Cold Creek Community Water Supply Ltd Monitoring Programme Annual Report 2017-2018

Technical Report 2018-48

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Executive summary

The Cold Creek Community Water Supply Ltd (CCCWSL) operates a rural water supply scheme located on Cold Creek[1], Kiri Road, in the Taungatara catchment. The report for the period July 2017 to June 2018 describes the monitoring programme implemented by the Taranaki Regional Council (the Council) to assess CCCWSL's environmental and consent compliance performance during the period under review. The report also details the results of the monitoring undertaken and assesses the environmental effects of the Company's activities.

CCCWSL holds three resource consents, which include a total of 27 conditions setting out the requirements that they must satisfy. CCCWSL holds one consent to allow it to take and use water, one consent to discharge filter back wash and one consent to maintain a weir.

During the monitoring period CCCWSL demonstrated a good level of environmental performance.

The Council's monitoring programme for the year under review included one inspection, one discharge sample, four river gaugings, and a review of water abstraction and stream flow data.

The monitoring showed that CCCWSL compiled with consent conditions in regards to discharge standards and abstraction rates, however during the monitoring period it was noted that instream stage and flow data was not being recorded as per consent conditions. A review of the data found that there had been significant issues in regards to data accuracy, equipment management, and equipment failure. An abatement notice was issued in regard to the CCCWSL not notifying the Council of equipment failure and an infringement notice was issued for breaches in regards to missing stream flow data and the inaccuracies in the data provided. There were also some minor issues in regards to missing data from the abstraction record.

During the year, CCCWSL demonstrated a good level of environmental and a poor level of administrative performance with the resource consents.

For reference, in the 2017-2018 year, consent holders were found to achieve a high level of environmental performance and compliance for 76% of the consents monitored through the Taranaki tailored monitoring programmes, while for another 20% of the consents, a good level of environmental performance and compliance was achieved.

In terms of overall environmental and compliance performance by the consent holder over the last several years, this report shows that the consent holder's performance has reduced.

This report includes recommendations for the 2018-2019 year.

[1] Cold Creek is otherwise known as Cold Stream. For the purposes of this report all references to the water body in question will be using the former, or 'Cold Creek'.

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1 Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1 Introduction

This report is for the period July 2017 to June 2018 by the Council describing the monitoring programme associated with resource consents held by Cold Creek Community Water Supply Ltd (CCCWSL) associated with the operation of a rural water supply scheme situated on Kiri Road, Opunake.

This report covers the results and findings of the monitoring programme implemented by the Council in respect of the consents held by CCCWSL that relate to abstractions and discharges of water in the Taungatara catchment. This is the second annual report to be prepared by the Council to cover CCCWSL's water abstractions and structures. Previously this activity was reported in the joint South Taranaki Water Supplies report.

1.1.2 Structure of this report

Section 1 of this report is a background section. It sets out general information about:

- consent compliance monitoring under the RMA and the Council's obligations;
- the Council's approach to monitoring sites though annual programmes;
- the resource consents held by CCCWSL in the Taungatara catchment;
- the nature of the monitoring programme in place for the period under review; and
- a description of the activities and operations conducted by CCCWSL.

Section 2 presents the results of monitoring during the period under review, including scientific and technical data.

Section 3 discusses the results, their interpretations, and their significance for the environment.

Section 4 presents recommendations to be implemented in the 2017-2018 monitoring year.

A glossary of common abbreviations and scientific terms, and a bibliography, are presented at the end of the report.

1.1.3 The Resource Management Act 1991 and monitoring

The RMA primarily addresses environmental 'effects' which are defined as positive or adverse, temporary or permanent, past, present or future, or cumulative. Effects may arise in relation to:

a. the neighbourhood or the wider community around an activity, and may include cultural and social-economic effects;
b. physical effects on the locality, including landscape, amenity and visual effects;
c. ecosystems, including effects on plants, animals, or habitats, whether aquatic or terrestrial;
d. natural and physical resources having special significance (for example recreational, cultural, or aesthetic); and
e. risks to the neighbourhood or environment.

In drafting and reviewing conditions on discharge permits, and in implementing monitoring programmes, the Council is recognising the comprehensive meaning of 'effects' inasmuch as is appropriate for each activity. Monitoring programmes are not only based on existing permit conditions, but also on the

obligations of the RMA to assess the effects of the exercise of consents. In accordance with Section 35 of the RMA, the Council undertakes compliance monitoring for consents and rules in regional plans, and maintains an overview of the performance of resource users and consent holders. Compliance monitoring, including both activity and impact monitoring, enables the Council to continually re-evaluate its approach and that of consent holders to resource management and, ultimately, through the refinement of methods and considered responsible resource utilisation, to move closer to achieving sustainable development of the region's resources.

1.1.4 Evaluation of environmental and administrative performance

Besides discussing the various details of the performance and extent of compliance by the CCCWSL, this report also assigns them a rating for their environmental and administrative performance during the period under review.

Environmental performance is concerned with actual or likely effects on the receiving environment from the activities during the monitoring year. Administrative performance is concerned with CCCWSL's approach to demonstrating consent compliance in site operations and management including the timely provision of information to Council (such as contingency plans and water take data) in accordance with consent conditions.

Events that were beyond the control of the consent holder and unforeseeable (that is a defence under the provisions of the RMA can be established) may be excluded with regard to the performance rating applied. For example loss of data due to a flood destroying deployed field equipment.

The categories used by the Council for this monitoring period, and their interpretation, are as follows:

Environmental Performance

High: No or inconsequential (short-term duration, less than minor in severity) breaches of consent or regional plan parameters resulting from the activity; no adverse effects of significance noted or likely in the receiving environment. The Council did not record any verified unauthorised incidents involving significant environmental impacts and was not obliged to issue any abatement notices or infringement notices in relation to such impacts.

Good: Likely or actual adverse effects of activities on the receiving environment were negligible or minor at most. There were some such issues noted during monitoring, from self reports, or in response to unauthorised incident reports, but these items were not critical, and follow-up inspections showed they have been dealt with. These minor issues were resolved positively, co-operatively, and quickly. The Council was not obliged to issue any abatement notices or infringement notices in relation to the minor non-compliant effects; however abatement notices may have been issued to mitigate an identified potential for an environmental effect to occur.

For example:

- High suspended solid values recorded in discharge samples, however the discharge was to land or to receiving waters that were in high flow at the time;
- Strong odour beyond boundary but no residential properties or other recipient nearby.

Improvement required: Likely or actual adverse effects of activities on the receiving environment were more than minor, but not substantial. There were some issues noted during monitoring, from self reports, or in response to unauthorised incident reports. Cumulative adverse effects of a persistent minor non-compliant activity could elevate a minor issue to this level. Abatement notices and infringement notices may have been issued in respect of effects.

Poor: Likely or actual adverse effects of activities on the receiving environment were significant. There were some items noted during monitoring, from self reports, or in response to unauthorised incident reports. Cumulative adverse effects of a persistent moderate non-compliant activity could elevate an 'improvement required' issue to this level. Typically there were grounds for either a prosecution or an infringement notice in respect of effects.

Administrative performance

High: The administrative requirements of the resource consents were met, or any failure to do this had trivial consequences and was addressed promptly and co-operatively.

Good: Perhaps some administrative requirements of the resource consents were not met at a particular time, however this was addressed without repeated interventions from the Council staff. Alternatively adequate reason was provided for matters such as the no or late provision of information, interpretation of 'best practical option' for avoiding potential effects, etc.

Improvement required: Repeated interventions to meet the administrative requirements of the resource consents were made by Council staff. These matters took some time to resolve, or remained unresolved at the end of the period under review. The Council may have issued an abatement notice to attain compliance.

Poor: Material failings to meet the administrative requirements of the resource consents. Significant intervention by the Council was required. Typically there were grounds for an infringement notice.

For reference, in the 2017-2018 year, consent holders were found to achieve a high level of environmental performance and compliance for 76% of the consents monitored through the Taranaki tailored monitoring programmes, while for another 20% of the consents, a good level of environmental performance and compliance was achieved.

1.2 Process description

Cold Creek Community Water Supply Ltd (CCCWS) covers 7,700 Ha, it includes about 150 dairy farms, 20,000 cows, 350 people and a number of smaller farms. Water is abstracted from the Cold Creek via gravity fed intake screen on a weir. The water is passed to the treatment plant where it is filtered and then chlorinated. The sand filter is backwashed approximately every nine hours to settling ponds that discharge back into Cold Creek. Water usage includes irrigation, dairy shed operations stock watering and domestic use.

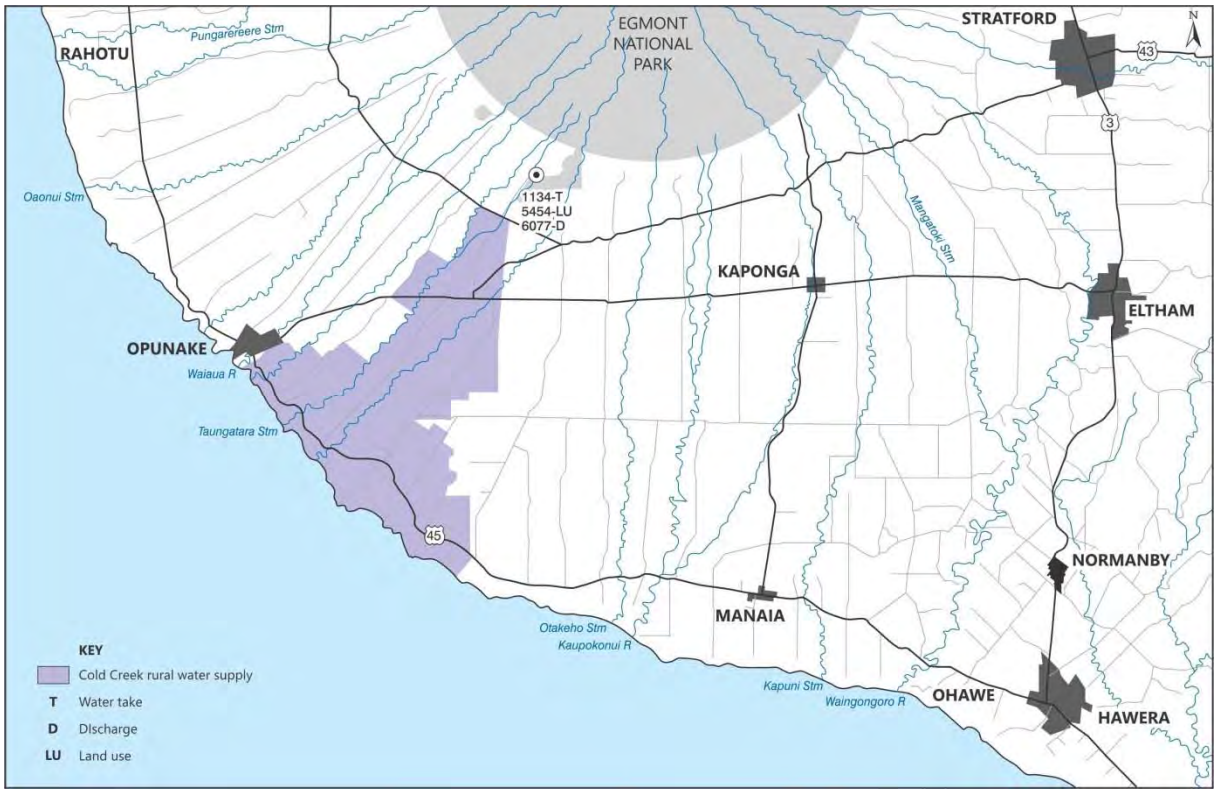

Figure 1 CCCWSL's water service area

Photo 1 CCCWSL's weir and intake screen

1.3 Resource consents

1.3.1 Water abstraction permit

Section 14 of the RMA stipulates that no person may take, use, dam or divert any water, unless the activity is expressly allowed for by a resource consent or a rule in a regional plan, or it falls within some particular categories set out in Section 14.

CCCWSL holds water permit **1134 to** take water from Cold Creek to supply the CCCWSL treatment plant. This permit was issued by the Council on 14 January 2016 under Section 87(d) of the RMA. It is due to expire on 1 June 2030.

It has thirteen special conditions.

Special conditions one and two set abstraction rate limits.

Special conditions three to eight deal with the measurement, recording and transmission of abstraction and river flow data.

Special condition nine deals with residual flow and limits water use in low flow conditions.

Special condition ten requires the intake to be screened.

Special condition eleven requires best practice to be adopted.

Special condition twelve requires an annual water efficiency and conservation report.

Special condition thirteen is a review condition.

The permit is attached to this report in Appendix I.

This summary of consent conditions may not reflect the full requirements of each condition. The consent conditions in full can be found in the resource consents which are appended to this report.

1.3.2 Water discharge permit

Section 15(1)(a) of the RMA stipulates that no person may discharge any contaminant into water, unless the activity is expressly allowed for by a resource consent or a rule in a regional plan, or by national regulations.

CCCWSL holds water discharge permit **6077** to discharge filter backwash water and supernatant from the Cold Creek water treatment plant into the Cold Creek in the Taungatara catchment. This permit was issued by the Council on 29 November 2002 under Section 87(e) of the RMA. It is due to expire on 1 June 2018.

It has five special conditions.

Special conditions one and two deal with the location and rate of discharge.

Special conditions three and four deal with limitation of contaminant concentrations in the discharge and effects on receiving waters.

Special condition five is a review condition.

The permit is attached to this report in Appendix I.

This summary of consent conditions may not reflect the full requirements of each condition. The consent conditions in full can be found in the resource consents which are appended to this report.

1.3.3 Land use permits

Section 13(1)(a) of the RMA stipulates that no person may in relation to the bed of any lake or river use, erect, reconstruct, place, alter, extend, remove, or demolish any structure or part of any structure in, on,

under, or over the bed, unless the activity is expressly allowed for by a resource consent, a rule in a regional plan, or by national regulations.

CCCWSL holds land use permit **5454** to erect, place, use and maintain a water intake structure on the bed of Cold Creek in the Taungatara catchment for water abstraction purposes. This permit was issued by the Council on 1 March 1999 under Section 87(a) of the RMA. It is due to expire on 1 June 2018.

It has nine special conditions.

Special condition one requires that the Council be notified prior to any maintenance work.

Special condition two requires the weir be operated according to information supplied in the application.

Special condition three to five deals with maintenance works.

Special conditions six and seven deal with fish passage and monitoring of fish populations.

Special condition eight deals with the removal of the weir once it is no longer needed.

Special condition nine is a review condition.

The permit is attached to this report in Appendix I.

This summary of consent conditions may not reflect the full requirements of each condition. The consent conditions in full can be found in the resource consents which are appended to this report.

1.4 Monitoring programme

1.4.1 Introduction

Section 35 of the RMA sets obligations upon the Council to gather information, monitor and conduct research on the exercise of resource consents within the Taranaki region. The Council is also required to assess the effects arising from the exercising of these consents and report upon them.

The Council may therefore make and record measurements of physical and chemical parameters, take samples for analysis, carry out surveys and inspections, conduct investigations and seek information from consent holders.

The monitoring programme for the CCCWSL site consisted of five primary components.

1.4.2 Programme liaison and management

There is generally a significant investment of time and resources by the Council in:

- ongoing liaison with resource consent holders over consent conditions and their interpretation and application;
- in discussion over monitoring requirements;
- preparation for any consent reviews, renewals or new consent applications;
- advice on the Council's environmental management strategies and content of regional plans; and
- consultation on associated matters.

1.4.3 Site inspections

The CCCWSL site was visited on one occasion to conduct an annual inspection. With regard to consents for the abstraction of or discharge to water, the main points of interest were plant processes with potential or actual discharges to receiving watercourses, including contaminated stormwater and process wastewaters. Sources of data being collected by CCCWSL were identified and accessed, so that performance in respect of

operation, internal monitoring, and supervision could be reviewed by the Council. The neighbourhood was surveyed for environmental effects.

1.4.4 Review of data supplied by CCCWSL

Abstraction, river flow and water usage data supplied by CCCWSL via telemetry was audited and reviewed by Council staff.

1.4.5 Biomonitoring

Two eight-site macroinvertebrate surveys were undertaken to assess the impact of the water abstraction discharges in the reticulated supply area.

1.4.6 Hydrological gaugings

During the period under review, four gaugings were undertaken to determine the flow in Cold Creek and assess CCCWSL's stage and flow recording data and to maintain a rating curve.

2 Results

2.1 Inspections

The site was visited on 29 March 2018 to conduct a compliance monitoring inspection. The staff gauge was inspected and found to be reading 300 mm and the pressure transducer was found to be reading 300 mm showing that the transducer was correctly reflecting the river level at the time. The intake and fish pass was inspected and no issues were noted. CCCWSL staff were cleaning the intake screens at the time. The flow meter was inspected and it was found that it was installed correctly. The abstraction flow was showing as 40 L/s and this matched the telemetered data. The backwash ponds were inspected and the backwash water appeared clean and clear. Both ponds were discharging at a slow rate. A sample was taken from the north pond and was found to be compliant with consent conditions. No effects were noted in receiving waters upon inspection.

2.2 Discharge sampling

One discharge sample was taken during the monitoring period. The results from that sample together with historical results, are set out in Table 1.

Table 1 Results of CCCWSL filter backwash discharge (site STW002066)

Parameter	Free Chlorine	pH	Suspended solids	Temperature	Turbidity
Units	**g/m³**	**pH**	**g/m³**	**Deg.C**	**NTU**
Minimum	0.01	7.2	3	5.2	-
Maximum	0.1	7.4	13	10.6	-
Median	0.05	7.2	8	8.8	-
Number	4	4	4	4	1
29 March 2018	<0.1	7.4	<2	16.1	1.3
Consent limit	*0.1*	*6-9*	*20*	-	-

The discharge was found to be compliant with consent limits and no visual effects were noted in the receiving environment during the sampling visit.

2.3 Results of abstraction and residual monitoring

CCCWSL collected water abstraction and Cold Creek flow data. This data was telemetered to the Council and reviewed for compliance. During the period under review CCCWSL provided a data set of abstraction rates and was found to comply with the normal operational abstraction limit of 69 L/s for over 99% of the data collected. However 23 days of data was missing and in some cases the data received may have not been accurate due to numerous data drop outs and anomalies arising from development works and lightning strikes at the site.

CCCSWL also provides telemetered river level data via a pressure transducer and fixed staff gauge in the stream. During the motoring period CCCWSL demonstrated a poor level of performance in regards to providing continuous, accurate data stream stage data. Twenty three days of data was missing from the record supplied by CCCWSL, and the data sent was found to contain numerous anomalies, the most notable being that the data appeared to be inverted for an extended period of time. CCCWSL was issued with an abatement notice and infringement notice in regards to these matters (see Section 2.5).

Currently the data sets (both abstraction and stream level) have been restored and it is recommended that Council hydrological staff visit the site on a monthly basis to ensure the equipment is functioning correctly.

2.4 Macroinvertebrate surveys

The Council undertook two macroinvertebrate surveys during the monitoring period, these were on 5 December 2017 and 27 March 2018.

The Council's 'kick-sampling' technique was used at eight sites to collect streambed macroinvertebrates from the Cold Creek and Taungatara Stream in relation to the CCCWSL site on two occasions. This has provided data to assess any potential impacts the consented water abstraction and water treatment plant discharges may have had on the macroinvertebrate communities of these streams while also providing a perspective of the overall condition of the catchment. Samples were processed to provide number of taxa (richness), MCI, and $SQMCI_S$ scores for each site.

