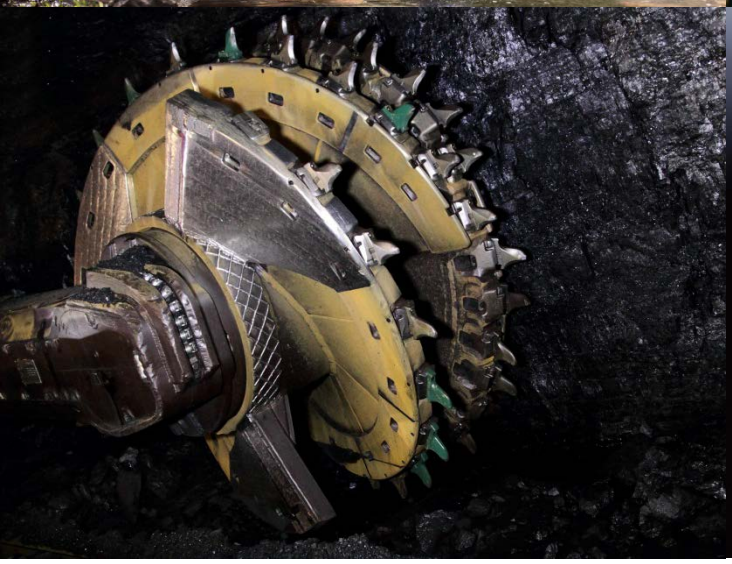


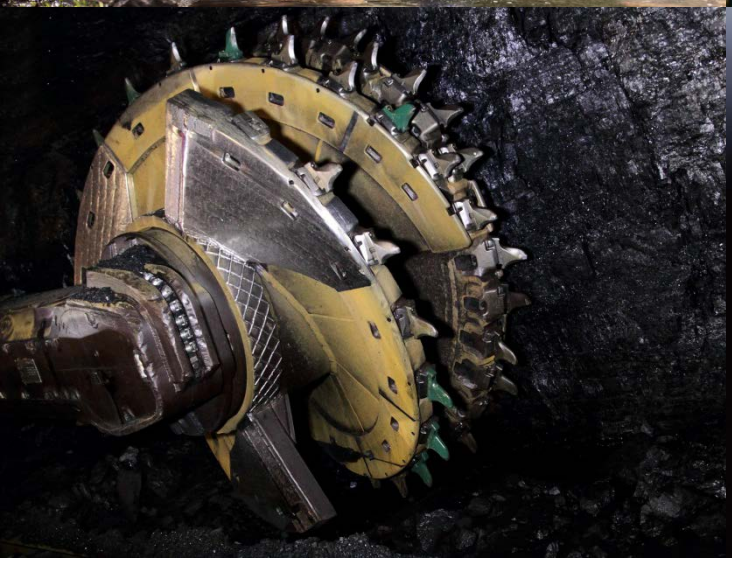
APPIN AREA 7 LONGWALL 706 END OF PANEL REPORT

ATTACHMENT C1 – LANDSCAPE REPORT

SOUTH32

Illawarra Coal
End of Panel Report






APPIN AREA 7
LONGWALL 706 END OF PANEL LANDSCAPE REPORT

January 2016

Contents

Abbreviations

DRE – New South Wales Department of Trade and Investment – Division of Resources and Energy

EMP – Environmental Management Plan

EoP – End of Panel Report

ICEFT – Illawarra Coal Environmental Field Team

Illawarra Coal – South 32 Illawarra Coal

SMP – Subsidence Management Plan

TARP – Trigger Action Response Plan

Executive Summary

This report has been prepared by the South32 Illawarra Coal Environmental Field Team (ICEFT) to summarise the observed and measured subsidence effects on water, landscape features and terrestrial ecology, resulting from the extraction of Longwall 706.

Extraction of Longwall 706 began on the 23rd of April 2014 and was completed on 28th November 2015.

The ICEFT conducts detailed monitoring and inspections of landscape features including the Nepean River, watercourses, groundwater, cliffs and steep slopes as well as private properties. This monitoring was conducted in accordance with the Appin Longwall 705 to 706 Environmental Management Plan (EMP), dated 23 July 2012, and the approved modifications to the monitoring program dated 4th June 2015.

ICEFT identified four impacts during the extraction of Longwall 706. One of these impacts (AA7_LW706_001) is a zone of gas release in the Nepean River. The others occurred on private properties recorded as; gas emissions from a private borehole (AA7_LW706_002) and soil cracking (AA7_LW706_003 and AA7_LW706_004). Gas Zones 5, 14 and 18, which were activated by previous longwalls, were also active during the extraction of Longwall 706.

1. Introduction

This report outlines monitoring of landscape features relevant to Longwall 706 and forms part of the Appin Area 7 Longwall 706 End of Panel Report (EoP Report). Monitored features include the Nepean River and its tributaries, cliffs and steep slopes, terrestrial flora, as well as private properties (farm dams, private boreholes and surface area). Monitoring of landscape features relevant to Longwall 706 has been carried out in accordance with the Longwall 705 to 706 Environmental Management Plan (EMP), dated 23rd July 2012 and modifications to the monitoring program approved by New South Wales Trade and Investment – Division of Resources and Energy (DRE) on the 4th June 2015. The Trigger, Action, Response Plan (TARP) set out in the EMP provides the actions required for any subsidence impacts (**Appendix 1**).

Extraction of Longwall 706 began on the 23rd of April 2014 and was completed on the 28th November 2015.

Monitoring was conducted for landscape features in the Subsidence Management Plan (SMP) Area for Longwall 705 and 706 during baseline, active mining (i.e. longwall within 400m of a feature) and post-mining periods. This monitoring involved measurement of surface water quality and levels, groundwater quality and levels (from Illawarra Coal and private boreholes) and general observation of the landscape features within the SMP Area. The results of the monitoring are outlined in the relevant sections below.

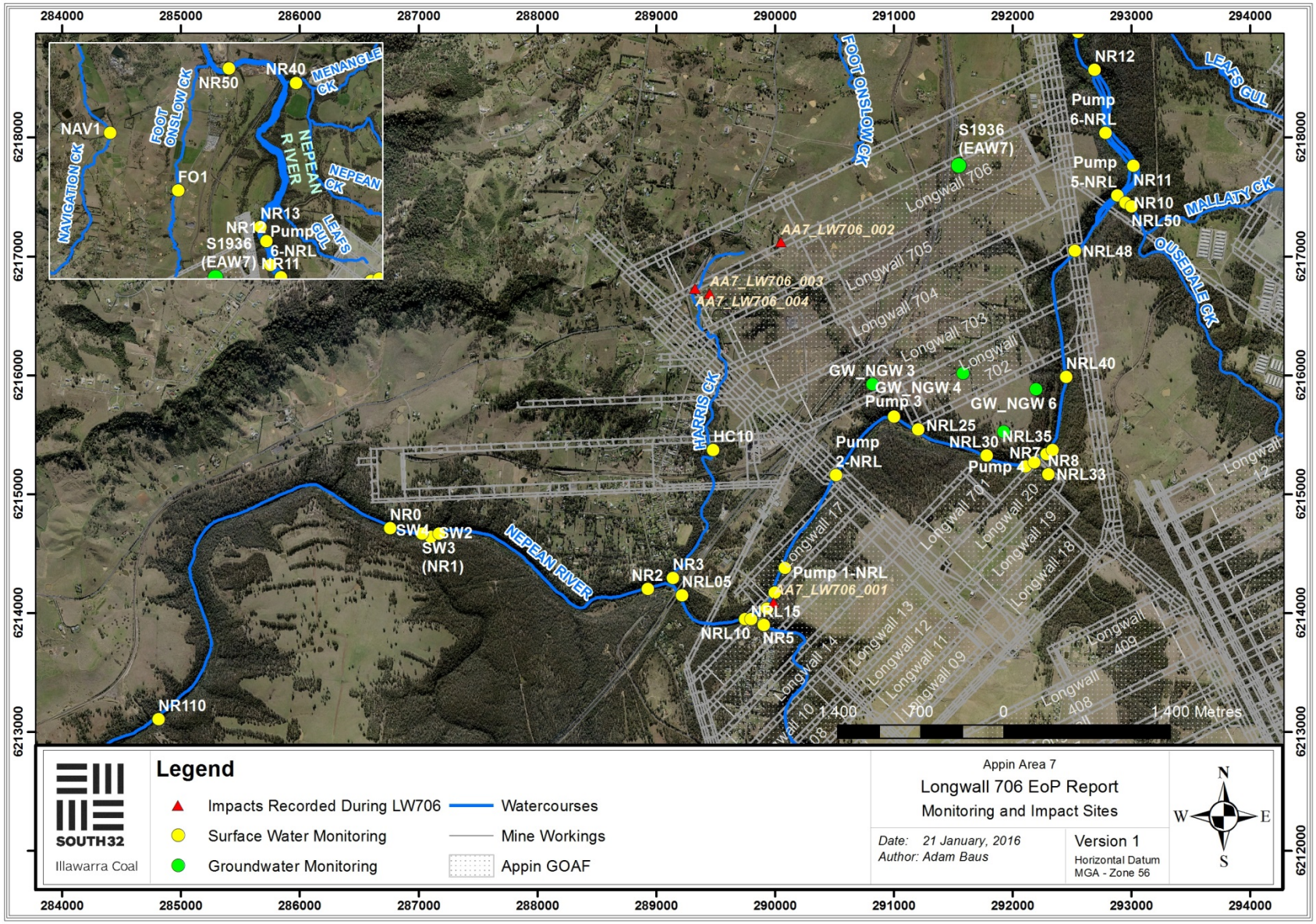


Figure 1: Location of Monitoring Sites and Impacts

2. Summary of Monitoring Program and Results

Monitoring of landscape features has been conducted in accordance with the EMP for Longwall 705 and 706 dated 23 July 2012. During the extraction of Longwall 706, approval was granted by DRE (on the 4th June 2015) to modify the monitoring program for the Nepean River. This modification involved:

- reduction from weekly inspections of the Nepean River to monthly;
- fortnightly inspections of impact sites;
- removal of monitoring sites NR20 and NR30;
- reduction in data download frequency for NGW groundwater bores.

