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Aquatic Biodiversity Technical Report
Tahmoor North – Western Domain
Longwalls West 3 and West 4

Prepared for Tahmoor Coal | 5 May 2021

Document control

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Glossary and list of abbreviations

Term or abbreviation	Definition
ABTR	Aquatic Biodiversity Technical Report
Aquatic macroinvertebrates	Small animals without a backbone that live for all, or part, of their lives in water. They are a useful indicator of stream health.
AUSRIVAS	Australian River Assessment System
BACI	Before After Control Impact
BC Act	*Biodiversity Conservation Act 2016*
CEEC	Critically Endangered Ecological Communities
CMA	Corrective Management Action
CTF	Cease to Flow
DoE	Department of Environment
DPIE	NSW Department of Planning, Industry and Environment (formerly Office of Environment and Heritage (OEH))
DPI	Department of Primary Industries
DRE	Division of Resources and Energy
EEC	Endangered Ecological Communities
EPT	Ephemeroptera, Plecoptera, Trichoptera – a macroinvertebrate index of stream health.
ha	Hectare/s
km	Kilometre/s
LW W1-W2	Longwalls West 1 and West 2
LW W1-W4	Longwalls West 1 to West 4
LW W3-W4	Longwalls West 3 and West 4
LW W3	Longwall West 3
LW W4	Longwall West 4
m	Metre/s
mm	Millimetre/s
Macrophytes	Aquatic vegetation
Niche	Niche Environment and Heritage
NSW	New South Wales
RCE Inventory	Riparian Channel and Environment Inventory assessment
SIGNAL	'Stream Invertebrate Grade Number – Average Level' is a simple biotic index for macroinvertebrates that uses the pollution tolerance levels of different macroinvertebrate types to create a site score and water quality rating for the river, creek or pond being studied.
Subsidence	The gradual caving in or sinking of an area of land.
TARP	Trigger Action Response Plan

TILs	Trigger Investigation Levels
Upsidence	Is defined as the difference between observed subsidence profiles within valleys and conventional subsidence profiles that would have otherwise been expected in flat terrain.

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1. Introduction

1.1 Background

The Tahmoor Coal Mine (Tahmoor Mine) is an underground coal mine located approximately 80 kilometres (km) south-west of Sydney between the towns of Tahmoor and Bargo, New South Wales (NSW) (refer to Figure 1). Tahmoor Mine produces up to three million tonnes of Run of Mine coal per annum from the Bulli Coal Seam. Tahmoor Mine produces a primary hard coking coal product and a secondary higher ash coking coal product that are used predominantly for coke manufacture for steel production. Product coal is transported via rail to Port Kembla and Newcastle for Australian domestic customers and export customers.

The Tahmoor Mine has been operated by Tahmoor Coal Pty Ltd (Tahmoor Coal) since Tahmoor Mine commenced in 1979 using bord-and-pillar mining methods, and via longwall mining methods since 1987. Tahmoor Coal is a wholly owned entity within the SIMEC Mining Division of the GFG Alliance group.

An Extraction Plan for Longwalls West 1 and West 2 (LW W1-W2), longwalls located in the Western Domain to the north-west of the Main Southern Railway, was approved by the NSW Department of Planning, Industry and Environment (DPIE) on 8 November 2019. Mining of LW W1 commenced on 15 November 2019 and finished on 6 November 2020. Mining of LW W2 commenced on 7 December 2020.

Tahmoor Coal is proposing to mine a further two longwalls in the Western Domain, Longwalls West 3 and West 4 (LW W3-W4), which will be the focus of this Extraction Plan.

1.2 Context

Niche Environment and Heritage (Niche) were commissioned by Tahmoor Coal to prepare an ABTR associated with LW W3-W4 to address the Approval Conditions in accordance with the Development Consent DA 67/98 (as modified). This assessment details the predicted impacts in relation to aquatic biodiversity and provides relevant Trigger Actions Response Plans (TARPs) associated with aquatic biodiversity.

1.3 Extraction plan Study Area

The proposed LW W3-W4 are located to the west of the township of Picton, and are located between Matthews, Cedar and Stonequarry creeks and the Main Southern Railway. These longwalls sit alongside the eastern side of the previously approved LW W1-W2, which are currently being extracted. The layouts of the completed, active and proposed longwalls at the mine are shown in Drawings Nos. MSEC1112-01 and MSEC1112-02, provided in MSEC (2021) (herein referred to as the Study Area) (Figure 1).

The Study Area (see Figure 1) is defined as the surface area that could be affected by the mining of LW W3-W4 as determined in MSEC (2021). As detailed in MSEC (2021), the extent of the Study Area has been calculated by combining the areas bounded by the following limits:

- A 35° angle of draw from the extents of LW W3-W4; and
- The predicted limit of vertical subsidence, taken as the 20 millimetres (mm) subsidence contour, resulting from the extraction of LW W3-W4.

1.4 Purpose and scope

The purpose of this ABTR is to describe the aquatic biodiversity values and assess the potential significance of the impact of the LW W3-W4 on those values within the Study Area or likely to be impacted by far-field or valley related movements outside the Study Area. This technical report specifically addresses aquatic biodiversity. The document outlines the management strategies, mitigation measures, controls and monitoring programs to be implemented for the management of aquatic flora and fauna from the proposed extraction workings.

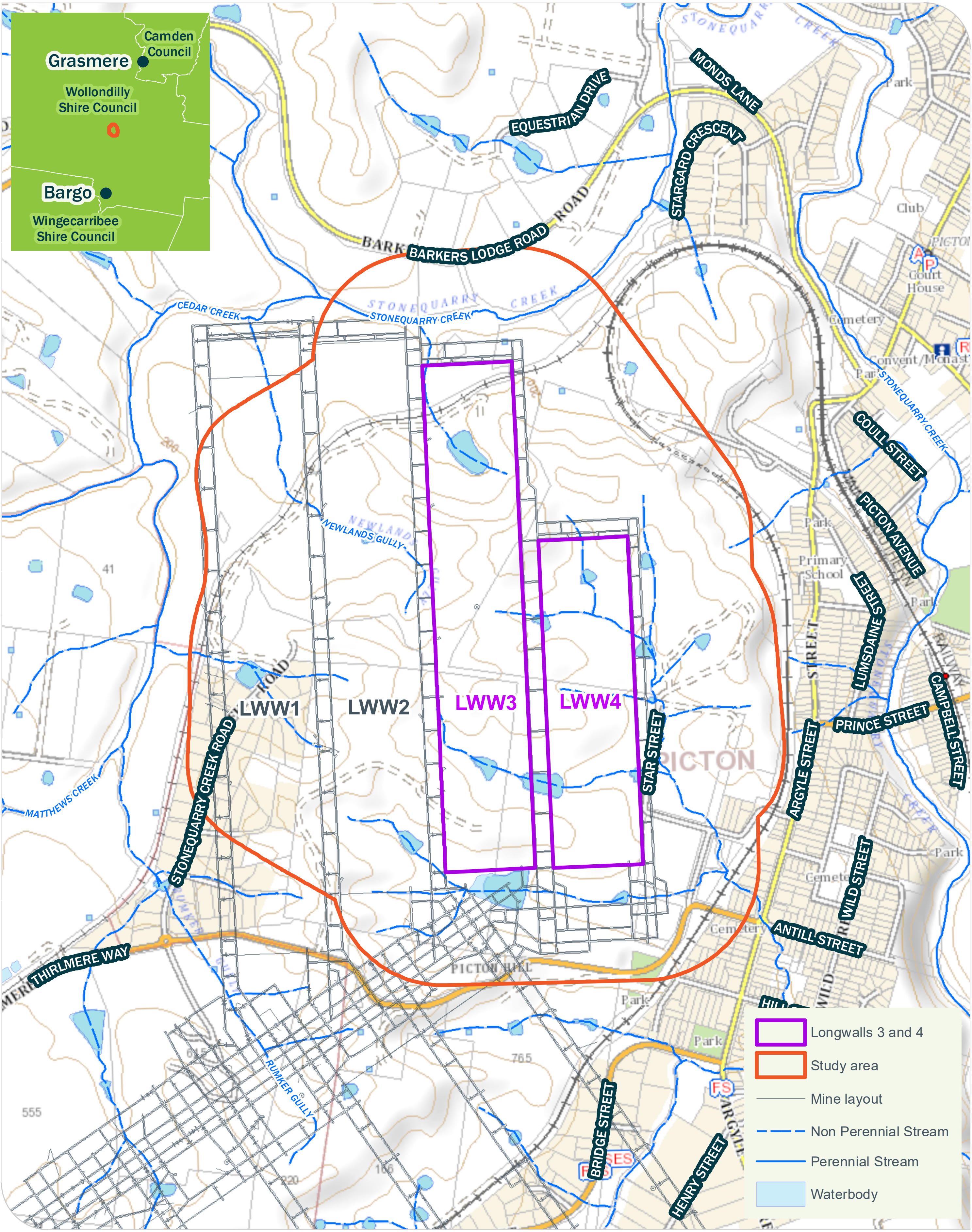
This ABTR includes the following:

- Summary of the baseline data for existing aquatic habitat, aquatic biodiversity, and stream morphology and review of LW W1 and LW W2 monitoring results.
- Provisions for the management of potential impacts and environmental consequences of the proposed second workings on aquatic biota and aquatic habitat.
- Provision of a TARP that includes a description of performance indicators to be implemented to ensure compliance with negligible environmental consequences to threatened species, threatened populations and their habitats, and endangered ecological communities; as well as considerations for the management or remediation of any impacts on and/or environmental consequences for aquatic biodiversity.
- Provisions for the inclusion of the monitoring of aquatic biota and aquatic habitat and a description of any adaptive management practices implemented to guide future mining activities in the event of greater than predicted impacts on aquatic habitat.

1.5 Structure of this document

The main text sections and attachments of this ABTR include the following:

Section 1	Provides an introduction to the ABTR for LW W3-W4, including the purpose and scope of the ABTR and the document structure.
Section 2	Describes the regulatory requirements, the subsidence performance measures relevant to this ABTR for LW W3-W4 and a summary of relevant legislation and stakeholder consultation.
Section 3	Describes the existing environment within the Study Area and the results of baseline monitoring.
Section 4	Summarises the predicted subsidence impacts and environmental consequences resulting from the extraction of LW W3-W4.
Section 5	Describes the management, monitoring and evaluation measures that will be implemented and how monitoring data will be used to assess the relevant performance indicators and performance measures.
Section 6	Provides a Contingency Plan to manage any unpredicted impacts and their consequences and Trigger Action Response Plan (TARP).



