

TARA STREAM ECOLOGICAL REPORT



PREPARED FOR: CANTERBURY COAL (2013) LTD

DATE: SEPTEMBER 2016

REPORT NUMBER: 34-2016-B

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1 INTRODUCTION

Canterbury Coal (2013) Ltd (Canterbury Coal) have applied to Environment Canterbury (ECan) for new resource consents for the discharge of treated mine water from the Canterbury Coal coal mine in the Wainniwaniwa Valley in Central Canterbury. Currently, the mine has discharge consents for mine and storm water to discharge to Tara Stream a tributary of the Wainiwanawa River. Canterbury Coal are seeking to update the consents and consent conditions to reflect the installation of new water treatment systems at the mine. The ecology and water quality of Tara Stream was surveyed in 2014 (Golder 2014) and this information was used in the resource consent application. ECan have made a Section 92 request for the ecological information on Tara Stream to be updated.

Tara Stream rises near the coal mine and the mine discharge is into a headwater area. This area is also forested with a radiata pine forest plantation. The stream extends downstream for approximately 1.2 km and ends at the same location as the pine forest is replaced by pastoral farmland. The wetland and downstream reaches have previously been surveyed in 2006 (Harding et al 2006) and 2014 (Golder 2014). Both surveys sampled the very downstream section of the wetland at the forest boundary. Harding & McIntosh (2006) also sampled two sites near the mine discharge point and one site downstream where Tara Stream is crossed by Malvern Hills Road. Golder (2014) also conducted sampling at Malvern Hills Road, but did not sample the upper reaches near the mine as this reach was reported as dry at the time of sampling.

This report provides the results of a recent survey of Tara Stream and compares the results to that reported in previous surveys.

2 METHOD

2.1 Introduction

A site visit was conducted to Tara Stream on the 8 September 2016. The weather in the day prior to and during the site visit featured a significant southerly storm that brought snow to low levels in central Canterbury and was accompanied by gale force winds. At the time of the site visit snow had settled around Tara Stream, snow showers were continuing although air temperatures were sufficient to cause snow melt. Therefore, it is expected that the flow in Tara Creek was elevated at the time of the assessment.

Three sites were sampled during the site visit, the wetland at the downstream end of the plantation forestry (Site 1), a site approximately 500 m upstream of this site (Site 2) and water quality measurements were taken at Malvern Hills Road (Site 3).

2.2 Habitat Assessment

A visual assessment of the stream/wetland and riparian vegetation was made at Sites 1 and 2. Water depth and channel widths were estimated where possible. Stream bed substrate was recorded and water clarity noted.