The EMP for Longwall 705 and 706 is included as **Appendix 1**, this includes the monitoring program, TARP Table and monitoring locations.

2.1. Water Quality

In-situ water quality parameters measured include temperature, specific conductivity (SpC), Oxidation-Reduction Potential (ORP), pH and dissolved oxygen (DO). These parameters for the Nepean River and its tributaries were measured by the ICEFT on a weekly basis (where access was safe and granted) prior to the modified monitoring program. Since these modifications were approved in-situ water quality parameters have been measured monthly, and fortnightly for active gas zones or as required due to mining impacts. Water samples are also collected on a monthly basis for laboratory tests for a range of parameters. For analysis of in-situ and sampled water results refer to the relevant water quality section of the Longwall 706 EoP Report.

2.2. Gas Releases

One zone of gas release, AA7_LW706_001, was activated during the extraction of Longwall 706. It was first observed on the 13th August 2014 and consisted of four releases in two 2m x 1m areas (**Photos 1 & 2**). When initially observed it was located approximately 3800m south-west of the nearest point of Longwall 706. Due to this distance it is most likely that it is a reactivation of a gas release from previously mined Longwall 16 which was completed in 1998 and is the closest longwall to this impact. AA7_LW706_001 was last observed to be active on the 7th January 2016 (**Photo 3**). As the flow rate of this gas release is less than 3000L/min it falls within a Level 1 trigger according to the Longwall 705-706 TARPs. For further information refer to the Impact Report attached (dated 14th August 2014).

Gas Zones 5, 14 and 18 were active during this period however they were activated by previous longwalls (Longwalls 704 and 705). Gas Zone 5 was last observed on the 13th August 2014, Gas Zone 14 on the 11th December 2015 and Gas Zone 18 on the 26th October 2015.

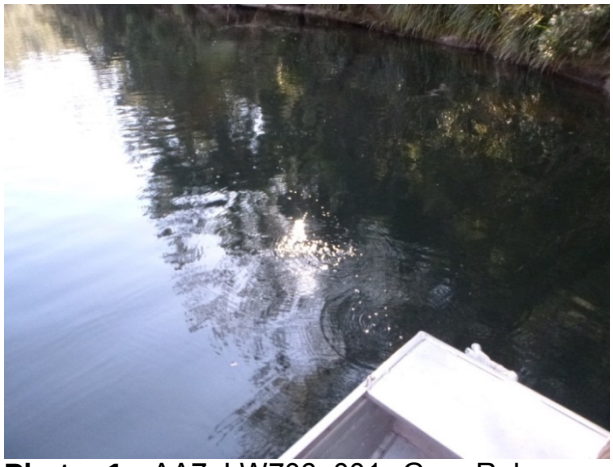


Photo 1: AA7_LW706_001 Gas Release. Taken on 13/08/2014.

Photo 2: AA7_LW706_001 Gas Release. Taken on 13/08/2014.

Photo 3: AA7_LW706_001 Gas Release. Taken on 07/01/2016.

2.3. Water Level and Flow

Water levels in the Nepean River and its tributaries were monitored by the ICEFT using observations and benchmarks on a weekly basis (where access was safe and granted). Following the approval to modify the monitoring regime (on the 4th June 2015), monitoring of water levels is conducted monthly or as required due to mining impacts. No subsidence induced flooding of river banks was observed. Likewise, no areas of dry river bed were observed. For assessment of water level and flow refer to the relevant section in the Longwall 706 EoP Report.

2.4. Appearance

The appearance of the Nepean River and its tributaries was monitored by the ICEFT on a weekly basis (where access was safe and granted). Following the approval to modify the monitoring regime (on the 4th June 2015), monitoring is conducted monthly or as required due to mining impacts. Photographs are taken of monitoring sites, gas zones and any other potential impact site. No impacts to the appearance of the Nepean River or tributaries were observed during the extraction of Longwall 706.

2.5. Groundwater

Boreholes relevant to Longwall 706 are; NGW3, NGW4, NGW5, NGW6 and EAW7. For assessment of groundwater data (level and quality) refer to the relevant section in the Longwall 706 EoP Report.

2.6. Landscape Features

Observations of clifflines and steep slopes along the Nepean Gorge and associated tributaries were conducted by the ICEFT on a monthly basis. Cliff A7_129 is the closest to Longwall 706 (approximately 900m from the Longwall). No impacts to cliffs were identified during the extraction of Longwall 706. Observations above the active longwall were conducted where access was available. Some minor impacts were identified on private properties as discussed below.

2.7. Terrestrial Ecology

Terrestrial ecology in Appin Area 7 is monitored by the ICEFT in conjunction with general observational monitoring. Aspects to look out for while conducting monitoring include changes in vegetation condition and vegetation that may have been impacted by rockfalls, soil slippage or gas emissions. No impacts or changes to terrestrial ecology were observed during monitoring for Longwall 706.

2.8. Private Property Inspections

Pre-mining and post-mining inspections of dams, boreholes and landscape features on private properties are conducted by the ICEFT. These inspections include:

- field observations for any surface impacts,
- measurement of in-situ water quality data (of any dams and private boreholes where applicable),
- collection of water samples for laboratory analysis (of any dams and private boreholes where applicable), and
- photos

Three impacts to private properties (AA7_LW706_002, AA7_LW706_003 and AA7_LW706_004) were recorded during the extraction of or at the completion of Longwall 706.

Impact AA7_LW706_002 was a period of strata gas emissions from a private borehole (**Photo 4**). It was first noted by the landholder and confirmed by Illawarra Coal. The borehole has been made safe by Illawarra Coal.

AA7_LW706_003 and AA7_LW706_004 are areas of soil cracking on a private property. AA7_LW706_003 consists of multiple soil cracks within a 30m x 35m area. The approximate maximum dimensions were 2.4m long, 0.03m wide and 0.425m deep (**Photos 5 and 6**). Discontinuous cracking along a fence with a total length of approximately 65m was also

identified at the property. AA7_LW706_004 consisted of a single soil crack at the base of a dam wall (**Photo 7**). It was approximately 1.3m long, with a maximum width and depth of 0.02m and 0.03m respectively. Both of these soil cracks are expected to self-remediate.

For further information on the above impacts, refer to the relevant Impact Reports attached (dated 21st July 2015 and 4th January 2016).

Photo 4: AA7_LW706_002; Borehole. Taken on 15/07/2015

Photo 5: AA7_LW706_003; widest identifiable crack on landholder's property. Taken on 04/01/2016.

Photo 6: AA7_LW706_003; cracking along fence line. Taken on 04/01/2016.

Photo 7: AA7_LW706_004; crack to base of dam wall. Taken on 04/01/2016.

2.9. Summary of Impacts

A summary of the impacts observed during the extraction of Longwall 706 is included in Table 1; refer to Figure 1 for locations. A detailed description of the impacts identified during Longwall 706 can be found in the attached impact reports. A summary of the Performance Measures (as defined in the Bulli Seam Operations Development Consent Approval and the Longwall 705 to 706 SMP Approval), TARPs and impacts observed is provided in **Appendix 2**.

Table 1: Summary of Impacts Activated by Longwall 706

Site ID	Impact Type	Identification Date	Initial Description	Feature Affected	TARP Level Triggered	Refer to Impact Report/s Dated
AA7_LW706_001	Gas Release	13/08/2014 *(date last observed 11/12/2015)*	Four light constant releases in two 2x1m areas, located 3800m from Longwall 706	Nepean River	Level 1	*Nepean River Impact Report – Gas Report* Dated: 14 August 2014
AA7_LW706_002	Gas Emission – Private Borehole	15/07/2015	Strata gas emission from a privately owned borehole	Private Borehole	N/A	*Property Inspection Report* Dated: 24 July 2015
AA7_LW706_003	Soil Cracking	04/01/2015	Multiple soil cracks in a 30x35m area. 2.4m Max	Private Property	N/A	*Appin Area 7 – Longwall 706 Impact Report* Dated: 11 January 2016
AA7_LW706_004	Soil Cracking	04/01/2015	Soil crack at the base of dam wall of Dam. Approx. 1.3m long and a max. width and depth of 0.02m and 0.03m	Private Property/Private Dam	N/A	*Appin Area 7 – Longwall 706 Impact Report* Dated: 11 January 2016

3. Future Monitoring

Post-mining monitoring will continue monthly for two years or as otherwise required/approved, as stated in the Longwall 705-706 EMP (**Appendix 1**). Monitoring of future longwalls in Appin Area 7 (Longwall 707 to 710) will follow the monitoring schedule and TARPs set out in the *Longwall 707-710 EMP (*dated: August 2015*),* Table 2 (included in **Appendix 3**). The Longwall 707 to 710 EMP was approved 2nd September 2015 by DRE.

