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Dear Josh,

LONGWALL 14 END OF PANEL REPORT AQUATIC FLORA AND FAUNA REVIEW

Introduction

South32 – Illawarra Coal (South32) is extracting coal using longwall mining techniques from the Dendrobium Coal Mine, situated approximately 15 km to 20 km west of Wollongong. Consent for the mine, granted in November 2001, allows extraction from three longwall domains, known as Areas DA1, DA2 and DA3. DA3, situated to the west of Lake Cordeaux, is currently being mined. A modification to the mine layout of DA3, approved in December 2008, allowed the mine to be expanded and Area 3 to be sub-divided into three smaller domains, DA3A, DA3B and DA3C. Mining of DA3B Longwalls is currently underway. Longwalls in DA3B have been extracted as follows:

- Longwall 9 commenced 9 February 2013; completed on 2 June 2014;
- Longwall 10 commenced 21 January 2014; completed 20 January 2015;
- Longwall 11 commenced 18 February 2015; completed 26 January 2016;
- Longwall 12 commenced 22 February 2016, completed 31 January 2017;
- Longwall 13 commenced 3 March 2017, completed on 19 April 2018; and,
- Longwall 14 commenced 22 May 2018, completed 26 February 2019.

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 14 to support the End of Panel reporting for the longwall. Cardno has been undertaking ongoing monitoring of watercourses within the DA3B mining area including the perennial Wongawilli Creek, Donalds Castle Creek and several associated tributaries. 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 flora and fauna review (AFFA) (Cardno Ecology Lab 2012) and Subsidence Management Plan (SMP) (BHPBIC 2012) for DA3B. 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 Corrective Management Actions (CMA) and future aquatic flora and fauna monitoring.

This review considers the effects of extraction of Longwall 14 in DA3B and focuses on the findings of ongoing monitoring by South32 and on data from aquatic ecology monitoring sites in Wongawilli Creek. Information on Lake Avon tributaries near the western extent of Longwall 14 and on Wongawilli Creek tributary WC15 has also been provided by South32, though these are not routinely monitored by Cardno as part of the ongoing aquatic ecology monitoring.

Any impacts to swamps and amphibians are considered by other specialist consultants.

Aquatic Ecology Management and Monitoring

The monitoring requirements recommended in the AFFA for DA3B and included in the SMP for DA3B incorporates a Before, After, Control, Impact (BACI) sampling design to monitor mine subsidence impacts on the aquatic environment with collection of at least two years of baseline data followed by monitoring during extraction, and at least two years of post-extraction monitoring. The following indicators were monitored at impact and control sites within and outside the SMP area for DA3B as a measure of aquatic health:

- Aquatic habitat condition - using a modified version of the Riparian, Channel and Environmental Inventory method (RCE) (Chessman *et al.* 1997);
- Macroinvertebrates, including threatened species of dragonfly (Adams emerald dragonfly and Sydney hawk dragonfly), using AUSRIVAS and standardised artificial collectors;
- Limited *in-situ* water quality – using a portable probe; and
- Fish abundance using backpack electrofishing and bait traps.

It was recommended that monitoring in DA3B be undertaken once every two years (Cardno Ecology Lab, 2012).

Table 1-1 summarises the monitoring that has been completed in DA3B in line with the AFFA and SMP. Baseline surveys were undertaken in DA3B in 2010 and 2011, followed by the during-extraction monitoring in 2013, 2015, 2017 and May 2019 (further surveys to be undertaken in autumn and spring of 2019). Additional monitoring was undertaken in DA3B in 2011 to support the AFFA, including more extensive fish surveys in WC21. The AFFA also includes a literature review on the physical setting, aquatic habitat, water quality, aquatic macroinvertebrates, fish, threatened species, populations and ecological communities in DA3B. Aquatic habitat in WC21 was also inspected visually during 2014 following the observation of physical mining impacts within the tributary.