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Location and Study Area

Western Domain - Longwalls West 3 & West 4
Aquatic Biodiversity Technical Report

Niche PM: Matt russell
Niche Proj. #: 6122
Client: Tahmoor Coal Pty Ltd

Figure 1

2. Statuary requirements

2.1 Project approval

The proposed LW W3-W4 (the Project) will be operating in the Tahmoor North mining area under Development Consents DA 57/93 and DA 67/98. DA 67/98 provides the conditional planning approval framework for mining activities in the Western Domain to be addressed within an Extraction Plan and supporting management plans and technical reports.

This ABTR is a component of the Tahmoor North – Western Domain LW W3-W4 Extraction Plan and has been prepared specifically to address Approval Condition 13H (vii)(d) of DA 67/98 (as modified) (Table 1). The biodiversity requirements as stated in Table 1 are addressed in two separate technical reports – an Aquatic Biodiversity Technical Report (this document) and a Terrestrial Biodiversity Technical Report (Niche 2021b).

Table 1: Development consent conditions (extracted from DA 67/98)

<table>
<tr><th>Condition</th><th colspan="2">Condition Requirement</th><th>Section</th></tr>
<tr><td colspan="4">SUBSIDENCE
Performance Measures – Natural and Heritage Features etc.</td></tr>
<tr><td>13A</td><td colspan="2">The Applicant must ensure that extraction of Longwall 33 and subsequent longwalls does not cause any exceedances of the performance measures in Table 1.
Note: The Applicant will be required to define more detailed performance indicators (including impact assessment criteria) for each of these performance measures in the various management plans that are required under this consent.</td><td rowspan="4">Section 5 and Section 6</td></tr>
<tr><td rowspan="3">Excerpt from Table 1</td><td>Feature</td><td>Performance Measure</td></tr>
<tr><td colspan="2">Biodiversity</td></tr>
<tr><td>Threatened species, threatened populations, or endangered ecological communities</td><td>Negligible environmental consequences.</td></tr>
<tr><td>13B</td><td colspan="2">Measurement and monitoring of compliance with performance measures and performance indicators in this consent is to be undertaken using generally accepted methods that are appropriate to the environment and circumstances in which the feature or characteristic is located. These methods are to be fully described in the relevant management plans and monitoring programs. In the event of a dispute over the appropriateness of proposed methods, the Secretary will be the final arbiter.</td><td>Section 5 and Section 6</td></tr>
<tr><td colspan="4">Additional Offsets</td></tr>
<tr><td>13C</td><td colspan="2">If the Applicant exceeds the performance measures in Table 1 and the Secretary determines that:
It is not reasonable or feasible to remediate the subsidence impact or environmental consequences, or
Measures implemented by the Applicant have failed to satisfactorily remediate the subsidence impact or environmental consequence.</td><td>Noted.
Performance measures in Table 1 of DA 67/98 are not anticipated to be exceeded.</td></tr>
</table>

Condition	Condition Requirement	Section
	Then the Applicant must provide a suitable offset to compensate for the subsidence impact or environmental consequence, to the satisfaction of the Secretary.	
13D	The offset must give priority to like-for-like physical environmental offsets, but may also consider payment into any NSW Offset Fund established by EES, or funding or implementation of supplementary measures such as: • Actions outlined in threatened species recovery programs • Actions that contribute to threat abatement programs • Biodiversity research and survey programs and/or • Rehabilitating degraded habitat. *Note: Any offset required under this condition must be proportionate with the significance of the impact or environmental consequence*	Noted. Performance measures in Table 1 of DA 67/98 are not anticipated to be exceeded.
Extraction Plan		
13H	The Applicant must prepare an Extraction Plan for all second workings in Longwall 33 and subsequent longwalls to the satisfaction of the Secretary. Each Extraction Plan must:	Extraction Plan main document
13H(vi)	• Describe in detail the performance indicators to be implemented to ensure compliance with the performance measures in Table 1 and Table 2, and manage or remediate any impacts and/or environmental consequences.	Section 5.1, Section 5.2, and Section 6
13H(vii)(d)	• Biodiversity Management Plan which has been prepared in consultation with EES, which establishes baseline data for the existing habitat on the site, including water table depth, vegetation condition, stream morphology and threatened species habitat, and provides for the management of potential impacts and environmental consequences of the proposed second workings on aquatic and terrestrial flora and fauna, with a specific focus on threatened species, populations and their habitats, EECs and groundwater dependent ecosystems.	Consultation detailed in Section 2.3. Monitoring detailed in Section 5. Management detailed in Section 6.
13H(vii)(h)	• Trigger Action Response Plan/s addressing all features in Table 1 and Table 2, which contain: ▪ Appropriate triggers to warn of increased risk of exceedance of any performance measure. ▪ Specific actions to respond to high risk of exceedance of any performance measure to ensure that the measure is not exceeded. ▪ An assessment of remediation measures that may be required if exceedances occur and the capacity to implement the measures. ▪ Adaptive management where monitoring indicates that there has been an exceedance of any performance measure in Table 1 or Table 2, or where any such exceedance appears likely.	Section 6.2 and Section 6.3.
13H(vii)(i)	• Contingency Plan that expressly provides for: ▪ Adaptive management where monitoring indicates that there has been an exceedance of any	Section 6, Section 5.3

Condition	Condition Requirement	Section
	performance measure in Table 1 and Table 2, or where any such exceedance appears likely.	
	▪ An assessment of remediation measures that may be required if exceedances occur and the capacity to implement those measures.	
	▪ Includes a program to collect sufficient baseline data for future Extraction Plans.	

2.2 Relevant Legislation

2.2.1 *Biodiversity Conservation Act 2016*

The NSW *Biodiversity Conservation Act 2016* (BC Act) provides protection for threatened species native to NSW (excluding fish and marine vegetation). Species, populations and ecological communities listed under Schedule 1 (Endangered) and Schedule 2 (Vulnerable) are considered to be threatened in NSW.

Protection is provided by integrating the conservation of threatened species, endangered populations and Endangered Ecological Communities / Critically Endangered Ecological Communities (EEC/CEECs) into development control processes under the EP&A Act.

The Terrestrial Ecology Assessment (Niche 2014b) determined that no significant impacts to threatened biodiversity are likely as a result of the extraction of LW W1-W2. The findings of this assessment, and updates based on the MSEC (2021) predications for the Study Area are provided in Section 4. Given that MSEC (2021) predictions do not exceed those addressed in the Biodiversity Impact Assessment (Niche 2014), similar conclusions regarding non-significant impacts to threatened biodiversity listed under the BC Act are considered likely as a result of the extraction of LW W3-W4.

2.2.2 *Fisheries Management Act 1994*

The objectives of the *Fisheries Management Act 1994* (FM Act) are to conserve, develop and share the fishery resources of NSW for the benefit of present and future generations. In particular, the objectives of the FM Act include to:

- Conserve fish stocks and key fish habitats.
- Conserve threatened species, populations and ecological communities of fish and marine vegetation.
- Promote ecologically sustainable development, including the conservation of biological diversity.

Protection is provided by integrating the conservation of threatened species, endangered populations and EEC/CEECs into development control processes under the EP&A Act. The Aquatic Ecology Impact Assessment (Niche 2014a) concluded there was a very low likelihood of threatened species, populations or ecological communities listed under the FM Act likely to be impacted by the approved disturbance.

2.2.3 *Environment Protection and Biodiversity Conservation Act 1999*

Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), approval from the Commonwealth Minister for Department of Agriculture, Water and the Environment is required for any action that may have a significant impact on Matters of National Environmental Significance. These matters are:

- Listed threatened species and ecological communities.
- Migratory species protected under international agreements.
- Ramsar wetlands of international importance.
- The Commonwealth marine environment.

- World Heritage properties.
- National Heritage place.
- Great Barrier Reef Marine Park.
- Nuclear actions.
- A water resource, in relation to coal seam gas development and large coal mining development.

Threatened species, migratory species and threatened ecological communities listed under the provisions of the EPBC Act were considered within the Study Area and an assessment was made to determine if LW W3-W4 would pose a significant impact on Matters of National Environmental Significance.

The Aquatic Ecology Impact Assessment (Niche 2014a) concluded there was a very low likelihood of threatened species, population or ecological communities listed under the EPBC Act to be impacted by the Project's approved disturbance.

2.3 Consultation

A letter was sent to NSW Department of Planning, Industry and Environment (DPIE) – Environment, Energy and Science (EES) Group detailing the Extraction Plan for LW W3-W4. Tahmoor Coal provided a figure of the Extraction Plan Study Area, and an overview of the longwalls. Preliminary comments from EES have been received and Tahmoor Coal will complete further consultation with EES following the submission of the Extraction Plan.

In addition, Tahmoor Coal has undertaken correspondence with Wollondilly Shire Council (WSC) providing a letter (dated 18th September 2020) and figure of the Extraction Plan Study Area, and an overview of the longwalls. With regard to aquatic ecology WSC made the comment provided in Table 2.

Table 2: Summary of consultation

Agency	Comment	Section addressed in document
WSC	A detailed assessment of potential impacts mining operations on the ecological health of waterways in a catchment context that includes aquatic ecology.	Addressed in section 4.3
	An accurate assessment of the extent and nature of impact of LW W3 and LW W4 on aquatic ecology (including downstream waterways).	Addressed in section 4.3.5

3. Existing environment

3.1 Baseline monitoring data sources

The existing environment has been characterised using baseline studies and ongoing aquatic monitoring in the Study Area. These include:

- Tahmoor North Longwalls 31 to 37 Aquatic Ecology Assessment (Niche 2014a):
  - Riparian Channel and Environment Inventory assessment to rank the relative health of stream condition.
  - AUSRIVAS stream health assessment (including aquatic habitat, macrophytes, *in situ* water quality and macroinvertebrates).
  - Fish survey.
  - Threatened species and key fish habitat assessment.
- Biannual aquatic ecological monitoring for spring 2017, autumn 2018, spring 2018 and autumn 2019 (Niche 2019a):
  - Riparian Channel and Environment Inventory assessment to rank the relative health of stream condition.
  - AUSRIVAS stream health monitoring (including aquatic habitat, macrophytes, *in situ* water quality and macroinvertebrates).
  - Quantitative macroinvertebrate (Before After Control Impact (BACI)) monitoring.
  - Fish survey (no longer conducted).
- Tahmoor Coal Pty Ltd - Tahmoor Colliery Longwall Panels 31 to 37 Streams, Dams & Groundwater Assessment, Tahmoor, NSW (GeoTerra, 2014).
- Extraction Plan LW W1 – W2 - Surface Water Technical Report (HEC 2019).

