (Figure 7). Temporary DO reductions (DO 'sags'), due to dissolved methane consumption by methanotrophic bacteria, associated with gas emissions in the Nepean River, were predicted as possible but unlikely to have a negative ecological impact (Ecoengineers 2012). More detailed information on the gas emissions observed in the Nepean River can be found in the Longwall 901 End of Panel Landscape Report; details for *AA9_LW901_026*, which was identified after the completion of the Longwall 901 End of Panel Landscape Report can be found in a separately attached Impact Report **(Attachment C2)**

There were no groundwater outflows or ferruginous springs observed during the reporting period.

Table 4: Summary table of potential and observed impacts to surface water quality within natural features (Source: HGEO 2018).

Potential Impact	Description	Impact Prediction	Observed Impact
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)	26 gas release zones identified in the Nepean River.
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
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	None identified

6.2. Groundwater Assessment

Within the AA9 Study Area, there are seven groundwater monitoring sites; groundwater levels are monitored using multi-level vibrating wire piezometers, which are grouted into a borehole. A moderate decline in groundwater level was identified in the Hawkesbury Sandstone at two monitoring bores, S2281 and S1941, 190 m and 980 m from Longwall 901 respectively (HGEO 2018). The reduction in groundwater level, at both S2281 and S1941, was less than the predicted maximum reduction of 10 m outlined in the WMP; thus, no TARP levels were reached.

It is likely that some groundwater quality changes would occur due to the extraction of Longwall 901 but there is a relatively low level of groundwater resource use in the area (GeoTerra 2011). Groundwater samples are collected at four monitoring boreholes; two of which are sampled at multiple depths. No significant changes in groundwater chemistry were observed during the monitoring period (HGEO 2018).

Loss of stream flow or substrate groundwater to the Bulli Seam workings has not been observed in any mines in the Southern Coalfield at similar depths of cover that exist at AA9. The potential for inflow of surface water to mine workings is low. The horizontal permeability of the Hawkesbury Sandstone and Bulgo Sandstone above and below the Bald Hill Claystone may be enhanced after

subsidence, however no free draining direct vertical hydraulic connection to the Bulli Seam workings is anticipated (GeoTerra 2011).

A daily water balance is maintained by South32. The balance tracks daily volumes of water pumped into the mine (supply), within the mine, and from the mine into storage and/or discharge. The rate of groundwater inflow to the Appin Mine workings is determined by subtracting the water supply volume (to Area 9) from the total volume of water pumped to storage. Total mine inflow to Area 9 is calculated from 31st July 2017. The TARP level for mine inflow is based on the 20-day moving average of inflow to Area 9. The calculated 20-day moving average groundwater inflow into the Appin Mine workings fluctuated between 0.2 and 1 ML/day, less than the level 1 TARP trigger of 2.7 ML/day (HGEO 2018).

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

Potential Impact	Description	Impact Prediction	Observed Impact
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).	A reduction was observed in the Hawkesbury Sandstone, which was less than Level 1 TARP triggers.
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 changes in groundwater chemistry were detected.
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 to the mine remained well below the Level 1 TARP trigger.

