# Bendigo-Ophir Gold Project Freshwater Ecological Assessment

## Santana Minerals Ltd
## Matakanui Gold Ltd

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**Matakanui Gold**
**Freshwater Ecological Assessment**

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Cover photo (credit e3s): Site visit image from Thompsons Saddle looking north-west.

# Executive Summary

Matakanui Gold Limited (MGL) is progressing with gold exploration in the Dunstan Mountains of Otago, between the townships of Bendigo and Matakanui. Mining feasibility studies are currently underway and no definite mining plans are currently in place. Potential future gold mining operations could include open cut and/or underground mining operations. e3Scientific Limited (e3s) has been asked to complete a baseline freshwater ecological and water quality assessment of the three primary creeks and tributaries within catchments which could be affected by potential mining operations.

An initial site visit was completed on 4 July 2022, and a subsequent freshwater ecological assessment was completed on 9 November 2022. This included electric fishing, macroinvertebrate sampling, macrophyte assessment and a discrete water sampling event across Rise & Shine, Bendigo and Shepherds Creeks. The field measurements and laboratory results indicate mixed water quality across the area. Results from Rise & Shine Creek indicated elevated arsenic concentrations which was not apparent in other creeks. While this study does not assess local geology, the increased arsenic concentrations may be due to historic gold mining activities or enhanced arsenic export due to local geology. Shepherd's Creek samples exhibited elevated nitrate and TKN observations, which could be due to livestock access to the streams, animal waste observed in the area or enhanced rock weathering within catchments. Outside of these exceptions, site stream water samples were below Otago receiving water thresholds, discharge thresholds, and New Zealand drinking water standards for the analytes measured.

Freshwater ecological values of the area are associated with the overall stream habitat and the macroinvertebrates present. No freshwater fish values were identified within Shepherds nor Rise and Shine Creeks despite both electric fishing and eDNA methods being utilised. In lower Bendigo Creek, kōaro, galaxiid (spp.) and brown trout markers were identified in eDNA sampling at the furthest downstream site (eDNA-1), indicating fish are present within the wider Bendigo catchment, but not within the Rise and Shine sub-catchment. A NZFFD record of brown trout in an upper Rise and Shine tributary was not corroborated by this assessment and may indicate the recorded individuals are no longer present at

this location. Macroinvertebrate samples varied in community health and diversity, with water quality classifications ranging from 'Good' to 'Poor' within each stream and from a 'B' to 'D' NPS-FW attribute band. This suggests a wide range of water quality and habitat conditions based on localised influences such as flow, stock access and substrate. Macrophyte species observed across all sites were common, with the invasive *Lagarosiphon major* found present throughout the lower reaches of both Shepherds and Bendigo Creek catchments.

Connectivity between Shepherd Creek and the Lindis River was not evident during the site visit or freshwater ecological assessment; however, it appears that connectivity may occur during periods of high flows. A hydrological assessment would be required to provide further assessment of the frequency and likelihood of downstream connectivity.

Based on the site visit and subsequent freshwater ecological assessment, Bendigo, Shepherds and Rise & Shine Creeks appear to be dynamic surface water features, which are likely to fluctuate in flow due to their steep catchments and locality. No Threatened nor At-Risk freshwater species (such as native fish) were identified during this assessment and macroinvertebrate communities exhibited degradation in areas but were otherwise considered fair. Despite these findings, these streams are considered ecologically integral freshwater resources within this semi-arid to arid landscape and support the ecology of the area, including both terrestrial and in-water flora and fauna.

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# 1 Introduction

## 1.1 Overview

Matakanui Gold Limited (MGL), 100% owned NZ subsidiary of Santana Minerals Limited (SML), is progressing with gold exploration in the Dunstan Mountains of Otago, between the townships of Bendigo and Matakanui. The exploration 'site' discussed within this report is an area within the exploration and prospecting permits (MEP60311 & MPPA60882) held by MGL located on the north side of the Dunstan Mountain Range above the Bendigo Terrace (Figure 1).

Mining feasibility studies are currently underway and as such no definite mining plans are in place. Any potential future gold mining operations could include open cut and/or underground mining, and the location and type of any associated processing facilities has not been determined to date. Two 'Phases' of mining may eventuate.

Initially, Phase 1 mining activities could likely focus specifically on the 'Rise & Shine (RAS)' prospect site (Figure 2). This site straddles the divide between Shepherds and Rise & Shine Creeks (in the Bendigo Creek catchment) and could include hillslope, ridge, and valley bottom landscape elements. Phase 1 operations would also likely include other mining infrastructure sites, which have not yet been determined and as such is not identified in Figure 2.

The Phase 2 portfolio includes five other prospects with potential mining sites currently under consideration by MGL. These additional sites have not been considered within this ecological assessment. In total, Phases 1 & 2 include six discrete sites on the north side of Dunstan Range ridge line. These sites can be seen in Figure 2 and include 'Come-in-Time', 'Alta Lode,' 'Shreks,' 'Shreks E,' and 'Thompsons Saddle.'

Within the Phase 1 potential mining operations footprint lie three primary creeks and tributaries, including Shepherds Creek, Bendigo Creek and Rise & Shine Creek (Rise & Shine Creek is an upper tributary of Bendigo Creek). Given this, MGL commissioned e3Scientific Ltd (e3s) to complete a baseline freshwater ecological and brief water quality assessment to characterise the existing ecological values within and surrounding Phase 1 (Rise & Shine) areas that could potentially be

affected by Phase 1 mining operations. e3s provided a draft sampling proposal to SML based on an initial site visit on 4 July 2022 (e3s, 2022). SML reviewed and provided input into the final sampling design to represent the Phase 1 sampling programme. The Phase 1 sampling programme is focused on providing an ecological characterisation specific to the potential Rise & Shine mining area and is not representative of all possible mining (Phase 2) sites.

The scope of this baseline ecological assessment includes the characterisation of the existing freshwater environment within the potential Phase 1 (Rise & Shine) footprint and the contribution to the development of an overall environmental baseline assessment including monthly water quality assessments. This report should not be considered a hydrological report.

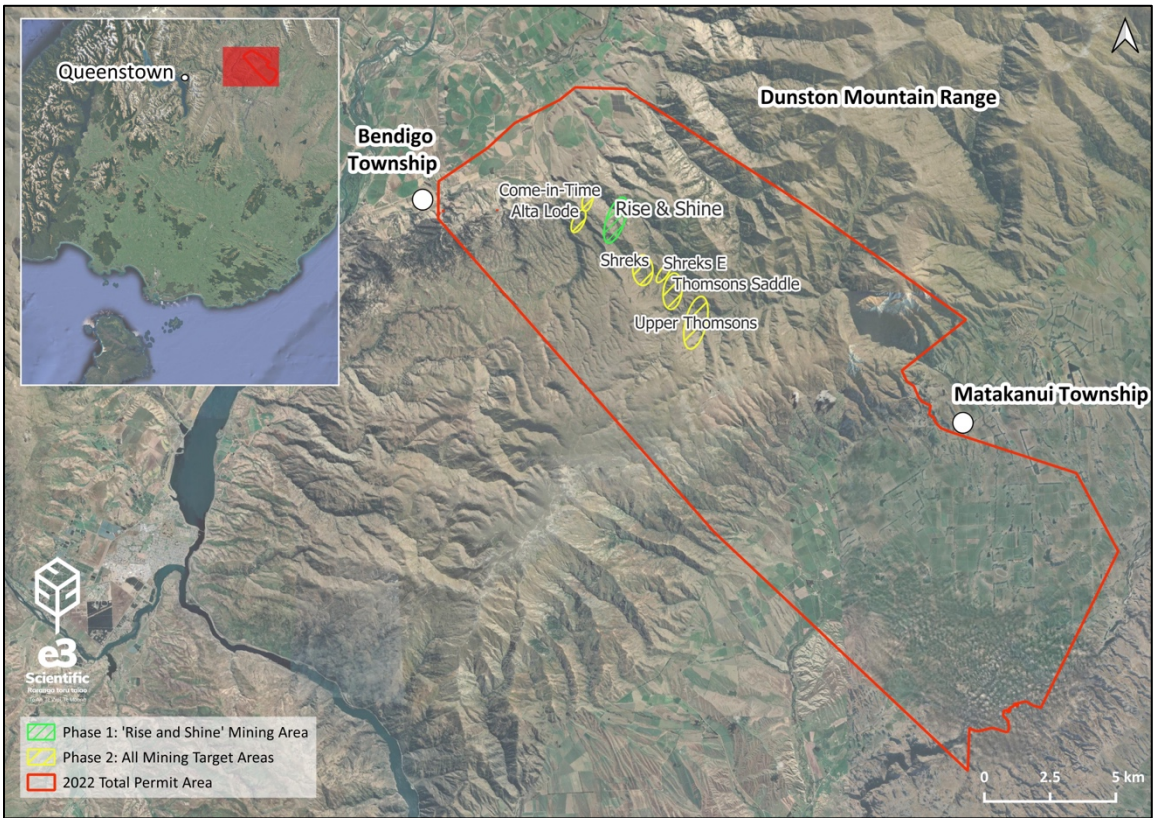


**Figure 1: Matakanui Gold site exploration location with potential mining site(s) and overall permit areas.**

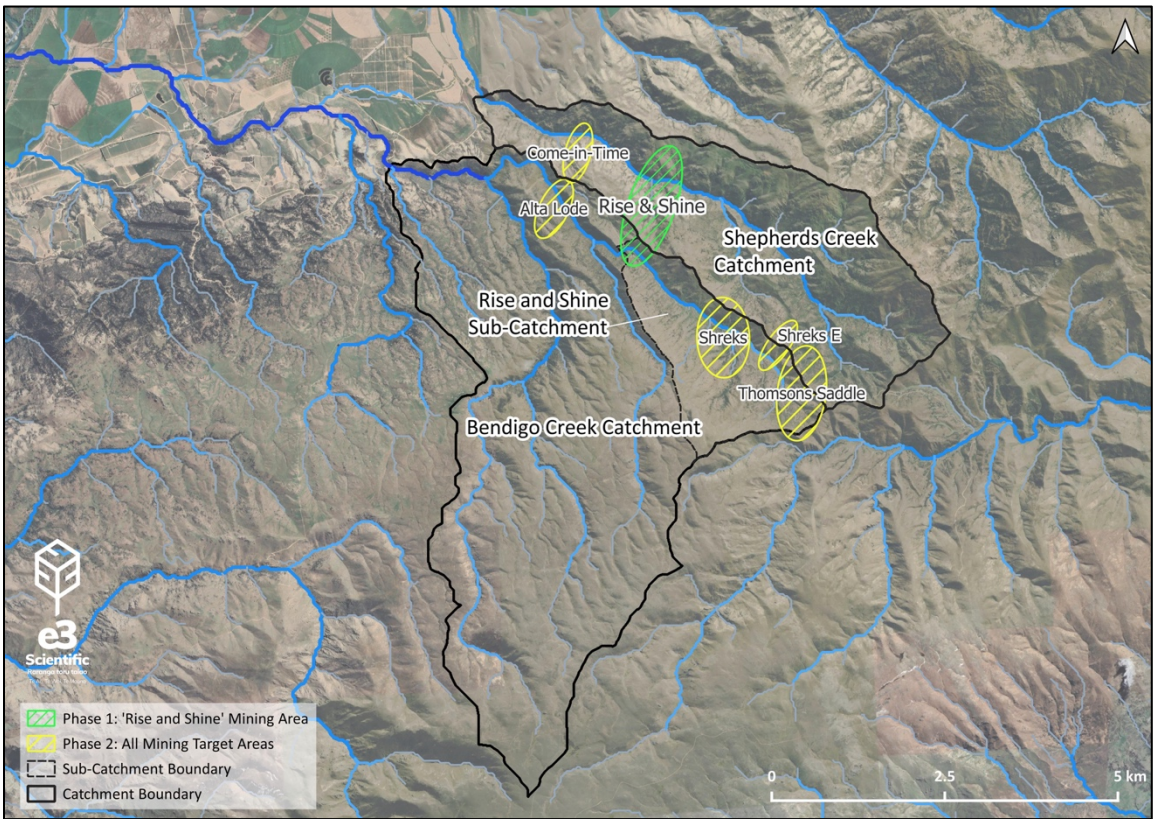


**Figure 2: Phase 1 & 2 potential mining sites within Bendigo, Shepherds Creek and Rise & Shine Catchments.** ***Note that the exploration areas straddle three main catchments and sub-catchments.**

## 1.2 Report Structure

The report is structured as follows:

- Section 2: Description of the environmental context.
- Section 3: The methodology employed during the ecological and water quality assessments.
- Section 4: Results of the sampling and a description of the flora and faunal values present within the study areas.
- Section 5: Assessment of the significance of the ecological values within the study areas and summary of the findings.

## 1.3 Limitations

e3s performed the services in a manner consistent with the normal level of care and expertise exercised by members of the environmental science profession. No warranties, express or implied, are made. The confidence in the findings is limited by the Scope of Work, and limited data due to the site visit being at one time of year. A full range of biota that are present at this site may not have been seen or recorded, however, desktop research was utilised to aid the assessment.

The results of this assessment are based upon site inspections conducted by e3s personnel, and information provided in scientific literature. All conclusions and recommendations regarding the properties are the professional opinions of e3s personnel involved with the project, subject to the qualifications made above. While normal assessments of data reliability have been made, e3s assumes no responsibility or liability for errors in any data obtained from regulatory agencies, statements from sources outside e3s, or developments resulting from situations outside the scope of this project.

# 2 Environmental Setting

The MGL advanced exploration 'sites' are in an area within the larger MGL Exploration permit (MEP60311), located in the Dunstan Mountain Range east of Lake Dunstan above the Bendigo Terrace (see Figure 1). Major drainages in the area include (from SW to NE): Bendigo Creek, Rise & Shine, and Shepherds Creek (Figure 2). These catchments drain into the fluvio-glacial sediments and groundwater aquifers of the Cromwell-Tarras valley. These groundwater aquifers in turn flow toward the Lindis and Clutha Rivers. Surface water flow is intermittent across the valley. Surface flow connectivity to the Lindis and Clutha Rivers and subsequently Lake Dunstan approximately 5 kilometres to the north-west likely occurs only during large events.

There are up to six areas of potential interest for exploration on the north-west side of the ridgeline which are considered the operational area (within Shepherds and Bendigo Creek catchments). Primary interests and detailed investigations within this area include the Phase 1 area focussed on the 'Rise & Shine' exploration site (Figure 2).

## 2.1 Physical Environment

### 2.1.1 Climate

Climate data is available for nearby population centres (Cromwell, Wanaka, Tarras) with average rainfall annual in the area between 400 and 550 mm that increases with elevation (Macara, 2015). Late summer rainfall can be as low as 60 mm (January to March). Median summer air temperatures for the area are 16–17 °C and winter median temperatures are 5-6 °C, cooling with increasing elevation (Macara, 2015).

As a proxy for rainfall and historical river levels in the area, the Otago Regional Council (ORC) measures flow in cumecs at the Lindis River at Ardgour Road, approximately 5.7 km away (Figure 3). At the day of site visit (9 November 2022) the flow was approximately 7 cumecs, and the median flow for this site is 3.5 cumecs (ORC, 20220).

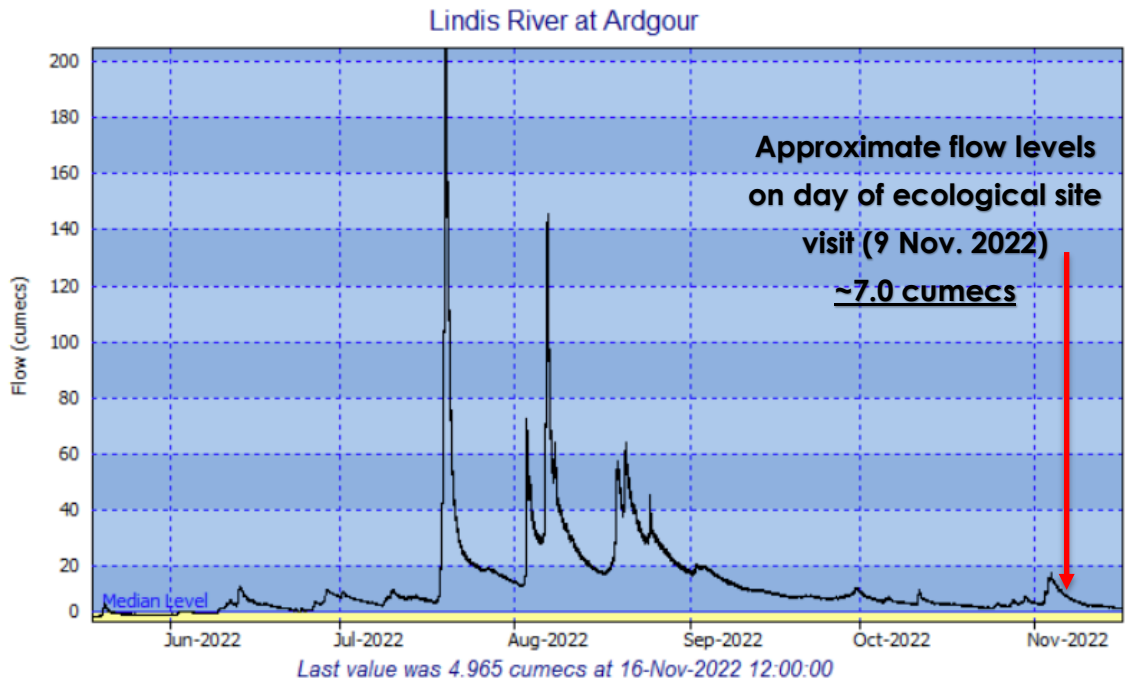


**Figure 3: Lindis River at Ardgour Road: historical river levels (www.orc.govt.nz/managing-our-environment/water/water-monitoring-and-alerts/upper-clutha/lindis-at-ardgour).**

### 2.1.2 Geology and Soils

The area geology has been mapped and is included on GNS Science's QMAP 1:250,000 scale geological maps (GNS Science, 2021). MGL has investigated the local geology in detail so only a brief overview relevant for water quality and site selection has been included here.

From NW to SE, the site catchments transition from the downslope Bendigo Terrace across the Lindis Formation consisting of quaternary boulders gravel sand silt clay with till consisting of moderately weathered, poorly sorted, bouldery sandy gravel with silt lenses within the Cromwell-Tarras valley. The Dunstan Mountain Range rises to the SE and is underlain by Torlesse TZ3 and TZ4 schist (psammite pelite greenschist with metachert and metaconglomerate marble) with interspersed alluvial fans in the stream valleys that consist of loose, commonly angular, boulders, gravel, sand, and silt forming alluvial fans that grade into scree (upslope) & valley alluvium longitudinally downstream. There is a shear fault running NW to SE through the areas of interest. The entire area is mapped as Pallic soils according to the Landcare Research national soils dataset (S-Map).