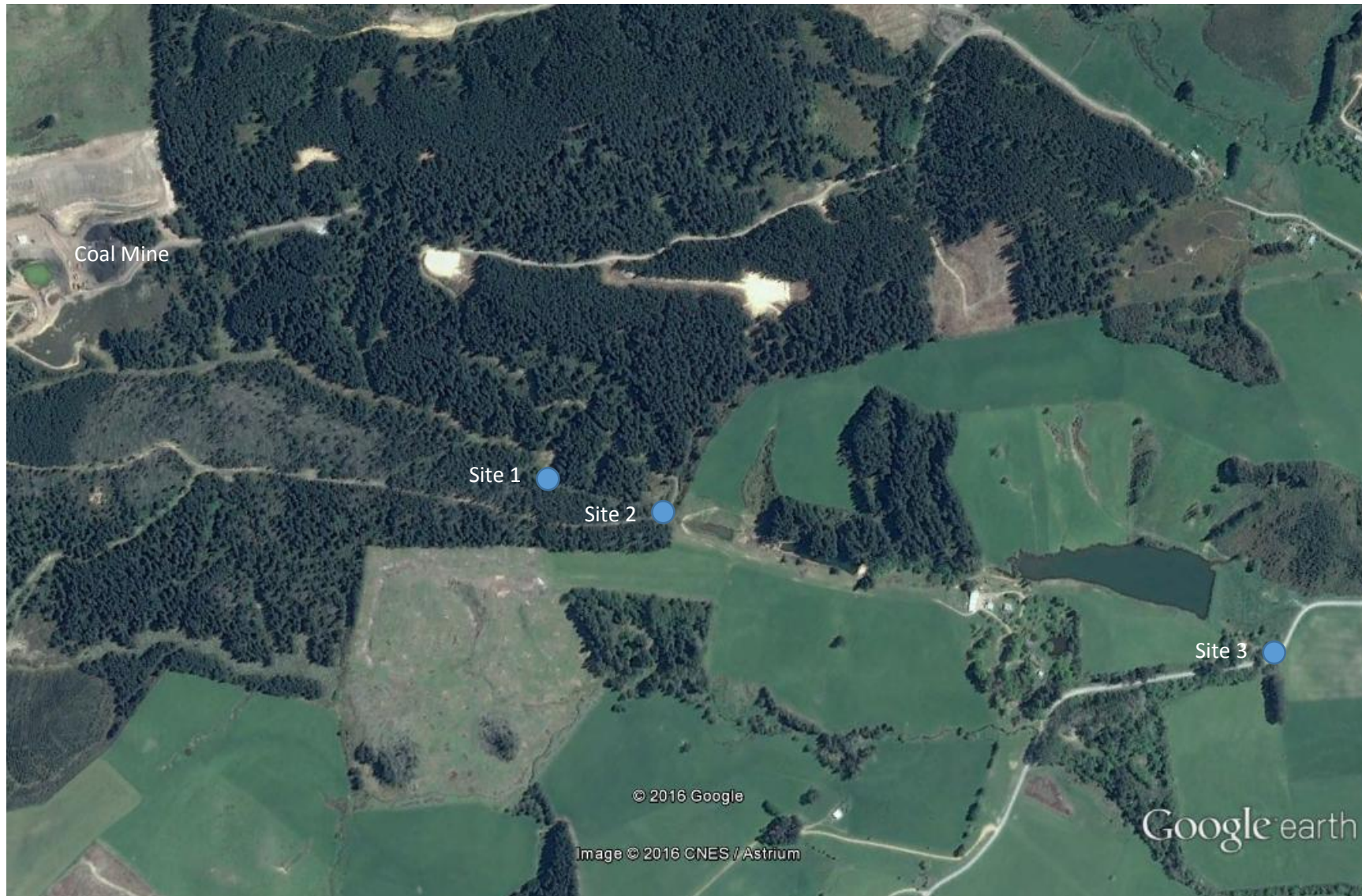


Figure 1: Site map with sample locations on Tara Stream.

2.2.1 Water Quality

A calibrated hand held water quality meter (Horiba U-10) was used to determine water temperature, dissolved oxygen (DO), conductivity ($\mu\text{S}/\text{cm}$) and pH. At Sites 1 and 2 three measurements were made of each parameter with samples taken in an upstream direction to avoid sampling disturbed water. At Site 3 the parameters were measured twice, once from each bank.

2.3 Macroinvertebrates

Kick net samples of approximately 1 m^2 were taken at Sites 1 and 2. Samples were preserved in 70% ethanol prior to sorting and enumeration. A full count of invertebrates in the samples was undertaken and identifications were made using the keys of Winterbourn & Griegson (1989) and NIWA (website). The macroinvertebrate data was used to generate the following indices:

- Taxa richness, the number of macroinvertebrate taxa in the sample;
- Taxa abundance, the total number of macroinvertebrates in the sample;
- EPT taxa, the number of Ephemeroptera, Plecoptera and Trichoptera taxa in the sample;
- %EPT, the percentage of EPT individuals in the total abundance of macroinvertebrates;
- Macroinvertebrate Community Index (MCI), and
- Quantitative Macroinvertebrate Community Index (QMCI),

3 RESULTS

3.1 Habitat Assessment

3.1.1 General notes

The weather on the day of the site visit included snow showers and strong winds. The snow had settled along the water course and accumulated to a depth of 0.15 m in some places. To locate the stream amongst the snow and riparian vegetation the survey areas were walked over several times. Snow covering the wetted channels would sink allowing the channels to be seen and their size and shape estimated. While snow was still falling during the site visit it was obvious that it was melting and the stream flow was elevated due to this snow melt. Therefore, estimates of water depth and channel widths reflect what could be considered a moderate to high flow event.