The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence/absence of taxa with varying degrees of sensitivity to environmental conditions. The $SQMCI_S$ takes into account taxa abundances as well as sensitivity to pollution. Significant differences in either the taxa richness, MCI or the $SQMCI_S$ between sites may indicate the degree of adverse effects (if any) caused by water abstractions. The abstraction of surface water particularly for extended periods of time may result in significant adverse effects on the macroinvertebrate communities living within a waterbody by potentially reducing flow velocities, wetted habitat area, and dissolved oxygen levels and increasing stream temperature, periphyton abundance, macrophytes, pH, and deposited sediment.

Below are summaries of the survey findings and full copies of the survey reports can be found in Appendix II.

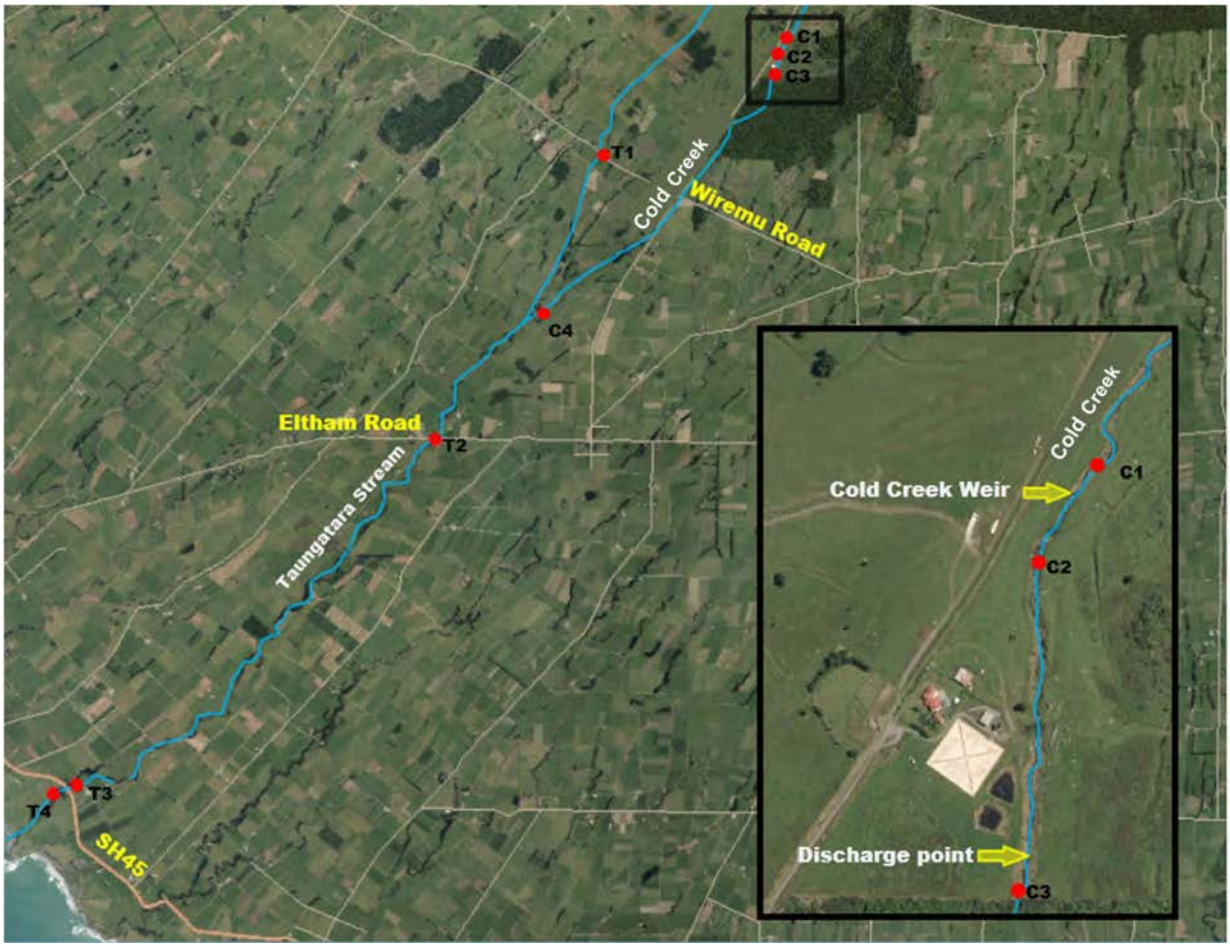

Figure 2 Biomonitoring sites related to the CCWLS

5 December 2017

A spring macroinvertebrate survey was performed at four established sites in the Cold Creek and four established sites in the Taungatara stream in relation to consented water abstraction and discharge by CCCWSL. This survey has provided data to assess the health of the macroinvertebrate communities in the Cold Creek and Taungatara Stream.

Taxa richnesses were moderate to high in the Cold Creek and Taungatara Stream and were near to or above the median richnesses recorded at 'control' sites in similar streams at comparative altitudes elsewhere in the region. The 'highly sensitive' mayfly taxon (*Deleatidium*) was very abundant to extremely abundant at all of the eight sites surveyed.

MCI scores at sites C2, T1, T2, T3 and T4 were significantly higher than median values recorded by 'control' sites. The remaining Cold Creek and Taungatara Stream sites recorded MCI scores that were either near to or above median values recorded by 'control' sites in similar streams at comparative altitudes. Site C1 recorded a MCI score significantly higher than site C4, while site C2 recorded a score significantly higher than sites C1, C3 and C4. Site T1 recorded a MCI score significantly higher than that recorded at sites T3 and T4, and site T2 recorded a MCI score significantly higher than that recorded at site T4. MCI scores in the Taungatara Stream and Cold Creek were reflective of 'good' to 'very good' macroinvertebrate health.

$SQMCI_s$ scores recorded at site C2, C3 and C4 in the Cold Creek were not substantially different to the median $SQMCI_s$ scores for 'control' sites in similar streams at comparative altitudes, while the $SQMCI_s$ score recorded at C1 was substantially lower. $SQMCI_s$ scores recorded in the Taungatara stream were all substantially higher than the median $SQMCI_s$ scores for 'control' sites in similar streams at comparative altitudes.

Within this predominantly dairying catchment there was general deterioration in macroinvertebrate health with decreasing altitude and distance from the National Park and based on predictive values using distance from the National Park Boundary, the rate of MCI decline in a downstream direction was slightly less than the predicted value when comparing the most upstream site (C1) to the furthermost downstream site (T4).

Overall, there was no evidence that water abstraction from the Cold Creek or discharge to the Cold Creek had significantly affected the freshwater macroinvertebrates of the Cold Creek or Taungatara Stream. In addition, there was no evidence that abstraction for pastoral irrigation above site T4 had

27 March 2018

A summer macroinvertebrate survey was performed at four established sites in the Cold Creek and four A spring macroinvertebrate survey was performed at four established sites in the Cold Creek and four established sites in the Taungatara Stream in relation to consented water abstraction and discharge by CCCWSL. This survey has provided data to assess the health of the macroinvertebrate communities in the Cold Creek and Taungatara Stream.

Taxa richnesses were moderate to high in the Cold Creek and Taungatara Stream and were near to or above the median richnesses recorded at 'control' sites in similar streams at comparative altitudes elsewhere in the region. The 'highly sensitive' mayfly taxon (*Deleatidium*) was 'very abundant' to 'extremely abundant' at all of the eight sites surveyed.

MCI scores at sites C2, T1, T2, T3 and T4 were significantly higher than median values recorded at similar 'control' sites. The remaining Cold Creek and Taungatara Stream sites recorded MCI scores that were either near to or above median values recorded by 'control' sites in similar streams at comparative altitudes. Site C1 recorded a MCI score significantly higher than site C4, while site C2 recorded a score significantly higher than sites C1, C3 and C4. Site T1 recorded a MCI score significantly higher than that recorded at sites T3 and T4, and site T2 recorded a MCI score significantly higher than that recorded at site T4. MCI scores in the Taungatara Stream and Cold Creek were reflective of 'good' to 'very good' macroinvertebrate health.

$SQMCI_s$ scores recorded at sites C2, C3 and C4 in the Cold Stream were not substantially different to the median $SQMCI_s$ scores for 'control' sites in similar streams at comparative altitudes, while the $SQMCI_s$ score recorded at C1 was substantially lower. $SQMCI_s$ scores recorded in the Taungatara stream were all substantially higher than the median $SQMCI_s$ scores for 'control' sites in similar streams at comparative altitudes.

Within this predominantly dairying catchment there was general deterioration in macroinvertebrate health with decreasing altitude and distance from the National Park and based on predictive values using distance from the National Park Boundary, the rate of MCI decline in a downstream direction was slightly less than the predicted value when comparing the most upstream site (C1) to the furthermost downstream site (T4).

Overall, there was no evidence that water abstraction from the Cold Creek or discharge to the Cold Creek had significantly affected the freshwater macroinvertebrates of the Cold Creek or Taungatara Stream. In addition, there was no evidence that abstraction for pastoral irrigation above site T4 had impacted on the macroinvertebrate communities at site T4. Finally, based on the current survey results the overall condition of the catchment was generally similar to or better than what would be expected of ring plain streams arising in the National Park

2.5 Investigations, interventions, and incidents

The monitoring programme for the year was based on what was considered to be an appropriate level of monitoring, review of data, and liaison with CCCWSL. During the year matters may arise which require additional activity by the Council, for example provision of advice and information, or investigation of

potential or actual courses of non-compliance or failure to maintain good practices. A pro-active approach that in the first instance avoids issues occurring is favoured.

The Council operates and maintains a register of all complaints or reported and discovered excursions from acceptable limits and practices, including non-compliance with consents, which may damage the environment. The incident register includes events where the company concerned has itself notified the Council. The register contains details of any investigation and corrective action taken.

Complaints may be alleged to be associated with a particular site. If there is potentially an issue of legal liability, the Council must be able to prove by investigation that the identified company is indeed the source of the incident (or that the allegation cannot be proven).

In the 2017-2018 period, the Council was required to undertake enforcement action in association with CCCWSL's conditions in resource consents or provisions in Regional Plans.

26 April 2018

It was noted that stream pressure transducer and abstraction data had dropped out on 10 April 2018 and that no notification of equipment failure had been received from CCCWSL as required by consent conditions. The consent holder was contacted and it was outlined that a lightning strike had damaged the process logic controller (PLC) and that they were waiting for a replacement. An abatement notice was issued in regards to the breach of consent conditions.

27 June 2018

Self notification was received that a lightning strike had caused an interruption in telemetered data. A review of the data fund that noted that the prior to the strike, the data was not considered reliable due recent step changes in stage readings. Also noted is that the stage data appeared to be inverted since October 2017 and contained many gaps and irregularities. A meeting was held with the consent holder to re-iterate the importance of their responsibilities and obligations as a water user, to comply with consent conditions.

As the CCCWSL was operating under an abatement notice in regards to equipment failure, an infringement notice was issued on this occasion.

3 Discussion

3.1 Discussion of site performance

An improvement in the performance of the site is required, especially in regards to the maintenance, checking and calibration of water / stream flow metering equipment.

No issued were noted with the weir, intake or fish pass and the discharge ponds appeared to be functioning well.

3.2 Environmental effects of exercise of consents

No effects as a result of abstraction or discharges were noted during the annual inspection. The intake and fish pass were maintained in manner that provided for fish passage, however some work may be required in the future to ensure this continues. Results of the biomonitoring surveys found no evidence of effects as a result of discharges or water abstraction.

3.3 Evaluation of performance

A tabular summary of the CCCWSL compliance record for the year under review is set out in Tables 2 to 4.

Table 2 Summary of performance for Consent 1134-3

Purpose: ***To take water from Cold Creek to supply the Cold Creek Water Supply Scheme***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Rate of abstraction during normal operations shall not exceed 69 L/s.	Review of abstraction data	> 99% of assessed data
2. Criteria and requirements for taking above 69 L/s	Not exercised	N/A
3. Measure and record abstraction volume and flow of stream	Data received - 94% complete for abstraction 95% complete for river flow	Non-compliance; river flow data found not to be accurate
4. Suitable format for water records	Records received	Yes
5. Measurements transmitted in 'real time' to Council	Data received	No
6. Documentation to show water measuring and recording equipment installed and operational	Record received- new verification required	Yes
7. Notification to Council of equipment failure	Notification received	No
8. Measuring and recording equipment to be accessible	Inspection	Yes

Purpose: *To take water from Cold Creek to supply the Cold Creek Water Supply Scheme*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
9. Restrictions on abstraction when flow below 209 L/s	No low flow period noted	N/A
10. Intake screened	Inspection	Yes
11. Best practicable option to minimise environmental effects	Inspections and liaison with consent holder	Yes
12. Report annually on efficient water use, leak detection and repair	Report received for previous period next due 31 August 2018	Yes
13. Review provision	Next option for review in June 2021	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**Good**
Overall assessment of administrative performance in respect of this consent		**Poor**

N/A = not applicable

Table 3 Summary of performance for Consent 5454-1

Purpose: *To erect, place, use and maintain a water intake structure on the bed of Cold Creek in the Taungatara Catchment for water abstraction purposes*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Notification of Council prior to construction and maintenance works	No maintenance in period under review	N/A
2. Construction and maintenance to be in accordance with application	No maintenance in period under review	N/A
3. Adoption of best practicable option to minimise adverse effects on water quality	No maintenance in period under review	N/A
4. Minimise riverbed disturbance and reinstate areas disturbed	No maintenance in period under review	N/A
5. Major maintenance to occur between 1 November and 30 April	No maintenance in period under review	N/A
6. No obstruction of fish passage	Inspection and triennial fish survey	Yes
7. Monitoring and reporting of adequacy of fish passage	Fish surveys scheduled for once every three years	Yes

Purpose: *To erect, place, use and maintain a water intake structure on the bed of Cold Creek in the Taungatara Catchment for water abstraction purposes*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
8. Structure to be removed when no longer required and area reinstated	Structure in use	N/A
9. Review provision	No further option for review prior to expiry	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**High**
Overall assessment of administrative performance in respect of this consent		**High**

N/A = not applicable

Table 4 Summary of performance for Consent 6077-1

Purpose: *To discharge filter backwash water and supernatant from the Cold Creek WTP into the Cold Creek*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Location of discharge point	Inspection	Yes
2. Limit on discharge rate	Inspection	Yes
3. Discharge not to cause certain effects in the receiving waters	Inspection	Yes
4. Limits on chlorine, suspended solids and pH in discharge	Sampling	Yes
5. Review provision	No further provision for review	N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**High**
Overall assessment of administrative performance in respect of this consent		**High**

During the year, CCCWSL demonstrated a good level of environmental performance and a poor level of administrative performance with the resource consents as defined in Section 1.1.4. An abatement notice and an infringement notice were issued in regards to incorrect measurement of stream level and flow,

3.4 Recommendation from the 2016-2017 Annual Report

In the 2016-2017 South Taranaki Water Supplies Annual Report, it was recommended:

1. THAT monitoring of CCCWSL in the 2017-2018 year continues at the same level as in 2016-2017.

This recommendation was implemented in full.

3.5 Alterations to monitoring programmes for 2018-2019

In designing and implementing the monitoring programmes for air/water discharges in the region, the Council has taken into account:

- the extent of information already made available through monitoring or other means to date;
- its relevance under the RMA;
- the Council's obligations to monitor consented activities and their effects under the RMA;
- the record of administrative and environmental performances of the consent holder; and
- reporting to the regional community.

The Council also takes into account the scope of assessments required at the time of renewal of permits, and the need to maintain a sound understanding of industrial processes within Taranaki exercising resource consents.

It is proposed that for 2018-2019 that monitoring of CCCWSL continue at the same level as 2017-2018 with the addition of monthly inspections to check stream flow recording equipment.

It should be noted that the proposed programme represents a reasonable and risk-based level of monitoring for the site(s) in question. The Council reserves the right to subsequently adjust the programme from that initially prepared, should the need arise if potential or actual non-compliance is determined at any time during 2018-2019.

4 Recommendation

1. THAT monitoring of CCCWSL in the 2017-2018 year continues at the same level as in 2016-2017 with the addition of monthly on-site equipment inspections.
2. THAT should there be issues with environmental or administrative performance in 2017-2018, monitoring may be adjusted to reflect any additional investigation or intervention as found necessary.

Glossary of common terms and abbreviations

The following abbreviations and terms may be used within this report:

Conductivity	Conductivity, an indication of the level of dissolved salts in a sample, usually measured at 20°C and expressed in mS/m.
g/m^3	Grams per cubic metre, and equivalent to milligrams per litre (mg/L). In water, this is also equivalent to parts per million (ppm), but the same does not apply to gaseous mixtures.
Incident	An event that is alleged or is found to have occurred that may have actual or potential environmental consequences or may involve non-compliance with a consent or rule in a regional plan. Registration of an incident by the Council does not automatically mean such an outcome had actually occurred.
Intervention	Action/s taken by Council to instruct or direct actions be taken to avoid or reduce the likelihood of an incident occurring.
Investigation	Action taken by Council to establish what were the circumstances/events surrounding an incident including any allegations of an incident.
Incident Register	The Incident Register contains a list of events recorded by the Council on the basis that they may have the potential or actual environmental consequences that may represent a breach of a consent or provision in a Regional Plan.
L/s	Litres per second.
MCI	Macroinvertebrate community index; a numerical indication of the state of biological life in a stream that takes into account the sensitivity of the taxa present to organic pollution in stony habitats.
mS/m	Millisiemens per metre.
Mixing zone	The zone below a discharge point where the discharge is not fully mixed with the receiving environment. For a stream, conventionally taken as a length equivalent to 7 times the width of the stream at the discharge point.
NTU	Nephelometric Turbidity Unit, a measure of the turbidity of water.
pH	A numerical system for measuring acidity in solutions, with 7 as neutral. Numbers lower than 7 are increasingly acidic and higher than 7 are increasingly alkaline. The scale is logarithmic i.e. a change of 1 represents a ten-fold change in strength. For example, a pH of 4 is ten times more acidic than a pH of 5.
Physicochemical	Measurement of both physical properties (e.g. temperature, clarity, density) and chemical determinants (e.g. metals and nutrients) to characterise the state of an environment.
Resource consent	Refer Section 87 of the RMA. Resource consents include land use consents (refer Sections 9 and 13 of the RMA), coastal permits (Sections 12, 14 and 15), water permits (Section 14) and discharge permits (Section 15).
RMA	*Resource Management Act 1991* and including all subsequent amendments.
SS	Suspended solids.
Supernatant	The liquid lying above a solid residue after crystallization, precipitation, centrifugation, or other process.
SQMCI	Semi quantitative macroinvertebrate community index.
Temp	Temperature, measured in °C (degrees Celsius).
Turb	Turbidity, expressed in NTU.

*an abbreviation for a metal or other analyte may be followed by the letters 'As', to denote the amount of metal recoverable in acidic conditions. This is taken as indicating the total amount of metal that might be solubilised under extreme environmental conditions. The abbreviation may alternatively be followed by the letter 'D', denoting the amount of the metal present in dissolved form rather than in particulate or solid form.

For further information on analytical methods, contact the Council's laboratory.

