

Our Ref: 59919055_001: DP
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7 August 2019

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Dear Josh,

LONGWALL 902 END OF PANEL REPORT AQUATIC FLORA AND FAUNA REVIEW

Introduction

South 32 Illawarra Coal (South32) extracts coal from the Bulli Seam in Area 9 of the Appin Colliery in the Southern Coalfield of New South Wales using longwall mining techniques. Appin Area 9 consists of Longwalls 901 to 904. The sequence of longwall extraction has been as follows:

- > Longwall 901: 19 January 2016 to 8 September 2017
- > Longwall 902: 12 May 2018 to 3 April 2019;

Extraction of Longwalls 903 and 904 is to follow.

Cardno NSW/ACT (Cardno) was commissioned by South32 to undertake a review of the status of aquatic flora and fauna in relation to the extraction of Longwall 902 to support the End of Panel reporting for the longwall. Cardno has been undertaking ongoing monitoring of aquatic habitat and biota in the section of the Nepean River in the Appin Area 9 (in conjunction with Appin Area 7) mining area. The overall objective of the monitoring is to determine whether the extent and nature of observed impacts, primarily subsidence-induced fracturing of bedrock, diversion and loss of aquatic habitat, if any, are consistent with the predictions made in the aquatic ecology assessment (Cardno Ecology Lab 2012) and Extraction Plan (EP) for Longwalls 901 to 904 (BHPBIC 2013) that was approved in September 2014. This review includes:

- > An overview of the management of aquatic flora and fauna including monitoring proposed and undertaken;
- > Review of observed impacts to aquatic habitat, flora and fauna from South32 impact reports and site visits undertaken by Cardno and a comparison with those predicted in the EP; and
- > Recommendations for any management actions associated with aquatic habitat and biota and future monitoring.

This review considers the effects of extraction of Longwall 902 in Appin Area 9 and focuses on the findings of ongoing monitoring by South32 and on data from aquatic ecology monitoring sites on the Nepean River.

Aquatic Ecology Management and Monitoring

The monitoring requirements recommended in the aquatic assessment and included in the EP for Longwalls 901 to 904 included biennial monitoring of the following indicators at impact and control sites as a measure of aquatic health:

- > Aquatic habitat, including fish habitat and riparian vegetation;
- > Aquatic macroinvertebrates sampled in accordance with the Australian River Assessment System (AUSRIVAS) and derived biotic indices;

- > Fish sampled using bait traps and backpack electrofishing;
- > Limited *in-situ* water quality sampling; and
- > Species composition of aquatic macrophytes.

These indicators are assessed at two potential impact sites (X3 and X4) near Longwalls 901 to 904 and at control sites (X5 to X8) upstream and downstream of this area on the Nepean River. Sites 1 and 2 located just upstream of Douglas Park Weir also provide a measure of potential downstream impacts. These sites are monitored annually for Appin Area 7.

Table 1-1 summarises the monitoring that has been completed in Appin Area 9 in line with the aquatic assessment and EP. Pre-extraction monitoring was undertaken in December 2014 (Cardno Ecology Lab 2015) and November 2015 (Cardno 2016). Monitoring in November of 2017 provided post-extraction data for Longwall 901 and further pre-extraction monitoring for Longwall 902. The aquatic assessments included a literature review on the physical setting, aquatic habitat, water quality, aquatic macroinvertebrates, fish, threatened species, populations and ecological communities in Appin Area 9. During the previous surveys during 2014 to 2017, riparian vegetation at Appin Area 9 sites was largely undisturbed, consisting of numerous large, established trees with few breaks in cover. At the downstream Nepean River sites (Sites 1 and 2), aquatic habitat consisted primarily of wide (approximately 30 m) channel, relatively deep and slow flowing water and sand / bedrock substrata (at least along the river edges). At the sites further upstream (Sites X3 and X8), the channel was narrower (approximately 10 to 20 m), shallower and faster flowing and the substratum included coarse pebbles, cobbles, boulders and bedrock. Two flow controlling structures occur nearby: Maldon Weir immediately upstream of Site X8; and Douglas Park Weir, just downstream of Site 2.

Table 1-1 Timing of aquatic ecology monitoring events undertaken for Appin Area 9 Longwalls 901 to 904. Pre = prior to commencement of mining, Post = post commencement of mining.

