

23 October 2024

GM3

Port Kembla Coal Terminal  
Port Kembla Road  
Inner Harbour  
PORT KEMBLA 2502  
New South Wales

**Stantec**

Level 9 - The Forum  
203 Pacific Highway  
St Leonards NSW 2065  
Australia

**Phone** +61 2 9496 7700  
**Fax** +61 2 9496 7748

[www.stantec.com](http://www.stantec.com)

## **LONGWALL 19A END OF PANEL REPORT AQUATIC FLORA AND FAUNA REVIEW**

### **Introduction**

GM3 (formerly IMC) extracts coal using longwall mining techniques from Dendrobium 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 Dendrobium Area 1, Dendrobium Area 2 and Dendrobium Area 3 (DA1, DA2 and DA3). DA3, situated between Lake Cordeaux and Lake Avon, is currently being mined. A modification to the mine layout of DA3, approved in December 2008, allowed the mine to be expanded, with DA3 divided into three smaller domains, DA3A, DA3B and DA3C. Longwall 19A is the fifth of five longwalls in DA3A and was extracted between 2 November 2023 to 28 June 2024.

Stantec (formerly Cardno) was commissioned by GM3 to undertake a review of the status of aquatic flora and fauna in relation to the extraction of Longwall 19A to support the End of Panel reporting. Stantec has been undertaking ongoing monitoring of watercourses within DA3 including the perennial Wongawilli Creek, Sandy Creek, Donalds Castle Creek and several associated first and second order ephemeral / intermittent tributaries. The overall objective of the monitoring is to determine whether the extent and nature of observed impacts, primarily subsidence-induced fracturing of bedrock, flow diversion and loss of aquatic habitat, if any, are consistent with predictions, including those made in the Aquatic Flora and Fauna Assessment (AFFA) (Cardno 2022a), Subsidence Management Plan (SMP) (IMC 2022a) and Watercourse Impact Monitoring, Management and Contingency Plan (IMC 2022b) for Longwall 19A. 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 GM3 impact reports and a comparison with those predicted in the SMP.
- > Recommendations for any Corrective Management Actions (CMA) and future aquatic flora and fauna monitoring.

This review focuses on any physical and water quality impacts to watercourses overlaying and within 400 m (i.e., have potential to be impacted based on previous observations of mining impacts in DA3) of Longwall 19A and any associated potential impacts to aquatic habitat and biota that may have occurred during extraction of Longwall 19A. Four tributaries of Wongawilli Creek (WC13, WC13A, WC14 and WC17B) and three tributaries of Sandy Creek (SC10, SC10A and SC10B) are located within 400 m of Longwall 19A. Wongawilli Creek and WC17B are not located within 400 m but are located within the 600 m Study Area for the Longwall 19A AFFA. This current AFFA for Longwall 19A is based on the findings of ongoing field surveys in these watercourses by the GM3 Environmental Field Team (EFT) and on Stantec's experience of undertaking monitoring and assessment of aquatic habitat and biota in DA3. Relevant findings of the latest biennial monitoring report (Stantec 2024) based on aquatic ecology surveys in 2023, including in November 2023 following commencement of extraction Longwall 19A, are also included.

The potential impacts to aquatic ecology attributed to extraction of Longwall 19A are also placed in context of the cumulative impacts to aquatic ecology experienced in DA3. A full assessment of impacts due to extraction of all longwalls in DA3 are provided in (Stantec 2024). 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 Longwall 19A incorporates a Before, After, Control, Impact (BACI) sampling design. The program monitors 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 Longwall 19A 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.
- > Fish abundance using bait traps.

**Table 1-1** summarises the monitoring that has been completed in relation to Longwall 19A. Baseline surveys were undertaken 2010 and 2011 (Cardno Ecology Lab 2011; 2014), followed by the during-extraction monitoring in 2013 (Cardno Ecology Lab 2014), 2014 Cardno Ecology Lab (2015), 2015 (Cardno 2016), 2017 (Cardno 2018), 2019 (Cardno 2020), 2021 (Cardno 2022b) and 2023 (Stantec 2024). Surveys in 2021 also provided further recent baseline data for Longwall 19A. The AFFA also included a literature review on the physical setting, aquatic habitat, water quality, aquatic macroinvertebrates, fish, threatened species, populations and ecological communities in DA3A.

