

Memo

From	Kristy Hogsden, NIWA
To	Campbell Robertson, Bathurst Coal Ltd
CC	
Date	5 March 2021
Subject	Canterbury Coal Mine - Aquatic Ecology Monitoring Programme
Client Report Number	2021043CH

1 Background

Bathurst Coal Limited (Bathurst) owns and operates coal mines around New Zealand, including the Canterbury Coal Mine (CCM) in the Canterbury Region. Bathurst holds a suite of existing resource consents from the Selwyn District Council (SDC) and Environment Canterbury (ECan) that authorise a range of activities at the CCM (e.g., open-cast mining, construction and maintenance of roads, treatment ponds, and associated infrastructure, wetland management, rehabilitation of mined areas).

During 2018–2020, Bathurst applied for resource consent for retrospective and future activities at the CCM. The bundled consent applications were publicly notified in 2020. In August 2020, NIWA assisted Bathurst with the Request for Information expertise (RFI) from ECan for the CCM consents application as related to aquatic ecology (Hogsden 2020). As part of this work, NIWA recommended a two-year aquatic ecology monitoring programme to assess and monitor the effects of mining activities on macroinvertebrates and fish, particularly as the catchment supports Canterbury mudfish which have the highest possible threat ranking of ‘Nationally-critical’ (Dunn et al. 2018). The aquatic ecology monitoring programme began in November 2020 and complements on-going water quality monitoring at the mine.

Bathurst is now proceeding with mine closure at CCM and has requested preliminary results from the monitoring programme to support planning for closure and post-closure activities. This memo provides a summary of the objectives, methods, and preliminary results from the first survey of the programme.

2 CCM Aquatic Ecology Monitoring Programme

2.1 Objectives

The aim of the aquatic ecology monitoring programme is to assess and monitor the effects of mining activities at the CCM on macroinvertebrate and fish communities in Tara Stream and Bush Gully Stream. Field surveys will be undertaken in spring and autumn when these waterways are flowing.

2.2 Survey design and methods

Field survey sites were established at six sites in Tara Stream and Bush Gully Stream during the first survey, which was completed on 30 November–1 December 2020 (Appendix 1). The survey sites are existing water quality sites monitored by Bathurst and have also been used in previous aquatic ecology assessments in the catchment. Macroinvertebrates and fish were sampled at one site on Tara Stream (CC03) and at four sites on Bush Gully Stream (CC24, CC19_mainstem, CC23 and CC26; listed from upstream to downstream). Fish

were also be sampled at an additional site on Tara Stream (CC09). The CC19_mainstem site is located on the main stem of Bush Gully Stream, just upstream of the confluence of the tributary where CC19 is located (Appendix 1). Two proposed survey sites were excluded from the programme¹.

At each site, in-stream physical habitat was assessed following the P1 protocol (Harding et al. 2009) and spot water quality measurements (pH, conductivity, temperature, and dissolved oxygen) were recorded using calibrated hand-held meters (TPS WP-81 and TPS WP-82Y).

Macroinvertebrates were collected in a single kick net sample (500 µm mesh) over a standardised area following the protocol outlined in the National Environmental Monitoring Standards (NEMS 2020). Samples were preserved in 80% isopropyl alcohol (IPA) and transported to the laboratory for later processing².

Fish were sampled using baited Gee minnow traps (three traps per site). Traps were baited with Marmite and set in the late afternoon and left overnight. Traps were retrieved the following morning and captured fish were identified, counted, measured (length) before being returned to the stream. Fish data were reported as catch per unit effort (CPUE; i.e., the number of fish captured per trap).

2.3 Preliminary results

Physical habitat and water quality

The two sites (CC03, CC09) on Tara Stream were characterised by pool habitats under baseflow conditions, with stable banks and fine in-stream substrates (clay/mud, silt/sand). Periphyton, wood, and moss were absent from both sites and leaves in the stream were common only at CC09, due to overhanging willows. No stock access was evident at either site. Riparian vegetation was dominated by grass, sedges and ferns at CC03 and by grass, shrubs and deciduous trees at CC09. Blackberry was also present at both sites, which were located adjacent to gravel roads.