Longwall	Commencement	Completion	Survey Date and Reference		
			Dec 14	Nov 15	Nov 17
			Cardno Ecology Lab (2015)	Cardno (2016)	Cardno (2018)
901	Jan 16	Sep 17	Pre	Pre	Post
902	May 17	Apr 19	Pre	Pre	Pre
903-904	Not yet commenced		Pre	Pre	Pre

Monitoring for Appin Area 7 Longwalls was also undertaken in September of 2003 and 2005, April and November of 2008 and annually in November/December through 2010 to 2018 (Cardno 2019 (in prep.)). Monitoring at Longwall 901 to 904 monitoring sites X3 to X8 was not undertaken in 2018 (due to the biennial monitoring program). However, Sites 1 and 2 were visited as part of the Appin Area 7 investigations. In the absence of information from other Appin Area 9 sites following the commencement of extraction of Longwall 902, the assessment of impacts to aquatic ecology in this review has been undertaken based on the preliminary findings of the surveys at Sites 1 and 2 in November 2018. It also considers the findings of surveys for physical mining impacts undertaken by the Illawarra Coal Environmental Field Team ICEFT (South32 2019a) and of changes in surface water quality assessed by HGeo (2019). ICEFT undertake weekly monitoring of landscape and natural features in Appin Area 9 when they are within 400 m of the active longwall. This includes monitoring during extraction of Appin Area 9 longwalls to identify any fracturing, pool water level reduction, changes in flow and water quality in the Nepean River. The next aquatic ecology survey for Longwalls 901 and 904 is planned for November/December 2019.

The Appin Area 9 Biodiversity Management Plan includes the following triggers as part of the Trigger Action Response Plans (TARPs) relating to aquatic ecology:

- > Level 1: Reduction in aquatic habitat resulting from mining over 1 season
- > Level 2: Reduction in aquatic habitat resulting from mining over 2 seasons; and
- > Level 3: Reduction in aquatic habitat resulting from mining for > 2 consecutive seasons or complete loss of habitat.

Trigger specific management actions aim to minimise any further impacts to the aquatic environment, and include requirements for further monitoring, reporting, application of mitigation measures and notification of relevant stakeholders, as required.

Predicted and Observed Impacts

Physical Impacts and Impacts to Water Quality and Availability

The results of physical impact monitoring undertaken in the Nepean River by ICEFT and analysed by other specialist consultants during extraction of Longwall 902 are provided in South32 (2019a and b). ICEFT identified six new gas release zones during extraction of Longwall 902; as of 24 May 2019, one of these zones was active. A total of seven gas release zones were active on the Nepean River as of 24 May 2019, which included six zones identified during the extraction of Longwall 901.. These gas release zones typically occur over areas of under approximately ten square metres, whilst larger zones can occur over areas up to several hundred square metres.

Assessment of changes in water levels and water quality undertaken by HGeo (2019) indicted a 0.43 m reduction water level at Site NR0 (adjacent to Site X3) below the baseline level that occurred throughout the reporting period of Longwalls 901 and 902. An increase in electrical conductivity (EC) (greater than two standard deviations for two consecutive months) was observed at Sites NR0 and NR1 (adjacent to Site X3), and NR2 (adjacent to Sites 1 and 2). A decrease in pH (between one and two standard deviations for two consecutive months) occurred at Sites NR0 and NR1 during the reporting period. Water quality triggers associated with these changes occurred during May 2018 to March 2019. Although the observed increase in EC may have been associated with the lower than average rainfall during 2017 and 2018, similar deviations from the baseline mean were not observed at the upstream control site (HGeo 2019). However, these changes appeared to be short-term and surface water quality in the Nepean River has since returned to baseline levels. Changes in dissolved oxygen (DO) and the concentration of iron were not observed. A change in concentration of magnesium was identified, however, it was not attributed to mining (HGeo 2019).

Impacts on Aquatic Habitat and Biota

The results of monitoring undertaken by Cardno are compared with the impacts to aquatic habitat and biota predicted to occur in the in the aquatic assessment (Cardno Ecology Lab 2019) and EP in **Table 1-2**. It is noted these comparisons have been undertaken using data from Sites 1 and 2 only visited in November 2018 (as part of the Appin Area 7 monitoring program). Changes that may have occurred at Sites X3 and X4 will be assessed following the next survey event at these Sites, currently planned for November/December 2019.

There were no obvious changes to indicators of aquatic ecology derived from AUSRIVAS sampling (number of taxa and biotic indices derived from macroinvertebrate sampling) that could be attributed to extraction of Longwall 902 at Sites 1 and 2 (Cardno 2019. In prep.). The aquatic habitat at Sites 1 and 2 was in good condition and there was no evidence of any change in the availability of aquatic habitat that could be attributed to mining. There was no evidence that the changes in water levels and water quality had affected aquatic habitat and biota at these sites and there was no evidence of any changes to fish and aquatic macrophytes. The fish assemblage sampled at these sites following the commencement of extraction of Longwall 902 was comparable with that sampled prior to extraction. No fish kills or any other observations that may suggest an impact due to mining were observed. It is noted, however, that this preliminary assessment based on examination of these sites in isolation from the upstream control sites.

Table 1-2 Predicted and observed impacts to aquatic ecology in the Nepean River associated with Longwall 902. Impacts to physical features and surface water quality assessed by ICEFT (2019a) and HGeo (2019), respectively. Impacts to aquatic ecology based on the preliminary findings of surveys undertaken at Sites 1 and 2 during November 2018 as part of Appin Area 7 monitoring.

