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Dear Josh,

LONGWALL 707 END OF PANEL REPORT AQUATIC FLORA AND FAUNA REVIEW

Introduction

South 32 Illawarra Coal (South32) extracts coal from the Bulli Seam in Area 7 of the Appin Colliery in the Southern Coalfield of New South Wales using longwall mining techniques. Appin Area 7 consists of Longwalls 701 to 710. The sequence of longwall extraction has been as follows:

- Longwall 701: 27 October 2007 to 9 May 2008;
- Longwall 702: 18 September 2008 to 20 May 2009;
- Longwall 703: 22 October 2009 to 3 March 2011;
- Longwall 704: 7 May 2011 to 29 July 2012;
- Longwall 705: 7 September 2012 to 27 March 2014;
- Longwall 706: 23 April 2014 to 28 November 2015; and
- Longwall 707: 7 January 2016 to 19 June 2018.

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 707 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 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 (The Ecology Lab 2004) and Subsidence Management Plan (SMP) for Longwalls 705 to 710 (Cardno Forbes Rigby 2008). 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 SMP; and
- Recommendations for any management actions associated with aquatic habitat and biota and future monitoring.

This review considers the effects of extraction of Longwall 707 in Appin Area 7 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 SMP for Longwalls 705 to 710 included monitoring of 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;
- Limited *in-situ* water quality sampling; and
- Species composition of aquatic macrophytes.

Table 1-1 summarises the monitoring that has been completed in Appin Area 7 in line with the aquatic assessment and SMP. Before extraction monitoring for Longwall 707 was undertaken 2003 to 2015. Monitoring in November of 2016 and 2017 provided after extraction data for this longwall. The aquatic assessment also includes a literature review on the physical setting, aquatic habitat, water quality, aquatic macroinvertebrates, fish, threatened species, populations and ecological communities in Appin Area 7.

Table 1-1 Aquatic ecology monitoring events undertaken to date at sites relevant to Appin Area 7 Longwall 707. Monitoring general included in-situ water quality, AUSRIVAS macroinvertebrates, and fish sampling and assessment of macrophytes unless otherwise identified. Bef and Aft indicate whether surveys were done before or after, respectively, commencement of extraction of Longwall 707.

LW	Extraction Period		Survey											
No.	Start	Finish	Sep 03	Sep 05	Apr 08	Nov 08	Dec 10	Dec 11	Dec 12	Dec 13	Dec 14	Nov 15	Nov 16	Nov 17
707	Jan 16	Jun 18	Bef	Bef	Bef	Bef	Bef	Bef	Bef	Bef	Bef	Bef	Aft	Aft
Report Reference			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Notes:			a	b	c			d	e	f	g			

Report Reference: (1) The Ecology Lab (2004), (2) The Ecology Lab (2006), (3) The Ecology Lab (2008b), (4) The Ecology Lab (2009), (5) Cardno Ecology Lab (2011a), (6) Cardno Ecology Lab (2012a), (7) Cardno Ecology Lab (2013), (8) (Cardno Ecology Lab 2014), (9) Cardno Ecology Lab (2015), (10) Cardno (2016), (11) Cardno (2017) and (12) Cardno (2018).

The Illawarra Coal Environmental Field Team (ICEFT) undertake weekly monitoring of landscape and natural features in Appin Area 7 when they are within 400 m of the active longwall. This includes monitoring during extraction of Appin Area 7 longwalls to identify any fracturing, pool water level reduction, changes in flow and water quality in the Nepean River.

The SMP includes the following triggers as part of the Trigger Action Response Plans (TARPs) relating to aquatic ecology:

- Level 1 – 1 season reduction in aquatic habitat resulting from mining when compared with baseline condition;
- Level 2 – 2 consecutive season reduction in aquatic habitat resulting from mining when compared with baseline condition; and
- Level 3 – greater than 2 consecutive season reduction in aquatic habitat resulting from mining or a 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 Mining Impacts

The results of impact monitoring undertaken in the Nepean River by ICEFT and other specialist consultants during extraction of Longwall 707 are provided in South32 (2018). Approximately four occasionally active gas zones identified on the Nepean River downstream of Douglas Park weir during extraction of previous longwalls were re-activated during extraction of Longwalls 707. No further gas releases, fracturing, changes in water levels and flow or changes in water quality have been attributed to mining.

Impacts on Aquatic Habitat and Biota

The results of impact monitoring undertaken in the Nepean River by ICEFT and Cardno are compared with the impacts to aquatic habitat and biota predicted to occur in the in the aquatic assessment (The Ecology Lab 2004) and SMP in **Table 1-2**.

There were no observed impacts to indicators of aquatic ecology (number of taxa and biotic indices derived from macroinvertebrate sampling) that could be attributed to extraction of Longwall 707 in data collected in November of 2016 and 2017 (Cardno 2018). These results were not surprising given only minor gas releases have been observed in the Nepean River associated with mining. Statistically significant differences in these indicators among surveys and monitoring locations on the Nepean River, where present, were attributed to natural spatial and temporal variation, rather than mining.

The aquatic habitat in sections of Nepean River visited was generally in good condition and there was no evidence of any change in the availability of aquatic habitat that could be attributed to mining. 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 within, upstream and downstream of the study area, may explain the often depauperate macroinvertebrate assemblages sampled. There was no evidence that any impaired aquatic habitat or water quality is due to any mining related disturbance in the Nepean River.