APPENDIX 1 – Longwall 705 to 706 Environmental Management Plan

Table 1.1: Appin Area 7 Environmental Monitoring

Monitoring Site	Site Type	Monitoring Frequency	Parameters
WATER QUALITY			
Nepean River Baseline upriver sites for cross-checking for upriver perturbations: ▪ NR0 ▪ NR2 (pre Area 9 mining) ▪ NR110 (New site - post Area 9 mining) ▪ NR4 ▪ NR5 ▪ NR6 Impact monitoring sites adjacent to each longwall: ▪ NR11 ▪ NR12 ▪ NR13 ▪ NR20 ▪ NR30 Other sites ▪ NR7 ▪ NR9 ▪ NR50 Refer Figure 1a	Grab Sample and field measurements	▪ Monthly baseline prior to mining (data has been recorded for most sites since 2003). ▪ Weekly observations and field analysis during mining. ▪ Monthly detailed laboratory analysis during mining. ▪ Monthly monitoring for 2 years post mining (or as otherwise required/approved). ▪ If required as a result of assessment of mining impacts.	▪ Field measurements of: – Temperature – Dissolved Oxygen (DO) – Electrical Conductivity (EC) – pH – ORP – Time – General Comments. ▪ Laboratory analysis of: – pH – EC – Na filtered – K filtered – Ca filtered – Mg filtered – Cl filtered – Br filtered – I filtered – As filtered – Cu filtered – Pb filtered – Ni filtered – Se filtered – Zn filtered – Fe filtered – Mn filtered – Al filtered – SO4 filtered – Fe Total – Mn Total – Al Total – TKN – NH3-N – NOx-N – FRP – TP – Total Alkalinity – TSS – TDS – DOC – CH4* – C2H6* – Trace Phenols* – Sulphide*
Ephemeral Watercourses ▪ Lower Harris Creek (NR3) ▪ Elladale Creek (NR8) ▪ Ousedale Creek (NR10) ▪ Menangle Creek (NR40) ▪ Upper Harris Creek (HC10) ▪ Foot Onslow Creek (FO1) ▪ Navigation Creek (NAV1) Refer Figure 1a	Grab sample and field measurements	▪ Prior to mining of longwall underlying watercourse or mining of any immediately adjacent longwall. ▪ Monthly detailed laboratory analysis during mining. ▪ Following the development of incremental subsidence for each longwall that will impact on the feature.	

Monitoring Site	Site Type	Monitoring Frequency	Parameters
LEVEL AND FLOW			
Nepean River ▪ At benchmark sites and water pump sites: – NRL05 – NRL10 – NRL12 – NRL13 – NRL15 – NRL20 – Pump 1 NRL – Pump 2 NRL – NRL25 – NRL30 – NRL33 – NRL35 – NRL40 – NRL45 – NRL48 – NRL50 – Pump 5 NRL – Pump 6 NRL Refer Figure 1a	Water Level Water flow (measured at SCA weirs)	▪ Monthly baseline prior to mining (data has been recorded for most sites since 2007). ▪ Weekly manual monitoring at nails during mining. ▪ Flow monitoring at weirs (data supplied by SCA). ▪ Ongoing monthly monitoring for 2 years post mining (or as otherwise required/approved).	▪ Areas of dry riverbed compared with baseline environmental conditions. ▪ Areas of flooded riverbed compared with baseline environmental conditions. ▪ Field measurement of water height compared with baseline environmental conditions.
Ephemeral Watercourses ▪ Lower Harris Creek (NR3) ▪ Elladale Creek (NR8) ▪ Ousedale Creek (NR10) ▪ Menangle Creek (NR40) ▪ Upper Harris Creek (HC10) ▪ Foot Onslow Creek (F01) ▪ Navigation Creek (NAV1) Refer Figure 1a	Water Level	▪ Prior to mining of longwall underlying watercourse or mining of any immediately adjacent longwall. ▪ Following the development of incremental subsidence for each longwall that will impact on the feature.	▪ Photo points ▪ Areas of increased flooding or drying of ephemeral streams

Monitoring Site	Site Type	Monitoring Frequency	Parameters
APPEARANCE			
Nepean River ▪ Visual observations along the length of the Nepean River within the active mining area.	Observational and photographic monitoring	▪ Monthly baseline prior to mining (data has been recorded for most sites since 2003). ▪ Weekly observations and field analysis during mining. ▪ Monthly monitoring for 2 years post mining (or as otherwise required/approved). ▪ If required as a result of assessment of mining impacts.	▪ Iron or salinity staining (e.g. orange or white staining in water or on banks/seeps). ▪ Water cloudiness ▪ Evidence of springs in Nepean River ▪ Visual signs of impacts (e.g. cracking, vegetation changes, increased erosion, changes in water colour etc.) ▪ Impacts determined from comparing photo points taken prior to, during and post mining. ▪ Erosion and/or sedimentation compared with baseline environmental conditions.
Ephemeral Watercourses ▪ Lower Harris Creek (NR3) ▪ Elladale Creek (NR8) ▪ Ousedale Creek (NR10) ▪ Menangle Creek (NR40) ▪ Upper Harris Creek ▪ Foot Onslow Creek ▪ Navigation Creek	Observational and photographic monitoring	▪ Prior to mining of longwall underlying watercourse or mining of any immediately adjacent longwall. ▪ Following the development of incremental subsidence for each longwall that will impact on the feature.	▪ Observable iron or salinity staining. ▪ Visual signs of impacts (e.g. cracking, vegetation changes, increased erosion, changes in water colour etc.) ▪ Impacts determined from comparing photo points taken prior to, during and post mining.
Water Pumps ▪ Pump 1 NRL ▪ Pump 2 NRL ▪ Pump 3 ▪ Pump 4 ▪ Pump 5 NRL ▪ Pump 6 NRL	Observational and photographic monitoring	▪ Pre mining photographs ▪ Weekly visual inspection during mining ▪ If required as a result of assessment of mining impacts.	▪ Pump submergence and disturbance

Monitoring Site	Site Type	Monitoring Frequency	Parameters
AQUATIC ECOLOGY			
Nepean River ▪ Sites 1 and 2 (located upstream of Longwall 701 near Douglas Park Weir). ▪ Sites 3 and 4 (located adjacent to Longwalls 701 and 702 near confluence of the Nepean River and Elladale Creek). ▪ Sites X1 and X2 (located adjacent to Longwalls 703 and 704). ▪ Sites 5 and 6 (located adjacent to Longwalls 705 and 706 downstream of the confluences with Mallaty and Ouesdale Creeks) ▪ Sites 7 and 8 (located downstream of all proposed Longwalls 701-710) Refer Figure 20.1 in LW705-710 SMP	Quantitative and observational monitoring	▪ Two Baseline monitoring campaigns (autumn/spring) prior to mining ▪ Annual monitoring campaigns (autumn and spring) during mining (i.e. longwall within 400m of monitoring site) ▪ Two monitoring campaigns (autumn/spring) post mining ▪ General observation of all streams in the active mining areas during all other monitoring	▪ Photographic records ▪ Macro-invertebrate Assessment ▪ Fish sampling ▪ Water Quality ▪ Monitored in conjunction with: – Flow – River Morphology
Ephemeral Watercourses ▪ Sites F1 and F2 (located on Foot Onslow Creek, over Longwalls 708 and 710) ▪ Site N1 (located on Navigator Creek northeast of Longwall 710) ▪ General observation of all other watercourses in active mining areas. Refer Figure 20.1 in SMP			

Monitoring Site	Site Type	Monitoring Frequency	Parameters
GROUNDWATER			
Water Level IC monitoring bores ▪ NGW3 ▪ NGW4 ▪ NGW6 ▪ NGW5 ▪ NGW7 ▪ NGW9 ▪ NGW10 ▪ NGW11 ▪ EAW5 ▪ EAW7 (S1936) ▪ S1584 ▪ S1809 ▪ S1853 ▪ S1854 Private bores ▪ 10 registered bores within the SMP area (refer to Built Feature Management Plans for monitoring/management) Refer Figure 1a	Groundwater level	IC Bores ▪ Pre-mining (data has been recorded since September 2004 for some sites) ▪ Water level logged hourly ▪ Post-mining – following the development of incremental subsidence for each longwall that will potentially impact on the borehole. ▪ Monitoring to continue for at least 12 months post mining. Private Bores ▪ Prior to mining of longwall underlying bore or mining of any immediately adjacent longwall (if in agreement with landholder). ▪ Post-mining – following the development of incremental subsidence for each longwall that will impact on the borehole (if in agreement with landholder). ▪ As requested by landholder or if physical impacts to bore identified (landholder to observe during use of bore).	NGW Bores (open holes) ▪ Standing groundwater level in bore using vibration wire Piezometer and logger – 1 hour recording. Grouted monitoring holes ▪ Piezometric head in various strata Private bores ▪ Water level measured with dip metre (where access to property is available and in agreement with landholder)