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Appendix I

Resource consents held by CCCWSL

(For a copy of the signed resource consent
please contact the TRC Consents department)

Water Permit

Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of Consent Holder:	Cold Creek Community Water Supply Limited 2 Havelock Street Opunake 4616
Decision Date (Change):	3 December 2015
Commencement Date (Change):	14 January 2016 (Granted Date: 10 July 2013)

Conditions of Consent

Consent Granted:	To take water from Cold Stream to supply the Cold Creek Water Supply Scheme
Expiry Date:	1 June 2030
Review Date(s):	June 2018, June 2021, June 2024, June 2027
Site Location:	620 Kiri Road, Opunake
Legal Description:	Pt Secs 4 & 5 Blk V Kaupokonui SD (Site of take)
Grid Reference (NZTM)	1686870E-5639970N
Catchment:	Taungatara
Tributary:	Cold Stream

For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document

General condition

a. The consent holder shall pay to the Taranaki Regional Council all the administration, monitoring and supervision costs of this consent, fixed in accordance with section 36 of the Resource Management Act 1991.

Special conditions

1. Subject to condition 2 below the rate of taking shall not exceed 69 litres per second.

2. The rate of taking may be higher than 69 litres per second over specific 14 day periods provided that:

   (a) due to unusually high demand resulting from extreme weather conditions, the consent holder can not maintain the reservoir above 80% full while taking at a rate of 69 litres per second;
   (b) the rate of taking is the minimum necessary maintain the reservoir above 80% full;
   (c) the rate of taking does not exceed 79 litres per second;
   (d) before taking water under this condition the consent holder advises the Chief Executive, Taranaki Regional Council, Te Korowai o Ngāruahine Trust and Fish and Game New Zealand of the date that the specific 14 day period will commence; and
   (e) the advice given in accordance with (d) above includes specific information about water demand and weather conditions supporting the need for the additional water.

   The advice required by this condition shall be given by email to worknotification@trc.govt.nz and to an email address as advised to the consent holder by each of Te Korowai o Ngāruahine Trust and Fish and Game New Zealand.

3. The consent holder shall:

   (a) measure and record, using a tamper-proof device, the volume of water taken at intervals not exceeding 15 minutes to an accuracy of ± 5%; and

   (b) determine the flow in Cold Stream immediately downstream of the intake at intervals not exceeding 15 minutes to an accuracy of ± 10%;

   (c) measure and record the reservoir level in a form that enables the Chief Executive, Taranaki Regional Council to determine compliance with conditions 2(a) and 2(b) above.

   Note: *Water meters and dataloggers must be installed, and regularly maintained, in accordance with manufacturer's specifications in order to ensure that they meet the required accuracy. Even with proper maintenance water meters and dataloggers have a limited lifespan.*

4. The records of water taken shall:

   (a) be in a format that, in the opinion of the Chief Executive, Taranaki Regional Council, is suitable for auditing; and

   (b) specifically record the water taken as 'zero' when no water is taken.

5. The measurements made in accordance with condition 3, in a format to be advised by the Chief Executive, Taranaki Regional Council, shall be transmitted to the Taranaki Regional Council's computer system to maintain a 'real time' record of the water taken and the flow immediately downstream of the intake.

6. The consent holder shall provide the Chief Executive, Taranaki Regional Council with a document from a suitably qualified person certifying that water measuring and recording equipment required by the conditions of this consent ('the equipment'):

   (a) has been installed in accordance with the manufacturer's specifications and/or current industry standards;

   (b) is being operated and maintained in accordance with the manufacturer's specifications and/or current industry standards; and/or

   (c) has been tested and shown to be operating to an accuracy of ± 5%.

   The documentation shall be provided:

   (i) within 30 days of the installation of a water meter or datalogger;

   (ii) at other times when reasonable notice is given and the Chief Executive, Taranaki Regional Council has reasonable evidence that the equipment may not be functioning as required by this consent; and

   (iii) no less frequently than once every five years.

7. If any measuring or recording equipment breaks down, or for any reason is not operational, the consent holder shall advise the Chief Executive, Taranaki Regional Council immediately. Any repairs or maintenance to this equipment must be undertaken by a suitably qualified person.

8. All measuring and recording equipment required by the conditions of this consent ('the equipment') shall be accessible to Taranaki Regional Council officers at all reasonable times for inspection and/or data retrieval. In addition, the equipment shall be designed and installed so that Taranaki Regional Council officers can readily verify that it is accurately recording the required information.

9. When the flow in Cold Stream immediately downstream of the intake point is less than 209 litres/second, the taking of water shall be restricted to the minimum amount necessary to maintain the health and welfare of people and animals (i.e. garden water and other non-essential uses are prohibited).

10. The consent holder shall ensure that the intake is screened to avoid fish entering the intake or being trapped against the screen.

11. At all times the consent holder shall adopt the best practicable option to prevent or minimise any actual or likely adverse effect on the environment associated with the abstraction of water, including, but not limited to, the efficient and conservative use of water.

12. The consent holder shall, on an annual basis, provide a report detailing:
    - the work done to detect and minimise leaks;
    - water use efficiency and conservation measures undertaken; and
    - water use benchmarking data for the region and how the area supplied by this consent supplied compare.

    The report(s) shall be provided to the Chief Executive, Taranaki Regional Council before 31 August each year and cover the previous 1 July to 30 June period.

13. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the months of June 2018 and/or June 2021 and/or June 2024 and/or June 2027, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Signed at Stratford on 3 December 2015

For and on behalf of
Taranaki Regional Council

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A D McLay
Director - Resource Management

Land Use Consent

Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of Consent Holder:	Cold Creek Community Water Supply Limited 2 Havelock Street OPUNAKE 4616
Decision Date:	1 March 1999
Commencement Date:	1 March 1999

Conditions of Consent

Consent Granted:	To erect, place, use and maintain a water intake structure on the bed of Cold Creek in the Taugatara catchment for water abstraction purposes
Expiry Date:	1 June 2018
Review Date(s):	June 2001, June 2006, June 2012
Site Location:	Cold Creek, Kiri Road, Opunake
Legal Description:	SO 377 Pt Sec 5 Blk V Kaupokonui SD
Grid Reference (NZTM)	1686940E-5640150N
Catchment:	Taungatara
Tributary:	Cold Creek

For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document

General conditions

a) That on receipt of a requirement from the Chief Executive, Taranaki Regional Council (hereinafter the Chief Executive), the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b) That unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c) That the consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

i) the administration, monitoring and supervision of this consent; and
ii) charges authorised by regulations.

Special conditions

1. That the consent holder shall notify the Taranaki Regional Council, at least 48 hours prior to the commencement and upon completion of the initial construction, and again prior to, and upon completion of, any subsequent maintenance works which would involve disturbance of, or the deposition to the riverbed or discharges to water.

2. That the stricture(s) authorised by this consent shall be constructed generally in accordance with the documentation submitted in support of the application and shall be maintained to ensure the conditions of this consent are met.

3. That during any construction or maintenance the consent holder shall adopt the best practicable option to avoid or minimise the discharge of silt or other contaminants into the water or onto the riverbed and to avoid or minimise the disturbance of the riverbed and any adverse effects on water quality.

4. That during any construction or maintenance the consent holder shall ensure that the area and volume of riverbed disturbance shall so far as is practicable, be minimised and any areas which are disturbed, shall so far as is practicable be reinstated.

5. That during any construction or maintenance the consent holder shall ensure that any disturbance of parts of the riverbed covered by water and/or any works which may result in downstream discolouration of water shall be undertaken only between 1 November and 30 April except where this requirement is waived by the written approval of the Chief Executive, Taranaki Regional Council.

6. That structure(s) which are the subject of this consent shall not obstruct fish passage.

7. That the consent holder shall develop and undertake a monitoring programme to determine the adequacy of fish passage as deemed necessary by the Chief Executive, Taranaki Regional Council, subject to section 35(2)(d) and section 36 of the Resource Management Act 1991. This monitoring information is to be forwarded to the Chief Executive, Taranaki Regional Council, upon request.

8. That the structure(s) authorised by this consent shall be removed and the area reinstated, if and when the structure(s) are no longer required. The consent holder shall notify the Taranaki Regional Council at least 48 hours prior to structure(s) removal and reinstatement.

9. That the Taranaki Regional Council may review any or all of the conditions of this consent by giving notice of review during the month of June 2001 and/or June 2006 and/or June 2012, for the purpose of ensuring that the conditions are adequate to deal with any significant adverse effects on the environment arising from the exercise of this consent, which either were not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Transferred at Stratford on 20 February 2014

For and on behalf of
Taranaki Regional Council

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A D McLay
Director-Resource Management

Discharge Permit

Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of Consent Holder:	Cold Creek Community Water Supply Limited 2 Havelock Street OPUNAKE 4616
Decision Date:	29 November 2002
Commencement Date:	29 November 2002

Conditions of Consent

Consent Granted:	To discharge filter backwash water and supernatant from the Cold Creek water treatment plant into the Cold Stream in the Taungatara catchment
Expiry Date:	1 June 2018
Review Date(s):	June 2006, June 2012
Site Location:	State Highway 45, Rahotu
Legal Description:	Lot 1 DP 16088 Blk V Kaupokonui SD
Grid Reference (NZTM)	1686823E-5639646N
Catchment:	Taungatara
Tributary:	Cold Creek

For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document

General conditions

a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council (hereinafter the Chief Executive), the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

i) the administration, monitoring and supervision of this consent; and
ii) charges authorised by regulations.

Special conditions

1. The discharge point shall be located at NZTM 1686823E- 5639646N.

2. The discharge rate shall not exceed 10 litres per second.

3. That after allowing for reasonable mixing, within a mixing zone extending 25 metres below the discharge point, the discharge shall not give rise to any of the following effects in the Cold Stream:

(a) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
(b) any conspicuous change in the colour or visual clarity;
(c) any emission of objectionable odour;
(d) the rendering of fresh water unsuitable for consumption by farm animals;
(e) any significant adverse effects on aquatic life, habitats, or ecology.

4. That the discharge quality shall not exceed the following limits at all times:

Suspended solids	20 gm^{-3}
pH	6.5-8.5
Free available chlorine	0.1 gm^{-3}

5. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2006 and/or June 2012, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Transferred at Stratford on 20 February 2014

For and on behalf of
Taranaki Regional Council

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A D McLay
Director-Resource Management

Appendix II

Biomonitoring reports

To	Job Manager, Scott Cowperthwaite
From	Environmental Scientist, Katie Blakemore
Document	2042369
Report No	KB042
Date	23 April 2018

Biomonitoring of the Cold Stream and Taungatara Stream in relation to the Cold Creek Water Supply Scheme, December 2017

Introduction

Cold Creek Community Water Supply Limited holds consent to abstract water from the Cold Stream to supply the Cold Creek Water Supply Scheme. It also has consent to discharge filter backwash water and supernatant from the Cold Creek Water Treatment Plant into the Cold Stream in the Taungatara catchment. The consents relevant to this biomonitoring survey are summarised in Table 1 below:

Table 1 Summary of consents held by Cold Creek Community Water Supply Limited, which are of relevance to this biological survey

Consent no.	Purpose
1134-3	To take water from Cold Stream to supply the Cold Creek Water Supply Scheme
5454-1	To erect, place, use and maintain a water intake structure on the bed of Cold Creek in the Taungatara Catchment for water abstraction purposes
6077-1	To discharge filter backwash water and supernatant from the Cold Creek water treatment plant into the Cold Stream in the Taungatara catchment

This spring biological survey was the first of two scheduled in the Taungatara catchment for the 2017-2018 monitoring year. The intention of these surveys is to monitor the health of the macroinvertebrate communities in the Cold Stream and Taungatara Stream in relation to any effects of water abstraction by Cold Creek Community Water Supply Limited, while also to gain a perspective of the overall health of the catchment; including whether there were any impacts from the abstraction of water for pastoral irrigation downstream of SH45.

Whether this level of monitoring will continue will be reviewed following the 2017-2018 period. This was the fifth biological survey to be carried out in relation to consents held by Cold Creek Community Water Supply Limited.

Methods

This biomonitoring survey was undertaken at eight sites on 5 December 2017 (Table 2 and Figure 1). Four of the eight sites surveyed were in the Cold Stream and the remaining sites were in the Taungatara Stream (Figure 1). The four sites surveyed on the Cold Stream included; a control site directly upstream of the intake weir (site C1), a primary impact site, approximately 50 metres downstream of the intake weir (site C2), a site 30 m downstream of the Cold Creek Water Supply Scheme discharge (Site C3), and a site below the intake weir and discharge point, immediately upstream of the confluence with the Taungatara Stream (site C4). The four sites surveyed in the Taungatara Stream included; a site at Wiremu Road (site T1), a site 50m downstream of Eltham Road (site T2), a site at State Highway 45 (T3) and a site approximately 500m further downstream of State Highway 45, and downstream of an abstraction point for pastoral irrigation (site T4).

Table 2 Biomonitoring sites in the Cold Stream and Taungatara Stream relating to the Cold Creek Water Supply Scheme

Stream	Site number	Site code	Location	Elevation (m asl)	Distance from source- NPk boundary (km)
Cold Stream	C1	CLD000175	Upstream of Cold Creek Water Supply scheme intake	350	1.0
	C2	CLD000177	50m downstream of Cold Creek Water Supply scheme intake	345	1.1
	C3	CLD000180	30m downstream of Cold Creek Water Supply scheme discharge	325	1.40
	C4	CLD000600	Immediately upstream of confluence with Taungatara Stream	170	6.73
Taungatara Stream	T1	TNG000200	At Wiremu Road	240	4.84
	T2	TNG000350	50m downstream of Eltham Road	120	11.50
	T3	TNG000900	At State Highway 45	20	20.52
	T4	TNG000920	Approximately 400m downstream of State Highway 45	20	20.85

The standard '400 ml kick-sampling' technique was used to collect streambed macroinvertebrates from all sites. The 'kick-sampling' technique is very similar to Protocol C1 (hard-bottomed, semi-quantitative), of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark *et al*, 2001).

Samples were preserved with Kahle's Fluid and ethanol for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using protocol P1 of NZMWG protocols for sampling macroinvertebrates in wadeable streams (Stark et al. 2001). Macroinvertebrate taxa found in each sample were recorded based on the abundance categories in Table 3.

Table 3 Macroinvertebrate abundance categories

Abundance category	Number of individuals
R (rare)	1-4
C (common)	5-19
A (abundant)	20-99
VA (very abundant)	100-499
XA (extremely abundant)	>499

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly 'sensitive' taxa were assigned the highest scores of 9 or 10, while the most 'tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience. By averaging the scores obtained from a list of taxa taken from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. More 'sensitive' communities inhabit less polluted waterways. A difference of 11 or more MCI units is considered significantly different (Stark 1998). A gradation of biological water quality conditions based upon MCI ranges which has been adapted for Taranaki streams and rivers (TRC, 2013) from Stark's classification (Stark, 1985; Boothroyd and Stark, 2000) (Table 4).

Table 4 Macroinvertebrate community health based on MCI ranges which has been adapted for Taranaki streams and rivers (TRC, 2013) from Stark's classification (Stark, 1985 and Boothroyd and Stark, 2000)

Grading	MCI
Excellent	>140
Very Good	120-140
Good	100-119
Fair	80-99
Poor	60-79
Very Poor	<60

A semi-quantitative MCI value ($SQMCI_s$) has also been calculated for the taxa present at each site by multiplying each taxon score by a loading factor (related to its abundance), totalling these products, and dividing by the sum of the loading factors (Stark 1998 and 1999). The loading factors were 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very abundant (VA) and 500 for extremely abundant (XA). Unlike the MCI, the $SQMCI_s$ is not multiplied by a scaling factor of 20, so that its corresponding range of values is 20x lower. A difference of 0.9 units or more in $SQMCI_s$ is considered significantly different (Stark, 1998).

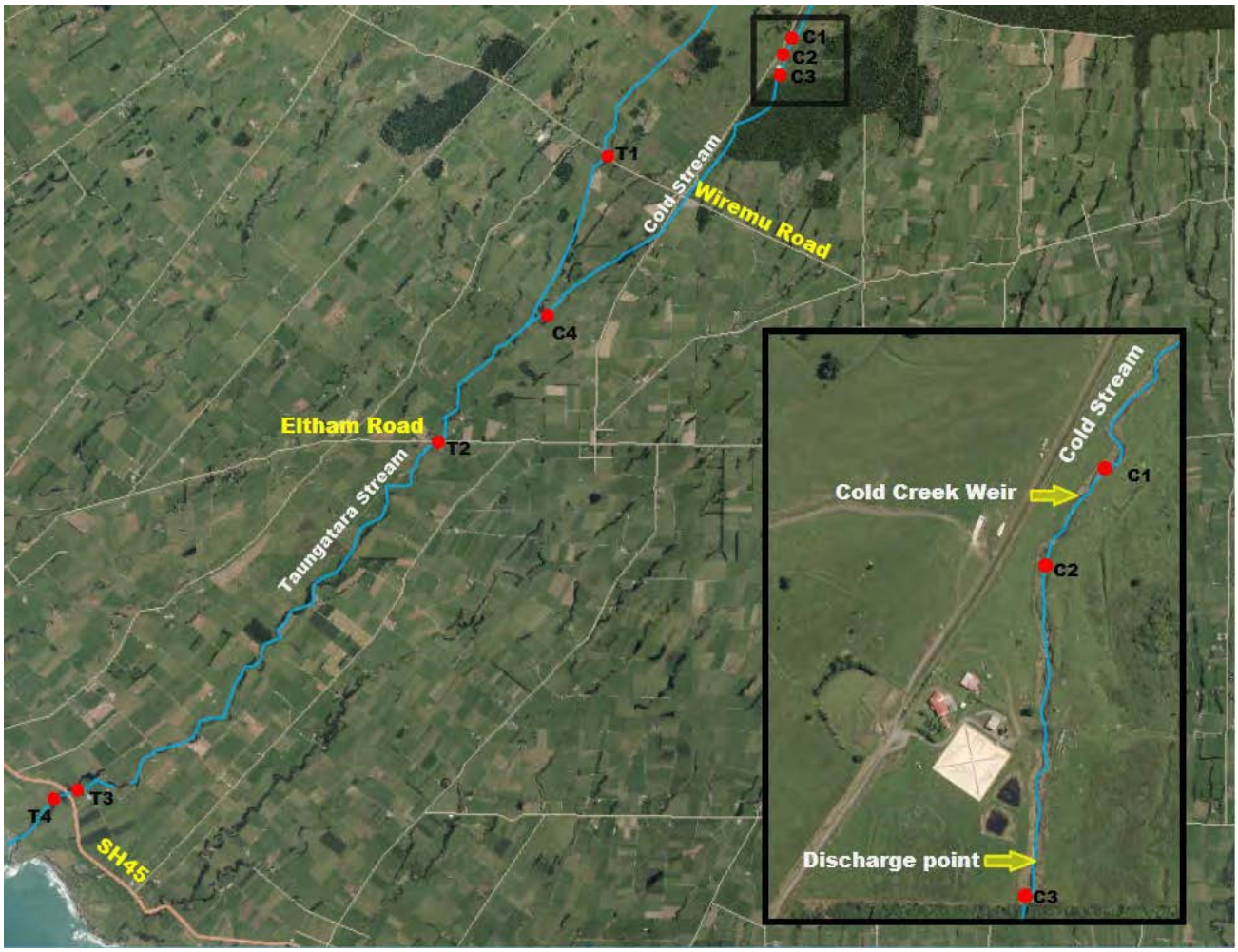

Figure 1 Biomonitoring sites related to the Cold Creek Water Supply Scheme on the Cold Stream and Taungatara Stream

Results

This December 2017 survey followed a period of 27 days since a fresh in excess of seven times median flow, as indicated by the nearby Punehu Stream flow recorder.