3.1.2 Site 1

The water course at Site 1 was between 0.2 m and 1.0 m wide. The channel banks were low in areas where the channel was wide, and high (up to 0.5 m) where the channel was narrow. Water depth was restricted to 0.1 m or less. The narrow channel sections were generally fully covered by vegetation and could not be easily seen whereas some of the wider channels were visible. The active channel appeared to meander along the site and multiple channels were present in some areas. Stream flow was obvious throughout the site. The water was generally clear, although a true left bank tributary was turbid with suspended sediment in runoff from forestry roading (Figure 2). The stream bed appeared to be free of periphyton and the majority of the bed was covered with leaf debris from *Carex* plants and pine needles. Riparian vegetation was dominated by *Carex*, blackberry and gorse with occasional pine trees (Figure 3). The stream bed in all areas was composed of fine sediments often of a depth greater than 0.4 m.



Figure 2: Tara Stream at Site 1 with overhanging Carex and turbid inflow from a true left bank tributary.



Figure 3: Tara Stream, downstream view at Site 1 showing riparian zone dominated by gorse and Carex.

3.1.3 Site 2

Site 2 is immediately upstream of a forestry access road and the stream flows through a culvert under the road. The road embankment and culvert have led to the stream infilling the upstream

area with sediment creating a wide wetland area for approximately 20 m upstream of the culvert. Within this area there were a series of shallow channels that flowed among the large *Carex* tussocks. Channels were generally shallow (>0.1 m deep) and width varied between 0.2 m and 1.5 m (Figure 4). The widest channel occurred in the upper part of this site where the stream entered the wetland area. The water was clear, but did not appear to be flowing in all areas. When the submerged vegetation and water was disturbed it rapidly became turbid with the suspension of orange coloured fine sediment. This orange colour material did not appear to be an iron floc (Figure 5) and settled quickly after being suspended.

A green filamentous algae dominated the stream bed in open areas covering all the stream bed. Riparian vegetation consisting of a range of grasses, large *Carex* tussocks and blackberry shaded narrower sections of the water courses, although algal was still present under this vegetation. In the upper part of the site radiata pines have been planted to with a metre of the water course.



Figure 4: A wide stream channel at Site 2, Tara Stream

3.1.4 Site 3

Site 3 is located at the Malvern Hills road crossing and at this site the stream has a well formed channel. The riparian zone had short pasture grass and some bare ground with large exotic trees providing overhead shade. The stream flow during the survey was turbid and the bed of the stream was not visible.



Figure 5: Orange stained water in a stream channel at Site 2, Tara Stream.

3.2 Water quality

Water quality measurements found the DO levels were high ranging from 10.5 mg/L to 13.04 mg/L (Table 1). Conductivity was also high at Sites 1 and 2, but had declined markedly at Site 3. pH was acidic with the highest acidity at Site 1 (mean pH 3.46) and lowest at site 2 (mean pH 5.6).

Table 1: Mean (and SE) pH, dissolved oxygen (DO) and conductivity at three sites in Tara Stream.

Site	pH	DO (mg/L)	Conductivity ($\mu\text{S}/\text{cm}$)
1	3.46 \pm 0.1	10.5 \pm 0.4	853 \pm 0.059
2	5.6 \pm 0.3	10.8 \pm 0.2	830 \pm 2.33
3	4.75 \pm 0	13.04 \pm 0.12	235 \pm 0.0

3.3 Macroinvertebrates

The macroinvertebrate communities collected at Sites 1 and 2 were sparse with few individuals and few taxa present (Table 2). It was noticeable that the Tanypodinae larvae collected at Site 1 were all very small individuals, whereas the Tanypodinae at Site 2 included a much greater size range of individuals as well a greater number of individuals. The presence of what have been identified as terrestrial slugs also indicated that the water level at these sites was elevated and had submerged previous dry areas of the channel, especially at Site 1.

The MCI and QMCI scores indicate relatively good water and or habitat quality. However, these index scores have been derived from very sparse macroinvertebrate communities and this limits the usefulness of the index scores.

Table 2: Macroinvertebrate data and indices scores for two sites in Tara Stream.