3.2 Watercourses and stream morphology

The Study Area is located in the Stonequarry Creek Catchment with the relevant natural waterway features comprising Matthews Creek, Cedar Creek, Stonequarry Creek and Redbank Creek, as shown in Figure 2. Redbank Creek flows from west to east adjacent to, though outside of, the southern boundary of the Study Area. A topographic ridgeline straddles the Study Area, with the south-east portion of the area discharging via tributaries to Redbank Creek. The south-west portion of the area discharges to Matthews Creek, while the north-northwest portion of the area discharges to Cedar Creek and Stonequarry Creek. A portion of Stonequarry Creek traverses the northern boundary of the Study Area, while Matthews Creek, Cedar Creek and Redbank Creek are located outside of the Study Area.

3.2.1 Matthews Creek

The headwaters of Matthews Creek lie within the residential area of Thirlmere, with residential development significantly affecting the vegetation and weed growth along the upper reaches of the creek. The catchment comprises mainly rural properties. The creek flows to the north-east on the northern side of Thirlmere (Figure 2). The creek then flows to the north, downstream of Thirlmere, through a rural area with sparse residential development, along with poultry farms, commercial vegetable gardens and a shale quarry. The riparian zone of the creek contains thick native vegetation in this region. The creek in the vicinity of Thirlmere is generally in a poor state, with a high content of weeds and rubbish dumped or washed into it. Downstream of the residential area the creek significantly improves to a more natural state, down to the junction with Cedar Creek. To date, the creek has not been mined beneath, and the headwaters of the creek are located outside of the Study Areas of the previous and current longwalls.

Within the Study Area, Matthews Creek is relatively incised in Hawkesbury Sandstone, with a steep V-shaped valley and isolated vertical scarps predominating adjacent. Just upstream and at the junction with Cedar Creek, the valley becomes more incised and steeper with more predominant vertical scarps in the basal exposed sandstone of the valley. Overhangs of undercut sandstone are also prevalent in this section. Within the Study Area, Matthews Creek falls approximately 40 m in height over a total length of approximately 1,600 m, with an inferred average gradient of 25 mm/m (MSEC 2014). The stream bed and banks of Matthews Creek are well vegetated and do not show significant erosion or bank instability, principally as it is developed on, or just above, exposed Hawkesbury Sandstone basement.

Water level baseline data for Matthew Creek has been detailed in HEC (2019), which described Matthews Creek as exhibiting 'flashy' responses to rainfall events and indicates that pools in Matthews Creek within the Study Area experience natural periods of no flow.

The eastern tributaries of Matthews Creek within the Study Area are first and second order, ephemeral streams. The first and second order tributaries flow beneath Stonequarry Creek Road and a residential area along this road known as "Stonequarry Estate" located to the east of the Picton Mittagong Loop Line. Surface water runoff from these tributaries has been partially diverted by urban drainage associated with "Stonequarry Estate" and flows through stormwater detention basins / dams and culverts under the rail line, with runoff from the tributaries likely to contribute to flow in Matthews Creek during periods of extended or significant rainfall only. The tributaries of Matthews Creek traverse LW W1 and LW W2 though do not traverse LW W3 or LW W4 (HEC 2021).

3.2.2 Cedar Creek

Cedar Creek flows from south-west to north-east adjacent to the western boundary of the Study Area Cedar Creek joins with Stonequarry Creek approximately 370 m north-west of LW W3 and has an estimated catchment area of 27 km^2. At the confluence with Stonequarry Creek, Cedar Creek is a fifth order stream (Figure 2). The catchment area of Cedar Creek contains rural properties including a number of poultry farms, while the upper reaches are timbered and the head of the catchment lies within the Nattai National Park.

The minor tributary of Cedar Creek within the Study Area is a first order, ephemeral stream and likely only flows during periods of extended or high rainfall. Surface water runoff from the headwater of this tributary is predominately captured by a farm dam with runoff from the tributary likely to contribute to flow in Cedar Creek during periods of extended or significant rainfall only. Flow in the tributary passes through a culvert under the Picton Mittagong Loop Line before flowing to Cedar Creek. The tributary of Cedar Creek traverses LW W1 and LW W2 though does not traverse LW W3 or LW W4 (HEC 2021).

Adjacent to the Study Area, the channel of Cedar Creek is incised in Hawkesbury Sandstone, with a steep sided valley and exposed sandstone base in some parts. Rockbar, boulder and rock shelf constrained pools are prominent in the portion of creek traversing the Study Area. The bed and banks are well vegetated and show little evidence of erosion or bank instability (GeoTerra, 2014). Groundwater seepage has been observed to occur at the junction of Cedar Creek and Matthews Creek based on high iron hydroxide precipitation within this reach (Niche, 2019b).

As described by HEC (2019), Cedar Creek monitoring sites were fairly consistent during the baseline monitoring period with subdued small peaks in water level recorded during rainfall periods. Sharp increases in water level were recorded at the most upstream monitoring sites following rainfall events followed by steep recessions.

3.2.3 Stonequarry Creek

Stonequarry Creek flows within the northern boundary of the Study Area and has an estimated catchment area of 44 km^2 to the downstream boundary of the Study Area. Within the Study Area, the creek is a fifth order stream (Figure 2). A minor tributary of Stonequarry Creek flows from south-east to north-west across the northern section of LW W3. Stonequarry Creek then flows eastwards outside boundary of the Study Area, through the town of Picton, joining the Nepean River near Maldon. The catchment area of Stonequarry Creek upstream of the Study Area comprises mainly rural properties and farmland with localised housing development.

The minor tributary of Stonequarry Creek within the Study Area is a first order, ephemeral stream which likely only flows during periods of extended or high rainfall. Surface water runoff from the headwater of the tributary is predominately captured by a farm dam with runoff from the tributary likely to contribute to flow in Stonequarry Creek during periods of extended or significant rainfall only. Flow in the tributary passes through a culvert under the Picton Mittagong Loop Line before flowing to Stonequarry Creek.

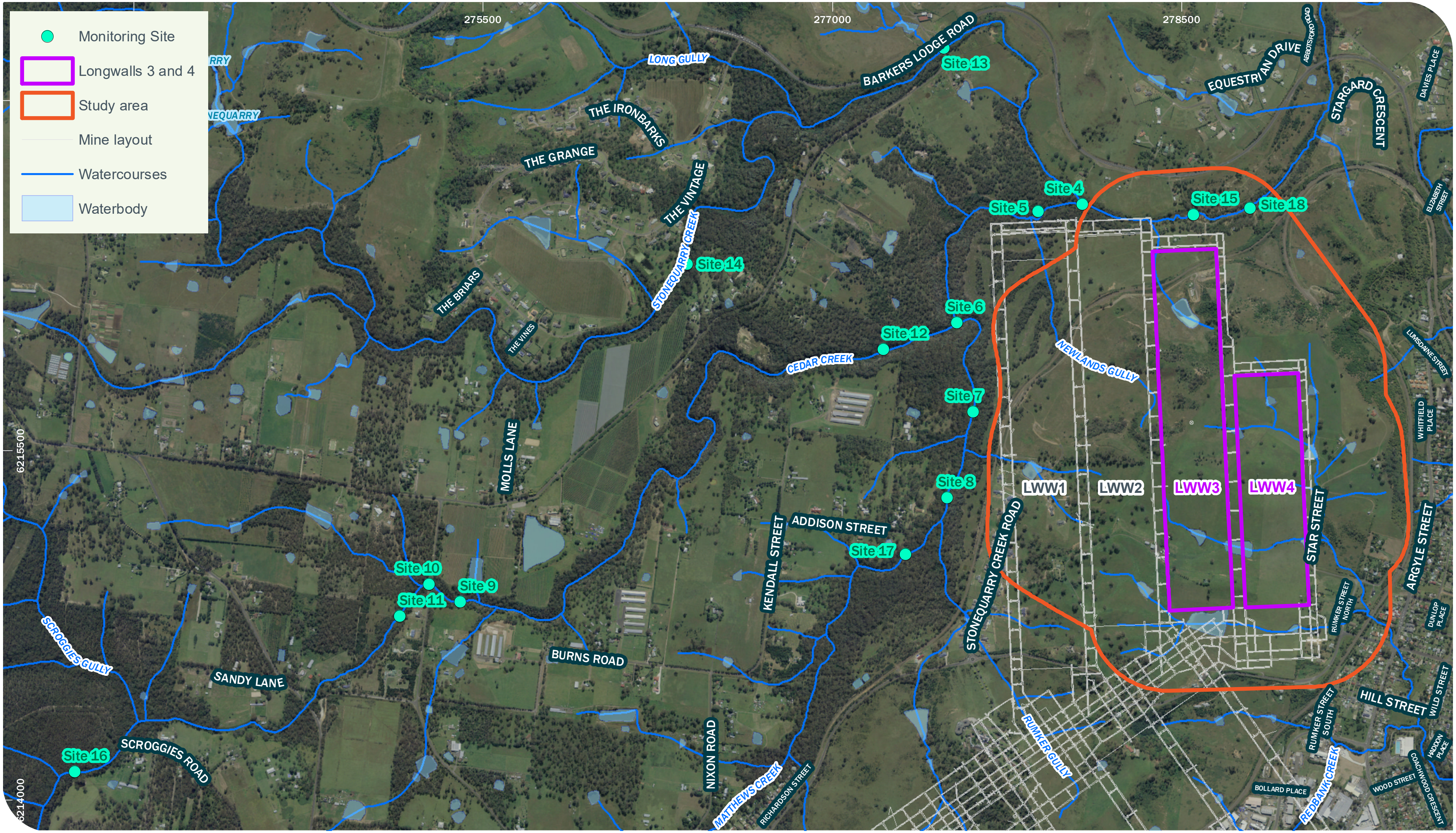
In the Study Area, the creek bed has a low gradient and predominately consists of a long pool (SR17), which extends from monitoring Site 4 to monitoring Site 15 (refer Figure 2). The pool is approximately 670 m long and is perennial in nature, with trickle flow observed over the rockbar during the period of prolonged low rainfall in 2019. Downstream of the SR17 rockbar (see Site 15, Figure 2) lies a series of connected pools, located on a large sandstone rock shelf and constrained by rockbars. The bed and banks within the section of Stonequarry Creek traversing the Study Area are well vegetated and show little evidence of erosion or bank instability (GeoTerra, 2014).

The catchment area of Stonequarry Creek upstream of the Study Area comprises mainly rural properties and farmland with localised housing development (HEC 2019). The headwaters of Stonequarry Creek lie to the north and west of Cedar Creek. Stonequarry Creek flows in a southerly direction immediately upstream of its junction with Cedar Creek, then to the east downstream of the junction through a rural area with sparse residential development, along with poultry farms, commercial vegetable gardens and a shale quarry. The riparian zone of the creek contains thick native vegetation and high weed growth in the Study Area. To date, the creek has not been mined beneath, and the headwaters are located outside of the Study Areas of the previous and current longwalls.