Water temperatures in the Cold Stream ranged between 11.5 °C and 19.3 °C. There was an uncoloured, clear, low and swift flow at all four sites in the Cold Stream. The substrate comprised of cobbles, gravels, boulders and sand at all sites. There were patchy mats and no filamentous periphyton at site C1, slippery mats and no filaments at sites C2 and C3, and patchy mats and patchy filaments of periphyton at site C4. There were no macrophytes recorded at any of the four sites monitored in the Cold Stream. All sites were unshaded.

Water temperatures in the Taungatara Stream ranged between 18.3 °C and 22.0 °C. There was a swift low flow at all four sites, which was clear and uncoloured at site T1 and cloudy grey at sites T2, T3 and T4. The substrate comprised boulders, cobbles, gravels and sand at all sites. At site T4 it was noted there was a pile of substrate in the middle of the streambed just upstream of the site. It appeared this substrate had been cleared at the pump intake point. There was an increase in fine sediment deposited on the streambed at this site. Periphyton mats were slippery at sites T1 and T3 and patchy at sites T2 and T4. Filamentous periphyton was absent at site T1 and patchy at sites T2, T3 and T4. There were no macrophytes recorded at any of the four sites in the Taungatara Stream. Site T1 was unshaded while sites T2, T3 and T4 were partially shaded.

Macroinvertebrate communities

Table 5 summarises the results of the current macroinvertebrate survey and the results from previous surveys at these sites. Table 5 also includes predicted MCI scores using an equation obtained from Stark and Fowles (2009) that examines the relationship between MCI score and distance from the Egmont National Park boundary. Comparative data for sites in similar streams are presented in Table 6. The full results from the current survey are given in Table 7 and Table 8.

Table 5 Previously recorded range of taxa richness, MCI and $SQMCI_s$ in the Cold Stream and Taungatara Stream, together with results of the current survey and predicted MCI scores for streams arising inside Egmont National Park.

Site	Number of previous surveys	Taxa Richness		MCI			SQMCIS		
		Range	Current Survey	Range	Current Survey	Predicted MCI Scores*	Number of previous surveys	Range	Current Survey
C1	9	23-35	23	119-133	124	126	8	6.0-7.5	5.6
C2	9	24-35	22	118-130	137	126	8	5.3-7.4	7.1
C3	10	24-37	26	115-132	122	125	9	4.2-7.7	7.7
C4	4	21-28	26	114-125	113	117	4	5.0-6.8	7.3
T1	4	22-29	23	110-127	125	120	4	6.6-7.6	6.5
T2	4	21-27	23	111-116	117	110	4	6.4-7.1	7.3
T3	4	19-23	20	84-107	110	96	4	5.5-7.4	7.3
T4	4	17-24	16	93-104	104	96	4	5.2-6.6	7.4

*Predicted MCI scores for streams arising inside Egmont National Park using an equation that examines the relationship between MCI score and distance from Egmont National Park boundary ($MCI=127.255-1.503*D_s$) (from Stark and Fowles (2009)).

Table 6 Range and median of number of taxa, MCI values and $SQMCI_s$ scores for control sites rising in the National Park at varying altitudes ((TRC, 1999 (updated 2017)).

Altitude (m asl)		No. of taxa	MCI value	$SQMCI_s$ value	Site relevant to data
0-24	No. Samples	416	416	326	T3 and T4
	Range	4-31	53-118	1.6-7.8	
	Median	20	90	4.0	
80-124	No. Samples	230	230	163	T2
	Range	2-36	50-136	1.8-7.8	
	Median	17	102	5.0	
155-199	No. Samples	439	439	336	C4
	Range	1-38	64-160	1.9-8.0	
	Median	20	108	6.0	
200-249	No. Samples	384	384	242	T1
	Range	5-37	73-148	1.6-7.7	
	Median	23	101	5.0	
300-349	No. Samples	222	222	164	C2 and C3
	Range	4-38	75-143	1.7-7.9	
	Median	23	119	7.0	
350-399	No. Samples	194	194	141	C1
	Range	8-39	100-147	3.9-8.4	
	Median	25	129	7.0	

Table 7 Macroinvertebrate fauna of the Cold Stream in relation Cold Creek Water Supply Scheme sampled on 5 December 2017

Taxa List	Site Number	MCI score	C1	C2	C3	C4
	Site Code		CLD000175	CLD000177	CLD000180	CLD000600
	Sample Number		FWB17439	FWB17440	FWB17441	FWB17442
ANNELIDA (WORMS)	Oligochaeta	1	-	-	R	R
MOLLUSCA	*Potamopyrgus*	4	R	-	-	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R	-	-	C
	Coloburiscus	7	C	C	C	A
	Deleatidium	8	VA	VA	XA	XA
	Ichthybotus	8	-	R	-	-
	Nesameletus	9	-	-	-	R
PLECOPTERA (STONEFLIES)	*Acroperla*	5	-	-	R	R
	Austroperla	9	-	R	-	-
	Megaleptoperla	9	R	C	R	R
	Spaniocercoides	8	R	-	-	-
	Stenoperla	10	R	R	C	-
	Zelandobius	5	C	R	R	R
	Zelandoperla	8	C	R	C	R
COLEOPTERA (BEETLES)	Elmidae	6	C	A	A	C
	Hydraenidae	8	R	R	C	-
	Hydrophilidae	5	R	-	R	-
	Ptilodactylidae	8	C	C	C	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	-	-	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	-	-	-	R
	Costachorema	7	-	-	R	C
	Hydrobiosis	5	R	R	R	R
	Hydrobiosella	9	-	-	R	-
	Hydrochorema	9	-	R	-	-
	Neurochorema	6	-	-	-	R
	Hydropsyche (Orthopsyche)	9	C	C	R	-
	Psilochorema	6	-	-	R	-
	Beraeoptera	8	A	VA	VA	C
	Olinga	9	-	-	-	R
	Pycnocentria	7	-	R	R	R
	Pycnocentrodes	5	R	-	R	VA
	Zelolessica	7	-	R	-	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	C	C	R
	Eriopterini	5	R	R	R	R
	Maoridiamesa	3	VA	A	A	A
	Orthocladiinae	2	A	A	C	R
	Polypedilum	3	R	-	R	R
	Muscidae	3	-	-	-	R
	Austrosimulium	3	-	-	-	R
ACARINA (MITES)	Acarina	5	R	R	R	-
	No of taxa		23	22	26	26
	MCI		124	137	122	113
	SQMCIs		5.6	7.1	7.7	7.3
	EPT (taxa)		12	14	15	16
	%EPT (taxa)		52	64	58	62

'Tolerant' taxa | 'Moderately sensitive' taxa | 'Highly sensitive' taxa

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 8 Macroinvertebrate fauna of the Taungatara Stream in relation Cold Creek Water Supply Scheme sampled on 5 December 2017

Taxa List	Site Number	MCI score	T1	T2	T3	T4
	Site Code		TNG000200	TNG000350	TNG000900	TNG000920
	Sample Number		FWB17443	FWB17444	FWB17445	FWB17446
ANNELIDA (WORMS)	Oligochaeta	1	-	-	-	C
	Lumbricidae	5	R	-	-	-
MOLLUSCA	*Potamopyrgus*	4	-	R	R	-
CRUSTACEA	Ostracoda	1	-	R	-	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	R	R	R	-
	Coloburiscus	7	C	A	R	R
	Deleatidium	8	XA	XA	XA	XA
	Nesameletus	9	C	C	C	C
PLECOPTERA (STONEFLIES)	*Stenoperla*	10	R	-	-	-
	Zelandobius	5	R	R	R	-
	Zelandoperla	8	-	-	-	R
COLEOPTERA (BEETLES)	Elmidae	6	VA	A	C	C
	Hydraenidae	8	R	R	-	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	R	C	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	R	C	C	A
	Costachorema	7	-	R	R	C
	Hydrobiosis	5	C	C	C	R
	Plectrocnemia	8	R	-	-	-
	Beraeoptera	8	A	A	C	-
	Helicopsyche	10	R	R	-	-
	Olinga	9	C	R	-	-
	Pycnocentria	7	-	R	-	-
	Pycnocentrodes	5	XA	VA	VA	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	C	C	C
	Eriopterini	5	R	-	-	-
	Hexatomini	5	-	-	R	-
	Maoridiamesa	3	R	C	A	A
	Orthocladiinae	2	R	C	-	A
	Polypedilum	3	R	-	R	-
	Tanypodinae	5	R	-	-	-
	Tanytarsini	3	-	-	R	-
	Ephydridae	4	-	-	R	-
	Muscidae	3	-	R	-	R
	Austrosimulium	3	-	-	-	R
	Tanyderidae	4	-	R	-	-
ACARINA (MITES)	Acarina	5	-	-	R	-
		No of taxa	23	23	20	16
		MCI	125	117	110	104
		SQMCIs	6.5	7.3	7.3	7.4
		EPT (taxa)	13	13	10	8
		%EPT (taxa)	57	57	50	50

'Tolerant' taxa | 'Moderately sensitive' taxa | 'Highly sensitive' taxa

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Cold Stream

Site C1

A moderate taxa richness of 23 taxa was found at site C1, two taxa less than the median richness found at similar sites elsewhere in the region and three taxa less than that found by the previous survey (Table 5, Table 6 and Table 7). The macroinvertebrate community comprised a significant proportion of 'sensitive' taxa (83%), which was reflected by the 'very good' MCI score of 124 units. This MCI score was similar to the median MCI score (129 MCI units) for 'control' sites in similar streams at comparative altitudes and was an insignificant (Stark, 1998) one unit lower than that recorded by the previous survey (Table 5). This MCI score was similar to the predicted MCI scores based on distance from the Egmont National Park boundary (MCI score 126 units) (Table 5).

The community at this site was characterised by two 'tolerant' taxa [midge larvae (Orthocladiinae and *Maoridiamesa*)] and two 'highly sensitive' taxa [mayfly (*Deleatidium*) and caddisfly (*Beraeoptera*)] (Table 7).

The numerical dominance by two 'sensitive' taxa was tempered by two abundant 'tolerant' taxa and resulted in the $SQMCI_S$ score of 5.6 units, which was significantly lower (by 1.4 unit) than the median score for 'control' sites in similar streams at this altitude and the previous (March 2017) survey result (by 1.0 unit) (Table 5 and Table 6).

Site C2

A moderate taxa richness of 22 taxa was found at site C2 (Table 5 and Table 7), one taxon less than the median richness found at similar sites at comparable altitudes, and seven taxa less than that recorded by the previous (March 2017) survey (Table 6). This was also the lowest taxa richness recorded at this site to date, by two taxa (Table 5).

The macroinvertebrate community comprised a significant proportion of 'sensitive' taxa (91%), which was reflected by the 'very good' MCI score of 137 units, which is the highest MCI score recorded at this site to date (Table 5). This MCI score was significantly (Stark, 1998) higher (by 18 units) than the median MCI score for 'control' sites in similar streams at comparative altitudes (Table 6) and the (by 11 units) predicted MCI scores based on distance from the Egmont National Park boundary (MCI score 126 units) (Table 5). It was also a significant 12 units higher than the MCI score recorded by the previous (March 2017) survey (Table 5).

The community at this site was characterised by two 'tolerant' taxa [midge larvae (Orthocladiinae and *Maoridiamesa*)], one 'moderately sensitive' taxon [elmid beetles] and two 'highly sensitive' taxa [mayfly (*Deleatidium*) and caddisfly (*Beraeoptera*)] (Table 7).

The numerical dominance by several 'sensitive' taxa was tempered by the abundance of two 'tolerant' taxa, resulting in the $SQMCI_S$ score of 7.1 units, which was slightly higher (by 0.1 unit) than the median score for 'control' sites in streams at comparable altitudes (Table 6). This $SQMCI_S$ score was also slightly higher (by 0.4 unit) than that recorded by the previous (March 2017) survey (Table 5).

Site C3

A moderately high taxa richness of 26 taxa was found at site C3 (Table 5 and Table 7), three taxa more than the median richness found at similar sites elsewhere in the region (Table 6), and two taxa more than that recorded by the previous (March 2017) survey. The macroinvertebrate community was again comprised of a higher proportion of 'sensitive' taxa (85%), which was reflected by the 'very good' MCI score of 122 units. This score was a non-significant (Stark, 1998) 3 units higher than the median MCI score for 'control' sites in similar streams at comparative altitudes (Table 6) and an insignificant 3 units lower than the predicted MCI

scores based on distance from the Egmont National Park boundary (MCI score 125 units) (Table 5). This score was a non-significant (Stark, 1998) 10 units lower than that recorded by the previous (March 2017) survey.

This community was characterised by four taxa in total, including one 'tolerant' taxon [midge larvae (*Maoridiamesa*)], one 'moderately sensitive' taxon [elmid beetles] and two 'highly sensitive' taxa [mayfly (*Deleatidium*) and caddisfly (*Beraeoptera*)] (Table 7).

The numerical dominance by 'sensitive' taxa resulted in the $SQMCI_S$ score of 7.7 units, which was equal to the highest score recorded to date at this site. This $SQMCI_S$ score was higher (by 0.7 unit) than the median score for 'control' sites in streams at comparable altitudes and slightly higher (by 0.6 unit) than that recorded by the previous (March 2017) survey (Table 5 and Table 6).

Site C4

A moderately high taxa richness of 26 taxa was found at site C4 (Table 5 and Table 7), six taxa more than the median richness found at similar sites elsewhere in the region (Table 6). The macroinvertebrate community again comprised a significant proportion of 'sensitive' taxa (85%), which was reflected by the 'good' MCI score of 113 units. This score was a non-significant (Stark, 1998) 5 units higher than the median MCI score for 'control' sites in similar streams at comparative altitudes (Table 6), and slightly lower than the predicted MCI scores based on distance from the Egmont National Park boundary (MCI score 117 units) (Table 5).

The community at this site was characterised by one 'tolerant' taxon [midge larvae (*Maoridiamesa*)], two 'moderately sensitive' taxa [mayfly (*Coloburiscus*) and stony cased caddis (*Pycnocentrodes*)] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 7).

The numerical dominance by several 'sensitive' taxa was tempered by the dominance of one 'tolerant' taxon which resulted in the $SQMCI_S$ score of 7.3 units, which was a significant 1.3 units higher than the median score for 'control' sites in similar streams at this altitude (Table 6). This score was also 2.3 units higher than that recorded by the previous (March 2017) survey (Table 5) and was the highest score recorded to date at this site (Table 5).

Catchment Overview- Cold Stream

MCI values and taxa richnesses for the Cold Stream are presented together with median values for similar streams at comparative altitudes in Figure 2. $SQMCI_S$ scores and median values for similar streams at comparative altitudes are presented in Figure 3.

MCI values recorded in the Cold Stream were reflective of 'very good' macroinvertebrate health at sites C1-C3 and 'good' health at site C4. At sites C1, C3 and C4 MCI scores were not significantly different to median scores for streams at comparable altitudes (Figure 2). Site C2 however recorded MCI scores significantly (Stark, 1998) higher than the median for streams at a comparable altitude (by 18 units). There was an 11 unit decrease in MCI score between sites C1 and C4, which was typical of the usual progressive deterioration in macroinvertebrate communities recorded in a downstream direction in Taranaki ringplain rivers and streams. Typically MCI scores deteriorate with decreasing altitude and with distance away from the National park, in part due to natural causes such as stream gradient and temperature but also as a result of cumulative effects from dairying and industry on physicochemical water quality. Taxa richnesses were moderate to high in the Cold Stream and either similar to or above median scores when compared to control sites at similar altitudes (Figure 2). $SQMCI_s$ scores recorded in the Cold Stream were not substantially different to the median $SQMCI_s$ scores for 'control' sites in similar streams at comparative altitudes at sites C2, C3 and C4; however, the $SQMCI_s$ score recorded at site C1 was substantially lower than

that recorded by the control sites (Figure 3). There was also a substantial increase in $SQMCI_s$ score between sites C1 and C2.

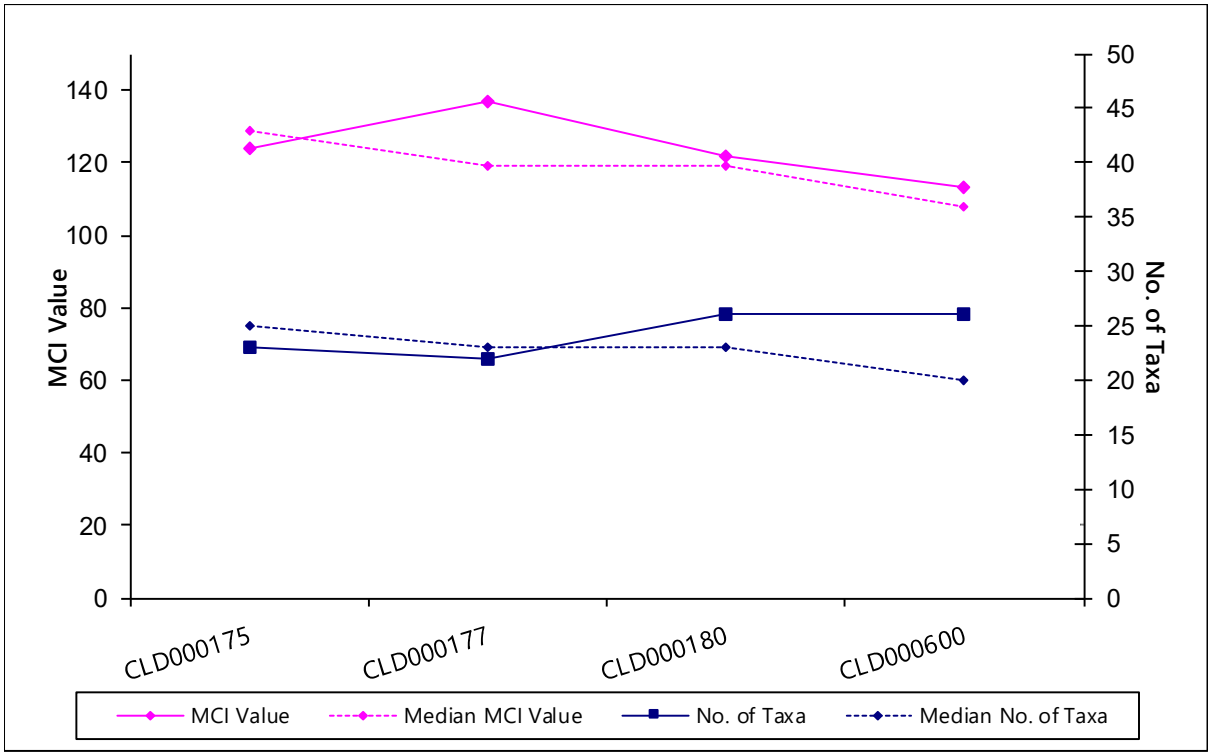

Figure 2 Numbers of macroinvertebrate taxa and MCI values recorded in the Cold Stream, December 2017, with median MCI and median taxa numbers obtained using control sites arising in the Egmont National Park