The four sites (CC24, CC19_mainstem, CC23, CC26; listed from upstream to downstream) on Bush Gully Stream were characterised by a mix of riffle, run and pool habitats. The banks were stable, with fine in-stream substrates (clay/mud, silt/sand) present at all sites. Gravels and cobbles, which are the preferred substrate and habitat for many macroinvertebrate taxa, were also present at CC24 and CC26. Periphyton was common at the upstream site (CC24) but not visible at sites further downstream. In-stream wood and leaves were absent or sparse at upstream sites but became more common downstream (CC23 and CC26), where shrubs and trees were present along the riparian margins. Riparian vegetation was dominated by grass, sedges and wetland plants at all sites, with willows present only at CC26. Stock access was evident at the upstream sites (CC24 and CC19_mainstem), with stock present in a paddock with stream access at the time of sampling.

¹ A reference site upstream of CC02-tele (mine water discharge point) on Tara Stream was excluded due to lack of flow and absence of obvious stream channel on 30 November 2020. The soil conditions and vegetation suggested the area, which is located in a pine forest on rolling hills, had been dry for some time. Dry conditions and lack of flow have previously been noted at this location in an aquatic ecology assessment (Golder Associates 2014) and by mine staff (E. Sinclair, pers. comm). Furthermore, a site in the farm ponds downstream of CC03 on Tara Stream were excluded as access was not granted by the landowner.

² Macroinvertebrate samples collected in November 2020 will be processed by May 2021. Macroinvertebrates will be identified to the lowest practicable taxonomic level and counted using the fixed count abundance protocol, including scans for rare taxa. Community metrics and indices will be calculated to provide an indication of stream health (e.g., total number of taxa, number of EPT taxa, MCI, SQMCI, MCI-SB, SQMCI-SB, AMDI, ASPM; refer to the Glossary for explanations of these acronyms). Indices will be compared with relevant standards and limits as specified in the CLWRP and NPS-FM. Preliminary results are not yet available.

Stream water was slightly acidic to circumneutral and specific conductivity ranged from 177–397 $\mu\text{S}/\text{cm}$ across all sites, with the highest conductivity values recorded at the downstream sites on both Tara Stream and Bush Gully Stream (Table 1). Dissolved oxygen concentrations and water temperatures were in the ranges suitable for supporting aquatic organisms at all sites. Dissolved oxygen concentrations were higher at all Bush Gully sites than in Tara Stream in November 2020.

Table 1: Summary of spot water quality measurements on 30 November 2020. Sites are ordered from upstream to downstream. pH data provided by Bathurst due to malfunction of NIWA probe during survey. - denotes missing data.

Stream	Site	pH	Conductivity ($\mu\text{S}/\text{cm}$)	Dissolved oxygen (mg/l)	Dissolved oxygen (%)	Temperature ($^{\circ}\text{C}$)
Tara Stream	CC03	-	295	4.62	41.6	-
Tara Stream	CC09	6.0	397	5.47	52.8	14.8
Bush Gully	CC24	5.9	230	9.83	91.1	11.9
Bush Gully	CC19_mainstem	5.5	177	9.65	90.5	12.1
Bush Gully	CC23	6.2	-	8.65	77.2	10.9
Bush Gully	CC26	6.2	308	7.33	69.8	11.5

Fish

A total of 167 fish from three fish species were recorded across the six sites. The counts comprised two Canterbury mudfish (*Neochanna burrowsuis*), one Canterbury galaxias (*Galaxias vulgaris*), and 164 upland bullies (*Gobiomorphus breviceps*). The greatest number of fish were captured at CC23 (Table 2). Upland bullies were the most common species captured but were only present at the Bush Gully sites. One individual Canterbury mudfish was found at the upstream site (CC03) on Tara Stream and the downstream site (CC26) on Bush Gully Stream. The Canterbury mudfish captured were 110 mm and 143 mm long, the single Canterbury galaxias was 118 mm long and the upland bullies ranged in length from 44–100 mm.