Table 1-1 Monitoring undertaken for DA3A longwalls in line with the Longwall 19A SMP Requirements and Recommendation in Cardno (2020a)

Report	Survey Date	Sampling Component
<b>Baseline Monitoring</b>		
	Mar / May / Sep / Nov 2008	
Dendrobium Area 3 – Baseline Aquatic Ecology Monitoring Spring 2008 – Spring 2010 (Cardno Ecology Lab 2011; 2014)	Mar / May / Sep / Nov 2010	Habitat assessment, fish, macroinvertebrates, water quality
	Apr / Jun / Sep / Oct 2011	
<b>During Extraction Monitoring</b>		
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)	Apr / Jun / Sep / Nov 2014	Habitat assessment, fish, macroinvertebrates, water quality
Dendrobium Area 3B Aquatic Ecology 2010 to 2015 (Cardno 2016)	May / Jun / Oct / Nov 2015	Habitat assessment, fish, macroinvertebrates, water quality
Dendrobium Area 3B Aquatic Ecology 2010 to 2017 (Cardno 2018)	Apr / May / Oct / Nov 2017	Habitat assessment, fish, macroinvertebrates, water quality
Dendrobium Area 3B Aquatic Ecology 2010 to 2019 (Cardno 2020)	May / Jun / Oct / Nov 2019	Habitat assessment, fish, macroinvertebrates, water quality
Dendrobium Area 3A and 3B Aquatic Ecology 2010 to 2021 (Cardno 2022b)	Apr / May / Sep / Oct 2021	Habitat assessment, fish, macroinvertebrates, water quality
Dendrobium Area 3A and 3B Aquatic Ecology 2010 to 2023 (Stantec 2024)	Apr / Jun / Sep / Nov 2023	Habitat assessment, fish, macroinvertebrates, water quality

GM3 undertake monthly monitoring prior to mining, weekly monitoring of landscape and natural features when within 400 m of the active longwall, and monthly thereafter. This includes monitoring during extraction of active longwalls to identify any fracturing, pool water level reduction, changes in flow and water quality in Wongawilli Creek, Sandy Creek, and their 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 is within 400 m of a feature, such as a creek).
- > Level 3 – Reduction in aquatic habitat for >2 years following the active subsidence period.

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

## **Predicted and Observed Impacts**

### ***Physical and Water Quality Changes***

Details of the triggers and changes identified in watercourses by GM3EFT (IMC 2024) during extraction of Longwall 19A are provided in **Table 1-2**. Six triggers were identified by GM3. These were an elevation in electrical conductivity (EC) in Sandy Creek at Rockbar 5, a reduction pool water level at Pool 23 in SC10, and an increase in pool water level recession rate at Pools 26a and 29 in SC10. It is noted that triggers may occur associated with natural variation and are not necessarily due to mining. Further interpretation is undertaken by specialists to determine if any triggers are due to mining.

The elevation in EC at Rockbar 5 in Sandy Creek occurred on 1 November 2023. EC was 137 $\mu$ S/cm, which exceeded the Level 1 trigger value of 129.9 $\mu$ S/cm (3 standard deviations from the baseline mean). Rockbar 5 is located approximately 50 m downstream of aquatic ecology monitoring Site 9. This elevation in EC coincided with catchment-wide elevations in EC associated with low rainfall levels at the time (IMC 2024) and was not attributed to Longwall 19A (HGEO 2024). It is noted that the elevated EC in Sandy Creek occurred just prior to extraction of Longwall 19A commenced and no other water quality triggers were identified following commencement of extraction of Longwall 19A (HGEO 2024).