Monitoring Site	Site Type	Monitoring Frequency	Parameters
Water Quality IC monitoring bores ▪ NGW6 ▪ NGW5 Private bores ▪ 10 registered bores within the SMP area (refer to Built Feature Management Plans for monitoring/management)	Grab Sample	IC Bores ▪ Pre-mining – prior to mining of longwall underlying bore or mining of any immediately adjacent longwall. ▪ Post-mining – following the development of incremental subsidence for each longwall that will impact on the feature (i.e. each longwall). ▪ As required to provide additional data for any bore impact investigation or if physical impacts to bore identified. Private Bores ▪ Prior to mining of longwall underlying bore or mining of any immediately adjacent longwall (if in agreement with landholder). ▪ Post-mining – following the development of incremental subsidence for each longwall that will impact on the borehole (if in agreement with landholder). ▪ As requested by landholder or if physical impacts to bore identified (landholder to observe during use of bore).	▪ Observable iron or salinity staining determined from comparison of pre-mining and post-mining photographs. ▪ Water quality field and lab parameters as outlined in the Nepean River Water Quality section.
Mine Water Inflows Active mining areas – longwall face and roadway development. Mined goaf areas – 705 and 706	▪ Visual ▪ Flow Meter	▪ Daily statutory mine inspections ▪ Mine dewatering monitored throughout the mining process by flow meter of water pumped into and discharged from workings.	▪ Groundwater make increasing from historical range as measured by mine dewatering monitoring ▪ Inflow event from mining area ▪ Water sample of any inflow event (Laboratory Analysis for major Cations & Anions as well as Stable Isotopes) for comparison to surface waters

Monitoring Site	Site Type	Monitoring Frequency	Parameters
LANDSCAPE FEATURES			
Cliffs ▪ Along Nepean Gorge **Steep Slopes** ▪ Along Nepean Gorge, associated tributaries and above western end of the proposed longwalls. Refer Figure 19.1 in LW705-710 SMP		▪ Once prior to mining. Photographic records taken. ▪ During mining, monthly visual inspections, increased to weekly inspections during critical periods (for cliffs and steep slopes along the Nepean Gorge and associated tributaries). ▪ Monitoring to continue 6 monthly for 2 years following the completion of mining (or as otherwise required/approved). ▪ As required when specific impacts are identified or when concern is raised by a landowner. ▪ As required, in accordance with Built Feature Management Plans and landholder agreement.	▪ Cliff and steep slopes will be observed for any instability (e.g. rock falls, mass movement) and seeps.
TERRESTRIAL ECOLOGY			
Monitored in conjunction with general observational monitoring for the Nepean River, ephemeral watercourses and landscape.		▪ If required as a result of assessment of mining impacts. ▪ General observation of active mining areas during all other monitoring.	▪ Vegetation communities ▪ Vegetation condition ▪ Changes in vegetation. ▪ Tree health ▪ Threatened species.

Monitoring Site	Site Type	Monitoring Frequency	Parameters
ABORIGINAL ARCHAEOLOGY			
▪ Nepean River 4 (52-2-2098) ▪ Nepean River 5 (52-2-2097) ▪ Nepean River 6 (52-2-2095) ▪ Nepean River 7 (52-2-2096) ▪ Nepean River 8 (52-2-2239) ▪ Upper Nepean Hand Stencils ▪ Bulli Site 40 (BS 40) Refer to Figure 5-22 of Bulli Seam Operations EA and Figure 3 Bulli Seam Operations Appendix G (Aboriginal Cultural Heritage Assessment)	Observational and photographic monitoring	▪ Baseline archival recording prior to longwall mining. ▪ Final impact assessment recording 12 months after undermining or 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 itself, graffiti, joints, bedding planes, exfoliation scars, cracks, mineral and micro-organism growth, drip line and water seepage locations.
HISTORIC HERITAGE			
▪ Buildings or structures of identified heritage significance *Note: Detailed Heritage Management Plans to be developed prior to any heritage item being influence by mining*	Observational, photographic monitoring and structural inspections.	▪ Baseline assessment recording prior to longwall mining. ▪ Monitoring during subsidence (if in agreement with landholder) ▪ Final assessment recording 12 months after undermining or final subsidence movement at the site.	▪ Building/structure condition ▪ Heritage value

** Analytes tested for only when gas release observed*

Monitoring	Trigger	Action
WATER QUALITY		
Nepean River Impact monitoring sites adjacent to each Longwall: ▪ NR11 ▪ NR12 ▪ NR13 ▪ NR20 ▪ NR30 Refer Figure 1a ***Notes:*** *Baseline upriver sites will be used for cross-checking for upriver perturbations*[3] *Baseline Upriver site NR2 data to be updated at end of panel following completion of each longwall, subject to checks-for, and discard-of upriver perturbed data*	***Level 1 (Within Prediction)***[1] Impact monitoring sites: ▪ 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 [2]	▪ Continue monitoring program ▪ Report impacts to key stakeholders ▪ Summarise impacts and record
	Level 2 (Within Prediction – CMAs may be required)[1] Impact monitoring sites: ▪ 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[2]	▪ Actions as stated for Level 1 plus: ▪ Review monitoring program ▪ Notify relevant specialists (BHPBIC) and develop and implement remedial action if necessary *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 sites - dissolved sulfide and total phenols from exactly above gas plume and at nearest downriver monitoring site(s)
	Level 3 (CMAs likely to be required)[1] Impact monitoring sites: ▪ Level 2-type reduction in water quality resulting from the mining observed for more than 6 consecutive months	▪ Actions as stated for Level 2 plus: ▪ Immediately notify OEH, D&PI, NoW & DRE and any other relevant specialist. ▪ Consultation with stakeholders. ▪ Collect laboratory samples and analyse for: - pH, EC, Total Fe and Mn - Suite of Filterable metals. - Dissolved methane, sulfide and total phenols (if relevant). ▪ Develop site management measures as soon as practically possible (pending stakeholder availability) and seek any approvals required to implement
	Exceeding Prediction ▪ More than negligible gas releases	▪ *Actions as stated for Level 3* ▪ Investigate reasons for the exceedance ▪ Update future predictions based on the outcomes of the investigation

Monitoring	Trigger	Action
WATER LEVEL AND FLOW		
Nepean River ▪ Visual observations along the length of the Nepean River within the active mining area	***Level 1 (Within Prediction)***[1] ▪ Observation of areas of dry and/or flooded riverbed in comparison to pre-mining baseline observations and flows, for less than 2 consecutive months.	▪ Continue monitoring program ▪ Report impacts to key stakeholders ▪ Summarise impacts and record
	Level 2 (Within Prediction – CMAs may be required)[1] ▪ Observation of areas of dry and/or flooded riverbed in comparison to pre-mining baseline observations and flows, for more than 2 consecutive months.	▪ *Actions as stated for Level 1* ▪ Review monitoring program ▪ Notify relevant technical specialists and seek advice on any CMA required ▪ Implement agreed CMAs as approved
	Level 3 (CMAs likely to be required)[1] ▪ Observation of areas of dry and/or flooded riverbed in comparison to pre-mining baseline observations and flows, for more than 6 consecutive months.	▪ *Actions as stated for Level 2* ▪ Immediately notify relevant government agencies, other resource managers and relevant technical specialists and seek advice on any CMA required. ▪ Site visits with stakeholders if required ▪ Develop site CMA in consultation with key stakeholders within 1 month. ▪ Completion of works following approvals ▪ Issue CMA report within 1 month of works completion ▪ Conduct initial follow up monitoring & reporting within 2 months of CMA completion if required ▪ Review the relevant TARP and Management Plan in consultation with key stakeholders
APPEARANCE		
Nepean River ▪ Visual observations along the length of the Nepean River within the active mining area	***Level 1 (Within Prediction)***[1] ▪ Identified iron staining resulting from the mining for two consecutive months ▪ Identified water cloudiness resulting from the mining for two consecutive months	▪ Continue monitoring program ▪ Report impacts to key stakeholders ▪ Summarise impacts and record
	Level 2 (Within Prediction – CMAs may be required)[1] ▪ Iron staining greater than baseline monitoring resulting from the mining for two consecutive months ▪ Water cloudiness greater than baseline monitoring resulting from the mining for two consecutive months	▪ *Actions as stated for Level 1* ▪ Review monitoring program ▪ Notify relevant technical specialists and seek advice on any CMA required ▪ Implement agreed CMAs as approved