Table 2: Fish species captured at six sites during the field survey in November 2020. CPUE is catch per unit effort; three traps were set at each site.

Stream	Site	Fish abundance (CPUE)			
		Canterbury mudfish	Canterbury galaxias	Upland bully	Total
Tara Stream	CC03	0.3	0	0	0.3
Tara Stream	CC09	0	0	0	0
Bush Gully	CC24	0	0	9	9
Bush Gully	CC19_mainstem	0	0	14.3	14.3
Bush Gully	CC23	0	0	19	19
Bush Gully	CC26	0.3	0.3	12.3	12.9

3 Aquatic communities and stream health in the catchment

Previous assessments of water quality and physical habitat indicate generally poor conditions to support aquatic biota in the waterways surrounding the CCM. Macroinvertebrate communities in Tara Stream and Bush Gully Stream have been described as sparsely-populated and numerically-dominated by a few taxa including dipterans, worms and snails, which are generally tolerant of poor water quality and habitat conditions (Golder Associates 2014; Water Ways Consulting 2016a,b; Boffa Miskell 2017, 2019).

Fish communities include three non-migratory native fish species with different conservation status rankings: Canterbury mudfish - 'Threatened, Nationally-critical'; Canterbury galaxias - 'At Risk, Declining'; and upland bullies - 'Not threatened' (Dunn et al. 2018). The presence and abundance of these three species have been reported in ecological assessments completed in different seasons, at different sites, and using different methods (e.g., unbaited minnow traps, spotlighting), which limits our comparison of data and understanding of populations in the catchment (Golder Associated 2014; Waterways 2016b). A recent assessment of the fish community in Bush Gully Stream using the same sampling methods (i.e., baited minnow traps) as this survey reported a total of 197 fish captured at three main sites and three supplementary sites (located upstream of each main site), including Canterbury mudfish, Canterbury galaxias, and upland bullies in March 2019 (Boffa Miskell 2019). Fish were found at all sites; upland bullies were most abundant, and mudfish were present at all but the most upstream site in the survey (downstream of CC23). The CPUE ranged from 6–21.5 and was highest at site 2 (downstream of CC25). The total number of fish captured, dominance of upland bullies, and relative abundance of fish (i.e., CPUE) were comparable to the survey in November 2020. A greater number of Canterbury mudfish and Canterbury galaxias were found in March 2019, which may partially reflect natural or seasonal variation in fish distribution or activity. Furthermore, Canterbury mudfish had not previously been reported at Tara Stream at CC03 (Golder Associates 2014). Future surveys in the monitoring programme will provide additional data on fish communities in two seasons (spring and autumn) at the same sites over an 18-month period.

The combination of surrounding land use (mining, production forestry, pastoral farming) and several other factors, including intermittent flows, low-water yielding catchment, soft sedimentary stream beds, and