### 2.1.3 Landscape Hydrology of the Area

The site is located on the northeast side of Lake Dunstan in the Dunstan Mountains with catchments open to the northwest onto the intervening fluvio-glacial sediments of the Cromwell-Tarras valley. Flow rates for the tributaries are not known; however, the creeks are likely to fluctuate strongly and exhibit a wide range of seasonal and spatial variability in baseflow and stormflow and response to rain events. The landscape is strongly water limited with excess energy available for evapotranspiration leading to a semi-arid to arid landscape (Figure 5), likely modest rates of groundwater recharge, and low streamflow per unit area (yield) (e3s, 2022).

NZ River Maps provides flow estimates for watercourses across New Zealand. The flow in the streams as they exit the mountains after passing through the MGL exploration permit and areas of potential mining interest are estimated to range from 48–129 l/s (median) and 99–236 l/s (mean), with mean of minimum 7 day flow (MALF) of 19–65 l/s despite catchment areas of ~11.5–15.5 $km^2$ (https://shiny.niwa.co.nz/nzrivermaps/, accessed 12/08/2022). Based on mapped streams and local observations, mapped streams can be perennial or intermittent in the area and can go to ground seasonally or consistently across reaches as a function of valley alluvium depths, local groundwater, and upstream flow. If/when streams do persist and flow onto the Bendigo Terrace, it is expected that they will experience transmission losses and go to ground, recharging local groundwater given the depth to terrace groundwater and coarse subsurface materials. Surface water flow is typically only intermittent across the valley with surface flows potentially reaching the Lindis and Clutha Rivers and Lake Dunstan approximately 5 kilometres to the north-west only during large events. These mountain streams are also irrigation water sources for local agriculture. For example, Shepherds Creek streamflow was 100% captured by an irrigation water take as it exited the constrained mountain valley at the edge of the Bendigo Terrace (observed on 4 July 2022) (Figure 4). For perspective, creek width just above the Shepherds Creek weir was 70 cm, with a depth of 22 cm and a wetted width of over 3 m. The irrigation take on Shepherds Creek is RM17.301.15 and the irrigation takes on Bendigo Creek are RM20.079.01 and RM20.079.02 (e3s, 2022).

**Figure 4: Lower Shepherds Creek irrigation weir at 100% capture.**

Given this hydro-climatic and geologic/geomorphic landscape setting, streams in the area of interest are expected to be strongly seasonal and responsive to precipitation while also experiencing prolonged low flow and no flow periods. The catchment area necessary to sustain perennial and prolonged streamflow in intermittent streams is not expected to be consistent across the area and likely varies as a function of hydrogeologic water support, elevation, aspect distributions, and valley alluvium depths (e3s, 2022).

**Figure 5: Come-in-Time prospect site on left of photo and Shepherds Creek Valley looking northwest with the Bendigo Terrace in the distance (4 July 2022).**

# 3 Methodology

The baseline ecological assessment for the proposed MGL Phase 1 area is based on a desktop study, an initial site visit on 4 July 2022, and ecological sampling events completed on 9 November 2022 and 19 December 2022. While the ecological study conducted within this report is considered a 'baseline' assessment, site selection and overall study structure was aimed at long-term monitoring for reference conditions before, during, and after mining. The chosen monitoring stations are incorporated into potential mining areas that will allow for documentation and assessment of any changes in streamflow, freshwater ecology, groundwater, and water quality before, during, and after mining. It is critical that locations are monitored prior to mining activities and that two modes of comparison can be used to detect mining related changes (e3s, 2022).

All sample locations were designed to enable assessments of both hydrological and ecological components of the current environment and are considered a first step in overall environmental monitoring. Selected baseline monitoring sites focus on two major watercourses that could be impacted by mining activities in the exploration area; Bendigo and Shepherds Creeks. Appropriate monitoring stations were identified and discussed within the e3s memo (dated 29 August 2022). Site selection was primarily driven by the identification of catchments and sub-catchments relative to proposed Phase 1 mining sites. Within this preliminary site selection, actual monitoring sites were identified *in situ* based on localised creek characteristics such as flow/water quality, accessibility, and ecological representativeness of the area. This assessment represents a reduced monitoring effort to that which was initially proposed by e3s and should be considered a Phase 1 baseline assessment.

Environmental (hydrological and ecological) monitoring sites can be seen in relation to catchments and proposed Phase 1 mining sites in Figure 6, with detailed metadata listed in Table 1.

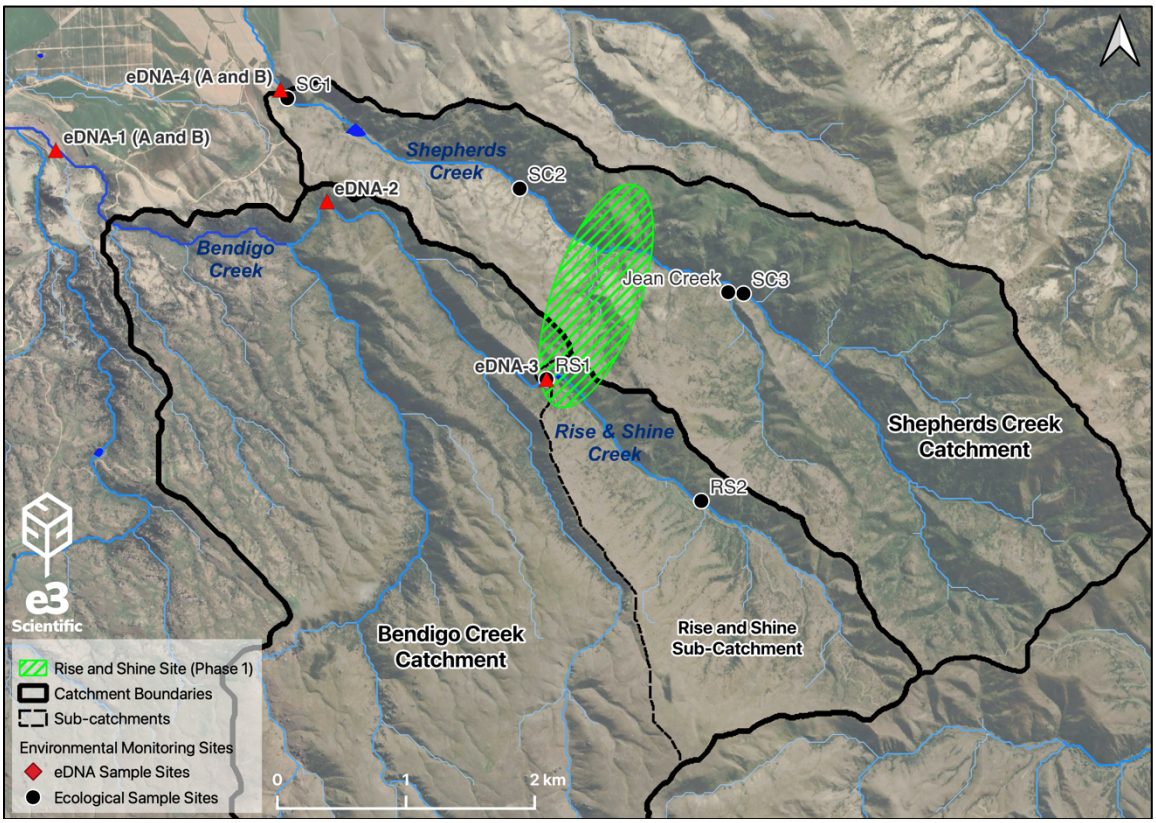


**Figure 6: Environmental monitoring sites in relation to potential Rise & Shine (Phase 1) mining sites, creeks and catchments.**

**Table 1: Environmental monitoring sites.** * Samples collected by Matakanui Gold.

| Drainage | Monitoring Location | Site Name | X, Y Location (NZTM 2000) | Elevation (m asl) | Catchment Area (km²) |
|---|---|---|---|---|---|
| Bendigo Creek | Rise & Shine Creek below Rise & Shine Site | RS1 | 1317713, 5016973 | 711.0 | 4.33 |
| | Rise & Shine Creek above Rise & Shine Site | RS2 | 1318918, 5016027 | 717.4 | 2.97 |
| | eDNA | eDNA-1 (A and B*) | 1313896, 5018752 | 285.9 | 28.0 |
| | eDNA | eDNA-2* | 1316004, 5018353 | 499.0 | 9.26 |
| | eDNA | eDNA-3* | 1316453, 5018157 | 702.9 | 4.33 |
| Shepherds Creek | Shepherds at Bendigo Terrace | SC1 | 1315697, 5019155 | 388.2 | 12.18 |
| | Shepherds below Rise & Shine Site | SC2 | 1317505, 5018453 | 439.9 | 10.11 |
| | Shepherds above Rise & Shine Site | SC3 | 1319246, 5017638 | 548.1 | 7.92 |
| | Jean Creek | Jean | 1319127, 5017648 | 585.6 | 1.39 |
| | eDNA | eDNA-4 (A and B*) | 1315645, 5019221 | 382.6 | 12.18 |

## 3.1 Desktop Research and Site Surveys

### 3.1.1 Ecological Assessment

The desktop assessment included:

- Review of existing ecological information to determine freshwater ecological habitats and species likely present on the site.
- Establish the presence and significance of the freshwater habitat and species through a site visit and review of the NZ Freshwater Fish Database (NZFFD), Ministry for Primary Industries spawning habitats database, and the Department of Conservation's threat classification for New Zealand freshwater fish (Dunn *et al.,* 2018).

The site visit was carried out on 9 November 2022 and included:

- A survey of the freshwater environments at specific sites including riparian and in-water freshwater flora and fauna visual assessments, and instream characteristics (water depth, channel width, substrate type, etc.)
- Electric fishing over 50 m stretches along sample sites to assess fish species present in the area. Macroinvertebrates were also collected during this operation.
- Macroinvertebrate sampling at 2 locations within Bendigo Creek and 4 locations within Shepherds Creek.
- Passive environmental DNA (eDNA) sampling at the base of both Bendigo and Shepherds Creeks.
- A fish passage assessment of Bendigo and Shepherds Creeks from their confluence with the Clutha and Lindis Rivers, respectively.

### 3.1.2 Water Quality Assessments

The water quality assessment included:

- Review of the Otago Regional Water Plan Schedule 15: Schedule of characteristics and numerical limits and targets for good quality water in Otago lakes and rivers.
- Review of *New Zealand Water Services (Drinking Water Standards for New Zealand) Regulations 2022* for reference given the suite of analytes assessed at the site.



- Review of toxicity guideline from the *Australian & New Zealand Guidelines for Freshwater and Marine Ecology* (https://www.waterquality.gov.au/anz-guidelines/guideline-values/default/water-quality-toxicants/toxicants).
- Stream water quality field measurements at 7 locations on 22 September 2022.
- Stream water sample collection for laboratory analysis from 7 locations collected on 22 September 2022.

## 3.2 Macroinvertebrate Sampling

Macroinvertebrate sampling was conducted within the main stem of both Bendigo and Shepherds Creeks, as well as a smaller upper tributary of Shepherds Creek called Jean Creek. Sample locations were generally associated with water quality monitoring sites for consistency and due to access. *In situ* evaluation of suitable (i.e. water flow, access, etc.) locations was conducted, resulting in sample locations identified in Figure 6. The primary objective was to identify representative macroinvertebrate communities and to gain a broader understanding of biodiversity gradients and presence within each creek. Two macroinvertebrate samples were collected within Bendigo Creek, three in Shepherds Creek and one sample in Jean Creek (a tributary of Shepherds Creek) (Figure 6) for a total of six samples. Sample RS2 was the only composite sample, consisting of two localised sites in the vicinity.

During electric fishing (discussed in Section 3.3.2) any macroinvertebrates caught in the stop net were also collected and combined into one composite representative sample for each creek (Shepherds, Bendigo and Jean Creek). These macroinvertebrate samples are named Shepherds EFM, Bendigo EFM and Jean Creek EFM.

Macroinvertebrate sampling largely followed protocols from the National Environmental Monitoring Standards for Macroinvertebrates (NEMS, 2020). At each location substrate particles from an area of 0.1024 $m^2$ (32 x 32 cm) were washed into a Surber kicknet with a mesh size of 500 µm, collecting macroinvertebrates, detritus and fine sediment. Samples retained in the net were transferred to a 500 mL sample jar and preserved in 70% ethanol. Macroinvertebrates were returned to the laboratory, identified, and enumerated to species level where possible.

### 3.2.1 Macroinvertebrate Sample Site Descriptions

Samples were collected on 9 November 2022 in clear, calm conditions with no rain in the previous 48 hours. At all sample locations, access to livestock was apparent, with sheep and cattle being noted throughout the area. See Figure 6 for site locations.

*Site RS1*

RS1 (Figure 7) was sampled within Rise & Shine Creek, a tributary of the larger Bendigo Creek. This site was located on the downstream edge of the potential Phase 1 exploration site (Rise & Shine). The upstream catchment area from station RS1 is 4.33 $km^2$. RS1 was sampled in a run just downstream from a riffle and small waterfall (40 cm). The sample was collected at the maximum creek depth of 20 cm, with an overall creek width of 1 m and a wetted width of 2 m. Sample substrate consisted of 30% cobbles, 60% gravels and 10% sand/silts, loosely compacted. Water clarity was clear (~80%) with no noticeable odour or tannins and riparian vegetation mostly shaded (80%) this area. Riparian vegetation consisted of rank grasses and scattered ferns within a dense Matagouri (*Discaria toumatou*) grove. Periphyton was common (>60%) with no macrophytes present. Submerged grasses and roots lined the creek bank, indicating moderate base flow conditions (see Figure 3 for relative flow scale). Stock access was apparent.

**Figure 7: Site RS1 looking upstream (left) and benthic substrate (right).**

*Site RS2*

Sample RS2 (Figure 8) was also located within Rise & Shine Creek, upstream from RS1 and the potential Phase 1 site footprint. The upstream catchment area from station RS2 is 2.97 km$^2$. The sample collected was an aggregate of two sites, with the second located approximately 25 m upstream in similar habitat. Both were sampled in a fast run at the maximum creek depth of 9 cm, with an overall creek width of 90 cm and a wetted width of 140 cm. Sample substrate consisted of 60% gravels and 40% sand/silts, loosely compacted. Water clarity was clear (~80%) with no noticeable odour or tannins and riparian vegetation partially shaded (50%) most of this area. Riparian vegetation consisted of mainly rank grasses, with shrubland to the north consisting of mixed Matagouri (*Discaria toumatou*) and *Carex secta* scattered throughout. Sparse periphyton was noted with scattered macrophytes mixed with submerged grasses and roots, indicating moderate base flow conditions (see Figure 3 for relative flow scale). Stock access was apparent.

**Figure 8: Site RS2. Downstream (top left), upstream (top right), benthic substrate (bottom).**

*Site SC1*

Sample SC1 (Figure 9) was located within lower Shepherds Creek, downstream of the potential Phase 1 site and just upstream of the irrigation water take shown in Figure 4. The upstream catchment area from station SC1 is 12.18 km$^2$. SC1 was sampled in a channelised riffle/run, adjacent to a wetted area, meandering through the valley floor. The sample was collected at the maximum creek depth of 22 cm, with an overall creek width of 70 cm and a wetted width of over 3 m. Sample substrate consisted of 80% gravels and 20% sand/silts, loosely compacted. Water clarity was clear with no noticeable odour. Riparian vegetation consisted of grasses, mixed shrubs and Matagouri (*Discaria toumatou*) nearby. Periphyton was sparse with dense macrophytes observed. Submerged grasses and roots lined the creek bank, indicating moderate base flow conditions (see Figure 3 for relative flow scale). Stock access to the creek was apparent.

**Figure 9: Sample SC1. Top row (left to right): looking downstream, looking upstream. Bottom row (left to right): sample site, benthic substrate.**

*Site SC2*

Sample SC2 (Figure 10) was located within Shepherds Creek, also downstream from the Phase 1 site. The upstream catchment area from station SC2 is 10.11 km$^2$. SC2 was sampled in a straight and exposed run, slowly bending through the valley floor. The sample was collected at the maximum creek depth of 23 cm, with an overall creek width of 60 cm and a wetted width of ~1.5 m. Sample substrate consisted of 10% cobbles, 70% gravels and 20% sand/silts, loosely compacted. Water clarity was turbid with no noticeable odour. Riparian vegetation consisted of grasses and bare earth with mixed shrubs and Matagouri (*Discaria toumatou*) nearby. Periphyton was sparse with no macrophytes observed. Submerged grasses and roots lined the creek bank, indicating moderate base flow conditions (see Figure 3 for relative flow scale). Stock access to the creek was apparent.

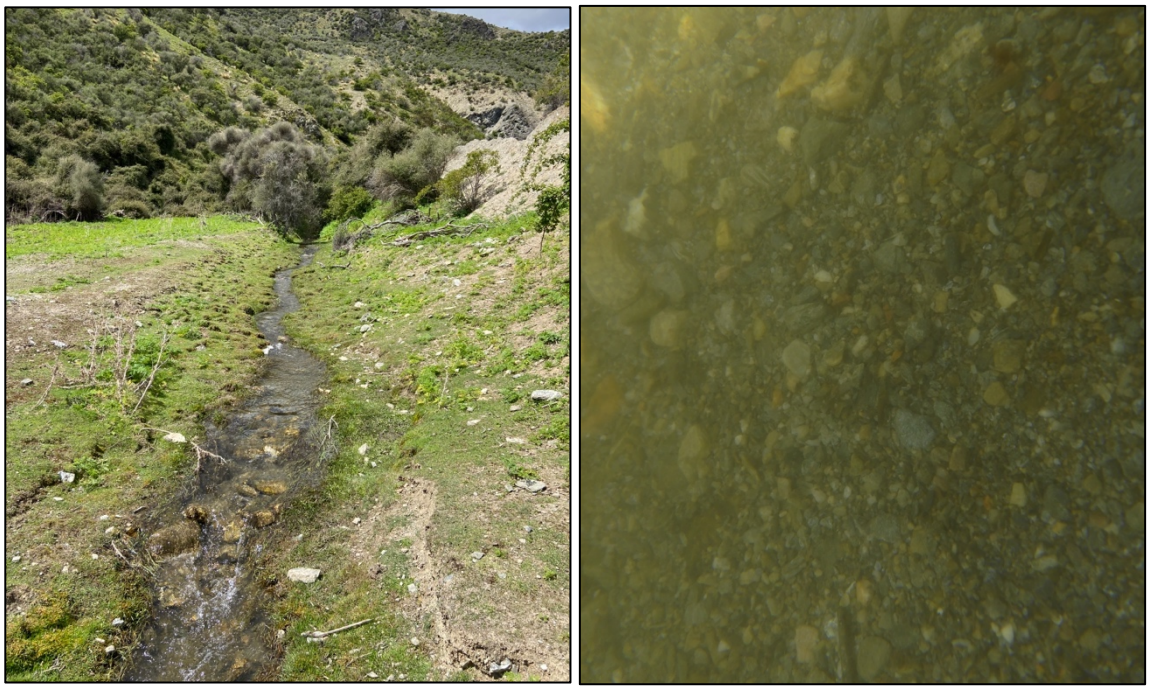

**Figure 10: Site SC2. Looking upstream (left), benthic substrate (right).**

*Site SC3*

Sample SC3 (Figure 11) was located within Shepherds Creek upstream of the potential Phase 1 site. The upstream catchment area from station SC3 is 7.92 km$^2$. SC3 was sampled in a narrow and channelised riffle, meandering through the valley floor. The sample was collected at the maximum creek depth of 10 cm, with an overall creek width of 60 cm and a wetted width of ~1 m. Sample substrate consisted of 10% cobbles, 80% gravels and 10% sand/silts, loosely compacted. Water clarity was clear with no noticeable odour or tannins and the area was generally exposed with shading only due to the deep channel of the creek. Riparian vegetation consisted of rank grasses and scattered *Carex secta* with mixed shrubs and Matagouri (*Discaria toumatou*) nearby. Periphyton was common (>60%) on roots with no macrophytes observed. Submerged grasses and roots lined the creek bank, indicating moderate base flow conditions (see Figure 3 for relative flow scale). Stock access to the creek was apparent.