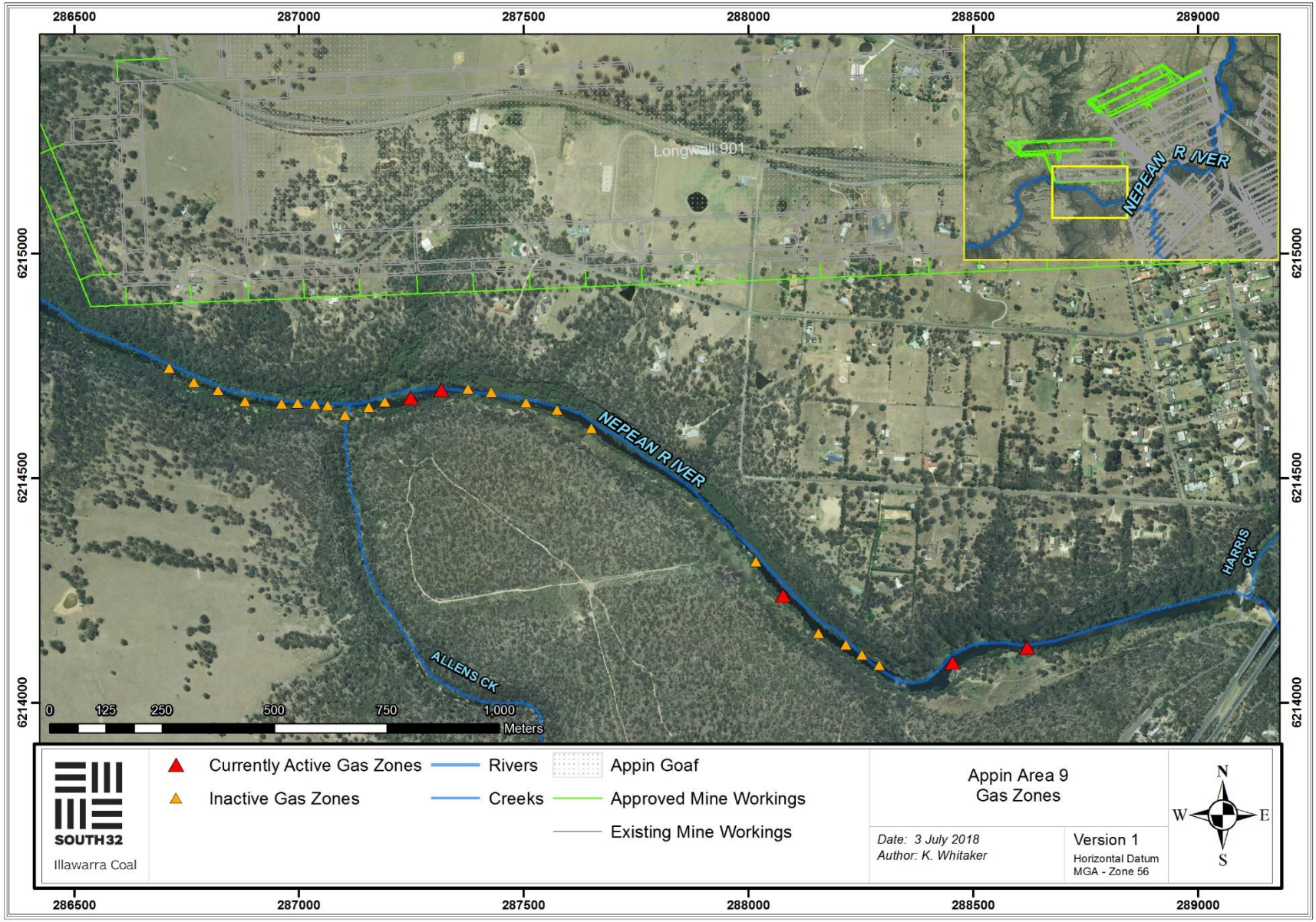

Figure 7: Map showing gas release zones on the Nepean River observed during the extraction of Longwall 901 as of the 3rd July 2018. The last recorded status of each impact site, i.e. either 'active' or 'inactive', is symbolised.

6.3. 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 8). The aims of the monitoring program are to:

> Determine the occurrence of fish and macroinvertebrates and asses 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.

The results of the latest aquatic ecology survey, which was conducted in November 2017, were compared with those obtained in November 2008, December of 2010, 2011, 2012, 2013 and 2014 and November of 2015 and 2016.

Observations from the surveys suggest that the aquatic habitat in the Nepean River was generally in good condition, though the AUSRIVAS results did not fully reflect this observation, but rather, suggested impaired habitat and / or water quality (Cardno 2018). Poor water quality, particularly water at the bottom of the water column, and alteration to the natural flow regime of the river due to several flow controlling structures, upstream and downstream of the Study Area, may explain the often depauperate macroinvertebrate assemblages sampled (Cardno 2018). The somewhat poor condition of the macroinvertebrate fauna in the Nepean River during the monitoring program was not attributed to mining, but rather, reduced water quality associated with poor water quality from catchment run-off and the existing flow impeding structures (i.e. weirs) on the Nepean River (Cardno 2018). There is also no evidence that the extraction of Longwall 901 (or longwalls in AA7) has had any impact on fish populations.