Table 1-2 Predicted and observed impacts to aquatic ecology associated with Longwall 707

Potential Impacts	Exceeding predictions	Observed Impacts to Aquatic Ecology
Loss and/or alteration of aquatic habitat and associated impacts to aquatic macroinvertebrates.		None identified during observations at aquatic ecology monitoring sites on the Nepean River in November of 2016 and 2017.
Impacts on fish passage (connectivity between upstream and downstream habitat)		None identified
Changes in water quality		None identified (GeoTerra 2018)
Impacts on species of conservation significance	More than negligible consequences for a threatened species threatened population of endangered ecological community	None identified
The distribution of submerged (attached) macrophytes above the mine area may change in response to the vertical movement of the riverbed. Macrophytes that occur in areas of riverbed subject to upsidence may dry out, although the flooded nature of the Nepean River in the study area would suggest that total desiccation is unlikely.		No impacts to macrophytes observed that could be attributed to mining. Relatively large changes in the extent and composition of macrophytes appear to occur naturally in the river following flood events.
If macrophytes respond negatively to the effects of mining (e.g. by retreating to less disturbed areas of river), abundances of fish above the mine area may be affected.		No impacts to the species composition or abundance of fish observed.

There was no evidence of any changes to fish and aquatic macrophytes attributable to mining. The fish assemblage sampled in the Nepean River following the commencement of extraction of Longwall 707 was comparable with that sampled prior to extraction and no fish kills or any other observations that may suggest an impact due to mining have been observed.

Over the course of the monitoring program large changes in the distribution of aquatic macrophytes have occurred. Most recently, high flows that occurred in the river between November of 2016 and 2017 appear to have had a substantial effect on the extent of aquatic macrophytes irrespective of mining. Despite this, the species composition of macrophytes has been relatively consistent and the number and type of species identified in November 2017 were very similar 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 was no evidence to suggest that changes in macrophyte diversity and distributions are outside what would be expected due to natural variation. In particular, changes to bank and river bed morphology due to recent flood events, appears to have resulted in substantial localised changes in the coverage of macrophytes independent of mining (**Plate 1**).

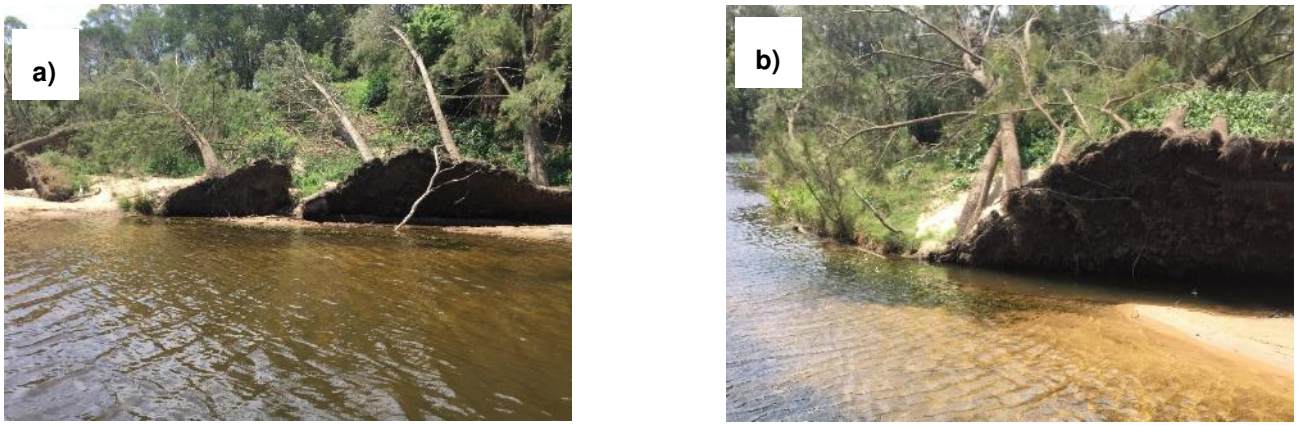

Plate 1 Uprooted trees observed in the Nepean River suggestive of elevated flow during floods

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 707 may be appropriate, if any. No reduction in aquatic habitat have been observed on the Nepean River 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 707 as of November 2017.

TARP	Trigger
Level 1 – 1 season reduction in aquatic habitat resulting from mining when compared with baseline condition.	Not triggered
Level 2 – 2 consecutive season reduction in aquatic habitat resulting from mining when compared with baseline condition.	Not triggered
Level 3 – greater than 2 consecutive season reduction in aquatic habitat resulting from mining or a complete loss of habitat.	Not triggered

Conclusion and Recommendations

No changes to aquatic ecology indicators that could be associated with extraction of Longwall 707 were detected in data collected following the commencement of extraction of this longwall. This is expected, given that no water quality or physical mining impacts (other than isolated gas releases) have been identified. The gas releases identified in the Nepean River during extraction of previous longwalls do not appear to have had any measurable effect on macroinvertebrates, fish and macrophytes in the Nepean River.

There is also no evidence that mining of Longwall 707 has had any impact on fish populations. The relatively large changes in the extent and distribution of aquatic macrophytes that have been observed since the commencement of monitoring represent natural variation relating to high flow periods, and unrelated to mining.

Yours sincerely,

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