**Figure 11: Site SC3. Upstream (left), benthic substrate (right).**

*Jean Creek*

This sample (Figure 12) was located at the base of Jean Creek, an intermittent small tributary of upper Shepherds Creek. The Jean Creek catchment has been identified as a possible material fill/disposal site and was requested by MGL to be evaluated. Downstream, Jean Creek joins with the main stem of Shepherds Creek, just below station SC3. The sample was collected in a small riffle, within a shaded gully of dense Matagouri (*Discaria toumatou*), grass and bare/loose soil. The sample was collected at the maximum creek depth of 5 cm, with an overall creek width of 35 cm and a wetted width of ~1 m. Sample substrate consisted of 25% gravels and 75% sand/silts/soil, loosely compacted. Water clarity was clear with no noticeable odour. Periphyton was sparse and no macrophytes were observed. Heavy stock access was apparent, with sheep and cattle observed in the creek on the initial site visit.

**Figure 12: Jean Creek. Looking upstream (top left), looking downstream (top right), benthic substrate (bottom).**

### 3.2.2 Macroinvertebrate Community Metrics

The health of the macroinvertebrate communities within the 6 sampled sites and 3 EFM aggregate samples were determined by using the macroinvertebrate data collected to calculate health indices. The indices used included Taxa Richness, the Macroinvertebrate Community Index (MCI), Quantitative Macroinvertebrate Community Index (QMCI), and the number and percent abundance of Ephemeroptera, Plecoptera and Trichoptera taxa (%EPT and %EPT abundance, respectively). MCI and QMCI scores were assessed against National Policy Statement for Freshwater Management (NPS-FM) macroinvertebrate attribute national bottom-line values as well as Stark & Maxted (2004, 2007).

Macroinvertebrate community indicators have been used to determine the health of the macroinvertebrate community within the sample areas. These are detailed below and in Table 2.

- Quantitative Macroinvertebrate Community Index (QMCI) is a quantitative variant of the MCI and has similar considerations to bed type. It is an index based on both the number and relative abundance of different taxa present and is more sensitive to changes in abundance or sample size. As for MCI, a single QMCI value is calculated for each site with higher values indicating a healthier stream environment.
- Macroinvertebrate Community Index (MCI) as classified according to Stark and, Stark and Maxted (2004, 2007) in Table 3 below. This index is used to measure the water quality of freshwater streams and assigns a number to each species of macroinvertebrate based on the sensitivity of that species to pollution. The higher the MCI score generally indicates a healthier stream with scores ranging from >119 indicating 'Excellent' to <80 indicating 'Poor' water quality. Included here are values for both soft-bottomed (SB) and hard-bottomed (HB) streams and lakes which will be described based on sample location. QMCI (Quantitative MCI) and SQMCI (Semi-Quantitative MCI) scores are also included here, following the methodology of *(Stark et al.,* 2001).
- Ephemeroptera, Plecoptera and Trichoptera (EPT) Richness Index estimates water quality by the relative abundance of three major orders of invertebrates that have a low tolerance to water pollution. A large percentage of EPT taxa indicates high water quality.
- Shannon Wiener Diversity Index (SWDI). This Index is a measure of community diversity that combines species richness and their relative abundances, ranging from values 0 – 5, with higher numbers representing better community diversity. A high macroinvertebrate diversity score generally indicates a healthy macroinvertebrate community.
- Shannon Wiener Evenness is a measure of the evenness of species in a community. The value ranges from 0 - 1, where 1 indicates complete evenness.
- Taxa Richness indicates the number of taxonomic groups present in a sample. Streams supporting a high number of different taxa generally indicate a healthy macroinvertebrate community.
- In addition to NEMS guidance, stream health may also be inferred from macroinvertebrate attribute bands identified in the National Policy



Statement for Freshwater Management (NPS-FM) (2020). The NPS-FM identify national bottom line for ecosystem health, values of 90 and 4.5 for MCI and QMCI, respectively, indicate a severely degraded system (Table 2).

**Table 2: Description of macroinvertebrate community metrics.**

| Index | Equation | Description |
|---|---|---|
| **Taxa Richness** | Count (taxa) | The total number of macroinvertebrate types (taxa) present in a sample. |
| **Macroinvertebrate Community Index (MCI)** | $MCI = \frac{\sum_{i=1}^{i=S} a_i}{S} \times 20$ | S = the total number of scoring EPT taxa, and ai = the tolerance score for the ith taxon. |
| **Quantitative Macroinvertebrate Community Index (QMCI)** | $QMCI = \sum_{i=1}^{i=s} \frac{(n_i \times a_i)}{N}$ | S = the total number of taxa, $n_i$ = the abundance for the ith scoring taxon, $a_i$ = the tolerance score for the ith taxon and N = the total abundance of EPT taxa. |
| **Percent abundance of EPT taxa (%EPT taxa richness)** | EPT taxa/total taxa | The percentage of taxa belonging to the orders Ephemeroptera, Plecoptera or Trichoptera (EPT). |
| **Relative abundance of EPT taxa (%EPT Abundance)** | EPT taxa Abundance /total Abundance | The relative abundance of individual macroinvertebrates belonging to EPT taxa. |
| **Shannon Wiener Diversity Index** | H = -Σpi * ln(pi) | The diversity of species in a community |
| **Shannon Wiener Evenness** | EH = H / ln(S) | The evenness of species in a community |

**Table 3: Interpretation of MCI-type biotic indices (Stark & Maxted, 2007).**

| Stark & Maxted (2004, 2007) quality class | Stark (1998) descriptions | MCI<br>MCI-sb | SQMCI & QMCI<br>SQMCI-sb & QMCI-sb |
|---|---|---|---|
| Excellent | Clean water | > 119 | > 5.99 |
| Good | Doubtful quality or possible mild pollution | 100–119 | 5.00–5.90 |
| Fair | Probable moderate pollution | 80–99 | 4.00–4.99 |
| Poor | Probable severe pollution | < 80 | < 4.00 |

**Table 4: National Policy Statement for Freshwater Management (2020): Macroinvertebrate Attribute delineation table.**

| Attribute band and description | Numeric attribute states | |
|---|---|---|
| | QMCI | MCI |
| **A**<br>Macroinvertebrate community, indicative of pristine conditions with almost no organic pollution or nutrient enrichment. | ≥6.5 | ≥130 |
| **B**<br>Macroinvertebrate community indicative of mild organic pollution or nutrient enrichment. Largely composed of taxa sensitive to organic pollution/nutrient enrichment. | ≥5.5 and <6.5 | ≥110 and <130 |
| **C**<br>Macroinvertebrate community indicative of moderate organic pollution or nutrient enrichment. There is a mix of taxa sensitive and insensitive to organic pollution/nutrient enrichment. | ≥4.5 and <5.5 | ≥90 and <110 |
| **National bottom line** | **4.5** | **90** |
| **D**<br>Macroinvertebrate community indicative of severe organic pollution or nutrient enrichment. Communities are largely composed of taxa insensitive to inorganic pollution/nutrient enrichment. | <4.5 | <90 |

## 3.3 Fish

An assessment of fish presence/absence was completed via desktop research and field sampling to identify potential fish populations within proposed mining catchments. Prior to fieldwork, a desktop study of nearby fish populations and species within the New Zealand Freshwater Fish Database (NZFFD) was completed. Fish values identified within the larger project catchment and within downstream receiving water bodies from this desktop assessment were recorded.

In addition to mapped potential fish values, *in situ* sampling was conducted to identify any possible remnant or stranded populations. This included the use of both eDNA passive sampling and electric fishing. The primary goal of fish sampling was to expand and update existing knowledge and identify any potentially unknown fish populations within the proposed works areas. A fish passage assessment was also undertaken to determine downstream connectivity potential.



### 3.3.1 Fish Passage Assessment

Fish passage to the Bendigo and Shepherds Creek catchments was assessed during the site visit on 9 November 2022. No rainfall had been recorded within the previous 48 hrs; however there had been some large rainfall events in the weeks prior and flows were considered above average. Each stream was assessed from their confluences with the Clutha and Lindis Rivers and any potential fish passage barriers (natural or man-made) were identified, photographed, and discussed.

### 3.3.2 Electric Fishing

Electric fishing was conducted at all macroinvertebrate sample sites identified in Figure 6 (RS1, RS2, SC1, SC2, SC3 and Jean Creek) using NIWA's EFM300 machine and standardized protocols. Specific techniques for EFM fish sampling were guided by the New Zealand Freshwater Fish Sampling Protocol (NZFFSP - Section 3.2) and procedures outlined in Section 3.4.1 of Joy (2013). An example of the relationship between EFM sampled stretches and macroinvertebrate waypoints can be seen in Figure 13 below.


**Figure 13: EFM sampling stretch example for upper Shepherds Creek (site SC3 and Jean Creek). EFM sampling was conducted for 50 m stretches downstream from the identified macroinvertebrate sample sites.**

At each ecological monitoring site (see Figure 6), a stretch of approximately 50 m was sampled downstream from the recorded site GPS waypoint (as seen in Figure 13). Although a continuous stretch of fishing was attempted, this was not always possible due to topography and dense vegetation at spots. All sites were fished prior to any instream macroinvertebrate sampling and any macroinvertebrates

affected by the EFM were also collected via the downstream net. Macroinvertebrate sampling sites described in Section 3.2.1 were located above and out of the influence of any EFM sampling stretch. Any fish caught were to be gathered by net and placed into a bucket where they could be identified, measured, photographed, and released. If no species were seen or collected, this information was recorded as well. Representative images and descriptions of habitat at sample locations are provided in Section 3.2.1. Collection of associated fish metadata followed the recommended fish collection forms in Appendix 5 of Joy (2013). This information was then entered into the NZFFD post sampling.

### 3.3.3 Environmental DNA (eDNA)

Environmental DNA or eDNA is used to assess trace amounts of genetic material within collected water samples to ascertain fish presence or absence metrics. When used to assess freshwater creeks or rivers in New Zealand, eDNA can detect cryptic species (flora and fauna) both in the water and within the region via surface flow into the creek.

eDNA sampling and analysis was completed through WilderLab NZ Ltd (www.wilderlab.co.nz). WilderLab provides pre-packaged eDNA sampling kits (Figure 14) and post-sample analysis. For all eDNA analysis, the 'basic' analysis package was used. WilderLab's eDNA metabarcoding produces a list of "*all DNA sequences detected within a broad taxonomic group (e.g. fish, insects, birds, mammals) and the number of times each appears in the sample. The DNA sequences are then compared against a reference database to assign species names and characterise the community as a whole. This method requires an extensively tested set of PCR 'primers' and a well-curated reference database. [WilderLab] has developed and optimised a suite of primers especially suited to New Zealand's unique flora and fauna, and curated an extensive reference database for each of these assays using data from both public and private sequence repositories* (WilderLab, 2022)." (Appendix A)


**Figure 14: WilderLab passive eDNA sampling kit (WilderLab, 2022).**

Passive eDNA samplers were deployed within Shepherds, Rise & Shine and Bendigo Creeks to help identify any potential fish DNA within the larger Bendigo and Shepherds Creek catchments. WilderLab passive samplers were used following standard WilderLab procedures (Appendix B). At sample sites, kits were placed at downstream locations which aim to characterise the relative upstream catchment within mining areas (Figure 6). eDNA metadata can be found in Table 5 below.

**Table 5: eDNA location and deployment metadata.**

| Name | GPS | Installation Date | Deployment Duration | Kit Number |
|---|---|---|---|---|
| Bendigo eDNA-1 (A) | -44.927083, 169.37455 | 9 Nov 2022 | 6 hours 51 min | 411369 |
| Bendigo eDNA-1 (B)* | -44.92709, 169.37454 | 19 Dec 2022 | 18 hours | 411772 |
| Alta (Upper Bendigo) eDNA-2* | 44.93151459, 169.40098616 | 19 Dec 2022 | 18 hours 30 min | 411773 |
| Rise & Shine below RS1 (Upper Bendigo) eDNA-3* | -44.9446, 169.421824 | 19 Dec 2022 | 18 hours 30 min | 411774 |
| Lower Shepherds eDNA-4 (A) | -44.923583, 169.3969 | 9 Nov 2022 | 6 hours | 411372 |

| | | | | |
|---|---|---|---|---|
| Lower Shepherds eDNA-4 (B)* | -44.92357, 169.3969 | 19 Dec 2022 | 18 hours 30 min | 411775 |

***Samples collected/attained by Matakanui Gold.**

**Figure 15: WilderLab eDNA passive sample kits (circled in red) deployed at Bendigo Creek (top left), Shepherds Creek (top right), *Alta (upper Bendigo) (lower left), and *Rise & Shine at RS1 (lower right). *Samples and images collected/attained by Matakanui Gold.**

## 3.4 Macrophyte Assessment

At each macroinvertebrate and fish sampling location any macrophytes found were collected, photographed, and identified to species level where possible.

## 3.5 Water Quality Assessments

### 3.5.1 Water Sampling Methodology

Stream water quality sampling was undertaken following standard methods and procedures with field observation of water colour water and water odour and handheld YSI ProDSS Water Quality Meter measurement of temperature, dissolved oxygen, electrical conductivity (specific conductance), pH, and oxidation reduction potential (Table 11). Manual stream water grab sampling with prescribed sample bottles provided by Analytica Labs was undertaken at each site and samples were labelled and chilled for overnight delivery to Analytica Laboratories for analysis. Stream flow on 22 September 2022 can be described as moderate baseflow with the nearby Lindis River stream gauging site provided in Figure 16 for reference. Sampling location include the 7 sites indicated in Figure **17** and represent a subset of those recommended by e3s in a draft sampling proposal to SML based on an initial site visit on 4 July 2022 (e3s, 2022). One additional site (RSA1) was added during sample collection based on field observations. RSA1 appeared to emerge from a historic mining operation and was located on river left seepage spring/tributary to Rise & Shine Creek. The tributary flowed through apparent mullock or waste rock stack deposits before entering Rise & Shine Creek.

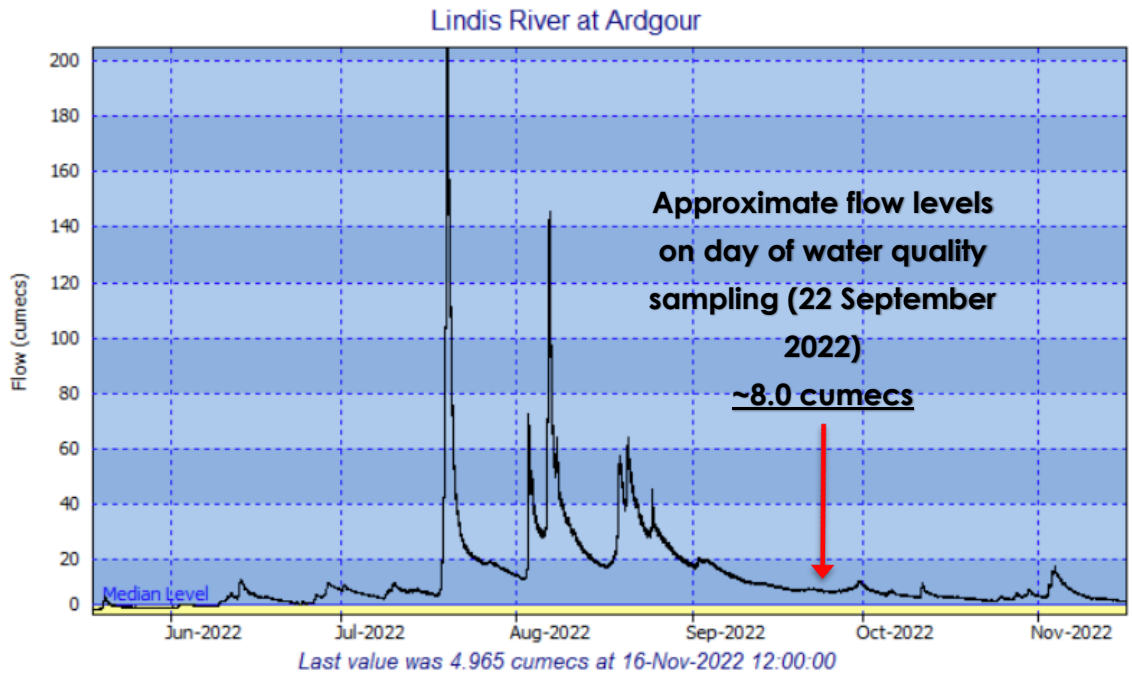


**Figure 16: Lindis River at Ardgour Road: river discharge (www.orc.govt.nz/managing-our-environment/water/water-monitoring-and-alerts/upper-clutha/lindis-at-ardgour).**

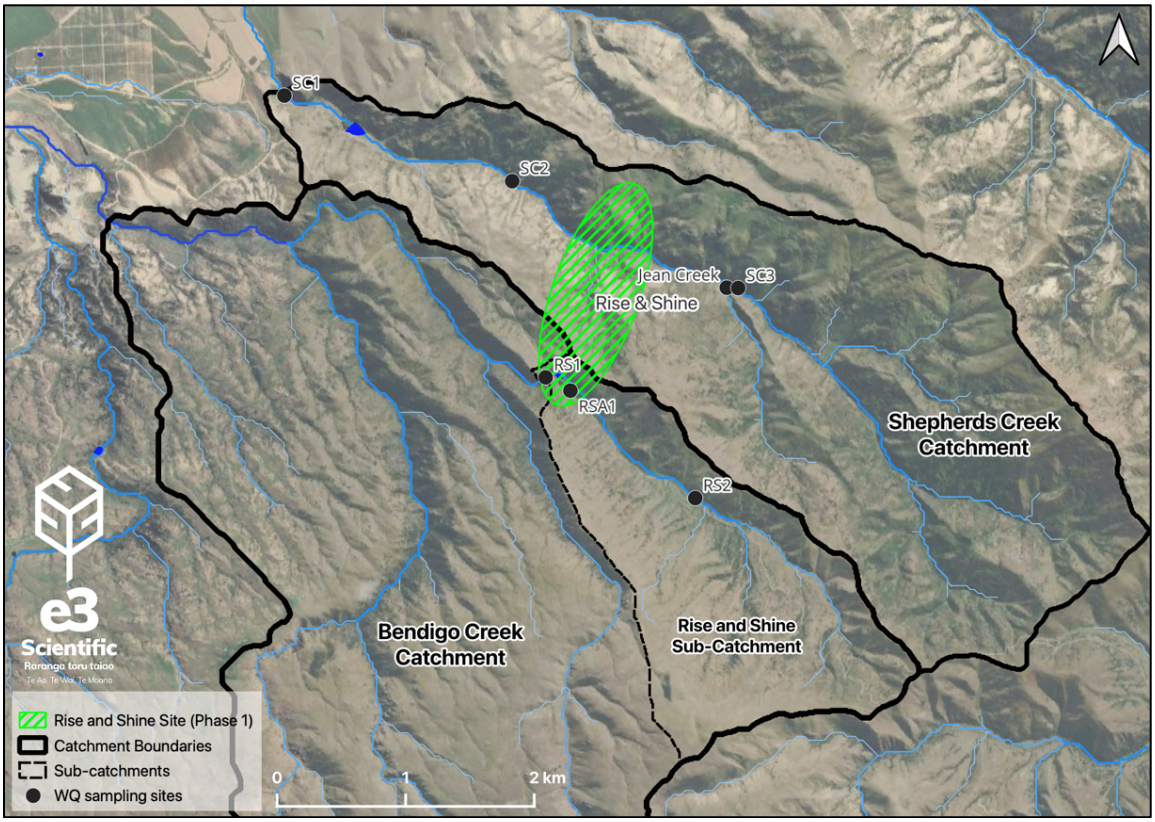


**Figure 17: Water quality monitoring sites in relation to Rise & Shine (Phase 1) mining site, creeks, and catchments.**

### 3.5.2 Water Quality Analytical Parameters

Stream water quality parameters included field observations, YSI ProDSS Water Quality Meter measurements, and grab samples for laboratory analyte analysis. Field parameters and lab analytes are included in Table 11.