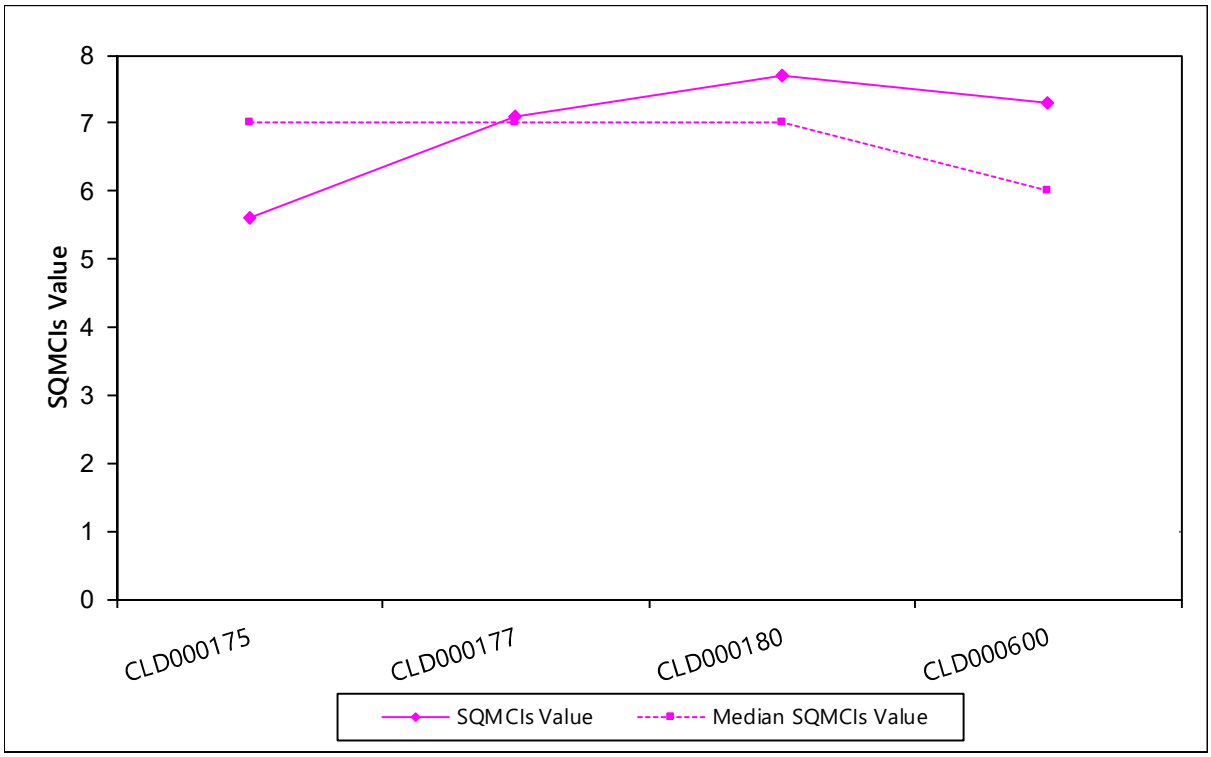

Figure 3 $SQMCI_S$ values recorded in the Cold Stream, December 2017, with median $SQMCI_S$ values obtained using control sites arising in the Egmont National Park

Taungatara Stream

Site T1

A moderate taxa richness of 23 taxa was recorded at site T1 (Table 5 and Table 8), equal to the median richness found at similar sites elsewhere in the region and one taxon less than that recorded by the previous (March 2017) survey (Table 6). The macroinvertebrate community comprised a significant proportion of 'sensitive' taxa (83%), which was reflected by the 'very good' MCI score of 125 units. This MCI score was higher than the previous (March 2017) survey result (by 7 units) but significantly higher than the median MCI score (by 24 units) for 'control' sites in similar streams at comparative altitudes (Table 5 and Table 6). This MCI score was slightly higher (by 5 units) than the predicted MCI scores based on distance from the Egmont National Park boundary (MCI score 120 units) (Table 5).

The community at this site was characterised by two 'moderately sensitive' taxa [elmid beetles and stony cased caddis (*Pycnocentrodes*)], and two 'highly sensitive' taxa [mayfly (*Deleatidium*) and caddisfly (*Beraeoptera*)] (Table 8).

The numerical dominance by 'sensitive' taxa resulted in the $SQMCI_S$ score of 6.5 units, which was significantly higher (by 1.5 units) than the median score for 'control' sites in similar streams at this altitude and lower (by 0.5 unit) than the previous (March 2017) score (Table 6).

Site T2

A moderate taxa richness of 23 taxa was found at site T2 (Table 8). This was two taxa more than that recorded by the previous (March 2017) survey and six taxa more than the median richness found at similar sites (Table 6). The macroinvertebrate community comprised a significant proportion of 'sensitive' taxa (70%), which was reflected by the 'good' MCI score of 117 units. This MCI score was an insignificant 6 units more than that recorded by the previous (March 2017) survey and was a significant (Stark 1998) 15 units

higher than the median MCI score for 'control' sites in similar streams at comparative altitudes (Table 6). The score was also higher (by 7 units) than the predicted MCI scores based on distance from the Egmont National Park boundary (MCI score 110 units) (Table 5).

The community at this site was characterised by three 'moderately sensitive' taxa [elmid beetles, mayfly (*Coloburiscus*) and stony cased caddisfly (*Pycnocentrodes*)] and two 'highly sensitive' taxa [caddisfly (*Beraeoptera*), and mayfly (*Deleatidium*)] (Table 8).

The numerical dominance by several 'sensitive' taxa resulted in the $SQMCI_S$ score of 7.3 units, which was significantly higher (by 2.3 units) than the median score for 'control' sites in similar streams at this altitude (Table 6). This score was higher than the previous (March 2017) score by 0.2 unit and was the highest $SQMCI_S$ score recorded at this site to date (Table 5).

Site T3

A moderate taxa richness of 20 taxa was found at site T3 (Table 5 and Table 8). This was equal to the median richness found at comparable sites elsewhere in the region (Table 6) and was one taxon more than that found by the previous (March 2017) survey. The macroinvertebrate community comprised a significant proportion of 'sensitive' taxa (70%), which was reflected by the 'good' MCI score of 110 units. This score was higher (by a significant 20 MCI units) than the median MCI score for 'control' sites in similar streams at comparative altitudes (Table 6). This MCI score was a significant (Stark, 1998) 14 units higher than that recorded by the previous (March 2017) and the predicted MCI scores based on distance from the National Park boundary (Table 5).

The community at this site was characterised by one 'tolerant' taxon [midge larvae (*Maoridiamesa*)], one 'moderately sensitive' taxon [stony cased caddisfly (*Pynconcentrodes*)], and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 8).

The numerical dominance by several 'sensitive' taxa resulted in the $SQMCI_S$ score of 7.3 units, which was substantially higher (by 3.3 units) than the median score for 'control' sites in similar streams at this altitude (Table 6). This score was lower (by only 0.1 unit) than that recorded by the previous (March 2017) survey, which was the highest $SQMCI_S$ score recorded at this site to date (Table 5).

Site T4

A moderate taxa richness of 16 taxa was found at site T4 (Table 5 and Table 8). This was similar to the median richness found at comparable sites elsewhere in the region (20 taxa) and lower than the previous (March 2017) survey result (24 taxa) (Table 6). The macroinvertebrate community comprised a moderate proportion of 'sensitive' taxa (63%), which was reflected by the 'good' MCI score of 104 units. This score was significantly higher (by 14 MCI units) than the median MCI score for 'control' sites in similar streams at comparative altitudes (Table 6), and higher than the predicted MCI scores based on distance from the Egmont National Park boundary (MCI score 96 units) (Table 5). This MCI score was was slightly higher than the previous (March 2017) result of 102 MCI units.

The community at this site was characterised by three 'tolerant' taxa [caddisfly (*Hydropysche* – formerly *Aoteapsyche*) and midge larvae larvae (Orthocladiinae) and (*Maoridiamesa*)] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 8).

The numerical dominance of the 'highly sensitive' taxon *Deleatidium* was tempered by three abundant 'tolerant' taxa and resulted in the $SQMCI_S$ score of 7.4 units, which was significantly higher (by 3.4 units) than the median score for 'control' sites in similar streams at this altitude (Table 6). It was a significant 2.0 units higher than that recorded by the previous survey (March 2017) (Table 5).

Catchment overview- Taungatara Stream

MCI values and taxa richnesses for the Taungatara Stream are presented together with median values for similar streams at comparative altitudes in Figure 4. SQMCIS scores and median values for similar streams at comparative altitudes are presented in Figure 5.

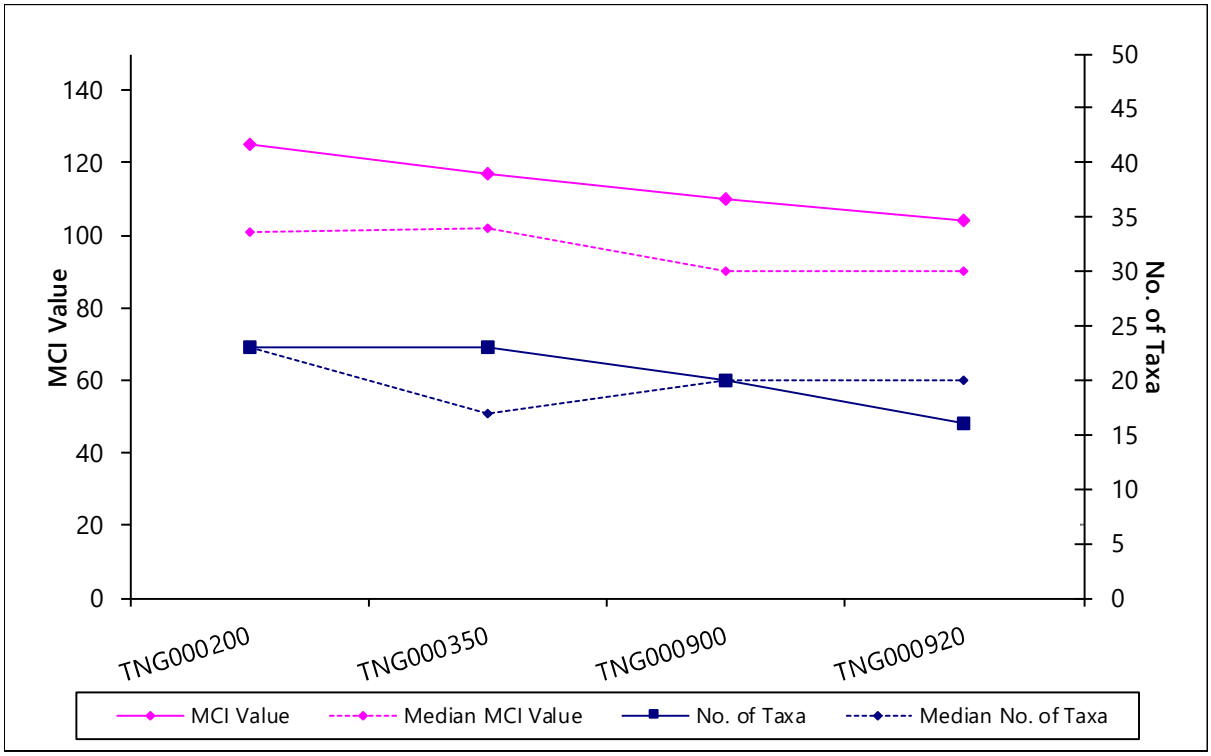

Figure 4 Numbers of macroinvertebrate taxa and MCI values recorded in the Taungatara Stream December 2017 with median MCI and median taxa numbers obtained using control sites arising in the Egmont National Park

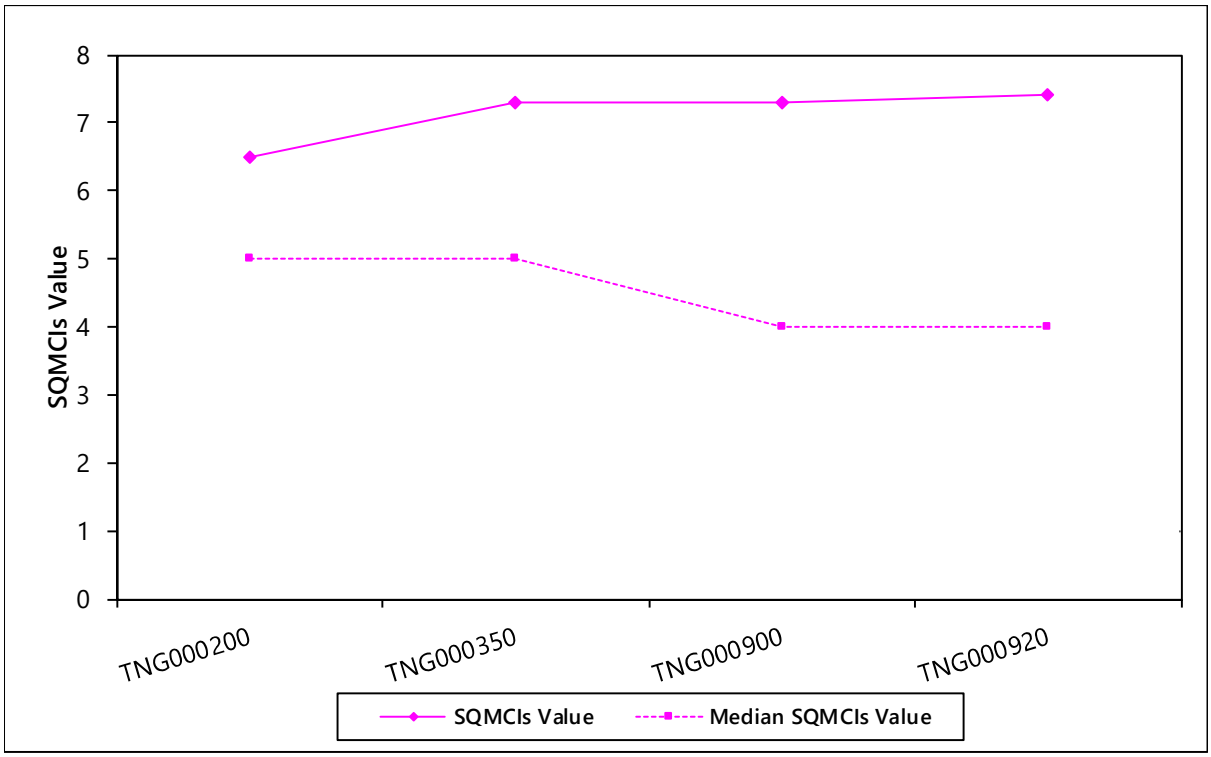

Figure 5 SQMCI$_S$ values recorded in the Taungatara Stream December 2017 with median SQMCI$_S$ values obtained using control sites arising in the Egmont National Park

MCI values recorded in the Taungatara Stream were reflective of 'good' to 'very good' macroinvertebrate health at all sites and were higher than median scores for streams at comparable altitudes (sites T1 and T3 both significantly) (Stark, 1998) (Figure 4). MCI scores generally decreased in a downstream direction, a reflection of the progressive deterioration in macroinvertebrate communities, typical of Taranaki ringplain rivers and streams. Typically MCI scores deteriorate with decreasing altitude and with distance away from the National park, in part due to natural causes for example stream gradient and temperature but also as a result of cumulative effects from dairying and industry on physicochemical water quality. Taxa richnesses were moderate in the Taungatara Stream and similar to median numbers recorded by control sites at comparable altitudes (Table 6).). All SQMCI$_s$ scores recorded in the Taungatara stream were substantially higher than the median SQMCI$_s$ scores for 'control' sites in similar streams at comparative altitudes (Figure 5). SQMCI$_s$ scores increased significantly (by 0.9 units) in a downstream direction from the upstream site to the furthermost downstream site.

MCI and SQMCI$_s$ scores from the four sites surveyed on the Taungatara Stream indicated that the overall condition of the stream was generally better than what would be expected of a ring plain stream arising in the National Park.

Discussion and conclusions

The Council's 'kick-sampling' technique was used at eight sites to collect streambed macroinvertebrates from the Cold Stream and Taungatara Stream in relation to the Cold Creek Water Supply Scheme. This has provided data to assess any potential impacts the consented water abstraction and water treatment plant discharges may have had on the macroinvertebrate communities of these streams while also providing a perspective of the overall condition of the catchment. Samples were processed to provide number of taxa (richness), MCI, and SQMCI$_S$ scores for each site.

The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence/absence of taxa with varying degrees of sensitivity to environmental conditions. The $SQMCI_S$ takes into account taxa abundances as well as sensitivity to pollution. Significant differences in either the taxa richness, MCI or the $SQMCI_S$ between sites may indicate the degree of adverse effects (if any) caused by water abstractions. The abstraction of surface water particularly for extended periods of time may result in significant adverse effects on the macroinvertebrate communities living within a waterbody by potentially reducing flow velocities, wetted habitat area, and dissolved oxygen levels and increasing stream temperature, periphyton abundance, macrophytes, pH, and deposited sediment. This December 2017 survey was undertaken to monitor whether the operation of the Cold Creek Water Supply Scheme was having an effect on the macroinvertebrate communities in the Cold Stream or Taungatara Stream downstream of the water take and discharge point under spring conditions. It was also undertaken to gain perspective on the overall catchment condition, including whether there were any impacts from the abstraction of water for pastoral irrigation downstream of SH45.

The macroinvertebrate communities recorded at the four Cold Stream sites comprised high proportions of 'sensitive' taxa and were also numerically dominated by 'sensitive' taxa. The 'highly sensitive' mayfly taxon (*Deleatidium*) was 'very abundant' or 'extremely abundant' at all four sites, and all sites except site C1 were characterised by more 'sensitive' taxa than 'tolerant' taxa. The composition of the communities at the Cold Stream sites reflected the cool, stony nature of the stream located in the upper mid-reaches of the catchment. This resulted in moderate to high taxa richnesses and MCI scores reflective of 'very good' or 'good' macroinvertebrate health at all sites. In comparison to the previous (March 2017) survey, there were generally similar abundances of 'sensitive' taxa, which resulted in similar or higher $SQMCI_s$ scores (excluding site C1 which recorded a substantially lower $SQMCI_s$ score in the current survey).

Taxa richnesses were moderate to high in the Cold Stream (22-26) and were similar to the median scores when compared to control sites at similar altitudes (Table 6). Taxa numbers were generally similar to those recorded by the previous (March 2017) survey. MCI scores at sites C1, C3 and C4 were not significantly different to medians for streams at comparable altitudes. Site C2 however recorded a MCI score significantly (Stark, 1998) higher than the median scores for streams at comparable altitudes. Site C2 also recorded a MCI score significantly higher than the predicted score based on distance from the National Park boundary. The MCI score at site C2 was significantly higher than the score at any other site in Cold Stream, while the score at site C4 was also significantly lower when compared to site C1. In comparison to the previous (March 2017) survey results, there was only one significant change in MCI score (a 12 MCI unit increase at site C2). $SQMCI_s$ scores recorded at sites C2 and C3 in Cold Stream were not substantially different to the median $SQMCI_s$ scores for 'control' sites in similar streams at comparative altitudes; whereas the $SQMCI_s$ score recorded at site C1 was substantially lower and at site C4 was significantly higher. The $SQMCI_s$ scores recorded at sites C2, C3 and C4 were not substantially different to one another, while the $SQMCI_s$ score recorded at site C1 was substantially lower than those recorded at the three downstream sites.