Over the course of the monitoring program large changes in the distribution of aquatic macrophytes have occurred. Most recently, high flows that have occurred in the river since the previous survey in 2016, appear to have had a substantial effect on the extent of aquatic macrophytes at some sites in the current survey. Despite this, the species composition of macrophytes has been relatively

consistent and the number and type of species identified in November 2017 were comparable to those identified in December of 2013 and 2014 and November of 2015 and 2016. Given the absence of any observed macrophyte desiccation and die-back, there is no evidence to suggest that changes in macrophyte diversity and distributions are outside what would be expected due to natural variation, particularly, changes to bank and river bed morphology due to recent flood events, which appear to have resulted in substantial localised changes in the coverage of macrophytes independent of mining (Cardno 2018).

There is no evidence that any impaired aquatic habitat or water quality is due to any mining related disturbance in the Nepean River (Cardno 2018). Analyses showed there were no changes to aquatic ecology indicators that could be associated with the extraction of Longwall 901, which was expected, given that no water quality or physical mining impacts (other than gas releases) were identified on the Nepean River (Cardno 2018). The gas releases identified in the Nepean River during extraction of Longwall 901 do not appear to have had any measurable effect on macroinvertebrates, fish and macrophytes in the Nepean River (Cardno 2018).

Monitoring of sites relevant to AA9 should be undertaken next in November 2019 (monitoring for AA9 is undertaken biennially). The next survey will provide during-extraction or further pre-extraction data for Longwall 902, depending on whether extraction has commenced. The requirement for monitoring associated with extraction of Longwalls 903 and 904 will be determined following extraction of Longwall 902.

Table 6: Predicted and observed impacts to aquatic ecology associated with Longwall 901 (Source: Cardno 2018).

Attribute	Predicted Physical Impacts	Predicted Impacts on Aquatic Ecology	Observed Impacts to Aquatic Ecology
Nepean River			
Ponding, flooding and scouring of stream banks	The river is not predicted to experience any significant changes in the levels of ponding, flooding or scouring of the river banks, or any significant changes in the water levels or stream alignment due to longwall extraction.	There are unlikely to be any measurable impacts on the availability or connectivity of aquatic habitats in the downstream reach of the Nepean River due to its flooded nature and very low gradient.	None identified during observations of aquatic macroinvertebrates, fish and aquatic macrophytes at aquatic ecology monitoring sites in 2017.
Fracturing of bedrock and diversion of surface flows	Minor and isolated fracturing of the river bed could occur; however, it is not expected to result in any loss of surface water flows.	It is considered unlikely that there would be any net loss of water from the catchment. No significant changes in the quantity or quality of permanent aquatic habitat.	None identified during observations of aquatic macroinvertebrates, fish and aquatic macrophytes at aquatic ecology monitoring sites in 2017.
Gas releases	Minor gas releases, associated iron precipitate and reductions in concentrations of dissolved	Negligible consequences to aquatic ecology.	None identified during observations of aquatic macroinvertebrates, fish and aquatic macrophytes at

	oxygen are likely to occur due to extraction.		aquatic ecology monitoring sites in 2017.
Drainage Lines			
Fracturing of bedrock and diversion of surface flows	Fracturing could occur in the drainage lines above or immediately adjacent to the proposed longwalls. In areas of exposed bedrock, some diversion of surface water flows and the draining of pools may occur in associated drainage lines. It was considered unlikely that there would be any net loss of water from the catchment.	Effects to aquatic habitat and biota due to any diversion of flows and draining of pools in drainage lines would be minimal, due to the limited aquatic habitat provided by these areas.	No fracturing observed in drainage lines.

6.4. 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 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 901 has resulted in negligible impacts to terrestrial ecology within the AA9 Study Area.