The Illawarra Coal Environmental Field Team (ICEFT) undertake weekly monitoring of landscape and natural features in DA3B when they are within 400 m of the active longwall, and monthly thereafter. This includes monitoring during extraction of DA3B longwalls to identify any fracturing, pool water level reduction, changes in flow and water quality in Wongawilli Creek and its tributaries (including WC21, WC15), Donalds Castle Creek, and Lake Avon tributaries.

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

- Level 1 – Reduction in aquatic habitat for 1 year;
- Level 2 – Reduction in aquatic habitat for 2 years following the active subsidence period (i.e. when a Longwall within 400 m of a feature, such as a creek, is completed); and
- Level 3 – Reduction in aquatic habitat for >2 years or complete loss of habitat following the active subsidence period.

These trigger specific management actions aim to minimise any further impacts to the aquatic environment, and include requirements for further monitoring, reporting, application of (CMAs), such as grouting and repair of fractures, and notification of relevant stakeholders, as required.

Table 1-1 Monitoring undertaken for DA3B longwalls in line with the DA3B SMP Requirements and Recommendation in Cardno Ecology Lab (2012)

Report	Survey Date	Sampling Component
Baseline Monitoring		
Dendrobium Areas 3A and 3B. Aquatic Ecology Monitoring 2008 to 2013 (Cardno Ecology Lab 2014)	Mar / May / Sep Nov 2010 Apr / Jun / Sep / Oct 2011	Habitat assessment, fish, macroinvertebrates, water quality
During Extraction Monitoring		
Dendrobium Areas 3A and B. Aquatic Ecology Monitoring 2008 to 2013 (Cardno Ecology Lab 2014)	Apr / Jun / Sep / Nov 2013	Habitat assessment, fish, macroinvertebrates, water quality
Dendrobium Area 3A Aquatic Ecology Monitoring 2008 to 2014 (Cardno Ecology Lab 2015)	Throughout 2014	Observations of mining impacts and effects on aquatic habitat in WC21 in 2014 that were attributed to extraction of Longwalls 9 and 10, undertaken as part of DA3A monitoring fieldwork
Dendrobium Area 3B Aquatic Ecology 2010 to 2015 (Cardno Ecology Lab 2017)	May / Jun / Oct / Nov 2015	Habitat assessment, fish, macroinvertebrates, water quality
Cardno (2018)	Apr / May / Oct / Nov 2017	Habitat assessment, fish, macroinvertebrates, water quality
Monitoring currently underway	May 2019 Planned for Jun, Sep and Oct 2019	Habitat assessment, fish, macroinvertebrates, water quality

Predicted and Observed Impacts

Physical Mining Impacts

Details of the physical and associated water level, flow and quality impacts identified by ICEFT (South32 2019) during extraction of Longwall 14 are provided in **Table 1-2**.

Table 1-2 Physical and water quality impacts observed by ICEFT during extraction of DA3B Longwall 14

Watercourse	Site / Reference	Impact Type	Date of Initial Observation	Comment
WC15	DA3B_LW13_046	Rock Fracturing	1/04/2019	Flow diversion not expected
WC15	DA3B_LW14_023	Rock Fracturing	1/04/2019	No flow diversion evident
Donalds Castle Creek	At Fire Road 6 (FR6) crossing	Level 3 EC trigger	06/12/2018	
WC15	DA3B_LW14_022 to 017	Rock fracturing / rock fracturing and uplift	20/02/2019	No flow diversion observed, though would be expected at most fractures
WC15	DA3B_LW14_016	Rock Fracturing, Uplift and Rock Displacement	21/01/2019	No flow diversion observed, though would be expected
Wongawilli Creek	At Fire Road 6 (FR6) crossing	Level 3 EC trigger and Level 3 DO trigger.	3/10/2018	
LA4B	DA3B_LW13_044	Rock Fracturing	26/07/2018	No flow diversion observed
WC15	DA3B_LW13_045	Rock Fracturing	8/07/2018	No flow diversion observed, though possible occur
LA4	DA3B_LW13_043 (Update)	Rock Fracturing, Rock Fall & Iron Staining	16/05/2018	First identified during extraction of Longwall 13. Additional rock fracturing and iron staining observed during extraction of Longwall 14.