Baseline data by HEC (2019) has indicated that water level at Stonequarry Creek remained above the cease to flow (CTF) level for the duration of the monitoring period, while the water level at downstream sites regularly fell below the CTF level, exhibiting ‘flashy’ responses to rainfall events followed by steeper recessions (HEC 2019).

3.3 Riparian vegetation

Vegetation along the upper banks of Stonequarry Creek has been mapped as Cumberland Shale Sandstone Transition Forest (PCT1395) with a small section of Cumberland River-flat Forest (PCT835) occurring to the north of the longwalls. The vegetation along the banks of Matthews Creek and Cedar Creek has been mapped as Hinterland Sandstone Gully Forest (PCT1181). The condition of the vegetation communities varied depending on grazing, historic clearing and invasion by introduced species. Cumberland River-flat Forest (PCT835) contained a greater number of introduced species. The headwaters of Matthews Creek lie within the residential area of Thirlmere, with the condition of the creek significantly degraded by residential development.



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Monitoring sites

Western Domain - Longwalls West 3 & West 4 Aquatic Biodiversity Technical Report

Niche PM: Matt Russell
Niche Proj. #: 6122
Client: Tahmoor Coal Pty Ltd

Figure 2

Drawn by: JB/YH Last updated: 5/5/2021 11:28:53 AM File: T:\spatial\projects\a6100\a6122_TahmoorCoal_WesternDomain_Biodiversity\Maps\report\ABTR\6122_Figure_2_MonitoringSites.mxd

3.4 Aquatic biodiversity

3.4.1 Aquatic baseline monitoring

Aquatic baseline monitoring includes an initial stream health assessment conducted in 2014 (Niche 2014) and monitoring primarily based on AUSRIVAS and quantitative macroinvertebrate sampling biannually since spring 2017. The baseline monitoring program was conducted in November 2017, April 2018, November 2018 and May 2019 and employed the following survey methods:

- Aquatic habitat assessment comprising:
  - Australian River Assessment System (AUSRIVAS)
  - Riparian Channel and Environment (RCE) Inventory.
- Macroinvertebrate survey comprising:
  - AUSRIVAS macroinvertebrate sampling
  - A quantitative benthic macroinvertebrate monitoring program.
- Water quality sampling
- Fish sampling.

The baseline monitoring is primarily focused on macroinvertebrate monitoring regimes including AUSRIVAS and quantitative Before After Control Impact (BACI) design. In AUSRIVAS, macroinvertebrate samples are compared to modelled reference sites and a rapid assessment based on presence/absence of invertebrates is completed. This provides of before /after impact monitoring of the sites through time.

The quantitative macroinvertebrate program compares potential impacts sites with upstream control sites and contains community assemblage data, which can be used to determine quantitative changes in fauna abundance, richness and structure that may be otherwise be missed by a rapid assessment approach. This approach takes into account the natural variability of the stream through the comparison to upstream control sites through time.

Collected habitat and water quality data is used to aid the interpretation of macroinvertebrate monitoring; to determine the likely drivers behind any changes in stream health indicators.

Fish sampling is no longer conducted due to the few individuals and species caught was not a suitable indicator to measure impacts.

The monitoring locations for the current monitoring program are shown in Figure 2, summarised below in Table 3 and detailed in Table 13.

Table 3: Monitoring site summary

Site Number	Site Code	Location	Sampling method	Stream	Reason for site selection	Easting	Northing
Potential impact sites – baseline (not yet impacted)							
Site 4	SQC4	Confluence of Stonequarry and Cedar creeks	Aquatic habitat assessment AUSRIVAS and Quantitative macroinvertebrate Water quality sampling	Stonequarry Creek	North of LW W2	278049	6216448
Site 5	CC5	Upstream of Stonequarry Creek confluence		Cedar Creek	North LW W1	277883	6216526

Site Number	Site Code	Location	Sampling method	Stream	Reason for site selection	Easting	Northing
Site 6	CC6	At confluence of Cedar and Matthews creeks		Cedar Creek	West of LW W1	277534	6216048
Site 7	MC7	Upstream of Cedar Creek confluence		Matthews Creek	West of LW W1	277606	6215667
Site 8	MC8	Most upstream site		Matthews Creek	West of LW W1	277494	6215298
Site 15	SQC15	Stonequarry Creek at causeway	Quantitative, water quality	Stonequarry Creek	North of LW W3 and LW 4. Downstream of longwalls. This site was included to have two impact sites on Stonequarry Creek as part of the quantitative monitoring.	278551	6216513
Site 18	SQC18	Stonequarry Creek downstream of causeway	Quantitative, water quality	Stonequarry Creek	North of LW W4. Downstream of longwalls. This site was included to have two impact sites on Stonequarry Creek as part of the quantitative monitoring.	278821	6216476
Control sites							
Site 9	CC9	Cedar Creek at Weir	Quantitative macroinvertebrate Water quality sampling	Cedar Creek	Upstream control	275401	6214851
Site 10	CC10	Cedar Creek at Bridge		Cedar Creek	Upstream control	275268	6214927
Site 11	CC11	Cedar Creek upstream		Cedar Creek	Upstream Control	275140	6214789
Site 12	CC12	Cedar Creek upstream of Matthews Creek		Cedar Creek	Upstream Control was added in autumn 2018 to be closer to Study Area.	276643	6215875
Site 13	SQC13	Stonequarry Creek at bridge		Stonequarry Creek	Upstream Control	277479	6217229
Site 14	SQC14	Stonequarry Creek at Vintage		Stonequarry Creek	Upstream control	276376	6216300

Site Number	Site Code	Location	Sampling method	Stream	Reason for site selection	Easting	Northing
Site 16	CC 16	Cedar Creek at Scroggies Lane		Cedar Creek	Upstream control was added in spring 2018 as other control sites were dry.	273744	6214122
Site 17	MC17	Matthews Creek upstream	Quantitative macroinvertebrate Water quality sampling	Matthews Creek	Upstream control was added in spring 2019 to have a control site on Matthews Creek	277315	6215055

3.4.2 Results and conclusions from aquatic baseline monitoring

The major results and conclusions from the baseline aquatic monitoring are provided in Table 4. This report has been updated to include all aquatic ecology data.

Table 4: Summary of results and conclusions of baseline aquatic monitoring

Indicator	Parameter	Results	Conclusion
Stream condition/ aquatic habitat	Stream condition	Matthews Creek, Stonequarry Creek and Cedar Creek were found to be in moderate to good stream/riparian condition with the best habitat located within the gorge along Matthews/Cedar Creek above Stonequarry Creek.	Streams are generally in moderate to good condition however low flows places natural stress on the aquatic environment and the availability and quality of aquatic habitat. Iron floc occurring in CC6 is natural and may indicate groundwater influencing benthic habitat at the location.
	Aquatic habitat	Habitat availability varied among seasons, particularly at MC8 (Site 8), which was dry on two occasions and could not be sampled. Macrophyte diversity was low with in the gorge and greatest downstream (CC5, SQC4, SC15) (Site 5, Site 4, and Site 15). Iron staining was observed at CC6 (Site 6) and CC12 (Site 12), however was reduced considerably after surveys after high rainfall.	
Water quality	Electrical conductivity	The water quality results showed high salinity (approximately 1000 µS/cm) within and upstream the Study Area. Salinity was generally lower in times of higher water levels and flow.	Electrical conductivity is naturally elevated above ANZECC guidelines in and upstream of the Study Area and resident fauna are likely to be adapted to these relatively high concentrations.

	Dissolved oxygen	Low dissolved oxygen was characteristic of all sites.	Low dissolved oxygen is considered normal for stream pools exhibiting low- to no-flow conditions.
	pH	The pH from 2017-spring 2019 was variable. Most exceedences were below ANZECC guidelines however there were sites and seasons that were above. This occurred in both potential impact sites and control sites.	Reduction in pH may be related to low rainfall, less surface water flow and increase in groundwater water influence.
	Alkalinity	Alkalinity was generally low in all streams.	Low alkalinity indicates a low buffering capacity against changes in pH.
Macroinvertebrates	AUSRIVAS	Most sites on all sampling occasions were different to modelled reference sites scoring in Band B and Band C. However, a site on Matthews Creek (MC8, Site 8) and Stonequarry Creek (SQC4, Site 4) scored in Band A on one occasion.	Low stream health scores and indices that were observed in the baseline study can be considered natural characteristics of drying intermittent/low flow streams.
	SIGNAL	Most sites had low signal score (<4).	
	EPT	EPT scores were generally low with Cedar Creek CC5 having the highest score. Most common pollution sensitive EPT taxa included Calamoceridae, Leptoceridae and Leptophlebiidae.	
	Assemblage data	The results showed that assemblages were temporally and spatially variable.	Temporal variability between surveys is likely related to change in flow/habitat quality. Spatial differences are likely to be related to morphological and hydrological differences in streams. Site 11 was an outlier and has been discontinued from monitoring.
Fish	Fish identification and counts	Few fish were observed. Most common in the Study Area and upstream sites was introduced *Gambusia Holbrooki*. One native fish was identified	Fish are unlikely to be a good indicator of environmental impact. Fish surveys have been

		within the Study Area *Gobiomorphus coxii. Galaxias olidus* was found in Cedar Creek upstream of the Study Area.	discontinued from the monitoring program.

3.4.3 Threatened species

No aquatic threatened species are considered likely to occur (Table 5), and therefore aquatic threatened species are unlikely to be impacted by longwall mining as part of the extraction of LW W3-W4. No threatened species have been identified as part of the baseline monitoring.

Table 5: Threatened species likelihood of occurrence

Threatened Species	FM Act	BC Act	EPBC Act	Likelihood of Occurrence
Macquarie Perch (*Macquaria australasica*)	Endangered	-	Endangered	No (Does not occur or have habitat in Study Area, however there are records downstream in the Nepean River).
Sydney Hawk Dragonfly (*Austrocordulia leonardi*)	Endangered	-	-	No (Does not occur or have habitat in Study Area however there are records downstream in the Nepean River).
Adam's Emerald Dragonfly (*Archaeophya adamsi*)	Endangered	-	-	No (Does not occur or have habitat in Study Area).
Giant Dragonfly (*Petalura gigantean*)	-	Endangered	-	No (Does not occur or have habitat in Study Area).