Pools 23, 26a and 29 are located on SC10 within Swamp 15a approximately 350 m, 700 m and 800 m, respectively, upstream of aquatic ecology monitoring Site 11. The reduction in water level in Pool 23 on 23 November 2023 was below the baseline level for this pool. The median rate of recession in Pool 26a on 16 November 2023 and Pool 29 on 27 November 2023 was greater than the 80th percentile (Level 1 Trigger) of baseline rate of recession following the start of Longwall 19A extraction. At Pool 29, the rate of recession also exceeded the 90<sup>th</sup> percentile (Level 2 Trigger) on 3 January 2024 and exceeded the 95th percentile (Level 3 Trigger) on 8 January 2024. The pool water level reduction and increased water level recession rates were partly attributed to the very dry conditions prior to the start of Longwall 19A (IMC 2024). It is noted also that baseline monitoring for Pool 26a predominantly occurred during a period of unusually high rainfall in 2021 and 2022. Pool 29 also has limited baseline data (2 months) as monitoring at this location was included in the program during the development of the revised Longwall 19A Swamp Impact, Monitoring, Management and Contingency Plan (SIMMCP) (IMC 2022b). It is noted also that water was present in these pools throughout extraction of Longwall 19A and there was no discernible effect of Longwall 19A on pools in SC10 (HGEO 2024). Triggers associated with reduced flow at Site SC10CS1 in SC10C first identified during extraction of Longwalls 7 and 8 were still apparent during and following extraction of Longwall 19A, though evidence of recovery in flow has been evident since 2017 (HGEO 2024).

The trigger associated with a minor increase in cease to flow frequency farther downstream at Site SCL2 on Sandy Creek first identified during extraction of Longwall 19 was also identified during extraction of Longwall 19A. However, the pool at SCL2 remained full during the review period.

Table 1-2 Triggers in watercourses recorded by GM3 during extraction of Longwall 19A

Site ID	Impact Type	Watercourse	Identification	Description	Trigger Level
Sandy Creek Rockbar 5	Water Quality	Sandy Creek	01/11/2023	Elevation in electrical conductivity (EC)	1
SC10 Pool 23	Water level	SC10	16/11/2023	Reduction in water level below baseline*	2
SC10 Pool 26a	Water level	SC10	27/11/2023	Pool water level recession rate greater than baseline	1
SC10 Pool 29	Water level	SC10	27/11/2023	Pool water level recession rate greater than baseline *	1
SC10 Pool 29 (update)	Water level	SC10	03/01/2024	Pool water level recession rate greater than baseline *.	2
SC10 Pool 29 (update)	Water level	SC10	09/01/2024	Pool water level recession rate greater than baseline *.	3

\*Limited baseline data available (< 2 years)

### ***Impacts on Aquatic Habitat and Biota***

The assessment of impacts to aquatic habitat and biota due to changes in the physical appearance and water quality of watercourses described above are summarised in **Table 1-3**. The findings are compared with the impacts to aquatic habitat and biota predicted to occur in the AFFA for Longwall 19A (Cardno

2022a). These predictions were based on the maximum predicted subsidence parameters for the sections of Wongawilli Creek and tributaries that flow through the Longwall 19A SMP Area, their predicted impacts on the physical and water chemistry characteristics of the waterways (MSEC 2022), and the assessment of potential impacts on surface water (HGEO 2022) and groundwater (WHG 2022). Lake Cordeaux and Sandy Creek are located at least 1.2 km from the Study Area and are unlikely to experience physical impacts due to extraction of Longwall 19A (MSEC 2022).

Table 1-3 Predicted and observed impacts to aquatic ecology associated with Longwall 19A.