Watercourse	Site / Reference	Impact Type	Date of Initial Observation	Comment
WC15	DA3B_LW13_042 (Update)	Rock Fracturing	16/05/2018	First identified (along with iron straining) during extraction of Longwall 13. Flow diversion and additional fracturing observed during extraction of Longwall 14.
WC15	DA3B_LW13_035 (Update)	Rock Fracturing	23/04/2018	First identified during extraction of Longwall 13. Flow diversion and additional fracturing observed during extraction of Longwall 14.

During extraction of Longwall 14 rock fracturing was observed in LA4B and LA4 (first and second order drainage lines of Lake Avon). Iron staining was also observed in LA4. No flow diversions were observed. Fracturing had been identified previously in LA4 during extraction of Longwall 13. Several fractures were also observed in WC15 (a second order drainage line of Wongawilli Creek) during extraction of Longwall 14. Fracturing at DA3B_LW13_042 and DA3B_LW13_035 were associated with flow diversions and located near fracturing that had been observed previously during extraction of Longwall 13. Although flow diversions associated with the other fractures identified in WC15 have not been observed, diversions would be expected to occur during high flow events (South32 2019). Approximately 400 m of WC15 (WC15 is approximately 2.5 km long in total) experienced water loss during extraction of Longwall 14.

No fracturing was observed in WC21, Donalds Castle Creek or Wongawilli Creek during extraction of Longwall 14.

Changes in water quality indicators (EC and DO) were observed 3 October 2018 in Wongawilli Creek at water quality monitoring site Wongawilli Creek (FR6) (approximately 3.5 km downstream of DA3B). DO was 45.5 % saturation and EC was 169 µS/cm. These were level 3 water quality triggers (i.e. DO less than 50.5 % saturation and EC greater than 154.1 µS/cm, equivalent to 3 standard deviations from the mean values measured during the baseline period).

EC at Donalds Castle Creek (FR6) was between approximately 190 µS/cm and 260 µS/cm (i.e. exceeding the level 3 trigger of 185.8 µS/cm) on four occasions during December 2018 to March 2019. It is noted that EC and DO outside the trigger levels were observed during the baseline monitoring period. There was also indication of an increase in EC and a decrease in pH in Pool 2b in Donald's Castle Creek tributary DC13 (approximately 680m downstream of DA3B and 2.4 km from Longwall 14) during late 2018 and in to 2019.

A reduction in water level in Pool 28 in WC15 (approximately 47 m from Longwall 14) was also observed in WC15 in February 2019. This was despite preceding rainfall events (South32 2019). No fractures have been identified in the pool, however, surface fracturing was observed upstream.

In Wongawilli Creek, there have also been indications of elevated EC (359 µS/cm in Pool 43b in June 2018 and 175 µS/cm in Pool WC_S1 in November 2018), elevated pH (7.1 and 7.2 in Pool 46 and siteWWM2, respectively, in June 2018) and reduced DO (7.9 % saturation in Pool 46 in March 2019). These values were outside the range measured since 2012 (data provided by ICEFT). These changes have been short term (a no more than a few weeks) and generally associated with low flow conditions in the creek (see below).