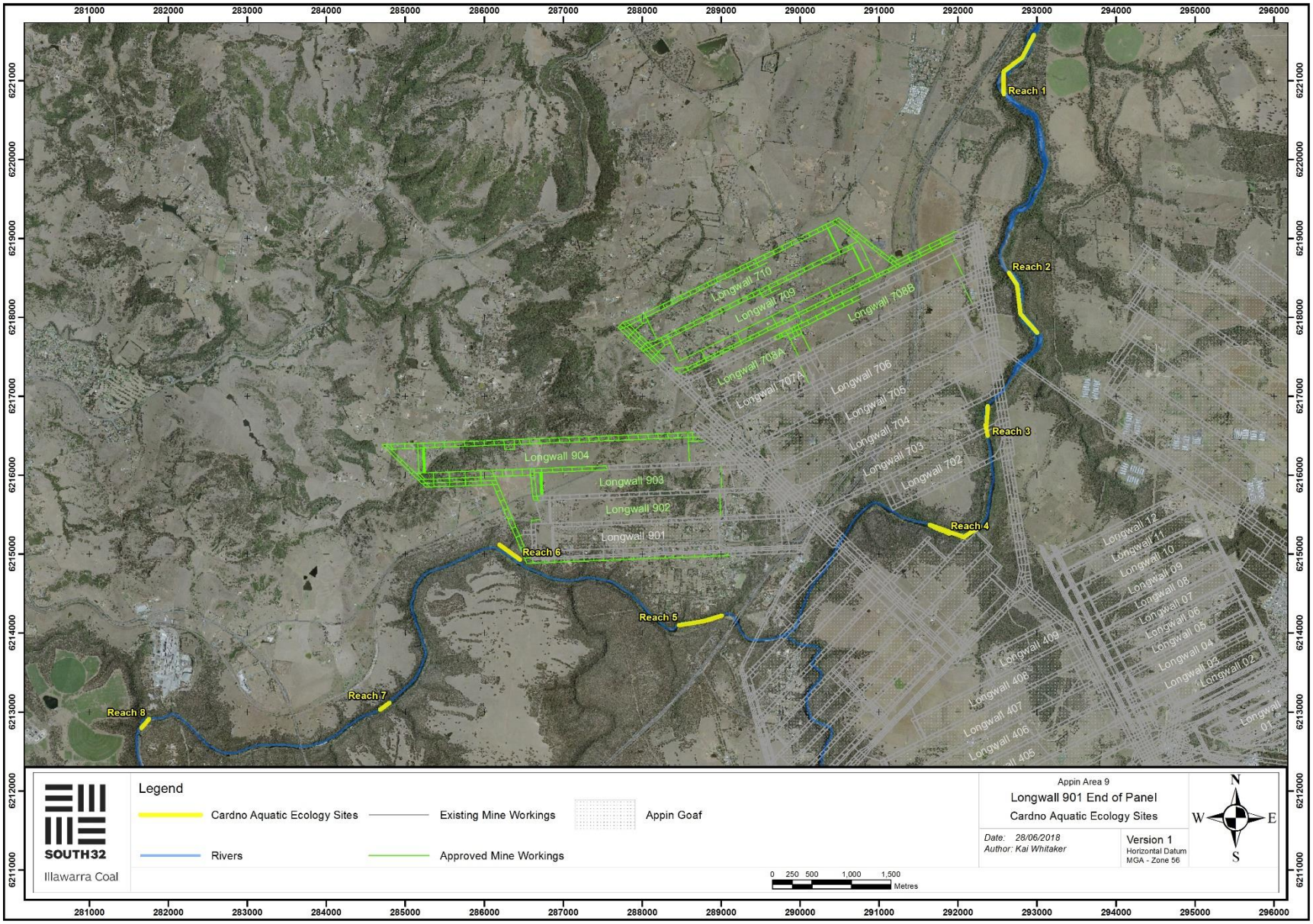

Figure 8: Aerial image displaying the aquatic ecology monitoring sites on the Nepean River and their respective Reaches in relation to AA7 and AA9 Longwalls. Sites 3, 4, X1 and X2 were not visited in the current study.

7. Longwall 901 Monitoring Program

Table 7: Summary of the Longwall 901 monitoring program; observations and recommendations for future monitoring (specifically Longwall 902) are also included