### 3.5.3 Water Sample Field and Laboratory QA/QC

The field QA/QC procedures performed during the sampling were as follows:

- Use of standardised field sampling forms and methods.
- Samples were transferred under chain of custody procedures.
- All samples were labelled to show point of collection, project number, and date.
- Headspace in sample bottles was avoided.
- All samples were stored in a cooled chilly bin containing ice while in the field.
- All samples were shipped in coolers with icepacks within hours of collection and received at Analytica Laboratories the next morning.

Analytica has IANZ accreditation for the analysis and conduct internal QA/QC in accordance with IANZ requirements.

### 3.5.4 Water Quality Analytical Result Review

Following the receipt of laboratory data, review of the analysis data was performed to assess its likely accuracy and validity. All laboratory data were checked for analytical and typographical errors no issues were noted.

### 3.5.5 Guideline Values

Relevant guideline water quality values include the Otago Regional Water Plan schedules for any discharge within the Lindis at Ardgour Road as an Area 2 catchment (Table 6). Table 15.2 Receiving water numerical limits and targets for achieving good quality water are also included (Table 6). In addition, reference to the *New Zealand Water Services (Drinking Water Standards for New Zealand) Regulations 2022* have also been included given the suite of analytes assessed at the site. Analytes that exceeded Group 2 Discharge Thresholds or Group 2 Targets (Table 6) are highlighted in red in Table 11 and those they exceeded current drinking water Standards for New Zealand are highlighted in blue.



**Table 6: Otago Regional Water Plan Schedule 15 excerpts: Schedule of characteristics and numerical limits and targets for good quality water in Otago lakes and rivers Table 15.1. Discharge thresholds for Area 2 catchments and receiving water quality Group 2 targets (including Lindis River and Clutha/Mata-Au) applying from 1 April 2020 (Otago Regional Council, 2021).**

| Category | Nitrate-nitrite nitrogen $NO_3$-N $NO_2$-N g/m³ | Dissolved reactive phosphorus DRP g/m³ | Ammoniacal nitrogen $NH_4$ g/m³ | *Escherichia coli* *E. coli* cfu/100 ml | *Turbidity* NTU |
|---|---|---|---|---|---|
| **Group 2 discharge thresholds** | 1.0 mg/l | 0.035 mg/l | 0.2 mg/l | 550 cfu/100ml | - |
| **Group 2 Targets** | 0.075 mg/l | 0.01 mg/l | 0.1 mg/l | 260 cfu/100ml | 5 NTU |

# 4 Results

The following sections presents the results of the macroinvertebrate sampling, fish assessment and fish passage surveys, macrophyte assessment and monthly water quality sampling. During the ecological survey, creek water levels were considered to be above average based on recent rainfall, submerged riparian vegetation and nearby ORC river level monitoring.

## 4.1 Macroinvertebrate Results

Macroinvertebrate sample site descriptions are provided in Section 3.2.1 and community metrics are explained in Section 3.2.2. Macroinvertebrate results are presented in Table 7 and are summarised below.

All sites were considered for 'hard-bottomed (HB)' substrates and MCI scores have been calculated accordingly. Where discrepancies between the MCI and QMCI water quality and NPS-FW attribute band classifications occur, all factors have been considered including site knowledge and other calculated site metrics, to determine the final classifications.

*Site RS1*

The macroinvertebrate community within this sample largely consisted of pollutant tolerant species with low MCI scores, such as oligochaete worms and with no EPT taxa present. The disproportionate number of oligochaete worms present, relative to other taxa found, resulted in a low SWDI score of 1 and evenness of 0.6. This resulted in an MCI score of 70 and a QMCI score of 1.8, indicating 'Poor' water quality and places the site within the 'D' band which falls below the NPS-FW 'National Bottom Line'.

*Site RS2*

The macroinvertebrate community within this sample was considered moderately healthy, with one fifth of the sample consisting of EPT taxa, and more tolerant taxa making up the majority of the sample. The SWDI score (1.7) also indicated a moderately diverse community, with a fair to poor evenness of taxa (0.8). These metrics combined resulted in relatively high MCI score of 93.3 when compared to other sampled sites. These collective scores are indicative of 'Fair' water quality

with 'Probable moderate pollution' (Stark & Maxted, 2007) and places the site within the NPS-FM 'C' band (NPS-FM, 2020).

*Site SC1*

The metrics for this sample were largely suggestive of poor to moderate community health primarily attributed the diversity and abundance of pollutant tolerant individuals found in this sample such as the native mudsnail *Potamopyrgus*. Only two EPT taxa were found, which made up a third of the sample (33.1%) and produced an EPT taxa abundance of 18.2%. This sample had an SWDI score of 1.4, evenness of 0.6 and a QMCI score of 4.9 which is indicative of a moderately diverse community. However, with an MCI score of 80, this sample is placed in the NPS-FW 'D' band, falling below the 'National Bottom Line' and is indicative of 'Poor 'water quality.

*Site SC2*

Overall, SC2 had relatively high scores across community health metrics, with the second highest number of taxa (14), EPT percentage abundance (73.3%) and taxa percentage abundance (50%). This sample also produced the highest diversity, with a score of 1.8, second highest evenness of 0.7 and a relatively high QMCI score of 5.8. Although SC2 exhibited relatively high scores overall, it produced a moderate to poor MCI score of 90, indicative of 'Fair' water quality, and placing it in the NPS-FW 'C' band. The QMCI score, however, suggests 'Good' water quality and places the community in the NPS-FW 'B' band. Although this sample contained an abundance of high scoring EPT taxa, nearly half of the taxa identified were lower scoring and pollutant tolerant. Because MCI scores are calculated using individual taxa scores, it does not account for the abundance of each taxa found, resulting in a lower MCI score when compared to the other calculated health metrics.

*Site SC3*

Macroinvertebrate metrics for this site were largely indicative of a moderately healthy community. The sample had a high proportion of EPT taxa present and high taxa richness. Despite high richness scores, diversity was moderate/low due to the disparate proportion of the mayfly larvae *Deleatidium* present in the sample. Although SC3 had a high taxa richness and high scoring EPT taxa present, the MCI score was 92 which is indicative of 'Fair' water quality with 'Probable moderate pollution' and places this site within the NPS-FW 'C' band. However, this



sample produced the second highest QMCI of 6.4, suggestive of "excellent' water quality and placed SC3 within the NPS-FW 'B' band. MCI scores are calculated based on the score of the taxa, QMCI scores also accounts for the abundance of each taxa found. Because SC3 contained a large number of high scoring *Deleatidium*, this resulted in the second highest QMCI score of the sampled sites.

*Jean Creek*

Overall, the macroinvertebrate sample at Jean Creek produced low community health scores with an EPT percentage abundance of 2.8%, EPT percentage taxa abundance of 14.3%, SWDI of 1.3, evenness 0.7 all is suggestive of poor community health and diversity. This can be attributed to the abundance of EPT taxa combined with the relatively high number of non-biting midges, *Chironomidae,* and other low scoring taxa. The QMCI score of 2.6 indicates 'Poor' water quality conditions and places this sample within the 'D' band which sits below the NPS-FW 'Bottom Line'. Although, this sample has an MCI score of 82.9, all metrics considered, the water quality is considered 'Poor'.

### 4.1.1 EFM Macroinvertebrate Composite Samples

During electric fishing (discussed in Section 3.3.2) any macroinvertebrates caught in the downstream fish net were also collected and combined into one composite sample for each creek (Shepherds, Bendigo and Jean Creek). These aggregated samples could be considered a representative subset of macroinvertebrate communities over the collective EFM areas.

*Rise & Shine EFM*

This sample is an aggregate of two 50 m stretches, one below Site RS1 and one below RS2. This collective sample had an EPT abundance of 41%, EPT taxa abundance of 28.6%, SWDI of 1.7 and evenness of 0.6, all suggestive of moderately healthy water and community conditions. The MCI of 90 and QMCI of 4.4 both indicates 'Fair' water quality conditions and places this sample within the NPS-FW 'C' band. Observations within this sample remain consistent with both RS1 and RS2 results.

*Shepherds EFM*

This sample is an aggregate of three 50 m stretches below Site SC1, SC2 and SC3. This sample exhibited the highest overall EPT abundance (83.6%) and EPT



percentage taxa abundance (58.3%), which can be attributed to the high number of *Deleatidium* (mayflies), along with a diverse range of other EPT taxa. Regardless, the number of *Deleatidium* was disproportionate compared with other taxa found and resulted in low SWDI (0.9) and evenness (0.5) scores. This sample produced the highest MCI (106.7) and QMCI (7) scores, representing 'Good' water quality classification and placement within the NPS-FW 'B' band. While there is high variability between the sites sampled within Shepherds Creek, the taxa found here are considered consistent when accounting for the collection (EFM) methodology.

*Jean Creek EFM*

This sample was collected over one 50 m EFM stretch on lower Jean Creek. This sample produced scores suggestive of poor water quality and community conditions, likely due to only 1 individual of the EPT taxa being present, the absence of other higher scoring taxa, combined with the comparatively large number of pollutant tolerant non-biting midges, *Chironomidae* found. The SWDI (0.9) and evenness (0.5) scores suggested poor diversity and all metrics considered, along with the MCI (83.3) and QMCI (2.3), the water quality within this site is considered 'Poor' and places it within the NPS-FW 'D' band, falling below the 'National Bottom Line'. This remains consistent with the other macroinvertebrate collections in Jean Creek.

## Table 7: Matakanui macroinvertebrate sampling results.

| Order | Family | Subfamily | RS1 | RS2 | SC3 | SC2 | SC1 | Jean Creek | Bendigo EFM Composite | Shepherds EFM Composite | Jean Creek EFM Composite |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Ephemeroptera | Leptophlebiidae | *Deleatidium* | 11 | | 181 | 46 | 42 | 5 | 83 | 338 | 1 |
| | | *Mauiulus* | | | | 1 | | | | | |
| | Coloburiscidae | *Coloburiscus* | | | | | | | | 3 | |
| Plecoptera | Gripopterygidae | *Zelandobius* | | | 2 | 2 | | | 5 | 3 | |
| | | *Acroperla* | | | 1 | | | | | | |
| Trichoptera | Leptoceridae | *Hudsonema* | 3 | | 16 | 32 | 12 | | 1 | 9 | |
| | | *Oecetis* | | | | | | | | 1 | |
| | Conoesucidae | *Pycnocentrodes* | | | 4 | 4 | | | | 3 | |
| | Hydrobiosidae | *Hydrobiosis* | 1 | | 1 | 1 | | | 5 | 1 | |
| | | *Aoteapsyche* | | | 1 | 1 | | | | | |
| | | *Costachorema* | 1 | | | | | | | | |
| | | *Psilochorema* | | | | 1 | | | | | |
| Coleoptera | Scirtidae | | | | | | | 8 | 1 | 1 | 2 |
| | Elmidae | | | | 4 | | | | | | |
| Odonata | Zygoptera | *Xanthocnemsis* | | 1 | | | | | 2 | | |
| | Lestidae | *Austrolestes* | | | | | | | 1 | | |
| Collembola | | | 1 | | 8 | | 1 | | | | |
| Hemiptera | Coroxidae | *Sigara* | | 1 | | | | | | | |
| Diptera | Simuliidae | *Austrosimulium* | 1 | 3 | 24 | 1 | 2 | 26 | 47 | 33 | 6 |
| | Chironomidae | | 22 | | 18 | 2 | 3 | 103 | 14 | 15 | 43 |
| | Muscidae | | | | | | 1 | 3 | | | |
| | Stratiomyidae | | | | | | 1 | | | 1 | |
| Annelida | Oligochaeta | | 18 | 39 | 9 | 12 | 13 | 20 | 62 | 20 | 5 |
| Gastropoda | Tateidae | *Potamopyrgus* | | 2 | 15 | 14 | 86 | 11 | 1 | | |
| | Physidae | *Physa* | | | | | | | 1 | | |
| | Lymnaeidae | *Lymnaea* | | | | | | | 5 | | 1 |
| Bivalvia | Sphariidae | | | | 5 | 2 | 1 | | | | |
| Ostracoda | | | 19 | 15 | | 1 | | | 1 | | |
| Acarina | | | | | 1 | | | | | | |
| Tricladida | Dugesiidae | *Neppia* | | | | | 1 | | | | |
| **MCI score (HB)** | | | **93.3** | **70** | **92** | **90** | **80** | **82.9** | **90** | **106.7** | **83.3** |
| **Abundance** | | | **77** | **61** | **290** | **120** | **163** | **176** | **229** | **428** | **58** |
| **Taxa Richness** | | | **9** | **6** | **15** | **14** | **11** | **7** | **14** | **12** | **6** |
| **EPT % Abundance** | | | **20.8** | **0** | **71** | **73.3** | **33.1** | **2.8** | **41** | **83.6** | **1.7** |
| **EPT % Taxa abundance** | | | **44.4** | **0** | **46.7** | **50** | **18.2** | **14.3** | **28.6** | **58.3** | **16.7** |
| **Shannon Diversity Index (H)** | | | **1.7** | **1** | **1.5** | **1.8** | **1.4** | **1.3** | **1.7** | **0.9** | **0.9** |
| **Shannon Evenness** | | | **0.8** | **0.6** | **0.6** | **0.7** | **0.6** | **0.7** | **0.6** | **0.4** | **0.5** |
| **QMCI** | | | **3.2** | **1.8** | **6.4** | **5.8** | **4.9** | **2.6** | **4.4** | **7** | **2.3** |

## 4.2 Freshwater Fish Species

### 4.2.1 NZFFD Desktop Research

The presence/absence of fish, species and ecological significance was established through a review of the NZ Freshwater Fish Database (NZFFD), the Department of Conservation's threat classification for New Zealand freshwater fish (Dunn, *et al.,* 2018), and *in situ* field sampling via electric fishing, and eDNA analysis.

The NZFFD was accessed on 16 November 2022 during a desktop assessment to ascertain known species within the larger potential mining area. The only species of fish historically identified within the proposed mining catchments was the brown trout (*Salmo trutta*), where 8 observations were made at one sample site in 2011 (Figure 18;

Table 8). This observation was made high up in the Rise & Shine sub-catchment (Bendigo Creek tributary) by the Department of Conservation (DOC) (NZFFD #101655). The accuracy of this NZFFD data point is uncertain as it does not lie within a waterway nor are the streams at this location of a size to support brown trout. Six other observations made by DoC (circa 2001 and 2000) within Bendigo and Shepherds Creek catchments had no species recorded.

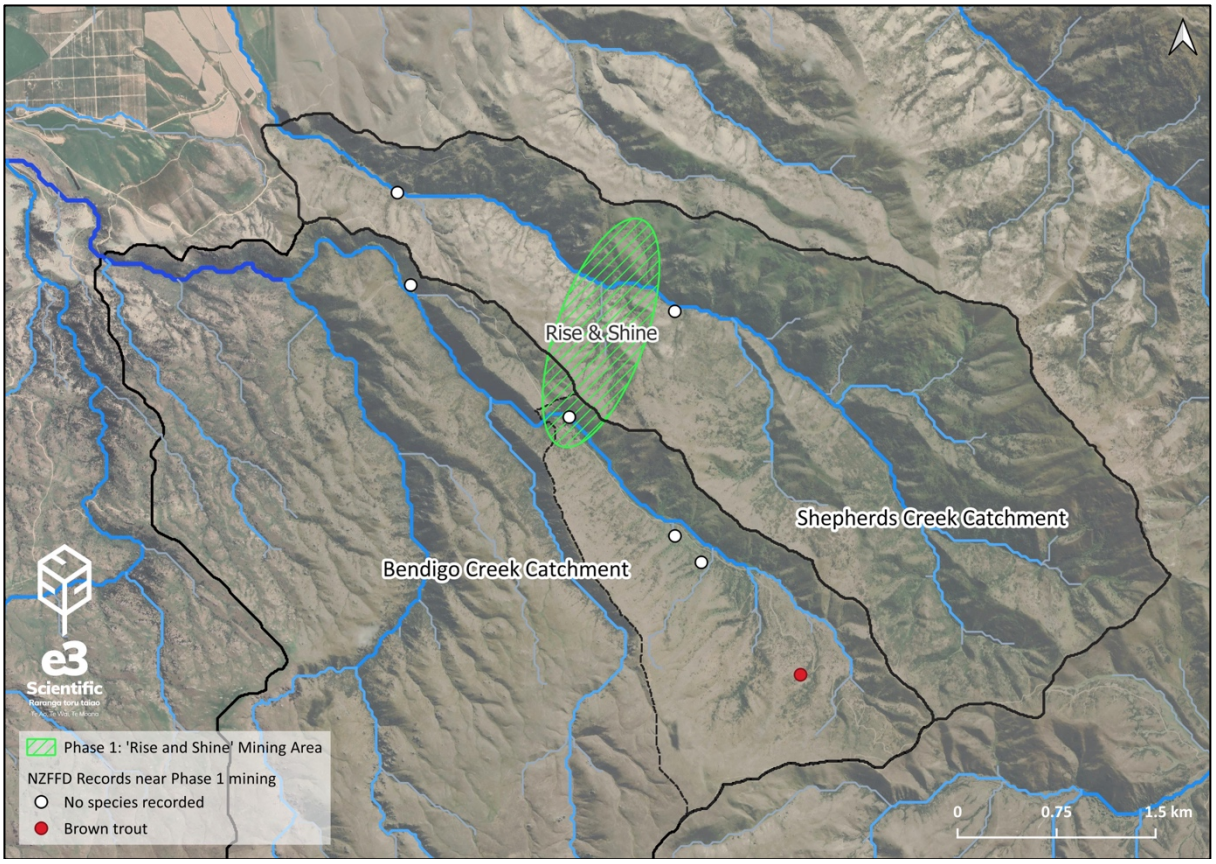


**Figure 18: NZFFD observations within Phase 1 mining catchments.**

**Table 8: NZFFD fish records from within the proposed Matakanui Gold mining area.**

| Common Name | Species | Threat Classification* | Number of Sample Sites | Number of Observations |
|---|---|---|---|---|
| **Brown trout** | *Salmo trutta* | Introduced and Naturalised | 1 | 8 |
| **No Fish Found** | *N/A* | N/A | 6 | N/A |

***All fish threat classifications are from Dunn, *et al.*, (2018)**

Other native fish that have been recorded as being present within the larger proximity of Bendigo township, the Lindis River, the Clutha River / Mata Au, Dunstan Mountains (NW side), and Dunstan Lake are mapped in Figure 19, with associated threat classifications in Table 9 (NZFFD, 2022).