Previously, monitoring in Wongawilli Creek during extraction of Longwall 13 identified reductions in flow and pool water levels within an approximate 1,400 m section of Wongawilli Creek. These were first observed in November 2017 in Pool 43a (**Plate 1**). Reductions and flow and pool water levels were also observed here during extraction of Longwall 14 (up to October 2018). This section was adjacent to Longwalls 9, 10 and 11, though it is possible that extraction of this longwall contributed to reduced flow and pool water levels via its contribution to any groundwater depressurisation. Surface flow was observed just downstream of the confluence with Wongawilli Creek tributary WC21. Following the initial reduction in the water level of Pool 43a in November 2017, an assessment of surface water levels, flow and water chemistry in Wongawilli Creek was undertaken by HGEO (2018). The reduction in water level in Pool 43a and changes in water quality further downstream at FR6 were attributed to low rainfall during the extraction of Longwall 13, rather than mining, and there was no significant mining effect on surface flow 2 km downstream (HGEO 2018).

Groundwater depressurisation associated with extraction of several DA3B longwalls is also thought to contribute to low flow and pool water levels in Wongawilli Creek, which become most noticeable during periods of low rainfall. Examination of water levels at WCS2 in Pool 43a on Wongawilli Creek indicated low pool water levels were experienced during January to October 2018, coinciding with periods of relatively low rainfall (**Figure 1-2**). Following relatively higher rainfall in early October 2018 pool water levels appeared relatively normal, though slight reductions in pool water levels were observed following a few weeks of low rainfall. Pool water levels were also observed to return to normal for a few weeks following a rainfall event in November 2017 (South32 2017). During the latest aquatic ecology surveys in May 2019, water levels in Wongawilli Creek at Sites 4 (within the affected section of creek) (**Plate 1**) and Site 3 (partly within the upstream section of affected creek) (**Plate 1**) appeared normal. Iron staining was observed within a drainage line adjacent to Site 4, however, the ICEFT noted that this was present prior to mining of DA3B.