	Monitoring Site	Monitoring Type	Monitoring Frequency	Parameters	Observations from Longwall 901	Future Monitoring (LW 902)
SURFACE WATER						
AREA 9	**Nepean River and tributaries** • NR110 (Lab, Field, Level, Obs) • NR0 (Lab, Field, Level, Obs) • SW2 (Lab, Field, Obs) • SW3 (NR1) (Field, Obs – LW901 only) • SW4 (Field, Obs – LW901 only) • NR2 (Lab, Field, Level, 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)	• Lab sample • Field parameters • Water levels • Observations	• 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	**Field Parameters:** • Temperature • Dissolved Oxygen (DO) • Specific Conductivity • pH • ORP **Standard Lab Sample:** • pH and EC • Filtered, Na, K, Ca, Mg, Cl, Ni, Zn, Fe, Mn, Al, SO_4 • Total Fe, Mn, Al • Total Alkalinity • TKN, TP, NH_3-N, NO_x-N (TON), FRP, TSS, DOC **Lab Sample for Gas Releases:** • CH_4 • C_2H_6 • Trace Phenols • Sulphide **Observations:** • Iron or salinity staining (e.g. orange or white staining in water or on banks/seeps) • Evidence of springs in the Nepean River	• 26 gas release zones identified • Deviations in water quality were observed; however, they were not attributed to mining impacts	• Continue monitoring as required

Monitoring Site		Monitoring Type	Monitoring Frequency	Parameters	Observations from Longwall 901	Future Monitoring (LW 902)
				• 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	• Reduction in water level, compared to baseline period, at 'NR0' and 'NR110'. Unable to attribute a cause to the reduction in water level due to a dislocated benchmark	• Reinstallation of water level benchmark at NR110

	Monitoring Site	Monitoring Type	Monitoring Frequency	Parameters	Observations from Longwall 901	Future Monitoring (LW 902)
AREA 9	**Flow monitoring** • Maldon Weir • Broughtons Pass Weir • Menangle Weir	• Gauged flow station	• Daily flow	**Analysis:** • 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	• Flow monitoring discontinued by WaterNSW.	• Reinstallation of water level benchmark at NR110
GROUNDWATER						
AREA 9	**Private Bores** • **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 *(in consultation with bore owner)*	• Lab sample • Field parameters • Water levels • Observations	• 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:** • Temperature • Dissolved Oxygen (DO) • Specific Conductivity • pH • ORP **Standard Lab Sample:** • pH and EC • Filtered, Na, K, Ca, Mg, Cl, Ni, Zn, Fe, Mn, Al, SO_4 • Total Fe, Mn, Al • Total Alkalinity • TKN, TP, NH3-N, NOx-N (TON), FRP, TSS, TDS, DOC •	• Reduction in yield to two private boreholes • Increased turbidity in dams on DP1321 Lots 59 – 63, not attributed to mining	• Continue monitoring as required • Quarterly sample of the dams at DP1321 Lots 59 – 63 to confirm any impact from mining

	BHPBIC Piezometers: • Potentiometric head; – EAW9 – EAW18 – EAW58 • Piezometers and water samples between Longwall 901 and the Nepean River – S2280 (POSP A) – S2281 (POSP B)	• Lab sample • Field parameters • Water levels • Observations	• 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	**Lab Sample for Gas Releases:** • CH4 • C2H6 • Trace Phenols • Sulphide **Observations:** • 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.)	• Moderate reduction in groundwater level in the Hawkesbury Sandstone at two borehole monitoring sites; both below the predicted level of reduction	• No changes proposed
	Groundwater inflows to the mine	• Mine water budget • Observations	• Flow meters	Water flow from the goaf to the mine (analysed as a moving average i.e. 20-day average)	• Groundwater inflow to the mine less than Level 1 trigger	• No changes proposed
AQUATIC ECOLOGY						
AREA 9	**Nepean River** • 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)	• Water quality - field parameters • Survey and sampling • Observations	• Twice in spring for two years prior to the commencement of mining • Once every two years during mining • Once every two years after mining	• Habitat surveys • Aquatic macrophyte observations • Macroinvertebrate monitoring • AUSRIVAS sampling • Fish sampling • Observations of threatened species • Assessments of: o Water quality o Flow o River morphology	• No observed impacts to aquatic ecology attributable to mining	• Next aquatic ecology survey to be conducted in November 2019