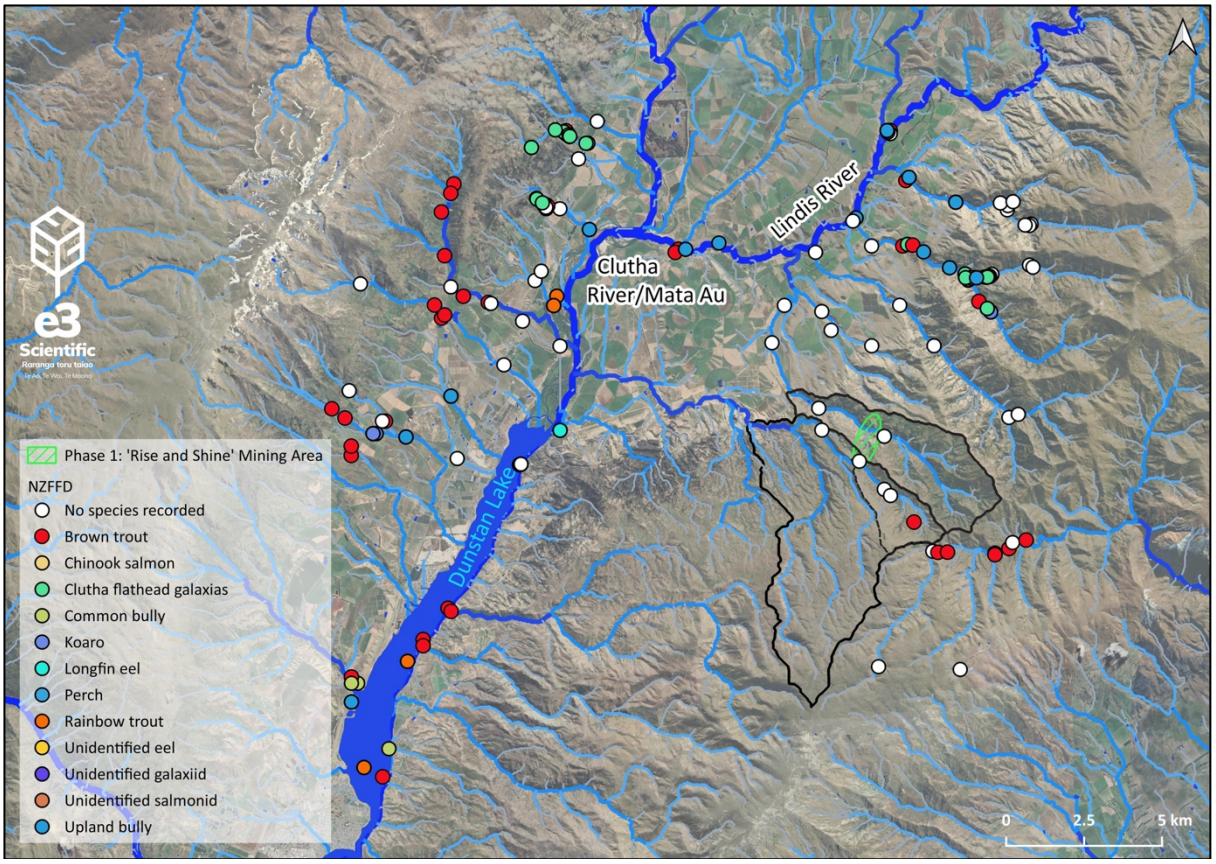


**Figure 19: NZFFD observations in and around the proposed Phase 1 mining catchments.**

**Table 9: NZFFD fish species identified within the wider vicinity of the Clutha and Lindis Rivers as seen in Figure 19.**

| Common Name | Species | Threat Classification* |
|---|---|---|
| **Clutha flathead galaxias** | *Galaxias species 'D'* | Threatened – Nationally Critical |
| **Longfin eel** | *Anguilla dieffenbachii* | At Risk - Declining |
| **Kōaro** | *Galaxias brevipinnis* | At Risk - Declining |
| **Unidentified galaxiid** | *Galaxias sp.* | N/A |
| **Unidentified eels** | *Anguilla sp.* | N/A |
| **Upland bully** | *Gobiomorphus breviceps* | Not Threatened |
| **Common bully** | *Gobiomorphus cotidianus* | Not Threatened |
| **Rainbow trout** | *Oncorhynchus mykiss* | Introduced and Naturalised |
| **Brown trout** | *Salmo trutta* | Introduced and Naturalised |
| **European perch** | *Perca fluviatillis* | Introduced and Naturalised |
| **Unidentified salmonid** | *Salmo sp.* | N/A |

***All fish threat classifications are from Dunn, *et al.*, (2018)**

### 4.2.2 Fish Passage

Fish passage to and from Bendigo and Shepherds Creek was assessed utilising site observations, basic hydrological modelling, and publicly available monitoring data. Both Bendigo and Shepherds Creek terrain analysis shows an incised stream network that flows out of the Dunstan Mountains, across the Bendigo Terrace where the creeks ultimately join the Clutha and Lindis Rivers above Lake Dunstan.

At the time of observation, no connectivity was present in Shepherds Creek, with a dry creek bed found below the base of the Dunstan range (see Figure 20). As discussed in Section 2.1, surface flow and overall stream connectivity is considered highly variable, seasonal and rainfall-dependant. Despite this, surface water connectivity for both networks is historically evident in erosional pathways and terrain analysis.

Once at the base of the Dunstan range there are many fine-scale obstacles to fish passage and survival upstream. For Shepherds Creek, an irrigation weir (water take) blocks the main channel just below monitoring station SC1 (only during times of high flow does this bypass with surface overflow). Upstream (on both creeks) there are multiple wetland flats with dense vegetation and very low-flow channels. Further upstream small channelised waterfalls are numerous with multiple culverts and small man-made reservoirs in various states of operability.

During one of the monthly water quality assessments on 22 September 2022, e3s hydrologists did observe surface flow below the Shepherds Creek weir (Figure 21). Due to private property and inaccessibility, e3s was unable to assess how far down surface flows went during this time; however, it is highly unlikely this surface flow continued to the confluence with the Lindis River.

**Figure 20: Shepherds Creek below the weir and SC1 monitoring site with no overland water flow.**

**Figure 21: Shepherds Creek (on 22 September 2022) below the weir and SC1 monitoring station.**

Bendigo Creek is a much larger network and while the upper sections of Rise & Shine and Jean Creek are similar to Shepherds, the lower sections of Bendigo offer fewer fish passage restrictions. Google aerial imagery clearly shows the lower section of Bendigo Creek, just after it plateaus on the Bendigo Terrace, going dry and subsurface. However, overall creek definition and pathway towards the Clutha River

/ Mata-Au is more pronounced and defined, with connectivity probable under high flow conditions.

### 4.2.3 Electric Fishing

No fish were caught or observed during the electric fishing activities across all six sites sampled.

### 4.2.4 eDNA

Passive eDNA samplers (Figure 14 & Figure 15) were used alongside electric fishing effort to provide additional accuracy in assessing presence or absence of fish populations within both Shepherds and Bendigo Creeks. Full eDNA analysis results are provided in Appendix C. No fish species were found within Shepherds nor Rise and Shine Creeks. Fish species were only identified within lower Bendigo Creek (Figure 7; eDNA-1 A & B) below the proposed works area. Fish species that were identified within these two lower Bendigo Creek samples include kōaro (*Galaxias brevipinnis*), unidentified galaxiid species and brown trout (*Salmo trutta*). At this location, the three fish species were identified during both (separate) sampling events. Based on these results it appears that the fish species identified via eDNA in lower Bendigo Creek are most likely not originating from the Rise and Shine Creek catchment and this stream, along with Shepherds Creek, does not currently support fish species.

The sequence count for each observation and current threat classification can be seen in Table 10. The sequence count is the number of times a unique sequence (full sheet) or unique taxa (aggregated sheet) was detected in each sample taken (WilderLab, 2022).

**Table 10: eDNA fish analysis results.**

| Location | Name | Common | Threat Status (Dunn, *et al.*, (2018)) | WilderLab eDNA Sequence Count |
|---|---|---|---|---|
| eDNA-1 | *Galaxias brevipinnis* | Kōaro | At Risk - Declining | 1174 (sample A)<br>138 (sample B*) |
| eDNA-1 | *Galaxias spp.* | Galaxiids | N/A | 360 (sample A)<br>17 (sample B*) |
| eDNA-1 | *Salmo trutta* | Brown trout | Introduced - Naturalised | 13982 (sample A)<br>13665 (sample B*) |

***Samples collected by Matakanui Gold.**

## 4.3 Macrophytes

Macrophytes identified during the site visit can be seen in Figure 22 and listed below alongside current threat classifications (de Lange *et al.* 2017). Observations occurred in both Shepherds and Bendigo Creek sites, but no macrophytes were seen in Jean Creek where EFM or macroinvertebrate samples were collected. Observations included the following species:

1. Exotic watercress (*Nasturtium officinale*),
2. Native – Not Threatened blunt pondweed (*Potamogeton ochreatus*)
3. Native – Not Threatened Duckweed (*Lemna disperma)*
4. Exotic Lagarosiphon spp. (*Lagarosiphon major*),

The lower reaches of Shepherds Creek, in the vicinity of monitoring station SC1, contained all macrophyte species. Duckweed occurred sporadically at slow moving sections on the lower sections and *Lagarosiphon* tended to correlate with larger rocky substrates. Watercress was moderately common and consistent upstream and other species could be considered sparse or non-existent upstream. At nearly all observed locations grass and grass roots were submerged within the water, indicating relatively high, or above average water levels at time of survey.

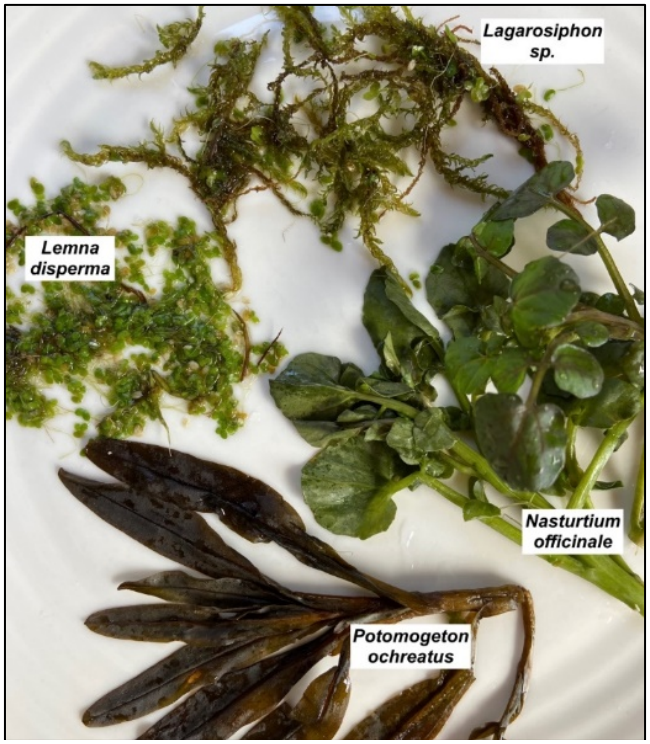


**Figure 22: Macrophytes (submerged vascular plants) of Bendigo and Shepherds Creeks.**

## 4.4 Water Quality Results

Water quality results from the medium base flow sampling event on 22 September 2022 are provided in Table 11 and sampling locations are shown in Figure 17. An additional water quality sampling site (RSA1) was not included in the ecological assessment. The RSA1 site was a potential historic mine drainage area with metals precipitation and elevated specific conductance indicated as it flowed to the Rise & Shine stream. It was sampled as a potential source of downstream solutes.

Surface water quality levels across the site were assessed during moderate baseflow conditions without significant recent rain (see Figure 16). Good stream water quality reflects low concentrations of nutrients and metals and good water clarity. Field measured and laboratory analysed stream water solute concentrations were compared to Otago Regional Council receiving water numerical limits and targets for achieving good quality water (Table 6). In addition, reference to the *New Zealand Water Services (Drinking Water Standards for New Zealand) Regulations 2022* for context has been included given the suite of analytes assessed at the site. Analytes that exceeded Group 2 Discharge Thresholds or Group 2 Targets (Table 6) are highlighted in red in Table 11 and those that exceeded current drinking water Standards for New Zealand are highlighted in blue. Additional information and toxicity guideline values can be obtained from the Australian & New Zealand Guidelines for Freshwater and Marine Ecology (https://www.waterquality.gov.au/anz-guidelines/guideline-values/default/water-quality-toxicants/toxicants).

Unless otherwise noted, site stream water samples were below Otago receiving water thresholds, discharge thresholds, and New Zealand drinking water standards for the analytes measured. Elevated nitrate, arsenic, and TKN were observed at some of the sites. Sites SC3, SC2, and SC1 all exhibited elevated nitrate ($NO_3$-N of 0.144, 0.144, 0.124 g/m$^3$) with respect to Group 2 receiving water targets (standard 0.075 g/m$^3$ $NO_3$-N $NO_2$-N g/m$^3$) (Table 11). In addition, RSA1 exhibited elevated TKN (Total Kjeldahl Nitrogen) of 2.33 g/m$^3$. This value is notably higher than the other sites and not indicative of pristine conditions. Sites RS1 And RSA1 exhibited elevated soluble (dissolved) arsenic concentrations of 0.028 and 0.0761 g/m$^3$ respectively while the drinking water standard is 0.01 g/m$^3$. The observed dissolved concentrations were 2.8 and 7.6 times greater than the NZ drinking water standard for arsenic. Total recoverable arsenic concentrations for sites RS1, RS2, and RSA1were 0.038, 0.012, and 0.243 g/m$^3$ respectively. These concentrations are 3.8, 1.2, and 24.3 times greater than the NZ drinking water standard.



## 4.5 Water Quality Data Interpretation

The field measurements and laboratory results indicate mixed water quality across the area. Elevated nitrate at sites SC3, SC2, and SC1 could be due to livestock observed in the area while the elevated TKN at site SCA1 could be again due to animal waste contributions or enhanced rock weathering in those catchments. The elevated arsenic observed in RS1, RS2, and RSA1 are likely due to historic gold mining activities and mining waste rock weathering/leaching observed in the immediate area or enhanced arsenic export due to local geology. Total recoverable concentrations that exceed soluble concentrations indicate elements associated with larger particles and can be more reflective of what is moving downstream. In this case, total recoverable arsenic in stream water was substantially greater than soluble concentrations (Table 11). Gold is known to be related to iron- and arsenic-containing minerals, such as pyrite ($FeS_2$) and arsenopyrite (FeAsS) and this could explain the observations presented here.



**Table 11: Site stream water quality results for water sampling on 22/09/2022. Values above discharge thresholds or receiving water thresholds in red, values above drinking water standards in blue, and elevated values of note in BOLD.**

| Field Parameters | Code | Units | | RS1 | RS2 | RSA1 | SC3 | Jean Creek | SC2 | SC1 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sampling time** | | | | 11:40 | 14:14 | 12:37 | 13:25 | 13:10 | 14:05 | 14:30 |
| **Water level** | | | | medium baseflow | medium baseflow | medium baseflow | medium baseflow | medium baseflow | medium baseflow | medium baseflow |
| **Water colour** | | | | clear | clear | red-orange | clear | clear | clear | clear |
| **Water odour** | | | | odourless | odourless | odourless | odourless | odourless | odourless | odourless |
| **Temperature** | Temp C | Degrees C | | 10.8 | 13.9 | 12.7 | 10.3 | 9.8 | 10.1 | 13.2 |
| **Dissolved oxygen** | DO % | % | | 95.4 | 98.6 | 27.4 | 100.2 | 99.1 | 99.6 | 107.3 |
| **Dissolved oxygen** | DO mg/l | mg/l | | 9.85 | 9.42 | 2.69 | 10.63 | 10.7 | 10.7 | 10.9 |
| **Electrical conductivity** | EC | uS/cm | | 164.4 | 135.5 | 505 | 268.7 | 412.2 | 323.3 | 410.1 |
| **pH** | pH | | | 7.57 | 7.77 | 7.15 | 8.2 | 8.56 | 8.46 | 8.44 |
| **Oxidation reduction potential** | ORP | mV | | 121.3 | 124.5 | -75.3 | -0.2 | 18.2 | 9.5 | 11.7 |

| Lab Analyses | Code | Units | PQL | RS1 | RS2 | RSA1 | SC3 | Jean Creek | SC2 | SC1 |
|---|---|---|---|---|---|---|---|---|---|---|
| **pH** | | pH | 1 | 7.8 | 7.7 | 8 | 8 | 8.4 | 8.2 | 8.3 |
| **Electrical Conductivity** | (EC) | µS/cm | 0.2 | 160 | 134 | 481 | 261 | 404 | 318 | 408 |
| **Total Alkalinity (CaCO3)** | | g CaCO3/m3 | 1 | 99.4 | 68.8 | 235 | 124 | 207 | 147 | 181 |
| **Chloride** | (Cl-) | g/m3 | 0.5 | 3.14 | 2.17 | 7.91 | 3.02 | 6.58 | 3.94 | 5.61 |
| **Sulfate** | (SO42-) | g/m3 | 0.15 | 2.74 | 1.77 | 17.5 | 12.7 | 12.9 | 18.6 | 34 |
| **Nitrate-N** | (NO3-N) | g/m3 | 0.002 | <0.0020 | 0.0092 | <0.0020 | **0.144** | 0.0158 | **0.144** | **0.124** |
| **Dissolved Reactive Phosphorus** | (DRP) | g/m3 | 0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | 0.004 |
| **Ammonia as N** | (NH3N) | g/m3 | 0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 |
| **Sodium** | (Na) | g/m3 | 0.01 | 5.57 | 4.6 | 15.5 | 6.59 | 13.3 | 9.15 | 10.9 |
| **Potassium** | (K) | g/m3 | 0.05 | 1.3 | 1 | 1.3 | 1.2 | 2 | 1.3 | 1.5 |
| **Calcium** | (Ca) | g/m3 | 0.05 | 23.8 | 19.9 | 69.6 | 38.3 | 58.2 | 45.4 | 57.1 |
| **Magnesium** | (Mg) | g/m3 | 0.01 | 4.61 | 3.68 | 18.6 | 9.69 | 15.6 | 12.3 | 17.9 |
| **Iron** | (Fe) | g/m3 | 0.005 | 0.066 | 0.015 | 0.08 | 0.021 | <0.0050 | 0.0065 | <0.0050 |
| **Zinc** | (Zn) | g/m3 | 0.001 | <0.0010 | <0.0010 | 0.0012 | <0.0010 | 0.0041 | <0.0010 | <0.0010 |
| **Manganese** | (Mn) | g/m3 | 0.0005 | 0.0059 | 0.00062 | 0.035 | 0.0042 | 0.00095 | 0.0012 | <0.00050 |
| **Sum of Anions*** | | meq/L | 0.01 | 2.15 | 1.48 | 5.35 | 2.87 | 4.73 | 3.53 | 4.59 |
| **Sum of Cations*** | | meq/L | 0.01 | 1.85 | 1.53 | 5.71 | 3.03 | 4.82 | 3.71 | 4.84 |
| **EC/10*** | (EC/10) | (mS/m)/10 | 0.002 | 1.6 | 1.34 | 4.81 | 2.61 | 4.04 | 3.18 | 4.08 |
| **Conductivity of Water** | | mS/m | 0.02 | 16 | 13 | 48 | 26 | 40 | 32 | 41 |
| **Total Kjeldahl Nitrogen** | (TKN) | g/m3 | 0.1 | 0.24 | 0.35 | **2.33** | 0.24 | 0.26 | 0.21 | 0.22 |
| **Total Phosphorus** | (TP) | g/m3 | 0.005 | 0.008 | 0.048 | 0.42 | 0.014 | <0.0050 | 0.0088 | 0.0064 |
| **Total Cyanide** | (CN) | g/m3 | 0.001 | <0.001 | 0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| **Total Organic Carbon** | (TOC) | g/m3 | 0.5 | 3.1 | 2.5 | 7.1 | 2.7 | 6.3 | 3.2 | 3.6 |