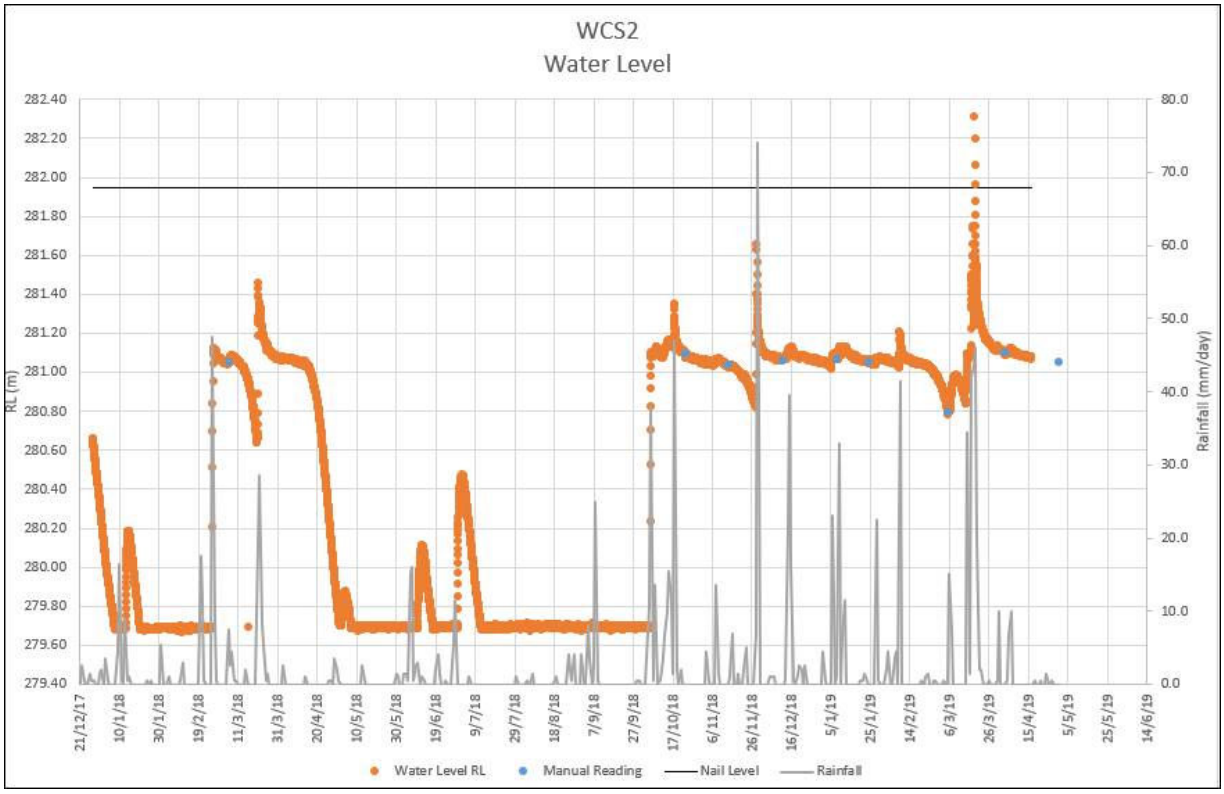

Figure 1-2 Water level at WCS2 and rainfall data recorded by ICEFT December 2017 to May 2019.

Plate 1. Pool 43a in Wongawilli Creek in December 2017 (top left) and January 2018 (top right) (South32 2018a) and aquatic ecology Site 4 (a few hundred metres upstream of Pool 43a) and Site 3 (approximately 500 m farther upstream) in May 2019.

Impacts on Aquatic Habitat and Biota

The impacts to aquatic habitat and biota observed by ICEFT and Cardno associated with the physical and water quality impacts described above are summarised in **Table 1-3**. They are compared with the impacts to aquatic habitat and biota predicted to occur in the in the AFFA (Cardno Ecology Lab 2012). These predictions were based on the maximum predicted subsidence parameters for the sections of Wongawilli Creek, Donalds Castle Creek and the tributaries that flow through the DA3B SMP Area, their predicted impacts on the physico-chemical characteristics of the waterways (MSEC 2011), and the assessment of potential impacts on surface water quality (Ecoengineers 2011).

The physical mining impacts observed in Lake Avon tributaries LA4 and LA4B and Wongawilli Creek tributary WC15 were or would be expected to be associated with some reduction in the amount aquatic habitat. Based on the abundance of first and second order stream habitat in the local area, in isolation these impacts are relatively minor in the context of the Metropolitan Special Area Catchment. The cumulative impact due to extraction of longwalls in DA3B and the wider Metropolitan Catchment, should, however, be considered. Mapping by ICEFT indicates that approximately 97 km, or 14 %, of the total 556 km length of watercourse habitat within the upper Avon and Cordeaux Catchments has experienced mine subsidence movements which could have resulted in loss of flow and reduction in pool water level (Cardno 2018). It is noted that a large proportion of this is expected to be ephemeral first and second order watercourses that provide more limited habitat for aquatic biota compared with larger and more permanent watercourses such as Wongawilli Creek. Nevertheless, these watercourses would still provide connectivity for some species at times of naturally high rainfall.

In Wongawilli Creek, the reductions in water levels and flow observed during extraction of Longwall 13 and during the first 5 to 6 months of extraction of Longwall 14 would have resulted in a full or partial (if some water remained in some pools) loss of aquatic habitat along approximately 1.4 km of the watercourse, representing about 10 % of its 12 km total length. Reductions in water levels in creeks would also have reduced longitudinal connectivity of aquatic habitat that remained. This would impact the ability of aquatic fauna, such as fish and large mobile invertebrates, to move in search of food and habitat and could isolate individuals to small sections where water remained. However, the loss of aquatic habitat and reduction in habitat connectivity was temporary, and water levels and flow returned to normal in October 2018 following more sustained rainfall. No impacts to aquatic habitat were observed during the May 2019 aquatic ecology surveys at Sites 3 and 4 (wholly or partly within the affected section of Wongawilli Creek). While impacts to the availability of aquatic habitat in Wongawilli Creek appear to be temporary, which would limit associated impacts to aquatic biota, some associated impacts to aquatic biota would be expected. This would be due to the reduced permanency of aquatic habitat in this section of creek, which in general would make it less suitable for many aquatic biota. This would be expected to result in a reduction in the population size of biota within the creek, though of a lesser magnitude than would be expected of there was an ongoing loss of habitat.