The macroinvertebrate communities recorded at the four Taungatara Stream sites comprised high proportions of 'sensitive' taxa and were numerically dominated by 'sensitive' taxa. The 'highly sensitive' mayfly taxon (*Deleatidium*) was 'extremely abundant' at all four sites. The composition of the communities at the Taungatara Stream sites reflected the cool, stony nature of the stream.

Taxa richnesses were moderate in the Taungatara Stream with all sites similar to medians of control sites at similar altitudes (Table 6). MCI scores were reflective of 'good' to 'very good' macroinvertebrate community health in the Taungatara Stream. MCI scores at all four sites were significantly (Stark 1998) higher than median scores for streams at comparable altitudes. There was one significant change in MCI score recorded between the current and previous survey, with the score at site T3 increasing by 14 units (Stark, 1998). All

$SQMCI_s$ scores recorded in the Taungatara stream were significantly (Stark 1998) higher than the median $SQMCI_s$ scores for 'control' sites in similar streams at comparative altitudes. $SQMCI_s$ scores increased by a significant 0.9 units in a downstream direction. In comparison to the previous (March 2017) survey $SQMCI_s$ scores remained similar at all sites except site T4 which recorded a significant increase.

MCI and $SQMCI_s$ scores from the eight sites surveyed on the Cold Stream and Taungatara Stream indicated that the overall condition of the catchment was similar to or better than what would be expected of ring plain streams arising in the National Park. Typically MCI scores deteriorate with decreasing altitude and distance away from the National park, in part due to natural causes for example stream gradient and temperature but also as a result of cumulative effects from dairying and industry on physicochemical water quality. As expected there was a significant decrease in MCI score within the catchment between site C1 (1 km below the National Park boundary) and site T4, (nearly 21 km below the National Park boundary), however the MCI rate of decline was lower than predicted (20 MCI units compared with 30 MCI units) (Stark and Fowles, 2009). Five of the eight sites surveyed recorded MCI scores significantly (Stark, 1998) higher, while none of the eight sites recorded MCI scores significantly lower than median values, from sites in similar streams at comparative altitudes. Like the previous (March 2017) survey, $SQMCI_s$ scores fluctuated between the eight sites surveyed, with the highest scoring site (C3) recording a $SQMCI_s$ score of 7.7, 2.1 units higher than the lowest scoring site (C1).

Results from the current survey indicated no major impact on the macroinvertebrate health at site T4 as a result of the water abstraction immediately upstream. The MCI scores recorded at sites T2, T3 and T4 were all reflective of 'good' macroinvertebrate health, and the MCI score recorded at site T1 was reflective of 'very good' macroinvertebrate health. The $SQMCI_s$ recorded at site T4 was significantly higher than that recorded at sites T1 and similar to sites T2 and T3.

Within this predominantly dairying catchment there was a general deterioration in macroinvertebrate health with decreasing altitude and distance from the National Park, and based on predictive values using distance from the National Park Boundary, the rate of MCI decline in a downstream direction was slightly less than that predicted. MCI scores indicated that the stream communities were in 'good' to 'very good' 'health' (TRC, 2015) and were similar to or above the biological health recorded by 'control' sites in similar streams at a comparative altitude elsewhere in the region. Overall, the results of this December 2017 survey of the Cold Stream and Taungatara Stream found no evidence that water abstraction from the Cold Stream by Cold Creek Community Water Supply Limited had had a significant effect on the freshwater macroinvertebrate communities downstream of the abstraction or discharge points, and that the overall catchment was in better than average condition.

Summary

A spring macroinvertebrate survey was performed at four established sites in the Cold Stream and four established sites in the Taungatara stream in relation to consented water abstraction and discharge by Cold Creek Community Water Supply Limited. This survey has provided data to assess the health of the macroinvertebrate communities in the Cold Stream and Taungatara Stream.

Taxa richnesses were moderate to high in the Cold Stream and Taungatara Stream and were near to or above the median richnesses recorded at 'control' sites in similar streams at comparative altitudes elsewhere in the region. The 'highly sensitive' mayfly taxon (*Deleatidium*) was 'very abundant' to 'extremely abundant' at all of the eight sites surveyed.

MCI scores at sites C2, T1, T2, T3 and T4 were significantly higher than median values recorded at similar 'control' sites. The remaining Cold Stream and Taungatara Stream sites recorded MCI scores that were either near to or above median values recorded by 'control' sites in similar streams at comparative altitudes. Site C1 recorded a MCI score significantly higher than site C4, while site C2 recorded a score significantly

higher than sites C1, C3 and C4. Site T1 recorded a MCI score significantly higher than that recorded at sites T3 and T4, and site T2 recorded a MCI score significantly higher than that recorded at site T4. MCI scores in the Taungatara Stream and Cold Stream were reflective of 'good' to 'very good' macroinvertebrate health.

$SQMCI_s$ scores recorded at sites C2, C3 and C4 in the cold stream were not substantially different to the median $SQMCI_s$ scores for 'control' sites in similar streams at comparative altitudes, while the $SQMCI_s$ score recorded at C1 was substantially lower. $SQMCI_s$ scores recorded in the Taungatara stream were all substantially higher than the median $SQMCI_s$ scores for 'control' sites in similar streams at comparative altitudes.

Within this predominantly dairying catchment there was general deterioration in macroinvertebrate health with decreasing altitude and distance from the National Park and based on predictive values using distance from the National Park Boundary, the rate of MCI decline in a downstream direction was slightly less than the predicted value when comparing the most upstream site (C1) to the furthermost downstream site (T4).

Overall, there was no evidence that water abstraction from the Cold Stream or discharge to the Cold Stream had significantly affected the freshwater macroinvertebrates of the Cold Stream or Taungatara Stream. In addition, there was no evidence that abstraction for pastoral irrigation above site T4 had impacted on the macroinvertebrate communities at site T4. Finally, based on the current survey results the overall condition of the catchment was generally similar to or better than what would be expected of ring plain streams arising in the National Park.

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To	Job Manager, Scott Cowperthwaite
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Biomonitoring of the Cold Stream and Taungatara Stream in relation to the Cold Creek Water Supply Scheme, March 2018

Introduction

Cold Creek Community Water Supply Limited holds consent to abstract water from the Cold Stream to supply the Cold Creek Water Supply Scheme. It also has consent to discharge filter backwash water and supernatant from the Cold Creek Water Treatment Plant into the Cold Stream in the Taungatara catchment. The consents relevant to this biomonitoring survey are summarised in Table 1 below:

Table 1 Summary of consents held by Cold Creek Community Water Supply Limited, which are of relevance to this biological survey

Consent no.	Purpose
1134-3	To take water from Cold Stream to supply the Cold Creek Water Supply Scheme
5454-1	To erect, place, use and maintain a water intake structure on the bed of Cold Creek in the Taungatara Catchment for water abstraction purposes
6077-1	To discharge filter backwash water and supernatant from the Cold Creek water treatment plant into the Cold Stream in the Taungatara catchment

This summer biological survey was the second of two scheduled in the Taungatara catchment for the 2017-2018 monitoring year. The intention of these surveys is to monitor the health of the macroinvertebrate communities in the Cold Stream and Taungatara Stream in relation to any effects of water abstraction by Cold Creek Community Water Supply Limited, while also to gain a perspective of the overall health of the catchment; including whether there were any impacts from the abstraction of water for pastoral irrigation downstream of SH45.

Whether this level of monitoring will continue will be reviewed following the 2017-2018 period. This was the fifth biological survey to be carried out in relation to consents held by Cold Creek Community Water Supply Limited.

Methods

This biomonitoring survey was undertaken at eight sites on 27 March 2018 (Table 2 and Figure 1). Four of the eight sites surveyed were in the Cold Stream and the remaining sites were in the Taungatara Stream (). The four sites surveyed on the Cold Stream included; a control site directly upstream of the intake weir (site C1), a primary impact site, approximately 50 metres downstream of the intake weir (site C2), a site 30 m downstream of the Cold Creek Water Supply Scheme discharge (Site C3), and a site below the intake weir and discharge point, immediately upstream of the confluence with the Taungatara Stream (site C4). The four sites surveyed in the Taungatara Stream included; a site at Wiremu Road (site T1), a site 50m downstream of Eltham Road (site T2), a site at State Highway 45 (T3) and a site approximately 500m further downstream of State Highway 45, and downstream of an abstraction point for pastoral irrigation (site T4).

Table 2 Biomonitoring sites in the Cold Stream and Taungatara Stream relating to the Cold Creek Water Supply Scheme

Stream	Site number	Site code	Location	Elevation (m asl)	Distance from source- NPk boundary (km)
Cold Stream	C1	CLD000175	Upstream of Cold Creek Water Supply scheme intake	350	1.0
	C2	CLD000177	50m downstream of Cold Creek Water Supply scheme intake	345	1.1
	C3	CLD000180	30m downstream of Cold Creek Water Supply scheme discharge	325	1.40
	C4	CLD000600	Immediately upstream of confluence with Taungatara Stream	170	6.73
Taungatara Stream	T1	TNG000200	At Wiremu Road	240	4.84
	T2	TNG000350	50m downstream of Eltham Road	120	11.50
	T3	TNG000900	At State Highway 45	20	20.52
	T4	TNG000920	Approximately 400m downstream of State Highway 45	20	20.85

The standard '400 ml kick-sampling' technique was used to collect streambed macroinvertebrates from all sites. The 'kick-sampling' technique is very similar to Protocol C1 (hard-bottomed, semi-quantitative), of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark *et al*, 2001).

Samples were preserved with Kahle's Fluid and ethanol for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using protocol P1 of NZMWG protocols for sampling macroinvertebrates in wadeable streams (Stark et al. 2001). Macroinvertebrate taxa found in each sample were recorded based on the abundance categories in Table 3.

Table 3 Macroinvertebrate abundance categories

Abundance category	Number of individuals
R (rare)	1-4
C (common)	5-19
A (abundant)	20-99
VA (very abundant)	100-499
XA (extremely abundant)	>499

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly 'sensitive' taxa were assigned the highest scores of 9 or 10, while the most 'tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience. By averaging the scores obtained from a list of taxa taken from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. More 'sensitive' communities inhabit less polluted waterways. A difference of 11 or more MCI units is considered significantly different (Stark 1998). A gradation of biological water quality conditions based upon MCI ranges which has been adapted for Taranaki streams and rivers (TRC, 2013) from Stark's classification (Stark, 1985; Boothroyd and Stark, 2000) (Table 4).

Table 4 Macroinvertebrate community health based on MCI ranges which has been adapted for Taranaki streams and rivers (TRC, 2013) from Stark's classification (Stark, 1985 and Boothroyd and Stark, 2000)

Grading	MCI
Excellent	>140
Very Good	120-140
Good	100-119
Fair	80-99
Poor	60-79
Very Poor	<60

A semi-quantitative MCI value ($SQMCI_s$) has also been calculated for the taxa present at each site by multiplying each taxon score by a loading factor (related to its abundance), totalling these products, and dividing by the sum of the loading factors (Stark 1998 and 1999). The loading factors were 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very abundant (VA) and 500 for extremely abundant (XA). Unlike the MCI, the $SQMCI_s$ is not multiplied by a scaling factor of 20, so that its corresponding range of values is 20x lower. A difference of 0.9 units or more in $SQMCI_s$ is considered significantly different (Stark, 1998).

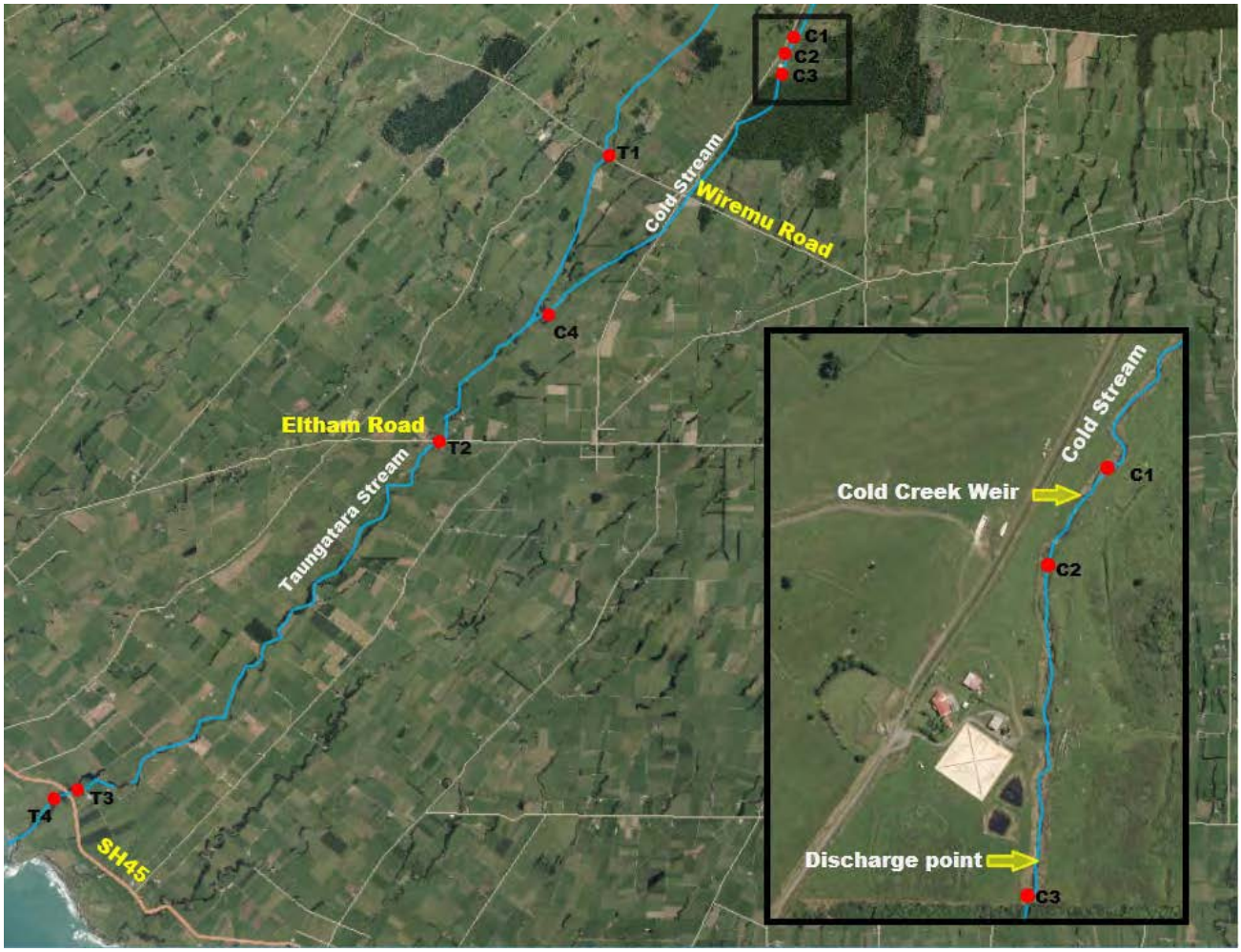

Figure 1 Biomonitoring sites related to the Cold Creek Water Supply Scheme on the Cold Stream and Taungatara Stream

Results

This March 2018 survey followed a period of 18 days since a fresh in excess of 3x median flow and 19 days since a fresh in excess of seven times median flow, as indicated by the nearby Punehu Stream flow recorder.

Water temperatures in the Cold Stream ranged between 10.4 °C and 14.6 °C. There was an uncoloured, clear, moderate and swift flow at all four sites in the Cold Stream. The substrate comprised of cobbles, gravels, boulders and sand at all sites. There were slippery periphyton mats and no filamentous periphyton at sites C1, C2 and C3, and patchy mats and patchy filaments of periphyton at site C4. There were no macrophytes recorded at any of the four sites monitored in the Cold Stream. All sites were unshaded.

Water temperatures in the Taungatara Stream ranged between 15.7 °C and 16.7 °C. There was a swift, moderate, clear and uncoloured flow at all four sites. The substrate comprised boulders, cobbles, gravels and sand at all sites. Periphyton mats were slippery at sites T1, T2 and T3 and patchy at site T4. Filamentous periphyton was absent from all four sites. There were no macrophytes recorded at any of the four sites in the Taungatara Stream. Sites T1 and T2 were unshaded while sites T3 and T4 were partially shaded.

Macroinvertebrate communities

Table 5 summarises the results of the current macroinvertebrate survey and the results from previous surveys at these sites. Table 5 also includes predicted MCI scores using an equation obtained from Stark and Fowles (2009) that examines the relationship between MCI score and distance from the Egmont National Park boundary. Comparative data for sites in similar streams are presented in Table 6. The full results from the current survey are given in Table 7 and Table 8.

Table 5 Previously recorded range of taxa richness, MCI and $SQMCI_s$ in the Cold Stream and Taungatara Stream, together with results of the current survey and predicted MCI scores for streams arising inside Egmont National Park.

Site	Number of previous surveys	Taxa Richness		MCI			$SQMCI_S$		
		Range	Current Survey	Range	Current Survey	Predicted MCI Scores*	Number of previous surveys	Range	Current Survey
C1	10	23-35	22	119-133	127	126	9	5.6-7.5	7.3
C2	10	22-35	12	118-137	138	126	9	5.3-7.4	7.3
C3	11	24-37	20	115-132	129	125	10	4.2-7.7	7.3
C4	5	21-28	23	113-125	130	117	5	5.0-7.3	6.9
T1	5	22-29	19	110-127	123	120	5	6.5-7.6	7.1
T2	5	21-27	15	111-117	113	110	5	6.4-7.3	7.6
T3	5	19-23	14	84-110	104	96	5	5.5-7.4	6.6
T4	5	16-24	17	93-104	112	96	5	5.2-7.4	6.9

*Predicted MCI scores for streams arising inside Egmont National Park using an equation that examines the relationship between MCI score and distance from Egmont National Park boundary ($MCI=127.255-1.503*D_s$) (from Stark and Fowles (2009)).

Table 6 Range and median number of taxa, MCI values and $SQMCI_s$ scores for control sites rising in the National Park at varying altitudes ((TRC, 1999 (updated 2017)).