| Lab Analyses | Code | Units | PQL | RS1 | RS2 | RSA1 | SC3 | Jean Creek | SC2 | SC1 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Dissolved Organic Carbon*** | (DOC) | g/m3 | 0.5 | 3.6 | 2.5 | 7.1 | 2.6 | 6.2 | 3.2 | 3.7 |
| **Total Hardness** | | g eqv. CaCO3/m3 | 0.05 | 77 | 66 | 260 | 140 | 210 | 170 | 210 |
| **Total Dissolved Solids** | (TDS) | g/m³ | 3 | 116 | 102 | 310 | 174 | 272 | 212 | 286 |
| **Total Acidity to pH 8.3 (CaCO3)** | | g/m3 | 1.0 | 4 | 2 | 6 | 2 | <2.00 | 2 | 2 |
| **Arsenic** | (As) | g/m3 | 0.0005 | **0.028** | 0.0059 | **0.0761** | <0.00050 | 0.00069 | <0.00050 | 0.00074 |
| **Aluminium** | (Al) | g/m3 | 0.003 | <0.0030 | 0.011 | 0.0042 | 0.006 | 0.0039 | 0.0041 | <0.0030 |
| **Barium** | (Ba) | g/m3 | 0.0002 | 0.0106 | 0.0095 | 0.0189 | 0.0255 | 0.0258 | 0.0258 | 0.029 |
| **Beryllium** | (Be) | g/m3 | 0.00001 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 |
| **Bismuth** | (Bi) | g/m3 | 0.0001 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 |
| **Boron** | (B) | g/m3 | 0.01 | <0.010 | <0.010 | <0.010 | 0.023 | 0.024 | 0.024 | 0.029 |
| **Cadmium** | (Cd) | g/m3 | 0.00002 | <0.000020 | <0.000020 | <0.000020 | <0.000020 | <0.000020 | <0.000020 | <0.000020 |
| **Cobalt** | (Co) | g/m3 | 0.00001 | 0.000094 | 0.000077 | 0.00019 | 0.000057 | 0.00012 | 0.000065 | 0.000057 |
| **Chromium** | (Cr) | g/m3 | 0.0002 | <0.00020 | <0.00020 | 0.00073 | <0.00020 | <0.00020 | <0.00020 | <0.00020 |
| **Caesium** | (Cs) | g/m3 | 0.00001 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 |
| **Copper** | (Cu) | g/m3 | 0.0002 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | 0.003 | 0.001 | 0.001 |
| **Germanium** | (Ge) | g/m3 | 0.00005 | 0.00014 | <0.000050 | 0.000082 | <0.000050 | <0.000050 | <0.000050 | <0.000050 |
| **Mercury** | (Hg) | g/m3 | 0.00008 | <0.000080 | <0.000080 | <0.000080 | <0.000080 | <0.000080 | <0.000080 | <0.000080 |
| **Lanthanum** | (La) | g/m3 | 0.00001 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 |
| **Lithium** | (Li) | g/m3 | 0.00001 | 0.00228 | 0.00275 | 0.00646 | 0.0044 | 0.00785 | 0.0057 | 0.00756 |
| **Molybdenum** | (Mo) | g/m3 | 0.0002 | <0.00020 | <0.00020 | 0.00031 | 0.00031 | 0.00096 | 0.00044 | 0.00046 |
| **Nickel** | (Ni) | g/m3 | 0.0002 | 0.0005 | 0.00029 | 0.00041 | 0.00023 | 0.0003 | 0.0002 | 0.0003 |
| **Phosphorus** | (P) | g/m3 | 0.04 | <0.040 | <0.040 | 0.13 | 0.11 | 0.16 | 0.14 | 0.12 |
| **Lead** | (Pb) | g/m3 | 0.00005 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | 0.00044 | <0.000050 | <0.000050 |
| **Rubidium** | (Rb) | g/m3 | 0.00002 | 0.00026 | 0.00028 | 0.00047 | 0.00025 | 0.00022 | 0.00021 | 0.0002 |
| **Sulfur** | (S) | g/m3 | 10 | <10 | <10 | <10 | <10 | <10 | <10 | 13 |
| **Antimony** | (Sb) | g/m3 | 0.0001 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | 0.00037 | 0.00011 | 0.00012 |
| **Selenium** | (Se) | g/m3 | 0.0005 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | 0.00057 |
| **Tin** | (Sn) | g/m3 | 0.0002 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 | <0.00020 |
| **Strontium** | (Sr) | g/m3 | 0.0001 | 0.302 | 0.304 | 1.34 | 0.692 | 0.835 | 0.755 | 0.968 |

| Lab Analyses | Code | Units | PQL | RS1 | RS2 | RSA1 | SC3 | Jean Creek | SC2 | SC1 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Thallium** | (Tl) | g/m3 | 0.00001 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 | <0.000010 |
| **Uranium** | (U) | g/m3 | 0.00003 | 0.00011 | 0.00037 | 0.00219 | 0.0027 | 0.0055 | 0.00336 | 0.00492 |
| **Vanadium** | (V) | g/m3 | 0.0005 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 |
| **Yttrium** | (Y) | g/m3 | 0.00001 | 0.000016 | 0.00002 | 0.000014 | 0.000017 | 0.000029 | 0.000023 | 0.00003 |
| **Arsenic *** | (As) | g/m3 | 0.0005 | **0.038** | **0.012** | **0.243** | 0.00061 | 0.00086 | 0.0006 | 0.0011 |
| **Aluminium *** | (Al) | g/m3 | 0.003 | 0.037 | 0.38 | 0.0074 | 0.329 | 0.026 | 0.26 | 0.047 |
| **Barium *** | (Ba) | g/m3 | 0.0001 | 0.0131 | 0.0183 | 0.0263 | 0.0391 | 0.0337 | 0.038 | 0.0384 |
| **Beryllium *** | (Be) | g/m3 | 0.00001 | <0.000010 | 0.000024 | <0.000010 | <0.000010 | <0.000010 | 0.000011 | <0.000010 |
| **Bismuth *** | (Bi) | g/m3 | 0.0001 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 |
| **Boron *** | (B) | g/m3 | 0.005 | <0.0050 | <0.0050 | 0.01 | 0.029 | 0.031 | 0.034 | 0.034 |
| **Calcium *** | (Ca) | g/m3 | 0.05 | 23.4 | 20.1 | 71.2 | 38.6 | 58.3 | 45.9 | 55.2 |
| **Cadmium *** | (Cd) | g/m3 | 0.00002 | <0.000020 | <0.000020 | <0.000020 | <0.000020 | <0.000020 | <0.000020 | <0.000020 |
| **Cobalt *** | (Co) | g/m3 | 0.00001 | 0.00015 | 0.00032 | 0.00024 | 0.00029 | 0.00015 | 0.00021 | 0.0001 |
| **Chromium*** | (Cr) | g/m3 | 0.0002 | <0.00020 | 0.00029 | <0.00020 | 0.00038 | <0.00020 | 0.00041 | 0.00034 |
| **Caesium *** | (Cs) | g/m3 | 0.00001 | <0.000010 | 0.000068 | <0.000010 | 0.000061 | <0.000010 | 0.000047 | <0.000010 |
| **Copper *** | (Cu) | g/m3 | 0.0002 | 0.00055 | 0.0013 | 0.00035 | 0.00089 | 0.0014 | 0.00084 | 0.0043 |
| **Iron *** | (Fe) | g/m3 | 0.005 | 0.543 | 0.78 | 0.913 | 0.515 | 0.028 | 0.35 | 0.057 |
| **Germanium *** | (Ge) | g/m3 | 0.00005 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 | <0.000050 |
| **Mercury *** | (Hg) | g/m3 | 0.0001 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 |
| **Potassium *** | (K) | g/m3 | 0.05 | 1.3 | 1.2 | 1.3 | 1.4 | 2 | 1.4 | 1.5 |
| **Lanthanum *** | (La) | g/m3 | 0.00001 | 0.000047 | 0.00034 | 0.000012 | 0.00026 | 0.000027 | 0.00017 | 0.000047 |
| **Lithium *** | (Li) | g/m3 | 0.00001 | 0.00219 | 0.00286 | 0.00592 | 0.00451 | 0.00747 | 0.00605 | 0.00751 |
| **Magnesium *** | (Mg) | g/m3 | 0.01 | 4.45 | 3.71 | 18.8 | 9.57 | 15.9 | 12.5 | 17.5 |
| **Manganese *** | (Mn) | g/m3 | 0.0005 | 0.0538 | 0.028 | 0.051 | 0.034 | 0.0016 | 0.016 | 0.0025 |
| **Molybdenum *** | (Mo) | g/m3 | 0.0002 | <0.00020 | <0.00020 | 0.0003 | 0.00031 | 0.00097 | 0.00046 | 0.00045 |
| **Sodium *** | (Na) | g/m3 | 0.01 | 5.48 | 4.76 | 15.8 | 6.57 | 13.8 | 9.19 | 11.1 |
| **Nickel *** | (Ni) | g/m3 | 0.0002 | 0.00036 | 0.00061 | 0.00028 | 0.00042 | 0.00025 | 0.0004 | 0.00029 |
| **Phosphorus *** | (P) | g/m3 | 0.04 | <0.040 | <0.040 | 0.084 | <0.040 | <0.040 | <0.040 | <0.040 |
| **Lead *** | (Pb) | g/m3 | 0.00005 | 0.000095 | 0.00064 | <0.000050 | 0.00034 | <0.000050 | 0.00028 | 0.000073 |
| **Rubidium *** | (Rb) | g/m3 | 0.00005 | 0.0004 | 0.0016 | 0.00056 | 0.0012 | 0.0003 | 0.001 | 0.0004 |
| **Sulfur*** | (S) | g/m3 | 10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| **Antimony *** | (Sb) | g/m3 | 0.0001 | <0.00010 | 0.00011 | 0.00014 | 0.00013 | 0.0005 | 0.00019 | 0.00018 |
| **Selenium *** | (Se) | g/m3 | 0.001 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 | <0.0010 |
| **Tin *** | (Sn) | g/m3 | 0.0005 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 |
| **Strontium *** | (Sr) | g/m3 | 0.0001 | 0.349 | 0.306 | 1.38 | 0.719 | 0.847 | 0.793 | 0.98 |

| Lab Analyses | Code | Units | PQL | RS1 | RS2 | RSA1 | SC3 | Jean Creek | SC2 | SC1 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Thallium *** | (Tl) | g/m3 | 0.0001 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 | <0.00010 |
| **Uranium *** | (U) | g/m3 | 0.00003 | 0.0001 | 0.00028 | 0.0014 | 0.0017 | 0.00351 | 0.0022 | 0.0031 |
| **Vanadium *** | (V) | g/m3 | 0.0005 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 | <0.00050 |
| **Yttrium *** | (Y) | g/m3 | 0.00005 | <0.000050 | 0.0002 | <0.000050 | 0.00016 | <0.000050 | 0.00013 | 0.000052 |
| **Zinc *** | (Zn) | g/m3 | 0.003 | <0.0030 | 0.0052 | <0.0030 | <0.0030 | <0.0030 | <0.0030 | <0.0030 |
| *Denotes total recoverable metals while no asterisk indicates soluble trace elements | | | | | | | | | | |
| -- | | | | | | | | | | |
| Surface water sampling record<br>Date: 22-09-2022<br>Weather: Sunny and medium to high baseflow.<br>Location: Matakanui Gold subset of recommended stream baseline sampling sites. | | | | | | | | | | |

# 5 Ecological Values and Summary

The ecological values of the area surrounding the proposed MGL mining site and the nearby watersheds are associated with the overall stream habitat, and the macroinvertebrates present.

## 5.1 Fish Values

Electric fishing within both Rise and Shine and Shepherds Creeks (Figure 6) found no fish observed or caught. eDNA results corroborated this finding with no fish recordings for Rise and Shine and Shepherds Creeks. Fish eDNA was only identified at the lower Bendigo Creek site (eDNA-1 A&B) where kōaro, galaxiid (spp.) and brown trout markers were identified in both sampling events (see Table 10). These results may indicate fish are present within the Bendigo catchment, but not within the Rise and Shine sub-catchment. Bendigo Creek connectivity between this lower site (at eDNA-1) and upstream areas within the Rise and Shine catchment is possible; however, a fine-scale assessment along the entire stretch was not conducted at this time.

Overall surface water connectivity to the Clutha and Lindis Rivers for both creeks is historically evident. Terrain analysis for both Bendigo and Shepherds Creeks shows an incised stream network that flows out of the Dunstan Mountains, across the Bendigo Terrace ultimately joining the Clutha and Lindis Rivers above Lake Dunstan. However, inadequate flow for this connection was observed during the site visit. As discussed in Section 2.1, surface flow and overall stream connectivity is considered highly variable, seasonal and rainfall-dependant. Mapped streams can be perennial or intermittent in the area and can go to ground seasonally or consistently across reaches as a function of valley alluvium depths, local groundwater, abstraction and upstream flow. Surface water flow is typically intermittent across the valley with surface flows potentially reaching the Lindis and Clutha Rivers only during large events. Overall, the observed freshwater habitat within proposed mining sites appears suitable for native galaxiid fish species; however, there was no evidence of fish populations within this assessment.

## 5.2 Freshwater Habitat Values

Both Shepherds and Rise and Shine Creeks are dynamic surface features which provide freshwater resources that are integral to an arid to semi-arid landscape. The main stem and tributaries of both creeks navigate steep terrain before gradually meandering through the valley floor, connecting lowland areas along the way (see stream dimensions at time of sampling in Section 3.2.1 and relative flow levels in Figure 3). Currently, much of the area is heavily impacted by stock access, roads, historical mining operations, damming and abstraction. Despite these impacts, freshwater ecosystems persist and support the overall ecology of the area. Supplementary images of the area were supplied by MGL and can be found in Appendix D.

The creek beds and waterways support an ecological niche important to the overall value of the region. Native fish were not found within these creeks which may be a result of historic mining (Rise & Shine area), or reduced connectivity; however, both Shepherds and Rise & Shine Creeks could be considered suitable habitat for many native fish species. Channelised, shaded and gravel laden upper streams such as these provide favourable habitat for galaxiid's and other native fish. The NZFFD record for trout within upper Rise and Shine Creek was not validated by the eDNA or electric fishing effort undertaken as part of this assessment. The trout recorded at this location may have since been removed or died out due to insufficient water flow.

Macrophyte species observed were common, with the invasive *Lagarosiphon major* found within the lower reaches.

## 5.3 Macroinvertebrate Values

Overall, samples varied greatly in community health and diversity, with water quality classifications ranging from 'Good' to 'Poor' and from a 'B' to 'D' NPS-FW attribute band. This suggests a wide range of water quality and habitat conditions. The majority of samples contained one taxa of particular abundance, such as mayflies (*Deleatidium)*, non-biting midges (*Chironomidae)*, blackflies (*Austrosimulium),* mudsnails (*Potamopyrgus)* or oligochaete worms, resulting in low diversity and evenness scores in most samples. Most samples had a relatively high EPT taxa richness, however, with an equal amount of pollutant tolerant low scoring taxa present, resulting in predominantly moderate to low MCI scores.



## 5.4 Ecological Values Summary

**Table 12: Ecological values summary.**

| Ecological Values | Rise & Shine Creek | Shepherds Creek |
|---|---|---|
| **Presence of fish species** | No fish were identified via electric fishing nor eDNA sampling.<br><br>Fish species were recorded in the lower Bendigo Creek through eDNA analysis (site eDNA-1 A&B) and included kōaro, galaxiid (spp.) and brown trout. DOC recorded historic sightings of brown trout (*Salmo trutta*) in Rise & Shine Creek, however, this was not verified within the results of this assessment. | No fish were identified via electric fishing nor eDNA sampling. Fish passage was limited by overland water flow. |
| **Spawning habitat** | Habitat is favourable for fish spawning; however, no fish species were identified as present. | Habitat is favourable for fish spawning; however, no fish species were identified as present. |
| **Aquatic habitat** | The aquatic habitat present within the two catchments is consistent with a moderately healthy creek environment. The varied substrate combined with overhangs and vegetation could provide suitable habitat for native fish species. Macrophytes identified were common species, with the invasive *Lagarosiphon major* found present throughout the lower reaches. | |
| **Presence of macroinvertebrates** | Macroinvertebrate communities were sampled in 6 locations throughout Shepherds and Rise and Shine Creeks. The majority of samples had equally abundant pollutant tolerant (low scoring) taxa present, resulting in predominantly moderate to low MCI scores. Generally, samples varied in community health and diversity, with water quality classifications ranging from 'Good' to 'Poor' and from 'B' to 'D' NPS-FW attribute bands. | |

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**Appendices**

## Appendix A:

**WilderLab eDNA data interpretation guide**

# Interpreting eDNA results

WILDERLAB

**Your results will be provided in both an Excel and online format**

## 1 Excel spreadsheet - Made up of three tabs:

### Metadata

The job and sample information included on the sample submission form, including additional fields such as a passcode to access your online sample reports, any laboratory notes, and your account information.

### Aggregated

A simplified version of the results without DNA sequence barcodes and with one row for each unique taxon (i.e. species, genus, etc) found in the samples.

### Full

The full eDNA results including DNA sequence barcodes and the assay codes which sequences were detected on, with one row for each unique eDNA sequence found in the samples.