Iron staining was observed in a drainage line with a confluence within Site 4 and some associated staining was observed in Wongawilli Creek also, though there was no evidence of any change in water quality here in limited water quality data collected by Cardno. No impacts to aquatic habitat or water quality were observed at Site 5 (just downstream of the confluence with WC21 and the section of Wongawilli Creek that has been affected). The changes in water quality that were recorded in Wongawilli Creek and Donalds Castle Creek at Fire Road 6 during extraction of Longwall 14 and further upstream in the pools affected by low water levels appear temporary and / or minor and are unlikely to represent a risk to aquatic habitats and biota.

Table 1-3 Predicted and observed impacts to aquatic ecology associated with Longwall 14

Attribute	Predicted Physical Impacts	Predicted Impacts on Aquatic Ecology	Observed Impacts to Aquatic Ecology
Wongawilli Creek			
Ponding, flooding and scouring of stream banks due to tilt	No significant change predicted.	No measurable effects due to tilt.	None identified by ICEFT during extraction of Longwall 14 or by Cardno at aquatic ecology monitoring sites on Wongawilli Creek in May 2019.
Fracturing of bedrock and diversion of surface flows	No significant fracturing resulting in surface water flow diversions. Minor, isolated fractures of the streambed may occur within 400 metres from the proposed Longwalls. Minor fracturing of the creek bed and subsequent diversion of flows would not have significant geochemical effects. Formation of ferruginous springs is unlikely, but could occur at the margins or upslope of swamps (Ecoengineers 2011).	No significant changes in the quantity or quality of permanent aquatic habitat due to fracturing of bedrock and diversion of surface flows.	Reductions in pool water levels and flow observed initially during extraction of Longwall 13 were present during the first 5 to 6 months of extraction of Longwall 14. These resulted in a reduction in aquatic habitat (full or partial loss of pool water) in approximately 1.4 km of Wongawilli Creek (around 10 % of the 12 km long creek). Loss of some aquatic biota (fish and macroinvertebrates) would likely also have occurred here. Indirect impacts to aquatic biota would include a loss of longitudinal habitat connectivity. However, impacts to the availability of aquatic habitat and to longitudinal connectivity were temporary. Water and flow returned to the affected area following rainfall events. No impacts to aquatic habitat were noted at affected water quality monitoring sites visited by Cardno in May 2019. The relatively minor changes in water quality that have been observed at FR6 are not expected to have significant impacts on aquatic biota. Potential associated impacts to aquatic macroinvertebrates will be assessed once the samples have been analysed.

Donalds Castle Creek and drainage lines (WC21, WC15, LA4 and LA4B)			
Ponding, flooding and scouring of stream banks due to tilt	Reversals in grade may occur along Tributary WC21, adjacent to the tailgates of Longwalls 10 and 11. These could result in small increases in the levels of ponding, flooding and scouring of stream banks in highly localised areas along the tributaries. The impacts resulting from such changes are expected to be small relative to those that occur naturally during floods.	Localised changes in habitat availability and connectivity may occur along the tributaries due to tilt, but will be difficult to detect because of the large variability in natural flows within these ephemeral systems.	No impacts observed due to tilt.
Fracturing of bedrock and diversion of surface flows	Fracturing of the bedrock is likely to occur. In ephemeral creeks with alluvial deposits, fractures are likely to be in-filled by deposits during flow events. In areas with exposed bedrock, some diversion of surface flows into underlying strata and drainage of pools may occur, particularly during low flows. It is unlikely, that this would result in a significant impact on the overall quantity or quality of water flowing from the catchment.	There is unlikely to be any significant long-term changes in the quantity, quality or connectivity of aquatic habitats. Any losses of habitat and connectivity that do occur would be minor, localised and transient.	None observed in Donalds Castle Creek or WC21 during extraction of Longwall 14. Fracturing of bedrock and diversion of flows in Lake Avon drainage lines LA4 and LA4B and Wongawilli Creek drainage line WC15 is likely to have resulted in some minor reduction in quantity and connectivity of aquatic habitat, particularly given the abundance of first and second order stream habitat in the upper Avon and Cordeaux Catchments. Associated impacts to aquatic biota would also be expected to be minor. The relatively minor changes in water quality that have been observed in Donalds Castle Creek at FR6 are not expected to have significant impacts on aquatic biota.