3.5 Aquatic monitoring during mining – assessment of impacts from LW W1 and LW2

Two monitoring sampling events have occurred during mining of LW W1 and one event after LW W2 commenced in December 2020. The monitoring results assess potential impacts of LW1 using quantitative and AURIVAS results. At the time of the report only AUSRIVAS sampling data had been analysed for LW W2.

3.5.1 During and post LW1 mining

Autumn 2020 monitoring (Niche 2020) had the following results:

- Autumn 2020 was considerably wetter than previous years with one high rainfall event and one moderate rainfall event occurring before sampling.
- All sites had similar riparian and channel condition prior to sampling, however there was more aquatic habitat available in autumn 2020 and less iron floc at Cedar Creek CC6. CC5 had a changed flow path however provided similar habitat types compared to previous surveys. In general, there were less macrophytes present at CC6, SQC4 and SQC17, however similar species were present.
- Water quality appeared to have improved, with EC within ANZECC guidelines. The pH exceeded guidelines however was more alkaline and above DTV compared to previous surveys which were below.
- AUSRIVAS scores in autumn 2020 were either comparable to previous results or higher than any scores observed pre-mining.

- Signal scores in autumn 2020 for CC5, MC7 and MC8 were marginally lower than any pre-mining scores. Cedar Creek CC5 had the lowest EPT scores in autumn 2020 compared to previous surveys of this location.
- Number of taxa were above or within the range of pre-mining results.

Spring 2020 monitoring (Niche 2021a) had the following results:

- No change in stream morphology and condition.
- Overall, despite some minor water quality exceedance in EC and pH, the water quality was comparable to control sites.
- AUSRIVAS scores in spring 2020 were either comparable to or higher than scores observed pre-mining.
- Signal scores in spring 2020 for sites SQ4, CC5, CC6 and MC8 were marginally lower than any pre-mining spring 2019 scores with MC7 marginally higher.
- EPT scores at all sites where the same or higher compared to pre-mining spring 2019 survey.
- Number of taxa were above or within the range of pre-mining results.

The Aquatic Biodiversity TARP for LW W1-W2 takes into account changes in aquatic ecology and surface water and visual subsidence monitoring. It was concluded in both the spring 2020 and autumn 2020 aquatic monitoring reports that the waterways were within TARP Level 1 (normal condition) and that mining of LW1 was having no measurable impact to aquatic ecology in autumn and spring 2020.

3.5.2 During LW W2

The preliminary AUSRIVAS results from the autumn 2021 monitoring event shows the following:

- No indication of any impact to aquatic ecology or water quality particularly as AUSRIVAS scores were within the range of, or above, pre-mining AURIVAS scores and natural variability.
- No water quality or stream morphological changes observed that can be related to any potential subsidence impact from LW W1 and LW W2.
- The preliminary autumn 2021 monitoring results confirm that all sites are considered to be 'normal' according to the LW W1-W2 Biodiversity Management Plan TARPs for aquatic ecology (macroinvertebrate indicators and aquatic habitat) and no TARP triggers have been exceeded.

3.6 Subsidence monitoring of LW W1 and LW2

Results from the monthly LW W1 and LW W2 monitoring are provided in Table 6.

Table 6. Summary of LW W1 and LW W2 monthly subsidence monitoring results

Monitoring type	Monitoring results and conclusions
Subsidence	• Very little to no measurable closure or upsidence was observed during the mining of LW W1. • Very minor valley closure has been measured around the confluence of Cedar and Stonequarry Creeks beyond the commencing ends of LW W1-W2 during the mining of LW W2 (MSEC 2021).
Gas emissions	• Small although reasonably persistent gas bubbles were observed in pool MR45 in Matthews Creek during the creek visual inspections conducted in February to June, October, November and December 2020 (HEC 2021). • This equated to a Level 3 Trigger Action Response Plan (TARP) significance during these periods in accordance with the LW W1 – W2 WMP (SIMEC, 2020). • The results of the gas chromatography analysis were insufficient to provide a direct linkage between mining related influences and the observed gas emissions, although a connection was considered probable (GeoTerra, 2020a).

	• No impact, such as riparian vegetation die back, has been observed in Matthews Creek as part of the biodiversity aquatic and terrestrial monitoring program.
Water quality	• Isolated occurrences of elevated water quality constituents, in excess of baseline conditions, were recorded at some monitoring sites on Matthews Creek, Cedar Creek and Stonequarry Creek following commencement of mining LW W1 (HEC 2021). • The elevated levels of constituents were predominately related to the extended low rainfall period of late 2019 to early 2020, or following the substantial rainfall which occurred in mid-January and February 2020 (HEC 2021). • A water quality TARP significance above Level 2 has not been reported for any sites in Matthews Creek, Cedar Creek or Stonequarry Creek since commencement of mining LW W1 and W2 (HEC 2021).
Water level	• A water level TARP significance above Level 1 has not been reported for any sites in Matthews Creek or Stonequarry Creek since commencement of mining LW W1 and W2 (HEC 2021). • Atypical surface water behaviour was recorded at Cedar Creek monitoring site CB (pool CR14) from 8 October 2020 to late January 2021 and at monitoring site CA (pool CB10), which is located upstream of monitoring site CB (pool CR14) in Cedar Creek, from early December 2020 to late January 2021 (HEC 2021). • This exceeded TARP trigger level 4 and required a detailed investigation (see below).
Water level - detailed investigation (see HEC 2021)	• There is evidence of a change in surface water characteristics in the reach of Cedar Creek within the Study Area (HEC 2021). • Monitoring site CC1A, CA and CB experienced a significant change in recorded water level recessionary behaviour in December 2020 at all sites and in January 2021 at monitoring sites CA and CB (HEC 2021). • The pool water level decline is considered highly likely to be related to regional groundwater level decline associated with mining induced groundwater depressurisation, however further monitoring is required to confirm this (HEC 2021). • Whilst not visible on the surface, it is likely that mining induced subsidence may have mobilised existing fractures resulting in changes in water level recession rates in pools CB3 (monitoring site CC1A), CB10 (monitoring site CA) and CR14 (monitoring site CB). However, these effects have only persisted at pool CB10 and pool CR14 and an additional period of monitoring data is required to confirm the longevity of these effects at these pools (HEC 2021). • The study concluded that (HEC 2021): ▪ Less than 10% of the pools within the Study Area have been impacted and no impacts to pool SR17 on Stonequarry Creek are evident. ▪ Consequently, there is negligible evidence to date of subsidence impacts with environmental consequences greater than minor associated with mining LW W1 and LW W2.
Biannual aquatic ecology	• No TARP exceedances during mining of LW W1 and LW W2 despite reduction in water level observed as part the surface water monitoring (Niche 2020, Niche 2021a).

4. Predicted subsidence impacts and environmental consequences

4.1 Subsidence impacts and environmental consequences

In accordance with the findings of the Southern Coalfield Inquiry (Hebblewhite 2009):

- Subsidence effects are defined as the deformation of ground mass, such as horizontal and vertical movement, curvature and strains.
- Subsidence impacts are the physical changes to the ground that are caused by subsidence effects, such as tensile and sheer cracking and buckling of strata.
- Environmental consequences are then identified, for example, as a loss of surface water flows and standing pools.

The cumulative maximum predicted subsidence, upsidence and closure in mm are provided in Table 7 and total maximum for LW W 3-W4 in Table 8 (MSEC 2021). The predicted subsidence impacts for LW W3-W4 are provided in Section 4.2 and the environmental consequences in Section 4.3.

Table 7: Maximum predicted total vertical subsidence, upsidence and closure for Matthews Creek, Cedar creek and Stonequarry creek (MSEC 2021)

Location	Longwall	Maximum predicted total vertical subsidence (mm)	Maximum predicted total upsidence (mm)	Maximum predicted total closure (mm)
Matthews Creek	After LW W2	90	90	170
	After LW W3	100	100	190
	After LW W4	100	100	200
Cedar creek	After LW W2	60	160	180
	After LW W3	70	170	200
	After LW W4	70	170	200
Stonequarry Creek	After LW W2	50	90	60
	After LW W3	70	120	80
	After LW W4	70	120	80

Table 8: Subsidence, upsidence and closure predictions for Matthews, Cedar and Stonequarry creeks (MSEC 20210)

Site	Subsidence (mm)	Upsidence (mm)	Closure (mm)
Matthews Creek	< 20	< 20	30
Cedar Creek	<20	<20	20
Stonequarry Creek	35	60	45

4.2 Potential subsidence impacts

Tahmoor Coal has designed the layout of LW W3-W4 to avoid mining directly beneath Matthews, Cedar and Stonequarry Creeks. The purpose of the design is to substantially reduce the severity and extent of impacts on surface water flows within these creeks, compared to impacts that would occur if the longwalls were extracted directly beneath them (MSEC 2021). LW W4 has been shortened near Stonequarry Creek to reduce impacts to a significant geomorphological and culturally sensitive rock bar and impacts to ARTC Rail infrastructure.

Potential subsidence impacts are discussed below and summary of potential subsidence impact to each waterway provided in Table 9.

Table 9: Predicted water chemistry and geomorphological impacts of Cedar, Matthews and Stonequarry Creeks and tributaries from the Extraction Plan Layout

Watercourse	Attribute	Predicted impacts (MSEC 20201; HEC 2019)
Cedar Creek	Grade reversal	Grade change negligible (MSEC 2021).
	Ponding	Adverse impacts due to increased levels of ponding unlikely (MSEC 2021).
	Flow	No impacts were observed within the creeks during the extraction of LW W1, taking into account variations due to rainfall and temperature. Impacts have, however, been observed to the side of LW W1 near the confluence of Cedar and Matthews Creeks as at March 2021 during the mining of LW W2. The impact sites are located where valley closure movements are predicted to be the greatest. It is possible that further impacts will be experienced at these sites during the mining of LW W3 (MSEC 2021).
	Reduced baseflow	There is predicted to be negligible apparent effect on flows in Cedar Creek due to baseflow reduction predictions associated with mining LW W3–W4. However cumulative mining impacts may result in effects on flows in Cedar Creek . This level of change would be detectable during normal periods of low flow and would likely be distinguishable from natural variability in catchment conditions (HEC 2021).
	Scour	Adverse impacts due to increased levels of scouring of the banks unlikely (MSEC 2021).
	Pool holding capacity	The predicted rate of impact for the pools along these creeks due to the extraction of the proposed longwalls is less than 10 % (MSEC 2021).
	Water quality changes	Isolated, episodic pulses in salinity, iron, manganese, zinc and nickel may occur. Potential subsidence related impacts to water quality at the junction of Cedar Creek and Matthews Creek (HEC 2021). Existing ferruginous deposition may be exacerbated by subsidence induced emergence of ferruginous springs. To date there has been negligible evidence of an influence of mining LW W1 or LW W2 on surface water quality in Cedar Creek (HEC 2021).
Matthews Creek	Grade reversal	Grade change negligible (MSEC 2021).
	Ponding	Adverse impacts due to increased levels of ponding unlikely (MSEC 2021).
	Flow	MSEC (2021) indicate that fracturing may occur at locations along Stonequarry Creek within the Study Area due to valley-related compressive strains. MSEC (2021) have assessed the potential for 'fracturing in a rock bar or upstream pool resulting in reduction in standing water level based on current rainfall and surface water flow' (MSEC, 2021). The proportion of rock bars within Matthews Creek and Cedar Creek that may experience fracturing is predicted as less than 10% based on a maximum predicted total closure of 200 mm due to the extraction of LW W1 – W4. Although there may be some temporary loss of flow (diversion) from the surface water systems in the event of cracking, connectivity between the groundwater and surface water systems is not predicted (HEC 2021).