Attribute	Predicted Physical Impacts	Predicted Impacts on Aquatic Ecology	Observed Impacts to Aquatic Ecology
<b>Wongawilli Creek and Sandy Creek</b>			
Ponding, flooding and scouring of stream banks due to tilt	No significant change predicted.	No measurable effects due to tilt.	None identified by GM3 during extraction of Longwall 19A.
Fracturing of bedrock and diversion of surface flows	<p>The overall likelihood of significant fracturing resulting in surface water flow diversions at the rockbars along Wongawilli Creek is 7% (based on the rate of rockbar fractures experienced in DA3B due to extraction of Longwalls 9 to 12). Wongawilli Creek is also located outside the 400 m boundary and major fracturing and diversion of flows is not expected.</p> <p>Fracturing and flow diversions are not predicted to occur in Sandy Creek.</p>	Based on the predicted fracture rate and likelihood of fracturing and flow diversions, any associated and reductions in aquatic habitat are not expected	<p>No reductions in pool water levels or changes in water quality observed by GM3 during extraction of Longwall 19A, and thus no suggestion of impacts occurring to aquatic habitat and biota.</p> <p>Minor increases in the cease to flow frequency in Sandy Creek was identified during this review period however the changes were also detected in previous reporting periods so not necessarily related to Longwall 19A. Regardless, these changes would be associated with negligible changes in the availability of aquatic habitat or population sizes of aquatic biota given the pool remained full.</p>
Water Quality and Availability	<p>Surface and Groundwater modelling (HGEO 2022; WHG 2022) indicated short term (up to 6 years) and long term (&gt; 40 years) incremental reduction in flow along Wongawilli Creek due to extraction of Longwall 19A would be up to 0.02 ML/day Longwall 19A would cause a negligible (&lt; 0.1 %) increase in the duration and length over which cease-to-flow conditions can occur in Wongawilli Creek during drought periods. Flow effects would likely not be discernible from natural variability or from other historical, approved and proposed longwalls.</p> <p>Based on previous observations, it was expected that water quality influence due to the extraction of Longwall 19A would be minor or undetectable (HGEO 2022).</p>	<p>Associated impacts to aquatic habitat and biota due to groundwater depressurisation and reductions in surface water availability due to Longwall 19A, in isolation, are likely also to be negligible and not detectable.</p> <p>Impacts to aquatic habitat and biota due to changes in water quality appear unlikely as only minor changes in water quality are expected.</p>	<p>No changes to water quality in Wongawilli Creek identified following extraction of Longwall 19A.</p> <p>The elevation in EC in Sandy Creek was temporary, minor in magnitude, and did not exceed the upper default trigger value of 350 µS/cm (ANZECC/ARMCANZ 2000). Thus, associated impacts to aquatic habitat and biota are expected to be negligible.</p> <p>Iron staining first observed in Wongawilli Creek in August 2021 persisted through the extraction of Longwall 19A. However, iron staining has not been observed within 600 m of Longwall 19A and there is no indication its extraction has contributed to iron staining.</p>
<b>Tributaries of Wongawilli Creek and Sandy Creek</b>			
Ponding, flooding and scouring of stream banks due to tilt	Although predicted changes in grade (3%) are larger as a proportion of the natural grade (5% to 20%), compared with that for creeks, it is unlikely that there would be large-scale adverse changes in the levels of ponding or scouring of the banks along these drainage lines due to subsidence induced tilt. It is possible that localised increased ponding could develop in some isolated locations, where the natural grades are small and where the drainage lines exit the mining area	Localised changes in habitat availability and connectivity may occur along the drainage lines due to tilt but these effects will be difficult to detect due the large variability in grade and natural flows within these ephemeral systems. The impacts resulting from the changes in surface water flows are expected to be small in comparison with those which occur during natural flooding conditions. Consequently, impacts to aquatic habitat and	No impacts observed due to tilt.