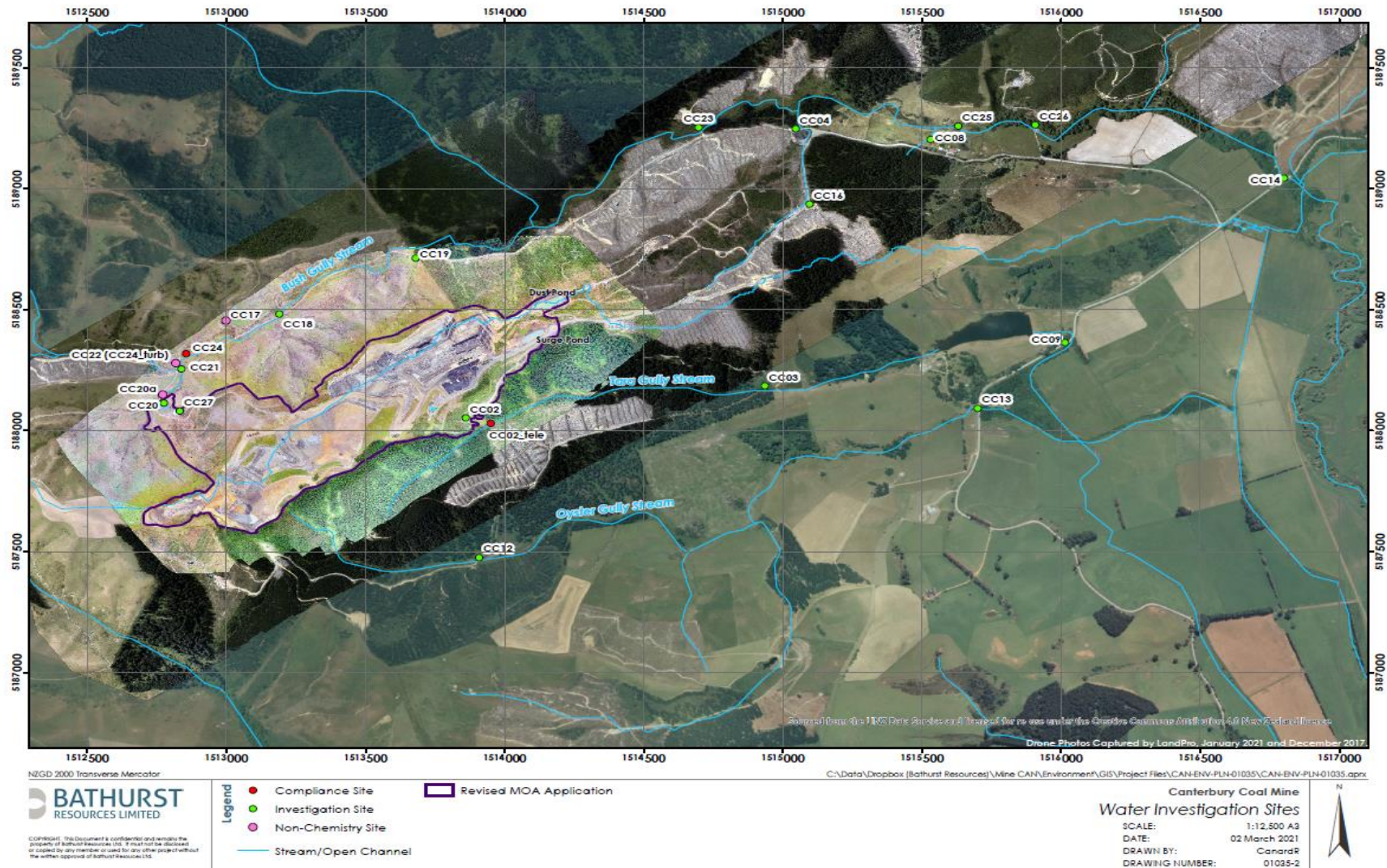
poor hydraulic connectivity are likely contributing to the species-poor and sparsely-populated aquatic communities found in streams in the catchment overtime.

Glossary of abbreviations

AMDI	Acid Mine Drainage Index
ASPM	Average Score Per Metric
CLWRP	Canterbury Land and Water Regional Plan
EPT taxa	Macroinvertebrate taxa from orders Ephemeroptera, Plecoptera, Trichoptera
NPS-FM	National Policy Statement for Freshwater Management
MCI	Macroinvertebrate Community Index
MCI-SB	Macroinvertebrate Community Index - Soft Bottom
SQMCI	Semi-quantitative Macroinvertebrate Community Index
SQMCI-SB	Semi-quantitative Macroinvertebrate Community Index - Soft Bottom

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- Water Ways Consulting Ltd. (2016b) Canterbury Coal: ELF Project Bush Gully Assessment. Report Number 34-2016-B. Report prepared for Canterbury Coal Limited.



Appendix 1: Waterways, water quality monitoring and aquatic ecology sampling sites at Canterbury Coal Mine. Macroinvertebrates were sampled at CC03 on Tara Stream and CC24, CC19_mainstem, CC23, and CC26 on Bush Gully Stream (sites listed from upstream to downstream). Fish were also sampled at CC09 on Tara Stream. Map provided by Bathurst.