Watercourse	Attribute	Predicted impacts (MSEC 20201; HEC 2019)
	Baseflow	HEC (2021) predict that there is no apparent effect on flows in Matthews Creek associated with mining LW W3 – W4 and the level of change would be low compared to natural variability in catchment conditions. Cumulative impacts however may be detectable during normal periods of low flow and distinguishable from natural variability in catchment conditions.
	Scour	Adverse impacts due to increased levels of scouring of the banks unlikely (MSEC 2021).
	Pool holding capacity	The predicted rate of impact for the pools along these creeks due to the extraction of the proposed longwalls is less than 10 % (MSEC 2021).
	Water quality changes	Isolated, episodic pulses in salinity, iron, manganese, zinc and nickel may occur. Potential subsidence related impacts to water quality at the junction of Cedar Creek and Matthews Creek (HEC 2021). Existing ferruginous deposition may be exacerbated by subsidence induced emergence of ferruginous springs. To date there has been negligible evidence of an influence of mining LW W1 or LW W2 on surface water quality in Matthews Creek. Gas emissions observed in Matthews Creek if related to subsidence may increase during LW W3, however no water quality impacts are predicted (MSEC 2021).
Stonequarry Creek	Grade reversal	Grade change negligible (MSEC 2021).
	Ponding	The pool extent and overall pool length is expected to change only slightly due to the extraction of LW W3–W4, although the central portion of pool SR17 is predicted to experience slightly more subsidence than rock bar SR17 resulting in this section of the pool increasing in depth by approximately 40 mm. Minor increases are considered to have a negligible impact on ponding (MSEC 2021).
	Flow	The predicted rate of impact for rock bar SR17 is assessed to be less than 5% based on a maximum total closure of 80 mm predicted for Stonequarry Creek and total closure of 60 mm at rock bar SR17 following extraction of LW W1 – W4 (MSEC, 2021). It is possible that mining-induced fractures could occur at rockbar SR17 due to the extraction of LW W3. As the rock bar is thinly bedded in places and natural fractures are present at isolated locations, it is possible that subsidence induced fracturing could result in surface water flow diversion within the rock bar. However, the likelihood of this occurring is assessed to be less than 5% (MSEC, 2021).
	Baseflow	Mining of LW W3 and W4 as well as cumulative impacts will have a level of change that would be detectable during normal periods of low flow and would likely be distinguishable from natural variability in catchment conditions (HEC 2021).
	Scour	Adverse impacts due to increased levels of scouring of the banks unlikely (MSEC 2021).
	Pool holding capacity	It is possible that subsidence induced fracturing could result in surface water flow diversion within the rock bar. However, the likelihood of this occurring is assessed to be less than 5% (MSEC 2021).
	Water quality changes	Isolated, episodic pulses in salinity, iron, manganese, zinc and nickel may occur. Existing ferruginous deposition may be exacerbated by subsidence induced emergence of ferruginous springs (HEC 2021). To date there has been negligible evidence of an influence of mining LW W1 or LW W2 on surface water quality in Stonequarry Creek (HEC 2021).

Watercourse	Attribute	Predicted impacts (MSEC 20201; HEC 2019)
Tributaries	Grade reversal	Predicted mining-induced changes in grade are small compared with the natural grades of the tributaries. It is unlikely that the tributaries would experience adverse impacts due to changes in stream alignment (MSEC 2021).
	Ponding	It is unlikely that the tributaries would experience adverse impacts due to increased levels of ponding (MSEC 2021).
	Flow	Fracturing could develop along the tributaries located within the Study Area. The fracturing will predominately occur where the tributaries are located directly above LW W1-W4, however can also occur at distances up to approximately 400 m outside the longwalls (MSEC 2021). Surface water flow diversions could occur along the tributaries that are located directly above LW W1-W4 (MSEC 2021). In times of heavy rainfall, the majority 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. The tributaries are ephemeral and, therefore, surface water flows only occur during and for short periods after rain events (HEC 2021).
	Baseflow	Modelling data shows that there is no apparent effect on flows in Redbank Creek tributary with the level of change predicted to be low compared to natural variability in catchment conditions (HEC 2021).
	Scour	It is unlikely that the tributaries would experience adverse impacts due to increased levels of scouring of the banks (MSEC 2021).
	Pool holding capacity	The tributaries are ephemeral and, therefore, surface water flows only occur during, and for short periods after, rain events (MSEC 2021). The main tributary, including the third order reach, is not known to contain any noteworthy surface water features (i.e. rockbars, pools and aquatic habitat). As such, potential impacts of mining on Tributary 1 of Redbank Creek are unlikely to have discernible impact with respect to surface water resources and ecosystems (HEC 2021).
	Water quality changes	None expected (HEC 2021).

4.3 Environmental consequences

Potential environmental consequences have been assessed through the consideration of predicted subsidence, hydrology (flow and quality) and hydrogeology impacts to aquatic ecology. Additionally, assessment of potential impacts have been informed through review of monitoring results from LW W1 and LW W2. To date there has been no measurable evidence of impact to aquatic ecology from the mining of LW W1 and LW W2 (Niche 2020, 2021a).

4.3.1 Ponding and scour

Increased ponding is likely to provide localised increase in available habitat for aquatic macroinvertebrates and if there is stream connectivity in the area of ponding, it may also provide additional habitat for fish and macrophytes. However, increase in water levels predicted in Stonequarry Creek is small and considered negligible. Scouring is not predicted to occur, therefore it is unlikely that aquatic ecology will be impacted by changes to this stream process.

4.3.2 Flow regime and pool holding capacity

Drainage of pools resulting from mine subsidence will impact aquatic biota inhabiting affected pools, including macroinvertebrates and native fish, with high mortalities likely in areas of complete pool drainage.

For invertebrates, there will be loss of habitat in sections of streams, and changes to invertebrate composition, density and family richness where these impacts occur. However, it is unlikely that at a sub-catchment to catchment scale changes to overall assemblage and family richness will be measurable, however total biomass is likely to be reduced if these impacts occur.

The sudden drainage of pools or rapid drop in stream flow due to subsidence are likely to have localised impacts to aquatic biota, particularly on organisms that are unable to move to areas that are damp or submerged. Aquatic plants and sessile animals are particularly vulnerable to desiccation, because of their inability to move elsewhere to other available habitat. The survival of mobile organisms is difficult to predict, as it depends on a number of factors such as their tolerance and response to desiccation and rapid changes in water level, their ability to move, weather conditions, the underlying substratum and duration of exposure (Larned et al. 2010). Streams with soft sediment banks are likely to contain moisture with interstices which may prolong the survival of stranded animals. In the streams with a bedrock substrate where there are few natural refugia, with the exception of cracks and cavities, few organisms may survive complete pool drainage. The majority of freshwater fish species recorded in the Study Area are likely to asphyxiate when exposed to air. Subsidence impacts are predicated to occur in less <10% of pools. Affected pools may experience these extremes as a result of reduction in habitat.

Recovery potential of stream biota

There is capacity for recovery of some stream biota, particularly macroinvertebrate fauna. Temporary rivers function as meta-communities (i.e. part of a larger community), with variable hydrological connectivity and multiple dispersal pathways (water, air, dry river bed) (Larned et al. 2010). Aquatic insects with aerial stages may be the most common migrants to and from disconnected aquatic habits. As well as those invertebrates that can persist for years as cysts, eggs, copodites, cocoons and dehydrated larvae and adults, and crayfish (*Cherax destructor* and *Euastacus spinifer*) which retreat to their burrows or disperse overland. Most taxa identified are able to adapt to drying conditions and have the potential to recruit back to pools once and if pool holding capacity is re-established. Animals with long larval stages and limited distribution, are obligates to a particular habitat, or are poor dispersers will be most impacted. Fish may be limited in their capacity to re-establish if river connectivity is reduced. However, surface flow will remain connected in higher flow periods (GeoTerra 2014) enabling movement of fish. Submerged and floating macrophytes generally require permanent water however they can, in time, recolonise dry areas if and when water levels return.

Although there is potential for recovery, long term impacts may persist. Some pools may not selfheal; either remaining permanently dry; or have a permanently reduced holding capacity (of both volume and retention); and thus contribute to reduced stream connectivity. This could lead to permanent changes to stream biota within the affected pools and restrict recovery of animals that require stream connectivity e.g. fish.

4.3.3 Water quality

The potential impacts of subsidence on water quality in overlying waterways include the liberation of contaminants from subsidence induced fracturing in watercourses. This causes localised and transient increases in iron concentrations and other constituents due to flushing of freshly exposed fractures in the sandstone rocks which contain iron and other minerals. Changes to chemical characteristics of surface flows can also occur as a result of changes to baseflow. One of the effects of longwall subsidence on watercourses commonly reported is the emergence of ferruginous springs (DoP 2008), often accompanied by iron flocs, staining of the bed, increased turbidity and the build-up of iron rich slimes. This ferruginous deposition occurs within sandstone streams in the Sydney Basin and was particularly prevalent at Cedar Creek near confluence of Matthew Creek as well as control sites.

Studies have shown considerable impact to flora and fauna from iron depositional related impacts (Wellnitz et al.1994; Johnson and Ritchie 2003). Invertebrate communities are impacted through a reduction in abundance, richness and changes to community composition (Johnson and Ritchie 2003; Wellnitz et al.1994; Rassmussan and Lindegaard 1988; Peters et al. 2011). It is thought that invertebrates are impacted through a reduction of habitat complexity, interference of holdfast mechanisms, affecting food supply, coating of respiratory surfaces, and inhibiting ion exchange (Johnson and Ritchie 2003; Wellnitz et al. 1994). A commonly affected insect order is mayflies, in particular the family Leptophlebiidae (SIGNAL 8) (Johnson and Ritchie 2003; Wellnitz et al.1994; Rassmussan and Lindegaard 1988; Peters et al 2011). The sensitivity of mayflies is likely to be related to the exposure of gills and the dependence on periphytic algae (Johnson and Richie 2003).