The occurrence of impacts to aquatic macroinvertebrates will be assessed once analysis of the samples collected in May 2019 and throughout 2019 has been completed. Previous monitoring of aquatic macroinvertebrates in DA3B was undertaken during April to November 2017 indicted some evidence of impacts to macroinvertebrates in WC21 and Wongawilli Creek attributed to extraction of previous DA3B longwalls. In particular, reductions in abundance associated with pool drainage following observed physical mining impacts. There was also some limited evidence (a reduction in the abundance of one taxon) of changes occurring in Wongawilli Creek. The findings of these previous studies suggest impacts to aquatic macroinvertebrates associated with pool drainage are localised to the pools directly affected by physical mining impacts. Mining related impacts were not detected by macroinvertebrate indicators at downstream monitoring sites. The relatively minor changes in water quality that have been observed in Wongawilli Creek and Donalds Castle Creek at FR6 are not expected to have significant impacts on aquatic biota.

It is unlikely that the threatened Macquarie perch previously identified downstream in Wongawilli Creek has been put at risk by extraction in DA3B. Macquarie perch has been recorded in Dendrobium Area 3 in the mid to lower reaches of Wongawilli Creek, including pools just upstream and downstream of the Fire Road 6 crossing (Cardno 2018 and references therein). However, this species was not identified further upstream in Wongawilli Creek where the reduction in flow and water levels have been observed. This was despite extensive sampling here as part of this and previous surveys in Wongawilli Creek for the DA3B monitoring program. It is possible that this species is unable to pass the natural barrier in the form of a cascade / waterfall present a few hundred metres upstream of the Fire Road 6 crossing, at least not in any appreciable numbers. There was no evidence of changes in abundance of other native fish at the sites visited in May 2019.

It is difficult to quantify the impact to aquatic habitat and biota that may have occurred in Wongawilli Creek, WC15, LA4, LA4B due to extraction of Longwall 14. The physical mining impacts observed during extraction of this longwall occurred following several other mining related impacts that occurred here during extraction of previous DA3B Longwalls 9, 10, 11, 12 and 13. At the very least, it is probable that the additional fracturing observed in WC15, and any that were not observed, has exacerbated the existing impacts to water levels and flow. If related to mining, the reductions in flow and pool water levels that occurred in Wongawilli

Creek during extraction of Longwall 14 up to October 2018 were almost certainly associated with extraction of previous longwalls. It is difficult to link any physical mining related impact with associated impacts on aquatic habitat and biota with extraction of individual longwalls. Physical mining impacts that have occurred may be associated with individual longwalls or a cumulative effect of several longwalls. In such cases, it is unclear if impacts are due to a delayed response following extraction of earlier longwalls, a cumulative effect of extracting multiple longwalls, or a combination of mining impacts with prevailing environmental conditions e.g. prolonged reduced rainfall periods.

Further investigation is to be undertaken by South 32 and other specialists to ascertain what proportion of reductions in flow and water levels is due to mining and patterns in rainfall.

Aquatic Ecology TARP

Table 1-4 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 14 and previous longwalls may be appropriate, if any. These TARPS are applicable only to watercourses where aquatic ecology monitoring sites are located (Wongawilli Creek, Donalds Castle Creek and WC21).