### Example of full results

| Sequence ① | Target ② | ScientificName | Rank | TaxID | CommonName | Group | 518902 ③ |
|---|---|---|---|---|---|---|---|
| ATCCTTGTTT | TP | Nasturtium officinale | species | 65948 | Watercress | Plants | 2366 |
| TCTTGCAGC | CI | Orthonychiurus folsomi | species | 2581074 | Springtail | Springtails | 1701 |
| TTAGCCCTA | RV | Homo sapiens | species | 9606 | Human | Mammals | 138 |
| TTTACTCTAA | WV | Lumbriculus variegatus | species | 61662 | Blackworm; California blackworm | Worms | 447 |
| TTTATCCGCA | CI | Deleatidium lillii | species | 1968926 | NZ mayfly | Insects | 761 |
| TCTTTCAGCT | CI | Coloburiscus humeralis | species | 241031 | NZ spinygilled mayfly | Insects | 545 |
| TTTATTTTTA | WV | Chaetogaster diaphanus | species | 212246 | Oligochaete worm | Worms | 118 |
| TTTATCTTAT | WV | Aulodrilus pluriseta | species | 76585 | Aquatic oligochaete worm | Worms | 71 |
| TTTAGACAC | WV | Galaxias brevipinnis | species | 66447 | Koaro | Fish | 121 |

④

① **Sequence**: This is a short stretch of DNA which can be used to identify different taxa, often referred to as 'sequence' or 'barcode'.

② **Target**: This is the code for the assay which the sequence was detected on.

③ **UID:** This header is your samples' unique identifying number and can be easily matched to your personally assigned sample names by referring to your Metadata sheet.

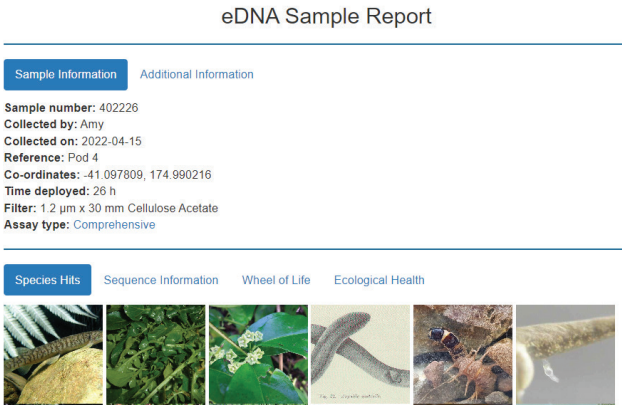
④ **Sequence count**: This is the number of times a unique sequence (Full sheet) or unique taxa (Aggregated sheet) was detected in each sample taken.

## 2 Online sample report

Each eDNA sample recieves an online sample report which can be viewed via the eDNA Explore Map. All sample reports are passcode protected (included on your Metadata tab), unless you specified to make them publicly accessible on the sample submission form.

These reports are a more interactive and visual way to explore, communicate and share your eDNA results. It includes lists of detected species with searching and filtering capabilities, detected species images, Biodiversity Wheels and ecological health insights.

These reports are also a living copy of your results, which are regularly updated as new sequence information is made available. For example, a sequence identified as 'Insect' today, could be refined to *Nesameletus*/Swimming mayfly tomorrow!




**We are always trying to find new ways to help you visualise and interpret your eDNA results, so the format and contents of these reports are ever evolving.**

## Understanding sequence counts

There are several factors which influence eDNA sequence counts including the distance of organisms from the sampling point, the presence of dead/decaying organisms, environmental factors which can speed up or slow down eDNA breakdown, and assay biases, which can lead to preferential detection of certain groups of organisms. Because of this, these counts can only loosely be used to predict the abundance/biomass of organisms in the local environment.

Interpretation of sequence counts can vary depending on the research question you are looking to ask of the dataset.

**Due to the high sensitivity of eDNA testing, a low sequence count in few replicate samples should be considered a tentative detection. Depending on the importance of the taxa, follow up eDNA sampling or similar biological survey should be used to determine presence or absence.**

## Unexpected detections or non-detections

Occasionally, some organisms that you had expected to find are not detected in your eDNA sample. This can occur if certain taxa are out of scope of our assays, missing from the reference database, or if insufficient replicates are taken. **For most applications, we recommend taking 6 replicate samples** at each sampling site to maximise the detection rate and reduce false negatives. There are usually several unidentified sequences which remain at the end of your sample results which are a combination of organisms not yet described or not yet in a reference database. These sequences can continue to be updated with new taxon information as new reference sequences become available, so the resolution of your data can continue to improve over time.

On the other hand, some organisms which you may not have expected to find are detected in your eDNA sample. Due to the sensitivity of eDNA testing, field gear, vehicles, run-off, and animal faeces, are all potential pathways for DNA to be introduced into your sampling area. This is when local knowledge and context of the site is particularly important and can be used alongside your understanding of sequence counts to reduce misinterpretation and false positives.

**It is very helpful for us if you let us know if you notice any taxa that might be missing (e.g. found in high abundance near the sampling site), as we can often use this information to improve our assay panel and reference database for the future.**

## Broader ecological insights

We have been hard at work optimising our new riverine ecological health index, the taxon-independent community index (TICI), and it is now available for any river/stream sample processed with our comprehensive assay panel.

The TICI is similar to the New Zealand's macroinvertebrate community index (MCI), except the tolerance values have been assigned to DNA sequences from across the tree of life, instead of just invertebrate taxa. Read more about the TICI here.

| TICI score | TICI value |
|---|---|
| < 80 | Very Poor |
| 80 – 90 | Poor |
| 90 – 100 | Average |
| 100 – 110 | Good |
| 110 – 120 | Excellent |
| > 120 | Pristine |

## To help interpret the TICI score we include:

**TICI nseqs:** The number of individual indicator sequences included in the TICI score.

**TICI reliability:** The reliability/robustness of the score as determined by the number of composite tolerance values.

**TICI quantile:** This indicates the position of your score amongst 52 well known river sites around the country (taken as part of a national eDNA trial carried out by Aotearoa's regional councils 2021/2022).

**TICI rating:** Qualitative value which aligns with the MCIhb scoring system.

**TICI dial:** On your online sample report, you can find a visual dial to report your TICI score.

# Assays

**We use a wide panel of general and specific primers to target a range of taxonomic groups in an ecosystem.**

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## Basic assay package:

1. **RV:** Vertebrates including fish, birds, mammals, amphibians and reptiles
2. **WV:** Vertebrates, worms and jellies
3. **LV:** Fish, birds and mammals
4. **DG:** Fish and some insects
5. **ZC:** Insects and crustaceans
6. **CI:** Insects, occasionally kōura and freshwater mussels/kākahi

### Species in scope:

**Freshwater fish**: All of Aotearoa's extant freshwater fish species are represented in our reference sequence database and are in scope.

**Mammals**: All mammal species in Aotearoa are included and in scope including both native pekapeka/bats.

**Birds**: Around half of Aotearoa's bird species are represented in our reference sequence database. Australasian bittern, spotless crake, whio, kākāpō, takahē and kōkako are included.

**Frogs and reptiles**: Hochstetter's, Archey's and Hamilton's frogs are included and in scope. Around half of our native skinks and geckos are included in the reference database. Red-eared slider turtles are included and in scope. *Note: amphibians and reptiles can be more difficult to detect than other vertebrates as they don't interact with water as predictably.*

**Aquatic invertebrates:** Around 70% of the ~700 species of aquatic insects listed in a recent paper are included in our reference database and in scope. We are working to collect specimens to sequence for the remaining species.

Freshwater kōura are slightly out of scope of the standard animal assays; we do detect them, but generally only at very high abundance. We are currently exploring new assays to better detect these important species.

## Comprehensive assay package - Includes all six assays and target organisms from basic package, plus an additional six:

7. **TP:** Vascular plants and algae
8. **MZ:** Vascular plants and algae
9. **EA:** *Echyridella* freshwater mussels/kākahi
10. **BE:** Eukaryotes, primarily phytoplankton and zooplankton
11. **BU:** Eukaryotes, primarily phytoplankton and zooplankton
12. **UM:** Bacteria

### Species in scope:

**Invasive macrophytes**: Alligator weed, *Lagarosiphon, Elodea, Egeria,* Hornwort and *Hydrilla* are all represented in our reference sequence database and in scope.

**Invasive diatoms**: Didymo and *Lindavia* are both included and in scope.

**Freshwater bivalves:** *Echyridella*/kākahi and *Pisidium* are both in scope.

**Broader ecological health assessment**: Any river samples processed with our comprehensive assay package also includes our ecological health index score, the TICI, to provide an overall indication to the quality of health.

If you are unsure whether a particular target organism is in scope of any of our assays, or have any other questions or feedback, please feel free to get in touch by emailing info@wilderlab.co.nz.

## Appendix B:

**WilderLab eDNA passive sampling kit - procedures**

# eDNA Peg–mount Instructions

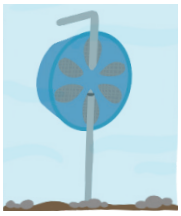
WILDERLAB

## Deploying the passive sampler:

1

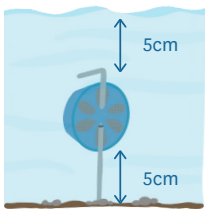
Put on a pair of gloves and check that the peg-mount is threaded through the filter pod, with the o-ring seated just below the pod.

2



Carefully push the peg into the stream bed, ideally in an area of moderate to high flow, with the leaf guard facing forward.

3




Ensure the peg is firmly in the stream bed with the filter at least 5cm above the bed, and 5 cm underneath the water surface.

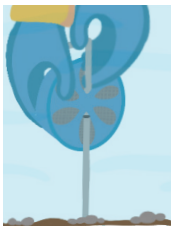
4


Record the location co-ordinates in WGS84 decimal format (for example -41.30951, 174.82110 as displayed on Google Maps).

**Leave the sampler deployed for 24 hours.**

## Retrieving the passive sampler:

1



Put on your remaining pair of gloves and pull the peg out of the stream bed. Make sure you don't lose the pod.

2

Pointing the leaf guard to the ground, pull on the easy-pull tag protruding from the back of the filter pod to remove the sponge filter. This motion squeezes out excess water from the sponge filter.

3

Avoid touching the filter directly. Holding the tag, flick the filter in a downward motion to rid the filter of even more excess water.

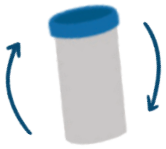
4

Take the sample jar out of the kit and place only the sponge filter in the sample jar.

5

Take out the small syringe containing preservative and unscrew the cap. Dispense all preservative into the sample jar containing the filter.

6



Screw the jar lid on tightly, then shake the sample jar well to ensure distribution of the preservative throughout the filter.

7

Put the sample jar into the sample bag, and complete the sample information on the back of the bag.

**If you would like more information including instructional videos, please scan the code to visit wilderlab.co.nz/directions**

## Submit your samples online at wilderlab.co.nz/submit-samples

Print and sign the chain of custody (CoC) form that has been emailed to you after sample submission. Include this in the parcel containing your samples (no refrigeration necessary).

**Send the samples by standard courier to:**

Wilderlab NZ Ltd
Level 2, 129 Park Road
Miramar
Wellington 6022

**Small packages can be sent by post to:**

Wilderlab NZ Ltd
PO Box 15059
Miramar
Wellington 6243

# Ngā tohutohu mō te tīpako hāngū pou

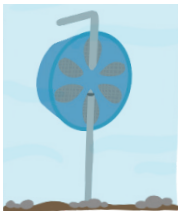
WILDERLAB

## Te whakamahi i te tīpako hāngū:

1

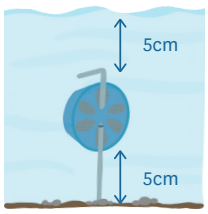
Kuhuna ngā karapu ka tirotiro mēnā kua tuia te pou piringa tia ki te pūoto tātari, me te ringi-o e noho ana i raro tata i te pūoto.

2



Āta poua te tia ki te papa o te awa, ki tētahi wāhi ngāwari te rere tae atu ki te kaha rere o te wai, me te ārai rau e anga whakamua ana.

3




Me whakarite kei roto pū te tia i te papa awa, ā, me 5cm neke atu rānei te tātari i runga ake i te papa awa, me te 5cm ki raro iho i te mata o te wai.

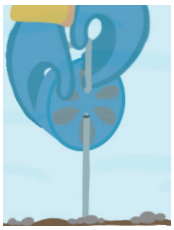
4


Tuhia ngā taunga tauwāhi mā te hōputu ā-ira WGS84 (hei tauira -41.30951, 174.82110 e whakaaturia ana ki Google Maps).

**Waiho te tīpako ki te mahi i tana mahi mō te 24 haora.**

## Te tiki i te tīpako hāngū:

1



Kuhuna ngā karapu e toe ana, ka hūtia te tia i te papa o te awa. Kia tūpato kei ngaro te pūoto.

2

Me anga te ārai rau ki te papa kātahi ka kūmea te raukume māmā mai i muri o te pūoto tātari hei tango i te tātari hautai. Mā tēnā ka kōtētē i te toenga wai i te tātari hautai.

3

Kaua e pā tika ki te tātari. Me pupuri i te raukume me te piu i te tātari ki raro hei tango i te nuinga o te toenga wai.

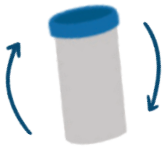
4

Tangohia te ipu tīpako i te kete, ka rau i te tātari hautai anake ki te ipu tīpako.

5

Tangohia te pūwero iti e pupuri ana i te tāroki, ka tango i te taupoki. Tukuna te tāroki katoa ki te ipu tīpako e pupuri ana i te tātari.

6



Kia kaha te whakamau i te taupoki, ka rurerure i te ipu tīpako kia pai ai te horapa o te tāroki ki te tātari.

7

Raua te ipu tīpako ki te pēke tīpako, ka whakaoti i ngā mōhiohio tīpako ki te taha whakamuri o te pēke.

**Ina hiahia koe i ētahi atu whakamārama, tae atu ki ngā ataata tohutohu, tēnā matawaitia te waehere e tae atu ai koe ki Wilderlab.co.nz/directions**

## Tukuna ō tīpako mā te ipurangi ki Wilderlab.co.nz/submit-samples

Tāia, kātahi ka waitohu i te puka tuinga tautiaki (CoC) kua īmēratia ki a koe i muri i te tukunga o tō tīpako. Tāpiritia tēnei ki te pāhara o ō tīpako (kāore he take o te pouaka mātao).

**Tukua ngā tīpako mā te karere kawe ki:**

Wilderlab NZ Ltd
Level 2, 129 Park Road
Miramar
Wellington 6022

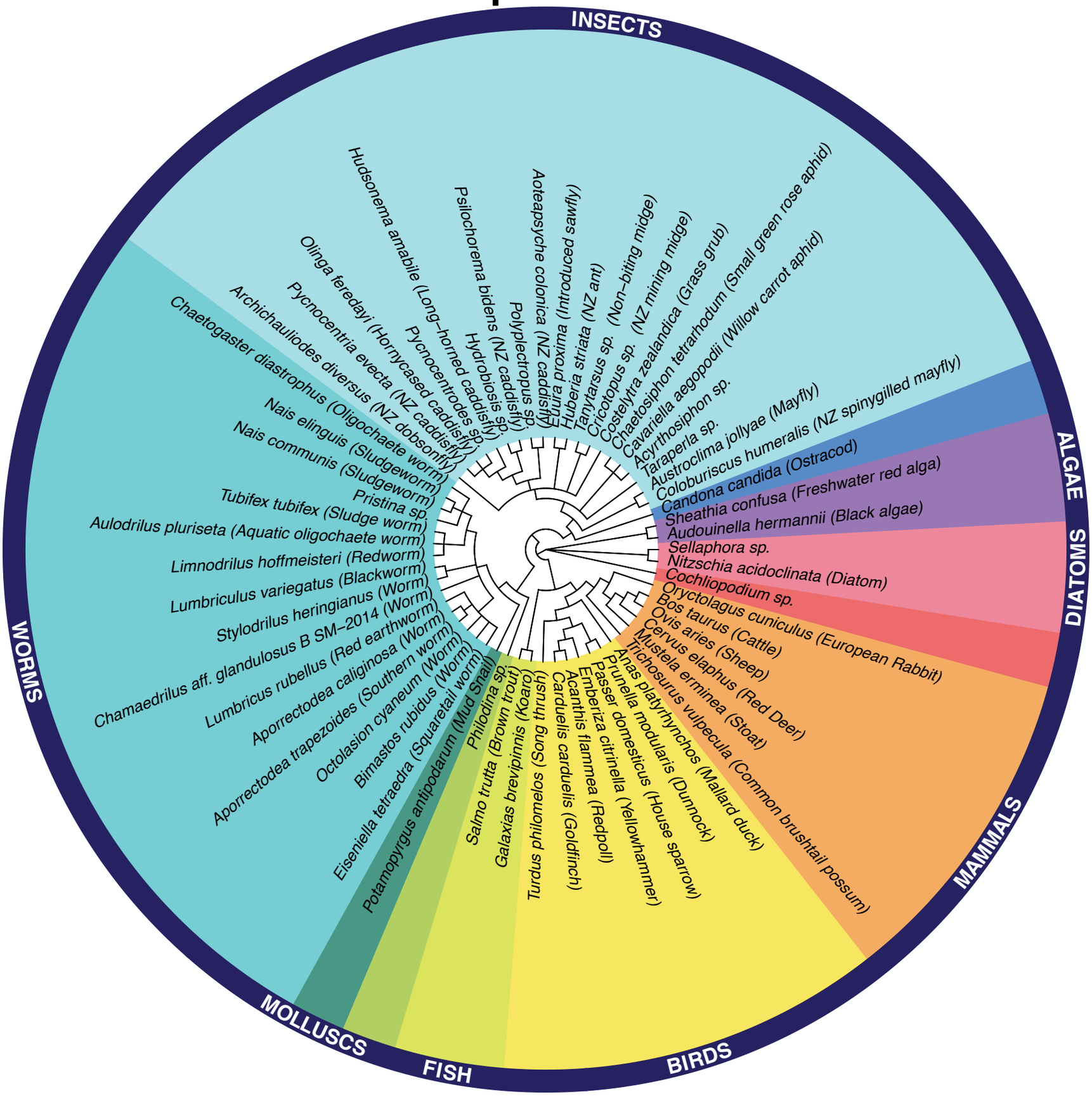
**Ka taea te tuku i ngā pāhara iti mā te pōhi ki:**