Monitoring	Trigger	Action
	Level 3 (CMAs likely to be required)[1] ▪ Iron staining greater than baseline monitoring resulting from the mining for six consecutive months ▪ Water cloudiness greater than baseline monitoring resulting from the mining for six consecutive months	▪ *Actions as stated for Level 2* ▪ Immediately notify relevant government agencies, other resource managers and relevant technical specialists and seek advice on any CMA required. ▪ Site visits with stakeholders if required ▪ Develop site CMA in consultation with key stakeholders within 1 month. ▪ Completion of works following approvals ▪ Issue CMA report within 1 month of works completion ▪ Conduct initial follow up monitoring & reporting within 2 months of CMA completion if required ▪ Review the relevant TARP and Management Plan in consultation with key stakeholders
	Exceeding Prediction ▪ More than negligible iron staining resulting from the mining ▪ More than negligible increase in water cloudiness resulting from the mining	▪ *Actions as stated for Level 3* ▪ Investigate reasons for the exceedance ▪ Update future predictions based on the outcomes of the investigation
Ephemeral Watercourses ▪ Upper Harris Creek (HC10) ▪ Foot Onslow Creek (FO1) ▪ Navigation Creek (NAV1) Visual observations at water quality monitoring sites and along the length of the stream within the active mining area where landholder access is granted	***Level 1 (Within Prediction)***[1] ▪ Fracturing with no observable loss of surface water flow ▪ Fracturing with no reduction in pool water level when compared to similar environmental conditions in baseline period ▪ Increase in turbidity, iron staining, algal growth, or other visible water quality parameters resulting from the mining for two consecutive months determined by comparing baseline photos with photos during the mining period	▪ Continue monitoring program ▪ Report impacts to key stakeholders ▪ Summarise impacts and record
	Level 2 (Within Prediction – CMAs may be required)[1] ▪ Fracturing resulting in loss of surface flow in some creeks or tributary ▪ Fracturing resulting in water loss from some permanent pools ▪ Reduced water retention time in pools ▪ Increase in turbidity, iron staining, algal growth, or other visible water quality parameters resulting from the mining for two consecutive months determined by comparing baseline photos with photos during the mining period	▪ *Actions as stated for Level 1* ▪ Review monitoring program ▪ Notify relevant technical specialists and seek advice on any CMA required ▪ Implement agreed CMAs as approved

Monitoring	Trigger	Action
	Level 3 (CMAs likely to be required)[1] ▪ Fracturing resulting in total loss of surface flow in all sections of a creek or tributary ▪ Fracturing resulting in total water loss from all permanent pools in the mining area ▪ Reduced water retention time in all pools in the mining area	▪ *Actions as stated for Level 2* ▪ Immediately notify relevant government agencies, other resource managers and relevant technical specialists and seek advice on any CMA required. ▪ Site visits with stakeholders if required ▪ Develop site CMA in consultation with key stakeholders within 1 month. ▪ Completion of works following approvals ▪ Issue CMA report within 1 month of works completion ▪ Conduct initial follow up monitoring & reporting within 2 months of CMA completion if required ▪ Review the relevant TARP and Management Plan in consultation with key stakeholders
	Exceeding Prediction ▪ Fracturing of controlling rockbars and/or stream bed, resulting in the diversion of all stream flow in the mining area ▪ Increased leakage from all pools in the mining area	▪ *Actions as stated for Level 3* ▪ Investigate reasons for the exceedance ▪ Update future predictions based on the outcomes of the investigation
Water Pumps ▪ There are six pumps in the Nepean River which will be monitored for the effects from subsidence: - Pump 1 - Pump 2 - Pump 3 - Pump 4 - Pump 5 - Pump 6	▪ Pump not functioning due to physical disturbance from subsidence	▪ Continue monitoring program ▪ Report impacts to key stakeholders ▪ Summarise impacts and record ▪ Develop and implement CMA (if required) in consultation with key stakeholders
AQUATIC ECOLOGY		
Nepean River ▪ Sites 5 and 6 (located adjacent to Longwalls 705 and 706 downstream of the confluences with Mallaty and Ouesdale Creeks)	***Level 1 (Within Prediction)***[1] ▪ 1 season reduction in aquatic habitat resulting from the mining when comparing to baseline condition	▪ Continue monitoring program ▪ Report impacts to key stakeholders ▪ Summarise impacts and record

Monitoring	Trigger	Action
▪ Sites 7 and 8 (located downstream of all proposed Longwalls 701-710) **Ephemeral Watercourses** ▪ Sites F1 and F2 (located on Foot Onslow Creek, over Longwalls 708 and 710) ▪ Site N1 (located on Navigator Creek northeast of Longwall 710) ▪ General observation of all other watercourses in active mining areas Refer Figure 20.1 in LW705-710 SMP	***Level 2 (Within Prediction – CMAs may be required)***[1] ▪ 2 consecutive season reduction in aquatic habitat resulting from the mining when comparing to baseline condition	▪ *Actions as stated for Level 1* ▪ Review monitoring program ▪ Notify relevant technical specialists and seek advice on any CMA required ▪ Implement agreed CMAs as approved
	Level 3 (CMAs likely to be required)[1] ▪ Reduction in aquatic habitat resulting from the mining for > 2 consecutive seasons or complete loss of habitat	▪ *Actions as stated for Level 2* ▪ Immediately notify relevant government agencies, other resource managers and relevant technical specialists and seek advice on any CMA required. ▪ Site visits with stakeholders if required ▪ Develop site CMA in consultation with key stakeholders within 1 month. ▪ Completion of works following approvals ▪ Issue CMA report within 1 month of works completion ▪ Conduct initial follow up monitoring & reporting within 2 months of CMA completion if required ▪ Review the relevant TARP and Management Plan in consultation with key stakeholders
	Exceeding Prediction ▪ More than negligible environmental consequences for a threatened species, threatened population or endangered ecological community	▪ *Actions as stated for Level 3* ▪ Investigate reasons for the exceedance ▪ Update future predictions based on the outcomes of the investigation
GROUNDWATER		
Water Level IC monitoring bores: ▪ NGW3 ▪ NGW4 ▪ NGW6 ▪ NGW5 ▪ EAW5 ▪ EAW7 (S1936) Private Bores ▪ Registered bores and any new bores within the SMP area	***Level 1 (Within Prediction)***[1] ▪ Up to an additional 2.5m reduction from the predicted standing water level or pressure (outside of pumping influences) over 2 consecutive months	▪ Continue monitoring program ▪ Report impacts to key stakeholders ▪ Summarise impacts and record
	Level 2 (Within Prediction – CMAs may be required)[1] ▪ Between 2.5m and 5m additional reduction from the predicted standing water level or pressure (outside of pumping influences) over 2 consecutive months	▪ *Actions as stated for Level 1* ▪ Review monitoring program ▪ Notify relevant technical specialists and seek advice on any CMA required ▪ Implement agreed CMAs as approved

Monitoring	Trigger	Action
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* Refer Figure 1a	***Level 3 (CMAs likely to be required)***[1] ▪ Greater than 5m of additional reduction from the predicted standing water level or pressure (outside of pumping influences) over 2 consecutive months ▪ Privately owned water supply adversely impacted from the mining (other than impact that is negligible)	▪ *Actions as stated for Level 2* ▪ Immediately notify relevant government agencies, other resource managers and relevant technical specialists and seek advice on any CMA required. ▪ Site visits with stakeholders if required ▪ Develop site CMA in consultation with key stakeholders within 1 month. ▪ Completion of works following approvals ▪ Issue CMA report within 1 month of works completion ▪ Conduct initial follow up monitoring & reporting within 2 months of CMA completion if required ▪ Review the relevant TARP and Management Plan in consultation with key stakeholders ▪ Compensatory water supply measures must be provided as an alternative long-term supply that is equivalent to the loss attributed to the mining impact, and be provided (at least on an interim basis) within 24 hours of the loss being identified.
Water Quality IC monitoring bores ▪ NGW6 ▪ NGW5 Private Bores ▪ Registered bores and any new bores within the SMP area (where water quality samples can be taken)	***Level 1 (Within Prediction)***[1] ▪ Groundwater quality reduction greater than 1 standard deviation but less than 2 standard deviation from pre-mining mean resulting from the mining for two consecutive months	▪ Continue monitoring program ▪ Report impacts to key stakeholders ▪ Summarise impacts and record
	Level 2 (Within Prediction – CMAs may be required)[1] ▪ Groundwater quality reduction greater than 2 standard deviation from pre-mining mean resulting from the mining for two consecutive months	▪ *Actions as stated for Level 1* ▪ Review monitoring program ▪ Notify relevant technical specialists and seek advice on any CMA required ▪ Implement agreed CMAs as approved
	Level 3 (CMAs likely to be required)[1] ▪ Level 2-type reduction in water quality resulting from the mining observed for more than 6 consecutive months	▪ *Actions as stated for Level 2* ▪ Immediately notify relevant government agencies, other resource managers and relevant technical specialists and seek advice on any CMA required. ▪ Site visits with stakeholders if required ▪ Develop site CMA in consultation with key stakeholders within 1 month. ▪ Completion of works following approvals ▪ Issue CMA report within 1 month of works completion ▪ Conduct initial follow up monitoring & reporting within 2 months of CMA completion if required ▪ Review the relevant TARP and Management Plan in consultation with key stakeholders ▪ Compensatory water supply measures must be provided as an alternative long-term supply that is equivalent to the loss attributed to the mining impact, and be provided (at least on an interim basis) within 24 hours of the loss being identified