Altitude (m asl)		No. of taxa	MCI value	$SQMCI_s$ value	Site relevant to data
0-24	No. Samples	416	416	326	T3 and T4
	Range	4-31	53-118	1.6-7.8	
	Median	20	90	4.0	
80-124	No. Samples	230	230	163	T2
	Range	2-36	50-136	1.8-7.8	
	Median	17	102	5.0	
155-199	No. Samples	439	439	336	C4
	Range	1-38	64-160	1.9-8.0	
	Median	20	108	6.0	
200-249	No. Samples	384	384	242	T1
	Range	5-37	73-148	1.6-7.7	
	Median	23	101	5.0	
300-349	No. Samples	222	222	164	C2 and C3
	Range	4-38	75-143	1.7-7.9	
	Median	23	119	7.0	
350-399	No. Samples	194	194	141	C1
	Range	8-39	100-147	3.9-8.4	
	Median	25	129	7.0	

Table 7 Macroinvertebrate fauna of the Cold Stream in relation Cold Creek Water Supply Scheme sampled on 27 March 2018

Taxa List	Site Number	MCI score	C1	C2	C3	C4
	Site Code		CLD000175	CLD000177	CLD000180	CLD000600
	Sample Number		FWB18181	FWB18182	FWB18183	FWB18184
ANNELIDA (WORMS)	Lumbricidae	5	-	-	R	-
MOLLUSCA	*Potamopyrgus*	4	R	-	R	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	-	-	-	C
	Coloburiscus	7	C	R	A	VA
	Deleatidium	8	VA	A	VA	VA
	Nesameletus	9	R	-	-	C
PLECOPTERA (STONEFLIES)	*Megaleptoperla*	9	C	C	C	R
	Stenoperla	10	R	R	R	-
	Zelandobius	5	R	-	-	R
	Zelandoperla	8	R	R	R	R
COLEOPTERA (BEETLES)	Elmidae	6	A	C	C	R
	Hydraenidae	8	R	-	R	R
	Ptilodactylidae	8	C	-	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	-	-	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	-	-	-	A
	Costachorema	7	R	R	R	R
	Hydrobiosis	5	R	-	C	R
	Neurochorema	6	R	-	-	R
	Hydropsyche (Orthopsyche)	9	C	R	C	-
	Psilochorema	6	R	-	-	R
	Beraeoptera	8	-	-	R	C
	Confluens	5	-	-	-	R
	Olinga	9	-	-	-	R
	Pycnocentria	7	C	R	R	R
	Pycnocentrodes	5	-	R	-	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	C	A	A
	Eriopterini	5	R	-	-	-
	Hexatomini	5	-	-	R	-
	Orthocladiinae	2	R	R	R	-
	Polypedilum	3	R	-	-	-
	Tanytarsini	3	-	-	R	-
	Muscidae	3	R	-	-	R
ACARINA (MITES)	Acarina	5	-	-	R	R
		No of taxa	22	12	20	23
		MCI	127	138	129	130
		SQMCIs	7.3	7.3	7.3	6.9
		EPT (taxa)	13	9	10	17
		%EPT (taxa)	59	75	50	74

'Tolerant' taxa | 'Moderately sensitive' taxa | 'Highly sensitive' taxa

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Table 8 Macroinvertebrate fauna of the Taungatara Stream in relation Cold Creek Water Supply Scheme sampled on 27 March 2018

Taxa List	Site Number	MCI score	T1	T2	T3	T4
	Site Code		TNG000200	TNG000350	TNG000900	TNG000920
	Sample Number		FWB18185	FWB18186	FWB18187	FWB18188
ANNELIDA (WORMS)	Oligochaeta	1	R	R	C	R
MOLLUSCA	*Potamopyrgus*	4	-	R	C	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C	R	-	R
	Coloburiscus	7	C	VA	C	A
	Deleatidium	8	VA	XA	VA	VA
	Nesameletus	9	A	C	R	R
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	R	-	-	-
	Zelandoperla	8	R	-	-	-
COLEOPTERA (BEETLES)	Elmidae	6	A	A	C	R
	Hydraenidae	8	R	-	-	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	C	C	C
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	A	C	A	A
	Costachorema	7	R	-	-	R
	Hydrobiosis	5	R	R	R	C
	Psilochorema	6	R	R	-	-
	Beraeoptera	8	C	-	-	-
	Olinga	9	R	R	R	-
	Pycnocentria	7	-	-	-	R
	Pycnocentrodes	5	A	A	A	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	-	-	R
	Eriopterini	5	-	C	-	-
	Orthocladiinae	2	R	R	R	C
	Polypedilum	3	-	-	R	R
	Austrosimulium	3	-	-	R	-
		No of taxa	19	15	14	17
		MCI	123	113	104	112
		SQMCIs	7.1	7.6	6.6	6.9
		EPT (taxa)	13	9	7	9
		%EPT (taxa)	68	60	50	53
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa				

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

Cold Stream

Site C1

A moderate taxa richness of 22 taxa was found at site C1, three taxa less than the median richness found at similar sites elsewhere in the region and one taxon less than that found by the previous survey (Table 5, Table 6and Table 7). This was the lowest taxa richness recorded at this site to date (Table 5). The macroinvertebrate community comprised a significant proportion of 'sensitive' taxa (82%), which was reflected by the 'very good' MCI score of 127 units. This MCI score was similar to the median MCI score (129 MCI units) for 'control' sites in similar streams at comparative altitudes and was an insignificant (Stark, 1998) three units higher than that recorded by the previous survey (Table 5). This MCI score was similar to the predicted MCI scores based on distance from the Egmont National Park boundary (MCI score 126 units) (Table 5).

The community at this site was characterised by two 'moderately sensitive' taxa [beetle (Elmidae) and cranefly (*Aphrophila*)] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 7).

The numerical dominance by two 'sensitive' taxa resulted in the $SQMCI_S$ score of 7.3 units, which was similar to the median score for 'control' sites in similar streams at this altitude and significantly higher (Stark 1998) than the previous (December 2017) survey result (by 1.7 unit) (Table 5 and Table 6).

Site C2

A low taxa richness of 12 taxa was found at site C2 (Table 5 and Table 7), 11 taxa less than the median richness found at similar sites at comparable altitudes, and ten taxa less than that recorded by the previous (December 2017) survey (Table 6). This was also the lowest taxa richness recorded at this site to date, by a substantial ten taxa (Table 5).

The macroinvertebrate community comprised a significant proportion of 'sensitive' taxa (92%), which was reflected by the 'very good' MCI score of 138 units, which is the highest MCI score recorded at this site to date (Table 5). This MCI score was significantly (Stark, 1998) higher (by 19 units) than the median MCI score for 'control' sites in similar streams at comparative altitudes (Table 4) and the (by 12 units) predicted MCI scores based on distance from the Egmont National Park boundary (MCI score 126 units) (Table 5). It was only one unit higher than the MCI score recorded by the previous survey, but was the highest MCI score recorded at this site to date (Table 5).

The community at this site was characterised by only one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 7).

The numerical dominance by several 'sensitive' taxa was tempered by the abundance of two 'tolerant' taxa, resulting in the $SQMCI_S$ score of 7.3 units, which was slightly higher (by 0.3 unit) than the median score for 'control' sites in streams at comparable altitudes (Table 4). This $SQMCI_S$ score was also slightly higher (by 0.2 unit) than that recorded by the previous survey (Table 5).

Site C3

A moderate taxa richness of 20 taxa was found at site C3 (Table 5 and Table 7), three taxa less than the median richness found at similar sites elsewhere in the region (Table 6), and six taxa less than that recorded by the previous (December 2017) survey. This taxa richness was the lowest recorded at this site to date (Table 5). The macroinvertebrate community was again comprised of a higher proportion of 'sensitive' taxa (85%), which was reflected by the 'very good' MCI score of 129 units. This score was a non-significant (Stark, 1998) ten units higher than the median MCI score for 'control' sites in similar streams at comparative altitudes (Table 6) and an insignificant 4 units higher than the predicted MCI scores based on distance from

the Egmont National Park boundary (MCI score 125 units) (Table 5). This score was a non-significant (Stark, 1998) seven units higher than that recorded by the previous survey.

This community was characterised by three taxa in total, two 'moderately sensitive' taxa [mayfly (*Coloburiscus*) and cranefly (*Aphrophila*)] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 7).

The numerical dominance by 'sensitive' taxa resulted in the $SQMCI_S$ score of 7.3 units, which was equal to the highest score recorded to date at this site. This $SQMCI_S$ score was higher (by 0.3 unit) than the median score for 'control' sites in streams at comparable altitudes but slightly lower (by 0.4 unit) than that recorded by the previous survey (Table 5 and Table 6).

Site C4

A moderate taxa richness of 23 taxa was found at site C4 (Table 5 and Table 7), three taxa more than the median richness found at similar sites elsewhere in the region (Table 6). The macroinvertebrate community again comprised a significant proportion of 'sensitive' taxa (91%), which was reflected by the 'very good' MCI score of 130 units. This was the highest MCI score recorded at this site to date, and was a significant (Stark, 1998) 22 units higher than the median MCI score for 'control' sites in similar streams at comparative altitudes (Table 6). The score was also significantly higher than the predicted MCI scores based on distance from the Egmont National Park boundary (MCI score 117 units) and the score recorded in the preceding survey (Table 5).

The community at this site was characterised by one 'tolerant' taxon [caddisfly (*Hydropsyche* – formerly *Aoteapsyche*)], three 'moderately sensitive' taxa [mayfly (*Coloburiscus*), stony cased caddis (*Pycnocentrodes*) and cranefly (*Aphrophila*)] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 7).

The numerical dominance by several 'sensitive' taxa was tempered by the dominance of one 'tolerant' taxon which resulted in the $SQMCI_S$ score of 6.9 units, which was a significant 0.9 units higher than the median score for 'control' sites in similar streams at this altitude (Table 6). This score was a non-significant 0.4 units lower than the previous survey result (which was the highest result recorded at this site to date).

Catchment Overview- Cold Stream

MCI values and taxa richnesses for the Cold Stream are presented together with median values for similar streams at comparative altitudes in Figure 2. $SQMCI_S$ scores and median values for similar streams at comparative altitudes are presented in Figure 3.

MCI values recorded in the Cold Stream were reflective of 'very good' macroinvertebrate health at all four sites. At sites C1, C2 and C3 MCI scores were not significantly different to median scores for streams at comparable altitudes (Figure 2). Site C4 however recorded MCI scores significantly (Stark, 1998) higher than the median for streams at a comparable altitude (by 29 units). There was a three unit increase in MCI score between sites C1 and C4, which while atypical of the usual progressive deterioration in macroinvertebrate communities recorded in a downstream direction in Taranaki ringplain rivers and streams, does not represent a significant change. Typically MCI scores deteriorate with decreasing altitude and with increasing distance away from the National park, in part due to natural causes for example stream gradient and temperature but also as a as a result of cumulative effects from dairying and industry on physicochemical water quality.

Taxa richnesses were moderate to moderately low in the Cold Stream and either similar to, or in the case of site C2, substantially lower than median scores when compared to control sites at similar altitudes (Figure 2). The richness at site C2 was substantially lower than any other site in the Cold Stream. It is of note that sites C1, C2 and C3 recorded their lowest taxa richnesses to date in the current survey, which was substantially lower than any previous result at site C2.

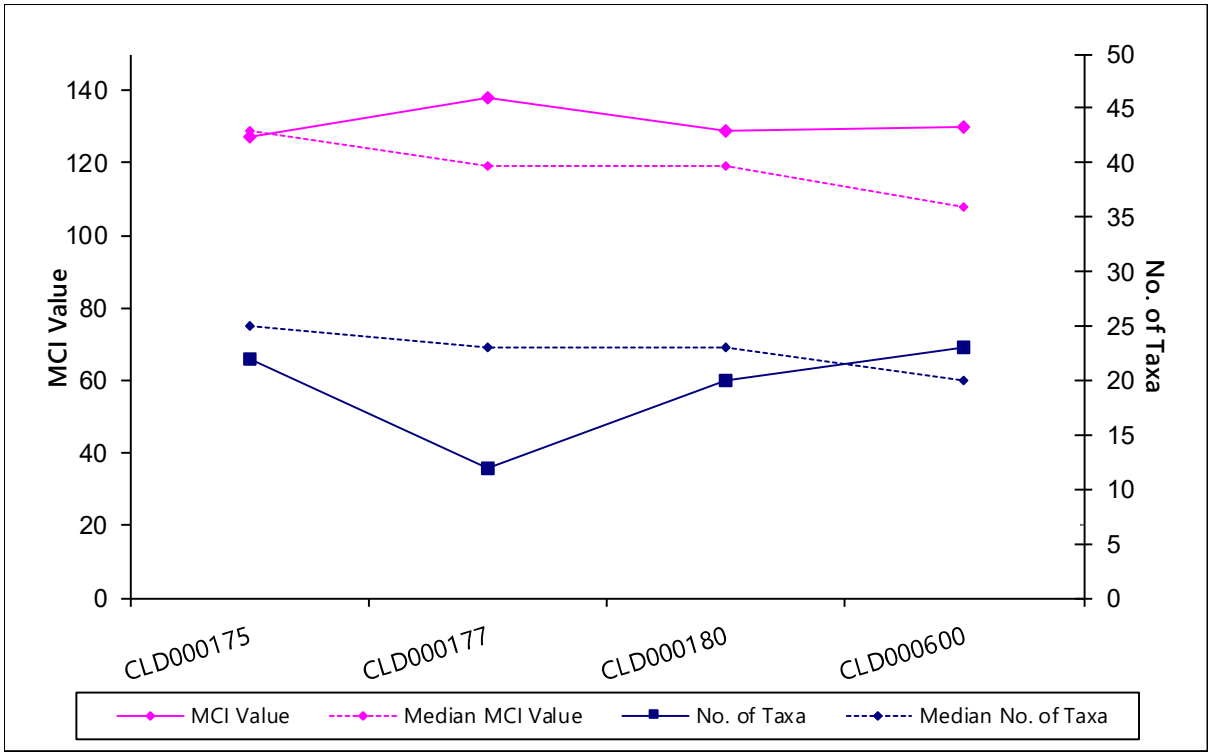

Figure 2 Numbers of macroinvertebrate taxa and MCI values recorded in the Cold Stream, March 2018, with median MCI and median taxa numbers obtained using control sites arising in the Egmont National Park

$SQMCI_s$ scores recorded in the Cold Stream were not substantially different to the median $SQMCI_s$ scores for 'control' sites in similar streams at comparative altitudes at sites C1, C2 and C3; however, the $SQMCI_s$ score recorded at site C2 was significantly higher than that recorded by the control sites (Figure 3). There was no significant change in $SQMCI_S$ between any of the four sites.

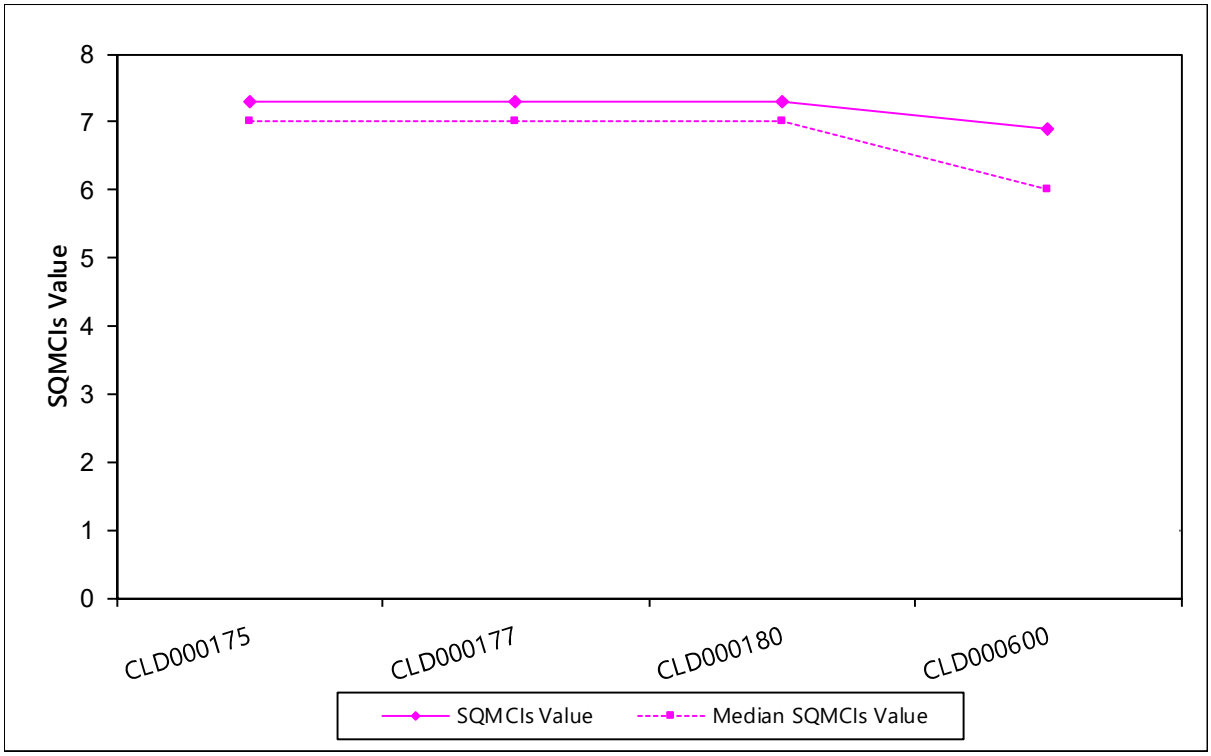

Figure 3 SQMCI$_S$ values recorded in the Cold Stream, March 2018, with median SQMCI$_S$ values obtained using control sites arising in the Egmont National Park

Taungatara Stream

Site T1

A moderate taxa richness of 19 taxa was recorded at site T1 (Table 5 and Table 8), four taxa less than both the median richness found at similar sites elsewhere in the region and that recorded by the previous survey (Table 5 and Table 8). This was the lowest taxa richness recorded at this site to date (Table 5). The macroinvertebrate community comprised a significant proportion of 'sensitive' taxa (84%), which was reflected by the 'very good' MCI score of 123 units. This MCI score was lower than the previous survey result (by only 2 units) but significantly higher than the median MCI score (by 22 units) for 'control' sites in similar streams at comparative altitudes (Table 5 and Table 6). This MCI score was slightly higher (by 3 units) than the predicted MCI scores based on distance from the Egmont National Park boundary (MCI score 120 units) (Table 5).

The community at this site was characterised by one 'tolerant' taxon [caddisfly (*Hydropsyche*, - formerly *Aoteapsyche*)] two 'moderately sensitive' taxa [elmid beetles and stony cased caddis (*Pycnocentrodes*)], and two 'highly sensitive' taxa [mayflies (*Deleatidium*) and (*Nesamelatus*)] (Table 8).

The numerical dominance by 'sensitive' taxa resulted in the SQMCI$_S$ score of 7.1 units, which was significantly higher (by 2.1 units) than the median score for 'control' sites in similar streams at this altitude and slightly higher (by 0.6 unit) than the previous score (Table 6).

Site T2

A moderate taxa richness of 15 taxa was found at site T2 (Table 5 and Table 8). This was eight taxa less than that recorded by the previous survey and two taxa less than the median richness found at similar sites (Table 6). This was the lowest taxa richness recorded at this site to date (Table 5). The macroinvertebrate community comprised a significant proportion of 'sensitive' taxa (73%), which was reflected by the 'good'

MCI score of 113 units. This MCI score was an insignificant four units less than that recorded by the previous survey and was a significant (Stark 1998) 11 units higher than the median MCI score for 'control' sites in similar streams at comparative altitudes (Table 6). The score was also higher (by 5 units) than the predicted MCI scores based on distance from the Egmont National Park boundary (MCI score 110 units) (Table 5).

The community at this site was characterised by three 'moderately sensitive' taxa [elmid beetles, mayfly (*Coloburiscus*) and stony cased caddisfly (*Pycnocentrodes*)] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 8).

The numerical dominance by several 'sensitive' taxa resulted in the $SQMCI_S$ score of 7.6 units, which was significantly higher (by 2.6 units) than the median score for 'control' sites in similar streams at this altitude (Table 6). This score was higher than the previous score by 0.3 unit and was the highest $SQMCI_S$ score recorded at this site to date (Table 5).

Site T3

A moderate taxa richness of 14 taxa was found at site T3 (Table 5 and Table 8). This was six taxa less than both the median richness found at comparable sites elsewhere in the region (Table 6) and the previous survey. This was the lowest taxa richness recorded at this site to date (Table 5). The macroinvertebrate community comprised a moderate proportion of 'sensitive' taxa (57%), which was reflected by the 'good' MCI score of 104 units. This score was higher (by a significant 14 MCI units) than the median MCI score for 'control' sites in similar streams at comparative altitudes (Table 6). This MCI score was a non-significant (Stark, 1998) six units less than that recorded by the previous and eight units higher than the predicted MCI scores based on distance from the National Park boundary (Table 5).