Iron is known to precipitate on the gills of fish and eggs, prevent oxygen uptake (Peuranen et al. 1994) and also affect the food supply (Wellnitz et al.1994). Scouring of iron flocculent increases turbidity and suspended solids and may inhibit fish feeding (Peuranen et al.1994).

The degree of impact will be related to the alkalinity of the stream. Streams that are acidic (low pH) and have low total alkalinity are more likely to be impacted than acidic streams with high total alkalinity (Johnson and Ritchie 2003; Wellnitz et al.1994; Peters et al. 2011) as they have a greater buffering capacity against changes to pH.

The impact of metals (iron, manganese, and zinc) is also expected to be localised and transient (GeoTerra 2014). The impacts to stream fauna similarly are expected to be localised, and fauna are likely be able to recover from transient spikes in concentration. Localised long term changes to fauna may occur if metal concentration is elevated for extended periods of time.

Increases in electrical conductivity has also been raised as an impact from subsidence that could potentially affect aquatic flora and fauna (DoP 2008); aquatic fauna such as Leptophlebiidae are likely to be affected if increases in electrical conductivity occurs. However, it must noted that high salinities can occur naturally in streams in the area. No changes in water quality have been observed to during monitoring of LW W1 and LW W2 however locations near confluence of Cedar Creek and Matthews Creek may experience change in water quality during mining LW W3.

Gas emissions have been known to occur in the Southern Coalfields (DoP 2008). In areas where gas releases occur into the water column there is insufficient time for any substantial amount of gas to dissolve into the water to change water quality (MSEC 2014). Gas emissions have caused rare and isolated dieback of riparian vegetation in the Southern Coalfields (DoP 2008). Minor gas emissions have been observed in Matthews Creek though the origin of the gas emissions is unclear. Regardless, gas emissions are unlikely to impact aquatic ecology and no resulting vegetative die back has been observed. If gas bubbles were discharged due to mine subsidence movements, it is likely that further emissions will occur during the mining of LW W2 and further emissions could possibly occur during the mining of LW W3. Monitoring of gas bubbling will continue in accordance with the LW W3-W4 Water Management Plan.

Where these gas releases occur into the water column there is insufficient time for any substantial amount of gas to dissolve into the water. The majority of the gas is released into the atmosphere and is unlikely to have an adverse impact on water quality or aquatic ecology.

4.3.4 Cumulative impacts to aquatic ecology

Aquatic ecology is affected by the combined influence of water quality, stream connectivity and habitat loss and is therefore susceptible to cumulative impacts to these environmental variables. The cumulative impacts on ecology are difficult to predict and are likely to be spatially and temporally variable. Impacts may be localised (e.g. to a pool), transient (e.g. occur in prolonged low flow condition only), gradational (e.g. downstream from a point source) and may be triggered when one or more environmental thresholds are met. Impacts to stream and biological processes may alter aquatic communities through: localised reduced abundances of sensitive flora and fauna, increased abundances of tolerant flora and fauna, reduced abundances of all aquatic flora and fauna, and/or a reduction of fauna richness. However, there is potential for partial recovery of stream fauna with re-establishment of aquatic communities following natural repair of pool habitat.

The environmental consequences of potential subsidence impacts in consideration of the physical, and surface water impacts are summarised in Table 10.

4.3.5 Downstream impacts

In consideration of the predicted surface water impacts, there are unlikely to be measurable change to aquatic ecology as a result of direct or indirect impact to the waterways. The main risk is potential cracking of Rock bar SR17 which could potentially lead to localised water quality changes in downstream locations where any diverted water resurfaces. However, the longwall layout has been designed with setbacks specifically to limit any impact to this sensitive location. In the event of unpredicted cracking and stream diversion, contingency measures will be implemented (such as grouting) to rehabilitate the rock bar and stream flow (MSEC 2021).

Table 10: Potential environmental consequences of changing aquatic values

Aquatic value	Waterway	Potential environmental consequence
Aquatic habitat	Matthews Creek	Potential reduction in pool habitat near LW W1, less than 10% reduction in overall pool habitat and increase in iron floc smothering the benthos at Cedar/Matthews Creek junction.
	Cedar Creek	Potential reduction in pool habitat near LW W1, less than 10% reduction in overall pool habitat and increase in iron floc smothering the benthos at Cedar/Matthews Creek junction.
	Stonequarry Creek	Minor/negligible reduction in pool habitat.
Riparian Vegetation	Matthews Creek	Potential localised impacts from gas emissions, low likelihood.

Aquatic value	Waterway	Potential environmental consequence
	Cedar Creek	Potential localised impacts from gas emissions, low likelihood.
	Stonequarry Creek	Potential localised impacts from gas emissions, low likelihood.
Macrophytes	Matthews Creek	Potential localised reduction in available wetted habitat, low likelihood.
	Cedar Creek-	Potential localised reduction in available wetted habitat.
	Stonequarry Creek	Potential minor reduction in wetted habitat.
Macroinvertebrates	Matthews Creek	Potential reduction in available habitat and macroinvertebrate biomass. Reduction of sensitive macroinvertebrate species at Cedar Creek/Matthews Creek junction. Potential localised temporal change in community composition from episodic changes in water quality.
	Cedar Creek	Potential localised reduction in available habit and macroinvertebrate biomass. Reduction of sensitive macroinvertebrate species at Cedar Creek/Matthews Creek junction. Potential localised temporal change in community composition from episodic changes in water quality.
	Stonequarry Creek	Potential localised temporal change in community composition from episodic changes in water quality. Low likelihood.
Fish	Matthew Creeks-	Potential localised temporal reduction in fish passage in low flows when there is naturally limited fish passage.
	Cedar Creek-	Potential localised temporal reduction in fish passage in low flows when there is naturally limited fish passage.
	Stonequarry Creek	Unlikely.
Threatened species	Matthew Creeks	Unlikely.
	Cedar Creek	Unlikely.
	Stonequarry Creek	Unlikely.

5. Management monitoring and evaluation

5.1 Subsidence performance measures and indicators

This ABTR outlines the management strategies, controls and monitoring programs to be implemented for the management of aquatic flora and fauna regarding potential environmental impacts from the proposed LW W3-W4 extraction workings.

Biodiversity performance measures were defined in DA 67/98 Condition 13A Table 1, and are repeated in Table 11 below. Tahmoor Coal must ensure that there is no exceedance of the subsidence impact performance measures for biodiversity as provided in Table 11, and have contingencies if these performance measures are exceeded.

The monitoring program will continue to be implemented to measure any impacts to aquatic biodiversity, as described in Section 5.2 and Table 12.

TARPs have been developed to:

- Establish compliance with the performance measures outlined in Table 11.
- Inform if the performance measures are likely to be exceeded during secondary extraction within the Study Area.
- Provide management/corrective actions for implementation if a risk is triggered.

The TARPs are described in Section 6.2 and provided in Table 14 of this ABTR.

Table 11: Biodiversity subsidence performance measures and performance indicators

Biodiversity feature	Subsidence performance measure	Adopted subsidence performance indicators
Threatened species, threatened populations, or endangered ecological communities	Negligible environmental consequences	This performance indicator will be considered to be triggered if: • Declines in macroinvertebrate and stream health indicators are statistically significant; and • The subsidence monitoring program identifies changes that exceed performance indicators for surface water or subsidence that may affect aquatic habitat.

5.2 Monitoring

5.2.1 Subsidence monitoring program

The monitoring program outlined below will be implemented to monitor subsidence impacts on aquatic biodiversity within the Study Area and surrounding areas likely to be impacted by far-field movements. As subsidence impacts are predicted to be small in magnitude, the monitoring program outlined below reflects the magnitude of these expected impacts.

5.2.2 Aquatic biodiversity monitoring program

Aquatic biodiversity monitoring would address stream health indicators and measure relevant water quality variables at appropriate spatial and temporal scales at both impact and control sites. This will enable changes to water quality, aquatic habitats and biota resulting from mining related subsidence to be distinguished from natural variability and other catchment influences.

Monitoring will be conducted in an adaptive management framework and be in accordance with the current monitoring program methods and protocols (see baseline monitoring report for details - Niche 2019).

Sampling has been conducted in spring and autumn for two years prior to the commencement of mining in order to establish a baseline condition. Monitoring will continue to be conducted in spring and autumn every year during and for a period of 12 months after mining to detect any changes to the aquatic environment and its biota that could be attributed to mining activities. Monitoring will employ a range of techniques including:

- Physiochemical water quality sampling
- Aquatic habitat observations
- AUSRIVAS macroinvertebrate sampling
- Quantitative macroinvertebrate sampling.

Detailed recommendations for monitoring including laboratory methods and data analysis are provided in Niche (2019a). The sampling regime and monitoring locations are provided in Table 12, Table 13 and Figure 2.

AUSRIVAS monitoring will allow monitoring of the sites through time with a before/after comparison. Quantitative sampling of macroinvertebrates will allow statistical testing of any change to family richness, density and macroinvertebrate assemblages in a BACI experimental design through temporal comparison of impact sites to upstream controls.

Reporting will be completed annually or as required by the TARPs.

5.3 Baseline monitoring for future extraction plans

The monitoring program going forward should aim to be consistent with previous monitoring conducted as part of the subsidence monitoring program (Table 12, Table 13). The monitoring program should also adapt to changing priorities, mine design and/or include improvements to overall design of the monitoring program. This may involve the addition or removal of sites and/or indicators as necessary to streamline and detect meaningful ecological change. The monitoring program should be reviewed, particularly after the completion of the LW W3, to ascertain whether survey effort is effectively monitoring stream health and anthropogenic induced changes and results of monitoring should inform future mine layouts.

Table 12: Monitoring program for aquatic biodiversity values

Feature	Monitoring component / location	Monitoring		
		Prior to mining	During mining	Post mining
Water quality	Physio chemical water quality sampling at all sites	Completed as part of baseline monitoring.	Bi-annually	Bi-annually (spring and autumn) for 12 months following the completion of LW W2. This period may be extended as per the decision by the Environmental Response Group.
Aquatic habitat	Aquatic habitat observations at Sites 4-8 (SQC4, CC5, CC6, MC7, MC8, SQC 15)			
Macroinvertebrates	AUSRIVAS macroinvertebrate sampling at Sites 4-8 (SQC4, CC5, CC6, MC7, MC8, SQC15)			
	Quantitative macroinvertebrate sampling at Sites 4-18 (Table 13).			