Monitoring	Trigger	Action
Mine Water Inflows	***Level 1 (Within Prediction)***[1] ▪ Abnormal rise in water flow from the goaf between 2.7 and 3ML/day (over 20 day average)	▪ Continue monitoring program ▪ Report impacts to key stakeholders ▪ Summarise impacts and record
	Level 2 (Within Prediction – CMAs may be required)[1] ▪ Abnormal rise in water flow from the goaf between 3 and 3.4ML/day (over 20 day average)	▪ *Actions as stated for Level 1* ▪ Review monitoring program ▪ Notify relevant technical specialists and seek advice on any CMA required ▪ Implement agreed CMAs as approved
	Level 3 (CMAs likely to be required)[1] ▪ Abnormal rise in water flow from the goaf >3.4ML/day (over 20 day average)	▪ *Actions as stated for Level 2* ▪ Immediately notify relevant government agencies, other resource managers and relevant technical specialists and seek advice on any CMA required. ▪ Site visits with stakeholders if required ▪ Develop site CMA in consultation with key stakeholders within 1 month. ▪ Completion of works following approvals ▪ Issue CMA report within 1 month of works completion ▪ Conduct initial follow up monitoring & reporting within 2 months of CMA completion if required ▪ Review the relevant TARP and Management Plan in consultation with key stakeholders
LANDSCAPE FEATURES		
Cliffs ▪ Along Nepean Gorge **Steep Slopes** ▪ Along Nepean Gorge, associated tributaries and above western end of the proposed Longwalls Refer Figure 19.1 in LW705-710 SMP	***Level 1 (Within Prediction)***[1] ▪ Any rock fall, displacement, dislodgement of boulders or slabs or fracturing of a cliff line flanking the Nepean River resulting from mining ▪ Erosion resulting from mining localised to a small area that should naturally stabilise within the monitoring period ▪ Surface movement resulting from mining with no more than negligible soil surface exposed	▪ Continue monitoring program ▪ Report impacts to key stakeholders ▪ Summarise impacts and record
	Level 2 (Within Prediction – CMAs may be required)[1] ▪ Any rock falls, displacements, dislodgements of boulders or slabs or fracturing of a cliff line(s) flanking the Nepean River resulting from mining that in total impacts 0.3% of the total cliff line face area of the mining domain. ▪ Erosion resulting from mining likely to naturally stabilise within the monitoring period. ▪ Surface movement or rock displacement resulting from mining with no more than minor soil surface exposed	▪ *Actions as stated for Level 1* ▪ Review monitoring program ▪ Notify relevant technical specialists and seek advice on any CMA required ▪ Implement agreed CMAs as approved

Monitoring	Trigger	Action
▪ Cliffs flanking the Nepean River	***Level 3 (CMAs likely to be required)***[1] ▪ Any rock falls, displacements, dislodgements of boulders or slabs or fracturing of a cliff line(s) flanking the Nepean River resulting from mining that in total impacts up to 0.5% of the total cliffline face area of the mining domain. ▪ Any rock falls, displacements, dislodgements of boulders or slabs or fracturing of a cliffline(s) flanking the Nepean River resulting from mining that in total impacts 0.4% of the total cliffline face area of the mining domain after 1 longwall. ▪ Mass movement of a slope causing large areas of exposed soil ▪ Any form of rockfall or erosion that poses a threat to public safety	▪ *Actions as stated for Level 2* ▪ Immediately notify relevant government agencies, other resource managers and relevant technical specialists and seek advice on any CMA required. ▪ Site visits with stakeholders if required ▪ Develop site CMA in consultation with key stakeholders within 1 month. ▪ Completion of works following approvals ▪ Issue CMA report within 1 month of works completion ▪ Conduct initial follow up monitoring & reporting within 2 months of CMA completion if required ▪ Review the relevant TARP and Management Plan in consultation with key stakeholders
	Exceeding Prediction ▪ More than negligible environmental consequences (that is occasional rockfalls, displacement or dislodgement of boulders or slabs, or fracturing, that in total impacts more than 0.5% of the total face area of such cliffs within the Longwall mining domain) ▪ Rockfall or erosion that poses more than a negligible increased risk to public safety	▪ *Actions as stated for Level 3* ▪ Investigate reasons for the exceedance ▪ Update future predictions based on the outcomes of the investigation
TERRESTRIAL ECOLOGY		
Monitored in conjunction with general observational monitoring for the Nepean River, ephemeral watercourses and active mining area	***Level 1 (Within Prediction)***[1] ▪ Vegetation impacted by mining (by rockfalls, soil slippage, gas emissions) that is likely to naturally regenerate within the monitoring period	▪ Continue monitoring program ▪ Report impacts to key stakeholders ▪ Summarise impacts and record
	Level 2 (Within Prediction – CMAs may be required)[1] ▪ Vegetation impacted by mining (by rockfalls, soil slippage, gas emissions) that is unlikely to naturally regenerate within the monitoring period	▪ *Actions as stated for Level 1* ▪ Review monitoring program ▪ Notify relevant technical specialists and seek advice on any CMA required ▪ Implement agreed CMAs as approved

Monitoring	Trigger	Action
	Level 3 (CMAs likely to be required)[1] ▪ Vegetation impacted by mining that is not responding to CMAs	▪ *Actions as stated for Level 2* ▪ Immediately notify relevant government agencies, other resource managers and relevant technical specialists and seek advice on any CMA required. ▪ Site visits with stakeholders if required ▪ Develop site CMA in consultation with key stakeholders within 1 month. ▪ Completion of works following approvals ▪ Issue CMA report within 1 month of works completion ▪ Conduct initial follow up monitoring & reporting within 2 months of CMA completion if required ▪ Review the relevant TARP and Management Plan in consultation with key stakeholders
	Exceeding Prediction ▪ More than negligible environmental consequences on threatened species, threatened populations, or endangered ecological communities	▪ *Actions as stated for Level 3* ▪ Investigate reasons for the exceedance ▪ Update future predictions based on the outcomes of the investigation
ABORIGINAL ARCHAEOLOGY		
▪ Nepean River 4 (52-2-2098) ▪ Nepean River 5 (52-2-2097) ▪ Nepean River 6 (52-2-2095) ▪ Nepean River 7 (52-2-2096) ▪ Nepean River 8 (52-2-2239) ▪ Upper Nepean Hand Stencils ▪ Bulli Site 40 (BS 40) Any other newly identified Aboriginal Archaeology sites Refer to Figure 5-22 of Bulli Seam Operations EA and Figure 3 Bulli Seam Operations Appendix G (Aboriginal Cultural Heritage Assessment)	***Level 1 (Within Prediction)***[1] ▪ Change in shelter conditions not attributable to natural weathering or preservation – mineral growth or micro-organism growth (as observed by comparing pre-mining photographs with post-subsidence/mining photographs) ▪ Changes external to the shelter that affect the site context – ground cracking, boulder slumping, rock and/or tree falls	▪ Continue monitoring program ▪ Report impacts to key stakeholders ▪ Summarise impacts and record
	Level 2 (Within Prediction – CMAs may be required)[1] ▪ Change in shelter conditions not attributable to natural weathering or preservation – change in drip line or seepage, cracking or exfoliation of overhang or shelter, movement or opening of existing planes and joints at panel, block fall within shelter or overhang	▪ *Actions as stated for Level 1* ▪ Review monitoring program ▪ Notify relevant technical specialists and seek advice on any CMA required ▪ Implement agreed CMAs as approved
	Level 3 (CMAs likely to be required)[1] ▪ Shelter or overhang collapse not attributable to natural weathering ▪ Level 2 impacts at greater frequency than predicted ▪ Level 2 impacts attributable to mining remote from the mining area	▪ *Actions as stated for Level 2* ▪ Immediately notify relevant government agencies, other resource managers and relevant technical specialists and seek advice on any CMA required. ▪ Site visits with stakeholders if required ▪ Develop site CMA in consultation with key stakeholders within 1 month. ▪ Completion of works following approvals ▪ Issue CMA report within 1 month of works completion ▪ Conduct initial follow up monitoring & reporting within 2 months of CMA completion if required ▪ Review the relevant TARP and Management Plan in consultation with key stakeholders

Monitoring	Trigger	Action
▪ Sites determined to hold high or moderate significance as a result of studies required for Extraction Plans	***Exceeding Prediction*** ▪ More than 10% of such sites across the mining area are affected by subsidence impacts (other than negligible impacts or environmental consequence)	▪ *Actions as stated for Level 3* ▪ Investigate reasons for the exceedance ▪ Update future predictions based on the outcomes of the investigation
▪ Other Aboriginal heritage sites	▪ Less than 10% of such sites (or 1 such site, whichever is the greater) within any longwall mining domain are/is affected by subsidence impacts (other than minor impacts or environmental consequence)	
HISTORIC HERITAGE		
▪ Buildings or structures of identified heritage significance ***Note:*** *Detailed Heritage Management Plans to be developed prior to any heritage item being influence by mining.*	***Exceeding Prediction*** ▪ Loss of heritage value greater than predicted under the Heritage Management Plan	▪ Continue monitoring program ▪ Report impacts to key stakeholders ▪ Summarise impacts and record ▪ Immediately notify relevant government agencies, other resource managers and relevant technical specialists and seek advice on any CMA required. ▪ Site visits with stakeholders if required ▪ Develop site CMA in consultation with key stakeholders within 1 month. ▪ Completion of works following approvals ▪ Issue CMA report within 1 month of works completion ▪ Conduct initial follow up monitoring & reporting within 2 months of CMA completion if required ▪ Review the relevant TARP and Management Plan in consultation with key stakeholders ▪ Investigate reasons for the exceedance ▪ Update future predictions based on the outcomes of the investigation