	Monitoring Site	Monitoring Type	Monitoring Frequency	Parameters	Observations from Longwall 901	Future Monitoring (LW 902)
TERRESTRIAL ECOLOGY						
AREA 9	• Inspection of the area will be conducted as outlined in the Landscape TARP	• As indicated in the Landscape TARP	• 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	• 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 impacts or changes observed	• No changes proposed
ABORIGINAL ARCHAEOLOGY						
AREA 9	• 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	• Observational and photographic monitoring	• In accordance with Landscape TARP	• Subsidence Impacts to cliff lines on the southern side of the Nepean River (e.g. directly north of Bradcorp 1)	• No impacts or changes observed	• No changes proposed
AREA 9	• Bradcorp 1 (if required)	• Observational and photographic monitoring	• 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	• 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	• Not required	• No changes proposed
EUROPEAN HERITAGE						
AREA 9	• Douglas Park Railway Cottage – Item 30	• Observational monitoring	• Baseline archival recording prior to commencement of mining	• With the consent of the owner, the subsidence monitoring program will include:	• No impacts or changes observed	• No changes proposed

			• 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	• 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		

LANDSCAPE FEATURES						
AREA 9	• Nepean River cliff lines • Harris Creek cliff lines • Sensitive terrain near built features (Razorback Range, Douglas Park Ridge) Monitoring locations on private properties to be determined as appropriate/required in consultation with landowner/s	• Observational and photographic monitoring • Piezometers • Slope inclinometers	• ***Harris Creek and Nepean River cliff lines*** - Baseline recording once prior to mining. - Monthly routine inspections with weekly inspections during critical periods • ***Low Terrain Sensitivity*** (visual inspection) - 6 months prior to mining - 6 months after active subsidence • ***Medium Terrain Sensitivity*** - 6 to 12 months prior to mining - 3 monthly during active subsidence - 6 months after active subsidence • ***High Terrain Sensitivity*** • 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	• Visual inspections • Photographic records • Ground survey (mid to high terrain sensitivity) • Piezometers (high terrain sensitivity) • Slope inclinometers (high terrain sensitivity)		• No changes proposed

8. Appendix A

Table 8: Summary table of Longwall 901 TARP levels and observed impacts.

Monitoring	Trigger	Action (if impact is observed)	Impacts Observed
WATER QUALITY			
• Adjacent and downstream sites: • Nepean River: – 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: • 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	• 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	• *26 gas release zones identified on the Nepean River, consistent with Level 1 criteria, named 'AA9_LW901_001' – AA9_LW901_026'*
	Level 2* Impact monitoring sites when comparing the baseline period to the mining period for that site: • 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	• *Actions stated for Level 1* • Review monitoring program • Notify relevant technical specialists and seek advice on any CMA required • Implement agreed CMAs as approved *Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. water quality changes with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts* • *Strata Gas Emission Plume:* • Estimate gas emission flow rates. Re-estimate should significant change be observed • Take sample of plume (if possible) for: – 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	• *No such impacts observed*
	Level 3* Impact monitoring sites when comparing the baseline period to the mining period for that site:	• *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)	• *No such impacts observed*

Monitoring	Trigger	Action (if impact is observed)	Impacts Observed
	• Level 2-type reduction in water quality resulting from the mining observed for more than 6 consecutive months	• Completion of works following approvals, including monitoring and reporting on success • Review the TARP and Management Plan in consultation with key stakeholders *Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. water quality changes with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts*	
	Exceeding Performance Measures • Mining results in more than negligible gas releases, iron staining or water cloudiness	• *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	• *No such impacts observed*
GROUNDWATER			
Groundwater flow into the mine **Groundwater Level:** GW 34425 GW 35033 GW 72249 GW 100673 GW 101133	• ***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	• 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	• *Two impacts to private boreholes; WMP developed with landholders in accordance with the BFMP*
GW 102043 GW 102584 GW 102798 GW 103161 GW 104068 GW 104602 GW 104661 GW 110671	• ***Level 2**** • Increase in water flow from the goaf between 3 to 3.4ML (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	• *Actions stated for Level 1* • Review monitoring program • Notify relevant technical specialists and seek advice on any CMA required • Implement agreed CMAs as approved *Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. cracking at the surface with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts*	• *No such impacts observed*