Attribute	Predicted Physical Impacts	Predicted Impacts on Aquatic Ecology	Observed Impacts to Aquatic Ecology
Fracturing of bedrock and diversion of surface flows	<p>Fracturing is expected to occur along the sections of the drainage lines that are located directly above the proposed Longwall 19A. Fracturing can also occur outside the extents the proposed longwalls, with minor and isolated fracturing occurring at distances up to approximately 400 m. Surface water flow diversions are also likely to occur along the sections of drainage lines that are located directly above the proposed longwalls.</p> <p>In times of heavy rainfall, most of the runoff would flow over the fractured bedrock and soil beds and would not be diverted into the dilated strata below. In times of low flow, however, surface water flows can be diverted into the dilated strata below the beds.</p>	<p>biota due to tilt, if any, are expected to be minor and localised.</p> <p>Fracturing induced flow diversions in the highly ephemeral drainage lines directly above the longwalls would result in a reduction in the amount of aquatic habitat. However, smaller drainage lines such as these are limited in habitat value for aquatic biota. Flow diversions would reduce the volume and duration of flow in these ephemeral drainage lines. Approximately 50 m of first and second order drainage lines occur directly above Longwall 19A and a further approximate 3.5 km within 600 m. These lengths represent a very small proportion of that present in the wider Cordeaux River Catchment. Most of these watercourses have previously been impacted by extraction of longwalls from DA3A and DA3B.</p>	<p>Reduction in water level in Pool 23 and increases in water level recession rate in Pools 26a and Pool 29 in SC10 within Swamp 15a were not related to mining of Longwall 19A. Water was present in these pools throughout extraction of Longwall 19A and there would have been minor to negligible associated impacts to the availability aquatic habitat and minor to negligible effects on aquatic biota.</p> <p>Reductions in flow in first identified in SC10C following extraction of Longwalls 7 and 8 would have resulted in localised reductions in availability of aquatic habitat and population sizes of aquatic biota in SC10C. However, recovery in surface flow has been recorded at SC10CS1 since 2017 and there is no evidence Longwall 19A has affected SC10C.</p>
Water quality	<p>Impacts to water quality due to mining are expected to be minor in stream reaches within subsidence affected areas. Effects are likely to include temporary changes in water salinity, pH and iron content with local discolouration of streambeds and rock faces by iron hydroxide.</p>	<p>Minor impacts to water quality are unlikely to represent substantial risks to aquatic habitat and biota in drainage lines.</p>	<p>No changes in water quality identified in tributaries following extraction of Longwall 19A (GM3 2024; HGEO 2024).</p> <p>Iron staining previously identified in SC10C and SC10 during extraction of Longwall 8 and continued during extraction of Longwall 19A. However, iron staining has not been observed within 600 m of Longwall 19A or at aquatic ecology monitoring Site 11, on SC10. There is also no indication in November 2023 data that Longwall 19A has contributed to observed iron staining or any changes in aquatic macroinvertebrates farther downstream (Stantec 2024).</p>

Only relatively minor changes were observed in watercourses following commencement of extraction of Longwall 19A. These were an elevation in EC in Sandy Creek, a reduction in water level in Pool 23 on SC10 and increases in water level recession rates in Pool 26a and 29 in SC10. These changes are expected to result in minor to negligible impacts to aquatic habitat and biota. The elevation in EC was minor, temporary and did not exceed default water quality guidelines (ANZECC/ARMCANZ 2000). While reductions in water levels and increased water level recession rates occurred in pools in SC10, there was not a complete loss of water from these pools and there would have been minor to negligible associated changes in availability in aquatic habitat and minor to negligible effects on aquatic biota. Such changes would be negligible at the wider catchment scale. Pools 23, 26a and 29 are 5.7 m, 20 m, and 6.5 m long, respectively, which represents a very small proportion of the total length of pool habitat in SC10. Tributaries such as SC10 provide more limited aquatic habitat compared to larger permanent watercourses and represent a very small component of the total aquatic habitat in the Dendrobium Mine Area. Reductions in flow and associated triggers were localised (in SC10C) or minor in magnitude (in Sandy Creek) and would be expected to result in minor and / or localised impacts to aquatic habitat and biota. No other changes in water quality in watercourses were identified (HGEO 2024). In any case, changes in SC10 were not attributed to mining.

During extraction of Longwall 19A, iron staining previously observed in SC10C and SC10 following extraction of Longwall 8 in 2013 has continued. During the latest aquatic ecology observations in April, June, September and November 2023 iron staining was present in SC10C (Site 13) and SC10 (Site 12) but not Sandy Creek (Site 9) or Site 11 farther upstream on SC10C (**Figure 1-2**). Impacts associated with iron staining can include potential aquatic toxicity associated with iron and a modification to aquatic habitat associated with iron flocculation and infilling of habitat interstices and changes in some other indicators of

water quality. The previous assessment of impacts to aquatic ecology in SC10C (Cardno 2020c) indicated a reduction in the abundance of the pollution-sensitive leptophlebiid mayfly and an increase in abundance of pollution tolerant chironomid non-biting midge that coincided with iron staining. However, changes in other taxa were not linked with iron staining, suggesting impacts to aquatic ecology associated with the iron staining and flocculation in SC10 and SC10C were limited.