(1) These may be revised in consultation with DoPI and DPI and other key stakeholders

(2) If strata gas emission plumes are detected – particularly coinciding with low river flow and significant gas evolution

(3) Baseline upriver sites for cross-checking for upriver perturbations impacting Area 7 monitoring sites:

- NR0 - possible perturbations from Allens Creek (>2 standard deviation)
- NR2 - upstream perturbations (>2 standard deviations) pre-Area 9 mining
- New site NR110 - possible perturbations from Area 9 (>2 standard deviations) post-Area 9 mining commencement
- Checks at Upriver sites NR4, NR5 and NR6 for possible Cataract River-based perturbations (>2 standard deviation)

Current values:

Level 1

NR11
- pH>6.93;<7.33
- DO>47.8%;<66.0%
- EC>561 uS/cm;<758 uS/cm
- Total Fe>0.589;<0.866mg/L
- Total Mn>0.044;<0.074 mg/L

NR2 upstream normality checks
- pH>7.01
- DO>55.3%
- EC<890 uS/cm
- Total Fe<1.220 mg/L
- Total Mn<0.090 mg/L

Level 2 and 3

NR11
- pH<6.93
- DO<47.8%
- EC>758 uS/cm
- Total Fe>0.866
- Total Mn>0.074

NR2 upstream normality checks
- pH>7.01
- DO>55.3%
- EC<890 uS/cm
- Total Fe<1.220 mg/L
- Total Mn<0.090 mg/L

The above data values are updated during the preparation of each End of Panel Report

APPENDIX 2 – Longwall 706 Impact Summary, TARPs and Performance Measures

Feature	Performance Measure*	Potential Impacts	*Exceeding* Prediction	TARP Trigger Level	Observed Impacts	Additional Comments
Appearance						
Nepean River Visual observations along the length of the Nepean River within the active mining area	Negligible environmental consequences including: • Negligible gas releases and iron staining; and • Negligible increase in water cloudiness	- Minor iron flocs in association with gas releases.	• More than negligible iron staining resulting from the mining • More than negligible increase in water cloudiness resulting from the mining	***Level 1*** • Iron staining resulting from the mining for two consecutive months • Water cloudiness resulting from the mining for two consecutive months	One gas release observed (Impact Ref AA7_LW706_001)	This impact was located approximately 3800m from the nearest point of Longwall 706 at the time of initial observation.
				Level 2 • Iron staining greater than baseline monitoring resulting from the mining for two consecutive months • Water cloudiness greater than baseline monitoring resulting from the mining for two consecutive months	No Level 2 impacts observed.	
				Level 3 • Iron staining greater than baseline monitoring resulting from the mining for six consecutive months • Water cloudiness greater than baseline monitoring resulting from the mining for six consecutive months	No Level 3 impacts observed.	
Ephemeral Watercourses	No greater subsidence impact or environmental consequences than predicted in the EA or SMP.	- fracturing in the uppermost bedrock	- Fracturing of controlling rockbars and/or stream	***Level 1*** • Fracturing with no observable loss of surface water flow	No Level 1 impacts observed.	

Feature	Performance Measure*	Potential Impacts	*Exceeding* Prediction	TARP Trigger Level	Observed Impacts	Additional Comments
• Upper Harris Creek (HC10) • Foot Onslow Creek (FO1) • Navigation Creek (NAV1) Visual observations at water quality monitoring sites and along the length of the stream within the active mining area where landholder access is granted		- localised increase in ponding and flooding.	bed, resulting in the diversion of all stream flow in the mining area - Increased leakage from all pools in the mining area	• Fracturing with no reduction in pool water level when compared to baseline period • Increase in turbidity, iron staining, algal growth, or other visible water quality parameters resulting from the mining for two consecutive months determined by comparing baseline photos with photos during the mining period		
				Level 2 • Fracturing resulting in loss of surface flow in some creeks or tributary • Fracturing resulting in water loss from some permanent pools • Reduced water retention time in pools • Increase in turbidity, iron staining, algal growth, or other visible water quality parameters resulting from the mining for two consecutive months determined by comparing baseline photos with photos during the mining period	No Level 2 impacts observed.	
				Level 3 • Fracturing resulting in total loss of surface flow in all sections of a creek	No Level 3 impacts observed.	

Feature	Performance Measure*	Potential Impacts	*Exceeding* Prediction	TARP Trigger Level	Observed Impacts	Additional Comments
				or tributary • Fracturing resulting in total water loss from all permanent pools in the mining area • Reduced water retention time in all pools in the mining area		
Water Pumps • Pump 1 • Pump 2 • Pump 3 • Pump 4 • Pump 5 • Pump 6				Pump not functioning due to water level changes or physical disturbance from subsidence.	No such impacts observed or reported.	
Landscape Features						
Cliffs • Along Nepean Gorge **Steep Slopes** • Along Nepean Gorge, associated tributaries and above western end of the proposed Longwalls	*Cliffs flanking the Nepean River* • Negligible environmental consequences (that is occasional rockfalls, displacement or dislodgement of boulders or slabs, or fracturing, that in total do not impact more than 0.5% of the total face area of such cliffs within the Longwall mining domain) *Cliffs of 'special*	- minor isolated rock falls could occur - any impacts on the cliffs is expected to represent in the order of 1% to 3% of the total length of the cliffs in the SMP Area. - surface cracking may occur on steep slopes, however only minor in nature.	*Cliffs flanking the Nepean River* • More than negligible environmental consequences (that is occasional rockfalls, displacement or dislodgement of boulders or slabs, or fracturing, that in total impacts more than 0.5% of the total face area of such cliffs within the Longwall mining domain) • Rockfall or erosion that	***Level 1*** • Any rock fall, displacement, dislodgement of boulders or slabs or fracturing of a cliff line flanking the Nepean River resulting from mining • Erosion resulting from mining localised to a small area that should naturally stabilise within the monitoring period • Surface movement resulting from mining with no more than negligible soil surface	No Level 1 impacts observed.	

Feature	Performance Measure*	Potential Impacts	*Exceeding* Prediction	TARP Trigger Level	Observed Impacts	Additional Comments
	significance' (i.e. cliffs longer than 200m and/or higher than 40m; and cliff-like rock faces higher than 5m constitute waterfalls) - Negligible environmental consequences (that is occasional rockfalls, displacement or dislodgement of boulders or slabs, or fracturing, that in total do not impact more than 0.5% of the total face area of such cliffs within the longwall mining domain). *Other cliffs* - Minor environmental consequences (that is occasional rockfalls, displacement or dislodgement of boulders or slabs, or fracturing, that in total do not impact more than 3% of the total face area of such cliffs within any longwall mining domain).		poses more than a negligible increased risk to public safety	exposed		
				Level 2 • Any rock falls, displacements, dislodgements of boulders or slabs or fracturing of a cliff line(s) flanking the Nepean River resulting from mining that in total impacts 0.3% of the total cliff line face area of the mining domain. • Erosion resulting from mining likely to naturally stabilise within the monitoring period. • Surface movement or rock displacement resulting from mining with no more than minor soil surface exposed	No Level 2 impacts observed.	
				Level 3 • Any rock falls, displacements, dislodgements of boulders or slabs or fracturing of a cliff line(s) flanking the Nepean River resulting from mining that in total impacts up to 0.5% of the total cliffline face area of the mining domain. • Any rock falls, displacements, dislodgements of	No Level 3 impacts observed.	

Feature	Performance Measure*	Potential Impacts	*Exceeding* Prediction	TARP Trigger Level	Observed Impacts	Additional Comments
				boulders or slabs or fracturing of a cliffline(s) flanking the Nepean River resulting from mining that in total impacts 0.4% of the total cliffline face area of the mining domain after 1 longwall. • Mass movement of a slope causing large areas of exposed soil • Any form of rockfall or erosion that poses a threat to public safety		
Terrestrial Ecology						
Monitored in conjunction with general observational monitoring for the Nepean River, ephemeral watercourses and active mining area	Negligible environmental consequences	*Endangered Ecological Communities (and other vegetation)* - Potential gas emissions may result in small, isolated areas of vegetation dieback in the Nepean River gorge. Potential surface fracturing and gas emissions considered unlikely to result in alteration of species composition or distribution. Unlikely to have a significant impact on any plant communities. *Threatened flora* Volume of water available	More than negligible environmental consequences on threatened species, threatened populations, or endangered ecological communities	***Level 1*** • Vegetation impacted by mining (by rockfalls, soil slippage, gas emissions) that is likely to naturally regenerate within the monitoring period	No Level 1 impacts observed.	
				Level 2 • Vegetation impacted by mining (by rockfalls, soil slippage, gas emissions) that is unlikely to naturally regenerate within the monitoring period	No Level 2 impacts observed.	
				Level 3 • Vegetation impacted by mining that is not responding to CMAs	No Level 3 impacts observed.	