Taxa	Site 1	Site 2
<i>Polyplectropus</i>		4
Scritidae	6	41
Muscidae		2
<i>Nothodixa</i>	1	2
Tanyodinae	28	190
<i>Austrolestes colenonis</i>		5
Oligochaetes	2	
Nematoda		1
Terrestrial slug (?)	6	1
Number of taxa	5	8
Abundance	43	246
Number of EPT taxa	0	1
Percentage Abundance of EPT taxa	0	1.6
MCI- hard bottom stream	90	105
MCI- soft bottom stream	126.5	102
QMCI hard bottom stream	4.5	5.5
QMCI soft bottom stream	5.5	6.4

4 DISCUSSION

The habitat observations at Site 1 indicate the channel is a natural incised channel that meanders across the valley floor. However, at Site 2 some modification has occurred as a result of sediment accumulating upstream of the road embankment creating a wetland area. The riparian vegetation at both sites consists of a mix of native and introduced vegetation. Given this was a winter time survey the riparian cover provided by blackberry was limited due to the winter die back. It can be expected that by late summer areas such as Site 1 will be very well shaded and hard to access due to blackberry growth.

The macroinvertebrate data indicates that Site 1 provides very limited habitat and if affected by poor water quality and or habitat quality. The abundance and diversity of aquatic fauna was very low. While much of the channel was shaded periphyton was also absent from the open areas. This absence of periphyton indicates that limitations on growth are present when compared with Site 2. It was also notable that the Tanyodinae larvae were of a very small size and the abundance of terrestrial slugs indicates that Site 1 may dry during low periods and the community sampled represents organisms that have recolonised the area since flow has been restored. The alternative is that the acidic nature of the stream at Site 1 prevents periphyton growth and limits the growth of the Tanyodinae present. The Scritidae present, aside from being rarer than at Site 2, displayed no indication of a size limitation but were relatively rare.

The macroinvertebrate community at Site 2 does indicate year round water is present, although it is expected to be more limited during summer than during this sampling. The presence of periphyton and *Polyplectropus* and *Austrolestes*, along with relatively abundant Tanyodinae support the presence of year round water. Golder (2014) has sampled Site 2 during November 2013 and noted the area retained water but little flow was present. The macroinvertebrate community Golder

(2014) collected included similar taxa to this sampling – *Polypsectropus* and Tanypodinae. Ostracods that were common in November 2013 were not recorded in this sampling and that may be due to the ostracods either being rare after winter or surviving the winter period in a dormant state (e.g. eggs). The combined sampling does indicate an aquatic fauna persists through a range of flow and pH conditions, both of which could be limiting the fauna.

Golder (2014) from sampling in November 2013 and Harding & McIntosh (2006) from sampling in July 2006 provide additional data on water quality parameters in Tara Stream. These data combined with the data collected in this study indicate considerable variation in DO, conductivity and pH can occur in the stream (Table 3). While pH is a concern and due to mine discharges the very low DO recorded by Golder (2014) indicate that the water quality in the stream creates additional limitation of fauna residing in the stream.

Table 3: pH, dissolved oxygen and conductivity measurements in Tara Stream from this study, Golder 2014 and Harding & McIntosh 2006.

Site	pH	DO	Conductivity (µS/cm)	Water Temperature °C
1, this study	3.46 ± 0.1	10.5 ± 0.4 (mg/L)	853 ± 0.059	3.3
Harding et al (2006), at mine discharge area	5.1	66 % saturated	569	2.8
2, this study	5.6 ± 0.3	10.8 ± 0.2	830 ± 2.33	3
2, Harding et al (2006)	7.1	89 % saturated	485	2.8
2, Golder (2014)	5.8	28.5 % saturated 2.9 mg/L	538	12.2
3 this study	4.75 ± 0	13.04 ± 0.12 mg/L	235 ± 0.0	4
3, Harding & McIntosh (2006)	6.8	72 % saturated	467	2.3
3, Golder (2014)	6.5	11 % saturated 1.1 mg/L	353	12.7