Extraction of Longwall 19A does not appear to have resulted in an increase in extent of iron staining where it was previously observed at aquatic ecology monitoring sites in SC10C, SC10 and Sandy Creek in November 2023 (Stantec 2024). Iron staining has not been observed in the section of SC10 adjacent to Longwall 19A (or Longwall 19) (GM3 2024) or at the aquatic ecology monitoring nearest to Longwall 19A (Site 11). This suggests iron staining is restricted to SC10C and to SC10 downstream from its confluence with SC10C, and, thus, not related to extraction of Longwall 19A. Iron staining first observed in Wongawilli Creek in August 2021 has also continued through extraction of Longwall 19A. However, iron staining in Wongawilli Creek has not extended within 600 m of Longwall 19A and there is no indication that extraction of Longwall 19A has contributed to iron staining in Wongawilli Creek. Monitoring and assessment of iron staining and any associated impacts to aquatic ecology will continue as part of the ongoing DA3 monitoring program, with further aquatic ecology surveys to be undertaken in spring of 2025.

The cumulative impact to tributaries due to extraction of longwalls in Dendrobium Area 3 and the wider Metropolitan Catchment should, also be considered alongside any impacts associated with individual longwalls. Mapping by the EFT indicates that approximately 40 km of the total 700 km length of watercourse habitat is located directly above longwall mining. This could result in loss of flow and reduction in pool water level. It is noted that a large proportion of this is expected to be mostly intermittent 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 habitat and connectivity for some species. It is also likely that extraction of Longwall 19A has and will continue to contribute to groundwater depressurisation in the Dendrobium Mine. This is expected to be associated with some reduction in the amount of aquatic habitat during drought conditions.

It is very unlikely that the threatened Macquarie perch previously identified downstream in Wongawilli Creek or in Lake Cordeaux has been put at risk by extraction of Longwall 19A. 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. 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. A substantial waterfall at the confluence of Sandy Creek and Lake Cordeaux would also prevent Macquarie perch from moving upstream into Sandy Creek and its tributaries. Macquarie perch would be very unlikely to occur in tributaries overlaying Longwall 19A due to the absence of suitable habitat otherwise provided by large permanent pools.

It is difficult to quantify the additional impact to aquatic habitat and biota in Dendrobium Area 3 due to extraction of individual longwalls. Physical mining impacts that have occurred can be associated with individual longwalls or a cumulative effect of several longwalls. In such cases, it is difficult to determine if aquatic ecology 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.