Table 13: Location of monitoring sites (refer also figure 2)

Site number	Site code	Location	Sampling method	Stream	Longwall	Easting	Northing
Potential impact sites – baseline (not yet impacted)							
Site 4	SQC4	Confluence of Stonequarry and Cedar creeks	Aquatic habitat assessment AUSRIVAS and Quantitative macroinvertebrate sampling Water quality sampling	Stonequarry Creek	North of Longwall W2	278049	6216448
Site 5	CC5	Upstream of Stonequarry Creek confluence		Cedar Creek	North LW W1	277883	6216526
Site 6	CC6	At confluence of Cedar and Matthews creeks		Cedar Creek	West of LW W1	277534	6216048
Site 7	MC7	Upstream of Cedar Creek confluence		Matthews Creek	West of LW W1	277606	6215667
Site 8	MC8	Most upstream site		Matthews Creek	West of LW W1	277494	6215298
Site 15	SQC15	Stonequarry Creek downstream	Quantitative macroinvertebrate sampling Water quality sampling.	Stonequarry Creek	Downstream of longwalls	278551	6216513
Site 18	SQC18	Stonequarry Creek downstream of causeway	Quantitative, water quality	Stonequarry Creek	Downstream of longwalls. This site was included to have two	278821	6216476

Site number	Site code	Location	Sampling method	Stream	Longwall	Easting	Northing
					impact sites on Stonequarry Creek as part of the quantitative monitoring.		
Control sites							
Site 9**	CC9	Cedar Creek at Weir	Quantitative macroinvertebrate sampling Water quality sampling.	Cedar creek	Upstream control	275401	6214851
Site 10**	CC10	Cedar Creek at Bridge		Cedar Creek	Upstream control	275268	6214927
Site 11*	CC11	Cedar Creek upstream		Cedar Creek	Upstream Control	275140	6214789
Site 12	CC12	Cedar Creek upstream of Matthews Creek		Cedar Creek	Upstream Control	276643	6215875
Site 13	SQC13	Stonequarry creek at bridge		Stonequarry Creek	Upstream Control	277479	6217229
Site 14	SQC14	Stonequarry Creek at Vintage		Stonequarry creek	Upstream control	276376	6216300
Site 16	CC 16	Cedar Creek at Scroggies Lane		Cedar Creek	Upstream control	273744	6214122
Site 17	MC17	Matthews Creek upstream		Matthew Creek	Site 17	MC17	Matthews Creek upstream

*no longer sampled

** Site 9 and 10 are considered the same site as they close together and joined in wet periods.

6. Contingency plan

6.1 Adaptive management

As part of the aquatic biodiversity management, Tahmoor Coal recognises the need to adapt to unforeseeable impacts or changes associated with the Project. Tahmoor Coal will implement the contingencies outlined in Section 6.2 and the TARPs (Table 14).

An Adaptive Management Framework provides for flexible decision making, adjusted to consider uncertainties as management outcomes are understood. Through feedback to the management process, the management procedures are changed in steps until monitoring shows that the desired outcome is obtained. The monitoring program has been developed so that there is statistical confidence in the outcome.

Adaptive management involves:

- Planning – identifying performance measures and indicators, developing management strategies to meet performance measures and establishing programs to monitor against the performance measures.
- Implementation – implementing monitoring programs and management strategies.
- Review – reviewing and evaluating the effectiveness of monitoring and management strategies.
- Contingency response – implementing the contingency plan in the event that a subsidence impact performance measure in relation to surface water resources has been exceeded.
- Adjustment – adjusting management strategies to improve performance.

An adaptive management response would be detailed in an Investigation Report prepared as a response to issues identified in the monitoring program. An Investigation Report will be written, which will determine any adaptive management responses based on the monitoring data and additional expert advice (if sought).

6.2 Trigger Action Response Plans (TARPs)

TARPs are used to set out response measures for unpredicted subsidence impacts and have been developed for potential impacts to sensitive biodiversity features, such as aquatic habitat and macroinvertebrates.

The monitoring results will be used to assess the impacts of mining in the Western Domain against the performance indicators and performance measures using the TARPs.

The frequency of assessment against the TARPs and the proposed method of analysis is summarised in Table 12 and Table 13 for each potential impact to aquatic biodiversity. The impact assessment triggers and proposed response/action plans are detailed in Table 14.

Table 14. TARPs associated with aquatic biodiversity

Potential impact	Trigger	Action	Response
Decline or significant negative change in macroinvertebrate indicators. These indicators include: • Density • Family richness • Community assemblages • EPT index • SIGNAL score • AUSRIVAS score	Level 1		
	Monitoring macroinvertebrate indicators are within range of baseline data as supported by statistical analysis.	• Continue monitoring as per monitoring program.	• No action required.
	Level 2		
	One or more macroinvertebrate indicators are not within range of baseline data as supported by statistical analysis. AND ONE OR BOTH OF THE FOLLOWING: • Subsidence monitoring program identifies potential for impact to watercourse parameters associated with aquatic habitat areas compared to baseline e.g. cracking. • Subsidence monitoring program identifies potential impacts to hydrology/water quality parameters compared to baseline.	• Continue monitoring as per monitoring program. • Convene Tahmoor Coal Environmental Response Group to review possible cause and response. • Review and confirm monitoring data, cross check aquatic biodiversity monitoring data against other related environmental data (e.g. control sites and benchmark data) and subsidence monitoring upon identification of the potential trigger. • Undertake further investigations as appropriate to confirm the potential issue and analyse data with the aim of determining whether the exceedance is likely to be mining related.	• As defined by Environmental Response Group. • Assess need for any increase to monitoring frequency or additional monitoring where relevant.
	Level 3		
	Monitoring indicates that three or more macroinvertebrate indicators are not within range of baseline data as supported by statistical analysis. AND ONE OR BOTH OF THE FOLLOWING:	• Continue monitoring as per monitoring program. • Convene Tahmoor Coal Environmental Response Group to review possible cause and response.	• Notify DPIE and relevant stakeholders within 7 days of investigation completion. • Complete an investigation report including the identification of potential remediation measures, and implement remediation measures in consultation with DPIE.

	• Subsidence monitoring identifies mining induced impacts compared to baseline watercourse parameters associated with aquatic habitat e.g. cracking. • Subsidence monitoring identifies significant impacts to hydrology/water quality that exceed predictions compared to baseline.	• Review and confirm monitoring data, cross check aquatic biodiversity monitoring data against other related environmental data (e.g. control sites and benchmark data) and subsidence monitoring upon identification of the potential trigger. • Undertake further investigations as appropriate to confirm the potential issue and analyse data with the aim of determining whether the exceedance is likely to be mining related.	

Potential impact	**Trigger**	**Action**	**Response**
Reduction in aquatic habitat though loss of pools or associated reduction in water quality (AUSRIVAS habitat assessment).	Level 1		
	Visual monitoring indicates aquatic habitat parameters are similar to baseline observations at aquatic ecology monitoring sites.	• Continue monitoring as per monitoring program.	• No action required.
	Level 2		
	Visual monitoring indicates potential change in aquatic habitat compared to baseline observations at aquatic ecology monitoring sites. AND ONE OR BOTH OF THE FOLLOWING: • Subsidence monitoring identifies potential for impact to watercourse parameters associated with macroinvertebrate indicators compared to baseline. Subsidence monitoring program identifies potential for impact to hydrology/water quality parameters compares to baseline.	• Continue monitoring as per monitoring program. • Convene Tahmoor Coal Environmental Response Group to review possible cause and response. • Review and confirm monitoring data, cross check aquatic biodiversity monitoring data against other related environmental data (e.g. control sites and benchmark data) and subsidence monitoring	• As defined by Environmental Response Group. • Assess need for any increase to monitoring frequency or additional monitoring where relevant.

		upon identification of the potential trigger. • Undertake further investigations as appropriate to confirm the potential issue and analyse data with the aim of determining whether the exceedance is likely to be mining related.	
	Level 3		
	Visual monitoring indicates a significant change in aquatic habitat compared to baseline observations at aquatic ecology monitoring sites. AND ONE OR BOTH OF THE FOLLOWING: • Subsidence monitoring identifies that macroinvertebrate indicators exceed prediction compared to baseline. • Subsidence monitoring identifies significant impacts to hydrology/water quality that exceed predictions.	• Continue monitoring as per monitoring program. • Convene Tahmoor Coal Environmental Response Group to review possible cause and response. • Review and confirm monitoring data, cross check aquatic biodiversity monitoring data against other related environmental data (e.g. control sites and benchmark data) and subsidence monitoring upon identification of the potential trigger. • Undertake further investigations as appropriate to confirm the potential issue and analyse data with the aim of determining whether the exceedance is likely to be mining related.	• Notify DPIE and relevant stakeholders within 7 days of investigation completion. • Complete an investigation report including the identification of potential remediation measures, and implement remediation measures in consultation with DPIE.

6.3 Contingency measures

As subsidence predictions for the study area as a result of the mining of LW W3 and W4 are minimal and mine design has been altered to avoid direct mining beneath creeks, potential impacts are considered unlikely. However, if required, Tahmoor Coal will undertake remediation in consultation with the relevant landholders and NSW Government Agencies. A Response Strategy will be adopted if a significant impact is detected as a result of mining activities within the Study Area.

Standard management measures will be implemented for negligible impacts to aquatic biodiversity where those impacts occur as a result of mining. These measures include continuation of the approved monitoring program and reporting.

Management measures for aquatic biodiversity will be employed where more than negligible impacts resulting from subsidence occur (e.g. Level 2 and Level 3 as described in the TARPs). Management measures include implementation of the standard management measures as well as the involvement of the Tahmoor Coal Environmental Response Group, relevant stakeholders, agencies and specialists to investigate and report on the changes that are identified.

If a Level 3 TARP is triggered, assessment of biodiversity impacts by a qualified Ecologist would be undertaken once the impact is confirmed to be related to mining. Additional monitoring would be undertaken with specialists providing updates on the investigation process and the relevant stakeholders and agencies would be provided with investigation results. In the event that the impacts of mine subsidence on aquatic habitats are greater than predicted, the following mitigation measures would also be considered, in consultation with key stakeholders:

- Should significant impacts on aquatic biodiversity occur that are considered to be outside of the Performance Measures of the approval conditions, Tahmoor Coal would review future longwalls configurations;
- Implementing stream remediation measures, such as backfilling or grouting in areas where fracturing of controlling rock bars and/or stream bed leads to diversion of stream flow and drainage of pools; and
- Implementing appropriate erosion/sedimentation control measures to limit the potential for deposition of eroded sediment into affected streams.

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