The community at this site was characterised by one 'tolerant' taxon [caddisfly (*Hydropsyche* – formerly *Aoteapsyche*)] one 'moderately sensitive' taxon [stony cased caddisfly (*Pynconcentrodes*)], and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 8).

The numerical dominance by several 'sensitive' taxa resulted in the $SQMCI_S$ score of 6.6 units, which was substantially higher (by 2.6 units) than the median score for 'control' sites in similar streams at this altitude (Table 6). This score was lower (by 0.7 unit) than that recorded by the previous survey.

Site T4

A moderate taxa richness of 17 taxa was found at site T4 (Table 5 and Table 8). This was similar to the median richness found at comparable sites elsewhere in the region (20 taxa) and the previous survey result (16 taxa) (Table 6). The macroinvertebrate community comprised a moderate proportion of 'sensitive' taxa (71%), which was reflected by the 'good' MCI score of 112 units. This score was significantly higher (by 22 MCI units) than the median MCI score for 'control' sites in similar streams at comparative altitudes (Table 6), and higher than the predicted MCI scores based on distance from the Egmont National Park boundary (MCI score 96 units) (Table 5). This MCI score was was slightly higher than the previous result of 102 MCI units and was the highest MCI score recorded at this site to date (Table 5 and Table 8).

The community at this site was characterised by one 'tolerant' taxon [caddisfly (*Hydropysche* – formerly *Aoteapsyche*)], one 'moderately sensitive' taxon [mayfly (*Coloburiscus*)] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 8).

The numerical dominance of the 'highly sensitive' taxon *Deleatidium* was tempered by three 'tolerant' taxa and resulted in the $SQMCI_S$ score of 6.9 units, which was significantly higher (by 2.9 units) than the median score for 'control' sites in similar streams at this altitude (Table 6). It was a non-significant 0.5 unit lower than that recorded by the previous survey (Table 5).

Catchment overview- Taungatara Stream

MCI values and taxa richnesses for the Taungatara Stream are presented together with median values for similar streams at comparative altitudes in Figure 4. $SQMCI_S$ scores and median values for similar streams at comparative altitudes are presented in Figure 5.

MCI values recorded in the Taungatara Stream were reflective of 'good' to 'very good' macroinvertebrate health and were significantly higher than median scores for streams at comparable altitudes at all sites (Stark, 1998) (Figure 4). MCI scores generally decreased in a downstream direction, although a slight increase was noted at site T4. This is a reflection of the progressive deterioration in macroinvertebrate communities, typical of Taranaki ringplain rivers and streams. Typically MCI scores deteriorate with decreasing altitude and with distance away from the National park, in part due to natural causes for example stream gradient and temperature but also as a as a result of cumulative effects from dairying and industry on physicochemical water quality. Taxa richnesses were moderate in the Taungatara Stream and were generally similar to median numbers recorded by control sites at comparable altitudes (Figure 4). It is of note that sites T1, T2 and T3 recorded their lowest taxa richnesses to date, by between three and six taxa.

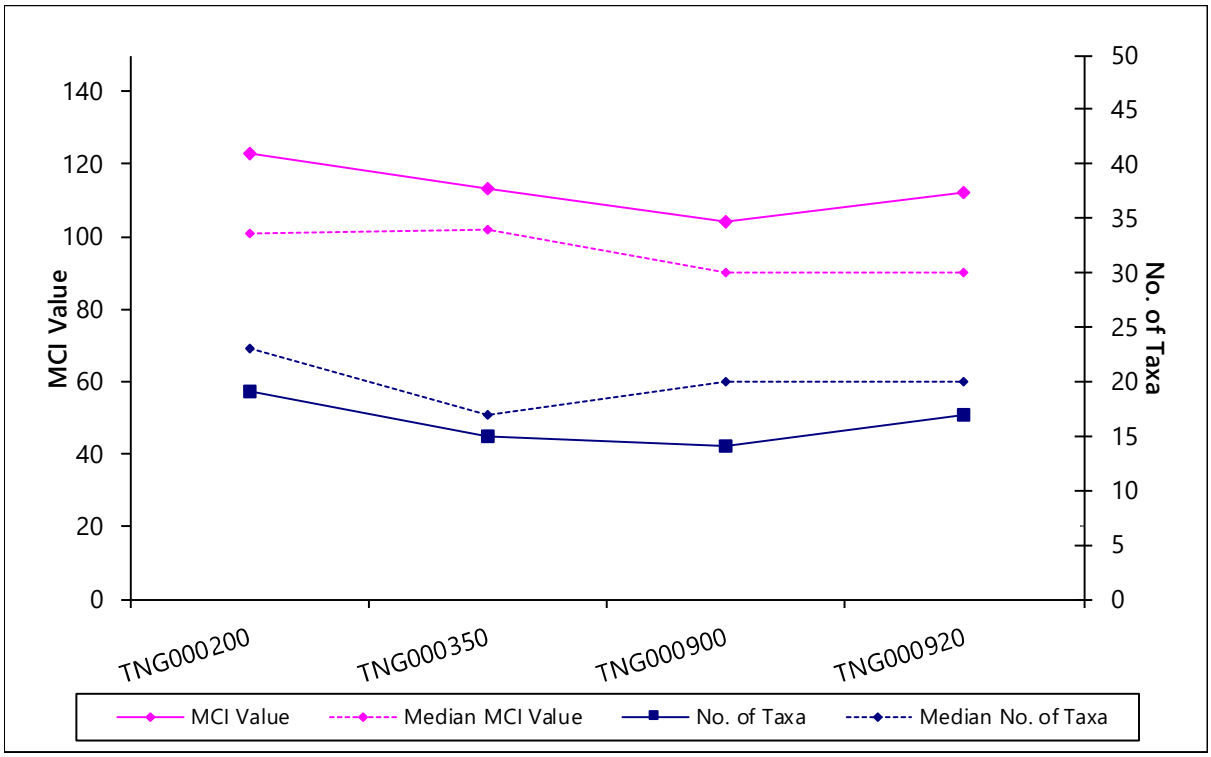

Figure 4 Numbers of macroinvertebrate taxa and MCI values recorded in the Taungatara Stream, March 2018, with median MCI and median taxa numbers obtained using control sites arising in the Egmont National Park

All $SQMCI_S$ scores recorded in the Taungatara stream were substantially higher than the median $SQMCI_S$ scores for 'control' sites in similar streams at comparative altitudes (Figure 5). There was a significant decrease in $SQMCI_S$ scores between sites T2 and T3, which was the only significant differences in $SQMCI_S$ scores between sites.

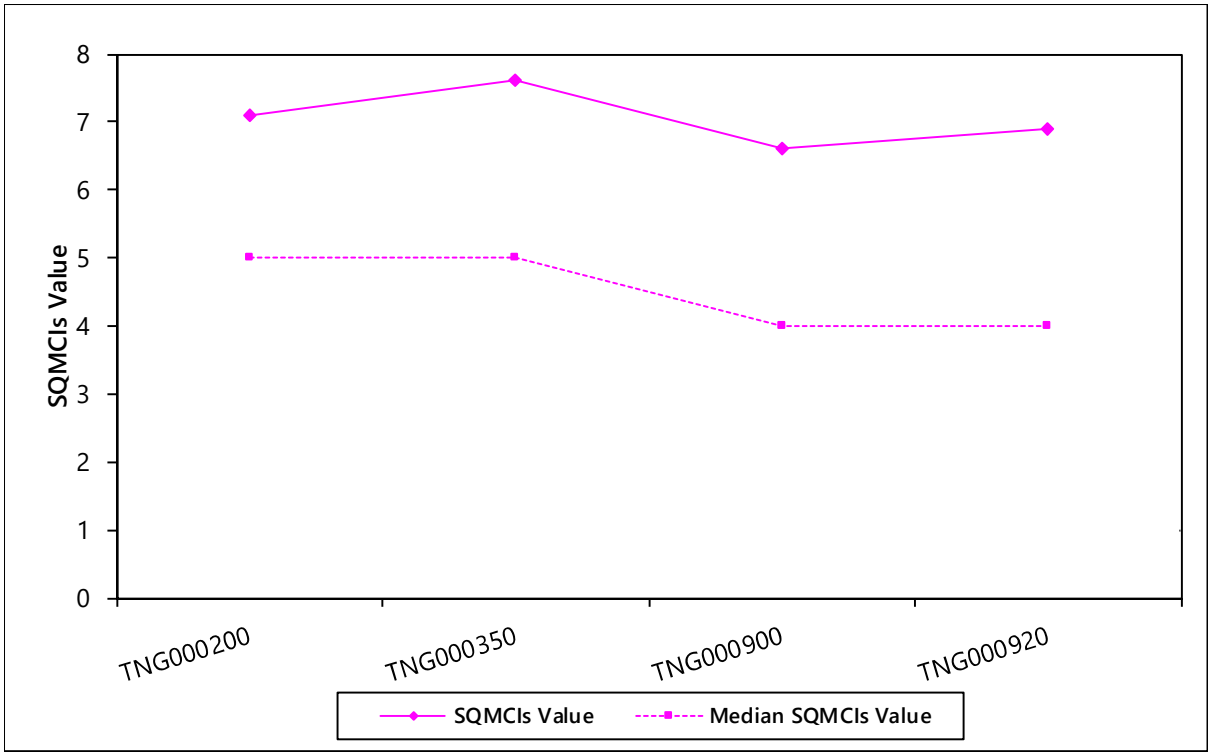

Figure 5 SQMCI$_S$ values recorded in the Taungatara Stream, March 2018, with median SQMCI$_S$ values obtained using control sites arising in the Egmont National Park

Discussion and conclusions

The Council's 'kick-sampling' technique was used at eight sites to collect streambed macroinvertebrates from the Cold Stream and Taungatara Stream in relation to the Cold Creek Water Supply Scheme. This has provided data to assess any potential impacts the consented water abstraction and water treatment plant discharges may have had on the macroinvertebrate communities of these streams while also providing a perspective of the overall condition of the catchment. Samples were processed to provide number of taxa (richness), MCI, and SQMCI$_S$ scores for each site.

The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence/absence of taxa with varying degrees of sensitivity to environmental conditions. The SQMCI$_S$ takes into account taxa abundances as well as sensitivity to pollution. Significant differences in either the taxa richness, MCI or the SQMCI$_S$ between sites may indicate the degree of adverse effects (if any) caused by water abstractions. The abstraction of surface water particularly for extended periods of time may result in significant adverse effects on the macroinvertebrate communities living within a waterbody by potentially reducing flow velocities, wetted habitat area, and dissolved oxygen levels and increasing stream temperature, periphyton abundance, macrophytes, pH, and deposited sediment. This March 2018 survey was undertaken to monitor whether the operation of the Cold Creek Water Supply Scheme was having an effect on the macroinvertebrate communities in the Cold Stream or Taungatara Stream downstream of the water take and discharge point under summer conditions. It was also undertaken to gain perspective on the overall catchment condition, including whether there were any impacts from the abstraction of water for pastoral irrigation downstream of SH45.

The macroinvertebrate communities recorded at the four Cold Stream sites comprised high proportions of 'sensitive' taxa and were numerically dominated by 'sensitive' taxa. The 'highly sensitive' mayfly taxon (*Deleatidium*) was 'abundant' or 'very abundant' at all four sites, and all four sites were characterised by more 'sensitive' taxa than 'tolerant' taxa. The composition of the communities at the Cold Stream sites

reflected the cool, stony nature of the stream located in the upper mid-reaches of the catchment. This resulted in MCI scores reflective of 'very good' macroinvertebrate health at all sites. In comparison to the previous survey, there were generally similar abundances of 'sensitive' taxa, which resulted in similar or higher $SQMCI_s$ scores.

Taxa richnesses were moderately low to moderate in the Cold Stream (12-23 taxa), and were low in comparison to previous results at these sites, with sites C1, C2 and C3 recording their lowest taxa richnesses to date. The richnesses were similar to median scores for control sites at similar altitude and the richnesses recorded in the preceding survey, with the exception of site C2.

MCI scores at sites C1 and C3 were not significantly different to medians for streams at comparable altitudes, while site C2 and C4 recorded a MCI score significantly (Stark, 1998) higher than the median scores for streams at comparable altitudes. Sites C2 and C4 also recorded a MCI score significantly higher than the predicted score based on distance from the National Park boundary. The MCI score at site C2 was the highest MCI score recorded at this site to date, and was significantly higher than the score at site C1, which was the only significant difference in MCI score between sites in Cold Stream. In comparison to the previous survey results, there was only one significant change in MCI score (a 17 MCI unit increase at site C4). $SQMCI_s$ scores recorded at sites C2 and C3 in Cold Stream were not substantially different to the median $SQMCI_s$ scores for 'control' sites in similar streams at comparative altitudes and there were no significant differences between sites. The scores were similar to those recorded in the previous survey, with the exception of site C1 which showed a significant increase.

The macroinvertebrate communities recorded at the four Taungatara Stream sites comprised moderate to high proportions of 'sensitive' taxa and were numerically dominated by 'sensitive' taxa. The 'highly sensitive' mayfly taxon (*Deleatidium*) was 'very abundant' or 'extremely abundant' at all four sites. The composition of the communities at the Taungatara Stream sites reflected the cool, stony nature of the stream.

Taxa richnesses were moderate in the Taungatara Stream, and as was the case in the Cold Stream, richnesses were low in comparison to previous results at these sites. Sites T1, T2 and T3 recorded their lowest richnesses to date in this survey. The richnesses were slightly lower than medians at all sites when compared to control sites at similar altitudes (Table 6).

MCI scores were reflective of 'good' to 'very good' macroinvertebrate community health in the Taungatara Stream. MCI scores at all four sites were significantly (Stark 1998) higher than median scores for streams at comparable altitudes. There were no significant changes in MCI score recorded between the current and previous survey. All $SQMCI_s$ scores recorded in the Taungatara stream were significantly (Stark 1998) higher than the median $SQMCI_s$ scores for 'control' sites in similar streams at comparative altitudes. $SQMCI_s$ scores ranged between 7.6 and 6.6 units, with a significant decrease between sites T2 and T3 and no other significant differences between sites. In comparison to the previous survey $SQMCI_s$ scores remained similar at all sites.

MCI and $SQMCI_s$ scores from the eight sites surveyed on the Cold Stream and Taungatara Stream indicated that the overall condition of the catchment was similar to or better than what would be expected of ring plain streams arising in the National Park. Typically MCI scores deteriorate with decreasing altitude and distance away from the National park, in part due to natural causes for example stream gradient and temperature but also as a as a result of cumulative effects from dairying and industry on physicochemical water quality. As expected there was a significant decrease in MCI score within the catchment between site C1 (1 km below the National Park boundary) and site T4, (nearly 21 km below the National Park boundary), however the MCI rate of decline was lower than predicted (15 MCI units compared with 30 MCI units) (Stark and Fowles, 2009). Six of the eight sites surveyed recorded MCI scores significantly (Stark, 1998) higher, while none of the eight sites recorded MCI scores significantly lower than median values, for sites in similar streams at comparative altitudes. Sites C2, C4 and T4 recorded their highest MCI scores to date. $SQMCI_s$

scores fluctuated between the eight sites surveyed, with the highest scoring site (T2) recording a $SQMCI_s$ score of 7.6, 1.0 unit higher than the lowest scoring site (T3).

Results from the current survey indicated no major impact on the macroinvertebrate health at site T4 as a result of the water abstraction immediately upstream. The MCI scores recorded at sites T2, T3 and T4 were all reflective of 'good' macroinvertebrate health, and the MCI score recorded at site T1 was reflective of 'very good' macroinvertebrate health. The $SQMCI_s$ recorded at site T4 was similar all other sites in the Taungatara Stream.

The taxa richnesses recorded in this survey were lower than has generally been recorded at these sites. Six of the eight sites in this survey recorded their lowest taxa richnesses to date, with a substantial decrease of ten taxa at site C2 since the previous survey (which also recorded the lowest score to date at site C2, by only two taxa). It is not uncommon to record high MCI scores in conjunction with low taxa richnesses, as is the case in this survey. This is due to the way the MCI score is calculated, meaning that when fewer taxa are present, each taxon has a greater influence on the overall MCI score.

Within this predominantly dairying catchment there was a general deterioration in macroinvertebrate health with decreasing altitude and distance from the National Park, and based on predictive values using distance from the National Park Boundary, the rate of MCI decline in a downstream direction was slightly less than that predicted. MCI scores indicated that the stream communities were of 'good' to 'very good' 'health' (TRC, 2015) and were similar to or above the biological health recorded by 'control' sites in similar streams at a comparative altitude elsewhere in the region. Overall, the results of this March 2018 survey of the Cold Stream and Taungatara Stream found no evidence that water abstraction from the Cold Stream by Cold Creek Community Water Supply Limited had had a significant effect on the freshwater macroinvertebrate communities downstream of the abstraction or discharge points. The overall catchment was in better than average condition, despite the lower than usual taxonomic richnesses recorded.

Summary

A summer macroinvertebrate survey was performed at four established sites in the Cold Stream and four established sites in the Taungatara stream in relation to consented water abstraction and discharge by Cold Creek Community Water Supply Limited. This survey has provided data to assess the health of the macroinvertebrate communities in the Cold Stream and Taungatara Stream.

Taxa richnesses were moderately low to moderate in the Cold Stream and Taungatara Stream and were generally similar to the median richnesses recorded at 'control' sites in similar streams at comparative altitudes elsewhere in the region. Despite this, taxa richnesses were lower than usual for these sites and six of the eight sites recorded their lowest taxa richnesses to date. The 'highly sensitive' mayfly taxon (*Deleatidium*) was 'abundant' to 'extremely abundant' at all of the eight sites surveyed.

MCI scores at sites C2, C4, T1, T2, T3 and T4 were significantly higher than median values recorded by 'control' sites. The remaining Cold Stream sites recorded MCI scores that were either near to or above median values recorded by 'control' sites in similar streams at comparative altitudes. Site C2 recorded a score significantly higher than sites C1. Site T1 recorded a MCI score significantly higher than that recorded at sites T3 and T4. MCI scores in the Taungatara Stream and Cold Stream were reflective of 'good' to 'very good' macroinvertebrate health.

$SQMCI_s$ scores recorded at site C4 in the cold stream were not substantially different to the median $SQMCI_s$ scores for 'control' sites in similar streams at comparative altitudes, while the $SQMCI_s$ scores at the remaining sites were similar to median scores. $SQMCI_s$ scores recorded in the Taungatara stream were all substantially higher than the median $SQMCI_s$ scores for 'control' sites in similar streams at comparative altitudes.

Within this predominantly dairying catchment there was general deterioration in macroinvertebrate health with decreasing altitude and distance from the National Park and based on predictive values using distance from the National Park Boundary, the rate of MCI decline in a downstream direction was less than the predicted value when comparing the most upstream site (C1) to the furthermost downstream site (T4).

Overall, there was no evidence that water abstraction from the Cold Stream or discharge to the Cold Stream had significantly affected the freshwater macroinvertebrates of the Cold Stream or Taungatara Stream. In addition, there was no evidence that abstraction for pastoral irrigation above site T4 had impacted on the macroinvertebrate communities at site T4. Finally, based on the current survey results the overall condition of the catchment was generally similar to or better than what would be expected of ring plain streams arising in the National Park.

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