These data indicate that at times pH throughout the majority of Tara Stream can be circum-neutral and within the known tolerance range of fish such as Canterbury mudfish (O'Brien & Dunn 2007). However, DO ranges from very high levels to very low and at the lowest level as recorded by Golder (2014) most fish and many invertebrates this would be below their tolerance level. Harding & McIntosh (2006) do not comment on flow conditions in Tara Stream, but Golder (2014) note the stream was more isolated pools at Site 2 and had little flow at Site 3. This is a significant contrast to the conditions in this study where the stream was fully connected and flowing and at Site 3 the flow was considered to be a fresh event. The water temperatures at the time of the studies also differ and this will influence DO levels with DO levels expected to be lower as the water temperature increases and as flow decreases reducing re-aeration. It is highly likely that flow and source of flow are the other factors influencing the water quality. Large volumes of runoff from the mine site may bring acidic water downstream. However, this can be diluted by runoff from other parts of the catchment as it progresses downstream. It was noted in this study that turbid water was entering the Tara Stream at Site 1 and this was runoff from the forestry area. This is expected to be providing some dilution and a reducing stream acidity. It is unclear at this stage why Site 3 was so acidic during this study, but it may be a pulse of acidic water passing downstream with less dilution than

was occurring upstream at the time of sampling or that the farm ponds are in some way influencing water quality.

5 MONITORING SITE OPTIONS

Access to Tara Stream within the forestry area is restricted by the large amount of windfall trees and pruning's lying on the forest floor. The undergrowth is also comprised of relatively thick groves of blackberry. This makes access to the stream difficult. Similarly, the riparian zone in the forestry area is heavily vegetated with blackberry and gorse. In summer time it is expected that access through either the forest or along the stream to Site 1 or will be difficult. Sampling of the stream at Site 1 or other areas away from road access area will need to access tracks cut and blackberry cleared from the sampling points to access the stream. Some vegetation management is also likely to be needed at Site 2, but the proximity to the forestry access road will limit the amount of work to access the stream. Unless it is considered critical for monitoring it is recommended that sampling at Site 1 is avoided and monitoring should be conducted at Site 2. This would also have the benefit of monitoring a reach of Tara Stream that appears to retain water and an aquatic community throughout the year whereas it is possible that Site 1 and areas upstream are at times dry.

6 SUMMARY

Surveys of the habitat of Tara Stream found the stream generally has a natural channel at the sites surveyed. The wetland area at Site 2 has been formed by sediment infilling the area upstream of forestry road embankment.

Riparian vegetation is dominated by mix of *Carex*, blackberry and gorse. It is expected that access to the stream will be limited by blackberry growth in the summer.

Water quality sampling Tara Stream in September 2016 found the stream to be acidic with pH ranging from 3.4 to 5.6. Conductivity was high ranging between 853 $\mu\text{S}/\text{cm}$ and 235 $\mu\text{S}/\text{cm}$ and declined in a downstream direction. Dissolved oxygen was also high ranging between 10.5 mg/L and 13.04 mg/L, increasing in a downstream direction. Previous surveys indicate that water quality varies more than observed in this survey alone. The acidic pH is expected to be a limiting factor for aquatic fauna. However, low flow conditions are also expected to degrade water quality (and quantity) and be a second limiting factor on the aquatic fauna and flora. These low flow limitations are expected to be more severe in summer when water temperatures are elevated leading to additional decreases in DO.

The aquatic fauna of the stream is depauperate both in terms of taxa richness and general abundance. This is expected to be the result of the combined effects of acid mine discharges and the low flow conditions.

7 REFERENCES

Golder Associates Ltd (2014). Aquatic baseline assessment of ecological values of streams in the Wainiwaniwa Valley. Client report 1378110242-006-R-Rev1 prepared for Canterbury Coal (2013) Ltd.

Gray, D.P & Harding, J. (2012). Acid Mine Drainage Index (AMD I): a benthic invertebrate biotic index for assessing coal mining impacts in New Zealand streams. *New Zealand Journal of marine and Freshwater Research* 46(3):335-352.

Harding, J.S., & McIntosh, A.R. (2006) The occurrence of Canterbury mudfish in Selwyn Plantation Board Ltd estate in the Wainiwaniwa Valley. Freshwater Ecology Research Group Research Report.

O'Brien, L., & Dunn, N. (2007). Mudfish (*Neochanna* Galaxiidae) literature review. Science for Conservation 277. Department of Conservation, Wellington.