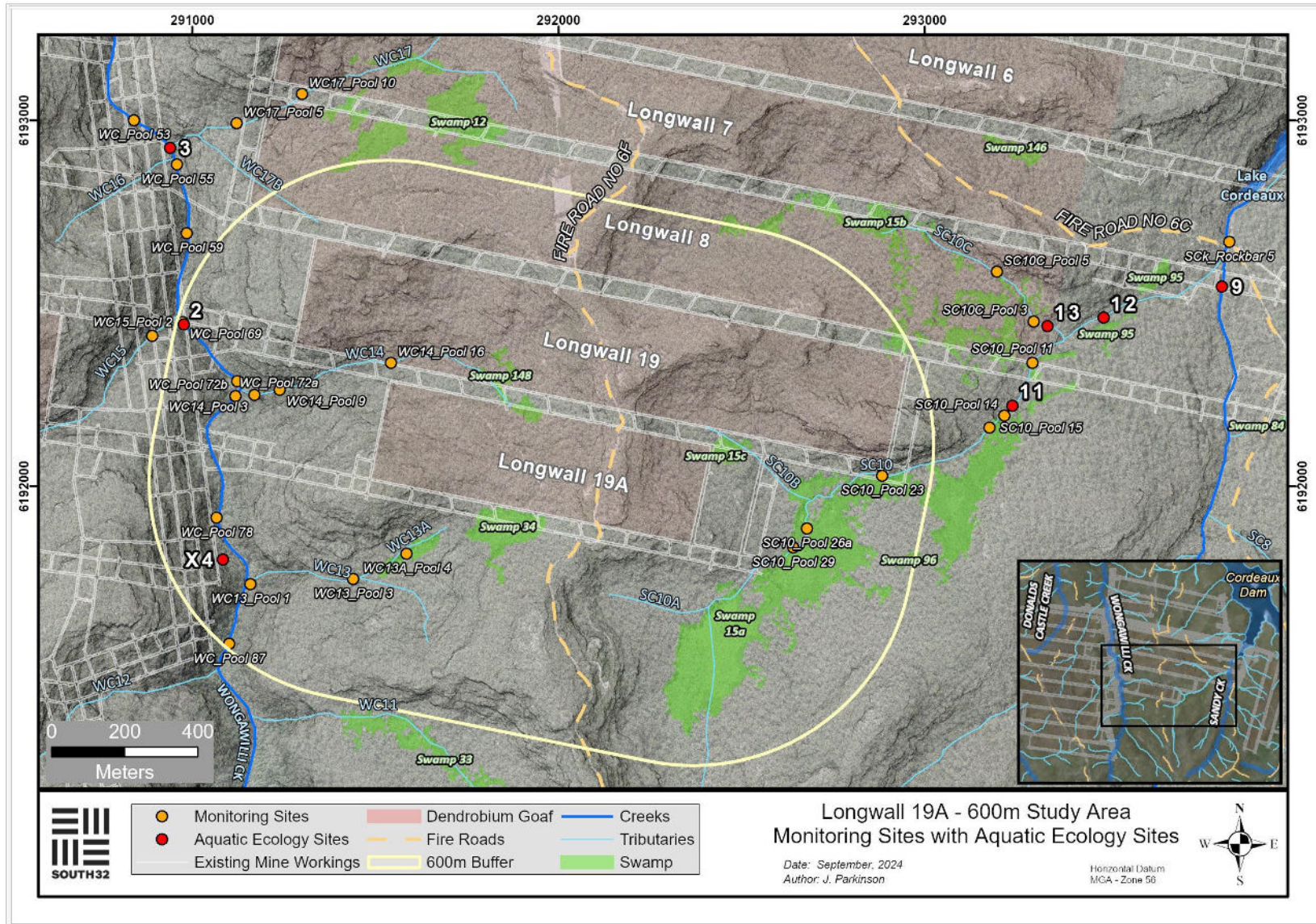


Figure 1-2 DA3A Longwalls 6 to 8, 19 and 19A, nearby watercourses and associated monitoring sites, including aquatic ecology monitoring sites.

## Aquatic Ecology TARP

**Table 1-4** compares observed impacts to aquatic ecology with the aquatic ecology TARP levels to determine if any have been triggered and what management actions associated with extraction of Longwall 19A and previous longwalls may be appropriate, if any. These TARPS are applicable to watercourses where aquatic ecology monitoring sites are located within 400 m of Longwall 19A. The nearest monitoring sites in Wongawilli Creek (Sites 2 and X4) are outside 400 m but within 600 m of Longwall 19A, and in Sandy Creek all sites are outside the 600 m boundary. Regardless, no aquatic ecology triggers occurred at these sites during extraction of Longwall 19A.

Table 1-4 TARP triggers and current status in Wongawilli Creek relevant to Longwall 19A.

TARP	Wongawilli Creek
Level 1 – Reduction in aquatic habitat for 1 year	Not triggered
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
Level 3 – Reduction in aquatic habitat for >2 years following the active subsidence period	Not triggered

## Conclusion and Recommendations

Only minor changes in cease to flow days in Sandy Creek were identified, a change that has persisted from previous review periods. No changes to pool water levels were observed in Sandy Creek and the change in cease to flow days would be associated with negligible impacts to aquatic habitat and biota. The elevation in EC in Sandy Creek occurred prior to Longwall 19A extraction and the reduction in water level in one pool and increased water level recession rates in two pools in SC10 were not attributed to mining. There is no indication that Longwall 19A has contributed to iron staining in the Wongawilli Creek and Sandy Creek catchments. At this stage, no specific actions associated with Longwall 19A are recommended.