Wilderlab NZ Ltd
PO Box 15059
Miramar
Wellington 6243

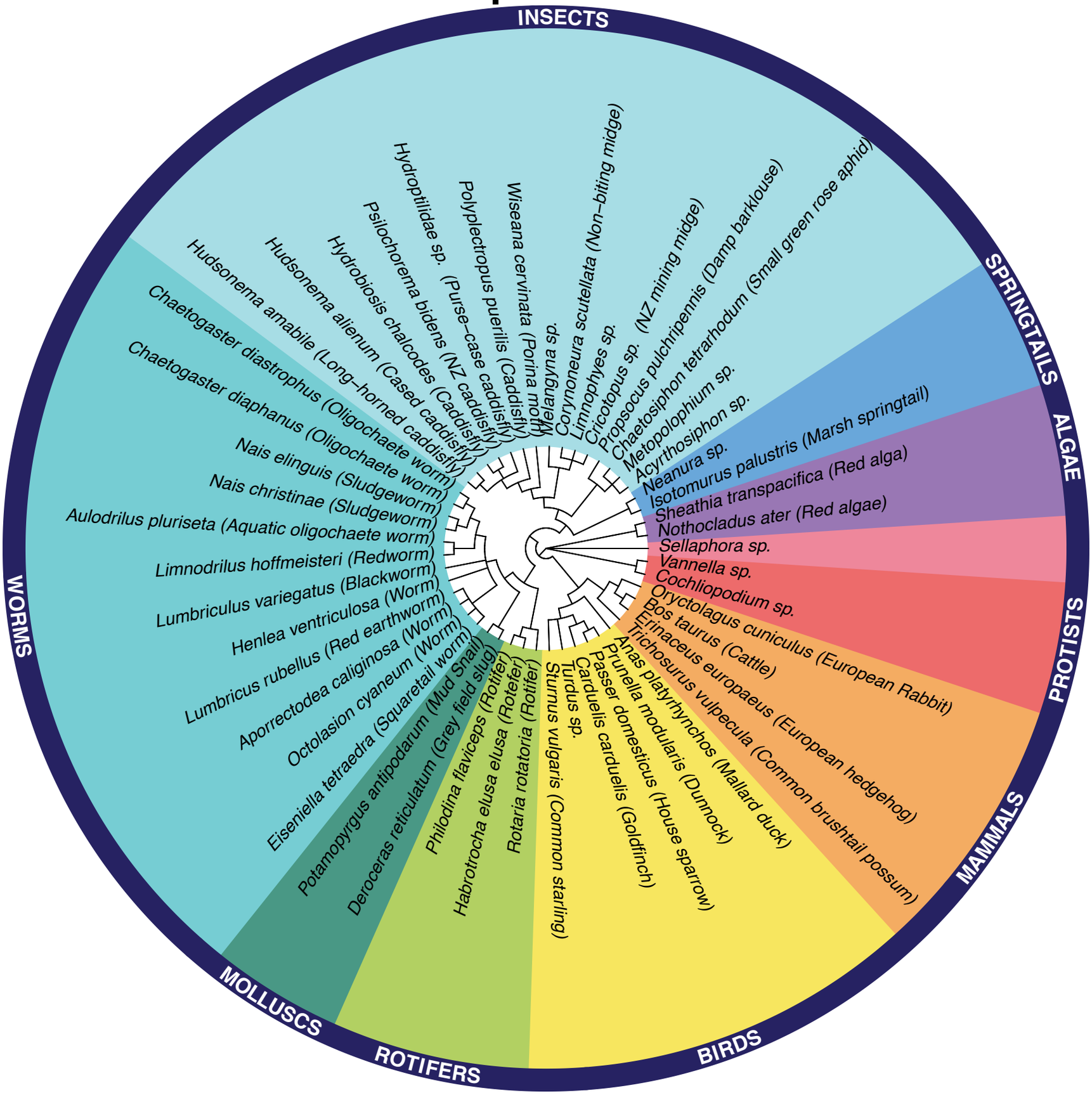
## Appendix C:

**WilderLab eDNA analysis results**

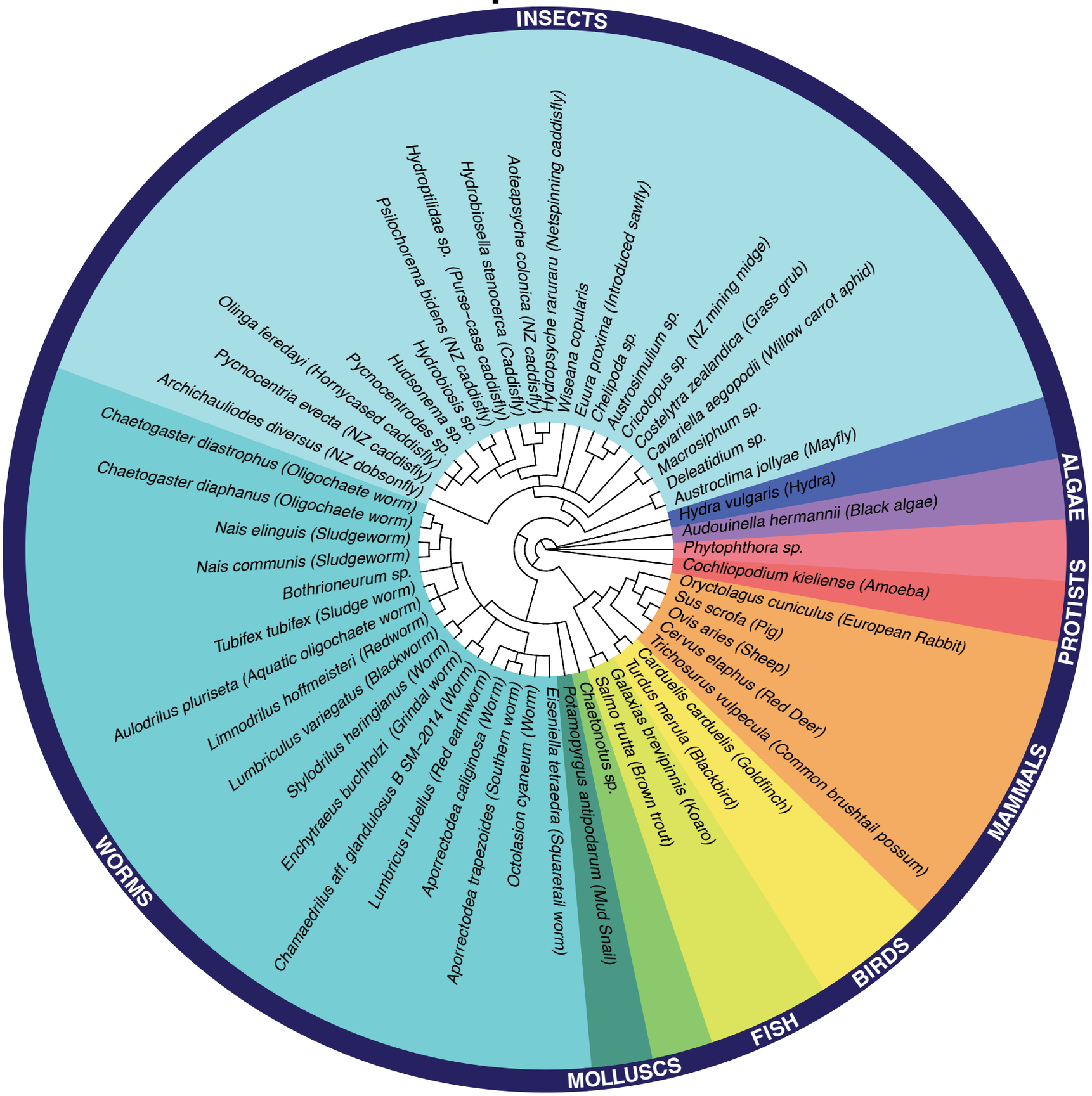
# Sample 411369



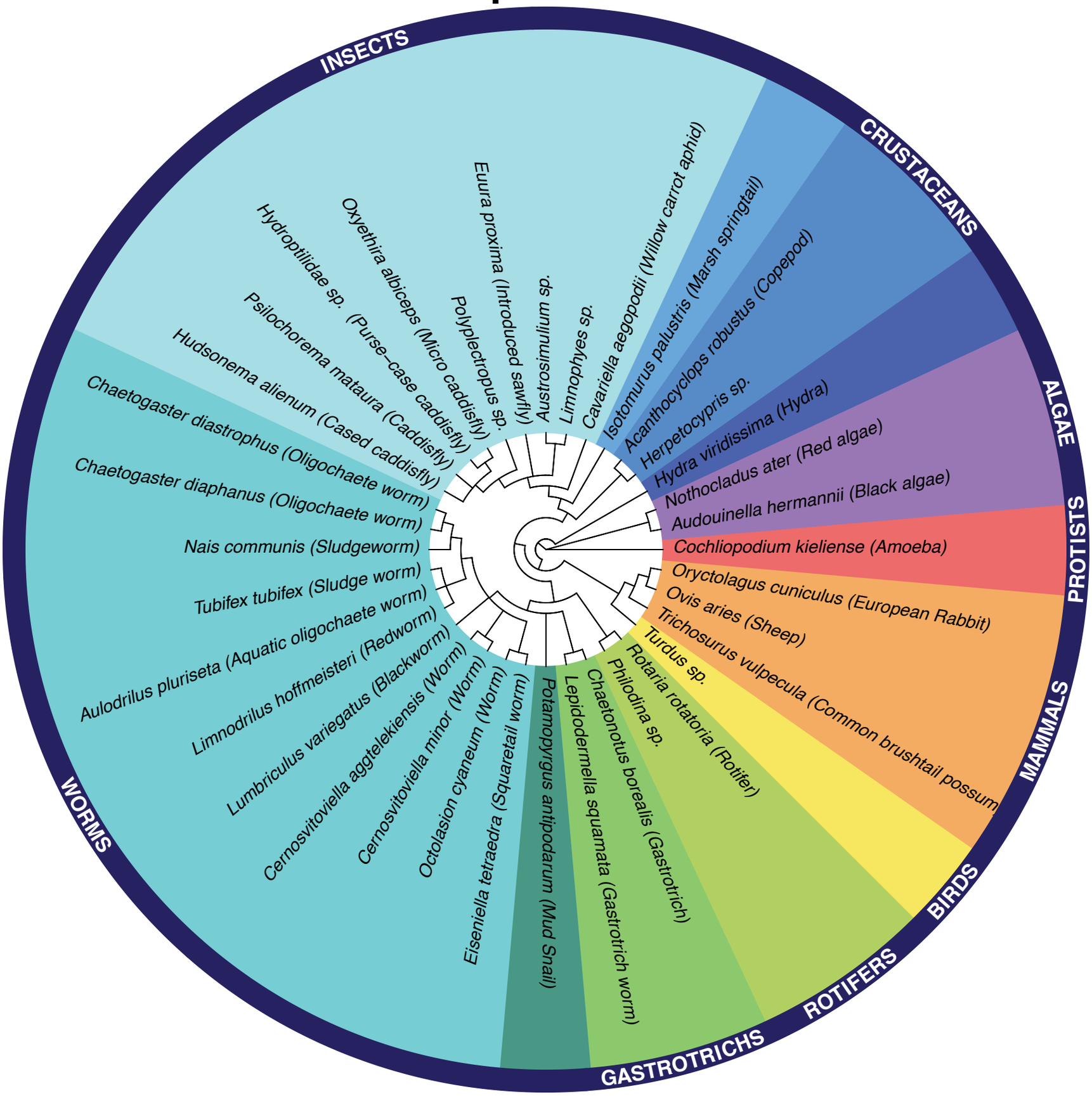
# Sample 411372



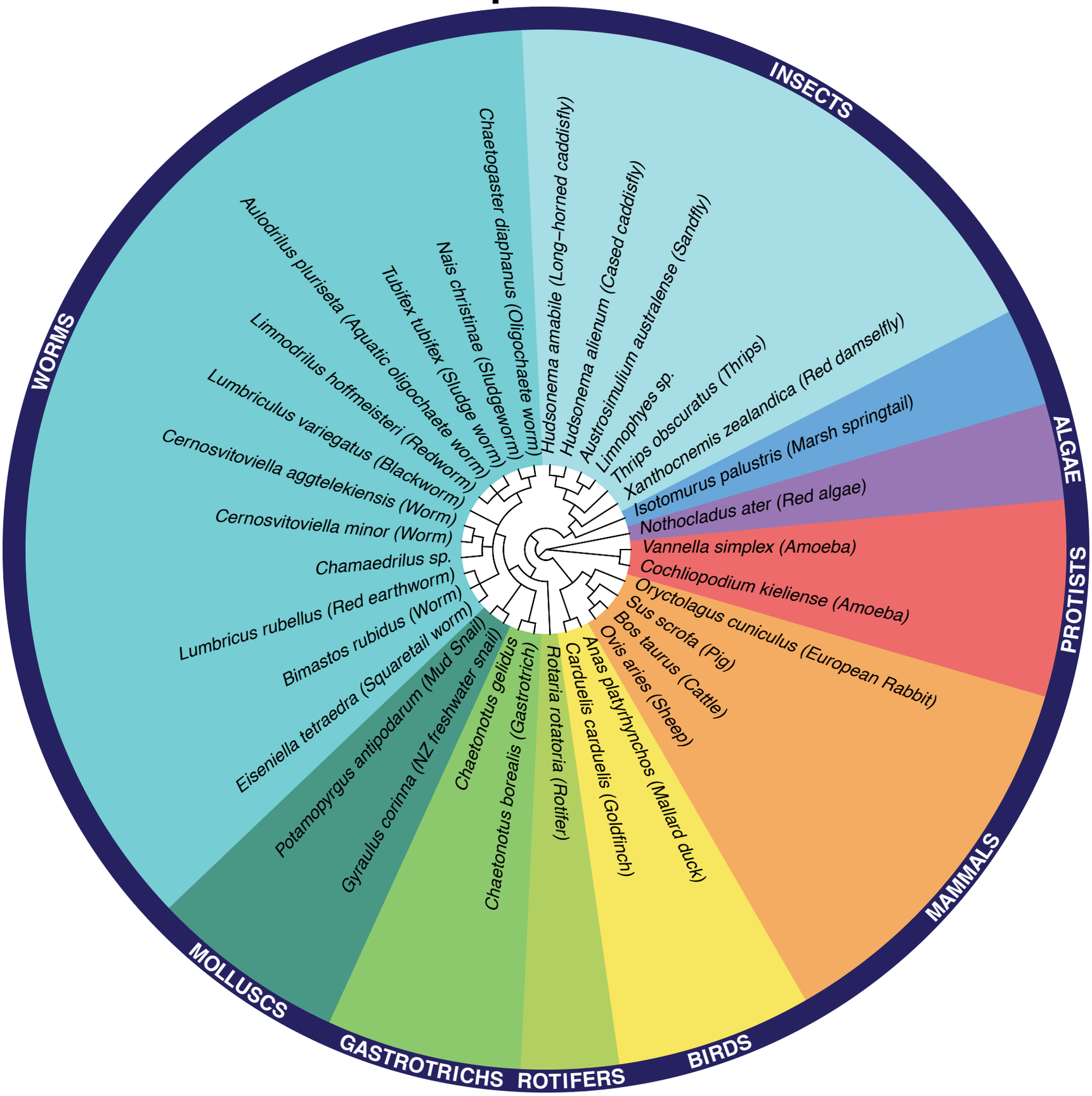
# Sample 411772



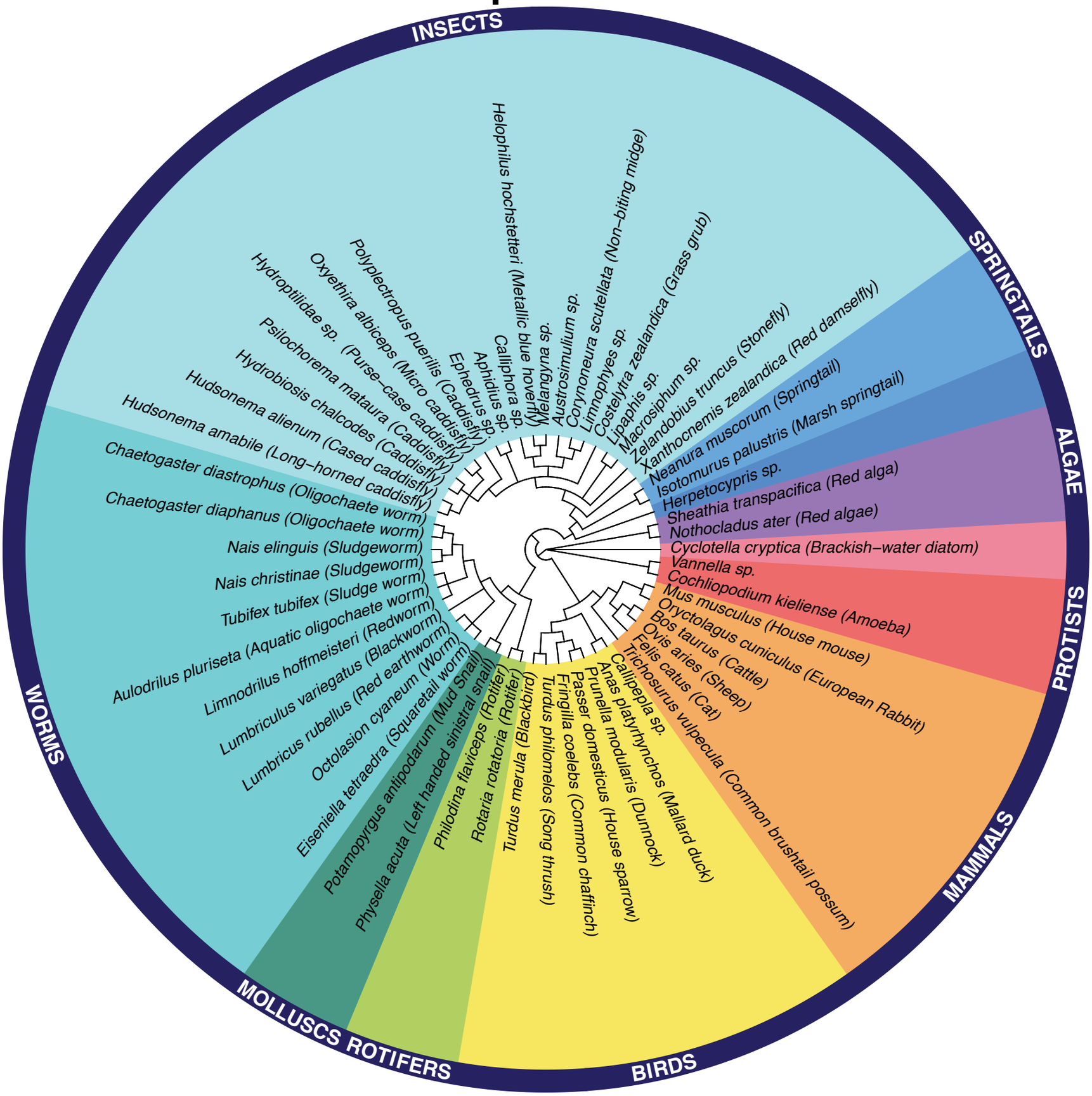
# Sample 411773



# Sample 411774



# Sample 411775



## Appendix D:

**Client provided supplementary images**

**View from the Crest of the Dunstan Range looking down Rise & Shine (upper Bendigo) creek. Image dated: 29 January 2023 at 06:23 (Image supplied by MGL).**

**View from the Crest of the Dunstan Range looking down Shepherds creek. Image dated: 29 January 2023 at 06:23 (Image supplied by MGL).**

**View of an upper Rise & Shine tributary (upper Bendigo). Image dated: 29 January 2023 at 06:23 (Image supplied by MGL).**