For Site X1 on Donalds Castle Creek, the active subsidence period ended on 24 October 2013 when Longwall 9 was more than 400 m away from this site. For Site X2 on WC21, the active subsidence period ended when Longwall 10 was completed on 20 January 2015. Thus, the reduction in aquatic habitat observed at these sites constitute a Level 3 Trigger (albeit no additional physical impacts were observed during extraction of Longwall 14, it is possible that extraction of this longwall may contribute to the magnitude or duration of existing impacts in these watercourses). Actions for a Level 3 Trigger include notification of stakeholders and the development and implementation of CMAs. Such actions have commenced as part of a remediation program for the impacts to WC21 (DPE 2015). Although the reductions in pool water levels and aquatic habitat in Wongawilli Creek were first observed over 1 year previously, these did not occur for a combined or consecutive period of 1 year or more, thus, the associated aquatic ecology TARP has not been triggered.

Table 1-4 TARP levels applicable to aquatic features relevant to Longwall 14 as of May 2019. It is noted that the TARP triggers here relate to mining of the domain as a whole, rather than individual longwalls.

TARP	Wongawilli Creek	Donalds Castle Creek	WC21
Level 1 – Reduction in aquatic habitat for 1 year	Not triggered	Triggered September 2014	Triggered December 2014
Level 2 – Reduction in aquatic habitat for 2 years following the active subsidence period (i.e. when a longwall within 400 m of a feature, such as a creek, is completed)	Not triggered	Triggered 24 October 2015	Triggered 20 January 2017
Level 3 – Reduction in aquatic habitat for >2 years or complete loss of habitat following the active subsidence period	Not triggered	Triggered During 2017 Aquatic Ecology Surveys (Cardno 2018)	Triggered During 2017 Aquatic Ecology Surveys (Cardno 2018)

Conclusion and Recommendations

The reductions of pool water levels and flow in Wongawilli Creek, WC21, WC15, LA4 and LA4B following the extraction of DA3B Longwalls 9 to 14 represent a local loss of aquatic habitat and biota. The loss of habitat in WC21 and Wongawilli Creek are relatively severe at the scale of individual pools / watercourses. The loss of aquatic habitat in these watercourses is expected to have resulted in a reduction in connectivity of remaining habitat and a loss of aquatic biota. Due to the impacts observed during extraction of Longwalls 9, 10, 11, 12 and 13, it is difficult to quantify what proportion of the observed impacts are associated with extraction of Longwall 14 alone. Nevertheless, it is likely that extraction of this longwall has contributed to the

observed physical mining impacts, reductions in aquatic habitat and assumed loss of some associated aquatic biota.

No TARPs have been triggered with respect to Wongawilli Creek as there has not been a loss in aquatic habitat for longer than 1 year. The reductions in aquatic habitat for over 2 years in WC21 constitute a level 3 trigger.

Due to the limited aquatic habitat provided by LA4, LA4B and WC15, and the abundance of these stream types in the Metropolitan Special Area, the fracturing and flow diversions observed represent a minor impact to aquatic ecology. At this stage, no specific recommendations associated with these tributaries is required.

It is recommended that further during and post mining aquatic ecology monitoring is completed in DA3B and in Wongawilli Creek in line with the AFFR and SMP. South32 should continue to monitor watercourses that have been affected by extraction of Longwall 14 and previous longwalls and the findings of these will be used to assess whether TARPs will subsequently be triggered. Further assessment should also be undertaken to determine what component of reductions in flow and water levels in Wongawilli Creek is attributed to patterns in rainfall and physical mining impacts.

Furthermore, the triggering of aquatic ecology TARPs associated with the impacts observed in Donalds Castle Creek and following extraction of previous longwalls in DA3B should continue to be reviewed, as these are likely to have been triggered, and management actions and CMAs may be appropriate.

Yours sincerely,

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