It would be expected that extraction of Longwall 19A would have contributed to mining induced groundwater depressurisation in DA3. Physical mining impacts, reduction in availability of aquatic habitat and assumed loss of some associated aquatic biota in tributaries overlying and within 400 m of Longwall 19A may also have occurred but have not yet been observed. Such impacts could result in a greater potential for and severity of any future similar reductions in pool water levels and flow in tributaries and Wongawilli Creek. It is noted that previous reductions in flow observed in Wongawilli Creek have been within predictions. No aquatic ecology TARPs have been triggered with respect to Wongawilli Creek or Sandy Creek.

It is recommended that further during- and post-mining aquatic ecology monitoring is completed in DA3A in Wongawilli Creek and tributaries in line with the AFFA and SMP for Longwall 19A. GM3 should continue to monitor watercourses (as required by the SMP) that have been affected by Area 3A longwalls. The findings of these will be used to assess whether TARPs will subsequently be triggered.

## References

- Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (ANZECC/ARMCANZ). (2000). *Australian guidelines for water quality monitoring and reporting*. National water quality management strategy, No. 7. Prepared for: Australian & New Zealand Governments. ANZECC/ARMCANZ, Australia.
- Cardno Ecology Lab (2011). Dendrobium Area 3 – Baseline Aquatic Ecology Monitoring Spring 2008 – Spring 2010. Report Prepared for BHPBIC. Report No. EL0607058C.
- Cardno Ecology Lab (2014). Dendrobium Areas 3A and B. Aquatic Ecology Monitoring 2008 to 2013.
- Cardno Ecology Lab (2015). Dendrobium Area 3A Aquatic Ecology Monitoring 2008 to 2014.
- Cardno (2016). Dendrobium Area 3B – Aquatic Ecology Monitoring 2010 to 2015.
- Cardno (2018). Dendrobium Area 3B. Aquatic Ecology Monitoring 2010 to 2017.
- Cardno (2020). Dendrobium Area 3B. Aquatic Ecology Monitoring 2010 to 2019.
- Cardno (2020c). SC10C Recovery Assessment. Dendrobium Area 3A.
- Cardno (2022a). Longwall 19A Subsidence Management Plan. Aquatic Flora and Fauna Assessment.



- Cardno (2022b). Dendrobium Area 3B. Aquatic Ecology Monitoring 2010 to 2021.
- Chessman, B.C Grouns, J.E and Kotlash, A.R. (1997). Objective derivation of macroinvertebrate family sensitivity grade numbers for the SIGNAL biotic index: Application to the Hunter River system, New South Wales. *Marine and Freshwater Research*, 48, pp. 159-172.
- HGEO (2022). Dendrobium Mine. Surface Water and Shallow Groundwater Assessment: Longwall 19A.
- HGEO (2024). Dendrobium Mine. End of Panel Surface Water and Shallow Groundwater Assessment: Longwall 19A (Area 3A).
- Mine Subsidence Engineering Consultants (MSEC) (2022). Dendrobium – Longwall 19A. Subsidence Predictions and Impact Assessments for the Natural and Built Features due to the Extraction of the Proposed Longwall 19 in Area 3A at Dendrobium Mine.
- IMC (2022a). Dendrobium Area 3A. Longwall 19A Area 3A Subsidence Management Plan. September 2022.
- IMC (2022b). Dendrobium Area 3A. Dendrobium Longwalls 19 and 19A. Watercourse Impact Monitoring, Management and Contingency Plan. September 2022.
- IMC (2024). End of Panel Landscape Report Dendrobium Area 3A. Dendrobium Area 3A Longwall 19A End of Panel Landscape Report. August 2024.
- Stantec (2024). Dendrobium Area 3 – Aquatic Ecology Monitoring 2008 to 2023.
- Watershed HydroGeo (WHG), 2022. Dendrobium Area 3A Longwall 19A Surface Water Assessment. Report September 2022.