Attribute	Predicted Physical Impacts	Associated Predicted Impacts on Aquatic Ecology	Observed Impacts
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	No changes in ponding flooding and scouring of stream banks observed (South32 2019a). No impacts to aquatic ecology identified during observations of aquatic macroinvertebrates, fish and aquatic macrophytes.
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.	No fracturing observed (South32 2019a). No impacts to aquatic ecology identified during observations of aquatic macroinvertebrates, fish and aquatic macrophytes.
Gas releases	Minor gas releases, associated iron precipitate and reductions in	Negligible environmental consequences	Six new gas release zones identified during extraction of Longwall 902. Four of these and seven gas release

Attribute	Predicted Physical Impacts	Associated Predicted Impacts on Aquatic Ecology	Observed Impacts
	concentrations of dissolved oxygen may occur due to extraction.		zones previously identified during extraction of Longwall 901 were still active in June 2019 No associated changes to indicators of aquatic ecology at downstream monitoring Sites 1 and 2.
Water Flow and Levels	<p>Potential for loss or diversion is very low in the downstream reach. Minor, localised fracturing of rock bars and diversion of flows may occur in the upstream reach.</p> <p>No measurable impact expected in the upstream reach and it is unlikely that there would be any significant change in the downstream reach.</p>	<p>There are unlikely to be any measurable impacts on availability or connectivity of aquatic habitats in the downstream reach of the river due to its flooded nature and very low gradient. In the upstream reach, any fracturing that occurs is expected to be isolated and minor in nature, so the potential for impacts on surface flow is limited.</p> <p>In the downstream reach, subsidence and upsidence may result in small changes in the levels of the river bed and banks. This could lead to minor increases and decreases, respectively in the availability of aquatic habitat, but may be difficult to detect.</p> <p>Dilation of the bedrock in the base of the river could result in a minor decrease in water volume and availability of aquatic habitat.</p> <p>Minor changes in the availability of aquatic habitat could result in a reduction in the abundance of aquatic macroinvertebrates living therein. Losses would be negligible relative to the amount of habitat available within the downstream reach of the river.</p>	<p>A decline in water level of 0.43 m below the baseline at Site NR0 from the start of Longwall 901 throughout the reporting periods for Longwalls 901 and 902.</p> <p>No associated changes to indicators of aquatic ecology.</p>
Water Quality	<p>Localised iron staining may occur.</p> <p>Minor changes to water quality may occur.</p>	No more than associated impacts to aquatic biota is expected.	<p>Increases in electrical conductivity (EC) and decreases in pH in excess of TARP trigger levels observed in the Nepean River adjacent to and just downstream of Longwalls 901 to 904. These occurred between May 2018 and March 2019 and surface water quality in the Nepean River has since returned to baseline levels.</p> <p>No associated changes to indicators of aquatic ecology were observed at Sites 1 and 2.</p>

Aquatic Ecology TARP

Table 1-3 compares observed impacts to aquatic ecology with the TARP levels to determine if these have been triggered and what management actions associated with extraction of Longwall 902 may be appropriate, if any. No reduction in aquatic habitat was observed on the Nepean River at Sites 1 and 2 during the aquatic ecology monitoring program that could be attributed to mining. Thus, TARPs have not been triggered.

Table 1-3 TARP levels applicable to aquatic features relevant to Longwall 902 as of November 2018. It is noted this is applicable to Sites 1 and 2 only.

TARP	Trigger
Level 1: Reduction in aquatic habitat resulting from mining over 1 season	Not triggered
Level 2: Reduction in aquatic habitat resulting from mining over 2 seasons.	Not triggered
Level 3: Reduction in aquatic habitat resulting from mining for > 2 consecutive seasons or complete loss of habitat	Not triggered

Conclusion and Recommendations

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

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

Yours sincerely,



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References

- BHP Billiton Illawarra Coal (BHPBIC) (2014b). Appin Area 9 Longwalls 901 to 904 Extraction Plan.
- Cardno Ecology Lab (2012). Appin Area 9 Longwalls 901 to 904. Aquatic Ecology Assessment.
- Cardno Ecology Lab (2015). Appin Longwalls 701 to 710 and 901 to 904. Aquatic Ecology Monitoring 2003 to 2014.
- Cardno Ecology Lab (2016). Appin Longwalls 701 to 710 and 901 to 904. Aquatic Ecology Monitoring 2003 to 2015.
- Cardno (2018). Appin Areas 7 and 9. Aquatic Ecology Monitoring 2003 to 2017.
- Cardno (2019 (in preparation)). Appin Area 7. Aquatic Ecology Monitoring 2003 to 2018.
- HGeo (2019). South32. Appin Mine. Area 9 Longwall 902 End of Panel surface water and groundwater monitoring review. Final. July 2019.
- South32 (2019a) Appin Mine Longwall 902 End of Panel Landscape Report. June 2019.
- South32 (2019b) Appin Mine Longwall 902 End of Panel Report. June 2019.