Feature	Performance Measure*	Potential Impacts	*Exceeding* Prediction	TARP Trigger Level	Observed Impacts	Additional Comments
		for plant use is unlikely to be significantly impacted. It is considered unlikely that subsidence impacts would result in a broad change in the floristic composition of the riparian zone. No significant impact to threatened flora. *Threatened fauna and flora habitat* Changed surface water conditions, such as effects to pools and streams. Impacts to steep slopes and cliffs. Impacts of gas emissions on water quality and riparian vegetation. Unlikely to result in a significant impact to threatened fauna.				

* Performance Measure as defined in BSO Development Consent Approval and Longwall 705 to 706 SMP Approval (Table 1).

APPENDIX 3 – Longwall 707 to 710 Environmental Monitoring Plan (approved)

Table 2: Appin Longwalls 707-710 Environmental Monitoring

MONITORING SITE	SITE TYPE	MONITORING FREQUENCY	PARAMETER
WATER QUALITY			
Nepean River Baseline upriver sites for cross-checking for upriver perturbations: • NR110 Impact monitoring sites adjacent to each longwall: • NR12 • NR13 Downstream site: • NR50 *Other sites:* • NR0 • NR7 • NR2 • NR9 • NR4 • NR11 • NR6 *Refer Figure 1*	Grab Sample and field measurements	• Monthly baseline prior to mining • Monthly observations and field analysis during mining[1] • Monthly detailed laboratory analysis during mining • Monthly monitoring for 2 years post mining (or as otherwise required/approved) • If required as a result of assessment of mining impacts	• Field measurements of: – Temperature – pH – ORP – Dissolved Oxygen (DO) – Electrical Conductivity (EC) – Time – General Comments • Laboratory analysis of: – pH – EC – SO4 filtered – Fe Total – Na filtered – K filtered – Ca filtered – Cl filtered – DOC – Pb filtered – Ni filtered – Zn filtered – Fe filtered – Mn filtered – As filtered – Br filtered – Cu filtered – I filtered – Se filtered – NOx-N – NH3-N – TKN – TP – TRP – TDS – CH_4[2] – Trace Phenols[2] – Sulfide[2]
1st and 2nd Order Watercourses • Lower Harris Creek (NR3) • Cataract River (NR5) • Elladale Creek (NR8) • Ousedale Creek (NR10) • Menangle Creek (NR40) • Upper Harris Creek (HC10) • Foot Onslow Creek (FO1) • Navigation Creek (NAV1) *Refer Figure 1*	Grab sample and field measurements	• Prior to mining of longwall underlying watercourse or mining of any immediately adjacent longwall • Monthly detailed laboratory analysis during mining • Following the development of incremental subsidence for each longwall that will impact on the feature	

MONITORING SITE	SITE TYPE	MONITORING FREQUENCY	PARAMETER
WATER LEVEL AND FLOW			
Nepean River At benchmark sites and water pump sites: • NR110 • NR0 • NRL05 • NRL10 • NRL15 • NR12 • NR13 • NRL20 • Pump 1-NRL • Pump 2-NRL • NRL25 • NRL30 • NRL33 • NRL35 • NRL40 • NRL45 • NRL48 • Pump 5-NRL • Pump 6-NRL SCA flow monitoring sites: • Maldon Weir • Broughtons Pass Weir • Menangle Weir *Refer Figure 1*	Water Level Water flow (measured at SCA weirs)	• Monthly baseline prior to mining (data has been recorded for most sites since 2007) • Monthly manual monitoring at benchmarks during mining(1) • Flow monitoring at weirs (data supplied by SCA) • Ongoing monthly monitoring for 2 years post mining (or as otherwise required/approved)	• Areas of dry riverbed compared with baseline • Areas of flooded riverbed compared with baseline • Measurement of water level compared with baseline (where benchmark is available) • Photo points
1st and 2nd Order Watercourses • Lower Harris Creek (NR3) • Cataract River (NRL15) • Elladale Creek (NRL33) • Ousedale Creek (NRL50) • Menangle Creek (NR40) • Upper Harris Creek (HC10) • Foot Onslow Creek (F01) • Navigation Creek (NAV1) *Refer Figure 1*	Water Level	• Prior to mining of longwall underlying watercourse or mining of any immediately adjacent longwall • Following the development of incremental subsidence for each longwall that will impact on the feature	• As above

MONITORING SITE	SITE TYPE	MONITORING FREQUENCY	PARAMETER
APPEARANCE			
Nepean River • Observations along the length of the Nepean River within the active mining area	Observational and photographic monitoring	• Monthly baseline prior to mining (data has been recorded for most sites since 2003) • Monthly observations and field analysis during mining (1) • Monthly monitoring for 2 years post mining (or as otherwise required/approved) • If required as a result of assessment of mining impacts	• Iron or salinity staining (e.g. orange or white staining in water or on banks/seeps) • Water cloudiness • Evidence of springs in Nepean River • Visual signs of impacts (e.g. cracking, vegetation changes, increased erosion, changes in water colour etc.) • Impacts determined from comparing photo points taken prior to, during and post mining • Erosion and/or sedimentation compared with baseline
1st and 2nd Order Watercourses • Lower Harris Creek (NR3) • Cataract River (NR5) • Elladale Creek (NR8) • Ousedale Creek (NR10) • Menangle Creek (NR40) • Upper Harris Creek (HC10) • Foot Onslow Creek (FO1) • Navigation Creek (NAV1)	Observational and photographic monitoring	• Prior to mining of longwall underlying watercourse or mining of any immediately adjacent longwall • Following the development of incremental subsidence for each longwall that will impact on the feature	• As above
Water Pumps • Pump 1 NRL • Pump 2 NRL • Pump 3 • Pump 4 • Pump 5 NRL • Pump 6 NRL	Observational and photographic monitoring	• Pre mining photographs • Monthly visual inspection during mining • If required as a result of assessment of mining impacts	• Pump submergence and disturbance
AQUATIC ECOLOGY			
Nepean River • Sites 1 and 2 • Sites 5 and 6 • Sites 7 and 8 • Sites X3 and X4 (AA9 Monitoring) • Sites X5 and X6 *Refer Figure 1*	Quantitative and observational monitoring	• Two Baseline monitoring campaigns prior to mining • Annual monitoring campaigns (spring) during mining • Two monitoring campaigns post mining	• Photographic records • Macro-invertebrate Assessment • Fish sampling • Water Quality • Monitored in conjunction with: – Flow – River Morphology

MONITORING SITE	SITE TYPE	MONITORING FREQUENCY	PARAMETER
GROUNDWATER			
Water Level IC Monitoring Bores • S1913 (EAW5) • S1936 (EAW7) *Additional Bulli Seam piezometers located throughout the mining area (Refer Figure 1)* Private Bores (10 registered bores): • GW104602 • GW104661 • GW105376 • GW105388 • GW105574 • GW101986 • GW105339 • GW106574 • GW072874 • GW105534 *Refer Figure 1*	Groundwater level	IC Bores • Pre-mining • Water level logged hourly • Post-mining – following the development of incremental subsidence for each longwall that will potentially impact on the borehole • Monitoring to continue for at least 12 months post mining depending on borehole functionality Private Bores • Prior to mining of longwall underlying bore or mining of any immediately adjacent longwall (if in agreement with landholder) • Post-mining – following the development of incremental subsidence for each longwall that will impact on the borehole (if in agreement with landholder) • As requested by landholder or if physical impacts to bore identified (landholder to observe during use of bore)	Grouted monitoring holes • Piezometric head in various strata Private bores • Water level measured with dip meter (where access to property is available and in agreement with landholder)
LANDSCAPE FEATURES			
Cliffs • Along Nepean Gorge **Steep Slopes** • Along Nepean Gorge, associated tributaries and above western end of the proposed longwalls *Refer Figure 19.1 in LW705-710 SMP*		• Once prior to mining. Photographic records taken • Monthly visual inspections • Monitoring to continue 6 monthly for 2 years following the completion of mining (or as otherwise required/approved) • As required when specific impacts are identified or when concern is raised by a landowner • As required, in accordance with Built Feature Management Plans and landholder agreement	• Cliff and steep slopes will be observed for any instability (e.g. rock falls, mass movement) and seeps

MONITORING SITE	SITE TYPE	MONITORING FREQUENCY	PARAMETER
TERRESTRIAL ECOLOGY			
Monitored in conjunction with general observational monitoring for the Nepean River, watercourses and landscape		• If required as a result of assessment of mining impacts • General observation of active mining areas during all other monitoring	• Vegetation communities • Vegetation condition • Changes in vegetation • Tree health • Threatened species
ABORIGINAL ARCHAEOLOGY			
There are no aboriginal archaeology sites on the AIHMS database within the Appin LW707-710 mining area. No sites have been identified during the SMP studies			Any sites identified during the mining period would be monitored as required by the Bulli Seam Operations Heritage Management Plan
HISTORIC HERITAGE			
• Gilbulla (Anglican Conference Centre) *Refer Figure 1*	Observational, photographic monitoring and structural inspections	Property Management Plan to be developed prior to influence of mining	• Building/structure condition • Heritage value

(1) *Fortnightly targeted monitoring of relevant sites when impacts are observed*

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