Monitoring	Trigger	Action (if impact is observed)	Impacts Observed
BHPBIC Piezometers: NGW3 NGW4 NGW5 NGW6 EAW5 EAW7 EAW9 EAW18 EAW58 ***Notes:*** *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* *Privately owned water supplies are monitored as agreed with landowners in the Built Feature Management Plans*	***Level 3**** • Abnormal increase in water flow from the goaf >3.4ML (20 day average) • >10m 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	• *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: – 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 *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*	• *No such impacts observed*
LANDSCAPE FEATURES			
Cliffs and Steep Slopes • Nepean River cliff lines • Harris Creek cliff lines • Sensitive terrain near built features (Razorback Range, Douglas Park Ridge) Monitoring locations on private properties to be determined as appropriate/required in consultation with landowner	• ***Level 1*** • 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	• 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	• *No such impacts observed*
	• ***Level 2*** • 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	• *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	• *No such impacts observed*

Monitoring	Trigger	Action (if impact is observed)	Impacts Observed
	• Crack or fracture between 100 – 300 mm width • Crack or fracture between 10 – 50 m length	*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*	
	Level 3 * • 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 •	• *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: – 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 *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*	• *No such impacts observed*
	Exceeding Performance Measures • 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	• *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	• *No such impacts observed*

AQUATIC ECOLOGY			
Nepean River • Sites 1 and 2 (downstream) • Sites X3 and X4 (adjacent to Longwalls 901 and 902)	***Level 1**** • Reduction in aquatic habitat resulting from the mining over 1 season	• 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	• *No such impacts observed*
	Level 2* • Reduction in aquatic habitat resulting from the mining over 2 seasons	• *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 *<u>Note:</u> 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*	• *No such impacts observed*
	Level 3* • Reduction in aquatic habitat resulting from the mining for >2 consecutive seasons or complete loss of habitat	• *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: – 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 • *<u>Note:</u> 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*	• *No such impacts observed*
	Exceeding Performance Measures • Mining results in more than negligible environmental consequences for a threatened species, threatened population or endangered ecological communities	• *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	• *No such impacts observed*
TERRESTRIAL ECOLOGY			
	Level 1*	• Continue monitoring program	• *No such impacts observed*

Visual inspections as part of landscape and water monitoring programs in active mining areas •	• 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	• 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	
	Level 2* • 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	• *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 *<u>Note:</u> 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*	• *No such impacts observed*
	Level 3* • 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	• *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: – 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 *<u>Note:</u> 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*	• *No such impacts observed*
	Exceeding Performance Measures • Mining results in more than negligible environmental consequences on threatened species, threatened populations, or endangered ecological communities	• *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	• *No such impacts observed*
ABORIGINAL ARCHAEOLOGY			
• Impacts to the cliff lines on the southern side of the Nepean River (directly north of the site)	***Level 1**** • Change in shelter conditions not attributable to natural weathering or preservation that do	• Continue with monitoring program • Condition assessment and photographic record	• *No such impacts observed*

will trigger an inspection of Bradcorp 1	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	• Notify relevant specialists and key stakeholders (e.g. Registered Aboriginal Parties) • Summarise impacts and report in the End of Panel Report and AEMR	
	Level 2* • 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	• *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	• *No such impacts observed*
	Level 3* • 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	• *Actions stated for Level 2* • Investigate reasons for impacts • Update future predictions based on outcomes of the investigation	• *No such impacts observed*
	Exceeding Performance Measures • More than 10% of sites across the mining area are affected by subsidence impacts (other than negligible impacts or environmental consequence)	• *Actions stated for Level 3* • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation	• *No such impacts observed*
EUROPEAN HERITAGE			
• Douglas Park Railway Cottage – Item 30 from the BSOP EA	***Level 1**** • 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	• 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	• *No such impacts observed*
	Level 2* • 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	• *Actions stated for Level 1* • Review monitoring program • Review impacts against the Performance Measures • Develop site management plan to mitigate effects in consultation with stakeholders, where appropriate	• *No such impacts observed*
	Level 3* • Continuous cracking or warping of weatherboards	• *Actions stated for Level 2* • Investigate reason for impacts • Notify DP&I and MSB as soon as practicable • Seek advice on any CMA required.	• *No such impacts observed*

	• 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	• Consultation with stakeholders (undertake site inspection if required). • Review the relevant TARP and Management Plan in consultation with key stakeholders	
	Exceeding Performance Measures • Loss of heritage value greater than predicted under the Heritage Management Plan	• *Actions stated for Level 3* • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation	• *No such impacts observed*

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